MINISTRY OF WATER RESOURCES (MOWR),
MINISTRY OF AGRICULTURE (MOA),
MINISTRY OF PLANNING (MOP)
REPUBLIC OF IRAQ

THE PREPARATORY SURVEY
ON
SOUTH JAZIRA IRRIGATION PROJECT
IN REPUBLIC OF IRAQ

FINAL REPORT
(MAIN REPORT)

OCTOBER 2011

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

SANYU CONSULTANTS INC.

LIST OF REPORTS

FINAL REPORT (MAIN)

1. English version
2. Arabic version
3. Japanese version

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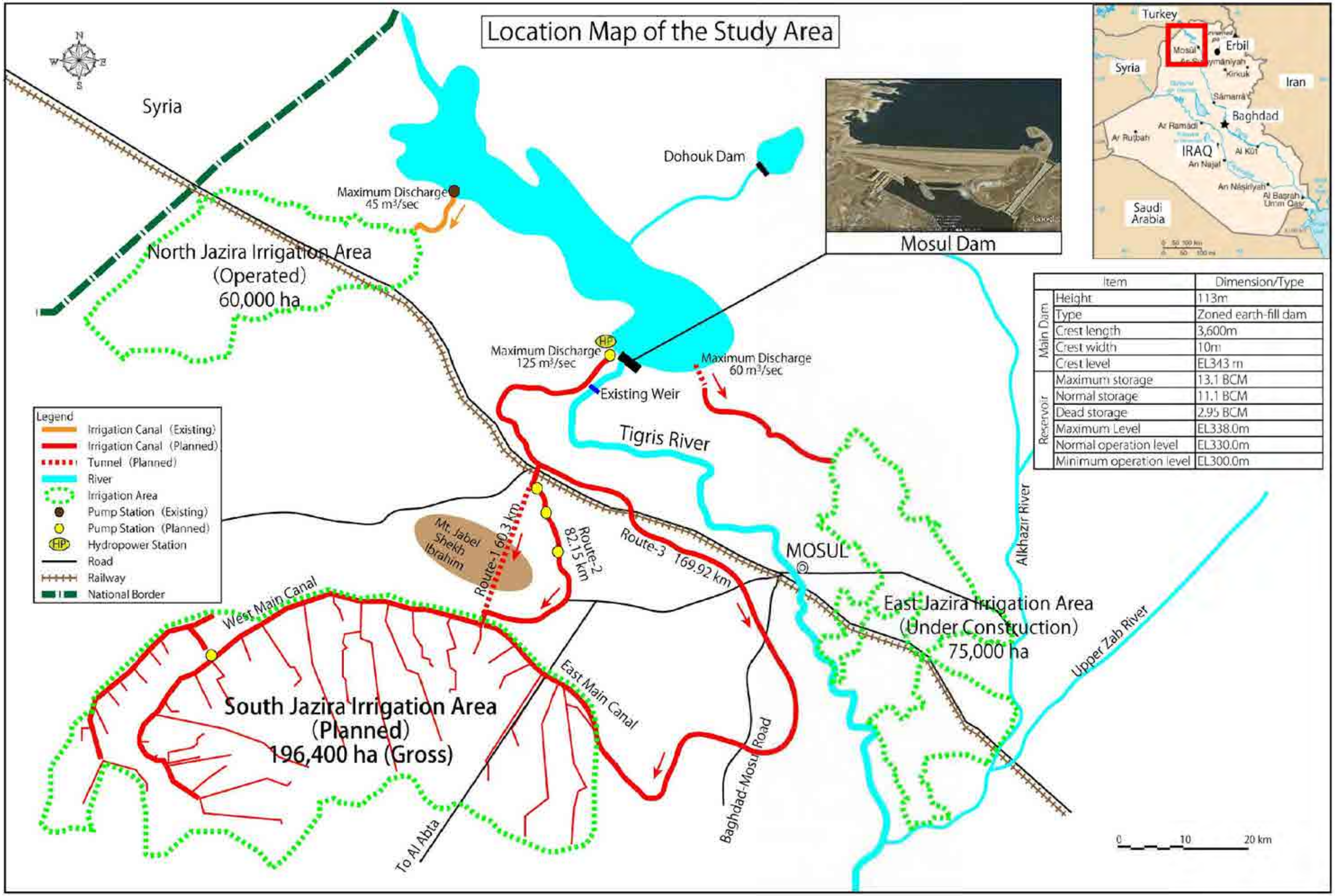
2. Pump Alternative
    1) Scenario-0 (Intake volume: Q=100 m^3/s)



	Item	Dimension/Type
Main Dam	Height	113m
	Type	Zoned earth-fill dam
	Crest length	3,600m
	Crest width	10m
	Crest level	EL343 m
Reservoir	Maximum storage	13.1 BCM
	Normal storage	11.1 BCM
	Dead storage	2.95 BCM
	Maximum Level	EL338.0m
	Normal operation level	EL330.0m
	Minimum operation level	EL300.0m

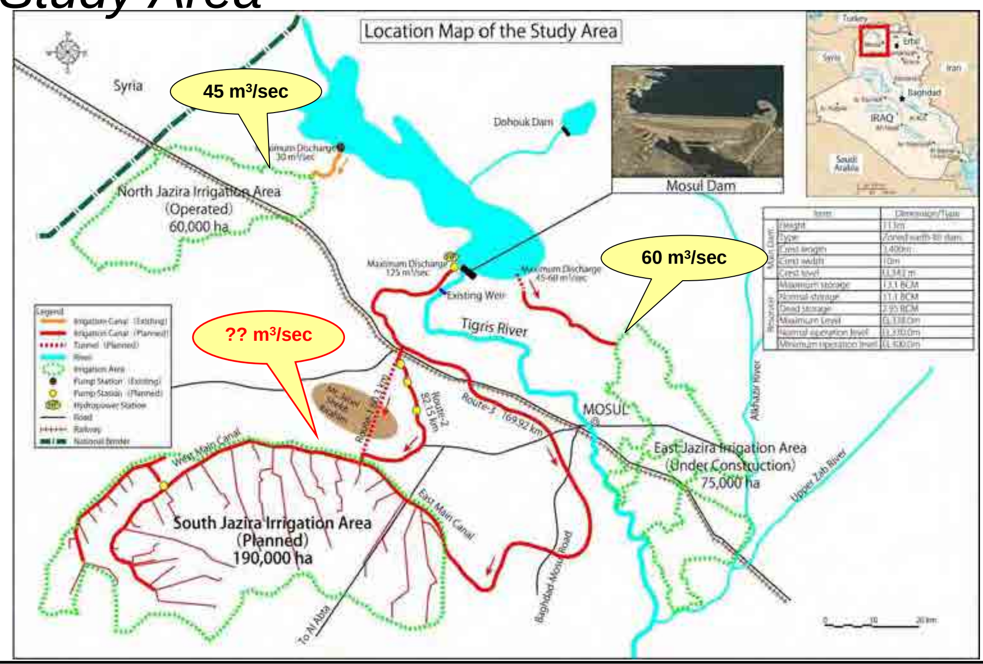
THE PREPARATORY SURVEY ON SOUTH JAZIRA IRRIGATION PROJECT IN REPUBLIC OF IRAQ

FINAL REPORT
SUMMARY

SEPTEMBER 2011

JICA STUDY TEAM FOR THE SURVEY

Study Area



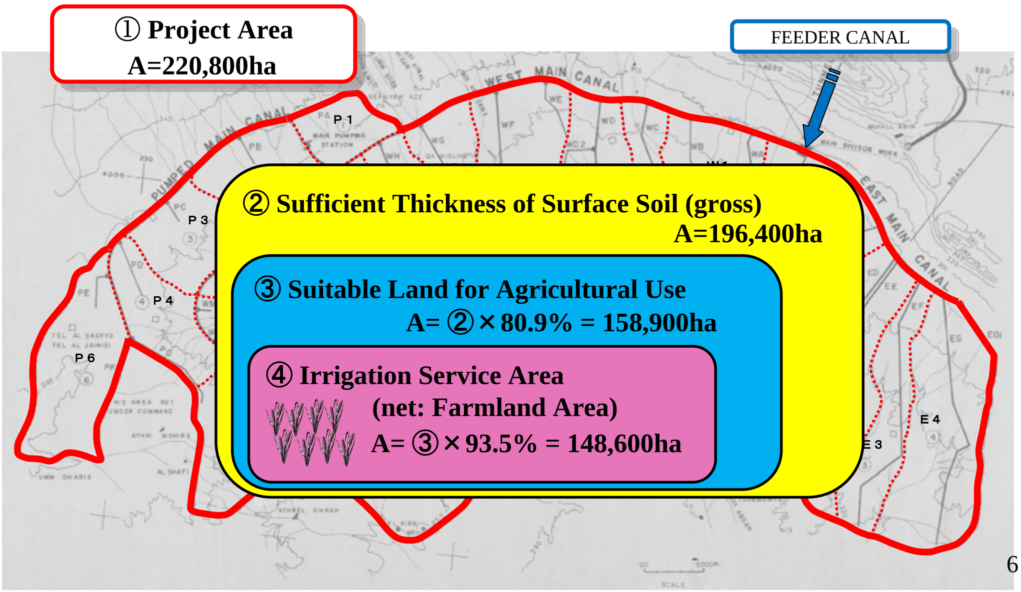
1. Understandings of the Study objectives

1. Understandings of the Study objectives

1) To confirm feasibility of the South Jazira Irrigation Project with review of the Swiss F/S considering of proper distribution of the water resource from the Tigris River.
2) To propose irrigated agriculture plan based on the analysis of available water resources in the Mosul dam reservoir.*by Scenarios*.
3) To prepare irrigation facility plan by alternatives including tunnel and pump for feeder canal considering of environmental and social conditions.*by Scenarios*.
4) To evaluate Project effects.*by Scenarios*.
5) To find minimum scale of the Project to be feasible.

2. Irrigated agriculture plan

2-1. Irrigation Service Area in the Project Area



2-2. Better cropping pattern brings more production and requires less water

Basic strategy to select crops
① Irrigation water should be saved.
② Production of principal food should be increased.
③ Fodder should be produced for livestock farmers.
④ National 5-years Plan, Swiss F/S, Experience of North Jazira Project should be concerned.

Crop Production of Rotation Block (Cultivated Area 2,400ha

	Crops	Proposed Yield (kg/ha)	Cropping Area (ha)	Pr (t
1	Winter alphalpha	7,000	-	-
2	Sugar beet	46,000	200	9,200
3	Wheat	5,600	900	5,040
4	Barley	5,200	300	1,560
5	Field beans	2,800	100	280
6	Oat	7,600	100	760
7	Vetch	7,600	100	760
8	Berseem	8,400	100	840
9	Potato	20,000	100	2,000
10	Summer alphalpha	7,000	400	2,800
11	Cotton	2,800	25	70
12	Maize	6,000	25	150
13	Sunflower	2,400	25	60
14	Chick pea	2,400	25	60

Fodder Crop

Principal Food

Fodder Crop

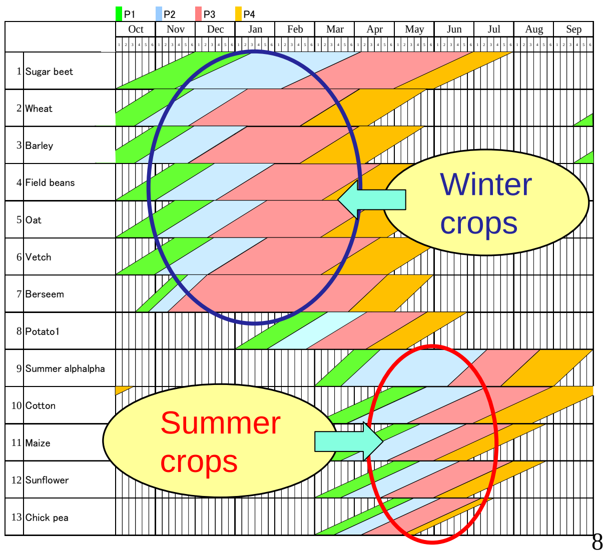
Fodder Crop

Summer crops need more irrigation water than winter crops.

2-3. Cropping schedule should be adjusted to make total water consumption minimum.

- Cropping schedule can be adjusted because of irrigation water by project.
  - ⇨ It is not necessary to wait rainfall for seeding.
- Reducing maximum monthly discharge and annual water consumption should be considered.
  - ⇨ Winter crops are main.
  - ⇨ Unit price of crop are not considered.

Growing stage of crop established by FAO
P1: Initial Stage
P2: Crop Development Stage
P3: Mid-Seasone Stage
P4: Late Seasone Stage



2-4. Maximum monthly discharge indicates capacity of canal system.

- Water consumption depends on the following factor.

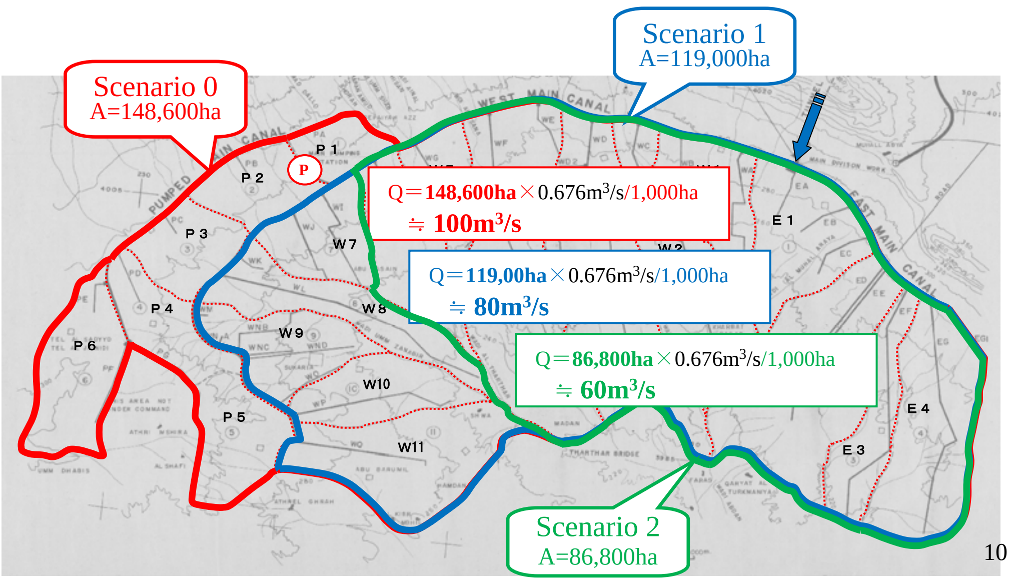
① Cropping area
② Climate (high in summer season)
③ Character of crop

Unit Water Consumption (m3/sec/1,000ha)

Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Maximum Discharge
0.21	0.22	0.19	0.19	0.28	0.57	0.68	0.61	0.52	0.43	0.34	0.11	0.68

In April most winter crops are still planted and summer crops are planted in April. Therefore, monthly water consumption of April becomes maximum.

2-5. Design discharge by Scenarios



3. Available water resources in the Mosul dam reservoir

3-1. Pre-conditions

1) SWLRI will take 2 to 3 years to complete the task,

2) Indicators provided by MOWR;

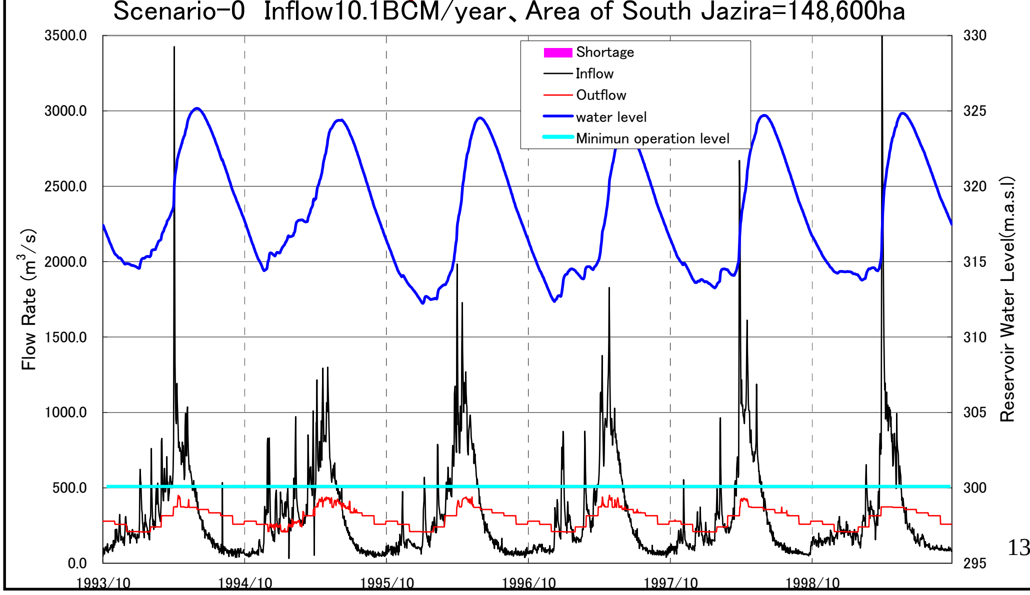
a) Inflow volume to the Mosul dam reservoir in future: ⇒ 10.1 BCM/year

b) Minimum requirement of releasing volume from the Mosul dam: ⇒ 200 m^3/s

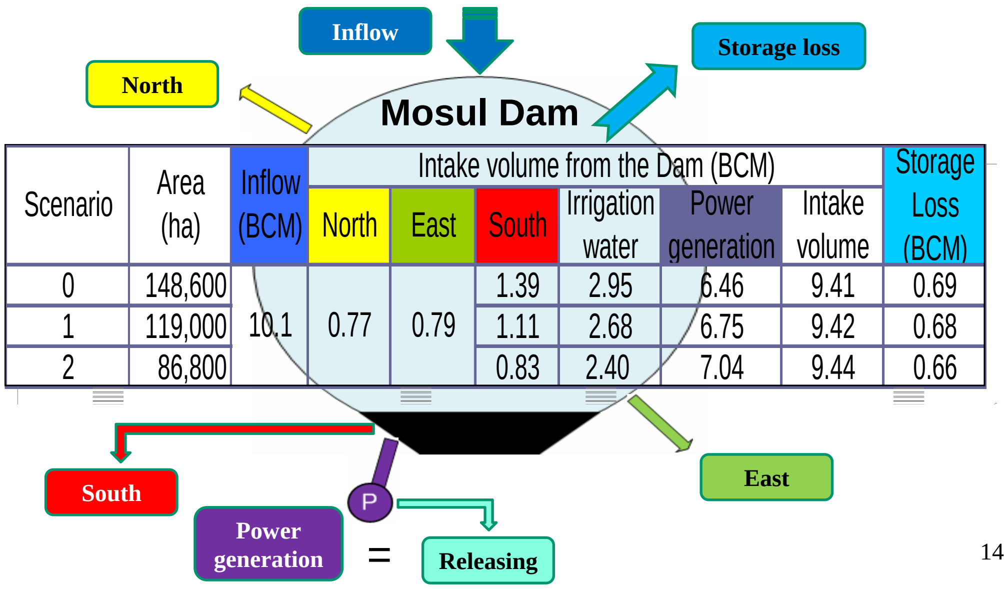
(if constant, 6.31BCM/year)

No shortage occurs in the case of maximum intake rate (Scenario-0)

This result is rarely different from other scenarios.



3-2. Available water resources in the Mosul dam reservoir



Scenario	Area (ha)	Inflow (BCM)	Intake volume from the Dam (BCM)						Storage Loss (BCM)
			North	East	South	Irrigation water	Power generation	Intake volume	
0	148,600	10.1	0.77	0.79	1.39	2.95	6.46	9.41	0.69
1	119,000				1.11	2.68	6.75	9.42	0.68
2	86,800				0.83	2.40	7.04	9.44	0.66

4. Construction schedule and minimum scale of the Project to be feasible

4-1. Component of Canal by Scenarios

Canal	Items	Unit	Scenario 0	Scenario 1	Scenario 2
Feeder canal	Design discharge (Q)	m^3/s	100	80	60
Open canal	Length (L)	km	41.16	41.16	41.16
	Canal bed width (B)	m	5.00	4.00	4.00
	Wall height (H)	m	6.00	5.70	5.00
Tunnel	Length (L)	km	19.14	19.14	19.14
	Horse-shoe type (2R)	m	7.90	7.30	6.50
East Main canal	Design discharge (Q)	m^3/s	23～8	23～8	23～8
	Length (L)	km	18.02	18.02	18.02
West Main canal	Design discharge (Q)	m^3/s	77～7	57～7	36～4
	Length (L)	km	76.40	76.40	39.05
Pumped Main canal	Design discharge (Q)	m^3/s	18～2	—	—
	Length (L)	km	27.70	—	—

4-2. Construction cost by Scenarios

Unit: Billion ID, 1 USD=1,170 ID

Work Type	Scenario 0	Scenario 1	Scenario 2
1. Feeder Canal (Open Canal)	152	136	121
2. Tunnel on Feeder Canal	181	165	142
Sub-total	333	300	264
3. Canals, Road and Networks (East Canal)	109	109	109
4. Canals, Road and Networks (West Canal)	350	327	171
5. Canals, Road and Networks (Pumped Canal)	198	—	—
6. Sprinkler System	599	480	350
Sub-total	1,256	916	630
6. Power and Pumping Station	176	140	105
7. Electrical Supply System	45	41	36
Sub-total	221	181	141
Total (as of year 2009)	1,809	1,397	1,035
Total (as of year 2010)	1,873	1,447	1,073

4-3. Project costs (Financial price)

(1,000 ID)

Contract Number	Facilities	Scenario 0 (w/ Pump)		Scenario-1	Scenario 2
Direct Cost Total		1,872,983,100	1,872,983,100	1,447,301,700	1,072,670,900
Consulting Services	10% of Direct Cost	187,298,300	187,298,310	144,730,100	107,267,100
Land Acquisition & Compensation	3% of Direct Cost	28,167,800	56,189,493	22,868,400	17,112,400
Administration Cost	3% of Direct Cost	28,167,800	56,189,493	22,868,400	17,112,400
Physical Contingency	20% of Above	423,323,400	434,532,079	327,553,800	242,832,500
Reconstruction Levy	5% of Direct Cost	46,702,800	0	34,251,000	25,112,800
Total		2,586,643,200	2,607,192,475	1,999,573,400	1,482,108,100

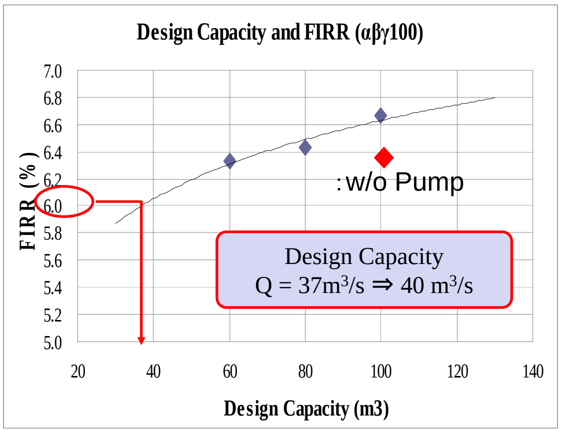
a/ Unit Costs of the East Jazira Irrigation Project are areapplied.

b/ Price escalation rate of 5.3% for local currency (L/C) and 1.8% for foreign currency (F/C) are applied to convert 2009 price to 2010 price.

c/ Foreign exchange rate of 1170ID/US$ and 0.07JPYen/ID are applied.

d/ Scenario-0 (w/o pump) case excledes the pump station cost.

4-4. Minimum scale of the Project to be feasible (1/2)

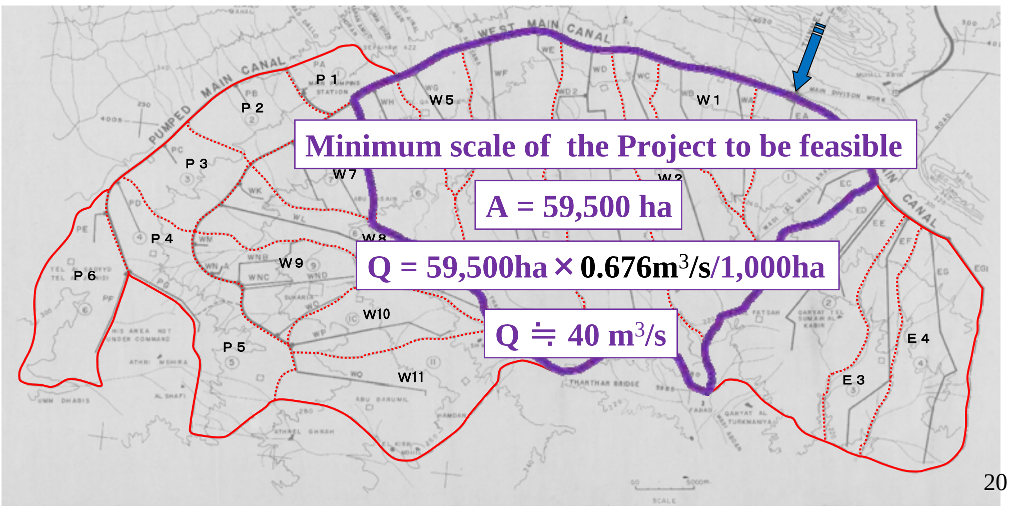


- Base Year : 2010
- Discount Rate : 6% (Policy Rate of the CBI)

Minimum scale of the Project to be feasible

Q = 40 m^3/s

4-4. Minimum scale of the Project to be feasible (2/2)



5. Conclusions

5-1. Decisions to be made on Project scale

Scenarios	Irrigation area (Net) ha	Intake discharge (m^3/s)	Annual water allocation (BCM)	Annual yield of wheat (ton)	Project cost (Billion ID)	FIRR
Scenario-0	148,600	100	1.39	312,000	2,587	6.3%
Scenario-1	119,000	80	1.11	245,000	2,000	6.4%
Scenario-2	86,800	60	0.83	182,000	1,482	6.0%
Scenario-3 Minimum scale	59,500	40	0.48	125,000	-	-

✓ Negative impact based on reduction of power generation is not considered in the calculation of EIRR.

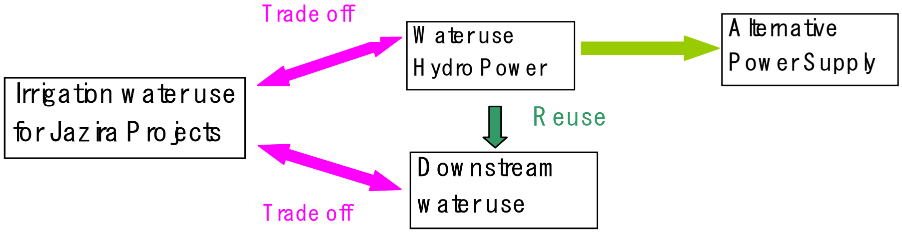
Decisions to be made on Project scale by the decision-makers of Iraqi government based on SWLRI.

6. Next steps

6-1. Issues on Water resources

When Inflow decrease by 10.1 BCM

- Need for Irrigation and Hydro-power : ⇒Trade off
- Hydro-power : re-use for the downstream area
- Impact : serious ⇒Alternative power supply
- Need for Jazira areas and the downstream water use ⇒Trade off



6-2. Towards the Project implementation

(1) Waiting for conclusion of the SWLRI

- SWLRI should indicate future inflow volume to the Mosul dam as well as necessary release volume to the downstream consisting of following demands In future;

1) *Agriculture (Irrigation),*
2) *Power generation,*
3) *Industry,*
4) *Drinking water, and*
5) *Conservation of marshlands located in southern Iraq.*

6-2. Towards the Project implementation

(2) Post-SWLRI

- It is expected that with having the conclusions by the SWLRI in near future, Iraqi government should finalize a strategic development scheme on the use of land and water resources aspects.

6-2. Towards the Project implementation

(3) Examination of annual water requirement based on daily basis meteorological data and soil survey data

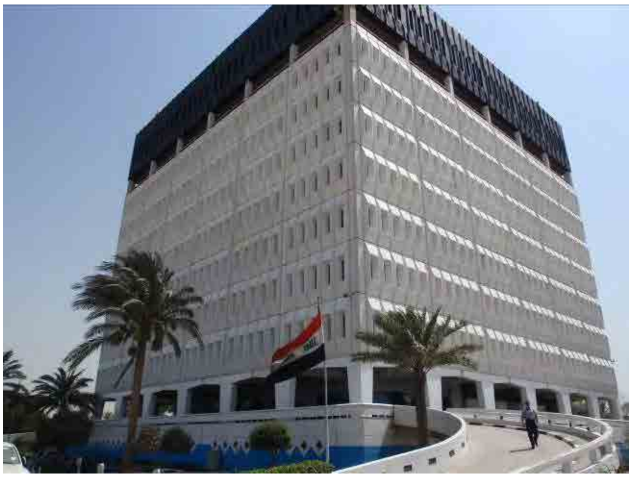
- *In order to estimate the most reliable water requirement, a pilot irrigation block shall be selected in the Project area,*
- *The observation of meteorological data in daily basis for the purpose of re-examination of annual irrigation water requirement be carried out in parallel with relevant soil survey (moisture content, etc.).*
- It may lead to possible **water saving**

6-2. Towards the Project implementation

(4) Capacity building for leaders for water management and organizing farmers in the pilot irrigation blocks before Project implementation

- *It is recommended one irrigation block shall be selected as a pilot area, then*
- *to experiment gypsum soil to be irrigated by sprinkler system,*
- *to strengthen the Project by establishing farmers organization as well as capacity building for extension services and water management,*
- *For this, the know-how learned from the preceding North Jazira Irrigation Project area shall be fully referred.*

Photos of the Study



Ministry of Water Resources, Baghdad

Prime Ministers Office Advisory Commission (PMAC), Baghdad

Meeting with PMAC, chaired by Mr. Ghadhban, in Baghdad on July 27, 2011

JICA and PMAC discussed result of the study in the PMAC meeting.

DFR Meeting at MOWR in Baghdad, July 25 and 26, 2011

DFR Meeting at MOWR in Baghdad, July 25 and 26, 2011

GIS survey was conducted in the South Jazira Irrigation Project Site, July 2010.

GIS survey in the South Jazira Irrigation Project Site.

Well survey was also carried out in the South Jazira Irrigation Project Site, July 2010.

Well survey in the South Jazira Irrigation Project Site.

Site identification of the well survey in the South Jazira Irrigation Project Site.

Water source for the sprinkler irrigation system, South Jazira Irrigation Site.

Irrigation canal, North Jazira Irrigation Project Area

Sprinkler system is introduced in North Jazira Irrigation Project Area

Intake part of the sprinkler system, North Jazira Irrigation Project Area

Intake gate on irrigation canal, Kurdish area

Sprinkler irrigation system, North Jazira Irrigation Project Area

Wheat and barley are the dominant crop in North Jazira Irrigation Project Area

Potato harvest by tractor, North Jazira Irrigation Project Area

Transportation of potato by tractor, North Jazira Irrigation Project Area

Transporting vegetables by pick-up track, Erbil wholesale market, August 10, 2010

Vegetables and fruits section in Erbil wholesale market, August 10, 2010

Private wholesalers in Erbil wholesale market, August 10, 2010

Country elevator for wheat, Northern area in Ninevah Governorate

1st PMT meeting was held in Erbil, July 1, 2010.

Participants discussed scope and goal of the study at the 1st PMT meeting.

Workshop style discussion was conducted at the 2nd PMT meeting.

2nd PMT meeting to share progress of the study was held at Erbil on July 29, 2010.

Mr. Ghanim (left), manager of PMT, at 3rd PMT meeting on August 9, 2010

3rd PMT meeting to share result of 1st field survey was held at Noble Hotel, Erbil on August 9, 2010

Mosul dam reservoir,
A view from spillway of the dam

Intake structure for Hydraulic Power Plant
at Mosul dam

Bypass shaft, starting point of feeder canal
at Mosul dam

Screen of the intake for the Suoth Jazira
Irrigation Project, Mosul dam

A view for the Mosul Hydraulic Power Plant
at Mosul dam

A view of Mosul dam downstream,
Tigris River

SUMMARY

1. INTRODUCTION

1.1 Background and Objectives of the Study

The Republic of Iraq (hereinafter referred to as "Iraq") has relatively rich water resources compared to other middle-eastern countries, however, the latest irrigation technique is yet to be introduced sufficiently, which leads to ineffective use of water resources. Since around 50 % of cultivable land in Iraq depends on rain water, the agricultural productivity is unstable, agricultural sector has a tendency of decline, contribution of this sector to national GDP was decreased drastically in these 20 years. This situation causes unstable food supply and decrease of job opportunities in rural areas.

A series of Feasibility Studies of the irrigation projects, namely, South Jazira, North Jazira and East Jazira Irrigation Projects was done in 1980s to introduce new irrigation system from the Tigris River for the purpose of agricultural production increase and socio-economic development. The North Jazira Irrigation Project was completed in 1991 and operation of Mosul dam providing water resource for those irrigation areas above was initiated in 1985. However, the project implementation in the South and the East Jazira Irrigation Area had been suspended due to the political and social turbulence.

The third (3rd) National Development Strategy (2007-2010) of Iraq was established on strengthening the foundations of economic growth by enhancement of sectors of oil and gas resource development, **improvement of agriculture** and mines, etc. that will govern strategic public actions for reconstruction and development, it emphasizes necessity to enhance agricultural sector. Improvement of agricultural technique, its extension and prompt infrastructure improvement including water resource development are essential for stable development of Iraq.

