THE HASHEMITE KINGDOM OF JORDAN

JORDAN VALLEY COMMISSION

WADI ARAB DAM AND IRRIGATION PROJECT

INTERIM REPORT

JULY [illegible]

[illegible] INTERNATIONAL COOPERATION AGENCY

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PREFACE

As stated in the Plan of Operation for the Feasibility Study on the Wadi Arab Dam and Irrigation Project, which is annexed to the Inception Report in April, 1976, the Study is divided into three phases: Phase I for inception works, Phase II for field investigation and Phase III for studies and preparation of a Feasibility Report.

In ending the Phase II this Interim Report is issued to present the summary of findings in the field investigation and preliminary Project plan based on the tentative analysis of collected information.

Data obtained through the field investigation are to be analyzed in detail in the subsequent Phase III and be reflected in the preparation of a draft feasibility report which is expected to be issued in the end of September, 1976.

FEASIBILITY STUDY
WADI ARAB DAM AND IRRIGATION PROJECT
INTERIM REPORT

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CURRENCY EQUIVALENTS

U.S.$ 1	=	J.D. 0.330
J.D.1 = 1,000 Fils	=	U.S.$ 3.03
J.D.1,000	=	U.S.$ 3,030.00

MEASURES

1 hectare (ha)	=	10 dunums (dn)
1 MCM	=	1 million cubic meters

DEFINITIONS

The Project	=	Wadi Arab Dam and Irrigation Project
The IDA Project	=	North East Ghor Irrigation Project
The Team	=	Japanese Expert Team for Feasibility Study for the Project

ABBREVIATIONS

JVC	=	Jordan Valley Commission
NRA	=	Natural Resources Authority
EGMC	=	East Ghor Main Canal
DA-	=	Development Area

I. FIELD INVESTIGATION

1.1 Investigation Program

Following the Phase I study the field investigation, Phase II Works has been carried out by the Team in accordance with the Plan of Operation annexed to the Draft Inception Report issued on 29th April, 1976. During the general field reconnaisance made in the beginning part of the Phase II, the investigation program was established mostly based on the scope of works mentioned in the Plan of Operation.

The field investigation covered the following items:-

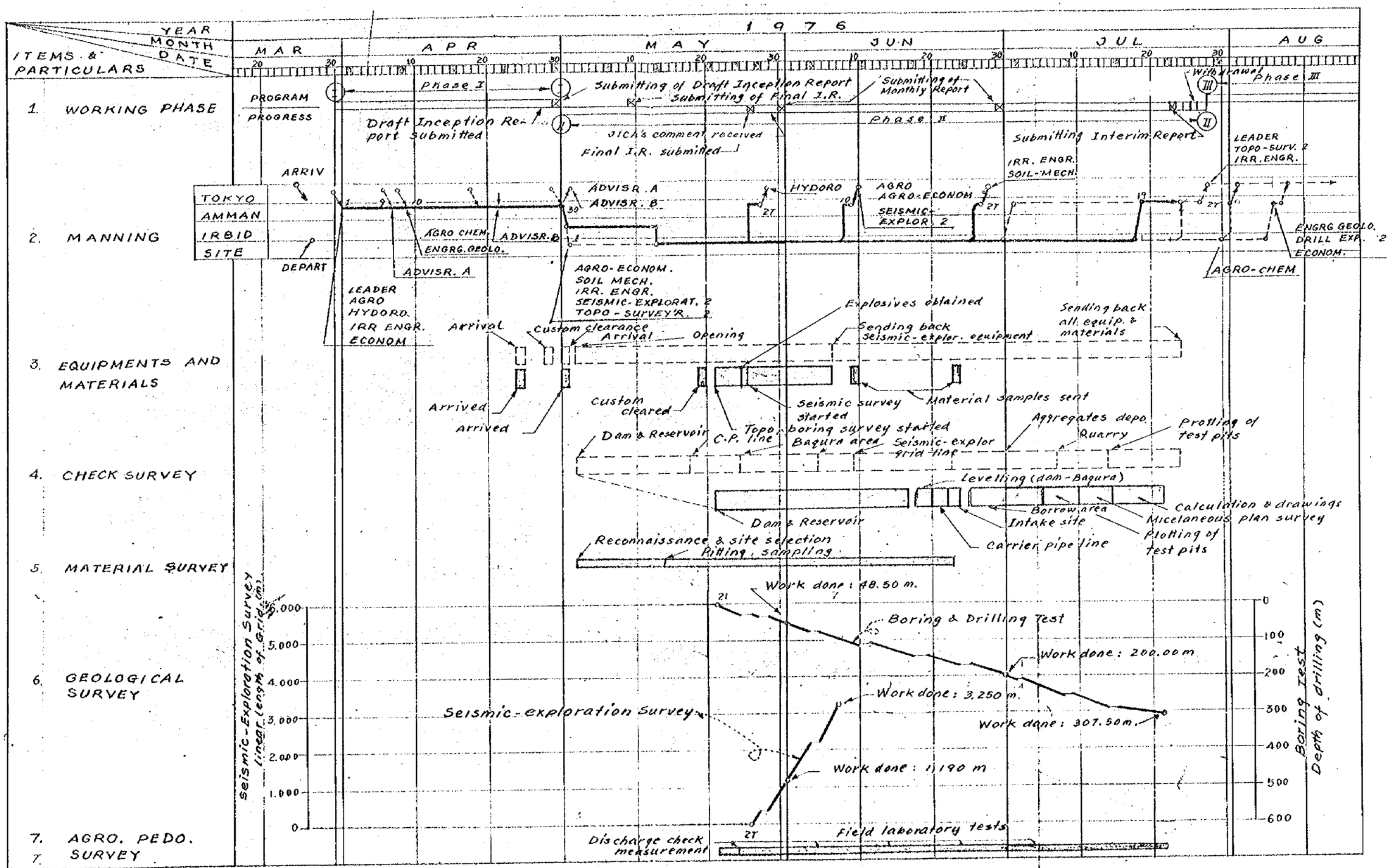
Topographic Survey,
Geological Investigation including Drilling Survey and Seismic Exploration Survey,
Construction Material Survey,
Meteohydrologic Investigation,
Agricultural Investigation including Soil Survey, Land Use Survey, Agronomic Survey, Farm Survey, Agro-Economic Survey.

1.2 Results of Investigation

Results and information obtained through the field investigation are summarized in Annexes of this report. It should be noted that the findings in the investigation are not yet completely analyzed. Those are to be carefully examined and studied in the subsequent Phase III Works in Japan. Collected samples of rock, soil and water will be tested also in Japan.

The progress of the works is illustrated in Fig. 1.1.

Fig. 1.1 W O R K P R O G R E S S



II. PRELIMINARY PLANNING

2.1 Basis of Planning

Principles to be considered in the preliminary planning of the Project are interpreted by the Team as follows:

1) The immediate objective of the Project is to construct a reservoir dam on the Wadi Arab to store remaining water after necessary water for the IDA Project has been taken and to irrigate Baqura and its adjacent areas.

2) The intake structure of the proposed Wadi Arab Dam is to be so designed as to serve both for the IDA irrigation area and the new area. Hence, the elevation of the intake is to be such that which keeps the static head required to provide the sprinkling activity on both areas. Then, two items proposed in the IDA Project, the Wadi Arab intake weir and the carrier pipe for 1.3 km, can be eliminated.

3) The scale of the new irrigation commanding area and the consequent scale of the dam are to be as large as possible within the limits of the amount of available water and the economic viability.

However, the Project scale suggested in this Phase II is not to be definite because its optimization study is to be continued in the Phase III Works by feed-back analysis of reciprocal factors such as cropping pattern, water requirement, reservoir capacity, dam size, costs and benefits.

2.2 Agricultural Planning.

Various aspects of the prospective agricultural development in the Jordan Valley have been discussed during the past quarter of century. For framing the 1975/1982 Development Plan, in 1975 JVC carried out up-dating study on the projection made by NEDECO/DAR AL-HANDASAH in 1967. This study includes some pending parts related to introduction of industrial crops and dairy farming into the Valley. Not only the policies but also the assumptions and circumstances mentioned in the above studies are carefully taken into consideration for preparing agricultural development plan to be proposed for the Wadi Arab Dam and Irrigation Project.

2.2.1 Prospective Change in Land Use.

As a result of land use survey, it is formulated that net irrigable area of 1,226 ha can be expected under gravity sprinkler irrigation system to be newly introduced into the Project area. Among the above 1,226 ha, the existing fruit tree cultivation area holds 349 ha, comprising 203 ha of bearing citrus fields, 59 ha of unbearing ones and 87 ha of banana fields. Taking unsuitability of sprinkler irrigation system and frequency of frost damage to banana cultivation into account, the banana fields should be converted to citrus fields. Therefore, an intensive irrigation farming depending upon a cropping pattern to be proposed will be realized in the remaining 877 ha.

2.2.2 Cropping Pattern.

For the establishment of cropping pattern, the combined effect of various factors must be taken into consideration. It is well known that the main determinants are the demand for agricultural produce, the total cultivatable area, the national-economic and farm-economic benefits of individual crops, and crop-rotational requirements from an agronomic point of view. In this report, studies on cropping pattern are made laying emphasis on use of less irrigation water and gain of more profits in comparison with JVC's cropping pattern.

First of all, a tentative cropping pattern as shown in Table 2.1 is

prepared for the sake of introducing improved farming practices prevailing in developed horticultural areas in Japan. Trial calculation of irrigation water requirement for this pattern carried out by the Blaney Criddle method which is same procedure as NEDECO/DAR AL-HANDASAH adopted in its study. The results of computation give that the peak water requirement of 1,174^{m3}/ha in net will occur in April and this peak amount shows an approximately 50% increase over that of JVC's cropping pattern. It is no doubt that this fact causes the raise of construction cost for irrigation facilities. From the view point of irrigation efficiency, furthermore, more simplification and uniformity of farm operation must be reflected upon for the introduction of sprinkler irrigation system. The tentative cropping pattern which is endowed with very complicated schedule of crop cultivation will put serious difficulties in the way of operating sprinkler system on each farm plot.

Secondly, JVC's cropping pattern is actually applied to the project area upon the principle of the proposed land use plan in order to review crop intensity and diversion requirement. The result of estimation as shown in Table 2.2 is that crop intensity shows a 4% decrease while diversion water requirements show a 12% increase in total and at peak time respectively because of increased crop intensity of citrus trees. It is thought that considerably increases in diversion requirement affect the water distribution program of IDA Project.

Taking into the above consideration, four revised cropping patterns are newly made as shown in Tables 2.2 and 2.3. Comparative studies on these patterns are done basing upon the total and peak diversion requirements as well as net profits of production. The results of studies as presented in Table 2.2 suggest that the cropping pattern D is the most recommendable one for the further study in phase 3.

Under the condition of "Without Project", no improvement of irrigation water supply system in the Project area can be expected. Accordingly, a minor change will occur in the present cropping pattern as given in Table 2.3.

2.2.3 Yield and Production.

Yield projection in the study of phase 2 is tentatively anticipated resulting from farm survey conducted in the Project area and referring to "Agricultural Sampling Survey in the Ghore" and many previous studies. The anticipated yields both with and without the Projects are as presented in Table 2.3. Annual production of indicidual crops is also given in the same table.

2.2.4 Labour Requirement.

Table 2.5 shows the estimated farm labour requirements per farm household with 3.0 ha of net farm land based on the recommended cropping pattern and with 6.0 ha of net citrus field respectively. For this calculation, monthly crop labour requirements estimated by NEDECO/DAR AL-HANDASAH are fully referred.

As seem in Table 2.4, the peak labour requirement occurs in February for mixed farm with annual crops and citrus and in November for citrus farm. In these months, the family labour force which is estimated at 65 man-days per month (2.7 labourers/family X 24 workable days/month) on an average will be not enough. The shortage of labour force will be met by seasonal hired labourers.

2.2.5. Production Value and Production Cost.

For the estimation of net production value, farm gate prices of individual crops and production cost given in the report of JVC are taken making some modifications. The results obtained for "With Project" and "Without Project" are summurized in Table 2.5

The difference in the net production value could be regarded as the benefit attributable to the Project.

TABLE 2 - 1

TENTATIVE CROPPING PATTERN

(Unit: %)

Only for Mixed Farm Type with Vegetables as Main Crop

Crop	NEDECO	TENTATIVE	
Vegetables (Solanaceae)			
a. Tomato	28.9	13.0	
b. Eggplant	12.9	10.0	
c. Pepper	2.9	***	Included in eggplant
d. Potato	4.3	12.0	
(Sub-total)	(36.8)	(35.0)	
Vegetables (Non-Solanaceae)			
e. Cucumber/Squash	6.2	19.0	
f. Watermelon	-	6.0	
g. Cabbage/Cauliflower	6.9	10.0	
h. Lettuce/Green onion	-	11.0	
i. Jew's mallow	-	8.0	
j. Radish/Carrot	-	15.0	
k. Bulb onion	3.5	10.0	
l. Beans	9.3	20.0	
(Sub-total)	(25.9)	(99.0)	
Cereals			
m. Wheat/Barley	10.0	9.0	
n. Maize (Grain)	15.0	12.0	
o. Sorghum (Grain)	-	8.0	
(Sub-total)	(25.0)	(29.0)	
Fodder crops			
p. Alfalfa	10.0	-	
q. Berseem	6.6	5.0	
r. Maize (Fodder)	6.6	-	
(Sub-total)	(23.2)	(5.0)	
TOTAL	110.9	168.0	
Estimated peak irrigation water requirement (mm/ha) in peak month	773.0	1,174.0	Net irrigation water requirement
Peak month	April	April	

Note: Cropping pattern and intensity of NEDECO is given in the "Jordan Valley Project" Final Report Vol. III Annex H I, Page 20, Table H-7, which is recommended for mixed farming only.

ALTERNATIVE CROPPING PATTERNS FOR PROJECT AREA

(Unit: %)

Crop	NEDECO	Pattern-A	Pattern-B	Pattern-C	Pattern-D
Vegetables (Solanaceae)					
a. Tomato	21.7	10.7	16.1	16.1	21.5
b. Eggplant	9.7	14.3	13.4	13.4	8.0
c. Pepper		-	-	-	-
d. Potato	3.2	3.6	2.7	2.7	2.7
(Sub-total)	(34.6)	(28.6)	(32.2)	(32.2)	(32.2)
Vegetables (Non-Solanaceae)					
e. Cucumber/Squash	4.6	3.6	2.7	5.4	5.4
f. Cabbage/Cauliflower	5.2	7.2	5.4	2.7	2.7
g. Bulb onion	2.6	-	-	-	-
h. Beans	7.0	-	-	8.0	8.0
(Sub-total)	(19.4)	(10.8)	(8.1)	(16.1)	(16.1)
Cereals					
i. Wheat	7.5	7.2	10.7	8.0	8.0
j. Maize (Grain)	11.5	3.6	2.7	2.7	2.7
(Sub-total)	(19.0)	(10.8)	(13.4)	(10.7)	(10.7)
Fodder crops					
k. Alfalfa	13.2	10.7	8.0	8.0	8.0
l. Berseem	8.8	7.2	10.7	8.0	8.0
m. Maize (Fodder)	8.8	7.2	5.4	5.4	8.0
(Sub-total)	(30.8)	(25.1)	(24.1)	(21.4)	(24.0)
Fruit trees					
n. Citrus	9.0	42.8	35.5	35.5	35.5
o. Banana	4.8	-	-	-	-
(Sub-total)	(13.8)	(42.8)	(35.5)	(35.5)	(35.5)
TOTAL CROP INTENSITY	117.6	118.1	113.3	115.9	118.5
ANNUAL DIVERSION REQUIREMENT (m^3/ha)	9,363	9,930	8,918	8,823	8,819
PEAK DIVERSION REQUIREMENT (m^3/ha/month)	1,070	1,168	1,027	992	977
GROSS PRODUCTION VALUE (JD)		1,453	1,340	1,446	1,457
NET PRODUCTION VALUE (JD)	992	1,011	934	1,023	1,036

Note: Gross production value can be expected to be obtained from the Project area.

ANTICIPATED CROP YIELD AND FUTURE PRODUCTION

Crop	WITH PROJECT			WITHOUT PROJECT		
	Intensity (%)	Yield (ton/ha)	Production (ton)	Intensity* (%)	Yield (ton/ha)	Production (ton)
Irrigated fields	(Net area 1,226 ha)			(Net area 951 ha)		
a. Tomato	21.5	23.0	6,072	6.9	12.7	1,080
b. Eggplant	8.0	22.0	2,156	6.9	11.4	970
c. Pepper	-	-	-	0.8	6.9	69
d. Potato	2.7	18.0	594	1.2	10.7	160
e. Broad beans	8.0	12.0	1,176	2.0	6.0	150
f. Cabbage	2.7	23.5	776	2.4	13.9	417
g. Cauliflower	-	-	-	0.8	14.4	144
h. Jew's mallow	-	-	-	1.6	10.3	206
i. Cucumber	5.4	16.0	1,056	1.6	6.9	138
j. Squash	-	-	-	3.3	9.9	396
k. Watermelon	-	-	-	2.0	13.7	342
l. Wheat	8.0	3.5	343	22.0	1.3	350
m. Barley	-	-	-	2.4	1.3	40
n. Maize (Grain)	2.7	4.0	132	-	-	-
o. Alfalfa	8.0	75.0	7,350	-	-	-
p. Berseem	8.0	60.0	5,880	-	-	-
q. Maize (Fodder)	8.0	50.0	3,300	-	-	-
r. Citrus	35.5	25.0	10,875	21.8	9.3	2,500
s. Banana	-	-	-	6.7	13.5	1,100
Non-irrigated fields	(Net area 0 ha)			(Net area 275 ha)		
t. Wheat	-	-	-	20.4	0.7	175
u. Barley	-	-	-	2.0	0.5	13
TOTAL CROP INTENSITY	118.5			104.8		

Note: *; Crop intensity of each crop is expressed as the propotion to the total cultivated area of 1,226 ha.

9 8

MONTHLY DISTRIBUTION OF LABOUR REQUIREMENT

(Unit: Man-day)

Item	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	TOTAL
Mixed farming area with vegetables as the main crop (3 ha of farm land to be distributed)													
-Total labour requirement	106	124	98	61	38	19	11	9	16	39	75	83	679
-Available family labour	65	65	65	65	65	65	65	65	65	65	65	65	780
-Hired labour requirement	41	59	33	-	-	-	-	-	-	-	10	18	161
Citrus farming area (6 ha of falm land to be re-distributed)													
-Total labour requirement	240	210	150	120	75	75	75	75	180	240	300	285	2,025
-Available family labour	65	65	65	65	65	65	65	65	65	65	65	65	780
-Hired labour requirement	175	145	85	55	10	10	10	10	115	175	235	220	1,245

Note: Each family has 2.7 workable persons. Working hour per day is assumed to be 4 hours.
Working day per month is assumed to be 24 days.

Estimation of total labour requirement is based on the "Jordan Valley Project" Final Report Vol. III Annex H I, Page 38, Table H-15.

TABLE 2 - 4

NET PRODUCTION VALUE

(Unit: JD)

	WITHOUT	WITH
(1) Gross Production Value	493,727	1,457,237
(2) Production Cost		
a. Farm input cost	116,251	268,367
b. Labour cost	264,659	320,823
(Sub-total)	(380,910)	(589,190)
(3) Net Production Value (1) - (2)	112,817	868,047

Note: Gross production value is estimated by use of the figures given in Table 2-3 and the farm gate price of each crop listed in the "Jordan Valley Development Plan 1975/1982", prepared by Jordan Valley Commission, Page 66, Table A-17.

Farm input cost is calculated on the basis of data available in the above document, Pages 60 and 61, Tables A-11 and A-12, respectively.

Both labour costs consist of hired labour cost and family labour cost. Unit labour costs are assumed to be 1.2 JD/day for hired labour and 0.9 JD/day for family labour, respectively.

The difference of 755,230 JD between both net production values could be regarded as the benefit attributable to the Project.

2.3 Irrigation Planning

2.3.1 Source of Irrigation Water

In this study streamflow of the Wadi Arab is considered to be a primary source of irrigation water for the Project. Other water resources such as groundwater and the Yarmouk River will be studied in the next phase.

The Wadi Arab, with a drainage area of about 260 km^2, has an average annual total flow of 29 MCM, varying from a minimum of 18 MCM to a maximum of 41 MCM according to records of recent 22 years. Remarkable decrease of discharge is found from 1955 to 1965, being caused by decrease of precipitation.

Under the IDA Project, an area of 2,760 ha would be irrigated under sprinkler system by the combined waters of the Wadis Arab, Ziglab and Jurum. The gross average annual water demand for the IDA Project area would be 25.8 MCM (9,357 m^3/ha).

The remaining discharge of the Wadi Arab after taking out by the IDA Project was estimated taking into account the following method of water utilization.

Water Use Plan of the Project

Priority	Name of Wadi	Effective Discharge
1	Jurum	90% of base flow
2	Ziglab (dam)	100% of total flow
3	Arab	90% of base flow

As a result, shown in Fig. 2.1 , an average remaining available discharge of the Wadi Arab would be 15 MCM, varying from a minimum of 3.4 MCM (1963/64) to a maximum of 31 MCM (1954/55). These figures are employed as a basis of the water balance study for the Project.

2.3.2 Water Requirement

Estimation of water requirement was carried out in six cases to find out the adequate cropping pattern using the Blaney Criddle method with modified crop factors.

As to the input factors of the estimation, the mean monthly temperature and the percentage of daylight hours were calculated from data recorded at the North Shuneh Station. Out of crop factors recommended by Blaney Criddle and the U. S. Soil Conservation Service, stage of growth and average prevailing temperature were adjusted to meet the actual condition of the Project area.

Effective precipitation was assumed to be 90% of precipitation when it was less than 50 mm per month and 80% when it was more. Furthermore, it was multiplied by a probability factor (0.7) expecting that the amount occurs for eight years during ten years.

Pre-irrigation was considered to be required during two weeks preceding commencement of planting. A net application of 60 mm was assumed.

Soil moisture depletion of 20 mm per month was assumed during the late season stage of crop development (within two months).

The overall irrigation efficiency is assumed to be 80% for sprinkler irrigation.

Results of estimation are shown in Table 2.6. Water requirement based on the tentative cropping pattern was adopted to the water balance study in this report. Keeping pace with the above study, the more adequate cropping pattern was considered (A - D). Of them, cropping pattern D is the most recommendable one because the peak and annual water requirement is the lowest.

2.3.3 Dam Capacity and Commanding Area

A relation between dam capacity and a maximum commanding area was obtained through a water balance study of the reservoir.

The estimation of a maximum commanding area was carried out on condition that water shortage of the Project area does not occur for eight years within ten years. Diversion requirement for the Project area is calculated based on the tentative cropping pattern. A discharge used for calculation is a remaining discharge of the Wadi Arab after the IDA Project area was fully irrigated as mentioned in 2.3.1.

The calculating period is ten years (1953/54 - 1962/63), which is just the same period as the estimation of the IDA Project.

The result shows that the storage capacity of 10 - 11 MCM is supposed to be the most effective considering the commanding area.

In case the commanding area is selected to be 1226 ha, or total net irrigable area of DA - 3, 4 and 5, the effective capacity of a proposed dam should be of 10.25 MCM. However, by application of the cropping pattern D to the Project area, the dam capacity related to an area of 1226 ha will be decreased to around 10 MCM. This point will be checked in the study of Phase III.

In addition to the above, a calculation was carried out to check the possibility of recovery of the storage of the reservoir (10.25 MCM) for the period of twelve years (1963/64 - 1974/75).

The result is shown in Fig. 2.2 . Recovery of storage is found after 1967/68.

