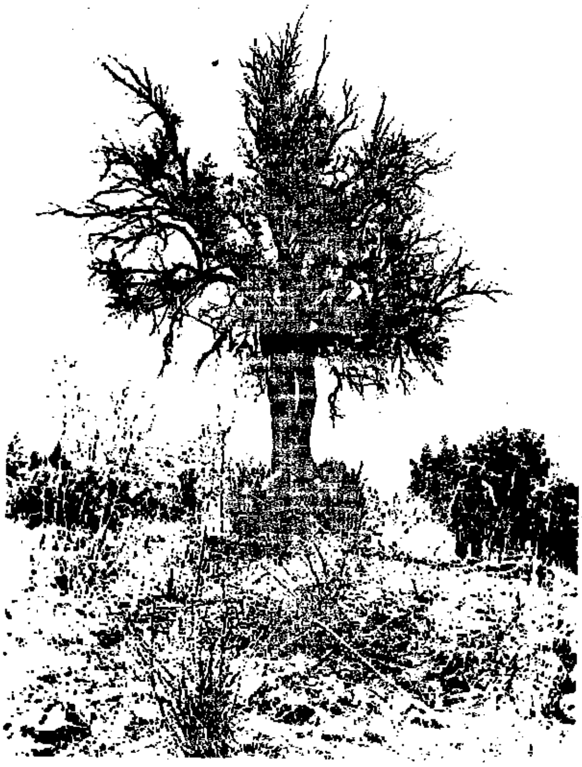
A Case Study of Water Resources Planning in Cyprus
A Test of the MIT Simulation Model



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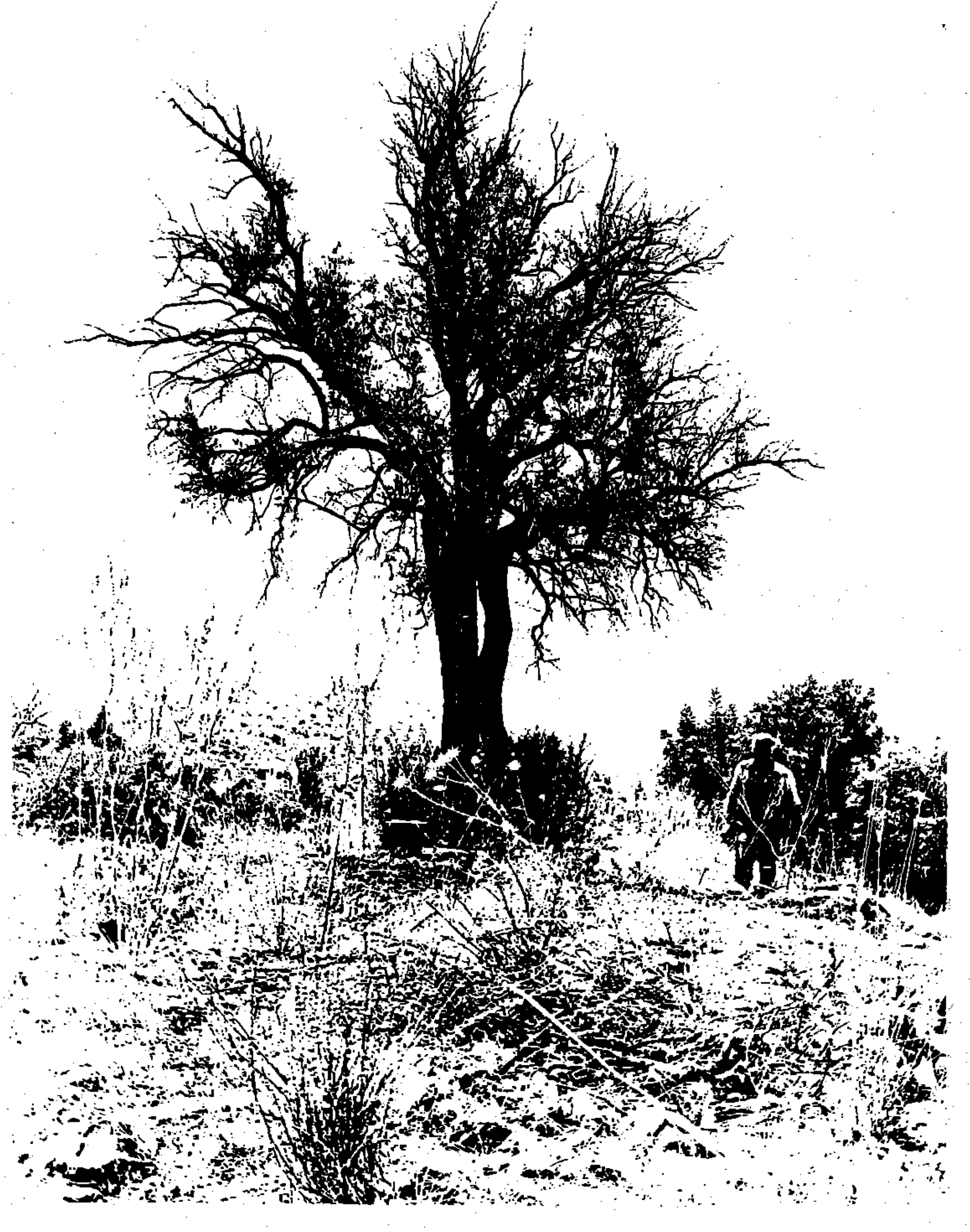

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Examensarbete 1981:4 Göteborg 1982

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Foreword

This disploma work is the result of personal interest and work of some people.

Dr. Lars Bergström came up with the idea to have diploma works done at Cyprus and managed to get money from the Board of Education at Civil Engineering and from the Project Group for Education Development Work. Mr. Bergström also organized the trip to Cyprus.

Mr. J. Jacovides at the Water Development Department in Nicosia gave us a very interesting problem to study. His personal interest and great knowledge was of unvaluable help.

The students themselves became so interested in the problem that they worked more than half a semester that is normally required for a diploma work.

It has not been possible to have a linguistic check of the English text and I ask the reader to overlook with linguistic mistakes.

Göteborg in October 1982

Steffen Häggström

Steffen Häggström
Tutor

Acknowledgement

This report is the result of an examination work at Chalmers University of Technology, Department of Hydraulics.

The aim of the work is to study the applicability of a run-off simulation model, called MITSIM, for water resources planning at Cyprus. MITSIM is developed at Massachusetts Institute of Technology U.S.A., by R.L. Lenton, K.M. Strzepek and others. The simulation is done for a water resource project, Vasilikos-Pendaskinos Project, in Cyprus.

Grateful thanks to our tutor Mr. S. Häggström, who gave us many valuable advices and great help and to Mr. L. Bergström, who created the idea of an examination work at Cyprus and organized the trip to Cyprus.

Thanks to Mr. J. Jacovides at Department of Water Development in Cyprus, who gave us reports (with data to MITSIM), information and showed us the project area in Cyprus and to Mr. R.M. Strzepek, who introduced us to MITSIM.

The authors are also grateful to Miss H. Melin and Mr. H.Strandner, who helped us with data routines, and to Mr. G. Lindvall, who set right our English and to Mrs. A-M Holmdahl, who typed this report.

Mats Franzon   Stefan Karlsson   Benny Robertsson   Bengt Rogsäter

CONTENTS

SUMMARY

This report treats the usefullness of a simulation model called MITSIM for water resources planning at Cyprus. MITSIM simulates the runoff from a river basin including for example the effects of dams, irrigations and domestic supplies. With MITSIM one can receive both economic and hydrologic results.

In this study MITSIM is applied on three river basins, Vasilikos, Pendaskinos and Maroni in Cyprus.

The project includes two new dams, several irrigation areas and domestic water supplies. The most interesting objects to study by simulation are the dams and the irrigation systems. The simulations indicate that the most profitable dam sizes are:

- o The dam at Vasilikos 14.5 Million cubic metres (MCM)
- o The dam at Pendaskinos 20.0 MCM

The optimal size of the irrigation area at Vasilikos is 670 ha.

The Water Development Department (W.D.D.) at Cyprus made simulations with an other model.

The most profitable dam sizes according to W.D.D.:s simulations are:

- o The dam at Vasilikos 17 MCM
- o The dam at Pendaskinos 15 MCM

And the optimal size of the irrigation area is 830 (Ha).

The present study indicates that MITSIM can be very useful at an early stage in waterresources planning. But more detailed simulations can be necessary by using other simulation models.

1. INTRODUCTION

The study reported here was initiated by Chalmers University of Technology (CTH) in order to give the students some international experience. For Swedish contractors it will be more and more necessary to have these experiences, because of the expanding international market.

Cyprus turned out to be a good starting ground to get international experience. There were no language problems and the Cyprus government was most helpful and easy to cooperate with.

Cyprus has a semi-arid climate and therefore water resources planning is very important. To increase the use of water the Vasilikos-Pendaskinos project is planned.

In this report a water resources simulation model, called MITSIM, is applied on the Vasilikos-Pendaskinos project.

This model is also used in a research project at the Department Hydraulics (CTH). It is therefore of great interest for the Department to test the model on other conditions.

MITSIM can also be an alternative to other simulation models which are used today by the Water Development Department (W.D.D.) at Cyprus.

2. CYPRUS

Geography

Cyprus is the third largest Mediterranean island. The area of the island is 9248 km^2 and the population 700.000. The largest cities are Nicosia (capital), Famagusta and Limassol. The main languages in Cyprus are greek and turkish.

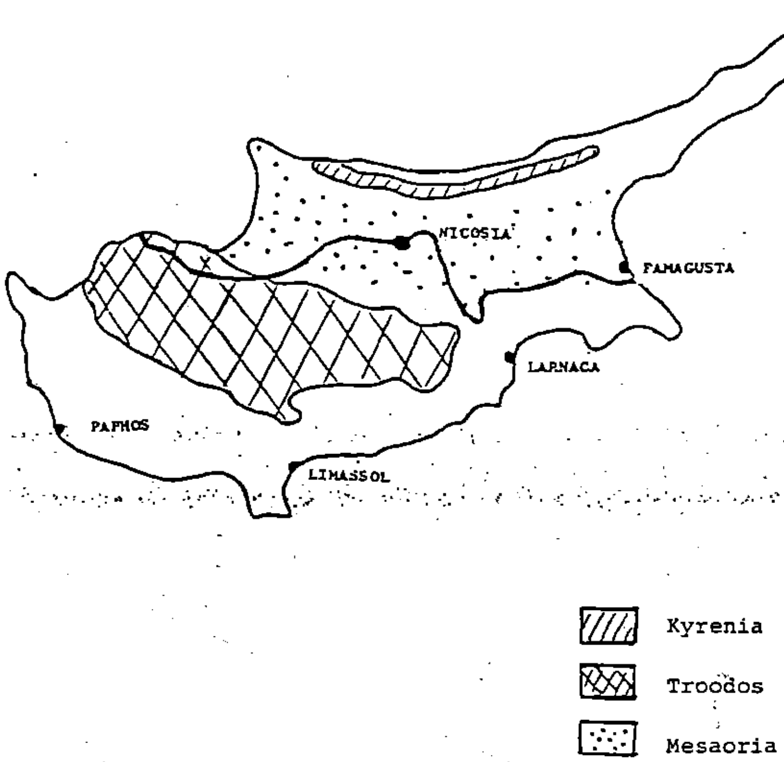


Figure 2.1 Cyprus

Geology

The two dominant features of the island are the foled Kyrenia Mountains in the north and the imposing Troodos Massit in the south. A flat lowland, open to the sea at the east and the west, known as the Mesoria Plain, lies between the two ranges.

The Kyrenia range is a narrow fold of limestone with occasional deposits of marble. It has a maximum height of just over 900 m.

The Troodos range is mainly igneous rock, impervious to water, but it has a thicker soil and a covering of pine, dwarf oak, cypress and cedar forests. The highest point is 1951 m.

The Mesaoria Plain, which spans the island from Morphon Bay in the west to Famagusta Bay in the east, is about 80 miles long and 15 to 30 miles wide.

Between autumn and spring the landscape is green and colourful with an abundance of wild flowers, flowering bushes, and shrubs, and there are also patches of woodland in which eucalyptus and many types of acacia, cypress and lowland pine predominate.

Climate

Cyprus has a pleasant Mediterranean-type climate in general, but the heat on the central plain in high summer is notorious. Rainfall averages between 350 mm on the plain and 1010 mm in the mountains, occurring between October and March.

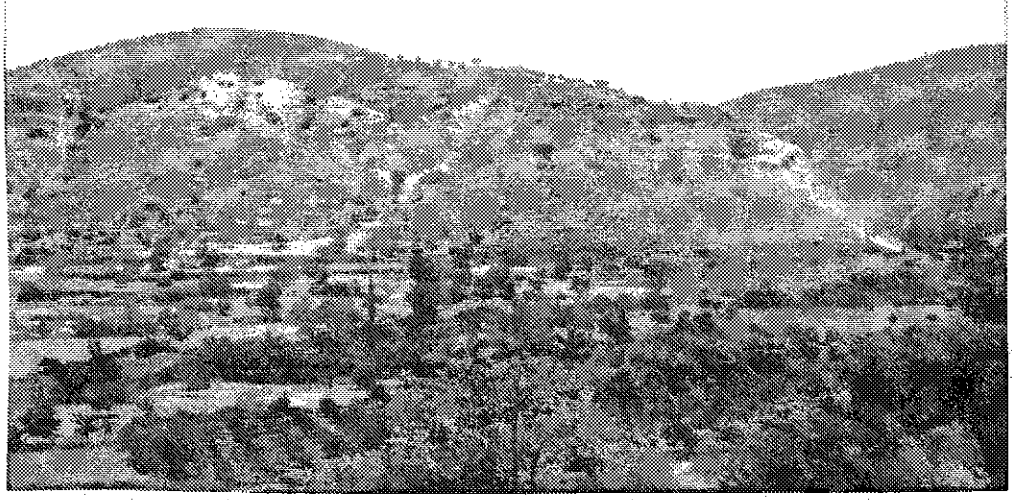


Figure 2.2 A typical view from Cyprus

There are no permanently flowing rivers, although the island is criss-crossed by dry river valleys which become fast flowing torrents during periods of heavy rainfall.

Economy

Agriculture

The main supply to the Cyprus economy comes from agriculture. It is also the most important source of exports earning. The main exports include citrus fruits, potatoes, carrots, carobs, table grapes, tobacco, raisins, early vegetables and melons. Animal husbandry is also important.

Local production of pork, poultry meat, and eggs satisfy local demand, but beaf, veal, and mutton have to be supplemented by imports. Agriculture also provides a raw material base for several manufacturing industries including wines and spirits, canned fruits, dairy products and wool products.

The present policy is to increase agricultural production, by land reclamation, intensive cultivation, extension of the irrigated area, and the promotion of mixed farming economy. Heavy investments are being made in conservation of water.

Industry

The main industries are food processing, and production of beverages, clothing, and footwear production. Other industries of the same size are printing, furniture making, metal production, bricks, tiles,and cement manufacturing. Tourism makes also a valuable and increasing contribution to the Cyprus economy.

Summary

Cyprus is an island which is very dependent on agriculture. The great problem is the absence of rainfall and the high temperature in the summer. Therefore the Cypriote people have to store as much water as they possibly can in the rainy periods, for use in the summer. Dams need to be built, and modern irrigation methods have to be used with great skill.

As in many other countries farmers are moving from the country side into the cities. One of the reasons to invest in agriculture is to manage this social problem.

3. THE VASILIKOS-PENDASKINOS PROJECT

Background

Before 1940, irrigation was mainly practiced in Cyprus through surface diversion mostly during floods in the winter.

In the beginning of the 1950´s a considerable expansion of the groundwater resources was achieved through the use of drilling machines.

The irrigated area was doubled since the middle of the 1940´s to the middle of the 1960´s.

The percentage of agricultural exports to the total exports from Cyprus has increased from 23% in 1956 to 54% in 1972. This increase of agricultural exports shows that agriculture now plays the most important role in the export trade of Cyprus.

The Project Area

The project area is located in the Larnaca District, between the Larnaca and Limassol cities. It includes all coastal land between Pendaskinos and Vasilikos rivers south of the main Nicosia-Limassol road.

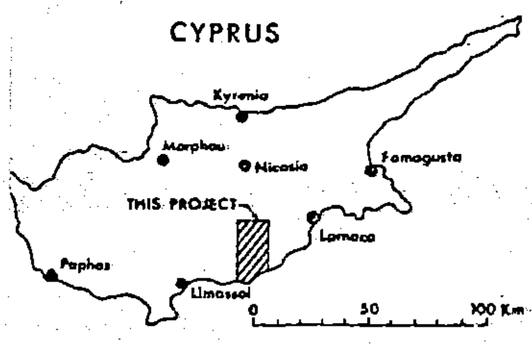


Figure 3.1 The project area

Today most of the agriculture is done by dryfarming. Of Vasilikos´ 830 ha cultivated area, only 25 ha are irrigated. These 25 ha are cultivated with citrusfruits. According to the plans (of the project) the irrigated area will be 830 ha. 412 ha will be cultivated with citrus and 157 ha with vines and the remaining 261 ha will be cultivated with vegetables.

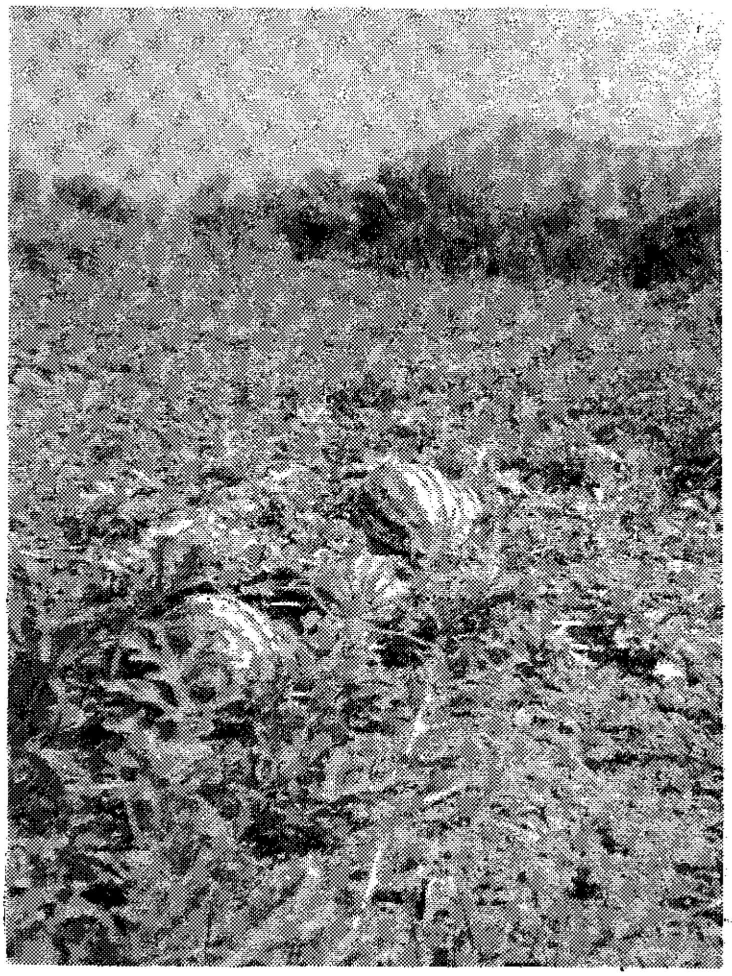


Figure 3.2 Irrigated melons in the Pendaskinos valley

Some of the reasons to form a new waterplan for the Vasilikos-Pendaskinos area were to increase agricultural export and to fulfill the policy to give jobs to as many people as possible in the countryside.

To increase the agricultural production, irrigation systems must be developed. The water supply to Nicosia will also increase. To meet the increased demand of water, two new dams are planned in the region. One in the river Pendaskinos and one in the river Vasilikos.

In September 1972 a waterscheme was prepared by the W.D.D. to cover the future demand of irrigation and water supply to Nicosia. In this scheme the supply of water to the cities of Nicosia, Larnaca and Famagusta have priority to the demand of irrigation water.

Irrigation Methods

The irrigation methods which will be used are as follows:

1) Sprinkler irrigation method

This method of irrigation is suitable for all the crops considered in the project. However, a great deal of water is lossed by evaporation and also to the ground.

2) Trickle irrigation method

This is the most effective method. The water is delivered in small pipes which are furnished with small holes.

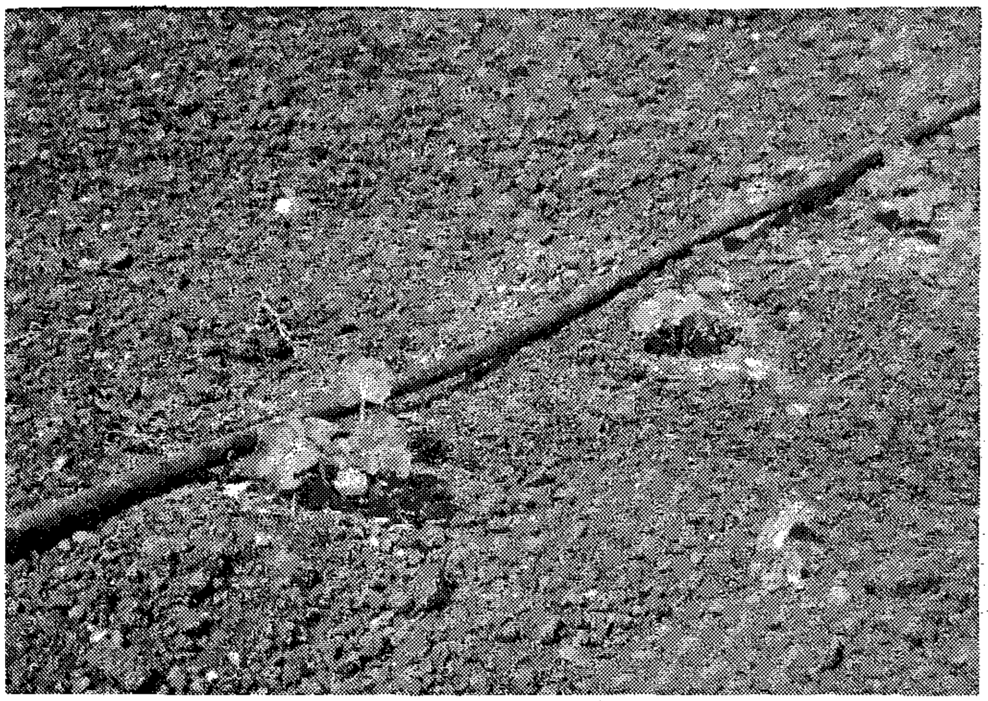


Figure 3.3 Trickle irrigation method.
A white ring is observed around the plant which is salt from fertilizers.

3) Furrow irrigation method

The water is delivered through furrows in the ground.

Existing Water Resources

The water resources of the region come from both the river runoff and groundwater.

The rivers in the region are:

- o Vasilikos river
- o Maroni river
- o Pendaskinos river

The groundwater resources in the region are:

- o Vasilikos subsurface dam
- o Groundwater extraction from alluvial sandstone and chalk aquifers.

The utilization of water resources in the future is as shown in figure 3.4.

The Vasilikos-Pendaskinos project is planned to satisfy the irrigation and domestic water demands until 1990. At that time the Southern Conveyor Project may be in operation. This is a project which is to convey surface flows from western waters heads to the eastern areas. More information about the project can be found in appendix A.

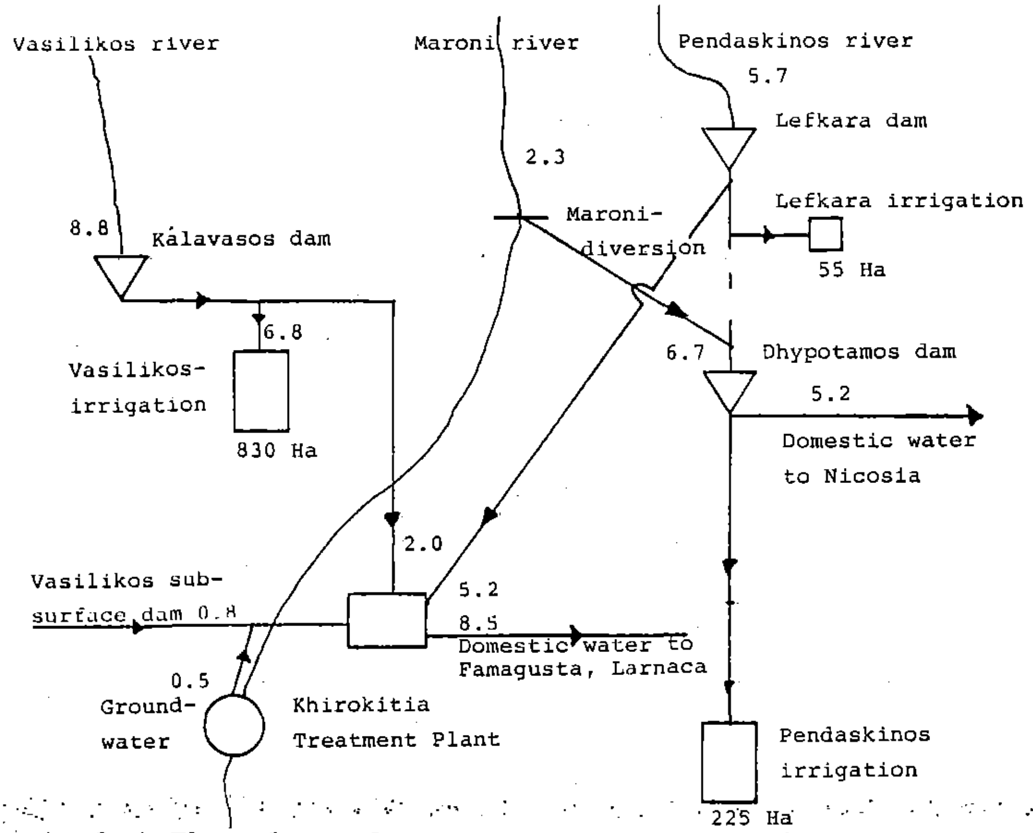


Figure 3.4 The planned water distribution (figures in MCM/year)

4. THE SIMULATION MODEL MITSIM

4.1 Introduction

MITSIM has been developed at Massachusetts Institute of Technology (MIT) during the last decade. Experience from practical applications has continuously modified the model. The MITSIM-model used in this study, MITSIM-1, was developed as a part of UNDP-sponsored study of the Vardar/Axios river basin in Yugoslavia and Greece. This version is suited for planning purposes where detailed institutional or operating rules for water management are not necessary.

The latest version of the MIT simulation model, MITSIM-2, was developed at IIASA in cooperation with MIT and is an extension of MITSIM-1. MITSIM-2 is intended to be used in analyses of existing systems with more detailed operating rules. The model has been applied on a case study in southern Sweden to show the usefulness when analyzing regional water resources systems.

4.2 General Survey of MITSIM

MITSIM is a simulation model for evaluating the hydrologic and economic consequences of various plans for surface water development of a river basin.

MITSIM principally consists of three parts, a hydrologic, a statistic and an economic part. Input to the model consists of economic and hydrologic data for the different physical components as well as hydrologic data for the basin as monthly mean streamflows. The output gives information of hydrology, statistics and economics on both individual components and on the project as a whole.

In order to simulate the hydrological behaviour of a river basin the river must be schematized. MITSIM uses a network of nodes and arcs. These nodes represent irrigation areas, reservoirs, power plants or diversions. They can also indicate points of water inflow to the basin, demands for specific use or places in the river of special interest. The nodes are linked together with arcs which represent natural or man-made connections between different parts of the basin. These arcs have no other task than transferring water from one node o another.

The nodes are listed in table 4.1 and a more detailed description is given in appendix B. In the following chapter the Vasilikos-Pendaskinor project is schematized into nodes and arcs.

Table 4.1 Nodes represented in MITSIM

Symbol	Representing	Hydrologic characteristics
○	Start or inflow	Inflow to the river basin as monthly mean values for the whole simulation period.
△,▲	Reservoir	Storage is calculated. Downstream monthly release values are given as input. Evaporation from reservoir can be taken into account. Can have two downstream discharges of which one has priority.
⇧,⬆	Reservoir and hydroelectric plant	Powerplant where the rate of power production can be calculated.
□,■	Irrigation area	Target demand and possible precipitation for each month are input. Fixed for all simulation years.
⬡,⬢	Municipal and Industrial water use (M&I)	Monthly target demands are input. Some amount of water can return to the river.
⋈	Diversion	Diverts water to another tributary or to another part of the basin. Desired diversions and downstream minimum realeases for each month are input. Downstream release has priority.
◇	Low flow node	Used only for registering simulated flows.
•	Confluence	Adds two flows together.
⟐	Groundwater	The amount of water to be pumped each month is input.
∘	Terminalnode	Represent(s) the end point(s) of the system, which usually are outlets to the sea.

□ Proposed

■ Existing

4.3 Hydrologic Calculations

In the hydrologic part the model traces the flows through the computeradapted river system (Fig. 4.1). It uses a time step of one month. First the model introduces flows at all start nodes. The inflow to each node is the outflow from the preceding one. The special operations within each node are carried out. The whole system is carried through for one month before the process is repeated for the following months. The water is allocated to the users in an upstream-downstream order.

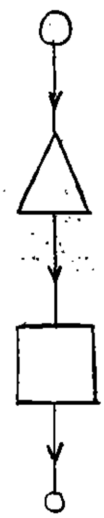


Figure 4.1 The way of calculating the model follows for each month

Concerning the hydrologic output one can receive inflow to each node for the whole simulation period in form of hydrographs (figure 4.2).

A useful possibility to check the functioning of the system with the given input is the output called "Idebug". This is the part of the output in which the inflows to and the outflows from each node every month throughout the first year of simulation are listed. Any errors in the water flows can easily be discovered here. An example and explanations of "Idebug" can be found in appendix D.

HYDROGRAPHS (M**3/SEC)

	KALDAM	DIV 1	VASIRRCI	END 2	DIV 6	DIV 4	END 7	DHYP.DAM	PENIRRCI	PENIRRVE
YEAR 1										
	0.11	0.11	0.05	0.0	0.0	0.11	0.0	0.08	0.00	0.00
	0.28	0.07	0.04	0.0	0.0	0.06	0.0	0.16	0.00	0.00
	0.46	0.05	0.02	0.0	0.08	0.08	0.0	0.49	0.01	0.01
	0.22	0.08	0.06	0.00	0.02	0.04	0.0	0.20	0.03	0.02
	0.07	0.31	0.28	0.00	0.01	0.02	0.0	0.10	0.10	0.03
	0.0	0.47	0.40	0.0	0.01	0.0	0.0	0.04	0.13	0.04
	0.0	0.53	0.45	0.00	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.56	0.47	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.44	0.35	0.0	0.0	0.0	0.0	0.00	0.0	0.0
	0.63	0.31	0.22	0.0	0.0	0.0	0.0	0.00	0.04	0.0
	0.04	0.07	0.0	0.0	0.0	0.0	0.0	0.01	0.03	0.01
	0.07	0.07	0.0	0.0	0.0	0.08	0.0	0.13	0.00	0.00
AVERAGE	0.11	0.26	0.20	0.00	0.01	0.03	0.0	0.10	0.05	0.02
YEAR 2										
	0.09	0.09	0.03	0.0	0.0	0.08	0.0	0.16	0.00	0.00
	0.41	0.07	0.04	0.0	0.06	0.14	0.0	0.71	0.00	0.00
	0.41	0.05	0.02	0.0	0.08	0.08	0.0	0.50	0.01	0.01
	0.18	0.08	0.06	0.00	0.07	0.04	0.0	0.24	0.03	0.02
	0.09	0.31	0.28	0.00	0.03	0.02	0.0	0.14	0.08	0.02
	0.0	0.47	0.40	0.0	0.01	0.0	0.0	0.06	0.10	0.00
	0.0	0.11	0.03	0.00	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.00	0.0
	0.06	0.06	0.0	0.0	0.18	0.11	0.0	0.83	0.00	0.00
AVERAGE	0.10	0.10	0.07	0.00	0.04	0.04	0.0	0.23	0.04	0.01
YEAR 3										
	0.63	0.11	0.05	0.0	0.26	0.16	0.0	0.66	0.08	0.08
	1.08	0.07	0.04	0.0	0.36	0.14	0.0	0.75	0.48	0.48
	0.76	0.05	0.02	0.0	0.26	0.08	0.0	0.64	0.06	0.06
	0.37	0.08	0.06	0.00	0.11	0.04	0.0	0.28	0.18	0.17
	0.15	0.31	0.28	0.00	0.06	0.02	0.0	0.14	0.07	0.01
	0.0	0.47	0.40	0.0	0.03	0.0	0.0	0.06	0.16	0.00
	0.0	0.53	0.45	0.00	0.00	0.0	0.0	0.02	0.15	0.04
	0.0	0.56	0.47	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.44	0.35	0.0	0.0	0.0	0.0	0.01	0.11	0.03
	0.0	0.31	0.22	0.0	0.0	0.0	0.0	0.01	0.02	0.0
	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0
	0.35	0.17	0.06	0.0	0.00	0.11	0.0	0.19	0.01	0.01
AVERAGE	0.28	0.26	0.20	0.00	0.09	0.05	0.0	0.23	0.12	0.08
YEAR 4										
	0.13	0.11	0.05	0.0	0.0	0.12	0.0	0.24	0.02	0.02

Figure 4.2 Hydrographs

4.4 Statistical Treatment

The results from the hydrologic calculations are used to determine the performance of the different nodes in the system.

Examples of statistical output data:

- The annual and monthly "reliability" of water use nodes. This term describes the frequency with which the supply reaches the demand target. When this is not the case the reliability is zero.