After the Iraqi War in 2003, the Government of Iraq (GOI) made a decision to restart the projects to strengthen the agricultural sector and food security. However, it is needed to review the F/S report in terms of safety and construction cost, which was prepared by Swiss Consultant around 20 years before, considering change of social conditions. Based on the request by the GOI, the Government of Japan (GOJ) decided to dispatch a Study Team to review the F/S report above and to propose an adequate irrigation plan in view of technique and economical efficiency taking into account change of water resource and advancement of irrigation technique, and security policy of dam (hereinafter referred to as "the Study").

The objectives of the South Jazira Irrigation Project (hereinafter referred to as "the Project") are 1)to promote agricultural production for the national food security, 2)to improve water use efficiency by introducing the latest irrigation technology and 3)to create job opportunities in the rural area, all in all to serve the prosperity of Iraqi people.

The Study on the Project covers the South Jazira Irrigation Area in Nineva Governorate and reviews the F/S report conducted by Swiss Consultants (hereinafter referred to as “the Swiss F/S”) taking consideration into proper water resource distribution of the Tigris River and agricultural sector development. Based on the analysis of available water resources and farming conditions in the Study Area, irrigation and agriculture development plan with high adequacy in terms of technique and economy is proposed.

1.2 Scope of the Study

Scope of the Study due to the reasons by late progress of 1)Delays of collecting deficit part of Swiss F/S, and 2)other data / information, 3)results of F/S review and 4)Progress status of “Strategy for Water and Land Resources in Iraq (SWLRI)”, scope of the Study were changed as follows;

Phase 1-A: Examination of relevance/validity of irrigation development in the South Jazira, review of the F/S, and preparation of draft scope of works for Phase 1-B.

Phase 1-B: Grasp of available water resources for South Jazira Irrigation Project by Scenarios, preparation of irrigated agriculture plans, analysis of project evaluation, and environmental and social consideration by Scenarios.

1.3 Outline of the Survey Result

1.3.1 Review of Swiss F/S Report

Since Swiss F/S had been started in end of 1970s, it was completed in 1984. Once its main report had been prepared in 1982 by tunnel plan (Alternative-1) for feeder canal, sequentially, pump plan (Alternative-2) was made as alternative in 1984. Result of comparative study, pump alternative was proposed in 1984. Furthermore, Tunnel plan has selected after reviewing in 1995. Followings are remarkable issues during comparative studies;

1) There was no Pump plan (Alternative-2) till 1982. Two(2) cropping patterns, namely, ABC and XYZ were examined on Tunnel plan (Alterbative-1). Annual water requirement for the both patterns were exceeded a possible annual water supply volume (1.275 BCM) which recommended by water balance study (originated from the Soviet report).
2) In 1984, a comparative study had made between Tunnel and Pump plans, but project cost and IRR had not calculated on Tunnel plan.
3) Main report which should describe “conclusion” was not prepared.
4) Though the Tunnel plan has been recommended during the review of the Swiss F/S done in 1995 without calculating IRR, irrigation areas for Tunnel and Pump plans of which were 104,000 ha and 140,630 ha respectively are quite difference for the comparative study.
5) Annual water requirement volume for both plans are exceeded 1.275 BCM.

Outline of results of the F/S reviews were explained to Project Management Team (PMT) with understanding of PMT during the 3rd PMT meeting held on August in 2010. Therefore, the Study Team propose the Irrigated Agriculture plan for this Study based on the Swiss F/S report in consideration with 1) There is no consistencies on comparative studies done among alternatives, 2)Results of analyzing annual water requirement are exceeded from the precondition, and Alternative plans are not examined under the same condition in the Swiss F/S.

1.3.2 Collected Important Data / Information during the Study

<Data-1> Soviet Report: Swiss F/S report bases "Soviet Report" which probably shows the result of detailed water balance calculation for limited annual water volume to be used from the Mosul dam.

Irrigation development plan in the F/S report was formulated using 1.275 BCM of annual water volume from the Mosul dam in the basis of Soviet report. It is very important for reviewing sustainability of irrigated agriculture plan shown in the F/S Report with examination of water balance. In the result of reviewing the Soviet report, however, any evidence was not found why 1.275 BCM had been used for the annual water volume for South Jazira Project from the said report.

<Data-2>Mosul Dam Safety Annual Report: Inflow / Outflow data, dam storage volume, water level, etc. of Mosul dam are recorded.

Base on Mosul dam actual operation such as 1)inflow volume from upstream to the Dam, 2)irrigation water for North Jazira, 3)water for power generator, 4)necessary discharge to downstream and etc. in latest 10 years, appropriate annual water volume for South Jazira Irrigation Project should be examined. And those data was collected and applied for the water balance study of the Mosul dam reservoir operation.

<Data-3>Information on International Water Treaty of Tigris River: Foreseeing inflow volume to the Mosul dam in the future

If inflow volume is limited due to the results of water treaty among counties related to the Tigris River, there is a possibility that implementation of South Jazira Irrigation Project would be faded away by reducing available water volume for the Project. It is very much difficult to collect this information which is probably sensitive on the international water treaty. Since proposed annual intake water volume (1.275 BCM) for the South Jazira Project is only about 10% of average annual inflow to the Mosul dam 19.43 BCM, the JICA Study Team proposed to analyze available water volume for the Project under the condition that the inflow volume in future would not much changed.

On other hand, MoWR consulted the JICA Study Team to use 10.1 BCM/year as an Indicator for inflow in future since SWLRI has not yet been concluded.

<Data-4>Indicator for Necessary Releasing (Outflow) Volume

Addition to the above Data-3, MoWR suggested providing an Indicator for necessary releasing volume to the southern part of Iraq from Mosul dam reservoir in consideration with future demands such as agriculture, water supply, power generation, and industry as well as marshland conservation. At the end, however, MoWR indicated that the necessary releasing volume is 200 m^3/s of which flow to secure water level of intake to supply drinking water in steady to Mosul city for analyzing available water resource of the South Jazira.

<Data-5>Information on construction schedule / methodology, tender document and etc. of Diaphragm Construction for Mosul dam

MoWR has not been positive to provide any information regarding on Mosul dam safety since the Study Team requested them. While view points of MoWR on both management and finance for grouting of Mosul dam foundation is excellent, there is no doubt to implement the diaphragm construction with engineering experiences of contractors which was selected under negotiation for the contract.

1.3.3 Numbers of Scenario for Irrigated Agriculture Plan

Even though MoWR has shown Indicators for both inflow and outflow of Mosul dam reservoir in future, recommendable inflow and outflow will be finalized by decision makers through the conclusion of SWLRI. Therefore, MoWR requested to the JICA Study Team to prepare plural numbers of Scenario. Due to a series of discussion between MoWR and JICA as well as the JICA Study Team, following scenarios shown in Table 1-5 are recommended to prepare the Irrigated Agriculture plan for each scenario. Outline design, cost estimate, drawings, etc. are prepared for Scenario-0, 1, 2 for Tunnel alternative and Senario-0 for Pump alternative. Scenario-3 of Tunnel alternative as minimum scale of the Project to be feasible will be examined only for water allocation of Mosul dam reservoir based on results of the project evaluation to be done for Scenario-0, 1 and 2.

Table. Planned intake discharge and irrigation area by Scenario

Alternatives	Scenario	Intake Volume	Beneficial Area	Irrigation Area (Gross)	Irrigation Area (Net)
1.Tunnel	Scenario-0	100 m^3/s	220,700 ha	196,400 ha	148,600 ha
	Scenario -1	80 m^3/s	179,900 ha	157,200 ha	119,000 ha
	Scenario -2	60 m^3/s	132,300 ha	114,800 ha	86,800 ha
	Scenario -3 (Tentative)	40 m^3/s	91,500 ha	78,700 ha	59,500 ha
2.Pump	Scenario -0	100 m^3/s	220,700 ha	196,400 ha	148,600 ha

Remarks: Intake volume and irrigation for Scenario-3 is tentative value at this Chapter. Values will be assumed by the results of project evaluation of 0 - 2. Final assumption will be shown in “11. Project Evaluation” of this Summary.

Table 1-6 shows consideration of area selected for each Scenario.

Table 1-6 Consideration of area selected for each Scenario

Scenarios	Consideration of area selected for each Scenario	Excluded Irrigation blocks
Scenario-0	Hole target of South Jazira Irrigation area	none
Scenario-1	To exclude pumped area located at western part of South Jazira from area of Scenario-0	P1, P2, P3, P4, P5, P6 were excluded from Scenario-0
Scenario-2	To exclude irrigation blocks located at western far from entrance point of the Feeder canal from Scenario-1	W7, W8, W9, W10, W11 were excluded from Scenario-1
Scenario-3	To exclude irrigation blocks located at eastern far from entrance point of the Feeder canal from Scenario-2	E2, E3, E4 were excluded from Scenario-2

1.3.4 Outline of Field Survey

Since it was hard to conduct field survey including questionnaire to the beneficiaries of the South Jazira by Japanese consultants due to the security restriction excepting Mosul dam, the Study team has been conducting them by using local consultants having questionnaire surveys to relevant agencies and farmers.

1.3.5 Technical Transfer during the Meetings

The JICA Study Team has given technical transfer through the several explanatory meetings of the reports such as ICR, PR, ITR, DFR, etc. where officials of MoWR, MoA, MoP as well as Project Management Team (PMT) of Ninewa province participated. In addition, the Team made opportunities to have discussion on review of Swiss F/S Report and methodology of calculation of irrigation water requirement and water balance study of Mosul dam reservoir with members of PMT, called PMT meetings of 4 times during the Survey.

2. CONFORMITY WITH NATIONAL PROGRAM OF IRAQ

2.1 National Development Plan (2010-2014) in Iraq

The National Development Plan (2010-2014, Source: Executive Summary of NDP, MoP) shows following general objectives within next five(5) years concerning Agriculture and Water Resources.

1) Increase in the gross domestic product (GDP) at a rate of 9.38% per year during the plan period.
2) Generate 3 to 4.5 million new jobs based on the proportion between capital concentration and work that will be used in activities and projects adopted by the Plan.
3) Diversify the Iraqi economy through achievement of gradual increases in the rate of participation by other sectors in GDP, particularly the production, agriculture, and industrial sectors, along with tourism, which is a sector with some accomplishments and promise. This role can be strengthened in the future both through generation of GDP and through the jobs it can generate.

4) Strengthen the role of the domestic and foreign private sectors, either in terms of the magnitude of investment anticipated within the country, estimated at about 46 percent, or in terms of job opportunities. The plan seeks to expand and diversify the activities that the private sector invests in, particularly comprehensive animal and vegetable production projects; fisheries.
5) Reduce poverty rates by 30 % from 2007 levels by focusing on comprehensive rural development and the creation of job opportunities, particularly for vulnerable groups such as youth and women, and focus on ensuring basic services, particularly educational and healthcare services, for rural areas and vulnerable groups.
6) Establish a spatial development trend characterized by fair distribution of infrastructure services and public services (water and sanitation, health, education, etc.) among all of Iraq's provinces in a manner consistent with their population size and the extent of their deprivation and need, with focus on rural areas and those urban areas that are the most deprived.
7) Establish sustainable development that balances economic, social, and environmental considerations so as to optimize use of available natural resources without undermining the right of future generations to benefit from those resources. Further to this, focus on keeping up with international developments in the areas of climate change and the use of environmentally friendly technologies.

And National Development Plan (2010-2014, Source: Chapter 5 of NDP, MoP) describes policy on agriculture and water resources development as below;

1) Reaching an agreement with the countries that share water from the Tigris and Euphrates and their tributaries (Turkey, Syria, and Iran) to do so according to international agreements and conventions to guarantee that Iraq obtains a quantitatively and qualitatively just share of water.
2) Complete the second stage of the water budget quickly (the strategic study of water and land resources) that the MoWR has undertaken for the various sectors that are beneficiaries and consumers.
3) Develop a central plan that specifies the share of water needed in all areas of arable land. Moreover, specify agricultural requirements such as machines, ratified seeds, and fertilizers. Agricultural staff should perform monitoring and evaluation to guarantee appropriate implementation hold rural inhabitants responsible for adhering to the MoWR.
4) Applying the principles of integrated management of water resources in coordination with all parties responsible for the ideal use of water resources and maintaining them.
5) Activating the projects of dams centrally.
6) Completing the connection of the main canals with the main outlet to rid rivers and canals from local pollution.
7) Supporting and expanding agricultural guidance, spreading the application of agricultural researchers, and expanding guidance projects so that users of water are aware of the importance of the wise use of water, ideally with the participation of the concerned ministries.
8) Strategically invest in underground water dedicating required sums to buy digging equipment and

holding the MoWR solely responsible for those resources.

9) Taking the limited water resources into consideration in the process of setting future agricultural policies by expanding the application of modern irrigation methods and encouraging the planting substitute crops that consume less water and can resist salinization and drought.
10) Building on the suggestions made by Turkey during water resource negotiations concerning the ideal and rational of water. This calls for focusing on the productivity, and it is necessary for the Ministry of Agriculture to take steps to qualify the capabilities of those who utilize the land.
11) Establishing an information bank in the field of managing water and irrigation to use in the processes of planning, managing the demand for water for different purposes, developing the apparatuses of measuring wastes and levels and methods of collecting hydrological and climate methods about the basins of the Tigris and Euphrates, and documenting them.
12) Continuing to maintain dams and reservoirs and solving problems related to the ideal operation of water resources; building new dams to store quantities of water in suitable areas, with priority given to implementing projects that have complete feasibility studies and available financing.
13) Establishing a national project that deals with studies on international climate change, its effects on the water that comes into Iraq, and the future living conditions in light of expected scarcity.
14) Directing research studies in the concerned ministries and universities toward finding the necessary methods and applications to increase the standard of irrigation.
15) Considering water an important economic resource and setting a suitable price for it to maintain this wealth.
16) Giving the maintenance of projects, irrigation networks, canals, and reclaimed lands top priority and returning to the method of managing and operating them by establishing independent authorized administrations.

2.2 A Water Resources Development Strategies (five-year Plan from 2010 to 2014)

A five-year Plan from 2010 to 2014 made by Ministry of Water Resources is summarized as follows;

1) The irrigated agricultural lands need more water than is available if all irrigation and reclamation projects are implemented. Therefore, the water availability is becoming a major limiting factor for agricultural production.
2) Water Resources Development Strategies should take into consideration the importance of improving water use, application of water saving technologies, implementing land reclamation projects, protecting the environment, constructing dams as required and maintaining and operating the infrastructures appropriately.
3) The Tigris and Euphrates Rivers are the main for water resources in Iraq. Most of their feeding sources are located outside the country.
4) The annual average inflow of the Euphrates River, up until 1989, was 27.40 BCM. However, from 1989 to 2005 the average annual flow at the Iraqi borders dropped to 17.4 BCM. Water inflows to the Tigris and Euphrates Rivers vary in accordance with climatic conditions and

nature of water year. They fluctuate between years of high, low and dry inflows, as below Table.

Table. Annual Average Flow in Tigris-Euphrates Rivers

Source: Water Resources Development Strategies (2010 to 2014), MoWR

Name of the River	Annual Average (BCM)	Wet Year(BCM)	Dry Year(BCM)
Tigris River & its Tributaries	49.48	95.68 (in 1969)	18.6 (in 1999)
Euphrates River	27.4 **(until 1989)** **17.4 (1989-2005)**	63.31 (in 1969)	9.56 (in 2001)

5) In the light of the available water resources development plans the current and expected annual flows in Iraqi rivers as shown in below Table. According to this table Tigris rivers inflow shall decrease drastically by upper-stream countries developments in the future.

Table. Inflow of Tigris-Euphrates Rivers after Development

Source: Water Resources Development Strategies (2010 to 2014), MoWR

River Name	The current status	The expected inflow after development
Euphrates River Average inflow in BCM	27.4 **(until 1989)** **17.4 (1989-2005)**	8.45
Tigris River Average inflow in BCM	19.43	9.16
Al-Khaboor (BCM)	2.10	2.10
Upper Zab (BCM)	14.23	14.00
Lower Zab (BCM)	7.07	7.00
Al Udhaim (BCM)	0.70	0.70
Diyala (BCM)	5.86	4.00

6) Currently the total reclaimed area in Iraq is about 4.1 million dunam (1.0 million ha [this figure is shown in WRDS (2010-2014)]). However 8.4 million dunam (2.1 million ha) is required to be reclaimed, the geographical distribution of which is as follows;
   - 0.8 million dunam (0.2 million ha) to complete Irrigation projects
   - 7.6 million dunam (1.9 million ha) on the Tigris and Euphrates basins to improve existing irrigation projects

7) Following Table is a list of reclamation project including existing as well as new projects for the years 2010 to 2014 in Nineva Governorate.

Table. Area to be developed from 2010 to 2014 in Nineva Governorate

Source: Water Resources Development Strategies (2010 to 2014), MoWR

Name of the Project/ Governorate	Net Area		Area reclaimed from 2010 to 2014		Reclaimed Area (10^3 dunam)				
Nineva Governorate	10^3 dunam	ha	10^3 dunam	Ha	2010	2011	2012	2013	2014
South Jazeera	416	104,000	250	62,500	40	40	50	60	60
Eastern Jazeera	215	53,750	190	47,500	30	40	40	40	40

(Remarks; According to the final report of the Preliminary Study for redefining The Southern Jazira Irrigation Project by Ryuichi Fukuhara, the gross of North Jazira irrigation project area is 60,000 ha, the planning Eastern Jazira irrigation project area is 75,000 ha and the South Jazira irrigation project is 190,000 ha (Gross). Then total gross irrigation area is 325,000 ha in the Jazira area.)

2.3 Present Status of Water Treaty in Tigris Basin

From the long-term perspective, the hydro political security complex of the Tigris and Euphrates River basins are the most critical factor to the water availability of Iraq. Some issues have been pointed out that the Tigris and Euphrates Rivers are complicated by politically and hydrologically and the need for cooperation among riparian countries to ensure the water security and to prevent potential water-related disputes.

2.3.1 Hydrological Environment in Iraq

The Tigris originates from a small mountain lake, south of the city of Elazig in eastern Turkey, and flows through the basaltic district of Diyarbakir. It forms the border between Turkey and Syria, and Iraq and Syria. Its two major tributaries are the Upper Zab and Lower Zab, which join the river downstream of Mosul. The contribution of the Tigris tributaries to the river’s potential is very significant and amounts to roughly 50% of the Tigris flow at Baghdad.

Iraq is at the utmost downstream of the Tigris and Euphrates River basins and more than 70% of Iraq's water resources originate in Turkey; 90% of the flow of the Euphrates in Iraq originates in Turkey and Syria; and 40% of the flow of the Tigris in Iraq originates in Turkey. Major storage and irrigation project development has occurred on the headwater areas in Turkey (the GAP project), Iran (Dez and Karun projects on the tributaries of the Tigris) and in Syria that has been expanding irrigated areas along the Euphrates.

2.3.2 Water Resources Development on the Tigris and Euphrates

At present, irrigated agriculture - the greatest user of water - is unequally developed in the three major riparian states. Iraq was the forerunner, who had already 0.5 million ha irrigated lands by the Euphrates in the beginning of the 20th century. Syria started in the 1960s, and intensified irrigation in the Upper Euphrates after the completion of the Tabqa Dam in the mid 1970s. Prior to the completion of the Ataturk Dam (1990), irrigation in south-east Turkey was limited to groundwater and extended to about 114,000 ha. A major threat to water resources, and to the riparian’s relations, is the envisaged enlargement of areas to be irrigated with water withdrawn from the Euphrates and the Tigris in all three countries: about 1.7 million ha in Turkey as part of the GAP project, 640,000 ha in Syria and 300,000 ha in Iraq.

After the completion of the Ataturk dam and Sanliurfa irrigation tunnels system, which are the major parts of the GAP Euphrates components, Turkey was ready to set for the major development of the Tigris, launching the construction of the Ilisu dam (with its maximum storage capacity of 10.4 BCM) in August 2006, and the Cizre dam is on the top of the waiting list. The Ilisu dam provokes the political and social controversies and attracted attentions, but the smaller Cizre dam would be hydrologically more problematic for the downstream as the Ilisu Dam is purely for the hydropower generations (1,200 MW) while the Cizre dam is for the irrigation covering 121,000 ha. For this additional irrigation, 4.3 BCM, 25% of the annual mean flow at Cizre, is planned to be diverted.

Until some years later, there will be surplus water in the Tigris and Euphrates rivers because the above-mentioned projects will take longer to implement than expected, and Iraqi water demand will not increase so rapidly due to the current situation. A shortage of water is imminent, though. This will oblige Iraq to transfer more surplus water from the Tigris to the Euphrates. Between 2020 and 2030, a water shortage on the Tigris and Euphrates will be looming along with the increasing demand in the riparian countries. In fact, an emergency is expected to take place already around 2020 because 4 BCM of water that will remain as surplus in the two rivers will not suffice for the drainage of the Tigris and Euphrates basin into the Gulf.

2.3.3 History and recent developments for water negotiations on the Tigris and Euphrates

Negotiations between Turkey and Iraq on the development of the Euphrates' water originally started in the 1940s, when the protocol annexed to the 1946 Treaty of Friendship and Good Neighborly Relations between Iraq and Turkey was agreed. The protocol provided the control and management of the Euphrates and the Tigris depending to a large extent on the regulations of flow in Turkish source areas.

The early 1990s were a turning point when Turkey started to fill the Ataturk dam on the Euphrates in January 1990 and downstream Syria and Iraq perceived the interruption of water flow entirely for a month. Then, tripartite negotiations came to an end. Iraq and Syria temporarily established the bilateral agreement in 1990 as follows.

The Iraq water share on the border region between Iraq and Syria is 58% as a fixed annual total percentage (water year) of the water Euphrates river allowed to pass in Syria through the border with Turkey, and the Syrian share of water is the remainder quantity 42% of the water of Euphrates river allowed to pass through the border between Turkey and Syria.

After the first Gulf war, the bilateral talk between Turkey and Syria resumed in 1998 when the political Adana Agreement was signed by the two parties. The agreement itself was controversial but the GAP administration contacted with the Syrian Ministry of Irrigation leading to a signature of a Joint Communiqué on August 2001 which fostered cooperation in areas such as training, technology exchange and conduct of joint projects. The document included provisions for training programs; joint projects such as a twin village project; joint irrigated agricultural research projects with twin research stations; exchange programs. It also intended to establish joint executive bodies, i.e. a Joint Technical Committee and a Steering Committee. However, until now such envisaged programs and initiatives have never materialized.

Restart of trilateral talks had to wait for the 2003 Iraq invasion. In the context of the Iraqi reconstruction by the international parties, UNESCO organized an informal trilateral meeting to facilitate the dialogues in November 2005, the first time in the last 15 years. In 2006, some joint training and meeting took place supported by UNESCO and other parties.

The first official tripartite meeting was held in March 2007 in Antalya, Turkey as a part of an international conference hosted by DSI. Two(2) month later, the Joint Technical Committee was officially resumed in Damascus with a participation of Director Generals from three parties to confirm they would meet regularly to discuss the water-related issues. The ministerial meeting was also promised in the meeting.

In light of the South Jazira Project, the Ilisu Dam had been raised during the JTC meetings; Turkey would guarantee the same amount of discharge to the downstream after the completion of the Ilisu Dam while the Cizre Dam has not appeared on the agenda as far as in the official minutes. Here is a pitfall; the Ilisu - Cizre Dam scheme is considered as one component in the GAP plan. As described in the previous subsection, the Cizre Dam projects to divert the 25% of the Tigris. Iraq should appeal the potential impact of the Cizre Dam during the trilateral talks in addition to the Ilisu Dam and the Euphrates.

Despite the efforts by the downstream countries toward adequate sharing of water resources on the Tigris and Euphrates over years, only two above-mentioned agreements (in bold) were bilaterally reached for the Euphrates. There is no basin-wide agreement, which means covering the Tigris, and no clause concerning the water quality. The impact of water resources development and management by the upstream countries is decisive to the water security of Iraq so that cooperation and information sharing for the basin-wide water resources management, in particular for the Tigris, is imperative for wise water use of the two rivers for the future, in particular for the sustainability of the South Jazira Project.

In 2008, Turkey, Iraq and Syria agreed to restart the Joint Trilateral Committee on water for the three(3) nations for better water resources management. Turkey, Iraq and Syria signed a memorandum of understanding on September 3rd, 2009, in order to strengthen communication within the Tigris-Euphrates Basin and to develop joint water-flow-monitoring stations. On September 19th, 2009, Turkey formally agreed to increase the flow of the Euphrates River to 450 to 500 cu. cms., but only until October 20th, 2009.

2.4 Food Issues

2.4.1 Self-sufficiency in Food

Even though wheat is the most important staple food for Iraqi peoples, consuming twice of the world average, Iraq is the world’s seventh-largest import country of wheat, according to USDA estimation in 2009. Iraq produces wheat around 300 thousand tons per year, on average between 1989 and 2000, but wheat consumption is 11 times larger than its production, resulting in only 9% of self-sufficiency rate of wheat.

On the other hand, self-sufficiency rate of barley is 72%, contributing to increase self-sufficiency rate of cereals. However, since consumption amount of barley itself is relatively smaller, self-sufficiency rate of cereals is still 20% in total. According to FAO/ GIEWS statistics, this rate has been increasing during the last decade, but still fluctuating around 30%.

It should be noted that the self-sufficiency rate of wheat might be underestimation, if we focus on the recent year's figures, since wheat production at national level is 1,255 thousand ton in 2007. In the same year, volume of import is 2,424 thousand. Even though we do not know the stock and other use of wheat in the year 2007, total consumption of wheat must be around 3,600 thousand ton, hence self-sufficient rate is estimated at around 35% in 2007. Anyway, both data indicated that production of wheat in Iraq is far below than the self-sufficiency level even in the last decade.

In spite of the above serious condition, all Iraqi peoples can access to these staples due to the nation-wide rationing system starting from 1991, after the economic sanction decided by the united nations. Since then, all Iraqi citizens can obtain, without charge, the same amount of basic foods, including wheat flour, rice and cooking oils.

In 2008 and 2009, serious drought took place in the study area, and farmers can not earn income from their crop production, according to the questionnaire survey organized by the Study Team in 2010. However, the rationing system works well to prevent farmers and Iraqi citizens from serious famine.

2.4.2 Nineva's Contribution to the National Food Consumption

Nineva governorate is the largest provider of wheat and barley in Iraq, and produces 15% and 28% of total wheat and barley production in 2007 respectively. In view of cultivated land of wheat and barley, Ninewa account for 30% of the total area for wheat and 58% of the country's total production area of barley.

However, yields of wheat and barley in Nineva are the lowest among all governorates since their agriculture is overly dependent on erratic rainfall, hence unstable agricultural production year by year. This fact indicates that current productivity of cereals in Nineva is quite low but having a room to increase its productivity through production enhancement including irrigation projects.

In 2010, Ministry of Trade purchases 1,825 thousand ton of wheat, equivalent to 983 billion ID, from farmers in the entire country, and Nineva is the largest wheat suppliers among 18 governorates, according to an announcement of the Ministry of Trade. The government's purchasing price in 2010 is estimated at 539 ID/ kg.

According to the crop plan in the original Swiss F/S, production volume of wheat at full development stage will be 356,900 t/year, which is equivalent to 20% of total production of wheat in 2010.

2.5 Validity of the Project in National Development Plan

In the above mentioned, as the targets in "National Development Plan (NDP)", "Water Resources Development Strategies (2010-2014)" and issues on food self-sufficiency are summarized below, the South Jazira Irrigation Project is verified to conform with national policy;

1) NDP focus on reducing poverty in the country with creating new jobs through agricultural development projects by supporting local government with improving necessary infrastructure.
2) "Policy on Water Resources Development in Iraq" states having consensus regarding water volume and quality with upper stream countries of Tigris-Euphrates rivers (Turkey, Syria, Iran) for the agriculture and water resources development by use of natural sources.
3) Also, "the Policy" mentions to save water by introducing modern irrigation techniques in consideration with limited water resources and to improve land productivity through technical transfer on the field of fertilizer application, agricultural machinery, pest control.
4) Iraq depends on import wheat which is staple food for the country. Rate of food self-sufficiency for grain including barley is only 30%.
5) Nineva governorate is the largest provider of wheat and barley in Iraq, and produces 15% and 28% of total wheat and barley production in 2007 respectively. However, land productivity of Nineva is much less than an average of the country which is only 50% of unit yield for wheat.

On the other hands, as shown in "2.3 Present Status of Water Treaty in Tigris Basin", followings are the some issues to complete the Study for the South Jazira Irrigation Project.

a) Since water treaty among countries is not making good progress particularly in Tigris, inflow volume to the Mosul dam will be possibly limited in the future.
b) Information concerning volume of discharge to the downstream of Tigris river is not yet clear, which will be possibly affected to the marsh of Southern Iraq in terms of natural environment.

3. CONDITIONS OF THE STUDY AREA

3.1 Natural Conditions

3.1.1 Climate

The Climate of Iraq has been classified as continental. However, it is modified by the presence of the Arabian Gulf and especially the Mediterranean Sea, making it in the northern part of the country resembles the Mediterranean type during the winter.

The summer months, from June to September, are completely dry with extremely high temperatures and very low relative humidity. In October and November, temperature drop and showers occur with increasing frequency. Lowest air temperatures are reached from December to February, with minimum temperatures occasionally below zero. About 80% of the rainfall is distributed fairly evenly over the period from December to April. From March to May, rainfall is again of the more showery type and sometimes accompanied by thunder and even hail. And during May, rainfall ceases completely and temperature rise quickly.

The meteorological data of Mosul, Tel Afar, Sinjar, Baghdad and other available stations relevant to the Project area for the recent 20 years from 1990 – 2009 were collected from Ministry of Transport

(MoT), which observes weather and manage meteorological data, through MoWR

3.1.2 Tendency of Temperature Fluctuation

Monthly mean temperature of the latest collected data (1982 - 2009) is a little higher than the data of Swiss F/S study (1969 - 1980).

3.1.3 Trend of Precipitation Fluctuation

According to comparison of the monthly mean rainfall at Telafar station between Swiss F/S study data (1969 - 1980) and the latest collected data (1982 - 2009). Amount of total annual rainfall is 212 mm by latest collected data, which is 65 % of 328 mm by the Swiss F/S data. This shows the amount of rainfall is on a declining trend in recent years.

3.1.4 Hydrology

(1) Surface runoff in the Project area

During the Swiss F/S in late 1979 to early 1980, stream flow gauging was initiated at 3 sites in the Project area. In December 1980, water level reading started at a four(4) sites. Monthly specific discharge for three(3) stations are shown in below Table.

Table. Monthly Specific Discharge in l/s/km^2 **(Source: Swiss F/S Report)**

Gauge	1980						1981		
	Jan	Feb	Mar	Apr	Dec	Year	Jan	Feb	Mar
Tel Abda	0.03	2.0	0.64	0.88	0.64	3.55	0.49	0.58	0.5
Shwa	N.A	N.A	1.2	N.A	0.31	1.51	0.25	0.45	N.A
Tel Hassar	N.A	N.A	2.0	N.A	0.36	2.36	0.46	0.09	0.06

The annual runoff height of each station can be 11mm of Tel Abda, 4 mm of Shwa and 6 mm of Tel Hassar by calculating from the annual discharge in 1980. These figures which mean runoff discharge in the Project area are very small and surface water can not be competent water resource. Any recent observation relating to the surface runoff in the Project area can not be found.

3.1.5 Topography and Geology

The ground of the project area is gently sloping to the south. The feeder canal alignment runs in the area where hills and low relief valleys repeatedly distributes.

Most of the project area belongs to the Wadi Tharthar watershed, whereas the south west part does to the Euphrates river watershed. There are no perennial streams. All water courses are wadi.

Villages and settlements are scattered in the Project area. Some of them have no or few residents at present. Systematic agricultural roads develop and regular configurations of farmlands surrounded by the roads distribute. Some parts of the roads and farmlands are created on buried wadi. There are typical geometric patterns in the agricultural field of the Project area.