2.3.4 Irrigation Method

(1) Selection of Irrigation Method

The conceivable methods of irrigation are, (a) surface irrigation, (b) sub-irrigation, (c) drip irrigation, and (d) sprinkler irrigation. Taking into account the local conditions of the Project area, features of these methods can be explained as follows:-

(a) Surface Irrigation:
Cost of facilities is relatively low. Irrigation efficiency is low. Labour requirement is high. From the viewpoint of efficient utilization of the restricted source of water, this method is not so profitable.

(b) Sub-irrigation:
The Project area has a less possibility to be adopted to this method because sub-soils are rather permeable. Furthermore, deterioration of water quality will be brought about by intrusion of salty groundwater into irrigation water. According to the results of field investigation and the previous studies in 1963 and 1969, the quality of groundwater expected in the Project area is thought to be moderately saline.

(c) Drip irrigation:
This method is adaptable to the Project area from the aspect of efficient utilization of water. On the other hand, cost of equipment is relatively high and also this method needs skilled farming technique. The introduction of this method requires more systematic studies in the future.

(d) Sprinkler irrigation:
This method is most recommendable from the viewpoint of facility cost and efficient use of water. Considering the present level of farming technique of the farmers in the Project area, however, provision of proper technical guidance

for sprinkler irrigation system should be required.

From the above comparison, the sprinkler method was selected as a proposed irrigation system. Technical study will be carried out in detail in the next phase.

(2) Determination of Irrigation Method by Crop

In due consideration of crop features, intermediate pressure sprinkler system with a portable function is selected for vegetables and grain crops. For citrus field, low pressure sprinkler system is adopted for the sake of under-tree sprinkling operation.

2.3.5 Outline of Preliminary Design

(1) Farm System

(a) Basic Principle:
Planning is carried out for a sprinkler irrigation system. The useful life of this system is considered to be 15 years, so that the introduction of drip irrigation method can be expected in the future.

(b) Farm Size:
In accordance with the present farm size, net irrigable area of 3 ha will be distributed to each household in the mixed cropping area with vegetables, cereals and fruit trees. In case of the existing fruit tree cultivation area, net irrigable area of 6 ha will become a minimum farm plot.

(c) Irrigation Particulars:
The irrigation system is designed to be operated for 24 hours at peak time with enough capacity of facility covering the water demand of alfalfa which indicates maximum water consumption.
- Number of days of intermittence: about 7 days (including 1 holiday).

- Irrigation intensity: Not more than 6 - 7 mm/hr.
- Sprinkler arrangement: To be determined to obtain high efficiency at average wind speed of around 1.0 m/sec.

(d) Farm layout and pipe distribution system:
Typical design is presented in Fig. 2.3.

(2) Pipeline Network

The pipeline network consists of a carrier pipe and distributary pipes.

(a) Carrier Pipe:
The carrier pipe connects the Wadi Arab Dam with the distributary pipes of the IDA Project and the Wadi Arab Project, and its diameter is to be around 1,200 mm and the length about 2.2 km.

The water level required at the starting point will be approximately -140.0 ASL which is determined based on the water level necessitated by the IDA Project.

(b) Distributary Pipe:
Distributary pipes connect the carrier pipe with the farm system having pipe diameters from 1,100 mm to 100 mm and total length of 40 km required. All distributary pipes are laid along farm roads for saving operation and maintenance works.

(3) Control System

The following three items are the main objects of this study:
- Control for keeping efficient and stable intake from the three wadis.
- Prevention of back-up flow caused by differences in water levels of the three wadis.
- Adjustment of excessive pressure.

(a) Control for stable intake from three wadis:

Jurum ..... natural intake (uncontrolled flow)
Ziglab ....
Arab .....) dam intake (controlled flow)

In case that the three wadis are utilized as one, intake is primarily done at the Jurum followed by the Ziglab or Arab. In case that the beneficiary area of the three wadis are divided into an Arab Area and a Ziglab-Jurum Area independently, there will be a necessity that the two independent areas must be connected by an emergency pipe.

Although it would be advantageous to utilize the three wadis as one from the standpoint of efficient use of water, it would be desirable to make the reservoir operation program possible for variable use of Arab and Ziglab Dams.

At intake site from a reservoir, a connecting tank is provided between the intake structure and the carrier pipe to absorb water level variation of the reservoir. The water level of this is determined by the water level requirement at the end of irrigation network.

(b) Prevention of back-up flow produced by differences in intake water levels at three wadis:

Jurum: -129.2 m (natural intake)
Ziglab: -134.2 m
Arab: -140.0 m) (dam intake)

No arrangement is done for the Jurum intake since natural intake is carried out there, while back-up prevention valves should be provided at the carrier pipes of Ziglab Dam and Arab Dam.

(c) Absorption of excessive pressure:

Water level variations of a reservoir can be expected to be absorbed by an intake tank.

Elevations in the Project area range from -200 m to -215 m (-240 m at parts). Since distribution pipes directly connect the three wadis, hydrostatic pressures of 85.8 m to 70.8 m at maximum will pose an economical problem with respect to the type of pipe to be used for the pipeline network of the Project. From the technical viewpoint, there seems to be a problem to keep the safety of system against water hammer because of the direct connections taking into account these problems pressure reduction tank should be arranged. This tank is inserted in the distribution pipe branched off near the terminal points of the carrier pipes.(Fig. 2.4.)

2.3.6 Drainage

(1) Surface Drainage

Drainage canals have already been provided at places of poor drainage in the Project area and since drainage improvements have been completed there will be no large scaled measures required this time. However, it will be necessary to improve collector drains for individual fields since the infiltration rates of the soils are low.

(2) Subsurface Drainage

With regard to leaching it will suffice for considerations to be given in the future when the necessity for this arises.

2.3.7 Farm Road

(1) New Area

Farm roads are provided along pipelines. Effective widths are

to be 3 to 4 m and surfacing is of gravel.

(2) Conversion Area

Roads have been provided along the existing waterways (open canal) and these will be used as is except for parts in poor condition which will be repaired and surfaced with gravel.

DIVERSION WATER REQUIREMENT

(Unit: m^3/ha)

CROPPING PATTERN

Month	NEDECO	Tentative	A	B	C	D
Jan.	434	316	321	346	346	350
Feb.	557	489	429	473	449	450
Mar.	725	824	688	706	671	657
Apr.	1,070	1,310	1,099	1,027	992	956
May	1,032	1,468	1,117	930	949	925
June	862	989	1,153	901	935	966
July	720	533	1,168	931	931	977
Aug.	819	460	1,066	856	848	908
Sept.	1,025	851	1,000	854	846	836
Oct.	982	908	954	896	900	867
Nov.	727	704	648	646	645	628
Dec.	410	303	287	352	311	299
ANNUAL	9,363	9,155	9,930	8,918	8,823	8,819
Vegetable*	56.2	134.0	39.4	40.3	48.3	48.3
Cereal*	18.8	29.0	10.8	13.4	10.7	10.7
Fodder*	30.8	5.0	25.1	24.1	21.4	24.0
Fruit*	13.8	-	42.8	35.5	35.5	35.5

Note: *; Each intensity is expressed as percentage.

Fig. 2.1 ANNUAL DISCHARGE OF THE WADI ARAB
1953/54-1974/75

Fig. 2.2 WATER BALANCE STUDY OF THE WADI ARAB DAM

(Effective Storage Capacity = 10.25 MCM)

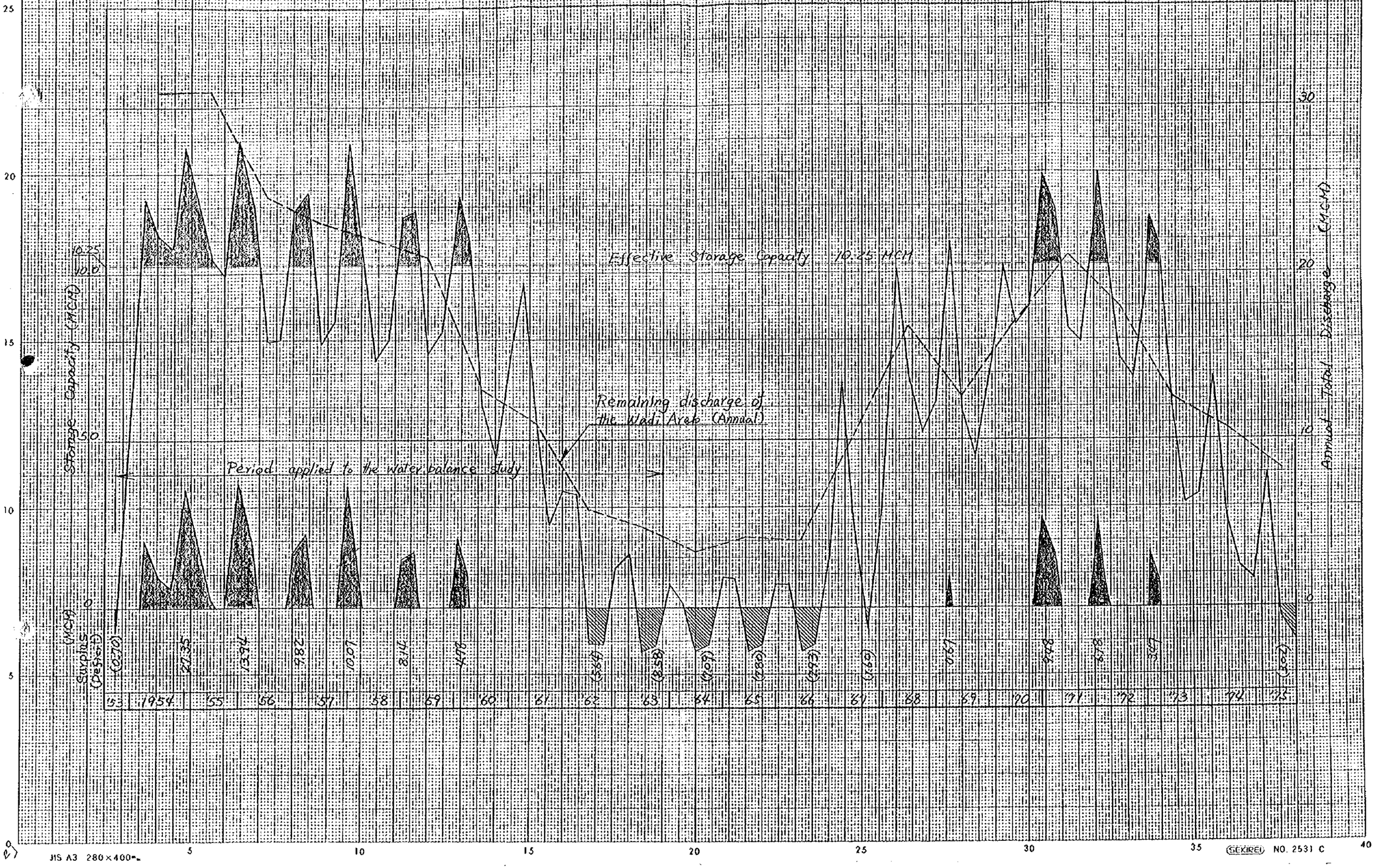
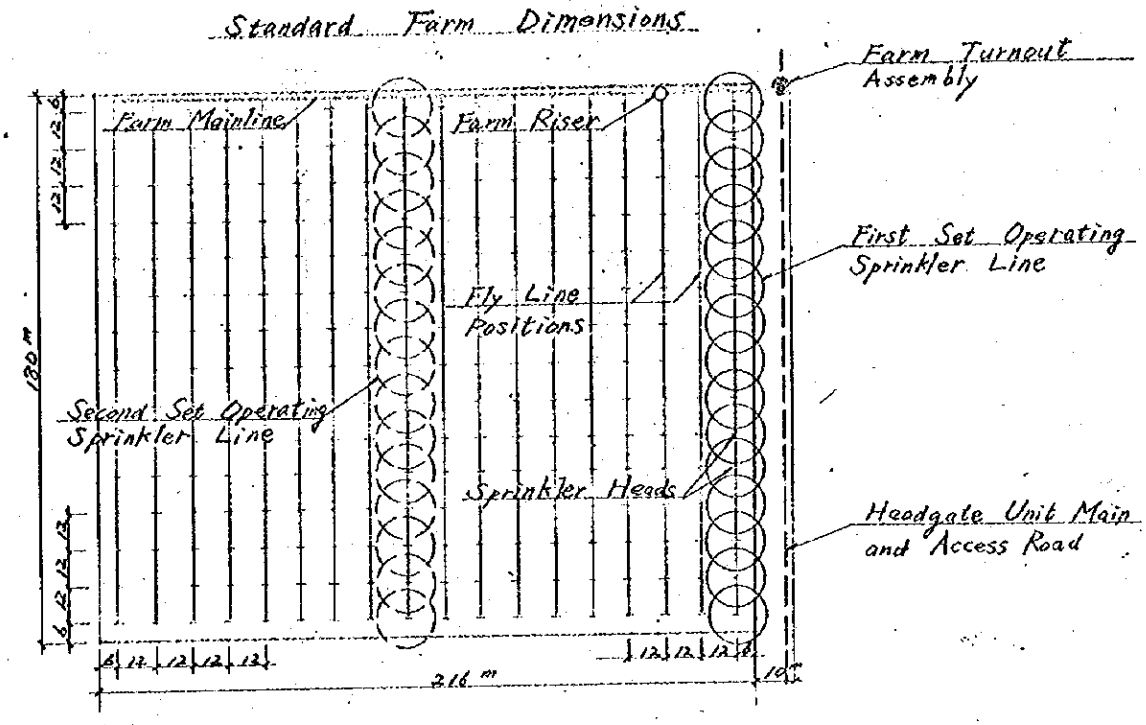


Fig. 2.3 FARM LAYOUT AND PIPE DISTRIBUTION SYSTEM



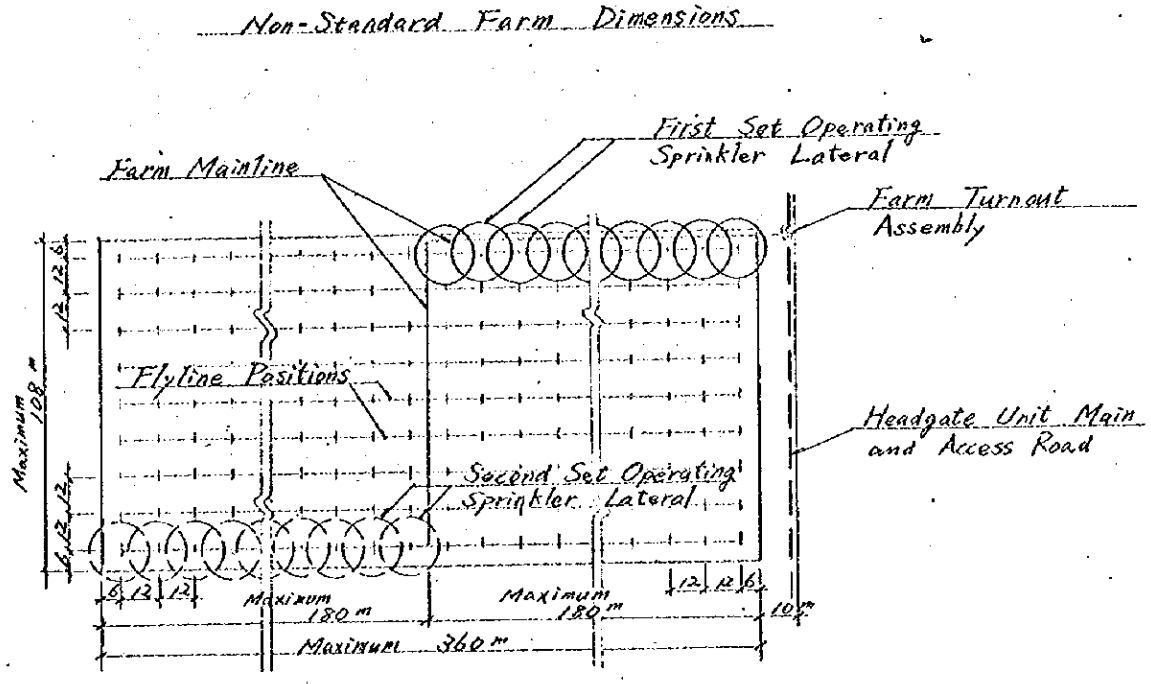
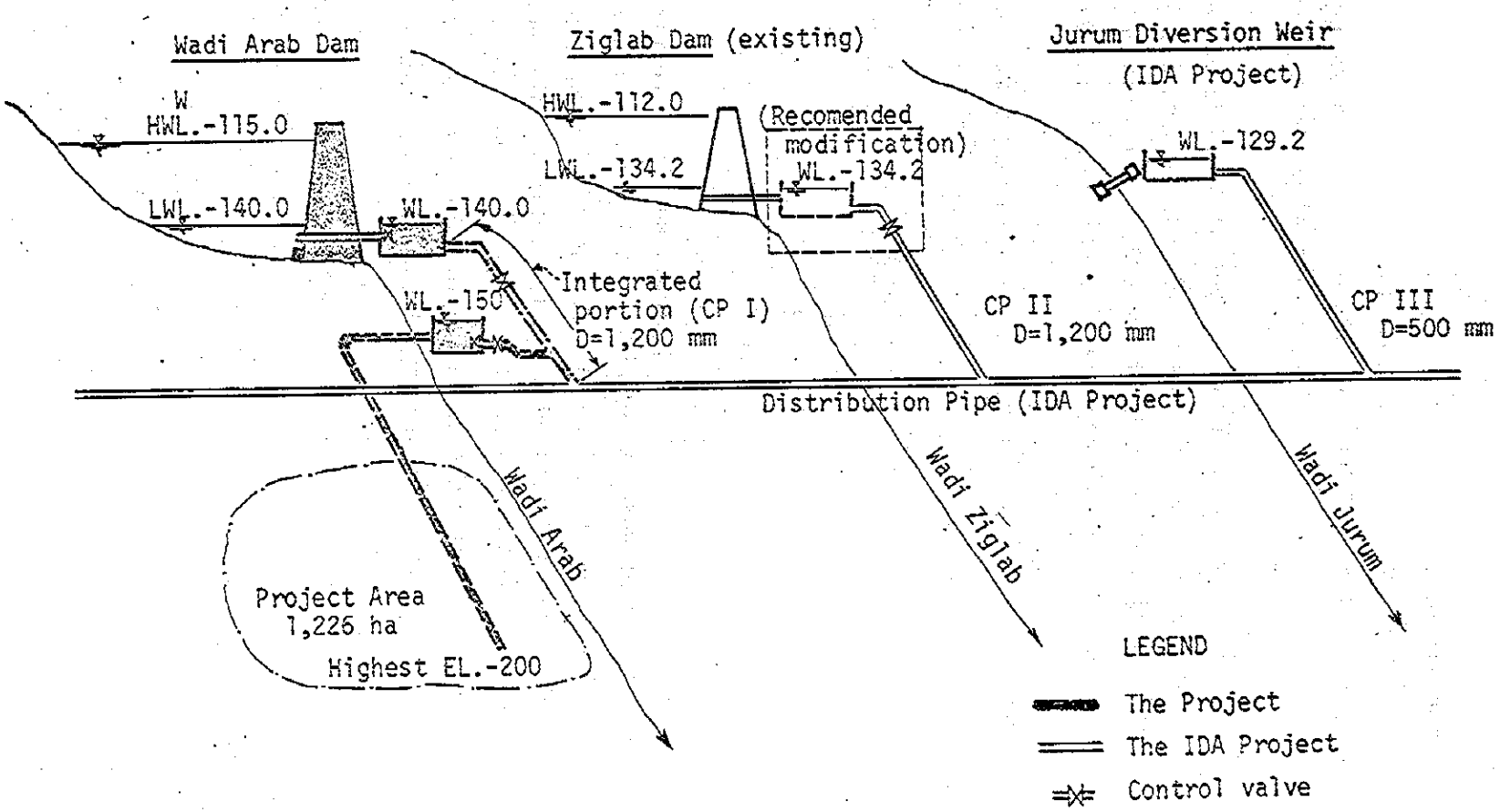


Fig. 2.4 WATER CONTROL SYSTEM



2.4 Dam Planning.

1) Prior to the formulation of the dam plan the selection of the dam site was made. At least three possible dam sites are recognizeable in view of the topography of the Project site. They are marked A, B and C, respectively, as shown in Fig. 2.5.

The site A is located at a confluence of Wadi Arab and Zahar where was proposed for a intake weir in the IDA Project. The site B is proposed by Sir Mcdonald and Partners in 1965 and is also selected by the Team. The site C down-stream of the site B is likely be possible site.

Comparison between dam volume of them roughly estimated for same reservoir capacity is as follows:-

Site	Volume ratio
A	3.9
B	1.0
C	2.0

Moreover, the reservoir shall be required to maintain necessary gravity head for sprinkling irrigation system to be taken in either project. To supply gravity irrigation water to commanding area at height of - 200 ASL, The intake water level shall be levelled more than - 140 ASL. Topography of the site C is not conditioned to provide. On the other hand, the site A shall take higher reservoir water level unnecessary for the required gravity and longer carrier pipe.

Taking into account of the above, the site B shall be selected as the proposed dam site for the Project.

2) Dam size was provided for the reservoir capacity which was required by a water consumption of the tentative cropping pattern. On the basis of 10 MCM reservoir capacity, the revised topographic map on a scale of 1 to 1,000 and a reservoir capacity curve, Fig.2.6,have given the dam size as below:-

Reservoir water level:	-115.50 m.	(ASL)
Intake water level:	-140.00 m.	(=)
Dam crest elevation:	-110.00 m.	(=)
Dam crest length:	425.0 m.	(=)
Dam bottom formation:	-162.00 m.	(=)
Dam height:	52.00 m.	
Dam type:	Homogeneous rolled earthfill.	
Dam volume:	2.19 MCM	
Up-stream slope:	1:3	
Downstream slope:	1:3	

The dam provides a spillway to release a discharge of the maximum design flood estimated at 570 cu.m. per second. This discharge was estimated by "Ratinal Formula" and assumed coefficient of run-off at 0.45. The spillway sites on the right abutment of the dam in type of open channel side spillway to be made of concrete.

A coffer dam and diversion tunnel are provided for a flood discharge of 170.0 cu.m. per second which was estimated for a discharge probably occurable every 10 years, probability 10 percent. As 4.50 m. diameter of a diversion tunnel discharges the said flood flow, the water level at an entrance takes -145.00 ASL and requires the crest elevation of coffer dam above -144.0 ASL. The tunnel is designed in pressured circular section which is made of reinforced concrete, a length of the tunnel takes about 400 m long excluding an entrance and outlet channels.

The geological section of line B - B', Fig. 2 - 2 in Annex 2, shows that highly permeable scree and sedimentals are fully covered the wadi floor. Thickness of these previous materials is inferred to 3.0 - 10.0 m. deep . Removal of these materials from the dam foundation or improvement of permeability shall be studied in further phase.

Use of rock materials is also considerable for dam planning. As disclosed by the geological survey, only timestone seems to be reliable as the dam materials. Generally the limestones are overlaid with thick chalky marl or heavily weathered materials. This fact evidently indicates that the rock materials inevitably be cost unless otherwise the soft rocks overlying the hard rocks be proved their durability, absorption and durability to be availed for the dam materials.

Earth or impervious material deposits in the proposed site as marked in Fig. 2.5. An amount of the material deposit is estimated for about 1.5 MCM and will easily assure to provide more than 3.0 MCM of qualified material.

