DESIGN REPORT
OF
PARALKOTE IRRIGATION CANAL SYSTEM SURVEY,
PARALKOTE ZONE, DANDAKARANYA PROJECT
IN
INDIA

VOLUME I

AUGUST 1971

OVERSEAS TECHNICAL COOPERATION AGENCY
JAPAN

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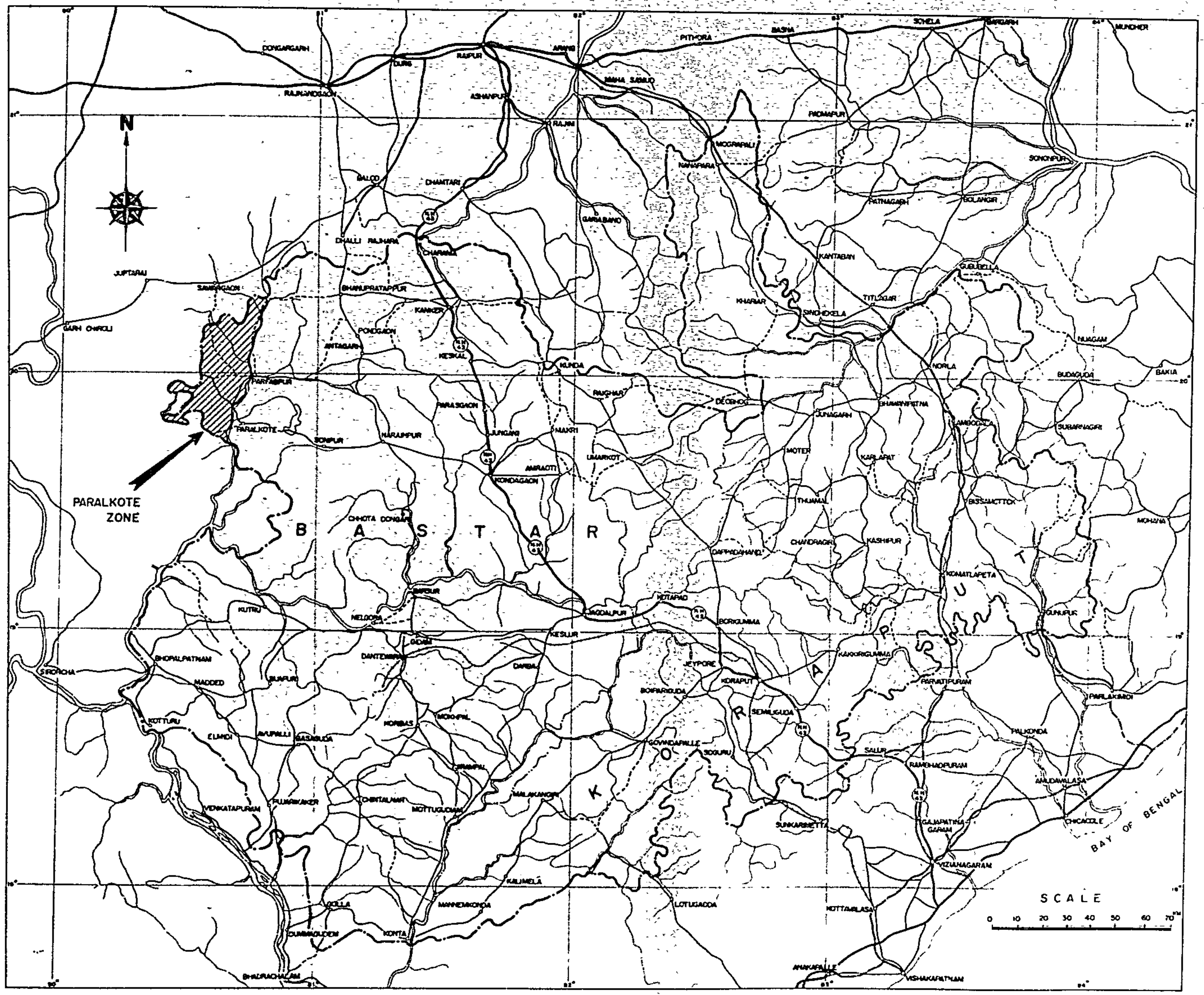
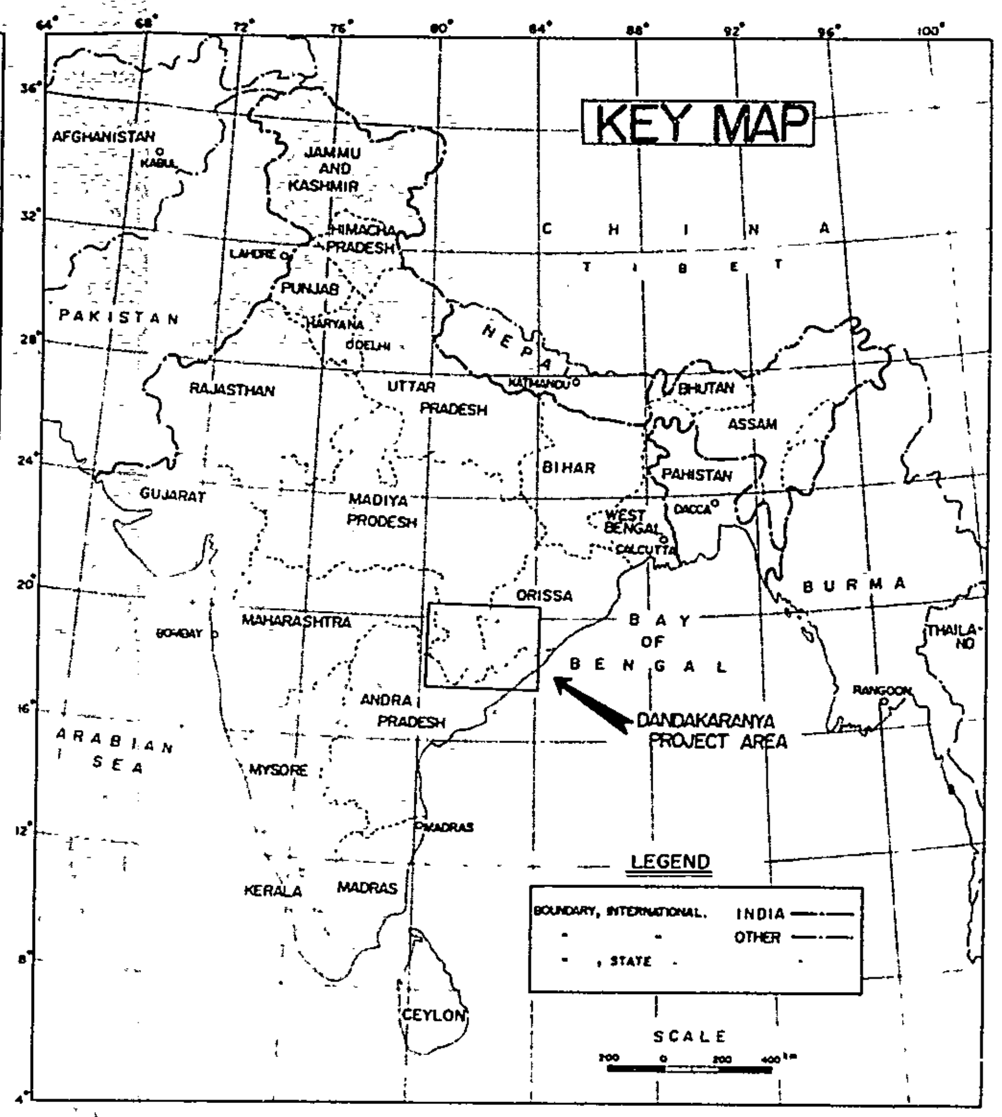
J A P A N

LOCATION MAP OF PARALKOTE ZONE IN DANDAKARANYA PROJECT





L E G E N D

- BOUNDARY OF DANDAKARANY PROJECT AREA
- BOUNDARY OF DISTRICT OR STATE
- RAILWAY
- NATIONAL HIGHWAY
- MINOR ROAD
- TRACK ROAD
- RIVER

ABBREVIATIONS AND SYMBOLS

%	percent
km	kilometer(s)
m	meter(s)
cm	centimeter(s)
mm	millimeter(s)
sq.km	square kilometer(s)
sq.m	square meter(s)
MSM	million square meter(s)
ha	hectare(s)
cu.m	cubic meter(s)
MCM	million cubic meter(s)
p.a.	per annum
p.m.	per month
m/sec	meter per second
cu.m/sec	cubic meter per second
EL.	elevation above mean sea level
kg	kilogram(s)
g	gram(s)
mg	milligram(s)
ppm	parts per million
KW	kilowatt(s)
KWH	kilowatt hour(s)
KVA	kilovolt ampere(s)
HP	horse power
r.p.m.	revolution per minute
°C	Centigrade degree(s)
°F	Fahrenheit degree(s)
sec	second(s)
hr	hour(s)
yr	year(s)
No.	Number
Rs	Rupee(s)
$	U.S. dollar(s)
Jan.	January
Feb.	February
Mar.	March
Apr.	April
Jun.	June
Jul.	July
Aug.	August
Sep.	September
Oct.	October
Nov.	November
Dec.	December
Fig.	Figure(s)
p.	page
para.	paragraph(s)
Sub-para.	Sub-paragraph(s)

CONVERSION TABLE

1. LENGTH

Unit	Equivalents inches	feet	yards	miles	cm	m
inches	1	0.08333	0.02778	0.00002	2.54	0.0254
feet	12	1	0.33333	0.00019	30.48	0.3048
yards	36	3	1	0.00057	91.44	0.9144
miles	63360	5280	1760	1	160934	1609.34
cemtimeters	0.39370	0.03281	0.1094	0.00001	1	0.01
meters	39.3701	3.28084	1.09361	0.00062	100	1

2. AREA

Unit	Equivalents sq.in	sq.ft	sq.yd	sq.miles	acre	ha	sq.m	sq.km	sq.cm
square inches	1	0.00694	0.00077	---	---	---	0.00065	---	6.4516
square feet	144	1	0.11111	---	0.00002	---	0.00065	---	929.030
square yards	1296	9	1	---	0.00021	---	0.83613	---	8361.27
square miles	---	---	---	1	---	259.000	---	2.58999	---
acre	---	43560	4840	0.00156	1	0.404686	404686	0.00405	---
hectare	15500000	107639	1196	0.00386	2.47097	1	10000	0.01	---
square meters	1550	10.7639	1.19599	---	0.00025	0.0001	1	0.000001	10000
square kilometers	---	---	---	0.3861	247.105	100	1000000	1	---
square centimeters	0.15500	0.00108	0.00012	---	---	---	0.0001	---	1

3. VOLUME

Unit	Eauibalents cu.in.	cu.ft	cu.yd	gallon	lit	cu.cm	cu.m
cubic inches	1	0.00058	0.0002	0.00360	0.01639	16.3871	0.0002
cubic feet	1728	1	0.03704	6.22883	28.3161	28316.8	0.02832
cubic yards	46656	27	1	168.179	764.555	7.64555	0.76455
Imperial gallon	277.42	0.16054	0.00595	1	4.54596	4546.09	0.00455
liter	61.0255	0.03532	0.00131	0.21998	1	1000	0.001
cubic centimeters	0.06102	0.00004		0.00022	0.001	1	0.000001
cubic meters	61023.7	35.3147	1.30795	219.975	1000	1000000	1

4. WEIGHT

Equivalents

Unit	g	kg	pound	ton
gram	1	0.001	0.00220	---
kilogram	1000	1	2.20462	0.00098
pound	453.592	0.45359	1	0.00045
long ton	---	1016.05	2240	1

5. MISCELLANEOUS CONVERSIONS

1 cubic feet per second = 0.0283 cubic meter per second

1 cubic meter per second = 35.31 cubic feet per second

1 pound per square inches = 0.070 kilogram per square centimeters

1 kilogram per square centimeters = 14.22 pounds per square inches

DESIGN REPORT OF
PARALKOTE IRRIGATION CANAL SYSTEM SURVEY

GENERAL CONTENTS

DESIGN REPORT OF PARALKOTE IRRIGATION CANAL SYSTEM SURVEY

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TABLE

CHAPTER 1 INTRODUCTION

1-1. Objective of the Survey

This report deals with a plan for the development of the Paralkote zone. The report has been worked out on the basis of a detailed survey for the final design of the paralkote right main irrigation canal system aiming at satisfactory irrigation requirements of the area and the most effective utilization of the irrigation water, forming a link in the chain of technical cooperation to the Paralkote Zone Development Project in accordance with the 'AGREEMENT BETWEEN THE GOVERNMENT OF JAPAN AND THE GOVERNMENT OF INDIA CONCERNING THE AGRICULTURAL DEVELOPMENT PROJECT IN THE PARALKOTE ZONE, DANDAKARANYA, INDIA' conluded in August 1970.

The survey team, consists of seven specialists, has completed the report based on the results of detailed survey for the final desigh of the main canal system and surrounding topics in the project field for about 40 days from the beginning of April, 1971 to the middle of May, 1971.

The survey has been executed in full combination with the survey team and the Indian specialists who joined in the survey on various fields, the Indian government officials who extended close assistances to the survey team, and the Japanese specialists who have been despatched in this area.

The survey team submits the report to the Government of India and the Government of Japan on its own responsibility and hopes that if the report will be approved, it will be a guide of the two Governments in executing the project for the development of this area.

1-2. Background of the Survey

The Dandakaranya District Development Project has been under way since 1958 under the direct control of the Ministry of Rehabilitation and Labour of the Central Government of India.

The basic development plan of the project has been drawn up by the Dandakaranya Development Authority, which has been set up under the control of the Ministry of Rehabilitation and Labour, forming one of the Indian Government's major politicies to help the refugees from East Pakistan live a stable life in the area and also help the natives of the area live a better life.

With the progress of the project the Government of India has asked the Government of Japan for her cooperation in development of this area in order to expand the development plan more effectively. The Government of Japan, therefore, has sent a survey team for several times, having had the team investigate in the project site and draw up a report based on various data, measurements and valuable experience which have been collected and acquired while the team was surveying the site, and has had the team negotiate with the Government of India concerning a definite plan of cooperation.

Consequently the agreement, namely: AGREEMENT BETWEEN THE GOVERNMENT OF JAPAN AND THE GOVERNMENT OF INDIA CONCERNING THE AGRICULTURAL DEVELOPMENT PROJECT IN THE PARALKOTE ZONE, DANDAKARANYA, INDIA, was concluded in August, 1970 between the Government of India and the Government of Japan.

In accordance with the above agreement Japan has begun to extend cooperation to the agricultural development project in the Paralkote zone, despatching six specialists in the various fields to India since October 1970, and at present state technical cooperation has been under way laying emphasis on the Mixed Farm.

Prior to this, the Paralkote right main irrigation canal, which may hold the keys of the project, has been designed by Indian Government and about 50 % of the construction works have been completed or in course of construction also by Indian Government, but technical cooperation for some parts of design or completed facilities are recognized to be necessarily called for by the Governments of Japan.

Accordingly the whole main irrigation canal system has been re-studied and some additional conveyance of other structures have been added in this report.

1-3. Investigations and the Basic Policy of Design

In order to accomplish the aim of the scheme, investigations are made in the project site regarding the following subjects, and final design for Paralkote right main irrigation canal is executed in accordance with the investigations.

1-3-1. Investigations in the Project Site

1-3-1-1. Examination of Flow Capacity

a) Route 'A' (Paralkote Dam to Kapsi Minor)

1) Construction works have been completed excluding for some additional structures.

2) Leveling survey for Bench Mark checking and route surveying (including profile surveying and cross sectional surveying) has been performed in the project site.

b) Route 'B' (Kapsi Minor to Pakhanjore Tank)

1) Open canal section is in course of construction.

2) Route surveying of the canal and detailed survey at the expected places of conveyance and additional structures have been performed.

c) Route 'C' (Pakhanjore Tank to Mixed Farm)

1) No design has been completed.

2) All surveying works for final design of the canal system have been executed.

1-3-1-2. Investigations in Regard to Control and Management Facilities of the Canal

a) For route 'A'

1) Exsisting facilities were investigated.

2) Data necessary for designing of additional facilities have been collected.

b) For route 'B' and 'C'

1) Detailed survey for designing of the facilities has been performed.

1-3-1-3. Water Utilization

1) Data necessary for planning study of water utilization for Paralkote zone including South Paralkote district were collected.

1-3-2. Basic Policy of Design

(1) Flow capacity is examined for constructed part of the canal and, on the other hand, all structures including the canal itself are finally designed in this report.

(2) Designs are performed in consideration with the local conditions of India, especially of Paralkote zone.

(3) Designs are performed in consideration with the effective use of the water, from viewpoints of both water management and farming program.

CHAPTER 2. OUTLINE OF PRESENT CONDITIONS OF PARALKOTE ZONE

2-1. Location and Topography

The Paralkote zone is located in the extreme north-west corner of the Baster District, bounded on the north by Drug District, on the west and the south by the Chanda District and on the east by the Kotri River, and it extends from latitude 19°57' to 20°15' N and from longitude 80°30' to 80°45'E.

The project area in the Paralkote zone falls within the area developed on the both banks of the Deodha Nalla flowing into the Kotri River, a tributary to the Indravati River, and it forms undulating shurbbery with the elevation ranging from 300 m to 400 m approximately above the mean sea level.

2-2. Climate and Hydrology

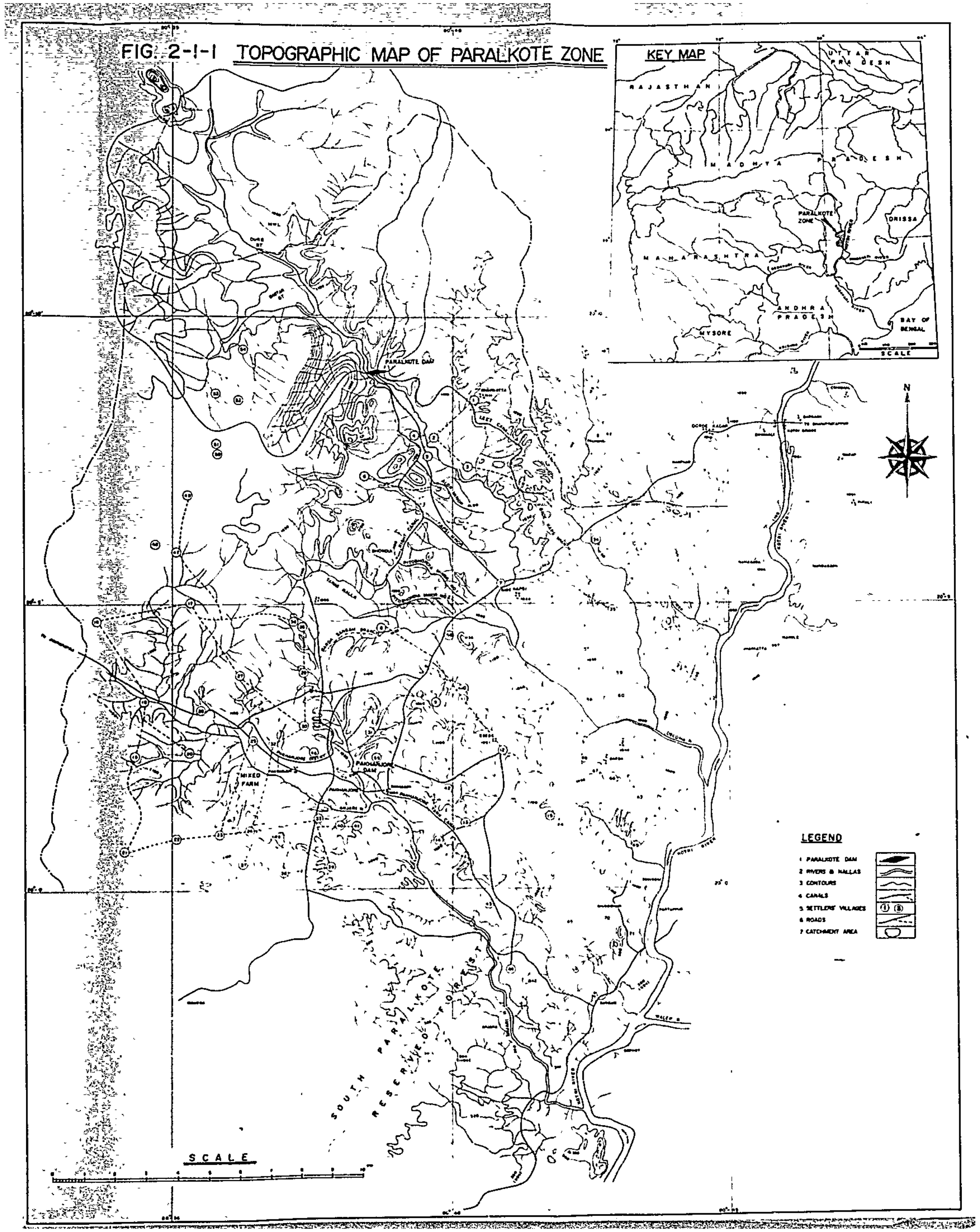
2-2-1. Climate

2-2-1-1. Temperature

The temperature records of the three stations are available as indicated in Table 2-2-1 and 2-2-2. According to these data, fluctuations of the maximum temperatures of those three stations have more or less a similar tendency through year, but the minimum temperature observed at Mixed Farm station situated in the project area is lower than those of the other two stations. Therefore, the temperature range at Mixed Farm is high in comparison with those of the other two station.

The project area being situated in the monsoon region, the climate conditions around the project area are influenced considerably by the

FIG. 2-1-1 TOPOGRAPHIC MAP OF PARALKOTE ZONE



monsoon. The characteristic of the temperature is summarized as follows;

The period of 6 months from the post-monsoon season (November to December) to the pre-monsoon season (April to May) belongs to the dry season and the maximum temperature observed at Mixed Farm is 42°C in May. After that, the temperature begins to go down and become comparatively low up to August due to the monsoon (June to October). After the monsoon season, the temperature raises again a little up to October, but goes down immediately to about 30°C.

On the other hand, the fluctuations of the mean minimum temperatures are different from those of mean maximum temperatures, and the lowest temperatures are recorded in January.

2-2-1-2. Relative Humidity

Relative humidity records at the three stations are also available as mentioned above, and the monthly fluctuations of the relative humidities are given in Table 2-2-3.

According to the records observed at Mixed Farm, the maximum relative humidities are recorded to be 90% or more in August, while the minimum relative humidities are 60% or more in April and May.

TABLE 2-2-1 Mean Daily Minimum Temperature in °C

Stations	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Raipur	13.4	16.3	20.4	24.8	28.1	26.1	24.0	23.8	23.7	21.3	16.2	13.3
Mixed Farm	9.7	10.7	13.5	20.1	25.0	26.0	23.5	22.6	22.2	17.9	14.9	10.9
Jagdalpur	12.6	14.8	18.9	22.3	24.6	22.9	22.6	22.4	22.3	20.0	15.3	12.5

TABLE 2-2-2 Mean Daily Maximum Temperature in °C

Stations	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Raipur	27.1	31.1	34.9	39.0	41.9	37.3	31.0	30.1	31.3	31.5	29.1	27.1
Mixed Farm	30.7	34.9	35.3	39.9	41.5	37.5	30.0	28.5	31.5	33.5	30.5	31.0
Jagdalpur	30.1	31.2	34.5	36.6	38.3	33.3	29.7	28.3	29.5	30.1	28.8	27.7

Note: Raipur is located in 180 km north-east of Paralkote zone, and also Jagdalpur in 160 km south-east.

Available periods of observation are as follows:

Raipur:	10 years	(1959 to 1968)
Mixed Farm:	5 years	(1965 to 1969)
Jagdalpur:	10 years	(1969 to 1968)

TABLE 2-2-3 Mean Daily Relative Humidity in Percent

Stations		Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Remarks
Rapipur	A	63	50	42	40	38	66	85	87	82	71	62	62	Observed at AM 8.30 hr.
	B	41	30	24	23	24	52.	76	77	72	56	44	44	Observed at PM17.30 hr.
	C	60	48	39	38	37	69	88	90	87	76	62	61	Observed at PM23.30 hr.
Mixed Farm		73	73	70	62	62	69.	87	91	87	86	73	77	Observed at AM 8.30 hr.
Jagdalpur	A	73	63	54	55	53	72	85	85	84	77	73	75	Observed at AM 8.30 hr.
	B	44	33	29	36	37	64	80	81	78	66	54	50	Observed at PM17.30 hr.
	C	74	63	53	58	57	79	90	91	90	86	80	78	Observed at PM23.30 hr.

2-2-1-3. Evaporation

All climate factors such as high temperature, heavy wind, low humidity and strong radiation cause the high rate of evaporation. According to the report of the Paralkote dam concerning hydrology, which is presented by the Dandakaranya Development Authority, the total annual evaporation comes up to 1,742 mm, of which 80% occurs during 4 months from March to June, and the maximum evaporation is observed to be 398 mm in May, as shown below;

Average Monthly Evaporation Rates

Month	Evaporation Rate, in mm
Jan.	90.4
Feb.	108.2
Mar.	198.1
Apr.	280.4
May	398.0
Jun.	191.0
Jul.	84.6
Aug.	77.7
Sep.	72.6
Oct.	86.6
Nov.	79.8
Dec.	74.4
Total	1,741.8

2-2-1-4. Rainfall

Annual Rainfall

There are two rainfall gaging stations in the vicinity of the project area, that is, the Paralkote dam site and Mixed Farm. The former has consecutive annual rainfall records of 39 years from 1922 to 1960, and the latter has 9 years records from 1961 to 1969. These rainfall records are shown in Table 2-1, 2-2 and 2-3 in Appendix, and Fig. 2-2-1 gives the monthly and annual rainfall fluctuations observed at the Paralkote dam site from 1922 to 1960. Basing on these data, the fluctuations of an average monthly rainfalls for the both stations are summarized as follows;

Average Monthly Rainfall

Month	Rainfall (mm) Dam site	Mixed Farm
Jan.	8.1	10.2
Feb.	15.7	11.1
Mar.	17.6	28.3
Apr.	14.4	20.7
May	8.8	25.5
Jun.	195.4	170.4
Jul.	615.2	486.0
Aug.	489.3	518.0
Sep.	255.0	334.2
Oct.	67.9	42.9
Nov.	13.5	5.3
Dec.	3.0	17.6
Total(Annual)	1,703.9	1,671.8
Total(Monsoon, Jun. to Oct.)	1,622.8	1,552.0

From the above table, the average annual rainfall during the period of 39 years (1922 - 1960) is about 1,700 mm, of which 95 % is observed in the monsoon season. As indicated in Fig. 2-2-1, the maximum and minimum annual rainfalls were found out to be 2,375.8 mm in 1940 and 1,002.3 mm in 1928 respectively.

On the other hand, the average annual rainfall observed at Mixed Farm during the last decade is amounted at about 1,670 mm which is about 30 mm lower than that observed at Dam site. From view point of meteorological analysis, a comparative study is undertaken with the monsoon rainfall records, which are observed at the Paralkote dam site for a long term of 48 years, for the sake of finding out a tendency of rainfall. The result of analysis on secular change of the seasonal rainfall is shown in Figure 2-2-2.

FIG. 2-2-1 MONTHLY AND ANNUAL RAINFALL FLUCTUATION AT PARALKOTE DAM SITE (1922 - 1960)

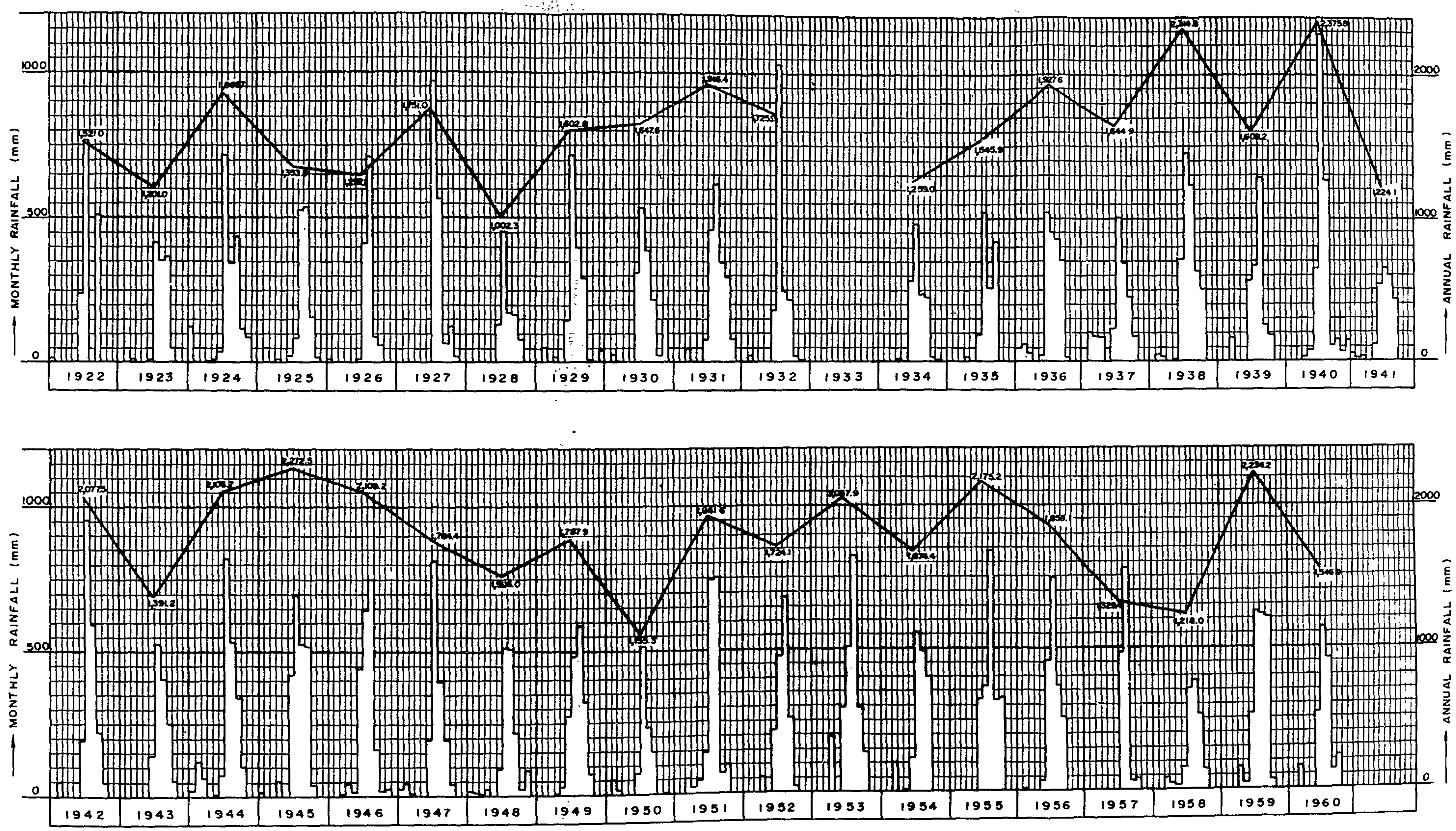
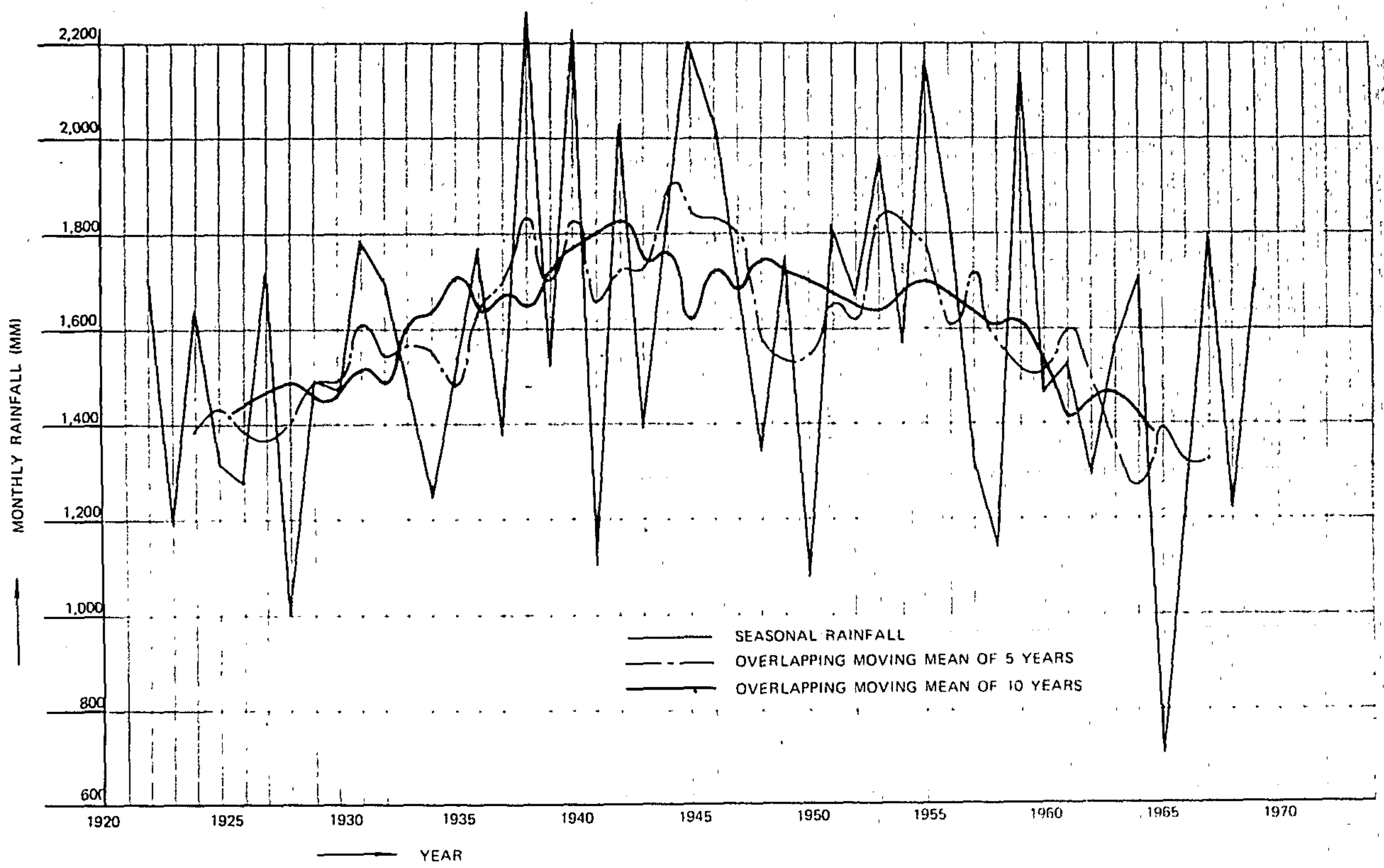


FIG. 2-2-2 SECULAR CHANGE OF SEASONAL RAINFALL AT PARALKOTE DAM SITE



As is evident from these figures, about 10 years before and after 1942 correspond to the high-rainfall years, and from that time the annual rainfalls are in the tendency of declining. Although the period of 48 years (1922 - 1969) is not enough to study a rainfall pattern, it is considered from these figures and the general tendency of rainfall in this climatic area that the rainfall pattern in this area has a cycle of about 40 years and that the rainfall during the last decade has been on the decrease year by year.

Maximum Daily Rainfall and Rainfall Distribution

Depending upon the eleven years rainfall records observed at the Paralkote dam site, the maximum daily rainfall is 152.4 mm, as shown in the following table.

Maximum Daily Rainfall

Order	Max. Daily Rainfall	Date of Occurence
1	152.4	26 - Jun. - 1968
2	150.2	29 - Aug. - 1959
3	132.0	13 - Aug. - 1962
4	129.0	5 - Aug. - 1964
5	121.0	15 - Aug. - 1964
6	115.6	28 - Jul. - 1968
7	115.0	22 - Jul. - 1962
8	115.0	7 - Aug. - 1964
9	114.0	13 - Sep. - 1962
10	106.0	25 - Aug. - 1956
11	106.0	21 - Sep. - 1965

As described in the previous paragraph, the average annual rainfalls are about 1,700 mm, but annual fluctuations of rainfall can be seen year by year, and also the starting and finishing times of the monsoon season fluctuates. Following table gives the number of consequtive droughty days during 6 months (June to October) in the period of 11 years from 1959 to 1969.

Consecutive Droughty Days

Order	Number of Consecutive Droughty Days	Date of Occurence
1	19	21-Sep. - 9-Oct., 1963
2	17	7-Sep. - 23-Sep., 1966
3	16	28-Sep. - 6-Oct., 1966
4	11	10-Sep. - 20-Sep., 1965
5	10	12-Oct. - 21-Oct., 1963
6	9	27-Aug. - 4-Sep., 1960
7	9	6-Aug. - 14-Aug., 1965
8	9	16-Jun. - 24-Jun., 1968
9	8	24-Jun. - 1-Jul., 1965
10	8	15-Jun. - 22-Jun., 1966

From the above table, the maximum droughty days last for 19 days even in the monsoon period, and then considering the rainfall fluctuation and droughty days in the monsoon period, the supplemental irrigation will be required for crop growth even in the monsoon period.

Correlation of Rainfall

For the reference, the studies on correlation of the rainfall during the monsoon season are made between the data of both stations, the Paralkote dam site and Mixed Farm. From the results of this analysis, the correlation of rainfall is expressed in the following equation;

$$Y = 1.031X - 3.903 \text{ cm}$$

Where; Y : Rainfall at Paralkote dam site, in cm

X : Rainfall at Mixed Farm, in cm

2-2-2. Hydrology

The Deodha Nalla, having the catchment area of 120.1 sq.km at the dam site, is the most important river as the main sole water resources for irrigation of the project area. However, since there is no other relevant data available, the runoff of the Deodha Nalla was computed by the Dandakaranya

Development Authority on the basis of the rainfall mentioned previously by the use of the Alexander & Binnie's percentage as adopted in M.P. only during the monsoon seasons from June to October. The computed runoff of the Deodha Nalla is indicated in Table 2-2-4.

From the result of the calculation, an average yield for the river during the monsoon season is estimated at 104.6 MCM. The maximum yield is 177.1 MCM in 1938, whereas the minimum yield is 50.7 MCM in 1950.

Fig. 2-2-3 shows the duration curve for the Deodha Nalla, based upon the data. In general, a flat duration curve is derived from a river having few floods and a large ground water discharge, whereas, a steep curve indicates a flashy stream. Judging from these facts, the river regime of the Deodha Nalla is considered to belong to the latter type.

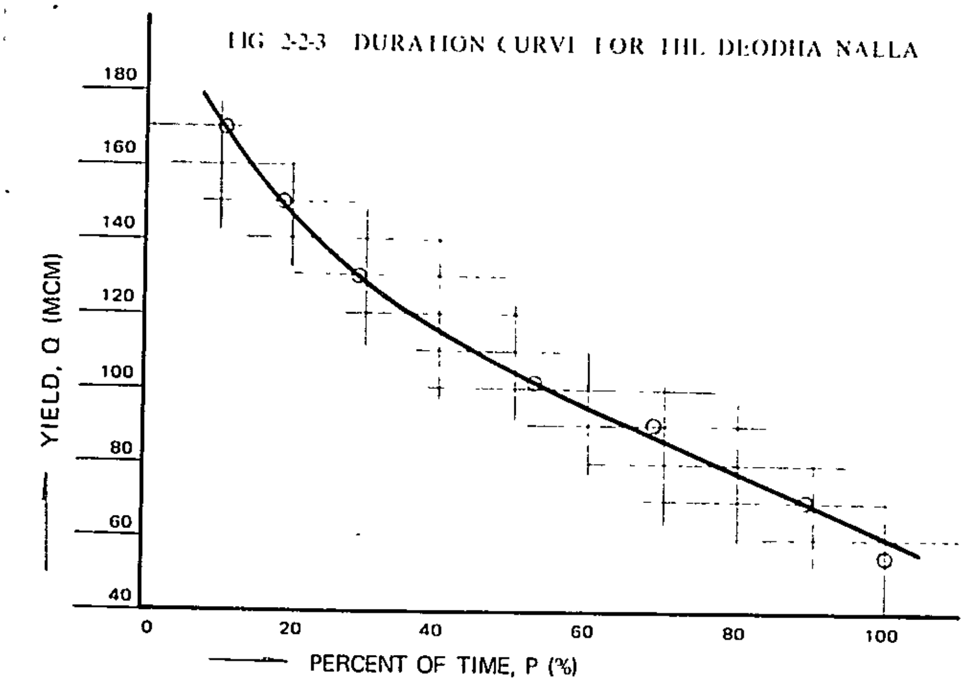


FIG 2-2-3 DURATION CURVE FOR THE DEODHA NALLA

Table 2-2-4 Computed Monsoon Runoff Records, in 1,000 cu.m

Year	June	July	August	September	October	Total
1922	1,985	41,396	-	45,151	-	88,532
1923	60	7,083	19,020	28,788	6,106	61,057
1924	305	24,056	27,537	39,687	12,211	103,796
1925	702	14,654	41,121	13,738	3,053	73,268
1926	91	6,991	48,754	8,273	3,053	67,162
1927	-	40,816	51,470	5,404	18,317	116,007
1928	1,099	12,882	10,441	12,211	18,440	55,073
1929	1,221	30,864	35,077	21,370	-	88,532
1930	3,357	26,987	33,123	22,011	-	85,478
1931	641	10,898	45,060	31,933	30,528	119,060
1932	1,526	60,996	22,255	22,072	6,106	112,955
1933		not	available			
1934	2,686	21,980	18,439	21,003	3,053	67,161
1935	793	31,141	22,011	37,641	-	91,586
1936	10,624	30,162	38,618	36,603	-	116,007
1937	946	20,546	27,780	20,943	6,106	76,321
1938	4,732	46,800	57,912	37,091	30,528	177,063
1939	2,717	25,186	56,233	10,624	9,158	103,918
1940	3,877	82,151	67,559	8,212	9,158	170,957
1941	2,564	11,661	20,119	20,606	-	54,950
1942	1,648	55,257	57,912	25,607	6,106	146,530
1943	1,190	17,371	32,695	22,011	6,106	79,373
1944	641	35,138	47,990	35,291	9,158	128,218
1945	7,083	46,982	49,547	58,187	6,106	167,905
1946	7,480	44,265	72,138	19,600	3,053	146,536
1947	1,648	47,808	36,603	17,737	6,106	109,902
1948	793	14,593	38,892	18,989	3,053	76,320
1949	2,656	21,980	50,372	31,594	6,106	112,708
1950	641	19,416	16,717	13,890	-	50,664
1951	1,221	33,123	69,604	7,602	10,776	122,326
1952	1,832	18,226	58,645	25,094	2,260	106,057
1953	1,649	19,416	70,703	30,986	15,295	138,049
1954	977	18,439	38,985	37,549	-	95,950
1955	3,847	15,966	72,601	33,551	37,856	163,821
1956	8,151	52,967	34,893	26,498	-	122,509
1957	-	9,250	57,852	2,564	3,082	72,748
1958	611	6,503	20,973	21,614	6,472	56,173
1959	2,564	30,101	56,782	66,400	3,509	159,356
1960	2,564	30,034	39,779	5,403	11,296	89,076
Mean	2,293	28,529	41,216	24,830	7,688	104,555

Note: Data is derived from Dandakaranya Development Authority, "Report of Paralkote Dam Hydrology."

2-3. Present Status of the Area for Development

2-3-1. Background of Paralkote Project

The project is of the comprehensive regional development of the Dandakaranya District, which materialize one of the Indian Government's major policies to provide the refugees from East Pakistan with stable lives in the area and also help indigenous natives of the area (tribal) to live in a better way.

The Indian Government set up the Dandakaranya Development Authority in 1958 under the control of the Ministry of Rehabilitation and Labour in order to carry out the project.

This development project was started in 1960, and the development plans have been drawn up for the area during these 10 years.

2-3-2. Execution of Project

2-3-2-1. Execution of Project

The development of the area began with the transfer of 32,272 ha (79,742 acres) of land from the state of Madya Pradesh to the Dandakaranya Authority, and out of which about 17,422 ha (43,050 acres) were found suitable for agriculture by the land survey.

The first settlement began in November 1960, when 646 farm households came to live in Kapsi, followed by settlement of 700 farm households into 15 places during the period of about one year. By 1963, 2,255 farm households settled into 45 places in this area, as shown in the following table.

Year	Villages Opened	Farm Household Immigrated
1960 - 1961	15	700
1961 - 1962	19	981
1962 - 1963	11	574
1963 - 1964	7	359
1965 - 1966	6	345
1966 - 1967	22	864
1967 - 1968	14	737
1968 - 1969	21	836

Note: Above figures do not include the 74 tribal houses settling in 13 villages.

However, the possibility of further settlement in no-th-western part of the area was proved by the survey made in 1964 and the further development works have been started.

Owing to the increase of the refugees year by year, the total number of villages in the Paralkote zone at present is 180 villages including the influx camps and colonies of 1970, and its total population is amounted to 38,640 persons as shown below;

Description	In Command upto Mixed Farm	In Command in Entire Paralkote Zone
No. of Villages	48 villages including 1970 influx camp & colonies	180 villages including 1970 influx camp & colonies
Total Population	17,230 persons	38,640 persons
Total Released Land	10,555ha(26,083 acres)	18,005ha(44,489 acres)

Note: Data is derived from Kapsi Irrigation Office in May 1971.

2-3-2-2. Irrigation Practice and Facilities

Since there are no adequate water resources for irrigation except the Paralkote Dam under construction, the Paralkote tank and some minor irrigation tanks in the Paralkote zone, the water resources of the almost all area for irrigation relies on rainfall only during the monsoon season. Land utilization ratio is very low accordingly.

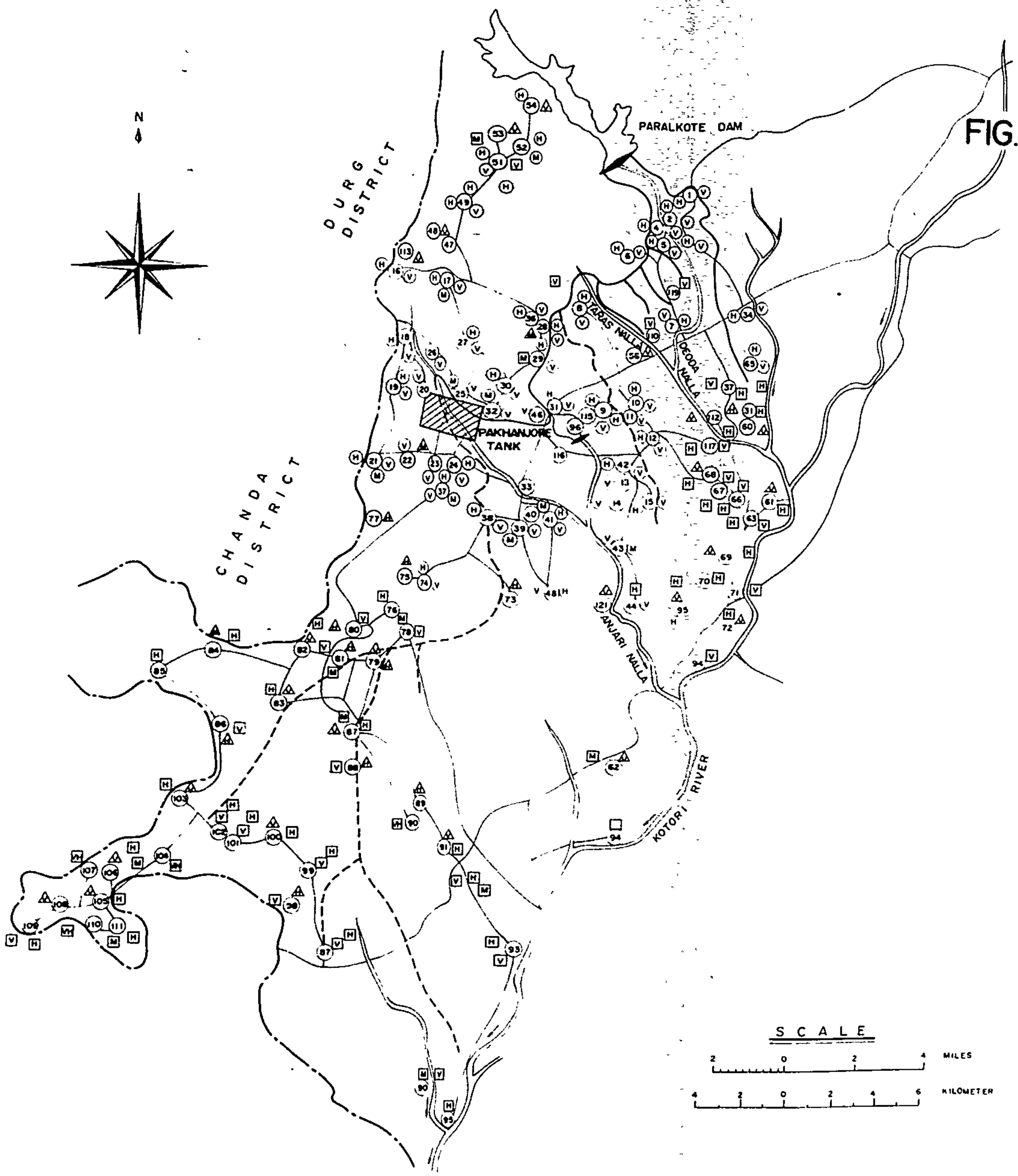
Some arable land is, however, irrigated during the dry season by utilizing the water resources stored in the minor irrigation tanks, of which locations are indicated in Fig. 2-3-1.

In order to increase an agricultural products during the dry season, the Dandakaranya Authority planned and provided the dams such as the Paralkote dam and the Pakhanjore Tank mentioned above.

The main features of these dams are summarized as follows;

Description	Paralkote Dam	Pakhanjore Tank
Catchment Area (sq.km)	120.10	15.02
Dam Type	Fill Type	Fill Type
Design Full Water Level(m)	348.69	307.24
Dead Water Level	336.80	300.50
Effective Storage Capacity(MCM)	64.40	2.47
Dead Storage Capacity(MCM)	2.00	0.11
Dam Height(m)	35.20	12.80
Max. Designed Discharge(cu.m/sec)	11.05(Both Canal)	0.453
Cultivable Commandable Area(ha)	13,000	258
Length of Main Irrigation Canal(km)	113(Both Canal)	9.6
Present State	Under Construction	Completed

FIG. 2-3-1 EXISTING FACILITIES FOR IRRIGATION AND DOMESTIC USES IN PARALKOTE ZONE



DESCRIPTIONS	MINOR IRRIGATION TANK	VILLAGE TANK	HEAD WATER TANK
ALREADY COMPLETED WORKS	6	48	42
WORKS IN PROGRESS	3	25	10
PROPOSED WORKS	9	29	41
TOTAL	18	102	93

LEGEND

- DAM
- 58—60 SETTLER'S VILLAGES AND LINK ROAD
- STATE BOUNDARY
- MIXED FARM
- RIVER AND NALLA
- PARALKOTE MAIN CANAL
- CANAL PROPOSED TO BE SURVEYED
- M MINOR IRRIGATION TANK
- V VILLAGE TANK
- H HEAD WATER TANK

As for the Paralkote dam, canal and its related structures, they are being constructed under the direct control of the Dandakaranya Authority. Out of these structures, the earth works of the main dam is almost completed except of spillway, which is under grouting. The main canal of 23.90 km, extending from the Paralkote dam to Mixed Farm, is in progress, and it can be classified into three parts as described below, depending upon the construction stage.