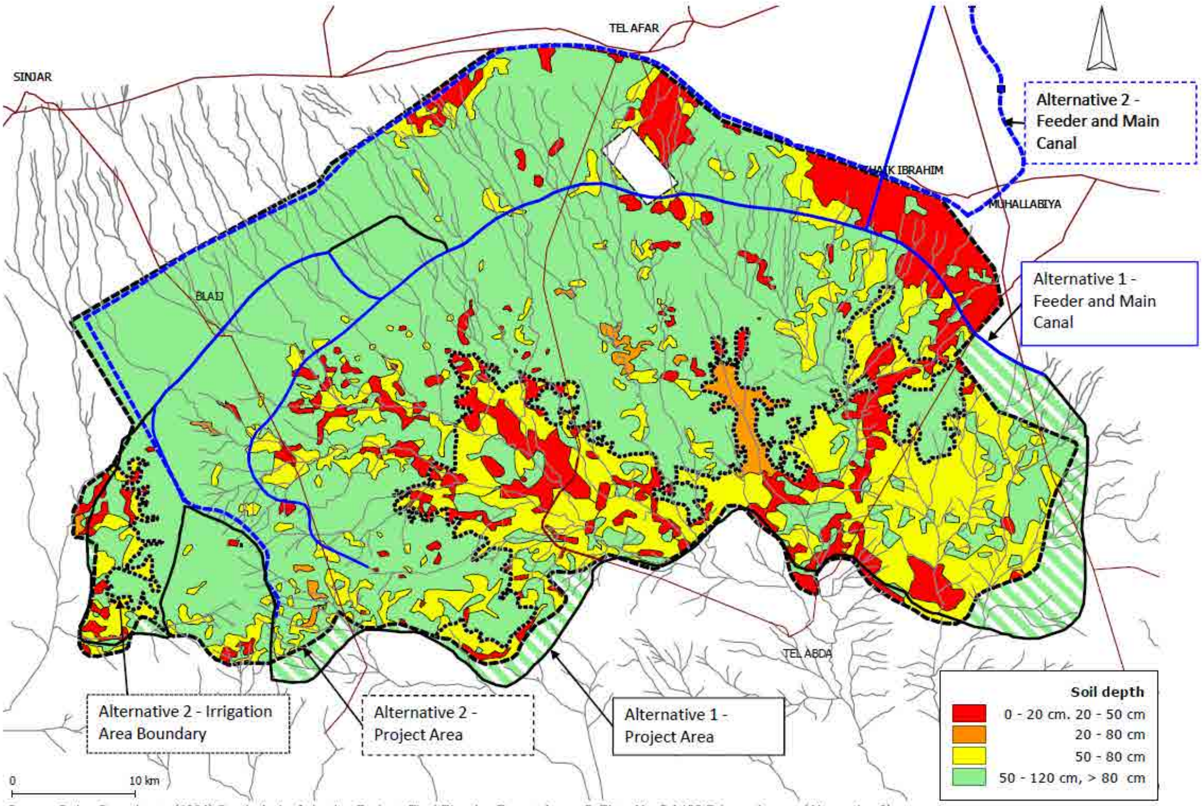
Center pivot and Lateral move sprinkler irrigation farms are slightly identified in and around the project area. Lateral move sprinkler is also found.

In the Project Area, it is reported that there are almost no outcrops. Gypsiferous overburden covers most ground. Claystone, sandstone and marl of Upper Fars Formation mainly underlie the overburden. In the alignment, Marls, gypsum and limestone of Lower Fars Formation of Miocene Age mainly underlies. This formation also constitutes the foundation of Mosul dam.

The result of drilling investigation for the Sheik Ibrahim Tunnel shows that the rock rating based on the RMR system (Rock Mass Rating system by Bienawski, 1976) counts 40 to 62, meaning “fair” to “good” rock and requiring medium or light steel support except near portals if the conventional tunneling method is used. Bitumen was found in the joints of drilled core and caring against petro-gas may be required in tunnel construction.

3.1.6 Soil

In the Project area, gypsiferous soil mainly underlies. Stony soils are found in the gently sloping foot of mountains. In the Swiss F/S, the project area is mainly determined based on soil depth map which was made by the semi-detailed survey of the State Organization for Soil and Land Reclamation (SOSLR). Following Fig. shows a soil depth map traced from “Plate 5.4.100 Primary Layout of Alternative 2”. The original “soil depth map SOSLR” is unavailable because of missing.



Source: Swiss Consultants (1984) South Jazira Irrigation Project, Final Planning Report Annex 5, Plate No. 5.4.100 Primary Layout (Alternative 2)
Dijla Center for Studies & Designs of Irrigation Projects (1990) South Jazira Irrigation Project, General Layout

Fig. Soil Depth Map in the Project Area

3.2 Socio-economical Conditions

3.2.1 Population

It was 1997 that the last nationwide population census was conducted in Iraq, and population in Nineva governorate was around 2,043,000 at that time, 9% of the total population. Based on this figure, the population of the Nineva governorate in 2007 is estimated at 2,811,000 with even break gender distribution. According to the estimates, 39% of the population is living in rural area, whereas the rests are residents in urban area.

Table. Population in Nineva Governorate and Iraq

	Population	Male	Female	Rural		Urban	
				Population	(%)	Population	(%)
Iraq	29,682,081	(50%)	(50%)	9,929,248	(33%)	19,752,833	(67%)
Ninevah	2,811,091	(50%)	(50%)	1,104,435	(39%)	1,706,656	(61%)

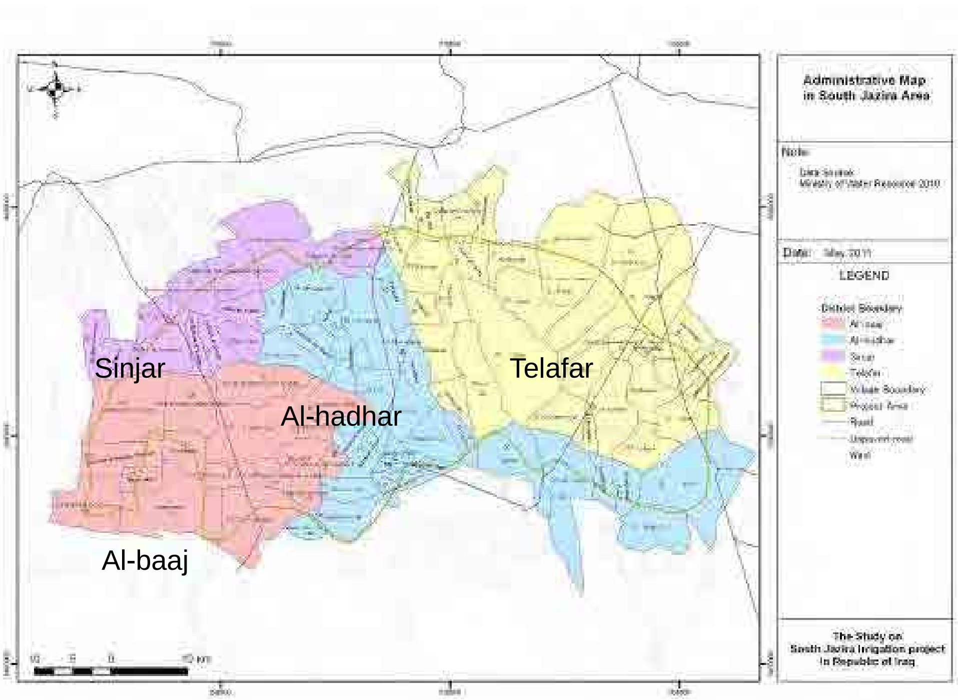
According to following Table, Mosul has the largest population, estimated at 1,720,000, followed by Telafar, Sinjar and Al-baaj and Al-hadhar among four districts related to the study area. Mosul and Telafar are relatively urbanized district, whereas majority of population in Sinjar and Al-baaj are living in rural area.

Table. Population by District in Nineva Governorate (2008)

	District	population	Number of Household	Per Household
1.	Mosul	1,719,860	322,295	5.3
2.	Al-hamdaniah	132,297	24,322	5.4
3.	Tallkif	133,465	22,834	5.8
4.	Al-shikhan	45,809	7,573	6.0
5.	Makhmour	113,109	19,438	5.8
6.	Telafar	372,366	61,208	6.1
7.	Sinjar	241,334	34,475	7.0
8.	Al-hadhar	65,540	8,909	7.4
9.	Al-baaj	145,634	19,892	7.3
	Total (Ninevah)	2,969,414	520,946	5.7

Source：Population Statistics based on Food coupon in 2008, Nivevah governorate, MoWR

According to the statistical data provided by PMT, Project area is covered by four(4) districts (Telafar, Sinjar, Al-hadhar, and Al-baaj) and 90 villages with 107,215 people.



Source: Project Management Office (PMT)

Fig. Boundary of 4districs and Villages in the Project Area

Irrigation area and number of beneficiary are different from each scenario as shown in below Table, because the available amount of water resources in South Jazira has not been fixed yet.

Table. Beneficial Area and Population by Scenarios

Scenario	Scenario-0		Scenario -1		Scenario -2		Scenario -3 (provisional)	
Village	Irrigation Area (ha)	Beneficiary	Irrigation Area (ha)	Beneficiary	Irrigation Area (ha)	Beneficiary	Irrigation Area (ha)	Beneficiary
1.Telafar	73,600	39,410	73,600	39,420	73,700	39,410	47,700	29,040
2.Sinjar	19,000	8,290	4,900	1,990	2,300	770	2,300	770
3.Al-hadhar	55,200	13,630	54,300	13,460	38,600	9,160	28,500	6,680
4.Al-baaj	48,600	9,770	24,400	4,510	200	70	200	70
Total	196,400	71,100	157,200	59,380	114,800	49,410	78,700	36,560

Remark: 1) Irrigation Area is identified in the soil depth of more than 50 cm, however, the number of beneficiary includes the area of more and less than 50 cm of soil depth.

2) The value of scenario-3 is provisional and it will be determined after the Project evaluation of scenario 0 to 2 will be calculated.

3.2.2 Land Distribution

According to the Baseline Farming Systems Survey, conducted by ICARDA-Iraq-Australia Project in 2005, three types of land tenure are observed in the Ninevah governorate; 1) privately owned land, 2) rented land from government or individuals, and 3) share-cropped land. The survey divides the governorate into 4 agro-ecological/ rainfall zones, namelly HRA (high raifall area, >450mm/year), MRA (moderate rainfall area, 350-450 mm/year), LRA (limited rainfall area, 200-350 mm/year), and SI (supplimentary irrigation system). The South Jazira is included in the LRA, while East and North Jazira are included in the MRA.

According to the survey result, the privately owned land is dominant type of land tenure in the

HRA and SI, whereas the share-cropped land is the most important type in the MRA. In the LRA, the rented land is the most important land tenure type, accounting for 50%, followed by the share-cropped land (32%) and the privately owned land (18%).

There is an interesting tendency in land holding size from north to south in the governorate. The land holding size in the southern part is larger than that in the northern part, reflecting availability of rainfall. Current land distribution status in the study area is now requested to the Nineva Governorate through Ministry of water resource.

3.2.3 Poverty

Poverty line in Iraq is estimated at 76,896 ID (about US$ 66) per person per month, or US$ 2.2 /person/day, according to a survey result conducted by Ministry of Planning and Development Cooperation, released on 21st of May, 2009. The survey indicated that the poverty headcount ratio, percentage of population below the national poverty line, is 20-25% on average in Iraq. The ratio is higher in rural area than urban area, and higher in the Southern region than the Northern region. However, it is said that actual rates must be higher than the survey result, since the state-run food rationing program strongly supports poor people in Iraq. The current food distribution system was started on 1995, and has provided food coupon to all Iraqi to assist their basic commodity consumption.

In 2003, median of household income in the Nineva governorate is 1,998,000 ID/year, which is 10% lower than that of the national average. According to WFP/ VAM data (2007), the poorest quintile earns 22% of income at entire Iraq level, whereas the poorest quintile in Ninevah governorate earns only 4% of income, indicating larger income disparity and existence of relatively higher income earners in Nineva governorate than the national level.

However, income level of peoples in the study area seems quite low. Among four districts related to the study, the lowest per capita income quintile of Talafar is the highest (57%) comparing to other districts (22-27%). The lowest per capita expenditure quintile also indicates same tendency, and the figure in Talafar district is the highest among the related four districts.

3.2.4 Gender

Illiteracy rate of women (30%) is higher than that of men (12%) in Ninevah governorate, and both figures are higher than the National average. Among four districts, female illiteracy rate is quite high in Sinjar (57%), followed by Talafar (32%), Al-Baaj (30%), and Mosul (24%).

The reason for the higher illiteracy rate in Sinjar is conceivably related to the low educational level of women in this district. According to the WFP statistics, percentage of women (more than 10 years old) with less than primary education in Sinjar is the highest (72%), followed by Talafar (66%), Al-Baaj (53%), and Mosul (52%). For male, 41% receives less than primary education, which is lower than the figure of women (58%), but higher than the all Iraq level (31%).

Regarding economic activity, women in Nineva is less participated in, comparing to the whole country level. Among four districts, the rate of women's labor participation is the lowest in Al-baaj, which is located in the most remote area from the governorate capital, Mosul city. Male's unemployment rate in the governorate is 13% in 2007, almost same to the national average, whereas women's rate is 35%, 2.7 times higher than the male's.

Male farmers take major role in farming activities in the Ninevah governorate. According to the Baseline Farming Systems Survey in 2005, 84% of farm activities are conducted by male, whereas female and children contribute 12% and 4% of the activities respectively.

3.3 Infrastructure

Water availability is still serious problem in the entire Iraq. Around one fourth of households in Ninevah governorate are not connected to the water network, according to the WFP statistic in 2007. The rate is exactly same to the national average, but regional disparity in the governorate is quite large. In the governorate capital of Mosul, for example, almost all households (93%) are connected to the water network, while the network coverage rate is 0% in Al-Baaj and 17% in Sinjar district. In Al-Baaj and Sinjar district, 65% and 72% of households respectively take domestic water from stream, well, and/or water tanker.

According to the questioner survey in the North Jazira area and the South Jazira area, conducted by the JICA Study Team in July 2010, all farmers in the North (6) use well for drinking water, whereas farmers in the South (12) buy drinking water from water tank truck. A water quality test in the South Jazira, conducted by the Study Team, indicated that the water from well in the South is not suitable for drinking and irrigation due to salinity problem.

Unstable electricity supply is also quite serious in Iraq. According to WFP/ VAM statistic in 2007, 52% of households suffer from long-time (more than 11 hours) power cut or no connection to the electricity network at whole country level, whereas around 30% of households in Nineva governorate meet the same problem. Among four districts related to the South Jazira study area, 100% of households in Sinjar and Al-baaj face the long-time power cut or no network connection, while only 26% and 50% of households in Telafer and Mosul meet the same problem.

To cope with the frequent failure in power supply, 43% of households in Nineva ready up alternative source of electricity such as diesel generator. As for districts in the study area, 90% of households do not have alternative source of electricity, followed by 49% in Sinjar and 37% in Al-baaj district.

Even though sanitary condition has been improving after the war, 26% of households in the Nineva governorate still use inadequate method including hole or nothing for the sanitation purpose. This figure is more than three times higher than that of national average. In Mosul, nobody uses such way of sanitation, whereas 12% and 10% of households still use the unsanitary way in the related four districts.

As for chronic malnutrition, urban populations are relatively in a good condition comparing with rural residents. According to the WFP/ VAM statistics, 30% of individuals suffer in Nineva governorate, but around 50% of individuals have the problem in Sinjar and Talafar district, followed by 42% in Al-baaj.

3.4 Information on Availability of Water Resources

3.4.1 Outlines of Jazira (North, East and South) Irrigation Project

Currently the agricultural production in the North of Iraq is vulnerable and impacts for the national food security as a whole. The South Jazira Irrigation Project has been planned also in this regard, located to the southwest of Mosul city in Nineva Government extending from the Sinjar Mountain at the northern tip of Wadi Tharthar on the right bank of Tigris River within Telafar district. It is the biggest part among the three components of Jazira Irrigation Project attached to the Mosul Dam Development Project planned during 1970s namely; the North (completed), East (under construction) and South Jazira Irrigation Projects. The water allocations for all of three (3) projects are depended on the reservoir of the Mosul Dam shown in following Table.

Table. Outlines of Jazira Irrigation Scheme of the Mosul Dam Project

	Total irrigated area (ha)	Length of Feeder canal (km)	Max water intake (m^3/s)	Main crops	Status
North	60,000	60	30 (planned to increase up to 45)	Wheat, Barley, tomato, potato and others	Completed in 1985-1991
East	75,000	82.1	60	Wheat, Barley tomato, potato and others	Under Construction
South	190,000 (gross) 104,000 (net)	60.3	125	Wheat, Barley, tomato, potato and others	Planned

3.4.2 Water Demand in the Downstream of Mosul Dam

As mentioned the Descriptions relating to project operation and water management in "Sadam Dam O&M Manual (1989) Final Report and As-built Drawings Vol. 1 by Swiss Consultants", a continuous minimum irrigation discharge of 330 m^3/s into Tigris River to the downstream of the Mosul dam should be desired. This means annual outflow rate downstream can be more than 10.4 BCM (= 330 m^3/sec ×86,400 sec ×365 days), since in winter season the outflow may be less and in summer season it may be more outflow than the minimum discharge of 330 m^3/s. This annual reservoir outflow is equivalent to approximately half of the annual flow into the Mosul Dam.

However, it is not found that the value came from where and how much intake rates for the North and the East Jazira Irrigation Project Areas was considered.

This figure comes from only the convenience of reservoir operation without considering the conditions of the downstream area of the dam. Essentially the responsible outflows downstream should be determined after considering the demands downstream of the dam.

Swiss F/S report might not include the Water Balance Study. It has done concurrently by Soviet at the same time of the F/S. MoWR provided limited portions of the report which Soviet had made as General Scheme of Water Resources and Land Development in Iraq, Stage II (Moscow-Baghdad 1982) to the JICA Study Team.

3.4.3 Availability of surface water in the South Jazira project area

According to the Swiss F/S, it can be seen that with respect to the salinity hazard, the surface water samples can all be classified in the classes “high” to “very high” salinity hazard whereas with respect to the sodium hazard, they belong mostly to the classes “low” to “medium” except for the samples taken at Shwa and Hatra which even belong to the “very high” salinity hazard. The high salinity hazard is mainly due to the calcium-sulphate (CaSO4) component in the water samples. However, at Shwa, the water of Wadi Tharthar appears to be sodium-rich throughout the year.

Thus, this surface water from the project area itself could only be used occasionally and under very special circumstances for irrigation purposes. Only plants with good to high salt tolerance and definitely no sodium sensitive crops may be cultivated. Furthermore, a good drainage of the soils is of utmost importance and excess water should be provided for leaching.

According to Swiss F/S, Al Sawaf estimates the surface runoff as 15% of precipitation, whereas other researcher assumed in Hatra Dam Study, a mean annual runoff volume of 86 MCM at Hatra Dam Site in al-Jazira region, which equals a runoff height of 17mm/year or about 5% of the precipitation. These figures as runoff coefficient are small.

As a conclusion from aforesaid, it can be stated that the storage of surface water for irrigation could only significantly contribute to a better water supply of the project area and is, therefore, not recommended.

3.4.4 Availability of Groundwater in South Jazira Area

Electric conductivity 3,000 micro-S/cm is a guideline to judge if the water is available for irrigation. If the value exceeds it, crop production may reduce. Considering this, most groundwater in the project area is not suitable for irrigation.

If we use groundwater for a large irrigation project, the water must be supplied sustainably. The recharge source of the groundwater in the area is rainfall in the project area and in the northern adjacent area. The groundwater recharge in the project area is roughly calculated as follows:

Average annual rainfall	330mm
Average annual groundwater recharge rate	10%

(The values from the F/S Report Annex 3 Hydrology; considered to be reasonable)

Then,

Average annual groundwater water height	33mm
Average daily groundwater recharge per km^2	

30mm/ 1000mm/m /365days x 1000000m^2/km^2 = 90m^3/day/km^2

Average daily groundwater recharge per the project area

82m^3/day/km^2 x 2,200 km^2 (gross project area) = 198,000 m3/d

= approx. 2.3 m^3/s

The groundwater recharge is too small to compare with the maximum water requirement of the Project, 125m^3/s. Even if considering groundwater recharge in the upstream area of the Project area, it must be far from the requirement.

From water quality and groundwater recharge points of view, groundwater cannot be a main source.

3.5 Information on Agricultural Activities

3.5.1 Land Use

Rural area looks dominant and urban area is only 11%. On the other hand, because average farm land area which one farmer possesses is 15.9 ha/farm, most farmer in Project area operate his large-sized farms.

Major crops are wheat and barley with rain-fed. Most farmers own livestock and they feed their livestock with residues of agricultural product, such as leaf and stem. Farmers hire agricultural labors to continue relatively large scale extensive farming. As it says, portion of farmers (99%) is dominant.

As land owaner ship, Individual farmers shares 89% of farmland in 4 districts within the Project area. Average possessed area of agricultural agent is 26 ha (104.8 donum). It is the largest average. The second position is individual farmer with 15 ha (61.9 donum). The third position is farmers' group with 11 ha (44.7 donum).

3.5.2 Main Crops

Main crops in the Project area are wheat and barley. Unit yield and cultivated area, which are found by farm survey.

Total crop yield of wheat and barley in South Jazira area in 2008 and 2009 were 0, and the average yield in 2010 is 800kg/ha (200 kg/donum) in South Jazira area. It is below 30% of average yield in North Jazira area. Crop yield in South Jazira area is nothing or very little so that crop yield without irrigation project is considered as nothing in F/S report. With regard to satellite images, a few irrigation facilities, such as center pivot or lateral type sprinkler, have a place in the Project area. It is presumed that they are supplemental irrigation system in winter season.

Most popular crop in four(4) districts within the Project area is cereal which includes wheat and barley. It is considered that wheat is as principal food and barley is as feed crop for live stock. Each district has characteristic feature in planting area for each crop.

In Mosul district onions, beans, vegetables and feeder crops are popular while oil production crops are not major. Onions and oil production crops are popular in Sinjar district. On the other hand, vegetables and oil production crops are popular in Telafar district. Al-baaj district concentrates on cereal planting.

As for number of livestock and owners in 4 districts within the Project area. Sheep holds first rank in the number. Goat holds second rank and cow holds third rank. However, the rank of cow and goat in Mosul district has reverse trend. It is thought that considerable amounts of consumption of dairy products in Mosul city affect the number of livestock in Mosul district.

3.5.3 Cropping Pattern

According to farm survey (listening from farmers), cropping pattern in Project area is as follows. Rain-fed wheat and barley are planted once in winter season. Although all works depend upon the weather, usually seeding period is from late October to late April, and harvesting period is from early May to middle of June.

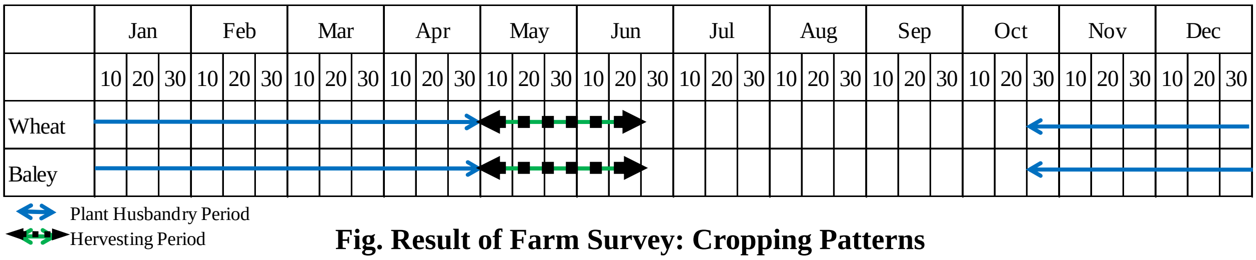


Fig. Result of Farm Survey: Cropping Patterns

Grazing by residues starts after harvest and ends before sowing time in the next year. According to the result of farm survey, this cropping and grazing pattern has been most popular pattern in the Project area for long time. It is considered that there has been no change since F/S enforced.

3.5.4 Cultivation Area of Irrigated and Rainfed Lands

According to F/S report (1982), the Project area is 213,900 ha and is classified as rain-fed cultivation area. Farmers who were interviewed by farm survey did not have irrigation facilities. Because it is difficult to find suitable water resource for irrigation in Project area, classification by F/S report is adequate. However, some farmers may apply irrigation facilities because satellite images of the Project area show trace of irrigation.

Cultivation area of main crops by irrigation or rain-fed in 4 districts within the Project area is limited within 1 %.

3.5.5 Availability of Agricultural Machinery

According to farm survey, most farmers use agricultural machinery for plowing and harrowing of topsoil, fertilizer and pesticide application, harvesting, and conveyance. Because average farm area is large, it is supposed that tractor, plow, rotary, speed sprayer, combine, and track are used. Specifications of these machineries are not clear.

3.6 Present Condition of Mosul Dam

The reservoir water of Mosul Dam is the main source for South Jazira Irrigation Project. The water must be supplied to the project area sustainably with a required amount. Ordinarily stability of water source is checked about the amount. In case of the Mosul Dam reservoir, however, not only amount of water but also stability of the dam itself is a great concern, while the dam foundation has a special type of geology a part of which resolves into water.

3.6.1 Outline of Mosul Dam

Mosul Dam is located on the Tigris River 50 km northwest of Mosul city with purpose of construction of the dam is mainly for flood control, irrigation and power generation. The main structures of Mosul dam and their features are as shown in below Table and Fig. The Mosul Dam reservoir has a huge capacity with 11.1 BCM at normal operation level. It is ranked as the fourth largest dam in the Middle East, measured by reserve capacity. It is constructed in 1981 to 1986 by the group of German-Italian companies with the design by Swiss Consultants consortium. The main supervisor is the Swiss group and the daily supervision was done by Swiss and Yugoslav companies.

Table. Main data of Mosul Dam

Item		Data	Item		Data
Dam	Height	113m	Reservoir	Maximum storage	13.1 BCM
	Type	Rockfill dam		Normal storage	11.1 BCM
	Crest length	3,600m		Dead storage	2.95 BCM
	Crest width	10m		Maximum Level	EL338.0m
	Crest level	EL341 m		Normal operation level	EL330.0m
Service Spillway	Max. discharge	12,600m^3/sec		Minimum operation level	EL300.0m
	Type	5 radial gates	Power facility	Generator capacity	187.5MW×4
Emergency Spillway	Max. discharge	4,000m^3/sec		Annual power production	2,420 Gwh
	Crest length	400m		Intake	7.0m×10.5m× 4 gates
Bottom Outlet	Max. discharge	2,440 m3/s	Jazira intake	Max. discharge	170 m3/s

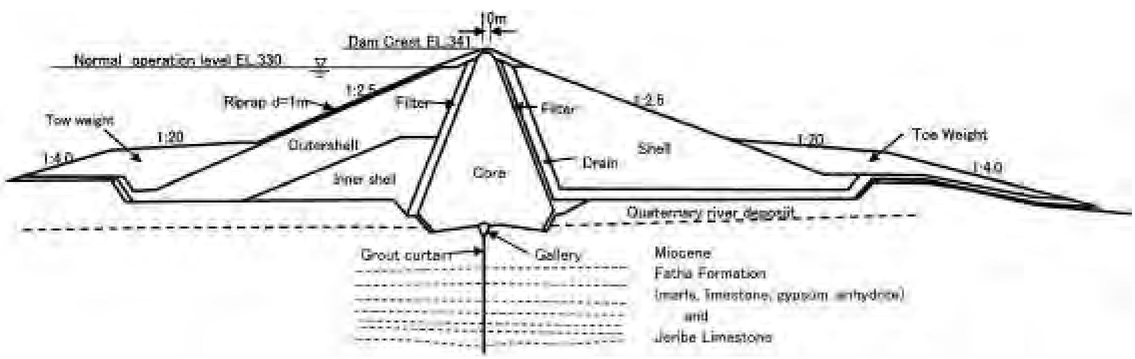


Fig. Schematic Section of Mosul Dam

Mosul Dam is constructed on Tigris River which runs between a tableland on the left bank and a hill on the right bank. The table land has gently undulated ground with 320 to 350 m in elevation. The hill on the right bank spreads west and north with top elevation of around 580 m. Tigris River has its bed on approximately 250m in elevation.

As for Overburden, Pleistocene terrace deposits distribute at different elevations along the Tigris River. They mainly consist of sandy gravel and cemented conglomerate. The lower terraces along the river course are underlain mainly by sandy silt. The existing river channel is filled by loose sand and gravel. At the main dam site, the sandy silt covers the conglomerate.

Among the sediments, the sandy silt was used for core material. The sand, gravel and conglomerate were used for coarse materials for dam and/or concrete aggregate.

The bedrock comprises well-bedded layers mainly of marl, limestone and anhydrite/Gypsum, which belong to ***Lower Fars Group*** of lower to middle Miocene and ***Jeribe - Euphrates Limestone Formation*** of Oligocene to lower Miocene.

For Geologic Structure, the right abutment is an axial part of the Dair Melah anticline (or Butmah anticline) plunging east, that is, to the left bank. Therefore, the layers dip gently to the left along the dam axis, and also they dip to the both sides of dam, to the upstream in the upstream area and to the downstream in the downstream area in general.

In the left abutment, layers dip slightly downstream or lie flat. The Jebel Taira anticline runs NEE –SWW direction off 3 km southeast of the main dam. The spillway and the saddle dam are located in a flat topographic area between the two anticline hills.

Karstification is a process of change of rock mass by dissolution of soluble rocks into water to produce hollows, caves or caverns which are often connected and form characteristic “karst” topography like a series of sinkholes (dorines). In and around the dam site, karstification develops in all area. The boundary between fresh rock mass and karstified one is called the “***Karst Line***”. Depth of the karst line ranges down to 40m to 150m from the ground surface as shown in Appendix B Fig. B-6. It is located especially deep in the right bank. Main soluble rock is reported to be gypsum/ anhydrite, but most formations suffer from karstification. Especially, ***F-bed*** limestone is highly karstified.

Permeability of rock is clearly different in lower and upper sides of the karst line. Above it, Lugeon value is high and it is permeable, whereas, below it, the most of voids are cemented with gypsum/anhydrite and it is impermeable. F-bed limestone, other vuggy limestones and breccia of gypsum layer show high permeability.

After impoundment of reservoir, sinkholes have appeared on ground. Most underground spaces of all sinkholes are considered to be created geo-historically before the impoundment. It is concluded that the right bank sinkholes appeared with induction by water level fluctuation of the downstream regulatory reservoir based on water level measurement in the sinkhole. The left bank ones are believed to have appeared due to progress of underground dissolution and erosion with increased groundwater flow from the main reservoir.

It is reported that among them, seepages at two points on the right bank, RSS1 and RSS2 are not connected to the main reservoir. The three seepages located around downstream of spillway fluctuate with the main reservoir level, so that the water must comes from the reservoir. The water may come mainly through the heavily-karstified F-bed limestone. Seepage through the foundation of the main dam may issue mainly into the downstream coffer dam pond.

Deep grout curtain was constructed with grouting to control seepage through foundation of the dam and abutments. The grouting has been continued to date to compensate deterioration of the curtain due to dissolution of gypsum.

The alignment reaches to 5,500m in total length and covers the most distance between the two anticlines on both sides. The curtain grouting alignment is divided and numbered at every 36 m in the main and coffer dam parts and at every 24 m in the extension parts. Grouting work is carried out and managed with the divided units.

The curtain covers at least the karstified section above the karst line, though the detailed depths of holes are unknown because of limitation of provided data. The approximate depth of the curtain as of 1988 may be 60m (left bank) - 130 m (right bank) at maim dam and 60m - 80m at saddle dam.

Blanket/contact grouting was intensively carried out on the foundation of structures. The holes are arranged in a network of triangle with 3 m spacing. In the core trench, 20 rows of blanket grout holes are used for the grouting in maximum. Depth of holes ranges 10 to 25 m. Contact grouting was implemented around the gallery in radial directions.

4. LESSONS AND LEARNED FROM NORTH JAZIRA IRRIGATION PROJECT

4.1 Achievement of Operation

4.1.1 Numbers of Farmers, Irrigation Area

Number of Farmers in North Jazira Irrigation Project area is 3,074 households in 2002 and initial irrigation area was 19,775 ha in 1992, then increased gradually and reached 52,175 ha in 1995. Peak level continued until 1997, and decreased subsequently to 47,413 ha in 2002.

4.1.2 Production

Unit yield (average of 1998-2008) of main crops is wheat, barley, and sugar beet of North Jazira area are smaller than planned unit yield of South Jazira area, while unit yield of sunflower of North Jazira area is equivalent to that of South Jazira area.

For the purpose of comparing productivity between North and South Jazira areas, farm survey is also carried out at North Jazira Irrigation area

Average unit yield about 2,800 kg/ha of wheat in North Jazira is mostly equal to minimum yield of

South Jazira shown in the Swiss F/S Report. And about 2,000 kg/ha of barley is almost middle level unit yield between North and South of which shows in the report of North Jazira irrigation project and Swiss F/S report respectively.

4.2 Main Crops and Cropping Pattern

Major winter crops are wheat, barley, potatoes, sugar beet, beans, and forage crops, while major summer crops are corn and fodder crops. Total plantings crops ratio is 123%.

4.3 Water Management

Most area of project irrigated by sprinkler machines (liner move sprinkler system),The area of one unit farm is between (50~150) ha, many farmers are responsible about one sprinkler machine that works according to a special table of time prepared for this purpose.

Irrigation efficiency in the North Jazira Irrigation Project is as shown in below Table.

Table. Efficiency of North Jazira Irrigation Project

Application efficiency		Irrigation efficiency		
Sprinkler	75 %		Sprinkler	Gravity
Gravity	60%	Main canal	0.71	0.56
Canal conveyance efficiency		Lateral	0.63	0.51
Main canal	95 %	Water course	0.60	0.48
Lateral	90 %			
Water course	94 %			

Source : Design criteria (China State Construction Corporation , 1986)

As a result of survey to farmers (6 villages) and listening to PMT, water users' association etc. are not organized. As a result of survey farmers (6 villages) and listening to PMT, water fee is free. Construction and maintenance of agricultural facilities are all being executed by the State. Tax to the beneficiaries and water fee are free. Also the beneficiaries can affect by aid of country in the purchase of fertilizers and seeds.