Approximate 100,000 cu. m. of gravel and sand is available from the wadi floor between the proposed dam site and a existing intake weir about 2.0 km. far from. The quantity of the material was examined by the test pits and area survey. The material contains much cobble andboulder stones of some size. These stones shall be crushed for sizing the materials for filter and aggregates. Total quantity of this material required for the project construction tentatively be estimated at about 70,000 cu.m. Necessity of a crushing plant will be studied in phase III

LEGEND

Road
Footpaths
River, Stream
Telegraph Line
Slope
Cliff
Village

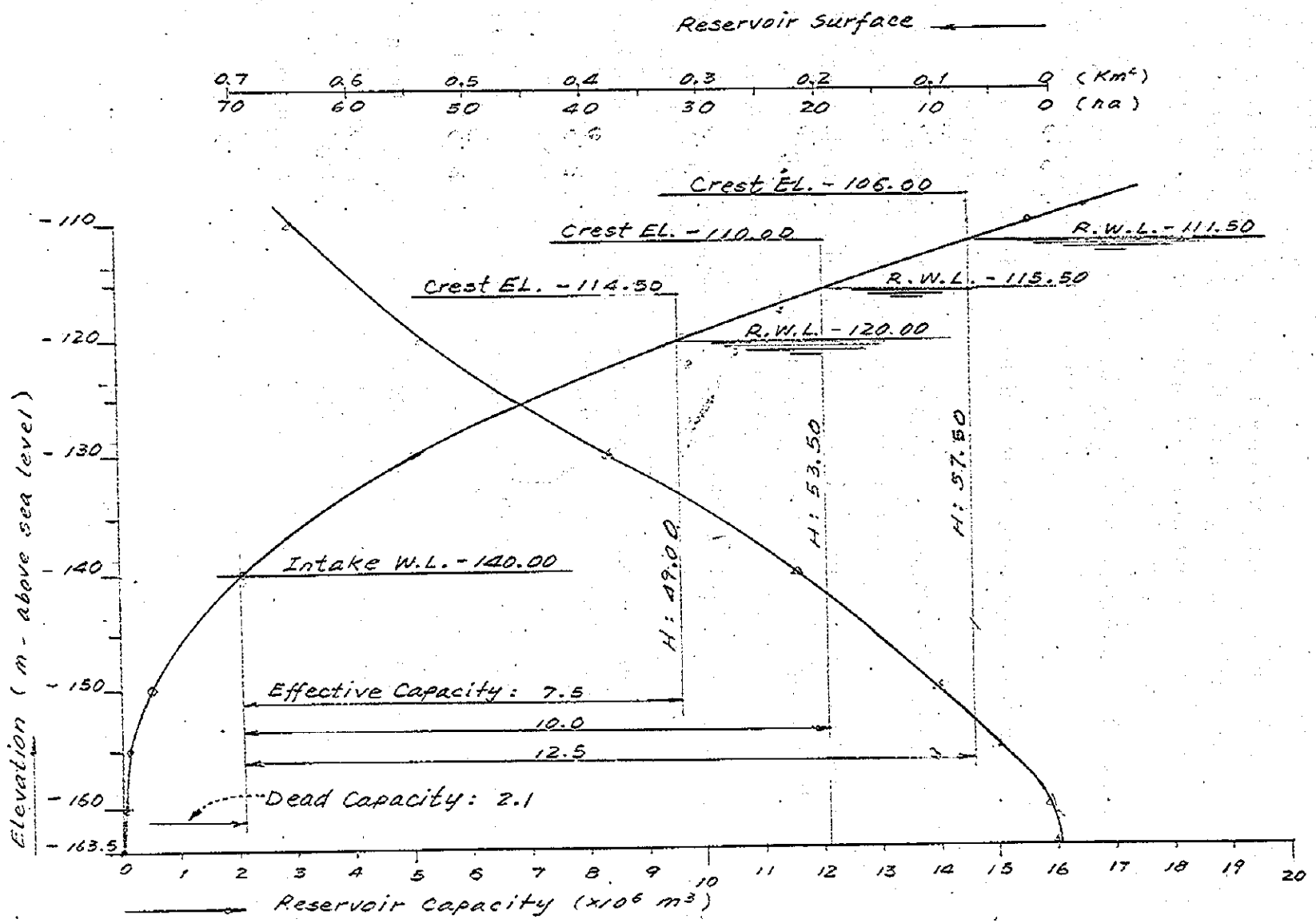
0 600 1000 M

El Baqūra
N. Shūneh
Es Sakhine
Wadi el Arab
JORDAN RIVER
Wadi Zahar
Axis of the proposed dam
Dam site A
Dam site B
Dam site C
Borrow Area (A)
Borrow Area (B)
Borrow Area (C)
TP-1
TP-2
TP-3
TP-4
TP-5
TP-6
TP-7
TP-8
TP-9
TP-10
TP-11
FP-1
FP-2
FP-3
FP-4
CB. No.1
CB. No.2
CB. No.3

WADI ARAB
DAM & IRRIGATION PROJECT
GENERAL LAYOUT PLAN

Fig 2.5

Fig. 2.6 RESERVOIR CAPACITY AND SURFACE AREA CURVES



2.5 Cost Estimates and Implementation Schedule

2.5.1 Cost Estimates

The total Project cost is tentatively estimated at U.S.$ 41.93 Million (J.D. 13.84 Million), including U.S.$ 12.7 Million (J.D. 4.2 Million) for physical and price contingencies.

It is noted that the estimated costs are quite tentative figures based on the following assumptions:

1) Costs of dam are estimated in case of homogeneous rolled earthfill type.
2) Costs of preparatory works are to be changeable depending on the scale of the preparatory works and plants.
3) Costs of irrigation works are for the irrigation system tentatively planned based on the water requirement derived from the tentatively established cropping pattern.
4) Engineering and administration costs are assumed at 20% of the cost of main works.
5) Physical contingencies are estimated at 15% for civil works and irrigation works excluding on-farm facilities and 10% for other costs.
6) Price contingencies are tentatively estimated at 30% compounded for all costs.

Consequently, the costs are subject to change depending on the detailed studies and analysis to be carried out in the Phase III Works. Breakdown of the tentative cost estimates is summarized in the next page.

Tentative Cost Estimates

	(U.S.$1,000)
Dam	
Preparatory Works	1,073
Diversion Works	816
Dam Works	14,204
Spillway Works	555
Subtotal	16,648
Irrigation	
Carrier Pipe	1,615
Distribution Pipes	1,942
Farm Roads	494
Farm Pipes	1,506
Sprinkler Sets	1,306
Subtotal	6,863
Engineering and Administration	4,700
Land Acquisition	1,000
TOTAL	29,211
Contingencies	
Physical	3,956
Price	8,763
Subtotal	12,719
GRAND TOTAL	41,930
	(J.D.13,837.000)

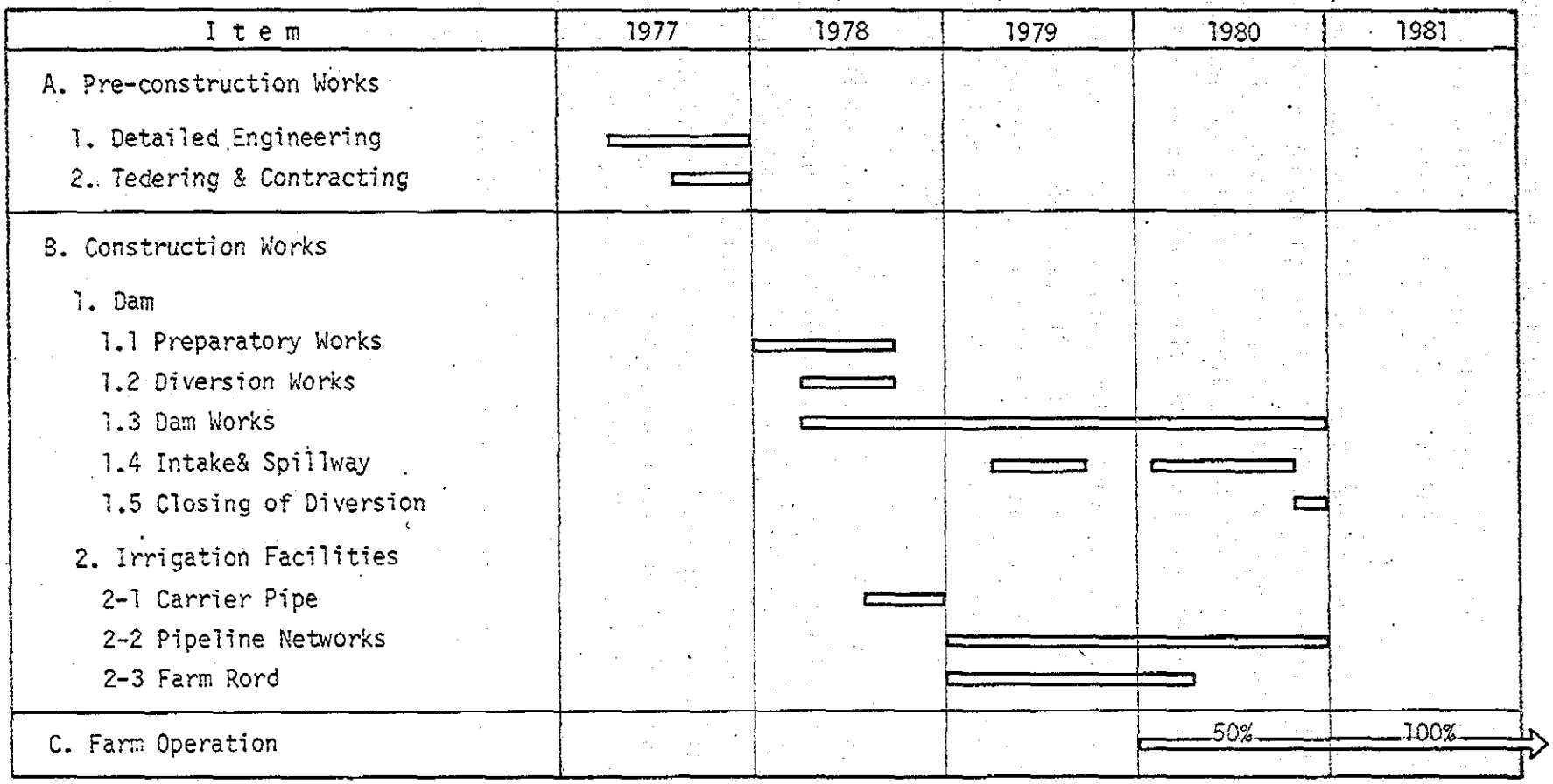
2.5.2 Further Implementation Schedule

An implementation schedule of the Project is tentatively fabricated as charted in Figure 2.7. The schedule sets forth the construction period within 36 months from the beginning of 1978 up to the end of 1980. An achievement of this schedule seems to be difficult but conceivable. The integration of the Project with the IDA Project affects the implementation and operation of the IDA Project.

Accordingly, the following considerations have been paid in the schedule:

1) Detailed design is to be completed within the end of 1977.
2) Preparatory works are also completed before the time scheduled so as to assure the further construction works.
3) Diversion work is completed within the year of 1978.
4) The schedule allows supplying some irrigation water to either commanding area from end-1979 if desired, so as to release the IDA Project from water shortage due to the implementation of the Project.
5) Adequate construction and contract forms are to be settled.

Fig. 2.7 TENTATIVE IMPLEMENTATION SCHEDULE



2.6 Benefits and Tentative Justification

In order to justify the proposed scale of the Project, a tentative benefit - cost analysis was undertaken.

The major economic benefit is the increment of the agricultural production in the future with the Project. This benefit will result in increments of foreign exchange earnings and domestic supplies of agricultural commodities, and eventually in the augment of aggregate consumption in the national economy.

While the net production value in the future without the Project is estimated at about J.D. 112,000 per annum, that in the future with the Project would be J.D. 867,000. Accordingly, the annual incremental benefit would be J.D. 755,000 after the full development of the Project.

As the integration of the Project with the IDA Project is essential, the economic rate of return was calculated for the integrated project combining costs and benefits of both the projects into one. Such the economic rate of return is estimated at 13% which would exceed the opportunity cost of capital. Then, the scale of the Project suggested in the preliminary plan discussed in the above sections will be acceptable in the viewpoint of the economic viability.

Basis of calculation of the economic rate of return is shown in Annex 6.

ANNEX - 1
METEOROLOGY AND HYDROLOGY

1-1 General

During the Phase I Works, collection of meteorologic and hydrologic data and brief study on them were made for the inception works to find the optimum range of the Project scale. Following the preceding Phase, collection of meteorologic and hydrologic data in more details were continued also during the Phase II Works. Such collection was intended to furnish as ample data as possible for the feasibility study of the Project.

1-2 Meteorological Data

During the Phase II Works, the daily rainfall data as listed below was collected from the Water Resources Division of Natural Resources Authority (NRA).

Area	Station*	Data Coverage	Duration (years)
Watershed	Irbid School	1937/38 - 1973/74	37
"	Irbid Agr. Station	1954/55 - 1973/74	20
"	Kofr Asad	1962/63 - 1973/74	12
"	Kofr Yuba	1937/38 - 1973/74	37
Irr. Area	Esh Shuneh	1950/51 - 1967/68	18
"	Baqura Agr. Station	1937/38 - 1968/69	22

In addition to the above, meteorological data was obtained from the Meteorological Department of the Ministry of Transport.

*Location of stations are shown in Fig.1-1.

The available data of the North Shuneh and Baqura Stations is adopted to the studies of the Project.

The collected data is listed below:-

1) Temperature (daily mean maximum and minimum)
   North Shuneh Station, 1955 - 1976

2) Mean Relative Humidity
   North Shuneh Station, 1961 - 1976

3) Wind Speed
   North Shuneh Station, 1965 - 1974

4) Monthly Evaporation
   North Shuneh Station;
   i) Piche = 1958 - 1974
   ii) Class "A" Pan = 1965 - 1974

5) Mean Sunshine Hours
   Baqura Agricultural Station, 1967 - 1976

6) Solar Radiation
   Baqura Agricultural Station, 1973 - 1974

The mean values for each recorded data are summarized in Table 1-1.

1-3 Hydrologic Data

During the Phase I Works, the monthly discharge of the Wadi Arab from 1935/36 through March, 1976, was collected. During this Phase, additional visits were made to the offices concerned such as the Water Resources Division, NRA and the Deir Alla Office of the East Ghor Canal Project; and scrutiny and confirmation of the discharge data of the Wadi Arab were conducted. Also, similar data of the Wadi Ziqlab and the Wadi Jurum were collected. Finally, the monthly discharge data of three wadis as listed

below were compiled.

River	Data Coverage	Duration (years)
Wadi Jurum	Oct., 1928 - Mar., 1976	47.5
Wadi Ziqlab	Oct., 1928 - Sept., 1975	47
Wadi Arab	Oct., 1928 - Mar., 1976	47.5

These data are to be used mainly for the water balance study.

Together with the said monthly discharge data, the largest daily mean discharge of each month of the Wadis Arab and Jurum were collected. It is intended to use these data to determine the design flood discharge for the spillway of the Wadi Arab Dam. It seems, however, that these data do not include notable high values by which probable values can be calculated directly. It would, therefore, be necessary to estimate the value of design flood through other means.

1-4 Check Measurement

The check measurement of the discharge of the Wadi Arab was carried out during field survey by the Team, May - July, 1976. The location of the measuring site and the result of the measurement are shown in Fig. 1-2 and Table 1-2. The results of the measurement indicate that the measured discharge is about 25% more than the estimated value by NRA. From the viewpoint of utilization of water of Wadi Arab, more water will be able to be taken in for irrigation than the amount of available water estimated basing on the discharge data by the NRA. Since the period of the check measurement is so short as less than two months, no modification on the existing data is able to be undertaken. Therefore, the discharge data estimated by NRA is decided to be used for the study without modification. It can be said that the available amount of water for irrigation will be a little more than that calculated in the water balance study.

ANNEX - 1
PAGE 4
TABLE 1-1

SUMMARY OF METEOROLOGICAL DATA

Item	Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Precipitation (mm)	SN	79.1	59.2	49.2	17.0	9.3	-	-	-	-	14.4	44.8	82.5	355.5
	BA	90.6	60.3	59.2	18.2	7.1	-	-	-	-	14.0	42.6	82.2	374.2
	IS	104.6	78.1	77.3	25.1	5.1	-	-	-	-	12.3	47.7	75.3	425.5
	IA	108.4	81.0	81.2	28.3	6.7	-	-	-	-	11.3	43.2	87.7	447.8
	KY	127.4	102.1	87.3	29.0	6.7	-	-	-	-	10.5	56.4	89.8	509.2
	KA	129.9	90.7	81.6	32.7	4.7	-	-	-	-	20.9	48.6	84.9	494.0
Temperature -Maximum(C)	SN	18.6	19.9	23.0	28.1	32.7	36.2	37.0	37.7	33.8	33.3	27.0	20.6	
-Minimum(C)	SN	8.7	9.1	10.6	13.6	16.8	20.7	22.9	23.6	21.5	17.7	15.0	11.0	
-Mean (C)	SN	13.7	14.5	16.8	20.9	24.7	28.5	30.0	30.7	28.7	26.1	21.0	15.3	
Relative Humiditity(%)	SN	67	67	65	56	49	49	52	54	53	52	55	65	Ave. 57
Wind Speed (m/sec)	SN	2.8	2.9	2.1	2.3	2.4	2.7	2.9	2.2	2.1	1.8	1.9	2.3	Ave. 2.4
Evaporation -Piche (mm)	SN	4.0	4.2	4.5	6.3	8.5	9.8	9.8	9.6	8.5	7.2	6.8	4.2	
-Class A Pan	SN	2.1	2.6	3.4	5.5	7.4	9.4	9.4	8.5	7.2	5.2	3.9	2.4	
Sunshine Hours (hrs)	BA	5.0	6.3	6.7	8.0	10.6	11.9	11.9	11.3	9.8	8.6	6.5	5.3	
Solar Radiation ($Cal/cm^2/day$)	BA	223	301	374	455	563	603	566	529	460	367	268	231	

Note: Station SN; Shuneh North, BA; Baqura Agricultural Station, IS; Irbid School, IA; Irbid Agricultural Station, KY; Kufr Yuba, KA; Kufr Asad.

Fig. 1-1. LOCATION OF THE CLIMATOROGICAL STATIONS

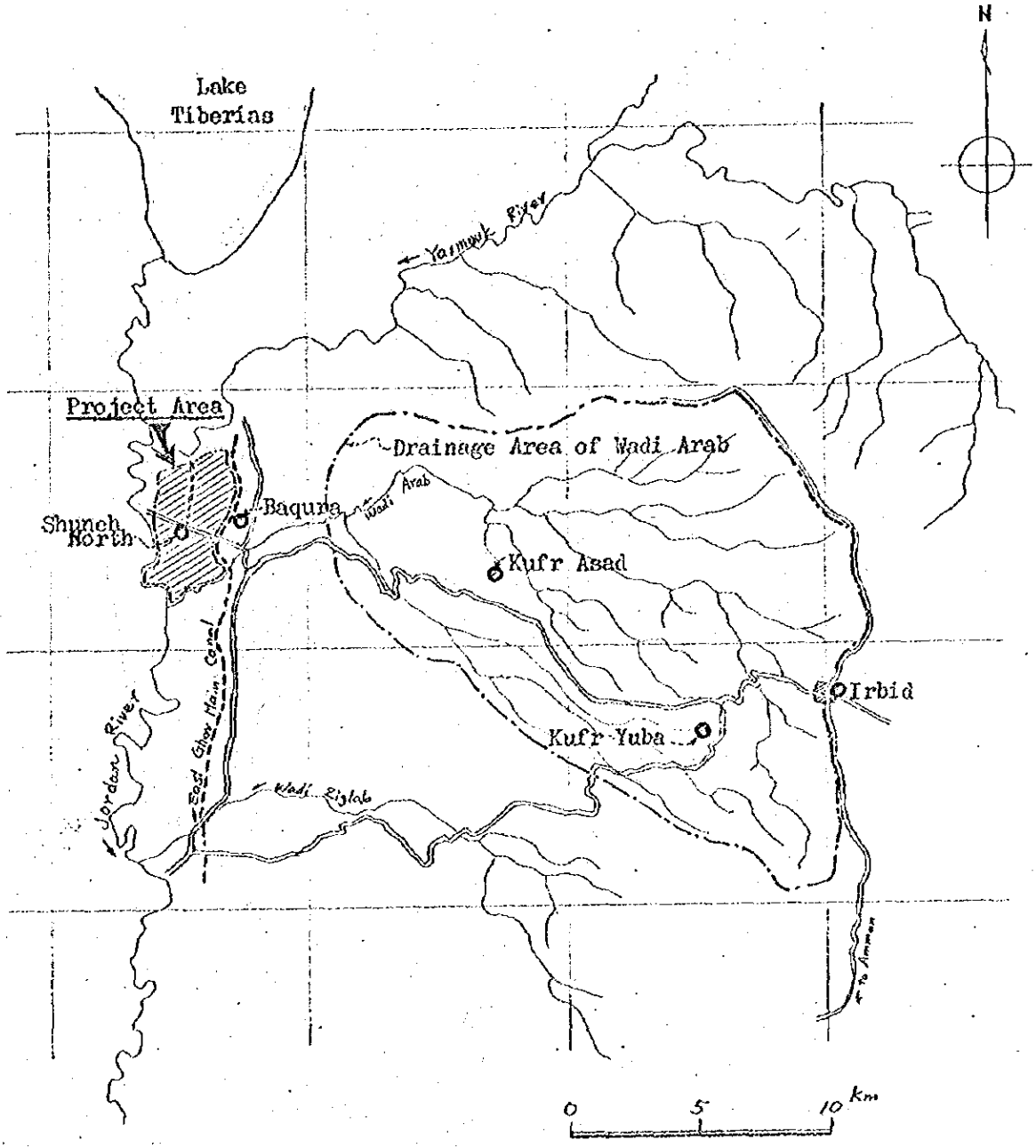


Fig. 1-2. LOCATION MAP OF THE MEASURING SITE OF THE DISCHARGE (WADI ARAB)

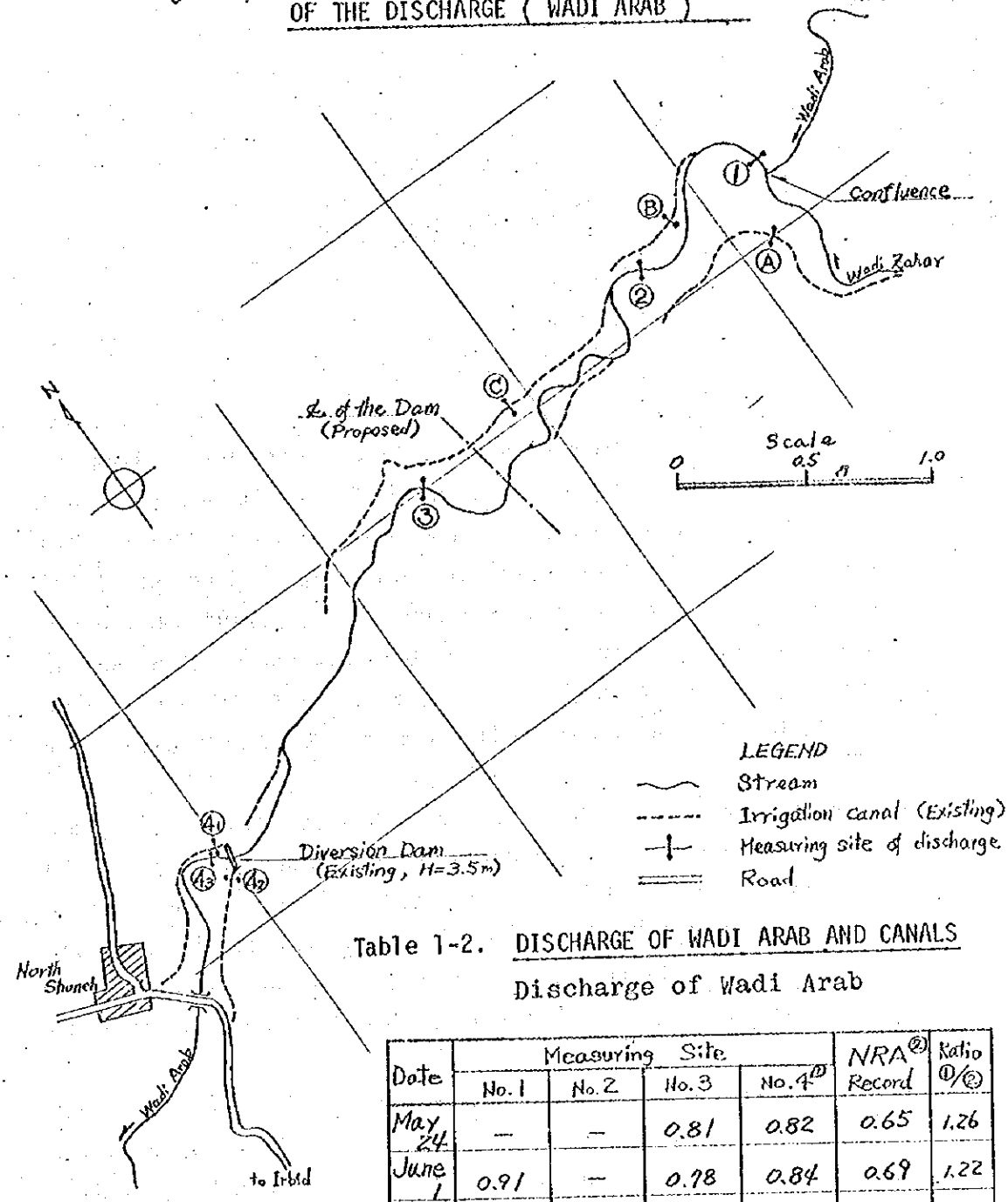


Table 1-2. DISCHARGE OF WADI ARAB AND CANALS

Discharge of Wadi Arab

Date	Measuring Site No. 1	No. 2	No. 3	No. 4 ①	NRA ② Record	Ratio ①/②
May 24	—	—	0.81	0.82	0.65	1.26
June 1	0.91	—	0.78	0.84	0.69	1.22
2	0.83	0.79	0.80	0.81	0.65	1.24
3	0.84	0.83	0.83	0.83	0.66	1.26
5	0.80	—	—	0.79	0.65	1.21
15	0.89	—	0.87	0.88	0.69	1.27
24	0.87	—	0.81	0.86	0.69	1.25
July 3	0.81	—	—	0.80	0.67	1.19
11	—	—	—	0.81	0.64	1.26
18	—	—	—	0.82	0.66	1.24

Note: $4 = 4_1 + 4_2 + 4_3$

Discharge of Canals

Unit: m^3/s

Measuring Site	Discharge
A	0.12 ~ 0.09
B	0.04 ~ 0.06
C	0.05 ~ 0.09
4-3	0.02 ~ 0.03

ANNEX - 2
ENGINEERING GEOLOGY

2.1 Geology

2.1.1 General

The most notable feature of geology in Jordan is existence of the "Jordan Rift Valley" which is a northern part of the "Great Rift Valley" extending from east side of Africa. Recently, new "Plate Tectonic Theory" deems the Great Rift Valley is a region producing a "Plate". It is understood that a few of faults observed in the proposed dam site and reservoir area had been formed in NW-SE and E-W strike diection along Wadi Arab due to thrusting aside both bank of the Jordan Valley when it had shaped up.