Classification	Proposed Canal Length	Construction Stage	
		Earth works	Structures
Paralkote Dam - Kapsi Minor	7.30 km	Completed	Almost Completed
Kapsi Minor - Pakhanjore Tank	10.70	Under Construction	Before Construction
Pakhanjore Tank - Mixed Farm	5.9	Before Construction	Before Construction
Total	23.90		

The construction schedules of these structures are being established as follows; the main dam will be completed by the end of June, 1973 and the canals by the end of June, 1972 respectively.

CHAPTER 3. IRRIGATION AND DRAINAGE SCHEMES FOR PARALKOTE AREA

3-1. General Description

As stated in the previous paragraphs, the Paralkote dam having the total storage capacity of about 66.4 MCM, is being constructed by the direct control of the Dandakaranya Development Authority. This chapter deals with the studies on irrigation and drainage schemes and the examination of irrigation water resources by utilizing the expected storage water for the Paralkote area, which covers the cultivable and commandable area of 13,152.8 ha (32,500 acres).

3-2. Irrigation Scheme for Paralkote Area

3-2-1. Study on Irrigation Water Requirements

3-2-1-1. Project Area

As for the Paralkote zone, since no topographic map of the project area is available, it is impossible to estimate an adequate project area under the present conditions.

Therefore, in this irrigation scheme, the estimation of the project area is made on the basis of the suggestion of the Dandakaranya Development Authority.

The area covered by the Paralkote dam is divided into two areas by the Deodha Nalla, and the project area was selected 9,615.7 ha (23,760 acres) in the right side of the river and 3,537.1 ha (8,740 acres) in the left side. Total project area for the Paralkote dam is 13,152.8 ha (32,500 acres).

This investigation was conducted in order to determine the net irrigable area covered by the right main irrigation canal. And it was estimated at 7,689.3 ha (19,000 acres) equiivalent to 80% of the project area of 9,615.7 ha (23,760 acres) as shown in the next table.

Description	Right Side of Deodha Nalla	Left Side of Deodha Nalla	Total
Project Area	9,615.7 ha (23,760 acres)	3,537.1 ha (8,740 acres)	13,152.8 ha (32,500 acres)
Net Irrigable Area	7,689.3 ha (19,000 acres)	2,832.9 ha (7,000 acres)	10,522.2 ha (26,000 acres)

Fig. 3-2-1 shows the project area covered by the Paralkote dam.

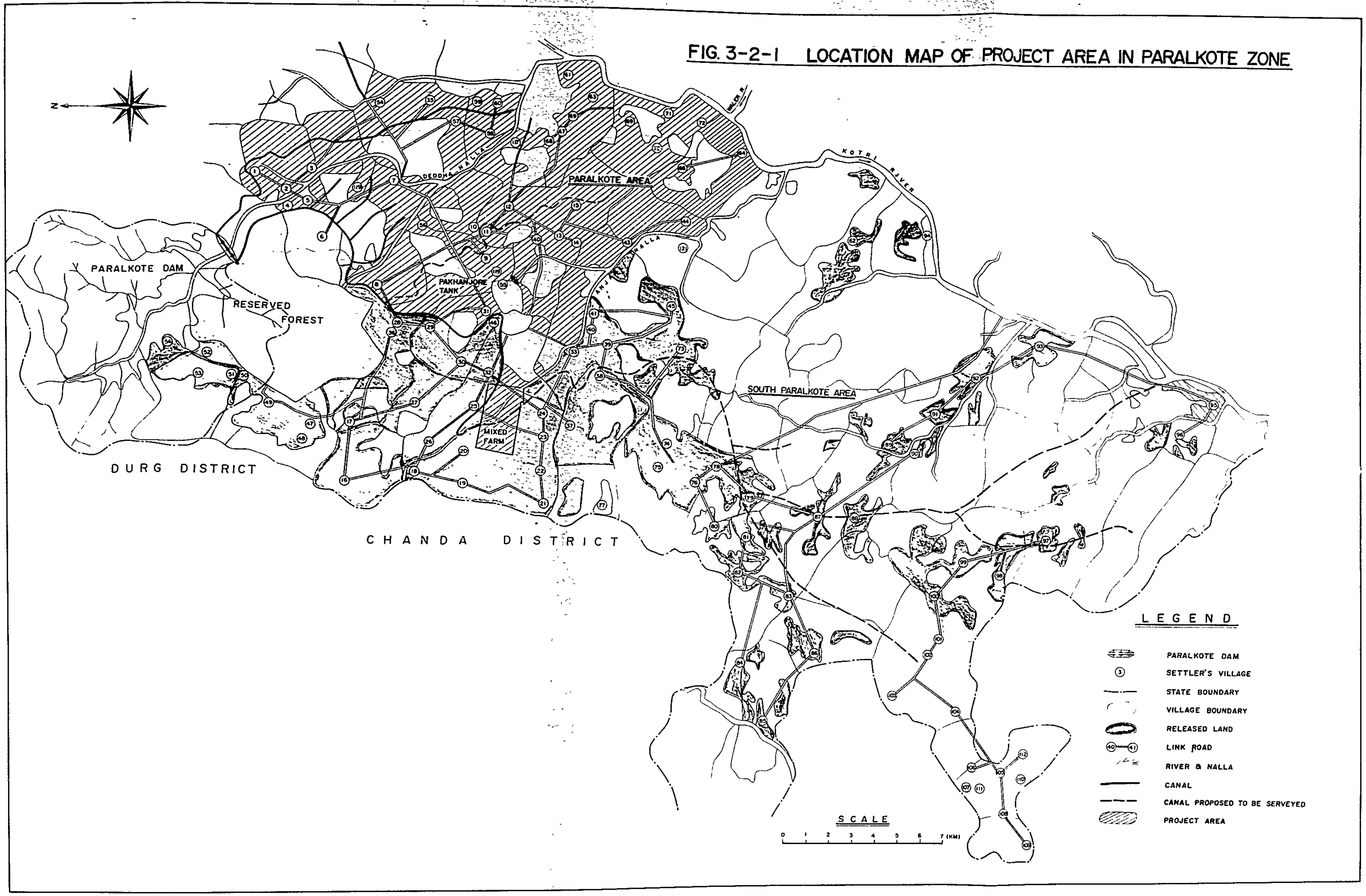


FIG. 3-2-1 LOCATION MAP OF PROJECT AREA IN PARALKOTE ZONE
N
PARALKOTE AREA
PARALKOTE DAM
RESERVED FOREST
PAKHANJORE TANK
MIXED FARM
SOUTH PARALKOTE AREA
KOTRI RIVER
DURG DISTRICT
CHANDA DISTRICT
LEGEND
PARALKOTE DAM
SETTLER'S VILLAGE
STATE BOUNDARY
VILLAGE BOUNDARY
RELEASED LAND
LINK ROAD
RIVER & NALLA
CANAL
CANAL PROPOSED TO BE SERVEYED
PROJECT AREA
SCALE
0 1 2 3 4 5 6 7 (KM)

3-2-1-2. Proposed Crops

As stated already, the project area is under the severe natural and socio-economic conditions. Therefore, the crop selection shall be made with due consideration of these conditions.

Furthermore, since the project area has quite a large scale area as 3,537.1 ha (8,740 acres), due considerations shall be given to a series of circulation systems of the agricultural activities such as cultivation practices, storage, transportation and processing of the products, marketing these products and so forth, so that they may promote the welfare of the people in the area.

In determining the proposed cropping pattern and crop allocation in the project, the consultations are made with the authorized cropping pattern and its allocation, which are adopted by the Dandakaranya Development Authority and shown in the next table.

Kharif (Wet Season)

Crops	Allocation
Paddy	60%
Millets and Pulses	10
Groundnuts	10
Sugar Cane	5
Garden Crops	10
Miscellaneous	5
	100%

Rabi (Dry Season)

Crops	Allocation
Wheat	15%
Rabi Paddy	5
Pulses	10
Sugar Cane	5
Garden Crops	10
Miscellaneous	5
	50%

Of these crops, since paddy and wheat are consumed as the main cereals in the project area, they will be indispensable in diet of the local peoples as the staple food with self-sufficiency. Therefore, these crops are introduced in the project with a same proportion to the above table. Concerning the other crops besides the paddy and wheat, selection is made based on the various considerations mentioned above.

Fig. 3-2-2 indicates the proposed cropping pattern for the project. As is shown in this figure, the cropping intensity is amounted to be 150% a year, and their cropping areas are planned as follows;

Cropping allocation and its area

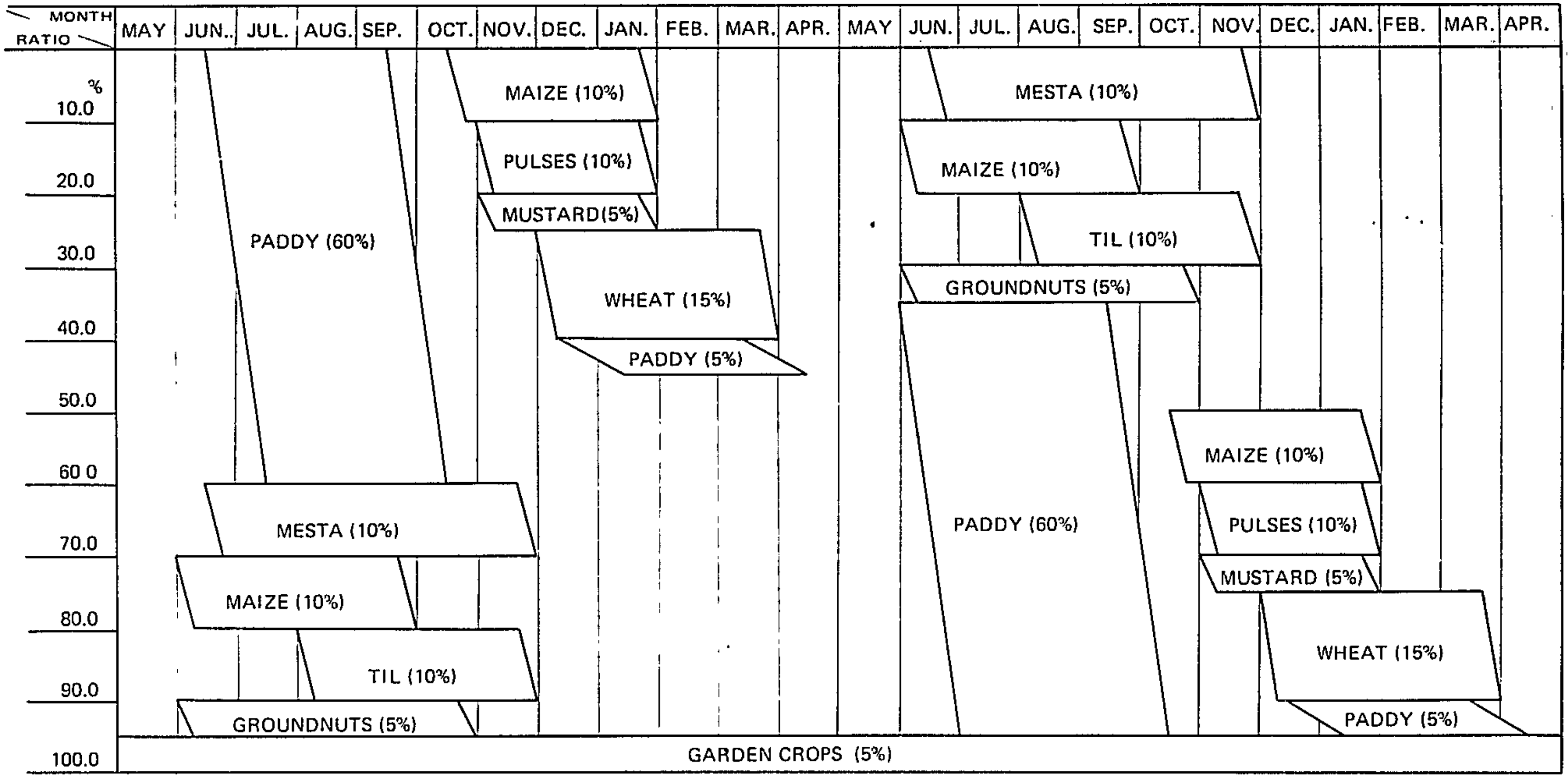
Kharif (Wet Season)

Crops	Allocation(%)	Area	
		acres	ha.
Paddy	60	11,400	4,613.6
Maize	10	1,900	768.9
Mesta	10	1,900	768.9
Til	10	1,900	768.9
Groundnut	5	950	384.5
Garden Crop	5	950	384.5
Total	100	19,000	7,689.3

Rabi (Dry Season)

Crops	Allocation(%)	Area	
		acres	ha.
Paddy	5	950	384.5
Wheat	15	2,850	1,153.4
Maize	10	1,900	768.9
Pulses	10	1,900	768.9
Mustard	5	950	384.5
Garden Crop	5	950	384.5
Total	50	9,500	3,844.6

FIG. 3-2-2 CROPPING PROGRAM OF PROPOSED CROPS (2-YEAR ROTATION)



(3) Unit Irrigation Requirement

Consumptive Use of Water

Since the rates of consumptive use of water by crops were not available, the estimates of them were made by applying the Blanney - Criddle method, which is applicable to the estimation of consumptive use of water for the arid region.

The Blanney - Criddle formula used in the study is expressed as follows;

$$U = KF = K \frac{P \cdot t}{100}$$

Where; U : monthly consumptive use, in mm

K : monthly consumptive coefficient

F : monthly consumptive use factor,

P : percentage of day-time hours occurring in month

t : mean temperature in Fahrenheit

The estimation of the consumptive use factor in the above formula is made based on the data of temperature at Mixed Farm from 1965 to 1969, and its result is shown as follows;

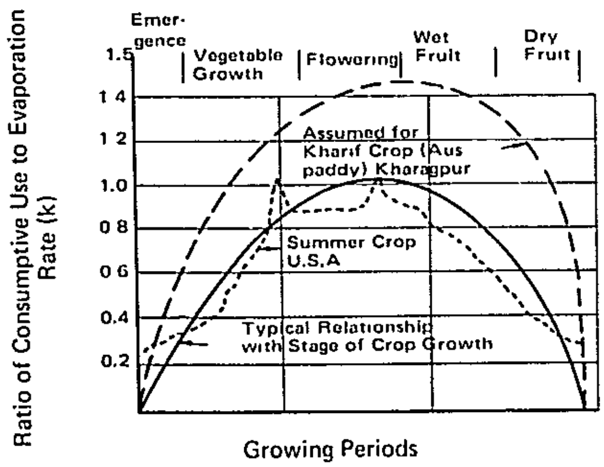
Estimated Consumptive Use Factor

Month	Mean Temperature(t)		Percentage of day-time hours, P(%)	Consumptive Use Factor, U	
	Centigrade(°C)	Farenheit(°F)		inch	mm
Jan.	20.2	68.3	7.74	5.29	134.4
Feb.	22.8	73.0	7.25	5.29	134.4
Mar.	24.4	75.9	8.41	6.38	162.1
Apr.	30.7	87.5	8.52	7.44	189.0
May	33.3	91.9	9.15	8.41	213.6
Jun.	31.7	89.1	9.00	8.02	203.7
Jul.	26.9	80.5	9.25	7.45	189.2
Aug.	25.5	77.9	8.96	6.98	177.3
Sep.	26.9	80.4	8.30	6.67	169.4
Oct.	25.8	78.4	8.18	6.41	162.8
Nov.	23.4	71.9	7.58	5.45	138.4
Dec.	19.9	67.8	7.66	5.19	131.8

As for the consumptive use coefficients for paddy crops, they were obtained from empirical or experimental data. Fig. 3-2-3 indicates the typical expected variation of consumptive use coefficients according to the stages of paddy growth.

In this irrigation scheme, these values are used to estimate the consumptive use of water for paddy.

FIG. 3-2-3 TYPICAL EXPECTED VARIATION OF CONSUMPTIVE USE COEFFICIENT FOR PADDY CROPS IN INDIA



On the other hand, the consumptive use coefficients for up-land crops such as wheat, maize, pulses and so forth, were reffered to the data developed by the Agricultural Reserch service in U.S.A.

Based on the estimated consumptive use factors(F) and coefficients (K) mentioned above, consumptive use of water for each crop is calculated, and the results are given in Table 3-2-1.

Unit Irrigation Requirement for Each Crop

The irrigation requirement is defined as the required amount of irrigation water, exclusive of rainfall, stored water and ground water, and the unit irrigation requirement for each crop is calculated as shown in Table 3-2-2, taking into account the consumptive use of water, which was estimated in previous paragraphs.

1/ This figure is quoted from the Report of Fifth Near East-South Asia Irrigation Practice Seminar, P.462 "Method for Scheduling and Determining Depth of Irrigation Employing Consumptive Use"

(Unit: mm)

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Temperature, in °F	68.3	73.0	75.9	87.3	91.9	89.1	80.5	77.9	80.4	78.4	71.9	67.8	
Consumptive Use Factor (F), in mm	134.4	134.4	162.1	189.0	213.6	203.7	189.2	177.3	169.4	162.8	138.4	131.8	
Proposed Crops Paddy	1.30	1.40	1 20			0.8	1.30	1.40	1.20			0.60	
Wheat	0.7	1.10	0.80									0.4	
Maize	0.60		Consumptive Use Coefficient (K)			0.50	0.70	1.00	0.80	0.40	0.60	0.80	
Pulses	0.60										0.60	0 75	
Mesta						0.50	0.70	0.80	1.00	0.90	0.80		
Til								0 40	0.50	0.70	0.60		
Groundnut						0.30	0 59	0 85	0.60	0 40			
Mustard	0.60										0.60	0.75	
Garden Crops	0.30	0 40	0 53	0 75	0 90	0 90	0.70	0.65	0.65	0.55	0.45	0.30	
Consumptive Use (U) Paddy	174.7	188.2	194.5			171.5	246.0	248.2	203.3			81.6	1,508.0
Wheat	94.1	147.8	129.7									52.7	424.3
Maize	80.6					101.9	132.4	177 3	135.5	65.1	83 0	105.4	881.2
Pulses	80.6										83.0	98.9	262.5
Mesta						101 9	132.4	141 8	169 4	146.5	110.7		802.7
Til								70.9	84.7	114.0	83.0		352.6
Grandnuts						61 1	104 1	150 7	101.6	65.1			482.6
Mustard	80.6										83.0	98.9	262.5
Garden Crops	40.3	53.8	89.2	141.8	192.2	183.3	132.4	115.2	110 1	89.5	62.5	39.5	1,249.6
Total (mm/month)	550.9	389.8	413 4	141.8	192.2	619 7	747.3	904.1	804.6	480.2	505.0	477 0	6,226.0

TABLE 3-2-2 UNIT IRRIGATION REQUIREMENT FOR EACH CROP

(unit: cu.m/ha)

Crops	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Paddy	2,647	2,722	2,875			3,215	3,390	3,412	2,933			2,826	24,020
Wheat	941	1,478	1,297									527	4,243
Maize	806					1,019	1,324	1,773	1,355	326	830	1,054	8,487
Pulses	806										830	989	2,625
Mesta						510	1,324	1,418	1,694	1,465	1,107		7,518
Til								709	847	1,140	830		3,526
Groundnut						611	1,041	1,507	1,016	651			4,826
Mustard	806										830	989	2,625
Garden Crops	403	538	892	1,418	1,922	1,833	1,324	1,152	1,101	895	623	395	12,496
Total	6,409	4,738	5,064	1,418	1,922	7,188	8,403	9,971	8,946	4,477	5,050	6,780	70,366

Note; Percolation rates in paddy field are assumed to be 3.0 mm per day.

Puddling water requirements necessary for the both month of June and December are estimated at 150 mm as follows;

Thickness of top soil for cultivation : 250 mm

Porosity of soil : 40 %

Submergence depth of paddling : 50 mm

Puddling water requirements = (250m x 0.4) + 50mm = 150mm

3-2-1-4. Irrigation Water Requirement

Weighted Irrigation Requirement

In order to reduce the complication of estimation of the irrigation water requirement in the scheme, crop-wised two types of weighted monthly irrigation requirement, that is, paddy crops and up-land crops, are assessed by multiplying the unit irrigation requirement for crops to be introduced by each irrigable area.

Following table gives the results of the weighted monthly irrigation requirement for the project.

Weighted Monthly Irrigation Requirement, in mm

Month	Paddy Crops	Up-Land Crops
Jan.	264.7	80.6
Feb.	272.2	124.3
Mar.	287.5	119.6
Apr.		141.8
May		192.2
Jun.	321.5	91.7
Jul.	339.0	127.6
Aug.	341.2	130.7
Sep.	293.3	123.8
Oct.		92.6
Nov.		86.5
Dec.	282.6	78.3
Total	2,402.0	1,389.7

Note; Detail calculation is shown in Table 3-2-3.

TABLE 3-2-3 WEIGHTED MONTHLY IRRIGATION REQUIREMENT FOR PROPOSED CROPPING PATTERN

Description	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
Proposed Crops													
Paddy		950(384.5)				Cropping Area		11,400Acre (4,613.6)					
Wheat		2,850(1,153.4)											
Maize	1,900(768.9)						1,900(768.9)				1,900(768.9)		
Pulses	1,900(768.9)										1,900(768.9)		
Mesta								1,900(768.9)					
Til									1,900(768.9)				
Groundnut								950(384.5)					
Mustard	950(384.5)										950(384.5)		
Garden Crops						950 (384.5)							
Area to be Irrigated													
Paddy (acre)	950	950	950			11,400	11,400	11,400	11,400			950	
" (ha)	384.5	384.5	384.5			4,613.6	4,613.6	4,613.6	4,613.6			384.5	
Up-Land Crops (acre)	8,550	3,800	3,800	950	950	5,700	5,700	7,600	7,600	7,600	9,500	8,550	
" (ha)	3,460.2	1,537.9	1,537.9	384.5	384.5	2,306.8	2,306.8	3,075.7	3,075.7	3,075.7	3,844.6	3,460.2	
Weighted Irrigation Requirement													
Paddy Crops (10^3cu.m)	1,017.8	1,046.6	1,105.4			14,832.7	15,640.1	15,741.6	13,531.7			1,086.6	64,002.5
" mm)	264.7	272.2	287.5			321.5	339.0	341.2	293.3			282.6	2,402.0
Up-Land Crops													
Wheat	1,085.3	1,704.7	1,496.0									607.8	4,893.8
Maize	619.7					783.5	1,018.0	1,363.3	1,041.9	250.7	638.2	810.4	6,525.7
Pulses	619.7										638.2	760.4	2,018.3
Mesta						392.1	1,018.0	1,090.3	1,302.5	1,126.4	851.2		5,780.5
Til								545.2	651.2	876.5	638.2		2,711.1
Groundnut						234.9	400.3	579.4	390.7	250.3			1,855.6
Mustard	309.9										319.1	380.3	1,009.3
Garden Crops	155.0	206.9	343.0	545.2	738.8	704.7	509.1	442.9	423.3	344.1	239.5	151.9	4,804.4
Sub-total (10^3cu.m)	2,789.6	1,911.6	1,839.0	545.2	738.8	2,115.2	2,945.4	4,021.1	3,809.6	2,848.0	3,324.4	2,710.8	29,598.7
" (mm)	80.6	124.3	119.6	141.8	192.2	91.7	127.6	130.7	123.8	92.6	86.5	78.3	1,389.7

Remarks: Total area to be irrigated
Dry season : 7,689.3 ha (19,000 acre)
Wet season : 3,844.6 ha (9,500 acre)

Irrigation Water Requirement for Project

Depending on the weighted monthly irrigation requirement, the studies on the irrigation water requirement for the project are made through 39 years from 1922 to 1960, taking into account effective rainfall. In this calculation, the irrigation water requirement can be obtained by dividing a net irrigation requirement (irrigation requirement - effective rainfall) by the factors such as application efficiency and conveyance losses, as described in the following expression;

$$I.W.R. = \frac{N.I.R.}{E(1-L)}$$

Where; I.W.R. : Irrigation water requirement, in mm

N.I.R. : Net Irrigation requirement, in mm

E : Application efficiency, assumed at 0.65 for up-land fields and 1.0 for paddy fields

L : Conveyance loss to the fields, assumed at 0.15

The effective rainfall is estimated at 75% of the monthly rainfall with reference to the report of the Paralkote dam, which is submitted by the Dandakaranya Development Authority. Concerning these monthly rainfall, as noted in Chapter 2,"Climate and Hydrology," 39 years annual rainfall records and 46 years rainfall records for monsoon seasons are available, and the analysis on the probability of the rainfall for the both cases are made by using the Hazen Paper, as indicated in Fig. 3-2-4 and 3-2-5.

From the results of the calculation for the irrigation water requirement the maximum irrigation water requirement to meet the net irrigable area of 7,689.3 ha (19,000 acres) is amounted to be 69.6 MCM in 1957 year considering the effective rainfall and required losses mentioned above, whereas the minimum one is of 32.4 MCM in 1936 year, and the average irrigation water requirement is amounted to be 51.2 MCM, as illustrated in Fig. 3-2-6. Furthermore, the irrigation water requirement, which will be occurred in 10-year probable annual rainfall equivalent to approximate 1,290 mm, is estimated at 58.7 MCM.

Detail calculations are given in Table 3-1 in Appendix.

3-2-2. Operation Study on Paralkote Dam and Examination of Water Resources

3-2-2-1. General Description

An operation study on the Paralkote dam was carried out for 39 years through 1922 to 1960 in accordance with the irrigation water requirement for overall commandable area covered by the dam, the available hydrological data of the Deodha Nalla and the capacity of the dam. Out of which the study in 1933 is exclusive because of no hydrological data.

In analyzing the dam operation study, the major dimensions of the dam used for calculation are summarized as follows;

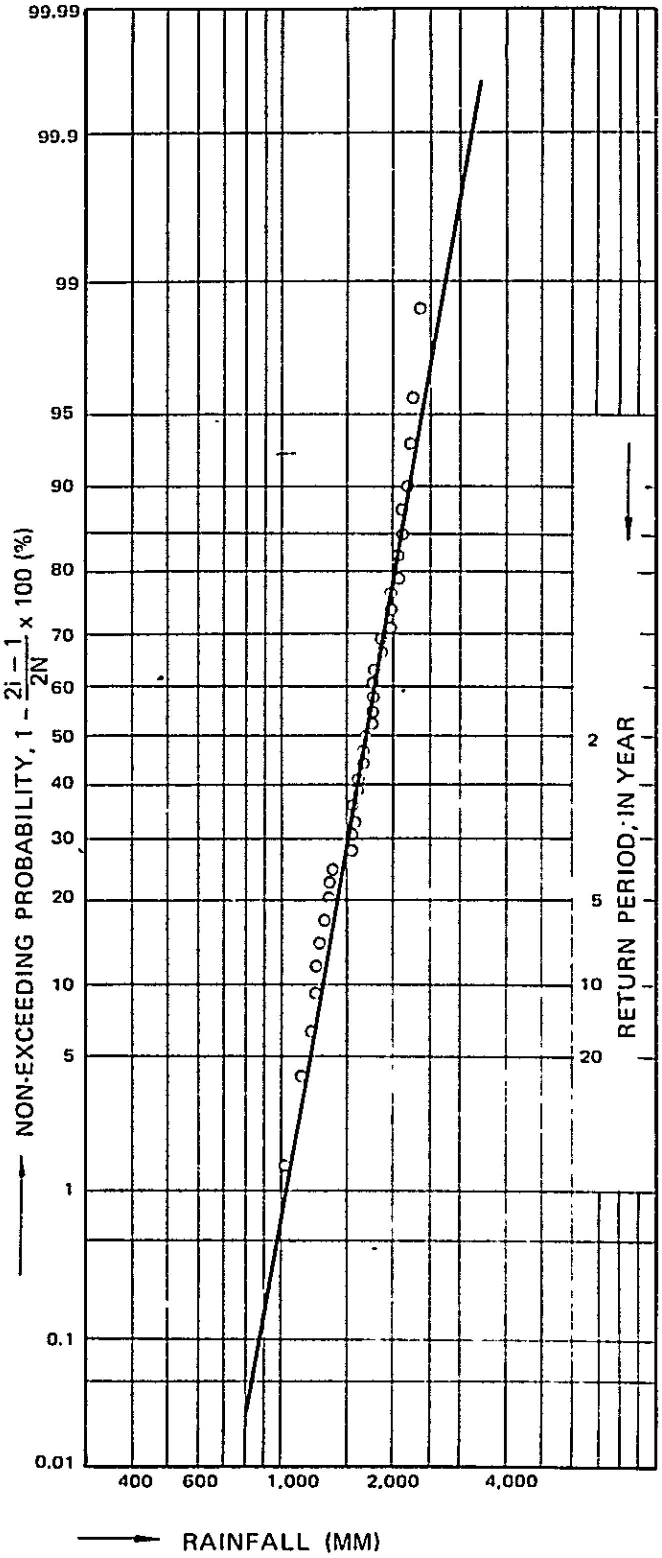
High water level of the dam	:	348.69 m
Low water level of the dam	:	336.80 m
Total storage capacity of the dam	:	66.4 MCM
Effective storage capacity of the dam	:	64.4 MCM
Effective depth of the dam	:	11.89 m

3-2-2-2. Procedure of Calculation for Water Balance

The procedure of the calculation and the definition of each terms for this studies are as follows;

Water Level and Water Surface Area of the Initial Reservoir are derived from the volume of water stored in the previous months by using the area and capacity curve indicated in Fig. 3-2-7.

FIG. 3-2-4 NON-EXCEEDING PROBABILITY OF ANNUAL RAINFALL



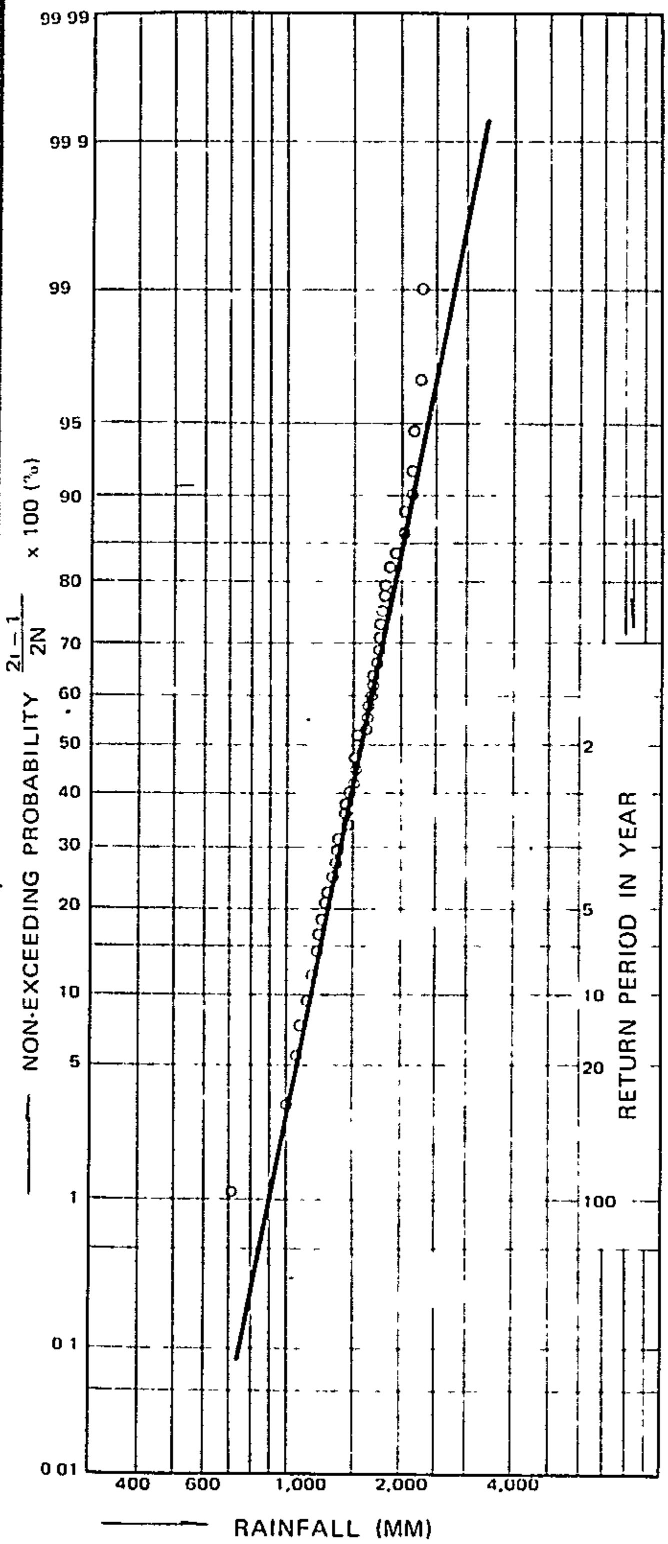
RAINFALL (MM)

i	RAINFALL	YEAR
1	1,002.3	1928
2	1,155.3	1950
3	1,201.1	1923
4	1,218.0	1958
5	1,224.1	1941
6	1,259.0	1934
7	1,292.1	1926
8	1,327.4	1957
9	1,353.8	1925
10	1,391.2	1943
11	1,521.0	1922
12	1,526.0	1948
13	1,545.9	1935
14	1,546.9	1960
15	1,602.8	1929
16	1,609.2	1939
17	1,644.9	1930
18	1,647.6	1937
19	1,674.4	1954
20	1,724.1	1952
21	1,725.9	1932
22	1,751.0	1927
23	1,784.4	1947
24	1,787.9	1949
25	1,858.1	1956
26	1,866.7	1924
27	1,916.4	1931
28	1,927.6	1936
29	1,941.6	1951
30	2,057.9	1953
31	2,077.5	1942
32	2,106.7	1944
33	2,109.2	1946
34	2,175.2	1955
35	2,234.2	1959
36	2,272.5	1945
37	2,375.8	1940

PROBABLE RAINFALL

F	R
1/2	1,600
1/5	1,410
1/10	1,290
1/20	1,190
1/100	1,020

FIG. 3-2-5 NON-EXCEEDING PROBABILITY OF SEASONAL RAINFALL



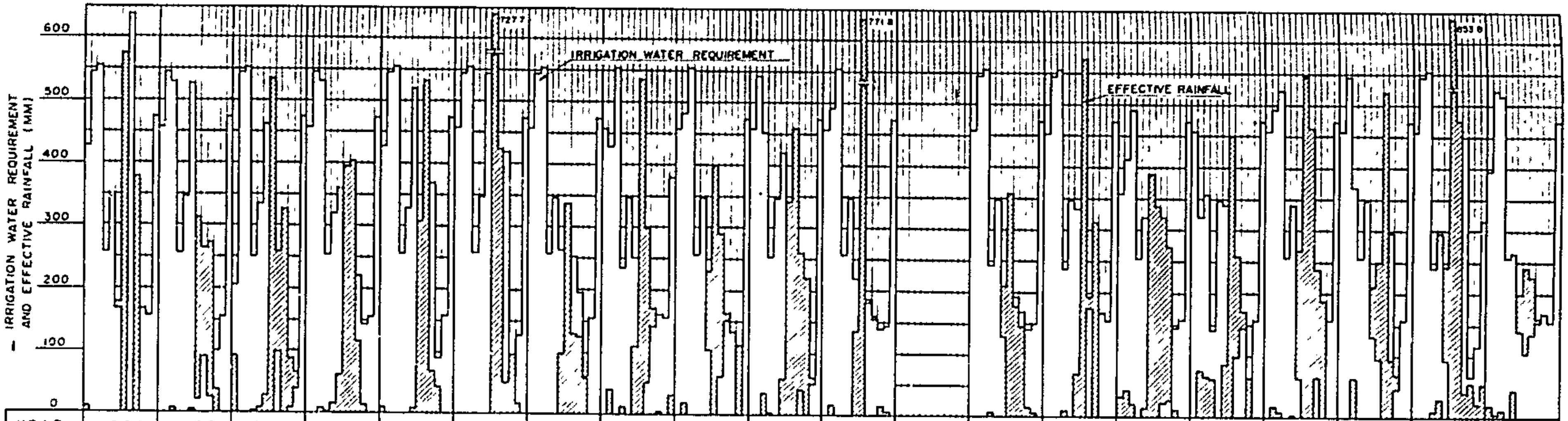
RAINFALL (MM)

i	RAINFALL	YEAR
1	704	1965
2	1,001	1928
3	1,080	1950
4	1,106	1941
5	1,140	1958
6	1,190	1923
7	1,212	1966
8	1,224	1968
9	1,241	1934
10	1,279	1926
11	1,294	1962
12	1,327	1957
13	1,366	1948
14	1,372	1937
15	1,391	1943
16	1,470	1930
17	1,470	1960
18	1,493	1929
19	1,508	1922
20	1,522	1939
21	1,528	1961
22	1,530	1935
23	1,565	1954
24	1,570	1963
25	1,646	1924
26	1,665	1952
27	1,693	1932
28	1,699	1947
29	1,700	1964
30	1,729	1969
31	1,729	1927
32	1,752	1949
33	1,776	1936
34	1,788	1931
35	1,796	1967
36	1,817	1951
37	1,820	1956
38	1,890	1944
39	1,930	1953
40	2,024	1942
41	2,024	1946
42	2,139	1959
43	2,170	1955
44	2,201	1945
45	2,224	1940
46	2,271	1938

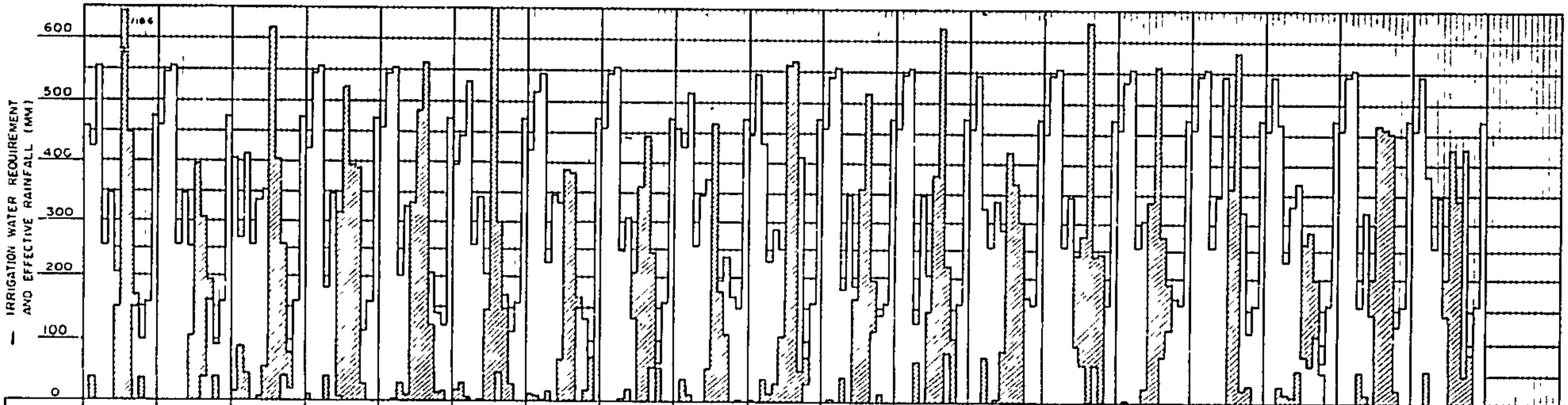
PROBABLE RAINFALL

F	R
1/2	1,570
1/5	1,290
1/10	1,160
1/20	1,070
1/100	900

FIG 3-2-6 FLUCTUATION OF MONTHLY IRRIGATION WATER REQUIREMENT (1922-1960)



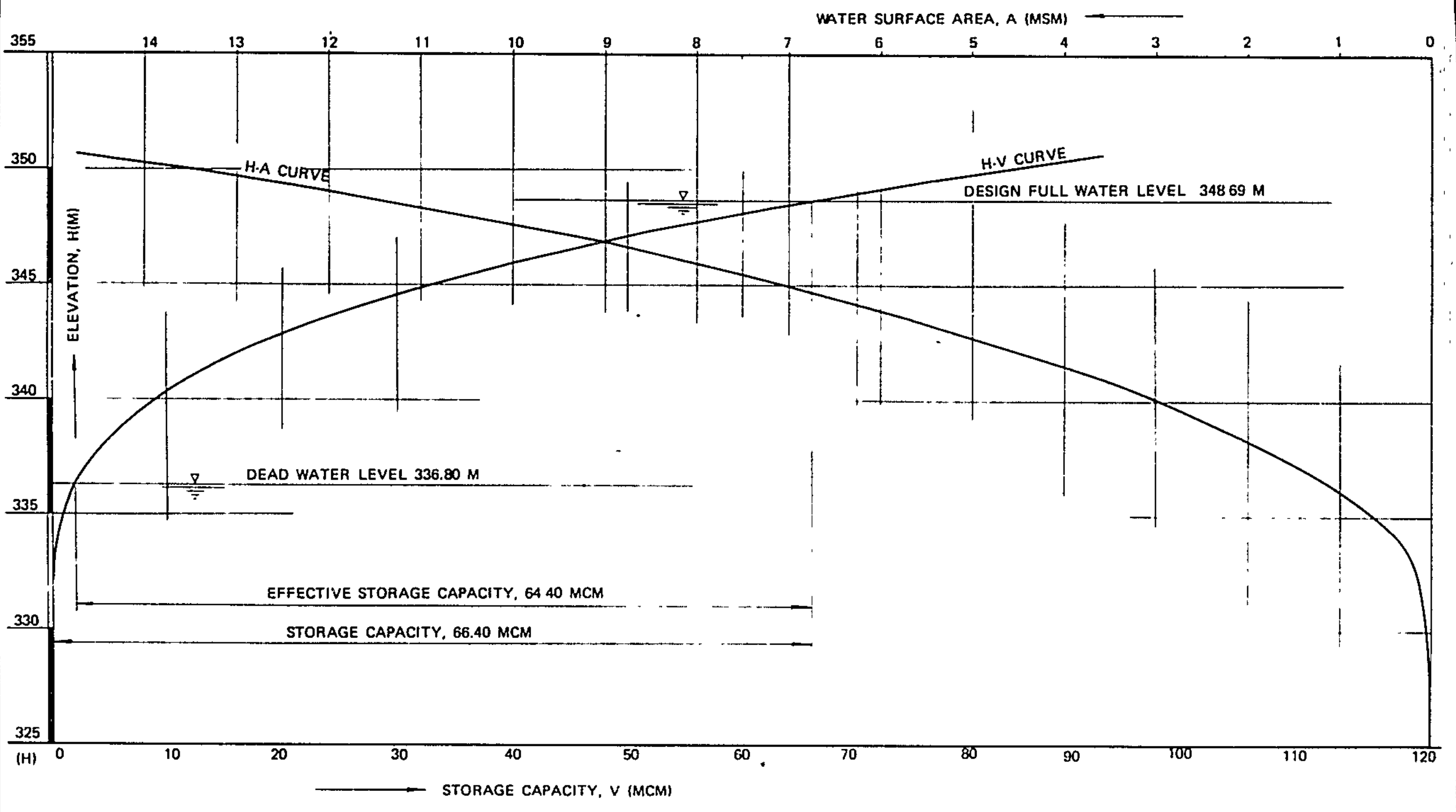
YEAR	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
IWR (MM)	3738 5	3530 2	2975 4	3461 5	3769 7	3726 6	3561 7	3164 3	3028 3	2987 5	3423 3		3379 3	3444 4	2664 8	2840 4	2827 4	3163 5	3130 5	3288 3
IWR (10³CUM)	68 189	59 910	43 611	59 444	69 404	67 531	64 741	52 043	42 286	42 056	59 021		55 624	57 636	32 377	50 968	35 048	52 300	49 344	57 654



YEAR	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	
IWR (MM)	3127 8	3339 1	2732 3	2803 7	3017 1	3144 1	3161 1	2999 5	3596 9	3267 0	3151 5	2953 8	3009 5	3009 9	3103 3	3769 0	3358 7	2929 8	3204 1	
IWR (10³CUM)	48 219	53 265	42 337	32 875	42 098	50 567	49 052	40 730	68 524	57 799	47 964	42 960	45 747	40 350	44 127	69 557	58 681	39 985	52 797	

NOTE , IWR IRRIGATION WATER REQUIREMENT

FIG. 3-2-7 AREA AND CAPACITY CURVE FOR PARALKOTE DAM



Inflow to the Paralkote dam during the monsoon seasons is derived from the report of hydrology at the Paralkote dam. In this report the inflow is computed by the Alexander Binnie's percentage, which is adopted in Madhaya Prodish (M.P) to estimate run-off discharges due to the lack of the other relevant data available for the monsoon seasons from June to October. On the other hand, though rainfalls can be seen even in the dry season, these rainfall can not be taken into account in the studies of water resources. Therefore, instead of consideration of run-off discharge caused by the rainfalls during the dry season, base flow of 0.804 l/sec/sq.km is taken into account as the inflows to the dam. This figure is observed at the Anjori Nalla in the dry season in 1970.

The Draw-Off for Irrigation in this project is divided into two portions, that of the right canal and of the left canal. Out of the draw-off for irrigation, that of the right canal has been already estimated in the previous paragraph and that of left canal is estimated at 37% of the value of that for the right canal, which is equivalent to the proportion of net irrigable area covered by the Paralkote dam.

Evaporation is derived from the report concerning the hydrology at the Paralkote dam. (refer to Chapter 2-2-1, (3) evaporation).

Net Deduction or Addition is a sum of water in 10^3 cu.m, and it can be obtained by subtracting columns (8) and (10) from column (5).

Final Reservoir Capacity is also a sum of expected dam water at the end of the month, and it can be obtained by adding the net deduction and the addition in the month to the final reservoir capacity of the previous month.

Overflow from the dam is such volumes of water that if the final reservoir capacity exceeds the designed capacity of 66.4 MCM in volume, the water will be released from the spillway provided on the dam as the overflow discharge.

Shortage means the deficiency of water for irrigation due to the insufficient inflow to the dam and/or the excessive requirements to meet with the net irrigable area of 10,522.2 ha (26,000 acres) covered by the Paralkote dam.

3-2-2-3.. Operation Study

The operation studies were conducted from 1922 to 1960. The results are shown in Table 3-2-4, of which detail calculations are also given in 3-2 in Appendix.

From the results of those calculations, the years in which the shortage of water for irrigation was occured are found out as shown in Table 3-2-4, and the maximum shortage of water is estimated at about 39 MCM in 1951, which is equivalent to 55% of the available storage capacity of 64.4 MCM, whereas the maximum overflow discharge is amounted to be about 112 MCM in 1945.

In the latter cases, the released discharge has a further potentiality to irrigate the extended area in the downstream of the project area, which is called the South Paralkote, but in the former case, it will be anticipated that the agricultural products will be damaged remarkably.

Fig. 3-2-8 illustrates the relationship between the shortage of water and the probability of rainfall inthe year prior to the occurrence of the shortage of water.

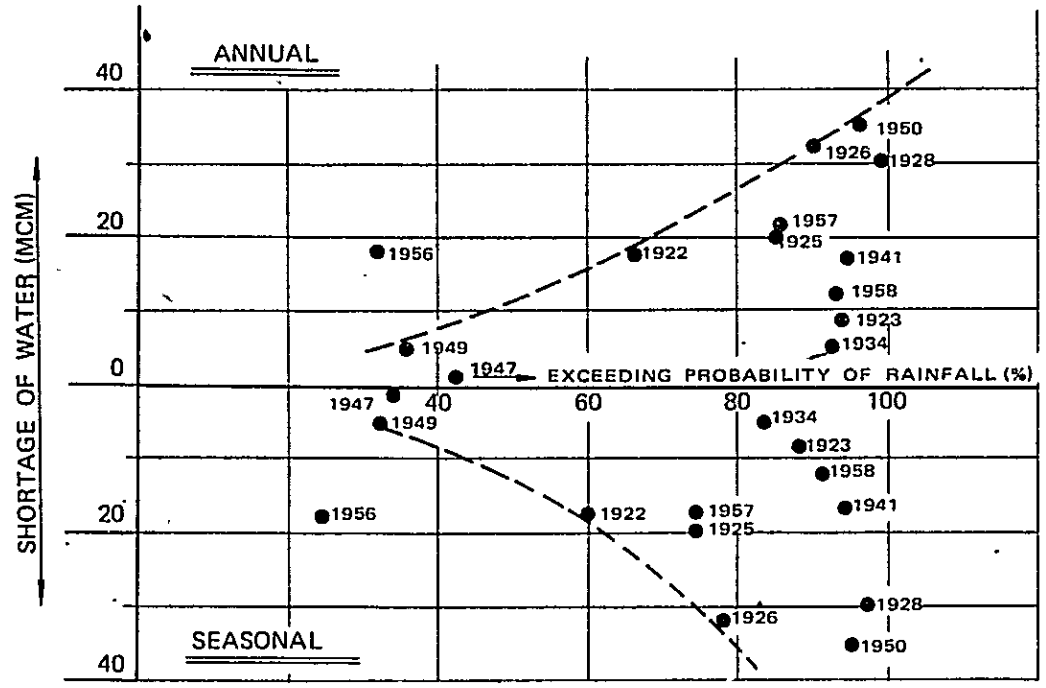
TABLE 3-2-4 RESULTS OF OPERATION STUDY FOR PARALKOTE DAM

Year	Rainfall(mm)		Exceeding Probability of Rainfall		Inflow	Draw-off for Irrigation(10^3cu.m)			Evaporation	Overflow	Shortage
	Annual	Seasonal(%)	Annual(%)	Seasonal(%)	(10^3cu.m)	Right-Canal	Left-Canal	Total	(10^3cu.m)	(10^3cu.m)	(10^3cu.m)
1922	1,521.0	1,508.3	66	60							
1923	1,201.1	1,189.7	94	88	62,827	59,910	22,168	82,073	9,217		17,804
1924	1,866.7	1,645.8	30	42	122,946	43,611	16,138	59,749	11,441	33,383	8,597
1925	1,353.8	1,319.2	85	74	75,038	59,444	21,995	81,439	13,125		
1926	1,292.1	1,279.4	90	78	68,932	69,404	25,680	95,084	8,749		20,450
1927	1,751.0	1,729.2	40	34	120,058	67,532	24,987	92,519	6,137	25,991	32,380
1928	1,002.3	1,000.5	99	97	56,843	64,741	23,955	88,696	9,998		
1929	1,602.8	1,492.8	58	62	94,866	52,043	19,255	71,298	5,134	8,175	29,566
1930	1,647.6	1,469.8	52	62	102,270	42,286	15,647	57,933	12,439	22,870	
1931	1,916.4	1,788.2	26	30	133,190	42,056	15,560	57,616	13,604	61,970	
1932	1,725.9	1,693.4	42	40	114,725	59,021	21,837	80,858	14,220	28,554	
1933	-	-	-	-	-	-	-	-	-	-	-
1934	1,259.0	1,241.2	92	83							
1935	1,545.9	1,529.6	64	55	93,615	57,636	21,326	78,962	10,770	13,296	5,229
1936	1,927.6	1,776.0	24	30	118,036	32,377	11,980	44,357	12,302	61,421	
1937	1,644.9	1,371.6	52	62	78,091	50,968	18,859	69,827	10,950		
1938	2,314.8	2,270.8	7	5	178,833	35,048	12,968	48,016	10,859	110,554	
1939	1,609.2	1,525.1	60	55	105,688	52,300	19,353	71,653	12,410	21,648	
1940	2,375.8	2,223.7	5	5	181,225	49,344	18,257	67,601	12,046	96,976	
1941	1,224.1	1,106.2	93	94	56,979	57,654	21,332	78,986	11,985		
1942	2,077.5	2,024.2	16	14	148,300	48,219	17,841	66,060	6,228	63,055	17,149
1943	1,391.2	1,390.7	80	71	81,143	53,265	19,709	72,974	11,567		
1944	2,106.7	1,890.0	15	22	129,988	42,337	15,665	58,002	12,520	56,054	
1945	2,272.5	2,201.4	8	11	169,675	32,875	12,164	45,039	12,966	111,684	
1946	2,109.2	2,023.3	15	16	150,329	42,098	15,576	57,674	12,649	79,992	
1947	1,784.4	1,698.8	42	34	111,672	50,567	18,709	69,276	12,915	29,462	
1948	1,526.0	1,366.2	66	73	87,028	49,052	18,150	67,202	11,943	108	1,034
1949	1,787.9	1,751.8	36	32	114,478	40,730	15,071	55,801	13,904	53,104	
1950	1,155.3	1,079.6	96	95	52,693	68,524	25,355	93,879	9,908		5,378
1951	1,941.6	1,817.4	24	26	124,096	57,799	21,385	79,184	4,823	36,513	35,390
1952	1,724.1	1,664.7	42	40	107,827	47,964	17,748	65,712	10,354	28,577	
1953	2,057.9	1,963.4	16	18	139,819	42,960	15,895	58,855	11,244	65,126	
1954	1,674.4	1,565.4	52	51	97,979	45,753	16,928	62,681	12.022	30,903	
1955	2,175.2	2,170.9	11	10	165,591	40,350	14,930	55,280	10,616	92,075	
1956	1,858.1	1,820.2	32	24	124,537	44,127	16,327	60,454	12,618	59,129	
1957	1,327.4	1,327.4	86	74	74,768	69,557	25,737	95,294	9,879	1,657	18,232
1958	1,218.0	1,145.9	93	91	57,903	58,681	21,713	80,394	5,865		19,995
1959	2,234.2	2,138.7	9	10	161,126	39,985	14,796	54,781	6,000	86,398	12,213
1960	1,546.9	1,470.7	64	62	90,846	52,797	19,535	72,332	11,670	13,495	

Note; Seasonal : June to October.