4.4 Conditions of Operation and Maintenance (O&M) and Organization

O&M works for the North Jazira Irrigation Project is managed by the Directorate of Water Resources in Nineva. Within Nineva province, as many as three(3) large scale irrigation projects are operated with having each of the 'D.Project Office'. One of those is the North Jazira Irrigation Project Office. While each of the Project Offices is attached with pumping station, however, the O&M works on the pumping station is not done by the Project Office but by the '13)Pumping Division under the C.Divisions' with due collaboration with each of the project office.

Concerning the personnel allocation under the North Jazira Irrigation Project Office, the Project Office is in charge of overall project O&M and there are additional offices exclusively for O&M of each of pumping stations with having engineers for irrigation, mechanical and electrical field as supported by technicians. Further, for the O&M and maintenance of sprinklers, there assigned an independent office in charge of stock control/management, inspection/maintenance and repairs in case of damages/mal-functioning.

Further to mention, based on the data/information provided by the PMT, the North Jazira Irrigation Project Office possesses as many as 250 units of sprinkler equipment and assuming the full coverage of irrigation service for the recorded-maximum cropping acreage of 52,000 ha with the irrigation ratio of 1:1 by surface irrigation and sprinkler irrigation, the average irrigation service coverage by 1 unit of sprinkler is calculated to be about 100 ha per annum.

In addition to the above, in the year 2009, about 381,000 USD was collected from the farmer water users as water fee (As per the interview from PMT, water fee has not been collected.), however the amount is limited only to some 12 % of the annual O&M cost including the electricity and the balance is covered by the government budget.

5. AVAILABLE WATER OF THE MOSUL DAM

5.1 Water Balance in the Swiss F/S :in relation with the Soviet Report

The Swiss F/S on the South Jazira Irrigation Project did not discuss water balance computation of the Mosul Dam as the water resource. Water balance throughout the country is examined in as called Soviet Report, namely, ”General Scheme of Water Resources and Land Development in IRAQ STAGE (MOSCOW-BAGHDAD, 1982)”, it seems that the Jazira Irrigation Project is integrated into the whole country water resource plan.

From the Soviet report, the irrigation service area in South and East Jazira projects can be confirmed as 183,250 ha also, the total annual irrigation water requirement can be computed as 1.43 BCM

At the start of the subject JICA Study, the total area of the whole Jazira was assumed to be 190,000 ha with the breakdown of 60,000 ha by North and 75,000 ha by East plus the South. In this case the total irrigation area which depends the water source on Mosul Dam comes out as 325,000 ha in total, which is much larger than the area indicated by the Soviet report.

Following Fig. shows the differences found in the monthly consumption amounts between the Soviet report and the Swiss F/S for the irrigation planning for the South Jazira Irrigation Project. Differences are there on the irrigation water requirements and the design discharges.

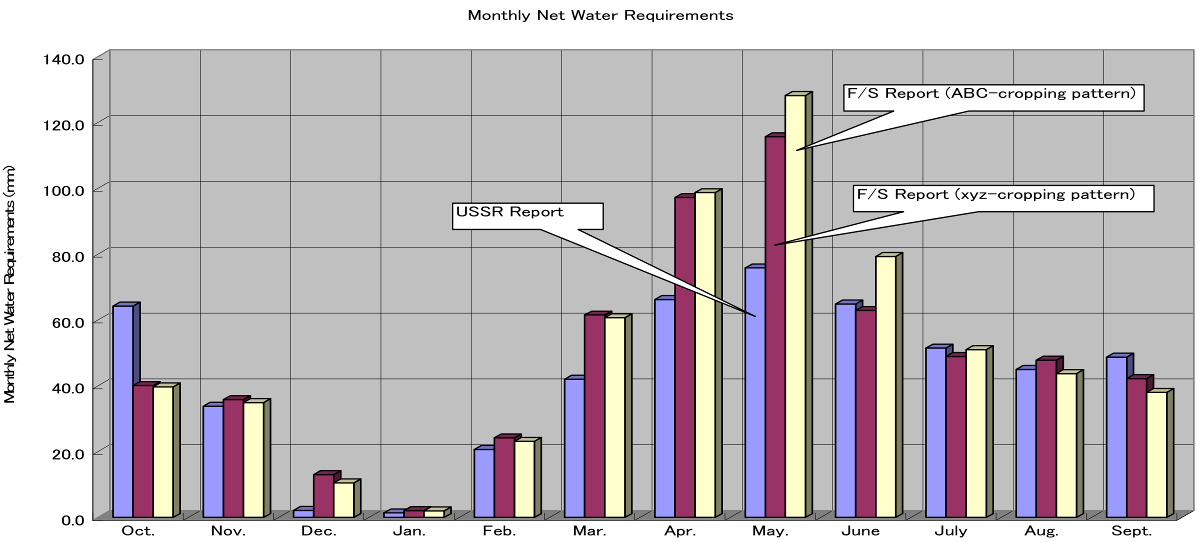


Fig. Comparison of monthly crop water consumption between Swiss F/S and Soviet report

As discussed in the foregoing, the Swiss F/S does not necessarily coincide with the Soviet report, which seemed to be the basis of water source planning under the F/S, in examining the irrigation water requirements too.

In the Soviet report, it can be known that professional engineers surveyed/investigated several numbers of irrigation systems and for concluding the irrigation water requirement, the following basic data were used for their calculation;

1) Net irrigation water requirement of major crops
2) Cropping patterns to determine the averaged net water requirement
3) Loss of irrigation system including percolation losses at canals and fields
4) Operation loss at the practicing irrigation system

As is the case, it seems that differences were induced as compared with the F/S where water requirements were calculated on individual service area basis.

As of today, it is considered that the Soviet report is the latest outcome of study discussing the water source operation covering the entire basins of Iraq. However, considering the actual situation of changes happening such as development activities in the upstream riparian countries, irregular river run-offs affected by climate changes caused by global warming as well as increasing water consumption everywhere and etc. it is considered necessary to have at the earliest a holistic water source operation plan newly conceived based on the said changes.

5.2 Examination on Actual Operation of the Mosul Dam: in relation with the Safety Annual Report

The Study Team will calculate the water balance by using dam operation data in case that whole irrigation water for the South Jazira is taken from the Mosul Dam. It will be possible to examine the relevance of water balance computation based on the calculation.

The Mosul Dam annual report in 2008 shows water level, reservoir storage and water balance of main reservoir. Reservoir storage can be calculated based on the reservoir storage on the previous day and water balance. It is possible to verify the degree of observatory accuracy by comparing the estimated reservoir storage with actual one. Reservoir storage can be calculated as follows;

Calculated reservoir storage: Calculated reservoir storage on the previous day
+ Variation of the reservoir storage on the day

Variation of the reservoir storage on the day: Q in－Q out

Q in :Inflow to the main dam on the day

Q out :Outflow from the main dam on the day
(= Irrigation water for the South Jazira + Water requirement for power generation + Outflow from the bottom discharge facility + Outflow from the spillway)

5.3 Examination of Water Resource Operation

5.3.1 View of the MoWR on inflow into Mosul Dam as well as discharge to the downstream in future

1) Average inflow from Tigris River basin during the period of 1931 - 2010 has been recorded as 20.1 BCM/year.
2) More recent average inflow into Mosul Dam observed during 1999 - 2010 has been 14.95 BCM/year where reduction has been considered due to the effect of exploitation in Turkish basin though it is thought that the effect has also been brought about by global warming effect and long-term climatic trends.
3) According to reports with regard to Ilisu Dam publicized in an internet information site as well as research reports by Ministry of Foreign Affairs, the annual water consumption in Tigris River consists of 6.5 BCM/year for irrigating over 635,000 ha of the perimeter within Turkish territory and 2.0 BCM/year for irrigating 200,000 ha in Syrian territory. Moreover, 1.50 BCM/year has annually been evaporated from the surface of Turkish dams. Accordingly, while water treaty among upstream countries is not stated, the total water consumption of this river basin is estimated at 10.1 BCM/year (＝20.1-6.5-2.0-1.5), namely, about a half of 20.1 BCM/year as referred to in 1).
4) As regards the future necessary releasing (outflow) volume to the southern part of Iraq from Mosul dam, MoWR suggested providing an Indicator for it in consideration with future demands such as agriculture, water supply, power generation, and industry as well as marshland conservation. At the end, however, MoWR indicated that the necessary releasing volume is 200 m^3/s for the downstream for analyzing available water resource of the South Jazira.

5.3.2 Operation Rules /Regulations of Mosul Dam

The followings are the operation rules of Mosul Dam presented by MoWR.

1) Rule of water intake: During last winter period terminated on June 1st, water is reserved so that water level reaches WL 330m as an ordinary operation water level (for recent 5 years it has been managed at WL 319 m owing to the safety control of the Dam).
2) Rule of water discharge: It is discharged to meet various water demands arising from southern as well as middle parts of Iraq. During last summer period terminated on November 1st stored water level is kept at WL 307 – 310m procuring both water required for irrigating North Jazira Irrigation Area and for power generation. In this connection, in the case of serious drought, operative water level is further lowered.

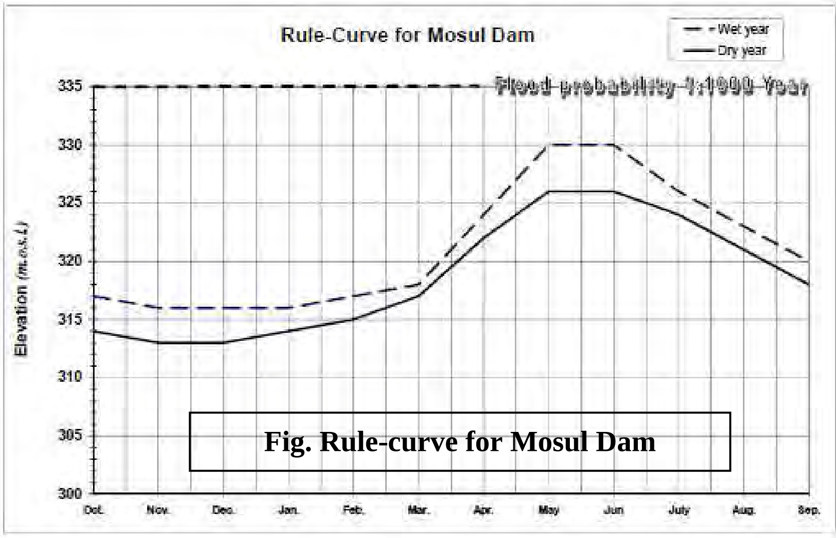


Fig. Rule-curve for Mosul Dam

Following Fig. shows a rule-curve for Mosul Dam presented in a reference by Water Control Center (Technical Data for Dams, Reservoirs & Main Control Structures with mean monthly flow-rate and water quality for Main Water Resources).

In this regard, calculating from the annual water volume reserved at WL 330m (reserved water volume: 11.11 BCM), the reserved water storage corresponding to WL 307m (reserved water volume 4.307 BCM) is calibrated at about 6.803 BCM (=11.11–4.307), while the ratio to future inflow, namely 10.1 BCM, is equal to 1.48 (= 10.1/6.803).

5.4 Examination on the dam operation

5.4.1 Preconditions for the examination

Estimation and determination of irrigation water requirement for South Jazira Irrigation Area requires a farming plan, crops and irrigation facilities to be equipped. Examination on the required irrigation water is tried with the following monthly water requirement by 3 irrigation sub-areas (North, East, South) in Jazira Irrigation Area.

The total irrigation water volume required for irrigating 3 sub-areas comes to 3.276 BCM as shown in below Fig., accounting for 16.3 % of the total annual inflow into Mosel Dam, namely 20.1 BCM. 32.4% of the estimated future annual inflow affected by further development in the upstream of river basin as well as by global warming effect, namely 10.1 BCM, thus the rate of irrigation water requirement to the total inflow will get higher level. This required water is equivalent to around 50%

of the managed water storage at WL 307 - WL 330m, namely 6.803 BCM.

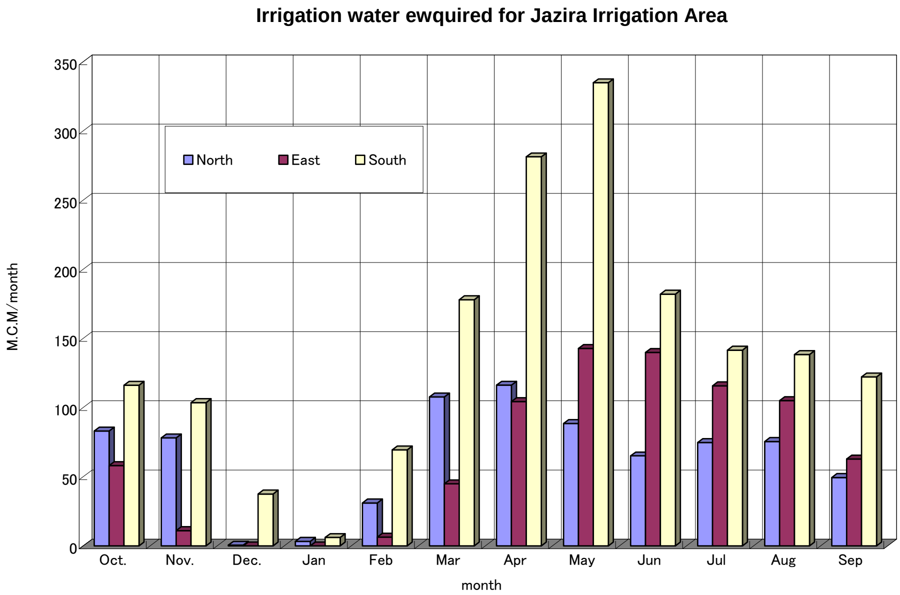


Fig. Irrigation water required for Jazira Irrigation Area

Besides, a farm management plan has been newly proposed for South Jazira Irrigation Project area under the present study where crop water requirements have been reviewed and modified based on the latest meteorological data collected and updated irrigation efficiencies.

Change in annual inflow into Mosul dam is shown in following Fig. Here, a declining trend of inflow can be identified either by moving average or by linear regression as the cause of decline, exploitation in the states located in the upstream basin and also long-term climatic change, however it is difficult to specify contributions of individual factors to the total change. According to linear regression, it is understood that the rate of annual decline is assumed at 0.145 BCM. Assuming that this declining rate would continue and the inflow in around 1975 is evaluated at 22 BCM or the value of the intercept, in about year 2050 or around 75 years ahead, the inflow will be calculated at a half, or 11 BCM.

Actually, however, in the case that the fluvial discharge is affected by such artificial development as irrigation projects in the states located in upstream basin, the pattern of inflow change does not indicate a linear trend, but seems to decline as the exploitation activities progress. As regards inflow volume, examination will be planned in cases where current inflow continues or where inflow decreases in future.

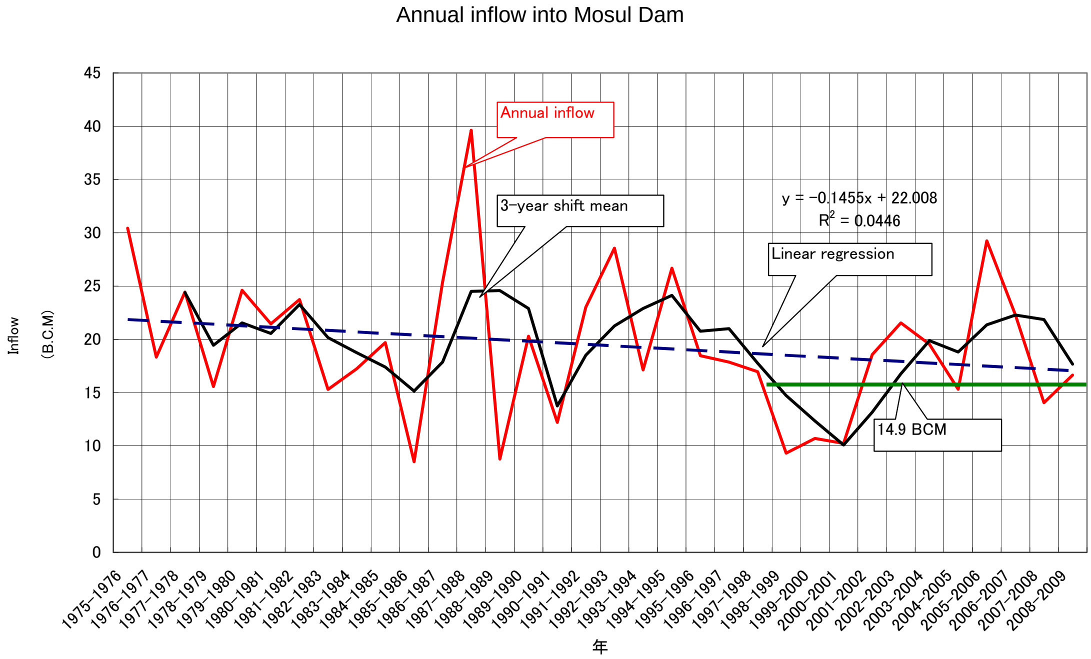


Fig. Trend of annual inflow

5.4.2 Examination by Operation Record

1) The total water volume required for irrigating North, East and South Jazira areas comes to 3.28 BCM, accounting for 16.3 % of the total annual inflow into Mosel Dam, namely 20.1 BCM (or 18.04 BCM based on 1993-1999 data). 32.4% of the estimated future annual inflow affected by further development in the upstream of river basin, namely 10.1 BCM, thus the rate of irrigation water requirement to the total inflow will get higher level. This required water is equivalent to around 50% of the dam water storage at WL 307-330 m, i.e. 6.7 BCM.
2) According to past operation performance, water balance of the Mosul dam is summarized as following Tables.

(Unit :BCM)

<table>
<tr><th rowspan="2">Average performance of annual inflow (a)</th><th colspan="4">Planned irrigation water (b)</th><th rowspan="2">Power generation (c)</th><th rowspan="2">Inflow Total d:(b+c)</th><th rowspan="2">Balance e:(a-d)</th><th rowspan="2">Available outflow (c+e)</th></tr>
<tr><th>North</th><th>East</th><th>South</th><th>Total</th></tr>
<tr><td>Case-A 1931-2010 :20.10</td><td rowspan="4">0.77</td><td rowspan="4">0.79</td><td rowspan="4">1.71 1)</td><td rowspan="4">3.28</td><td rowspan="4">16.59</td><td rowspan="4">19.87</td><td>0.23</td><td>16.82</td></tr>
<tr><td>Case-B 1993-1999 :18.04</td><td>▲1.83</td><td>14.76</td></tr>
<tr><td>Case-C 1999-2010 :14.95</td><td>▲4.92</td><td>11.67</td></tr>
<tr><td>Case-D Estimated inflow in future :10.10</td><td>▲9.77</td><td>6.82</td></tr>
</table>

Remark 1) Value 1.71 BCM was based on the Swiss F/S report.

Evaluating the above cases is shown in below;

Case-A:	Provided that inflow is 20.10 BCM, outflow of 16.82 BCM can be discharged to downstream even with current water volume for power generation and delivery fully-planned irrigation water of North, East and South (3) Jazira areas.
Case-B:	Provided that inflow is 18.04 BCM, it is required to control the scale of the designed irrigation plan for 3 Jazira irrigation areas to 44% of the original one if current water for power generation should be maintained. Inversely, if water for power generation is restrained for giving priority to the irrigation plan, it will be necessary to limit water for power generation to 89% of current supply, or 14.76 BCM.
Case-C:	Provided that inflow is 14.95 BCM, the irrigation plan for 3 Jazira irrigation areas becomes impossible in the case that current water for power generation is maintained. Inversely, if priority is given to the irrigation plan and water for power generation is to be restrained, necessity arises to limit water for power generation within 70% of current supply, or 11.67 BCM.
Case-D:	Provided that inflow is 10.10 BCM with the consideration on future development of irrigation in the countries located in the upstream, irrigation plan for 3 Jazira irrigation areas will not be able to realize. Inversely, if priority is given to the irrigation plan while scale of power generation is controlled, water for power generation will have to be controlled at 41 % of the current supply, or 6.82 BCM.

3) Also, the conditions adopted in each case and the results of the evaluation are summarized in following table **(Refer to the below Tables of Case Studies of Water Balance)**;

Case	Condition of inflow (Mean annual inflow)	Scale of irrigation (Mean annual intake)	Water for power generation		Mean annual deficit	Evaluation
			Condition	(Mean annual water use)		
Case 1-1	Average performance (18.0BCM)	100% (3.28BCM)	Average performance	(16.6BCM)	1.7BCM	Given priority to irrigation, power generation is required to control.
Case 1-2			Performance + stop in water deficit	(14.9BCM)	0 BCM	Given priority to irrigation, power generation should be stopped in water deficit.
Case 1-3			96% of average performance + stop in water deficit	(14.3BCM)	0 BCM	Given priority to irrigation, even with power at 96% of average performance, power should be stopped in water deficit.
Case 2-1		50% (1.64BCM)	Average performance	(16.6BCM)	0.3BCM	Given priority to power, even with 50% of planned irrigation scale, power generation will be deficit.
Case 3-1	Future inflow (10.1BCM)	100% (3.28BCM)	Average performance	(16.6BCM)	9.5BCM	Given priority to irrigation, serious influence is raised in power generation.
Case 3-2		0% (0 BCM)	Average performance	(16.6BCM)	6.7BCM	Even stop irrigation, influence is raised in power generation.
Case 3-3		100% (3.28BCM)	35% of average performance	(5.8BCM)	0 BCM	Given priority to irrigation, power generation should be reduced by 35%

4) Under the conditions that serious decrease in future inflow is most likely assumed, they definitely

give negative impact on water for power generation. Therefore, necessity would arise to examine whether there is an alternative realizable way of power supply or not.

5) In the case that priority is given to irrigation plan with restraining water for power generation, discharge to the downstream will be reduced. It is essential to be discussed on competitive relationship with power generation as well as comprehensive development plan covering the entire downstream basin of Tigris River.

Case Studies of Water Balance

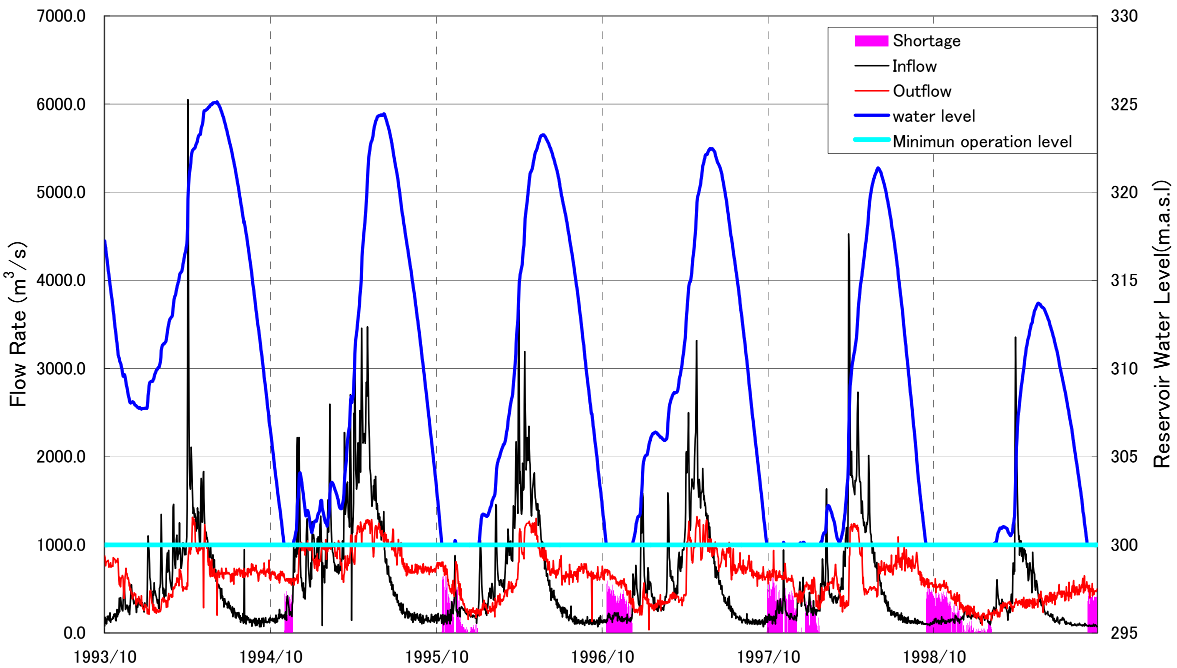


Fig. Water Balance in Case 1-1

(By Actual Inflow, Irrigation: 100%, Power: 100%)

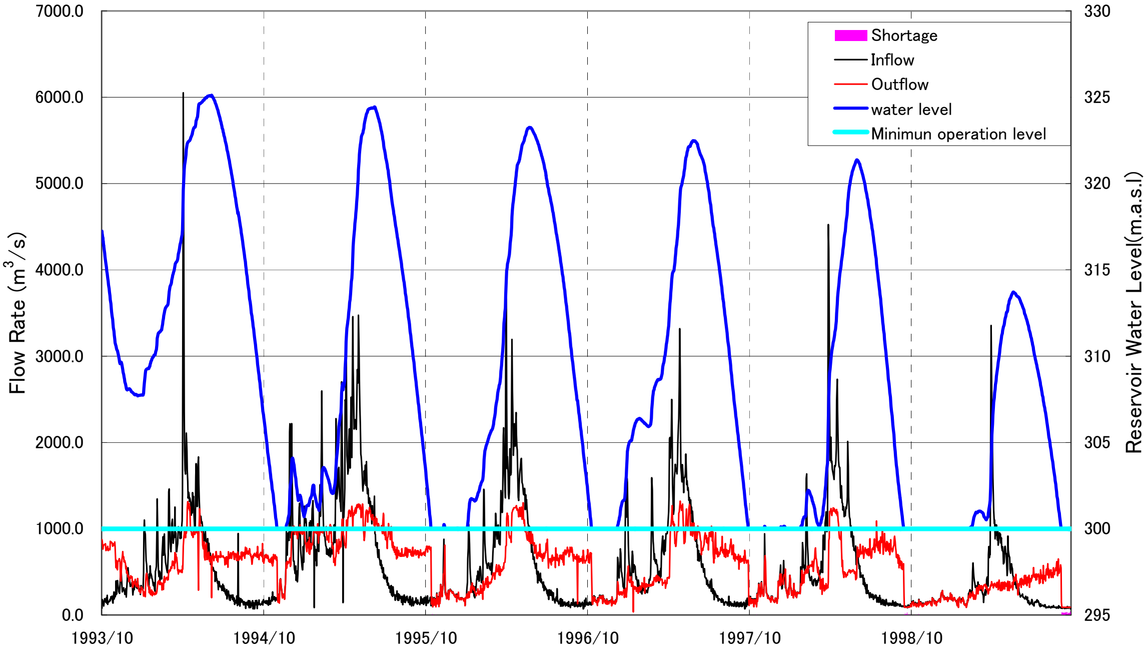


Fig. Water Balance in Case 1-2
(By Actual Inflow, Irrigation: 100%,
Power: 100% but stop power in the case water deficit arises)

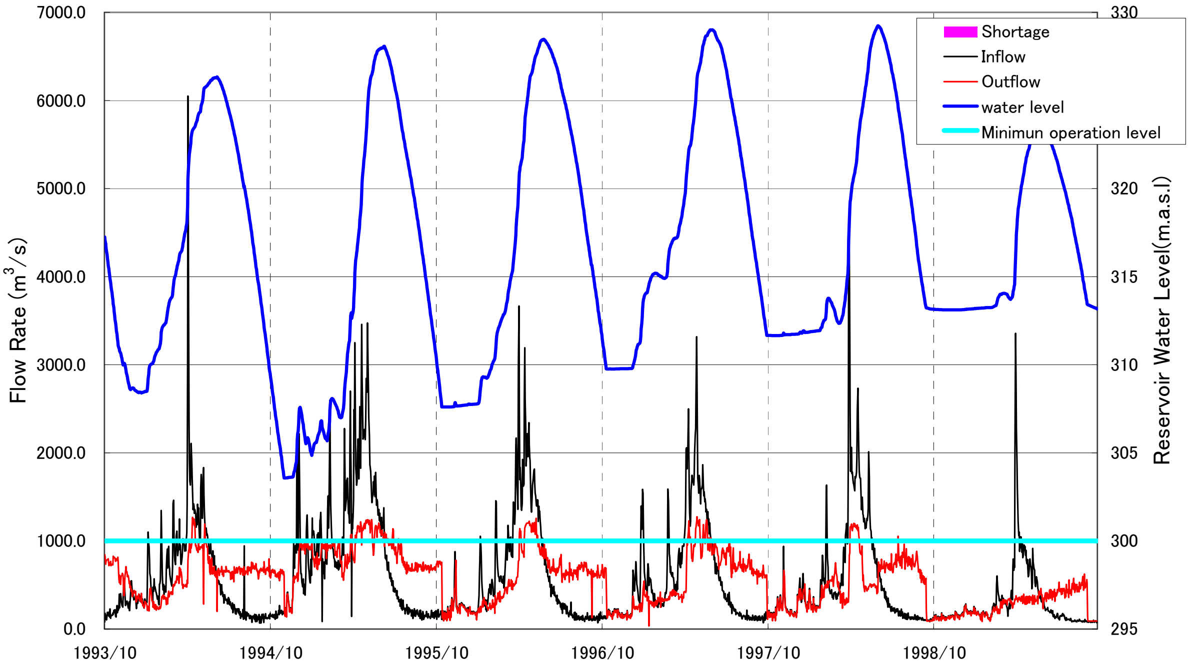


Fig. Water Balance in Case 1-3
(By Actual Inflow, Irrigation: 100%,
Power: 96% but stop power in the case water deficit arises)

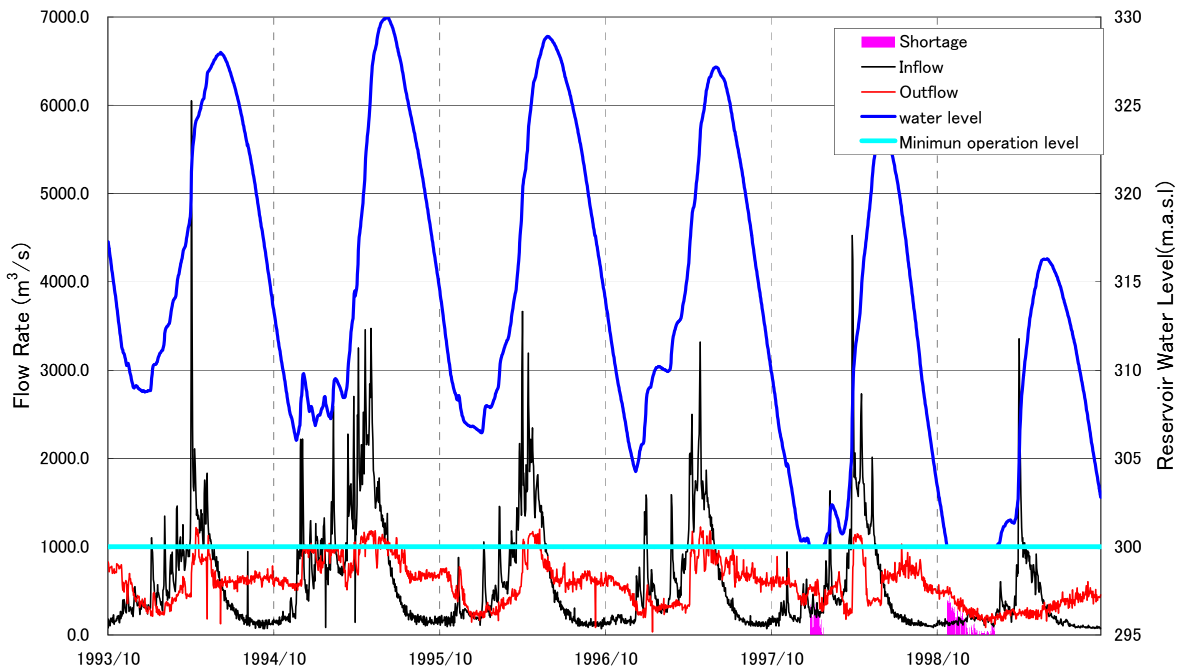


Fig. Water Balance in Case 2-1
(By Actual Inflow, Irrigation: 50%, Power Generation: 100%)