- Monthly and annual mean diversions to water use nodes
- Monthly and annual mean deficits for water use nodes
- Monthly and annual mean storages with standard deviations and coefficient of variations (reservoir-node)
- Histograms of diversion, storage and flow for irrigation-, reservoir- and lowflow nodes respectively

```
PERFORMANCE EVALUATION FOR IRRIGATION AREA:  VASIRRCI
=========================================

GENERAL CHARACTERISTICS:
========================

MAXIMUM POTENTIAL AREA.......... =     412.00   HA
TARGET AREA..................... =     412.00   HA
APPLICATION EFFICIENCY.......... =     100.00   %
RETURN FLOW COEF................ =       0.0    %
= RETURN TO STREAM.............. =       0.0    %
= PERCOLATION TO GROUNDWATER.... =       0.0    %

MONTHLY USE PARAMETERS:
=======================

PARAMETER                  JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  YEAR=
DIVERSION TARGET (MCM)     ***************  0.1  0.5  0.7  0.8  0.8  0.6  0.3  0.1*****  3.9

PERFORMANCE RESULTS
===================

INDEX                      JAN     FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC  YEAR

RELIABILITY=               96.*****     96.  96.  95.  93.  89.  84.  80.  78.  71.  76.  69.
MEAN DIVERSION             0.0*****     0.0  0.1  0.4  0.6  0.7  0.7  0.5  0.3  0.1  0.0  3.4
STANDARD DEV               0.0*****     0.0  0.0  0.1  0.2  0.2  0.3  0.2  0.1  0.1  0.0  1.1
COEF OF VAR                0.0*****     0.8  0.2  0.2  0.3  0.3  0.4  0.5  0.5  0.6  0.6  0.3

NOTES
=====
=  % TIMES TARGET DEMAND MET

MONTHLY HISTOGRAM OF IRRIGATION DIVERSIONS
==========================================

DIVERSION RANGE(MCM)       PROPORTION OF TIMES WITHIN RANGE
FROM         TO            JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC

0.0          0.08          1.00 1.00 1.00 0.04 0.04 0.05 0.09 0.15 0.20 0.20 0.29 1.00
0.08         0.16          0.0  0.0  0.0  0.96 0.0  0.02 0.0  0.0  0.0  0.0  0.71 0.0
0.16         0.25          0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.02 0.0  0.0
0.25         0.33          0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.33         0.41          0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.78 0.0  0.0

 - - - - - - - - - - - - - - - - - - - - -

0.41         0.49          0.0  0.0  0.0  0.0  0.96 0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.49         0.57          0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.57         0.65          0.0  0.0  0.0  0.0  0.0  0.0  0.02 0.02 0.80 0.0  0.0  0.0
0.65         0.74          0.0  0.0  0.0  0.0  0.0  0.93 0.0  0.0  0.0  0.0  0.0  0.0
0.74         0.82          0.0  0.0  0.0  0.0  0.0  0.0  0.89 0.84 0.0  0.0  0.0  0.0
0.82***********            0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

Figure 4.3 Computer printout for irrigation areas

4.5 Economic Calculations

Economic calculations are made only for reservoirs, irrigation areas, M&I supply, groundwater and diversion structures. These nodes require economic data. From these the model calculates:

- System costs; i.e. capital costs and operation, maintenance and repairment (OMR) costs.

- Long term benefits; i.e. the benefits that would occur over the planning period if there where no water deficits. These benefits are independent of the simulation and depend only on the design of the system.

- Short term losses; i.e. the economic losses that would occur when the available water does not meet the target demand. First the mean annual loss is computed and then it is discounted over the planning period.

Often benefits from one project are linked with costs from another. MITSIM therefore is designed to allow allocation of costs and benefits between supply and demand nodes. An example of this is shown in figure 4.4.

The economic output can be received from the whole project area, different regions and/or from each node. The desired output is to be specified in the input. An example of a basin wide output is shown below in figure 4.5.

BENEFIT AND COST ANALYSIS FOR RESERVOIR: KALDAM

ACTIVE STORAGE.................... = 15.90 MCM
CREST ELEVATION................... = 176.50 M
CAPITAL COSTS..................... = 2079.00 N
OMR COSTS......................... = 67.89 N
TOTAL COSTS....................... = 2146.89 A

ALLOCATION OF RESERVOIR COSTS

NAME	TYPE	% COSTS ATTRIBUTED	COSTS ATTRIBUTED
		%	N
KHTRECON	MUN+IND	23.	489.49
VASIRRCI	IRGATION	45.	959.66
VASIRRVE	IRGATION	24.	513.11
VASIRRVI	IRGATION	9.	184.63
TOTAL			2146.89

A. IRRIGATION BENEFITS:

NAME	REMAINING BENEFITS	BENEFIT ALLOCATION FACTOR	RESERVOIR ASSIGNED REMAINING BENEFITS	RESERVOIR ALLOCATED BENEFITS
	N		N	N
VASIRRVE	1432.37	0.0	0.0	513.11
VASIRRVI	226.32	0.0	0.0	184.63
VASIRRCI	1205.66	0.0	0.0	959.66
TOTAL	2864.35	0.0	0.0	******

C. BENEFITS FROM WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE:

NAME	REMAINING BENEFITS	BENEFIT ALLOCATION FACTOR	RESERVOIR ASSIGNED REMAINING BENEFITS	RESERVOIR ALLOCATED BENEFITS
	N		N	N
KHTRECON	2536.69	0.0	0.0	489.49
TOTAL	2536.69	0.0	0.0	489.49

TOTAL BENEFITS.................... = 2146.89 N

TOTAL NET BENEFITS................ = -0.00 N
BENEFIT-COST RATIO................ = 1.00 N

Figure 4.4 Sample of economic output for reservoir node

BASIN-WIDE BENEFIT AND COST INFORMATION FOR: SYS WIDE

NOTE! ALL BENEFITS AND COSTS ARE PRESENT VALUE
ALL COSTS INCLUDE BOTH CAPITAL AND OMR COMPONENTS

1. IRRIGATION AREAS

NAME	TARGET AREA	POTENTIAL BENEFITS=	SHORTFALL== LOSSES	ACTUAL+ BENEFITS	% POT BENEFITS	IRRIGATION EMPLOYMENT GENERATED	IRRIGATION COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO	INTERNAL RATE OF RETURN
	HA	£	£	£	%	PPL/YR	£	£	£	£	%
VASIRRCI	412.	4008.77	1453.15	2555.63	64.	301.	392.30	1351.96	1203.66	1.89	1.5
VASIRRVE	261.	3155.82	962.17	2193.65	70.	149.	248.18	761.28	1432.37	2.88	1.5
VASIRRVI	157.	758.32	197.37	560.95	74.	71.	147.99	332.62	228.32	1.69	1.5
S.LO.IRR	86.	411.68	91.07	320.62	78.	49.	51.56	51.56	269.05	6.22	1.5
MARI IRR	48.	360.41	98.17	262.25	73.	27.	88.37	88.37	173.87	2.97	1.5
TOKNTIRR	42.	0.0	0.0	0.0	0.	24.	0.0	0.0	0.0	0.0	******
LEF IRR	55.	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0	0.0	******
PENIRRCI	150.	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0	0.0	******
PENIRRVE	75.	859.97	620.05	239.92	28.	57.	223.61	705.19	-465.26	0.34	1.5
TOTAL	1286.	9554.97	3421.97	6133.00	64.	678.	******	3290.99	2842.01	1.86	

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

2. HYDROELECTRIC POWER GENERATION

NAME	INSTALLED CAPACITY	ENERGY BENEFITS	CAPACITY BENEFITS	SHORTFALL LOSSES==	TOTAL BENEFITS+	PLANT COSTS	TOTAL= COSTS++	NET BENEFITS	B-C RATIO	INTERNAL RATE OF RETURN
	MW	£	£	£	£	£	£	£	£	%

NO HYDROPLANTS IN THIS SYSTEM

3. WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE

NAME	TARGET DEMAND	POTENTIAL= BENEFITS	SHORTAGE== LOSSES	ACTUAL+ BENEFITS	% POTENTIAL BENEFITS	M & I COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	MCM/YR	£	£	£	%	£	£	£	-
UPS.USE1	0.09	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
UPS.USE2	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
UPS.USE3	0.02	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
KHIRFCON	0.06	3872.65	846.46	3026.19	78.	0.0	489.49	2536.69	6.18
KHCHFCK2	0.09	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
NICOSIA	0.16	10068.87	193.12	9875.75	98.	0.0	3817.40	6058.35	2.59
KHCHFCK1	0.16	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
KHTROKTI	0.25	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
DFEL.COM	0.01	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
TOTAL	0.85	13941.52	1039.58	12901.94	93.	0.0	4306.89	8595.04	3.00

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

4. FLOOD CONTROL & RECREATION

LOCATION	TOTAL BENEFITS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	£	£	£	-

NO FLOOD CONTROL OR RECREATION LOCATIONS

SUMMARY OF COSTS AND BENEFITS FOR: SYS WIDE
================================

TOTAL COSTS.................... = 7597.88 £
TOTAL BENEFITS................. = 19034.93 £
TOTAL NET BENEFITS............. = 11437.05 £
TOTAL BENEFIT/COST RATIO....... = 2.51 £
TOTAL IRRIGATION EMPLOYMENT.... = 678. PPL/YR

Figure 4.5 Economic output for basinwide

5. MITSIM APPLIED TO THE VASILIKOS-PENDASKINOS PROJECT

5.1 Simulation Model

The Vasilikos-Pendaskinos project includes three rivers, Vasilikos, Maroni and Pendaskinos river. There will be some drastic changes when developing the project. These are

1. Two dams in the Pendaskinos and the Vasilikos rivers

2. A diversion from the Maroni river to the Pendaskinos river

3. Irrigation systems in all three watersheds

4. Water supply systems for the cities of Nicosia, Larnaca and Famagusta

The water resources will be shared between all irrigation areas and domestic water supplies, both existing and proposed. However, the water resources are very limited and the project must be as economic as possible. The optimum size of each construction is therefore determined by looking at the maximum net benefits for the project. The different hydraulic structures influence each other. Thus a change in one construction affects the design of the others. Looking for the maximum net benefits is a very complex problem and a simulation model can be useful. In this case we use MITSIM.

When using MITSIM one has to approximate the river basin with a schematic representation, which can be more or less alike the river basin depending on how detailed the simulation is done.

A short description of the water-ways in the project is made on the following pages.

5.2 Waterways of the project

Simple Description of the Waterways

A simple description of the proposed project is given in the figure below.

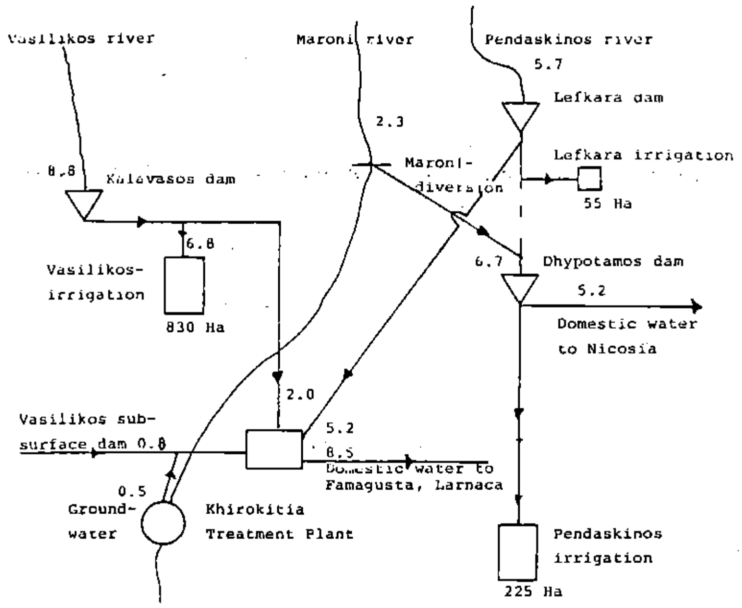


Figure 5.1 The planned water distribution (figures in MCM/year)

Presentation of the Vasilikos Riversystem

Today the water is used in the following ways:

- Domestic water supply to the Khirokitia water treatment plant
- Water supply to some villages in the upper part of the river
- Some minor water use for irrigation along the river

Below the river is presented according to the project plan.

The origin of the Vasilikos river is situated in the Troodos mountain. The first water use from the river is made by some small existing villages between the Troodos and the proposed Kalavasos dam. In the Kalavasos dam the water is stored.

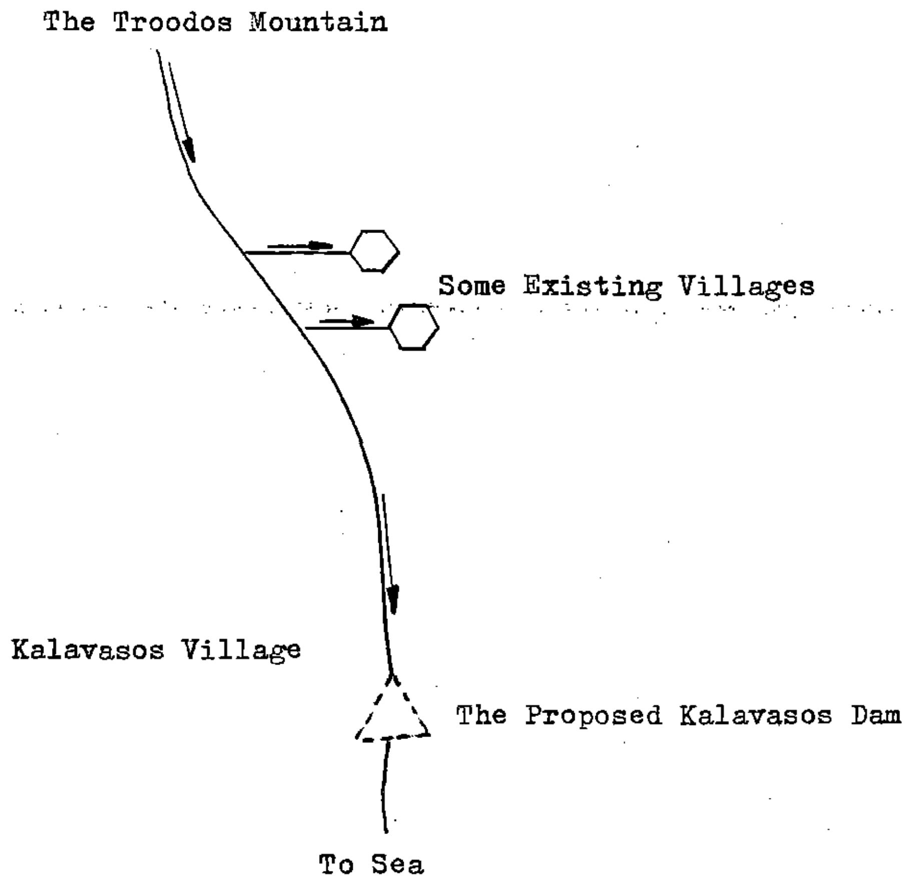


Figure 5.2 The Vasilikos river between Troodos and Kalavasos

The water in the dam is needed in two places:

1. Proposed irrigation system in the Vasilikos watersheds
2. Proposed domestic water supply

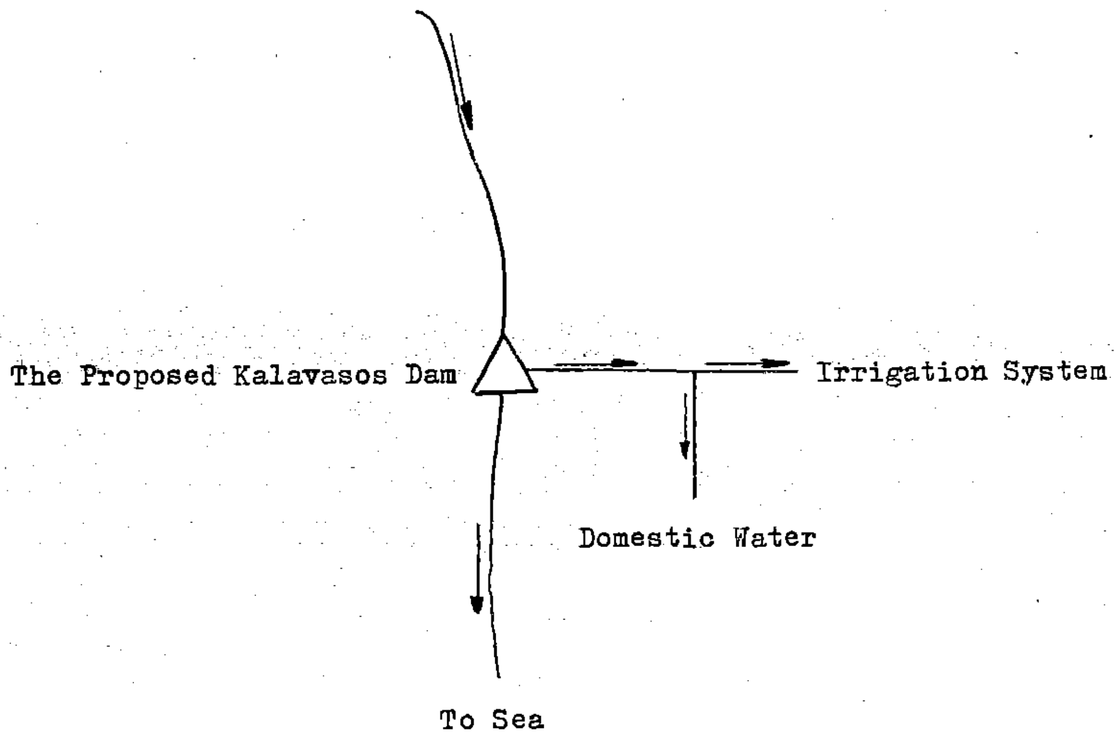


Figure 5.3 Kalavasos dam and its outflows

First of all the water is delivered to the cities. Therefore the domestic water supply has priority over the irrigation supply. Downstream of the dam water in the river is used by some existing villages and also to refill the Vasilikos subsurface dam. The riverwater downstream the dam comes mainly from direct rainfall and tributaries. When Kalavasos dam is full the surplus water is added to the other flows. The water coming from direct rainfall and tributaries is represented in the schematic representation by a start node.

The flow data to the simulation has been measured and evaluated by means of measuring weirs in the rivers. This has been done by the W.D.D. Precipitation data has also been used in combination with a run-off model to get a long series of flow data.

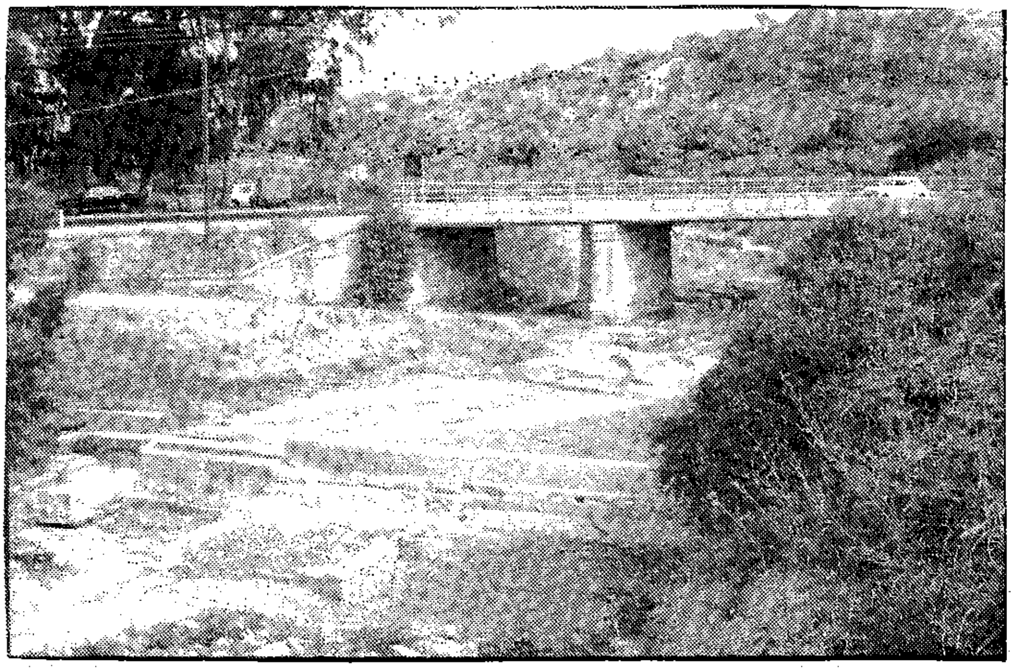


Figure 5.4 A measuring weir

The existing subsurface dam at Vasilikos supplies water to Larnaca and Famagusta. The function of this dam is explained later in this chapter.

Presentation of the Maroni River System

Also the Maroni river has its origin in the Troodos mountain. At present the river water is used in two ways:

1. Some water is taken to villages in the upper part of the watershed

2. Refilling the gypsum aquifer. The aquifer supplies some villages and an irrigation system with water

Development of the project causes some changes in the water system:

1. A diversion, called Maroni diversion, takes water from the Maroni river to the Pendaskinos river. The diversion is located between the aquifer and the upstream villages.

2. Some more irrigation system are supplied with water from the Gypsum aquifer.

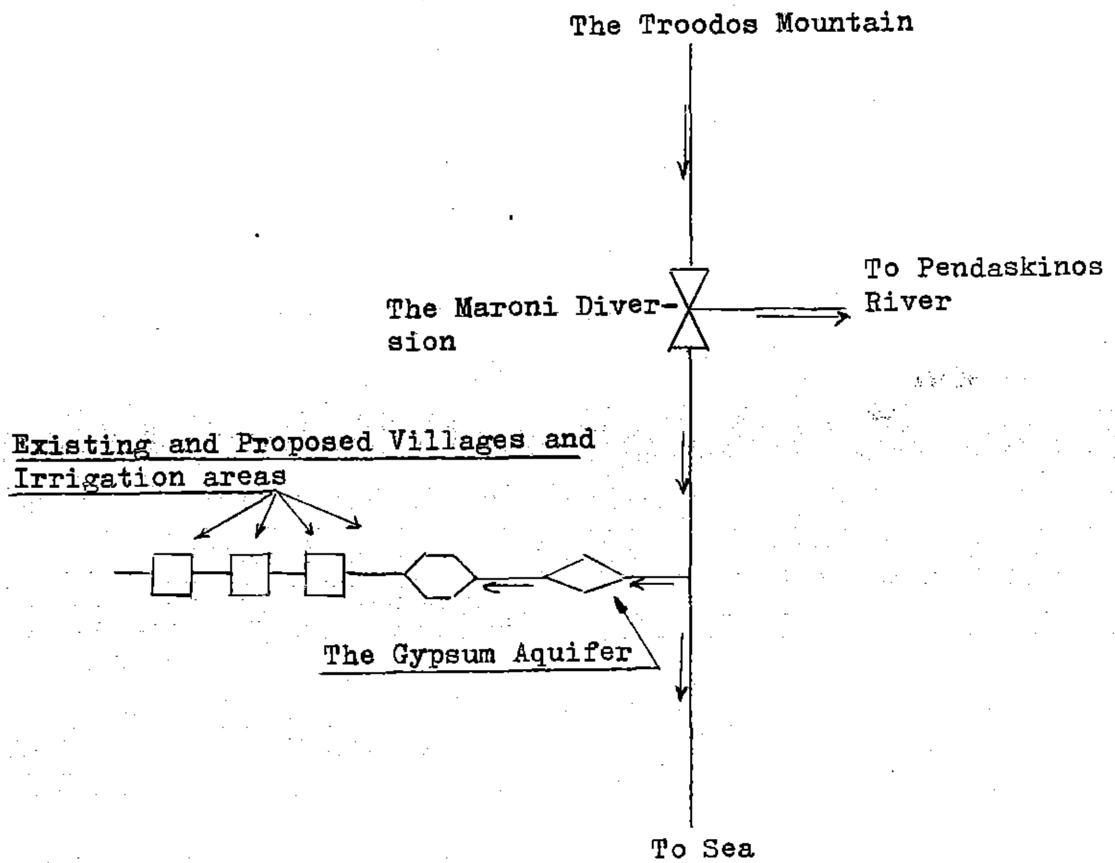


Figure 5.5 Maroni river system, when the project is developed

The functions of the Maroni diversion and the Gypsum aquifer are explained later in this chapter.

Presentation of the Pendaskinos River System

The present situation

The Pendaskinos is the most developed river of the three rivers.

- A dam at Lefkara supplies the Khirokiha treatment plant with water. This water is used in Larnaca and Famagusta.
- Irrigation systems exists along the whole river. However mostly in the lower part.

The proposed project

Some small villages upstream Lefkara use water for irrigation. The water use in these villlages is very small and is therefore neglected in the schematic representation. At Lefkara village the river-water enters the existing Lefkara dam.

The water is used in two ways:

1. Irrigation at Lefkara
2. Water supply to Larnaca and Famagusta

Even here the domestic water supply has priority over the irrigation.

Upstream Dhypotamos but downstream Lefkara a tributary joins the river. The tributary is represented by a start node. A dam is proposed at Dhypotamos. Water to the dam comes from

1. The Tributary
2. The Maroni diversion
3. Surplus water from Lefkara dam

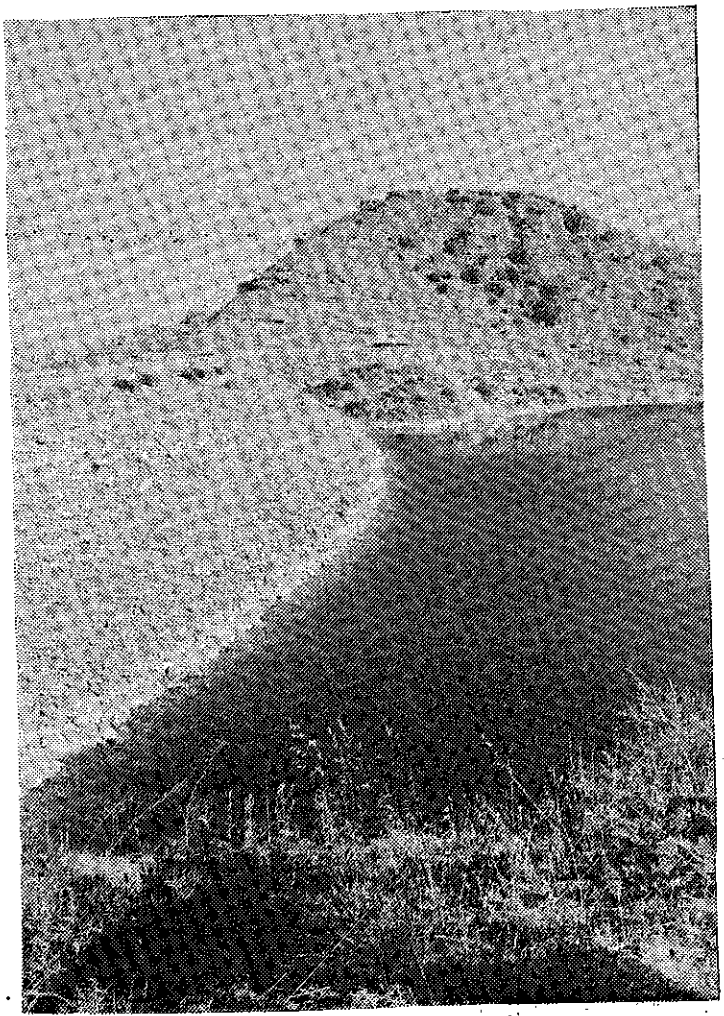


Figure 5.6 The existing Lefkara dam

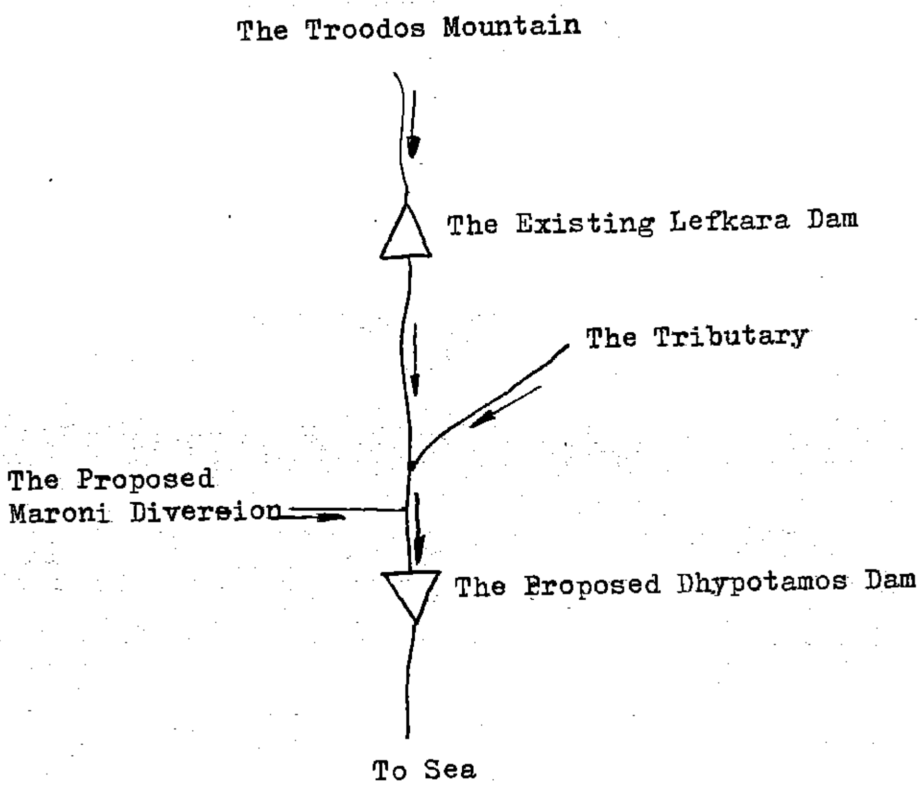


Figure 5.7 Water to the Dhypotamos dam

The water in the dam is used for

1. Domestic supply
2. Pendaskinos irrigation system

Domestic water supply has priority over the irrigation system. The irrigation system gets some additional groundwater.

5.3 Schematic Representation for the whole Project

The earlier presented figure in section 5.2 gives a simplified view of the project. In figure 5.8 below the project is presented as it is simulated in MITSIM.

Abbreviations in the schematic representation

Kaldam	=	Kalavasos dam
Ups. use	=	Upstream user
Vassub	=	Vasilikos subsurface dam
Div	=	Diversion
Vassirrci	=	Vasilikos irrigation citrus
Vassirrvi	=	Vasilikos irrigation vines
Vassirrve	=	Vasilikos irrigation vegetables
Penirrci	=	Pendaskinos irrigation citrus
Penirrve	=	Pendaskinos irrigation vegetables
Dhyp. dam	=	Dhypotamos dam
Lef dam	=	Lefkara dam
Lef irr	=	Lefkara irrigation
Gyps. aqu	=	Gypsym aquifer

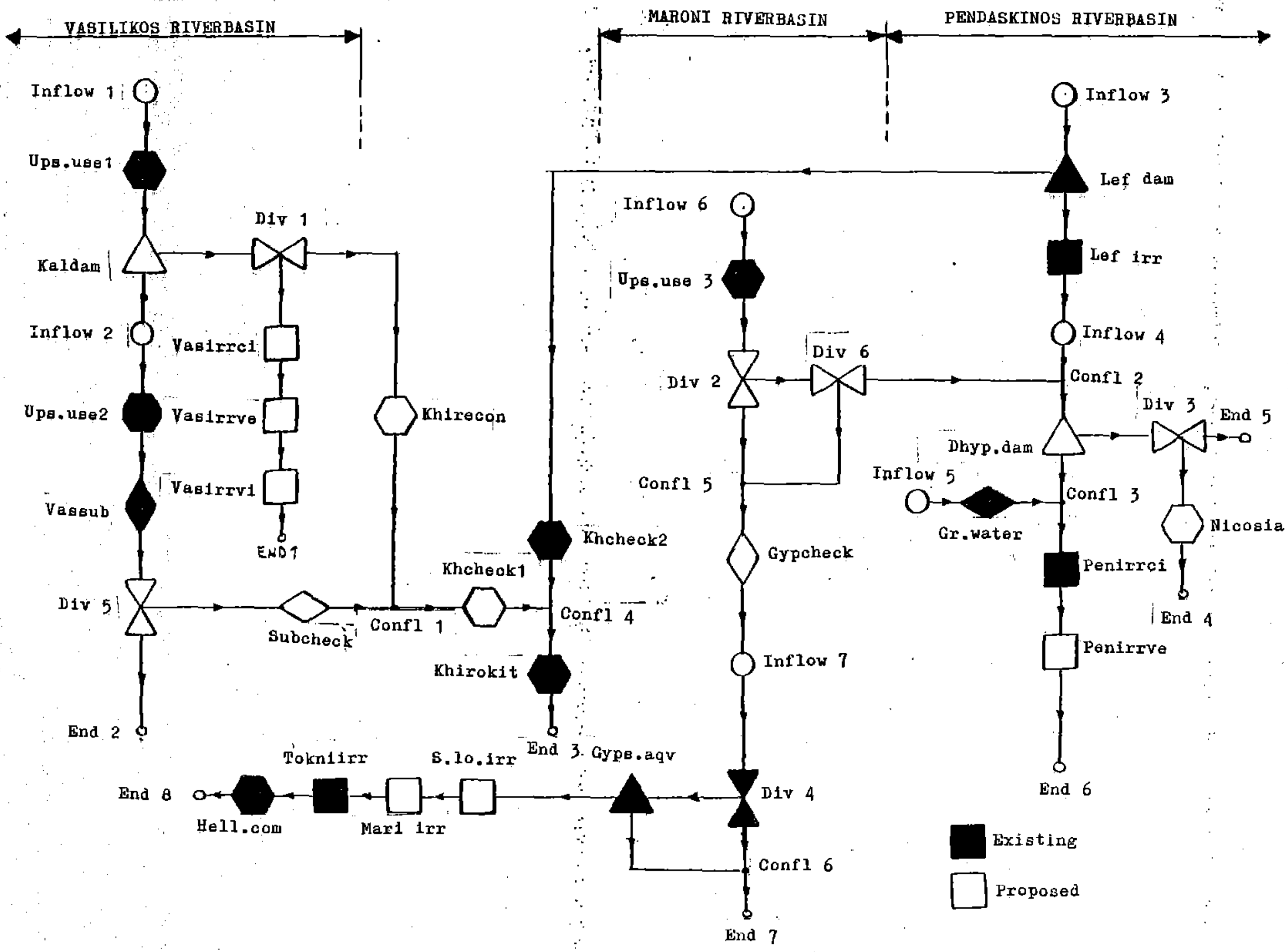


Figure 5.8 The project schematic represented

5.4 Details in the Schematic Representation

Finally some details in the schematic representation are explained. The explanations show some possibilities of MITSIM and how to apply it in a specific case.

Vasilikos Irrigation System

The irrigation area includes three different crops citrus, vegetable and vine (grape). The sensibility against water deficit and the water use each month is different for each crop. Therefore the irrigation area is divided into three irrigation nodes in the schematic representation.

The sequence of the nodes depends of the sensibility against water deficit. The most sensitive is citrus and is therefore the first crop to get water. The sequence is citrus, vegetables and vines.

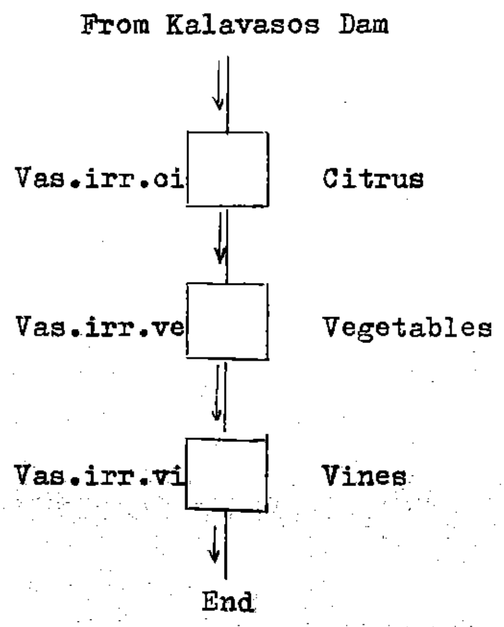


Figure 5.9 The Vasilikos irrigation system

The economic losses by a water deficit can thus be minimized with this sequence. However the effects of different prices have been neglected. The demand of water for irrigation is 6.8 MCM per year. W.D.D. has found that 830 ha total irrigation area is the most profitable.

The problem of Allocating, Costs and Benefits of Water to Larnaca/Famagusta

The water supply to Larnaca and Famagusta goes through Khirokitia treatment plant which is supplied from the Vasilikos and the Pendaskinos river system.

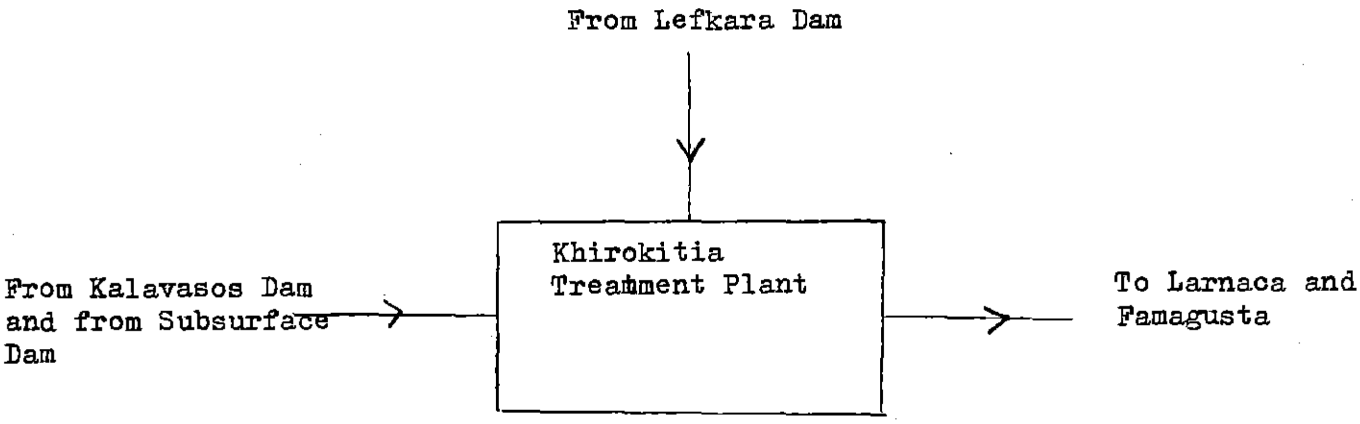


Figure 5.10 Water to Khirokitia treatment plant

In this study only proposed water supplies and water consumers allocate costs and benefits. Only the amount of water that comes from the Kalavasos dam is proposed and shall therefore allocate costs and benefits.

Another problem arises when Khirokitia has a water deficit. It may be difficult to tell which river system that has the deficit. The solution of the problem is shown in the figure below.

The allocations of costs and benefits from proposed water supply between Kalavasos dam and Khirokitia are done by a M o I node, called Khirecon. It has no other function. The water consumption is, however, done by Khirokitia. Thus Khirecon consumes no water but takes care of costs and benefits. Khirokit on the other hand consumes all water to the cities of Larnaca and Famagusta but allocates no costs or benefits.

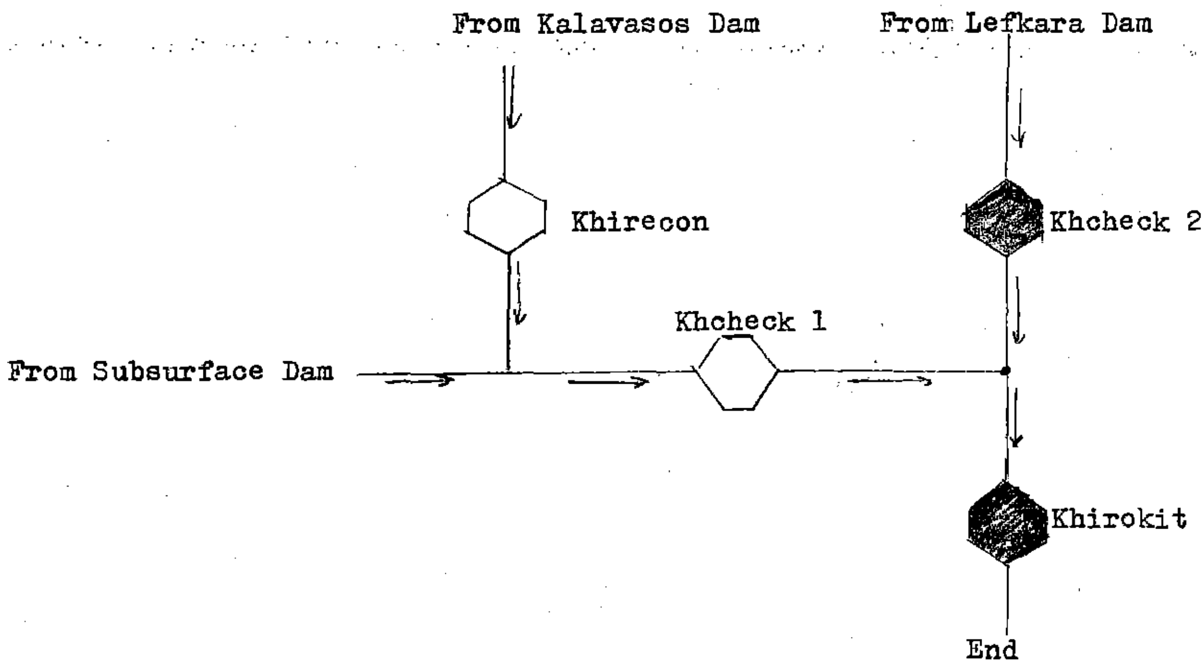


Figure 5.11 The water supply to Khirokitia in the developed project

The water deficit to Khirokitia can easily be traced by the two check-nodes, Khcheck 1 and Khcheck 2. With this solution you can tell which river system that has a water deficit.

The quantity of wate to Khirokitia comes from

1.	The existing Lefkara dam	5.2 MCM/year
2.	The existing Vasilikos subsurface dam	0.8 MCM/year
3.	The proposed Kalavasos dam	2.0 MCM/year

Water Supply to Nicosia

The water supply to Nicosia comes from Dhypotamos dam. Therefore costs and benefits should be allocated to the dam. A M o I node can only allocate benefits. Therefore a Diversion node is added to the system. This node allocates the costs to the dam. It has no other function and the water just passes by.

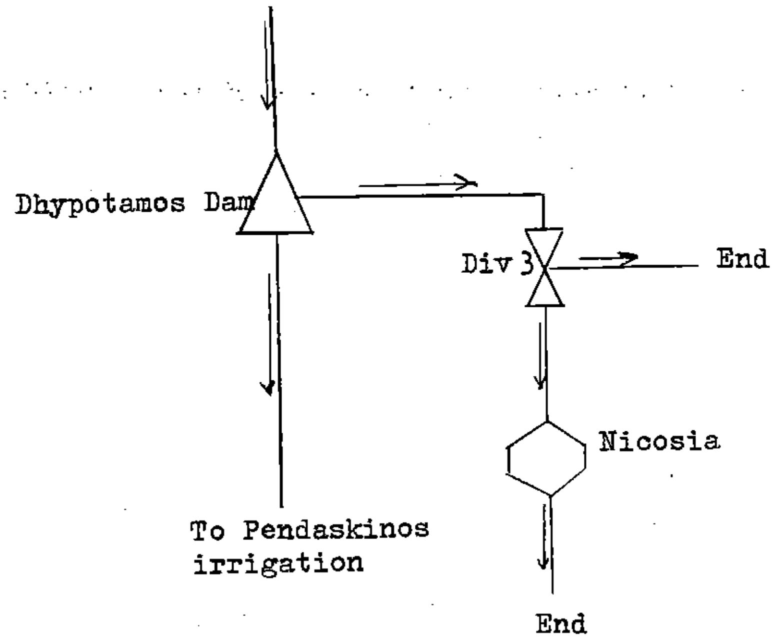


Figure 5.12 Nicosia water supply

Vasilikos Subsurface Dam

The subsurface dam at Vasilikos works very much lika a surface water dam. It consists of a barrier in the riverbed aquifer. Water is taken to Khirokitia and surplus water goes by the riverbed to ocean.

This can´t be simulated by a groundwater node alone since this node can only have one downstream outflow. By adding a diversion node downstream the groundwater node, this problem is solved.

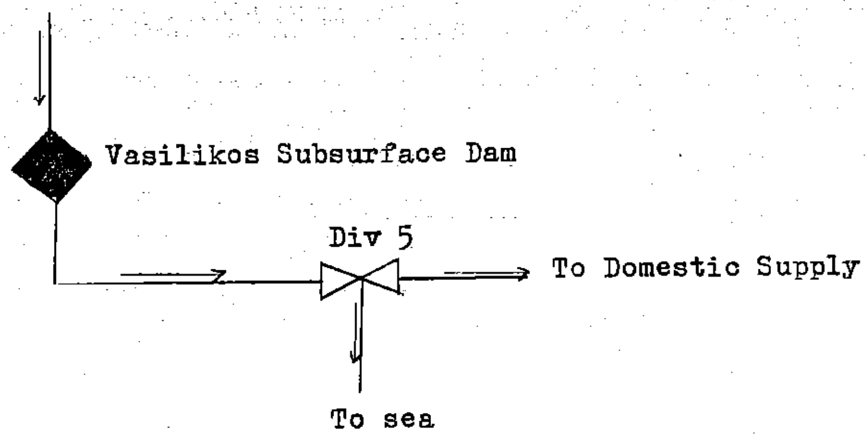


Figure 5.13 The subsurface dam

When the outflow from the groundwater node exceeds the target for Khirokitia (only possible when the subsurface dam is full), the surplus water goes by the diversion to the ocean.

The refill of Vasilikos subsurface dam is done by

1. Infiltration by river water
2. Infiltration by the part of the precipitation which does not reach the river

When the project is developed, the main refill of the sur-surface dam comes as inflow downstream the Kalavasos dam.

The Sinkhole at Maroni Village

The gypsum aquifer is refilled by a sinkhole in the river near Maroni village. However a problem is that only a part of the flow refills the aquifer. Another problem, creating a schematic representation, is that all water shall reach the ocean when the aquifer is full.

The first problem is solved by a diversion node with priority to the aquifer.

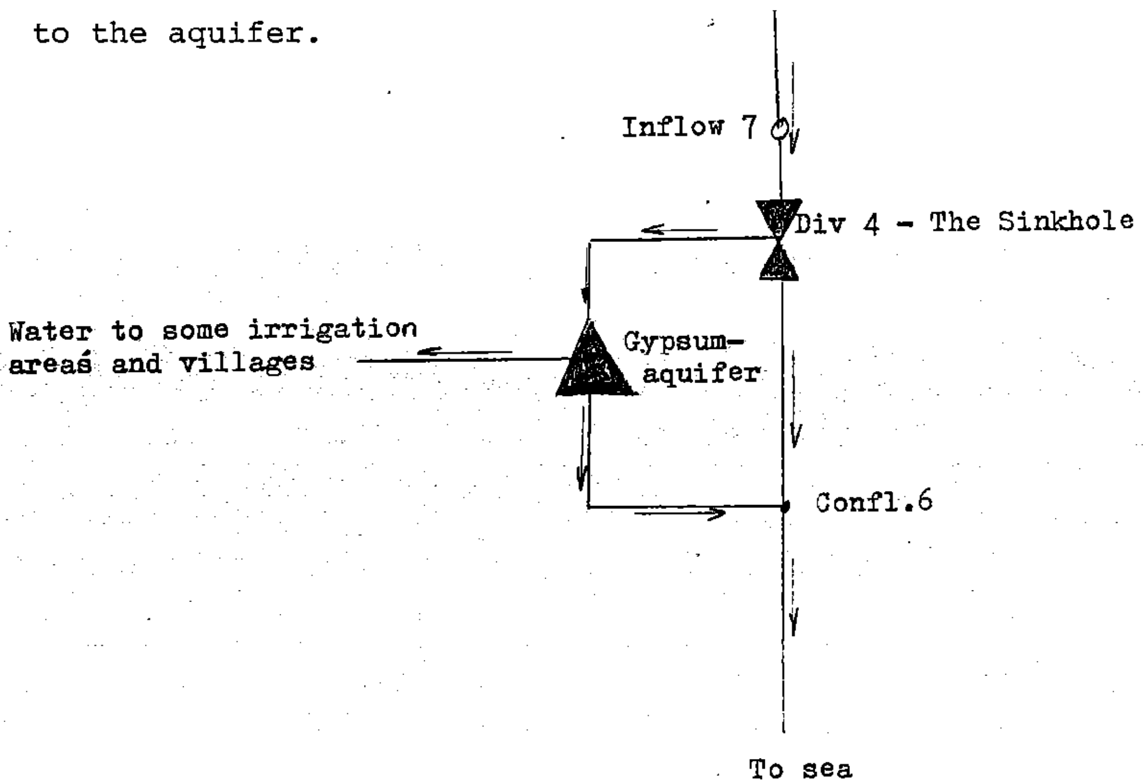


Figure 5.14 The schematily represented sinkhole

A groundwater node has only one outflow of delivering water. In our case we want two possibilities:

1. Water to the irrigation system and to some villages
2. A full aquifer shall divert the surplus water to the ocean