The proposed dam site and reservoir area are situated in an area of chalky marl, limestone, bituminous marl and chart in the Tertiary undifferential. General trend of these rocks inclines gently to the north. But at the left bank of Wadi Arab, they incline to the south, gently. So, it is considered that an anticline structure with E-W direction forms along Wadi Arab.

These sedimentary rocks are overlain widely by basalt lava, 5 -10 meter thick, on the right bank of the river, and also overlain with marl, gravel and travertine of diluvium in the Quarternary on the left bank downstream of a confluence of Wadis Arab and Zahar. Uncemented sediments of alluvium, the Quarternary, distribute along the river and foot of the both banks.

A geological succession on the proposed dam site is shown in Fig.2-1.

2.1.2 Left Abutment

The left abutment is composed of chalky marl with subsisiary bituminous marl having strike N90°E dip 15°-12°N and inclining generally to the Wadi. They are generally soft and massive exept the rocks distributing in the steep clif on the left bank just downstream of the proposed dam axis. In the cliff, the rocks are comparatively hard and well joined as well as the limestone in the right abutment.

According to the boring survey, weathering has advanced approximately 40 meters under the ground surface at an elevation of - 115 ASL along the section line B-B' as shown in Fig. 2-2. It is understood that this weathered zones have bearing strength sufficient to the foundation of proposed fill dam.
However, this zone is permeable. A permeability was measured as stated in Fig.2-3 through Fig.2-7. Effective countermeasures such as grouting or drain will be required in design for the dam foundation.

2.1.3 Right Abutment

Limestone with subsiary charts and marls (strike N 80°E and dip 25°E) are exposed above an elevation of - 135 ASL along the section line B-B'.

The rocks are comparatively hard and have clear bedding planes in habit. They have many joint in parallel and vertical to the bedding planes, strike N 15°E dip 85°W and strike N 80°W dip 60°S, respectively. Weathering has advanced along these joint approximately 35 meters deep under the ground surface at a height of -115 ASL on the section line B-B'.

Chalky marl exposes and overlie on the said limestones above a height of about -112ASL along the section line B-B'. A boundary of chalky marl and limestone is not clear. Chalky marls are less than limestone.

Bituminous marls are overlain by scree below a height about -135 ASL. They are very soft under wet condition. These bituminous marls are impermeable and have enough strength for foundation of fill dam lower than about 50 meters high.

Lower terrace deposit distributing downstream of the proposed dam axis is composed of gravel, marl, travertine and scree. This deposit is not well cemented and is about 15-20 meters in thickness. Bearing strength of this deposit seems to be reliable but its permeability will not be favourable to the proposed dam foundation.

2.1.4 Wadi Floor

It is difficult to know basement rocks structuring the Wadi floor throughout the proposed dam and reservoir. Because the Wadi floor completely be covered by superficial uncemented materials such as terrace and scree. Judging from the boring survey, outcrops and geological structure, it is considered that the basement rocks are composed of bituminous marl and limestone.

At downstream face of a knoll at the right abutment of proposed dam, bituminous marl has a steep 60^{o} - 80^{o} dip and has distorted and sheared. Many fine joints are observed along the bedding planes. Under the wet condition, it easily become soft and under the dry condition, it easily be brittle.

Bearing strength and permeability of this rock probably be reliable for the proposed dam foundation. Faults and weathered zones in this marl shall be technically improved by adequate method.

Limestone basement intruded with the bituminous marl is about 8 - 10 meters thick. This limestone is well jointed but fairly permeable. Therefore, adequate improvement such as cement grouting shall be necessary for obtaining special permeability.

At least three faults were disclosed in the surface investigation. Location and features of them are shown in DWG. No. 2-1.

The terrace and scree materials covering the Wadi floor in the proposed dam and reservoir area deposit about 3 - 10 meters thick, and uncement with highly permeable.

2.1.5 Reservoir Area

The reservoir area features with composed chalky marl forming steeply stopping hills on both bank of the river. The reservoir floor is structured by the basement rocks consisting of limestones and bituminous marls overlying below some meters thick of the previous materials as preceded.

Generally, bituminous marl is characterized by impervious and used for impervious blanket material.

No caves which will induce probable water leakages from reservoir, are observed within the proposed reservoir area. Cliffs of the bituminous marls siting near the confluence of Wadi Arab and Zahr will be likely to landslide sometime but such occurence will not affect stability of the dam by distance between the proposed dam site and occurable so far about one and half kilometers.

2.2 Geological Investigation of the Dam Site and the Reservoir Area

2.2.1 Method of the Investigation

The geological investigation of the proposed dam site and reservoir was carried out in the following items:

Dam Site

Detailed surface geological survey	(scale 1:1,000)	
Seismic survey	8 lines	3,235 m

Boring survey	8 holes	282 m
Water pressure		
Grouting test	2 holes	80 m
Test pitting	4 pitts	

Reservoir Area

Rough surface geological survey (scale 1:5,000)

2.2.2 Progress of the Investigation

a) Surface Geological Survey

A rough surface geological survey was made in the reservoir area and the surrounding area, 7.5 sq. km, in total, based on a topographic map in a scale of 1:5,000 which was made from a topographic map of 1:25,000.

After the above-mentioned survey, the detailed surface survey was carried out twice on the proposed dam site: the first with an existing topographic map of 1:1,000 and the second with a revised topographic map of the same scale.

b) Seismic Survey

The seismic survey was carried out at the proposed dam site. The line arrangement of the survey is shown in a table below and in a geological map, DWG. No.2-1. The total line length of the seismic survey was 3,235 m.

Line Arrangement of Seismic Survey

Line	A	B	C	I	II	II	III	IV	Total
Length(m)	575	630	420	280	280	350	350	350	3,250
Notes	Parallel to the dam axis			Parallel to the Wadi Arab					

c) Boring Survey

The boring survey has been done along the B line of the seismic survey which is also dam axis, to investigate the foundation condition and the geological structure.

The quantity of bore holes is shown below and the place of the bore holes is shown in a geological map of the dam site, DWG.No.2-1.

Quantity of Bore Holes

Bore hole No.	DB-1	2	3	4	5	6	7	8	Total Depth
Depth (m)	45	33	9	45	40	40	40	30	282
Direction	Vertical								
Diameter	56 m/m								
Notes	all core boring		non-core boring					all core boring	

d) Water Pressure Test

The water pressure test has been made, utilizing the all bore holes except the collapsed range of the bore hole.

The supplied water pressure is 1 → 3 → 5 → 7 → 10 → 8 → 6 → 4 → 2 kg/cm^2 as a rule, but in case when the water pressure does not increase, the pressure has been decreased on the way to up.

Permeability is shown in Fig. 2-3 through Fig. 2-7 by "Lugeon Unit" which is as follows:

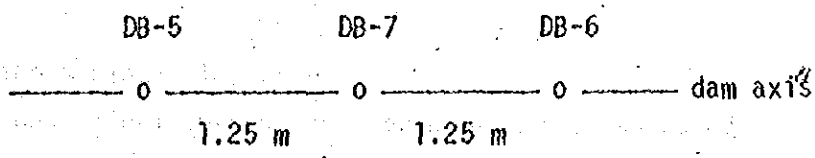
$$Lu = \frac{Q}{L} \cdot \frac{10}{P}$$

, where, Lu = Lugeon value ($l/min/m/10kg/cm^2$)
Q = Water leakage (l/min)
P = Supplied water pressure (kg/cm^2)
L = Section length of water pressure test(m)

e) Grouting Test

As a result of detailed surface survey at the dam site, it was judged that limestone distributing at the right abutment is well joined and permeable in habit. A grouting test, therfore, has been made at the right abutment.

The arrangement of the bore holes for grouting and checking is as follows:



DB-5 & 6: Grouting holes (40meters in depth)
DB-7 : Checking hole (40 meters in depth)

The results are shown in Fig.2-8 through Fig.2-12.

f) Test Pitting

Four test pitts were carried out at the dam site to determine the strength (cohesion and friction) of scree and terrace deposit.

Density of scree and terrace deposits have been measured in the test pitting, and some samples have been taken and sent to Japan for soil laboratory test.

The locations of the pitts are shown in DWG. no. 2-1 and No. 2-2.

2.3 Investigation on the Embankment Materials

2.3.1 Material Survey

The geological investigation on the embankment materials for the proposed dam includes the following:

- Surface geological survey
- Test pitting
- Boring survey
- Material sampling for soil and rock tests

a) Surface Geological Survey

Surface geological survey has been made within surrounding area of the proposed dam site. The volume and the quality of the embankment materials such as rock-filter and core material has been grasped roughly.

Wadi Arab and the surrounding area is composed of chalky marl with subsidiary limestone, bituminous marl and chert, in the tertiary undifferentiated.

Basalt lava with 5 -10 m. in thickness overlies these sedimentary basement rocks at the right bank of the Wadi Arab. And also, marl and travertine of diluvium in Quaternary overlies the basement rocks at the left bank downstream of the confluence of the Wadi Arab and Zahar. The superficial deposits overlying the above mentioned geology are terrace, scree and aluvium deposit.

The geological succession within the surrounding area of the dam site and the suitability of the rocks and the sediments for the embankment materials are shown in Table 2-1.

b) Test Pitting

Eleven test pitts were dug for core material and ten pitts for filter materials and aggregate to investigate the quality of the materials and to take samples for laboratory test. The places of the test pittings are shown in a geological map, DWG. No. 2-2.

c) Boring Survey

Three bore holes have been drilled for core material. The bore hole for rock material was not done because the basalt lava which will be able to be used as rock material is thin and hardly weathered, so it is not significant to make the bore holes.

d) Material Sampling for the Soil and Rock Tests

Samples of material were taken for the various tests of the fill materials and the concrete aggregate as shown below:

Material Sampling for the Tests

Material	Sampling place	Sample quantity	Total Vol.	Test
Core	Test Pit	11	450kg	Soil Test
Rock,ramdam	Outcrop	3	150kg	Rock Test
Filter, Aggregate	Test Pit, Outcrop	4	400kg	Aggregate & Concrete Test

2.3.2 Core Material

As a result of the surface geological survey, it is judged that the rocks and layers may be used as the impervious material:

- Scree
- Alluvium deposit
- Weathered zone of basalt lava
- Weathered zone of limestone

Scree is composed of sandy clay - sandy silt including debris, and will be able to use independently as the impervious material of the fill dam. Alluvium deposit and the weathered zone of basalt lava have too much clay content to use it independently. On the contrary, the weathered zone of marl has less clay content, but it also can not be used independently.

Consequently, detail investigation has all done as the impervious material. At first, five test pittings were made in the reservoir area. As a result of the survey, it was known that the volume of scree os not sufficient for the embankment. Secondly, six test pitts and three boring have made beside the road running from North Shuneh to Irbid at which scree has been widely distributed. And it was found that the scree has good quality as the impervious material of the fill dam, and is about 1.5 million cubic meters in volume.

Samples of scree have beem taken in each test pitts and sent to Japan to know the physical and dynamic characters.

2.3.3 Rock Material

The hard rock may be used as the pervious material of the fill dam in the surrounding area is as follows:

- Basalt lava
- Limestone

Basalt lava is 5 - 10 meters in thickness. Theee are lots of the fresh and hard blocks with 30 - 80 centimeters in diameter on the ground surface in the basalt lava, though basalt lava is hardly and wholly weathered. The volume of the blocks is not enough for the riprap of the earthfill dam.

Limestone with about 30 meters in thickness has been interbedded in marls and inclined gently from the Wadi to the mountain at the both sides of the Wadi, so it is difficult to take out limestone only. The rocks are well joined, so it is also difficult to take lots of large pieces.

Samples of basalt block, limestone and marl have been taken and sent to Japan for rock tests.

2.3.4 Aggregate and Filter Materials

The layers and the rocks which may be used as the aggregate for the concrete and filter material for the fill dam, is as follows:

- River deposit
- Upper terrace deposit
- Lower terrace deposit
- Basalt lava
- Limestone

River deposit is mainly composed of hard gravel. The deposit has good quality as the aggregate or the filter material, but the volume is short. Upper terrace deposit has the same quality as river deposit. Lower terrace deposit is composed of irregular alternation of gravel, marl and travertine. So, it is difficult to take out the gravel from the others,

Although the fresh basalt blocks are very hard, they are unsuitable as the aggregate for concrete because they are very porous and have zealite which will rise the alkali aggregate reaction in the pore. As mentioned before, it is impossible to take out economically hard limestone only.

Accordingly, river deposit and upper terrace deposit which will be able to use, have been investigated. At first, six test pittings were made near the North Shuneh Village. As a result of the last pitting survey, it was found that the distribution of these deposits are limitted in the narrow zone along the Wadi Arab and the volume is not enough. Secondly, four test pitts were dug along the Wadi downstream of the dam site. It is observed that these deposits are at least one hundred thousand cubic meters in volume.

Samples have been taken in the test pitts and sent to Japan for aggregate test and concrete test.

Fig. 2-1 Stratigraphic Column of Dam Site

Geological Age			Geological Name	Thickness (m)	Symbol	Lithology
Cenozoic	Quaternary	Alluvium	River Deposit	3~5		gravel, sand, uncemented.
			Scree	2~7	sc	debris, sand, clay, uncemented.
			Upper Terrace Deposit	5~10	tru	gravel, sand uncemented
			Middle Terrace Deposit	3~7	trm	gravel, sand, clay, uncemented.
		Diluvium	Lower Terrace Deposit	15~20	trl	gravel, sand weakly cemented, marl, travertine.
	Tertiary	Undifferentiated	Chalky Marl	100+	Mr	chalky marl with subsiduary chert, bituminous marl, massive, soft, partly hard.
			Limestone	30	Ls	limestone (~calcareous marl) with subsiduary marl, chert, compact, hard, well jointed.
			Bituminous Marl	60	Mb	bituminous marl ~shale, well bedded, jointed along bedding plane, soft under wet condition.
			Limestone	8	Ls	hard, well jointed
			Bituminous Marl	30+	Mb	dark grey ~ black, well jointed along bedding plane.

Fig. 2-2 Geological Section Along B-B' Line

Scale 1:1,000 H:V=1:1

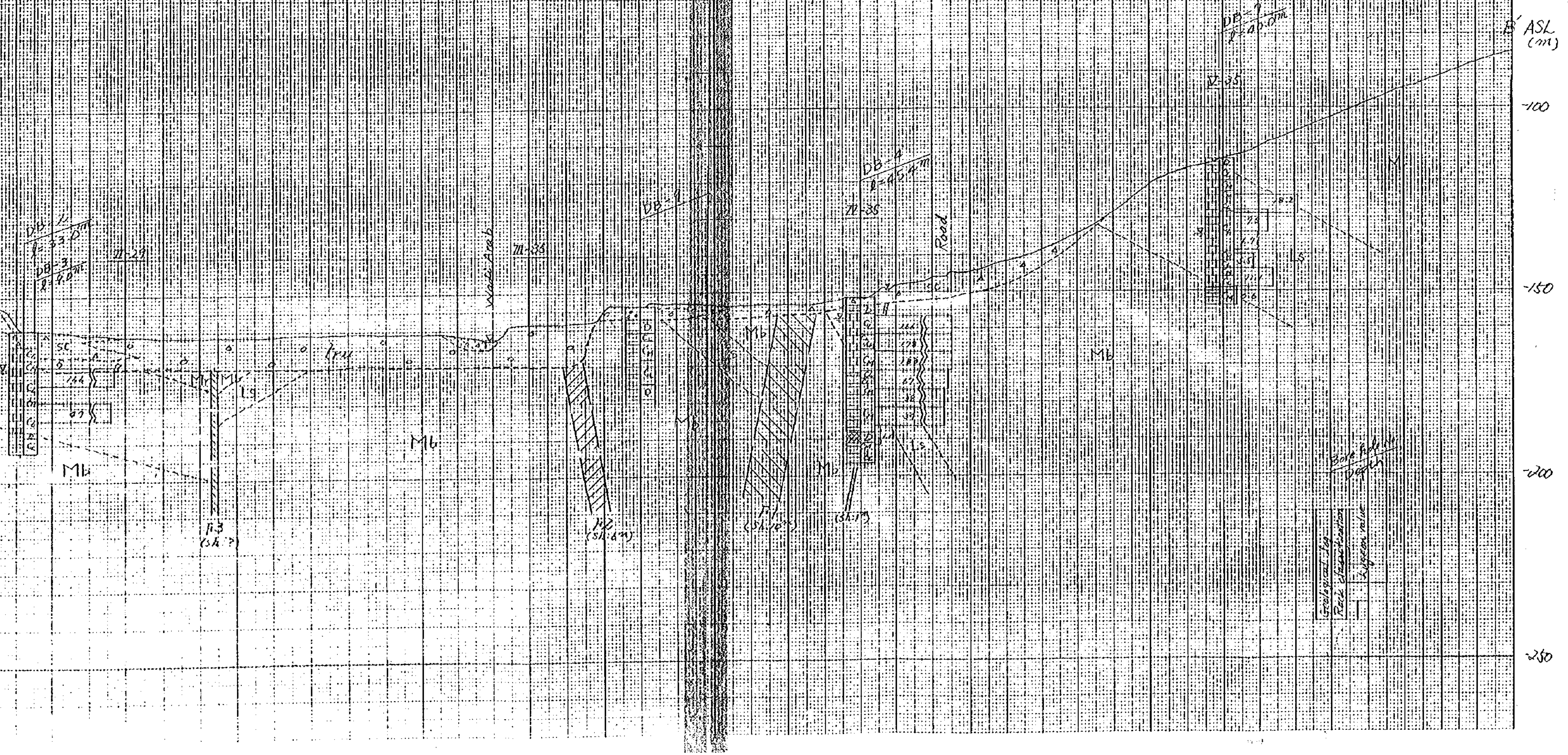
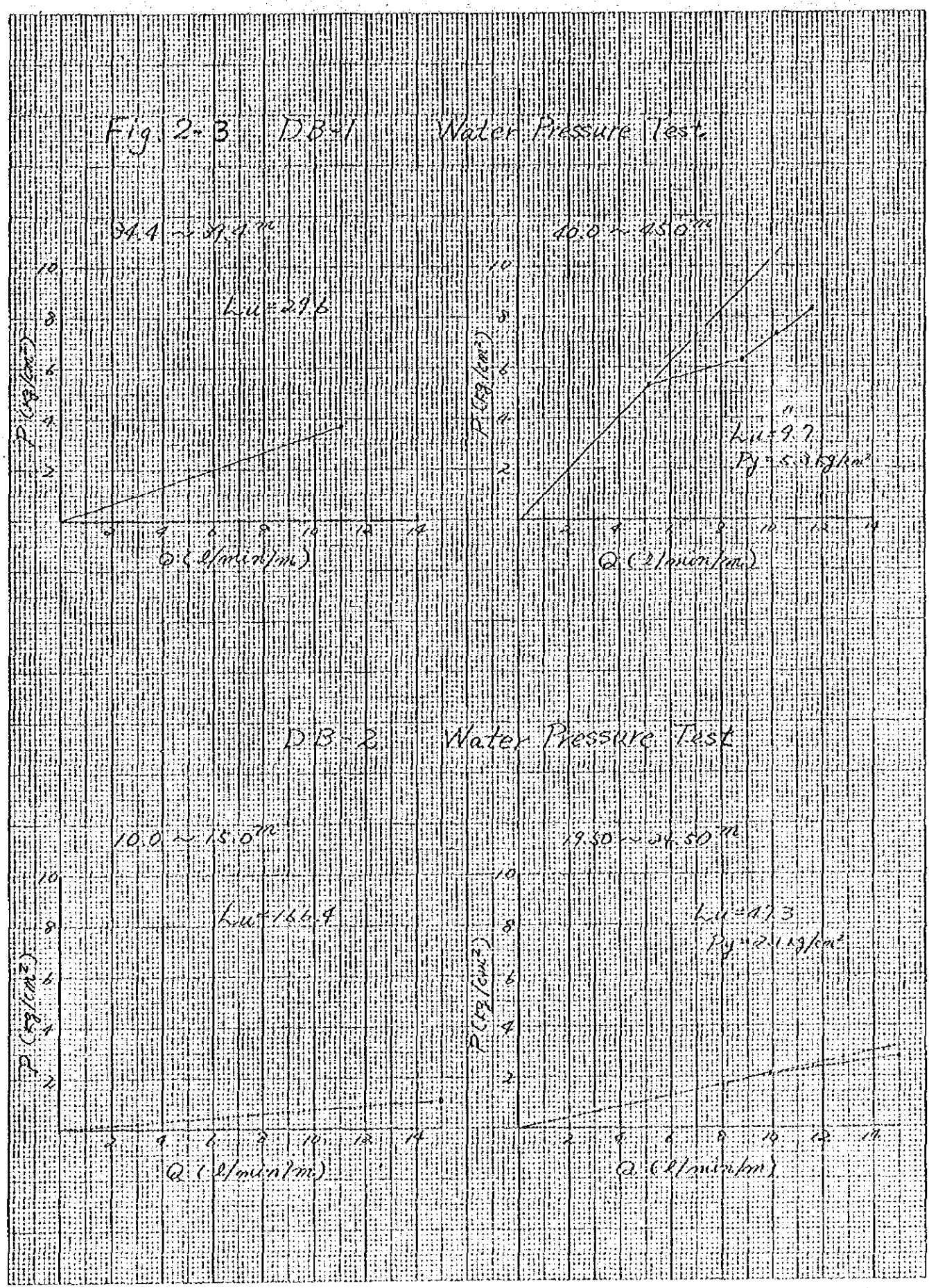
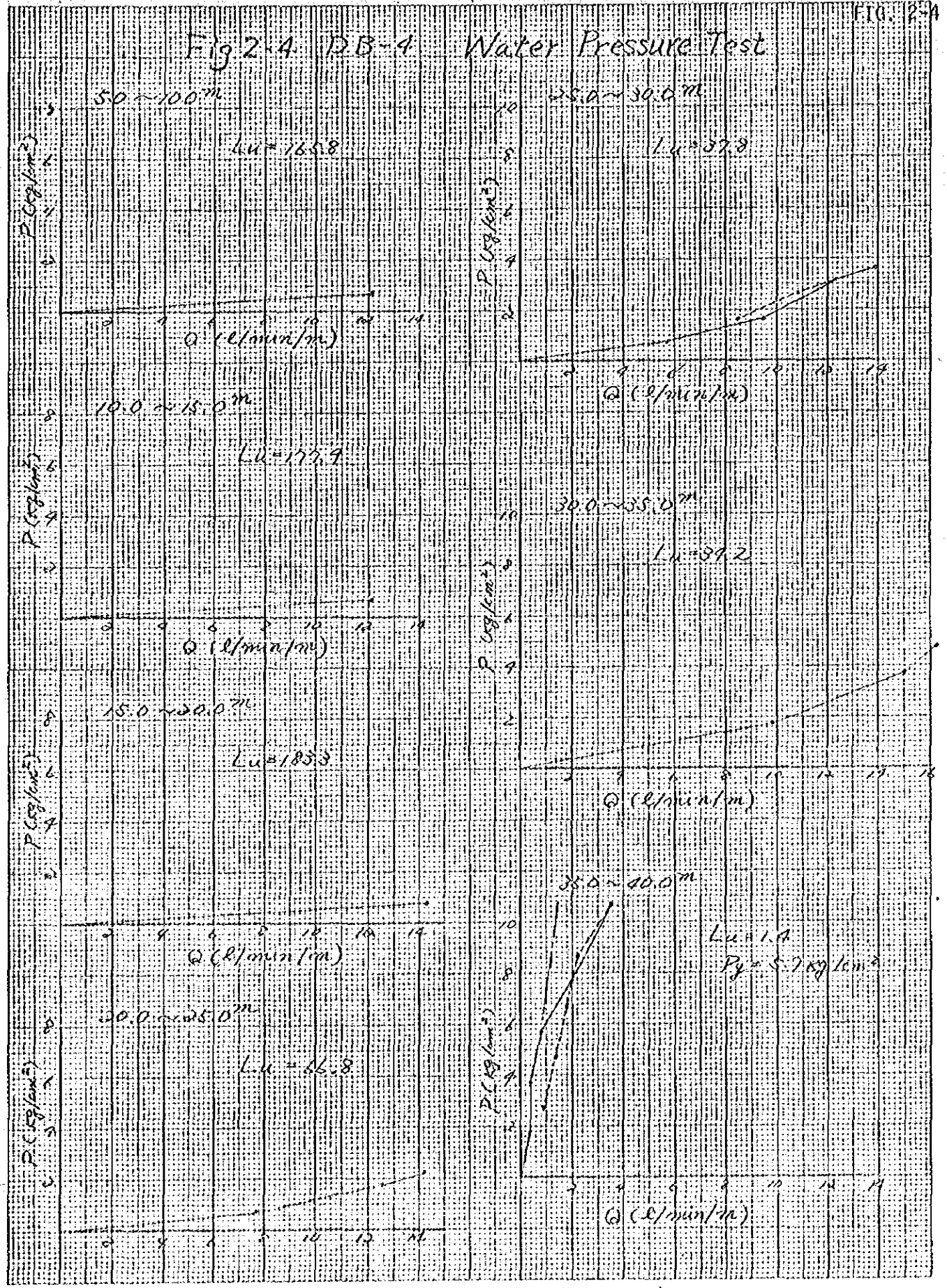