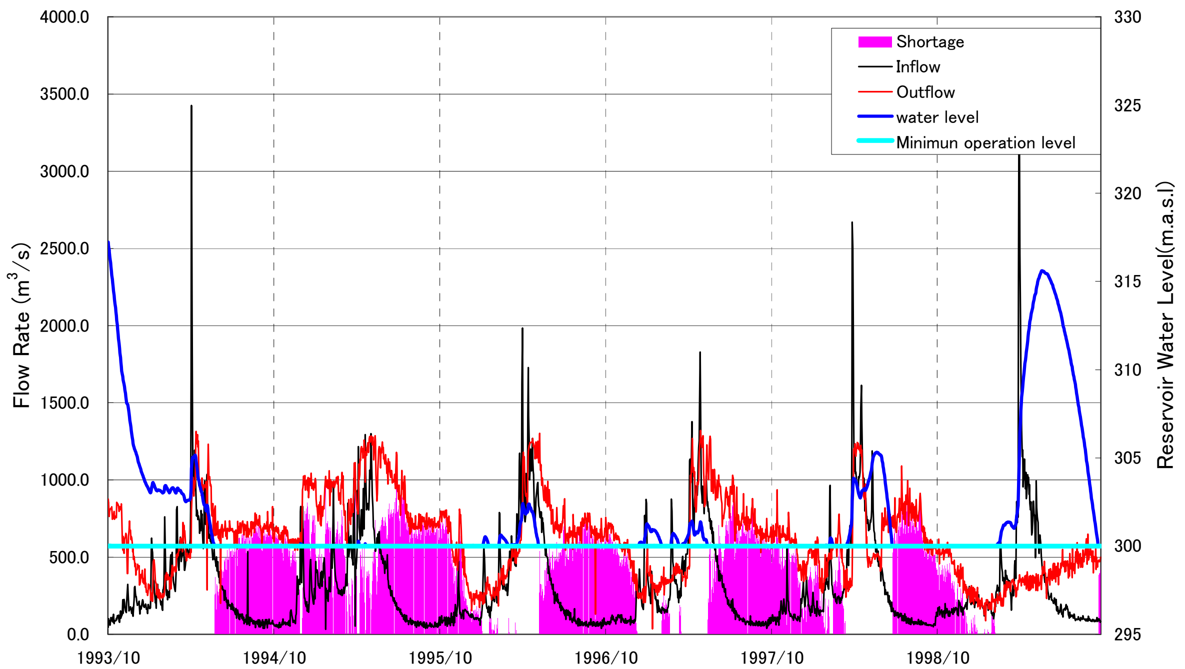


Fig. Water Balance in Case 3-1
(By Future inflow, Irrigation: 100%, Power Generation: 100%)

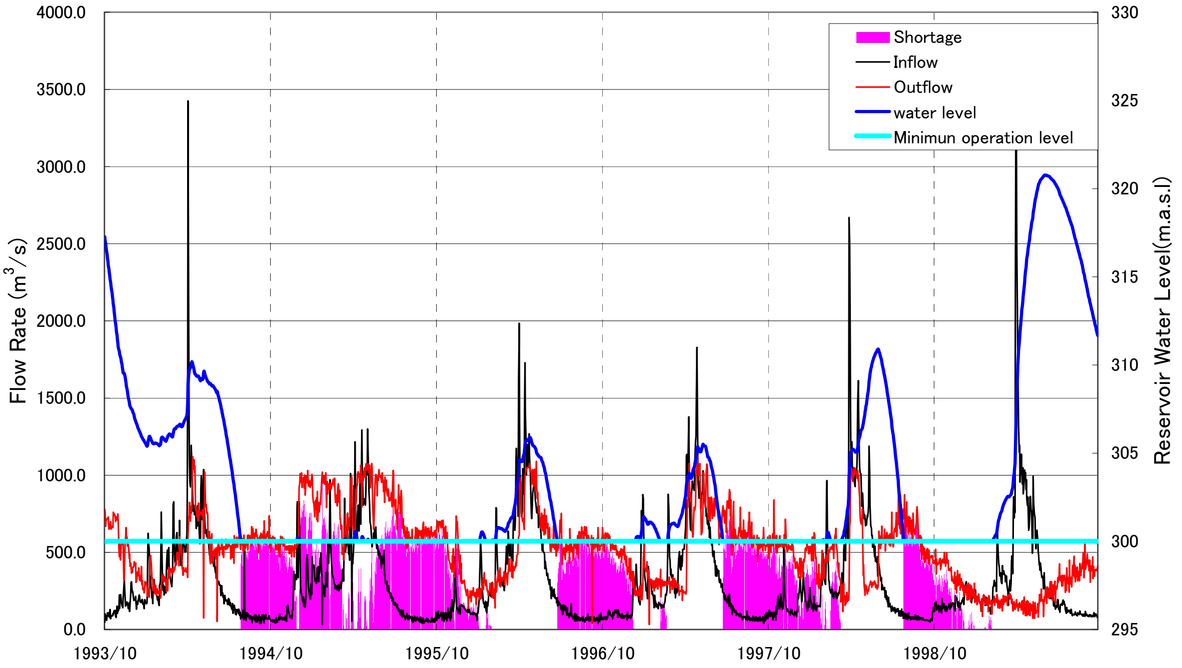


Fig. Water Balance in Case 3-2
(By Future inflow, Irrigation: 0%, Power Generation: 100%)

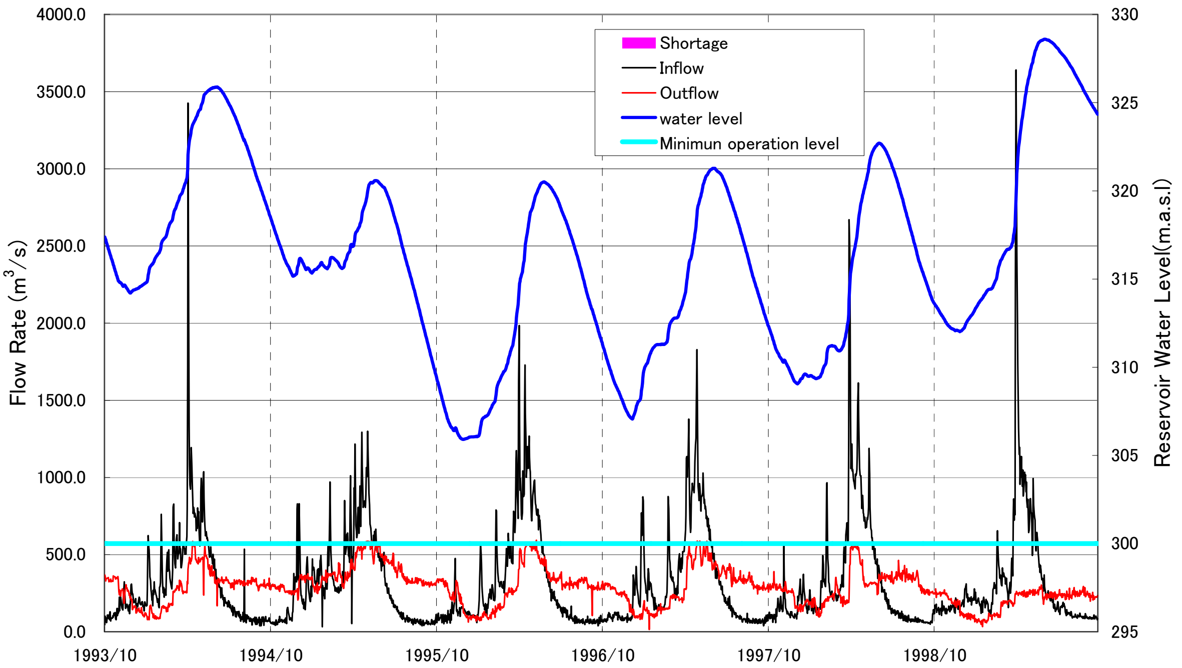


Fig. Water Balance in Case 3-3
(By Future Inflow, Irrigation: 100%, Power Generation: 35%)

5.5 Priority of Water Resources Utilization (1. Flood control, 2. Agriculture, 3. Power)

Mosul Dam is a multi-purpose dam for flood control, irrigation and power generation. In the "Operation & Maintenance Manual for Sadam Dam (Former name of Mosul Dam)", the priorities for each purpose are specified as the followings;

1) Highest priority is given to flood control. Within the limit of design as storage level shall not exceed the maximum level, flood control is to be given with the highest priority in it's operation.
2) Irrigation water is to be secured as maximum as possible. All the irrigation water required shall be guaranteed as much as possible, though depending in practice on the actually prevailing situation of inflow and storage volume.
3) Power generation shall follow the water release plan for irrigation purpose. Only in the cases that there is a surplus in storage volume or release for flood control is necessary, the said rule 2) will not apply.

Of the irrigation and power generation, higher priority is given to the irrigation purpose. As is the case, the priority order is indicated as the following.

Flood control > Irrigation water > Power generation

It was in the meeting with the PMT that confirmation was made on the water volume. That is downstream of the Mosul Dam has to be at least more than 200 m^3/sec.

5.6 Availability of Water Resources by Scenarios (Scenario-0, 1, 2)

Water balance was examined based on the actual dam operation data (1993-1999) with the following conditions applied;

1) Calculation was made on daily basis.
2) Using the co-relation of water level-storage volume and of water level-storage surface area, the water level was assessed in combination with the storage water surface area and the storage loss was estimated to be incorporated in the water balance.
3) For storage loss, the loss assumed from actual operation results in 2008 was adopted.
4) In the dam/reservoir operation, the low water level was set at W.L 300 m.
5) Intakes were fixed at the designed amount for both irrigation and power generation. In case intake could not be materialized due to the water level lower than 300 m, the deficits were accumulated as deficit amount.
6) For the amount of release water to downstream areas, the calculation results which can secure 200 m^3/sec be adopted.

In this report, a new farm management plan has been proposed for South Jazira Irrigation Project where crop water requirement has been reviewed /modified based on the latest meteorological data and updated irrigation efficiency.

Case numbers are given for each area depending on the irrigation areas assumed by applying the results of the said proposal. The crop intensity of this case is 100%.

Table. Irrigation water requirement in South Jazira area (Proposed)

Scenario	Scenario-0		Scenario-1		Scenario-2	
Area (ha)	148,600		119,000		88,800	
Month	M.C.M	m^3/sec	M.C.M	m^3/sec	M.C.M	m^3/sec
Oct	72.5	27.1	58.1	21.7	43.3	16.2
Nov	62.3	24.0	49.9	19.2	37.2	14.4
Dec	26.1	9.7	20.9	7.8	15.6	5.8
Jan	19.9	7.4	15.9	6.0	11.9	4.4
Feb	62.6	25.9	50.1	20.7	37.4	15.5
Mar	156.0	58.2	124.9	46.6	93.2	34.8
Apr	227.6	87.8	182.2	70.3	136.0	52.5
May	223.4	83.4	178.9	66.8	133.5	49.8
Jun	200.9	77.5	160.9	62.1	120.1	46.3
Jul	166.8	62.3	133.5	49.9	99.7	37.2
Aug	130.9	48.9	104.8	39.1	78.2	29.2
Sep	41.5	16.0	33.2	12.8	24.8	9.6
Total/Average	1,390.4	44.0	1113.5	35.3	830.9	26.3

Here factors of effective rainfall are taken into account and the service area is fixed at smaller than the original plan.

Following Table shows the results of examination on each scenario.

In each scenario, there occurred no water shortage during the examined period.

For the release (Power generation) to the downstream area, more than 200 m^3/sec was conditioned for the whole period and the computation results showed a balance in incoming and outgoing without shortage in all scenarios.

However, the releases to downstream areas ranges from 6.46 - 7.04 BCM for the cases of scenario 0-2 against the present actual volume of 16.59 BCM, showing the performance less than half at 39-42 % only.

Table. Irrigation water requirements for each scenario for the South Jazira area

Scenario	Irrigation area (ha)	Inflow (BCM)	Intake volume from the Dam (BCM)						Storage loss (BCM)	Deficit (BCM)
			North	East	South	Irrigation water (Sub-total)	Power generation (Releasing)	Intake volume (Total)		
0	148,600	10.1	0.77	0.79	1.39	2.95	6.46	9.41	0.69	0.0
1	119,000				1.11	2.68	6.75	9.42	0.68	0.0
2	86,800				0.83	2.40	7.04	9.44	0.66	0.0

5.7 Integrated Results of Examination

The following effects are expected in future in case the inflow into Mosul Dam be reduced to 10.1 BCM/year due to the water resources development in upstream countries and the climatic changes.

1) There will be no shortage of water if irrigation plans be operated with the original Swiss F/S or similar and the released water to downstream (Power generation and etc.) be fixed at 35 % only of the actual performance ever (16.59 BCM/year). However, it implies a drastically huge reduction of released water amount and it will surely cause serious effects on the power generation outputs as well as on the various water uses in the downstream basins.

2) Following Fig. shows relationships and structure of problems on water resources as served by Mosul Dam. It is considered necessary to take actions to cope with the to-be-reduced run-off of Tigris River by all the parties concerned including those non-agricultural sectors.

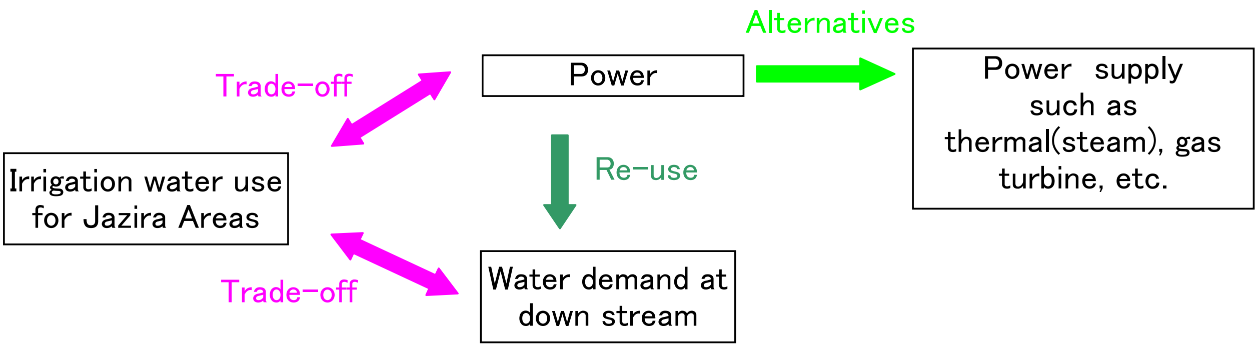


Fig. Problem structure on reducing run-off of Tigris River

It is possible to secure irrigation water requirement for Jazira area with having the minimum water release of 200 m^3/sec to downstream areas if considering the water operation served by Mosul Dam only.

However, it is noted that the issues of water allocation for the whole basin of Iraq shall be verified after obtaining the study results by the presently on-going SWLRI (Phase II)".

When inflow into a dam be reduced by half, the speed of water level recovery will be slowed down and storage water level may not be regained so as to make it difficult to avail the desired storage function, though it depends on the scale of reservoir and intake volumes, in the case that present performance of water use is adopted.

An example of reservoir operation in case of reduced inflow by half and as can be seen the water level hardly rises up after consuming the stored volume during the early stage of the first year.

The case with the same volume of water use but with having inflow of 20.1 BCM/year where situation of dam/reservoir operation is completely different and the storage function is fully utilized.

In view of the effective use of stored water energy, higher water level setting is preferable in realizing power generation with high efficiency, lower pumping cost and also the more economical water conveyance for irrigation. While, by lower water level setting may cause increasing of flood control capacity and reducing of water leakages from dam body and foundations and evaporation from the stored water surface.

In combination with the need for study on water operation for the entire country as a whole, it is necessary to fix new reservoir operation rules suited to the projected declining inflow as an important issue for the future.

6. IRRIGATED AGRICULTURE PLAN

6.1 Irrigation Service Area

6.1.1 Updating the Map of Surface Soil Depth

It is confirmed by the satellite images that the farm lands in the South Jazira area have been readjusted and also there are small and mid-scale wadi in the existing farming area. If these wadi had been reclaimed during the land readjustment, the surface soil depth of the farm lands may have been partially changed. Therefore, the Study Team measured the surface soil depth of the farmlands around the wadi and compared the difference between the measurement and the data on the existing map of the surface soil depth in order to judge the necessity of updating the map.

Based on the results of soil survey, As there is no significant gap between the data, it is judged that the updating the map is not necessary.

6.1.2 Approximate Identification of the Irrigation Service Area Based on the Map of Surface Soil Depth

Areas classified by the thickness of surface soil coverage were measured on maps. The Swiss F/S designates those areas as having the surface soil deeper than 50 cm to be suitable for irrigation with assuming the water-saving irrigation by sprinkler. In this case, as large as 89 % of the whole area is considered suitable for irrigation. In the North Jazira Project area, surface irrigation has been practiced in combination, but in the subject South Jazira area, there found gypsum layer under the surface soil, and the surface irrigation manner shall not be introduced in the area. Especially, it is necessary to avoid surface irrigation in the areas where the thickness of surface soil is less than 50 cm.

6.1.3 Exclusion of the area unsuitable for irrigation

The areas unsuitable for irrigation are excluded from the irrigation service area. These areas are wadi, residential area, commercial area, lands for roads and railways, and other off-farm lands, that can be identified by the satellite images. The location and area unsuitable for irrigation are estimated based on the following criteria:

1) Wadi: 20m from the center of the wadi to both sides
2) Residential area / commercial area: the areas identified by the satellite images
3) Lands for roads: 20 m from the center of the land to both sides

4) Lands for railways: 10m from the center of the land to both sides
5) Other off-farm lands: the areas identified by the satellite images

By the above manner, the ratio of land suitable / unsuitable for irrigation is 80.9% / 19.1% measured based on the map.

6.1.4 Establishment of Model Farm and Estimation of Cultivated Area

Ratio of site area reduction is estimated by the following; firstly establishing a model farm divided into blocks for crop rotation and secondly measuring the areas of gross farmland, suitable for farm land and reduction (canals, roads, and other areas unable to put in cultivation). As the result, area of suitable farm land is 93.5% as shown in the following Fig.

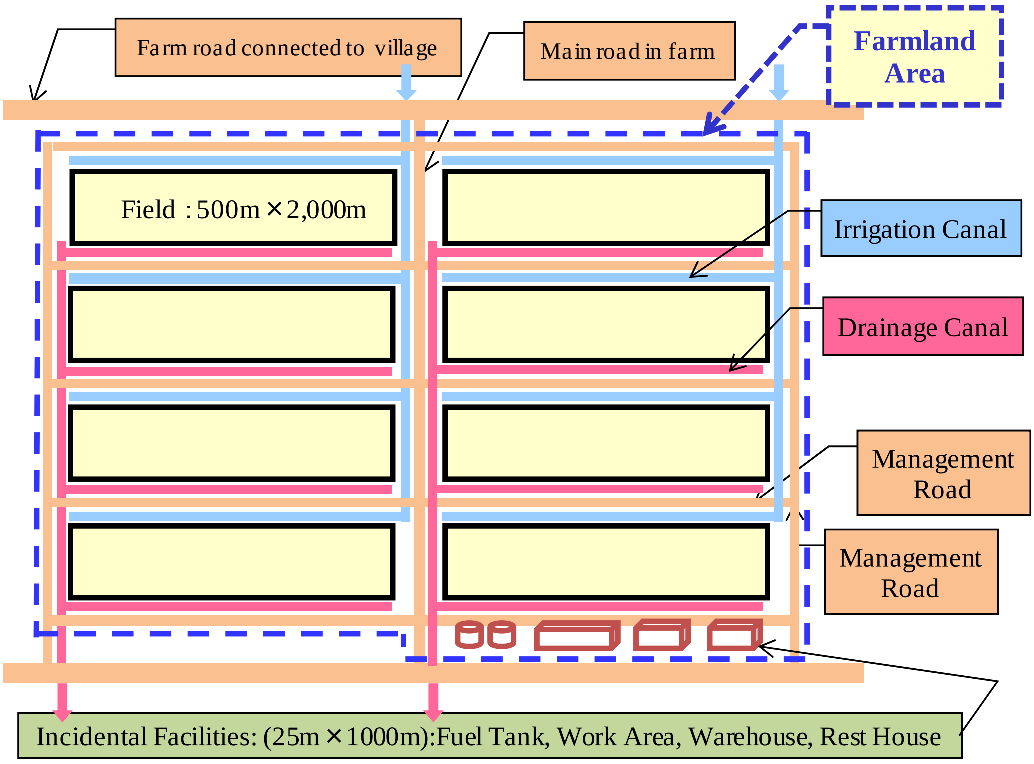


Fig. Illustration of the Model Farm with Crop Rotation

6.1.1 Estimated irrigation area (Cultivation area)

In the estimation, factors on the ratio of cultivation area and the thickness of surface soil were taken into consideration and the results are as shown in the following Table. The farm area with having surface soil thickness more than 50 cm is estimated at 196,400 ha, and multiplying the above-stated factors with it, the suitable farm land area and the irrigation area (cultivation) are estimated at 158,900 ha and 148,600 ha, respectively.

Table. Estimated irrigation area (Cultivation area)

Description	Area (ha)	Remarks
1)Area with more than 50cm of surface soil depth	196,400	
2)Cultivated area (land for agricultural use)	158,900	Share for cultivated area=80.9%
3) Irrigation service sera	148,600	Share for irrigation service area within cultivated area=93.5%

6.2 Meteorological condition and crop water consumption in the project area

6.2.1 Arrangement and analysis on the meteorological data

During the survey period of the subject Study, data were collected from five(5) stations, four(4) as the neighboring to the project area such as Mosul, Telafar, Sinjar and Al-baaj and one(1) as the comparison purpose at Baghdad. The locations and the elevations of said 5 stations are as shown in following Table .

Table. Locations of meteorological observation stations

Stations	Location		Elevation (m)
	Latitude.	Longitude.	
Mosul*	36°19'	41°50'	223
Telafar	36°22'	42°38'	400
Singer*	36°19'	43°09'	538
Al-baaj	36°00'	41°40'	320
Baghdad*	33°20'	44°24'	34

Source :"General Scheme of Water Resources and Land Development in IRAQ Vol. I Book 1 Climate and Water Resources and others

The data collection was made to cover the period of 1990-2009, but data for some periods are missing in most of the stations. Particularly in the year 2003, data are missing and/or get scattered and lost in most of the stations due to the negative effects by the Iraqi war.

6.2.2 Examination of rainfall in the project area

Monthly basis rainfall data at Mosul, Telafar, Sinjar, and Baghdad were collected for the period to cover 1990-2009.

In the following Fig, the annual rainfall observed at Mosul is shown as vertical axis and horizontally Telafar, Sinjar and Baghdad are shown to indicate the co-relations (Distributions). Within the range of larger annual rainfall, the annual rainfall at Mosul is the largest followed by Sinjar, Telafar and Baghdad in order.

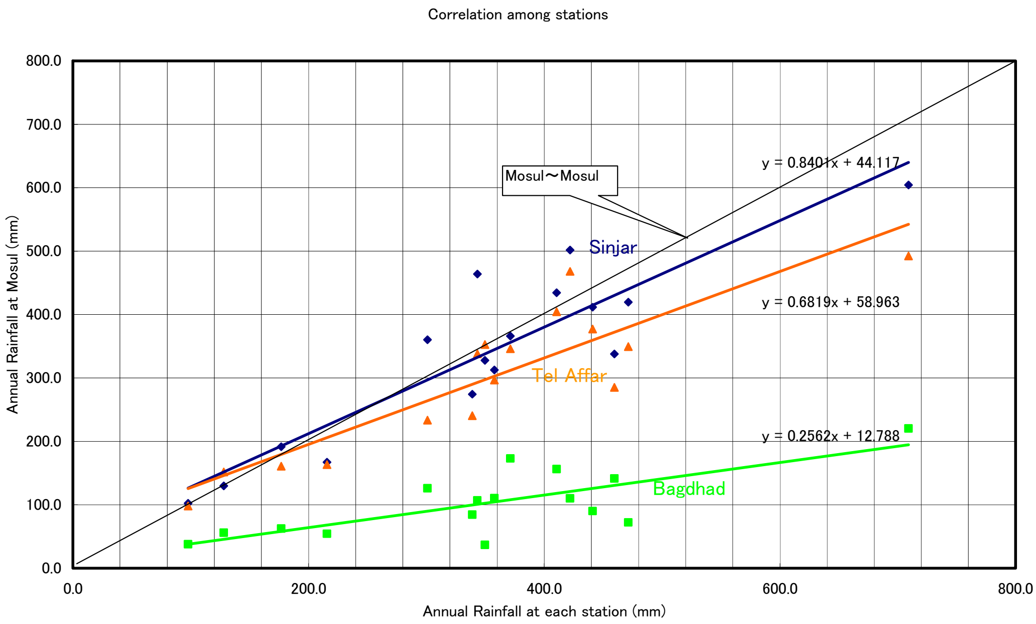


Fig. 6.2-3 Co-relations of observed rainfall

Based on the examinations, the annual rainfall for the project area shall be estimated with applying the following method.

<u>"The observation data at Telafar shall be adopted with multiplying the factor of 0.91"</u>

The reasons/justifications are explained as follows.

1) There is no meteorological observation station in the project area and it is necessary to estimate the annual rainfall based on the observation records of the stations located nearby. As the existing stations are located at north even away from the northern part of the project area, common estimation method like the Thiessen method can not be adopted to grasp the areal rainfall. (Stations existing at the south of project area are located quite far from the project area.)

2) Sinjar station is located at the mountain-foot with higher elevation and can not be adopted to represent the project area.

3) Observed data at Mosul show rather low co-relation with Sinjar and Telafar as analyzed and located far away from the other observation stations with having distance from the center of Jazira area, it is not justified to adopt the Mosul data for estimation.

4) Telafar is judged to be most reasonable among all to represent the project area situation, since Telafar is the nearest to the project area, it shows high co-relation with Sinjar but the elevation is not such high as Sinjar. As is the case, to reflect the difference from the project area, 0.91 multiplier factor be applied to the Telafar data as referring the analysis result presented in Soviet report.

Monthly basis rainfall data at Telafar are obtained for the period of 20 years from 1990 to 2009 except the missing of years 2003 and 2004. The full data are arranged as shown in the following

Table. As discussed in (2) above, the mea Telafar be multiplied with 0.91 factor and shown as in Table 6.2-5.

Table. Summary of monthly rainfall at Telafar

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2005	2006	2007	2008	2009	Average	*0.91
Jan	40.7	13.4	75.7	60.2	93.8	19.3	235.5	34.6	99.1	26.1	46.6	29.2	28.3	120.0	103.1	19.9	24.6	1.0	59.5	54.2
Feb	69.4	31.9	113.7	47.2	43.3	84.0	42.5	88.1	22.2	36.4	10.8	36.2	8.3	58.0	82.9	45.5	26.9	33.3	48.9	44.5
Mar	21.4	215.1	30.9	16.3	78.6	75.2	127.8	37.7	30.3	64.0	34.4	69.4	116.2	13.4	10.2	30.2	40.1	24.0	57.5	52.3
Apr	48.4	14.9	18.0	112.3	30.6	27.7	18.7	16.9	18.2	10.1	23.0	25.5	27.4	1.0	56.4	17.0	0.0	42.7	28.3	25.7
May	1.7	8.[illegible]	25.7	92.1	6.2	0.4	14.5	1.8	38.1	0.0	0.4	27.1	3.4	20.5	3.0	26.1	0.2	0.0	15.0	13.6
Jun	0.0	0.[illegible]	0.6	0.0	0.0	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.8	0.8
Jul	0.0	0.[illegible]	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	11.4	0.8	0.7
Oct	2.3	18.8	0.0	13.8	22.7	0.0	3.3	31.5	3.0	16.0	2.8	4.3	12.3	0.0	55.5	2.0	9.6	18.1	12.0	10.9
Nov	0.0	7.4	77.6	63.1	82.5	20.6	8.3	38.4	0.0	11.1	53.6	13.4	10.7	22.7	4.0	2.4	19.0	15.8	25.0	22.8
Dec	43.2	58.5	86.7	47.6	79.4	6.7	162.0	63.8	12.1	18.7	94.2	39.2	91.5	6.8	35.2	1.1	22.3	51.8	51.2	46.6
Annual	227.1	368.1	428.9	452.6	437.1	247.1	614.4	312.8	227.3	182.4	265.8	244.3	298.1	243.6	350.3	144.2	143.5	198.1	299.2	272.3
*0.91	206.7	335.0	390.3	411.9	397.8	224.9	559.1	284.7	206.8	166.0	241.9	222.3	271.3	221.7	318.8	131.2	130.6	180.3	272.3	

The mean annual rainfall in the area is accumulated as 272 mm/annum and the monthly fluctuations are as indicated in following Fig

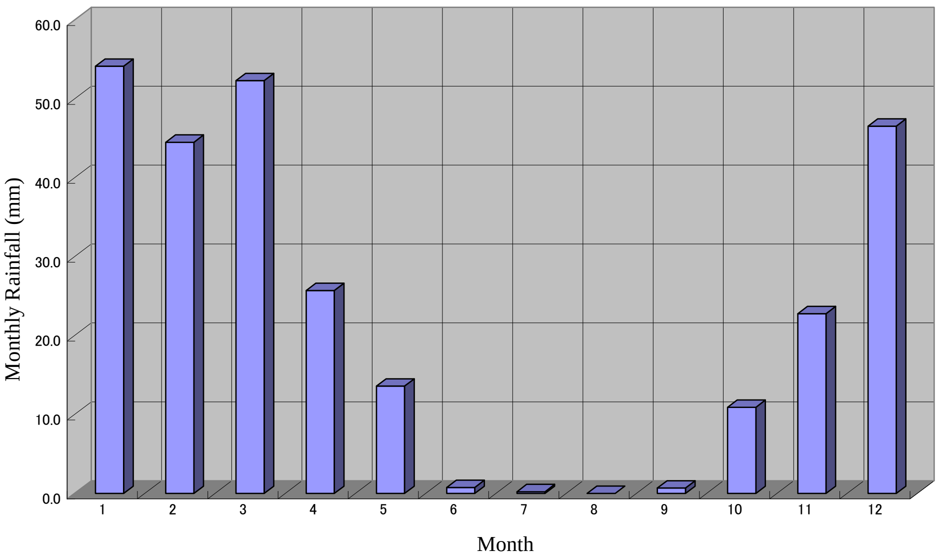


Fig. Monthly distribution of rainfall in the area

FAO defines by probability of exceedance three(3) different rainfall years as “Drought year”, “Ordinary year” and “Wet year”.

1) 80 % probability of exceedance implies that 4 years out of 5 years show the rainfall amount more than the probability value and the subject 1 year is the drought year to be the standard year for determining the scale of irrigation system.

2) 50 % probability is considered to be an ordinary year and the 20 % probability as wet year.

In order to calculate the probable rainfall, the annual rainfall data as shown in the Table 6.2-5 shall be re-arranged in descending order and the probability value be computed with the following formula.

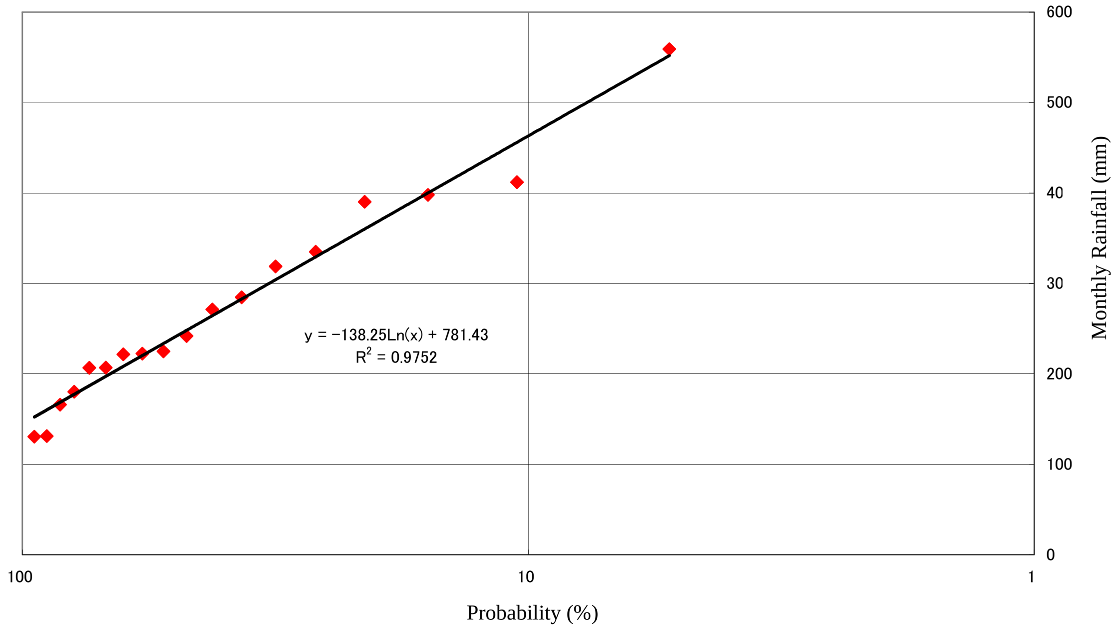


Fig. Estimation of probable rainfall

From the above Fig., it can be read that the estimation by regression formula is also reasonable when calculating the probable rainfall by regression formula, the results come out as shown in the Table 6.2-7. The calculation results this time shows 80-90 % of F/S values with smaller rainfall amount.

Table. Summary of probable rainfall calculated

Classifications	Probable rainfall at project area(mm/annum) x 0.91	Probable rainfall at Telafar (F/S) (mm/annum)
Drought year (80 % P)	175	220
Ordinary year (50 % P)	240	300
Wet year (20 % P)	367	410

The results, monthly basis probable rainfall shall be presented in following Table.

Table. Calculation result of probable monthly rainfall

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly average	54.2	44.5	52.3	25.7	13.6	0.8	0.2	0.0	0.7	10.9	22.8	46.6	272.3
Dry year	34.9	28.7	33.7	16.6	8.8	0.5	0.1	0.0	0.4	7.0	14.7	30.0	175.4
Wet year	73.0	60.0	70.6	34.7	18.4	1.0	0.3	0.0	0.9	14.7	30.7	62.8	367.1
Normal year	47.8	39.3	46.2	22.7	12.0	0.7	0.2	0.0	0.6	9.6	20.1	41.1	240.4

6.2.3 Calculation of relative evapo-transpiration (Potential)

FAO recommends the Penman-Monteith method as the only standard method to acquire the evapo-transpiration value with the following reasons. The FAO recommendation is derived from the result of comparison study on the researches made by using lysimeter by ASCE (American Society of Civil Engineers) and EC.