This table is summarized from Table in Appendix.

FIG. 3-2-8 RELATION BETWEEN SHORTAGE OF WATER AND PROBABILITY OF RAINFALL



Note: Year remarked shows the previous year occurring the shortage of water

As is shown in the above figure, the shortage of water can be seen even if the low exceeding probability of rainfall such as around 40%. These shortage of water can be considered to occur in June, due to the fluctuation of the monsoon season. Furthermore, the shortage of water at the probability of rainfall more than 80% is considered to be originated from an absolute quantity of annual rainfall. These shortages of water due to the absolute quantity of annual rainfall can not be indispensable for the project, and their occurences concerntrate mainly in the 1920's and after the year of 1950. The both periods correspond to low-rainfall years from view point of meteorological analysis of secular change, which is studied on the data available for 39 years from 1922 to 1960, as indicated in Fig. 2-2-2.

The probability of rainfall shows that the shortage of water for irrigation will be occured in the return period of about 7 years, except the cases of shortage of water for the sake of fluctuation of the monsoon season mentioned above.

3-2-2-4. Examination of Water Resources for South Paralkote Area

As stated in the previous chapter, the South Paralkote area falls in the Paralkote zone, and is located in the southern part of the Anjori Nalla adjacent to the project area as shown in Fig. 3-2-1. The existing topography has remarkable undurations, and the existing agricultural managements are carring out upon the rainfed irrigation during the monsoon season as same as in the existing project area, and hence, the land utilization ratio has been low through a year.

Under these circumstances, the Dandakaranya Development Authority has another irrigation plan to introduce the water of the Deodha Nalla, that is only one main water resource in this area, into the South Paralkote area in order to increase the agricultural products, to rise and to stabilize the self-sufficiency of the farmer there.

However, as is evident from the result of operation studies conducted previously, the average frequency of shortage of irrigation water for the project area corresponds to the return period of 7-years, and therefore, the storage capacity of the Paralkote dam (66.4 MCM in total) is not enough to supply water further downstream to the South Paralkote area. And, another dam will be required besides the Paralkote dam under construction.

Consequently, the examination of the water resources described subsequently, which will become rough estimation because of no adequate data at present, is conducted basing on the following procedure; The surplus water of the Deodha Nalla, excluded the required irrigation water for the project from an annual discharge of the Deodha Nalla, will be utulized for the irrigation of the South Paralkote area.

From the result of an operation study, Fig. 3-2-9 can be made up, and it gives the relation between an irrigable area and its required irrigation water at each frequency of annual rainfall, and also gives the expected run-off discharge of the Deodha Nalla exclusive of evaporation from the dam at each frequency of annual rainfall. Various figures concerned above relations are shown in the following table.

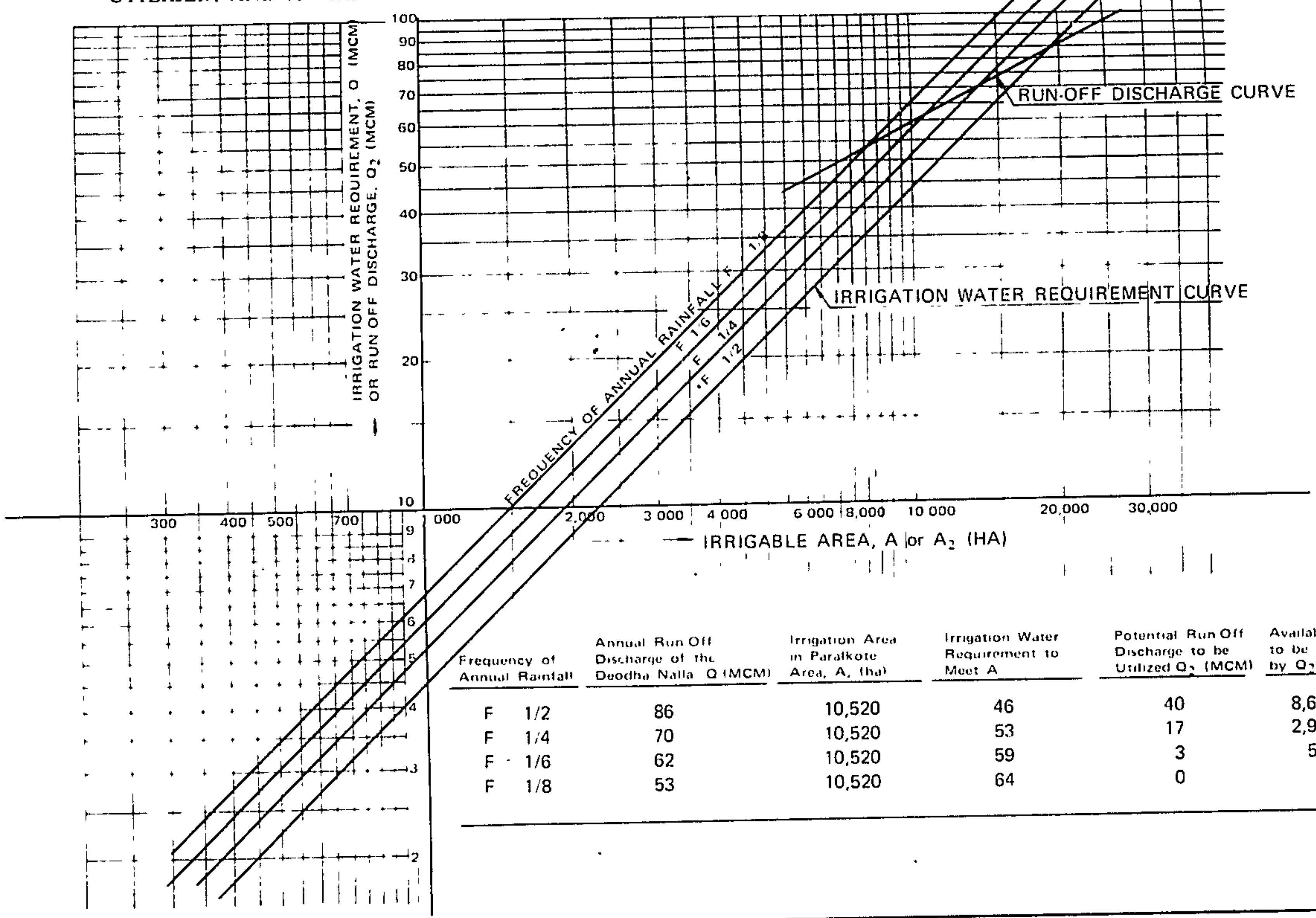
Frequency of Annual Rainfall	Year Coresponding Left Column	Irrigation Water Requirement for the Project 1/
(1)	(2)	(3)
F = 1/2	1954	45.7 MCM
F = 1/4	1948	53.3
F = 1/6	1943	59.4
F = 1/8	1925	64.4

Annual Run-off Discharge of the Deodha Nalla	Evaporation from dam	(4) - (5)
(4)	(5)	(6)
98.0 MCM	12.0 MCM	86.0
81.1	11.6	69.6
75.0	13.1	61.9
68.9	8.7	60.2

Note; 1/ : Irrigable area for the project is about 10,520 ha.

As for the detail figures, reference to Table 3-2 in Appendix shall be made.

FIG. 3-2-9 CHART OF ESTIMATING POTENTIAL RUN-OFF DISCHARGE TO BE UTILIZED, AND AVAILABLE AREA TO BE IRRIGATED



Frequency of Annual Rainfall	Annual Run Off Discharge of the Deodha Nalla Q (MCM)	Irrigation Area in Paralkote Area, A, (ha)	Irrigation Water Requirement to Meet A	Potential Run Off Discharge to be Utilized Q_2 (MCM)	Available Area to be Irrigated by Q_2, A_2 (ha)
F 1/2	86	10,520	46	40	8,600
F 1/4	70	10,520	53	17	2,900
F 1/6	62	10,520	59	3	500
F 1/8	53	10,520	64	0	0

In studying the water resources for the South Paralkote area by using the figures in Fig. 3-2-9, the following assumptions are made; 1) proposed crops and their cropping allocation in the South Paralkote area are the same to those of the project area, and the required irrigation water per hectare along with above assumption is also at the same rate. 2) the run-off discharge of the Deodha Nalla is in propotion to the annual rainfall at the same frequency of rainfall.

Based on the above assumptions, the potential run-off discharge to be utilized for the irrigation of the South Paralkote area, and the available area to meet with the obtained discharge are estimated at the each frequency of annual rainfall, by using Fig. 3-2-9, and their results are indicated also in Fig. 3-2-9.

According to the results of the study, no surplus water is available in the Deodha Nalla to utilize the irrigation for the South Paralkote area at the return period of 8 years. This fact is clear from the result of operation study made in the previous paragraphs.

On the other hand, 2,900 ha of lands in the South Paralkote area will be able to be irrigated with the expected run-off discharge of about 17 MCM at the return period of 4 years. And furthermore the irrigation of 8,600 ha will be available with the expected run-off discharge of about 40 MCM at the return period of 2 years.

However, it can not be considered to be reasonable to adopt such a low return period as the basic year for irrigation plan, because frequent damages of an agricultural products is most anticipated owing to the lack of water for irrigation.

Furthermore, from economical view, taking into account the benefit expected from the scheme and the required cost for providing the facilities such as dam and canals, it also can not be considered to be appropriate to introduce the water of the Deodha Nalla to the South Paralkote with the extended canals.

Judging from the result of the rough examination of the water resources mentioned above, it is proved conclusively that the run-off discharge of the Deodha Nalla will reach the limit of utilization for irrigation of about 10,520 ha in the Paralkote area, and it is considered to be more appropriate to secure another irrigation water resources for future agricultural development of the South Paralkote area from the view point of both water utilization and economy.

3-3. Drainage Scheme for Paralkote Area

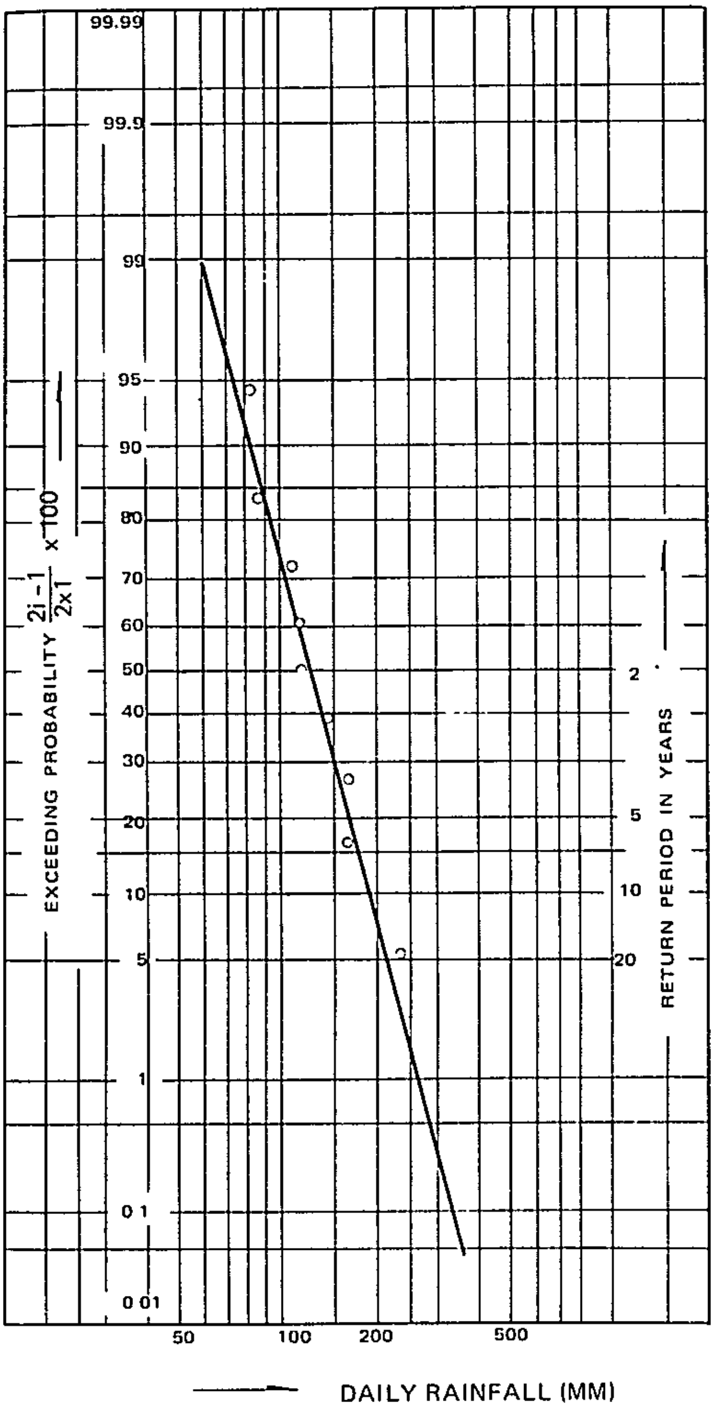
3-3-1. Study on Design Rainfall

3-3-1-1. Basic Rainfall

In order to determine the basic rainfall for the drainage scheme, the maximum daily rainfall is selected from the available rainfall records of 9 years from 1961 to 1969 observed at Mixed Farm.

From the result of studies on the probability of daily rainfall, by using Hazen paper indicated in Fig. 3-3-1, the probability of daily rainfall for each return period is determined as is shown in the following table.

FIG. 3-3-1 EXCEEDING PROBABILITY OF MAXIMUM DAILY RAINFALL



RAINFALL (MM)

i	R	YEAR
1	235.0	1967
2	168.0	1964
3	165.0	1962
4	141.0	1968
5	120.0	1966
6	113.6	1963
7	110.0	1969
8	88.4	1965
9	81.6	1961

PROBABLE RAINFALL

F	R
1/2	129
1/5	169
1/10	191
1/100	265

Probable Rainfall for Each Return Period

Return Period	Probable Daily Rainfall, in mm
5	169
10	191
20	215
30	229
50	242
100	265

3-3-1-2. Rainfall Intensity

The rainfall intensities in case of 20, 30 and 40 years frequencies have been already presented by the Dandakaranya Development Authority as indicated in Fig. 3-3-3, so that the studies on 10 years frequency only is carried out in this analysis.

Hourly rainfall records observed by the automatic rainfall gauge at Mixed Farm are available only of the period of 6 months from June to October in 1969. Of these hourly rainfall data, the rainfall more than 30 mm per day is selected as shown below;

Hourly Accumlative Rainfall, in mm

Date	Daily Rainfall	Accumulative Rainfall					
		1 hr	2 hr	4 hr	6 hr	12 hr	18 hr
25 July '69	108.5	48.0	63.0	70.5	71.0	77.0	85.0
29	46.0	8.0	13.0	18.5	23.0	40.5	43.0
30	77.5	24.5	37.5	47.5	54.5	55.0	62.0
14 Aug. '69	40.5	13.0	25.0	33.0	36.0	39.5	40.0
7 Sep. '69	99.5	17.5	34.0	42.0	64.0	79.5	99.5
19	31.0	8.5	14.5	17.5	19.0	26.0	26.0
21	65.5	27.0	38.0	51.0	58.0	64.0	65.5

FIG. 3-3-2 RELATION BETWEEN DAILY RAINFALL AND ACCUMULATIVE RAINFALL

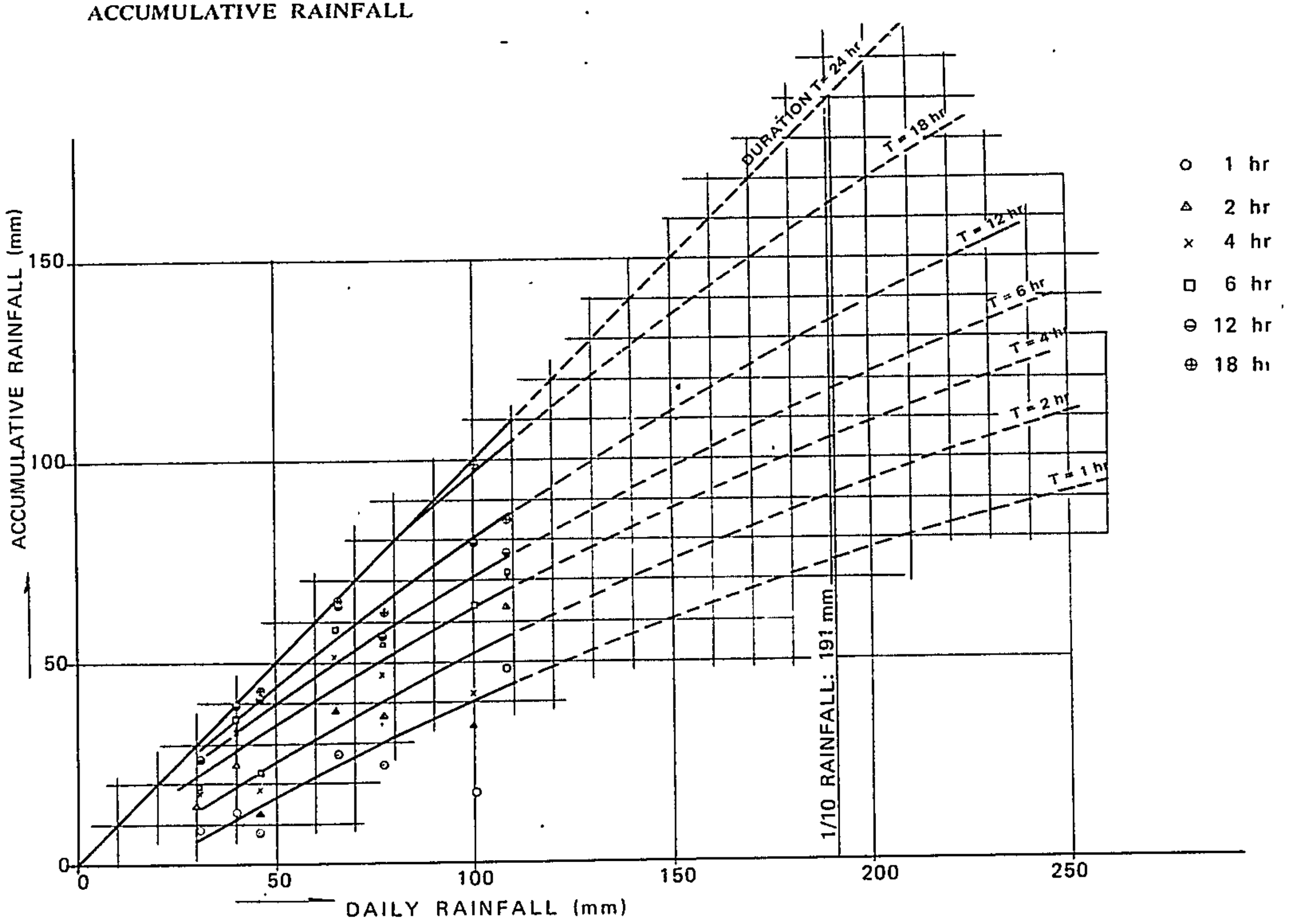
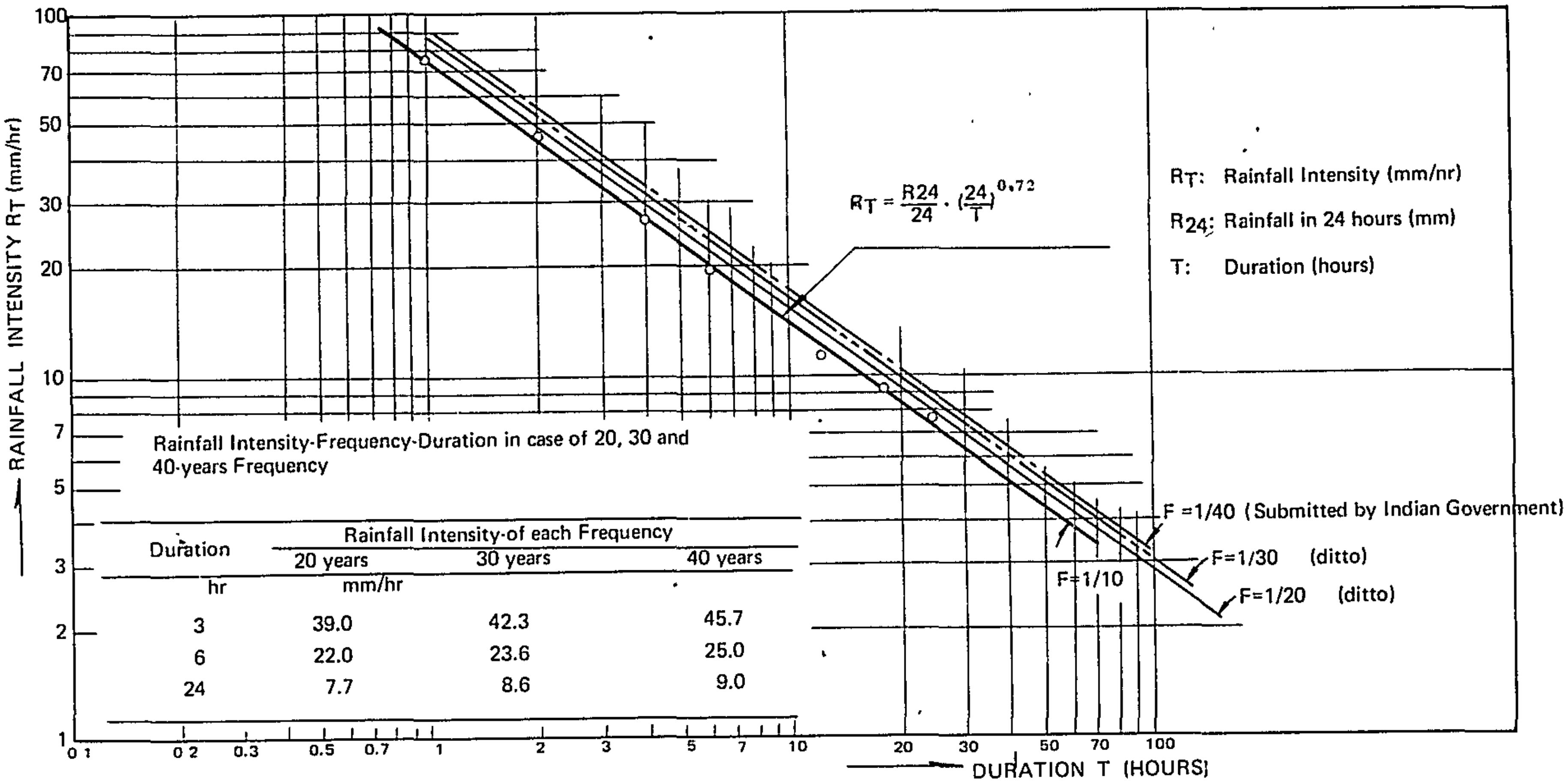


FIG. 3-3-3 RAINFALL INTENSITY - FREQUENCY - DURATION CURVE



Rainfall Intensity-Frequency-Duration in case of 20, 30 and 40-years Frequency

Duration	Rainfall Intensity of each Frequency		
	20 years	30 years	40 years
hr	mm/hr		
3	39.0	42.3	45.7
6	22.0	23.6	25.0
24	7.7	8.6	9.0

Fig. 3-3-2 indicates the relationship between the daily rainfall and accumlative rainfall depending upon the above figures. From the Fig. 3-3-2, the relationship mentioned above in case of 10 years frequency is obtained in graphically as illustrated in Fig. 3-3-3, together with 20, 30 and 40 years frequencies, and they are expressed in the following formula. In this study, it is assumed that the same fluctuation of the accumlative rainfall can be expected even in case of daily rainfall more than about 110 mm.

$$R_T = \frac{R_{24}}{24} \left(\frac{24}{T}\right)^{0.72}$$

Where;

R_T : Rainfall Intensity, in mm per hr.

R_{24} : Rainfall in 24 hours, in mm

T : Duration, in hr.

Consequently, the rainfall intensity in case of 10 years frequency is estimated as shown in the following table.

Rainfall Intensity (10 years frequency)

Duration hr	Rainfall Intensity mm	Duration hr	Rainfall Intensity mm
2	41.0	14	11.0
4	27.0	16	9.9
6	21.0	18	9.2
8	16.4	20	8.4
10	14.0	22	7.8
12	12.3	24	7.4

CHAPTER 4. FINAL DESIGN OF PARALKOTE RIGHT MAIN IRRIGATION CANAL

4-1. Introduction

In accordance with the basic policy of the design, the final design is planned for the Paralkote right main irrigation canal system which is the main foundation of regional development, for the purpose of effective water utilization of Paralkote Dam, on the basis of local conditions of Paralkote zone.

Paralkote right main irrigation canal will be divided into three parts, namely, the route 'A', route 'B', and route 'C'.

In this chapter, flow capacity is re-studied and examined for existing canal of the route 'A', and the final design is made for the newly constructed part of the route 'A' and for overall of the route 'B' and the route 'C'.

For effective use of irrigation water, operation and maintenance of the irrigation system are also studied in this chapter.

The scope of study is as follows.

(1) design of irrigation canal

(2) hydraulic and structural calculations

(3) drawings

(4) bill of quantities

(5) construction planning

(6) additional specification

(7) plan of operation and maintenance

4-2. Basic Policy of Design

4-2-1. Determination of Design Factors of the Main Canal Cross Section

Design factors of the main canal cross section are determined so that the canal has functions as both irrigation canal and drainage canal.

As for the irrigation, the irrigable area and unit water requirement are determined on the basis of the collected data in the project site, and then designed discharge of canal is decided. The design factors of cross section are studied through a diagram of irrigation system.

As for the drainage, the discharge is determined in accordance with the drainage catchment area, and then design factors of cross section are studied through a diagram of drainage system.

The final design factors of cross section are, determined in studying two different functions of the canal.

4-2-2. Separation of Irrigation and Drainage

In general, the principle in designing main canal is to separate irrigation and drainage.

Drainage discharge is, however, introduced into the main canal where various structures have already been completed in the main canal as seen in the route 'A', where drainage discharge is comparatively small, and where separation of irrigation and drainage seems to be especially unprofitable from a topographic point of view, and the introduced drainage discharge is wasted from the main canal through spillway or escape structure.

4-2-3. Existing Structures

Existing structures are studied to utilize them as they are, and to avoid reconstruction as far as possible.

However, reconstruction or improvement works should be required for such structures that have not enough flow capacity or have problems found in their function. If the problem is not serious and acceptable practically, it will be only noted in this report or improvement is recommended but no drawings for improvement are made.

4-2-4. Design of Structures

Structures are designed as simply as possible in style and composition. Structures of the same kind will be summarized and drawings will not be made itemly.

(1) construction materials

As for the construction materials, stone should be utilized as much as possible and reinforced concrete or reinforced concrete pipe should be avoided wherever possible.

(2) gates

Gates should be provided for the facilities such as intakes which are frequently operated for the diversion of water, and flash board weirs for others which are not operated frequently. Either, steel,or wood, will be available as the materials of gate.

(3) aqueducts and bridges

Considering the difficulties in obtaining construction materials and skilled labors, aqueducts are designed both of reinforced cement concrete structure and wet masonry one, and bridges both of reinforced cement concrete structure and wooden structure. Selection of the structural type should be made in consideration with the local condition and easiness of construction.

4-2-5. Design Criteria

4-2-5-1. Allowable Stress of Reinforced Concrete

(1) allowable stress for compression of concrete
σ_{ca} = 40 kg/sq.cm

(2) allowable stress for tension of reinforcement
σ_{sa} = 1,400 kg/sq.cm

(3) allowable shearing stress of concrete
τ_{ca} = 4.5 kg/sq.cm

(4) safety factor F = 3.5

4-2-5-2. Unit Weight of the Materials

(1)	reinforced concrete	2.4 ton/cu.m
(2)	concrete	2.3 ton/cu.m
(3)	wet masonry	2.5 ton/cu.m
(4)	saturated soil	2.0 ton/cu.m
(5)	wet soil	1.8 ton/cu.m
(6)	water	1.0 ton/cu.m

4-2-5-3. Coefficient of Earth Pressure

Using Rankine's formula, earth pressure is expressed as;

$$P = K_A \cdot r \cdot H$$

where

P: earth pressure of given depth of earth (ton/sq.m)

K_A: coefficient of earth pressure

r: unit weight of earth (ton/cu.m)

H: given depth of earth (m)

A coefficient of earth pressure, K_A, is given in the term of internal friction angle, ϕ, as

$$K_A = \frac{1 - \sin\phi}{1 + \sin\phi}$$

Here, assuming $\phi = 30°$, K_A is then given as follows.

$$K_A = \frac{1 - \sin 30°}{1 + \sin 30°} = \frac{1}{3} = 0.333$$

4-2-5-4. Control Point for Surveying

The results surveyed by Japanese survey team are used as standard datum of leveling.

The results of standard datum of leveling are tabulated below together with Indian results.

No.	Location of the Standard datum	Indian result	Japanese result
		Elevation-meter	Elevation-meter
1.	near the intake structure of Paralkote dam site	342.937	342.937
2.	on the side-wall of the drainage syphon RD.19370 of right main canal	336.569	336:453
3.	concrete pile near RD.32100 of right main canal	336.993	336.946
4.	concrete pile near RD.42100 of right main canal	331.915	331.928
5.	concrete pile, RD.58735 of right main canal	334.451	334.718

4-3. Design Modules for Determining Canal Capacity

In determining the canal capacity of the right main irrigation canal, two factors, irrigation requirement and drainage discharge, will be taken into account, since the canal has two functions as not only irrigation canal to supply water, but also drainage canal receiving drainage discharges from the area situated on the right side of the canal.

This paragraph deals with the study on design modules for determining the canal capacity for irrigation as well as drainage.

4-3-1. Design Modules for Irrigation

As stated previously in Chapter 2, the maximum droughty day of 19 days can be found out even in the rainy season (the monsoon season, June to October), so that supplemental irrigation during the rainy season will be required for the project area.

Table 4-3-1 indicates the monthly irrigation water requirements exclusive of effective rainfalls. From this estimation, the maximum irrigation water requirement is assumed to be 9.63 cu.m/sec in August. Based on this figure the design discharges for irrigation at the places of distribution are illustrated in Fig. 4-3-1.

4-3-2. Design Modules for Drainage

For calculating the runoff from the catchment, Fig. 4-3-2 is made for the route 'A' and the route 'B' of the right main canal and Fig. 4-3-3 for the route 'C'. Using the above figures, diagrams of the drainage system are made and illustrated in Fig. 4-3-4, Fig. 4-3-5 and Fig. 4-3-6.

Table 4-3-1 Estimation of Maximum Irrigation Water Requirements

Month	Cropping Area (ha)			Weighted Irrigation Requirements		Irrigation Water Requirements				Total	
	Paddy Crops	Up land Crops	Total	Paddy Crops	Up land Crops	Paddy Crops		Up land Crops			
						(mm)	(10^3cu.m)	(mm)	(10^3cu.m)	(10^3cu.m)	(cu.m/sec)
Jan.	384.5	3,460.2	3,844.7	264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
Feb.	384.5	1,537.9	1,922.4	272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
Mar.	384.5	1,537.9	1,922.4	287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
Apr.		384.5	384.5		141.8			256.7	987	987	0.38
May		384.5	384.5		192.2			347.9	1,338	1,338	0.50
Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	378.2	17,449	116.0	3,829	21,278	8.21
Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	389.3	17,961	231.0	5,329	23,290	8.70
Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	401.4	18,519	236.6	7,279	25,796	9.63
Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	345.1	15,922	224.1	6,893	22,815	8.80
Oct.		3,075.7	3,075.7		92.6			167.6	5,155	5,155	1.92
Nov.		3,844.6	3,844.5		86.5			156.6	6,021	6,021	2.32
Dec.	384.5	3,460.2	3,844.7	282.6	78.3	332.5	1,278	141.7	4,903	4,903	1.83

Note: 1) Cropping area and Weighted irrigation water requirements are derived from Table 3-1 given in Appendix.

2) Irrigation water requirements are estimated based upon the following equation;

$$\text{Irrigation Water Requirement} = \frac{\text{Irrigation Requirement}}{E(1-L)}$$

where; E: Application efficiency, assumed to be 0.65 for up land field and 1.0 for paddy field.

L: Conveyance losses to the fields, assumed to be 0.15.

FIG. 4-3-1 DIAGRAM OF NET IRRIGATION AREA AND REQUIRED DISCHARGE (RIGHT CANAL)

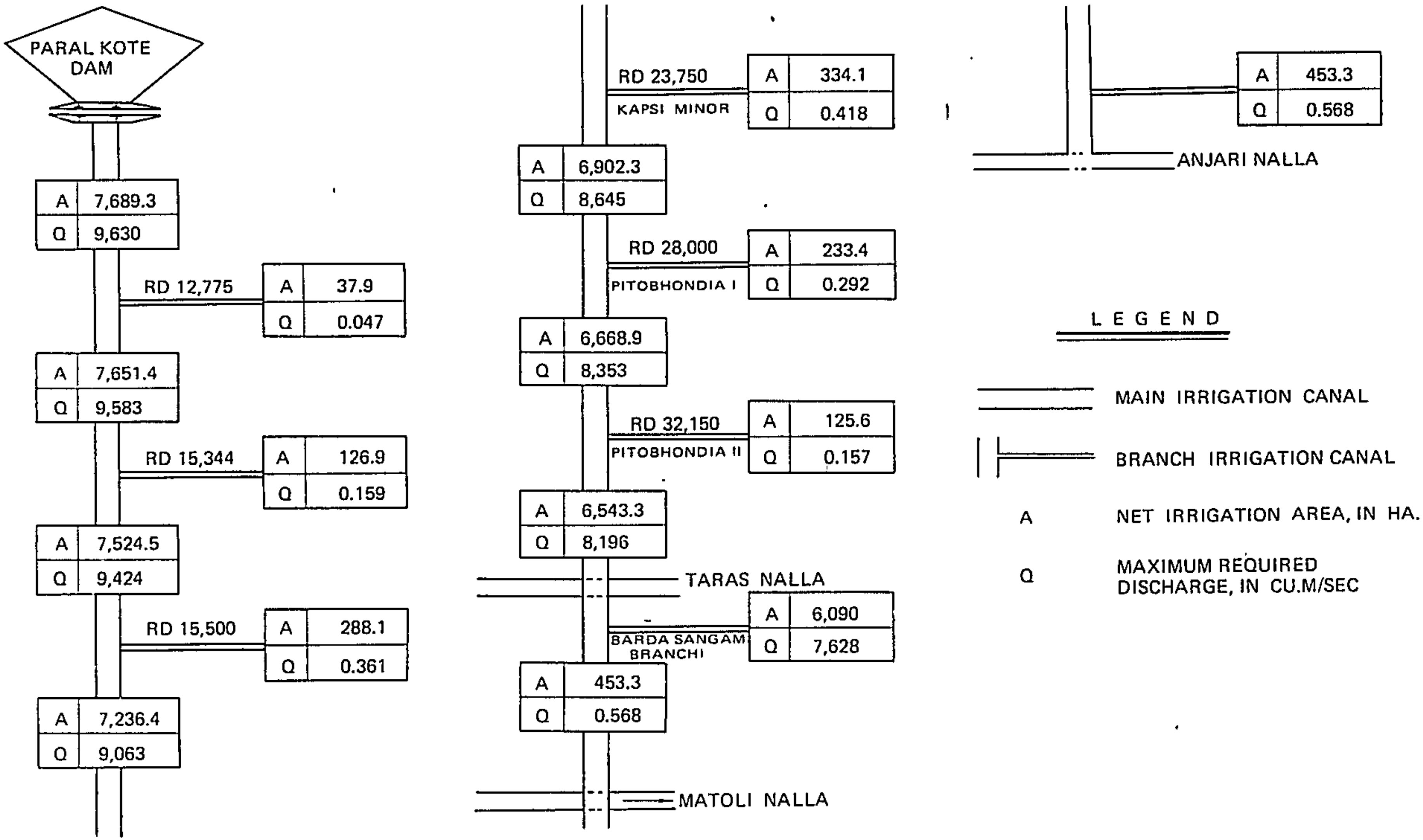
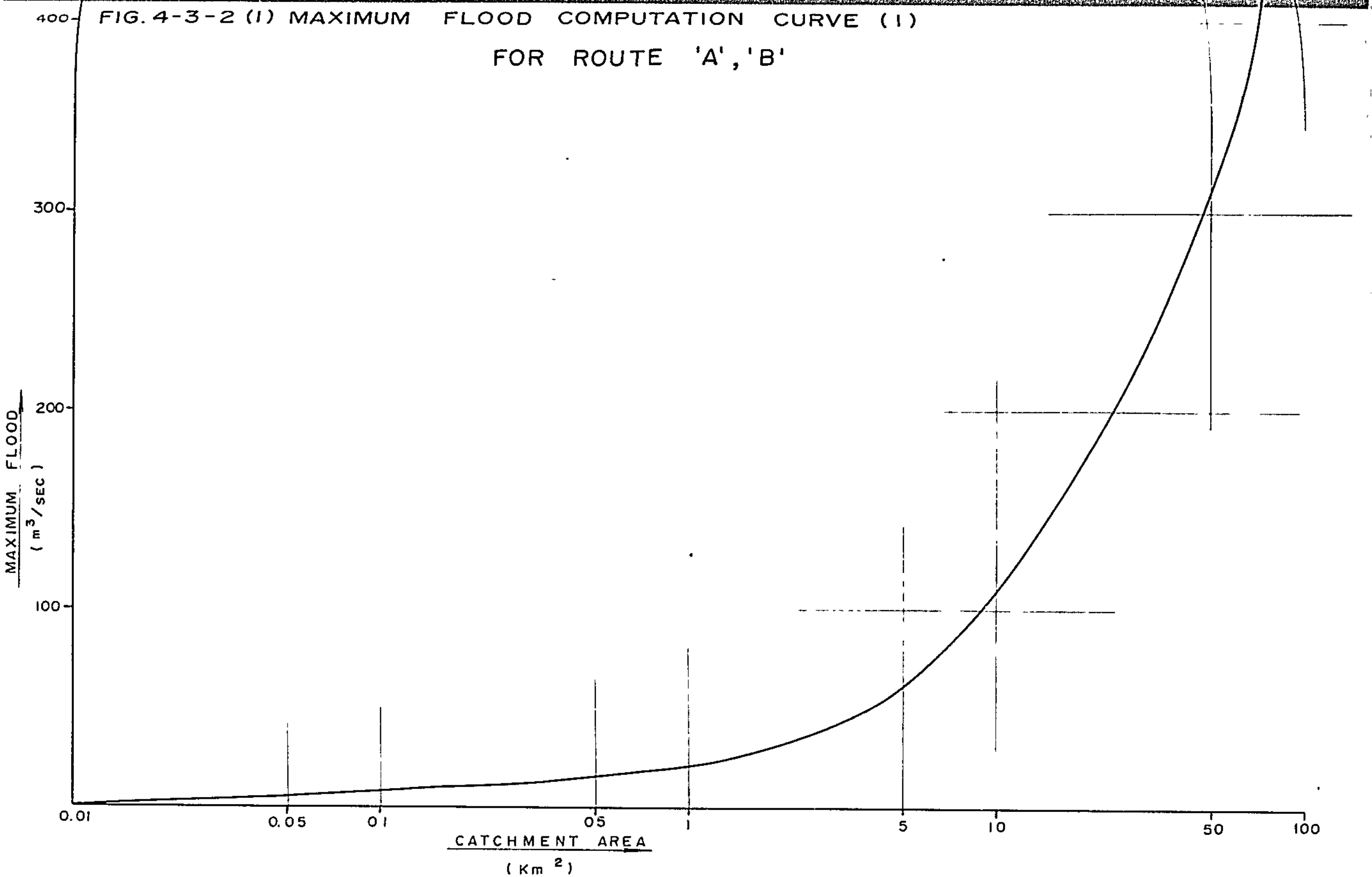


FIG. 4-3-2 (I) MAXIMUM FLOOD COMPUTATION CURVE (I)

FOR ROUTE 'A', 'B'



MAXIMUM FLOOD COMPUTATION CURVE (2)

FOR ROUTE 'A','B'

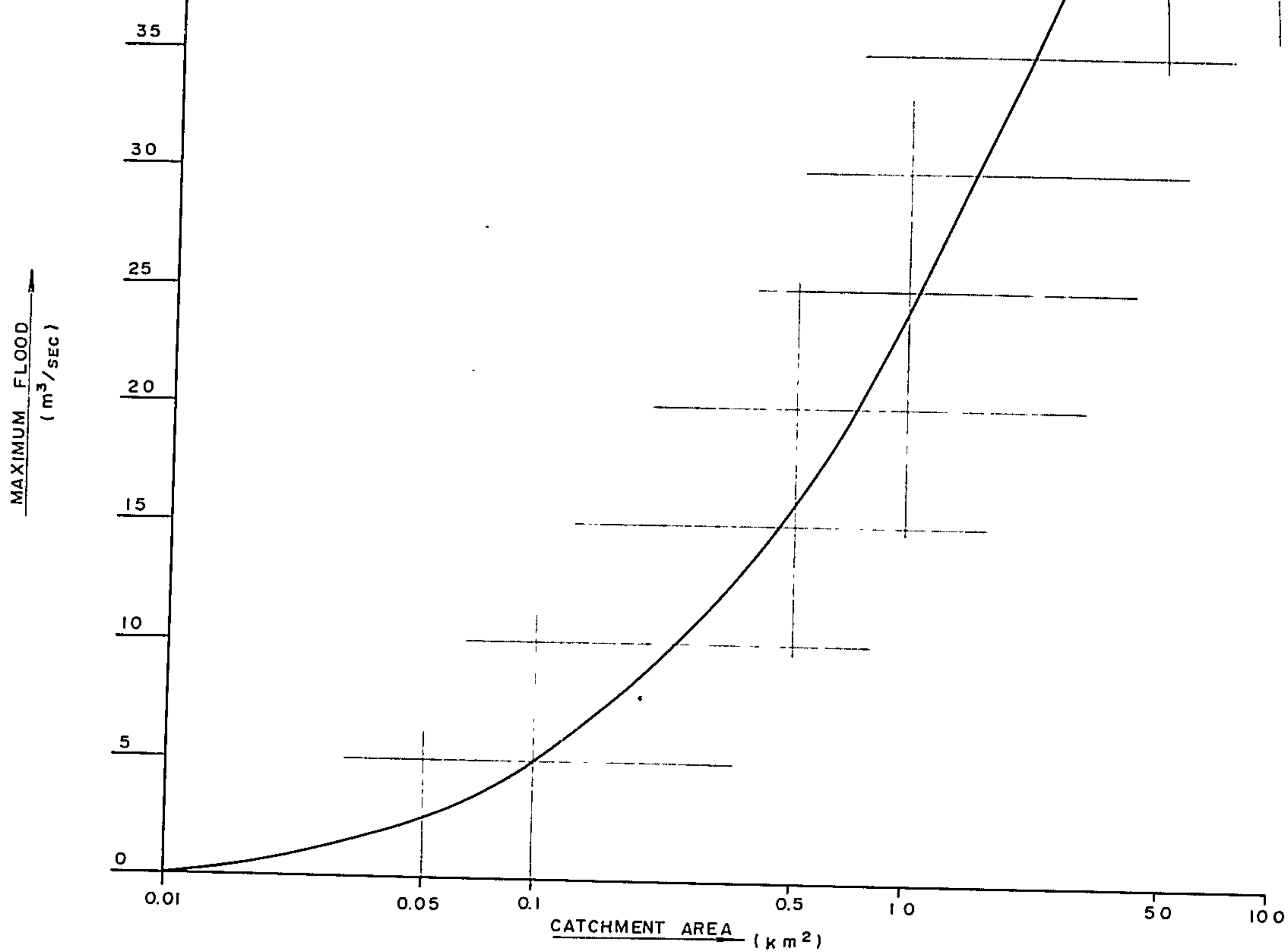


FIG. 4-3-3 MAXIMUM FLOOD COMPUTATION CURVE FOR ROUTE 'C'