The solution of this problem is to use a dam node instead of a groundwater node. A full dam diverts the surplus water downstream. Downstream is in our solution a confluence node. By the confluence node the surplus water is back to the riverbed as in reality.

The replenishment of the gypsum aquifer is done in the following ways:

1. Through the sinkhole, average 1.5 MCM/year
2. Direct rainfalls, average 0.5 MCM/year

The replenishment by direct rainfall is done by an inflow node. The annual extraction from the aquifer can reach 1.8 MCM yearly.

Figure 5.15 The sinkhole at Maroni village

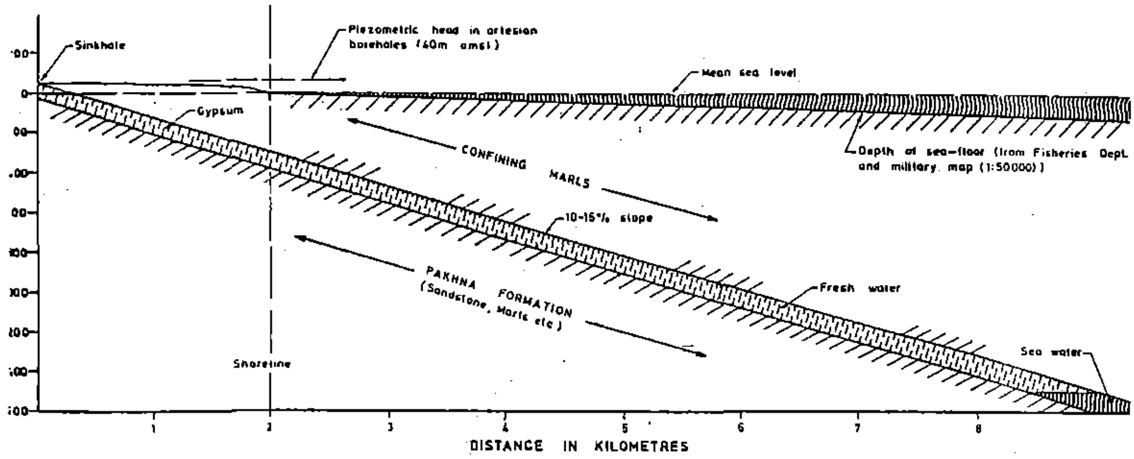


Figure 5.16 Section of the gypsum aquifer
(Source: Number 7 in the reference list)

Maroni Diversion

In the Maroni river a diversion is proposed that will deliver water in the following way:

- Water to refill the Gypsum aquifer with first priority
- Surplus water to the Dhypotamos dam

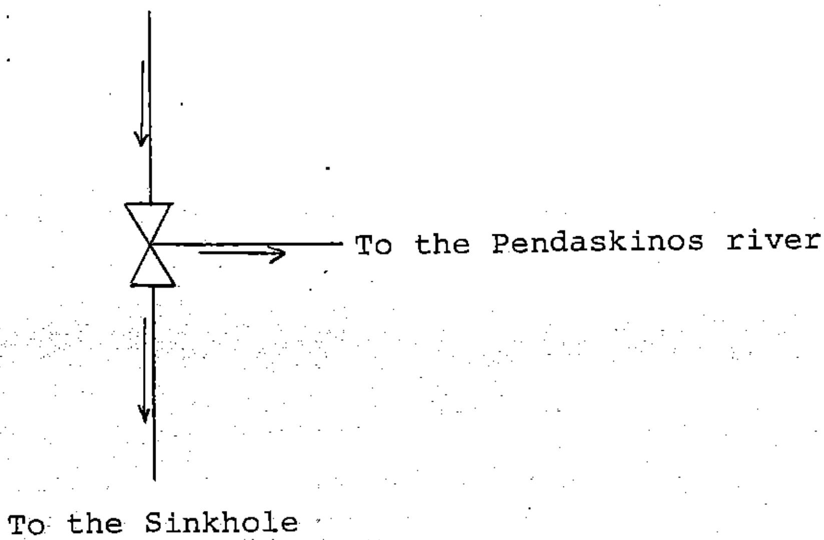


Figure 5.17 The Maroni diversion

A diversion node in MITSIM has two outflows and works in the following way.

The flow with first priority gets its target first. The second outflow gets its target thereafter. When both targets are reached the surplus water goes to the flow with first priority.

To get higher priority to the Gypsum aquifer and at the same time get the surplus water to Dhypotamus dam, the flow to Dhypotamos has priority with a zero water target. In this way only surplus water goes this way and the water target to the Gypsum aquifer is met first.

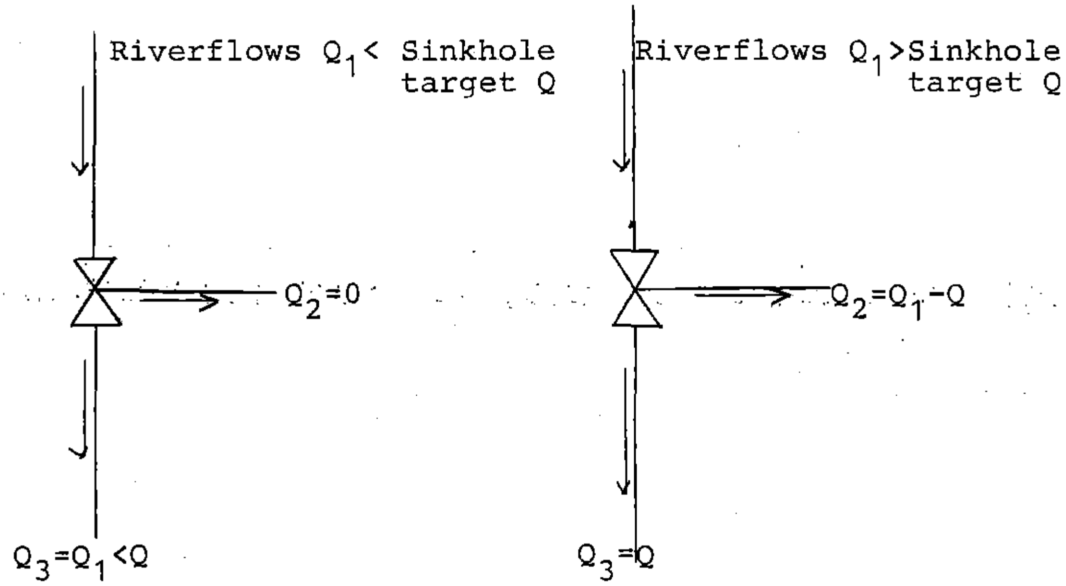


Figure 5.18 Function of the Diversion node, Div. 2

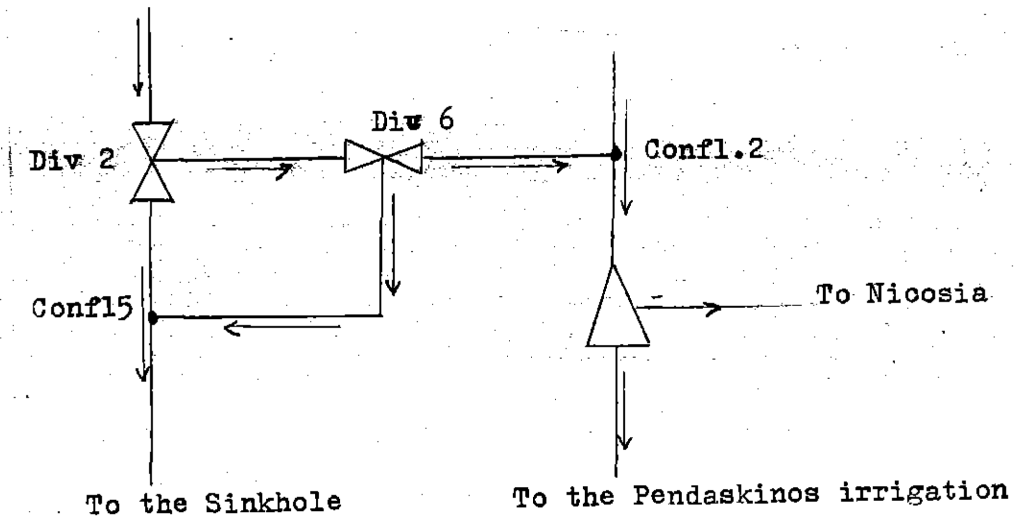


Figure 5.19 The schematic representation of Maroni diversion

6. SIMULATION STUDIES

6.1 Introduction

The main objectives of this chapter are:

- o Description of the optimization with MITSIM (at Vasilikos-Pendaskinos)
- o Presentation of the result
- o Comparison between MITSIM simulated system and the planned system

Optimization with MITSIM

At first it must be explained that the optimization is not a real optimization. Only one variable is varied at a time. If optimization of dams are made the irrigated area is held constant, and vice verse if optimization of the irrigated area is made. This way of optimization may lead to an suboptimization.

The first step in the optimization is to optimize the storage capacities of the two main dams of the project. And when the optimal size of the dams is found, optimization of the irrigation area is made.

Finally an optimization of the irrigation area with the planned dam size was made.

The figure below shows the area which was optimized.

Results

	MITSIM	W.D.D.
Kalavasos dam	14.5 MCM	17.0 MCM
Dhypotamos dam	20.0 MCM	15.0 MCM
Vasilikos irrigation	670 ha	830 ha

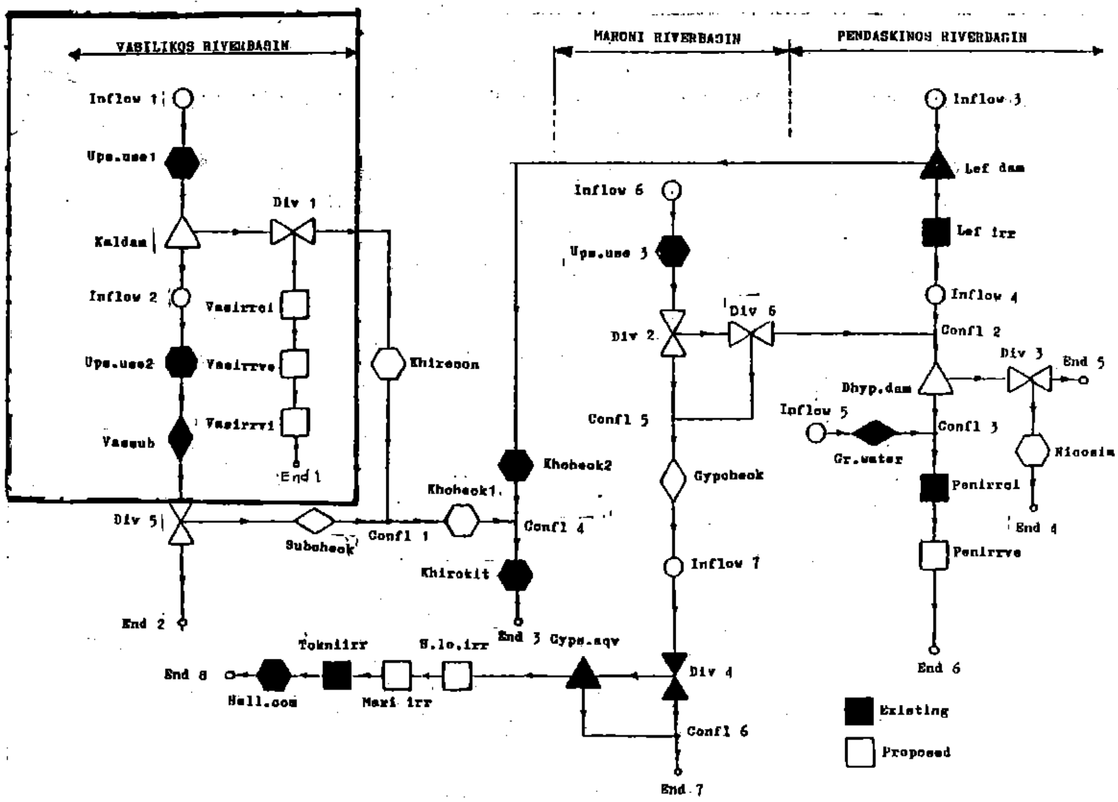


Figure 6.1 This shows the optimizated area

We made also one irrigation optimization with the planned dam size 17.0 MCM at Kalavasos. The most profitable irrigation area at this optimization was found to 830 ha (look at 6.3).

6.2 The Basic Proposal for the Vasilikos-Pendaskinos Project

All input data to the MITSIM simulation are taken from reports published by the W.D.D. Facts like irrigation size, dam size and other variable inputs are the same as they have found being the best for the Vasilikos-Pendaskinos project.

The basic proposal will be presented by means of some economic and hydrologic outputs from the MITSIM simulation. The complete result can be found in appendix E. A very interesting figure is the benefit cost ratio, which is the acutal benefits divided by the total costs. This term shows if the project is profitable or not. For the whole Vasilikos-Pendaskinos project the benefit cost ratio is 2.53.

If you take the total cost from the actual benefit you get the net benefit which figure 6.2 illustrate.

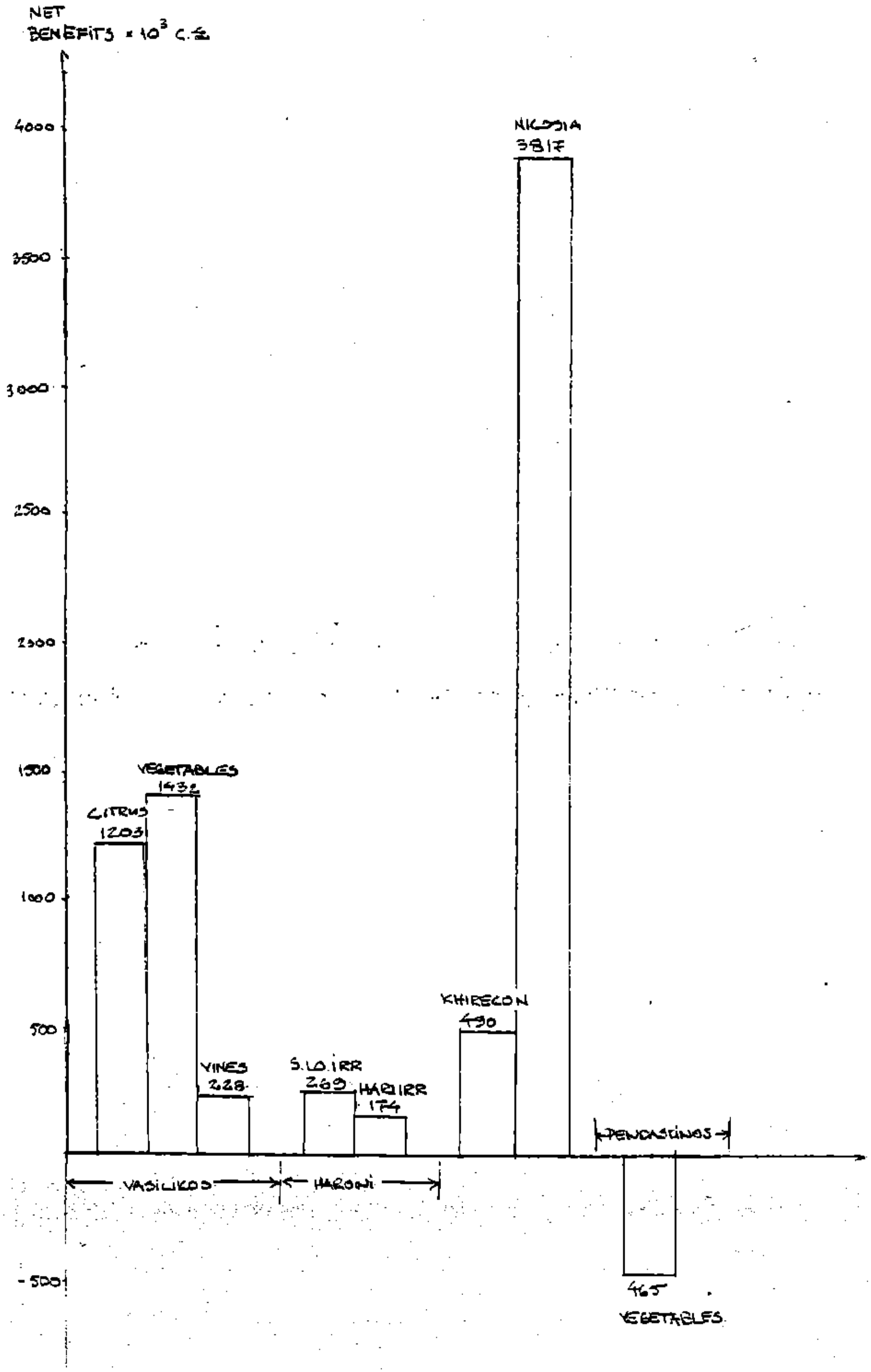


Figure 6.2 The net benefits for the different projects

The great net benefit in Nicosia depends on the water priority in the basic proposal. First of all water is served to the cities and after that to the irrigation areas. In this way the short fall losses are pressed to a minimum. The capital costs are also small compared to the irrigation areas (dams, workers, irrigation equipments and so on). You also get a higher price for the water to the towns than to the irrigation areas.

The vegetables in the Pendaskinos valley have a negative net benefit. This is caused by the great short fall losses. In the simulation with MITSIM it is difficult to find a good solution when you have two places which deliver water. The water comes from Dhypotamus dam and from Groundwater. One dry year when there is little water in the Groundwater, Dhypotamus dam can not give more water than other years and the vegetables get a loss of water.

As mentioned in the previous chapter an economic analysis is done only for the proposed projects and not for the existing projects.

Figure 6.3 shows the total discounted costs for different parts of the whole Vasilikos-Pendaskinos project. The total costs includes capital costs and operational, maintenance and repairment costs (OMR-costs). All costs are discounted into present value. The discounted value is for 40 years which is the planning horizon.

A figure which connects the economic calculation with the loss of water is a factor called the short fall losses. If the water demand is not satisfied you get a loss of benefits. The loss curve does not have to be a linear curve. Especially the crops in the irrigation areas are sensitive to loss of water, because of their tendency to fade. The short fall losses are shown in figure 6.4.

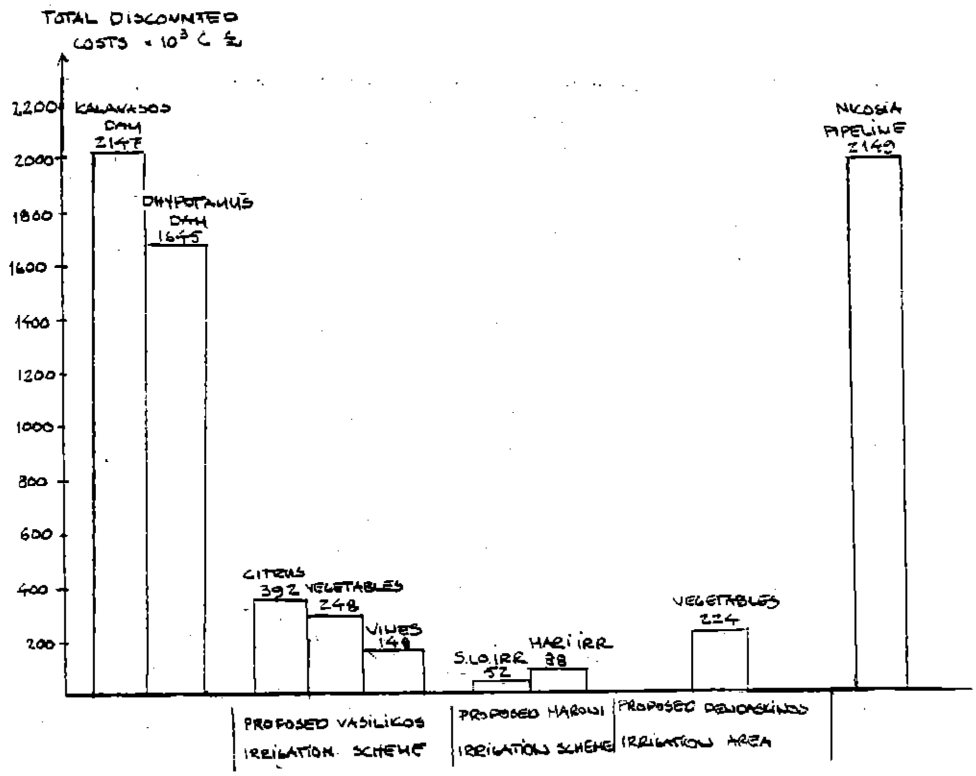


Figure 6.3 The total discounted costs for the dams and the different irrigation areas

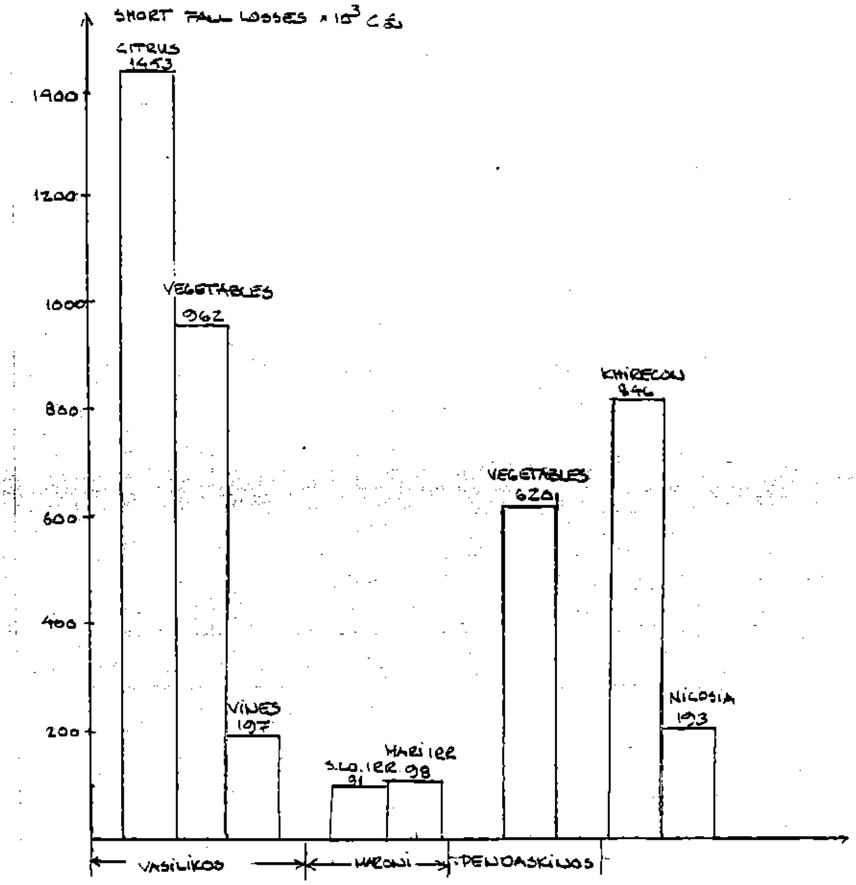


Figure 6.4 The short fall losses for the towns and for the irrigation areas

Citrus have greater short fall losses than the other crops in spite of the priority given to the citrus irrigation. An explanation is that the distribution demand differs over the year of water from crop to crop, and one single month of deficit is very cevere for the citrus fruits.

The last figure describing economy is figure 6.5 which illustrate the benefit cost ratio for different projects in the Vasilikos Pendaskinos project.

The connection between the economic and the hydrologic results can easily be shown by comparing the water reliability with the short fall losses. The water reliability for Vassirrci, Vassirrvi and Vassirrve is shown in figure 6.6.

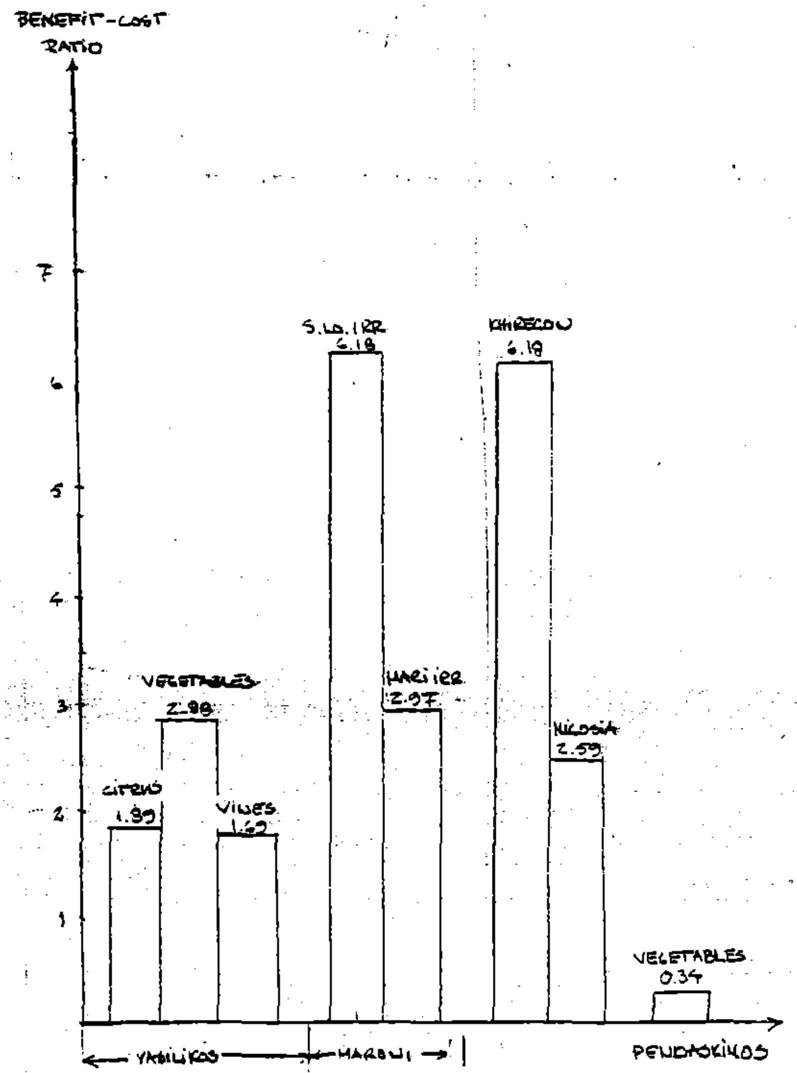


Figure 6.5 The benefit cost ratio for the cities and the irrigation areas

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	0.1	0.5	0.7	0.8	0.8	0.6	0.3	0.1	*****	3.9

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	96.	*****	96.	96.	95.	93.	89.	84.	80.	78.	71.	76.	69.
MEAN DIVERSION	0.0	*****	0.0	0.1	0.4	0.6	0.7	0.7	0.5	0.3	0.1	0.0	3.4
STANDARD DEV	0.0	*****	0.0	0.0	0.1	0.2	0.2	0.3	0.2	0.1	0.1	0.0	1.1
COEF OF VAR	0.0	*****	0.8	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.3

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	*****	0.2	0.3	0.1	0.1	*****	*****	*****	*****	0.8

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	*****	*****	*****	*****	95.	93.	87.	82.	*****	*****	*****	*****	82.
MEAN DIVERSION	*****	*****	*****	*****	0.2	0.2	0.1	0.1	*****	*****	*****	*****	0.7
STANDARD DEV	*****	*****	*****	*****	0.1	0.1	0.0	0.0	*****	*****	*****	*****	0.2
COEF OF VAR	*****	*****	*****	*****	0.2	0.3	0.4	0.5	*****	*****	*****	*****	0.3

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.2	2.1

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	93.	98.	96.	96.	95.	93.	85.	80.	80.	76.	69.	73.	69.
MEAN DIVERSION	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.1	1.7
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.6
COEF OF VAR	0.2	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.5	0.7	0.6	0.4

Figure 6.6 The water reliability for Vassirrci, Vassirrvi and Vassirrve

As you can see the vines in the Vasilikos irrigation scheme have the highest reliability which is connected with the lowest short fall losses. The reliability is also higher for the towns than for the irrigation areas because of the priority of water to the towns.

Table 6.1 shows the connection between water reliability and benefit cost ratio for different objects

Objects yearly	Reliability %	Benefit/cost
Khirecon	88	6.18
Nicosia	99	2.59
citrus } Vasilikos	69	1.89
vegetables } Vasilikos	69	2.88
vines } Vasilikos	82	1.69
vegetables } Pendaskinos	0	0.34
Safta Lourka irrigation	20	6.18
Mari irrigation	20	2.97

Some of the projects have a low reliability. This depends on a very unfortunate flow simulation period with two dry years after each other in the very beginning of the simulation. When the dams have not had the time to reach full capacity it is difficult to get high reliabilities.

One limitation in MITSIM is that the whole project is considered completed when the simulation starts.

6.3 Optimization

MITSIM can be used as an aid for optimization. The output in MITSIM is made so that each node is represented. For each node the following economic output can be presented: total cost, OMR cost, actual benefit, net benefit and benefit-cost ratio.

The Dam Optimization

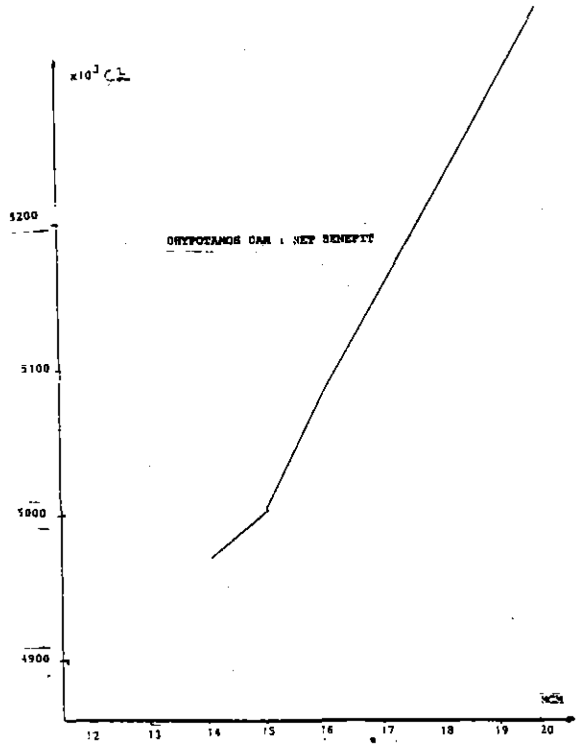
This study is based on data from the W.D.D. studies of the project. All data except those for the dam sizes are hold constant. Changes in dam sizes have only effects in the corresponding river. Therefore changes in both rivers can be made in the same simulation.

The following storage volumes are simulated:

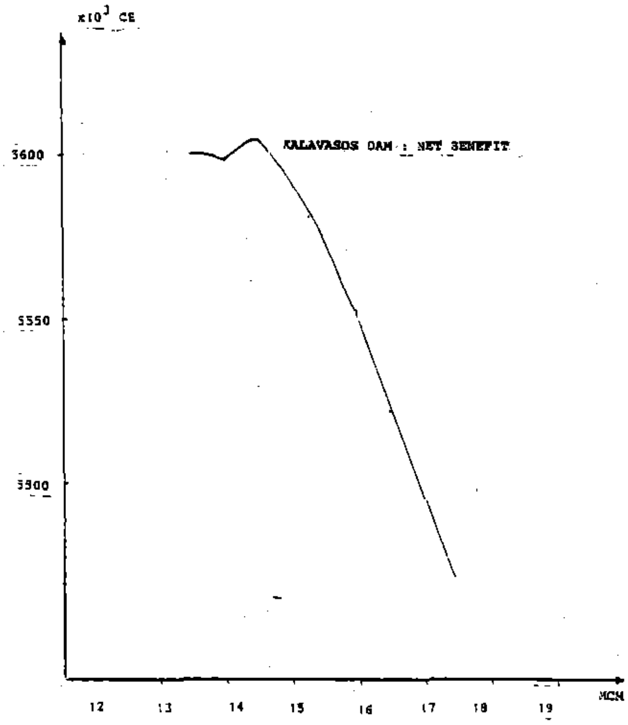
- Kalavasos dam: 13.5 14.0 14.5 15.5 16.0 16.5 17.0 17.5 MCM
- Dhypotamos dam: 14.0 15.0 16.0 17.0 20.0 MCM

The simulation results are shown as dam size corresponding to net benefit for the river region. The results are given in the figures below.

The results for Kalavasos dam are given in figure B. As you can see, the net benefits are greatest for 14.5 MCM.



A-The Dhypotamos dam



B-The Kalavasos dam

Figure 6.7 The results fo the Dam optimization

W.D.D. has found that 17 MCM is the most economic size. However, there are very small changes in net benefits in the simulations.

The results for Dhypotamos dam are shown in figure A. The net benefit increases with dam size. However the dam has its natural limitation at 20 MCM of storage volume. Therefore the best dam size is 20 MCM. W.D.D.´s has designed the dam for a storage volume of 15 MCM.

Optimization of Vasilikos Irrigation System with 14.5 MCM Kalavasos Dam

The present study is based on W.D.D.´s data. The results of the dam optimization are used in this study. The dam sizes are consequently 14.5 MCM for Kalavasos dam and 20 MCM for Dhypothamos dam. The irrigation area is varied in the different simulations. Simulations are done for following irrigation areas.

Total Vasilikos irrigation area	Vass.irr.ci	Vass.irr.ve	Vass.irr.vi
830 ha	412 ha	261 ha	157 ha
730 "	362 "	230 "	138 "
670 "	332 "	211 "	127 "
620 "	308 "	195 "	117 "

W.D.D. has designed the Vasilikos irrigation area to 830 ha. In this simulation the relative distributions of the different crops are the same for the different simulated areas.

We might get a better result with another distribution, but we have to limit the number of simulations.

The simulation results are given in the figures below.

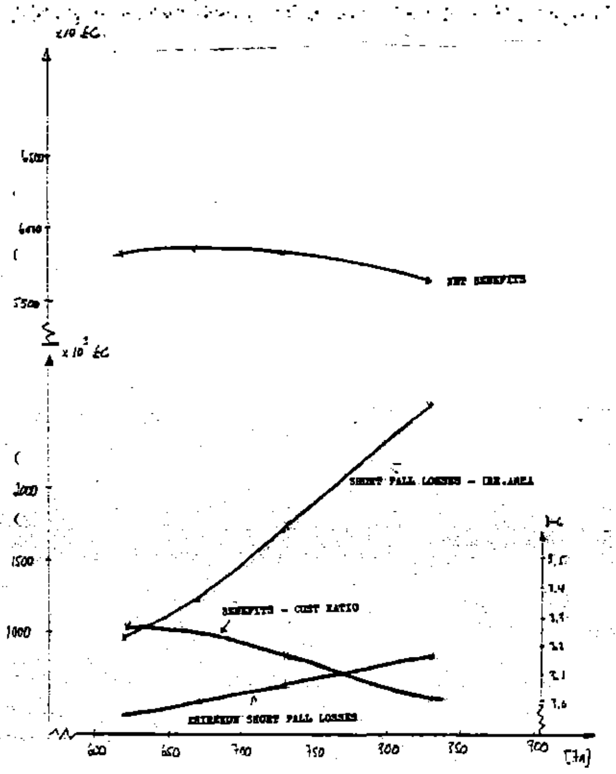


Figure 6.8.A- Results of Vasilikos river basin

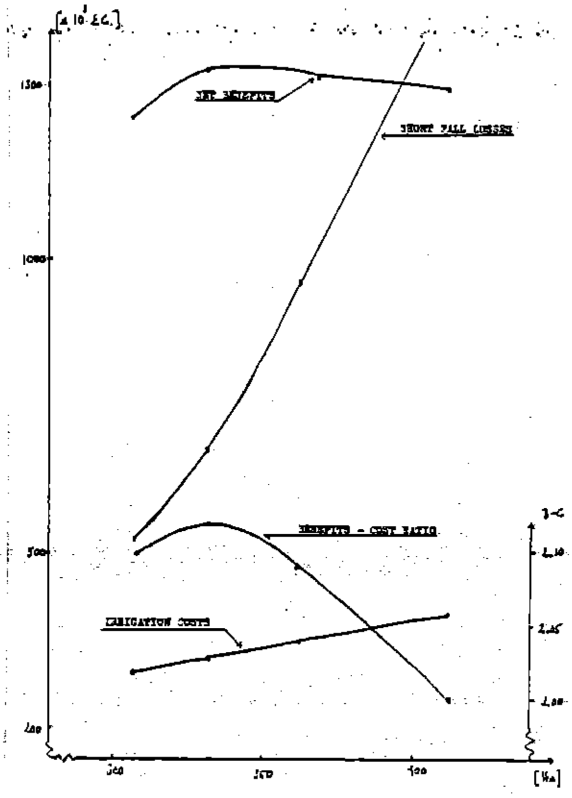


Figure 6.8.B- Results of Vasilikos irrigation-citrus

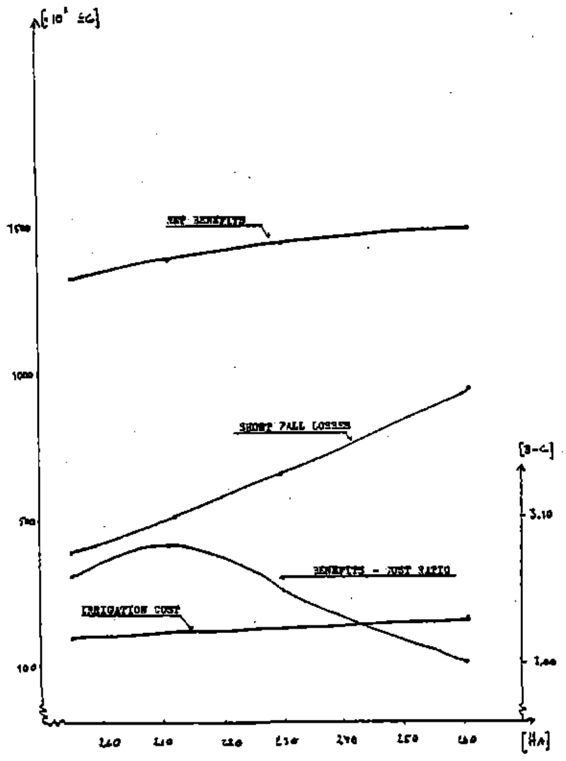


Figure 6.8.C-Results of Vasilikos irrigation-vegetables

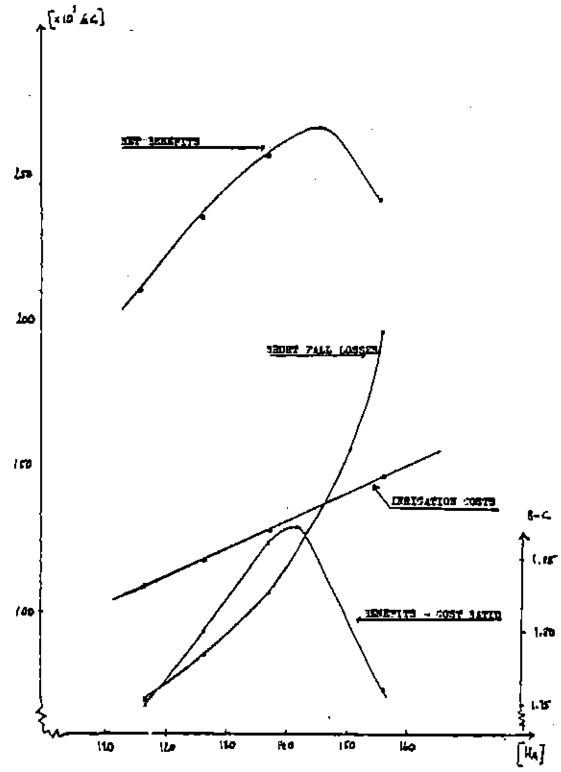


Figure 6.8.D-Results of Vasilikos irrigation-vines

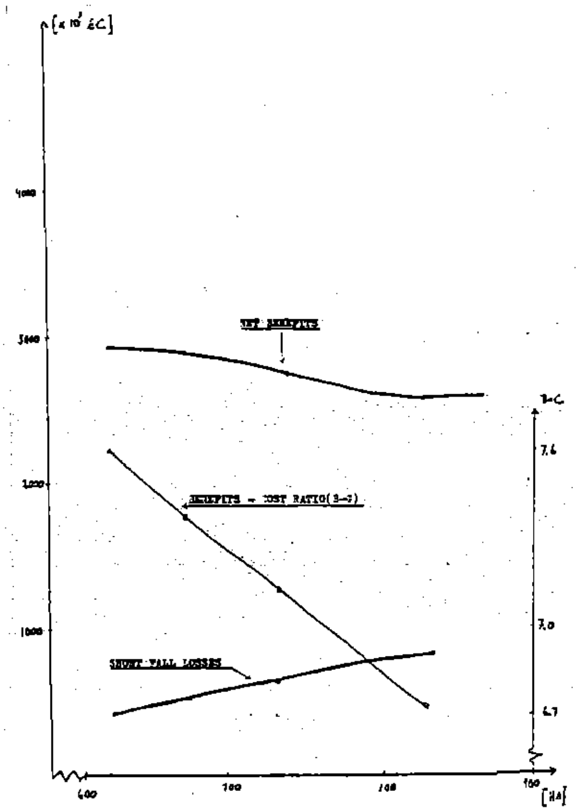


Figure 6.8.E-Results of Khirecon

Figure A shows

1. Net benefits for Vasilikos river basin
2. Short term losses (= short fall losses) for total Vasilikos irrigation system
3. Short term losses (= short fall losses) for Khirecon
4. Benefits-cost ratio

corresponding to total irrigation area.

As you can see, maximum net benefit is at 670 ha irrigation area. The difference in net benefit between our solution (670 ha) and W.D.D.´s (830 ha) is rather small. The flat curve of net benefit can explain the difference between the solution. The solutions are made with different storage volume of Kalavasos dam which also affects the results.

Fig. B-D show each irrigation area in the same way. Fig. E shows the results of Khirecon thus giving the economy of the domestic water supply. Finally the following table shows all the simulation results.

Optimization of Vasilikos Irrigation System with 17 MCM Kalavasos Dam

Finally an economic study of Vasilikos river basin is done. The study is based on the dam size of Kalavasos that W.D.D. has designed. Three simulations are made, 670, 730 and 830 ha total Vasilikos irrigation area. The relative distribution of the corps is the same. W.D.D. has designed the irrigation area to be 830 ha. As mentioned before a better result can probably be achieved with another distribution. The result of the study is shown in the figure below.

As you can see the net benefits have a maximum at 830 ha in the interval 670 ha to 830 ha. 830 ha is the cultivated area today. This is the same result as W.D.D. found.

Total irrigation area	Potential benefits	Short fall losses	Actual benefits	Irrigation costs	Total costs	Net benefits	B-C Ratio
	10^3£C	10^3£C	10^3£C	10^3£C	10^3£C	10^3£C	10^3£C
VASSIRRCI							
412 Ha	4008.77	1451.23	2557.54	392.30	1278.50	1279.04	2.00
362 Ha	3522.27	954.33	2567.94	344.80	1231.01	1336.94	2.09
332 Ha	3230.37	678.18	2552.19	316.30	1202.50	1349.68	1.12
308 Ha	2996.85	525.21	2471.64	293.50	1179.70	1291.93	2.10
VASSIRVE							
261 Ha	3155.82	943.10	2212.72	248.18	722.09	1490.71	3.06
230 Ha	2780.99	646.82	2134.17	218.81	692.64	1441.53	3.08
211 Ha	2551.26	492.23	2059.02	200.81	674.64	1384.38	3.05
195 Ha	2357.80	378.99	1978.81	185.66	659.49	1319.32	3.10
VASSIRVI							
157 Ha	758.32	197.37	560.95	147.99	318.49	242.46	1.76
138 Ha	666.55	108.28	558.27	130.29	300.79	257.48	1.86
127 Ha	613.42	87.11	526.30	120.04	290.54	235.76	1.81
117 Ha	565.12	72.70	492.91	110.72	281.22	211.69	1.75
KHIRECON							
830 Ha	3872.65	827.90	3044.75		452.02	2592.73	6.73
730 Ha	3872.65	646.56	3326.08		452.02	2774.06	7.14
670 Ha	3872.65	531.39	3341.25		451.02	2889.23	7.39
620 Ha	3872.65	426.85	3445.85		451.02	2993.77	7.62
TOTAL VASSIRR							
830 Ha	7922.91	2591.70	5331.21		2319.01	3012.2	2.30
730 Ha	6969.80	1709.43	5260.37		2224.44	3035.95	2.36
670 Ha	6395.04	1257.53	5137.51		2167.69	2969.82	2.37
620 Ha	5919.75	976.40	4943.36		2120.41	2822.95	2.33
TOTAL REGION 1							
830 Ha			8375.96		2772.03	5604.91	3.02
730 Ha			8486.46		2676.46	5810.00	3.17
670 Ha			8478.76		2619.71	5859.05	3.24
620 Ha			8389.15		2572.44	5816.71	3.26

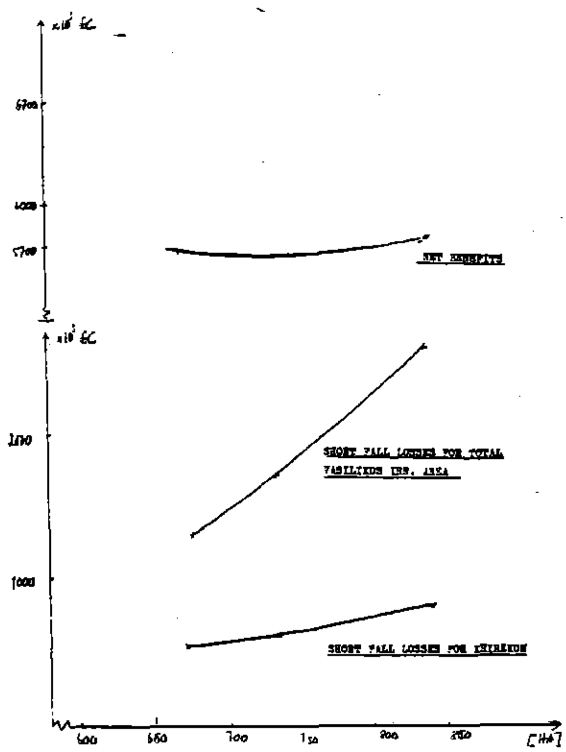


Figure 6.9 The result of the economic study

The Advantage with MITSIM

The advantage with MITSIM when making optimizations are

1. It´s easy to follow up the economy for a specific object, because the total cost, OMR cost and the net benefits for the actual node are given.

2. It´s easy to follow the economy for a whole region.

3. It´s easily shown what effects the changing of an irrigation area or a dam size means to other projects. Both economy and the reliability of the water delivery can be studied.

6.4 Conclusions

The results above differ from what Water Development Department (W.D.D.) has obtained. The simulation studies can not directly be compared because of the different proposes and assumptions. Anyway we will try to point out some reasons that make the differences.

W.D.D. has developed this project under several years. In their results not only simulation studies but also other aspects as social, financial, political etc., are taken into account. The purpose of this study is to show the applicability of MITSIM at this type of project and how it can be used at an "optimization". A complete optimization of the project is therefore beyond reach of this study.

W.D.D. used nine separate models to carry through their simulation studies. The different models together describe the whole project. It is obvious that the MITSIM simulation cannot be as detailed as theirs.

MITSIM is designed for steady state simulation studies. This means that all water supply, demand targets, precipitations etc, must be fixed for the whole simulation period. We therefore have been forced to assume that the project is fully developed at the beginning of the simulation period. In practice the crops have different establishing periods, which W.D.D. has considered. Vegetables, vines and citrus reach their full demand and productivity after 3, 7 and 11 years respectively. Thus W.D.D. has less demands for irrigation during the first eleven years. The initial storage volumes for the dams are the same in both studies. These factors may affect the size of the Kalavasos dam. Due to the greater demand and relative dry years in the beginning of the simulation period we have greater short fall losses. A smaller dam at Kalavasos gives smaller costs and is therefore more favourable for the Vasilikos region. Our results may approach W.D.D.´s when increasing the initial storage volume of the dam. Rearranging the monthly streamflow values so that the dry years occur unaggregated later in the simulation period could also have this effect. This can be done provided that the standard deviation is unchanged.

Our result concerning the size of the Dhypotamus dam was 20 MCM which was the upper limit for the dam site. The difference between this and 15 MCM (W.D.D.) can depend on another limitation of MITSIM. The model always calculates in an upstream-downstream order and cannot feel if one water supplier fails and compensate from another. This is the case for the Pendaskinos irrigation scheme where there is two water suppliers. Thus a loss of groundwater is not compensated for from the Dhypotamus dam even if there is a sufficient amount of water available. The way the water targets is chosen will probably also be significant for the "optimum" size of the dam.

Summary of simplifications and other uncertainties in the simulation study:

- o No respect on social, financial and political factors has been taken.
- o The project is assumed to be fully developed at the beginning of the simulation period.
- o Target demands for irrigation areas have been assumed to be constant during the simulation period.
- o The consumptive use of water for irrigation has been reduced by a monthly mean precipitation value.
- o The sedimenation in the Kalavasos and Dhypotamus dams have been considered by reducing their storage volumes. The reduction is taken as the mean value for the simulation period
- o The groundwater aquifers are described in a rather rough way.
- o There may be "misunderstandings" in the input data.

This version of MITSIM is not very detailed. In spite of this we have shown that it describes a complicated river basin relatively well. One advantage of MITSIM is that it contains statistics as well as economics and is easy to survey. In our opinion MITSIM can be valuable in an early phase in the planning process and give guidance for more detailed studies.

6.5 Guidelines

The MITSIM manual contains detailed program descriptions and instructions how to give input data. However it can be difficult to understand the function of the program and make simulations only with help of the manual in its present shape. A new improved version is coming though.