1) The Penman method alone causes excessively higher value in many cases and it is necessary to make partial corrections on the effects by winds.
2) Radiation method leads to comparatively acceptable results in the wet land case where factors on air dynamics are relatively small, but in case of dry area, it estimate the evapo-transpiration at too small.
3) Temperature method requires some adjustment to reflect the local characteristics to get satisfactory results from experiences.
4) The Penman-Monteith method causes relatively higher accuracy both in dry and wet lands to be accepted with due satisfaction.

In view of the above, this study adopts the Penman-Monteith method to estimate the relative evapo-transpiration for crops.

The following meteorological data collected at Telafar and arranged are used to estimate the relative evapo-transpiration by Penman-Monteith method.

Table. Summary of meteorological observation data

Item / Month	Min. Temp.	Max. Temp.	Relative Humidity	Wind Speed	Sunshine
	℃	℃	%	km/day	hours
Jan	3.3	11.4	76.8	233.3	6.35
Feb	4.3	13.3	69.7	250.6	9.99
Mar	7.6	18.0	60.7	250.6	11.86
Apr	12.6	24.6	54.6	250.6	15.30
May	18.2	32.0	35.9	267.8	17.95
Jun	24.1	38.4	24.0	293.8	21.04
Jul	27.7	42.1	21.9	293.8	19.63
Aug	27.3	41.6	22.8	293.8	17.89
Sep	23.3	37.1	24.1	267.8	15.97
Oct	17.0	29.9	37.3	241.9	11.02
Nov	10.1	20.3	57.1	207.4	7.81
Dec	5.0	13.6	75.2	250.6	5.77
Average	15.0	26.9	46.7	258.5	13.4

In the calculation operation, the CROPWAT program (Ver. 8.0 for Windows) as provided by FAO was used. The calculation results are as shown in following Table. The annual fluctuation shows the highest in July by 11.8 mm/day and continuously fluctuates till it declines to the minimum at 1.28 mm/day. The annual mean is 6 mm/day and between the maximum and the minimum, difference reaches almost at 10 times (Max:11.8 mm, Min:1.28mm).

Table. Calculation results of relative evapo-transpiration

Month	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
ET_0(mm/day)	1.28	2.02	3.38	5.46	8.39	11.17	11.8	11.01	8.64	5.41	2.66	1.46	6.06

Of the total mean annual rainfall of 272 mm in the area, most of them appear in November-April period. It is important to utilize this rainfall for the crop production, and therefore in considering the water source management, irrigation water requirement shall be fixed after deducting the effective rainfall amount from the calculated evapo-transpiration amount.

FAO suggests several estimation methods of effective rainfall, of which the one developed by the Bureau of soil Conservation, US Department of Agriculture with due analysis on as many as 22 locations for the period of 50 years is to be adopted as can be calculated by CROPWAT program.

Given the result of estimation of effective rainfall in drought year , the effective rainfall is largely affected by the rainfall pattern and the manner of farm management too and it is desirable to examine further based on the daily basis rainfall data and the investigation results of soil moisture contents.

Table Results of estimation of effective rainfall

Month	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	34.9	28.7	33.7	16.6	8.8	0.5	0.1	0	0.4	7	14.7	30	175.4
Effective Rainfall (mm)	33	27.4	31.9	16.2	8.7	0.5	0.1	0	0.4	6.9	14.4	28.6	168.1

Further to the above, it is desirable to judge the scale of irrigation facilities after examining the occurrence frequency of peak requirement through conducting an irrigation simulation based on the daily basis data reflecting the rainfall pattern so as to grasp fully the effective rainfall.

6.3 Formulation of Farming Plan

6.3.1 Selection of Major Crops

In the Swiss F/S, cropping patterns are examined with having as many as 12 kinds of crops. Under the JICA Study, 1) higher-priority-given plans were reviewed/confirmed, 2) actual planting performance at the irrigated agriculture in nearby area was generally grasped and 3) hearing from the persons concerned was undertaken, and the justification of crops selected by Swiss F/S was generally confirmed. In addition, such potential crops were selected to be newly introduced and added in the proposed cropping pattern.

Following Table shows the ABC pattern and XYZ pattern of crops in the Swiss F/S report. The two patterns consist of the almost same crops each other but the share of each crop area differs. The cops have been selected considering the climate, soil depth, actual practice of cropping, demand, and crop water consumption in the Project area and these preconditions are still valid at present.

Table. Cropping Area per 100 ha

		ABC（ha）	XYZ(ha)	XYZ-ABC(ha)
		Cropping Area	Cropping Area	Difference
1	Winter alphalpha	14.6	16.7	2.1
2	Sugar beet	22.9	4.2	△18.7
3	Wheat	29.2	41.7	12.5
4	Barley	16.7	20.8	4.1
5	Field beans	8.3	8.3	0.0
6	Oat	1.0	4.2	3.2
7	Vetch	1.0	4.2	3.2
8	Berseem	6.3	-	△6.3
9	Potato	-	-	-
	Winter total	100.0	100.0	-
10	Summer alphalpha	12.5	12.5	-
11	Cotton	1.5	2.1	0.6
12	Maize	0.1	-	△0.1
13	Sunflower	0.1	-	△0.1
14	Chick pea	0.3	2.1	1.8
	Summer total	14.5	16.7	2.2
	Total	114.5	116.7	2.2

The National Development Plan (2010-2014), “Chapter 5 Agriculture and Water Resources“ recommends wheat, barley, potato, tomato, onion and rice in winter season, and maize and dates in summer season.

According to the report on the North Jazira area, the actually cultivated crops are wheat, barley, potato, sugar beet, sunflower and other vegetables.

Referring to the information of the Project area as well as the above information, proposed crops are selected. Following Table shows the candidate crops and the reasons of selection or non-selection.

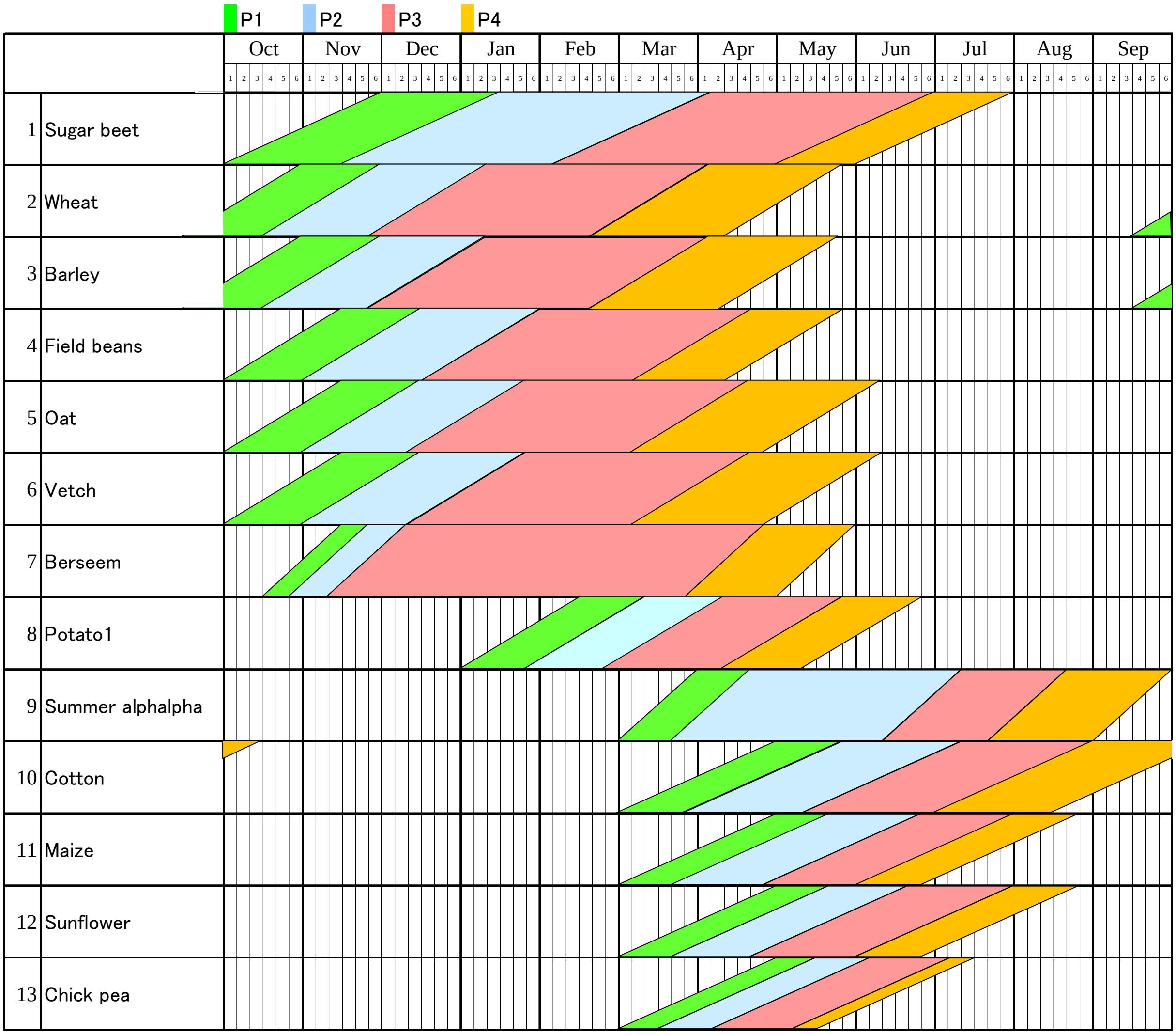
Table. Possibility of introducing crops

		Grounds Document				Possibility of Introduction	Reason of Selection / Non-selection
		F/S ABC	F/S XYZ	National Five-Year Pla	North Jazira		
	Winter Crop						
1	Winter alphalpha	○	○			○	Fodder for livestock, major industry in the Project area
2	Sugar beet	○	△		○	○	Actually cultivated in the Project area
3	Wheat	○	○	○	○	○	To secure staple food
4	Barley	○	○	○	○	○	Fodder for livestock, major industry in the Project area
5	Field beans	○	○			○	Actually cultivated in the Project area
6	Oat	○	○			○	Fodder for livestock, major industry in the Project area
7	vetch	○	○			○	Fodder for livestock, major industry in the Project area
8	Berseem	○				○	Fodder for livestock, major industry in the Project area
9	Potato			○	○	○	Actually cultivated in the Project area
10	Tomato			○			Labor will get short
11	Onion			○			Labor will get short
12	Rice			○			It may affect the layer of gypsum
13	Winter fruits						Water consumption is high
	Summer Crop						
14	Summer alphalpha	○	○			○	Fodder for livestock, major industry in the Project area
15	Cotton	○	○			○	Supply source of materials for major products in Mosul
16	Chick pea	○	○			○	Actually cultivated in the Project area
17	Maize	○		○		○	To secure staple food
18	Sunflower	○			○	○	Supply source of food oil
19	Summer fruits						Water consumption is high
	Perenial Crop						
20	Dates			○			Water consumption is high

6.3.2 Cropping Pattern

Cropping schedules of the selected crops as discussed in the foregoing sections are as shown in the following Table. Growing periods for crops were referred to the Swiss F/S and the ones not appearing in the F/S report, the periods were newly fixed based on hearings and the FAO’s technical manual No. 24. While for the starting time of planting, considerations were so given that the seasonal water consumption and the gross water consumption per annum will not be very large.. Further, the sowing and seedling periods were estimated to be shorter than the F/S, since the working efficiency of farm machineries would be much improved by introducing large-size field plot under the Project.

Table. Cropping pattern of introduced crop



6.3.3 Plan of Production

Following Table. shows the cropping areas of XYZ, ABC and the pattern with additional candidate crops to XYZ. Crop rotation in the Swiss F/S is planned as 8 year-rotation of one block of 100ha (2,000m×500m), hence one unit of crop rotation is 800ha. Furthermore, each XYZ and ABC pattern consists of 3 units of crop rotation, namely 2,400ha (800ha×3) as a total crop rotation block. Cropping area of ABC and XYZ patterns made by Swiss F/S are shown in the Table. Simultaneously, αβγ100 patterns proposed by study team is shown in the Table.

Table. Cropping Area by Crop in the Rotation Block (Cultivated Area: 2,400ha)

	Crops	Cropping Area（ha）		
		ABC	XYZ	αβγ100
1	Winter alphalpha	350	400	-
2	Sugar beet	550	100	200
3	Wheat	700	1,000	900
4	Barley	400	500	300
5	Field beans	200	200	100
6	Oat	25	100	100
7	Vetch	25	100	100
8	Berseem	150	-	100
9	Potato	-	-	100
	Winter total	2,400	2,400	1,900
10	Summer alphalpha	300	300	400
11	Cotton	37	50	25
12	Maize	3	-	25
13	Sunflower	3	-	25
14	Chick pea	8	50	25
	Summer total	350	400	500
	Total	2,750	2,800	2,400

Production by crops is calculated by multiplying cropping intensity per block with proposed yield as shown in Table 6.3-6.

Table. Crop Production of Rotation Block (Cultivated Area 2,400ha)

	Crops	Proposed Yield	Cropping Area（ha）			Production（ton/Year）		
		kg/ha	ABC	XYZ	αβγ100	ABC	XYZ	αβγ100
1	Winter alphalpha	7,000	350	400	-	2,450	2,800	-
2	Sugar beet	46,000	550	100	200	25,300	4,600	9,200
3	Wheat	5,600	700	1,000	900	3,920	5,600	5,040
4	Barley	5,200	400	500	300	2,080	2,600	1,560
5	Field beans	2,800	200	200	100	560	560	280
6	Oat	7,600	25	100	100	190	760	760
7	Vetch	7,600	25	100	100	190	760	760
8	Berseem	8,400	150	-	100	1,260	-	840
9	Potato	20,000	-	-	100	-	-	2,000
10	Summer alphalpha	7,000	300	300	400	2,100	2,100	2,800
11	Cotton	2,800	37	50	25	103	140	70
12	Maize	6,000	3	-	25	16	-	150
13	Sunflower	2,400	3	-	25	6	-	60
14	Chick pea	2,400	8	50	25	19	120	60

The cropping pattern is proposed considering 80% possibility drought year. Therefore, it is possible to cultivate proposed crops as scheduled even in drought year, which occurs at the frequency of once in five years. However, it is needed to reduce irrigation area according to the available water resource in severe drought year. Since it is difficult to predict occurrence of drought beforehand, decision on whether it is needed to reduce the irrigation area will be made based on the observation of precipitation and water level of the Mosul Dam. In case of unexpectedly severe drought, firstly, irrigation for summer vegetables (field beans, maize, and chick pea) and industrial crops (sugar beet, cotton, and sunflower) will be discontinued, secondly, one for feed crops (barley, summer alphalpha, oat, vetch, berseem) will be stopped. In case of much severe drought, irrigation area of staple food, namely, wheat will be reduced.

6.3.4 Seasonal Water Consumption

The Swiss F/S adopted the Pen-man formula for calculating the seasonal crop water consumption. While the JICA Study employs the Pen-man-Montis formula for the calculation as recommended by FAO with the following reasons as 1) Reappearance ratio is high, 2) service area is upland field and 3) reliability is high. The said two formulas uses the same relations among the unit duty of water, effective rainfall and crop factors though the calculation formula for the relative evapo-transpiration is different. The basic formula showing the relations is as indicated below.

In (Unit water requirement) = ETcrop − Pe

ETcrop (Crop evapo-transpiration) = ET_0 × Kc

ET_0: Evapo-transpiration for related crops

Pe: Effective rainfall

Kc: crop coefficient

(1) Data used for Estimating Seasonal Water Consumption

1) Evapo-transpiration for related crops (ET_0)

ET_0, relative evapo-transpiration derived from the Swiss F/S (Pen-man) and CROPWAT (Pen-man-Montis) are as shown in the following Table. The difference between the two is about 5 % only in terms of the annual total. While for the maximum value, the ET_0 by CROPWAT is larger than Swiss F/S by 15 % with the occurrence appeared in July in both cases.

Table Calculated ET_0 (mm/month) and ET_0 (mm/month) in the Swiss F/S

mm/month

ET_0	Calculation	Formula	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total mm/year
Swiss F/S	F/S report	Penman	190.0	106.0	51.0	49.0	59.0	103.0	147.0	226.0	276.0	316.0	314.0	261.0	2,098.0
Study Team	CROP WAT	Penman - Monteith	168.0	79.8	45.6	39.7	56.3	104.8	163.5	260.1	335.1	365.8	341.3	259.2	2,219.1

2) Crop coefficient (Kc)

Staged crop growth periods and crop factors as applied in the Swiss F/S shall be adopted in the present study. But for potato and alfalfa, the same shall refer to the FAO value. While for berseem, the values for grass at pasture as suggested by FAO were adopted.

Table Kc value at Crop growth stage-wise period (5 days unit) and the crop factors at the start and the end

	Crop	P1*2	P2*2	P3*2	P4*2	Kc ini	Kc mid	Kc end
1	Winter alphalpha*1	1	4	2	2	0.00	0.00	0.00
2	Sugar beet	9	16	17	6	0.35	1.20	1.00
3	Wheat	6	8	17	10	0.70	1.15	0.25
4	Barley	6	8	17	10	0.30	1.15	0.25
5	Field beans	6	9	16	7	0.40	1.10	0.30
6	Oat	6	8	17	10	0.30	1.15	0.25
7	Vetch	6	8	17	10	0.30	1.15	0.25
8	Berseem	2	3	27	7	0.40	1.15	1.10
9	Potato	5	6	9	6	0.50	1.15	0.75
10	Summer alphalpha*1	1	4	2	2	0.00	0.00	0.00
11	Cotton	5	9	10	9	0.35	1.20	0.70
12	Maize	4	7	7	5	0.30	1.15	1.05
13	Sunflower	4	6	8	5	0.35	1.15	0.35
14	Chick pea	3	4	6	2	0.50	1.15	1.10

*1 Cultivate 4 times.
*2 Unit: 1/6 month

3) Effective rainfall (Pe)

The effective rainfall (Pe) as adopted by the Swiss F/S and the effective rainfall as adopted by this study are shown in the following Table. Through multiplying the factor 0.91 as suggested by Swiss F/S, the rainfall of Telafar was converted to the rainfall at the Project beneficiary area. The results of conversion shows the annual mean rainfall of 272.3 mm/annum which is quite similar to the one in F/S report at 282.0 mm. Assuming the drought year but the rainfall amount still allow plants growing, the effective rainfall remains at smaller than the mean annual rainfall. The study team obtains input average monthly rainfall to CROPWAT program to get effective rainfall as result of calculation.

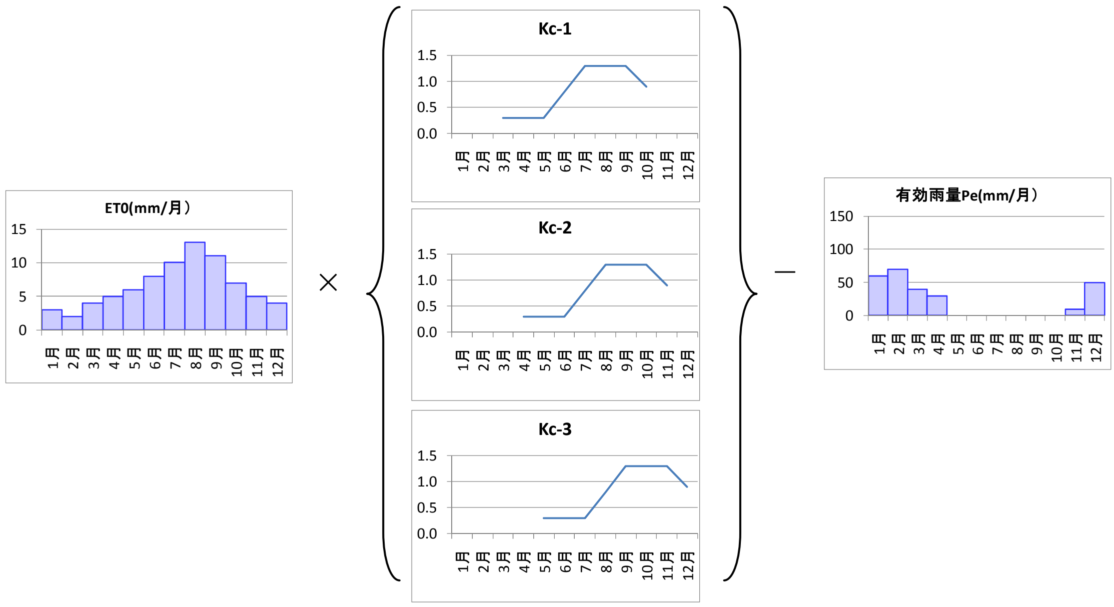
Table. Pe (effective rainfall (mm/month)) in the Study and Pe in the Swiss F/S

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total mm/year
Swiss F/S	Average Rainfall	5.0	22.0	49.0	50.0	41.0	49.0	49.0	17.0	0.0	0.0	0.0	0.0	282.0
	Effective Rainfall: Pe (80% probability)	0.0	14.0	14.0	12.0	10.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	58.0
Study Team	Average Rainfall	10.9	22.8	46.6	54.2	44.5	52.3	25.7	13.6	0.8	0.2	0.0	0.7	272.3
	Effective Rainfall: Pe (by CROPWAT)	6.9	14.4	28.6	33.0	27.4	31.9	16.2	8.7	0.5	0.1	0.0	0.4	168.1

* Average rainfall of study area is calculated by multiplication of average rainfall in Tel Afar station and conversion coefficient (0.91).

Proposed farming plan in this Project is to establish crop rotation system with 100ha (2,000m×500m) as a unit. Each crop operation will be carried out in series and therefore, sowing and planting operation will take long time (from 6 five-day to 12 five-day from the beginning to the end). For this reason, on the farm plot sown or planted in the early time and the plot sown or planted in the late time, ET_0 and Pe at the stage of crop growth will be different and that will affect the net water requirement (In).

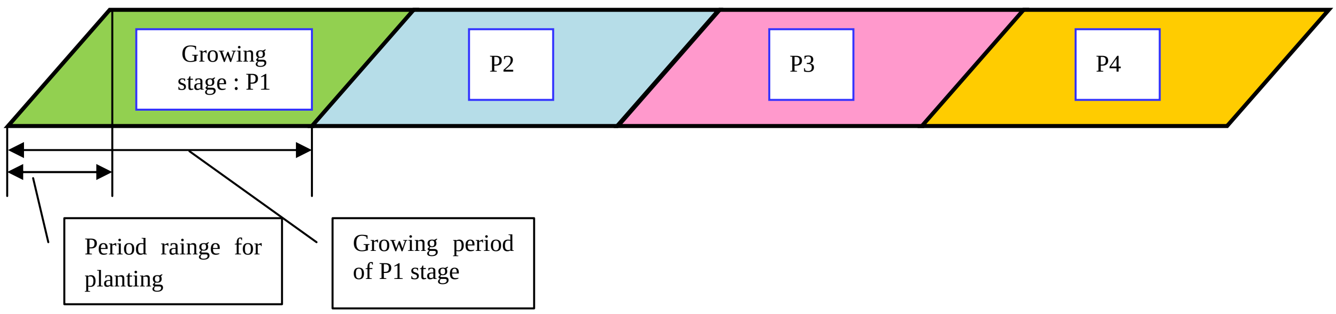
In order to consider this fact, unit water requirement per five-day is estimated by the period of sowing or planting as follows and summed up to come up with the total unit water requirement per five-day, illustration as shown in the following Fig.



Remarks: ET_0 to multiply and Pe to deduct will differ according to the earliness and lateness of sowing or planting period

Fig. Illustration of ETcrop calculation

The Swiss F/S adopted the same idea as mentioned above. The "Periods for activities to be done in order" under the subject Study has been fixed taking into account the seasonal crop water consumption as shown in the following table on the basis of the "Periods for activities to be done" indicated in the Swiss F/S.



4) Irrigation Efficiencies

Under the subject Study, introducing of large scale self-propelled sprinkler system is considered aiming at higher workability at the large size cultivation field and higher water use efficiency for limited resources, and then, the irrigation efficiency of 0.68 shall be adopted. To determine the gross irrigation requirements the irrigation efficiencies have to be taken into account, irrigation efficiencies was adapted as follows.

Table. Irrigation Efficiency

Irrigation Efficiency			Remarks
Application efficiency	e_a	0.80	Sprinkler system is planned.
Watercourse efficiency	e_b	0.95	Watercourse should be lined.
Conveyance efficiency	e_c	0.90	Distribution system should be lined.
Project efficiency	e_p	0.68	$= e_a \times e_b \times e_c$

6.3.5 Irrigated Agriculture Plan by Scenarios (Scenario-1,2,3)

Calculation was made to obtain the seasonal crop water consumption by using the CROPWAT program as recommended by FAO.

In order to calculate the seasonal water intake from Mosul Dam, the effective rainfall as discussed in the foregoing shall be adopted. While for determining the scale of hydraulic facility (i.e. design discharge of feeder canal), zero effective rainfall shall be applied to estimate the seasonal crop water requirement and the maximum value is fixed as the design discharge. This is a countermeasure to the prevailing condition that there are lacks of data/information about the rainfall and water holding capacity of soils in the project area.

The ET_0 resulted from CROPWAT program calculation is as shown in the following Table.

Table. Monthly water duty for varieties of crops (mm/month)

mm/month

Crops	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total mm/year
Winter alphalpha	165.1	80.7	45.1	39.4	55.7	35.4	0.0	0.0	0.0	0.0	0.0	141.3	562.7
Sugar beet	16.6	22.7	21.2	29.7	59.0	127.2	201.0	305.1	247.2	67.2	0.0	0.0	1,096.9
Wheat	70.9	66.4	48.5	46.2	65.6	107.0	86.9	22.3	0.0	0.0	0.0	9.3	523.1
Barley	37.2	43.8	44.6	46.2	65.6	107.0	86.9	22.3	0.0	0.0	0.0	4.0	457.6
Field beans	37.7	41.2	41.6	44.2	63.0	104.6	58.5	1.1	0.0	0.0	0.0	0.0	391.9
Oat	19.1	30.6	37.7	45.4	65.8	116.0	118.2	51.2	0.9	0.0	0.0	0.0	484.9
Vetch	19.1	30.6	37.7	45.4	65.8	116.0	118.2	51.2	0.9	0.0	0.0	0.0	484.9
Berseem	11.1	59.5	53.0	46.4	66.0	123.4	186.5	99.1	0.0	0.0	0.0	0.0	645.0
Potato	0.0	0.0	0.0	8.5	36.4	110.4	189.0	204.1	49.6	0.0	0.0	0.0	598.0
Summer alphalpha	0.0	0.0	0.0	0.0	0.0	67.3	164.3	260.8	337.2	369.4	336.0	84.5	1,619.5
Cotton	3.6	0.0	0.0	0.0	0.0	12.2	66.6	216.6	386.4	434.2	309.1	94.3	1,523.0
Maize	0.0	0.0	0.0	0.0	0.0	11.1	74.5	238.7	373.3	245.6	43.4	0.0	986.6
Sunflower	0.0	0.0	0.0	0.0	0.0	12.9	83.7	251.4	344.0	188.9	21.6	0.0	902.5
Chick pea	0.0	0.0	0.0	0.0	0.0	19.8	113.6	247.1	165.0	13.8	0.0	0.0	559.3
ET0	168.0	79.8	45.6	39.7	56.3	104.8	163.5	260.1	335.1	365.8	341.3	259.2	2,219.1

It was confirmed that there are layers of gypsum in the Project Area. If sufficient water is irrigated there, peroration water can reach to the layers of gypsum and dissolve them, which can lead to differential settlement in the farmlands. Therefore, following countermeasures are proposed:

1) Only farmlands which have gypsum layers at deep layer can be irrigated
2) Irrigation plan (irrigation intensity and irrigation interval) considering water holding capacity of soil is proposed

In "Chapter 6.1 Irrigation Service Area", farmlands which have deeper soil layers than 50cm is decided as irrigation targets, therefore, this definition can be applied in 1) above mentioned. Concerning 2) above, it is needed to limit irrigation volume to the consumable amount by the evapo-transpiration and to keep percolation water from reaching to the gypsum layers. In other words, it is proposed to irrigate a small amount of water at short interval. Moreover, it is necessary to measure soil water holding capacity in advance, it is recommended to include it in the measurement items, which will be implemented in the pilot farm.

6.4 Irrigated agriculture plans for each Scenario

Through multiplying the cropping acreages with the monthly water duty by CRPWAT, the seasonal crop water consumption can be computed. On this basis, the annual water consumption (Gross intake per annum) and the seasonal peak consumption (Design discharge) shall be worked out. The results may differ depending on the acreages to be irrigated. Under the present study, four (4) scenarios were fixed for different irrigation areas and the corresponding seasonal consumption shall be calculated, result shown below Table.

It is noted that the annual total of crop water consumption (Intake quantity per annum) is the accumulation of the seasonal crop water consumptions as computed by CROPWAT program with the inputs of effective rainfall based on the monthly basis rainfall data. While for the seasonal (Peak) consumption (Design discharge) is the maximum consumption quantity as resulted by CROPWAT computation with zero effective rainfall.

Table. Irrigation areas for each scenario (ha)

	Scenario-0	Scenario-1	Scenario-2	Scenario-3
Irrigation Service Area	148,600	119,000	86,800	59,500

6.4.1 Volume of water consumption

The proportions of planted are for each crop shall refer to the "Table 6.3-4 Crop rotation block" and applying the cropping pattern αβγ100, unit water duty of each crop, irrigation acreages and irrigation efficiency of 0.68, the seasonal crop water consumptions for each scenario are calculated as indicated in the following Table.

(1) Scenario-0: irrigation area is 148,600ha

In case of the Scenario-0 in which the irrigation area becomes the largest, the gross annual water intake reahes at 1,390 Million m^3/annum and the amount will decrease in accordance with the decrease in irrigation area. During the period of July-August, the relative evapo-transpiration, ET_0 of crops becomes the highest, but, the seasonal consumption amount is comparatively small with having a limited planted area.

Table. Annual Water Consumption (BCM/year) of Scenario-0: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝148,600

Scenario-0	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	73	62	26	20	63	156	228	223	201	167	131	41	1,390

(2) Scenario-1: irrigation area is 119,000ha

Scenario-1 targets the Project Area excluding western plateau where pump is needed. The total annual water intake reaches at 1,113 Million m^3/annum.

Table. Annual Water Consumption (BCM/year) of Scenario-1: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝119,000

Scenario-1	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	58	50	21	16	50	125	182	179	161	134	105	33	1,113

(3) Scenario -2: irrigation area is 86,800ha

Scenario-2 plans to irrigate 86,800ha and the total annual water intake is 812 Million m^3/annum.

Table. Annual Water Consumption (BCM/year) of Scenario-2: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝86,800

Scenario-2	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	42	36	15	12	37	91	133	130	117	97	76	24	812

(4) Scenario-3: irrigation area is 59,500ha

The service area of Scenario is 59,500ha and the total annual water intake is 557 Million m^3/annum.

Table. Annual Water Consumption (BCM/year) of Scenario-3: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝59,500													
Scenario-3	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	29	25	10	8	25	62	91	89	80	67	52	17	557

(1) Scenario-0: irrigation area is 148,600ha

Since the maximum monthly discharge calculated is at 100.4 m^3/sec, the design discharge is set at 100 m^3/sec. The crop intensity becomes high in winter when Crop evapo-transpiration (ETo) is low and monthly discharge becomes biggest in April.

Table. Design Discharge (m^3/sec) of Scenario-0: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝148,600													
Scenario-0	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m3/sec)	30.6	32.9	27.5	28.2	42.2	84.0	100.4	90.1	77.7	64.4	50.5	16.1	100.4

(2) Scenario-1: irrigation area is 119,000ha

Since the maximum monthly discharge calculated at 80.4 m^3/sec, the design discharge is set at 80 m^3/sec.

Table. Design Discharge (m^3/sec) of Scenario-1: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝119,000													
Scenario-1	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m3/sec)	24.5	26.3	22.0	22.6	33.8	67.3	80.4	72.2	62.2	51.6	40.4	12.9	80.4

(3) Scenario-2: irrigation area is 86,800ha

Since the maximum monthly discharge calculated at 58.6 m^3/sec, the design discharge is set at 60 m^3/sec.

Table. Design Discharge (m^3/sec) of Scenario-2: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝86,800													
Scenario-2	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m3/sec)	17.9	19.2	16.1	16.5	24.7	49.1	58.6	52.7	45.4	37.6	29.5	9.4	58.6

(4) Scenario-3: irrigation area is 59,500ha

Since the maximum monthly discharge calculated at 40.2 m^3/sec, the design discharge is set at 40 m^3/sec.