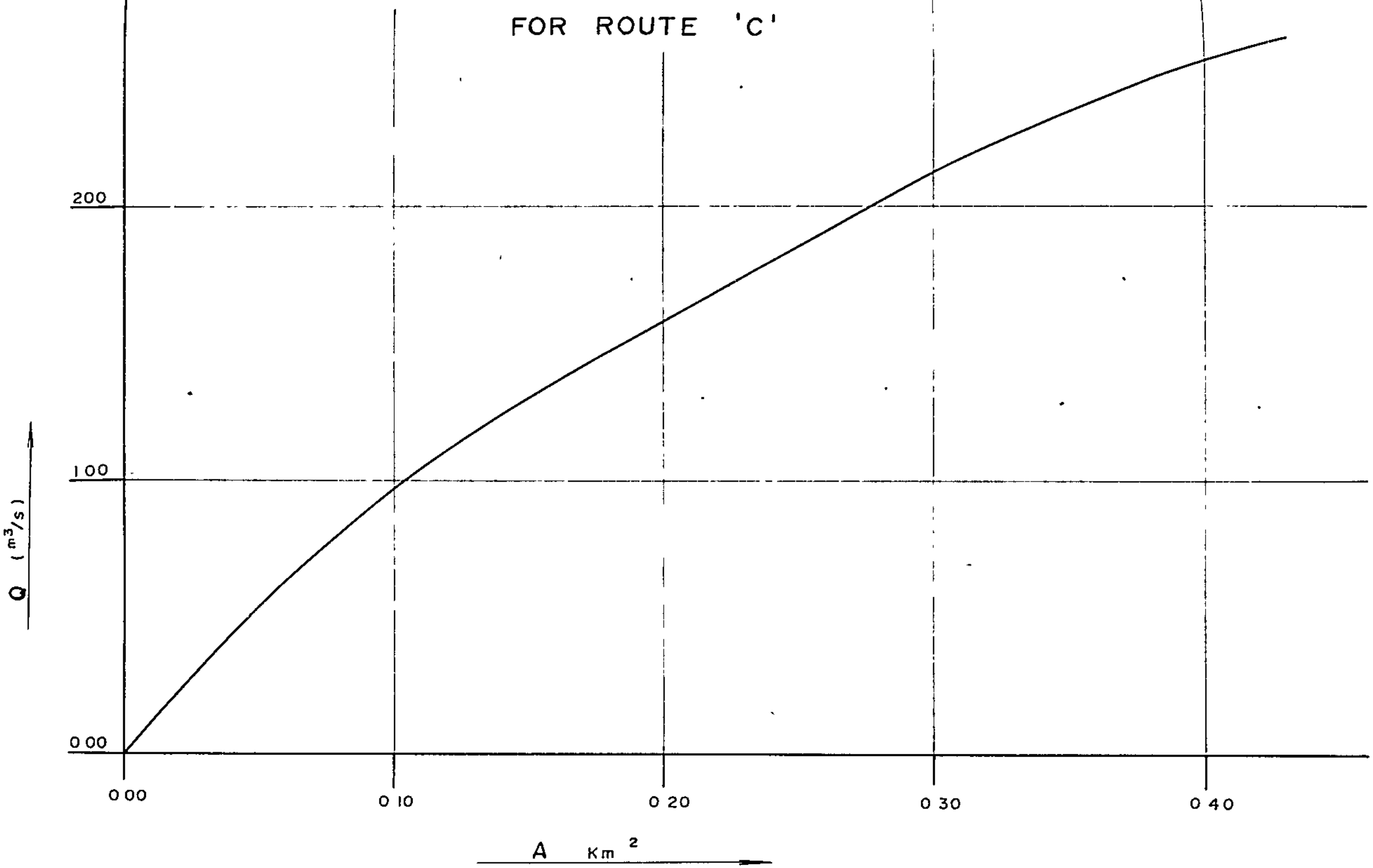
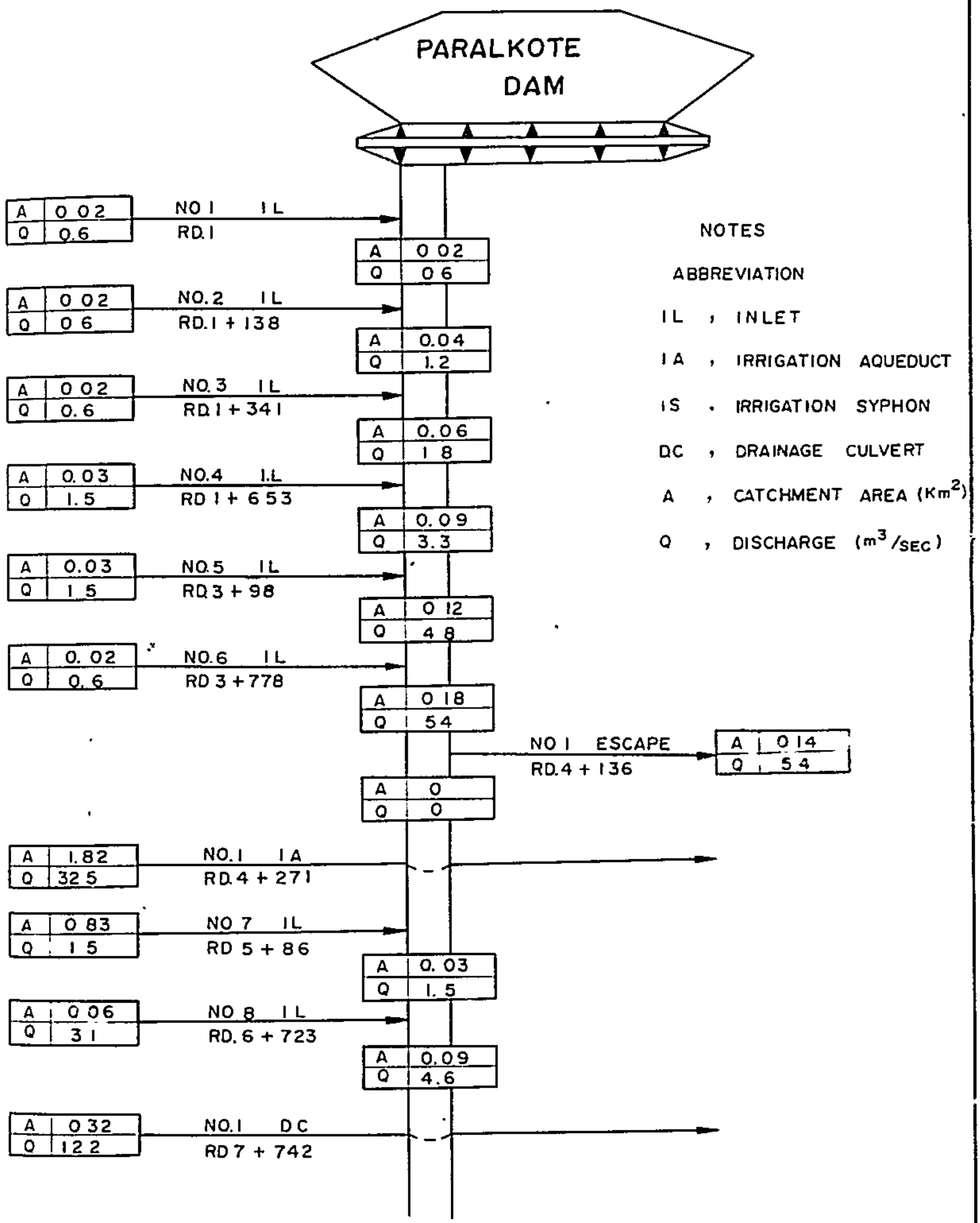
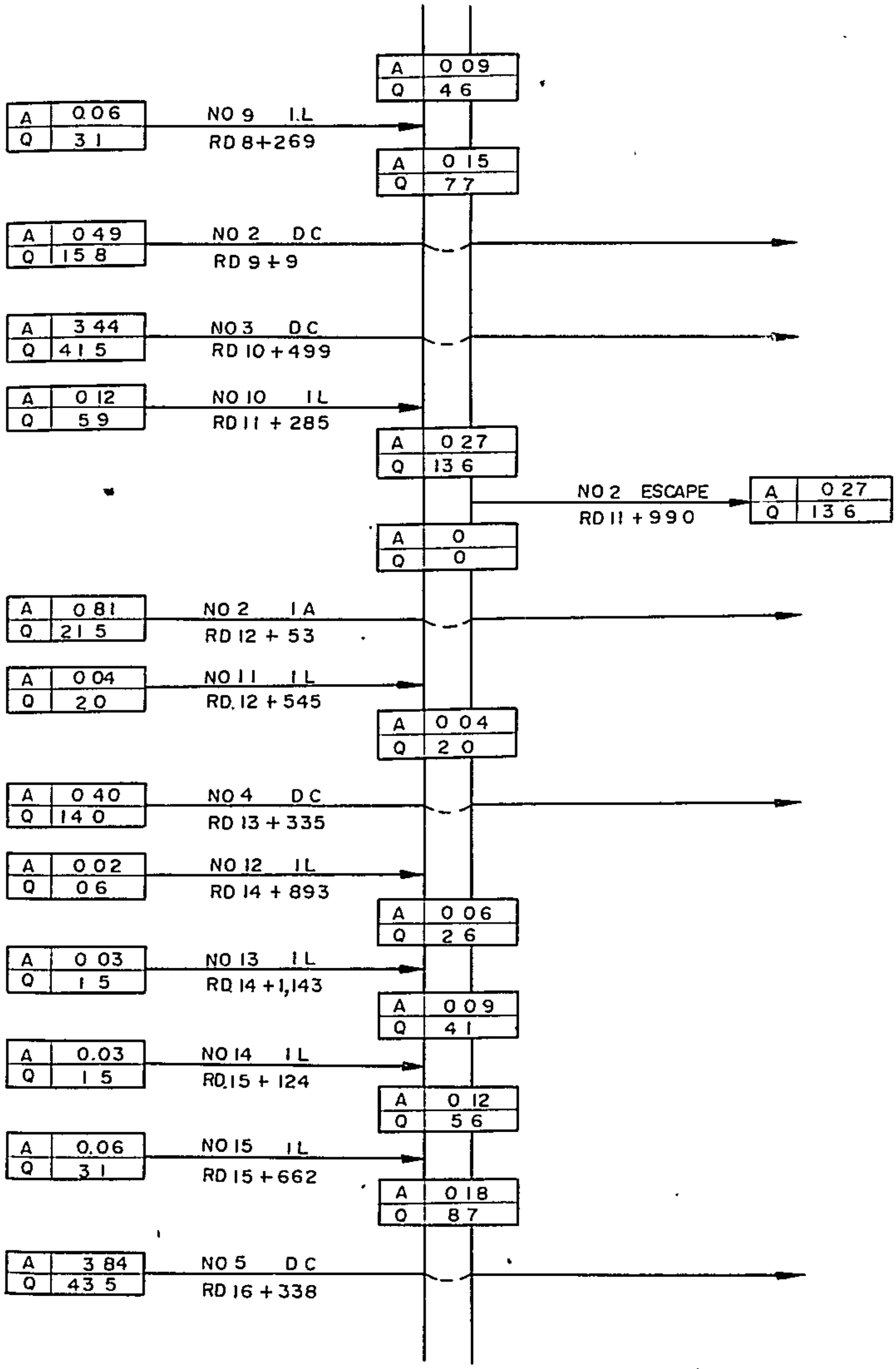


FIG. 4-3-14 DIAGRAM OF DRAINAGE SYSTEM, CATCHMENT AREA AND DESIGN FLOOD DISCHARGE FOR ROUTE 'A'




A 0 09
Q 46
A 0.06
Q 31
NO 9 I.L
RD 8+269
A 0 15
Q 77
A 049
Q 158
NO 2 DC
RD 9+9
A 344
Q 415
NO 3 DC
RD 10+499
A 0 12
Q 59
NO 10 IL
RD 11 + 285
A 0 27
Q 136
NO 2 ESCAPE
RD 11 +990
A 0 27
Q 136
A 0
Q 0
A 0 81
Q 215
NO 2 IA
RD 12 + 53
A 0 04
Q 20
NO 11 IL
RD.12 + 545
A 0 04
Q 20
A 0 40
Q 140
NO 4 DC
RD 13 + 335
A 0 02
Q 06
NO 12 IL
RD 14 + 893
A 0 06
Q 26
A 0 03
Q 15
NO 13 IL
RD 14 +1,143
A 0 09
Q 41
A 0.03
Q 15
NO 14 IL
RD.15 + 124
A 0 12
Q 56
A 0.06
Q 31
NO 15 IL
RD 15 +662
A 0 18
Q 87
A 3 84
Q 435
NO 5 DC
RD 16 +338

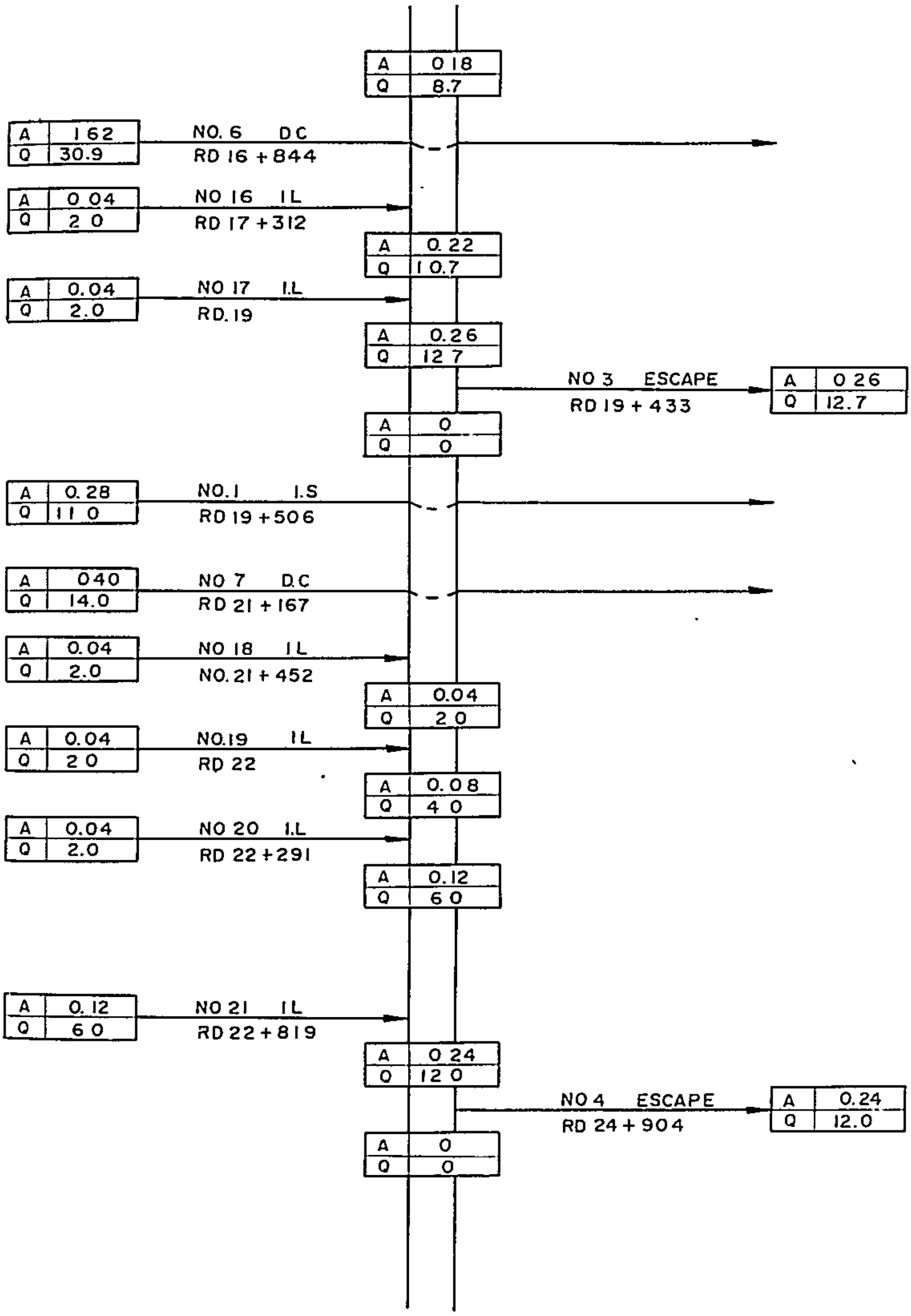
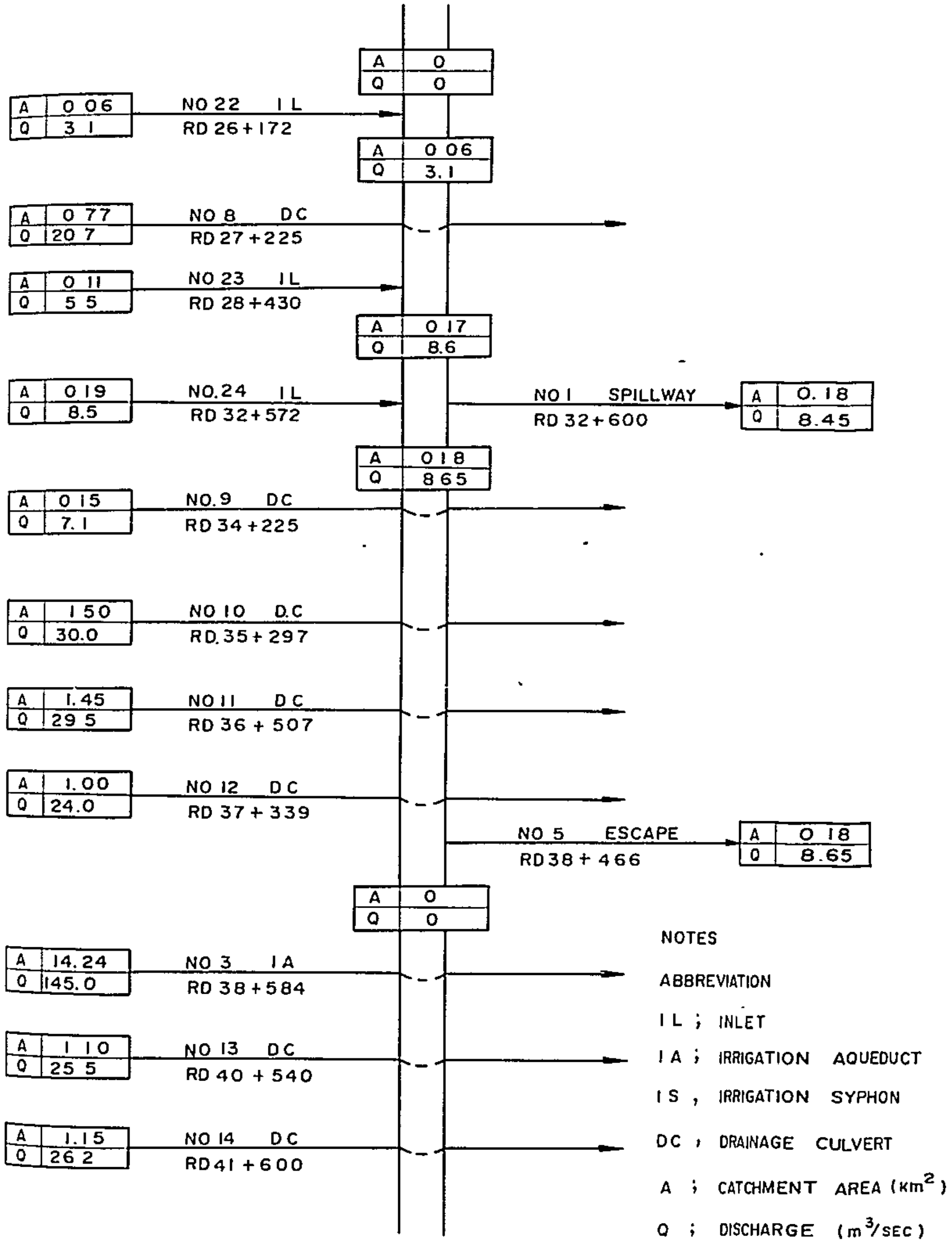

A 0 18
Q 8.7
A 1 62
Q 30.9
NO. 6 D C
RD 16 + 844
A 0 04
Q 2 0
NO 16 I L
RD 17 + 312
A 0. 22
Q 10.7
A 0.04
Q 2.0
NO 17 I.L
RD. 19
A 0.26
Q 12 7
NO 3 ESCAPE
RD 19 + 433
A 0 26
Q 12.7
A 0
Q 0
A 0.28
Q 11 0
NO. 1 I.S
RD 19 + 506
A 040
Q 14.0
NO 7 D.C
RD 21 + 167
A 0.04
Q 2.0
NO 18 I L
NO. 21 + 452
A 0.04
Q 2 0
A 0.04
Q 2 0
NO.19 I L
RD 22
A 0.08
Q 4 0
A 0.04
Q 2.0
NO 20 I.L
RD 22 + 291
A 0.12
Q 6 0
A 0. 12
Q 6 0
NO 21 I L
RD 22 + 819
A 0 24
Q 12 0
NO 4 ESCAPE
RD 24 + 904
A 0.24
Q 12.0
A 0
Q 0

FIG. 4-3-5 DIAGRAM OF DRAINAGE SYSTEM, CATCHMENT AREA AND DESIGN FLOOD DISCHARGE FOR ROUTE 'B'



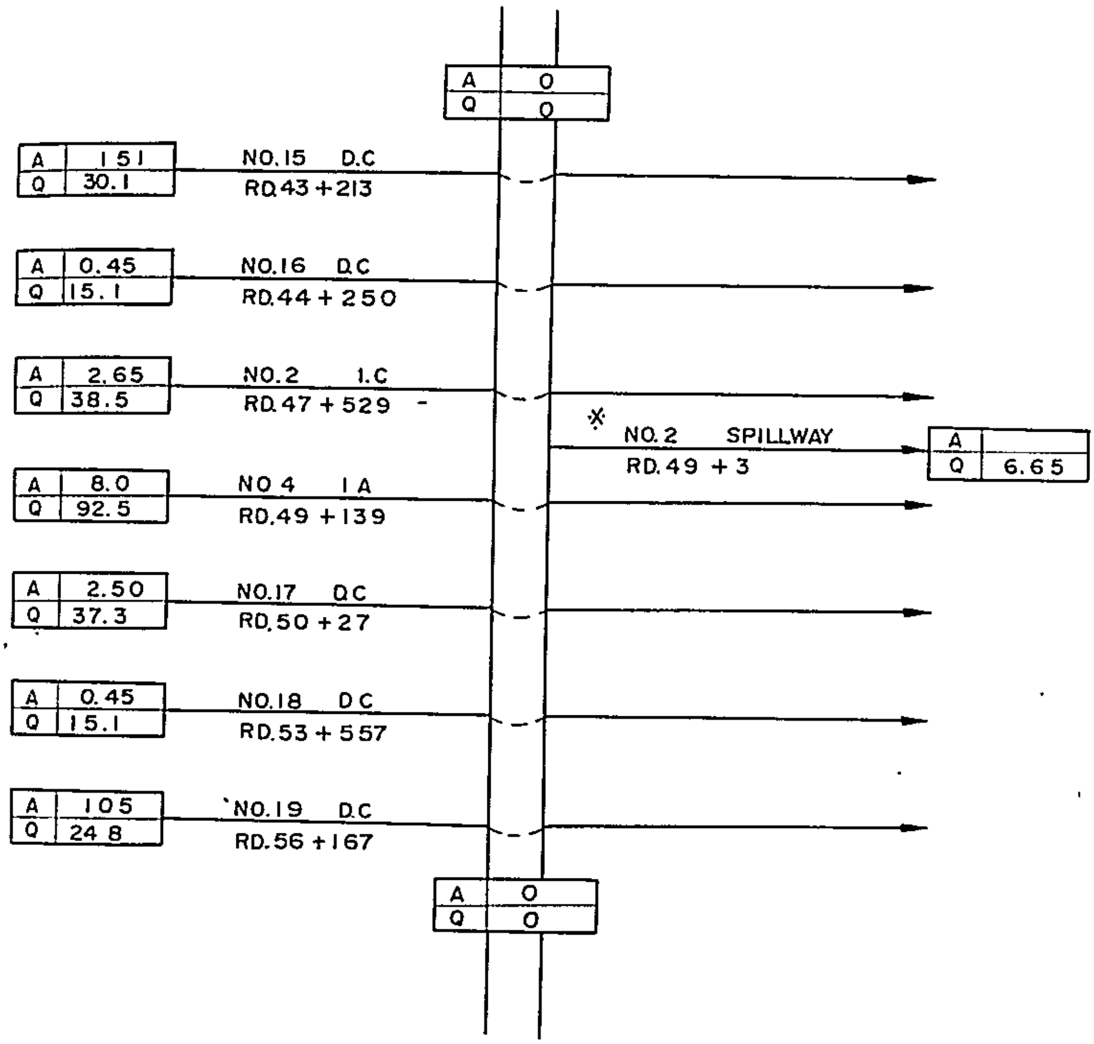
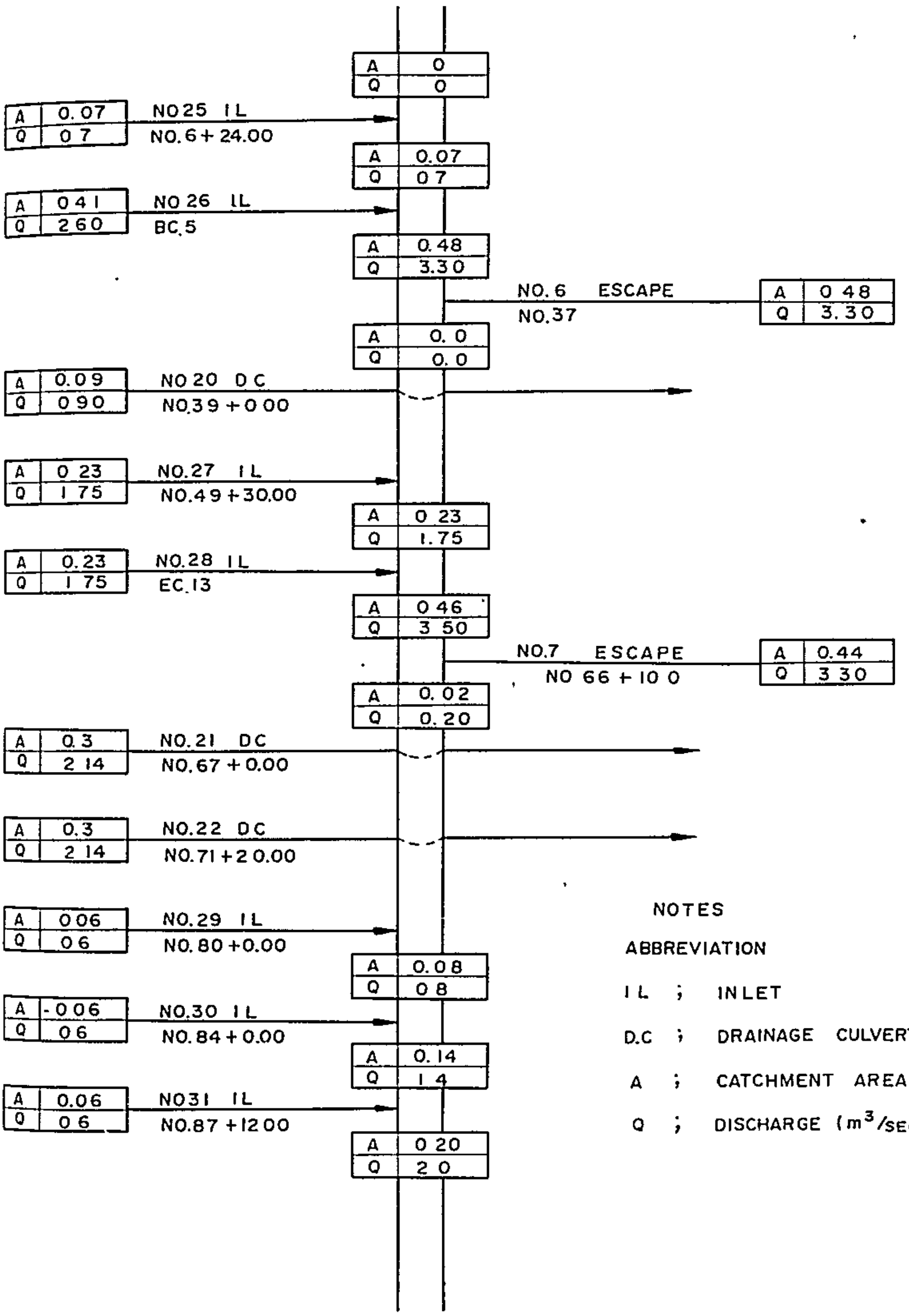

A 0
Q 0
A 151
Q 30.1
NO.15 D.C
RD.43+213
A 0.45
Q 15.1
NO.16 D.C
RD.44+250
A 2.65
Q 38.5
NO.2 I.C
RD.47+529
※ NO.2 SPILLWAY
RD.49 +3
A
Q 6.65
A 8.0
Q 92.5
NO 4 I A
RD.49 +139
A 2.50
Q 37.3
NO.17 D.C
RD.50+27
A 0.45
Q 15.1
NO.18 D C
RD.53+557
A 105
Q 24 8
NO.19 D.C
RD.56+167
A 0
Q 0

FIG. 4-3-6 DIAGRAM OF DRAINAGE SYSTEM, CATHMENT AREA AND DESIGN FLOOD DISCHARGE FOR ROUTE 'C'



NOTES

ABBREVIATION

IL ; INLET

D.C ; DRAINAGE CULVERT

A ; CATCHMENT AREA (Km^2)

Q ; DISCHARGE (m^3/SEC)

4-4. Route 'A'

4-4-1. Canal Routing and Present Condition of Canal

Route 'A' of the Paralkote right main canal, starting from the end of the intake structure of the Paralkote dam site, will run southward diverting some water to Alor Minor, and will reach at the immediate downstream of the outlet structure for Kapsi Minor (coordinate to RD. 24 + 1,026).

The total length of the canal is about 7.6 km. The route 'A' canal has been designed by the Indian authorities concerned and at present about 90% of the open canal construction has been completed.

As for the irrigation structures, one intake, three inverted syphons, three outlets, twenty one inlets, five spillways, two drainage culverts and three bridges have been also constructed by the Indian authorities.

4-4-2. Study on Present Completed Facilities

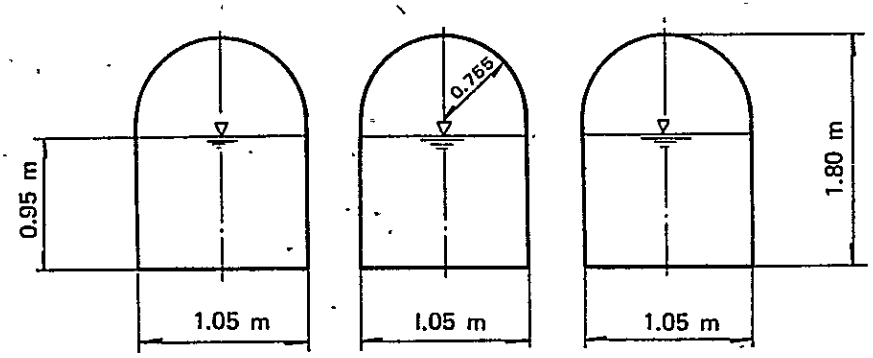
As to the completed facilities mentioned in 4-4-1, capacities for the completed sections are studied and examined hydraulically.

4-4-2-1. Intake

The intake structure of the total construction length of 74.5 m has been built at RD. 0.

Dimensions of the typical cross section of the intake is given in Fig. 4-4-1.

FIG. 4-4-1 CROSS SECTION OF THE INTAKE



Assuming the depth of water to be H = 0.95 m, hydraulic calculations using the Manning formula are as follows.

Flow area (cross sectional area of flow)	$A = 1.05^{m} \times 0.95^{m} \times 3^{sects} = 2.99^{m^2}$
Wetted perimeter	$P = (1.05 + 2 \times 0.95) \times 3 = 8.85^{m}$
Hydraulic radius	$R = A/P = 2.99/8.85 = 0.338^{m}$
Velocity of flow	$V = 1/0.015 \times 0.338^{2/3} \times (1/100)^{2/1} = 3.27^{m/sec}$
Discharge	$Q = A \cdot V = 2.99 \times 3.27 = 9.66^{m^3/sec}$

where a coefficient of roughness for Manning's formula is assumed to be 0.015 for the normal reinforced concrete structures.

The above calculations show that the structure will have a capacity for the designed discharge of 9.63 m^3/sec when the depth of water is 0.95 m. This fact means the structure has sufficient capacity to let the designed discharge flow even when the Paralkote dam shows the droughty water level.

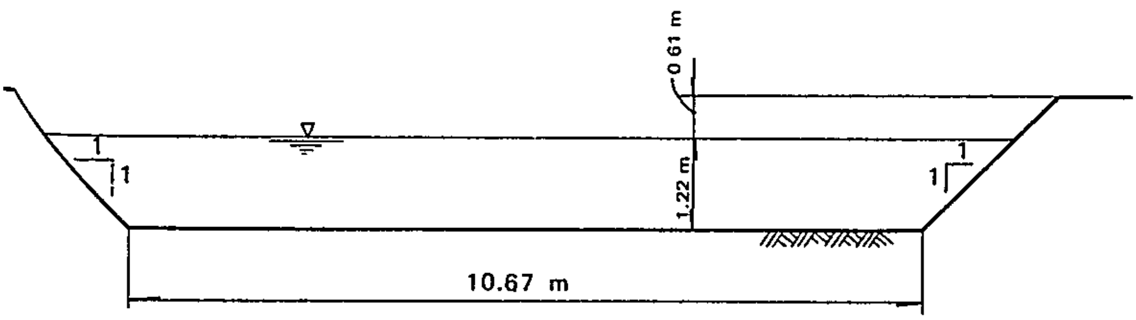
4-4-2-2. Open canal

Open canal has been designed as an earth canal (with no earth lining). The section of 30.0 m long between RD. 0 + 218, where is immediate downstream of the intake, and RD. 0 + 317 is a portion of rock cutting, and the canal has been constructed with the bottom width of 3.00 m and the cut slope of 1 : 0.3.

In the other section of the canal constructed, bottom width varies from 7.00 m to 12.00 m and the longitudinal slope of the canal, which is not constant but varies from place to place, has been observed to be 1/4,850 in average.

The typical cross section of the canal designed by the Indian authorities is shown in Fig. 4-4-2.

FIG. 4-4-2 DESIGN FACTORS OF CROSS SECTION OF THE MAIN CANAL DESIGNED BY INDIAN AUTHORITIES CONCERNED



LONGITUDINAL SLOPE OF THE CANAL	I = 1/5,000
MANNING'S COEFFICIENT OF ROUGHNESS	n = 0.0225
FREEBOARD	Fb = 0.61 m

The designed canal will have a sufficient capacity, but it was noticed that the constructed cross section does not accord with the designed dimension, which may cause problems.

4-4-2-3. Inverted syphon

Inverted syphons are designed using concrete pipes and three syphons have been completed at RD. 4 + 203, RD. 12 + 53 and RD. 19 + 453.

Hydraulic calculations are done and listed below.

No.	Location	Diameter of Pipes	Flow Area	Velocity
1	RD. 4+203	750^{mm} x 1^{set}	0.4416^{m^2}	$21.8^{m/sec}$
2	RD.12+ 53	800 x 1	1.5024	19.2
3	RD.19+453	1,200 x 1	1.1304	8.5

Above calculations show that all syphons will cause a shortage in flow area, because the flow velocities are calculated to be greater than the allowable maximum velocity 3.0 m/sec for concrete pipes, when the designed discharge flow. Consequently all syphons should be examined thoroughly.

4-4-2-4. Outlet

Outlets have been built at RD.12 + 775, RD.15 + 334 and RD.17 + 56 by means of cutting the embankment off.

No facilities for controlling and measuring water have been provided and it is impossible for service roads to cross the outlet structures.

All outlets should be improved from a viewpoint stated above.

4-4-2-5. Inlet

Twenty-one inlets have been already constructed as mentioned in 4-4-1.

These inlets are divided into two types.

Type I For small drainage discharges, the right bank of the main canal is cut off for inlet opening. The stream beds are covered by stone pitching.

Type II For comparatively large drainage discharges, the stream beds are ensured without embanking the right banks of the canal.

For both types of inlets, inflow of sand or gravel and/or erosion of the main canal will possibly be caused. Introduction of drainage discharges into the main canal should be avoided whenever it is allowed topographically and economically.

4-4-2-6. Spillway

Spillways have been constructed at the locations of RD.8 + 600, RD.10, RD.10 + 696, RD.11 + 488, and RD.16 + 1,010.

The structures are of broad crest weir type in cross section and, at the same time, of side weir type in longitudinal section.

All spillways will have shortages in length of the side weirs and weir crest elevations will not be suitable at the present situations. (For some spillways, the weir crest elevation is too low to keep the designed water level normal.)

4-4-2-7. Drainage culvert

Two drainage culverts have been completed in the route 'A'. One is located at RD.13 + 335 with the cross section of $\phi 750^{m} \times 1^{set}$, and another at RD.21 + 167 with the cross section of $\phi 150^{mm} \times 3^{sets}$ for the expected designed drainage discharges of 14.0 m^3/sec.

Flow area of both culverts is not enough for the designed drainage discharge and new culverts are designed other than the reconstruction of existing culverts.

4-4-2-8. Bridge

Bridges located at RD.1 + 856, RD.13 + 788 and RD.19 + 1,001 have been suitably designed and constructed from the viewpoint of flow area and elevation.

4-4-3. Water Conveyance Structures

4-4-3-1. Open canal

Identically to the present completed canal, the open canal is designed as an earth canal without lining.

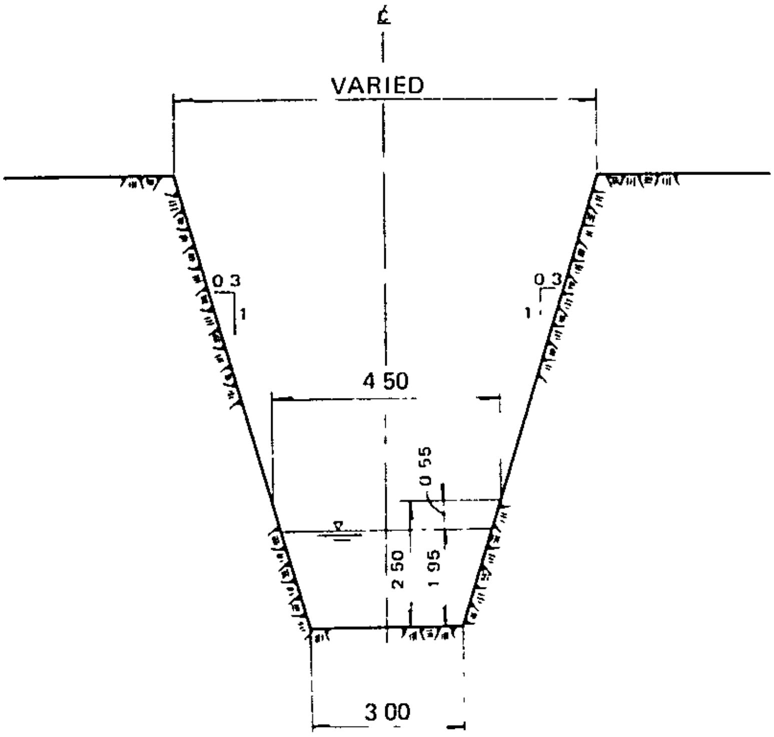
As mentioned in 4-4-2-2, open canal of 30.0 m from RD.0 + 218 to RD.0 + 317 is of rock cutting. In this portion, the canal cross section will be designed similar to the existing condition, because of difficulties to widen the canal section by excavating rock. The bottom width and the longitudinal slope of the canal will be designed to be 3.00 m and 1/1,000 respectively. Transition structures will be provided at the both ends of this portion of the canal to stabilize the flow hydraulically.

For the other portion of the open canal, design is done utilizing the existing canal portion which has been constructed.

Width of the canal bottom is planned to be 10.0 m taking an average bottom width of the existing canal, and the longitudinal slope is designed to be 1/5,000.

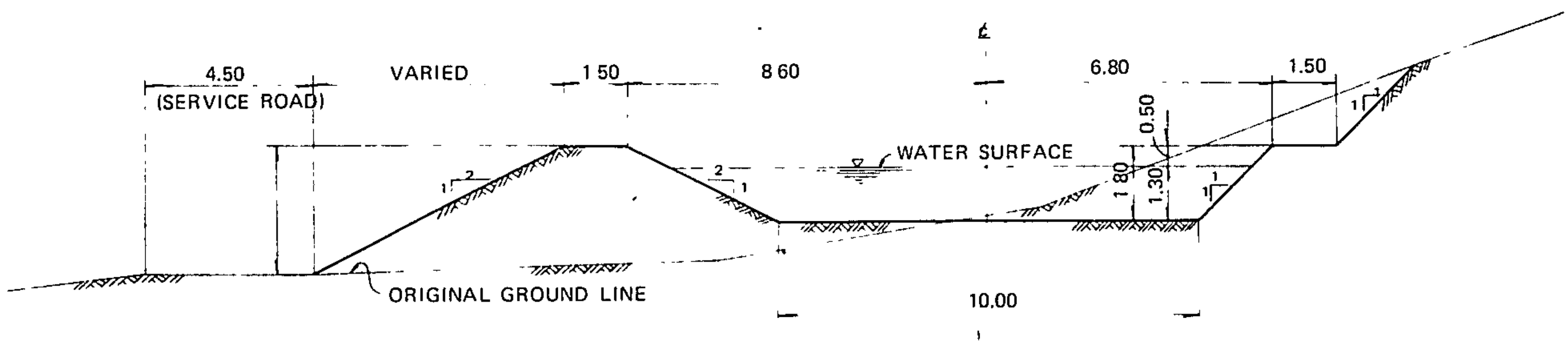
Designed factors of cross sections are listed in Fig. 4-4-3 for the type 'A' canal and in Fig. 4-4-4 for the type 'B' canal.

FIG. 4-4-3 DESIGN FACTORS OF CROSS SECTION OF THE TYPE 'A' MAIN CANAL DESIGNED BY JAPANESE SURVEY TEAM



BOTTOM WIDTH OF THE CANAL	B	3 00^{m}
LONGITUDINAL SLOPE	I	1 1,000
EMBANKMENT SLOPE	S	1 0 3
MANNING'S COEFFICIENT OF ROUGHNESS	n	0 0225
WATER DEPTH	H	1 95^{m}
FLOW AREA	A	6 99$^{m^2}$
WETTED PERIMETER	P	7 08^{m}
HYDRAULIC RADIUS	R	0 987^{m}
VELOCITY	V	1 393 $^{m/sec}$
DISCHARGE	Q	9 74$^{m^3/sec}$ > 9 63$^{m^3/sec}$

FIG. 4-4-4 DESIGN FACTORS OF CROSS SECTION OF THE TYPE 'B' MAIN CANAL
DESIGNED BY JAPANESE SURVEY TEAM



BOTTOM WIDTH OF THE CANAL	B - 10.00^{m}
LONGITUDINAL SLOPE	I = 1 · 5,000
EMBANKMENT SLOPE	S = 1 1
MANNING'S COEFFICIENT OF ROUGHNESS	n = 0.0225
WATER DEPTH	H = $1\ 30^{m}$
FLOW AREA	A - 14.69^{m^2}
WETTED PERIMETER	P - $13\ 68^{m}$
HYDRAULIC RADIUS	R = $1\ 074^{m}$
VELOCITY	V $0.659^{m/sec}$
DISCHARGE	Q = $9\ 68^{m^3/sec} > 9\ 63^{m^3/sec}$

4-4-3-2. Transition

Transition sections are installed for conserving the water head by minimizing the losses in case of high velocity and by recovering as much head as possible in case of low velocity. They are located at inlets, outlets, inverted syphons, and closed conduits as well as at places where the shape of the canal cross section suddenly changes.

The proper length of a transition depends on the relative changes such as shape of section, initial velocity and velocity change; the longer transitions require for the higher velocities and greater velocity changes. In designing transition sections, the shapes and length of transition should be carefully calculated hydraulically and examined.

4-4-3-3. Aqueduct

Aqueducts will be located where the main canal crosses depressions and drainage stream beds. It will be most efficient to design aqueduct structures where;

(1) drainage discharges are great

(2) a valley is too deep to construct an inverted syphon because of the high water pressure

(3) it is impossible to construct a drainage culvert because of too much differences in elevations.

Therefore, among three places where inverted syphons are designed at the present conditions, two places, RD.4 + 144 and RD.11 + 1,000, should be revised to be the aqueduct structures.

From the economical view, the aqueducts are designed not for conveying drainage discharge in the rainy season but only for supplying the irrigation requirement of the area.

Two types of structures are considered as aqueduct;

(1) Aqueduct of a simple beam
Reinforced concrete single or multiple open flume type with wet masonry abutments

(2) Aqueduct of an arch-bridge
Wet masonry arch-shaped bridge type

For one of standard examples of arch-shaped bridge type aqueduct, drawings are made for the RD.4 + 144 aqueduct.

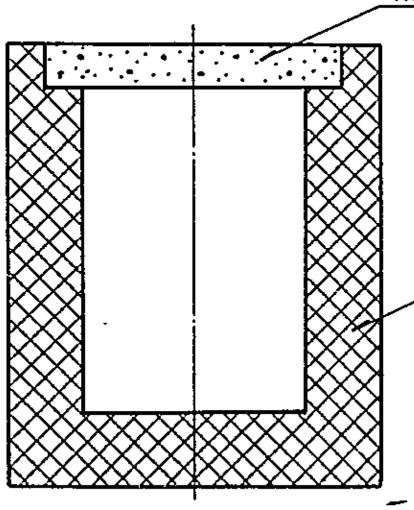
4-4-3-4. Inverted syphon

Among the topographic conditions stated in the section 4-4-3-3, inverted syphons should be designed where the elevation of a stream bed is too high to design a drainage culvert. However, the construction materials are limited, so that syphons should be designed where high water pressure does not work.

In the same way as for aqueducts design factors of cross section are determined basing only on irrigation requirement, and structures are of wet masonry single or multiple conduit type with reinforced concrete top slab.

According to the above mentioned conception, an inverted syphon is built at RD.19 + 443, and a typical cross section of syphon is given on Fig. 4-4-5.

FIG. 4-4-5 TYPICAL CROSS SECTION OF INVERTED SYPHON



4-4-4. Additional Structures

4-4-4-1. Outlet

Outlets are used to divert water from the main canal into branch canals. The water is diverted through hydraulically shaped transition structure and a covered conduit made of wet masonry.

The flow diverted through outlet is controlled by a hand operated sluice gate and is measured by a staff gage installed immediate downstream of the gate.

A covered conduit is designed where a branch canal crosses a road for management and maintenance of the main canal.

In the route 'A' outlets are built according to the diagram of irrigation system shown in Fig. 4-3-1.

For the standard of discharge measurement by using a staff gage, the water depth-discharge curve is made for the outlet for Banda Sangan Branch (RD.44 + 400 in route 'B') and shown in Fig. 4-5-6.

4-4-4-2. Inlet

In the route 'A', inlets are designed where the main canal runs across a drainage stream and drainage discharge in the rainy season is comparatively small (less than the capacity of the main canal). In this case, drainage discharge could be safely introduced into the main canal because irrigation water does not flow into the main canal during the rainy season.

It may also be said to be technically difficult to construct other types of structure such as aqueducts, syphons, or drainage culverts where the bed elevation of the main canal is nearly equal to the bed elevation of a drainage stream.

In those cases, inlet structures should be designed and drainage discharge is received by the main canal.

Drainage discharges to be received by the main canal and the places where inlets are built are shown in Fig. 4-3-4.

Protective structures must be added on the main canal and on the end of drainage stream to protect the structures from erosions caused by turbulence of the flow.

4-4-4-3. Drainage culvert

Drainage culverts are designed where the main canal runs across drainage streams, where drainage discharges are greater than the main canal capacity or where stream beds are located higher than the main canal beds. Drainage culverts are planned by the Indian side to be used at the places RD.13 + 335 and RD.21 + 167, but additional five places, namely, RD.7 + 742, RD.9 + 392, RD.10 + 499, RD.16 + 338 and RD.16 + 844 are found to be suitable for the same structures.

Consequently seven culverts are designed in the route 'A' with discharges shown in Fig.4-3-4.

They are designed as wet masonry single or multiple box conduits with reinforced concrete top slabs.

Masonry pitching is to be placed around both ends of culvert for the purpose of protecting the structure from erosion. Protecting structure of masonry pitching should be designed also on the bed of the main canal where top elevation of the conduit is nearly equal to that of the main canal bottom.

4-4-4-4. Escape

As mentioned before, in case that the main canal runs across a drainage stream or a depression by means of an aqueduct or an inverted syphon, escapes are designed immediate upstream of those crossing structures, so that the security of the structures should be considered by wasting water out of the main canal through escapes.

In the route 'A' the escapes are built at RD.4 + 136 and RD.11 + 990, which are direct upstream of aqueduct, at RD.19 + 433 direct upstream of the inverted syphon, and at RD.24 + 904 direct upstream of the check gate.

They are designed with double stop-log or flash board and operated by

(1) filling the space between the logs or boards by sand or soil during the dry season for the purpose of keeping water up to the designed water level, and at the same time, securing the capacity of the canal for irrigation

(2) taking stop-logs or boards off during the rainy season for the purpose of wasting water out of the main canal without giving no damages to the adjacent structures.

4-4-4-5. Spillway

As stated in 4-4-2-6, five spillways have been already completed at the present conditions.

After careful considerations, no additional spillway is found to be necessary.

4-4-4-6. Bridge

Bridges are designed where the main canal runs across a road.

In the route 'A', four bridges are planned to be designed at the locations of RD.1 + 856, RD.13 + 778, RD.19 + 1,001 and RD.22 + 750. Among those bridges, three bridges located at RD.1 + 856, RD.13 + 788 and RD.19 + 1,001 have already been completed and after careful examinations they are found to have sufficient cross sectional area of flow for designed discharges and found to be suitable as related structures with main canal.

As for RD.22 + 750 bridge, reinforced concrete span is designed to be as short as possible so that the cross sectional area will be the minimum and the velocity is the maximum within the limit of the allowable velocity for the wet masonry. The abutment of the bridge is designed to be wet masonry and superstructure to be reinforced concrete.

In addition to the above design, the wooden bridge is also designed for the same bridge at RD.22 + 750 considering the easiness of obtaining construction materials.

4-5. Route 'B'

4-5-1. Canal Routing and the Present Conditions of Canal

The route 'B' of the Paralkote right main canal, starting at RD.23 + 1,026, will run southward diverting irrigation water into Pitobnondia Minor, Banda-Sangam Branch and Matori Minor and reach at RD.58 + 588 of the Pakhanjore dam site. Total length of the route 'B' main canal is about 10.25 km.

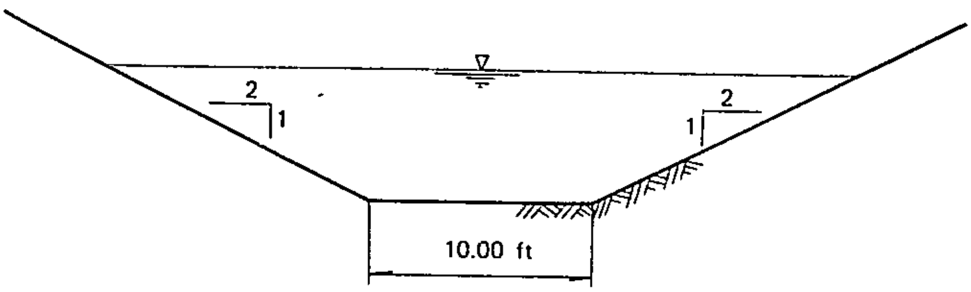
For the route 'B', drawings of longitudinal sections for the main canal have been completed by the Indian authorities and the construction have been proceeding.

In any portions of the main canal, however, no completed cross section has been seen.

As for the irrigation structures (i.e. aqueduct, syphon, culvert, outlet, inlet, etc.), designings have not completed yet up to the present time.

Design factors of the typical cross section of the main canal designed by the Indian authorities are shown in Fig. 4-5-1.

FIG 4-5-1 DESIGN FACTORS OF CROSS SECTION OF THE MAIN CANAL DESIGNED BY INDIAN AUTHORITIES CONCERNED



BOTTOM WIDTH OF THE CANAL	10 0 ft
LONGITUDINAL SLOPE	1/5,000
EMBANKMENT SLOPE	1 2
MANNING'S COEFFICIENT OF ROUGHNESS	0 0225

4-5-2. Conveyance Structures

4-5-2-1. Open canal

Open canal is designed as earth canal (with no earth lining), and the capacity is determined on the basis of the diagram of irrigation system shown in Fig. 4-3-1.

From RD.23 + 1,026 to RD.49 + 41 of the main canal, design factors of the cross section of the canal are determined with reference to the typical cross section designed by the Indian authorities, and called Type 'C' canal.

According to the diagram of irrigation system, 7.63 cu.m/sec of irrigation requirement is to be diverted into Banda-Sangam Branch at RD.44 + 400.

Therefore, it is economical to contract the cross section of the canal at the immediate downstream of the outlet structure at RD.44 + 400.

In case of contracting the cross section of the canal, some structure should be built to waste excess water from the main canal and to avoid any damages to the canal, especially in the event that no water is diverted.

From RD.44 + 400 up to RD.49, on the other hand, ground level is comparatively high and no connective river in which large volume of waste water can be diverted is found.

Type 'C' canal is, therefore, extended up to RD.49 + 41 at which inverted syphon is constructed under Matri Nalla, and waste water is planned to be diverted into Matri Nalla through escape structure constructed direct upstream of the inverted syphon.

In spite of the fact that only 0.569 cu.m/sec of irrigation water is required for the canal after diverting 7.63 cu.m/sec into Banda-Sangam Branch, the canal downstream of RD.49 + 41 is designed to have a capacity of 2.00 cu.m/sec by reason mentioned in 4-6-1-3, and it is named type 'D' canal.

Type 'C' canal

Design factors of cross section is determined after reviewing a typical cross section designed by the Indian authorities shown in 4-4-1. In our design, the canal bottom width is determined to be 3.00 m (i.e. nearly equal to 10 feet), for the metric unit is used in our design. By using 'Direct computation method of normal flow depth', normal flow depth is found to be 1.89 m, adding 0.61 m as a freeboard, the canal height is determined as 1.89 m + 0.61 m = 2.50 m.

For the cross sectional factors determined as above, hydraulic calculations are done and the capacity of the canal is checked as shown in Fig. 4-5-2.

Type 'D' canal

Type 'D' canal is designed as earth canal having a bottom width of 1.00 m, embankment slope of 1 : 2, and the longitudinal slope of 1/5,000, similar to those of type 'C' canal.

Based on the section factors mentioned above, the normal flow depth of 1.23 m is computed using the direct computation method of normal flow depth. Adding 0.47 m as a freeboard, the height of the canal is determined to be 1.70 m. In accordance with the design factors determined above, the capacity of the canal is examined as shown in Fig. 4-5-3.