MITSIM is designed for simulations with maximum 100 nodes. By adding several simulations large systems can be evaluated. The ten different types of nodes incorporated can describe complex systems quite well.

MITSIM has perspicuous outputs. The program is designed to check the input data. A number of messages are printed if it is incorrect. The simulation is not carried out before right inputs are given. Moreover, the output "idebug" is a useful tool to find errors in the water allocations.

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Appendix A

GOVERNMENT OF CYPRUS
MINISTRY OF AGRICULTURE AND NATURAL RESOURCES
DEPARTMENT OF WATER DEVELOPMENT

VASILIKOS-PENDASKINOS PROJECT

DESCRIPTION OF PROJECT WORKS

VASILIKOS-PENDASKINOS PROJECT
DESCRIPTION OF PROJECT WORKS

1. General

The principal features of the Project are:

(a) Kalavasos Dam
(b) Dhypotamos Dam
(c) Maroni Diversion
(d) Vasilikos Main Canal and Nightstorage Reservoir
(e) Vasilikos Irrigation Network
(f) Pendaskinos Irrigation Pipeline
(g) Kalavasos Dam-Khirokitia pipeline, Pumping Station and Storage Reservoir
(h) Dhypotamos Pumping Station - Phase II installations and connections
(i) Nicosia Treatment Plant and Pumping Station

2. Kalavasos Dam

The dam will be an earth and rockfill structure 57 m high and will form a reservoir with a capacity of 17 MCM. It will have an impervious central rolled clay core flanked by river gravel filters with compacted sluiced rockfill shoulders with side slopes of 1:1.6. The total volume of the embankment will be 1,271,000 m^3 of which 228,000 m^3 will be clayfill, 154,000 m^3 filters and the remainder rockfill. Most of the construction materials have been found and proved within a haulage distance of 4 km.

An ogee-crested spillway, 42 m wide, on the right abutment will discharge upto 622 m^3/s without overtopping the embankment. A 3.3 m dia. tunnel through the left abutment will be used for river diversion during construction and will later house the outlet pipelines. The foundation rock consists of upper and lower pillow lavas covered in places by river deposits and some talus. The dam site is tectonically disturbed and exhibits faulting and shearing. A grout curtain will be constructed along the centre line of the core, to minimise seepage losses.

3. Dhypotamos Dam

The dam will be 49 m high with the same type of design as Kalavasos dam and will provide a storage capacity of 15 MCM. The spillway will pass upto 600 m^3/s without overtopping the embankment, which corresponds to a flood greater than the 1,000 year design flood. The outlet works will utilize the 2.7 m dia diversion tunnel.

Bedrock at the damsite consists of igneous rocks belonging to the Basal Group. Alluvial deposits in the form of gravels cover the valley bottom and have an average thickness of 5 m. These will have to be removed and the dam founded on sound rock. A grout curtain will have to be constructed in order to minimise seepage losses below the cutoff of the clay core.

The total volume of the embankment will be 868,000 m^3 out of which 185,000 m^3 clay core, 101,000 m^3 filters and 582,000 m^3 rockfill.

4. Maroni Diversion

A diversion system will be constructed to convey excess flows of Maroni River to the Dhypotamos Reservoir. It will consist of an overflow-crested diversion weir providing adequate head for the diversion of 1 m^3/s forming a lake having a storage capacity of 50,000 m^3 and safely passing a flood of 112 m^3/s. This will be connected to a concrete lined canal about 10.3 km long including a 550 m long tunnel, several syphons and a drop structure into Dhypotamos reservoir.

5. Vasilikos Main Canal and Nightstorage Reservoir

A canal will be constructed about 10 km long from Kalavasos Dam to a site above the Vasilikos Irrigation Area where it will terminate in a 20,000 m^3 regulating reservoir to be constructed from local materials compacted to form embankments and covered by a synthetic membrane to achieve watertightness. The reservoir will store canal flows not used by farmers, for an 8-hour period during the night and releases will help meet peak daytime demands. The canal will have a capacity of 650 l/s and be constructed of reinforced concrete in a rectangular shape.

6. Vasilikos Irrigation Network

The net area to be irrigated covers 830 ha. The distribution system will be working under pressurised conditions with pipelines buried along the farm access roads. Each delivery pipeline will provide suitably located outlets along its length and each outlet - located so as to serve two plots - will consist of a common valve and two valves and two water meters installed in parallel. Water will be supplied from the Tokhni Nightstorage Reservoir through a main conveyor, 700 mm in diameter. A part of the area (about 205 ha) which is situated within the Vasilikos river valley will be supplied with irrigation water directly from the main canal. Certain sectors of the area to be irrigated will undergo Land Consolidation.

7. Pendaskinos Irrigation Pipeline

This is a 19 km long pipeline to be constructed along the river valley and serve an area of 225 ha. About 150 ha of this area are existing citrus plantations which are at present irrigated mainly from groundwater. After the construction of Dhypotamos dam and the expected reduction of replenishment, this area will have to be supplied with water over and above the future safe yield of the aquifer and will be extended to cover 225 ha. A section of the pipeline, 3.2 km in length, from the proposed domestic water Pumping Station below Dhypotamos Dam down to its intersection with the existing domestic water pipeline from the Khirokitia Treatment Plant to the Larnaca-Famagusta area, is being constructed by the Government of Cyprus prior to the Project to deliver part of the excess water in that system to the new pipeline being built from the Dhypotamos Pumping Station to Nicosia. This will provide a temporary supplementary water supply to Nicosia until the dam is completed. When Dhypotamos Dam is completed, and its multiple purpose water supply become available, that section of the pipeline will be reconverted to irrigation use.

8. Kalavasos Dam-Khirokitia pipeline, Pumping Station and Storage Reservoir

This component of the Project will serve for the augmentation of the Famagusta-Larnaca water supplies by allocating about 2 MCM per annum of the Kalavasos Dam water for this purpose. From the dam a 450 mm dia raw-water main will be laid roughly following the river course down to a point just upstream of Kalavasos village at which a Pumping Station will be constructed. The pumping main will then rise towards the NE and will discharge into a concrete reservoir to be constructed near the Khirokitia Treatment Plant with a capacity of 2,750 m^3. Thence the raw-water will be conveyed to the sedimentation tank of the Plant for treatment and conveyance to Larnaca and Famagusta through the existing system.

9. Dhypotamos Pumping Station - 2nd Phase Installations

The Dhypotamos Pumping Station will effectively house two systems. One system will be able to pump raw-water to the Khirokitia Treatment Plant through a suitable connection with the existing Lefkara-Khirokitia pipeline and the second system will be able to pump raw-water to the proposed Nicosia Treatment Plant via the new pipeline now under construction. As mentioned under (7) above the excess treated water from Khirokitia is now, as part of an emergency scheme, being diverted to Nicosia via the Dhypotamos Pumping Station.

In this scheme the Pumping station is being built and equiped with the second system of pumps mentioned above which will act as booster pumps for the conveyance of the treated water from Khirokitia to the Stavrovouni balancing tank and thence by gravity to Nicosia.

As part of the Vasilikos-Pendaskinos Project the first set of pumps mentioned above will be installed and the necessary connections made to the dam raw-water outlet and the nearby Lefkara-Khirokitia pipeline.

10. Nicosia Treatment Plant and Pumping Station

The site chosen for the Treatment Plant lies on the Dhypotamos-Nicosia pipeline route adjacent to the Nicosia-Limassol road and at a distance of 36 km from Nicosia. The Plant will provide for the following stages of treatment.

(a) Prechlorination
(b) Coagulation - Sedimentation
(c) Rapid gravity sand - filtration
(d) Chlorination
(e) pH correction

The works will have a maximum capacity of 20,300 m^3/day but provision will be made for their future extension to 31,800 m^3/d. Storage will be provided upstream and downstream of the Plant to enable continuous operation despite the fact that Pumping Stations will only be operating 18-20 hrs/d on relatively cheap off peak electricity.

A pumping station will be constructed next to the Treatment Plant which will be similar in head and discharge capacity to that part of the Dhypotamos Pumping Station that is to pump water to Khirokitia (Phase II installations). Treated water will be pumped from there to the Stavrovouni Balancing tank from where it will gravitate to the Nicosia Terminal Reservoir.

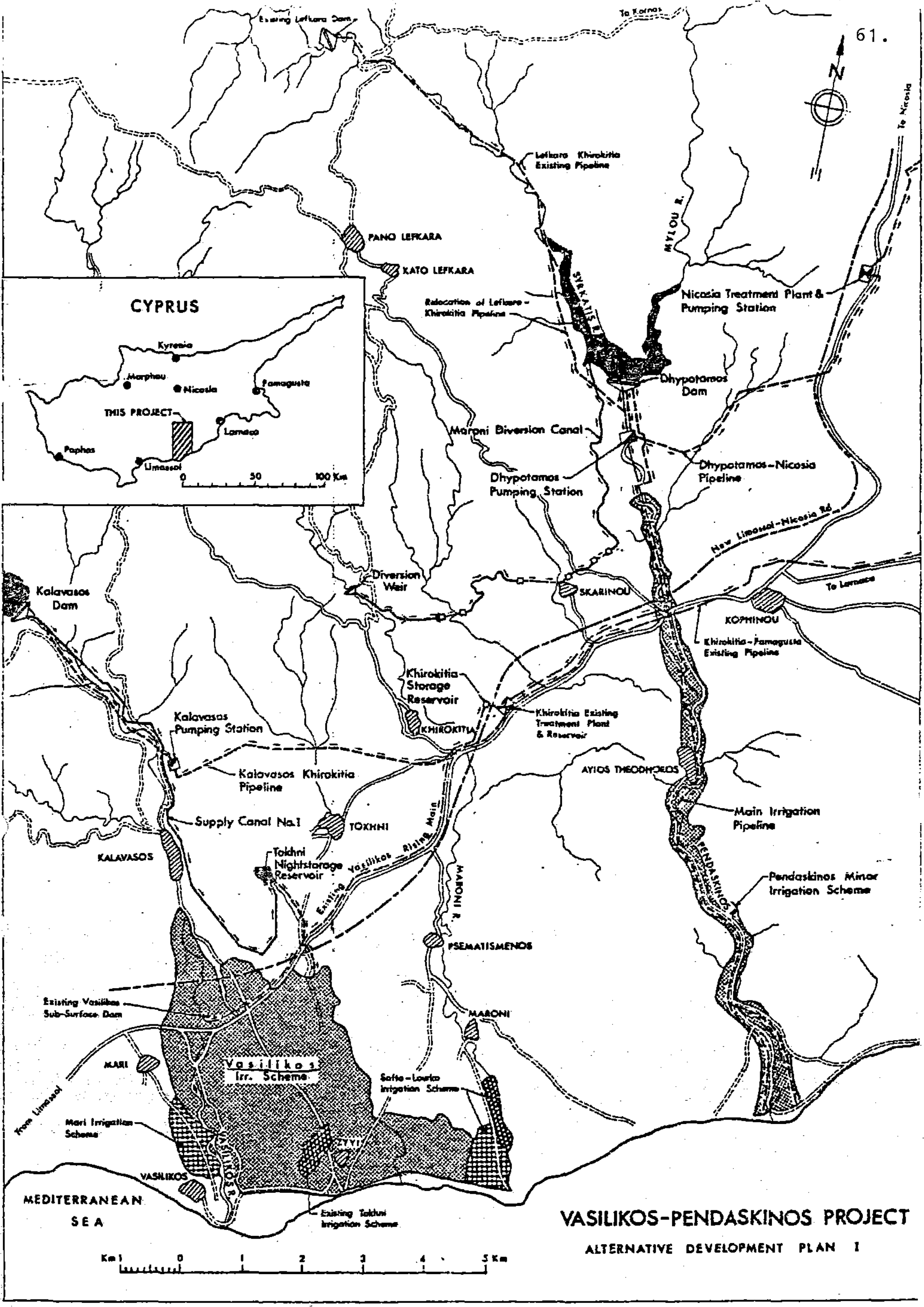
VASILIKOS-PENDASKINOS PROJECT
ALTERNATIVE DEVELOPMENT PLAN I
CYPRUS
Kyrenia
Morphou
Nicosia
Famagusta
THIS PROJECT
Larnaca
Paphos
Limassol
0 50 100 Km
Existing Lefkara Dam
To Kornos
N
To Nicosia
Lefkara Khirokitia Existing Pipeline
PANO LEFKARA
KATO LEFKARA
MYLOU R.
SYRKATIS R.
Relocation of Lefkara-Khirokitia Pipeline
Nicosia Treatment Plant & Pumping Station
Dhypotamos Dam
Maroni Diversion Canal
Dhypotamos-Nicosia Pipeline
Dhypotamos Pumping Station
New Limassol-Nicosia Rd.
Diversion Weir
Kalavasos Dam
SKARINOU
To Larnaca
KOPHINOU
Khirokitia-Famagusta Existing Pipeline
Khirokitia Storage Reservoir
KHIROKITIA
Khirokitia Existing Treatment Plant & Reservoir
Kalavasos Pumping Station
Kalavasos Khirokitia Pipeline
AYIOS THEODHOROS
Main Irrigation Pipeline
Supply Canal No.1
TOKHNI
KALAVASOS
Tokhni Nightstorage Reservoir
Existing Vasilikos Rising Main
MARONI R.
PENDASKINOS R.
Pendaskinos Minor Irrigation Scheme
PSEMATISMENOS
Existing Vasilikos Sub-Surface Dam
MARONI
MARI
Vasilikos Irr. Scheme
Softe-Lourka Irrigation Scheme
From Limassol
Mari Irrigation Scheme
VASILIKOS R.
ZYYI
VASILIKOS
MEDITERRANEAN SEA
Existing Tokhni Irrigation Scheme
Km 1 0 1 2 3 4 5 Km

FIG. 1-1

APPENDIX B

Presentation of the Nodes Used in MITSIM

In this appendix we have intended to give a more detailed description of the nodes used in MITSIM. The most important input for each node is given. As to the output we refer to appendix E.

To describe the commonfeature of most river systems, ten different types of nodes have been incorporated in the model. MITSIM-1 is designed to simulate a river basin with up to 100 separate nodes. These nodes and their maximum numbers are listed in table B1.

Table B1 The nodes represented in MITSIM

Symbols	Name	Maximum number
	Start or streamflow input node	90
	Considered and existing reservoir	35
	Reservoir and hydroelectric plant	35
	Considered and existing irrigation area	20
	Considered and existing municipal and industrial water use (M&I-node)	9
	Diversion node	10
	Confluence node	70
	Groundwater node	15
	Low flow node	5
	Terminal node	<100

Start Nodes

Start nodes represent locations where natural flows as well as intervening flows enter the system. Therefore start nodes must be located at points in the river system where flows from tributaries, from lateral inflow or from groundwater are considered significant. For instance this is the case immediately upstream of an important water withdrawal. Diffusive inflows located between nodes of interest would normally be aggregated to one start node.

Input to the start nodes must be "original flows" which means flows that would occur if the basin was undisturbed. The model accepts monthly streamflow data from disk or tape as well as cards.

Reservoir Nodes

A reservoir node represents either:

1. A storage reservoir alone
2. A storage reservoir with an associated hydroelectric plant
3. A run-of-the-river power plant

No powerplants are involved in our study at Cyprus, therefore we concentrate the discussion to the first alternative.

For the reservoir node the storage volume is calculated for each month. From this volume water is allocated to different users and/or to satisfy a downstream minum flow in the river. The node can have two outlets of which one has priority (Fig.1). For these outlets monthly target releases are specified in the input.

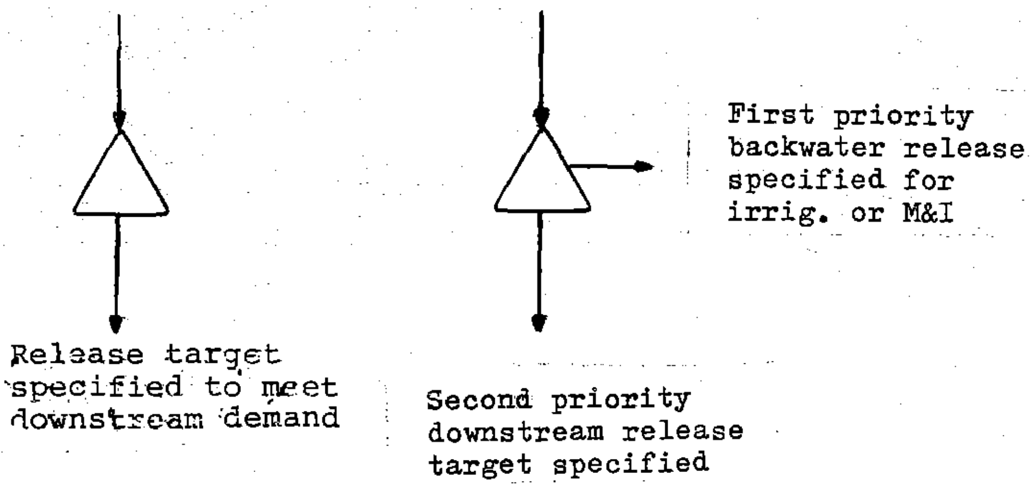

Figure B1 Different flow schemes for reservoir nodes

The operation within the node starts with a calculation of available water. This amount is received by adding the inflow during the month to the water stored at the beginning of the month. From this value the evaporation during the month can be subtracted. Then the water is allocated according to the "Standard Operating Policy" to different water users or to satisfy downstream low flow target. This rule is divided into three cases, which depend on the amount of available water.

In Case I, the available water is insufficient to meet the target release. All available water will therefore be released in an effort to at least partially satisfy the demand.

In Case II, there is sufficient water. All water not required for immediate use is stored for future use.

In Case III, the available water, after demands have been satisfied, exceeds the active storage capacity of the reservoir. All water in excess of this capacity is released downstream and registered as spill.

Some of the most important input data to the node are described in table B2.

Table B2 Most important input data to a reservoir node

Hydrologic Data	Economic Data
• Storage volume and surface area as functions of water elevation	• Discounted capital and OMR costs as functions of water elevation for the full reservoir.
• Monthly target releases; i.e. for downstream or possible backwater withdrawal	
• Initial and simulated storage volumes for the reservoir	
• Minimum and maximum storage volumes to which the reservoir operation is constrained for each month	
• Monthly evaporation values	

Irrigation Nodes

These nodes are used in MITSIM to signify the river-related effects of irrigated agricultural activity.

To each irrigation node is given a target of the monthly water supply. This corresponds to the size of the area and the cropping pattern. The expected monthly values of effective precipitation can also be given as input. If the inflow to the node exceeds its target demand the surplus water is sent downstream. (Fig. 2). When it fails to reach this target, all water is diverted. Conveyance losses, which return to the river, can be subtracted from the diverted water.

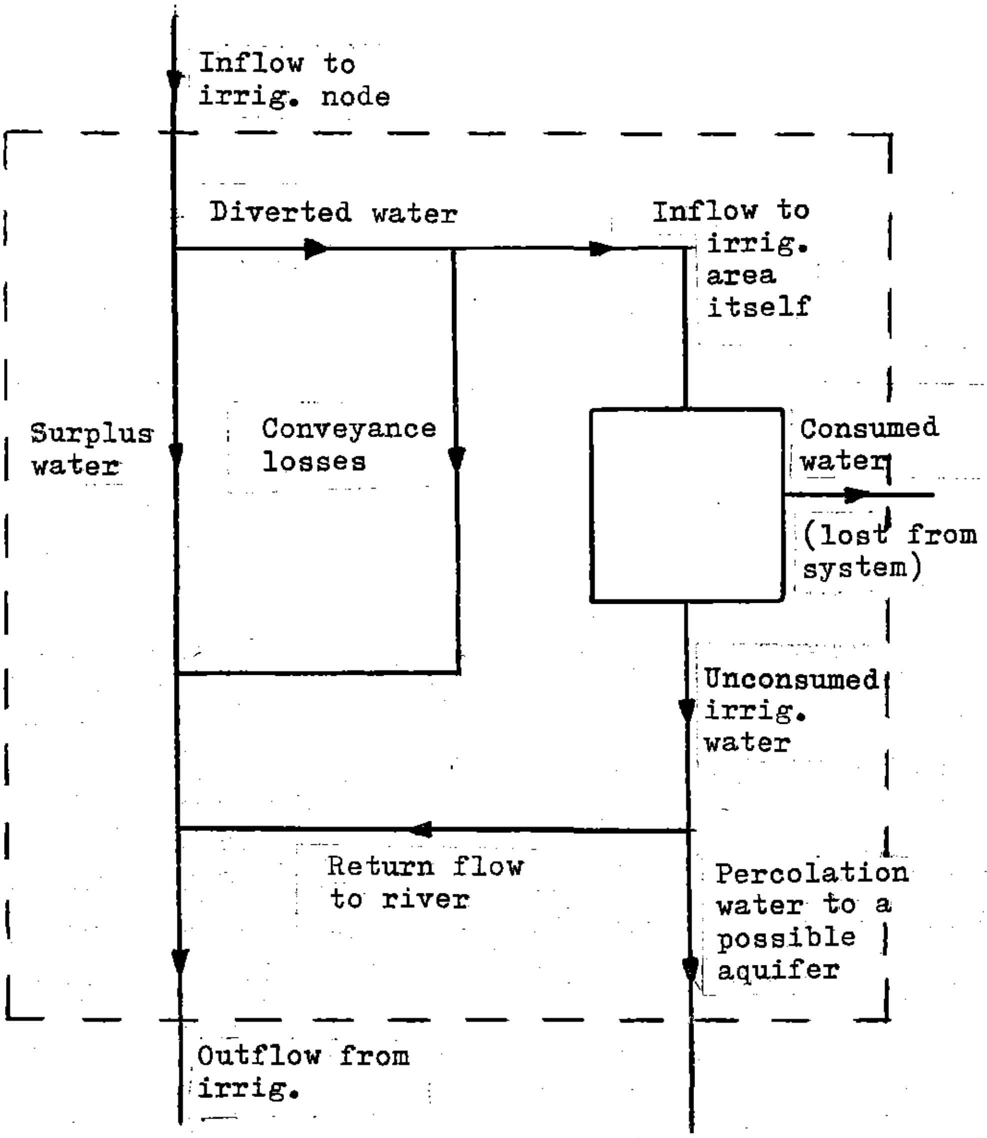

Figure B2 Irrigation node schematic

Unconsumed water can return to the river basin depending on the irrigation efficiency and the effective precipitation. If irrigation efficiency is hundred per cent and precipitation zero all water is consumed. The returning water percolates to an aquifer and/or reaches the river as surface water (Figure 3).

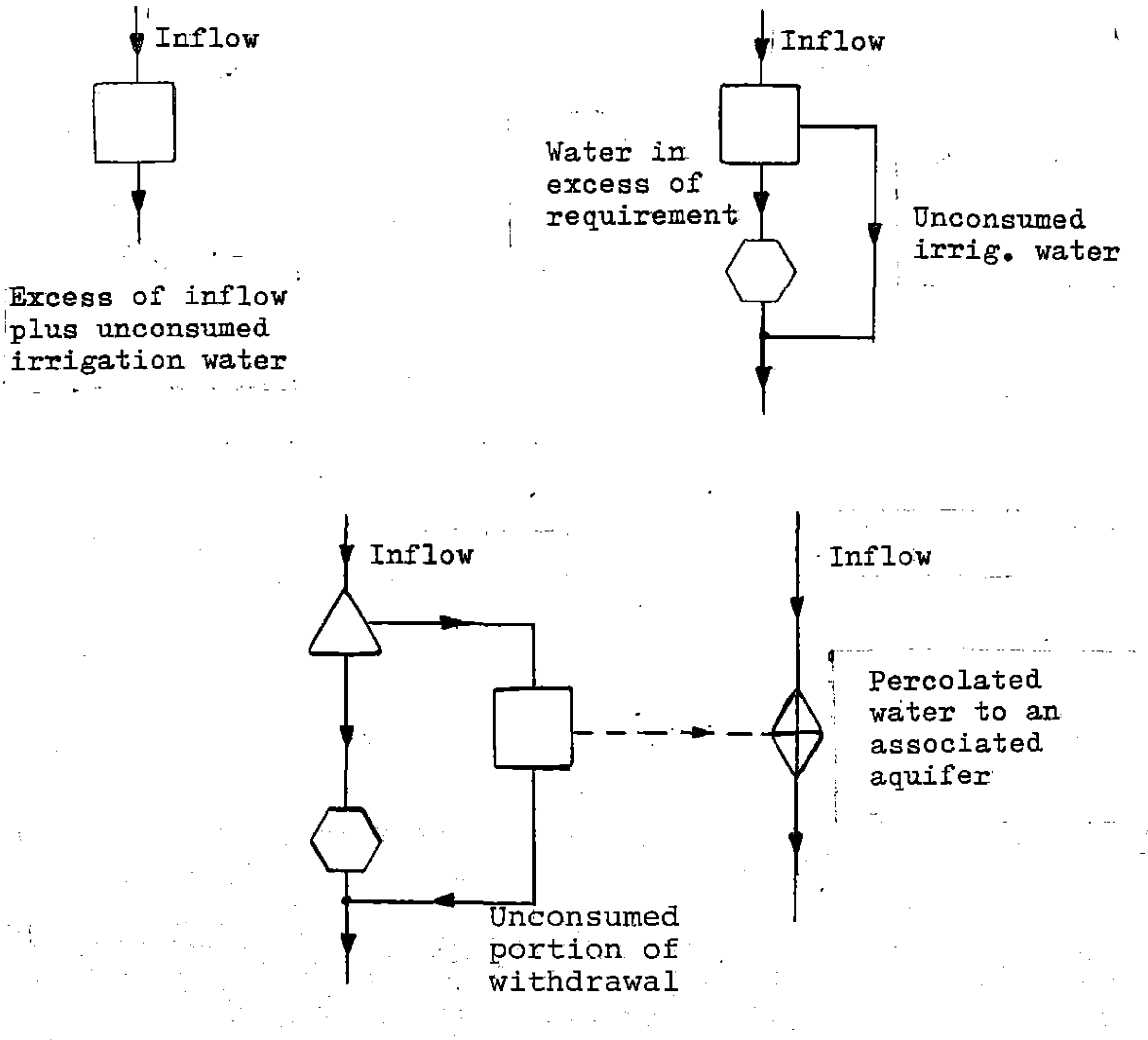

Figure B3 Irrigation return flow schemes

Table B3 Most important input data to an irrigation node

Hydrologic Data

- Irrigated area to be simulated
- Total annual water demand
- Monthly target demand to be diverted to the irrigation area
- Expected rainfall for each month of the year
- Consumptive use for the crops within the irrigation area for each month
- Irrigated area to be simulated
- Conveyance losses and irrigation efficiency

Economic Data

- Discounted capital and OMR costs as functions of irrigated area
- Annual long-term benefit per hectare
- Parameters of a quadratic loss function ($y=ax^2 + bx$) used when calculating the short term losses

Municipal and Industrial Water Supply Nodes

Municipal and industrial supply nodes (M&I) represent concentrated water demands for domestic or industry use. As input such demands are given as monthly target values at each M&I node.

The diversion rule of the M&I is similar to the irrigation node. This means that inflow exceeding the target flows downstream in the river.

The consumed water is given as a percentage of the M&I supply for each node. The unconsumed water is added directly to the river or at another place in the river system (fig. 4).

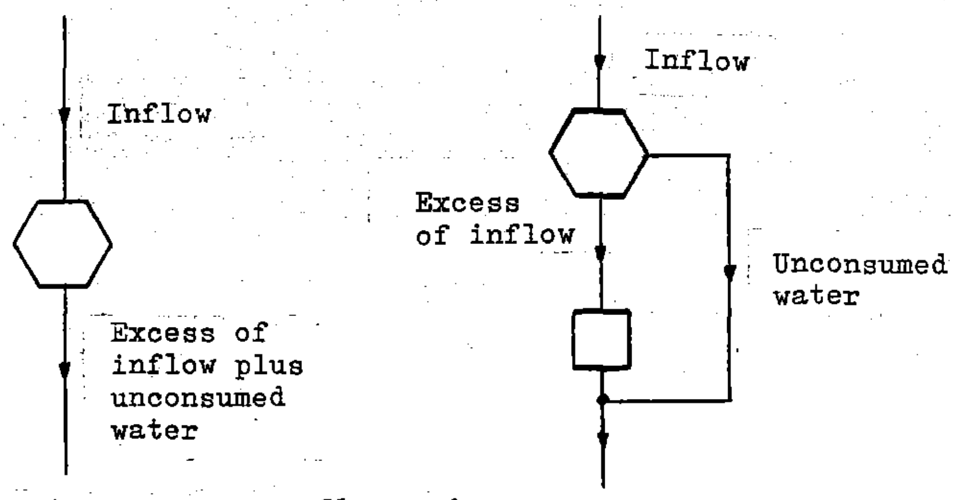

Figure B4 M&I return flow schemes

Table B4 Most important inputdata to a M&I node

Hydrologic Data

- The percentage of the water demand which is assumed to be consumptively used
- Total annual water demand
- Monthly target demand for each month of the year

Economic Data

- The long term annual benefit per unit of water
- The short term loss per unit of water, not meeting the demand

Diversion Nodes

Diversion nodes indicate locations where water is diverted from the river for a special purpose or to be transferred to another tributary.

The diversion rule gives a downstream release priority. This means that water is not diverted before the downstream target is met (fig. 5).

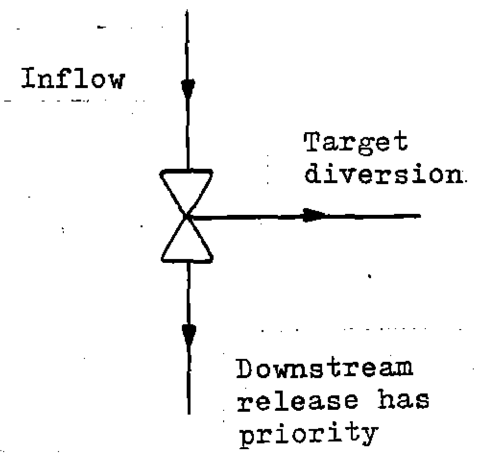

Figure B5 The diversion node

Table B5 Most important input data to a diversion node

Hydrologic Data

- Designed diversion flow capacity
- The target diversion for each month
- The downstream target release for each month

Economic Data

- Discounted capital and OMR costs as functions of designed diversion flow

Confluence Nodes

Confluence nodes describes points where several upstream river channels or man-made conceyance structures converges or where flows from water users return to the river.

The node adds two flows together. When more than two flows converge they are subsequently added two by two (fig. 6).

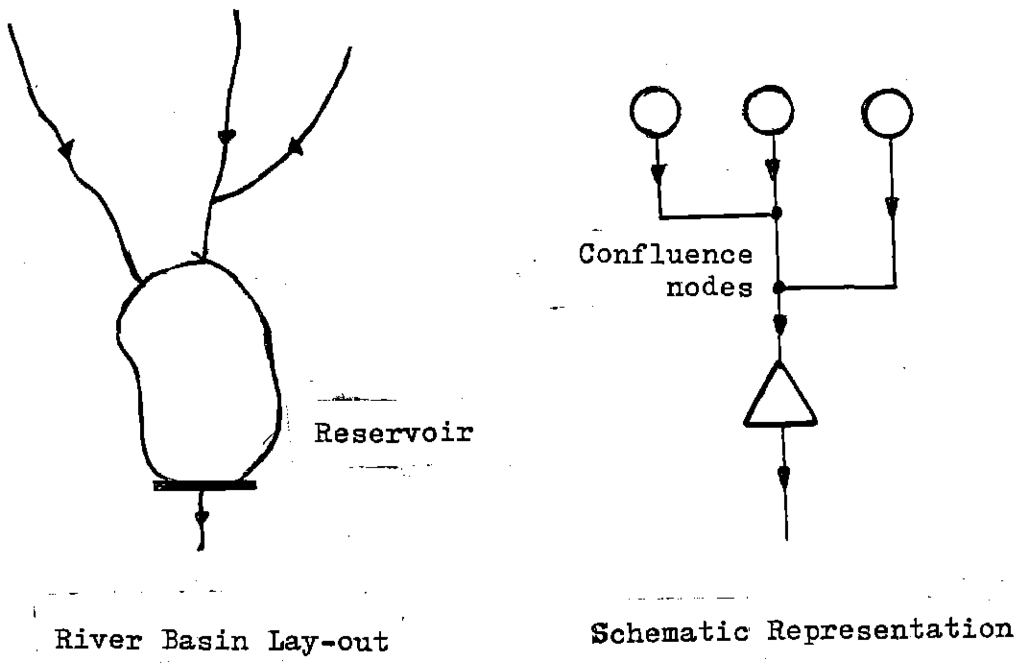

Figure B6 The use of confluence nodes

Groundwater Nodes

The groundwater node operates much like a reservoir. Monthly targets of water to be pumped from the aquifer are specified as input.

Recharge may be simulated as a percentage of the unconsumed irrigation water. As in our case it can also be filled up directly from the river (fig. 7). A groundwater has only one outlet.

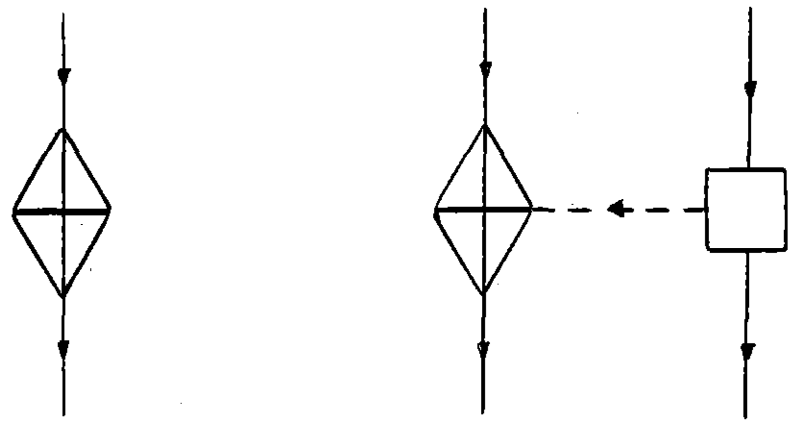

Figure B7 Recharges to a groundwater node

The groundwater node describes an aquifer in a rather approximate way.

Table B6 Most important inputdata to a groundwater node

Hydrologic Data	Economic Data
• Groundwater head levels and pumping capacities which correspond to storage volumes	• Pumping energy cost per kilowatt-hour
• Maximum and initial storage volume	• Capital and OMR costs as functions of installed groundwater pumping capacities
• The annual groundwater target to be pumped	
• Monthly supply target for each month of the year	

Low-flow Nodes

These nodes only register flows at locations where minimum flows must be maintained for reasons of water quality, fish and wild life, navigation etc.

For each lowflow node monthly minimum targets flow are given as input.

Therminal Nodes

These nodes are the endpoints or boundaries of the system and usually represent outlets to the sea.

APPENDIX C

Input for the Basic Proposal

<u>Part 2:</u>

Information about node connectivity. The names of the nodes which are immediately downstream and upstream of the actual node.

Information about cost- and benefit allocation and desired output.