Fig. 2-3 DB-1 Water Pressure Test



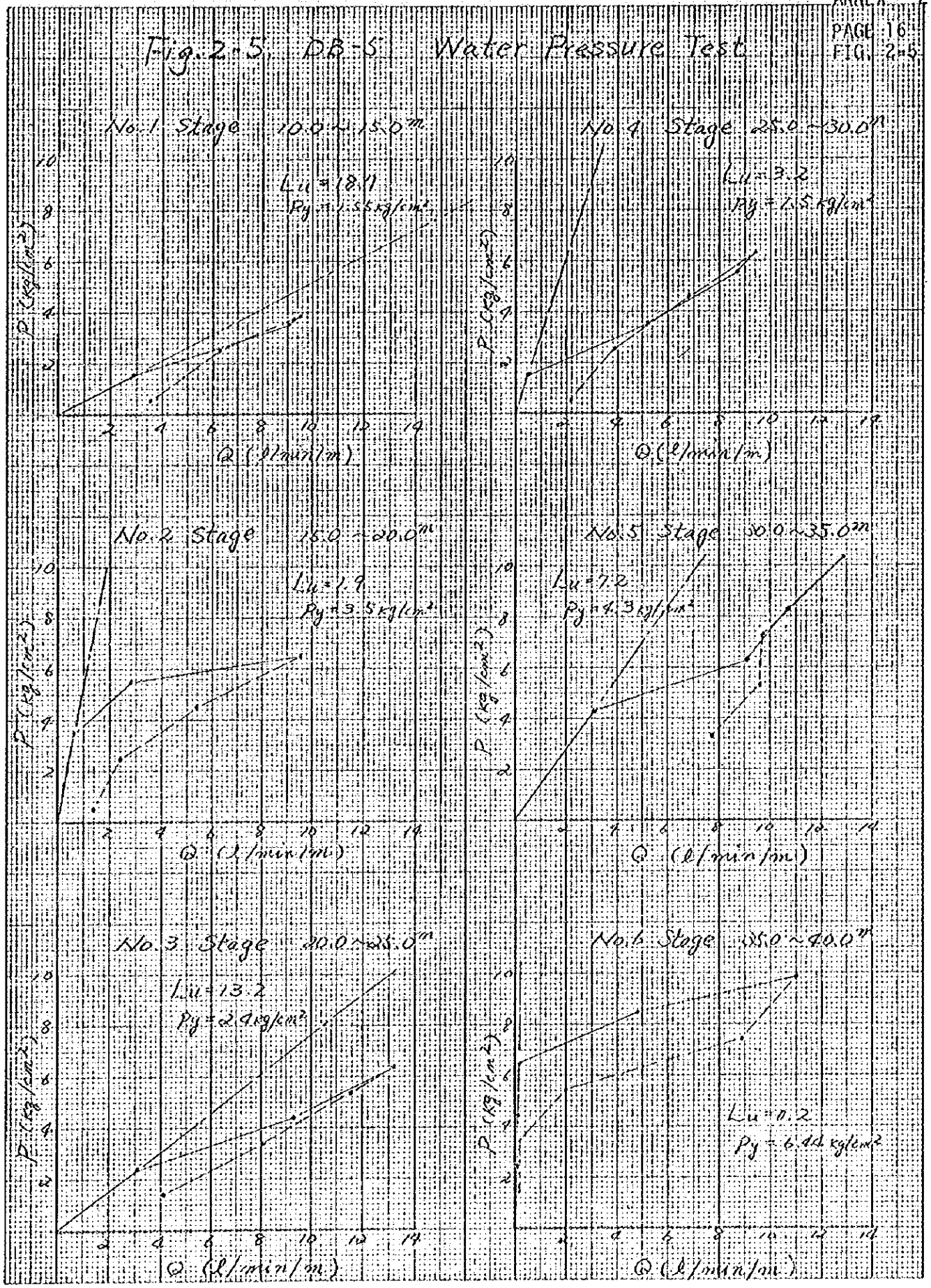
DB-2 Water Pressure Test

Fig 2-4 DB-4 Water Pressure Test



pp4.

Fig. 2-5. DB-5 Water Pressure Test



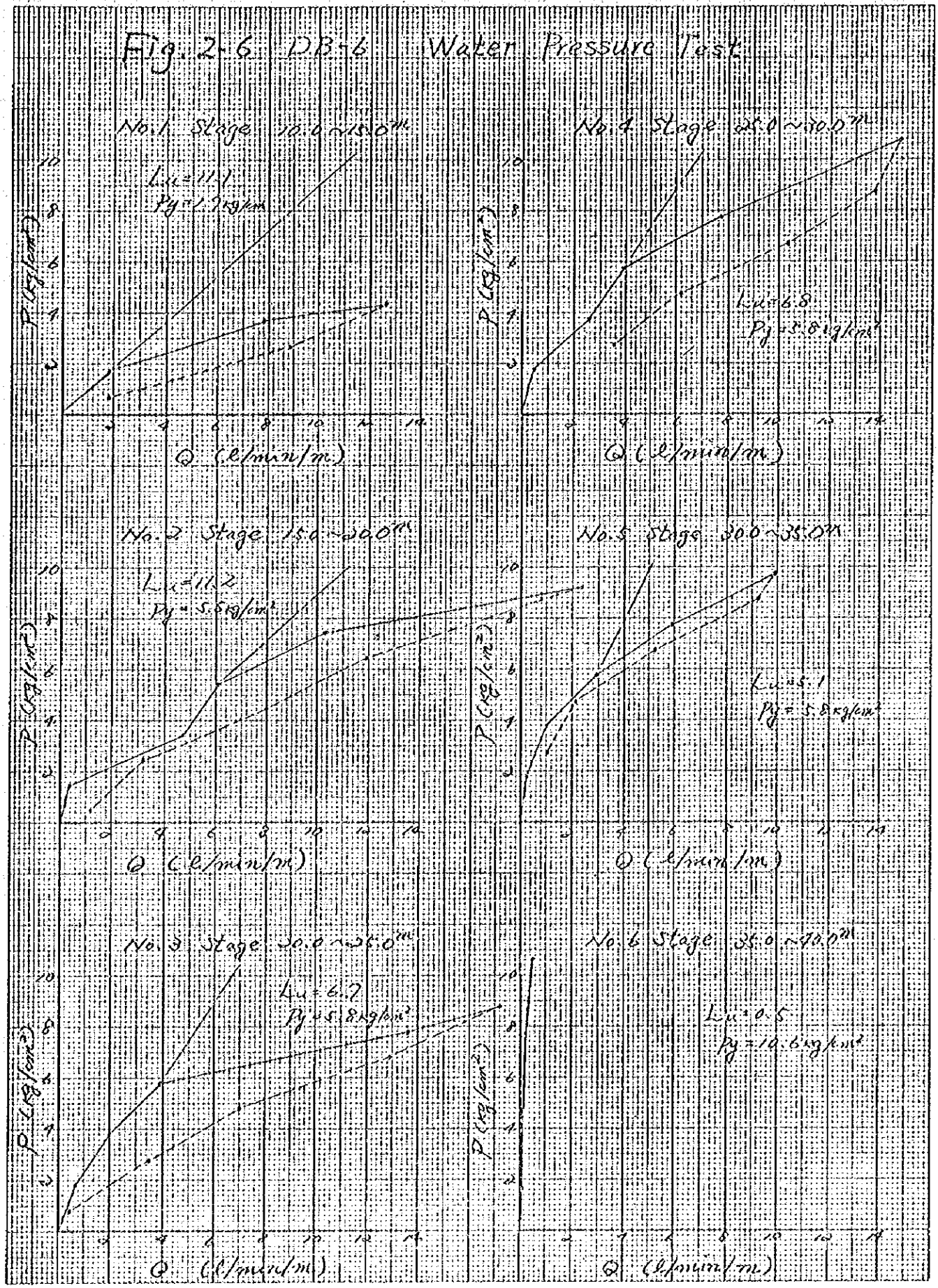


Fig. 2-6 DB-6 Water Pressure Test
No. 1 Stage 10.4 ~ 15.0m
Lu=11.1
Pj=1.9kg/cm²
No. 4 Stage 25.0 ~ 30.0m
Lu=6.8
Pj=3.8kg/cm²
No. 2 Stage 15.0 ~ 20.0m
Lu=11.2
Pj=5.5kg/cm²
No. 5 Stage 30.0 ~ 35.0m
Lu=5.1
Pj=5.8kg/cm²
No. 3 Stage 20.0 ~ 25.0m
Lu=6.2
Pj=5.8kg/cm²
No. 6 Stage 35.0 ~ 40.0m
Lu=0.5
Pj=10.6kg/cm²
P (kg/cm²)
Q (ℓ/min/m)

Fig 2-7 DB-7 Water Pressure Test

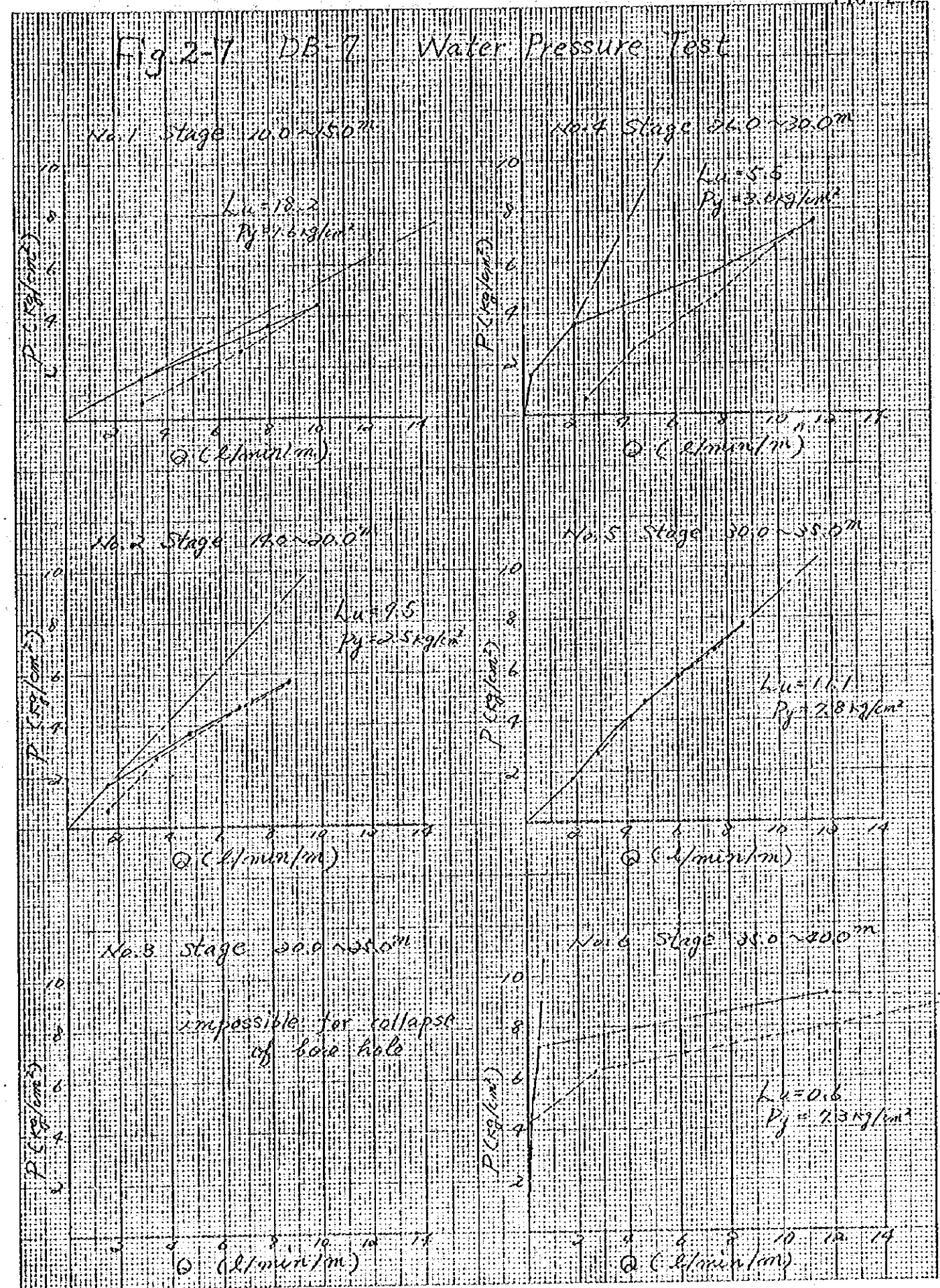
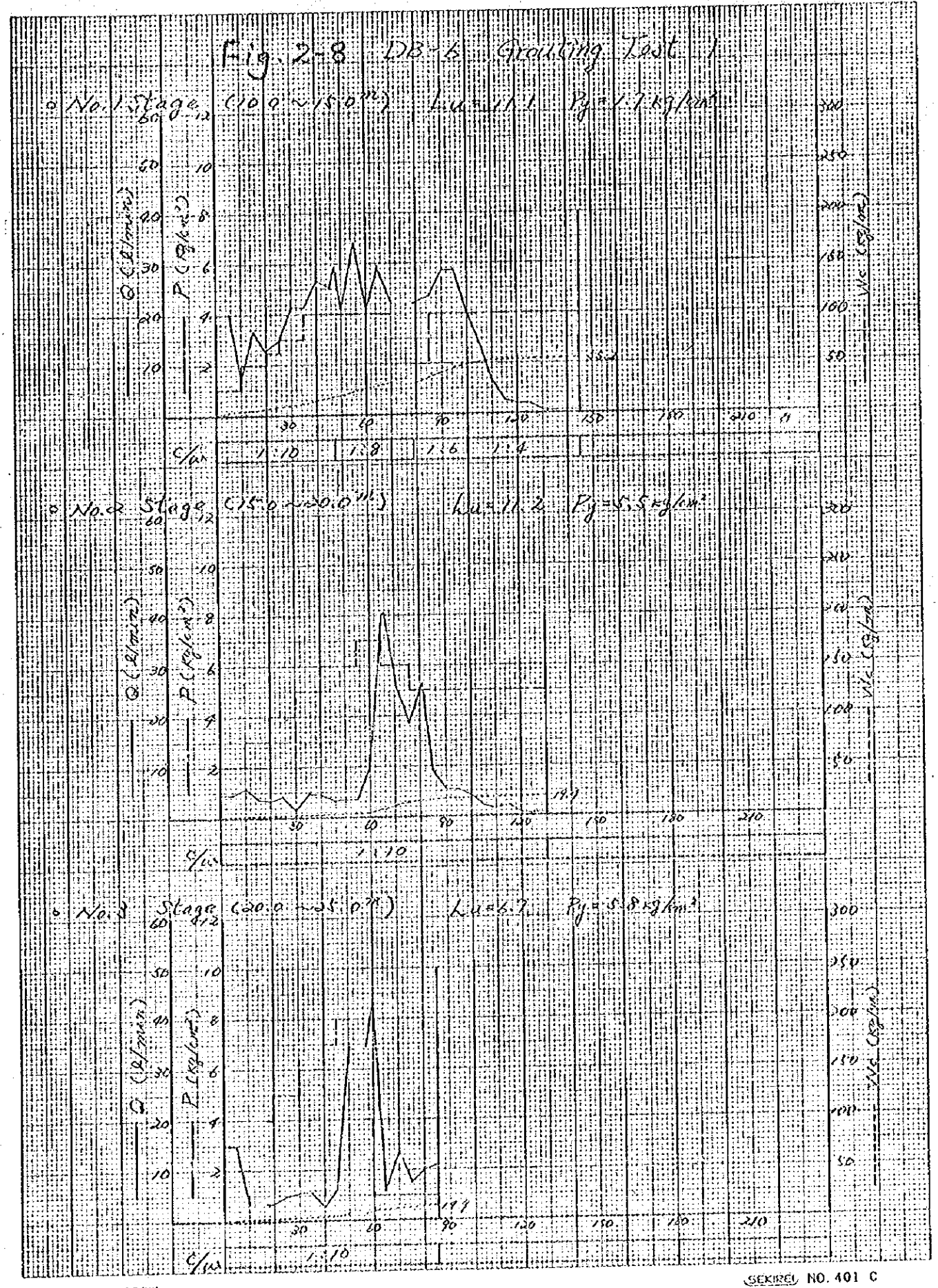


Fig. 2-8 DB-6 Grouting Test



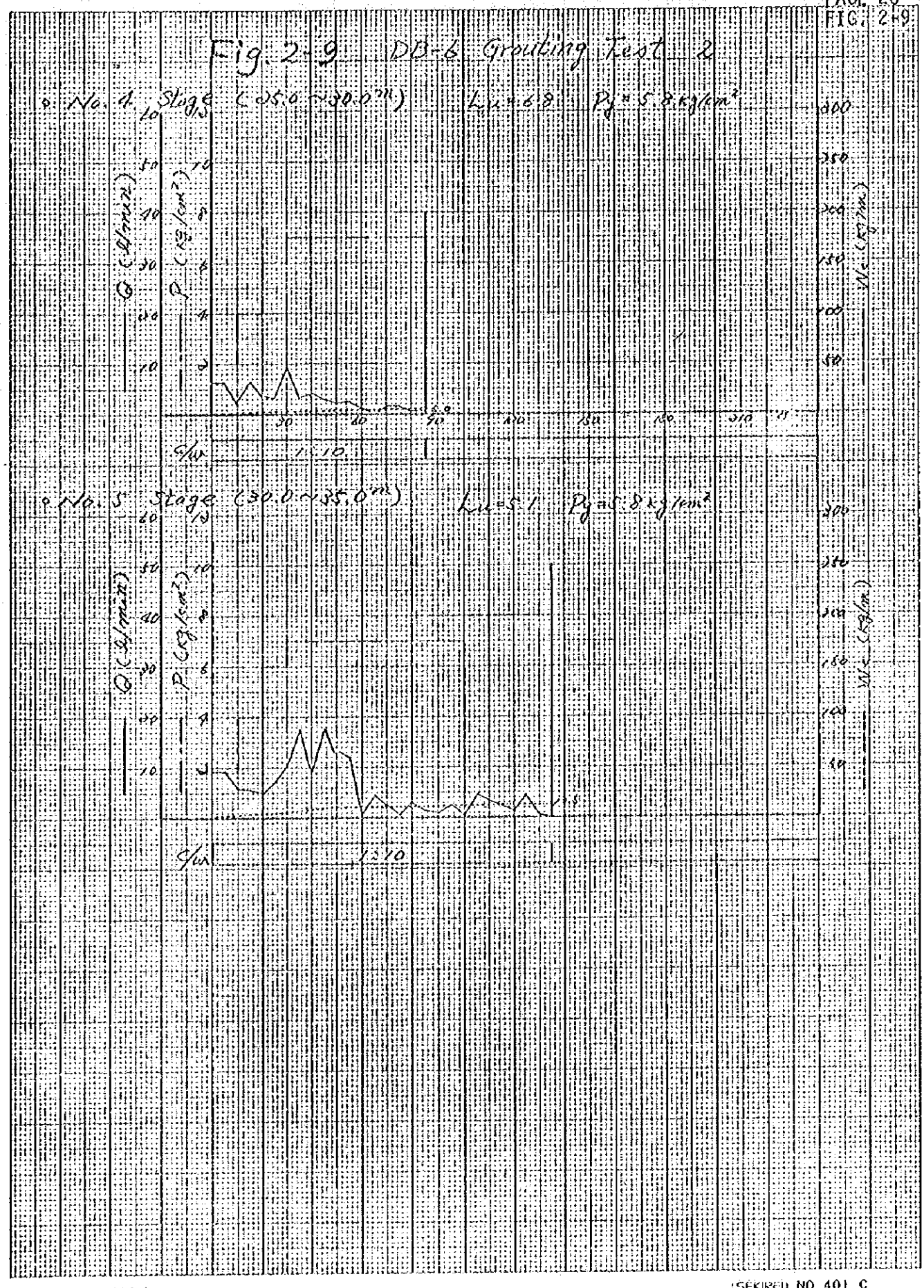


Fig. 2-9 DB-6 Grouting Test 2
No. 4 Stage (25.0 ~ 30.0m) Lu=6.8 Pg=5.8kg/cm²
No. 5 Stage (30.0 ~ 35.0m) Lu=5.1 Pg=5.8kg/cm²
Q (l/min)
P (kg/cm²)
N (kg/m)
1:10