Direct Computation Method of Normal Flow Depth

Flow area, A, and hydraulic radius, R, of the given section are expressed in the term of the canal bottom width, B, as $A = \alpha B^2$ and $R = \beta B$.

Using the Manning formula, the discharge is given as

$$Q = A \cdot V = A \cdot 1/n\ R^{2/3} \cdot I^{1/2}$$

$$= 1/n \cdot \alpha B^2 \cdot (\beta B)^{2/3} \cdot I^{1/2}$$

$$= 1/n \cdot \alpha \cdot \beta^{2/3} \cdot B^{8/3} \cdot I^{1/2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where Q: discharge in cu.m/sec
n: coefficient of roughness
I: longitudinal slope of the canal

When Q, n, B and I are given, the above equation (1) had better be expressed as

$$\frac{n \cdot Q}{I^{1/2} \cdot B^{8/3}} = \alpha \cdot \beta^{2/3} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Using the term D for normal depth of the canal, flow area A and hydraulic radius R can be expressed for a trapezoidal cross section of the canal as

$A = D(B + ZD)$ and $R = \{D(B + DZ)\}/\{B + 2D\sqrt{1 + Z^2}\}$

where Z denotes the embankment slope of 1 : Z.

Therefore,

$$\alpha = \frac{A}{B^2} = \frac{D(B+Z \cdot D)}{B^2} = \frac{D}{B}(1 + Z\frac{D}{B}) \text{ and}$$

$$\beta = \frac{R}{B} = \frac{D(B+Z \cdot D)}{B(B+2 \cdot D \cdot \sqrt{1+Z^2})} = \frac{D}{B} \cdot \frac{1+Z(D/B)}{1+2(D/B)\sqrt{1+Z^2}}$$

Equation (2) is, therefore, expressed as follows.

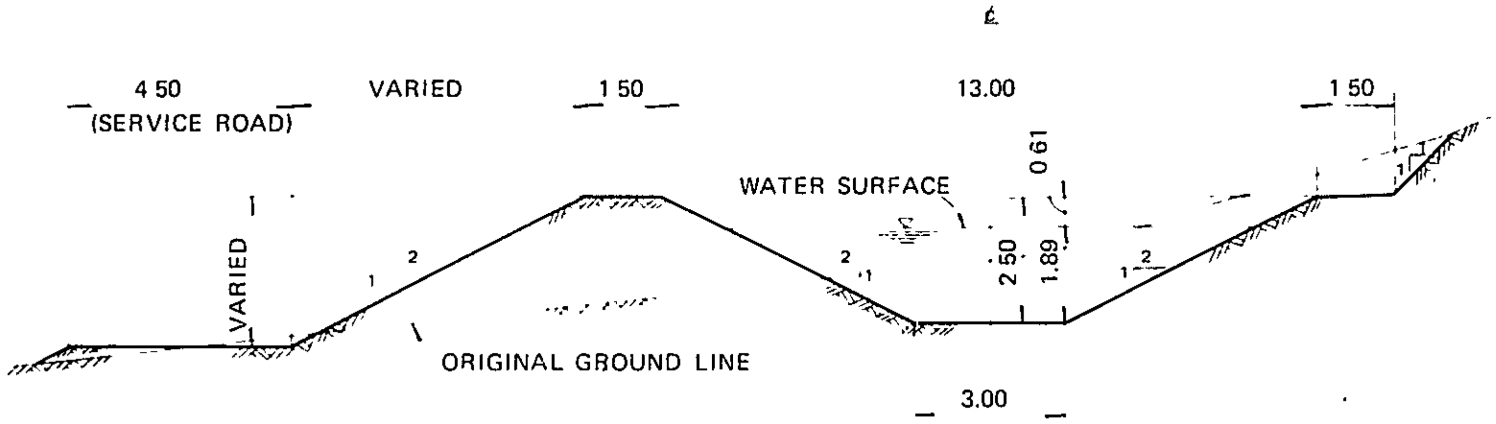
$$\frac{n \cdot Q}{I^{1/2} \cdot B^{8/3}} = (\frac{D}{B})^{5/3} \left[(1+Z \cdot \frac{D}{B})^{5/3}/(1+2 \cdot \frac{D}{B}\sqrt{1+Z^2})^{2/3}\right] \quad \ldots\ldots\ldots \quad (3)$$

In the equation (3), the right hand side of the equation is expressed in the term of D/B where Z is given.

A correlative diagram is therefore made for main values of D/B, and the normal depth for the given section can be computed by using the above diagram.

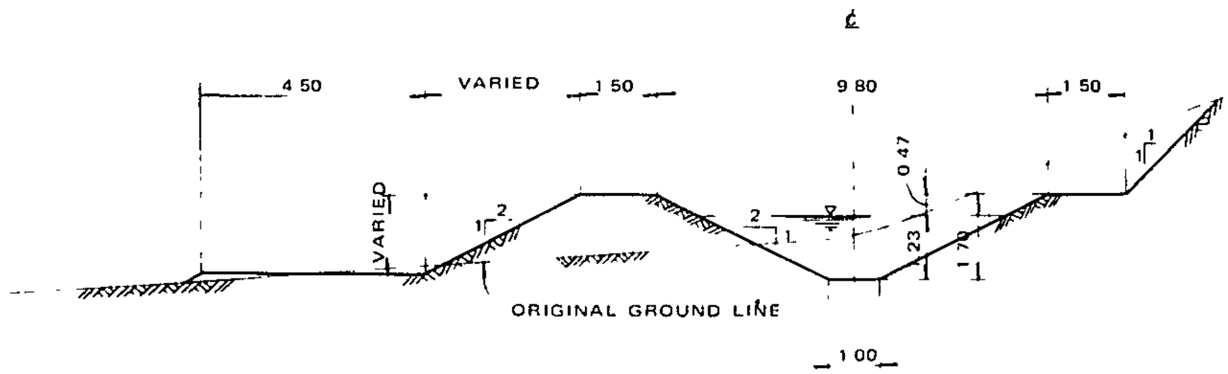
An example of a correlative diagram for a given embankment slope of 1 : 2 is shown in Fig. 4-5-4, and computations are then executed as shown in Fig. 4-5-5.

FIG. 4-5-2 DESIGN FACTORS OF CROSS SECTION OF THE TYPE 'C' MAIN CANAL DESIGNED BY JAPANESE SURVEY TEAM



BOTTOM WIDTH OF THE CANAL	B = 3.00^{m}
LONGITUDINAL SLOPE	I = 1 : 5,000
EMBANKMENT SLOPE	S = 1 2
MANNING'S COEFFICIENT OF ROUGHNESS	n = 0.0225
WATER DEPTH	H = 1.89^{m}
FLOW AREA	A = 12 81$^{m^2}$
WETTED PERIMETER	P 11.46^{m}
HYDRAULIC RADIUS	R 1 118^{m}
VELOCITY	V = 0 677$^{m/sec}$
DISCHARGE	Q = 8.67 $m^3/sec > 8\ 65 m^3/sec$

FIG 4-5-3 DESIGN FACTORS OF CROSS SECTION OF THE TYPE 'D' MAIN CANAL DESIGNED BY JAPANESE SURVEY TEAM



BOTTOM WIDTH OF THE CANAL	B 1 00^{m}
LONGITUDINAL SLOPE	I = 1 : 5,000
EMBANKMENT SLLPE	S = 1 2
MANNING'S COEFFICIENT OF ROUGHNESS	n = 0 0225
WATER DEPTH	H = 1 23^{m}
FLOW AREA	A = 4.26$^{m^2}$
WETTED PERIMETER	P 6 50^{m}
HYDRAULIC RADIUS	R = 0 655^{m}
VELOCITY	V = 0.474$^{m/sec}$
DISCHARGE	Q = 2.02$^{m^3/sec}$ > 2.00$^{m^3/sec}$

FIG. 4-5-4 CORRELATIVE CHART BETWEEN D/B AND $n.Q/I^{1/2} \cdot B^{8/3}$ FOR A GIVEN EMBANKMENT SLOPE OF 1 TO 2

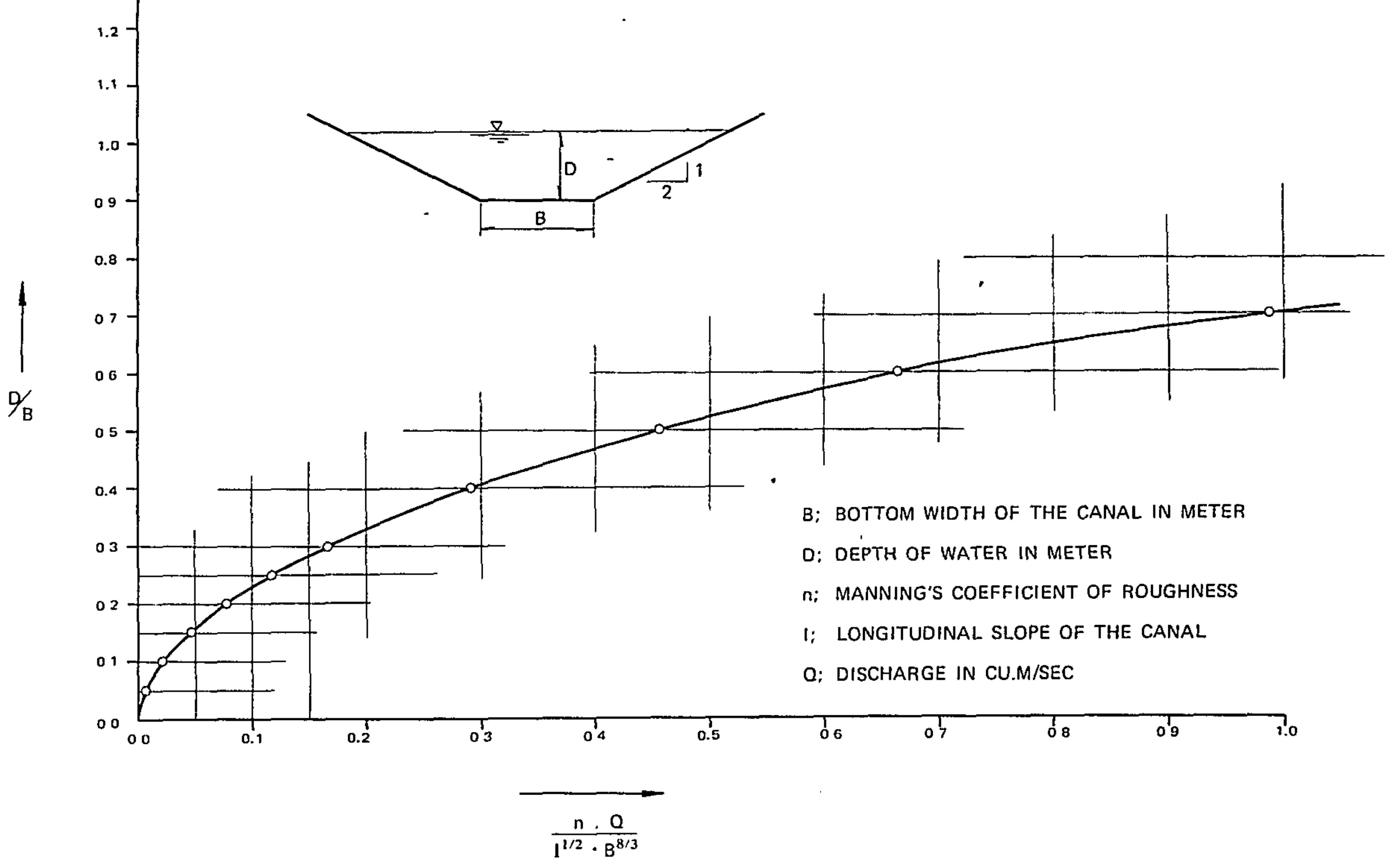
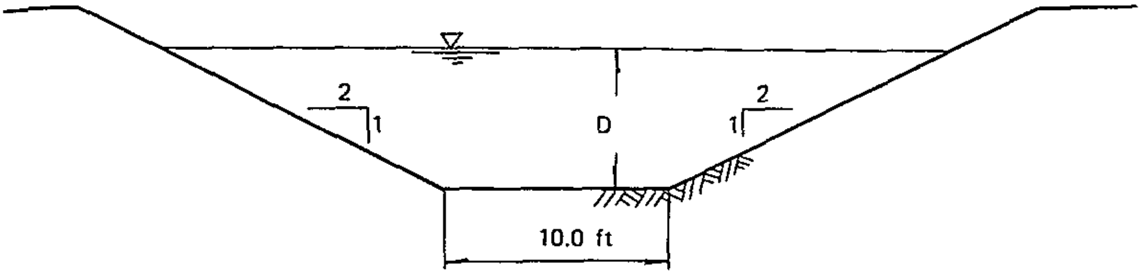


FIG. 4-5-5 AN EXAMPLE OF COMPUTATION OF NORMAL FLOW DEPTH FOR A GIVEN CROSS SECTION



FOR THE TYPE 'C' CANAL OF THE ROUTE 'B' FOLLOWING FACTORS OF CROSS SECTION ARE GIVEN.

BOTTOM WIDTH OF THE CANAL B = 10 0 ft = 3.048 m = 3.00 m

LONGITUDINAL SLOPE I = 1/5,000

MANNING'S COEFFICIENT OF ROUGHNESS n = 0.0225

DISCHARGE = REQUIRED CAPACITY Q = 8.65 CU.M/SEC

THEN,

$$\frac{n \cdot Q}{I^{1/2} \cdot B^{8/3}} = \frac{0.0225 \times 8.65}{(1/5{,}000)^{1/2} \times (3.00)^{8/3}} = 0.735$$

FOR THIS VALUE, CORRELATIVE CHART SHOWN IN FIG. 4-5-4 GIVES D/B = 0.629

FROM THE VALUE OF D/B, THE NORMAL FLOW DEPTH IS GIVEN AS D = 0.629 x B = 0.629 x 3.00 = 1.887 m

4-5-2-2. Aqueduct

An aqueduct is designed at the place where the main canal meets with the topographical conditions mentioned in 4-3-3-3. In the rout 'B' an aqueduct is designed at RD.38 + 474.

Similar as in the route 'A', no drainage discharges should be introduced into the aqueduct, but the capacity is determined only upon the irrigation discharge.

Structures are the same as stated in para. 4-3-3-3 (1).

4-5-2-3. Inverted syphon

An inverted syphon is designed at RD.49 + 57 (Matri Nalla crossing) according to the conditions mentioned in para. 4-4-3-4.

Similar to the aqueduct, drainage discharge should be cut off at immediate upstream of the structure, and the design factors of cross section is determined by irrigation requirement without introducing drainage discharges into main structure.

Inverted syphon is designed in wet masonry structure with reinforced concrete top slab.

When box structures are designed at both end of syphon, the height of the boxed sill is too high from a viewpoint of strength of the material.

On the other hand vertically curved syphon body will be difficult to construct.

In the route 'B' the syphon is therefore designed in straight bended type with transitions at both end of the structure.

4-5-2-4. Irrigation culvert

Irrigation culverts are designed at the places where the main canal runs across roads, drainage stream or depressions and where the designed normal water level is lower than the bed elevations of the objects to cross over.

Considering the above conditions, three irrigation culverts are constructed in the route 'B' at places of RD.47 + 365, RD.45 + 569 and RD.17 + 874.

Irrigation culverts are designed in wet masonry single or multiple box conducts with reinforced concrete top slab.

4-5-3. Additional Structures

4-5-3-1. Outlet

After careful considerations on topographic and divertion conditions, 10 outlets are designed in the route 'B' according to the conditions given in Fig. 4-3-1.

For a standard of discharge measurement by means of a staff gage, water depth-discharge curve is made for the outlet located at the place of RD.44 + 400 (Banda-Sangam Branch), and shown in Fig. 4-5-6.

Structures are the same as stated in 4-3-4-1.

4-5-3-2. Inlet

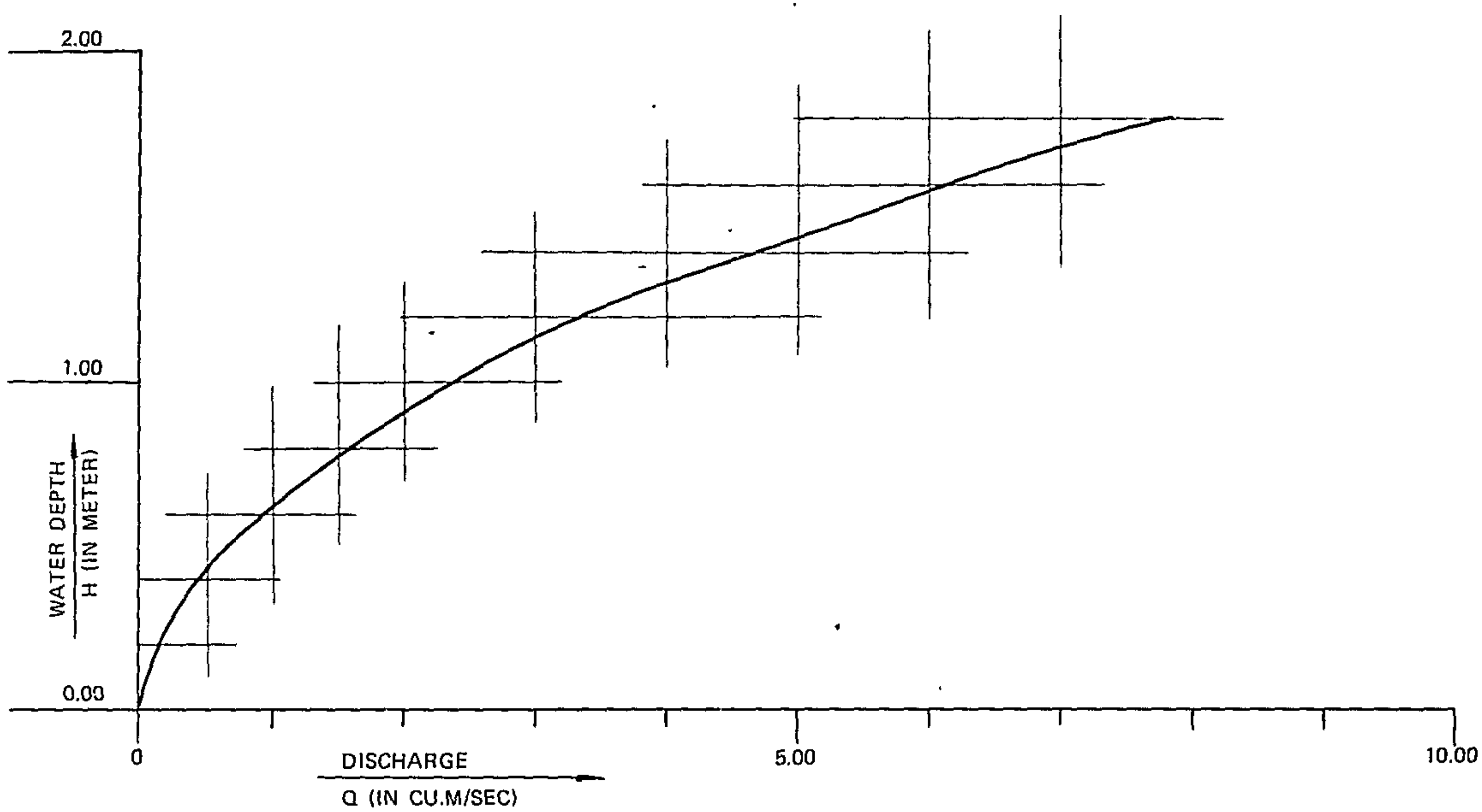
Inlets are designed based on the conceptions mentioned in para. 4-3-3-6. Four inlets are designed at RD.26 + 172, RD.28 + 430 and RD. 32 + 572 according to the conditions shown in the diagram of drainage system, Fig. 4-3-2.

Similar to the case in the route 'A', masonry pitching are to be placed to the main structures to protect structures from erosion.

4-5-3-3. Drainage culvert

Drainage culverts are designed based on the conceptions and structures stated in para. 4-3-4-2, and also on the conditions shown in Fig. 4-3-2.

FIG. 4-5-6 WATER DEPTH-DISCHARGE CURVE FOR BANDA-SANGAN BRANCH



4-5-3-4. Escape

Conseptions and structures are the same as stated in para. 4-3-4-4. In the route 'B' an escape is designed at RD.38 + 446, immediate upstream of the aqueduct, with conditions shown in Fig. 4-3-2.

4-5-3-5. Spillway

Two spillways are designed in the route 'B'. One spillway is designed at RD.49 + 3 for the purpose of wasting water out of the main canal as soon as possible, since the cross section of the canal contracts suddenly at the immediate downstream point of RD.49 + 3. For the same purpose mentioned above, another spillway is designed at RD.32 + 600, since it is topographically required to construct a inlet structure and large volume of the drainage discharge should then flow into the canal.

As seen in the existing spillways of the route 'A' spillways will be designed as broad crest weir type in the cross section and, at the same time, side weir type in the longitudinal section.

4-5-3-6. Bridge

Five bridges are designed in the route 'B' at the places of RD.28 + 678, RD.34 + 850, RD.35 + 850, RD.40 + 600 and RD.54 + 772. In constructing bridges in the project site, construction materials for top slab may be reinforced concrete or wood, so that the designed bridges are of wet masonry abutment with reinforced concrete top slab.

When bridges are constructed by wood, the design should follow to the No.4 wooden bridge, which is located at RD.22 + 750 in the route 'A', and illustrated on the drawing as the typical wooden bridge.

4-6. Route 'C'

4-6-1. Main Canal

4-6-1-1. Canal Alignment

Based upon the concrete AP pile located by the Dandakaranya Development Authority at the point of RD.58+735, the area downstream of the pile was surveyed to determine the alignment of the route'C' of Paralkote right main irrigation canal. On surveying and determination of the canal route, the preliminary plan suggested by Indian Authorities on the basis of balanced contour method has been taken into consideration, but some parts of the paln have been revised in this study.

The selected canal route of about 6 km long starts at RD.58+735 and runs across the Pakhanjore-Kapsi main road at the place near from the beginning point of the route. After that, it runs eastward along the road lead to PV.32, detouring the PV.32 Minor Irrigation Tank, running along the Mixed Farm through PV.25, and finally reaches at a tributary of the Anjori Nalla.

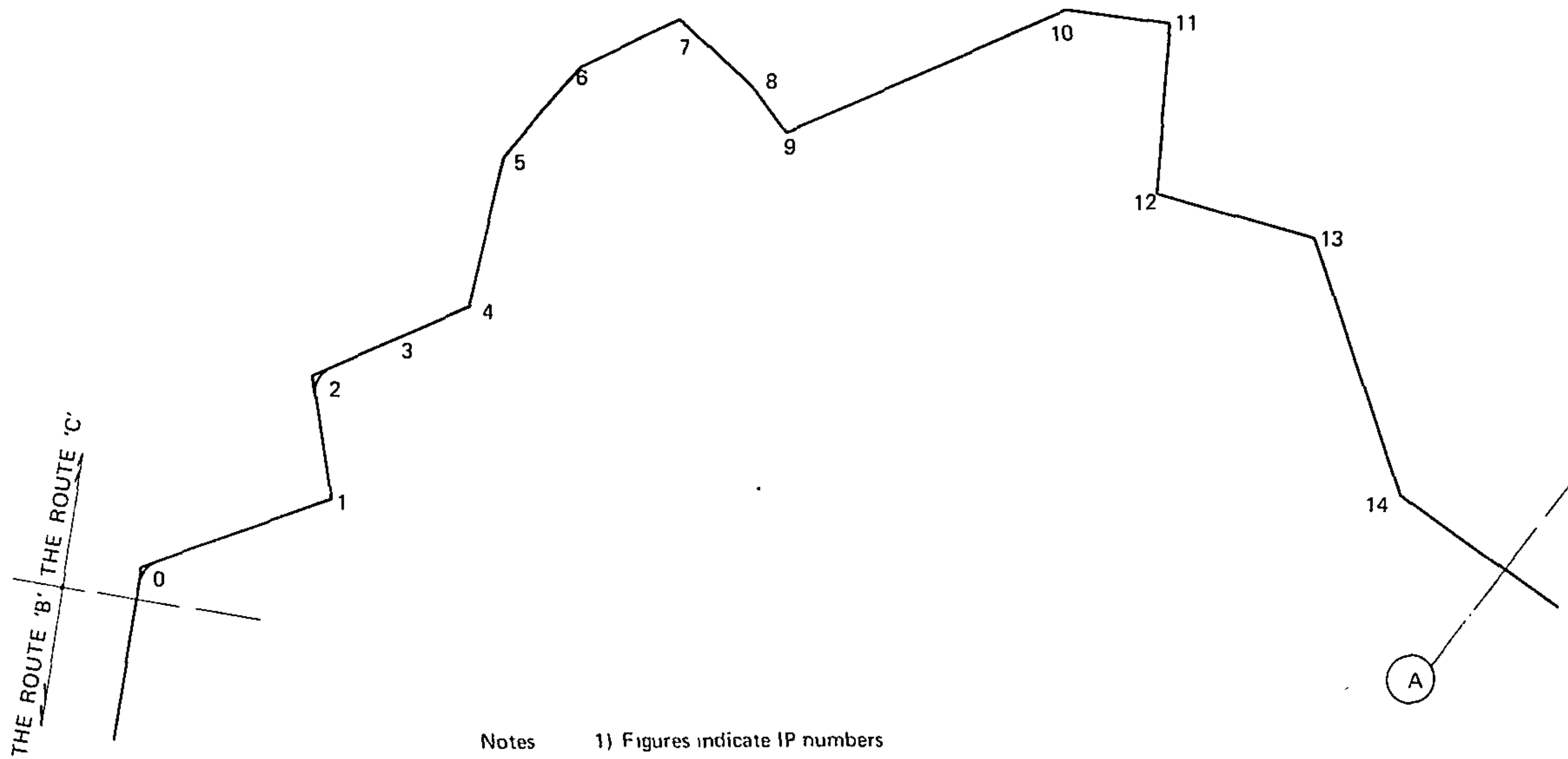
Outline of the route is shown in Fig. 4-6-1.

In the field, piles excluding additional piles and IP piles, are driven in every 40 m, and numbers are given for identifying them from others.

In the corrected sections of the route, however, there are some differences between the stations in the plan and in the site. Nevertheless, construction should be done on the basis of the stations shown in the plan.

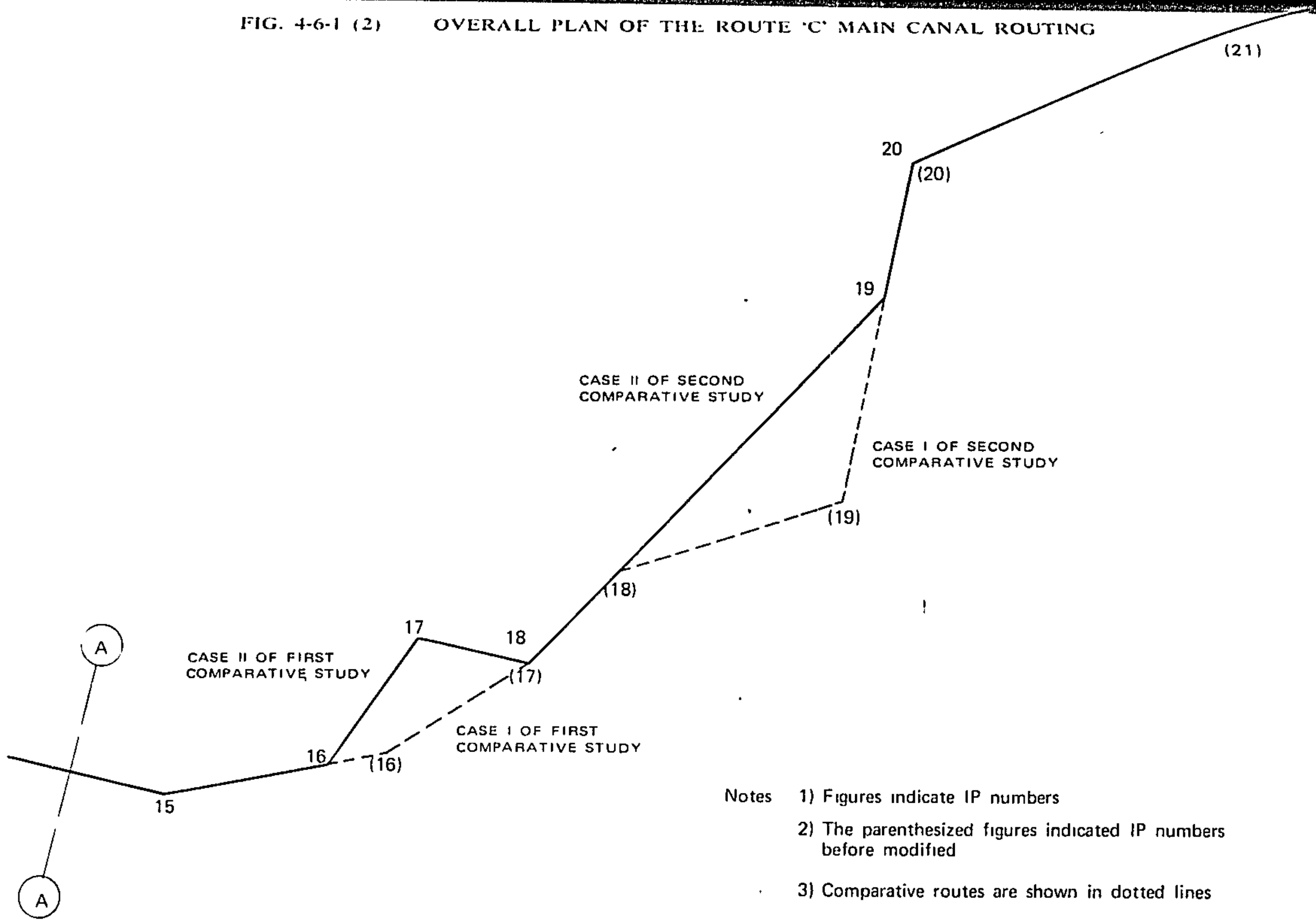
Curves are set on the drawings using the calculation method given in para. 4-6-2-1.

FIG. 4-6-1 (1) OVERALL PLAN OF THE ROUTE 'C' MAIN CANAL ROUTING



Notes 1) Figures indicate IP numbers

FIG. 4-6-1 (2) OVERALL PLAN OF THE ROUTE 'C' MAIN CANAL ROUTING



Notes
1) Figures indicate IP numbers
2) The parenthesized figures indicated IP numbers before modified
3) Comparative routes are shown in dotted lines

TABLE 4-6-1 CALCULATION OF CURVES

STATION NO.	INTERSECTION ANGLE	RADIUS OF CURVE	CURVE LENGTH	TANGENT LENGTH	SECANT LENGTH	NOTES
		m	m	m	m	
BM	61°40'	75.00	80.68	44.77	12.34	
IP.1	80°	"	104.66	62.93	22.91	
2	77°	"	100.70	59.66	20.83	
3	1°20'	400.00	9.28	4.66	0.04	
4	53°30'	75.00	69.99	37.80	8.99	
5	27°30'	"	35.94	18.35	2.21	
6	24°	"	31.37	15.94	1.67	
7	69°	"	90.24	51.55	16.01	
8	11°	"	14.37	7.22	0.35	
9	78°20'	"	102.44	61.09	21.74	
10	31°	"	40.55	20.80	2.83	
11	86°30'	"	113.13	70.56	27.96	
12	78°40'	"	102.91	61.46	21.96	
13	55°40'	"	72.82	39.60	9.81	
14	36°30'	"	47.71	24.73	3.97	
15	24°	"	31.37	15.94	1.67	
16	44°	"	57.56	30.30	5.89	
17	66°40'	"	87.18	49.33	14.76	
18	58°30'	"	76.54	42.00	10.96	
19	32°20'	"	42.30	21.74	3.08	
20	53°50'	"	70.42	38.08	9.11	

4-6-1-2. Comparison study for route determination

In the route'C' of Paralkote right main irrigation canal shown in Fig. 4-6-1, two sections listed below are the subjects of this study.

(1) Between IP.16 and IP.18

Case I Introducing the main canal into PV.32 Minor Irrigation Tank and supplying the tank with water, the tank are used to control the irrigation water.

CaseII The canal detours the tank not introducing water into the tank.

After studying on the above two cases, we came to the following conclusion.

Design water level of the main canal is 330.05 m at the palce of the tank. Water level of the tank, on the other hand, was 331.67 m at the date of the investigation, and the high water level of the tank is estimated to be about 332.85 m by inspecting the trace marked on the tank. This is 1.93 m higher than the design water level of the canal at the beginning point of the route'C'.

It will be impossible to introduce the canal into the tank even if any technichal treatment is adopted. Case I is, therefore, avoided in this design.

(2) Between No.105+20.0 and IP.19

In case I, the canal turns to the right at the place of No.105+20.0 and detours in higher part of the area. In case II, the canal goes straight ahead in lower part.

In both cases, the canal should be excavated, owing to the topographic conditions.

Construction volume is listed below for both cases.

	total length of construction	excavation	embankment	Residual
Case I	746.3 m	45,040 m^3	0 m^3	45,040 m^3
Case II	665.8	23,106	0	23,106

The construction volume will be 80.5 m longer in total construction length and will be 22,000 m^3 more in excavation in case I, comparing with in case II.

On the other hand, it had been considered that the irrigable area would increase about 6.5 ha if case I was chosen.

The area however can not be irrigable when no additional facilities, such as pump, is attached, because all the area is located higher than the designed water level of the canal.

Considering the present conditions, there exists an irrigation tank upstream of this area and some small-scale irrigation ditches have been provided for irrigation of this area, it can be possible to irrigate upstream area of the canal by a suitable operation of the irrigation tank.

For above reasons case II was chosen.

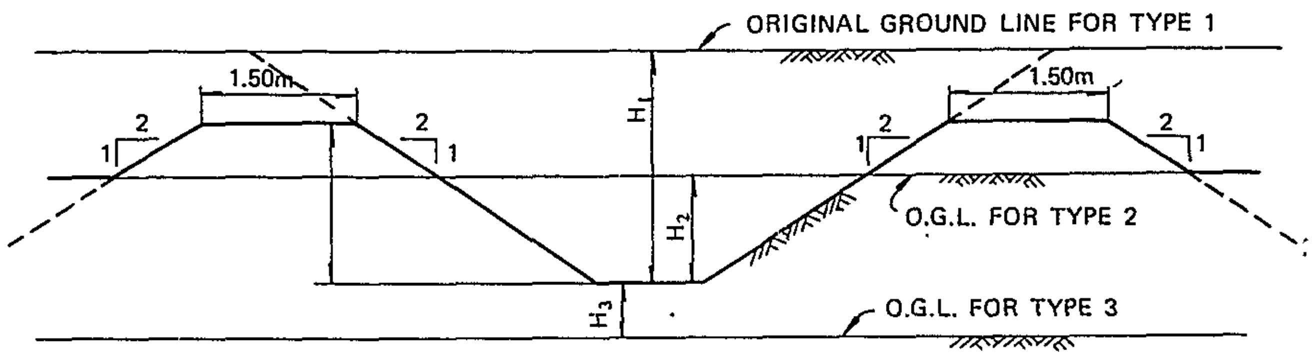
Rough calculations on the volume of earth works for case I and case II are given on Table 4-6-1 and Table 4-6-2, respectively.

4-6-1-3. Determination of the cross section of the main canal

Considering the local conditions as well as soil condition, the canal is designed as earth canal (without lining).

As a general rule, irrigation and drainage canals should be separated by letting drainage discharge flow under or over the main canal.

FIG. 4-6-2 CALCULATION OF EXCAVATION AND EMBANKMENT



Notes

1) For Type 1 (Cutting depth $H \geqq 1.70$ m)
   Excavation = $H_1 + 2H_1^2$
   Embankment = 0

2) For Type 2 ($0 \leqq H < 1.70$)
   Excavation = $H_2 + 2H_2^2$
   Embankment = $2H_2^2 - 8.3H_2 + 5.44$

3) For Type 3 ($H < 0$)
   Excavation = 0
   Embankment = $2H_3^2 + 17.6H_3 + 24.14$

TABLE 4-6-2 CONSTRUCTION VOLUME OF EARTH WORKS FOR [illegible]

STATION	DISTANCE BETWEEN STATIONS	ORIGINAL GROUND LEVEL	CANAL BED ELEVATION	H	TYPE	EXCAVATION			EMBANKMENT		
						SECTION	AVERAGE SECTION	VOLUME	SECTION	AVERAGE SECTION	VOLUME
	M	M	M	M		SQ.M	SQ.M	CU.M	SQ.M	SQ.M	CU.M
IP. 18		335.42	328.50	6.92	1	102.69			0	0	0
No.100	20.00	335.43	328.49	6.94	1	103.27	102.98	2060	0	0	0
101	40.00	335.16	328.48	6.68	1	95.92	99.60	3984	0	0	0
102	"	334.46	328.47	5.99	1	77.75	86.84	3474	0	0	0
103	"	333.92	328.46	5.46	1	65.08	71.42	2857	0	0	0
104	"	333.75	328.45	5.30	1	61.48	63.28	2531	0	0	0
105	"	333.80	328.44	5.40	1	63.72	62.60	2504	0	0	0
106	"	333.83	328.43	5.40	1	63.72	63.72	2549	0	0	0
107	"	333.92	328.42	5.50	1	66.00	64.86	2594	0	0	0
108	"	333.85	328.41	5.44	1	64.63	65.32	2613	0	0	0
109	"	334.58	328.40	6.18	1	82.56	73.60	2944	0	0	0
IP. 19	16.00	334.62	328.40	6.22	1	83.60	83.08	1329	0	0	0
No.110	24.00	334.21	328.39	5.82	1	73.56	78.58	1886	0	0	0
111	40.00	333.38	328.38	5.20	1	59.28	66.42	2657	0	0	0
112	"	331.96	328.37	3.59	1	29.37	44.33	1773	0	0	0
113	"	331.30	328.35	2.94	1	20.23	24.80	992	0	0	0
114	"	331.27	328.35	2.92	1	19.97	20.10	804	0	0	0
115	"	332.27	328.34	3.93	1	34.82	27.40	1096	0	0	0
116	"	332.60	328.33	4.27	1	40.74	37.78	1511	0	0	0
117	"	330.50	328.32	2.18	1	11.68	26.21	1048	0	0	0
118	"	333.54	328.31	5.23	1	59.94	35.81	1432	0	0	0
No.118 +6.28	6.28	333.55	328.31	5.24	1	60.16	60.05	2402	0	0	0
TOTAL	746.28							45,040			

TABLE 4-6-3 CONSTRUCTION VOLUME OF EARTH WORKS FOR CASE II OF THE COMPARATIVE STUDY

STATION	DISTANCE BETWEEN STATIONS	ORIGINAL GROUND LEVEL	CANAL BED ELEVATION	H	TYPE	EXCAVATION			EMBANKMENT		
						SECTION	AVERAGE SECTION	VOLUME	SECTION	AVERAGE SECTION	VOLUME
	M	M	M	M		SQ.M	SQ.M	CU.M	SQ.M	SQ.M	CU.M
No.105 +20.00		335.42	328.50	6.92	1	102.69					
No.106	20.00	335.24	328.49	6.75	1	97.88	100.29	2006	0	0	0
107	40.00	334.85	328.48	6.37	1	87.52	92.70	3708	0	0	0
108	"	334.13	328.47	5.66	1	69.73	78.63	3145	0	0	0
109	"	333.44	328.46	4.98	1	54.58	62.16	2486	0	0	0
110	"	332.59	328.45	4.14	1	38.42	46.50	1860	0	0	0
111	"	331.17	328.44	2.73	1	17.64	28.03	1121	0	0	0
112	"	330.65	328.43	2.22	1	12.08	14.86	594	0	0	0
113	"	330.19	328.42	1.77	1	8.04	10.06	402	0	0	0
114	"	329.91	328.41	1.50	1	6.00	7.02	281	0	0	0
115	"	331.09	328.40	2.69	1	17.16	8.61	344	0	0	0
116	"	331.70	328.39	3.31	1	25.22	21.19	848	0	0	0
117	"	330.88	328.38	2.50	1	15.00	20.11	804	0	0	0
118	"	330.46	328.37	2.09	1	10.83	12.92	517	0	0	0
119	"	331.93	328.36	3.57	1	29.06	19.95	798	0	0	0
120	"	332.60	328.35	4.25	1	40.38	34.72	1389	0	0	0
121	"	330.50	328.34	2.16	1	11.49	25.94	1038	0	0	0
122	"	333.54	328.33	5.21	1	59.50	35.50	1420	0	0	0
No.122 +5.78	5.78	333.55	328.33	5.22	1	59.72	59.61	345	0	0	0
TOTAL	665.78							23,106			

In the case where the drainage discharge is comperatively small, however, the canals are some times designed so that drainage discharges are introduced into the main canal through inlet structures.

In the main canal of the route 'C', though the discharge based on the irrigation requirements is calculated as 0.569 m^3/sec as stated before, the canal is designed to have a capacity of 2.00 m^3/sec so that the irrigation discharge could be easily increased as the irrigation water supplying system be completed in future.

In this route, using a free board, discharge of upto 3.30 m^3/sec can be introduced into the canal in the event of flood.

For the discharge exceeding 3.30 cu.m/sec, the excess water is wasted out of the canal safely through escapes or spillways.

4-6-2. Conveyance structure

4-6-2-1. Open canal

Open canal is designed as earth canal with a capacity of 2.00 m^3/sec as stated in para. 4-5-1-3.

In the route 'C' over 1/5,000 of longitudinal slope of the canal can hardly be taken in hydraulic calculations, because topographically, this district has a very gentle slope.

As for the embankment slope, 1/2 slope is taken in order to protect embankment from sliding, washing or erosion.

In the event excavation exceeds 3.0 m in depth, a berm with 1.0 m width should be constructed to secure the stability of the slope.

The design factors of cross section and hydraulic calculations are similar to those of the type 'D' canal given in para. 4-5-2-1.

Curves are set using the following method, and when construction is executed construction piles are driven in the project site according to the calculations.

Curve setting

Curves are set using equations given in Fig. 4-6-4. In the event of construction in the project site

(1) The tangent deflection angle, σ, is calculated using Eq.(8), where ℓ denotes distance between piles shown on drawings.

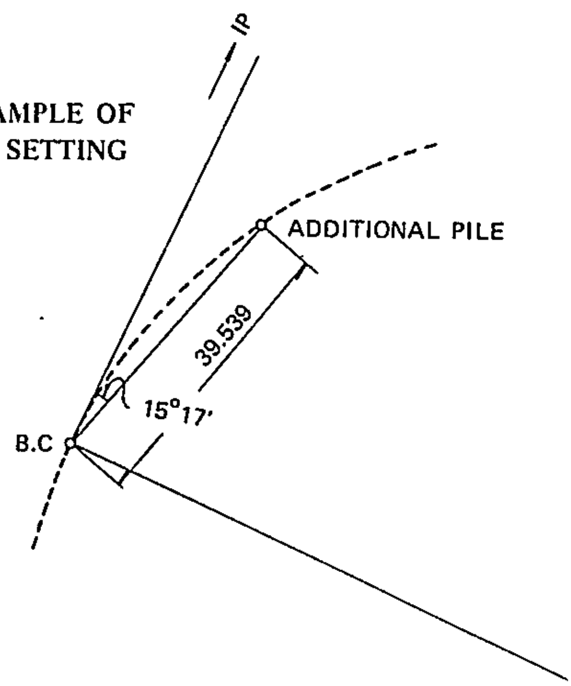
(2) Using Eq.(7), the straight converted distance of ℓ is calculated.

(3) Taking the above distance, y, on the tangent deflection angle, an additional pile is driven.

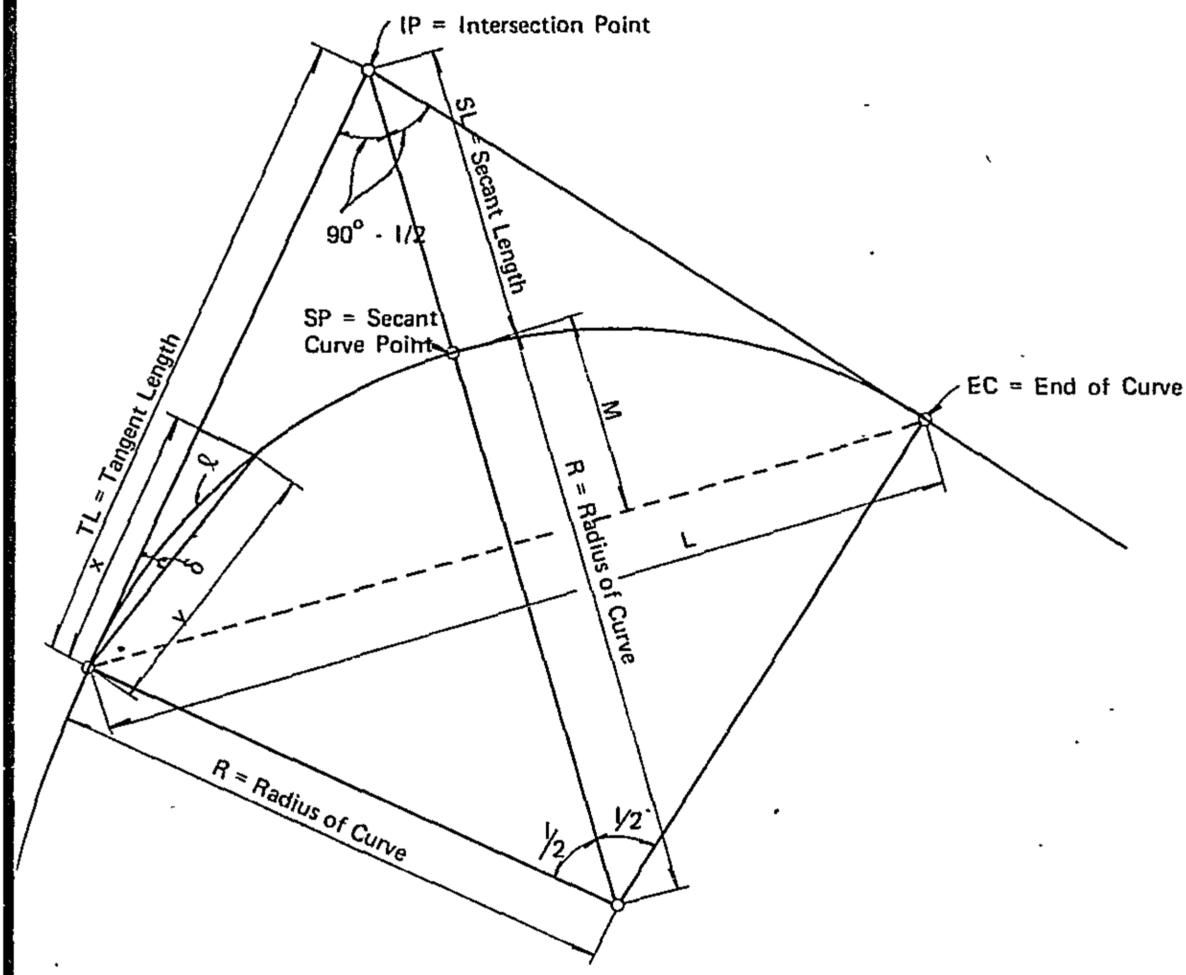
(4) The same procedures are repeated until all additional piles are driven.

For example, when R and ℓ are given as 75.00 m and 40.00 m, respectively, the procedure is given in Fig. 4-6-3.

FIG. 4-6-3- AN EXAMPLE OF CURVE SETTING



FIB. 4-6-4 CALCULATION OF CURVE



$TL = R \cdot \tan I/2$ (m)	....	Eq. (1)
$SL = R (\sec I/2 - 1)$ (m)	....	Eq. (2)
$CL = 0.01745\ RI$ (m)	....	Eq. (3)
$M = R (1 - \cos I/2)$ (m)	....	Eq. (4)
$x = R \sin 2\delta$ (m)	....	Eq. (5)
$d = R (1 - \cos 2\delta) = R - \sqrt{R^2 - x^2}$ (m)	....	Eq. (6)
$y = \frac{R (1 - \cos 2\delta)}{\sin \delta} = \frac{R \sin 2\delta}{\cos \delta}$ (m)	....	Eq. (7)
$\delta = 1{,}719 \times \ell / R$ (minites)	....	Eq (8)
$L = 2R \cdot \sin I/2$	....	Eq. (9)

4-6-2-2. Irrigation culvert

Irrigation culverts are designed where the main canal runs across roads, other canals, drainage streams or depressions and the designed water level of the main canal is situated lower than the bed elevation of these crossing matters.

According to the above conception eight culverts are built in the route 'C' at places of No.3 + 3.50, No.25 + 3.50, No.53 + 25.0, No.93 + 30.0, No.113 + 15.0, No.121 + 15.0, No.133 + 20.0 and No.138 + 30.0.

Among these culverts, four culverts located at No.3 + 3.50, No.25 + 3.50, No.53 + 25.0 and No.113 + 15.0 are designed so that the main canal runs under roads because of the fact that 5 to 6 m excavations will be needed and a span will be so long and it is difficult to construct from a viewpoint of construction materials, when bridges are used.

No.93 + 30.0 culvert is designed where the main canal detours PV.32 Minor Irrigation Tank and No.131 + 15.0 culvert is designed where the main canal runs across PV.25. For both cases, the canal goes across a village situated in high elevation, where many roads and irrigation canals are running complicated, and so they are effective when they are designed as the continuous culverts from viewpoints of both economy and structure.

No.113 + 15.0 culvert is designed where the main canal goes across a shallow depression. It is designed as a culvert for the purpose of taking standing water out during the rainy season from the area.

All irrigation culverts are designed as single 2.0 m x 2.0 m conduits of wet masonry with reinforced concrete top slab.

4-6-2-3. Aqueduct

An aqueduct is designed at No.88 + 35.0 choosing the place where the main canal goes across a drainage stream of comparatively deep valley.

This drainage stream is connected with the spillway of PV.32 Minor irrigation tank and the waste water of the tank flows through this point.

Drainage culvert instead of aqueduct, will be dangerous in structure when unexpected flood is presumed during the monsoon season.

On the other hand, related with the location of the tank, the main canal cannot help curving at this point under consideration, inverted syphon will be difficult to construct.

For the reasons mentioned above, aqueduct with horizontal axis deflections should be used. There would be no problem if so designed from structural, hydraulic and construction point of view, since the deflection angle is small and radius of the curve are comparatively large.

Aqueduct is, similar to that in the route 'A' and route 'B', designed as wet masonry structure with reinforced concrete open flume.

4-6-2-4. Inverted syphon

Inverted syphon is designed where the main canal runs across drainage stream of comparatively shallow and wide valley, and where it is impossible to take the bed width of the stream wide enough to let the flood discharge flow downstream, when an aqueduct is used.

In the route 'B', an inverted syphon is designed at No.120 + 15.0.

As shown in Fig. 4-4-5, syphon is designed as wet masonry single conduit type with reinforced concrete top slab, and using a box structure at both ends of the syphon, the body of the syphon is designed to be straight having no gradient longitudinally.