```
PART 2
 0
  INFLOW 3              1     2      0   LEF DAM
  INFLOW 3                           0             0              0
                                                   0.0                 0
    LEF DAM             2     2      0   LEF IRR   KHCHECK1   INFLOW 3
    LEF DAM                          0             1              0
                                                   0.0                 0
  KHCHECK1              9     2      0   CONFL 4                LEF DAM
  KHCHECK1                           0             0              0
                                                   0.0                 0
  INFLOW 1              1     1      0  UPS.USE1
  INFLOW 1                           0             0              0
                                                   0.0                 0
  UPS.USE1              9     1      0    KALDAM              INFLOW 1
  UPS.USE1                           0             0              0
                                                   0.0                 0
      KALDAM            2     1      1  INFLOW 2       DIV 1  UPS.USE1
      KALDAM                         0             1              1
      KALDAM               KHIRECON               22.80                0
      KALDAM               VASIRRCI               44.70                0
      KALDAM               VASIRRVE               23.90                0
      KALDAM               VASIRRVI                8.60                0
                                                   0.0                 0
        DIV 1           4     1      0  VASIRRCI  KHIRECON      KALDAM
        DIV 1                        0             1              1
                                                   0.0                 0
```

```
VASIRRCI     6    1    1   VASIRRVI                      DIV 1
VASIRRCI               0          1           1
VASIRRCI          KALDAM          0.0              0
                                  0.0              0
VASIRRVI     6    1    1   VASIRRVE                VASIRRCI
VASIRRVI               0          1           0
VASIRRVI          KALDAM          0.0              0
                                  0.0              0
VASIRRVE     6    1    1      END 1                VASIRRVI
VASIRRVE               0          1           0
VASIRRVE          KALDAM          0.0              0
                                  0.0              0
   END 1    11    1    0                           VASIRRVI
   END 1               0          0           0
                                  0.0              0
INFLOW 2     1    1    0   UPS.USE2                  KALDAM
INFLOW 2               0          0           0
                                  0.0              0
UPS.USE2     9    1    0     VASSUB                INFLOW 2
UPS.USE2               0          0           0
                                  0.0              0
  VASSUB    10    1    0      DIV 5                UPS.USE2
  VASSUB               0          0           0
                                  0.0              0
   END 2    11    1    0                             DIV 5
   END 2               0          0           1
                                  0.0              0
SUBCHECK     8    1    0    CONFL 1                  DIV 5
SUBCHECK               0          1           0
                                  0.0              0
   DIV 5     4    1    0   SUBCHECK       END 2     VASSUB
   DIV 5               0          0           0
                                  0.0              0
KHIRECON     9    1    0    CONFL 1                  DIV 1
KHIRECON               0          0           0
KHIRECON          KALDAM          0.0              0
                                  0.0              0
 CONFL 1     3    1    0   KHCHECK2                KHIRECON  SUBCHECK
 CONFL 1               0          0           0
                                  0.0              0
KHCHECK2     9    1    0    CONFL 4                 CONFL 1
KHCHECK2               0          0           0
                                  0.0              0
 CONFL 4     3    4    0   KHIROKIT                KHCHECK1  KHCHECK2
 CONFL 4               0          0           0
                                  0.0              0
KHIROKIT     9    4    0      END 3                 CONFL 4
KHIROKIT               0          0           0
                                  0.0              0
   END 3    11    4    0                           KHIROKIT
   END 3               0          0           0
                                  0.0              0
 LEF IRR     6    2    0   INFLOW 4                 LEF DAM
 LEF IRR               0          0           0
                                  0.0              0
INFLOW 4     1    2    0    CONFL 2                 LEF IRR
INFLOW 4               0          0           0
                                  0.0              0
 CONFL 2     3    2    0   DHYP.DAM                INFLOW 4     DIV 6
 CONFL 2               0          0           0