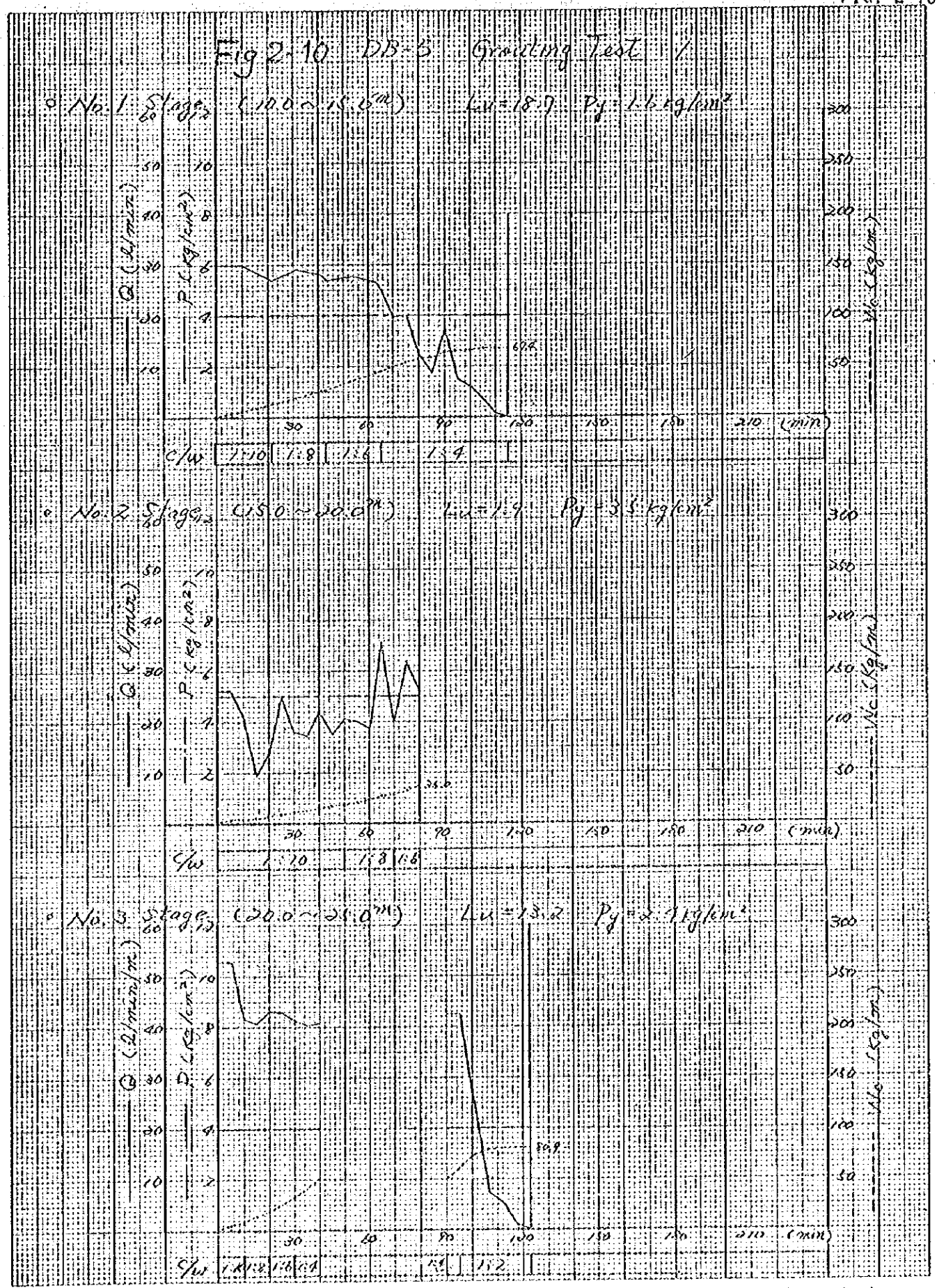
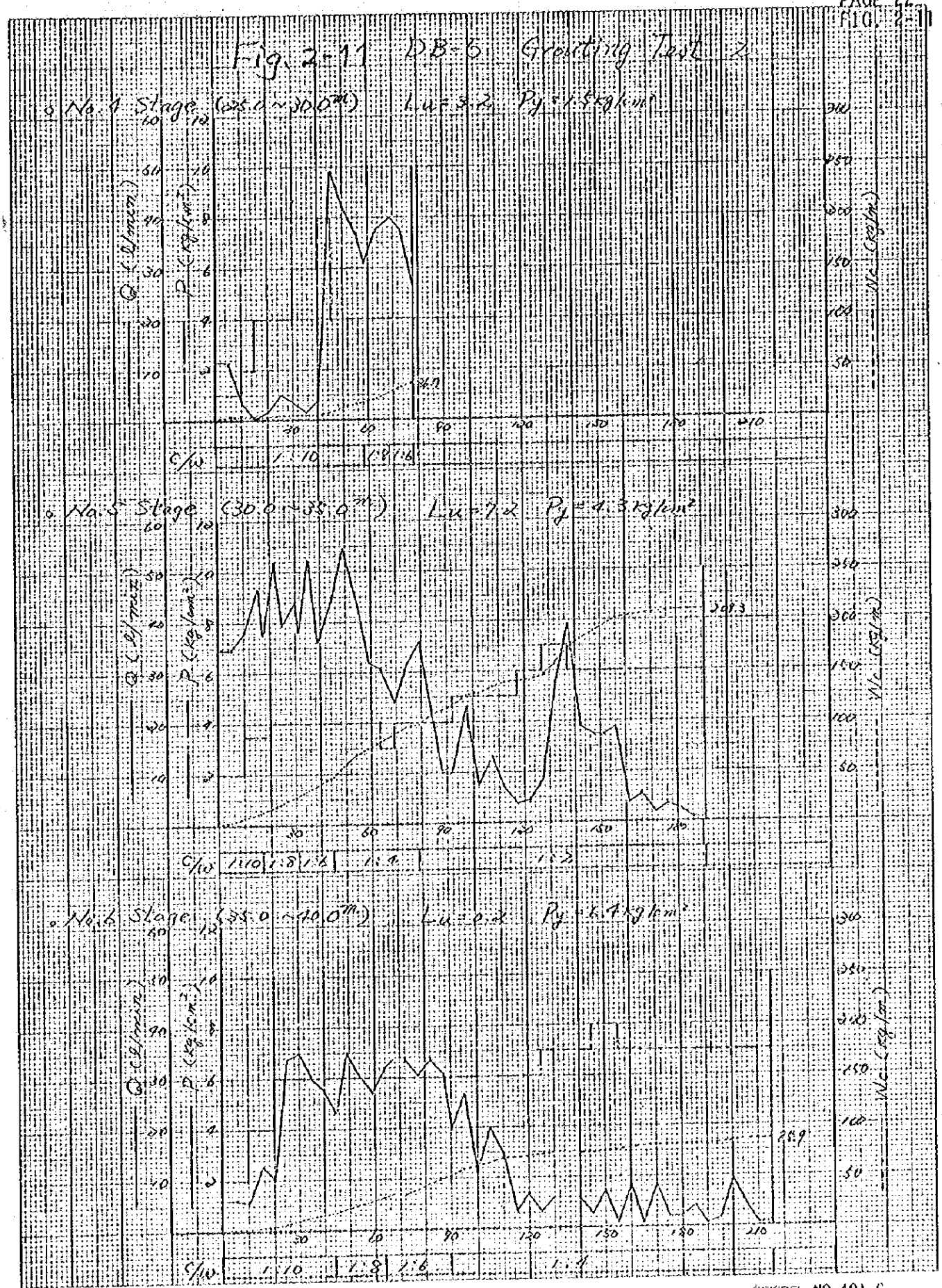


Fig 2-10 DB-5 Grouting Test
No. 1 Stage (10.0 ~ 15.0m) Lu = 18.7 Py = 1.6 kg/cm²
No. 2 Stage (15.0 ~ 20.0m) Lu = 19 Py = 3.5 kg/cm²
No. 3 Stage (20.0 ~ 25.0m) Lu = 13.2 Py = 2.4 kg/cm²
Q (ℓ/min/m)
P (kg/cm²)
C/W
Vc (kg/cm²)
(min)



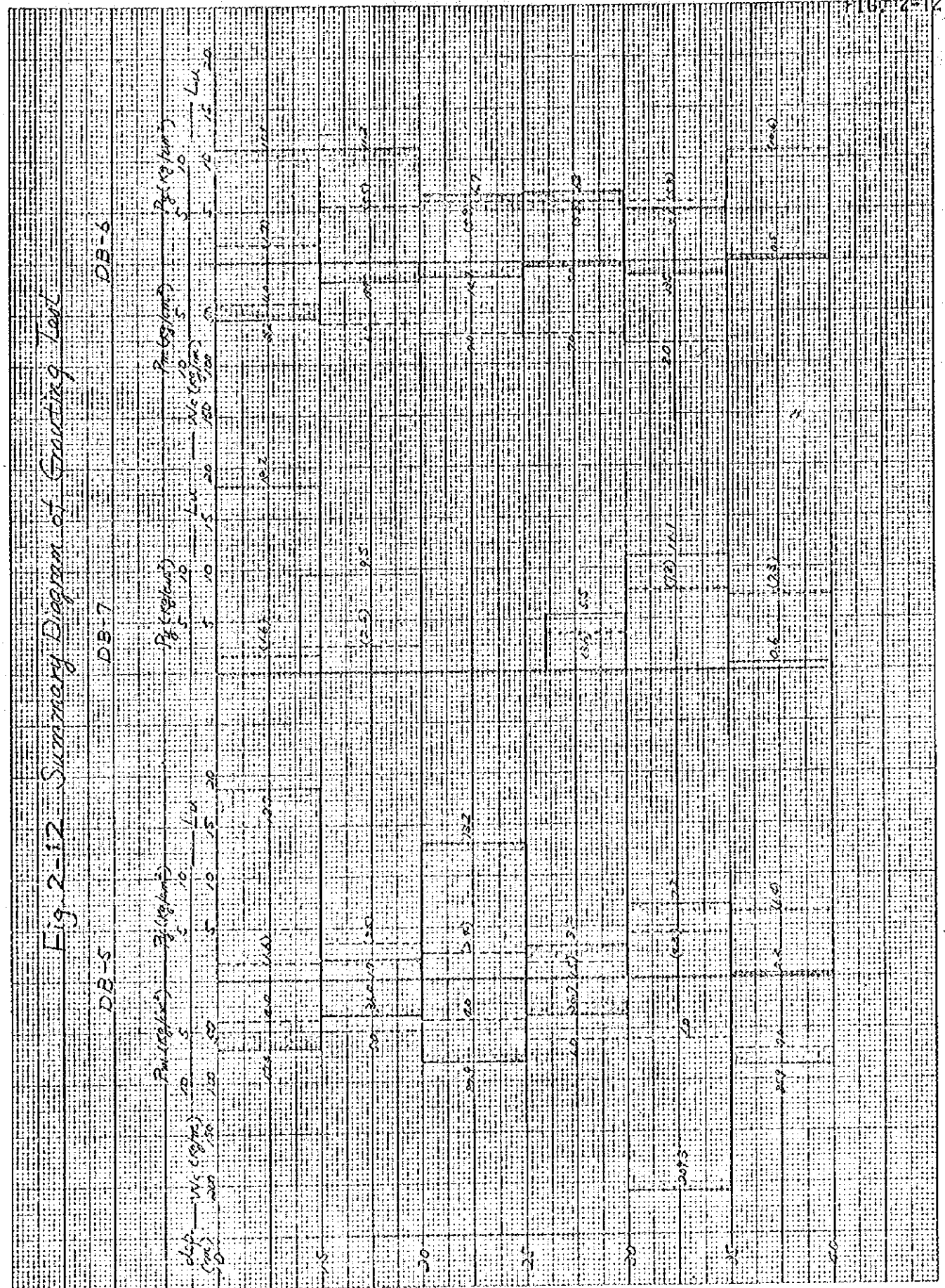


Fig. 2-12 Summary Diagram of Grouting for DB-5

Table 2-1 Geological Succession Within The Surrounding Area Of The Dam Site

Geological Age			Geological Name	Symbol	Lithology	Suitability			
						Rock	Filter	Core	Cut-off
Cenozoic	Quaternary	Alluvium	River Deposit		fresh hard gravel, sand, uncemented.		○		○
			Scree	sc	weathered debris, sand, silt, clay, uncemented.			○	
			Upper Terrace Deposit	tru	fresh hard gravel, sand, silt, uncemented.		○		○
			Alluvium Deposit	al	silt, clay, uncemented.				
		Diluvium	Lower Terrace Deposit	trl	hard gravel, sand, marl, travertine, weakly cemented.		△		△
	Tertiary ~Quaternary Pliocene ~Diluvium		Basalt Lava	Ba	5~10meters thickness, hardly weathered. hard block remained, porous	○			
	Tertiary	Undifferentiated	Chalky Marl	Mr	chalky marl with subsiduary bituminous marl, chert, massive soft, partly hard.				
			Limestone	Ls	limestone ~calcareous marl with marl, chert, compact, hard, well jointed	△	△		△
			Bituminous Marl	Mb	bituminous marl~shale, well bedded, jointed along bedding plane, partly soft.				

ANNEX 3

SOIL AND LAND CLASSIFICATION.

3.1 Previous Study.

Systematic field investigation on soils in the Jordan Valley was primarily carried out by Baker and Harza Engineering Company in 1953/1954. As a result of this investigation, a land classification for irrigated agriculture under open channel system was made according to the standards of Bureau of Reclamation, U. S. A. In 1964/1965, for getting information on soil salinity/alkalinity in the Valley, a special examination was done by the Institute of Pedology and Technology, Zagreb. Resulting from an additional soil survey of 1966, Messrs. NEDECO/DAR AL-HANDASAH gave a soil suitability classification on a basis of the procedure used by the Soil Survey Department, USDA and supplemented a picture of the potentialities of the soils mentioned in the above documents. In 1973, JVC prepared a summary of these investigations in order to frame the rehabilitation and development plan of the Jordan Valley. A semi-detailed soil map on a scale of 1:50,000 traced from NEDECO/DAR AL-HANDASAH's report was attached to this summary.

3.2 Procedure of Soil Survey.

3.2.1 Field Work.

With a special view to confirming information on chemical characteristics and physical properties of soils in the Project area obtained from the documents and semi-detailed soil map above-mentioned, the field work is carried out. A topographic map on a scale of 1:2,500 along with the base map on a scale of 1:10,000 provided by JVC is used throughout the survey period. Most field works are proceeded in accordance with the procedures defined in the Soil Survey Manual,

Handbook 18, USDA, 1951. The area covered by the soil survey is approximately 1.300 ha consisting of the Development Area No. 3 to 5.

At a selected site, a pit is dug to a depth of one meter and thereafter hand auger boring is done for the examination of profile features and soil sampling. Additional auger tests are conducted to check the depth of so-called Ghor series soils consisting of sediments being erosion materials which overlie the lacustrine sediments named as lisan series soil. In the course of field works, the soil alkalinity in pH values, the soil salinity in EC values and moisture contents are determined definitely. For the confirmation of irrigation efficiency under over-head sprinkler system discussed in the previous studies, measurements of both cylinder and furrow intakes, the field capacity, the porosity and the leaching effect of pre-irrigation method are done at six pit sites chosen from the view point of land utilized and irrigated conditions, respectively, at present. The number of essential tests and measurements made are as follows:-

Item	Unit	Number
Pitting with auger boring for profile survey	Spot	7
Auger boring to check effective soil depth	Spot	63
Field measurement of physical properties	Spot	6
Indoor test of chemical characteristics	Soil Sample	273*
Detailed chemical analysis	Soil Sample	58**
Detailed physical test	Soil Sample	60***

* Samples are taken from augering holes.
** Samples are collected from pits and physical measurement sites.
*** Samples are taken at the same time of physical investigation.

3.2.2. Laboratory Work.

Before preparation of air dried soil samples, moisture contents of the whole samples are determined by using infrared moisture meter. Both values of pH and EC are respectively by the use of portable pH and electric conductivity meters with 1:2.5 soil-water extraction. These indoor tests are done at the Team's office in North Shuneh.

To carry out detailed chemical and physical analysis in the laboratory, 118 soil samples in total are sent to Tokyo. The items of laboratory work to be scheduled are as listed as below.

(1) Particle size distribution analysis.

(2) Soil reaction with 1:1 soil-water extraction.

(3) Electric conductivity with saturated, 1:1 and 1:2.5 soil-water extractions.

(4) Water soluble cations.

(5) Water soluble chloride.

(6) Water soluble sulfate.

(7) Water soluble carbonate and bi-carbonate.

(8) Exchangeable cations.

(9) Cation exchange capacity.

(10) Total carbonate.

(11) Total nitrogen.

(12) Total carbon.

(13) Available phosphate.

(14) Specific gravity.

3.3 Summarized Results of Field Investigation.

3.3.1 Profile feature.

From the results of the previous studies, it is informed that fine-textured type of Ghor-1 series soils having the origin of fluviatile-colluvial sediments on the Ghor-terrace cover the entire Project area. The profile survey made can confirm the above information.

The typical feature of soil profile developed on well-drained land is A-AC-C horizon sequence. The textures of A- and AC-horizons are usually clay to clay loam. Very hard blocky structure are also quite common on irrigated wheat fields. A gradual boundary between AC- and C- horizons are observed at 60-120 cm depth. Very friable soils having loamy texture are permeable. The pH values of 1:2.5 soil-water extracts are almost same being around 8.5. The EC values of 1:2.5 soil-water extracts range from 0.5 to 0.9 mm hos/cm. Variation of EC values depending on profile sequence show that no salt accumulation to the surface of soils caused by the repitition of surface irrigation can been seem.

The soils of the lowest elevated part of the Project area being located on the center of Development Area No. 4 are fine-textured clay. The bottom of AC-horizon reaches to the depth of 120 - 180 cm. At present, the excess water consisting of both surface and sub-surface drainage water from upslope irrigation areas and seepage from the foothills are fairly well arained by the drainge system available in the area where these hydromorphic soils occur. No groundwater table appears within the depth of one meter from the ground surface. However the soils through the profile are still wet, plastic and sticky.

3.3.2 Measurements of intake rates.

Cylinder intake rate by the use of cylinder infiltrometer are measured at six pit sites, among which one site being situated at non-irrigated wheat field of the Development Area No. 3 is selected in order to examine furrow intake rate under the same soil condition.

The results of field measurements are as shown in Figs. 3-1 and 3-3. The formulas used for calculation are as follows:-

(1) Cumulated quantity of seepage (mm) $D_c = CT^n$

(2) Cylinder intake rate (mm/hr) $I_c = 60.C.nT^{n-1}$

(3) Basic intake rate (mm/hr) $I_B = 60.C.n\ ((600\ (1-n)))^{n-1}$

Where,

T = Time (min.)
C, n = constant

3.4 Outline of Future Study.

3.4.1 Land Classification.

For the introduction of gravity sprinkler irrigation system into the Project area, an evaluation of land capability should be revised from the view point of soils, topography and drainage condition. To evaluate, the standards of Bureau of Reclamation, USA will be primarily taken into consideration. If necessary, some criteria defined in the above standards will be partly modified on the basis of the results of laboratory test because the application of criteria for the evaluation must be the key factor with regard to planning and designing of intensive irrigation agriculture.

3.4.2 Confirmation of irrigation efficiency.

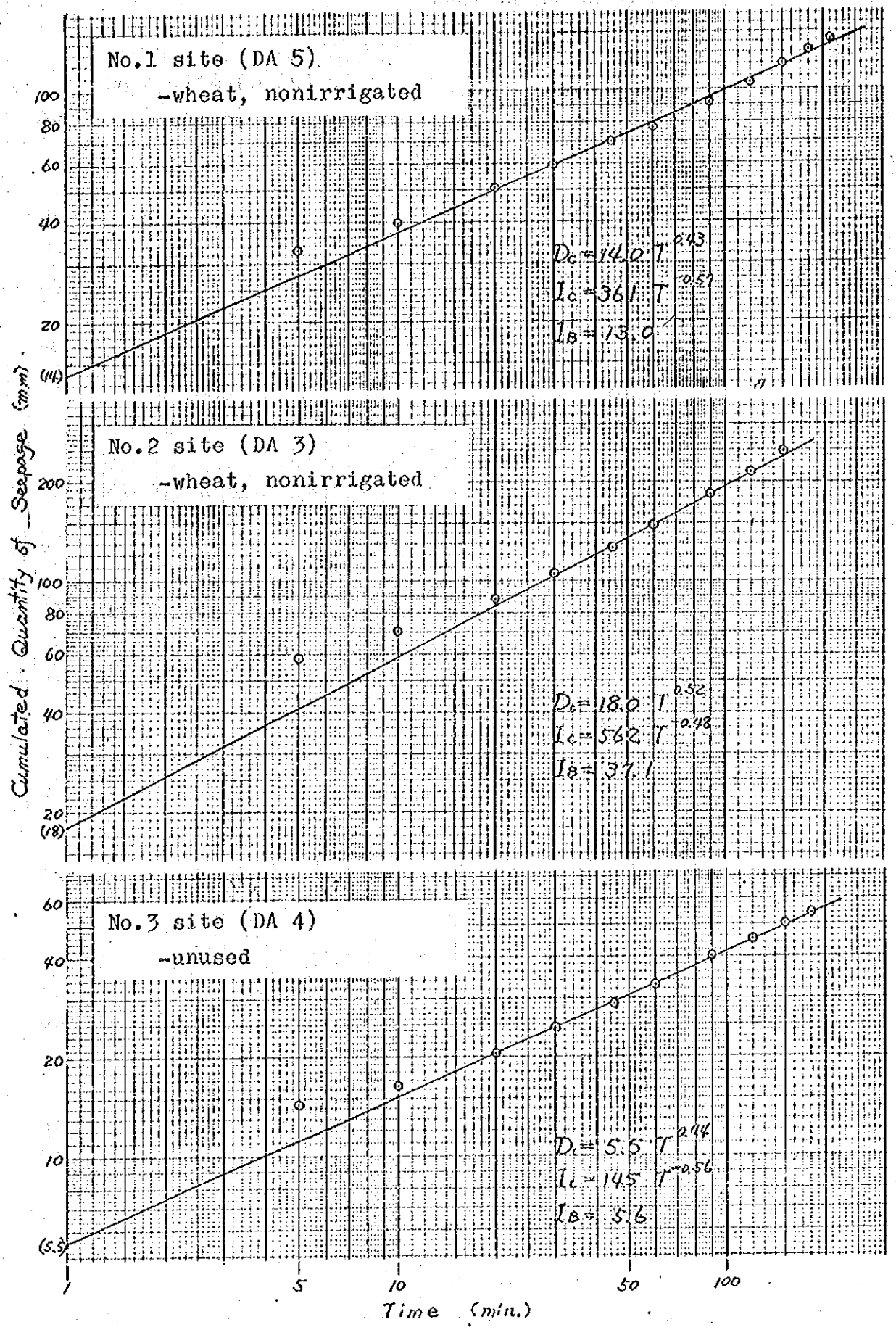
For confirming irrigation efficiency in case of the over-head sprinkler system taken into the calcultation of diversion water requirement for the IDA Project, physical properties of soils in the Project area will be more detailed by studied taking both results of physical tests in the laboratory and on the field into account.