4-6-3. Additional Structures

4-6-3-1. Outlet and structure used both as outlet and escape

In the route 'C' of Paralkote right main canal, for the purpose of reducing the number of structures as few as possible, as stated in para. 4-6-3-1, by means of introducing as much drainage discharge as possible into the main canal using a free board, structures used both as outlets and escapes are designed under the conditions given in Fig. 4-3-1 and 4-3-4.

They are used as outlet by diverting irrigation requirements into branch canals during the dry season and as escape by taking a part of, or all of waste water out of the main canal through gates during the rainy season.

In the route 'C', two structures located at No.37 and No.66 + 10.0 are used both as outlet and escape, in these cases, however, spillway should be constructed at the downstream of the branch canal where suitable connected drainage stream or canal is found through which waste water is diverted.

A structure placed at No.113, from which water is diverted to Mixed Farm Tank, is used only as an outlet. This is also designed under conditions shown in Fig. 4-3-1, and the structure is similar to that as mentioned in para. 4-4-3-5.

4-6-3-2. Inlet

Inlets are designed where the main canal runs across drainage stream and drainage discharge is comparatively small. In the route 'C' of Paralkote right main canal, original ground level is high overall and a proportion of excavation length in whole canal route is found to be great.

Furthermore the total length of the sections of open canal is occupying about 76% of the route 'C' main canal and inflow of drainage discharge into the main canal is assumed to be great.

In general, existing canals or drainage streams are planned to flow across the main canal through crossing structures, but inlets are used and drainage discharge is introduced into the canal where the catchment area or drainage discharge is comparatively small and the bed elevation of the stream is situated nearly equal to the bed elevation of the canal.

Inlets are designed under conditions given in Fig. 4-3-2, with protective structure of masonry pitching on both beds of the canal and stream in order to protect them from erosion caused by inflow discharge.

4-6-3-3. Drainage culvert

In the route 'C', three drainage culverts are designed at places No.39, No.67 and No.71 + 20.0 considering the topographic conditions mentioned in para. 4-4-3-7.

An inverted syphon will be effective as a structure used at No.39 of these three places allowing drainage stream run over the structure, but at this place the canal is curving and the syphon will be difficult to be constructed, and so, the main canal is designed as open canal by embanking the upper part of the culvert through which drainage discharge flows.

Drainage culverts are designed as single or multiple box conduit of wet masonry with reinforced concrete top slab.

4-7. Plan of Construction Works

The followings show the construction schedule and the points on implementation of construction for the important structures in the main construction works.

4-7-1. General

1. Construction shall be implemented in the dry season. In that case, it is considered that most of rivers and streams except the Taras Nalla will be running dry.

2. Since there is little rainfall in the dry season, a coffer dam and temporary drainage facilities shall not be provided for the construction works. Even if drainage is required, buckets shall be available for bailing out the water, because required drainage is considered very little.

3. All earth works shall be carried out by manpower.

4. Principally concrete works shall be performed using a concrete mixer with a capacity of about 0.1 cu.m.

5. In the earth works, side slope of excavation shall be determined according to conditions and characters of soils. The slope, however, shall be as steep as possible within a safety range against the collapse or other damage to the slope.

6. For the section of embankment canal, the residual earth from the section of excavation canals shall be transported longitudinally and utilized as the earth material for embankment, excepting the case that transport distance of the earth is so long that it is more economical to utilize the earth material excavated from the area near the canal.

4-7-2. Aqueduct

1. Implementation of construction shall be started from excavation of the abutment and pier foundation. After completion of the said excavation, wet masonry work for abutment and pier shall be followed.

2. Since the excavation for the foundation of the pier will be very deep, the rain will be stored and the side slope of the excavation will be collapsed. Therefore, the excavation shall be carried out as soon as possible not allowing the water storing.

3. Earth backfilling for the backside of abutment shall be executed carefully so that backfill earth will not subside. Compaction by means of manpower or water spraying shall be carried out to protect the backfill earth from subsiding. In case that sufficient compaction of the backfill earth is proved impossible, natural compaction may be permitted and construction of a transition canal shall be postponed until the next dry season comes.

4. A part of transition canal of about 1 m width shall be compacted thoroughly to avoid piping and leakage of water from the earth canal through the transition canal.

5. Since the design is made in providing a water-stop to an expansion joint for the protection of the water leakage, handling of the water-stop and asphalt filling to the joint shall be carried out carefully. In case asphalt is not available, a wooden board may be used instead of asphalt.

6. Reinforced concrete for the aqueducts shall be completely compacted watertight using equipments such as vibrator, etc. In case that vibrators are not available or out of order, the slump of reinforced concrete shall be increased without changing the water-cement ratio and the concrete shall be compacted with bamboo sticks sufficiently.

7. Wet masonry facing the flow of the canal shall be constructed after the backfill earth is completely settled so that ununiform settlement of the earth will not occur.

4-7-3. Culvert

1. For construction of the invert and walls shall be progressed from upstream side.

2. Form work and reinforcement for the top slab shall be commenced after the wet masonry of invert and walls has been sufficiently cured.

3. Concrete shall be placed according to the specification.

4. Earth backfilling of side walls shall be commenced after the wet masonry has been sufficiently cured. The backfilling shall be progressed balancing the earth load simultaneously on both sides of culvert.

5. Earth shall be backfilled on the top slab of the culvert after the concrete has been completely cured.

6. Backfill earth on the portions 1 m from the both ends of the culvert shall be so tamped that seepage will be prevented.

4-7-4. Syphon

1. Contraction joint shall be constructed as shown in the drawing to prevent water leakage owing to the internal water pressure.

2. Water-stop shall be installed exactly at the proper places as shown in the drawing.

4-7-5. Other structures

1. Every part of the structures shall be constructed in detail as indicated in the previous paragraphs.

2. Gate shall be of steel or wood according to the local conditions. Metal channels to receive the gate shall be installed at the same time when reinforced concrete is placed.
In case no metal channels can be obtained, concrete shall be formed in channel shape to receive the gate.

4-7-6. Basis of Calculation for Construction Schedule

1. Earth Work (per 1 set)

(1) Excavation (Man Power)

0.25 cu.m/hr/person

0.25 cu.m x 5 person = 1.25 cu.m/hr

1.25 cu.m x 8 hr = 10.0 cu.m/day

(2) Short Distance Transportation

0.01 cu.m/cycle/person (weight about 20 kg)

where it takes 6 minutes for one cycle,

0.01 cu.m x 10 cycle = 0.1 cu.m/hr/person

0.1 cu.m x 13 person = 1.3 cu.m/hr > 1.25 cu.m/hr

2. Concrete Work (per 1 set)

(1) Short Distance Transportation (Man Power)

0.005 cu.m/cycle/person (weight about 13 kg)

where it takes 10 minutes for one cycle,

0.005 cu.m x 6 cycle = 0.03 cu.m/hr/person

0.03 cu.m x 40 person = 1.2 cu.m/hr (240 cycles)

Loading 2 time/min x 2 place = 4 time/min

4 time/min x 60 min = 240 time

(2) Concrete Mixing (with Mixer of about 0.11 cu.m)

5 min/batch

0.11 cu.m x 60/5 = 1.3 cu.m/hr > 1.2 cu.m/hr

3. Labor Required for Concrete Placing

(1) Weighing and Short Distance Transportation of Materials

	persons	
Cement	4	
Sand	4	
Gravel	8	
Water	10	(Varies according to job site conditions)
Sub-Total	26	

(2) Mixing

Concrete Mixer	2 persons

(3) Short Distance Transportation and Loading

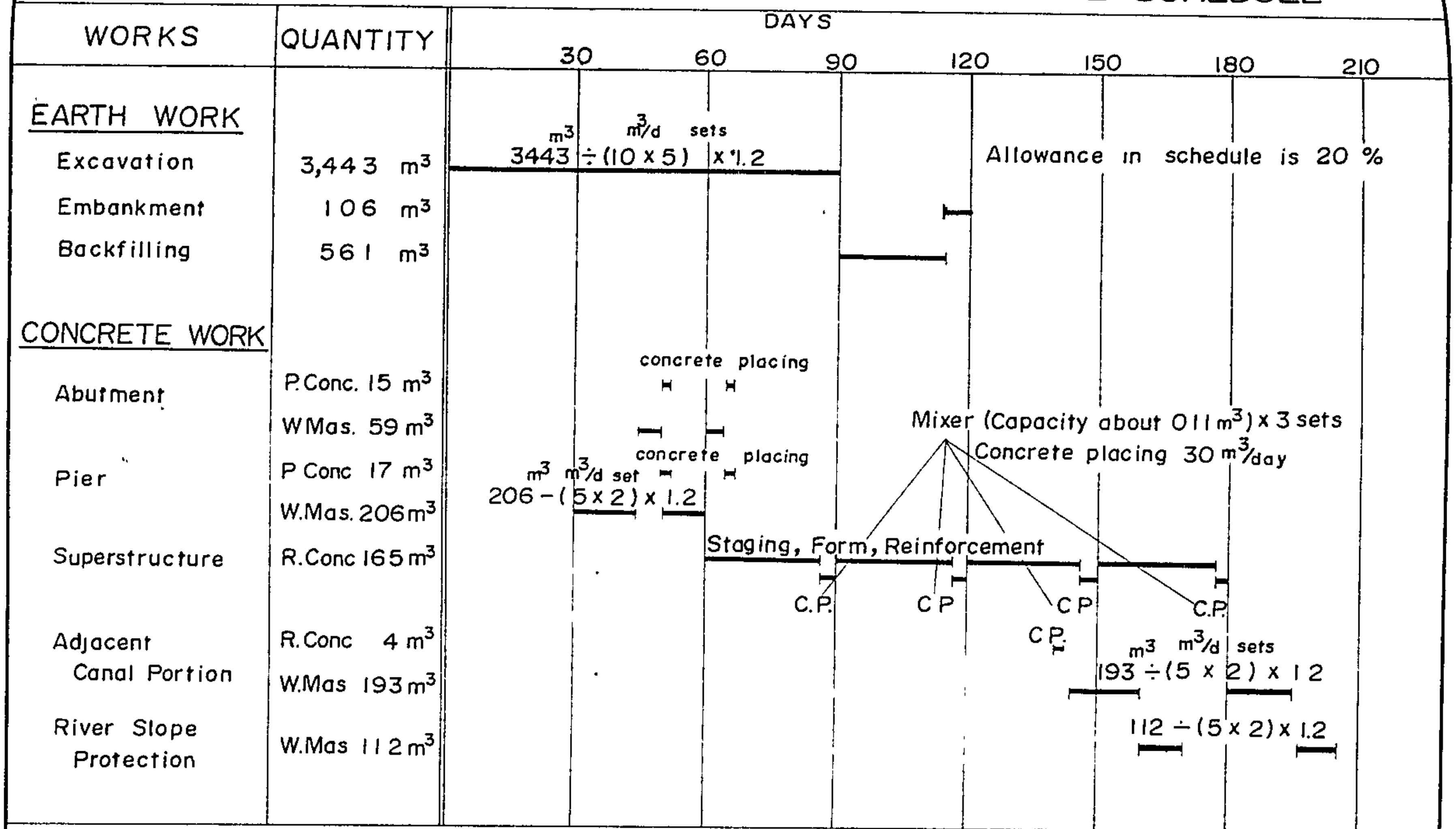
Loading	2 persons
Transportation	40 persons

(4) Planning and Compaction

Placing and Compaction	10 persons

Total required number of labor for Concrete Work	80 persons

FIG. 4-7-1 IRRIGATION AQUEDUCT (No. 1) CONSTRUCTION TIME SCHEDULE



Abbreviation ;

P.Conc.; Plain Concrete, R.Conc.; Reinforced Concrete, W.Mas.; Wet Masonr, C.P.; Concrete Placing

FIG. 4-7-2 IRRIGATION SYPHON (No.1) CONSTRUCTION TIME SCHEDULE

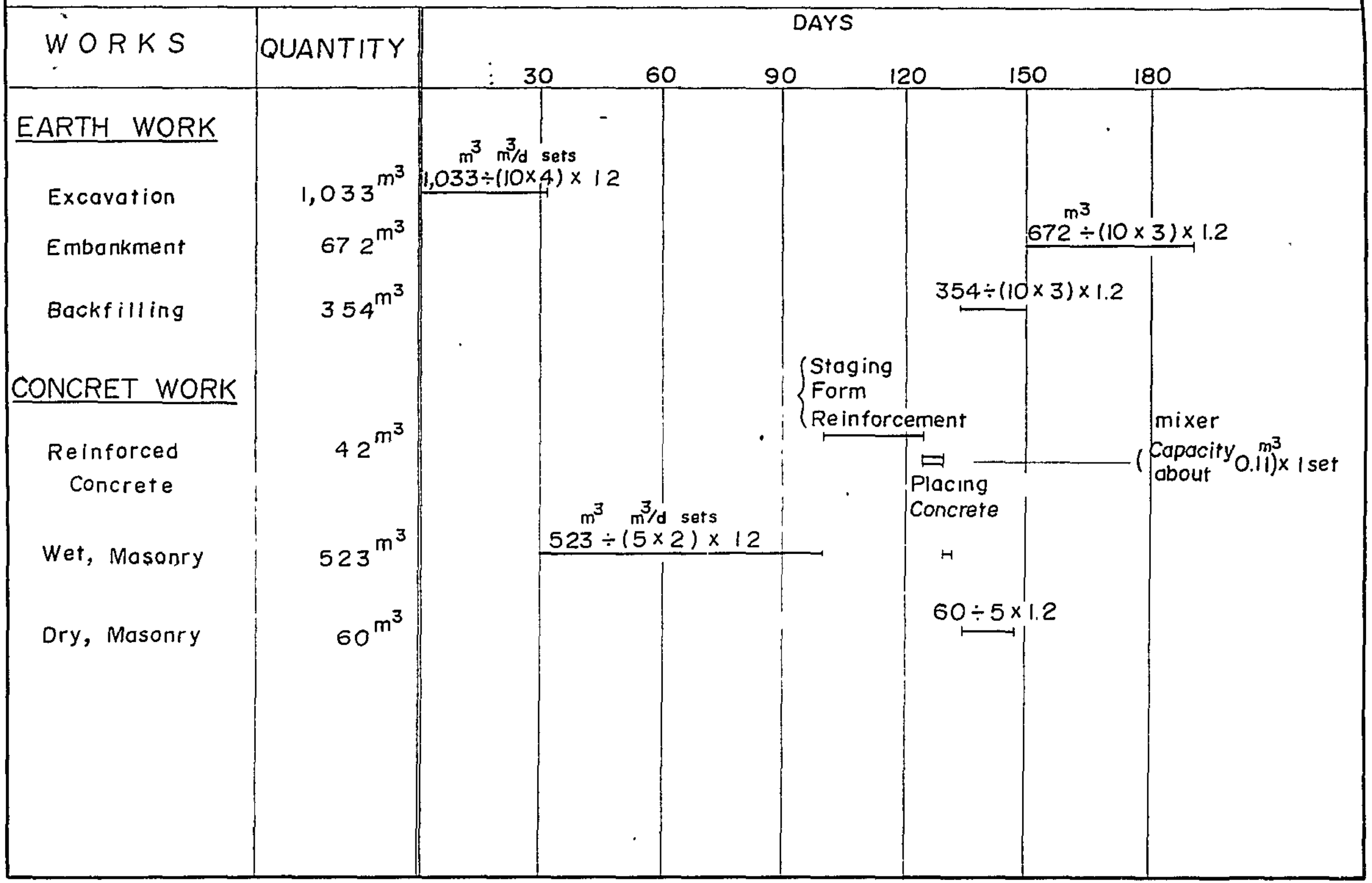


FIG. 4-7-3 IRRIGATION CULVERT (No. 2) CONSTRUCTION TIME SCHEDULE

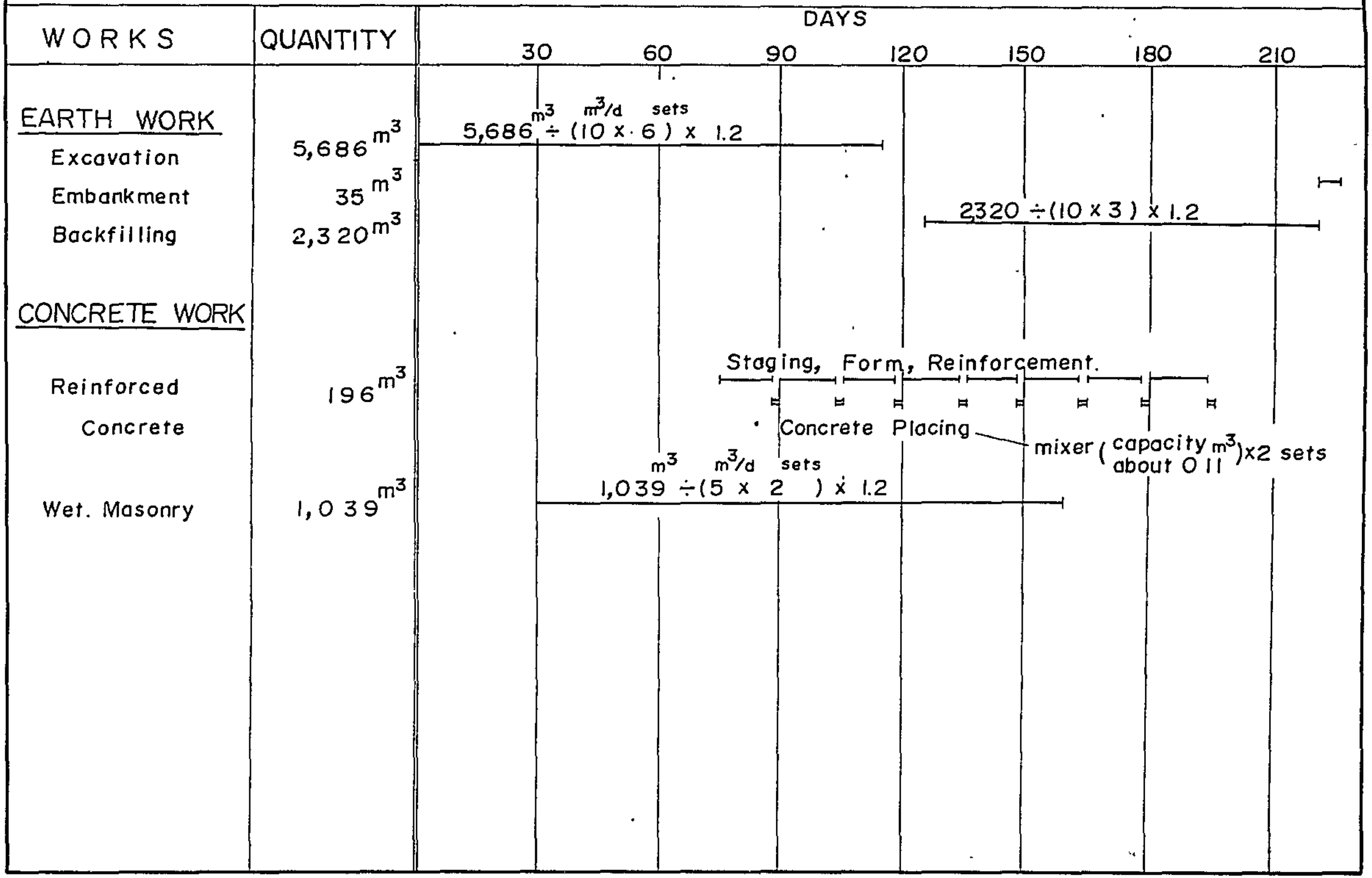


FIG. 4-7-4 OUTLET STRUCTURE (No.1) CONSTRUCTION TIME SCHEDULE

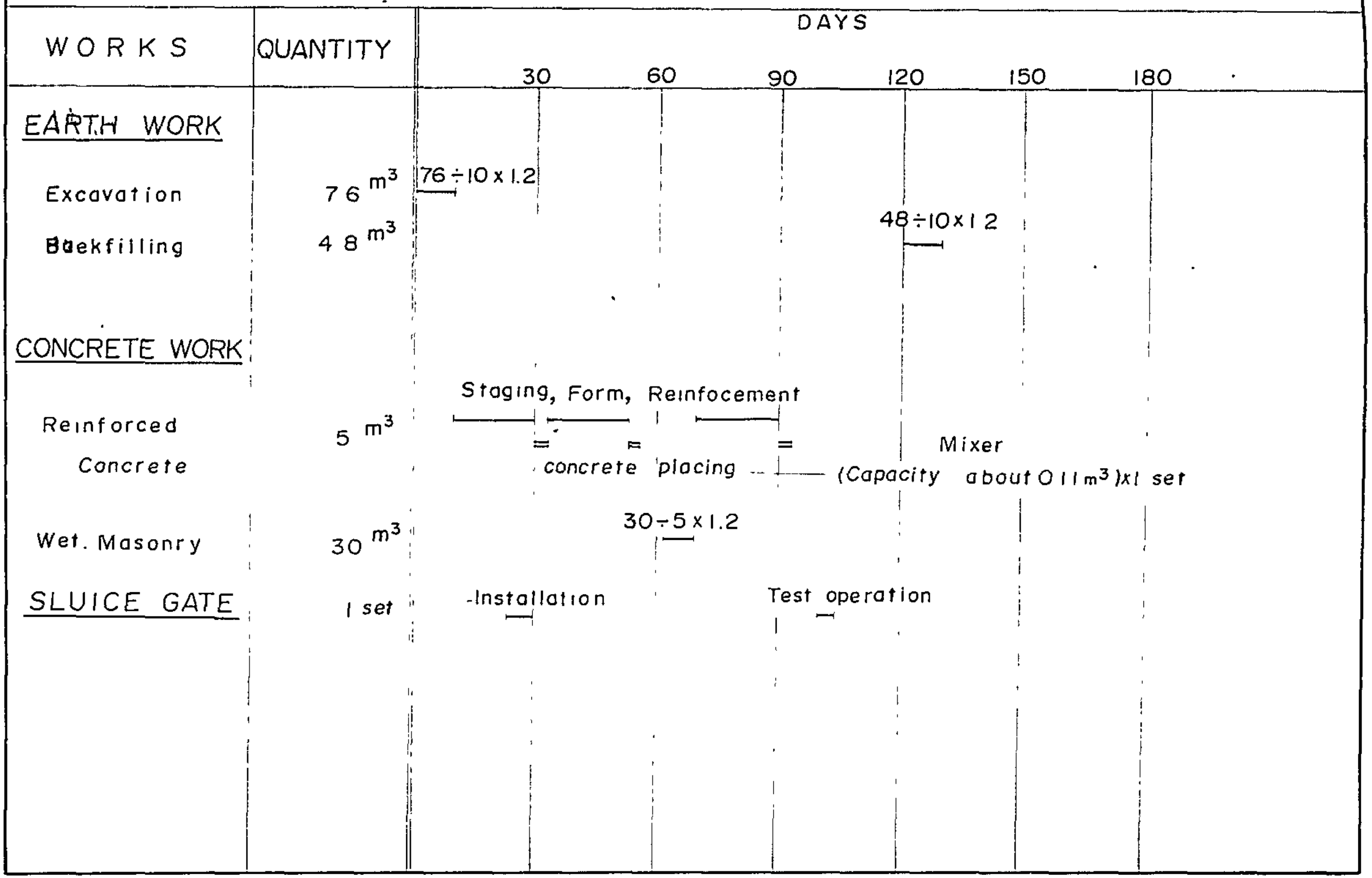
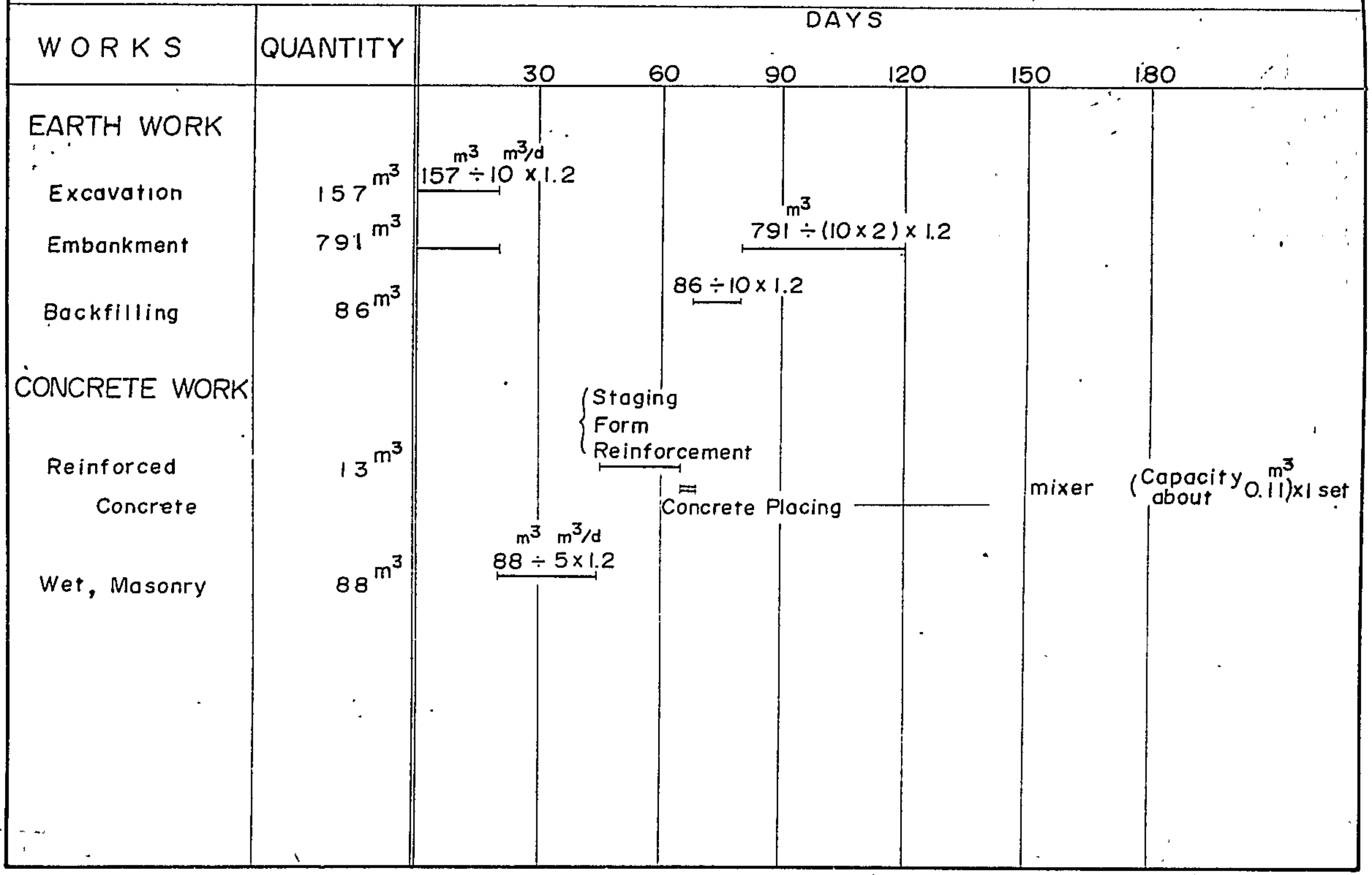


FIG.4-7-5 BRIDGE (No.5) CONSTRUCTION TIME SCHEDULE



4-8. Additional Specifications

This project shall be accomplished in accordance with Indian Standard and the Specifications as follows.

4-8-1. Earth Work

(Excavation)

1. Before the earth work is started, rulers or profile strings shall be so installed in accordance with the drawings of longitudinal and cross section, as to fix the position of slope shoulder. The slope of excavation and its shoulder position shall be clearly shown by excavating the portion of 1 m wide and 1 m long of slope for the prior inspection and approval of the Engineer.

2. The treatment of unexpected poor soils or embeded wood or other materials shall be given to as directed by the Engineer.

3. The excavation work shall be carried out exactly to the slope shown on the drawing. In rock excavation, sides and bottom shall be free from loosened rock or unfixed stone. When stumps or large stones on the excavated surface are found difficult to remove or unsuitable to the work, the proper treatment shall be given to as directed by the Engineer.

4. Attention shall be paid not to excavate to the depth greater than that shown on the drawings. Where the slope of excavation varies according to the soil type, the work shall not disturb the original earth stability.

5. The excavation for structure foundation shall be carried out in such manner that provides firm foundation for structure. The sides and bottom of excavation shall then be tamped with suitable tools and finished to the proper dimensions. In rock excavation, sides and bottom surfaces shall be finished in washing by water.

After the excavation work for structure foundation, the soil types, support capacity or other necessary items shall be inspected and approved by the Engineer. Without approval of the Engineer, no work shall be proceeded.

(Embankment)

6. Before the earth work is started, the area coming under and adjacent to the embankment shall be cleared and shall be inspected by the Engineer.

7. Where there are spring water and/or standing water on area coming under and adjacent to the embankment, the suitable drainage systems shall be provided in a manner as directed by the Engineer.

8. Earth materials for embankment shall be in accordance with the specifications and direction of the Engineer. Where it is not specified, earth materials for embankment shall be suitable to the purpose of embankment and be approved by the Engineer prior to the commencement of work. It is generally specified as follows.

(1) Organic matter of any kind, materials of excessive change in volume, poor clay becoming loose after drying and weathered rock pieces shall not be used for embankment.

(2) Materials containing proper amount of clay, having low permeability and good stability against water shall be used for embankment of water holding. The high permeability layers of sand, gravel or weathered rock pieces shall not be allowed for the embankment of such purpose as specified above.

(3) For reclamation or embankment in the water, the materials shall be sandy silt, sand or gravel, and shall be steady in the water.

9. Before commencement of earth-fill, rigid leading frame, fixed ruler or profile strings shall be installed at each station in accordance with the drawings, and shall be inspected and approved by the Engineer.

10. Earth shall be laid in thin layer which shall be level and continuous in full width of embankment. Each layer of earth shall be adequately tamped before placing next layer. Where embankment is to be constructed on the slope, the placing of earth fill shall be started from the toe of embankment in a manner specified above.

Where compaction of each layer is specified, earth shall be laid in specified thickness and shall be compacted in a manner as specified and then the next layer shall be placed.

11. Where sliding of slope is expected, benching-cut shall be made as directed by the Engineer.

12. The extra-banking shall be made, where directed, to ensure the stability and to compensate the subsidence of the embankment. The height of extra-banking is principally 10% of the height of embankment.

13. Process of extra-banking shall be to locate the toe of the embankment slope at the proper position at first and then to place earth layer in full width of embankment including extra-banking portion. Additional embankment for extra-banking shall not be permitted.

(Backfill)

14. Earth materials used for backfill of structures shall be the specified one. When it is not specified, materials shall be selected suitable for structure.

15. The backfill earth shall be placed in layer which shall be moistened properly and compacted until it gives density of equal to or more than that of original foundation.

4-8-2. Stone Work

1. Stone shall be the best of its kind, hard, sound and durable, and free from decay and weathering. The stone and the quarry from which it is obtained shall be subject to the approval of the Engineer.

2. Leading frame or profile string shall be installed at face and rear of the stone masonry in accordance with the drawing, and shall be inspected and approved by the Engineer.

3. After the excavation, the bearing capacity of foundation and necessary itms shall be inspected and approved by the Engineer.

4. The foundation shall be cut at right angles with the side slope of the stone masonry, and where foundation level differs excessively, benching-cut shall be made.

5. Prior to the commencement of any masonry work, sufficient quantity of stone shall be stored at job site according to the size of stone to enable easy selection.

The stone to be placed at the bottom of structure shall be the largest in size and stable in shape. The stone at the top of structure shall be as large as possible within the designed dimension.

6. The stone work shall be uncoursed masonry work, unless otherwise directed. Before laying stones, the leading frame shall be marked in several horizontal layers with guide string. The stone shall then be carefully laid in layer according to the guide string.

7. The stone shall be laid from the bottom of structure and shall be leveled up horizontally. During the above process of work, laying of stone shall be started from corner or curved portion of structure.

8. The stone at the bottom of masonry shall be placed carefully and properly to enable it to come into close proximity with the neighbouring stones and the firm bond shall be obtained in fitting closely to the adjacent stones and using bond stones.

9. The stone shall be laid in horizontal layers using guide string in which every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints and the height of each layer shall be adjusted uniform as far as possible using several sizes of stones. Total height of masonry structure shall be adjusted within the upper three layers.

10. Slope face of masonry structure shall be finished to the proper line and shall not be formed waving, nor convex shape.

11. In case of dry masonry work, the stone shall be fixed by small bond stones and backed up by flat stone, filling gravel into the backing. All spaces between the stones shall be filled with gravel.

12. In case of wet masonry work, stones shall be fixed with bond stones. After laying stones in one layer, gravel shall be filled into the backing and then specified mixed concrete mortar shall be filled into all spaces and joint of stones using steel bars or by other tools ensuring no hollow spaces are left anywhere in the masonry.

13. Following items shall be specially noted for the wet masonry work.

(1) Stones shall be clean, and mud or other foreign materials shall be washed off.

(2) If the stones or backing gravels are dry, they shall be wetted before use.

(3) After filling concrete mortar, the masonry work shall be protected by suitable covering and shall be kept constantly moist on all the faces.

(4) Wet masonry wall shall be provided with drainage system enabling the masonry free from spring water or standing water at the back side of masonry structure. Unless otherwise specified, drainage system shall be steel, bamboo or wooden pipe which shall go through the masonry wall, projecting from the wall face and having suitable slope for water flowing. The rear end of the pipe shall be cut at the back face of backing mortar and shall be covered by small stones to collect water.

4-8-3. Cement and Concrete Work

(Material)

1. Materials shall be the ones specified in the Indian Standard.

2. In determination of proportioning for cement concrete, following specifications shall be regarded in addition to the Indian Standard.

(1) Fundamental requirement for proportioning

The proportioning of concrete shall be so determined from a laboratory test as to keep unit-quantity of water as small as possible within the limit satisfying required strength, durability, impermeability and workability.

(2) Water-cement ratio

In proportioning on the basis of concrete compressive strength, the appropriate water-cement ratio shall be principally determined from a compressive strength test of concrete. The water-cement ratio shall be determined from c/w -σ curve derived from the results of the compressive strength test, in which the compressive strength shall be properly increased in accordance with safety factor and variable factors at the job site.
In case the proportioning is based on the concrete durability, the maximum water-cement ratio shall be 60%, and in case based on the concrete impermeability, the ratio shall not exceed 53%.

(3) Maximum size of coarse aggregate

Coarse aggregate shall be as large as possible within the specified limits required for type and dimension of structures, space between reinforcement rods and other requirements for construction. Standerdized maximum size of coarse aggregate shall be 40 mm for both plain and reinforced concrete.

(4) Workability

Concrete shall be workable and slump value to indicate the consisitency of concrete shall be as small as possible within the workable limit. Maximum value of slump shall be;

(a) Plain concrete, 5.0 cm
(b)' Reinforced concrete, 10.0 cm

The above values are based on using the concrete vibrator, and in case of no vibrator used, each value shall be increased by 2.5cm.
(It is recommendable to use concrete vibrators for advancing the quality of concrete.)

(5) Specified proportion

On the basis of above conditions, specified proportion shall be determined in accordance with the aggregate obtainable at the job site. Field proportion based on the specified one, shall be collected according to the moisture content of aggregate existing at the site and to the mix proportion of fine and coarse aggregate.

(Mixing)

3. It is recommendable to use concrete mixer for mixing of concrete ingredients. Hand mixing however is approved in case the mixer is not availabe.

(1) The best concrete mixing shall be obtained from a tilting batch mixer.

(2) Materials for concrete shall be weighed at every batch of mixing.

(3) All materials for concrete shall then be charged uniformly into the drum of mixer at a time. However, pouring of water shall be started a little earlier than other materials and be finished a little later, and pouring speed shall be constant.

(4) Mixing operation shall be continued until the concrete become plastic and uniform.

(5) Mixing time after charging all materials into the mixing drum shall be longer than one and a half minutes. The ordinary mixing time shall not exceed as long as three times of the most suitable mixing time for the concrete.

(6) Entire concrete in the mixer shall be discharged before the materials for next mixing are charged into the drum.

(7) The mixer shall be cleaned thoroughly with water before and after its use.

(8) Hand mixed concrete may be used only for miscellaneous works which require a small quantity of concrete, and only upon the approval of the Engineer.

(9) Hand mixing shall be performed on an iron-made platform with mixing shovels. Mixing procedure is principally as follows. The cement and sand shall be mixed dry over 4 times, water shall then be added properly and be mixed over 3 times. And the entire batch shall be thoroughly mixed and blended until the concrete becomes uniform in composition as well as consistency throughout the mixed batch.

(Placing)

4. Preparation

(1) Before placing concrete, transporting apparatus shall be cleaned and be free from old concrete and miscellaneous things.

(2) Before placing concrete, all the surfaces upon which the concrete is to be placed shall be thoroughly cleaned.

(3) Before placing concrete, the surface of founations upon whcih the concrete is to be placed shall be covered, wherever necessary, with a layer of mortal. The material proportion for mortal shall be equal to that of mortal contained in the concrete to be placed.

(4) Before placing concrete, standing water in foundation shall be removed and protections shall be made for the placed concrete from damage by water flowing into the foundation.

5. Placing operation

(1) Mixed concrete shall be transported and placed immediately in a manner which prevents segregation and loss of concrete ingredients. Even if it is not placed immediately due to

unavoidable reasons, the time from the beginning of mixing to the completion of placement shall not exceed one hour. While waiting for placing, the mixed concrete shall be away from direct sunshine, rainfall and wind, and before placing, the concrete shall be re-mixed without additional water. The hardened concrete before placing shall be wasted in regardless of its hardness and quantity.

(2) The transportation method of mixed concrete shall be any kind as far as the placed concrete is of the specified quality.

(3) Concrete shall be placed in a manner which proves not necessary to move concrete once it has been placed in the form.

(4) When some water should come out on the surface of placed concrete, the water shall be taken away, otherwise the next concrete shall not be placed.

(5) The concrete shall be placed continuously for the designated plot to be formed monolithically.

6. Compaction

(1) Concrete shall be thoroughly compacted while being placed and immediately after placing. Compaction shall be principally executed by means of inside vibrators.

(2) When inside vibrator is used, vibrating time, space of vibrator rods and thickness of concrete layer to be compacted shall be directed by the Engineer.
A concrete layer shall be compated in a manner that the top. of vibrator rod shall reach 10 cm inside of the lower concrete layer, and that the rod shall be withdrawn slowly from the concrete ensuring no hole left in concrete by the rod.

(3) Operators of vibrator including members for shift, shall be designated personnel. Operator shall always pay attention to the vibrating points, time and depth.

(4) In case the compaction is done by sticking, the thickness of a concrete layer to be sticked shall be accorded with the Engineer's instructions.

7. Curing

(1) The concrete after being placed shall be cured in a manner that protects concrete from cold temperature, dry weather and abrupt change in temperature. Curing period shall be as directed by the Engineer.

(2) After the concrete has become hard enough in curing, the surface of concrete shall be covered with water or with moistened sand or cloth with a spray of water on it or any other materials approved by the Engineer.
Curing shall be continued until the next concrete is placed on it. If the next concrete is not placed, the surface of concrete shall be kept moistened for minimum period of 7 days principally.

(3) During high temperature, the curing shall be done in a manner that immediateley after the placing, the surface of concrete shall be covered from the direct sunshine so as to be protected from quick drying, and special attention shall be paid to keep concrete surface moistened thoroughly.

(4) In case the form becomes possibly dry, the form shall be flooded with water.

8. Construction joint

(1) The construction joints shall be formed and kept at place strictly as designated in design or in construction planning.

(2) In case of making construction joint which is not designed or not instructed in construction planning, the joint shall not reduce the strength or disturb outlook of the structures, and the location, direction and construction method shall be subject to the approval of the Engineer.

9. Reinforcement

(1) Steel bars shall be cut and bent cold, correctly and accurately to the size and shape having correct diameter of bend as shown on the drawings. Cutting, bending and welding shall not lower the quality of steel bars. Bending by heating bars shall not be permitted.

(2) Placing in position and joint

Before the reinforcement bars are erected and placed in position, the surfaces of bars shall be cleaned of heavy flaky dust, loose mill scale, dirt, oil, grease or other foreign materials that are objectionable to the bond with concrete. Reinforcement bars shall be placed in correct position and the space between the bars and the shuttering boards shall be kept correct, using metal chairs, metal hangers and mortal spacers (mix proportion of 1 : 1) or other spacers. Reinforcement bars shall be fixed rigid ensuring no deformation made by concrete placing.

10. Form work

(1) Form work shall be sufficiently strong and able to resist forces caused by deposition of concrete, vibration, drying or incidental loads associated with the work so as to keep the placed concrete to the correct location, shape and dimensions as shown on drawings. Form work shall be of the type that is easily and safely removed.

(2) Spacing or centering materials shall be steel bars or plates or concrete bars which have no objectionable effects when they are left in concrete.
Wooden spacers shall be used only for such places where they are not required to be removed during concrete placing. If the wooden spacers have to be used inside of placed concrete because of unavoidable reason, the wooden spacers shall be removed in accordance with the progress of concrete placing, ensuring the shuttering boards are not moved.

(3) In case the shuttering boards are coated with mineral oil or others as a removal liquid, prior approval of the Engineer shall be required. Once the shuttering boards have been used, the surface facing to the concrete shall be cleaned before the next use.

11. Staging work

(1) The staging shall have sufficient support capacity and shall be rigid enough against vibration or other incidental loads.
Where the foundation ground is soft, the staging shall rest on the suitable receiver spreading the loads on the staging and preventing subsidence.

(2) Form and staging works for beams and slabs of longer span shall have a suitable camber.

(3) In case of staging by means of earth embankment, the subsidence of embankment shall be considered.

(Special joints)

12. Water stop

(1) The water stop shall be placed at the joints where directed by drawing or by the Engineer.
The water stop shall be handled carefully and the damaged ones shall not be used. The water stop shall be kept cool as far as

possible and the direct sunshine shall be avoided when stored outside.

(2) The water stop shall be placed in a manner that a half of the water stop shall immerse in one side of the joint concrete and the other half in the other side of the joint.
When placing concrete around the water stop or during vibrating the concrete, care shall be taken to keep solid contact of concrete and water stop.

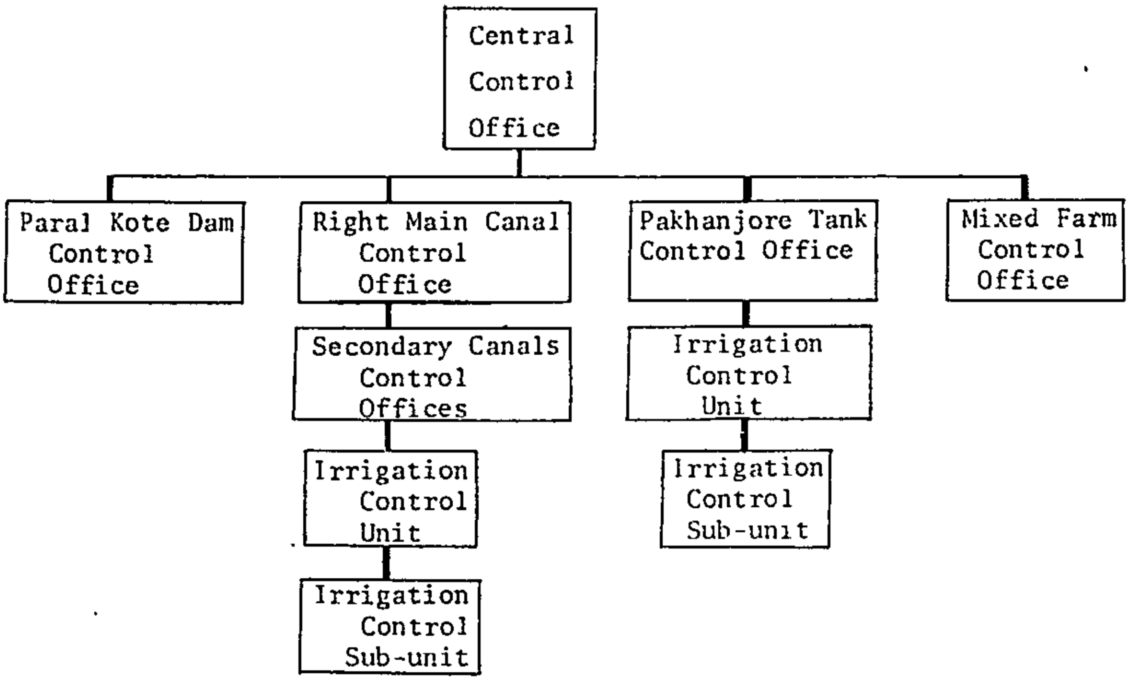
4-9 Operation and Maintenance Plan

4-9-1 General

One of the most important things for successful management of irrigation water in this project are to establish the operation and maintenance system which distributes irrigation water as directed by the manager of the Central Control Office (temporary named) and to realize efficient distribution and utilization of irrigation water in the whole project area. For this purpose, the organization for the operation and maintenance of this project has been drafted and is shown in Fig. 4-9-1. Prior to the execution of the above operation and maintenance plan, repair and construction of roads connecting irrigation facilities (dam, main canal and related facilities) have to be completed together with establishment and rehabilitation of communication system for the smooth communications between the control offices and the irrigation units. Without repair and construction of the roads and the communication facilities, satisfactory operation and maintenance can not be expected.

4-9-2 Drafted Organization of Operation and Maintenance

Fig. 4-9-1



4-9-3 Major Works of Control Offices

1. Central Control Office

This office will supervise the management of irrigation water and the operation and maintenance of irrigation facilities in the whole area of the Pakhanjore Project.

a. Planning and direction on the irrigation water distribution and supervision of water-distribute officers and operators of facilities.

b. Giving guidance to farmers in the project, and settlement of troubles on irrigation water.

c. Inspection and cleaning of irrigation facilities and giving guidance to the inspectors.

d. Repair and rehabilitation of irrigation facilities.

e. Other works necessary for the operation and maintenance of irrigation facilities.

2. Paralkote Dam Control Office

This office will operate and maintain the Paralkote Dam.

a. Operation of the Paralkote Dam
Operation of the gates, and observation of hydrology......(Operator)

Note: Regulations for operation of the dam are to be prepared separately.

b. Maintenance of the Paralkote Dam
To keep the facilities clean and away from damage and to repair ...... (Inspector)

3. Main Canal Control Office

This office will manage the irrigation water and maintain the facilities of the main canal from the Paralkote Dam to Mixed Farm.

a. Operation of Main Canal

Operation of outlets and escapes ...... (Water-distribute Officer)

b. Maintenance of the Main Canal

To keep facilities clean and away from damage and to repair ...... (Inspector)

4. Pakhanjore Tank Control Office

This office will operate and maintain the Pakhanjore Tank.

a. Operation and maintenance of the Pakhanjore Tank ...... (Operators and Inspectors)

Note: Regulations for operation of the Tank are referred to those of the Paralkote Dam.

5. Mixed Farm Control Office

This office will operate and maintain the Weir at Anjori Nalla.

a. Operation and maintenance of the weir ...... (Operators)

6. Secondary Canals Control Offices

a. Operation of secondary canal ...... (Water-distribute Officers)

b. Maintenance of secondary canal ...... (Inspectors)

4-9-4 Rules for Irrigation Water Distribution (Draft)

Note: The followings indicate a draft of fundamental rules for irrigation water distribution, further details are required to be figured out.

1. Items to be investigated before irrigation

a. Irrigation area

Irrigation area shall be adjusted every year at each secondary canal in accordance with the report from the irrigation control units.

b. Crop and irrigation area

Irrigation area shall be summarized for each crops and cropping patterns according to their water requirements in a manner described in Sub-para. a.

c. Determination of irrigation period

Irrigation time and period shall be determined according to the cropping period at each irrigation unit.

d. Rainfall forecasting

Data of long term forecasting for rainfall shall be collected from the meteorological observatory.

e. Existing conditions of water at reservoirs in the project

Existing conditions of water storing at each regulation reservoir shall be reported from the irrigation unit.
In case there are many reservoirs in the project area, a representative reservoir will be selected after classifying them into several types and the investigation will be performed only for the representatives.

2. Items to be determined at irrigation period

a. Estimate of rainfall pattern

Based on the data collected in the sub-paragragh d, the rainfall pattern of drought year, normal year or flood year shall be estimated in accordance with the standards to be specified separately.

b. Standard amount of water distribution for secondary canal

Based on the data collected in the sub-paragragh a and b of the section 1, standard amount of water to be distributed shall be determined. The standard amount will be finally fixed by the manager of the Central Control Office in accordance with the following formula.

$$\text{Amount of water} = \text{Monthly mean unit water requirement} \left(\text{including losses}\right) \times \text{Irrigation A area}$$

c. Water storing at reservoirs

Amount of water to be stored at the regulation reservoirs shall be determined based on the rainfall pattern.

3. Discharge from the Dam

a. The discharge amount for each five days from the Paralkote Dam shall be determined, and directed to the manager of the Dam control office.

4. Water distribution to secondary canals

a. Standard distribution amount

Standard distribution amount determined in the Sub-para. b of the section 2 shall be adjusted according to the periodical variations at each secondary canal.

b. Revision of distribution amount

Revision of the distribution amount of irrigation water may be permitted according to the proposal from the irrigation unit only when the propriety is confirmed by investigation and upon approval of the manager of the Central Control Office.

c. Temporary revision of distribution amount

If the proposed amount of revision in water distribution is so small and short in period that the secondary canal can manage, the manager of the secondary canal control office may give permission to the revision.

d. Water distribution in rainfall time

When there are 5 mm rainfalls, the distribution amount of irrigation water shall be cut half. When rainfall reaches at 20 mm and more rainfall is expected, distribution of water shall be stopped totaly.

5. Irrigation water distribution in drought year

a. In drought year, economization of irrigation water shall be performed in accordance with the additional rules specified separately.

4-10. Bill of Quantities

4-10-1. Numbers of Irrigation and Additional Structures

Numbers of structures designed in this report are listed as follows.

Classification	Route'A'	Route'B'	Route'C'	TOTAL
Open Canal	0.03 km (Type A)	7.38 km (Type C)	4.54 km (Type D)	
	6.97 (Type B)	2.91 (Type D)		21.83 km
Aqueduct	2	1	1	4
Irrigation Syphon	1	1	1	3
Irrigation Culvert	-	3	8	11
Transition	4	-	-	4
Outlet	4	10	1	15
Inlet	21	3	7	31
Drainage Culvert	7	12	3	22
Escape	4	1	2	7
Spillway	-	2	-	2
Bridge	1	5	-	6
Check-gate	1	-	-	1
Tail Escape	-	-	1	1

4-10-2. Bill of Quantities

Bill of quantities for the structures listed above are given in the following tables.