                                  0.0              0
   DIV 2     4    2    1    CONFL 5       DIV 6    UPS.USE3
   DIV 2               0          1           0
   DIV 2         NICOSIA          77.60            0
   DIV 2        PENIRRVE          22.40            0
                                  0.0              0
   DIV 6     4    2    1    CONFL 2     CONFL 5      DIV 2
   DIV 6               0          1           1
                                  0.0              0
INFLOW 6     1    2    0   UPS.USE3
INFLOW 6               0          0           0
                                  0.0              0
UPS.USE3     9    2    0      DIV 2                INFLOW 6
UPS.USE3               0          0           0
                                  0.0              0
GYPCHECK     8    3    0   INFLOW 7                 CONFL 5
GYPCHECK               0          1           0
                                  0.0              0
INFLOW 7     1    3    0      DIV 4                GYPCHECK
INFLOW 7               0          0           0
                                  0.0              0
```

```
CONFL 5      3    3    0   GYPCHECK                      DIV 2     DIV 6
CONFL 5                0         0              0
                                 0.0            0
DIV 4        4    3    0   CONFL 6   GYPS.AQV   INFLOW 7
DIV 4                  0         1              1
                                 0.0            0
GYPS.AQV     2    3    0   CONFL 6   S.LO.IRR      DIV 4
GYPS.AQV               0         1              0
                                 0.0            0
CONFL 6      3    3    0      END 7             GYPS.AQV     DIV 4
CONFL 6                0         0              0
                                 0.0            0
END 7       11    3    0                          CONFL 6
END 7                  0         0              1
                                 0.0            0
S.LO.IRR     6    3    1   MARI IRR             GYPS.AQV
S.LO.IRR               0         0              0
                                 0.0            0
MARI IRR     6    3    1   TOKNIIRR             S.LO.IRR
MARI IRR               0         0              0
                                 0.0            0
HELL.COM     9    3    0      END 8             TOKNIIRR
HELL.COM               0         0              0
                                 0.0            0
TOKNIIRR     6    3    0   HELL.COM             MARI IRR
TOKNIIRR               0         0              0
                                 0.0            0
END 8       11    3    0                        HELL.COM
END 8                  0         0              0
                                 0.0            0
DHYP.DAM     2    2    1   CONFL 3      DIV 3     CONFL 2
DHYP.DAM               0         1              1
DHYP.DAM          NICOSIA       77.60           0
DHYP.DAM          PENIRRVE      22.40           0
                                 0.0            0
DIV 3        4    2    1   NICOSIA      END 5   DHYP.DAM
DIV 3                  0         0              0
DIV 3             NICOSIA      100.00           0
                                 0.0            0

END 5       11    2    0                           DIV 3
END 5                  0         0              0
                                 0.0            0
NICOSIA      9    2    0      END 4                DIV 3
NICOSIA                0         1              0
NICOSIA           DHYP.DAM       0.0            0
NICOSIA              DIV 3       0.0            0
NICOSIA              DIV 2       0.0            0
                                 0.0            0
END 4       11    2    0                          NICOSIA
END 4                  0         0              0
                                 0.0            0
GR.WATER    10    2    0   CONFL 3              INFLOW 5
GR.WATER               0         0              0
                                 0.0            0
CONFL 3      3    2    0   PENIRRCI             DHYP.DAM   GR.WATER
CONFL 3                0         0              0
                                 0.0            0
INFLOW 5     1    2    0   GR.WATER
INFLOW 5               0         0              0
                                 0.0            0
PENIRRCI     6    2    0   PENIRRVE               CONFL 3
PENIRRCI               0         1              1
                                 0.0            0
PENIRRVE     6    2    1      END 6             PENIRRCI
PENIRRVE               0         1              1
PENIRRVE          DHYP.DAM       0.0            0
PENIRRVE             DIV 2       0.0            0
                                 0.0            0
END 6       11    2    0                        PENIRRVE
END 6                  0         0              0
                                 0.0            0
FINISH       0    0    0
```

Part 3:

Reservoir node input.

Information about the design of the dam, monthly target releases, evaporation etc.

PART 3						
KALDAM	4	1				1
KALDAM	0.0	0.0	0.0			
KALDAM	170.50	173.00	175.00	176.00	176.50	177.00
	1732500.00	1866500.00	1986000.00	2048200.00	2079000.00	2109800.00
	170.50	173.00	175.00	176.00	176.50	177.00
	56575.00	61664.00	64873.00	66884.00	67890.00	68896.00
KALDAM	170.50	173.00	175.00	176.00	176.50	177.00
	0.70	0.77	0.83	0.86	0.88	0.89
	12.00	14.00	15.50	16.50	17.00	17.50
KALDAM	17.00	17.00	5.60	2.50	1.10	0.0
KALDAM	0.0	0.30	0.0	0.0	1.10	14.00
KALDAM	0.0	0.16	0.0	0.0	1.10	14.00
KALDAM	0.0	0.13	0.0	10.20	1.10	14.00
KALDAM	0.0	0.22	0.0	71.90	1.10	14.00
KALDAM	0.0	0.80	0.0	129.20	1.10	14.00
KALDAM	0.0	1.24	0.0	191.00	1.10	14.00
KALDAM	0.0	1.39	0.0	217.80	1.10	14.00
KALDAM	0.0	1.47	0.0	207.30	1.10	14.00
KALDAM	0.0	1.15	0.0	151.20	1.10	14.00
KALDAM	0.0	0.82	0.0	76.40	1.10	14.00
KALDAM	0.0	0.64	0.0	15.30	1.10	14.00
KALDAM	0.0	0.45	0.0	0.0	1.10	14.00
GYPS.AQV	4	1				
GYPS.AQV	0.0	0.0	0.0			
GYPS.AQV	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
GYPS.AQV	100.00	200.00	400.00	0.0	0.0	0.0
	0.01	0.01	0.01	0.0	0.0	0.0
	1.20	2.40	4.80	0.0	0.0	0.0
GYPS.AQV	4.50	4.50	4.00	2.50	0.0	0.0
GYPS.AQV	0.0	0.06	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.06	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.10	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.19	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.25	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.24	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.20	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.20	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.16	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.12	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.09	0.0	0.0	0.0	4.50
GYPS.AQV	0.0	0.06	0.0	0.0	0.0	4.50
LEF DAM	4	1				
LEF DAM	0.0	0.0	0.0			
LEF DAM	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
LEF DAM	291.00	310.00	320.00	330.00	345.00	361.00
	0.0	0.05	0.10	0.22	0.45	0.74
	0.0	0.20	1.00	2.50	7.50	16.00
LEF DAM	13.85	13.85	10.00	0.37	1.00	0.0
LEF DAM	0.00	0.43	0.0	0.0	1.00	13.85
LEF DAM	0.00	0.43	0.0	0.0	1.00	13.85
LEF DAM	0.01	0.43	0.0	0.0	1.00	13.85
LEF DAM	0.03	0.43	0.0	64.90	1.00	13.85
LEF DAM	0.06	0.43	0.0	124.40	1.00	13.85
LEF DAM	0.09	0.43	0.0	188.20	1.00	13.85
LEF DAM	0.09	0.43	0.0	217.10	1.00	13.85
LEF DAM	0.09	0.43	0.0	206.70	1.00	13.85
LEF DAM	0.07	0.43	0.0	146.70	1.00	13.85
LEF DAM	0.04	0.43	0.0	68.40	1.00	13.85
LEF DAM	0.02	0.43	0.0	3.30	1.00	13.85
LEF DAM	0.00	0.43	0.0	0.0	1.00	13.85
DHYP.DAM	4	1				
DHYP.DAM	0.0	0.0	0.0			
DHYP.DAM	169.00	171.50	173.50	175.50	177.50	180.00
	232000.00	1378300.00	1516900.00	1617000.00	1732500.00	1832600.00
	169.00	171.50	173.50	175.50	177.50	180.00
	61660.00	68915.00	75845.00	80850.00	86625.00	91630.00
DHYP.DAM	169.00	171.50	173.50	175.50	177.50	180.00
	0.72	0.81	0.91	1.01	1.08	1.18
	10.00	12.00	14.00	16.00	18.00	20.00
DHYP.DAM	15.00	15.00	3.60	2.50	1.40	0.0
DHYP.DAM	0.0	0.30	0.0	0.0	1.40	20.00
DHYP.DAM	0.0	0.30	0.0	0.0	1.40	20.00
DHYP.DAM	0.0	0.30	0.0	10.20	1.40	20.00
DHYP.DAM	0.0	0.42	0.0	71.90	1.40	20.00
DHYP.DAM	0.15	0.55	0.0	129.20	1.40	20.00
DHYP.DAM	0.25	0.55	0.0	191.00	1.40	20.00
DHYP.DAM	0.39	0.55	0.0	220.80	1.40	20.00
DHYP.DAM	0.39	0.55	0.0	207.30	1.40	20.00
DHYP.DAM	0.30	0.55	0.0	151.20	1.40	20.00
DHYP.DAM	0.66	0.42	0.0	76.40	1.40	20.00
DHYP.DAM	0.0	0.42	0.0	20.30	1.40	20.00
DHYP.DAM	0.0	0.30	0.0	0.0	1.40	20.00

Part 4:

The names of each confluence node.

Part 5:

Information about the monthly streamflow data.