Table. Design Discharge (m^3/sec) of Scenario-3: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝59,500													
Scenario-3	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m3/sec)	12.2	13.2	11.0	11.3	16.9	33.6	40.2	36.1	31.1	25.8	20.2	6.4	40.2

6.5 Impacts on Livestock Farming by the Project

(1) Effects by the Irrigation Project

Livestock farming is richly operated in the South Jazira, and barley and residuum of wheat are utilized for animal feeding staff. The project can contribute to promotion of the livestock farming in South Jazira as follows:

① Increase of feed crop production
② Provision of water for livestock
③ Stable feed crop production

Concerning ① mentioned above, total income is regarded as project effect as well as other crops. In case of ② above, it is difficult to estimate the effect caused by change of water resource (from salty underground water to little salty river water). The calculation method to estimate the quantitative effect of ③ mentioned above has yet to be established, however, it is possible to examine the qualitative ones. The effects are described as below.

(2) Effects by Stable Feed Crop Production

1) Reduction of feed crop transportation cost

Since feed crop production depends on rainfall, the production can be decreased in drought year, which leads to shortage of animal feeding staff. If livestock farmers in the area purchase feed crops from other areas to supply a deficit at present, they can save transportation cost by purchase of feed crops in the area after the project completion.

2) Expansion of size of business

The livestock farmers can control their livestock numbers as scheduled by stable supply of feed crops by the Project. It means that they can expand their sizes of business in line with available amount of feed crops and they will not have to sell their livestock at the low price in drought years, which will lead to improvement and stability for the farmers' house incomes.

3) Introduction of big livestock

Stable supply of feed crops and water for livestock enable the livestock farmers to introduce big livestock, namely, beef cattle and dairy cow instead of goats and sheep, which can contribute to income improvement.

7. OUTLINE DESIGN OF FEEDER CANAL

7.1 General Outline of Canal System

Feeder canal is an irrigation water conveyance system from Mosul Dam built on the Tigris River as the water source to South Jazira Irrigation Project area located about 60 km South-west from the Dam. Intake facilities for South Jazira area have ever been planned as follows by the preceding "Mosul Scheme 4 of the Mosul Dam Project" and the same will constitute the basics for the present planning as shown in following Fig.

1) Components of intake facilities: Intake work at Dam - Feeder tunnel - Pumping Station /By-pass pipeline - Transition
2) Transfer water level: WL 310.00 m

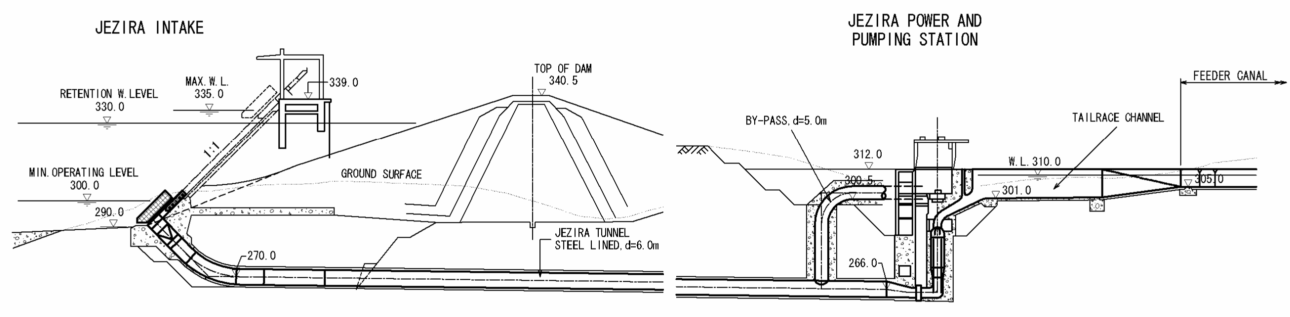


Fig. Map showing the outline of Intake Facilities

The subject system of feeder canal is planned applying the concept of water control by upstream water level with supply-side commanding water management system.

1) The system is of large scale and long distance open canal for water conveyance.
2) Transfer water level at the start of feeder canal is to be controlled /regulated under dam operation side.
3) Water resource at the dam reservoir is in very tight situation.

7.2 Calculation of Design Discharge

The design discharge of feeder canal can be obtained by the following formula and the design discharge for the Scenario-0, Scenario-1 and Scenario-2 are as indicated in the following Table.

Design discharge (m^3/sec) = Maximum water requirement (m^3/sec/ha) / Irrigation efficiency x Irrigation area (ha)

Table. Design discharge of feeder canal for each scenario

Scenario	Unit water requirement (m^3/sec/ha)	Irrigation efficiency	Irrigation area (ha)	Design discharge (m^3/s)
0	0.0004594	0.68	148,600	100
1			119,000	80
2			86,800	60

7.3 Alternative Design

7.3.1 Selection of alternative designs

Concerning the water conveyance to South Jazira area, a comparison study is made to fix the ultimate feeder canal system based mainly on the Swiss F/S (1984) and Iraqi D/D report (1991). Matters to be paid with due attention in selecting the alternatives are as follows;

1) Water source is Mosul Dam and the transfer water level is fixed at WL. 310.00m.
2) Topographically, plateaus are extended from Mosul Dam with the elevations ranging EL 300.00-EL 320.00m, and there is Mt Jabel Shekh Ibrahim with the peak elevation over 550.00 m located at the northern part of the beneficiary area.
3) The project beneficiary area is provided with considerable elevation difference ranging from EL. 220.00 to EL. 320.00m.
4) Water level required at the diversion site located at the northern part of the beneficiary area is approximately WL. 297.50 m.

As the water conveyance system between the 37 km position of the feeder canal to the diversion site at the upstream-most of beneficiary area, two (2) alternatives, namely, tunnel by-passing and pumping scheme can be considered.

Alternative 1: Tunnel   Alternative 2: Pumping

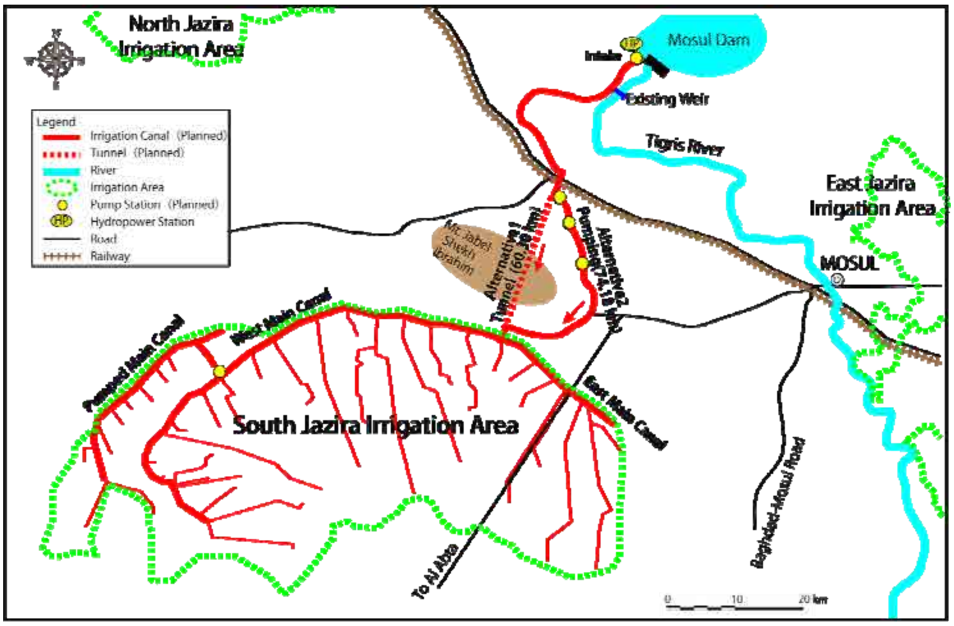
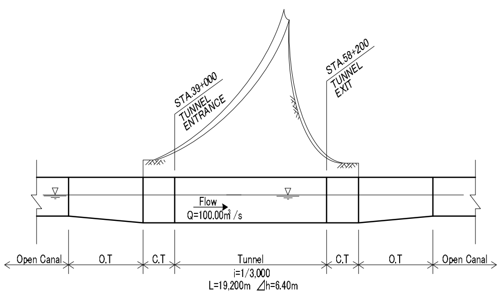
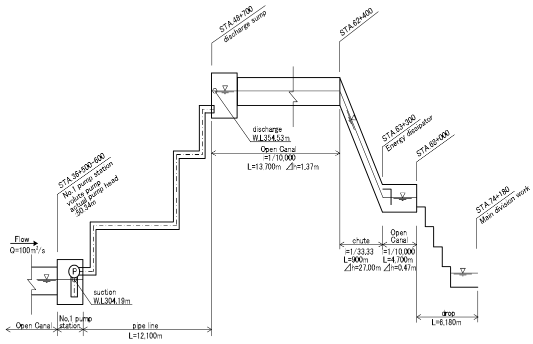


Fig. Schematic Drawing of the Alternatives for Water Conveyance System

7.3.2 Determination of Water Conveyance System by Feeder Canal

Following Table. shows all the items examined for comparison of alternatives selected. Through the comparison studies as made, the tunnel system shall be selected with advantages in economic aspect (Initial cost and running cost) as well as the easiness in O&M works.

Table. Composition of Alternatives for Water Conveyance System

<table>
<tr><th colspan="2">Items</th><th>Tunnel</th><th>Pumping</th></tr>
<tr><td rowspan="2">Composition of works</td><td>Main Features</td><td>・ Open canal for flat land and tunnel for mountainous portions
・ Minimum distance to the diversion point at upstream beneficiary area.
・ Design discharge：Q＝100m³/sec
・ Tunnel works
Non-pressure tunnel：standard horse-shoe type（2R horse-shoe）
2R＝7.90m</td><td>・ Detour mountainous portion and feed the water to diversion point by pumping through plateau area
・ Design discharge：Q＝100m³/sec
・ Pump Spec（High lift）
Type：centrifugal pump
Actual head：68m
Number of unit：11 units (including one unit as a spare)
Discharge：10m³/sec/unit
Dia.：φ1,900mm×φ1,500mm
Power output：9,200kw/unit</td></tr>
<tr><td>Drawings</td><td></td><td></td></tr>
<tr><td rowspan="2">O&M</td><td>Easiness</td><td>・ Easy</td><td>・ Difficult</td></tr>
<tr><td>Comments</td><td>・ In principle, maintenance free.
・ Easy in inspection and repairing as compared with pumping case.
・ By controlling water level, the discharge can be controlled without difficulty.</td><td>・ Necessary to assign supervising. electrical/mechanical engineers and no much advantage in O&M.
・ There are many consumable spare parts in pumping devices.
・ No safety in pressured pipes in case of sudden stoppage and starting of pumps.
・ To control the discharge control on water level, pump units number and number of rotation is necessary to be inferior in easier water management practice.</td></tr>
<tr><td colspan="2">Economic Aspect</td><td>・Cheaper initial cost than pump

Construction Cost :333 Billion ID
Low Cost
(1.00)</td><td>・ Higher initial cost than tunnel and moreover, energy cost is needed for operation.
Construction Cost : 465 Billion ID
High Cost
(1.40)</td></tr>
<tr><td colspan="2">Environmental Consideration</td><td>Land acquisition is needed for the feeder canal construction, however, the area is 900ha, which is small compared with the that of Alternative-2.</td><td>The land area to be acquired for feeder canal construction is 1,200ha, which can give more adverse effect on social environment than Alternative-1.</td></tr>
<tr><td colspan="2">Result</td><td>◎</td><td>△</td></tr>
</table>

7.4 Study on the Route of Feeder Canal

7.4.1 Basic ideas

Routing for the feeder canal shall be determined in a way that the system may be provided with the higher stability in terms of hydraulics through taking due considerations of roads network and villages/residential areas as confirmed by satellite images.

For securing stabilized hydraulic condition for the system, the center line of the feeder canal shall follow the following requirements;

1) Minimum radius : Radius of routing center line shall be larger than 10 times of canal width (Water surface)
2) Max bend angle : (θ) shall be less than 60°
3) Alignment in case of turning side by side : If bending part turns side by side, avoid to connect bend by bend by inserting straight line of longer than 6 B

7.4.2 Tunnel plan

Tunnel alignment shall be layout at the upstream part of beneficiary area (Main diversion work) with the least distance, paying due attentions on the following items.

1) Basically, a straight line shall be adopted judging from the topographical and geological conditions of the natural ground and the easiness in construction works.
2) In order to prevent from collapsing of natural ground surface slope and distorted pressure action on tunnel, layout in parallel with land sliding area and mountain slope shall be avoided. The layout is preferable at the symmetrical center of natural ground with right angle where geological condition is stable with low earth pressure.
3) The portal of tunnel is the place facing unstable earth pressure always, therefore, in layout, collapsed soil ground, talus cone and valleys in which effects of rainfall is very likely shall be avoided.
4) Locations shall be so selected that the noise and vibration at the tunnel portal will not cause disturbances on the villages nearby.

7.4.3 Pumping scheme

Routing of feeder canal in case of pumping scheme was selected to detour on the comparatively lower elevated plateau (About EL. 360 m) situated at the eastern side of Mt. Jabel Shekh Ibrahim (EL. 550 m plus) in the northern part of the beneficiary area and connect with the upstream part of the beneficiary area (Main diversion work).

7.5 Designing of Feeder Canal by Scenarios

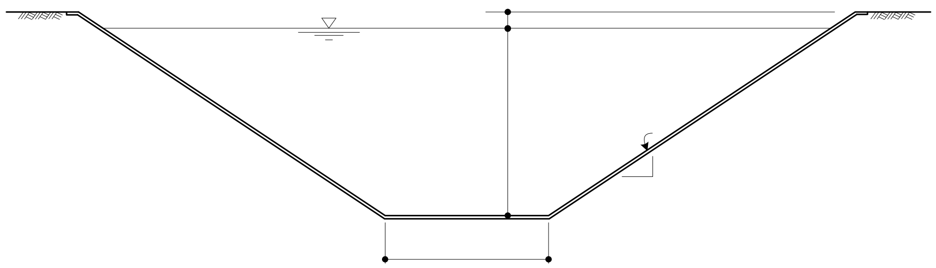
7.5.1 Open Channel

The cross-section of open canal shall be of uniformed flow and economically advantageous by adopting a trapezoidal figure allowing the minimum excavation volume and length for lining based on the averaged ground level of the open canal cross-section.

Major dimensions of open canal for each scenario shall be confirmed as the following Table.

Table. Major dimensions of open canal

Dimensions			Scenerio-0	Scenerio-1	Scenerio-2
Canal bed width:	B	(m)	5.00	4.00	4.00
Water depth	d	(m)	5.51	5.22	4.58
Canal free board	Fb	(m)	0.49	0.48	0.42
Wall hight (d+Fb)	H	(m)	6.00	5.70	5.00

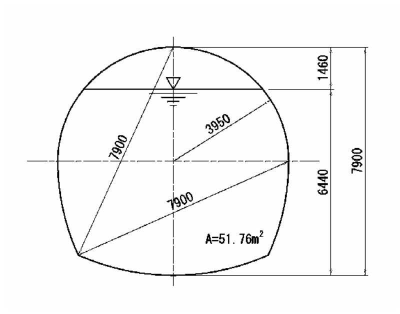
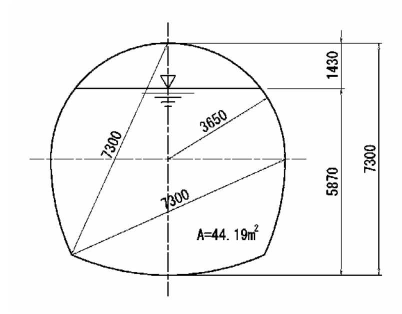
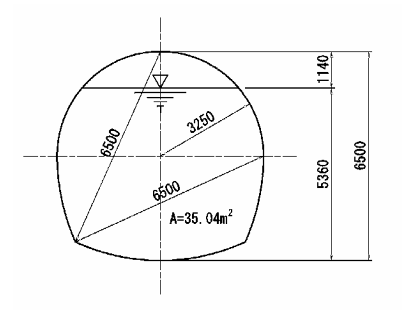


7.5.2 Tunnel

In case considering the whole of feeder canal system as one hydraulic unit, the tunnel works will cause higher cost than open canal. Then, when discussing the gradient of longitudinal profile of tunnel, it is necessary to minimize the cross-section of tunnel by setting the gradient as steep as possible by using the maximum head available in the tunnel section, the gradient of tunnel profile shall be fixed at I = 1/3,000 for each scenario.

The cross-section of tunnel shall be determined through examining the characteristics on hydraulics and structural necessity, easiness in construction and the economy point of view. Standard horse-shoe type (2R) (Non-pressured) shall be adopted due to the advantages in free selection of geological conditions and less inner section area (Excavation volume). Those tunnel cross-sections for each scenario case shall be shown in the following Table.

Table. Tunnel cross sections for each scenario

Scenario-0	Scenario-1	Scenario-2
Discharge Q=100m^3/sec 2R=7.90m Inner Cross-section A=51.76m^2	Discharge Q=80m^3/sec 2R=7.30m Inner Cross-section A=44.19m^2	Discharge Q=60m^3/sec 2R=6.50m Inner Cross-section A=35.04m^2
		

For the construction method, it should take into consideration that the designed tunnel is relatively wide in cross-section such as 2R standard horseshoe shape (2R = 6.50m) and the inner cross-section area (A = 35.04 m^2). Also considering the following reasons, New Austrian Tunneling Method (NATM Method) is adopted for the construction.

1) This method is to build flexible structure support so that the behavior of the structure is integrated with the ground. Hence this method is superior for the structural stability of the tunnel for long term.
2) The method has advantage for construction and economy compared with other rigid structure support, as the looseness of the ground becomes smaller and time for self-sustainability of the unlined tunnel surface is longer with this method. That can make the unit length of excavation longer to other methods.
3) As the flexible structure can reduce the thickness of concrete, it gives economic advantage.
4) The method has been adopted for many tunnels of middle and large cross-section.

Given that the length of proposed tunnel is 19km, which needs long construction period, it can lead to delay of whole feeder canal construction. Therefore, it is needed to shorten the tunnel construction period for early benefit generation corresponding to the Agriculture Development Plan of Ninevah Governorate (Five-Year Plan of Water Resource Development Strategy). Therefore, it is proposed to divide the construction section into four sub-sections by setting three pit mouths, namely, the entrance, exit and way point of the tunnel.

Scenario-0 : 4years and 6month (54 months)
Scenario-1 : 4years and 3months (51months)
Scenario-2 : 3years and 10months (46months)

7.5.3 Pump facilities

The location of pump station shall be examined with comparison for the following 2 cases.

- Plan A : 3 stations

Pumping stations shall be planned at 3 locations of No.37 + 700, No.41 +500 and No. 48 + 0. Each station shall have the lift capacity of H=17 m and among each station, open canal is availed for water conveyance.

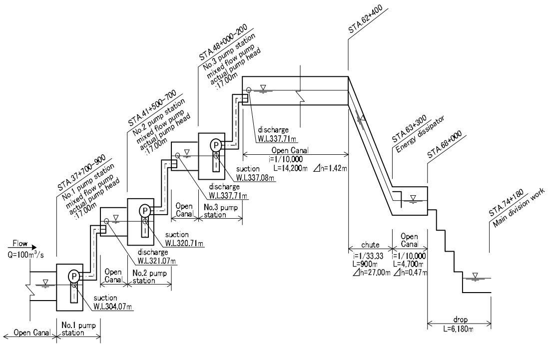
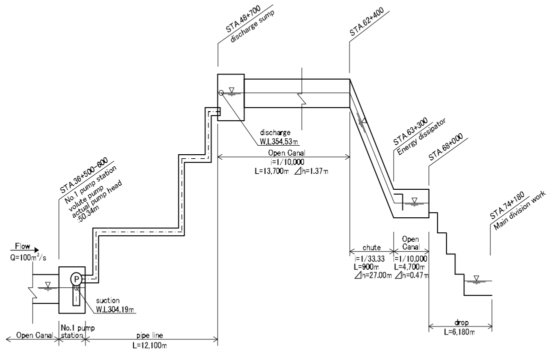
- Plan B : 1 station
  1 station is located at No. 36 + 500. The lift shall be H=50 m and pressured pipeline is provided for water conveyance to the station No. 48 + 700.

The number of pump units per station is to be determined through examining various relevant factors as capacities of wide-use pumps, flexibility to cope with the seasonal fluctuations of discharges, easiness in operation and maintenance (Availability of spare-parts and risk diversification during the damages occurred and etc. Under the subject study, it was so decided to plan as many as 10 units of pumps per a station with the number of experiences of 10 m3/sec capacity as large scale pumping project in the past.

- Design discharge per a station: Q = 100 m^3/sec
- Pump capacity/ unit: Q = 10 m^3/sec/unit
- Number of units /station: N = 10 units

The results of comparison studies on 2 cases of pump station locations are presented in the following Table . From the comparison, the Plan B, 1 station plan is selected as the manner of water conveyance by pump, which is more advantageous than Plan A in O&M easiness and higher economic viability.

Table Comparison of Alternatives on Number of Pump Stations

<table>
<tr><th colspan="2">Items</th><th>Alternative A (3 Stations)</th><th>Alternative B (1 Station)</th></tr>
<tr><td rowspan="2">Composition of Works</td><td>Main Features</td><td>▪ 3 steps of low lift pump be provided for pumping water to open canal at the highest level.
▪ Design Discharge：Q＝100m^3/sec
▪ Pump Specs（Low lift pump）
Type：Inclined vertical pump
Actual head：17m×3 steps
Number of unit：11 units ×3 steps (including one unit as a spare)
Discharge：10m^3/sec/ unit
Dia.：φ2,200
Power output：2,200kw/ unit</td><td>▪ 1 step of high lift pump and pump up the water to the highest level by pipeline.
▪ Design Discharge：Q＝100m^3/sec
▪ Pump Specs（High lift pump）
Type：Centrifugal pump
Actual head：68m
Number of unit : 11 units (including one unit as a spare)
Discharge：10m^3/sec/ unit
Dia.：φ1,900mm×φ1,500mm
Power output：9,200kw/unit</td></tr>
<tr><td>Drawings</td><td>
</td><td>
</td></tr>
<tr><td rowspan="2">O&M</td><td>Easiness</td><td>▪ Difficult</td><td>▪ Easier than A due to less number of pump unit</td></tr>
<tr><td>Comments</td><td>▪ Need to assign electrical/mechanical engineers for each of 3 stations and not advantageous in O&M.
▪ Due to more number of pump units as compared to alternative B, inferior in O&M aspect with more consumables.
▪ To control discharge, operation on water level, number of units and adjustment on rotation are necessary.
▪ Collaborations among the stations are necessary, requiring more sophisticated operation techniques in O&M works.</td><td>▪ Advantageous with less number of pumping equipment than A.
▪ Inferior tin safety of pipeline structure in case of sudden stoppage and starting.
▪ For discharge control, not easy operation is required, but easier than A with less number of stations.
▪ Pumping efficiency is higher than A though not much.</td></tr>
<tr><td colspan="2">Economic Aspect</td><td>Construction cost :511Billion ID
High Cost
(1.10)</td><td>Construction cost :465Billion ID
Low Cost
(1.00)</td></tr>
<tr><td colspan="2">Result</td><td>△</td><td>◎</td></tr>
</table>

8. OUTLINE DESIGN OF IRRIGATION FACILITIES

8.1 Irrigation Network

Irrigation area by blocks is shown in below Table;

Table. Irrigation area by blocks

Main Canal	Area Name	Soil Depth Area (≧50cm) ①	Area Suitable for Irrigation ②	Sinario 0 Q=100m³/s	Sinario 1 Q=80m³/s	Sinario 2 Q=60m³/s
				Share of Cultivated Area ③		75.6%
East Main Canal	E1	8,600	6,500	6,500	6,500	6,500
	E2	15,300	11,500	11,500	11,500	11,500
	E3	6,700	5,100	5,100	5,100	5,100
	E4	14,100	10,700	10,700	10,700	10,700
Wast Main Canal	W1	7,700	5,800	5,800	5,800	5,800
	W2	12,200	9,200	9,200	9,200	9,200
	W3	17,500	13,300	13,300	13,300	13,300
	W4	20,700	15,600	15,600	15,600	15,600
	W5	4,800	3,700	3,700	3,700	3,700
	W6	7,200	5,400	5,400	5,400	5,400
	W7	6,300	4,800	4,800	4,800	
	W8	8,100	6,100	6,100	6,100	
	W9	7,900	6,000	6,000	6,000	
	W10	6,400	4,900	4,900	4,900	
	W11	13,700	10,400	10,400	10,400	
Pumped Main Canal	P1	3,600	2,700	2,700		
	P2	6,000	4,600	4,600		
	P3	6,000	4,500	4,500		
	P4	6,500	4,900	4,900		
	P5	7,700	5,800	5,800		
	P6	9,400	7,100	7,100		
TOTAL		196,400	148,600	148,600	119,000	86,800

Area Suitable for Irrigation ② ＝Soil Depth Area (≧50cm) ① × Share of Cultivated Area ③ / 100

Irrigation water of main canal will be calculated based on maximum daily consumptive water use, irrigation efficiency and irrigation area and the calculation process is shown below;

Irrigation water amount of Main Canal (m^3/s)

=Maximum daily consumptive water use (m^3/sec/ha) / Irrigation efficiency × Irrigation area (ha)

Irrigation efficiency : 0.68

8.2 Preliminary Design of Main Canal

Preliminary design of tunnel route will be drawn up.

The cross section of main canal shall be of uniformed flow and economically advantageous by adopting a trapezoidal figure allowing the minimum excavation volume and length for lining based on the same cross section as feeder and open canal.

Dimension of cross section for main canal by scenarios are as shown in following Tables.

Table. Dimension of Cross Section for Main Canal (Scenario 0)

TYPE		HYDRAULIC DATA				GEOMETRICAL DATA				
		Q m3/s	S m/m	n	v m/s	Fr	B m	d m	Fb m	H m
EAST CANAL	EMC_01	23	0.0005	0.015	1.729	0.37	2.50	2.26	0.34	2.60
	EMC_02	19	0.0005	0.015	1.647	0.37	2.50	2.06	0.32	2.40
	EMC_03	11	0.0005	0.015	1.431	0.36	2.40	1.60	0.28	1.90
	EMC_04	8	0.0005	0.015	1.328	0.34	1.70	1.52	0.27	1.80
WEST CANAL	WMC_01	77	0.00005	0.015	0.974	0.14	9.40	4.77	0.41	5.20
	WMC_02	73	0.00005	0.015	0.961	0.14	9.20	4.68	0.41	5.10
	WMC_03	67	0.00005	0.015	0.940	0.14	9.10	4.50	0.40	4.90
	WMC_04	58	0.00005	0.015	0.905	0.14	8.90	4.21	0.38	4.60
	WMC_05	48	0.00005	0.015	0.863	0.14	8.30	3.92	0.37	4.30
	WMC_06	45	0.00005	0.015	0.849	0.14	8.10	3.83	0.36	4.20
	WMC_07	26	0.00005	0.015	0.735	0.14	7.40	2.98	0.31	3.30
	WMC_08	22	0.00005	0.015	0.705	0.13	7.00	2.79	0.30	3.10
	WMC_09	19	0.00005	0.015	0.685	0.13	5.80	2.78	0.30	3.10
	WMC_10	15	0.00005	0.015	0.650	0.13	4.50	2.70	0.30	3.00
	WMC_11	11	0.00005	0.015	0.606	0.12	3.10	2.60	0.29	2.90
	WMC_12	7	0.00005	0.015	0.540	0.12	2.90	2.13	0.26	2.40
PUMPED MAIN CANAL	PMC_1	2	0.0001	0.015	0.512	0.15	1.60	1.17	0.22	1.40
	PMC_2	18	0.0001	0.015	0.888	0.17	3.50	2.69	0.30	3.00
	PMC_3	15	0.0001	0.015	0.850	0.17	2.90	2.60	0.30	2.90
	PMC_4	12	0.0001	0.015	0.805	0.16	2.20	2.50	0.29	2.80
	PMC_5	9	0.0001	0.015	0.749	0.16	2.10	2.22	0.28	2.50
	PMC_6	5	0.0001	0.015	0.646	0.16	1.80	1.75	0.25	2.00

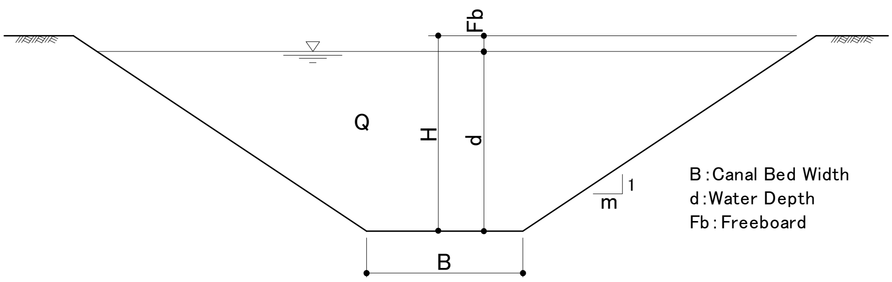


Table. Dimension of Cross Section for Main Canal (Scenario 1)

TYPE		HYDRAULIC DATA				GEOMETRICAL DATA				
		Q m3/s	S m/m	n	v m/s	Fr	B m	d m	Fb m	H m
EAST CANAL	EMC_01	23	0.0005	0.015	1.729	0.37	2.50	2.26	0.34	2.60
	EMC_02	19	0.0005	0.015	1.647	0.37	2.50	2.06	0.32	2.40
	EMC_03	11	0.0005	0.015	1.431	0.36	2.40	1.60	0.28	1.90
	EMC_04	8	0.0005	0.015	1.328	0.34	1.70	1.52	0.27	1.80
WEST CANAL	WMC_01	57	0.00005	0.015	0.902	0.14	8.70	4.21	0.38	4.60
	WMC_02	53	0.00005	0.015	0.886	0.14	8.40	4.11	0.38	4.50
	WMC_03	47	0.00005	0.015	0.860	0.14	8.00	3.93	0.37	4.30
	WMC_04	38	0.00005	0.015	0.816	0.14	7.30	3.65	0.35	4.00
	WMC_05	28	0.00005	0.015	0.756	0.13	6.50	3.25	0.33	3.60
	WMC_06	26	0.00005	0.015	0.742	0.13	6.30	3.17	0.32	3.50
	WMC_07	22	0.00005	0.015	0.712	0.13	5.90	2.98	0.31	3.30
	WMC_08	19	0.00005	0.015	0.691	0.13	4.80	2.97	0.31	3.30
	WMC_09	15	0.00005	0.015	0.652	0.12	4.10	2.78	0.30	3.10
	WMC_10	11	0.00005	0.015	0.602	0.12	4.00	2.40	0.28	2.70
	WMC_11	7	0.00005	0.015	0.540	0.12	2.90	2.13	0.26	2.40

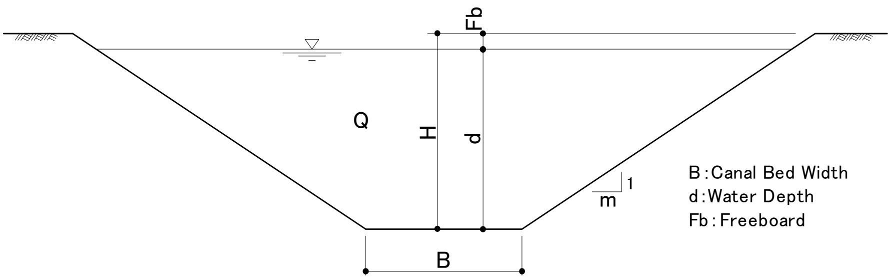
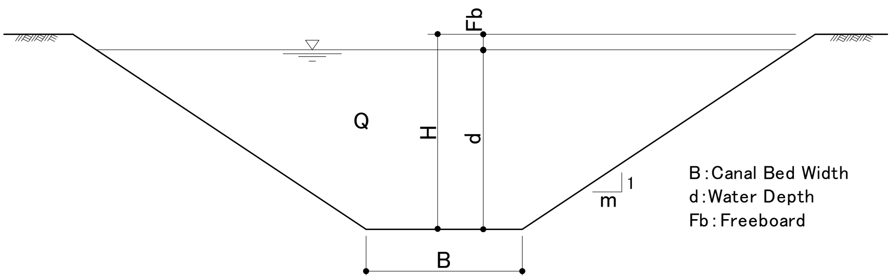


Table. Dimension of Cross Section for Main Canal (Scenario 2)

TYPE		HYDRAULIC DATA				GEOMETRICAL DATA				
		Q m3/s	S m/m	n	v m/s	Fr	B m	d m	Fb m	H m
EAST CANAL	EMC_01	23	0.0005	0.015	1.729	0.37	2.50	2.26	0.34	2.60
	EMC_02	19	0.0005	0.015	1.647	0.37	2.50	2.06	0.32	2.40
	EMC_03	11	0.0005	0.015	1.431	0.36	2.40	1.60	0.28	1.90
	EMC_04	8	0.0005	0.015	1.328	0.34	1.70	1.52	0.27	1.80
WEST CANAL	WMC_01	36	0.00005	0.015	0.804	0.14	7.30	3.55	0.34	3.90
	WMC_02	32	0.00005	0.015	0.782	0.13	6.70	3.45	0.34	3.80
	WMC_03	26	0.00005	0.015	0.742	0.13	6.30	3.17	0.32	3.50
	WMC_04	17	0.00005	0.015	0.664	0.13	6.00	2.59	0.29	2.90
	WMC_05	7	0.00005	0.015	0.538	0.12	3.40	2.02	0.26	2.30
	WMC_06	4	0.00005	0.015	0.470	0.11	2.30	1.74	0.24	2.00



8.3 Drainage System

It is considered that present drainage condition has less influence to farming because groundwater level in the beneficial area of the project is a few meters beneath the surface of the ground according to well survey. However, it will be feared that groundwater level will be raised by capillary action caused by rising of amount of water in the soil along with the supply of irrigation water

Eluviation of gypsum layer spread under the topsoil will be caused by rising of groundwater level and it will also lead to roughness of the land of canal, roads and farm land. Therefore, drainage system will be adopted to avoid the rain water or excessive amounts of irrigation water not to influence to conservation of farm land, growing harvest and work efficiency of farm equipment.