BILL OF QUANTITIES

KINDS	UNIT	A-ROUTE	B-ROUTE	C-ROUTE	TOTAL	REMARKS
(1) EARTH WORK						
EXCAVATION (SAND)	m^3	23,509.2	40,807.2	173,993.7	238,310.1	
EXCAVATION (ROCK)	m^3	87.2			87.2	
EMBANKMENT	m^3	3,079.7	13,301.5	19,657.5	36,038.7	
BACK-FILLING	m^3	5,136.2	17,366.2	46,777.3	69,279.7	
(2) CONCRETE WORK						
REINFORCED CONCRETE	m^3	858.63	1,274.74	1,323.86	3,457.23	
PLAIN CONCRETE	m^3	58.00	397.32	10.63	465.95	
PAVEMENT CONCRETE	m^3	1.64	4.98		6.62	
FORM	m^2	3,165.95	5,153.36	3,068.40	11,387.71	
REINFORCEMENT	kg	81,583.59	126,164.05	107,840.79	315,588.43	
(3) OTHERS						
WET MASONRY	m^3	9,888.68	10,857.70	8,789.52	29,535.90	
DRY STONE PITCHING	m^3	894.90	1,185.84	461.70	2,542.44	
BACK-FILL COBBLE	m^3	132.80	158.04	20.32	311.16	
WATER STOP	m	176.33	172.60	101.80	450.73	
ASPHALT	m^3	1.43	0.45	0.15	2.03	
FLASH BOARD	m^3	25.58	8.50	3.96	38.04	
BEARING	SET	42	12	16	70	
SAND	m^3	10.26	3.00	2.04	15.30	H W
SLVICE GATE	SET	1	7	1	9	600 x 700
" "	SET	2	2		4	900 x 1,000
" "	SET	1			1	1,100 x 1,200
" "	SET	4			4	1,900 x 2,000
" "	SET		2		2	1,600 x 2,200

BILL OF QUANTITIES FOR A-ROUTE

KINDS	UNIT	IRRIGATION AQUEDUCT	IRRIGATION SYPHON	TRANSITION STRUCTURE	OUTLET STRUCTURE	INLET STRUCTURE	DRAINAGE CULVERT	ESCAPE STRUCTURE	BRIDGE STRUCTURE	CHECK GATE	TOTAL
(1) EARTH WORK											
EXCAVATION (SAND)	m^3	5,735.3	1,033.2	486.1	351.2	5,312.2	9,673.2	822.9	43.2	51.9	23,509.2
EXCAVATION (ROCK)	m^3			87.2							87.2
EMBANKMENT	m^3	841.2	672.0	481.8					1,048.9	35.8	3,079.7
BACK-FILLING	m^3	737.4	353.7	88.1	198.7		3,625.0	116.7	9.3	7.3	5,136.2
(2) CONCRETE WORK											
REINFORCED CONCRETE	m^3	296.87	41.71		21.63		433.74		22.82	41.86	858.63
PLAIN CONCRETE	m^3	58.00									58.00
PAVEMENT CONCRETE	m^3								1.64		1.64
FORM	m^2	1,368.36	100.58		106.42		1,391.60		48.76	150.23	3,165.95
REINFORCEMENT	kg	27,411.02	3,151.29		2,097.24		44,459.26		2,156.88	2,307.90	81,583.59
(3) OTHERS											
WET MASONRY	m^3	1,019.79	538.88	434.13	133.64	3,378.41	3,746.15	561.88	75.80		9,888.68
DRY STONE PITCHING	m^3		60.00			300.00	534.90				894.90
BACK-FILL COBBLE	m^3	132.80									132.80
WATER STOP	m	97.90	78.43								176.33
ASPHALT	m^3	1.43									1.43
FLASH BOARD	m^3	3.54	3.00					19.04			25.58
BEARING	SET	42.-									42
SAND	m^3							10.26			10.26
SLUICE GATE(600x700)	SET				1						1
" " (900x1,000)	"				2						2
" " (1,100x1,200)	"				1						1
" " (1,900x2,000)	"									4	4

BILL OF QUANTITIES FOR B-ROUTE

KINDS	UNIT	IRRIGATION AQUEDUCT	IRRIGATION SYPHON	IRRIGATION CULVERT	OUTLET STRUCTURE	INLET STRUCTURE	DRAINAGE CULVERT	ESCAPE STRUCTURE	SPILLWAY STRUCTURE	BRIDGE STRUCTURE	TOTAL
(1) EARTH WORK											
EXCAVATION (SAND)	m^3	835.9	1,733.9	17,135.3	1,507.8	213.9	18,095.0	281.8	280.1	723.5	40,807.2
EMBANKMENT	m^3	2,025.1	174.7	34.5	74.0	3,341.6			4,074.5	3,577.1	13,301.5
BACK-FILLING	m^3	303.2	1,103.3	5,756.6	849.7		8,914.1	37.6		401.7	17,366.2
(2) CONCRETE WORK											
REINFORCED CONCRETE	m^3	109.66	25.50	384.80	76.52		620.85			57.41	1,274.74
PLAIN CONCRETE	m^3	17.00							380.32		397.32
PAVEMENT CONCRETE	m^3									4.98	4.98
FORM	m^2	537.51	68.06	743.92	340.03		1,994.88		1,331.12	137.84	5,153.36
REINFORCEMENT	kg	7,416.58	2,782.30	31,463.25	6,539.70		74,015.97			3,946.25	126,164.05
(3) OTHERS											
WET MASONRY	m^3	800.21	493.05	1,969.78	597.36	398.90	5,614.55	169.27	414.51	400.09	10,857.70
DRY STONE PITCHING	m^3		6.00			164.64	845.70		169.50		1,185.84
BACK-FILL COBBLE	m^3	158.04									158.04
WATER STOP	m	43.00	129.60								172.60
ASPHALT	m^3	0.45									0.45
FLASH BOARD	m^3	1.70	1.20					5.60			8.50
BEARING	SET	12.-									12
SAND	m^3							3.00			3.00
SLUICE GATE(600x700)	SET				7						7
" " (900x1,000)	SET				2						2
" " (1,600x2,200)	SET				2						2

BILL OF QUANTITIES FOR C-ROUTE

KINDS	UNIT	IRRIGATION AQUEDUCT	IRRIGATION SYPHON	IRRIGATION CULVERT	OUTLET STRUCTURE	INLET STRUCTURE	DRAINAGE CULVERT	ESCAPE STRUCTURE	TAIL ESCAPE	TOTAL	REMARKS
(1) EARTH WORK											
EXCAVATION (SAND)	m^3	1,383.0			72.4	866.7	1,689.0	299.4	(169,611.9) 71.3	173,993.7	
EMBANKMENT	m^3	15.9				1,884.7			(17,745.3) 11.6	19,657.5	
BACK-FILLING	m^3	126.7			42.0		837.8	48.6	(45,705.8) 16.4	46,777.3	
(2) CONCRETE WORK											
REINFORCED CONCRETE	m^3	67.24	15.30	1,208.66	4.37		28.29			1,323.86	
PLAIN CONCRETE	m^3	10.63								10.63	
FORM	m^2	440.71	41.04	2,460.57	20.03		106.05			3,068.40	
REINFORCEMENT	kg	4,717.48	1,669.38	97,873.76	444.64		3,135.53			107,840.79	
(3) OTHERS											
WET MASONRY	m^3	144.89	123.41	6,975.93	30.20	600.64	631.60	230.68	52.17	8,789.52	
DRY STONE PITCHING	m^3		1.50			321.00	139.20			461.70	
BACK-FILL COBBLE	m^3	20.32								20.32	
WATER STOP	m	27.00	74.80							101.80	
ASPHALT	m^3	0.15								0.15	
FLASH BOARD	m^3							3.96		3.96	
BEARING	SET	16								16	
SAND	m^3							2.04		2.04	
SLUICE GATE (600x700)	SET				1					1	

TABLE 2-1 Monthly Rainfall at Dhanora (Paralkote Dam Site) (1922 - 1960)

(Unit: mm)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Annual	Total Monsoon (Jun.-Oct.)
1922	12.7					237.5	765.6		505.2				1,521.0	1,508.3
1923			11.4			8.1	417.1	352.0	363.2	49.3			1,201.1	1,189.7
1924	120.7		0.8	4.6	8.9	35.8	715.0	342.6	435.6	116.8	85.9		1,866.7	1,645.8
1925			10.2	2.5	20.6	82.0	526.8	537.2	155.2	18.0	1.3		1,353.8	1,319.2
1926	12.7					11.4	410.2	711.2	88.4	58.2			1,292.1	1,279.4
1927							970.3	565.4	66.8	126.7	21.8		1,751.0	1,729.2
1928		1.8				130.0	451.1	172.0	168.7	78.7			1,002.3	1,000.5
1929		52.1		16.5		145.8	715.5	397.3	229.1	5.1		41.4	1,602.8	1,492.8
1930		27.9				308.9	533.1	386.3	217.9	23.6	149.9		1,647.6	1,469.8
1931		0.8	45.7	2.5		77.2	456.7	614.9	347.0	292.4	79.2		1,916.4	1,788.2
1932		23.6				180.8	1,029.0	247.7	214.6	21.3	8.9		1,725.9	1,693.4
1933														
1934				9.9		280.9	479.0	236.2	226.3	18.8	7.9		1,259.0	1,241.2
1935	1.8			14.5		94.0	762.5	257.3	415.8				1,545.9	1,529.6
1936	44.5	58.9	28.4		19.8	519.4	450.3	427.0	362.5	16.8			1,927.6	1,776.0
1937		100.1	87.6	85.6		113.5	601.5	344.4	227.6	84.6			1,644.9	1,371.6
1938		23.4	14.2		6.4	357.4	728.0	616.7	317.2	251.5			2.314.8	2,270.8
1939			82.8	1.3		282.4	334.3	693.2	124.5	90.7			1,609.2	1,525.1
1940				11.4	38.6	323.1	1,138.4	633.2	53.3	75.7	30.5	71.6	2,375.8	2,223.7
1941	27.7	10.2	17.8		62.2	268.2	323.1	301.5	213.4				1,224.1	1,106.2
1942		53.3				196.6	958.1	598.2	222.3	49.0			2,077.5	2,024.2
1943				0.5		142.0	529.6	407.9	255.8	55.4			1,391.2	1,390.7
1944	22.9	122.4	63.0		8.4	77.2	825.0	537.7	342.9	107.2			2,106.7	1,890.0
1945	15.2			55.9		420.1	696.0	526.0	519.4	39.9			2,272.5	2,201.4
1946			4.1	42.4	14.5	443.7	645.9	750.8	162.6	20.3	24.9		2,109.2	2,023.3
1947	27.4	45.0	9.9		3.3	194.3	868.7	398.3	196.9	40.6			1,784.4	1,698.8
1948	16.0	15.0	4.6	23.4	1.5	94.0	516.1	510.5	219.7	25.9	99.3		1,526.0	1,366.2
1949				6.6	29.5	277.6	482.1	591.3	324.6	76.2			1,787.9	1,751.8
1950		53.3	17.8			76.2	619.3	235.0	149.1		4.6		1,155.3	1,079.6
1951	3.8		54.4	21.3	44.7	143.5	749.3	754.6	71.4	98.6			1,941.6	1,817.4
1952		2.8		56.6		217.4	478.3	688.6	260.6	19.8			1,724.1	1,664.7
1953				94.5		194.8	505.7	826.3	296.9	139.7			2,057.9	1,963.4
1954			101.9		7.1	114.8	558.8	491.5	400.3				1,674.4	1,565.4
1955	3.0				1.3	320.5	366.3	840.7	318.3	325.1			2,175.2	2,170.9
1956		4.6			33.3	451.6	747.8	366.8	254.0				1,858.1	1,820.2
1957							480.3	777.2	30.5	39.4			1,327.4	1,327.4
1958			38.6	20.3	13.2	77.1	351.5	382.0	264.2	71.1			1,218.0	1,145.9
1959				75.2	20.3	266.7	622.3	614.7	604.5	30.5			2,234.2	2,138.7
1960			76.2			266.7	569.0	457.2	63.5	114.3			1,546.9	1,470.7
Mean	8.1	15.7	17.6	14.4	8.8	195.4	615.2	489.3	255.0	67.9	13.5	3.0	1,703.9	1,622.8

TABLE 2-2 Monthly Rainfall at Mixed Farm (1961 - 1969)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	sep.	Oct.	Nov.	Dec.	Total	
													Annual	Monsoon
1961						58.0	457.1	706.2	550.2	69.6	12.6	0	1,853.7	1,841.1
1962	0	0.5	0.4	38.1	16.6	168.4	507.8	406.0	264.2	0	18.4	24.4	1,444.8	1,346.4
1963	0	0	4.0	21.4	65.2	157.2	584.0	786.4	415.1	123.3	0	0	2,156.6	2,066.0
1964	0	23.0	25.0	0	0	206.5	360.1	801.8	371.9	66.8	5.0	0	1,860.1	1,807.1
1965	35.6	0	10.2	23.0	19.5	144.8	329.0	99.8	215.0	0	0	0	876.9	788.6
1966	56.0	0	5.1	24.3	24.2	85.5	420.2	345.9	293.4	61.0	9.0	96.9	1,421.5	1,206.0
1967	0	0	140.8	27.9	10.2	282.8	471.3	899.0	187.7	3.6	0	36.9	2,060.2	1,844.4
1968	0	76.2	69.5	46.3	0	276.4	549.3	291.9	368.7	62.0	0	0	1,740.3	1,548.3
1969	0	0	0	5.0	94.0	154.0	659.1	329.4	342.0	0	3.0	9.5	1,632.0	1,520.5
1970	9.5													
Mean	10.2	11.1	28.3	20.7	25.5	170.4	486.0	518.0	334.0	42.9	5.3	17.6	1,671.8	

TABLE 2-3 Seasonal Rainfall at Hanker (Paralkote Dam Site) (1959 - 1969)

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1959						262.4	502.3	782.8					1,547.5
1960						353.5	717.4	318.2	202.2				1,591.3
1961							275.1	748.0	482.6	22.6			1,528.3
1962						42.0	529.5	431.5	290.5				1,293.5
1963						164.0	541.0	509.0	267.0	89.0			1,570.0
1964						99.0	383.0	873.0					1,355.0
1965						72.0	315.0	89.0	228.0				704.0
1966						112.5	512.0	316.0	256.0	15.0			1,211.5
1967						281.9	469.9	889.0	139.7	15.2			1,795.7
1968						222.5	531.0	257.8	188.0				1,199.3
1969						153.9	816.4	429.5	328.7				1,728.5

TABLE 3-1 Estimation of Irrigation Water Requirement for Project Area

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Upland Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10³cu.m)	Up-Land Crops (mm)	Up-Land Crops (10³cu.m)	Total (10³cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1922	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	12.7	9.5	255.2	71.1	300.2	1,154	128.7	4,453	5,607	2.09
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5		1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	237.5	178.1	143.4	-	168.7	7,783	-	-	7,783	3.00
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	765.6	574.2	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7			341.2	130.7	401.4	18,519	236.6	7,277	25,796	9.63
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	505.2	378.9	-	-	-	-	-	-	-	-
	Oct.		3,075.7	3,075.7		92.6				92.6			167.6	5,155	5,155	1.92
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,521.0	1,140.7	1,582.1	1,037.1	1,861.2	31,265	1,877.3	36,924	68,189	
1923	Jan.	384.5	3,460.2	3,844.7	264.7	80.6		—	264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	11.4	8.6	278.9	111.0	328.1	1,262	200.9	3,090	4,352	1.62
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	8.1	6.1	315.4	85.6	371.1	17,121	154.9	3,573	20,694	7.98
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	417.1	312.8	18.1	-	21.3	983	-	-	983	0.37
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	352.0	264.0	77.2	-	90.8	4,189	-	-	4,189	1.56
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	363.2	272.4	20.9	-	24.6	1,135	-	-	1,135	0.44
	Oct.		3,075.7	3,075.7		92.6	49.3	37.0	-	55.6	-	-	100.6	3,094	3,094	1.16
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,201.1	900.9	1,530.0	955.9	1,800.0	28,396	1,730.2	31,514	59,910	

Note: Farm apprication efficiency: 0.65
Conveyance losses: 0.15

Year (1)	Month (2)	Cropping Area (ha) Paddy Crops (3)	Cropping Area (ha) Up-Land Crops (4)	Cropping Area (ha) Total (5)=(3)+(4)	Irrigation Requirement (mm) Paddy Crops (6)	Irrigation Requirement (mm) Up-Land Crops (7)	Rainfall (mm) Rainfall (8)	Rainfall (mm) Effective Rainfall (9)=0.75x(8)	Net Irrigation Requirement (mm) Paddy Crops (10)=(6)-(9)	Net Irrigation Requirement (mm) Up-Land Crops (11)=(7)-(9)	Irrigation Water Requirement Paddy Crops (mm) (12)=(10)/(1-0.15)	Irrigation Water Requirement Paddy Crops (10^3cu.m) (13)=(3)x(12)	Irrigation Water Requirement Up-land Crops (mm) (14)=(11)/0.65(1-0.15)	Irrigation Water Requirement Up-land Crops (10^3cu.m) (15)=(4)x(14)	Irrigation Water Requirement Total (10^3cu.m) (16)=(13)+(15)	Irrigation Water Requirement Total cu.m/sec (17)=(16)/30x86,400
1924	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	120.7	90.5	174.2	-	204.9	788	-	-	788	0.29
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	0.8	0.6	286.9	119.0	337.5	1,298	215.4	3,313	4,611	1.72
	Apr.		384.5	384.5		141.8	4.6	3.5	-	138.3	-	-	250.3	962	962	0.37
	May		384.5	384.5		192.2	8.9	6.7	-	185.5	-	-	335.8	1,291	1,291	0.48
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	35.8	26.9	294.6	64.8	346.6	15,991	117.3	2,706	18,697	7.21
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	715.0	536.3	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	342.6	257.0	84.2	-	99.1	4,572	-	-	4,572	1.71
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	435.6	326.7	-	-	-	-	-	-	-	-
	Oct.		3,075.7	3,075.7		92.6	116.8	87.6	-	5.0	-	-	9.1	280	280	0.10
	Nov.		3,844.6	3,844.6		86.5	85.9	64.4	-	22.1	-	-	40.0	1,538	1,538	0.59
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,866.7	1,400.2	1,394.7	737.3	1,640.6	25,158	1,334.6	18,453	43,611	
1925	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	10.2	7.7	279.8	111.9	329.2	1,266	202.5	3,114	4,380	1.64
	Apr.		384.5	384.5		141.8	2.5	1.9	-	139.9	-	-	253.2	974	974	0.38
	May		384.5	384.5		192.2	20.6	15.5	-	176.7	-	-	319.8	1,230	1,230	0.46
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	82.0	61.5	260.0	30.2	305.9	14,113	54.7	1,262	15,375	5.93
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	526.8	395.1	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	537.2	402.9	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	155.2	116.4	176.9	7.4	208.1	9,601	13.4	412	10,013	3.86
	Oct.		3,075.7	3,075.7		92.6	18.0	13.5	-	79.1	-	-	143.2	4,404	4,404	1.64
	Nov.		3,844.6	3,844.6		86.5	1.3	1.0	-	85.5	-	-	154.8	5,951	5,951	2.30
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,353.8	1,015.5	1,536.2	913.9	1,807.3	28,686	1,654.2	30,758	59,444	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops		Up-Land Crops		Total	
											(mm)	(10^3cu.m)	(mm)	(10^3cu.m)	(10^3cu.m)	cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1926	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	12.7	9.5	255.2	71.1	300.2	1,154	128.7	4,453	5,607	2.09
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	11.4	8.6	312.9	83.1	368.1	16,983	150.4	3,469	20,452	0.79
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	410.2	307.7	23.2	-	27.3	1,250	-	-	1,250	0.47
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	711.2	533.4	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	88.4	66.3	227.0	57.5	267.1	12,323	104.1	3,202	15,525	5.99
	Oct.		3,075.7	3,075.7		92.6	58.2	43.7	-	48.9	-	-	88.5	2,722	2,722	1.02
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,292.1	969.2	1,660.6	1,003.3	1,953.6	35,519	1,816.1	33,885	69,404	
1927	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	0.19
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7			321.5	91.7	378.2	17,449	166.0	3,829	21,278	8.21
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	970.3	727.7	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	565.4	424.1	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	66.8	50.1	243.2	73.7	286.1	13,200	133.4	4,103	17,303	6.68
	Oct.		3,075.7	3,075.7		92.6	126.7	95.0	-	-	-	-	-	-	-	-
	Nov.		3,844.6	3,844.6		86.5	21.8	16.4	-	70.1	-	-	126.9	4,879	4,879	1.88
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,751.0	1,313.3	1,671.7	972.3	1,966.6	35,655	1,760.0	31,877	67,532	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1928	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	1.8	1.4	270.8	122.9	318.6	1,225	222.4	3,420	4,645	1.92
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	130.0	97.5	224.0	-	263.5	12,157	-	-	12,157	4.69
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	451.1	338.3	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	172.0	129.0	212.2	1.7	249.7	11,520	3 1	95	11,615	4.34
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	168.7	126.5	166.8	-	196.2	9,052	-	-	9,052	3.49
	Oct.		3,075.7	3,075.7		92.6	78.7	59.0		33.6			60.8	1,870	1,870	0.70
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,002.3	751.7	1,708.6	857.2	2,010.1	37,729	1,551.6	27,012	64,741	
1929	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	52.1	39.1	233.1	85.2	274.2	1,054	154.2	2,371	3,425	1.42
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	16.5	12.4		129.4			234.2	900	900	0.35
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	145.8	109.4	212.1	-	249.5	11,511	-	-	11,511	4.44
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	715.5	536.6	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	397.3	298.0	43.2	-	50.8	2,344	-	-	2,344	0.88
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	229.1	171.8	121.5	-	142.9	6,593	-	-	6,593	2.54
	Oct.		3,075.7	3,075.7		92.6	5.1	3.8		88.8			160.7	4,943	4,943	1.85
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3	41.4	31.1	251.5	47.2	295.9	1,138	85.4	2,955	4,093	1.53
	Total						1,602.8	1,202.2	1,413.6	829.5	1,662.9	25,137	1,501.4	26,906	52,043	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops		Up-Land Crops		Total	
											(mm)	(10^3cu.m)	(mm)	(10^3cu.m)	(10^3cu.m)	cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1930	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	27.9	20.9	251.3	103.4	295.7	1,137	187.2	2,879	4,016	1.66
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	308.9	231.7	89.8	-	105.6	4,872	-	-	4,872	1.88
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	533.1	399.8	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	386.3	289.7	51.5	-	60.6	2,796	-	-	2,796	1.04
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	217.9	163.4	129.9	-	152.8	7,050	-	-	7,050	2.72
	Oct.		3,075.7	3,075.7		92.6	23.6	17.7		74.9			135.6	4,171	4,171	1.56
	Nov.		3,844.6	3,844.6		86.5	149.9	112.4		-			-	-	-	-
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,647.6	1,235.6	1,357.3	780.8	1,596.8	19,630	1,431.5	22,656	42,286	
1931	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	0.8	0.6	271.6	123.7	319.5	1,228	223.9	3,443	4,671	1.93
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	45.7	34.3	253.2	85.3	297.9	1,145	154.4	2,375	3,520	1.31
	Apr.		384.5	384.5		141.8	2.5	1.9	-	139.9			253.2	974	974	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	77.2	57.9	263.6	33.8	310.1	14,037	61.2	1,412	15,449	5.96
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	456.7	342.5	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	614.9	461.2	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	347.0	260.3	33.0	-	38.8	1,790	-	-	1,790	0.69
	Oct.		3,075.7	3,075.7		92.6	292.4	219.3		-			-	-	-	-
	Nov.		3,844.6	3,844.6		86.5	79.2	59.4		27.1			49.1	1,888	1,888	0.73
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,916.4	1,437.4	1,368.7	760.9	1,610.2	20,675	1,377.3	21,381	42,056	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops		Up-Land Crops		Total	
											(mm)	(10^3cu.m)	(mm)	(10^3cu.m)	(10^3cu.m)	cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1932	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	23.6	17.7	254.5	106.6	299.4	1,151	192.9	2,967	4,118	1.70
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	180.8	135.6	185.9	-	218.7	10,090	-	-	10,090	3.89
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	1,029.0	771.8	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	247.7	185.8	155.4	-	182.8	8,434	-	-	8,434	3.15
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	214.6	161.0	132.3	-	155.7	7,183	-	-	7,183	2.77
	Oct.		3,075.7	3,075.7		92.6	21.3	16.0		76.6			138.6	4,263	4,263	1.59
	Nov.		3,844.6	3,844.6		86.5	8.9	6.7		79.8			144.4	5,552	5,552	2.14
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,725.9	1,294.6	1,562.9	875.5	1,838.7	30,633	1,584.6	28,388	59,021	
1933	Jan.	384.5	3,460.2	3,844.7	264.7	80.6										
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3										
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6										
	Apr.		384.5	384.5		141.8										
	May		384.5	384.5		192.2										
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7										
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6										
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7										
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8										
	Oct.		3,075.7	3,075.7		92.6										
	Nov.		3,844.6	3,844.6		86.5										
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3										
	Total															

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1934	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	9.9	7.4		134.4			243.3	935	935	0.36
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	280.9	210.7	110.8	-	130.4	6,016	-	-	6,016	2.32
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	479.0	359.3	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	236.2	177.2	164.0	-	192.9	8,900	-	-	8,900	3.32
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	226.3	169.7	123.6	-	145.4	6,708	-	-	6,708	2.59
	Oct.		3,075.7	3,075.7		92.6	18.8	14.1		78.5			142.1	4,371	4,371	1.63
	Nov.		3,844.6	3,844.6		86.5	7.9	5.9		80.6			145.9	5,609	5,609	2.16
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,259.0	944.3	1,505.4	888.5	1,771.0	26,630	1,608.3	28,994	55,624	
1935	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	1.8	1.4	263.3	79.2	309.8	1,191	143.4	4,962	6,153	2.30
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	14.5	10.9		130.9			236.9	911	911	0.35
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	94.0	70.5	251.0	21.2	295.3	13,624	38.4	886	14,510	0.56
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	762.5	571.9	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	257.3	193.0	148.2	-	174.4	8,046	-	-	8,046	3.00
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	415.8	311.9	-	-	-	-	-	-	-	-
	Oct.		3,075.7	3,075.7		92.6				92.6			167.6	5,155	5,155	1.92
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,545.9	1,159.6	1,504.8	924.8	1,770.4	26,670	1,674.0	30,966	57,636	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1936	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	44.5	33.4	231.3	47.2	272.1	1,046	85.4	2,955	4,001	1.49
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	58.9	44.2	228.0	80.1	268.2	1,031	145.0	2,230	3,261	1.35
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	28.4	21.3	266.2	98.3	313.2	1,204	177.9	2,736	3,940	1.47
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	19.8	14.9		177.3			320.9	1,234	1,234	0.46
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	519.4	389.6	-	-	-	-	-	-	-	-
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	450.3	337.7	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	427.0	320.3	20.9	-	24.6	1,135	-	-	1,135	0.42
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	362.5	271.9	21.4	-	25.2	1,163	-	-	1,163	0.45
	Oct.		3,075.7	3,075.7		92.6	16.8	12.6		80.0			144.8	4,454	4,454	1.66
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,927.6	1,445.5	1,050.4	789.5	1,235.8	6,857	1,429.0	25,520	32,377	
1937	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	100.1	75.1	197.1	49.2	231.9	892	89.1	1,370	2,262	0.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	87.6	65.7	221.8	53.9	260.9	1,003	97.6	1,501	2,504	0.93
	Apr.		384.5	384.5		141.8	85.6	64.2		77.6			140.5	540	540	0.21
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	113.5	85.1	236.4	6.6	278.1	12,830	11.9	275	13,105	5.06
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	601.5	451.1	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	344.4	258.3	82.9	-	97.5	4,498	-	-	4,498	1.68
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	227.6	170.7	122.6	-	144.2	6,653	-	-	6,653	2.57
	Oct.		3,075.7	3,075.1		92.6	84.6	63.5		29.1			52.7	1,621	1,621	0.61
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,644.9	1,233.7	1,408.1	654.0	1,656.5	28,351	1,183.9	22,617	50,968	

Year	Month	Cropping Area (ha) Paddy Crops	Cropping Area (ha) Up-Land Crops	Cropping Area (ha) Total	Irrigation Requirement (mm) Paddy Crops	Irrigation Requirement (mm) Up-Land Crops	Rainfall (mm) Rainfall	Rainfall (mm) Effective Rainfall	Net Irrigation Requirement (mm) Paddy Crops	Net Irrigation Requirement (mm) Up-Land Crops	Irrigation Water Requirement Paddy Crops (mm)	Irrigation Water Requirement Paddy Crops (10^3cu.m)	Irrigation Water Requirement Up-Land Crops (mm)	Irrigation Water Requirement Up-Land Crops (10^3cu.m)	Irrigation Water Requirement Total (10^3cu.m)	Irrigation Water Requirement Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1938	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	23.4	17.6	254.6	106.7	299.5	1,152	193.1	2,970	4,122	1.70
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	14.2	10.7	276.8	108.9	325.7	1,252	197.1	3,031	4,283	1.60
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	6.4	4.8		187.4			339.2	1,304	1,304	0.49
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	357.4	268.1	53.4	-	62.8	2,897	-	-	2,897	1.12
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	728.0	546.0	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	616.7	462.5	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	317.2	237.9	55.4	-	65.2	3,008	-	-	3,008	1.16
	Oct.		3,075.7	3,075.7		92.6	251.5	188.6		-			-	-	-	-
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,314.8	1,736.2	1,187.5	790.2	1,397.1	10,784	1,430.3	24,264	35,048	
1939	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	82.8	62.1	225.4	57.5	265.2	1,020	104.1	1,601	2,621	0.98
	Apr.		384.5	384.5		141.8	1.3	1.0		140.8			254.8	980	980	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	282.4	211.8	109.7	-	129.1	5,956	-	-	5,956	2.30
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	334.3	250.7	80.2	-	94.4	4,355	-	-	4,355	1.63
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	693.2	519.9	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	124.5	93.4	199.9	30.4	235.2	10,851	55.0	1,692	12,543	4.84
	Oct.		3,075.7	3,075.7		92.6	90.7	68.0		24.6			44.5	1,369	1,369	0.51
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,609.2	1,206.9	1,434.6	815.2	1,688.0	25,888	1,475.5	26,412	52,300	

Year	Month	Cropping Area (ha			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops		Up-Land Crops		Total	
											(mm)	(10^3 cu.m)	(mm)	(10^3 cu.m)	(10^3 cu.m)	cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1940	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	11.4	8.6		133.2			241.1	927	927	0.36
	May		384.5	384.5		192.2	38.6	29.0		163.2			295.4	1,136	1,136	0.42
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	323.1	242.3	79.2	-	93.2	4,300	-	-	4,300	1.66
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	1,138.4	853.8	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	633.2	474.9	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	53.3	40.0	253.3	83.8	298.0	13,749	151.7	4,666	18,415	7.10
	Oct.		3,075.7	3,075.7		92.6	75.7	56.8		35.8			64.8	1,993	1,993	0.74
	Nov.		3,844.6	3,844.6		86.5	30.5	22.9		63.6			115.1	4,425	4,425	1.71
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3	71.6	53.7	228.9	24.7	269.3	1,035	44.7	1,547	2,582	0.96
	Total						2,375.8	1,782.0	1,385.8	828.8	1,630.3	22,812	1,500.2	26,532	49,344	
1941	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	27.7	20.8	243.9	59.8	286.9	1,103	108.2	3,744	4,847	1.81
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	10.2	7.7	264.5	116.6	311.2	1,197	211.0	3,245	4,442	1.84
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	17.8	13.4	274.1	106.2	322.5	1,240	192.2	2,956	4,196	1.57
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	62.2	46.7		145.5			263.4	1,013	1,013	0.38
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	268.2	201.2	120.3	-	141.5	6,528	-	-	6,528	2.52
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	323.1	242.3	88.6	-	104.2	4,807	-	-	4,807	1.79
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	301.5	226.1	115.1	-	135.4	6,247	-	-	6,247	2.33
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	213.4	160.1	133.2	-	156.7	7,230	-	-	7,230	2.79
	Oct.	-	3,075.7	3,075.7		92.6				92.6			167.6	5,155	5,155	1.92
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,224.1	918.3	1,522.3	827.3	1,790.9	29,630	1,497.4	28,024	57,654	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops		Up-Land Crops		Total	
											(mm)	(10^3cu.m)	(mm)	(10^3cu.m)	(10^3cu.m)	cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1942	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	53.3	40.0	232.2	84.3	273.2	1,050	152.6	2,347	3,397	1.40
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	196.6	147.5	174.0	-	204.7	9,444	-	-	9,444	3.64
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	958.1	718.6	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	598.2	448.7	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	222.3	166.7	126.6	-	148.9	6,870	-	-	6,870	2.65
	Oct.		3,075.7	3,075.7		92.6	49.0	36.8		55.8			101.0	3,106	3,106	1.16
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,077.5	1,558.3	1,367.6	839.1	1,608.9	21,139	1,518.9	27,080	48,219	
1943	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	0.5	0.4	-	141.8	-	-	256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	142.0	106.5	215.0	-	252.9	11,668	-	-	11,668	4.50
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	529.6	397.2	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	407.9	305.9	35.3	-	41.5	1,915	-	-	1,915	0.71
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	255.8	191.9	101.4	22.4	119.3	5,504	40.5	1,246	6,750	2.60
	Oct.		3,075.7	3,075.7		92.6	55.4	41.6		51.0			92.3	2,839	2,839	1.06
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,391.2	1,043.5	1,458.7	896.7	1,716.0	24,093	1,623.1	29,172	53,265	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1944	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	22.9	17.2	247.5	63.4	291.2	1,120	114.8	3,972	5,092	1.90
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	122.4	91.8	180.4	32.5	212.2	816	58.8	904	1,720	0.71
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	63.0	47.3	240.2	72.3	282.6	1,087	130.9	2,013	3,100	1.16
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	8.4	6.3	-	185.9	-	-	336.5	1,294	1,294	0.48
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	77.2	57.9	263.6	23.8	310.1	14,307	43.1	994	15,301	5.90
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	825.0	618.8	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	537.7	403.3	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	342.9	257.2	36.1	-	42.5	1,961	-	-	1,961	0.76
	Oct.		3,075.7	3,075.7		92.6	107.2	80.4	-	12.2	-	-	22.1	680	680	0.25
	Nov.		3,844.6	3,844.6		86.5			-	86.5	-	-	156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,106.7	1,580.2	1,250.4	696.7	1,471.1	20,569	1,261.2	21,768	42,337	
1945	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	15.2	11.4	253.3	69.2	298.0	1,146	125.3	4,336	5,482	2.05
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	55.9	41.9	-	99.9	-	-	180.8	695	695	0.27
	May		384.5	384.5		192.2			-	192.2	-	-	347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	420.1	315.1	6.4	-	7.5	346	-	-	346	0.13
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	696.0	522.0	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	526.0	394.5	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	519.4	389.6	-	-	-	-	-	-	-	-
	Oct.		3,075.7	3,075.7		92.6	39.9	29.9	-	62.7	-	-	113.5	3,491	3,491	1.30
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,272.5	1,704.4	1,102.0	832.7	1,296.4	5,301	1,507.3	27,574	32,875	

Year	Month	Cropping Area (ha) Paddy Crops	Cropping Area (ha) Up-Land Crops	Cropping Area (ha) Total	Irrigation Requirement (mm) Paddy Crops	Irrigation Requirement (mm) Up-Land Crops	Rainfall (mm) Rainfall	Rainfall (mm) Effective Rainfall	Net Irrigation Requirement (mm) Paddy Crops	Net Irrigation Requirement (mm) Up-Land Crops	Irrigation Water Requirement Paddy Crops (mm)	Irrigation Water Requirement Paddy Crops (10 cu.m)	Irrigation Water Requirement Up-Land Crops (mm)	Irrigation Water Requirement Up-Land Crops (10 cu.m)	Irrigation Water Requirement Total (10 cu.m)	Irrigation Water Requirement Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1946	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	4.1	3.1	284.4	116.5	334.6	1,287	210.9	3,243	4,530	1.69
	Apr.		384.5	384.5		141.8	42.4	31.8	-	110.0	-	-	199.1	766	766	0.30
	May		384.5	384.5		192.2	14.5	10.9	-	181.3	-	-	328.2	1,262	1,262	0.47
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	443.7	332.8	-	-	-	-	-	-	-	
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	645.9	484.4	-	-	-	-	-	-	-	
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	750.8	563.1	-	-	-	-	-	-	-	
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	162.6	122.0	171.3	1.8	201.5	9,296	3.3	101	9,397	3.63
	Oct.		3,075.7	3,075.7		92.6	20.3	15.2	-	77.4	-	-	140.1	4,309	4,309	1.61
	Nov.		3,844.6	3,844.6		86.5	24.9	18.7	-	67.8	-	-	122.7	4,717	4,717	1.82
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,109.2	1,582.0	1,275.2	838.0	1,500.2	14,289	1,516.9	27,809	42,098	
1947	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	27.4	20.6	244.1	60.0	287.2	1,104	108.6	3,758	4,862	1.82
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	45.0	33.8	238.4	90.5	280.5	1,079	163.8	2,519	3,598	1.49
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	9.9	7.4	280.1	112.2	329.5	1,267	203.1	3,123	4,390	1.64
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	3.3	2.5	-	189.7	-	-	343.4	1,320	1,320	0.49
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	194.3	145.7	175.8	-	206.8	9,541	-	-	9,541	3.68
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	868.7	651.5	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	398.3	298.7	42.5	-	50.0	2,307	-	-	2,307	0.86
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	196.9	147.7	145.6	-	171.3	7,903	-	-	7,903	3.05
	Oct.		3,075.7	3,075.7		92.6	40.6	30.5	-	62.1	-	-	112.4	3,457	3,457	1.29
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,784.4	1,338.4	1,409.1	821.1	1,657.8	24,479	1,486.3	26,088	50,567	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17)=(16)/ 30x86,400
1948	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	16.0	12.0	252.7	68.6	297.3	1,143	124.2	4,298	5,441	2.03
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	15.0	11.3	260.9	113.0	306.9	1,180	204.5	3,145	4,325	1.79
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	4.6	3.5	284.0	116.1	334.1	1,285	210.1	3,231	4,516	1.69
	Apr.		384.5	384.5		141.8	23.4	17.6	-	124.2	-	-	224.8	864	864	0.33
	May		384.5	384.5		192.2	1.5	1.1	-	191.1	-	-	345.9	1,330	1,330	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	94.0	70.5	251.0	21.2	295.3	13,624	38.4	886	14,510	5.60
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	516.1	387.1	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	510.5	382.9	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	219.7	164.8	128.5	-	151.2	6,976	-	-	6,976	2.69
	Oct.		3,075.7	3,075.7		92.6	25.9	19.4	-	73.2	-	-	132.5	4,075	4,075	1.52
	Nov.		3,844.6	3,844.6		86.5	99.3	74.5	-	12.0	-	-	21.7	834	834	0.32
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,526.0	1,144.7	1,459.7	797.7	1,717.3	25,486	1,443.8	23,566	49,052	
1949	Jan.	384.5	3,460.2	3,844.7	264 7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	6.6	5.0	-	136.8	-	-	247.6	952	952	0.37
	May		384.5	384.5		192.2	29.5	22.1	-	170.1	-	-	307.9	1,184	1,184	0.44
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	277.6	208.2	113.3	-	133.3	6,150	-	-	6,150	2.37
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	482.1	361.6	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	591.3	443.5	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	324.6	243.5	49.8	-	58.6	2,704	-	-	2,704	1.04
	Oct.		3,075.7	3,075.7		92.6	76.2	57.2	-	35.4	-		64.1	1,972	1,972	0.74
	Nov.		3,844.6	3,844.6		86.5			-	86.5	-		156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,787.9	1,341.1	1,270.1	831.6	1,494.2	13,860	1.505.3	26,870	40,730	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10³cu.m)	Up-Land Crops (mm)	Up-Land Crops (10³cu.m)	Total (10³cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1950	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	53.3	40.0	232.2	84.3	273.2	1,050	152.6	2,347	3,397	1.40
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	17.8	13.4	274.1	106.2	322.5	1,240	192.2	2,956	4,196	1.57
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	76.2	57.2	264.3	34.5	310.9	14,344	62.4	1,439	15,783	6.09
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	619.3	464.5	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	235.0	176.3	164.9	-	194.0	8,950	-	-	8,950	3.34
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	149.1	111.8	181.5	12.0	213.5	9,850	21.7	667	10,517	4.06
	Oct.		3,075.7	3,075.7		92.6				92.6			167.6	5,155	5,155	1.92
	Nov.		3,844.6	3,844.6		86.5	4.6	3.5	-	83.0	-	-	150.2	5,775	5,775	2.23
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,155.3	866.7	1,664.3	905.5	1,958.0	37,909	1,638.9	30,615	68,524	
1951	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	3.8	2.9	261.8	77.7	308.0	1,184	140.6	4,865	6,049	2.26
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	54.4	40.8	246.7	78.8	290.2	1,116	142.6	2,193	3,309	1.24
	Apr.		384.5	384.5		141.8	21.3	15.9	-	125.9	-	-	227.9	876	876	0.34
	May		384.5	384.5		192.2	44.7	33.5	-	158.7	-	-	287.2	1,104	1,104	0.41
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	143.5	107.6	213.9	-	251.7	11,612	-	-	11,612	4.48
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	749.3	561.9	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	754.6	566.0	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	71.4	53.6	239.7	70.2	282.0	13,010	127.1	3,909	16,919	6.25
	Oct.		3,075.7	3,075.7		92.6	98.6	74.0	-	18.6	-	-	33.7	1,037	1,037	0.39
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,941.6	1,456.2	1,516.9	819.0	1,784.6	29,431	1,482.4	28,368	57,799	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops		Up-Land Crops		Total	
											(mm)	(10^3cu.m)	(mm)	(10^3cu.m)	(10^3cu.m)	cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1952	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	2.8	2.1	270.1	122.2	317.8	1,222	221.2	3,402	4,624	1.91
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	56.6	42.5	-	99.3	-	-	179.7	691	691	0.27
	May		384.5	384.5		192.2			-	192.2	-	-	347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	217.4	163.1	158.4	-	186.4	8,600	-	-	8,600	3.32
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	478.3	358.7	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	688.6	516.5	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	260.6	195.5	97.8	-	115.1	5,310	-	-	5,310	2.05
	Oct.		3,075.7	3,075.7		92.6	19.8	14.9	-	77.7	-	-	140.6	4,324	4,324	1.61
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,724.1	1,293.3	1,361.1	856.4	1,601.4	18,907	1,550.1	29,057	47,964	
1953	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	94.5	70.9	-	70.9	-	-	128.3	493	493	0.19
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	194.8	146.1	175.4	-	206.4	9,522	-	-	9,522	3.67
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	505.7	379.2	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	826.3	619.7	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	296.9	222.6	70.7	-	83.2	3,839	-	-	3,839	1.48
	Oct.		3,075.7	3,075.7		92.6	139.7	104.7	-	-	-	-	-	-	-	-
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,057.9	1,543.2	1,353.1	752.4	1,591.9	18,367	1,361.9	24,593	42,960	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)= (3)+(4)	(6)	(7)	(8)	(9)= 0.75x(8)	(10)= (6)-(9)	(11)= (7)-(9)	(12)=(10)/ (1-0.15)	(13)= (3)x(12)	(14)=(11)/ 0.65(1-0.15)	(15)= (4)x(14)	(16)= (13)+(15)	(17=(16)/ 30x86,400
1954	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	101.9	76.4	211.1	43.2	248.4	955	78.2	1,203	2,158	0.81
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	7.1	5.3	-	186.9	-	-	338.3	1,301	1,301	0.49
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	114.8	86.1	235.4	5.6	276.9	12,775	10.1	233	13,008	5.02
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	558.8	419.1	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	491.5	368.6	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	400.3	300.2	-	-	-	-	-	-	-	-
	Oct.		3,075.7	3,075.7		92.6				92.6			167.6	5,155	5,155	1.92
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,674.4	1,255.7	1,266.0	839.8	1,489.4	17,436	1,520.1	28,311	45,747	
1955	Jan.	384.5	3,460.2	3,844.7	264.7	80.6	3.0	2.3	262.4	78.3	308.7	1,187	141.7	4,903	6,090	2.27
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	1.3	0.9	-	191.3	-	-	346.3	1,332	1,332	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	320.5	240.3	81.2	-	95.5	4,406	-	-	4,406	1.70
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	366.3	274.7	56.2	-	66.1	3,050	-	-	3,050	1.14
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	840.7	630.5	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	318.3	238.7	54.6	-	64.2	2,962	-	-	2,962	1.14
	Oct.		3,075.7	3,075.7		92.6	325.1	243.8	-	-	-	-	-	-	-	-
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						2,175.2	1,631.2	1,296.7	820.1	1,525.4	15,414	1,484.5	24,936	40,350	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1956	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3	4.6	3.5	268.7	120.8	316.1	1,215	218.6	3,362	4,577	1.90
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2	33.3	24.9		167.3			302.8	1,164	1,164	0.44
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	451.6	338.7	-	-	-	-	-	-	-	-
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	747.8	560.9	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	366.8	275.1	66.1	-	77.8	3,589	-	-	3,589	1.34
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	254.0	190.5	102.8	-	120.9	5,578	-	-	5,578	2.16
	Oct.		3,075.7	3,075.7		92.6				92.6			167.6	5,155	5,155	1.93
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,858.1	1,393.6	1,272.4	887.5	1,496.9	14,157	1,606.4	29,970	44,127	
1957	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7			321.5	91.7	378.2	17,449	166.0	3,829	21,278	8.21
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	480.3	360.2	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	777.2	582.9	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	30.5	22.8	270.5	-	318.2	14,680	-	-	14,680	5.66
	Oct.		3,075.7	3,075.7		92.6	39.4	29.6	-	63.0	-	-	114.0	3,506	3,506	1.31
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.6	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,327.4	995.5	1,699.0	978.0	1,998.7	37,135	1,770.3	32,422	69,557	

Year	Month	Cropping Area (ha) Paddy Crops	Up-Land Crops	Total	Irrigation Requirement (mm) Paddy Crops	Up-Land Crops	Rainfall (mm) Rainfall	Effective Rainfall	Net Irrigation Requirement (mm) Paddy Crops	Up-Land Crops	Irrigation Water Requirement Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)=(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1958	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	38.6	29.0	258.5	90.6	304.1	1,169	164.0	2,522	3,691	1.34
	Apr.		384.5	384.5		141.8	20.3	15.2		126.6			229.1	881	881	0.34
	May		384.5	384.5		192.2	13.2	9.9		182.3			330.0	1,269	1,269	0.47
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	77.1	57.8	263.7	33.9	310.2	14,311	61.4	1,416	15,727	6.07
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	351.5	263.6	67.3	-	79.2	3,654	-	-	3,654	1.36
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	382.0	286.5	54.7	-	64.4	2,971	-	-	2,971	1.11
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	264.2	198.2	95.1	-	111.9	5,163	-	-	5,163	1.99
	Oct.		3,075.7	3,075.7		92.6	71.1	53.3		39.3			71.1	2,187	2,187	0.82
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,218.0	913.5	1,558.8	842.4	1,833.9	30,974	1,524.8	27,707	58,681	
1959	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6			287.5	119.6	338.2	1,300	216.5	3,330	4,630	1.73
	Apr.		384.5	384.5		141.8	75.2	56.4		85.4			154.6	594	594	0.23
	May		384.5	384.5		192.2	20.3	15.2		177.0			320.4	1,232	1,232	0.46
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	266.7	200.0	121.5	-	142.9	6,591	-	-	6,591	2.54
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	622.3	466.7	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	614.7	461.0	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	604.5	453.3	-	-	-	-	-	-	-	-
	Oct.		3,075.7	3,075.7		92.6	30.5	22.8		69.8			125.6	3,863	3,863	1.44
	Nov.		3,844.6	3,844.6		86.5				86.5			155.7	5,986	5,986	2.31
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	140.9	4,875	6,153	2.30
	Total						2,234.2	1,675.4	1,228.5	821.5	1,445.2	11,597	1,484.6	28,388	39,985	

Year	Month	Cropping Area (ha)			Irrigation Requirement (mm)		Rainfall (mm)		Net Irrigation Requirement (mm)		Irrigation Water Requirement					
		Paddy Crops	Up-Land Crops	Total	Paddy Crops	Up-Land Crops	Rainfall	Effective Rainfall	Paddy Crops	Up-Land Crops	Paddy Crops (mm)	Paddy Crops (10^3cu.m)	Up-Land Crops (mm)	Up-Land Crops (10^3cu.m)	Total (10^3cu.m)	Total cu.m/sec
(1)	(2)	(3)	(4)	(5)=(3)+(4)	(6)	(7)	(8)	(9)=0.75x(8)	(10)=(6)-(9)	(11)(7)-(9)	(12)=(10)/(1-0.15)	(13)=(3)x(12)	(14)=(11)/0.65(1-0.15)	(15)=(4)x(14)	(16)=(13)+(15)	(17)=(16)/30x86,400
1960	Jan.	384.5	3,460.2	3,844.7	264.7	80.6			264.7	80.6	311.4	1,197	145.9	5,048	6,245	2.33
	Feb.	384.5	1,537.9	1,922.4	272.2	124.3			272.2	124.3	320.2	1,231	225.0	3,460	4,691	1.94
	Mar.	384.5	1,537.9	1,922.4	287.5	119.6	76.2	57.2	230.3	62.4	270.9	1,042	112.9	1,736	2,778	1.04
	Apr.		384.5	384.5		141.8				141.8			256.7	987	987	0.38
	May		384.5	384.5		192.2				192.2			347.9	1,338	1,338	0.50
	Jun.	4,613.6	2,306.8	6,920.4	321.5	91.7	266.7	200.0	121.5	-	142.9	6,593	-	-	6,593	2.54
	Jul.	4,613.6	2,306.8	6,920.4	330.9	127.6	569.0	426.8	-	-	-	-	-	-	-	-
	Aug.	4,613.6	3,075.7	7,689.3	341.2	130.7	457.2	342.9	-	-	-	-	-	-	-	-
	Sep.	4,613.6	3,075.7	7,689.3	293.3	123.8	63.5	47.6	245.7	76.2	289.1	13,338	137.9	4,241	17,579	6.78
	Oct.		3,075.7	3,075.7		92.6	114.3	85.7		6.9			12.5	384	384	0.14
	Nov.		3,844.6	3,844.6		86.5				86.5			156.6	6,021	6,021	2.32
	Dec.	384.5	3,460.2	3,844.7	282.6	78.3			282.6	78.3	332.5	1,278	141.7	4,903	6,181	2.31
	Total						1,546.9	1,160.2	1,417.0	849.2	1,667.0	24,679	1,537.1	28,118	52,797	