3.4.3 Possibility of salt accumulation.

In order to grasp the effect of intensive irrigation on salt accumulation into surface soils and its salinity/alkalinity hazard for crop growth, future study will cover leaching effect of pre-irrigation as well as sub-surface drainge.

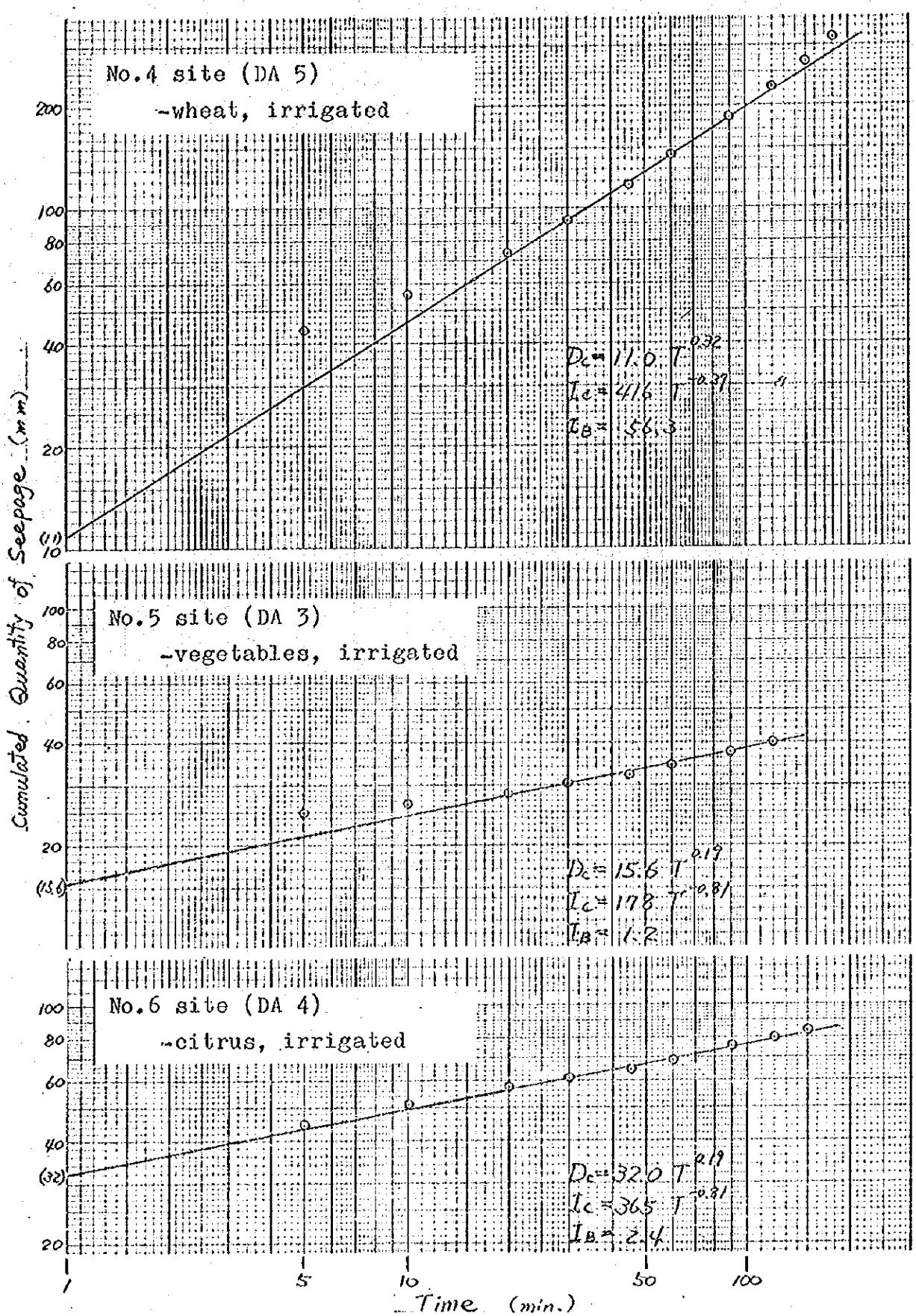
INTAKE RATE CURVE (1)

(NONIRRIGATED AREA)



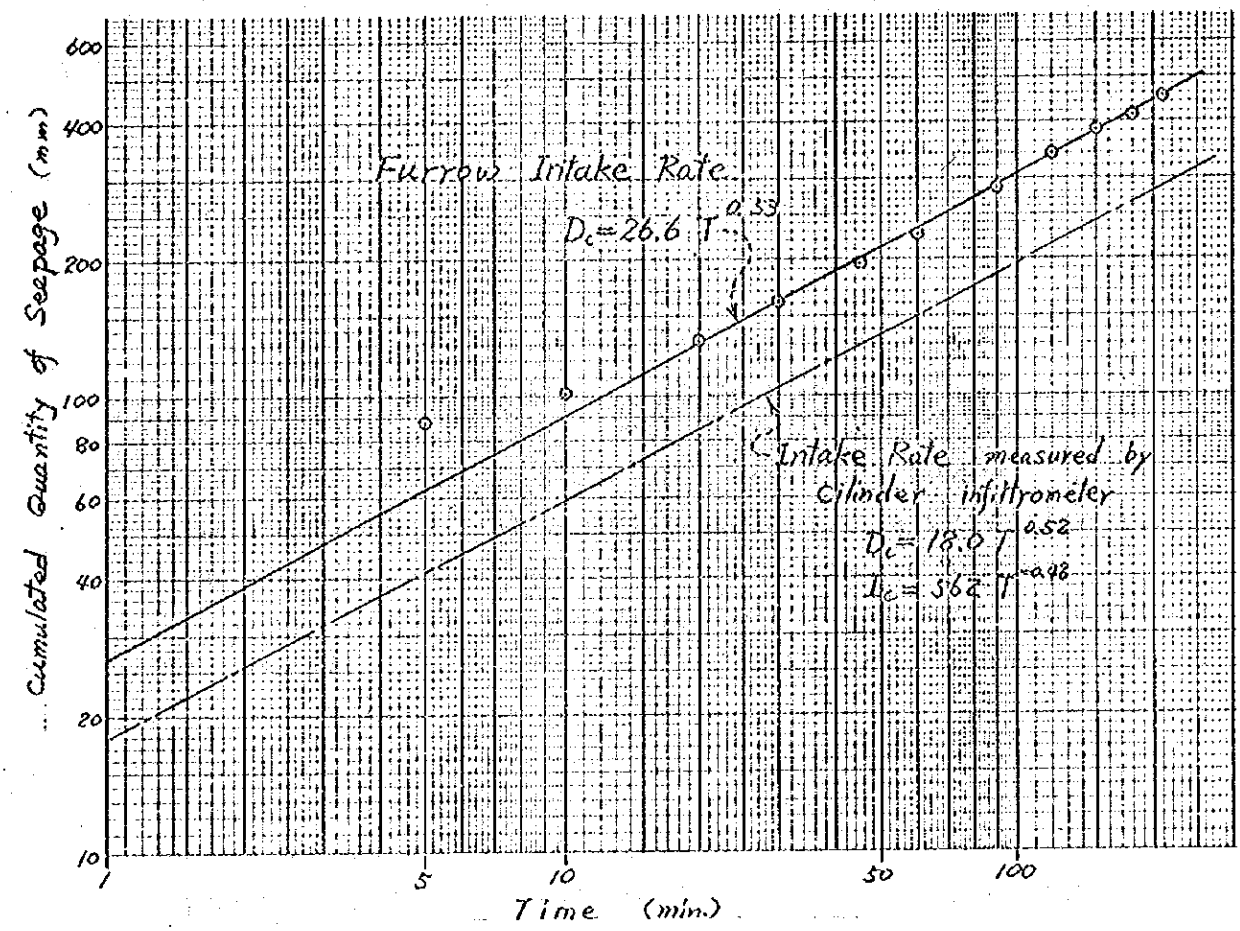
INTAKE RATE CURVE (2)

(IRRIGATED AREA)



FURROW INTAKE RATE CURVE

(NONIRRIGATED AREA)



ANNEX 4

AGRICULTURE

4.1 Farm Survey.

An agricultural survey is carried out to evaluate the present agronomic and economic conditions, and further to estimate the future agricultural productions.

At the beginning of this survey, "The Agricultural Sample Survey in the Ghore" published annually by the Department of Statistics, Ministry of National Economy are fully referred with the intention of getting informations on the actual results of land use, cropping pattern and agricultural production during the last several years. Along with this, other data are collected from the Research Department, Ministry of Agriculture and its experiment station at Deir Alla and sub-stations at Wadi Yabis and North Shouneh.

The land use condition as well as cropping pattern of early spring sowing season in 1976 are investigated through field reconnaissance for the soil survey. From May to June, some interrogators under the supervision of agro-economist visit the farmers and make inquiries about the production pattern, cropping calender, farming practices, farm inputs, yield and production as well as other items concerning agro-economy and agricultural institution. Reliability of all data collected and results of interviews made are reconfirmed by cross-checking with inter-related data.

The main results of investigation and data analyses are summarized hereinafter.

4.2 Land Use and Cropping Pattern.

4.2.1 Land Use.

The surveyed area covering the Development Area No. 3 to 5 is located on the northern part of the Ghor Terrace. It is bordered on the north by Yarmouk River and cliff side of the Terrace, on the east by the East Ghore Main Canal (EGMC), on the south by Wadi Arab and on the west by Jordan River. Steep slope area between the west end of Terrace and Yarmouk River is almost used for military purpose under the direct control of the Government.

As shown in Table 4.1, the whole area is estimated at 1,380 ha. In this, outskirts of the Terrace beyond an earth barrier artificially made are not included while around 70 ha of flood plains along Jordan River is counted taking into consideration the fact that these areas are irrigated by the use of water coming from EGMC for banana cultivation.

Among the whole area of 1,380 ha, the net farm land totals 1,226 ha comprising 1,226 ha irrigated and 275 ha ever non-irrigated. Present situation of the cultivated land above-mentioned is given in table 4.2.

4.2.2 Cropping Pattern.

Citrus and banana cultivations are prevailing and total cropping area of these fruit trees forms approximately 35% of irrigated farm land in the surveyed area. Table 4.2 shows that annual crop fields irrigated have recently been converted into new planting area of citrus trees.

In the remaining irrigated area, such rotation cropping as vegetables - cereals - vegetables has become universal since irrigation water from EGMC was available and it still pervades as usual cropping pattern in this area. Diverse kind of vegetables are taken into the above crop rotation as shown in Table 4.3.

On the other hand, rainfed monoculture of wheat or barley is common in non-irrigated area.

The crop intensity in 1975 is estimated at 1.05 for irrigated area and 1.00 for non-irrigated area, respectively.

4.3 Farming Practices.

In case of cereal cultivation, most part of farm operation except threshing has been mechanized. A tractor for plowing and harrowing and a combined harvestor for harvesting are used paying rental charge. Even for irrigated fields water is usually supplemented before sowing. No application of fertilizer and agro-chemicals is common.

To vegetable fields irrigation water can reach to a turnout equiped with each farm plot by request of farmers without a long delay. The water drawn in the plot is conveyed through a zigzig furrow. Whole land preparatory works and some part of plant protection work are mechanized. Other farming practices, especially harvesting, are relying on manpower.

With respect to fruit trees, bearing citrus and banana fields are sufficiently irrigated by basin flow method. Most farm operations broadly observed in the Project area are dependent upon manual power.

4.4 Yield and Production.

As shown in Table 4.4, crop yield in the Project area is still affected by the change in the climatic condition during the wet season not with standing completion of irrigation facilities. Another unfavourable factor resulting in the fluctuation of crop yield is to be lacking in well-trained techniques for proper farm operation under the intensive irrigation system.

In the light of official data and the results of farm survey, an average yield and total production in the Project area in 1975 are summarized in Table 4.3.

4.5 Land Tenure and Agricultural Holdings

According to the Law No. 31, 1972, the landholdings in the government-developed area are to be allocated in not less than 3 ha of Class I and IIand 5 ha of Class III land. The maximum holding in such irrigated land cannot exceed 20 ha. There are no size restrictions on non-irrigated land.

In the gross Project area (1,380 ha), Development Area 3, 4 and 5, private owned land is about 1,115 ha with 286 holdings. Nearly 60% of holdings in the area are in the range of 3 to 6 ha. As DA-3 is not government-developed irrigation area, though it is private-irrigated, units of land holdings are scattered in the wide range. Details are shown below:

Range of Holdings (dn)	Number of Holdings (No.) 1/ DA 3	DA 4	DA 5	Total	Percent of Holdings
Under 20	23	-	-	23	8
20 - 30	1	42	33	76	26.5
30 - 40	4	51	59	144	50
40 - 50	3	2	14	19	6.6
50 - 80	7	1	7	15	5.2
Over 80	4	-	6	10	3.5
Total	42	96	149	287	

1/ Not including government owned land (Rotenberg Area)

DA-3 includes about 230 ha of government owned land, originally non-irrigated, so-called "Rotenberg Project Area - Mashrou", which lies between the Jordan River and the North-South main road running through DA-3. This land is taken over by the Government from the British Power Company after the war, then entrusted to UNRWA to release it to the Palestinian refugees with 33 years concession. It is said about 100 people have

concession in this area, but actually only several family groups are doing extensive agriculture.

As the above units of holdings are counted by each agricultural plot, it does not necessarily indicate the real state of land ownership. Actually, the plural numbers of plots are owned by the same families. There remains disguised big land owner - tenant system. Apart from the land ownership, 3 to 4 ha of agriculutral holdings is most predominant unit of farm operation in the Project area.

According to the Socio-Economic Survey of the East Jordan Valley done in 1973, about 35% of holdings is owner-operated, 50% is sharecropped or rented and 15% is mixed tenure. However, it is actually understood that owner-operated holdings share only 10-15%, and remainings are mostly sharecropped by or some are rented to landless farmers. Big land owners enjoy quite favourable returns from the land, for example, getting 50% of crops from the share-croppers who bear all the production costs. If the Project envisages income distribution effect as one of its objectives, it is quite essential to establish some measures to reform the existing land tenure system.

4.6 Marketing

As in the other areas in Jordan, the marketing of agricultural produce in the Project area is mostly handled by commission agents. In North Shuneh eight agents are active, but the two powerful agents of them organize the two groups and govern the trading market. Agents send their small trucks or trailer-tractors and labourers for packing and loading to farms to collect products. The products gathered to the center of the town are immediately weighed and loaded onto the ten ton lorries which transport the commodities usually to the foreign markets, such as Syria, Kuwait, Saudi Arabia.

Most farmers depend their marketing on commission agents. Small number of farmers sell some of their produce to the Shuneh Agricultural Cooperatives. Few big and rich farmers who have lorries send and sell their products to the wholesale markets or foreign markets without owing to commission agents. It is very difficult, however, for most of the farmers to be independent in selling their products although some of the farmers try to do so. If a farmer sends directly to the wholesale market their product, big commission agents interfere with the ambitious farmer by sending big quantities of the same commodity to the same market and lowering the wholesale market price. Trades between farmers and commission agents are done in a form of free competitiveness, but actually the prices are decided by agents.

Major part of the products in the Project area is exported to Syria and other neighbouring countries. Especially in the case of tomatoes and eggplants, more than 80% of produce is exported to Syria directly from North Shuneh. Though the commission agent's fee varies from time to time and is not known usually, it seems to be more than 5% and sometime 20 to 30% of wholesale prices. Transportation charges of big lorries, if hired by commission agents, cost about 20 J.D. to Amman and 38 J.D. to Damascus.

Since the present marketing system where commission agents play significant roles is firmly established, any proposal for new marketing system which completely neglects the role of commission agents will not be practical. It will be quite advantageous to well utilize the on-going system with an adequate modification and improvement in the commission system.

4.7 Agricultural Institution

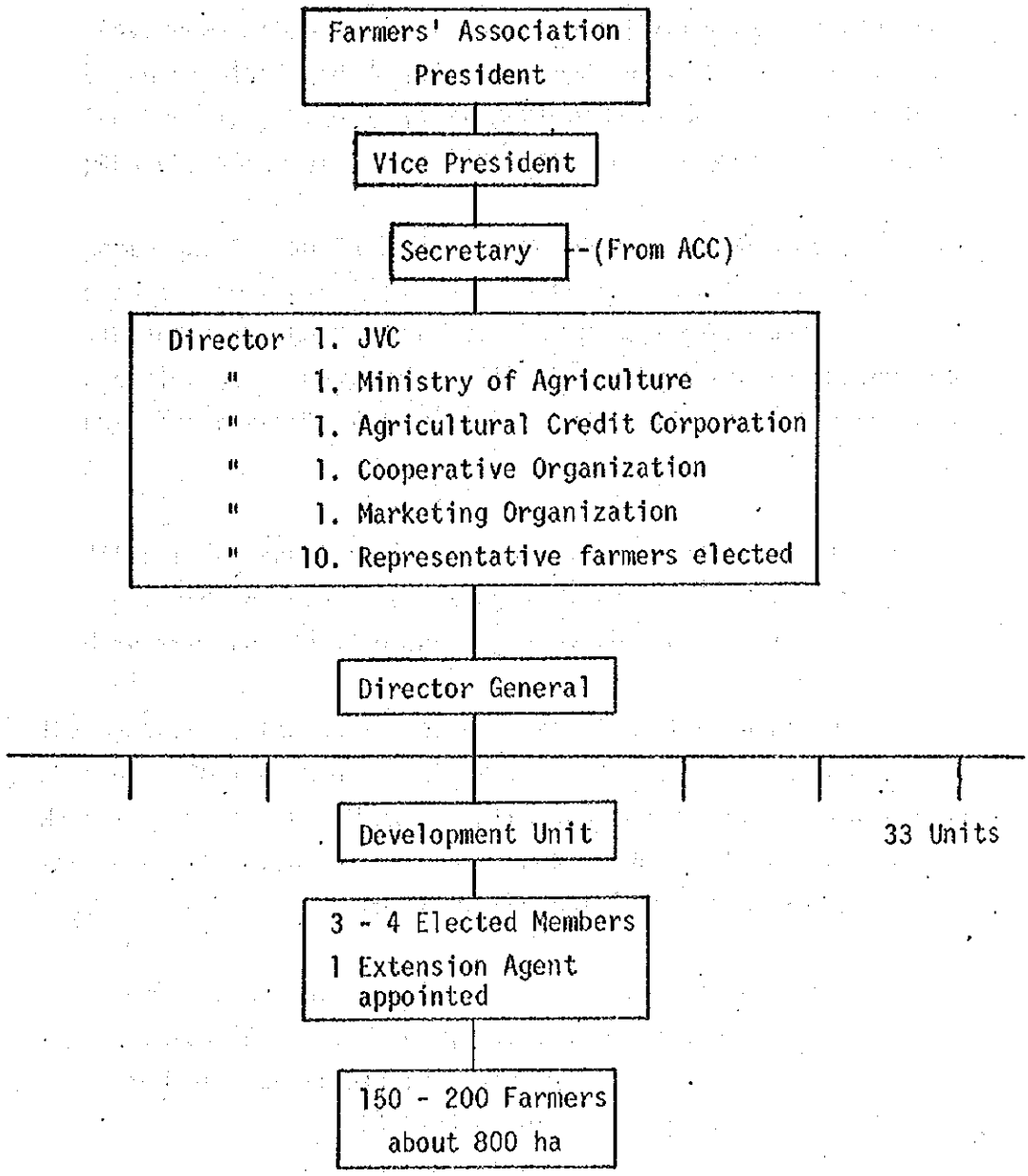
4.7.1 Farmers' Association

As a compulsory organization of the farmers in the Jordan Valley, a Farmers' Association was established under the Farmers' Association Law promulgated in 1974. Executive body of Farmers' Association is composed of fifteen members, five of which are appointed by the council of ministers to represent the Government agencies concerned, namely Jordan Valley Commission, Agricultural Credit Corporation, Agricultural Marketing Organization and Cooperative Organization, and ten of which are elected representatives of the farmers as shown in organization chart hereinafter.

The Jordan Valley is divided into 33 of Development Area as the implementation unit of the Farmers' Association. Each Development Area is composed by 150 - 200 farm families with 800 ha, at least, of cultivation area on an average and managed by 3 - 4 representative farmers elected from among the farmers in each area under the guidance and assistance of an agricultural extension agent appointed by the Department of Research and Extension as a secretary of the Development Area.

The Association shall hold a key position in the agricultural development of the Valley. In order to achieve its purposes, it is entrusted with the functions of supply of major agricultural requisites such as farm equipments, instruments and tools, seeds, fertilizers and pesticides, etc., provision of loans, undertaking of common agricultural practices, and the establishment and operation of agricultural marketing centers in the Valley. The Association is also expected to assist in facilitating the implementation of the Government policies especially with respect to the projected cropping pattern and other matters of improving agricultural productivities in the Valley.

ORGANIZATION CHART OF FARMERS' ASSOCIATION



4.7.2 Farmers' Organizations

Agricultural Cooperative is the only form of farmers' organization in the Jordan Valley. According to the information from the Jordan Cooperative Organization, there are 45 registered agricultural cooperatives in the Valley with total membership of 1,150 members, of which about 10 cooperatives are actively working at present.

In order to promote and facilitate the cooperative's activities, the Government supplies necessary funds through Jordan Cooperative Organization and despatches competent agricultural officers as the Secretary General of an Agricultural Cooperative during preparatory stage of cooperative less than 10 years after 1975.

In North Shuneh, an Agricultural Cooperative of new system was started in the beginning of 1976 with the fund of J.D. 60,000 subsidized from the Government. The number of members are accounted 160 as of May, 1976. All the members are borrowing some amount of the credit for vegetable cultivation from the cooperative.

Credit service and farm in-put supply are main activities at present, and in future marketing service and farm machinery lending service are also envisaged by the cooperative.

The members of the North Shuneh Agricultural Cooperative are consisted of 30 from Baqura, 30 from Adasia, 40 from Shuneh, 40 from Manshia and 10 from Waqas. Although the members of the cooperative are scattered to the whole area of North Shuneh, however, they are only 3 - 4 percent of the total number of farmers.

Membership Fee.....5 - 10 J.D./year
Interest Rate of Credit.....6%/year
Kind of Credit: 1) Short Term.....1 year
2) Medium Term.....5 years
3) Long Term.....5 - 10 years

4.7.3 Farm Credit

The Agricultural Credit Corporation (ACC) extends short and medium term credit for agriculture on a countrywide basis.

The Wadi Yabis branch office which covers Northern Ghor area from Adasia in the North to Darar in the South was established in June, 1971. The amount of loan disbursement, number of loan applications and number of borrowers amount to J.D. 672,480, 681 and 728 respectively since June, 1971, up to the end of May, 1976, as shown in the table below.

ACC meets only a fraction of the total demand for short term credit requirements. Its lending rate is 8% per annum for short term loans which is reduced to 7% for borrowers who repay on time or earlier. For medium term credit the interest rate is 6% per annum with no concession for timely repayment. Short term credit extends for one year or less. Medium term credit extends for one to ten years. Branch office is only in charge of these two kinds of loans.

Activities of Wadi Yabis Branch Office of ACC

Year		Disbursement	No. of Applications	No. of Borrowers
1971 (since June)	S.	10,330	19	20
	M.	6,230	3	4
1972	S.	13,013	89	92
	M.	105,169	75	79
1973	S.	51,353	67	74
	M.	167,800	88	96
1974	S.	30,883	71	76
	M.	88,075	46	48

(cont....)