```
PART  4
      CONFL  1
      CONFL  2
      CONFL  3
      CONFL  4
      CONFL  5
      CONFL  6
        FINISH
PART  5
CARD
  INFLOW  1                    1
  INFLOW  2                    2
  INFLOW  3                    3
  INFLOW  4                    4
  INFLOW  5                    5
  INFLOW  6                    6
  INFLOW  7                    7
      FINISH                   0
```

Part 6:

Irrigation node input.

Information about size, water demand, precipitation, annual longterm benefit, costs etc.

PART 6						
VASIRRCI	412.00	412.00				
VASIRRCI	200.00	413.00	0.0	0.0	0.0	0.0
	172450.00	355247.00	0.0	0.0	0.0	0.0
	200.00	413.00	0.0	0.0	0.0	0.0
	18449.00	38006.00	0.0	0.0	0.0	0.0
VASIRRCI	904.50	0.73	0.04	0.19	3.93	
VASIRRCI		0.0	100.00	0.0	0.0	1.00
VASIRRCI	0.02	0.0	0.20	0.0		
VASIRRCI	0.0	0.0	0.0	0.0		
VASIRRCI	0.16	0.0	1.10	0.0		
VASIRRCI	2.40	0.0	23.30	0.0		
VASIRRCI	11.50	0.0	109.50	0.0		
VASIRRCI	17.40	0.0	165.70	0.0		
VASIRRCI	20.80	0.0	198.10	0.0		
VASIRRCI	19.90	0.0	190.10	0.0		
VASIRRCI	15.10	0.0	143.70	0.0		
VASIRRCI	8.40	0.0	80.10	0.0		
VASIRRCI	3.80	0.0	36.40	0.0		
VASIRRCI	0.60	0.0	5.30	0.0		
VASIRRVE	261.00	261.00				
VASIRRVE	130.00	262.00	0.0	0.0	0.0	0.0
	112092.00	225047.00	0.0	0.0	0.0	0.0
	130.00	262.00	0.0	0.0	0.0	0.0
	11992.00	24076.00	0.0	0.0	0.0	0.0
VASIRRVE	1124.00	0.57	0.0	1.73	2.10	
VASIRRVE		0.0	100.00	0.0	0.0	1.00
VASIRRVE	6.80	0.0	20.70	0.0		
VASIRRVE	4.47	0.0	21.30	0.0		
VASIRRVE	2.29	0.0	41.90	0.0		
VASIRRVE	2.57	0.0	91.10	0.0		
VASIRRVE	2.64	0.0	127.60	0.0		
VASIRRVE	5.19	0.0	122.00	0.0		
VASIRRVE	11.30	0.0	98.00	0.0		
VASIRRVE	15.82	0.0	98.90	0.0		
VASIRRVE	15.13	0.0	75.70	0.0		
VASIRRVE	12.15	0.0	54.80	0.0		
VASIRRVE	12.26	0.0	36.10	0.0		
VASIRRVE	9.39	0.0	18.50	0.0		
VASIRRVI	157.00	157.00				
VASIRRVI	75.00	159.00	0.0	0.0	0.0	0.0
	64669.00	135373.00	0.0	0.0	0.0	0.0
	75.00	159.00	0.0	0.0	0.0	0.0
	6918.50	14483.00	0.0	0.0	0.0	0.0
VASIRRVI	449.00	0.45	0.03	0.84	0.75	
VASIRRVI		0.0	100.00	0.0	0.0	1.00
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	29.40	0.0	140.80	0.0		
VASIRRVI	35.40	0.0	169.00	0.0		
VASIRRVI	17.60	0.0	84.50	0.0		
VASIRRVI	17.60	0.0	84.50	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
VASIRRVI	0.0	0.0	0.0	0.0		
S.LO.IRR	86.00	86.00				
S.LO.IRR	40.00	87.00	0.0	0.0	0.0	0.0
	8244.00	17725.00	0.0	0.0	0.0	0.0
	40.00	87.00	0.0	0.0	0.0	0.0
	16015.00	34432.00	0.0	0.0	0.0	0.0
S.LO.IRR	445.00	0.57	0.03	0.84	0.72	
S.LO.IRR		0.0	100.00	0.0	0.0	1.00
S.LO.IRR	2.70	0.0	21.00	0.0		
S.LO.IRR	2.80	0.0	21.50	0.0		
S.LO.IRR	5.40	0.0	42.00	0.0		
S.LO.IRR	11.50	0.0	89.30	0.0		
S.LO.IRR	15.90	0.0	123.30	0.0		
S.LO.IRR	15.00	0.0	116.80	0.0		
S.LO.IRR	12.00	0.0	93.10	0.0		
S.LO.IRR	12.00	0.0	93.30	0.0		
S.LO.IRR	9.20	0.0	71.60	0.0		
S.LO.IRR	6.70	0.0	52.30	0.0		
S.LO.IRR	4.50	0.0	35.30	0.0		
S.LO.IRR	2.30	0.0	18.60	0.0		
PART IRR	48.00	48.00				
PART IRR	20.00	49.00	0.0	0.0	0.0	0.0
	21250.00	51000.00	0.0	0.0	0.0	0.0
	20.00	49.00	0.0	0.0	0.0	0.0
	16328.00	39186.00	0.0	0.0	0.0	[illegible]
PART IRR	698.00	0.57	[illegible]	[illegible]	[illegible]	

PENIRRCI	0.12	0.0	1.10	0.0		
PENIRRCI	2.44	0.0	23.34	0.0		
PENIRRCI	11.48	0.0	109.55	0.0		
PENIRRCI	17.38	0.0	165.70	0.0		
PENIRRCI	20.77	0.0	198.10	0.0		
PENIRRCI	19.93	0.0	190.10	0.0		
PENIRRCI	15.07	0.0	143.70	0.0		
PENIRRCI	8.40	0.0	80.10	0.0		
PENIRRCI	3.82	0.0	36.40	0.0		
PENIRRCI	0.56	0.0	5.30	0.0		
PENIRRVE	75.00	75.00				
PENIRRVE	75.00	150.00	0.0	0.0	0.0	0.0
	202000.00	404000.00	0.0	0.0	0.0	0.0
	75.00	150.00	0.0	0.0	0.0	0.0
	21614.00	43228.00	0.0	0.0	0.0	0.0
PENIRRVE	1065.90	0.76	0.0	1.73	0.60	
PENIRRVE		0.0	100.00	0.0	0.0	1.00
PENIRRVE	0.21	0.0	20.84	0.0		
PENIRRVE	0.32	0.00	1.41	0.0		
PENIRRVE	2.24	0.0	42.07	0.0		
PENIRRVE	9.67	0.0	91.26	0.0		
PENIRRVE	14.26	0.0	127.60	0.0		
PENIRRVE	17.13	0.0	121.80	0.0		
PENIRRVE	15.51	0.0	97.77	0.0		
PENIRRVE	16.73	0.0	98.51	0.0		
PENIRRVE	12.82	0.0	75.45	0.0		
PENIRRVE	7.56	0.0	54.75	0.0		
PENIRRVE	3.61	0.0	36.09	0.0		
PENIRRVE	0.53	0.0	18.60	0.0		
FINISH	0.0	0.0				
MARI IRR		0.0	100.00	0.0	0.0	1.00
MARI IRR	2.70	0.0	21.00	0.0		
MARI IRR	2.80	0.0	21.50	0.0		
MARI IRR	5.40	0.0	42.00	0.0		
MARI IRR	11.50	0.0	89.30	0.0		
MARI IRR	15.90	0.0	123.30	0.0		
MARI IRR	15.00	0.0	116.80	0.0		
MARI IRR	12.00	0.0	93.10	0.0		
MARI IRR	12.00	0.0	93.30	0.0		
MARI IRR	9.20	0.0	71.60	0.0		
MARI IRR	6.70	0.0	52.30	0.0		
MARI IRR	4.50	0.0	35.30	0.0		
MARI IRR	2.30	0.0	18.60	0.0		
TOKNIIRR	42.00	42.00				
TOKNIIRR	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
TOKNIIRR	0.0	0.57	0.0	0.0	0.33	
TOKNIIRR		0.0	100.00	0.0	0.0	1.00
TOKNIIRR	2.70	0.0	21.00	0.0		
TOKNIIRR	2.80	0.0	21.50	0.0		
TOKNIIRR	5.40	0.0	42.00	0.0		
TOKNIIRR	11.50	0.0	89.30	0.0		
TOKNIIRR	15.90	0.0	123.30	0.0		
TOKNIIRR	15.00	0.0	116.80	0.0		
TOKNIIRR	12.00	0.0	93.10	0.0		
TOKNIIRR	12.00	0.0	93.30	0.0		
TOKNIIRR	9.20	0.0	71.60	0.0		
TOKNIIRR	6.70	0.0	52.30	0.0		
TOKNIIRR	4.50	0.0	35.30	0.0		
TOKNIIRR	2.30	0.0	18.60	0.0		
LEE IRR	55.00	55.00				
LEE IRR	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
LEE IRR	0.0	0.0	0.0	0.0	0.50	
LEE IRR		0.0	100.00	0.0	0.0	1.00
LEE IRR	0.11	0.0	1.00	0.0		
LEE IRR	0.15	0.0	1.35	0.0		
LEE IRR	1.11	0.0	10.00	0.0		
LEE IRR	5.60	0.0	49.85	0.0		
LEE IRR	12.78	0.0	114.85	0.0		
LEE IRR	17.26	0.0	155.05	0.0		
LEE IRR	18.31	0.0	164.40	0.0		
LEE IRR	18.43	0.0	165.55	0.0		
LEE IRR	14.01	0.0	125.85	0.0		
LEE IRR	8.00	0.0	71.90	0.0		
LEE IRR	3.72	0.0	33.40	0.0		
LEE IRR	0.55	0.0	4.90	0.0		
PENIRRCI	150.00	150.00				
PENIRRCI	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
PENIRRCI	0.0	0.0	0.0	0.0	1.43	
PENIRRCI		0.0	100.00	0.0	0.0	0.78
PENIRRCI	0.02	0.0	0.20	0.0		
PENIRRCI	0.0	0.0	0.0	0.0		

Part 7:

Information for diversion nodes.

Target diversion, downstream release and costs.

PART 7						
DIV 1	1.00	1.00				
DIV 1	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
DIV 1	0.14	0.15				
DIV 1	0.09	0.08				
DIV 1	0.05	0.07				
DIV 1	0.15	0.07				
DIV 1	0.73	0.07				
DIV 1	1.16	0.18				
DIV 1	1.19	0.20				
DIV 1	1.25	0.22				
DIV 1	0.91	0.23				
DIV 1	0.59	0.23				
DIV 1	0.41	0.23				
DIV 1	0.22	0.23				
DIV 2	1.00	2.00				
DIV 2	0.50	1.00	2.00	0.0	0.0	0.0
	227500.00	445000.00	910000.00	0.0	0.0	0.0
	0.50	1.00	2.00	0.0	0.0	0.0
	29790.00	59578.00	119156.00	0.0	0.0	0.0
DIV 2	0.23	0.0				
DIV 2	0.28	0.0				
DIV 2	0.22	0.0				
DIV 2	0.11	0.0				
DIV 2	0.06	0.0				
DIV 2	0.0	0.0				
DIV 2	0.0	0.0				
DIV 2	0.0	0.0				
DIV 2	0.0	0.0				
DIV 2	0.0	0.0				
DIV 2	0.0	0.0				
DIV 2	0.10	0.0				
DIV 3	0.35	0.35				
DIV 3	0.34	0.36	0.0	0.0	0.0	0.0
	1962000.00	1962000.00	0.0	0.0	0.0	0.0
	0.34	0.36	0.0	0.0	0.0	0.0
	187100.00	187100.00	0.0	0.0	0.0	0.0
DIV 3	0.30	0.0				
DIV 3	0.30	0.0				
DIV 3	0.30	0.0				
DIV 3	0.42	0.0				
DIV 3	0.55	0.0				
DIV 3	0.55	0.0				
DIV 3	0.55	0.0				
DIV 3	0.55	0.0				
DIV 3	0.55	0.0				
DIV 3	0.42	0.0				
DIV 3	0.42	0.0				
DIV 3	0.30	0.0				
DIV 4	0.58	0.58				
DIV 4	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 4	0.0	1.50				
DIV 5	1.00	1.00				
DIV 5	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
DIV 5	0.08	0.0				
DIV 5	0.15	0.0				
DIV 5	0.16	0.0				
DIV 5	0.16	0.0				
DIV 5	0.16	0.0				
DIV 5	0.05	0.0				
DIV 5	0.03	0.0				
DIV 5	0.01	0.0				
DIV 5	0.00	0.0				
DIV 5	0.00	0.0				
DIV 5	0.0	0.0				
DIV 5	0.0	0.0				
DIV 6	1.00	2.00				
DIV 6	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
DIV 6	2.59	0.0				
FINISH	0.0	0.0				

Part 8:

Information for each M&I node.

Water demand, annual longterm benefit etc.

Part 9:

Information for each groundwater node.

Storage volume, monthly supply target, costs etc.

```
PART  8
  UPS.USE1                0.0        0.0      100.00       2.70       2.50       2.50
  UPS.USE1                1.00
  UPS.USE1                0.0        0.0        3.70       5.50       9.30      15.90
                         17.80      15.90      14.10      12.20       5.60       0.0
  UPS.USE2                0.0        0.0      100.00       0.0        1.00       1.00
  UPS.USE2                1.00
  UPS.USE2                8.33       8.33       8.33       8.33       8.33       8.33
                          8.33       8.33       8.33       8.33       8.33       8.33
  UPS.USE3                0.0        0.0      100.00       0.68       1.00       1.00
  UPS.USE3                1.00
  UPS.USE3                8.82       7.35       0.0        0.0        0.0        4.42
                          7.35      11.76      14.71      17.65      16.18      11.76
  KHIRECON           180000.00  295000.00       0.0        2.00       2.50       2.50
  KHIRECON                1.00
  KHIRECON                7.67       4.17       3.67       3.67       3.67       9.17
                         10.17      11.17      11.67      11.67      11.67      11.67
  KHCHECK2                0.0        0.0        0.0        2.80       2.50       2.50
  KHCHECK2                1.00
  KHCHECK2                8.44       8.26       8.37       8.35       8.25       8.27
                          8.46       8.22       8.35       8.37       8.34       8.34
   KICOSTA           180000.00  295000.00     100.00       5.20       1.00       2.00
   KICOSTA                1.00
   KICOSTA                5.80       5.80       5.80       8.10      10.50      10.50
                         10.50      10.50      10.50       8.10       8.10       5.80
  KHCHECK1                0.0        0.0        0.0        5.20       0.37       1.00
  KHCHECK1                1.00
  KHCHECK1                8.33       8.33       8.33       8.33       8.33       8.33
                          8.33       8.33       8.33       8.33       8.33       8.33
  KHIROKII                0.0        0.0      100.00       8.00       2.50       2.50
  KHIROKII                1.00
  KHIROKII                8.33       8.26       8.30       8.30       8.26       8.27
                          8.34       8.25       8.30       8.30       8.29       8.29
  WELL.COM                0.0        0.0      100.00       0.30       2.50       2.50
  WELL.COM                1.00
  WELL.COM                8.33       8.33       8.33       8.33       8.33       8.33
                          8.33       8.33       8.33       8.33       8.33       8.33
    FINISH                0.0        0.0        0.0        0.0        0.0        0.0
PART  9
   VASSUP      0.0          0.08       0.10
   VASSUP                 0.30       0.60       0.90       1.20       1.50       1.80
                          4.70       9.40      14.10      18.80      23.50      28.50
                          0.30       0.60       0.90       1.20       1.50       1.80
                          0.08       0.08       0.08       0.08       0.08       0.08
   VASSUP                 0.0        0.0        0.0        0.0        0.0        0.0
                          0.0        0.0        0.0        0.0        0.0        0.0

                          0.0        0.0        0.0        0.0        0.0        0.0
                          0.0        0.0        0.0        0.0        0.0        0.0
   VASSUP                10.37      14.47      20.12      20.05      19.65       6.12
                          4.18       0.80       0.07       0.11       0.0        0.0
   VASSUP               30.        1.         0.         1.         2.
  GR.WATER     0.0          0.08       0.10
  GR.WATER                0.30       1.20       0.0        0.0        0.0        0.0
                          7.50      30.00       0.0        0.0        0.0        0.0
                          0.30       1.20       0.0        0.0        0.0        0.0
                          0.08       0.08       0.0        0.0        0.0        0.0
  GR.WATER                0.0        0.0        0.0        0.0        0.0        0.0
                          0.0        0.0        0.0        0.0        0.0        0.0
                          0.0        0.0        0.0        0.0        0.0        0.0
  GR.WATER                0.0        0.0        0.0        0.0        0.0        0.0
                          0.31       0.38       3.04      17.85      20.48      20.20
                          0.0        0.0        0.0       20.15      15.26       2.25
  GR.WATER              30.        1.         0.         1.         1.
    FINISH     0.0          0.0        0.0
```

Part 10:

Low flow node input.

```
PART 10
  SUBCHECK        OUTFLOW.T
  SUBCHECK             0.03       0.06       0.06       0.06       0.06       0.02
                       0.01       0.00       0.00       0.00       0.0        0.0
  GYPCHECK        INFLOW.T
  GYPCHECK             0.09       0.08       0.04       0.02       0.0        0.0
                       0.0        0.0        0.0        0.0        0.0        0.04
     FINISH
PART 11
     FINISH            0.         0
```

APPENDIX D:

The "idebug" output
from the Basic Proposal

Explanations:

A Inflow to the node (m^3/s)

B Outflow to the node (m^3/s)

1 Storage volume in reservoir at the end of the month (MCM)

2 Waterlevel in reservoir at the beginning of the month (m)

3 Waterlevel in reservoir at the end of the month (m)

4 Produced energy (GWH)

5 Spill from reservoir

6 Target demand for M&I (m^3/s)

7 Storage volume in groundwater at the end of the month (MCM)

8 Outflow from groundwater; i.e. pumped amount (m^3/s)

JANUARY

		A		B			
0	1.						
INFLOW 3 (1)		0.0	0.0	0.14	0.0		
	9.93		349.71 (2)	349.57 (3)		0.0 (4)	0.0 (5)
LEF DAM (6)		0.14	0.0	0.00	0.16		
	0.18						
KHCHECK1		0.16	0.0	0.16	0.0		
INFLOW 1		0.0	0.0	0.11	0.0		
	0.0						
UPS.USE1		0.11	0.0	0.11	0.0		
	5.79		162.75	162.74		0.0	0.0
KALDAM		0.11	0.0	0.0	0.11		
DIV 1		0.11	0.0	0.05	0.06		
	0.0		0.0	0.00			
VASIRRCI		0.05	0.0	0.05	0.0		
	0.0		0.0	0.0			
VASIRRVI		0.05	0.0	0.05	0.0		
	0.0		0.0	0.05			
VASIRRVE		0.05	0.0	0.00	0.0		
END 1		0.0	0.0	0.0	0.0		
INFLOW 2		0.0	0.0	0.07	0.0		
	0.0						
UPS.USE2 (7)		0.07	0.0	0.07	0.0		
	0.71		0.0				
	0.0[illegible] (8)						
VASSUB		0.07	0.0	0.03	0.0		
DIV 5		0.03	0.0	0.03	0.0		
	0.06						
KHIRECON		0.06	0.0	0.06	0.0		
	0.0		0.0	0.00			
LEF IRR		0.00	0.0	0.0	0.0		
INFLOW 4		0.0	0.0	0.08	0.0		
INFLOW 6		0.0	0.0	0.05	0.0		
	0.02						
UPS.USE3		0.05	0.0	0.03	0.0		
INFLOW 5		0.0	0.0	0.05	0.0		
END 2		0.0	0.0	0.0	0.0		
SURCHECK		0.03	0.0	0.03	0.0		
CONFL 1		0.06	0.03	0.09	0.0		
	0.09						
KHCHECK2		0.09	0.0	0.09	0.0		
CONFL 4		0.16	0.09	0.25	0.0		
	0.25						
KHIROKII		0.25	0.0	0.00	0.0		
END 3		0.00	0.0	0.0	0.0		
DIV 2		0.03	0.0	0.03	0.0		
DIV 6		0.0	0.0	0.0	0.0		
CONFL 5		0.03	0.0	0.03	0.0		
	0.62		0.0				
	0.00						
GR.WATER		0.05	0.0	0.00	0.0		
CONFL 2		0.08	0.0	0.08	0.0		
GYPCHECK		0.03	0.0	0.03	0.0		
INFLOW 7		0.03	0.0	0.11	0.0		
DIV 4		0.11	0.0	0.0	0.11		
	4.22		333.33	351.40		0.0	0.0
GYPS.AQV		0.11	0.0	0.0	0.02		
CONFL 6		0.0	0.0	0.0	0.0		
END 7		0.0	0.0	0.0	0.0		
	0.0		0.0	0.01			
S.LC.IRR		0.02	0.0	0.02	0.0		

	0.0		0.0		0.00			
KARI IRR		0.02	0.0	0.01		0.0		
	0.0		0.0		0.00			
TOKEIIRR		0.01	0.0	0.01		0.0		
	3.51		161.00		160.89		0.0	0.0
DHYP.DAM		0.08	0.0	0.0		0.11		
DIV 3		0.11	0.0	0.11		0.0		
END 5		0.0	0.0	0.0		0.0		
	0.11							
NICOSIA		0.11	0.0	0.0		0.0		
END 4		0.0	0.0	0.0		0.0		
CONFL 3		0.0	0.00	0.00		0.0		
	0.0		0.0		0.00			
PENIRRCI		0.00	0.0	0.00		0.0		
	0.0		0.0		0.00			
PENIRRVE		0.00	0.0	0.00		0.0	* FEBRUARY	
END 6		0.00	0.0	0.0		0.0		
	0.01							
HELL.COM		0.01	0.0	0.00		0.0		
END 8		0.00	0.0	0.0		0.0		
INFLOW 3		0.0	0.0	0.09		0.0		
	9.74		349.57		349.21		0.0	0.0
* LEF DAM		0.09	0.0	0.00		0.16		
	0.16							
KHCHECK1		0.16	0.0	0.16		0.0		
INFLOW 1		0.0	0.0	0.28		0.0		
	0.0							
UPS.USE1		0.28	0.0	0.28		0.0		
	6.35		162.74		163.43		0.0	0.0
KALDAM		0.28	0.0	0.0		0.07		
DIV 1		0.07	0.0	0.04		0.03		
	0.0		0.0		0.0			
VASIRRCI		0.04	0.0	0.04		0.0		
	0.0		0.0		0.0			
VASIRRVI		0.04	0.0	0.04		0.0		
	0.0		0.0		0.04			
VASIRRVE		0.04	0.0	0.00		0.0		
END 1		0.0	0.0	0.0		0.0		
INFLOW 2		0.0	0.0	0.16		0.0		
	0.0							
UPS.USE2		0.16	0.0	0.16		0.0		
	0.97		0.0					
	0.06							
VASSUB		0.16	0.0	0.06		0.0		
DIV 5		0.06	0.0	0.06		0.0		
	0.03							
KEIREFCON		0.03	0.0	0.03		0.0		
	0.0		0.0		0.00			
LEF IRR		0.00	0.0	0.0		0.0		
INFLOW 4		0.0	0.0	0.16		0.0		
INFLOW 6		0.0	0.0	0.04		0.0		
	0.02							
UPS.USE3		0.04	0.0	0.02		0.0		
INFLOW 5		0.0	0.0	0.01		0.0		
END 2		0.0	0.0	0.0		0.0		
SUBCHECK		0.06	0.0	0.06		0.0		
CONFL 1		0.03	0.06	0.09		0.0		
	0.09							
KHCHECK2		0.09	0.0	0.09		0.0		
CONFL 4		0.16	0.09	0.25		0.0		

	0.25							
KHIROKI1		0.25	0.0	0.00		0.0		
END 3		0.00	0.0	0.0		0.0		
DIV 2		0.02	0.0	0.02		0.0		
DIV 6		0.0	0.0	0.0		0.0		
CONFL 5		0.02	0.0	0.02		0.0		
	0.64		0.0					
	0.00							
GR.WATER		0.01	0.0	0.00		0.0		
CONFL 2		0.16	0.0	0.16		0.0		
GYPCHECK		0.02	0.0	0.02		0.0		
INFLOW 7		0.02	0.0	0.06		0.0		
DIV 4		0.06	0.0	0.0		0.06		
	4.31		351.40		359.37		0.0	0.0
GYPS.AQV		0.06	0.0	0.0		0.02		
CONFL 6		0.0	0.0	0.0		0.0		
END 7		0.0	0.0	0.0		0.0		
	0.0		0.0		0.01			
S.LO.IRR		0.02	0.0	0.02		0.0		
	0.0		0.0		0.00			
MARI IRR		0.02	0.0	0.01		0.0		
	0.0		0.0		0.00			
TOKNIIRR		0.01	0.0	0.01		0.0		
	3.62		160.89		161.02		0.0	0.0
DHYP.DAM		0.16	0.0	0.0		0.11		
DIV 3		0.11	0.0	0.11		0.0		
END 5		0.0	0.0	0.0		0.0		
	0.11							
NICOSIA		0.11	0.0	0.0		0.0		
END 4		0.0	0.0	0.0		0.0		
CONFL 3		0.0	0.00	0.00		0.0		
	0.0		0.0		0.0			
PENIRRCI		0.00	0.0	0.00		0.0		
	0.0		0.0		0.00			
PENIRRVE		0.00	0.0	0.00		0.0		
END 6		0.00	0.0	0.0		0.0		
	0.01							
HELL.COM		0.01	0.0	0.00		0.0		
END 8		0.00	0.0	0.0		0.0		

APPENDIX E:

Output from the
Basic Proposal

APPENDIX E

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

RIVER BASIN SIMULATION MODEL

RUN TITLE: VASILIKOS-PENDASKINO
RUN NO.: 1
DATE: 2- 6-82
PLACE: CHALMERS GOTHENBURG
OPERATOR: EX. ARB. CYPERN

DEVELOPED AT
RALPH M. PARSONS LABORATORY FOR WATER RESOURCES AND HYDRODYNAMICS
DEPARTMENT OF CIVIL ENGINEERING
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASSACHUSETTS 02139
JULY 1979 VERSION

GENERAL INFORMATION

BENEFIT AND COST BASE YEAR	=	1973
DISCOUNT RATE	=	9. %
DATE OF PROJECT IMPLEMENTATION	=	1916
LENGTH OF PLANNING HORIZON	=	40 YEARS
SIMULATION TIME PERIOD	=	1 MONTH

GENERAL CHARACTERISTICS OF SIMULATED SYSTEM

NOTE: ALL COSTS ARE DISCOUNTED
TO PRESENT VALUE AND INCLUDE BOTH CAP-
ITAL AND O&R COSTS.

1. RESERVOIRS

NAME	REGION	STATUS	ACTIVE STORAGE MCM	MAXIMUM POTENTIAL ACTIVE STORAGE MCM	TOTAL COSTS £
KALDAM	REGION 1	PROPOSED	16.	16.	2146.890
GYPS.AQV	REGION 3	EXISTING	5.	5.	0.0
LEF DAM	REGION 2	EXISTING	13.	13.	0.0
DHYP.DAM	REGION 2	PROPOSED	14.	14.	1645.297

2. IRRIGATION AREAS

NAME	REGION	STATUS	TARGET AREA HA	MAXIMUM POTENTIAL AREA HA	TOTAL COSTS £
VASIRRCI	REGION 1	PROPOSED	412.	412.	392.30
VASIRRVE	REGION 1	PROPOSED	261.	261.	248.18
VASIRRVI	REGION 1	PROPOSED	157.	157.	147.99
S.LO.IRR	REGION 3	PROPOSED	86.	86.	51.56
MARI IRR	REGION 3	PROPOSED	48.	48.	88.37
TOKNIIRR	REGION 3	EXISTING	42.	42.	0.0
LEF IRR	REGION 2	EXISTING	55.	55.	0.0
PENIRRCI	REGION 2	EXISTING	150.	150.	0.0
PENIRRVE	REGION 2	PROPOSED	75.	75.	223.61

3. MUNICIPAL AND INDUSTRIAL USE

NAME	REGION	STATUS	TARGET MCM/YR	MAXIMUM POTENTIAL TARGET MCM/YR	TOTAL COSTS £
UPS.USE1	REGION 1	EXISTING	3.	79.	0.0
UPS.USE2	REGION 1	EXISTING	0.	32.	0.0
UPS.USE3	REGION 2	EXISTING	1.	32.	0.0
KHIRECON	REGION 1	EXISTING	2.	79.	0.0
KHCHECK2	REGION 1	EXISTING	3.	79.	0.0
NICOSIA	REGION 2	EXISTING	5.	63.	0.0
KHCHECK1	REGION 2	EXISTING	5.	32.	0.0
KHIROKIT	REGION 4	EXISTING	8.	79.	0.0
HELL.COM	REGION 3	EXISTING	0.	79.	0.0

4. HYDROELECTRIC POWER PLANTS

NAME	REGION	STATUS	INSTALLED CAPACITY MW	MAXIMUM POTENTIAL CAPACITY MW	TOTAL COSTS £

NO HYDROELECTRIC POWER PLANTS

5. GROUNDWATER DEVELOPMENTS

NAME	REGION	STATUS	PUMPING CAPACITY M**3/SEC	MAXIMUM POTENTIAL CAPACITY M**3/SEC	TOTAL COSTS £
VASSUR	REGION 1	EXISTING	0.080	0.100	0.0
GR.WATER	REGION 2	EXISTING	0.080	0.100	0.0

6. INTRABASIN TRANSFER

NAME	REGION	STATUS	CAPACITY M**3/SEC	MAXIMUM POTENTIAL CAPACITY M**3/SEC	TOTAL COSTS £
DIV 1	REGION 1	EXISTING	1.0	1.0	0.0
DIV 2	REGION 2	PROPOSED	1.0	2.0	504.58
DIV 3	REGION 2	PROPOSED	0.4	0.4	2149.10
DIV 4	REGION 3	EXISTING	0.6	0.6	0.0
DIV 5	REGION 1	EXISTING	1.0	1.0	0.0
DIV 6	REGION 2	PROPOSED	1.0	2.0	0.0

OVERALL PERFORMANCE OF SIMULATED SYSTEM

SYS WIDE

NOTE: ALL COSTS ARE ARE DISCOUNTED

ALLOCATED COSTS NOT INCLUDED

1. RESERVOIRS

NAME	TOTAL STORAGE	% MONTHS FULL	% MONTHS EMPTY	CAPITAL COSTS	DISCOUNTED OMR COSTS	TOTAL DISC COSTS
	(MCM)			($)	($)	($)
KALDAM	17.0	11.90	14.58	2079.00	67.89	2146.89
GYPS.AQV	4.5	0.15	0.0	0.0	0.0	0.0
LEF DAM	13.9	3.42	11.61	0.0	0.0	0.0
DHYP.DAM	15.0	15.77	1.49	1566.95	78.35	1645.30

2. IRRIGATION AREAS

NAME	TARGET AREA	YEARLY TARGET DEMAND	AVERAGE YEARLY SUPPLY	YEARLY RELIAB. (% TOT YEARLY TARGET MET)	CAPITAL COSTS	DISCOUNTED OMR COSTS	TOTAL DISC COSTS
	HA	MCM/YR	MCM/YR	%	$	$	$
VASIRRCI	412.	3.9	3.4	69.09	354.39	37.91	392.30
VASIRRVE	261.	2.1	1.7	69.09	224.19	23.98	248.18
VASIRRVI	157.	0.8	0.7	81.82	133.69	14.30	147.99
S.LO.IRR	26.	0.7	0.6	20.00	17.52	34.04	51.56
MARI IRR	46.	0.4	0.3	20.00	49.97	38.40	88.37
TOKNIIRR	42.	0.3	0.3	20.00	0.0	0.0	0.0
LEF IRR	55.	0.5	0.5	81.82	0.0	0.0	0.0
PENIRRCI	150.	1.4	1.3	0.0	0.0	0.0	0.0
PENIRRVE	75.	0.6	0.3	0.0	202.00	21.61	223.61

3. MUNICIPAL AND INDUSTRIAL WATER SUPPLY

NAME	DIVERSION CAPACITY	YEARLY TARGET DEMAND	AVERAGE YEARLY SUPPLY	RELIABILITY (% MONTHLY TARGETS MET)	CAPITAL COSTS	DISCOUNTED OMR COSTS	TOTAL DISC COSTS
	MCM/YR	MCM/YR	MCM/YR	%	$	$	$
UPS.USE1*********		2.7	1.3	53.87	0.0	0.0	0.0
UPS.USE2*********		0.0	0.0	100.00	0.0	0.0	0.0
UPS.USE3*********		0.7	0.3	59.67	0.0	0.0	0.0
KHIRECON*********		2.0	1.7	68.24	0.0	0.0	0.0
KHCHECK2*********		2.8	2.5	88.24	0.0	0.0	0.0
NICOSIA*********		5.2	5.1	98.66	0.0	0.0	0.0
KHCHECK1*********		5.2	4.7	88.84	0.0	0.0	0.0
KHIRUKIT*********		8.0	7.3	82.74	0.0	0.0	0.0
HELL.COM*********		0.3	0.2	76.04	0.0	0.0	0.0

4. HYDROELECTRIC POWER PLANTS

NAME	INSTALLED CAPACITY	DEPENDABLE ENERGY	TOTAL POWER GENERATION (AVERAGE)	YEARLY CAPACITY FACTOR	CAPITAL COSTS	DISCOUNTED OMR COSTS	TOTAL DISC COSTS
	MW	GWH/MO	GWH/MO		$	$	$

NO POWER PLANTS IN THIS SYSTEM

5. GROUND-WATER DEVELOPMENTS

NAME	PUMP CAPACITY	YEARLY TARGET DEMAND	AVERAGE YEARLY SUPPLY	RELIABILITY (% MONTHLY TARGETS MET)	CAPITAL COSTS	DISCOUNTED OMR COSTS	TOTAL DISC COSTS
	M**3/SEC	MCM/YR	MCM/YR	%	$	$	$
VASSUB	0.	1.	4.	98.81	0.0	0.0	0.0
GR.WATER	0.	0.	1.	54.76	0.0	0.0	0.0

6. INTRA-BASIN TRANSFERS

NAME	CAPACITY	YEARLY TARGET DEMAND	AVERAGE YEARLY SUPPLY	RELIABILITY (% MONTHLY TARGETS MET)	CAPITAL COSTS	DISCOUNTED OMR COSTS	TOTAL DISC COSTS
	MCM/YR	MCM/YR	MCM/YR	%	$	$	$
DIV 1*********		7.	6.	85.57	0.0	0.0	0.0
DIV 2*********		1.	1.	88.10	445.00	59.58	504.58
DIV 3*********		5.	5.	98.66	1962.00	187.10	2149.10
DIV 4*********		0.	0.	100.00	0.0	0.0	0.0
DIV 5*********		1.	1.	98.81	0.0	0.0	0.0
DIV 6*********		31.	3.	0.15	0.0	0.0	0.0

7. LOW FLOW LOCATIONS

NAME	PURPOSE	LOW FLOW TARGET	AVERAGE ANNUAL DEFICIT	RELIABILITY (% ANNUAL TARGETS MET)
		M**3/SEC	M**3/SEC	%
SUBCHECK	OTFLOW.T	0.06	0.00	98.21
GYPCHECK	INFLOW.T	0.09	0.00	0.0

INDIVIDUAL PROJECT RELIABILITY FOR

SYS WIDE

PERFORMANCE EVALUATION FOR RESERVOIR: LEF DAM

GENERAL CHARACTERISTICS:

NORMAL WATER SURFACE ELEVATION M.S.L..=	357.0	M
MAXIMUM POTENTIAL STORAGE CAPACITY....=	13.9	MCM
TOTAL STORAGE CAPACITY...............=	13.9	MCM
MINIMUM IRRIGATION STORAGE...........=	1.0	MCM
MAXIMUM STORAGE......................=	13.9	MCM
MINIMUM STORAGE......................=	1.0	MCM
OPERATING POLICY.....................=	4	

MONTHLY PERFORMANCE:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MAX STOR TRG(MCM)	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	13.9	
MIN STOR TRG(MCM)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
% AT MAXIMUM	3.6	7.1	10.7	10.7	7.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8	3.4
% AT MINIMUM	10.7	5.4	5.4	5.4	5.4	10.7	10.7	14.3	14.3	17.9	19.6	19.6	11.6
MEAN STORAGE	5.9	6.7	7.3	7.3	7.1	6.8	6.4	6.0	5.6	5.2	4.9	5.1	6.2
STANDARD DEV	3.8	3.9	3.9	4.0	4.0	4.0	3.9	3.8	3.8	3.7	3.6	3.8	3.9
COEF OF VAR	0.7	0.6	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.6
AVE SPILL(MCM)=	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
AVE RELEASE1(MCM)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	4.7
AVE RELEASE2(MCM)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.4

*NOTE-SPILLS MAY INCLUDE WATER PASSED THROUGH THE TURBINES THAT OTHERWISE WOULD HAVE BEEN SPILLED

MONTHLY STORAGE HISTOGRAM

STORAGE RANGE(MCM) PROPORTION OF TIMES WITHIN RANGE

FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.0	2.3	0.20	0.16	0.13	0.13	0.13	0.14	0.16	0.20	0.29	0.32	0.36	0.30
2.3	3.6	0.14	0.04	0.05	0.04	0.07	0.14	0.14	0.16	0.09	0.11	0.11	0.18
3.6	4.9	0.16	0.20	0.14	0.16	0.16	0.09	0.13	0.11	0.11	0.09	0.07	0.07
4.9	6.1	0.13	0.13	0.11	0.13	0.11	0.11	0.09	0.09	0.11	0.07	0.13	0.09
6.1	7.4	0.07	0.14	0.20	0.13	0.11	0.11	0.09	0.11	0.13	0.16	0.09	0.11
7.4	8.7	0.05	0.05	0.04	0.07	0.09	0.14	0.14	0.09	0.04	0.0	0.0	0.0
8.7	10.0	0.04	0.05	0.09	0.11	0.09	0.02	0.0	0.0	0.0	0.05	0.11	0.07
10.0	11.3	0.07	0.04	0.02	0.0	0.0	0.0	0.05	0.11	0.14	0.13	0.11	0.11
11.3	12.6	0.07	0.07	0.07	0.09	0.11	0.14	0.11	0.13	0.11	0.07	0.04	0.05
12.6	13.8	0.07	0.13	0.16	0.16	0.14	0.11	0.09	0.02	0.0	0.0	0.0	0.02
13.8	*******	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: KHCHECK1

GENERAL CHARCTERISTICS*,

MAXIMUM POTENTIAL DIVERSION CAPACITY...... =	1.00	M**3/SEC
DIVERSION CAPACITY........................ =	0.37	M**3/SEC
TOTAL DEMAND.............................. =	5.20	MCM/YR
CONSUMPTIVE USE PERCENTAGE................ =	0.0	%

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	5.2
RELIABILITY (% TIMES TARGET MET)	89.	95.	95.	95.	95.	91.	89.	88.	86.	84.	80.	80.	89.
AVERAGE DEFICIT (MCM)	0.03	0.02	0.02	0.01	0.02	0.02	0.04	0.05	0.06	0.06	0.08	0.07	0.5
MEAN DIVERSION(MCM)	0.40	0.42	0.42	0.42	0.42	0.41	0.39	0.39	0.37	0.37	0.36	0.37	4.7

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: UPS_USE1

GENERAL CHARACTERISTICS=,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... = 2.50 M**3/SEC
DIVERSION CAPACITY......................... = 2.50 M**3/SEC
TOTAL DEMAND............................... = 2.70 MCM/YR
CONSUMPTIVE USE PERCENTAGE................. = 100.00 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.0	0.0	0.10	0.15	0.25	0.43	0.48	0.43	0.38	0.33	0.15	0.0	2.7
RELIABILITY (% TIMES TARGET MET)	100.	100.	96.	95.	89.	38.	2.	0.	2.	7.	18.	100.	54.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.00	0.01	0.02	0.12	0.28	0.31	0.31	0.25	0.08	0.0	1.4
MEAN DIVERSION(MCM)	0.0	0.0	0.10	0.14	0.24	0.31	0.20	0.12	0.07	0.08	0.07	0.0	1.3

PERFORMANCE EVALUATION FOR RESERVOIR: KALDAM

GENERAL CHARACTERISTICS:

NORMAL WATER SURFACE ELEVATION M.S.L..= 176.5 M
MAXIMUM POTENTIAL STORAGE CAPACITY....= 17.0 MCM
TOTAL STORAGE CAPACITY................= 17.0 MCM
MINIMUM IRRIGATION STORAGE............= 1.1 MCM
MAXIMUM STORAGE.......................= 14.0 MCM
MINIMUM STORAGE.......................= 1.1 MCM
OPERATING POLICY......................= 4

MONTHLY PERFORMANCE:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TOR IRG(MCM)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	
TOR IRG(MCM)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
% AT MAXIMUM	7.1	21.4	39.3	41.1	32.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8	11.9
% AT MINIMUM	7.1	3.6	3.6	3.6	5.4	7.1	16.1	21.4	21.4	25.0	32.1	28.6	14.6
MEAN STORAGE	7.2	9.0	10.0	10.4	10.0	8.9	7.7	6.5	5.6	5.0	4.6	5.3	7.5
STANDARD DEV	4.2	4.4	4.3	4.2	4.4	4.2	4.0	3.6	3.2	3.0	2.9	3.7	4.4
COFF OF VAR	0.6	0.5	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6	0.7	0.6
PILL(MCM)*	0.1	0.8	0.9	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
ELEASE1(MCM)	0.3	0.2	0.1	0.2	0.8	1.2	1.2	1.2	0.9	0.6	0.5	0.4	7.5
ELEASE2(MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

*SPILLS MAY INCLUDE WATER PASSED THROUGH THE TURBINES THAT OTHERWISE WOULD HAVE BEEN SPILLED

MONTHLY STORAGE HISTOGRAM

STORAGE RANGE(MCM) PROPORTION OF TIMES WITHIN RANGE

FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.1	2.7	0.23	0.14	0.07	0.07	0.09	0.16	0.21	0.21	0.32	0.34	0.38	0.38
2.7	4.3	0.11	0.07	0.11	0.09	0.07	0.05	0.02	0.11	0.05	0.09	0.05	0.07
4.3	5.9	0.09	0.07	0.04	0.04	0.05	0.04	0.09	0.09	0.09	0.07	0.09	0.09
5.9	7.5	0.05	0.11	0.09	0.04	0.09	0.09	0.11	0.07	0.09	0.14	0.30	0.13
7.5	9.0	0.18	0.05	0.07	0.09	0.05	0.09	0.05	0.07	0.41	0.36	0.16	0.18
9.0	10.6	0.07	0.05	0.07	0.11	0.07	0.05	0.07	0.43	0.04	0.0	0.02	0.07
10.6	12.2	0.13	0.14	0.11	0.07	0.09	0.14	0.45	0.02	0.0	0.0	0.0	0.07
12.2	13.8	0.07	0.14	0.09	0.09	0.21	0.38	0.0	0.0	0.0	0.0	0.0	0.0
13.8	15.4	0.07	0.21	0.36	0.41	0.27	0.0	0.0	0.0	0.0	0.0	0.0	0.02
15.4	17.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17.0	*******	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR INTRA-BASIN TRANSFER AT: DIV 1

MAXIMUM POTENTIAL DIVERSION CAPACITY 1.00 M**3/SEC
DIVERSION CAPACITY 1.00 M**3/SEC

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DIVERSION (MCM)	0.1	0.1	0.1	0.1	0.7	1.1	1.2	1.2	0.9	0.6	0.4	0.2	6.8
DOWNSTREAM FLOW TARGET= (MCM)	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.0
RELIABILITY (% TIMES TARGET MET)	93.	98.	96.	96.	95.	93.	84.	79.	79.	75.	68.	71.	86.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.1	0.1	0.1	1.0

= DOWNSTREAM FLOW TARGET HAS PRIORITY OVER DIVERSION

PERFORMANCE EVALUATION FOR IRRIGATION AREA: VASIRRCI

GENERAL CHARACTERISTICS:

MAXIMUM POTENTIAL AREA.......... =	412.00	HA
TARGET AREA..................... =	412.00	HA
APPLICATION EFFICIENCY.......... =	100.00	%
RETURN FLOW COEFF............... =	0.0	%
= RETURN TO STREAM.............. =	0.0	%
= PERCOLATION TO GROUNDWATER.... =	0.0	%

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	****	0.1	0.5	0.7	0.8	0.8	0.6	0.3	0.1	*****	3.9

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	96.	*****	96.	96.	95.	93.	89.	84.	80.	78.	71.	76.	69.
MEAN DIVERSION	0.0	*****	0.0	0.1	0.4	0.6	0.7	0.7	0.5	0.3	0.1	0.0	3.4
STANDARD DEV	0.0	*****	0.0	0.0	0.1	0.2	0.2	0.3	0.2	0.1	0.1	0.0	1.1
COEF OF VAR	0.0	*****	0.8	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.6	0.3

NOTES

= % TIMES TARGET DEMAND MET

MONTHLY HISTOGRAM OF IRRIGATION DIVERSIONS

DIVERSION RANGE(MCM) FROM	TO	PROPORTION OF TIMES WITHIN RANGE JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.0	0.08	1.00	1.00	1.00	0.04	0.04	0.05	0.09	0.15	0.20	0.20	0.29	1.00
0.08	0.16	0.0	0.0	0.0	0.96	0.0	0.02	0.0	0.0	0.0	0.0	0.71	0.0
0.16	0.25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0
0.25	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.33	0.41	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.78	0.0	0.0
0.41	0.49	0.0	0.0	0.0	0.0	0.96	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.49	0.57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.57	0.65	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.02	0.80	0.0	0.0	0.0
0.65	0.74	0.0	0.0	0.0	0.0	0.0	0.93	0.0	0.0	0.0	0.0	0.0	0.0
0.74	0.82	0.0	0.0	0.0	0.0	0.0	0.0	0.89	0.84	0.0	0.0	0.0	0.0
0.82	***********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR IRRIGATION AREA: VASIRRVI

GENERAL CHARACTERISTICS:

MAXIMUM POTENTIAL AREA.......... =	157.00	HA
TARGET AREA..................... =	157.00	HA
APPLICATION EFFICIENCY.......... =	100.00	%
RETURN FLOW COEFF............... =	0.0	%
= RETURN TO STREAM.............. =	0.0	%
= PERCOLATION TO GROUNDWATER.... =	0.0	%

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	*****	0.2	0.3	0.1	0.1	*****	*****	*****	*****	0.8

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	*****	*****	*****	*****	95.	93.	87.	82.	*****	*****	*****	*****	82.
MEAN DIVERSION	*****	*****	*****	*****	0.2	0.2	0.1	0.1	*****	*****	*****	*****	0.7
STANDARD DEV	*****	*****	*****	*****	0.1	0.1	0.0	0.0	*****	*****	*****	*****	0.2
COEF OF VAR	*****	*****	*****	*****	0.2	0.3	0.4	0.5	*****	*****	*****	*****	0.3

NOTES

= % TIMES TARGET DEMAND MET

MONTHLY HISTOGRAM OF IRRIGATION DIVERSIONS

DIVERSION RANGE(MCM) FROM	TO	PROPORTION OF TIMES WITHIN RANGE JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.0	0.03	1.00	1.00	1.00	1.00	0.05	0.07	0.11	0.16	1.00	1.00	1.00	1.00
0.03	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0
0.05	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0
0.08	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.11	0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.87	0.82	0.0	0.0	0.0	0.0
0.13	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.16	0.19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.19	0.21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.21	0.24	0.0	0.0	0.0	0.0	0.95	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.24	0.27	0.0	0.0	0.0	0.0	0.0	0.93	0.0	0.0	0.0	0.0	0.0	0.0
0.27	***********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR IRRIGATION AREA: VASTPRVE

GENERAL CHARACTERISTICS:

MAXIMUM POTENTIAL AREA.......... = 261.00 HA
TARGET AREA..................... = 261.00 HA
APPLICATION EFFICIENCY.......... = 100.00 %
RETURN FLOW COEF................ = 0.0 %
= RETURN TO STREAM.............. = 0.0 %
= PERCOLATION TO GROUNDWATER.... = 0.0 %

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.2	2.1

PERFORMANCE RESULTS=

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	93.	98.	96.	96.	95.	93.	85.	80.	80.	76.	69.	73.	69.
MEAN DIVERSION	0.1	0.1	0.0	0.1	0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.1	1.7
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.6
COEF OF VAR	0.2	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.5	0.5	0.7	0.6	0.4

NOTES

= % TIMES TARGET DEMAND MET

MONTHLY HISTOGRAM OF IRRIGATION DIVERSIONS

DIVERSION RANGE(MCM) FROM	TO	PROPORTION OF TIMES WITHIN RANGE JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.0	0.03	0.04	0.02	0.04	0.04	0.05	0.07	0.13	0.18	0.20	0.22	0.29	0.27
0.03	0.07	0.02	0.0	0.96	0.96	0.95	0.0	0.0	0.0	0.0	0.0	0.02	0.0
0.07	0.10	0.02	0.98	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.10	0.13	0.0	0.0	0.0	0.0	0.0	0.93	0.0	0.0	0.0	0.02	0.0	0.0
0.13	0.17	0.93	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.17	0.20	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.73
0.20	0.23	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.23	0.27	0.0	0.0	0.0	0.0	0.0	0.0	0.85	0.0	0.0	0.76	0.69	0.0
0.27	0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.30	0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.82	0.80	0.0	0.0	0.0
0.33	***********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: UPS.USE2

GENERAL CHARCTERISTICS=,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... = 1.00 M**3/SEC
DIVERSION CAPACITY......................... = 1.00 M**3/SEC
TOTAL DEMAND............................... = 0.0 MCM/YR
CONSUMPTIVE USE PERCENTAGE................. = 100.00 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RELIABILITY (% TIMES TARGET MET)	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.	100.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEAN DIVERSION(MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR GROUNDWATER DEV. AT VASSUB

MAXIMUM POTENTIAL PUMPING CAPACITY........ = 0.10 M**3/SEC
PUMPING CAPACITY.......................... = 0.08 M**3/SEC
TOTAL ANNUAL TARGET = 0.80 MCM/YR

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET (MCM/MO)	0.1	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0**********			0.8
RELIABILITY (TIMES TARGET MET)	100.0	100.0	98.2	98.2	98.2	98.2	98.2	98.2	98.2	96.2**********			98.8
AVERAGE SUPPLY (MCM/MO)	0.4	1.1	1.2	0.7	0.3	0.1	0.1	0.0	0.0	0.0**********			4.1

PERFORMANCE EVALUATION FOR LOW FLOW AT LOCATION: SUBCHECK

PURPOSE: UTFLOW.T

MONTHLY FLOW STATISTICS:

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	% YEARLY TARGETS MET	% TA[illegible] ME[illegible]
LOW FLOW TARGET (M**3/SEC)	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
RELIABILITY (% TIMES TARGET MET)	100.	100.	98.	98.	98.	98.	98.	98.	98.	98.	100.	100.	98.	
AVERAGE MAGNITUDE VIOLATION (M**3/SEC)	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	

MONTHLY HISTOGRAM OF FLOWS

FLOW RANGE(M**3/SEC) FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		PROPORTION OF TIMES WITHIN RANGE											
0.0	0.01	0.0	0.0	0.0	0.02	0.02	0.02	0.02	1.00	1.00	1.00	1.00	1.00
0.01	0.02	0.0	0.0	0.0	0.0	0.0	0.98	0.98	0.0	0.0	0.0	0.0	0.0
0.02	0.04	1.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.04	0.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.05	0.06	0.0	1.00	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.06	0.07	0.0	0.0	0.98	0.98	0.98	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.07	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.08	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.09	0.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.11	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.12**********		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR INTRA-BASIN TRANSFER AT: DIV 5

MAXIMUM POTENTIAL DIVERSION CAPACITY 1.00 M**3/SEC
DIVERSION CAPACITY 1.00 M**3/SEC

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DIVERSION (MCM)	0.1	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0**********			0.8
DOWNSTREAM FLOW TARGET* (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RELIABILITY (% TIMES TARGET MET)	100.	100.	98.	98.	98.	98.	98.	98.	98.	98.**********			99.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0**********			0.0

* DOWNSTREAM FLOW TARGET HAS PRIORITY OVER DIVERSION

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: KHIRECON

GENERAL CHARCTERISTICS=,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... = 2.50 M**3/SEC
DIVERSION CAPACITY......................... = 2.50 M**3/SEC
TOTAL DEMAND............................... = 2.00 MCM/YR
CONSUMPTIVE USE PERCENTAGE................. = . 0.0 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.15	0.08	0.07	0.07	0.07	0.18	0.20	0.22	0.23	0.23	0.23	0.23	2.0
RELIABILITY (% TIMES TARGET MET)	96.	98.	96.	96.	96.	95.	93.	84.	79.	79.	70.	77.	88.
AVERAGE DEFICIT (MCM)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.04	0.05	0.05	0.06	0.03	0.3
MEAN DIVERSION(MCM)	0.15	0.08	0.07	0.07	0.07	0.17	0.19	0.19	0.18	0.18	0.17	0.20	1.7

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: KHCHECK2

GENERAL CHARCTERISTICS=,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... = 2.50 M**3/SEC
DIVERSION CAPACITY......................... = 2.50 M**3/SEC
TOTAL DEMAND............................... = 2.80 MCM/YR
CONSUMPTIVE USE PERCENTAGE................. = 0.0 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.24	0.23	0.23	0.23	0.23	0.23	0.24	0.23	0.23	0.23	0.23	0.23	2.8
RELIABILITY (% TIMES TARGET MET)	96.	98.	96.	96.	96.	95.	93.	84.	79.	79.	70.	77.	88.
AVERAGE DEFICIT (MCM)	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.04	0.05	0.05	0.06	0.03	0.3
MEAN DIVERSION(MCM)	0.23	0.23	0.23	0.23	0.23	0.22	0.22	0.19	0.18	0.18	0.17	0.20	2.5

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: KHIROKIT

GENERAL CHARCTERISTICS*,

MAXIMUM POTENTIAL DIVERSION CAPACITY...... = 2.50 M**3/SEC
DIVERSION CAPACITY........................ = 2.50 M**3/SEC
TOTAL DEMAND.............................. = 8.00 MCM/YR
CONSUMPTIVE USE PERCENTAGE................ = 100.00 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.67	0.66	0.66	0.66	0.66	0.66	0.67	0.66	0.66	0.66	0.66	0.66	8.0
RELIABILITY (% TIMES TARGET MET)	89.	95.	93.	93.	93.	89.	86.	79.	73.	71.	64.	68.	83.
AVERAGE DEFICIT (MCM)	0.03	0.02	0.02	0.01	0.02	0.03	0.06	0.08	0.11	0.11	0.14	0.10	0.7
MEAN DIVERSION(MCM)	0.63	0.64	0.65	0.65	0.64	0.63	0.61	0.58	0.56	0.55	0.53	0.57	7.3

PERFORMANCE EVALUATION FOR IRRIGATION AREA: LEF IRR

GENERAL CHARACTERISTICS:

MAXIMUM POTENTIAL AREA.......... = 55.00 HA
TARGET AREA..................... = 55.00 HA
APPLICATION EFFICIENCY.......... = 100.00 %
RETURN FLOW COEF................ = 0.0 %
= RETURN TO STREAM.............. = 0.0 %
= PERCOLATION TO GROUNDWATER.... = 0.0 %

MONTHLY-USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	0.0	0.1	0.1	0.1	0.1	0.1	0.0	*****	*****	0.5

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	91.	96.	96.	96.	96.	91.	91.	87.	87.	85.	82.	82.	82.
MEAN DIVERSION	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.5
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
COEF OF VAR	0.0	0.0	0.6	0.1	0.2	0.3	0.3	0.4	0.4	0.4	0.2	1.4	0.3

NOTES

= % TIMES TARGET DEMAND MET

PERFORMANCE EVALUATION FOR INTRA-BASIN TRANSFER AT: DIV 2

MAXIMUM POTENTIAL DIVERSION CAPACITY 2.00 M**3/SEC
DIVERSION CAPACITY 1.00 M**3/SEC

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DIVERSION (MCM)	0.2	0.3	0.2	0.1	0.1	*****	*****	*****	*****	*****	*****	0.1	1.0
DOWNSTREAM FLOW TARGET* (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RELIABILITY (% TIMES TARGET MET)	66.	84.	88.	86.	91.	*****	*****	*****	*****	*****	*****	43.	86.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.0	*****	*****	*****	*****	*****	*****	0.1	0.2

* DOWNSTREAM FLOW TARGET HAS PRIORITY OVER DIVERSION

PERFORMANCE EVALUATION FOR INTRA-BASIN TRANSFER AT: DIV 6

MAXIMUM POTENTIAL DIVERSION CAPACITY 2.00 M**3/SEC
DIVERSION CAPACITY 1.00 M**3/SEC

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DIVERSION (MCM)	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	31.1
DOWNSTREAM FLOW TARGET* (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RELIABILITY (% TIMES TARGET MET)	2.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
AVERAGE DEFICIT (MCM)	2.0	1.9	2.0	2.3	2.4	2.5	2.6	2.6	2.6	2.6	2.6	2.3	28.4

* DOWNSTREAM FLOW TARGET HAS PRIORITY OVER DIVERSION

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: UPS.USE3

GENERAL CHARCTERISITICS*,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... = 1.00 M**3/SEC
DIVERSION CAPACITY......................... = 1.00 M**3/SEC
TOTAL DEMAND............................... = 0.68 MCM/YR
CONSUMPTIVE USE PERCENTAGE................. = 100.00 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.06	0.05	0.0	0.0	0.0	0.03	0.05	0.08	0.10	0.12	0.11	0.08	0.7
RELIABILITY (% TIMES TARGET MET)	91.	96.	100.	100.	100.	93.	57.	2.	0.	0.	13.	64.	60.
AVERAGE DEFICIT (MCM)	0.00	0.00	0.0	0.0	0.0	0.00	0.01	0.05	0.08	0.10	0.08	0.02	0.3
MEAN DIVERSION(MCM)	0.06	0.05	0.0	0.0	0.0	0.03	0.04	0.03	0.02	0.02	0.03	0.06	0.3

PERFORMANCE EVALUATION FOR LOW FLOW AT LOCATION: GYPCHECK

PURPOSE: INFLOW.I

MONTHLY FLOW STATISTICS:

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	% YEARLY TARGETS MET	% TA ME
LOW FLOW TARGET (M**3/SEC)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
RELIABILITY (% TIMES TARGET MET)	66.	88.	96.	96.	100.	100.	100.	100.	100.	100.	100.	0.	0.	
AVERAGE MAGNITUDE VIOLATION (M**3/SEC)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

MONTHLY HISTOGRAM OF FLOWS

FLOW RANGE(M**3/SEC) FROM	TO	PROPORTION OF TIMES WITHIN RANGE JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.0	0.02	0.11	0.07	0.04	0.04	0.07	1.00	1.00	1.00	1.00	1.00	1.00	0.52
0.02	0.03	0.07	0.04	0.0	0.07	0.93	0.0	0.0	0.0	0.0	0.0	0.0	0.05
0.03	0.05	0.09	0.02	0.0	0.89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.43
0.05	0.07	0.05	0.0	0.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.07	0.09	0.06	0.0	0.89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.09	0.10	0.0	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.10	0.12	0.0	0.84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.12	0.14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.14	0.16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.16	0.17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.17	**********	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR INTRA-BASIN TRANSFER AT: DIV 4
==

MAXIMUM POTENTIAL DIVERSION CAPACITY 0.58 M**3/SEC
DIVERSION CAPACITY 0.58 M**3/SEC

MONTHLY PERFORMANCE
==================

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DIVERSION (MCM)	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
DOWNSTREAM FLOW TARGET= (MCM)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	18.0
RELIABILITY (% TIMES TARGET MET)	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	100.
AVERAGE DEFICIT (MCM)	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

= DOWNSTREAM FLOW TARGET HAS PRIORITY OVER DIVERSION

PERFORMANCE EVALUATION FOR RESERVOIR: GYPS_AGV
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GENERAL CHARACTERISTICS:
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NORMAL WATER SURFACE ELEVATION M.S.L..= 375.0 M
MAXIMUM POTENTIAL STORAGE CAPACITY....= 4.5 MCM
TOTAL STORAGE CAPACITY................= 4.5 MCM
MINIMUM IRRIGATION STORAGE............= 0.0 MCM
MAXIMUM STORAGE.......................= 4.5 MCM
MINIMUM STORAGE.......................= 0.0 MCM
OPERATING POLICY......................= 4

MONTHLY PERFORMANCE:
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	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MAX STOR TRG(MCM)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	
MIN STOR TRG(MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
% AT MAXIMUM	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
% AT MINIMUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEAN STORAGE	0.9	1.1	1.2	1.2	1.0	0.7	0.6	0.4	0.3	0.3	0.3	0.5	0.7
STANDARD DEV	0.8	0.8	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.9
COEF OF VAR	1.0	0.7	0.7	0.7	0.9	1.1	1.5	2.0	2.5	2.6	2.7	1.6	1.3
AVE SPILL(MCM)=	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AVE RELEASE1(MCM)	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1	0.0	0.0	0.1	1.4
AVE RELEASE2(MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

=NOTE-SPILLS MAY INCLUDE WATER PASSED THROUGH THE TURBINES THAT OTHERWISE WOULD HAVE BEEN SPILLED

MONTHLY STORAGE HISTOGRAM
========================

STORAGE RANGE(MCM) PROPORTION OF TIMES WITHIN RANGE

FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.0	0.4	0.20	0.05	0.04	0.05	0.13	0.39	0.80	0.82	0.84	0.86	0.86	0.86
0.4	0.9	0.03	0.38	0.20	0.34	0.68	0.43	0.05	0.04	0.04	0.02	0.04	0.02
0.9	1.3	0.64	0.41	0.59	0.45	0.05	0.05	0.02	0.04	0.02	0.04	0.02	0.02
1.3	1.8	0.04	0.04	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.0	0.02	0.02
1.8	2.2	0.02	0.02	0.04	0.07	0.04	0.02	0.02	0.02	0.02	0.04	0.02	0.02
2.2	2.7	0.02	0.02	0.02	0.02	0.0	0.02	0.04	0.02	0.04	0.02	0.04	0.04
2.7	3.1	0.02	0.02	0.02	0.02	0.04	0.02	0.02	0.04	0.02	0.02	0.0	0.02
3.1	3.6	0.04	0.04	0.02	0.02	0.02	0.04	0.02	0.02	0.02	0.02	0.02	0.02
3.6	4.0	0.0	0.02	0.04	0.04	0.02	0.02	0.02	0.0	0.0	0.0	0.0	0.0
4.0	4.5	0.02	0.02	0.02	0.02	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4.5	*******	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR IRRIGATION AREA: S.LO.IRR

GENERAL CHARACTERISTICS:

```
MAXIMUM POTENTIAL AREA.......... =      86.00   HA
TARGET AREA..................... =      86.00   HA
APPLICATION EFFICIENCY.......... =     100.00   %
RETURN FLOW COEF................ =       0.0    %
= RETURN TO STREAM.............. =       0.0    %
= PERCOLATION TO GROUNDWATER.... =       0.0    %
```

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	*****	0.7

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	100.	100.	100.	100.	96.	96.	93.	85.	62.	20.	20.	100.	20.
MEAN DIVERSION	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.6
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
COEF OF VAR	0.2	0.2	0.1	0.0	0.1	0.2	0.3	0.4	0.5	2.0	2.0	0.2	0.2

NOTES

= % TIMES TARGET DEMAND MET

PERFORMANCE EVALUATION FOR IRRIGATION AREA: MARI IRR

GENERAL CHARACTERISTICS:

```
MAXIMUM POTENTIAL AREA.......... =      48.00   HA
TARGET AREA..................... =      48.00   HA
APPLICATION EFFICIENCY.......... =     100.00   %
RETURN FLOW COEF................ =       0.0    %
= RETURN TO STREAM.............. =       0.0    %
= PERCOLATION TO GROUNDWATER.... =       0.0    %
```

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	0.0	0.1	0.1	0.0	0.0	0.0	*****	*****	*****	0.4

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	100.	100.	100.	100.	96.	96.	91.	84.	60.	20.	20.	100.	20.
MEAN DIVERSION	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
COEF OF VAR	0.3	0.3	0.2	0.1	0.2	0.2	0.3	0.4	0.8	2.0	0.9	0.4	0.2

NOTES

= % TIMES TARGET DEMAND MET

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: HELI.COM

GENERAL CHARCTERISTICS=,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... = 2.50 M**3/SEC
DIVERSION CAPACITY......................... = 2.50 M**3/SEC
TOTAL DEMAND............................... = 0.30 MCM/YR
CONSUMPTIVE USE PERCENTAGE................. = 100.00 %

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.3
RELIABILITY (% TIMES TARGET MET)	100.	100.	100.	100.	96.	95.	88.	77.	20.	20.	18.	100.	76.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.0	0.1
MEAN DIVERSION(MCM)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.00	0.02	0.2

PERFORMANCE EVALUATION FOR IRRIGATION AREA: TOKNTIRR

GENERAL CHARACTERISTICS:

MAXIMUM POTENTIAL AREA.......... = 42.00 HA
TARGET AREA..................... = 42.00 HA
APPLICATION EFFICIENCY.......... = 100.00 %
RETURN FLOW COEF................ = 0.0 %
= RETURN TO STREAM.............. = 0.0 %
= PERCOLATION TO GROUNDWATER.... = 0.0 %

MONTHLY USE PARAMETERS:

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	0.0	0.1	0.0	0.0	0.0	0.0	*****	*****	*****	0.3

PERFORMANCE RESULTS-

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	100.	100.	100.	100.	96.	95.	89.	78.	58.	20.	20.	100.	20.
MEAN DIVERSION	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
COEF OF VAR	0.4	0.3	0.2	0.1	0.1	0.1	0.3	0.5	0.8	0.7	1.1	0.4	0.2

NOTES

= % TIMES TARGET DEMAND MET

PERFORMANCE EVALUATION FOR RESERVOIR: DHYP.DAM

GENERAL CHARACTERISTICS:

NORMAL WATER SURFACE ELEVATION M.S.L...=	174.5	M
MAXIMUM POTENTIAL STORAGE CAPACITY....=	15.0	MCM
TOTAL STORAGE CAPACITY...............=	15.0	MCM
MINIMUM IRRIGATION STORAGE...........=	1.4	MCM
MAXIMUM STORAGE......................=	20.0	MCM
MINIMUM STORAGE......................=	1.4	MCM
OPERATING POLICY.....................=	4	

MONTHLY PERFORMANCE:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
MAX STOR TRG(MCM)	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	20.0	
MIN STOR TRG(MCM)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	
% AT MAXIMUM	16.1	32.1	42.9	44.6	41.1	5.4	0.0	0.0	0.0	0.0	1.8	5.4	15.8
% AT MINIMUM	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	5.4	5.4	5.4	0.0	1.5
MEAN STORAGE	13.5	14.9	15.5	15.6	15.3	14.7	13.8	12.9	12.1	11.7	11.5	12.1	13.6
STANDARD DEV	5.4	5.3	5.1	5.1	5.2	5.2	5.2	5.2	5.2	5.1	5.3	5.4	5.4
COEF OF VAR	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4
AVE SPILL(MCM)=	0.5	0.7	0.8	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	2.5
AVE RELEASE1(MCM)	0.3	0.3	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.3	5.1
AVE RELEASE2(MCM)	0.0	0.0	0.0	0.0	0.1	0.2	0.4	0.4	0.3	0.1	0.0	0.0	1.5

=NOTE-SPILLS MAY INCLUDE WATER PASSED THROUGH THE TURBINES THAT OTHERWISE WOULD HAVE BEEN SPILLED

MONTHLY STORAGE HISTOGRAM

STORAGE RANGE(MCM) PROPORTION OF TIMES WITHIN RANGE

FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1.4	2.8	0.04	0.0	0.0	0.0	0.0	0.0	0.05	0.05	0.05	0.07	0.07	0.05
2.8	4.1	0.04	0.05	0.0	0.0	0.04	0.05	0.0	0.02	0.05	0.05	0.09	0.07
4.1	5.5	0.04	0.0	0.05	0.05	0.02	0.0	0.02	0.07	0.07	0.05	0.04	0.04
5.5	6.8	0.04	0.07	0.0	0.0	0.02	0.05	0.09	0.04	0.02	0.05	0.04	0.09
6.8	8.2	0.07	0.05	0.09	0.07	0.09	0.07	0.04	0.05	0.07	0.04	0.05	0.04
8.2	9.6	0.05	0.04	0.04	0.05	0.02	0.02	0.04	0.04	0.04	0.05	0.04	0.02
9.6	10.9	0.05	0.05	0.04	0.05	0.05	0.07	0.05	0.05	0.07	0.11	0.11	0.09
10.9	12.3	0.02	0.04	0.07	0.04	0.05	0.05	0.05	0.11	0.07	0.02	0.04	0.07
12.3	13.6	0.07	0.04	0.05	0.07	0.05	0.05	0.09	0.02	0.04	0.07	0.05	0.04
13.6	15.0	0.07	0.04	0.05	0.05	0.09	0.07	0.04	0.07	0.04	0.02	0.02	0.02
15.0	*******	0.52	0.63	0.61	0.61	0.57	0.55	0.54	0.48	0.48	0.46	0.46	0.46

PERFORMANCE EVALUATION FOR INTRA-BASIN TRANSFER AT: DIV 3

MAXIMUM POTENTIAL DIVERSION CAPACITY	0.35	M**3/SEC
DIVERSION CAPACITY	0.35	M**3/SEC

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DIVERSION (MCM)	0.3	0.3	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.3	5.2
DOWNSTREAM FLOW TARGET= (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RELIABILITY (% TIMES TARGET MET)	100.	100.	100.	100.	100.	100.	100.	100.	95.	95.	95.	100.	99.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1

= DOWNSTREAM FLOW TARGET HAS PRIORITY OVER DIVERSION

PERFORMANCE EVALUATION FOR SURFACE WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE AT: NICOSIA

GENERAL CHARACTERISTICS=,

MAXIMUM POTENTIAL DIVERSION CAPACITY....... =	2.00	M**3/SEC
DIVERSION CAPACITY......................... =	1.00	M**3/SEC
TOTAL DEMAND............................... =	5.20	MCM/YR
CONSUMPTIVE USE PERCENTAGE................. =	100.00	%

MONTHLY PERFORMANCE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET DEMAND (MCM)	0.30	0.30	0.30	0.42	0.55	0.55	0.55	0.55	0.55	0.42	0.42	0.30	5.2
RELIABILITY (% TIMES TARGET MET)	100.	100.	100.	100.	100.	100.	100.	100.	95.	95.	95.	100.	99.
AVERAGE DEFICIT (MCM)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.02	0.02	0.0	0.1
MEAN DIVERSION(MCM)	0.30	0.30	0.30	0.42	0.55	0.55	0.55	0.55	0.53	0.40	0.40	0.30	5.1

PERFORMANCE EVALUATION FOR GROUNDWATER DEV. A1 GR.WATER
===

MAXIMUM POTENTIAL PUMPING CAPACITY........ = 0.10 M**3/SEC
PUMPING CAPACITY.......................... = 0.08 M**3/SEC
TOTAL ANNUAL TARGET = 0.50 MCM/YR

MONTHLY PERFORMANCE
=================

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
TARGET (MCM/MO)	0.0	0.0	0.0	0.1	0.1	0.1***************				0.1	0.1	0.0	0.5
RELIABILITY (TIMES TARGET MET)	91.1	91.1	83.9	17.9	7.1	3.6***************				3.6	8.9	50.0	54.8
AVERAGE SUPPLY (MCM/MO)	0.2	0.2	0.1	0.1	0.2	0.0***************				0.1	0.0	0.1	1.0

PERFORMANCE EVALUATION FOR IRRIGATION AREA: PENIRRCI
==

GENERAL CHARACTERISTICS:
======================

MAXIMUM POTENTIAL AREA.......... = 150.00 HA
TARGET AREA..................... = 150.00 HA
APPLICATION EFFICIENCY.......... = 100.00 %
RETURN FLOW COEF................ = 0.0 %
= RETURN TO STREAM.............. = 0.0 %
= PERCOLATION TO GROUNDWATER.... = 0.0 %

MONTHLY USE PARAMETERS:
=====================

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	***************			0.0	0.2	0.2	0.3	0.3	0.2	0.1	0.1*****		1.4

PERFORMANCE RESULTS-
==================

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	93.*****		89.	76.	73.	100.	100.	98.	95.	2.	11.	73.	0.
MEAN DIVERSION	0.0*****		0.0	0.0	0.2	0.2	0.3	0.3	0.2	0.1	0.0	0.0	1.3
STANDARD DEV	0.0*****		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
COEF OF VAR	0.0*****		2.1	0.4	0.0	0.0	0.0	0.0	0.2	0.2	2.0	0.5	0.0

NOTES
=====
= % TIMES TARGET DEMAND MET

MONTHLY HISTOGRAM OF IRRIGATION DIVERSIONS
======================================

DIVERSION RANGE(MCM) FROM	TO	PROPORTION OF TIMES WITHIN RANGE JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0.0	0.03	1.00	1.00	1.00	0.18	0.0	0.0	0.0	0.0	0.05	0.04	0.89	1.00
0.03	0.06	0.0	0.0	0.0	0.82	0.0	0.0	0.0	0.0	0.0	0.0	0.11	0.0
0.06	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.93	0.0	0.0
0.09	0.12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0
0.12	0.15	0.0	0.0	0.0	0.0	0.07	0.0	0.0	0.0	0.0	0.02	0.0	0.0
0.15	0.18	0.0	0.0	0.0	0.0	0.93	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.18	0.21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.21	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.95	0.0	0.0	0.0
0.24	0.27	0.0	0.0	0.0	0.0	0.0	1.00	0.0	0.0	0.0	0.0	0.0	0.0
0.27	0.30	0.0	0.0	0.0	0.0	0.0	0.0	1.00	1.00	0.0	0.0	0.0	0.0
0.30**********		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

PERFORMANCE EVALUATION FOR IRRIGATION AREA: PENIRRVE
==

GENERAL CHARACTERISTICS:
========================

MAXIMUM POTENTIAL AREA..........	=	75.00	HA
TARGET AREA.....................	=	75.00	HA
APPLICATION EFFICIENCY..........	=	100.00	%
RETURN FLOW COEF................	=	0.0	%
= RETURN TO STREAM..............	=	0.0	%
= PERCOLATION TO GROUNDWATER....	=	0.0	%

MONTHLY USE PARAMETERS:
=======================

PARAMETER	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR=
DIVERSION TARGET (MCM)	*****	*****	*****	0.1	0.1	0.1	0.1	0.1	0.1	0.0	*****	*****	0.6

PERFORMANCE RESULTS-
====================

INDEX	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
RELIABILITY=	93.	91.	84.	55.	13.	4.	100.	98.	95.	2.	11.	51.	0.
PEAK DIVERSION	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.3
STANDARD DEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
COEF OF VAR	2.7	1.6	0.3	0.7	1.4	1.4	0.0	0.1	0.2	0.0	1.3	1.5	0.2

NOTES
=====
= % TIMES TARGET DEMAND MET

MONTHLY HISTOGRAM OF IRRIGATION DIVERSIONS
==

DIVERSION RANGE(MCM) FROM	TO	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		PROPORTION OF TIMES WITHIN RANGE											
0.0	0.01	1.00	1.00	0.16	0.35	0.55	0.31	0.0	0.02	0.05	0.98	0.89	1.00
0.01	0.02	0.0	0.0	0.84	0.02	0.15	0.55	0.0	0.0	0.0	0.0	0.0	0.0
0.02	0.03	0.0	0.0	0.0	0.04	0.13	0.11	0.0	0.0	0.0	0.0	0.11	0.0
0.03	0.04	0.0	0.0	0.0	0.05	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.04	0.05	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.02	0.0	0.0
0.05	0.06	0.0	0.0	0.0	0.55	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.06	0.07	0.0	0.0	0.0	0.0	0.02	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.07	0.08	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.95	0.0	0.0	0.0
0.08	0.09	0.0	0.0	0.0	0.0	0.13	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.09	0.10	0.0	0.0	0.0	0.0	0.0	0.04	1.00	0.98	0.0	0.0	0.0	0.0
0.10	**********	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BASIN-WIDE BENEFIT AND COST INFORMATION FOR: SYS WIDE

NOTE! ALL BENEFITS AND COSTS ARE PRESENT VALUE
ALL COSTS INCLUDE BOTH CAPITAL AND OMR COMPONENTS

1. IRRIGATION AREAS

NAME	TARGET AREA	POTENTIAL BENEFITS=	SHORTFALL== LOSSES	ACTUAL+ BENEFITS	% POT BENEFITS	IRRIGATION EMPLOYMENT GENERATED	IRRIGATION COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO	INTERNAL RATE RETURN
	HA	M	M	M	%	PPL/YR	M	M	M	M	%
VASIRRCL	412.	4008.77	1453.15	2555.63	64.	301.	392.30	1351.96	1203.66	1.89	1.5
VASIRRVE	261.	3155.82	962.17	2193.65	70.	149.	248.18	761.28	1432.37	2.88	1.5
VASIRRVI	157.	758.32	197.37	560.95	74.	71.	147.99	332.62	228.32	1.69	1.5
S.LO.IRR	86.	411.68	91.07	320.62	78.	49.	51.56	51.56	269.05	6.22	1.5
MARI IRR	48.	360.41	98.17	262.25	73.	27.	88.37	88.37	173.87	2.97	1.5
TOKNIIRR	42.	0.0	0.0	0.0	0.	24.	0.0	0.0	0.0	0.0	******
LEF IRR	55.	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0	0.0	******
PENIRRCI	150.	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0	0.0	******
PENIRRVE	75.	859.97	620.05	239.92	28.	57.	223.61	705.19	-465.26	0.34	1.5
TOTAL	1286.	9554.97	3421.97	6133.00	64.	678.	******	3290.99	2842.01	1.86	

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

2. HYDROELECTRIC POWER GENERATION

NAME	INSTALLED CAPACITY	ENERGY BENEFITS	CAPACITY BENEFITS	SHORTFALL LOSSES==	TOTAL BENEFITS+	PLANT COSTS	TOTAL= COSTS++	NET BENEFITS	B-C RATIO	INTERNAL RATE OF RETURN
	MW	M	M	M	M	M	M	M	M	%

NO HYDROPLANTS IN THIS SYSTEM

3. WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE

NAME	TARGET DEMAND	POTENTIAL= BENEFITS	SHORTAGE== LOSSES	ACTUAL+ BENEFITS	% POTENTIAL BENEFITS	M & I COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	MCM/YR	M	M	M	%	M	M	M	-
UPS.USE1	0.09	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0

UPS.USE2	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
UPS.USE3	0.02	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
KHIRECON	0.06	3872.65	846.46	3026.19	78.	0.0	489.49	2536.69	6.18
KHCHECK2	0.09	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
NICOSIA	0.16	10068.86	193.12	9875.75	98.	0.0	3817.40	6058.35	2.59
KHCHECK1	0.16	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
KHIROKTI	0.25	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
HELL.COM	0.01	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
TOTAL	0.85	13941.52	1039.58	12901.94	93.	0.0	4306.89	8595.04	3.00

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

4. FLOOD CONTROL & RECREATION*

LOCATION	TOTAL BENEFITS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	£	£	£	-

NO FLOOD CONTROL OR RECREATION LOCATIONS

SUMMARY OF COSTS AND BENEFITS FOR: SYS WIDE
================================

TOTAL COSTS.................... = 7597.88 £
TOTAL BENEFITS................. = 19034.93 £
TOTAL NET BENEFITS............. = 11437.05 £
TOTAL BENEFIT/COST RATIO....... = 2.51 #
TOTAL IRRIGATION EMPLOYMENT.... = 678. PPL/YR

BASIN-WIDE BENEFIT AND COST INFORMATION FOR: REGION 1

NOTE: ALL BENEFITS AND COSTS ARE PRESENT VALUE
ALL COSTS INCLUDE BOTH CAPITAL AND OMR COMPONENTS

1. IRRIGATION AREAS

NAME	TARGET AREA	POTENTIAL BENEFITS*	SHORTFALL** LOSSES	ACTUAL+ BENEFITS	% POT BENEFITS	IRRIGATION EMPLOYMENT GENERATED	IRRIGATION COSTS	TOTAL++ COSTS	NET BENEFITS	B-COF RATIO	INTERNAL RATE RETURN
	HA	£	£	£	%	PPL/YR	£	£	£	£	%
VASIRRCI	412.	4608.77	1453.15	2555.63	64.	301.392.30		1351.96	1203.66	1.89	1.5
VASIRRVE	261.	3155.82	962.17	2193.65	70.	149.248.18		761.28	1432.37	2.88	1.5
VASIRRVI	157.	758.32	197.37	560.95	74.	71.147.99		332.62	228.32	1.69	1.5
TOTAL	830.	7922.91	2612.69	5310.21	67.	520.788.47		2445.87	2864.35	2.17	

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

2. HYDROELECTRIC POWER GENERATION

NAME	INSTALLED CAPACITY	ENERGY BENEFITS	CAPACITY BENEFITS	SHORTFALL LOSSES**	TOTAL BENEFITS+	PLANT COSTS	TOTAL* COSTS++	NET BENEFITS	B-C RATIO	INTERNAL RATE OF RETURN
	MW	£	£	£	£	£	£	£	£	%

NO HYDROPLANTS IN THIS SYSTEM

3. WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE

NAME	TARGET DEMAND	POTENTIAL* BENEFITS	SHORTAGE** LOSSES	ACTUAL+ BENEFITS	% POTENTIAL BENEFITS	M & I COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	MCM/YR	£	£	£	%	£	£	£	-
UPS.USE1	0.09	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
UPS.USE2	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
KHIRECON	0.06	3872.65	846.46	3026.19	78.	0.0	489.49	2536.69	6.18
KHCHECK2	0.09	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
TOTAL	0.24	3872.65	846.46	3026.19	78.	0.0	489.49	2536.69	6.18

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR

== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

4. FLOOD CONTROL & RECREATION*

LOCATION	TOTAL BENEFITS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	£	£	£	-

NO FLOOD CONTROL OR RECREATION LOCATIONS

SUMMARY OF COSTS AND BENEFITS FOR: REGION 1

TOTAL COSTS.................... = 2935.36 £
TOTAL BENEFITS................. = 8336.40 £
TOTAL NET BENEFITS............. = 5401.04 £
TOTAL BENEFIT/COST RATIO....... = 2.84 £
TOTAL IRRIGATION EMPLOYMENT.... = 520. PPL/YR

BASIN-WIDE BENEFIT AND COST INFORMATION FOR: REGION 2

NOTE! ALL BENEFITS AND COSTS ARE PRESENT VALUE
ALL COSTS INCLUDE BOTH CAPITAL AND OMR COMPONENTS

1. IRRIGATION AREAS

NAME	TARGET AREA	POTENTIAL BENEFITS=	SHORTFALL== LOSSES	ACTUAL+ BENEFITS	% POT BENEFITS	IRRIGATION EMPLOYMENT GENERATED	IRRIGATION COSTS	TOTAL++ COSTS	NET BENEFITS	B-C OF RATIO	INTERNAL RATE RETURN
	HA	£	£	£	%	PPL/YR	£	£	£	£	%
LEF IRR	55.	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0	0.0	******
PENIRRCI	150.	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0	0.0	******
PENIRRVE	75.	859.97	620.05	239.92	28.	57.	223.61	705.19	-465.26	0.34	1.5
TOTAL	280.	859.97	620.05	239.92	28.	57.	223.61	705.19	-465.26	0.34	

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

2. HYDROELECTRIC POWER GENERATION

NAME	INSTALLED CAPACITY	ENERGY BENEFITS	CAPACITY BENEFITS	SHORTFALL LOSSES==	TOTAL BENEFITS+	PLANT COSTS	TOTAL= COSTS++	NET BENEFITS	B-C RATIO	INTERNAL RATE OF RETURN
	MW	£	£	£	£	£	£	£	£	%

NO HYDROPLANTS IN THIS SYSTEM

3. WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE

NAME	TARGET DEMAND	POTENTIAL= BENEFITS	SHORTAGE== LOSSES	ACTUAL+ BENEFITS	% POTENTIAL BENEFITS	M & I COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	MCM/YR	£	£	£	%	£	£	£	-
UPS.USES	0.02	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
NICOSIA	0.16	10068.88	193.12	9875.75	98.	0.0	3817.40	6058.35	2.59
KHCHECK1	0.16	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
TOTAL	0.35	10068.88	193.12	9875.75	98.	0.0	3817.40	6058.35	2.59

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET

\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

4. FLOOD CONTROL & RECREATION*

LOCATION	TOTAL BENEFITS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	₦	₦	₦	-

NO FLOOD CONTROL OR RECREATION LOCATIONS

SUMMARY OF COSTS AND BENEFITS FOR: REGION 2
==================================

TOTAL COSTS.................. = 4522.59 ₦
TOTAL BENEFITS............... = 10115.67 ₦
TOTAL NET BENEFITS........... = 5593.09 ₦
TOTAL BENEFIT/COST RATIO..... = 2.24 ₦
TOTAL IRRIGATION EMPLOYMENT.... = 57. PPL/YR

BASIN-WIDE BENEFIT AND COST INFORMATION FOR: REGION 3

NOTE! ALL BENEFITS AND COSTS ARE PRESENT VALUE
ALL COSTS INCLUDE BOTH CAPITAL AND OMR COMPONENTS

1. IRRIGATION AREAS

NAME	TARGET AREA	POTENTIAL BENEFITS=	SHORTFALL== LOSSES	ACTUAL+ BENEFITS	% POT BENEFITS	IRRIGATION EMPLOYMENT GENERATED	IRRIGATION COSTS	TOTAL++ COSTS	NET BENEFITS	B-C OF RATIO	INTERNAL RATE RETURN
	HA	₦	₦	₦	%	PPL/YR	₦	₦	₦	₦	%
S.LO.IRR	86.	411.68	91.07	320.62	78.	49.	51.56	51.56	269.05	6.22	1.5
MARI IRR	48.	360.41	98.17	262.25	73.	27.	88.37	88.37	173.87	2.97	1.5
TOKNIIRR	42.	0.0	0.0	0.0	0.	24.	0.0	0.0	0.0	0.0	******
TOTAL	176.	772.10	189.23	582.86	75.	100.	139.94	139.94	442.93	4.17	

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

2. HYDROELECTRIC POWER GENERATION

NAME	INSTALLED CAPACITY	ENERGY BENEFITS	CAPACITY BENEFITS	SHORTFALL LOSSES==	TOTAL BENEFITS+	PLANT COSTS	TOTAL= COSTS++	NET BENEFITS	B-C RATIO	INTERNAL RATE OF RETURN
	MW	₦	₦	₦	₦	₦	₦	₦	₦	%

NO HYDROPLANTS IN THIS SYSTEM

3. WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE

NAME	TARGET DEMAND	POTENTIAL= BENEFITS	SHORTAGE== LOSSES	ACTUAL+ BENEFITS	% POTENTIAL BENEFITS	M & I COSTS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	MCM/YR	₦	₦	₦	%	₦	₦	₦	-
WELL.COM	0.01	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0
TOTAL	0.01	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.0

= PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
== PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

4. FLOOD CONTROL & RECREATION*

LOCATION	TOTAL BENEFITS	TOTAL++ COSTS	NET BENEFITS	B-C RATIO
	₦	₦	₦	-

NO FLOOD CONTROL OR RECREATION LOCATIONS

SUMMARY OF COSTS AND BENEFITS FOR: REGION 3
==================================

TOTAL COSTS.................. = 139.94 ₦
TOTAL BENEFITS............... = 582.86 ₦
TOTAL NET BENEFITS........... = 442.93 ₦
TOTAL BENEFIT/COST RATIO..... = 4.17 ₦
TOTAL IRRIGATION EMPLOYMENT.... = 100. PPL/YR

INDIVIDUAL PROJECT ECONOMIC ANALYSIS FOR:

SYS WIDE

BENEFIT AND COST ANALYSIS FOR RESERVOIR: KALDAM

ACTIVE STORAGE...................... = 15.90 MCM
CREST ELEVATION..................... = 176.50 M
CAPITAL COSTS....................... = 2079.00 ¤
OMR COSTS........................... = 67.89 ¤
TOTAL COSTS......................... = 2146.89 ¤

ALLOCATION OF RESERVOIR COSTS

NAME	TYPE	% COSTS ATTRIBUTED	COSTS ATTRIBUTED
		%	¤
KHIRECON	MUN+IND	23.	489.49
VASIRRCI	IRGATION	45.	959.66
VASIRRVE	IRGATION	24.	513.11
VASIRRVI	IRGATION	9.	184.63
TOTAL			2146.89

A. IRRIGATION BENEFITS:

NAME	REMAINING BENEFITS	BENEFIT ALLOCATION FACTOR	RESERVOIR ASSIGNED REMAINING BENEFITS	RESERVOIR ALLOCATED BENEFITS
	¤		¤	¤
VASIRRVE	1432.37	0.0	0.0	513.11
VASIRRVI	228.32	0.0	0.0	184.63
VASIRRCI	1203.66	0.0	0.0	959.66
TOTAL	2864.35	0.0	0.0	******

C. BENEFITS FROM WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE:

NAME	REMAINING BENEFITS	BENEFIT ALLOCATION FACTOR	RESERVOIR ASSIGNED REMAINING BENEFITS	RESERVOIR ALLOCATED BENEFITS
	¤		¤	¤
KHIRECON	2536.69	0.0	0.0	489.49
TOTAL	2536.69	0.0	0.0	489.49

TOTAL BENEFITS...................... = 2146.89 ¤
TOTAL NET BENEFITS.................. = -0.00 ¤
BENEFIT-COST RATIO.................. = 1.00 ¤

BENEFIT AND COST ANALYSIS FOR RESERVOIR: DHYP.DAM

ACTIVE STORAGE...................... = 13.60 MCM
CREST ELEVATION..................... = 174.50 M
CAPITAL COSTS....................... = 1566.95 ¤
OMR COSTS........................... = 78.35 ¤
TOTAL COSTS......................... = 1645.30 ¤

ALLOCATION OF RESERVOIR COSTS

NAME	TYPE	% COSTS ATTRIBUTED	COSTS ATTRIBUTED
		%	¤
NICOSIA	MUN+IND	78.	1276.75
PENIRRVE	IRGATION	22.	368.55
TOTAL			1645.30

A. IRRIGATION BENEFITS:

NAME	REMAINING BENEFITS	BENEFIT ALLOCATION FACTOR	RESERVOIR ASSIGNED REMAINING BENEFITS	RESERVOIR ALLOCATED BENEFITS
	¤		¤	¤
PENIRRVE	-465.26	0.0	0.0	368.55
TOTAL	-465.26	0.0	0.0	368.55

C. BENEFITS FROM WATER SUPPLY FOR MUNICIPAL AND INDUSTRIAL USE:

NAME	REMAINING BENEFITS	BENEFIT ALLOCATION FACTOR	RESERVOIR ASSIGNED REMAINING BENEFITS	RESERVOIR ALLOCATED BENEFITS
	¤		¤	¤
NICOSIA	6058.35	0.0	0.0	******
TOTAL	6058.35	0.0	0.0	******

TOTAL BENEFITS...................... = 1645.30 ¤
TOTAL NET BENEFITS.................. = -0.00 ¤
BENEFIT-COST RATIO.................. = 1.00 ¤

BENEFIT AND COST ANALYSIS FOR INTRA-BASIN TRANSFER AT : DIV 2

CAPACITY........................	=	1.00 M**3/SEC
CAPITAL COSTS...................	=	445.00 £
OMR COSTS.......................	=	59.58 £
TOTAL COSTS.....................	=	504.58 £

IRRIGATION BENEFITSFITS:

NAME	REMAINING BENEFITS £	BENEFIT ALLOCATION FACTOR	DIVERSION ASSIGNED REMAINING BENEFITS £	DIVERSION ALLOCATED BENEFITS £
PENIRRVE	-465.26	0.0	0.0	113.03
TOTAL	-465.26	0.0	0.0	113.03

BENEFITS FROM MUNICIPAL AND INDUSTRIAL USE

NAME	REMAINING BENEFITS £	BENEFIT ALLOCATION FACTOR	DIVERSION ASSIGNED REMAINING BENEFITS £	DIVERSION ALLOCATED BENEFITS £
NICOSIA	6058.35	0.0	0.0	391.55
TOTAL	6058.35	0.0	0.0	391.55

TOTAL BENEFITS..................	=	0.0 £
TOTAL NET BENEFITS..............	=	-504.58 £
BENEFIT-COST RATIO..............	=	0.0 £

BENEFIT AND COST ANALYSIS FOR INTRA-BASIN TRANSFER AT : DIV 3

CAPACITY........................	=	0.35 M**3/SEC
CAPITAL COSTS...................	=	1962.00 £
OMR COSTS.......................	=	187.10 £
TOTAL COSTS.....................	=	2149.10 £

BENEFITS FROM MUNICIPAL AND INDUSTRIAL USE

NAME	REMAINING BENEFITS £	BENEFIT ALLOCATION FACTOR	DIVERSION ASSIGNED REMAINING BENEFITS £	DIVERSION ALLOCATED BENEFITS £
NICOSIA	6058.35	0.0	0.0	******
TOTAL	6058.35	0.0	0.0	******

TOTAL BENEFITS..................	=	0.0 £
TOTAL NET BENEFITS..............	=	-2149.10 £
BENEFIT-COST RATIO..............	=	0.0 £

BENEFIT AND COST ANALYSIS FOR MUNICIPAL AND INDUSTRIAL USE AT: KHIRECON

TARGET DEMAND...................	=	2.00 MCM/YR
CAPITAL COSTS...................	=	0.0 £
OMR COSTS.......................	=	0.0 £
TOTAL COSTS.....................	=	0.0 £
TOTAL ALLOCATED COSTS (SEE BELOW)	=	489.49 £
TOTAL COSTS.....................	=	489.49 £

RESERVOIR, GROUNDWATER OR DIVERSION COSTS ATTRIBUTED TO THIS SITE:

PROJECT TYPE	NAME	TOTAL COST £	% ATTRIBUTED TO M & I USE %	ATTRIBUTED COSTS £
RESRVOIR	KALDAM	2146.89	23.	489.49
TOTAL	KHIRECON	2146.89	0.	489.49

POTENTIAL M + I BENEFITS*........	=	3872.65 £
SHORTAGE LOSSES**................	=	846.46 £
ACTUAL M + I BENEFITS+...........	=	3026.19 £
TOTAL REMAINING BENEFITS++.......	=	2536.70 £
TOTAL BENEFIT-COST RATIO.........	=	6.18 £

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR MUNICIPAL AND INDUSTRIAL USE AT: NICOSIA

TARGET DEMAND........................ = 5.20 MCM/YR
CAPITAL COSTS........................= 0.0 £
OMR COSTS............................= 0.0 £
TOTAL COSTS..........................= 0.0 £
TOTAL ALLOCATED COSTS (SEE BELOW)= 3817.40 £
TOTAL COSTS..........................= 3817.40 £

RESERVOIR, GROUNDWATER OR DIVERSION COSTS ATTRIBUTED TO THIS SITE:

PROJECT TYPE	NAME	TOTAL COST	% ATTRIBUTED TO M & I USE	ATTRIBUTED COSTS
		£	%	£
DIVRSION	DIV 3	2149.10	100.	2149.10
RESRVOIR	DHYP.DAM	1645.30	78.	1276.75
DIVRSION	DIV 2	504.58	78.	391.55
TOTAL	NICOSIA	4298.97	1.	3817.40

POTENTIAL M + I BENEFITS*......... = 10068.88 £
SHORTAGE LOSSES**................ = 193.12 £
ACTUAL M + I BENEFITS?............ = 9875.75 £
TOTAL REMAINING BENEFITS++........ = 6058.35 £
TOTAL BENEFIT-COST RATIO.......... = 2.59 £

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR IRRIGATION AREA: VASIRRCI

TARGET AREA......................... = 412.00 HA
IRRIGATION CAPITAL COSTS.......... = 354.39 £
IRRIGATION OMR COSTS............. = 37.91 £
TOTAL IRRIGATION COSTS............ = 392.30 £
TOTAL ALLOCATED COSTS (SEE BELOW)= 959.66 £
TOTAL COSTS......................... = 1351.96 £

RESERVOIR, GROUNDWATER OR DIVERSION COSTS ATTRIBUTED TO THIS IRRIGATION AREA

PROJECT TYPE	NAME	TOTAL COST	% ATTRIBUTED TO IRRIGATION AREA	ATTRIBUTED COSTS
		£	%	£
RESRVOIR	KALDAM	2146.89	45.	959.66
TOTAL	VASIRRCI	2146.89	45.	959.66

POTENTIAL IRRIGATION BENEFITS.... = 4008.77 £
SHORTAGE LOSSES**................ = 1453.15 £
ACTUAL IRRIGATION BENEFITS+....... = 2555.63 £
TOTAL REMAINING BENEFITS++........ = 1203.60 £
TOTAL BENEFIT-COST RATIO.......... = 1.89
INTERNAL RATE OF RETURN........... = 1.50 %

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR IRRIGATION AREA: VASIRRVE

TARGET AREA......................... = 261.00 HA
IRRIGATION CAPITAL COSTS.......... = 224.19 £
IRRIGATION OMR COSTS............. = 23.98 £
TOTAL IRRIGATION COSTS............ = 248.18 £
TOTAL ALLOCATED COSTS (SEE BELOW)= 513.11 £
TOTAL COSTS......................... = 761.28 £

RESERVOIR, GROUNDWATER OR DIVERSION COSTS ATTRIBUTED TO THIS IRRIGATION AREA

PROJECT TYPE	NAME	TOTAL COST	% ATTRIBUTED TO IRRIGATION AREA	ATTRIBUTED COSTS
		£	%	£
RESRVOIR	KALDAM	2146.89	24.	513.11
TOTAL	VASIRRVE	2146.89	24.	513.11

POTENTIAL IRRIGATION BENEFITS.... = 3155.82 £
SHORTAGE LOSSES**................ = 962.17 £
ACTUAL IRRIGATION BENEFITS+....... = 2193.65 £
TOTAL REMAINING BENEFITS++........ = 1432.37 £
TOTAL BENEFIT-COST RATIO.......... = 2.88
INTERNAL RATE OF RETURN........... = 1.50 %

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR IRRIGATION AREA: VASIRRVI

TARGET AREA...................... =	157.00	HA
IRRIGATION CAPITAL COSTS.......... =	133.69	R
IRRIGATION OMR COSTS.............. =	14.30	R
TOTAL IRRIGATION COSTS............ =	147.99	R
TOTAL ALLOCATED COSTS (SEE BELOW)=	184.63	R
TOTAL COSTS....................... =	332.62	R

RESERVOIR, GROUNDWATER OR DIVERSION COSTS ATTRIBUTED TO THIS IRRIGATION AREA

PROJECT TYPE	NAME	TOTAL COST	% ATTRIBUTED TO IRRIGATION AREA	ATTRIBUTED COSTS
		R	%	R
RESRVOIR	KALDAM	2146.89	9.	184.63
TOTAL	VASIRRVI	2146.89	9.	184.63

POTENTIAL IRRIGATION BENEFITS..... =	758.32	R
SHORTAGE LOSSES**................. =	197.37	R
ACTUAL IRRIGATION BENEFITS+....... =	560.95	R
TOTAL REMAINING BENEFITS++........ =	228.32	R
TOTAL BENEFIT-COST RATIO.......... =	1.69	
INTERNAL RATE OF RETURN........... =	1.50	%

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR IRRIGATION AREA: S.LO.IRR

TARGET AREA...................... =	86.00	HA
IRRIGATION CAPITAL COSTS.......... =	17.52	R
IRRIGATION OMR COSTS.............. =	34.04	R
TOTAL IRRIGATION COSTS............ =	51.56	R
TOTAL ALLOCATED COSTS (SEE BELOW)=	0.0	R
TOTAL COSTS....................... =	51.56	R

POTENTIAL IRRIGATION BENEFITS..... =	411.68	R
SHORTAGE LOSSES**................. =	91.07	R
ACTUAL IRRIGATION BENEFITS+....... =	320.62	R
TOTAL REMAINING BENEFITS++........ =	269.05	R
TOTAL BENEFIT-COST RATIO.......... =	6.22	
INTERNAL RATE OF RETURN........... =	1.50	%

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR IRRIGATION AREA: MARI IRR

TARGET AREA...................... =	48.00	HA
IRRIGATION CAPITAL COSTS.......... =	49.97	R
IRRIGATION OMR COSTS.............. =	38.40	R
TOTAL IRRIGATION COSTS............ =	88.37	R
TOTAL ALLOCATED COSTS (SEE BELOW)=	0.0	R
TOTAL COSTS....................... =	88.37	R

POTENTIAL IRRIGATION BENEFITS..... =	360.41	R
SHORTAGE LOSSES**................. =	98.17	R
ACTUAL IRRIGATION BENEFITS+....... =	262.25	R
TOTAL REMAINING BENEFITS++........ =	173.87	R
TOTAL BENEFIT-COST RATIO.......... =	2.97	
INTERNAL RATE OF RETURN........... =	1.50	%

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

BENEFIT AND COST ANALYSIS FOR IRRIGATION AREA: PENIRRVE

TARGET AREA...................... =	75.00	HA
IRRIGATION CAPITAL COSTS.......... =	202.00	R
IRRIGATION OMR COSTS.............. =	21.61	R
TOTAL IRRIGATION COSTS............ =	223.61	R
TOTAL ALLOCATED COSTS (SEE BELOW)=	481.57	R
TOTAL COSTS....................... =	705.19	R

RESERVOIR, GROUNDWATER OR DIVERSION COSTS ATTRIBUTED TO THIS IRRIGATION AREA

PROJECT TYPE	NAME	TOTAL COST	% ATTRIBUTED TO IRRIGATION AREA	ATTRIBUTED COSTS
		R	%	R
RESRVOIR	DHYR.DAM	1645.30	22.	368.55
DIVRSION	DIV 2	504.58	22.	113.03
TOTAL	PENIRRVE	2149.87	22.	481.57

POTENTIAL IRRIGATION BENEFITS..... =	859.97	R
SHORTAGE LOSSES**................. =	620.05	R
ACTUAL IRRIGATION BENEFITS+....... =	239.92	R
TOTAL REMAINING BENEFITS++........ =	-465.26	R
TOTAL BENEFIT-COST RATIO.......... =	0.34	
INTERNAL RATE OF RETURN........... =	1.50	%

* PRESENT VALUE OF ANNUAL BENEFITS IF NO SHORTFALLS FROM THE SPECIFIED SUPPLY TARGET OCCUR
** PRESENT VALUE OF ANNUAL LOSSES DUE TO SHORTFALLS FROM SPECIFIED SUPPLY TARGET
\+ POTENTIAL BENEFITS MINUS SHORTAGE LOSSES
++ INCLUDE ATTRIBUTABLE RESERVOIR, DIVERSION, AND/OR PUMPING COSTS WHERE APPLICABLE

HYDROGRAPHS (M**3/SEC)

ONLY THE FIRST TEN YEARS ARE SHOW

	KALDAM	DIV 1	VASIRRCI	END 2	DIV 6	DIV 4	END 7	DHYP_DAM	PENIRRCI	PENIRRVE
YEAR 1										
	0.11	0.11	0.05	0.0	0.0	0.11	0.0	0.08	0.00	0.00
	0.28	0.07	0.04	0.0	0.0	0.06	0.0	0.16	0.00	0.00
	0.46	0.05	0.02	0.0	0.08	0.08	0.0	0.49	0.01	0.01
	0.22	0.08	0.06	0.00	0.02	0.04	0.0	0.20	0.03	0.02
	0.07	0.31	0.28	0.00	0.01	0.02	0.0	0.10	0.10	0.03
	0.0	0.47	0.40	0.0	0.01	0.0	0.0	0.04	0.13	0.04
	0.0	0.53	0.45	0.00	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.56	0.47	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.44	0.35	0.0	0.0	0.0	0.0	0.00	0.0	0.0
	0.03	0.31	0.22	0.0	0.0	0.0	0.0	0.00	0.04	0.0
	0.04	0.07	0.0	0.0	0.0	0.0	0.0	0.01	0.03	0.01
	0.07	0.07	0.0	0.0	0.0	0.08	0.0	0.13	0.00	0.00
AGE	0.11	0.26	0.20	0.00	0.01	0.03	0.0	0.10	0.05	0.02
YEAR 2										
	0.09	0.09	0.03	0.0	0.0	0.08	0.0	0.16	0.00	0.00
	0.41	0.07	0.04	0.0	0.06	0.14	0.0	0.71	0.00	0.00
	0.41	0.05	0.02	0.0	0.08	0.08	0.0	0.50	0.01	0.01
	0.18	0.08	0.06	0.00	0.07	0.04	0.0	0.24	0.03	0.02
	0.09	0.31	0.28	0.00	0.03	0.02	0.0	0.14	0.08	0.02
	0.0	0.47	0.40	0.0	0.01	0.0	0.0	0.06	0.10	0.00
	0.0	0.11	0.03	0.00	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.00	0.0
	0.06	0.06	0.0	0.0	0.18	0.11	0.0	0.83	0.00	0.00
AGE	0.10	0.10	0.07	0.00	0.04	0.04	0.0	0.23	0.04	0.01
YEAR 3										
	0.63	0.11	0.05	0.0	0.26	0.16	0.0	0.66	0.08	0.08
	1.08	0.07	0.04	0.0	0.36	0.14	0.0	0.75	0.48	0.46
	0.76	0.05	0.02	0.0	0.26	0.08	0.0	0.64	0.06	0.06
	0.37	0.08	0.06	0.00	0.11	0.04	0.0	0.28	0.18	0.17
	0.15	0.31	0.28	0.00	0.06	0.02	0.0	0.14	0.07	0.01
	0.0	0.47	0.40	0.0	0.03	0.0	0.0	0.06	0.10	0.00
	0.0	0.53	0.45	0.00	0.00	0.0	0.0	0.02	0.15	0.04
	0.0	0.56	0.47	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.44	0.35	0.0	0.0	0.0	0.0	0.01	0.11	0.03
	0.0	0.31	0.22	0.0	0.0	0.0	0.0	0.01	0.02	0.0
	0.0	0.06	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0
	0.35	0.17	0.08	0.0	0.00	0.11	0.0	0.19	0.01	0.01
AGE	0.28	0.26	0.20	0.00	0.09	0.05	0.0	0.23	0.12	0.08
YEAR 4										
	0.13	0.11	0.05	0.0	0.0	0.12	0.0	0.24	0.02	0.02
	0.80	0.07	0.04	0.0	0.28	0.14	0.0	1.33	0.0	0.0
	1.52	0.05	0.02	0.06	0.61	0.08	0.0	1.67	0.0	0.0
	0.72	0.08	0.06	0.00	0.34	0.04	0.0	0.77	0.04	0.03
	0.35	0.31	0.28	0.00	0.15	0.02	0.0	0.35	0.08	0.01
	0.07	0.47	0.40	0.0	0.07	0.0	0.0	0.18	0.10	0.00
	0.0	0.53	0.45	0.00	0.02	0.0	0.0	0.06	0.15	0.04
	0.0	0.56	0.47	0.01	0.0	0.0	0.0	0.03	0.15	0.04
	0.0	0.44	0.35	0.01	0.0	0.0	0.0	0.01	0.11	0.03
	0.0	0.31	0.22	0.01	0.0	0.0	0.0	0.01	0.02	0.0
	0.0	0.24	0.16	0.00	0.0	0.0	0.0	0.00	0.0	0.0
	0.14	0.17	0.08	0.06	0.0	0.09	0.0	0.12	0.00	0.00
AGE	0.31	0.28	0.22	0.01	0.12	0.04	0.0	0.40	0.06	0.01

	KALDAM	DIV 1	VASIRRCI	END 2	DIV 6	DIV 4	END 7	DHYP_DAM	PENIRRCI	PENIRRVE
YEAR 5										
	0.09	0.11	0.05	0.0	0.0	0.12	0.0	0.29	0.01	0.01
	0.39	0.07	0.04	0.0	0.11	0.14	0.0	0.68	0.10	0.10
	0.55	0.05	0.02	0.0	0.19	0.08	0.0	0.51	0.03	0.03
	0.27	0.08	0.06	0.00	0.08	0.04	0.0	0.25	0.02	0.00
	0.16	0.31	0.28	0.00	0.06	0.02	0.0	0.16	0.06	0.0
	0.0	0.47	0.40	0.0	0.05	0.0	0.0	0.14	0.10	0.00
	0.0	0.53	0.45	0.00	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.40	0.32	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.11	0.03
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.02	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.01	0.0
	0.10	0.10	0.01	0.0	0.0	0.08	0.0	0.06	0.00	0.00
AGE	0.13	0.18	0.14	0.00	0.04	0.04	0.0	0.18	0.06	0.02
YEAR 6										
	0.08	0.08	0.03	0.0	0.0	0.11	0.0	0.09	0.00	0.00
	0.56	0.07	0.04	0.0	0.18	0.14	0.0	0.59	0.21	0.21
	0.53	0.05	0.02	0.0	0.05	0.08	0.0	0.29	0.02	0.01
	0.23	0.08	0.06	0.00	0.02	0.04	0.0	0.13	0.01	0.0
	0.06	0.31	0.28	0.00	0.01	0.02	0.0	0.07	0.07	0.01
	0.0	0.47	0.40	0.0	0.01	0.0	0.0	0.03	0.10	0.00
	0.0	0.41	0.33	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.11	0.03
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.02	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.0	0.0
	0.04	0.04	0.0	0.0	0.0	0.09	0.0	0.08	0.00	0.00
AGE	0.13	0.13	0.10	0.00	0.02	0.04	0.0	0.11	0.07	0.03
YEAR 7										
	0.15	0.11	0.05	0.0	0.0	0.13	0.0	0.18	0.02	0.02
	0.45	0.07	0.04	0.0	0.09	0.14	0.0	0.56	0.04	0.04
	0.80	0.05	0.02	0.0	0.22	0.08	0.0	0.79	0.06	0.06
	0.36	0.08	0.06	0.00	0.09	0.04	0.0	0.29	0.02	0.01
	0.18	0.31	0.28	0.00	0.05	0.02	0.0	0.15	0.07	0.01
	0.0	0.47	0.40	0.0	0.02	0.0	0.0	0.06	0.10	0.00
	0.0	0.53	0.45	0.00	0.0	0.0	0.0	0.02	0.15	0.04

	0.0	0.32	0.24	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.01	0.11	0.03
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.02	0.0
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0
	0.08	0.08	0.0	0.0	0.0	0.08	0.0	0.03	0.00	0.00
VERAGE	0.17	0.17	0.13	0.00	0.04	0.04	0.0	0.18	0.06	0.02
YEAR 8										
	0.89	0.11	0.05	0.15	0.32	0.16	0.0	1.36	0.21	0.21
	1.16	0.07	0.04	0.08	0.36	0.14	0.0	1.22	0.10	0.10
	0.62	0.05	0.02	0.03	0.16	0.08	0.0	0.50	0.03	0.03
	0.31	0.08	0.06	0.02	0.08	0.04	0.0	0.23	0.02	0.00
	0.10	0.31	0.28	0.00	0.04	0.02	0.0	0.11	0.06	0.00
	0.0	0.47	0.40	0.02	0.02	0.0	0.0	0.05	0.10	0.00
	0.0	0.53	0.45	0.01	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.56	0.47	0.01	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.44	0.35	0.01	0.0	0.0	0.0	0.01	0.11	0.03
	0.0	0.31	0.22	0.00	0.0	0.0	0.0	0.02	0.02	0.0
	0.0	0.17	0.08	0.00	0.0	0.0	0.0	0.05	0.00	0.0
	0.05	0.05	0.0	0.03	0.0	0.10	0.0	0.14	0.00	0.00
VERAGE	0.26	0.26	0.20	0.03	0.08	0.05	0.0	0.31	0.08	0.04
YEAR 9										
	0.65	0.11	0.05	0.25	0.34	0.16	0.0	1.19	0.09	0.09
	0.33	0.07	0.04	0.0	0.06	0.14	0.0	0.37	0.03	0.03
	0.25	0.05	0.02	0.0	0.04	0.08	0.0	0.21	0.02	0.02
	0.13	0.08	0.06	0.00	0.03	0.04	0.0	0.12	0.01	0.0
	0.02	0.31	0.28	0.00	0.02	0.02	0.0	0.06	0.06	0.0
	0.0	0.47	0.40	0.0	0.01	0.0	0.0	0.03	0.10	0.00
	0.0	0.30	0.22	0.00	0.0	0.0	0.0	0.01	0.15	0.04
	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.01	0.15	0.05
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	0.11	0.03
	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.02	0.02	0.0
	0.0	0.0	0.0	0.03	0.0	0.0	0.0	0.05	0.06	0.04
	0.05	0.05	0.0	0.05	0.0	0.08	0.0	0.05	0.18	0.18
VERAGE	0.12	0.12	0.09	0.03	0.04	0.04	0.0	0.18	0.08	0.04
	KALDAM	DIV 1	VASIRRCI	END 2	DIV 6	DIV 4	END 7	DHYP.DAM	PENIRRCI	PENIRRVE
YEAR 10										
	1.14	0.11	0.05	0.62	0.59	0.16	0.0	2.67	0.53	0.53
	0.93	0.07	0.04	0.22	0.33	0.14	0.0	1.26	0.18	0.18
	1.79	0.05	0.02	0.90	0.84	0.08	0.0	2.39	0.97	0.97
	0.96	0.08	0.06	0.31	0.37	0.04	0.0	0.89	0.82	0.80
	0.41	0.31	0.28	0.16	0.18	0.02	0.0	0.40	0.21	0.15
	0.08	0.47	0.40	0.11	0.09	0.0	0.0	0.19	0.10	0.01
	0.0	0.53	0.45	0.08	0.03	0.0	0.0	0.09	0.15	0.04
	0.0	0.56	0.47	0.05	0.0	0.0	0.0	0.02	0.15	0.04
	0.0	0.44	0.35	0.03	0.0	0.0	0.0	0.01	0.12	0.04
	0.0	0.31	0.22	0.01	0.0	0.0	0.0	0.01	0.02	0.0
	0.0	0.24	0.16	0.01	0.0	0.0	0.0	0.01	0.0	0.0
	0.03	0.17	0.08	0.04	0.0	0.08	0.0	0.05	0.00	0.00
VERAGE	0.44	0.28	0.22	0.21	0.20	0.04	0.0	0.67	0.27	0.23