TABLE 3-2 Operation Study of Paralkote Dam

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1922	Jan.												
	Feb.												
	Mar.												
	Apr.												
	May												
	Jun.			1,985	7,783	2,880	10,663	191.0					
	Jul.			41,396				84.6					
	Aug.				25,796	9,545	35,341	77.7					
	Sep.			45,151				72.6			66,400		
	Oct.	348.69	11,550	259	5,155	1,907	7,062	86.6	1,000	- 7,803	58,597		
	Nov.	348.00	7,700	250	6,021	2,228	8,249	79.8	614	- 8,613	49,984		
	Dec.	347.10	8,750	259	6,181	2,287	8,468	74.4	651	- 8,860	41,124		
	Total												
1923	Jan.	346.10	8,200	259	6,245	2,311	8,556	90.4	741	- 9,038	32,086		
	Feb.	344.90	7,000	234	4,691	1,736	6,427	108.2	757	- 6,950	25,136		
	Mar.	343.80	5,850	259	4,352	1,610	5,962	198.1	1,159	- 6,862	18,274		
	Apr.	343.50	4,850	250	987	365	1,352	280.4	1,360	- 2,462	15,812		
	May	342.00	4,400	259	1,338	495	1,833	398.0	1,751	- 3,325	12,487		
	Jun.	341.20	3,800	250	20,694	7,657	28,351	191.0	726	-29,017	1,274		-17,804
	Jul.	335.60	820	7,083	983	364	1,347	84.6	668	+ 5,668	6,942		
	Aug.	339.20	2,500	19,020	4,189	1,550	5,739	77.7	194	+13,087	20,029		
	Sep.	342.80	5,050	28,788	1,135	420	1,550	72.6	367	+26,871	46,800		
	Oct.	346.70	8,850	6,106	3,094	1,145	4,239	86.6	766	+ 1,101	47,901		
	Nov.	346.90	9,000	250	6,021	2,228	8,249	79.8	718	- 8,717	39,184		
	Dec.	345.80	8,200	259	6,181	2,287	8,468	74.4	610	- 8,819	30,365		
	Total			62,827	59,910	22,168	82,073	1,741.8	9,217	-28,463			-17,804

Note: Catchment Area : 120.1 sq.km

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1924	Jan.	344.60	6,650	10,929	788	292	1,080	90.4	601	+ 9,248	39,613		
	Feb.	345.90	8,050	234	4,691	1,736	6,427	108.2	871	- 7,064	32,549		
	Mar.	344.90	6,950	259	4,611	1,706	6,317	198.1	1,377	- 7,435	25,114		
	Apr.	343.80	5,900	250	962	356	1,318	280.4	1,654	- 2,722	22,392		
	May	343.30	5,450	259	1,291	478	1,769	398.0	2,169	- 3,679	18,713		
	Jun.	342.60	4,850	305	18,697	6,918	25,615	191.0	926	-26,236	1,074		-8,597
	Jul.	335.10	650	24,056				84.6	55	+24,001	25,075		
	Aug.	343.80	5,850	27,537	4,572	1,692	6,264	77.7	455	+20,818	45,893		
	Sep.	346.60	7,750	39,687				72.6	563	+39,124	66,400	18,617	
	Oct.	348.69	11,550	12,211	280	104	384	86.6	996	+10,831	66,400	10,831	
	Nov.	348.69	11,550	6,960	1,538	569	2,107	79.8	918	+ 3,935	66,400	3,935	
	Dec.	348.69	11,550	259	6,181	2,287	8,468	74.4	856	- 9,065	57,335		
	Total			122,946	43,611	16,138	59,749	1,741.8	11,441	+51,756		33,383	-8,597
1925	Jan.	347.90	10,350	259	6,245	2,311	8,556	90.4	936	- 9,233	48,102		
	Feb.	346.90	9,100	234	4,691	1,736	6,427	108.2	985	- 7,178	40,924		
	Mar.	346.00	8,150	259	4,380	1,621	6,001	198.1	1,615	- 7,357	33,567		
	Apr.	345.10	7,150	250	974	360	1,334	280.4	2,005	- 3,089	30,478		
	May	344.70	6,800	259	1,230	455	1,685	398.0	2,706	- 4,132	26,346		
	Jun.	344.00	6,100	702	15,375	5,689	21,064	191.0	1,165	-21,527	4,819		
	Jul.	338.20	1,950	14,654				84.6	165	+14,489	19,308		
	Aug.	342.70	5,000	41,121				77.7	389	+40,732	60,040		
	Sep.	348.10	10,650	13,738	10,013	3,705	13,718	72.6	773	- 753	59,287		
	Oct.	348.00	10,550	3,053	4,404	1,629	6,033	86.6	914	- 3,894	55,393		
	Nov.	347.70	10,150	250	5,951	2,202	8,153	79.8	810	- 8,713	46,680		
	Dec.	346.70	8,900	259	6,181	2,287	8,468	74.4	662	- 8,871	37,809		
	Total			75,038	59,444	21,995	81,439	1,741.8	13,125	-19,526			

Year	Month	Initial Reservoir Level (m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation (10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	Evaporation (10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1926	Jan.	345.60	7,700	259	5,607	2,075	7,682	90.4	696	- 8,119	29,690		
	Feb.	344.50	6,550	234	4,691	1,736	6,427	108.2	709	- 6,902	22,788		
	Mar.	343.40	5,550	259	4,630	1,713	6,343	198.1	1,099	- 7,183	15,605		
	Apr.	341.90	4,350	250	987	365	1,352	280.4	1,220	- 2,322	13,283		
	May	341.40	3,950	259	1,338	495	1,833	398.0	1,572	- 3,146	10,137		
	Jun.	340.70	3,450	91	20,452	7,567	28,019	191.0	659	-28,587	1,341		-20,450
	Jul.	332.50	150	6,991	1,250	463	1,713.	84.6	13	+ 5,265	6,606		
	Aug.	339.00	2,400	48,754				77.7	186	+48,568	55,174		
	Sep.	346.60	10,000	8,273	15,525	5,744	21,269	72.6	726	-13,722	41,452		
	Oct.	346.10	8,250	3,053	2,722	1,007	3,729	86.6	714	- 1,390	40,062		
	Nov.	345.90	8,050	250	6,021	2,228	8,249	79.8	642	- 8,641	31,421		
	Dec.	344.80	6,900	259	6,181	2,287	8,468	74.4	513	- 8,722	22,699		
	Total			68,932	69,404	25,680	95,084	1,741.8	8,749	-34,901			-20,450
1927	Jan.	343.30	5,500	259	6,245	2,311	8,556	90.4	497	- 8,794	13,905		
	Feb.	341.50	4,000	234	4,691	1,736	6,427	108.2	433	- 6,626	7,279		
	Mar.	339.40	2,620	259	4,630	1,713	6,343	198.1	519	- 6,603	1,481		- 805
	Apr.	335.80	900	250	987	365	1,352	280.4	252	- 1,354	1,229		- 1,100
	May	335.50	800	259	1,338	495	1,833	398.0	318	- 1,892	911		- 1,574
	Jun.	335.00	620	250	21,278	7,873	29,151	191.0	118	-29,019	793		-28,901
	Jul.	334.80	550	40,816				84.6	47	+40,769	41,562		
	Aug.	346.10	8,250	51,470				77.7	641	+50,829	66,400	25,991	
	Sep.	348.69	11,550	5,404	17,303	6,402	23,705	72.6	835	-19,136	47,264		
	Oct.	346.80	8,950	18,317				86.6	775	+17,542	64,806		
	Nov.	348.60	11,350	2,281	4,879	1,805	6,684	79.8	906	- 5,309	59,497		
	Dec.	343.10	10,700	259	6,181	2,287	8,468	74.4	796	- 9,005	50,492		
	Total			120,058	67,532	24,987	92,519	1,741.8	6,137	+21,402		25,991	-32,380

Year	Month	Initial Reservoir Level (m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1928	Jan.	347.20	9,500	259	6,245	2,311	8,556	90.4	859	- 9,156	41,336		
	Feb.	346.10	8,250	234	4,645	1,719	6,364	108.2	893	- 7,023	34,313		
	Mar.	345.20	7,250	259	4,630	1,713	6,343	198.1	1,436	- 7,520	26,793		
	Apr.	344.00	6,100	250	987	365	1,352	280.4	1,710	- 2,812	23,981		
	May	343.60	5,750	259	1,338	495	1,833	398.0	2,289	- 3,863	20,118		
	Jun.	342.90	5,150	1,099	12,157	4,498	16,655	191.0	984	-16,540	3,578		
	Jul.	337.50	1,600	12,882				84.6	135	+12,747	16,325		
	Aug.	342.10	4,500	10,441	11,615	4,298	15,913	77.7	350	- 5,822	10,503		
	Sep.	340.50	3,300	12,211	9,052	3,349	12,401	72.6	240	- 430	10,073		
	Oct.	340.40	3,200	18,440	1,870	692	2,562	86.6	277	+15,601	25,674		
	Nov.	343.90	6,000	250	6,021	2,228	8,249	79.8	479	- 8,478	17,196		
	Dec.	342.30	4,650	259	6,181	2,287	8,468	74.4	346	- 8,555	8,641		
	Total			56,843	64,741	23,955	88,696	1,741.8	9,998	-41,851			
1929	Jan.	339.90	2,900	259	6,245	2,311	8,556	90.4	262	- 8,559	1,738		- 1,918
	Feb.	336.00	950	234	3,425	1,267	4,692	108.2	103	- 4,561	1,635		- 4,458
	Mar.	335.90	930	259	4,630	1,713	6,343	198.1	184	- 6,268	1,451		- 6,084
	Apr.	335.70	860	250	900	333	1,233	280.4	241	- 1,224	1,210		- 983
	May	335.30	730	259	1,338	495	1,833	398.0	291	- 1,865	919		- 1,574
	Jun.	335.00	620	1,221	11,511	4,259	15,770	191.0	118	-14,667	801		-14,549
	Jul.	334.60	500	30,864				84.6	42	+30,822	31,723		
	Aug.	334.90	7,000	35,077	2,344	867	3,211	77.7	544	+31,322	63,045		
	Sep.	348.40	11,130	21,370	6,593	2,439	9,032	72.6	808	+11,530	66,400	8,175	
	Oct.	348.69	11,550	259	4,943	1,829	6,772	86.6	996	- 7,509	58,891		
	Nov.	348.00	10,600	250	6,021	2,228	8,249	79.8	846	- 8,845	50,046		
	Dec.	347.10	9,400	4,564	4,093	1,514	5,607	74.4	699	- 1,742	48,304		
	Total			94,866	52,043	19,255	71,298	1,741.8	5,134	+18,434		8,175	-29,566

Year	Month	Initial Reservoir Level (m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation (10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1930	Jan.	346.90	9,150	259	6,245	2,311	8,556	90.4	827	- 9,124	39,180		
	Feb.	345.80	7,900	234	4,016	1,486	5,502	108.2	855	- 6,123	33,057		
	Mar.	345.00	7,050	259	4,630	1,713	6,343	198.1	1,397	- 7,481	25,576		
	Apr.	343.80	5,850	250	987	365	1,352	280.4	1,640	- 2,742	22,834		
	May	343.40	5,550	259	1,338	495	1,833	398.0	2,209	- 3,783	19,051		
	Jun.	342.70	5,000	3,357	4,872	1,803	6,675	191.0	955	- 4,273	14,778		
	Jul.	341.70	4,200	26,987				84.6	355	+26,632	41,410		
	Aug.	346.10	8,300	33,123	2,796	1,035	3,831	77.7	645	+28,647	66,400	3,657	
	Sep.	348.69	11,550	22,011	7,050	2,609	9,659	72.6	839	+11,513	66,400	11,513	
	Oct.	348.69	11,550	259	4,171	1,543	5,714	86.6	1,000	- 6,455	59,945		
	Nov.	343.10	10,750	15,013				79.8	858	+14,155	66,400	7,700	
	Dec.	348.69	11,550	259	6,181	2,287	8,468	74.4	859	- 9,068	57,332		
	Total			102,270	42,286	15,647	57,933	1,741.8	12,439	+31,898		22,870	
1931	Jan.	347.80	10,300	259	6,245	2,311	8,556	90.4	931	- 9,228	48,104		
	Feb.	346.90	9,100	234	4,671	1,728	6,399	108.2	985	- 7,150	40,954		
	Mar.	346.10	8,300	259	3,520	1,302	4,822	198.1	1,644	- 6,207	34,747		
	Apr.	345.20	7,250	250	974	360	1,334	280.4	2,033	- 3,117	31,630		
	May	344.80	6,850	259	1,338	495	1,833	398.0	2,726	- 4,300	27,330		
	Jun.	344.10	6,200	641	15,449	5,716	21,165	191.0	1,184	-21,708	5,622		
	Jul.	338.60	2,150	10,898				84.6	182	+10,716	16,338		
	Aug.	342.10	4,550	45,060				77.7	354	+44,706	61,044		
	Sep.	343.20	10,800	31,933	1,790	662	2,452	72.6	784	+28,697	66,400	23,341	
	Oct.	348.69	11,550	30,528				86.6	1,000	+29,528	66,400	29,528	
	Nov.	348.69	11,550	12,610	1,888	699	2,587	79.8	922	+ 9,101	66,400	9,101	
	Dec.	348.69	11,550	259	6,181	2,287	8,468	74.4	859	- 9,068	57,332		
	Total			133,190	42,056	15,560	57,616	1,741.8	13,604	+61,970		61,970	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1932	Jan.	347.80	10,300	259	6,245	2,311	8,556	90.4	931	- 9,228	48,104		
	Feb.	346.90	9,100	234	4,118	1,524	5,642	108.2	985	- 6,393	41,711		
	Mar.	346.10	8,300	259	4,630	1,713	6,343	198.1	1,644	- 7,728	33,983		
	Apr.	345.20	7,300	250	987	365	1,352	280.4	2,047	- 3,149	30,834		
	May	344.70	6,800	259	1,338	495	1,833	398.0	2,706	- 4,280	26,554		
	Jun.	344.00	6,100	1,526	10,090	3,733	13,823	191.0	1,165	-13,462	13,092		
	Jul.	341.30	3,900	60,996				84.6	330	+60,666	66,400	7,358	
	Aug.	348.69	11,550	22,255	8,434	3,120	11,554	77.7	897	+ 9,804	66,400	9,804	
	Sep.	348.69	11,550	22,072	7,183	2,658	9,841	72.6	839	+11,392	66,400	11,392	
	Oct.	348.69	11,550	6,106	4,263	1,577	5,840	86.6	1,000	- 734	65,666		
	Nov.	343.60	11,350	250	5,552	2,054	7,606	79.8	906	- 8,262	57,404		
	Dec.	347.90	10,350	259	6,181	2,287	8,468	74.4	770	- 8,979	48,425		
	Total			114,725	59,021	21,837	80,858	1,741.8	14,220	+19,647		28,554	
1933	Jan.												
	Feb.												
	Mar.												
	Apr.												
	May												
	Jun.												
	Jul,												
	Aug.												
	Sep.												
	Oct.												
	Nov.												
	Dec.												
	Total												

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1934	Jan.												
	Feb.												
	Mar.												
	Apr,												
	May												
	Jun.												
	Jul.												
	Aug.												
	Sep.			21,003	6,708	2,482	9,190	72.6			66,400		
	Oct.	348.69	11,550	3,053	4,371	1,617	5,988	86.6	1,000	- 3,935	62,465		
	Nov.	348.30	11,000	250	5,609	2,075	7,684	79.8	878	- 8,312	54,153		
	Dec.	347.50	9,900	259	6,181	2,287	8,468	74.4	737	- 8,946	45,207		
	Total												
1935	Jan.	346.50	8,700	259	6,153	2,277	8,430	90.4	786	- 8,957	36,250		
	Feb.	345.40	7,500	234	4,691	1,736	6,427	108.2	812	- 7,005	29,245	—	
	Mar.	344.40	6,500	259	4,630	1,713	6,343	198.1	1,288	- 7,312	21,933		
	Apr.	343.20	5,400	250	911	337	1,248	280.4	1,514	- 2,512	19,421		
	May	342.70	5,000	259	1,338	495	1,833	398.0	1,990	- 3,564	15,857		
	Jun.	342.00	4,250	793	14,510	5,369	19,879	191.0	812	-19,898	1,188		-5,229
	Jul.	335.60	800	31,141				84.6	68	+31,073	32,261		
	Aug.	344.90	7,000	22,011	8,046	2,977	11,023	77.7	544	+10,444	42,705		
	Sep.	346.30	8,950	37,641				72.6	650	+36,991	66,400	13,296	
	Oct.	348.69	11,550	259	5,155	1,907	7,062	86.6	1,000	- 7,803	58,597		
	Nov.	348.00	7,650	250	6,021	2,228	8,249	79.8	610	- 8,609	49,988		
	Dec.	347.10	9,350	259	6,181	2,287	8,468	74.4	696	- 8,905	41,083		
	Total			93,615	57,636	21,326	78,962	1,741.8	10,770	+ 3,883		13,296	-5,229

Year	Month	Initial Reservoir Level (m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1936	Jan.	346.20	8,300	259	4,001	1,480	5,481	90.4	750	- 5,972	35,864		
	Feb.	345.40	7,500	234	3,261	1,207	4,468	108.2	812	- 5,046	30,818		
	Mar.	344.70	6,800	259	3,940	1,458	5,398	198.1	1,347	- 6,486	24,332		
	Apr.	343.60	5,700	250	987	365	1,352	280.4	1,598	- 2,700	21,632		
	May	343.20	5,400	259	1,234	457	1,691	398.0	2,149	- 3,581	18,051		
	Jun.	342.50	4,800	10,624				191.0	917	+ 9,707	27,758		
	Jul.	344.20	6,300	30,162				84.6	533	+29,629	57,387		
	Aug.	347.80	10,300	38,618	1,135	420	1,555	77.7	800	+36,263	66,400	27,250	
	Sep.	348.69	11,550	36,603	1,163	430	1,593	72.6	839	+34,171	66,400	34,171	
	Oct.	348.69	11,550	259	4,454	1,648	6,102	86.6	1,000	- 6,843	59,557		
	Nov.	348.10	10,700	250	6,021	2,228	8,249	79.8	854	- 8,853	50,704		
	Dec.	347.20	9,450	259	6,181	2,287	8,468	74.4	703	- 8,912	41,792		
	Total			118,036	32,377	11,980	44,357	1,741.8	12,302	+61,377		61,421	
1937	Jan.	346.10	8,300	259	6,245	2,311	8,556	90.4	750	- 9,047	32,745		
	Feb.	344.90	7,000	234	2,262	837	3,099	108.2	757	- 3,622	29,123		
	Mar.	344.50	6,600	259	2,504	926	3,430	198.1	1,307	- 4,478	24,645		
	Apr.	343.70	5,800	250	540	200	740	280.4	1,626	- 2,116	22,529		
	May	343.30	5,450	259	1,338	495	1,833	398.0	2,169	- 3,743	18,786		
	Jun.	342.60	4,900	946	13,105	4,849	17,954	191.0	936	-17,944	832		
	Jul.	334.60	500	20,546				84.6	42	+20,504	21,336		
	Aug.	343.10	5,300	27,780	4,498	1,664	6,162	77.7	412	+21,206	42,542		
	Sep.	346.20	8,350	20,943	6,653	2,462	9,115	72.6	606	+11,222	53,764		
	Oct.	347.50	9,850	6,106	1,621	600	2,221	86.6	853	+ 3,032	56,796		
	Nov.	347.80	10,300	250	6,021	2,228	8,249	79.8	822	- 8,821	47,975		
	Dec.	346.80	9,000	259	6,181	2,287	8,468	74.4	670	- 8,879	39,096		
	Total			78,091	50,968	18,859	69,827	1,741.8	10,950	- 2,686			

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1938	Jan.	345.80	7,900	259	6,245	2,311	8,556	90.4	714	- 9,011	30,085		
	Feb.	344.60	6,650	234	4,122	1,525	5,647	108.2	720	- 6,133	23,952		
	Mar.	343.60	5,700	259	4,283	1,585	5,868	198.1	1,129	- 6,738	17,214		
	Apr.	342.30	4,650	250	987	365	1,352	280.4	1,304	- 2,406	14,808		
	May	341.70	4,200	259	1,304	482	1,786	398.0	1,672	- 3,199	11,609		
	Jun.	340.80	3,500	4,732	2,897	1,072	3,969	191.0	669	+ 94	11,703		
	Jul.	340.90	3,550	46,800				84.6	300	+46,500	58,203		
	Aug.	348.00	10,600	57,912				77.7	824	+57,088	66,400	48,891	
	Sep.	348.69	11,550	37,091	3,008	1,113	4,121	72.6	835	+32,135	66,400	32,135	
	Oct.	348.69	11,550	30,528				86.6	1,000	+29,528	66,400	29,528	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	918	- 8,917	57,483		
	Dec.	347.90	10,400	259	6,181	2,287	8,468	74.4	774	- 8,983	48,500		
	Total			178,833	35,048	12,968	48,016	1,741.8	10,859	+119,958		110,554	
1939	Jan.	347.00	9,250	259	6,245	2,311	8,556	90.4	836	- 9,133	39,367		
	Feb.	345.90	8,000	234	4,691	1,736	6,427	108.2	866	- 7,059	32,308		
	Mar.	344.90	6,950	259	2,621	970	3,591	198.1	1,377	- 4,709	27,599		
	Apr.	344.20	6,250	250	980	363	1,343	280.4	1,753	- 2,846	23,753		
	May	343.60	5,750	259	1,338	495	1,833	398.0	2,289	- 3,863	19,890		
	Jun.	342.90	5,100	2,717	5,956	2,204	8,160	191.0	974	- 6,417	13,473		
	Jul.	341.40	3,950	25,186	4,355	1,611	5,966	84.6	334	+18,886	32,359		
	Aug.	344.90	7,000	56,233				77.7	544	+55,689	66,400	21,648	
	Sep.	348.69	11,550	10,624	12,543	4,641	17,184	72.6	839	- 7,399	59,001		
	Oct.	348.00	10,600	9,158	1,369	507	1,876	86.6	918	+ 6,364	65,365		
	Nov.	348.60	11,400	250	6,021	2,228	8,249	79.8	910	- 8,909	56,456		
	Dec.	347.80	10,350	259	6,181	2,287	8,468	74.4	770	- 8,979	47,477		
	Total			105,688	52,300	19,353	71,653	1,741.8	12,410	+21,625		21,648	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1940	Jan.	346.80	8,900	259	6,245	2,311	8,556	90.4	805	- 9,102	38,375		
	Feb.	345.70	7,850	234	4,691	1,736	6,427	108.2	849	- 7,042	31,333		
	Mar.	344.80	6,900	259	4,630	1,713	6,343	198.1	1,367	- 7,451	23,882		
	Apr.	343.60	5,750	250	927	343	1,270	280.4	1,612	- 2,632	21,250		
	May	343.10	5,300	259	1,136	420	1,556	398.0	2,109	- 3,406	17,844		
	Jun.	342.40	4,750	3,877	4,300	1,591	5,891	191.0	907	- 2,921	14,923		
	Jul.	341.80	4,250	82,151				84.6	360	+81,791	66,400	30,314	
	Aug.	348.69	11,550	67,559				77.7	897	+66,662	66,400	66,662	
	Sep.	348.69	11,550	8,212	18,415	6,814	25,229	72.6	839	-17,856	48,544		
	Oct.	346.90	9,150	9,158	1,993	737	2,730	86.6	792	+ 5,636	54,180		
	Nov.	347.60	10,050	3,002	4,425	1,637	6,062	79.8	802	- 3,862	50,318		
	Dec.	347.20	9,500	6,005	2,582	955	3,537	74.4	707	+ 1,761	52,079		
	Total			181,225	49,344	18,257	67,601	1,741.8	12,046	+101,578		96,976	
1941	Jan.	347.40	9,800	259	4,847	1,793	6,640	90.4	886	- 7,267	44,812		
	Feb.	346.50	8,650	234	4,442	1,644	6,086	108.2	936	- 6,788	38,024		
	Mar.	345.60	7,700	259	4,196	1,553	5,749	198.1	1,525	- 7,015	31,009		
	Apr.	344.70	6,800	250	987	365	1,352	280.4	1,907	- 3,009	28,000		
	May	344.30	6,400	259	1,013	375	1,388	398.0	2,547	- 3,676	24,324		
	Jun.	343.70	5,750	2,564	6,528	2,415	8,943	191.0	1,098	- 7,477	16,847		
	Jul.	342.20	4,600	11,661	4,807	1,779	6,586	84.6	389	+ 4,686	21,533		
	Aug.	343.10	5,300	20,119	6,247	2,311	8,558	77.7	412	+11,149	32,682		
	Sep.	344.90	7,000	20,606	7,230	2,675	9,905	72.6	508	+10,193	42,875		
	Oct.	346.30	8,450	259	5,155	1,907	7,062	86.6	732	- 7,535	35,340		
	Nov.	345.30	7,400	250	6,021	2,228	8,249	79.8	591	- 8,590	26,750		
	Dec.	344.00	6,100	259	6,181	2,287	8,468	74.4	454	- 8,663	18,087		
	Total			56,979	57,654	21,332	78,986	1,741.8	11,985	-33,992			

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1942	Jan.	342.50	4,800	259	6,245	2,311	8,556	90.4	434	- 8,731	9,356		
	Feb.	340.20	3,100	234	3,397	1,257	4,654	108.2	335	- 4,755	4,901		
	Mar.	338,20	1,950	259	4,630	1,713	6,343	198.1	386	- 6,470	1,614		- 3,183
	Apr.	335.80	850	250	987	365	1,352	280.4	238	- 1,340	1,376		- 1,102
	May	335.60	820	259	1,338	495	1,833	398.0	326	- 1,900	1,050		- 1,574
	Jun.	335.10	650	1,648	9,444	3,494	12,938	191.0	124	-11,414	926		-11,290
	Jul.	334.80	550	55,257				84.6	47	+55,210	56,136		
	Aug.	347.80	10,300	57,912				77.7	800	+57,112	66,400	46,848	
	Sep.	348.69	11,550	25,607	6,870	2,542	9,412	72.6	839	+15,356	66,400	15,356	
	Oct.	348.69	11,550	6,106	3,106	1,149	4,255	86.6	1,000	+ 851	66,400	851	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.90	10,450	259	6,181	2,287	8,468	74.4	777	- 8,986	48,493		
	Total			148,300	48,219	17,841	66,060	1,741.8	6,228	+76,012		63,055	-17,149
1943	Jan.	347.00	9,200	259	6,245	2,311	8,556	90.4	832	- 9,129	39,364		
	Feb.	345.80	7,900	234	4,691	1,736	6,427	108.2	855	- 7,048	32,316		
	Mar.	344.90	7,000	259	4,630	1,713	6,343	198.1	1,387	- 7,471	24,845		
	Apr.	343.70	5,850	250	987	365	1,352	280.4	1,640	- 2,742	22,103		
	May	343.20	5,400	259	1,338	495	1,833	398.0	2,149	- 3,723	18,380		
	Jun.	342.50	4,850	1,190	11,668	4,317	15,985	191.0	926	-15,721	2,659		
	Jul.	337.00	1,400	17,371				84.6	118	+17,253	19,912		
	Aug.	342.90	5,150	32,695	1,915	709	2,624	77.7	400	+29,671	49,583		
	Sep.	347.10	9,400	22,011	6,750	2,498	9,248	72.6	682	+12,081	61,664		
	Oct.	348.30	10,900	6,106	2,839	1,050	3,889	86.6	944	+1,273	62,937		
	Nov.	348.40	11,100	250	6,021	2,228	8,249	79.8	886	- 8,885	54,052		
	Dec.	347.60	10,050	259	6,181	2,287	8,468	74.4	748	- 8,957	45,095		
	Total			81,143	53,265	19,709	72,974	1,741.8	11,567	- 3,398			

Year	Month	Initial Reservoir Level (m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation (10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	Evaporation (10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1944	Jan.	346.50	8,650	259	5,092	1,884	6,976	90.4	782	- 7,499	37,596		
	Feb.	345.60	7,700	234	1,720	636	2,356	108.2	833	- 2,955	34,641		
	Mar.	345.20	7,300	259	3,100	1,147	4,247	198.1	1,446	- 5,434	29,207		
	Apr.	344.40	6,500	250	987	365	1,352	280.4	1,825	- 2,925	26,282		
	May	344.00	6,100	259	1,294	479	1,773	398.0	2,428	- 3,942	22,340		
	Jun.	343.20	5,400	641	15,301	5,661	20,962	191.0	1,031	-21,352	988		
	Jul.	334.80	550	35,138				84.6	47	+35,091	36,079		
	Aug.	345.00	7,800	47,990				77.7	606	+47,384	66,400	17,063	
	Sep.	348.69	11,550	35,291	1,961	726	2,687	72.6	839	+31,765	66,400	31,765	
	Oct.	348.69	11,550	9,158	680	252	932	86.6	1,000	+ 7,226	66,400	7,226	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.80	10,250	259	6,181	2,287	8,468	74.4	763	- 8,972	48,507		
	Total			129,988	42,337	15,665	58,002	1,741.8	12,520	+59,466		56,054	
1945	Jan.	347.00	9,250	259	5,482	2,028	7,510	90.4	836	- 8,087	10,420		
	Feb.	346.20	8,350	234	4,691	1,736	6,427	108.2	903	- 7,096	33,324		
	Mar.	345.00	7,100	259	4,630	1,713	6,343	198.1	1,407	- 7,491	25,833		
	Apr.	343.90	6,000	250	695	257	952	280.4	1,682	- 2,384	23,449		
	May	343.50	5,650	259	1,338	495	1,833	398.0	2,249	- 3,823	19,626		
	Jun.	342.70	5,000	7,083	346	128	474	191.0	955	+ 5,654	25,280		
	Jul.	343.80	5,900	46,982				84.6	499	+46,483	66,400	5,363	
	Aug.	348.69	11,550	49,547				77.7	897	+48,650	66,400	48,650	
	Sep.	348.69	11,550	58,187				72.6	839	+57,348	66,400	57,348	
	Oct.	348.69	11,550	6,106	3,491	1,292	4,783	86.6	1,000	+ 323	66,400	323	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.90	10,450	259	6,181	2,287	8,468	74.4	777	- 8,986	48,493		
	Total			169,675	32,875	12,164	45,039	1,741.8	12,966	+111,670		111,684	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1946	Jan.	347.00	9,250	259	6,245	2,311	8,556	90.4	836	- 9,133	39,360		
	Feb.	345.80	7,950	234	4,691	1,736	6,427	108.2	860	- 7,053	32,307		
	Mar.	344.90	7,000	259	4,530	1,676	6,206	198.1	1,387	- 7,334	24,973		
	Apr.	343.70	5,800	250	766	283	1,049	280.4	1,626	- 2,425	22,548		
	May	343.30	5,250	259	1,262	467	1,729	398.0	2,090	- 3,560	18,988		
	Jun.	342.80	5,080	7,480				191.0	970	+ 6,510	25,498		
	Jul.	343.80	5,900	44,265				84.6	499	+43,766	66,400	2,864	
	Aug.	348.69	11,550	72,138				77.7	897	+71,241	66,400	71,241	
	Sep.	348.69	11,550	19,600	9,397	3,477	12,874	72.6	839	+ 5,887	66,400	5,887	
	Oct.	348.69	11,550	3,053	4,309	1,594	5,903	86.6	1,000	- 3,850	62,550		
	Nov.	348.40	11,100	250	4,717	1,745	6,462	79.8	886	- 7,098	55,452		
	Dec.	347.70	10,200	2,282	6,181	2,287	8,468	74.4	759	- 6,945	48,507		
	Total			150,329	42,098	15,576	57,674	1,741.8	12,649	+80,006		79,992	
1947	Jan.	346.90	9,150	259	4,862	1,799	6,661	90.4	823	- 7,225	41,282		
	Feb.	346.10	8,200	234	3,598	1,331	4,929	108.2	887	- 5,582	35,700		
	Mar.	345.40	7,500	259	4,390	1,624	6,014	198.1	1,486	- 7,241	28,459		
	Apr.	344.30	6,350	250	987	365	1,352	280.4	1,781	- 2,883	25,576		
	May	343.80	5,900	259	1,320	488	1,808	398.0	2,348	- 3,897	21,679		
	Jun.	343.20	5,400	1,648	9,541	3,530	13,071	191.0	1,031	-12,454	9,225		
	Jul.	340.10	3,050	47,808				84.6	258	+47,550	56,775		
	Aug.	347.80	10,250	36,603	2,307	854	3,161	77.7	796	+32,646	66,400	23,021	
	Sep.	348.69	11,550	17,737	7,903	2,924	10,827	72.6	839	+ 6,071	66,400	6,071	
	Oct.	348.69	11,550	6,106	3,457	1,279	4,736	86.6	1,000	+ 370	66,400	370	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.90	10,400	259	6,181	2,287	8,468	74.4	744	- 8,953	48,526		
	Total			111,672	50,567	18,709	69,276	1,741.8	12,915	+29,481		29,462	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1948	Jan.	347.00	9,250	259	5,441	2,013	7,454	90.4	836	- 8,031	40,495		
	Feb.	346.00	8,150	234	4,325	1,600	5,925	108.2	882	- 6,573	33,922		
	Mar.	345.20	7,300	259	4,516	1,671	6,187	198.1	1,446	- 7,374	26,548		
	Apr.	344.00	6,100	250	864	320	1,184	280.4	1,710	- 2,644	23,904		
	May	343.60	5,750	259	1,330	492	1,822	398.0	2,289	- 3,852	20,052		
	Jun.	342.80	5,050	793	14,510	5,369	19,879	191.0	965	-20,051	1,035		-1,034
	Jul.	335.00	620	14,593				84.6	52	+14,541	15,576		
	Aug.	341.90	4,350	38,892				77.7	338	+38,554	54,130		
	Sep.	347.60	10,500	18,989	6,976	2,581	9,557	72.6	762	+ 8,670	62,800		
	Oct.	348.40	11,100	3,053	4,075	1,508	5,583	86.6	961	- 3,491	59,309		
	Nov.	348.00	10,600	9,188	834	309	1,143	79.8	846	+ 7,199	66,400	108	
	Dec.	348.69	11,550	259	6,181	2,287	8,468	74.4	856	- 9,065	57,335		
	Total			87,028	49,052	18,150	67,202	1,741.8	11,943	+ 7,883		108	-1,034
1949	Jan.	347.80	10,300	259	6,245	2,311	8,556	90.4	931	- 9,228	48,107		
	Feb.	346.80	9,050	234	4,691	1,736	6,427	108.2	979	- 7,172	40,935		
	Mar.	346.00	8,150	259	4,630	1,713	6,343	198.1	1,615	- 7,699	33,236		
	Apr.	345.00	7,100	250	952	352	1,304	280.4	1,991	- 3,045	30,191		
	May	344.60	6,700	259	1,184	438	1,622	398.0	2,667	- 4,030	26,161		
	Jun.	343.90	6,000	2,656	6,150	2,276	8,426	191.0	1,146	- 6,916	19,245		
	Jul.	342.70	5,000	21,980				84.6	423	+21,557	40,302		
	Aug.	345.90	8,050	50,372				77.7	625	+49,747	66,400	23,649	
	Sep.	348.69	11,550	31,594	2,704	1,000	3,704	72.6	839	+27,051	66,400	27,051	
	Oct.	348.69	11,550	6,106	1,972	730	2,702	86.6	1,000	+ 2,404	66,400	2,404	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.80	10,300	259	6,181	2,287	8,468	74.4	766	- 8975	48,504		
	Total			114,478	40,730	15,071	55,801	1,741.8	13,904	+44,773		53,104	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m)			Evaporation		Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
					Right Canal	Left Canal	Total	(mm)	(10^3cu.m)				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1950	Jan.	347.00	9,250	259	6,245	2,311	8,556	90.4	836	- 9,133	38,371		
	Feb.	345.70	7,850	234	3,397	1,257	4,654	108.2	849	- 5,269	33,102		
	Mar.	345.00	7,100	259	4,196	1,553	5,749	198.1	1,407	- 6,897	26,205		
	Apr.	343.90	6,050	250	987	365	1,352	280.4	1,696	- 2,798	23,407		
	May	343.50	5,650	259	1,338	495	1,833	398.0	2,249	- 3,823	19,584		
	Jun.	342.80	5,050	641	15,783	5,840	21,623	191.0	965	-21,947	1,035		- 3,398
	Jul.	331.80	100	19,416				84.6	8	+19,408	20,443		
	Aug.	342.90	5,150	16,717	8,950	3,312	12,262	77.7	400	+ 4,055	24,498		
	Sep.	343.70	5,850	13,890	10,517	3,891	14,408	72.6	425	- 943	23,555		
	Oct.	343.60	5,750	259	5,155	1,907	7,062	86.6	498	- 7,301	16,254		
	Nov.	342.10	4,550	250	5,775	2,137	7,912	79.8	363	- 8,025	8,229		
	Dec.	339.80	2,850	259	6,181	2,287	8,468	74.4	212	- 8,421	1,788		- 1,980
	Total			52,693	68,524	25,355	93,879	1,741.8	9,908	-51,094			- 5,378
1951	Jan.	336.30	1,100	259	6,049	2,238	8,287	90.4	100	- 8,128	1,688		- 8,028
	Feb.	336.00	950	234	4,691	1,736	6,427	108.2	103	- 6,296	1,585		- 6,193
	Mar.	335.90	930	259	3,309	1,224	4,533	198.1	184	- 4,458	1,401		- 4,274
	Apr.	335.60	820	250	876	324	1,200	280.4	230	- 1,180	1,171		- 950
	May	335.30	730	259	1,104	408	1,512	398.0	330	- 1,583	841		- 1,258
	Jun.	334.60	500	1,221	11,612	4,296	15,908	191.0	96	-14,783	745		-14,687
	Jul.	334.20	400	33,123				84.6	34	+33,089	33,868		
	Aug.	345.10	7,200	69,604				77.7	559	+69,045	66,400	36,513	
	Sep.	348.69	11,550	7,602	16,919	6,260	23,179	72.6	839	-16,416	49,984		
	Oct.	347.10	9,400	10,776	1,037	384	1,421	86.6	814	+ 8,541	58,525		
	Nov.	348.00	10,600	250	6,021	2,228	8,249	79.8	846	- 8,845	49,680		
	Dec.	347.00	9,250	259	6,181	2,287	8,468	74.4	688	- 8,897	40,783		
	Total			124,096	57,799	21,385	79,184	1,741.8	4,823	+40,089		36,513	-35,390

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10³sq.m)	Inflow (10³cu.m)	Draw-off for Irrigation(10³cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10³cu.m)	Net Deduction or Addition (10³cu.m)	Final Reservoir Capacity (10³cu.m)	Overflow (10³cu.m)	Shortages (10³cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1952	Jan.	346.00	8,150	259	6,245	2,311	8,556	90.4	737	- 9,034	31,749		
	Feb.	344.80	6,900	234	4,624	1,711	6,335	108.2	747	- 6,848	24,901		
	Mar.	343.80	5,900	259	4,630	1,713	6,343	198.1	1,169	- 7,253	17,648		
	Apr.	342.40	4,750	250	691	256	947	280.4	1,332	- 2,029	15,619		
	May	341.90	4,350	259	1,338	495	1,833	398.0	1,731	- 3,305	12,314		
	Jun.	341.10	3,750	1,832	8,600	3,182	11,782	191.0	716	-10,666	1,648		
	Jul.	335.90	950	18,226				84.6	80	+18,146	19,794		
	Aug.	342.80	5,050	58,645				77.7	392	+58,253	66,400	11,597	
	Sep.	348.69	11,550	25,094	5,310	1,965	7,275	72.6	839	+16,980	66,400	16,980	
	Oct.	348.69	11,550	2,260	4,324	1,600	5,924	86.6	1,000	- 4,664	61,736		
	Nov.	348.30	10,950	250	6,021	2,228	8,249	79.8	874	- 8,873	52,863		
	Dec.	347.50	9,900	259	6,181	2,287	8,468	74.4	737	- 8,946	43,917		
	Total			107,827	47,964	17,748	65,712	1,741.8	10,354	+31,761		28,577	
	Jan.	346.40	8,550	259	6,245	2,311	8.556	90.4	773	- 9,070	34,847		
	Feb.	345.20	7,250	234	4,691	1,736	6,427	108.2	784	- 6,977	27,870		
	Mar.	344.20	6,300	259	4,630	1,713	6,343	198.1	1,248	- 7,332	20,538		
	Apr.	343.70	5,850	250	493	182	675	280.4	1,640	- 2,065	18,473		
	May	342.50	4,850	259	1,338	495	1,833	398.0	1,930	- 3,504	14,969		
	Jun.	341.80	4,250	1,649	9,522	3,523	13,045	191.0	812	-12,208	2,761		
	Jul.	337.00	1,380	19,416				84.6	117	+19,299	22,060		
	Aug.	343.20	5,400	70,703				77.7	420	+70,283	66,400	25,943	
	Sep.	348.69	11,550	30,986	3,839	1,420	5,259	72.6	839	+24,888	66,400	24,888	
	Oct.	348.69	11,550	15,295				86.6	1,000	+14,295	66,400	14,295	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.70	10,200	259	6,181	2,287	8,468	74.4	759	- 8,968	48,511		
	Total			139,819	42,960	15,895	58,855	1,741.8	11,244	+69,720		65,126	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1954	Jan.	347.00	9,250	259	6,245	2,311	8,556	90.4	836	- 9,133	39,378		
	Feb.	345.80	7,950	234	4,691	1,736	6,427	108.2	860	- 7,053	32,325		
	Mar.	349.90	7,000	259	2,158	798	2,956	198.1	1,387	- 4,084	28,241		
	Apr.	344.30	6,200	250	987	365	1,352	280.4	1,738	- 2,840	25,401		
	May	343.80	5,900	259	1,301	481	1,782	398.0	2,348	- 3,871	21,530		
	Jun.	343.10	5,300	977	13,008	4,813	17,821	191.0	1,012	-17,856	3,674		
	Jul.	337.60	1,650	18,439				84.6	140	+18,299	21,973		
	Aug.	343.20	5,400	38,985				77.7	420	+38,565	60,538		
	Sep.	348.20	10,800	37,549				72.6	784	+36,765	66,400	30,903	
	Oct.	348.69	11,550	259	5,155	1,907	7,062	86.6	1,000	- 7,803	58,597		
	Nov.	347.60	10,000	250	6,021	2,228	8,249	79.8	798	- 8,797	49,800		
	Dec.	347.10	9,400	259	6,187	2,289	8,476	74.4	699	- 8,916	40,884		
	Total			97,979	45,753	16,928	62,681	1,741.8	12,022	+23,276		30,903	
	Jan.	346.00	8,150	259	6,090	2,253	8,343	90.4	737	- 8,821	32,063		
	Feb.	344.90	7,000	234	4,691	1,736	6,427	108.2	757	- 6,950	25,113		
	Mar.	343.80	5,900	259	4,630	1,713	6,343	198.1	1,169	- 7,253	17,860		
	Apr.	342.40	4,750	250	987	365	1,352	280.4	1,332	- 2,434	15,426		
	May	341.90	4,350	259	1,332	493	1,825	398.0	1,731	- 3,297	12,129		
	Jun.	341.00	3,650	3,847	4,406	1,630	6,036	191.0	697	- 2,886	9,243		
	Jul.	340.10	3,050	15,966	3,050	1,129	4,179	84.6	258	+11,529	20,772		
	Aug.	343.00	5,250	72,601				77.7	408	+72,193	66,400	26,565	
	Sep.	348.69	11,550	33,551	2,962	1,096	4,058	72.6	839	+28,654	66,400	28,654	
	Oct.	348.69	11,550	37,856				86.6	1,000	+36,856	66,400	36,856	
	Nov.	348.69	11,550	250	6,021	2,228	8,249	79.8	922	- 8,921	57,479		
	Dec.	347.80	10,300	259	6,181	2,287	8,468	74.4	766	- 8,975	48,504		
	Total			165,591	40,350	14,930	55,280	1,741.8	10,616	+99,695		92,075	

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1956	Jan.	346.90	9,150	259	6,245	2,311	8,556	90.4	827	- 9,124	39,380		
	Feb.	345.90	8,050	234	4,577	1,693	6,270	108.2	871	- 6,907	32,473		
	Mar.	345.00	7,100	259	4,630	1,713	6,343	198.1	1,407	- 7,491	24,982		
	Apr.	343.80	5,900	250	987	365	1,352	280.4	1,654	- 2,756	22,226		
	May	343.20	5,400	259	1,164	431	1,595	398.0	2,149	- 3,485	18,741		
	Jun.	342.50	4,800	8,151				191.0	917	+ 7,234	25,975		
	Jul.	343.90	6,000	52,967				84.6	508	+52,459	66,400	12,034	
	Aug.	348.69	11,550	34,892	3,589	1,328	4,917	77.7	897	+29,078	66,400	29,078	
	Sep.	348.69	11,550	26,498	5,578	2,064	7,642	72.6	839	+18,017	66,400	18,017	
	Oct.	348.69	11,550	259	5,155	1,907	7,062	86.6	1,000	- 7,803	58,597		
	Nov.	348.00	10,550	250	6,021	2,228	8,249	79.8	842	- 8,841	50,756		
	Dec.	347.20	9,500	259	6,181	2,287	8,468	74.4	707	- 8,916	41,840		
	Total			124,537	44,127	16,327	60,454	1,741.8	12,618	+51,465		59,129	
1957	Jan.	346.10	8,200	259	6,245	2,311	8,556	90.4	741	- 9,038	32,802		
	Feb.	345.00	7,080	234	4,691	1,736	6,427	108.2	766	- 6,959	25,843		
	Mar.	343.90	6,000	259	4,630	1,713	6,343	198.1	1,189	- 7,273	18,570		
	Apr.	342.60	4,900	250	987	365	1,352	280.4	1,374	- 2,476	16,094		
	May	342.30	4,650	259	1,338	495	1,833	398.0	1,851	- 3,425	12,669		
	Jun.	341.20	3,800	250	21,278	7,873	29,151	191.0	726	-29,627	1,274		-18,232
	Jul.	335.40	750	9,250				84.6	63	+ 9,187	10,461		
	Aug.	340.50	3,300	57,852				77.7	256	+57,596	66,400	1,657	
	Sep.	348.69	11,550	2,564	14,680	5,432	20,112	72.6	839	-18,387	48,013		
	Oct.	346.90	9,100	3,082	3,506	1,297	4,803	86.6	788	- 2,509	45,504		
	Nov.	346.60	8,750	250	6,021	2,228	8,249	79.8	698	- 8,697	36,807		
	Dec.	345.50	7,600	259	6,181	2,287	8,468	74.4	588	- 8,797	28,010		
	Total			74,768	69,557	25,737	95,294	1,741.8	9,879	-30,405		1,657	-18,232

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1958	Jan.	344.20	6,250	259	6,245	2,311	8,556	90.4	565	- 8,862	19,148		
	Feb.	342.60	4,900	234	4,691	1,736	6,427	108.2	530	- 6,723	12,425		
	Mar.	341.10	3,700	259	3,691	1,366	5,057	198.1	733	- 5,531	6,894		
	Apr.	339.20	2,500	250	881	326	1,207	280.4	701	- 1,658	5,236		
	May	338.40	2,050	259	1,269	470	1,739	398.0	816	- 2,296	2,940		
	Jun.	337.10	1,450	611	15,727	5,819	21,546	191.0	277	-21,212	1,723		-19,995
	Jul.	335.80	850	6,503	3,654	1,352	5,006	84.6	72	+ 1,425	3,148		
	Aug.	337.20	1,500	20,933	2,971	1,099	4,070	77.7	117	+16,746	19,894		
	Sep.	342.80	4,950	21,614	5,163	1,910	7,073	72.6	359	+14,182	34,076		
	Oct.	345.10	7,200	6,472	2,187	809	2,996	86.6	624	+ 2,852	36,928		
	Nov.	345.50	7,600	250	6,021	2,228	8,249	79.8	606	- 8,605	28,323		
	Dec.	344.20	6,250	259	6,181	2,287	8,468	74.4	465	- 8,674	19,649		
	Total			57,903	58,681	21,713	80,394	1,741.8	5,865	-28,356			-19,995
1959	Jan.	342.80	5,100	259	6,245	2,311	8,556	90.4	461	- 8,758	10,891		
	Feb.	340.70	3,400	234	4,691	1,736	6,427	108.2	368	- 6,561	4,330		
	Mar.	337.90	1,800	259	4,630	1,713	6,343	198.1	357	-6,441	1,643		- 3,754
	Apr.	335.90	950	250	594	220	814	280.4	266	- 830	1,377		- 564
	May	335.60	820	259	1,232	456	1,688	398.0	326	- 1,755	1,051		- 1,429
	Jun.	335.00	620	2,564	6,591	2,439	9,030	191.0	118	- 6,584	933		- 6,466
	Jul.	334.90	600	30,101				84.6	51	+30,050	30,983		
	Aug.	344.70	6,800	56,782				77.7	528	+56,254	66,400	20,837	
	Sep.	348.69	11,550	66,400				72.6	839	+65,561	66,400	65,561	
	Oct.	348.69	11,550	3,509	3,863	1,429	5,292	86.6	1,000	- 2,783	63,617		
	Nov.	348.80	11,750	250	5,986	2,215	8,201	79.8	938	- 8,889	54,728		
	Dec.	347.60	10,050	259	6,153	2,277	8,430	74.4	748	- 8,919	45,809		
	Total			161,126	39,985	14,796	54,781	1,741.8	6,000	+10,345		86,398	-12,213

Year	Month	Initial Reservoir Level(m)	Water Surface Area (10^3sq.m)	Inflow (10^3cu.m)	Draw-off for Irrigation(10^3cu.m) Right Canal	Left Canal	Total	Evaporation (mm)	(10^3cu.m)	Net Deduction or Addition (10^3cu.m)	Final Reservoir Capacity (10^3cu.m)	Overflow (10^3cu.m)	Shortages (10^3cu.m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)=(6)+(7)	(9)	(10)	(11)=(5)-(8+10)	(12)=(12)i-1+(11)	(13)	(14)
1960	Jan.	346.60	8,750	259	6,245	2,311	8,556	90.4	791	- 9,088	36,721		
	Feb.	345.50	7,650	234	4,691	1,736	6,427	108.2	828	- 7,021	29,700		
	Mar.	344.50	6,600	259	2,778	1,028	3,806	198.1	1,307	- 4,854	24,846		
	Apr.	343.70	5,850	250	987	365	1,352	280.4	1,640	- 2,742	22,104		
	May	343.20	5,350	259	1,338	495	1,833	398.0	2,129	- 3,703	18,401		
	Jun.	342.50	4,850	2,564	6,593	2,439	9,032	191.0	926	- 7,394	11,007		
	Jul.	340.70	3,450	30,034				84.6	292	+29,742	40,749		
	Aug.	346.00	8,150	39,779				77.7	633	+39,146	66,400	13,495	
	Sep.	348.69	11,550	5,403	17,579	6,504	24,083	72.6	839	-19,519	46,881		
	Oct.	346.80	8,950	11,296	384	142	526	86.6	775	+ 9,995	56,871		
	Nov.	347.80	10,300	250	6,021	2,228	8,249	79.8	822	- 8,821	48,050		
	Dec.	347.00	9,250	259	6,181	2,287	8,468	74.4	688	- 8,897	39,153		
	Total			90,846	52,797	19,535	72,332	1,741.8	11,670	+ 6,844		13,495	