Year		Disbursement	No. of Applications	No. of Borrowers
1975	S.	46,619	107	117
	M.	88,298	65	68
1976 (up to May)	S.	15,660	29	31
	M.	49,050	22	23
Grand Total	S.	167,858	382	410
	M.	504,622	299	318
TOTAL		672,480	681	728

4.7.4 Agricultural Research & Extension

Agricultural research work in Jordan was started in 1951 with the establishment of the Deir Alla Station as an agricultural experiment station on the Eastern Bank of the Jordan Valley.

The Department of Agricultural Research was founded in 1958, whereby a national agricultural research program was formulated and implemented under the control of a director.

In 1970 the Department of Agricultural Research and the Department of Agricultural Extension established in 1954 were amalgamated in order to get closer coordination between research and extension, and a new Department was formed under the name of Agricultural Research and Extension within the Ministry of Agriculture. The Department consists of three divisions, namely Research, Extension and Documentation.

Through the Deir Alla Agricultural Station and two substations in the Valley, the Department conducts experiments on existing and new field crops, vegetables and fruits.

Wheat experiments have resulted in the release of the high yielding variety of Deir Alla I for the Valley.

Agricultural extension service in the Valley is carried out through each Extension area divided into three parts in the whole area of the Valley, namely North Ghor, Middle Ghor and South Ghor.

The North Ghor area is served by the North Ghor Agricultural Department located in Wadi Yabis. The Agricultural Department consists of Mashala Extension Office, Klea'at Extension Office and North Shuneh Agricultural Office.

The North Shuneh Agricultural Office is subdivided into three Extension Offices, namely North Shuneh, Adasia Manshia and Waqas served by an extension agent respectively.

The extension agents in the North Shuneh Agricultural Office are equipped with insufficient transportation means and extension tools such as motorcycle, soil tester, slide projector, illustration board, etc.

The Adasia Extension Office covers about 5,000 ha of cultivation area and 1,000 farm families and includes three Development Areas of Farmers' Association which will start in 1977.

Extension agents are directed to work on the fields at least five days a week and one day for office work. Mainly through farm visits and demonstration farm, extension works carry out their extension service.

At present three demonstration farms of 3 ha each for wheat and barley and three demonstration farms of 1 ha each for maize are carrying out with subsidiary of seeds, fertilizers and machines.

Method demonstration of plant protection is also carried out one or two times per month during growing season.

These efforts would be more effective when the number of Extension Agents is increased so as to cover each Development Area by one Extension Agent.

4.8 Labour Force

Although the exact number of population of the Project area is not available, it is said that about 10,000 poeple live in North Shuneh and its surroundings, including Baqura Village. Population estimated on a basis of 1973 Socio-economic survey, with 3.2% of annual increase, is about 9,800 including about 500 in Baqura, which number is obtained from verbal information.

According to the 1973 survey, ratio of labour force to the whole population in the Northern Ghor is 28.4% which is remarkably higher than that of the country average. This high ratio is a result of the fact that 80% of labour force is workers in agriculture and out of it 70% is female labourers. Consequently, women labour force ratio is counted more than 15%. Though the unemployment ratio is as low as 2.1%, the fact that family workers count nearly 30% of agricultural workers and 75% of them are female workers suggests the existence of disguised unemployment.

In the Project area the availability of labour seems to be favourable although explicit unemployment is not remarkable.

PRESENT LAND USE CONDITION

(Unit: ha)

	DA-3	DA-4	DA-5	WHOLE AREA
(1) Net irrigated area	169.0	306.0	476.0	951.0
(2) Area for on-farm service facilities	3.0	6.0	10.0	19.0
(3) Gross irrigated area	172.0	312.0	486.0	970.0
(4) Non-irrigated area	207.0	-	68.0	275.0
(5) Rights-of-way	11.0	8.0	20.0	39.0
(6) Arable land (3)+(4)+(5)	390.0	320.0	574.0	1,284.0
(7) Non-arable land	20.0	-	76.0	96.0
TOTAL	410.0	320.0	650.0	1,380.0

Source: The results of field investigation.

PRESENT SITUATION OF CULTIVATED LAND

(Unit: ha)

	DA-3	DA-4	DA-5	WHOLE AREA
(1) Irrigated area				
a. Citrus (Bearing)	2.0	55.0	146.0	203.0
b. -do- (Unbearing)	12.0	27.0	20.0	59.0
c. Banana	-	4.0	83.0	87.0
(Sub-total)	(14.0)	(86.0)	(249.0)	(349.0)
d. Cereals	90.0	103.0	106.0	299.0
e. Vegetables	65.0	117.0	121.0	303.0
(Sub-total)	(155.0)	(220.0)	(227.0)	(602.0)
TOTAL	169.0	306.0	476.0	951.0
(2) Non-irrigated area				
f. Cereals	207.0	-	68.0	275.0
GRAND TOTAL	376.0	306.0	544.0	1,226.0

Source: The results of field investigation.
"Agricultural Sampling Survey in the Ghors 1975"

CROPPED AREA, PRODUCTION AND AVERAGE YIELD

	Cropped area (ha)	Production (ton)	Average yield (ton/ha)
(1) Irrigated crops			
a. Citrus (Bearing)	203.0	1,900	9.4
b. -do- (Unbearing)	59.0	-	-
c. Banana	87.0	1,800	20.7
d. Wheat	269.0	350	1.3
e. Barley	30.0	40	1.3
f. Tomato	83.0	1,400	16.9
g. Eggplant	81.0	1,400	17,3
h. Pepper	9.0	100	11.1
i. Potato	16.0	2oo	12.5
j. Broard beans	25.0	180	7.2
k. Cucumber	20.0	290	14.5
l. Squash	40.0	450	11.3
m. Watermelon	25.0	280	11.2
n. Cabbage	30.0	470	15.7
o. Cauliflower	8.0	140	17.5
p. Jew's mallow	15.0	180	12.0
(2) Non-irrigated crops			
q. Wheat	250.0	150	0.6
r. Barley	25.0	10	0.4

Note: Figures show the actual results in the Project area in 1975.

Data are collected from the North Shuneh Agricultural Office and also obtained through the field investigation.

FLUCTUATION OF CROP YIELD

(Unit: ton/ha)

Crop	1975	1974	1973	1972	Mean*
(1) Irrigated crops					
a. Citrus (Bearing)	9.04	10.32	(8.19)	15.49	9.28
b. Banana	21.28	11.96	(2.88)	14.11	13.53
c. Wheat	1.32	1.50	(1.08)	1.54	1.26
d. Barley	1.26	(1.17)	1.26	1.68	1.27
e. Maize	1.50	1.77	(1.07)	1,43	1.40
f. Tomato	17.34	10.30	(7.94)	16.44	12.65
g. Eggplant	17.40	(8.78)	9.76	13.90	11.42
h. Pepper	10.94	(3.31)	9.22	9.38	6.88
i. Potato	12.73	6.17	(4.62)	11.43	10.72
j. Broad beans	7.23	4.89	(2.70)	9.45	6.03
k. Cucumber	14.44	4.36	(4.08)	7.96	6.92
l. Squash	11.28	11.90	(7.84)	9.53	9.85
m. Watermelon	11.53	10.72	16.87	(10.49)	13.69
n. Cabbage	15.79	13.83	(11.91)	14.24	13.89
o. Cauliflower	18.28	(10.68)	14.28	17.47	14.35
p. Jew's mallow	12.32	9.16	12.32	(8.36)	10.33
(2) Non-irrigated crops					
q. Wheat	0.58	1.37	(nil)	1.01	0.67
q. Barley	0.42	1.07	(nil)	0.41	0.47

Note: *; For each crop, weighted mean is estimated during the period from 1972 to 1975.

Figures on underline show the maximum and those in parentheses give the minimum.

Each crop yield is expressed as weighted mean which is calculated by the use of records on cropped area and production in both sowing seasons of early spring and autumn in every year. The records available in "Agricultural Sampling Survey in the Ghors", 1972 to 1975 are referred.

ANNEX - 5

IRRIGATION AND DRAINAGE

5.1 Area.

The Project area consists of three Development Areas (No. 3, 4 and 5) which were established in order to manage the water supply from the East Ghor Main Canal (E.G.M.C.) adequately. At present the most part of DA-5 and about two-third of DA-4 are irrigated by the lateral canals of the E.G.M.C. under gravity system. The remaining area of DA-4 (one-third of this area) is irrigated by water from the Wadi Arab.

DA-3 is a land with relatively high elevation and the whole area of DA-3 cannot be supplied water from the EGMC by gravity. About 40% of the total irrigable area of DA-3 (150 ha) is irrigated by the water pumped up from the Yarmouk River. The area of 19 ha of DA-3 is also equipped with the distribution canal of the Wadi Arab irrigation network. However, at present, this canal is not used. The remaining area of DA-3 is a rainfed cultivated area.

The above-mentioned net irrigable area is tabulated as follows:-

	Irrigated area					
Area	from EGMC	from W.Arab	from R.Yarmouk	Sub-Total	Nonirrigated Area	Total
	(ha)	(ha)	(ha)	(ha)	(ha)	(ha)
DA-3	-	19	150	169	207	376
DA-4	206	100	-	306	-	306
DA-5	476	-	-	476	68	544
Total	682	119	150	951	275	1,226

5.2 Irrigation Facilities.

5.2.1 East Ghor Canal network for DA-4 and -5

The construction of East Ghor Main Canal and its lateral canals in DA-4 and -5 were completed in 1961. Since then the facilities have been sufficiently maintained. However, the metalworks on the lateral canals are pretty damaged.

5.2.2 Irrigation facilities for the Wadi Arab network.

The existing diversion weir on the Wadi Arab was constructed in 1948. The dimension of the weir is as follows:-

Length : 50m
Hight : 3.5m
Capacity: to pass a maximum flow of 250^{m3}/sec.
Intake : two-side intake,
right side intake = 1.4m wide.
left side intake = 1.2m wide.

Two intakes are arranged at the both side of the weir. Concrete lined canals are provided from intakes to the field. The downward of these canals are connected to the EGMC in order to spill out excess water. During the dry season, whole discharge of the Wadi Arab flows into these canals.

The diversion dam and upper part of these canals are now deteriorated.

5.2.3 Irrigation facilities in DA-3

Source of irrigation water for DA-3 is the Yarmouk river. Small six pumps, which are installed by private owners at the river side near Baqura village are operated for taking irrigation water from the Yarmouk River. Four of them are set in a pump station together and supply water to the field of 126 ha. The present condition of these facilities are as follows:-

Pumping facilities

Item	No. 1 - 4	No. 5	No. 6
Capacity of pump (m3/min)	7.2, in total	0.6	0.6

Item	No. 1 - 4	No. 5	No. 6
Actual Head (m)	90	80	80
Type of pump	Single suction volute pump	=	=
Bore of outlet pipe (inch)	6" x 2, 10"	4"	4"
Irrigation area (ha)	126	16	8

The available discharge of pumps per month is estimated at 82^{m3}/ha/day. The distribution canals for No. 1 - 4 pumps consist of partially damaged concrete flume and earth canal. As a result, the conveyance loss seems to be high.

5.3 Operation and Maintenance.

Water distribution and maintenance of the supply system, both the East Ghor Main canal and the Wadi Arab network are controlled by the Natural Resources Authority (N.R.A.), established in 1968. Before 1968, the East Ghor Canal Authority assumed these functions.

The operation and maintenance office at North Shune (Shuneh Water office) has the responsibility for the daily O & M works in DA-4 and -5. The Water distribution for DA-4 and -5 is now executed by 19-Ditch riders.

The results of water use of the past five years in DA-4 and -5 recorded by the above-mentioned office are as shown in Table 5-1 and 5-2.

On the other hand, the water distribution of DA-3 is executed by pump owners and share croppers privately and there is no recorded information.

5.4. Present Drainage System.

Originally, the middle part of DA-4 was an ill-drained area caused by low-elevated topographic condition. After completion of the drainage canal in 1961, the drainage condition was remarkably improved. Another area in the Project area has no problem about drainage.

The present drainage canal system consist of two main drainage canals and several collector drains. The total length of them are as follows:-

Main drainage canal	4.6 km.
Collector drain	15.0 km.

The No. 1 main drainage canal crosses almost the center of DA-4 and -5. The outlet of this canal is connected to a gully, which develops on the right bank of the Wadi Arab. The No. 2 main drainage canal joins with the No. 1 main drainage canal at the southern part of DA-4.

The drainage discharge is measured at the end point of the No. 1 main drainage canal in the begining of July, 1976. The discharge recorded is 13 lit/sec. It seems to be constant during our surveying period, May - July 1976.

At present these drainage canals are maintained in good condition by the N.R.A.

The more detailed study will be presented after the results of analysis for soil and water samples are available.

MONTHLY WATER USE RECORDS (DA - 4)

Month	1971		1972		1973		1974		1975		Average	
	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit
Jan.	43,075	20	585	2	40,395	47	9,299	17	11,244	11	20,920	19
Feb.	3,975	3	(9,793)	(11)	32,725	38	1,123	1	1,350	2	9,793	11
Mar.	11,195	13	10,385	15	53,455	39	12,950	20	23,880	22	22,373	22
Apr.	16,140	21	22,020	23	200,240	85	38,169	42	179,413	76	91,196	49
May	43,975	38	103,175	57	201,290	79	199,524	72	177,634	79	145,120	65
June	306,550	81	176,565	66	246,565	84	264,673	74	232,493	81	245,369	77
July	240,130	81	159,955	71	281,055	92	230,368	75	249,673	79	232,236	80
Aug.	137,380	67	162,905	69	274,720	85	211,676	73	203,498	77	198,036	74
Sept.	160,350	67	152,070	67	203,205	78	190,133	79	164,201	70	173,992	71
Oct.	148,300	69	161,650	63	76,375	52	199,680	76	148,863	70	146,974	66
Nov.	44,090	46	71,300	58	44,250	54	100,046	71	62,262	57	64,390	57
Dec.	8,650	13	31,165	37	45,205	42	7,206	10	6,735	14	19,792	23
ANNUAL	1,163,810	519	1,061,568	539	1,699,480	775	1,464,847	610	1,461,246	632	1,370,191	615

Note: Data are collected from the Shuneh Water Office, N.R.A.

DA-4 area comprises 209.2 ha of irrigated area from the East Ghore Main Canal and 96.8 ha of irrigated area from the Wadi Arab.

The irrigated area from EGMC has 67 units and the area irrigated by the Wadi Arab posseses 31 units.

MONTHLY WATER USE RECORDS (DA - 5)

Month	1971		1972		1973		1974		1975		Average	
	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit	Q'ty (m^3)	Unit
Jan.	193,780	64	4,430	5	121,830	71	40,155	24	39,376	17	79,914	36
Feb.	41,050	11	7,785	8	72,570	48	3,129	5	3,499	5	25,607	15
Mar.	185,155	72	77,970	46	142,160	76	14,880	23	122,669	47	108,567	53
Apr.	183,815	51	123,685	64	523,810	131	93,099	71	564,645	127	297,811	89
May	315,700	108	716,770	122	950,460	137	769,473	136	633,891	139	677,259	128
June	1,031,320	132	1,021,655	130	1,025,370	138	873,136	120	777,170	140	945,730	132
July	1,008,585	131	1,16 ,355	128	1,277,665	137	850,193	136	800,215	138	1,019,803	134
Aug.	1,123,385	124	1,297,235	122	1,376,185	141	812,149	129	765,053	132	1,074 801	130
Sept.	1,185,610	127	1,236,035	131	1,426,850	141	749,330	131	699,751	133	1,059,515	133
Oct.	1,016,360	127	1,301,740	136	458,690	116	707,252	139	547,976	138	806,404	131
Nov.	409,020	116	592,515	131	334,415	113	327,297	131	265,747	126	385,799	123
Dec.	156,680	67	213,670	86	165,055	79	14,712	17	18,607	33	113,745	56
ANNUAL	6,850,460	1,130	7,755,845	1,109	7,875,060	1,328	5,254,805	1,062	5,238,599	1,175	6,594,954	1,161

Note: Data are obtained from the Shuneh Water Office, N.R.A.

Whole irrigated part of DA-5 area is supplied with water from EGMC. The area irrigated is recorded to be 476 ha cosisting of 145 units.

ANNEX - 6

TENTATIVE ECONOMIC RATE OF RETURN

Following assumptions are made in the tentative calculation of Economic Rate of Return:-

1. Benefits

The economic benefits of the Project are quantified basing on the incremental production of vegetables and fruits which is to be expected in the future with the Project. The production in the future without Project is estimated from the data in the Agricultural Sample Survey for the last four years, and the supplemental data collected through the farm survey. The production with the Project in its full development stage is projected considering various factors. The incremental production by crop, from "Without Project" to "With Project", is shown in Chapter 2.2.

The prices used in the calculation of benefits are the farm gate prices of weighted average in 1974/75 shown in "Jordan Valley Development Plan 1975 - 1982" by Jordan Valley Commission, November, 1975.

In calculation of production costs, the farm input costs estimated in the said Plan 1975-1982 of JVC are employed; but the labour costs are newly calculated based on the labour requirement estimated by the Team. (Chapter 2.2 and Annex 4)

Benefits to be sacrificed due to the construction of a storage dam, 8,000 - 9,000 J.D. per annum, are deemed as minus benefits and deducted from gross benefits with Project.

Average costs for the maintenance of the existing irrigation systems in the Project area, 6,000 J.D. per annum, are deducted from gross benefits to be attained in the future without Project.

2. Costs

Economic cost of the Project investment is obtained in deducting land acquisition cost and price contingency from the financial cost estimated in Chapter 2.5.

Annual operation and maintenance costs are assumed to be 3% of investment cost for irrigation works and 1% for the dam works. The sprinkler units are to be replaced in each 15 years interval after their installation.

3. Benefits and Costs of the IDA Project

Benefits of the IDA Project are updated in consideration of the following:-

a. Incremental production is calculated only for 2,800 ha.

b. Farm gate prices are changed to employ the same as the Wadi Arab Project.

c. Production costs are updated considering 30% of cost increase during two years after 1973.

d. Due to the delay of the intake facilities of the Wadi Arab the first and second years' benefits are reduced to half and the third year's by two-thirds.

Economic costs of the IDA Project are also updated as follows:-

a. Costs of irrigation facilities are updated basing on the new estimate by the Consultants made in June, 1975, and deleting the costs of the Wadi Arab intake weir and carrier pipe.

b. Other costs are obtained doubling the costs in the IDA Report of May, 1974, and allocating them for 2,800 ha pro-rata.

c. Yearly O, M and R costs are calculated as the same proportion to the Investment Cost as in the 1974 IDA Report.

4. Development Period

The construction period of the Project is assumed as four years. A half of the irrigation system can be operated from the beginning of the third year. Full development will be achieved after five years from the commencement of each operation. During such maturity period, benefits will increase 50% in the first two years and remaining in other three years.

5. Project Life

For the sake of the benefit cost analysis for the integrated project, the project life is assumed as 40 years. Sprinkler units, however, are to be replaced in each 15 years.

6. IRR of the integrated project - economic rate of return is calculated for the integrated project of the Project and the IDA Project as one unit. For the convenience yearly costs and benefits of both Projects are simply added year by year. The cost-benefit stream of the integrated project is presented in Table 6-1.

ECONOMIC COSTS AND BENEFITS

(The Project Plus The IDA Project)

(1,000 JD.)

	INVESTMENT COSTS			O, M & R				BENEFITS			
Year	IDA	Arab	S-Total	IDA	Arab	S-Total	Total	IDA	Arab	Total	Net Benefits
1975	179		179				179				-179
1976	1,405		1,405				1,405				-1,405
1977	1,483	427	1,910	25		25	1,935	17		17	-1,918
1978	819	3,250	4,069	37		37	4,106	147	-8	139	-3,967
1979	31	3,639	3,670	199		199	3,869	421	-8	413	-3,456
1980		3,300	3,300	254	34	288	3,588	1,096	93	1,189	-2,399
1981				254	122	376	376	1,542	283	1,825	1,449
1982				254	122	376	376	1,865	438	2,303	1,927
1983				254	122	376	376	2,069	567	2,636	2,260
1984				254	122	376	376	2,178	693	2,871	2,495
1985-92				254	122	376	376	2,178	755	2,933	2,557
1993				805	122	927	927	2,178	755	2,933	2,006
1994				254	337	591	591	2,178	755	2,933	2,342
1995				254	338	592	592	2,178	755	2,933	2,341
1996-2007				254	122	376	376	2,178	755	2,933	2,557
2008				805	122	927	927	2,178	755	2,933	2,006
2009				254	337	591	591	2,178	755	2,933	2,342
2010				254	338	592	592	2,178	755	2,933	2,341
2011-16				254	122	376	376	2,178	755	2,933	2,557

ANNEX - 7

TOPOGRAPHY

Topographic maps concern the Wadi Arab Dam and Irrigation Project available for the feasibility study are as follows:-

(1) General Map, scale of 1 to 250,000.	1 sheet
(2) General Map, scale of 1 to 25,000.	1 sheet
(3) Aerial Surveyed Map, scale of 1 to 10,000. "YARMOUK - JORDAN VALLEY PROJECT" Sheet No. 1, 2.	2 sheets
(4) Aerial Surveyed Map, scale of 1 to 2,500. "YARMOUK - JORDAN VALLEY PROJECT" Sheet No. 221.5/206, 208, 210. Sheet No. 223.0/206, 208, 210. Sheet No. 224.5/206, 208, 210. Sheet No. 226.0/206, 208, 210. Sheet No. 227.5/200, 208.	14 sheets
(5) Topographic Map, scale of 1 to 1,000. "WADI ARAB DAM SITE" By LAYOUT SECTION, TECHNICAL DIVISION, EAST GHOR CANAL AUTHORITY, MAY 1964. Sheet No. 2, 3.	2 sheets
(6) Topographic Map, scale of 1 to 1,000. "WADI ARAB POWER SCHEME" By ENERGOPRJET, SEPTEMBER 1966. Sheet No. 1.	1 sheet

(7) Tender Drawings, scale of 1 to
"NORTH EAST GHOR IRRIGATION &
RURAL DEVELOPMENT PROJECT"
By NEDECO and DAR AL HANDASA.
Drawing No. J668/n 502

First of all, a check survey was conducted for the proposed dam site and reservoir area on the basis of the above topographic maps (5) and (6). This check survey has found that these three (3) sheets of topo maps had be controlled by different datum of coordinates and bench marks, respectively. Accordingly the maps (5) and (6) are unable to be joined one to another on a same grid and contour systems.

Then, topographic survey has been carried out by the team and prepared revised topo-map covering the proposed dam site and reservoir area and possible sites of major hydraulic structures and devices.

This survey has also covered on all relative area and sites such as borrow areas, construction plants, possible alignment of a carrier pipe line and the part of the Bagura irrigation commanding area.

All of the survey and mapping made by the Team have based on the following datum given from a topographic control system of the IDA project, conducted by NEDECO AND DAR AL HANDASAH.

Control Station PI-7:	N 225,145.83	(Latitude)
	E 210,624.43	(Departure)
Control Station PI-9:	N 225,004.05	
	E 210,271.17	
Datum Bench Mark BM-1:	- 126.595	
Datum Bench Mark BM-3:	- 138.662	

Topographic maps which have been prepared by the Team in this phase are summarily mentioned below:

(1) Topographic Plan of proposed Dam Site and Reservoir.
Scale: 1/1,000
Covering area: 500 x 2,400 sq.m.

(2) Topographic Plan of proposed Borrow Area.
Scale: 1/1,000
Covering area: 300 x 2,000 sq.m.

(3) Possible Alignment Plan of Carrier Pipe Line.
Scale: 1/1,000
Covering area: 20 x 2,400 sq.m.

(4) Revised Map on Baqura Area.
Scale: 1/2,500
Covering area: 400 ha (400,000 sq.m.)