Drainage system will be set up to create water dispersion from farmland to avoid stagnant rain water in the farm land taking into account the land features of the beneficial area. Drainage water flows to field drain first and then goes to branch drain through collector drain, and finally water reach to wadi

Most of the beneficial area belongs to Wadi Thartar watershed and drainage water reach to Thartar Lake through each wadi.

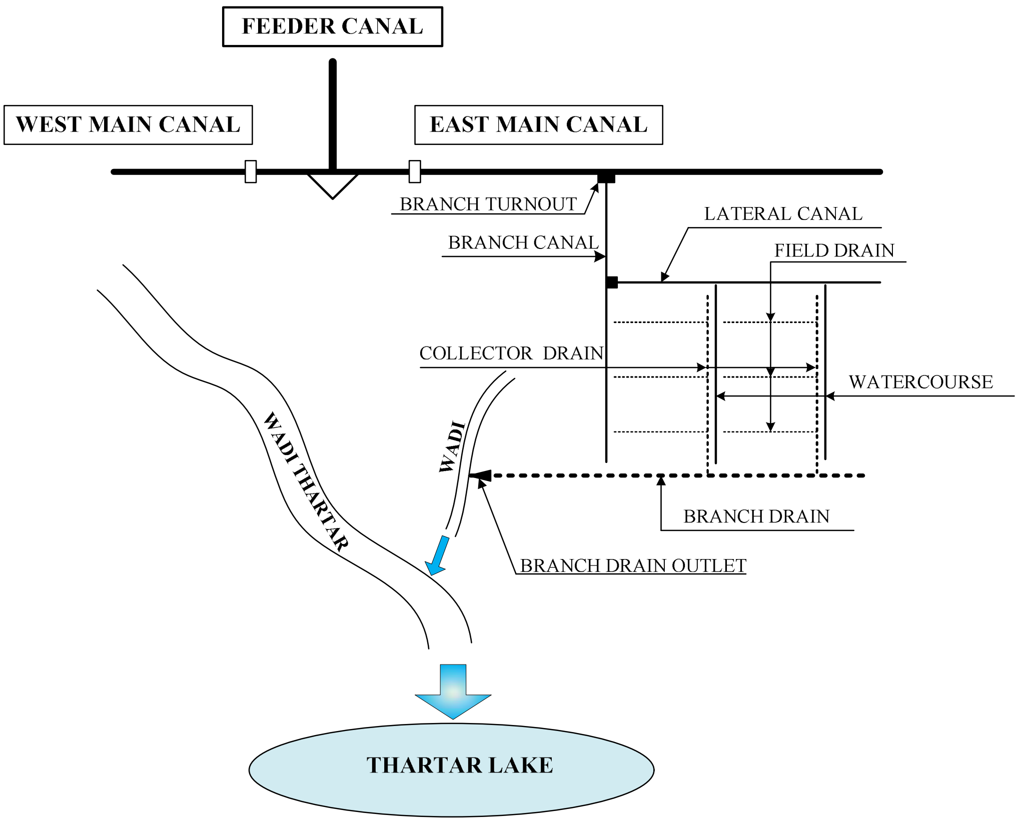


Fig. Drainage System

9. PROJECT IMPLEMENTATION PLAN

9.1 Construction Schedule

Implementation schedule of the Project is as shown in following Tables.

Table. Implementation Schedule (Scenario 0 : with Pump)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										12
Canals, Roads and Networks (Pumped Canal)										12
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

Table. Implementation Schedule (Scenario 0 : without Pump)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										12
Canals, Roads and Networks (Pumped Canal)										12
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

Table. Implementation Schedule (Scenario 1)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										12
Canals, Roads and Networks (Pumped Canal)										
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

Table. Implementation Schedule (Scenario 2)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station		■	■	■						
Feeder Canal & related structure		■	■	■	■					
Tunnel on Feeder Canal		■	■	■	■					
Electrical supply system				■	■	■				
Canals, Roads and Networks (East Canal)					■	■	■			14
Canals, Roads and Networks (West Canal)										
Phase 1						■	■			12
Phase 2						■	■	■		12
Phase 3										
Canals, Roads and Networks (Pumped Canal)										
Pumping Station on West Canal										
Pump Houses in Sprinkler System						■	■	■		
Sprinkler Systems							■	■	■	

9.2 Construction Cost

Cost estimation in each of Scenarios is shown in following Table.

Table. Construction cost estimation in each of Scenarios (Billion ID) 1 USD=1,170 ID

Work Type		Scenario 0 (With pump)	Scenario 1	Scenario 2
1. Feeder canal	1) Open canal	152	136	121
	2) Tunnel	181	165	142
Sub-total		**333**	**300**	**264**
2. Canal, road and canal net works (East canal) **Sub-total**		**109**	**109**	**109**
3. Canal, road and canal net works (West canal)	1) Phase 1	111	103	94
	2) Phase 2	147	132	78
	3) Phase 3	92	92	-
Sub-total		**350**	**327**	**171**
4. Canal, road and networks (Pumped canal)	1)Canal network	112	-	-
	2)Pump station	86	-	-
Sub-total		**198**	-	-
5. Sprinkler system	1)Pump house	111	89	65
	2)Sprinkler	488	391	285
Sub-total		**599**	**480**	**350**
6. Power and pumping station	1)Power and pumping	176	140	105
	2)Electrical supply	45	41	36
Sub-total		**221**	**181**	**141**
Total		**1,809**	**1,397**	**1,035**

9.3 Operation and Maintenance (O&M)

9.3.1 Outline

While O&M is divided into two(2) categories, one is for water management to distribute appropriate water amount to farm lands and the other is to maintain function of irrigation facilities properly.

Since "Supply-driven canal system" is adopted by controlling discharge at the Mosul dam, it is important to distribute irrigation water rationally and properly to the vast beneficial areas of the Project. Basic process of the water management is as follows;

1) In-charge of dam operation at intake should decide the releasing amount of irrigation water based on the request from the demand side of beneficiaries' group by weekly.
2) Based on the above decision, in-charge of water control should make schedule of water distribution including gate operation plan.
3) The above water distribution plan should be informed to all over the operators at main and branch as well as terminal canals thoroughly.

Maintenance aiming for proper and safe operation of the irrigation facilities is categorized by stages of 1)operation, 2) inspection and 3)repair and replacing.

Since the above stage, "3)repair and replacing" is required large investment for long term and / or large scale of replacement, it should be out of the scope. Then, outline for O&M of the facilities in two(2) stages of 1)operation, 2)checking is as shown in following Table.

Table. Outline of O&M for the irrigation facilities

<table>
<tr><td colspan="3">cycle
Item</td><td>During operation</td><td>Regularly (daily/weekly)</td><td>Monthly</td><td>Yearly</td></tr>
<tr><td rowspan="2">Facilities,</td><td>Movable facilities</td><td>1)Gate
2)Valve
3)Pump
4)Sprinkler
5)Remote control
6)Measurement equipment</td><td>checking during operation

at trouble</td><td>Regular inspection

Maintenance</td><td>Regular check

Regular maintenance</td><td>Overhaul

Replacement partly</td></tr>
<tr><td>Facilities</td><td>1)Irrigation canal
2)Drainage canal
3)Road
4)Architect</td><td></td><td>Patrol
1)removal of driftwood</td><td>Patrol</td><td>Patrol
1)Remove the weeds
2)De-silting
3)Repair of pavement
4)Others</td></tr>
<tr><td colspan="3">Management of the facilities</td><td>Operation management</td><td colspan="3">Inspection / Maintenance</td></tr>
</table>

9.3.2 Management system and Man-Month Schedule

On the basis of the above outline of water management and maintenance of facilities, organization chart of management structure is proposed as shown in following Figure.

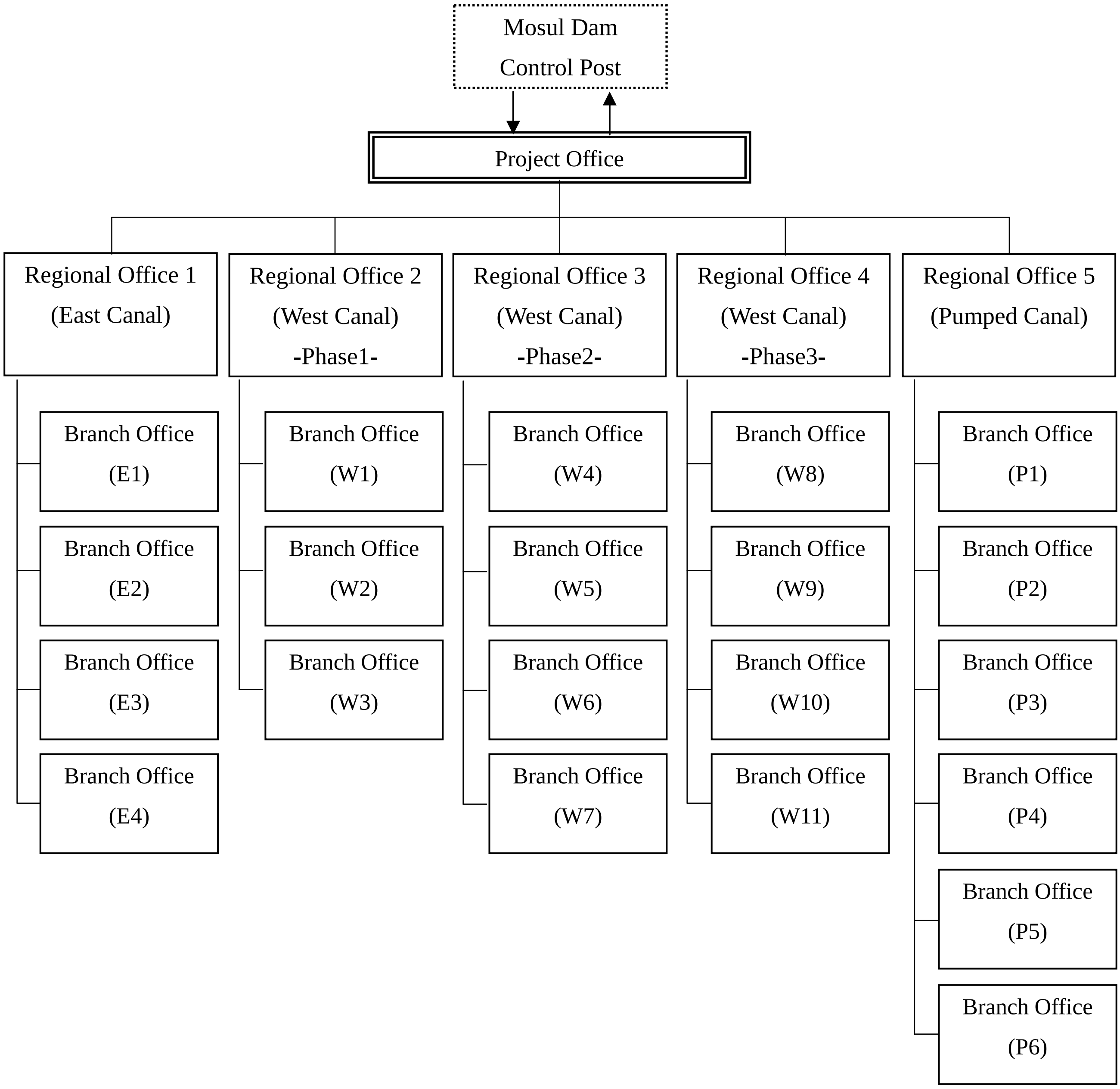


Fig. Organization chart of management structure

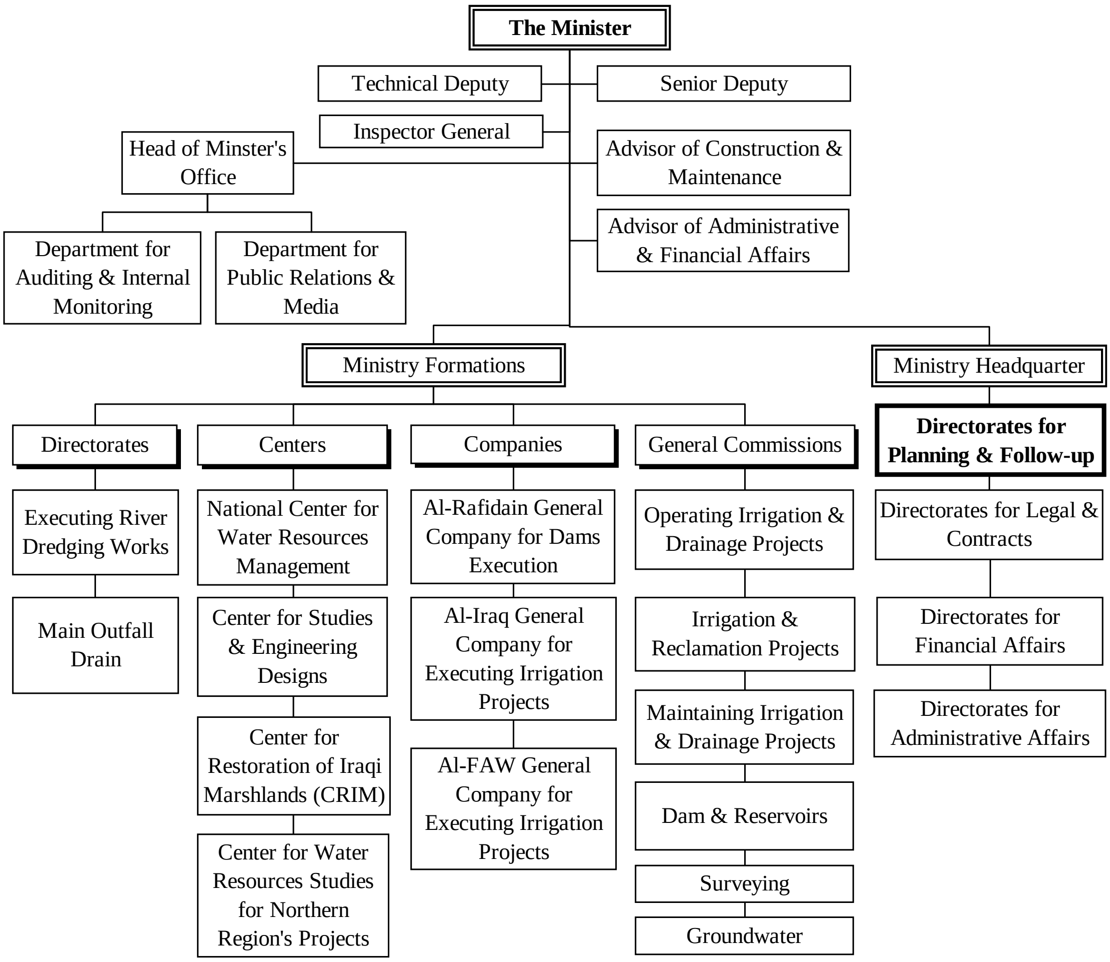
9.4 Project Implementation Structure

9.3.3 Implementation Agencies

The Ministry of Water Resources (MOWR) of GOI is directly responsible for the Project implementation of which the Ministry's organization chart is shown as in the following Fig. "Centers" is one of the four(4) core Ministry Formations under MOWR where such institutions for survey and research on water resources development and management are clustered.

Further to mention, the "Directorate for Planning & Follow-up" is positioned as Ministry Headquarter to be in charge of planning and monitoring on overall national policy on water resources development and management. The said Directorate assumes the member-ship of the Steering

Committee organized for the South Jazira Irrigation Project.



Source: MOWR, GOI

Fig. Organization chart of MOWR

The number of personnel employed by MOWR reveals at about 25,000 nation-wide as shown in the following Table. Of the total, more or less 30 % are of engineering and/or professional designations and assigned at the Ministry's central office at Baghdad and Directorate offices in each governorate. Of the total, as much as 70 % of personnel is shared by regular employment officials.

Table. Number of personnel under MOWR (2010)

Categories	Engineer	Technician	Sub-total	Administrative, others	Total
1) Permanent	3,119	3,417	6,536	10,420	16,956 (68.7%)
2) Temporary	121	136	257	630	887
3) Contract	104	263	367	2,813	3,180
4) Employee	19	111	130	3,538	3,668
Total	3,363	3,927	7,290 (29.5%)	17,401	24,691

Source: MOWR, GOI

9.3.4 Capacity of Implementation Agencies

The annual budgets allocated for MOWR and MOA, Ministry of Agriculture, one of the members of SC, are as shown in the following Table. Steady growth of the budgets allocated for both Ministries can be observed from the Table.

Table. Budgets allocated for MOWR and MOA (2006-2011)

Unit: Billion ID, 1USD=1,170 ID

Financial year	MOWR	MOA	National budget (as reference)
2006	299.7	36.7	46,449
2007	338.7	62.8	47,970
2008	1,057.1	179.4	81,900
2009	701.1	181.9	78,390
2010	1,161.7	209.4	86,229
2011	1,376.5	321.8	80,028

Source: MOWR, MOP, and HP of MOF, GOI

As per the NDP (2010-2014), GOI aims at the target of annual mean GDP growth at 9.38 % per annum and expects due contribution by agriculture/fishery sector accordingly. However, the share by the said sector during the last 5 years period had been declined from 14.3 % in 2003 to 9.2 % in 2007 as indicated in following Table. Moreover, the share is projected to be further decreased in future as shown in the said Table.

Table. Changes of GDP share by agriculture/fishery sector

(Unit: Billion ID, at year 1988 prices)

	Performance					Estimation (Increase by ratio of 9.38%)					
Year	2003	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014
GDP	26,990	41,608	43,439	47,851	48,511	54,654	59,781	65,388	71,522	78,230	85,568
Agriculture sector	3,850	4,522	5,940	6,196	4,480	4,443	4,465	4,898	5,143	5,400	5,670
Ratio	14.3%	10.9%	13.7%	12.9%	9.2%	8.1%	7.8%	7.5%	7.2%	6.9%	6.6%

Source: National Development Plan (201102014), GOI

While GOI emphasizes the importance of manufacturing sector (Including oil and electric power) in it's investment plan under the NDP with the remarkable share as large as 30 % towards the overall improvement and re-construction of national socio-economic infrastructure, the share by the agriculture sector is also considerably high at 9.5 % with paying due attention to the national food security.

Table. Sector-wise development budget in Iraq

(Unit: Billion ID 1USD=1,170 ID)

Sector /Financial year	2011-14	(%)	2010	2011	2012	2013	2014
1. Agriculture	**11,115**	**(9.5)**	**1,238**	**2,284**	**2,720**	**2,342**	**2,531**
2. Industry (incl. Oil, Electricity)	35,100	(30.0)	7,509	6,510	6,615	6,394	8,072
3. Transportation & communication	10,530	(9.0)	1,271	1,951	2,126	2,326	2,855
4. Construction, building & services	19,890	(17.0)	6,119	5,964	3,846	2,145	1,815
5. Education	5,850	(5.0)	877	1,373	1,305	1,213	1,082
6. Province development	14,625	(12.5)	2,500	3,031	3,031	3,031	3,031
7. Kurdistan region	19,890	(17.0)	-	-	-	-	-
Total	117,000	(100)	(19,515)	(21,113)	(19,643)	(17,452)	(19,388)

Source: National Development Plan (2010-2014), GOI

The annual investment budgets for water resources development/improvement during the period

2010-2014 by the MOWR are as shown in the following Table. Five year's total budget reveals at 32,500 Billion ID (Approx. 28 Billion USD), of which about 49 % is allocated for "Item 2.Irrigation and drainage" so as to achieve as large as 1 million ha irrigation development in the planned 5 years period. The irrigation and drainage development item is followed by the cost item for "Item 1. Dam & reservoir (33 %)". The total of the said two(2) items exceeds 80 % of the total. It is considered that the budget for the South Jazira Irrigation Projects is included in the "Item 2. Irrigation & drainage projects".

Table. MOWR's yearly budget for development/investment (2011-2014)

(Unit: Billion ID, 1USD=1,170 ID)

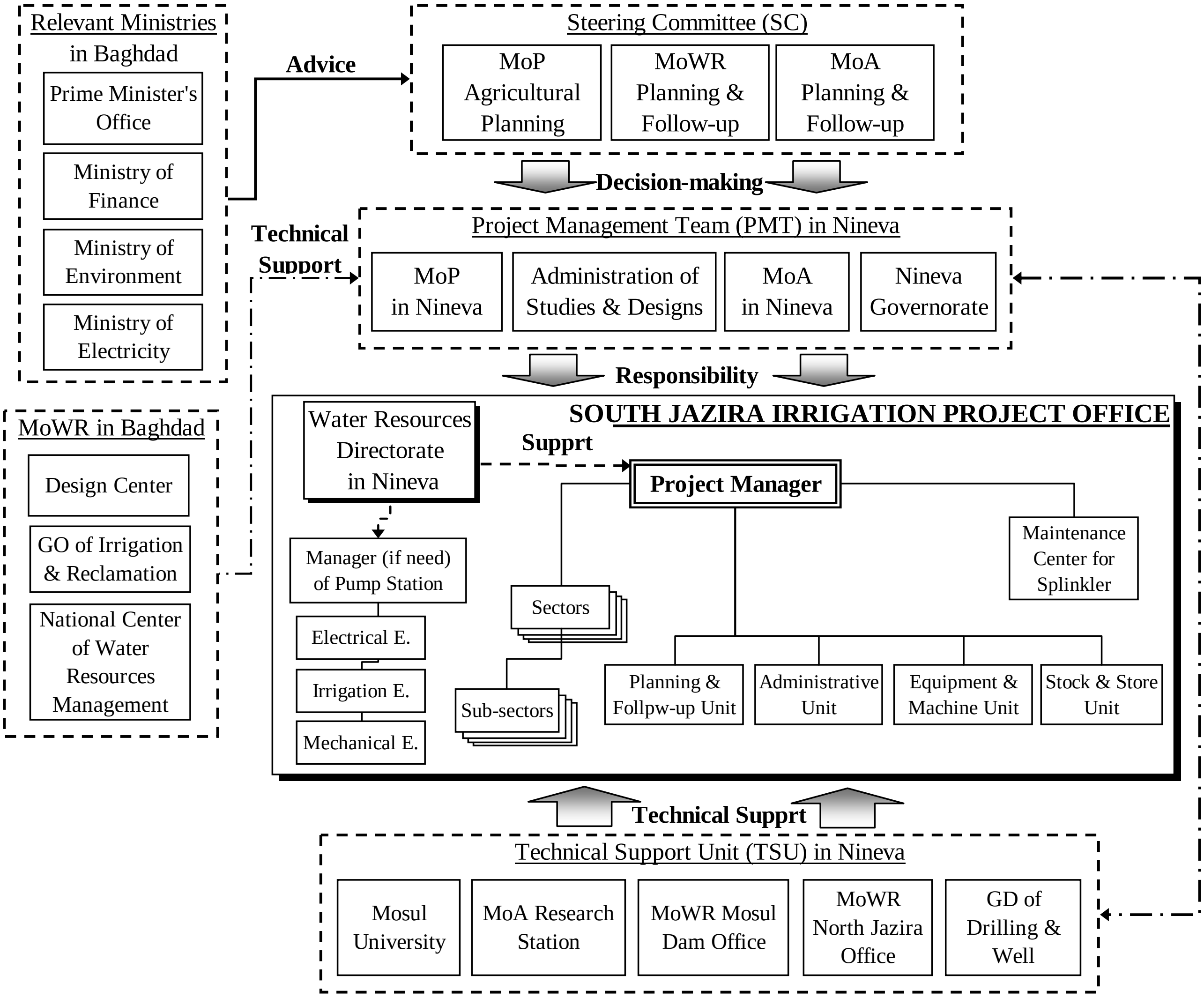
	Financial year	2011-14	(%)	2010	2011	2012	2013	2014
1.	Dams & reservoirs	10,817	(33.3)	2,329	2,852	2,620	1,675	1,342
2.	Irrigation & drainage projects Reclaiming area (unit: 1,000 ha)	16,020 (1,001)	(49.2)	2,436 (152)	3,040 (190)	3,304 (207)	3,580 (224)	3,660 (229)
3.	Outfall drain	584	(1.8)	179	99	108	108	90
4.	Operating irrigation & reclamation projects	1,205	(3.7)	223	238	255	270	220
5.	Maintaining irrigation & drainage project	1,156	(3.6)	277	248	208	209	214
6.	Directorate for executing river dredging works	256	(0.8)	91	72	50	28	15
7.	Center for restoration of Iraqi marshlands (CRIM)	83	(0.3)	20	18	15	15	15
8.	Center for studies & engineering designs	49	(0.2)	10	10	10	10	10
9.	Surveying	15	(0.0)	3	3	3	3	3
10.	National center for water resources management	121	(0.4)	26	30	33	15	18
11.	Directorate for main outfall drain	177	(0.5)	51	27	25	37	37
12.	Groundwater (5,000 nos.)	752	(2.3)	125	130	148	158	191
13.	Ministry head office	1,263	(3.9)	253	253	253	253	253
	Total	32,497	(100)	6,023	7,018	7,029	6,360	6,068

Source: Water Resources Development Strategies (2010-2014), MOWR, GOI

In view of the policies involved in the NDP, personnel availability and budget allocation in future as confirmed above, it can be judged that GOI is provided with sufficient capability to implement the subject South Jazira Irrigation Project.

9.3.5 Project Implementation Structure (Draft)

Based on the Project Implementation Structure as indicated in the Minutes of Discussions signed and exchanged by and between the project executing agencies concerned of GOI and the JICA Fact Finding Mission on July 2009, the following project implementation structure as following Fig. is proposed.



Source: Added to "the Chart of Proposed Implementation Structure of the Project" in the Minutes of Discussions, on Fact Finding Meeting, July 2009」

Fig. Project implementation structure (draft)

10. ENVIRONMENTAL AND SOCIAL CONSIDERATION (EIA REPORT)

10.1 Pre-condition for Environmental and Social Consideration

According to “the Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, 2002”, all kinds of projects are sorted into any of Category A, Category B and Category C, taking consideration into potential environmental impacts, magnitude and scale of the projects and so on. Based on the Guideline, the project is classified into Category A, which is likely to have significant adverse impact on the environment, the proponent of the Project is requested to prepare an EIA report. In general, there is no significant difference between Iraqi EIA report contents and Japanese ones. Therefore, the Guideline mentioned above can be applicable for the Study. According to the M/M on the Study exchanged in August 2010 between Iraqi side (MoP, MoWR and MoA) and JICA, the EIA shall be carried out by the MoWR, and the JICA Study Team shall support this process.

At this moment, the decision on whether the Project would be implemented, has yet to be made.

In addition to that, due to the security issues in Iraq, it is difficult to implement detailed site surveys. Therefore, it is proposed to prepare a part of the EIA report based on the secondary data during the Study and to implement a full-scale EIA after the final decision on the project implementation as needed. Detail contents of EIA report stipulated by JICA are shown below and a part of items are not covered by the Study and they will be examined in the full-scale EIA.

10.1.1 Description of Proposed Project

The proposed main project components are as follows:

Table. Main Components of the Proposed Project

Facilities	Scale	Remarks
Feeder canal	Alternative-1:Tunnel Plan (Scenario 0) Feeder canal: 60.30km long Tunnel length: 19.1km long for all the Scenarios Tunnel cross section; Scenario 0: 2R=7.90m, A=51.76m^2 Scenario 1: 2R=7.30m, 44.19m^2 Scenario 2: 2R=6.50m, 35.04m^2 Alternative-2: Pump Plan (Scenario 0) Feeder canal 74.18km long, one pump system and 10 vorticose pumps	Since both of the proposed alternatives go across the railway and road, it is needed to prepare tentative constructions. In case of Alternative-2, electrical consumption and area of land acquired will be more that those in case of Alternative-1.
Main Canal	Scenario 0: Three lines of canal 122.1km long and one pump system Scenario 1: Two lines of canal 94.4km long Scenario 2: Two lines of canal 57.1km long	It is needed to acquire land for the proposed main canal construction.
Branch Canal	Scenario 0: 39 lines of canal 363.3km long Scenario 1: 32 lines of canal 329.9km long Scenario 2: 20 lines of canal 257.2km long	It is needed to acquire land for the proposed branch canal construction.
Pump	Alternative-2: 11 units of pumps (φ1,900mm × φ1,500mm)	
Sprinkler	Scenario 0: 1,500 sets Scenario 1: 1,200 sets Scenario 2: 900 sets	

10.1.2 Baseline Data of Environmental and Social Conditions

Please see "3. CONDITION OF THE STUDY AREA" of this Summary.

10.1.3 Policy, Legal and Administrative Framework in Iraq

After the war against the USA in 2003, the Ministry of Environment (MoE) was newly set up in September 2003. The MoE has a mission to protect environment and the people in Iraq from pollutions and risks. In addition, environmental standard setting, policy formation and modification of laws are parts of their tasks. It is responsible for concerns in various sectors such as economic development, energy, transportation, agriculture, industry, trade and so on. Moreover, the Law for Protection and Improvement of Environment was revised once again in 2005, the draft final version of the law is available at present.

The Chapter Six, Item-15 of the law above emphasizes the necessity of Environmental Impact Assessment (EIA) prior to project implementation. Some environmental studies based on the existing data have been implemented, however, no full-scale EIA level studies are not done. As for 2010, operational guideline describing EIA procedures and proceeding is still under preparation.

However, the Study Team received the comment that it is needed to implement EIA for the Study at the meeting on Interim Report in November 2011. In addition to that, it is necessary to include following contents for EIA report of any irrigation projects according to the Letter No.549 issued by the MoWR.

- General description of the project
- Objectives and positive impacts of the project
- Probable adverse effects caused by the project
- Mitigation and prevention measures against the adverse effects
- Monitoring of environmental impacts during construction and other periods
- Conclusion and recommendation

As mentioned before, EIA was supposed to be implemented by MoWR and the JICA Study Team shall support this process. However, SWLRI is still ongoing, right conditions to implement EIA on the Study by MoWR have yet to be fulfilled.

Many of environmental standards in Iraq were established in 1960s and they are still effective. Applicable standards for the Study are Iraqi National Standards for Ambient Air Quality, Iraqi National Water Quality Standards and Iraqi National Wastewater Discharge Limit Standards.

10.1.4 Analysis of Alternatives including Zero-option

The Study mainly examines the Alternative-1 (Tunnel Plan) and the Alternative-2 (Pump Plan), the Alternative-1 has 3 scenarios (Scenario 0, Scenario 1, and Scenario 2), while the Alternative-2 has only one scenario as shown below:

Alternative	Scenario	Quantity of water intake
Alternative-1: tunnel	Scenario 0	$100m^3/s$
Alternative-1: tunnel	Scenario 1	$80m^3/s$
Alternative-1: tunnel	Scenario 2	$60m^3/s$
Alternative-2: pump	Scenario 0	$100m^3/s$

The scale of anticipated environmental impacts can be different depending on the scenarios within the Alternative-1. For example, the more water is taken from the Mosul Dam, the more area can be irrigated, which will lead to more land acquisition due to bigger scale construction of irrigation facilities. However, the anticipated environmental parameters will not be diverse among the scenarios mentioned above. Therefore, the Scenario 0 is regarded as the representative among three (3) scenarios of Alternative-1 hereinafter and three (3) options, namely, 1) Zero-option (no project implementation), 2) Alternative-1 (Scenario 0 of Tunnel Plan, quantity of water intake: $100m^3/s$) and 3) Alternative-2 (Pump Plan, quantity of water intake: $100m^3/s$) are examined in terms of environmental impacts, economical efficiency, technical aspects and so on.

Summarized examination result of the proposed alternatives is shown in the following table. At this moment, it can be said that the optimum alternative is Alternative-1 compared with Alternative-2 and Zero-option.

Table. Examination of the Proposed Alternatives

Items/ Options	Zero-option	Alternative-1 (Tunnel: Scenario-0)	Alternative-2 (Pump: Scenario-0)
Start and endpoint of feeder canal *	—	Start : Mosul Dam power plant, Endpoint: starting point of main canal in South Jazira	Start : Mosul Dam power plant, Endpoint: starting point of main canal in South Jazira
Length of feeder canal	—	60.3km	74.18 km
Irrigation area	0ha	148,600 ha	148,600 ha
Pathway of feeder canal	—	The feeder canal will go across the road, railway and Mt. Jabel Shekh Ibrahim.	The feeder canal will go across the road and railway.
Land use in and around project area	—	Farmland or desert	Farmland or desert
Project cost[1]		333 Billion ID	465 Billion ID
Operation and Maintenance	—	△Operation and maintenance is relatively easy and its cost is also low compared with that of the Alternative-2 due to the gravity utilization. Moreover, control of flow is also easy.	×Electricity expense and cost for spare parts are high due to use of pump. Assignment of electric and mechanical engineers is needed for the system management. Furthremore, it is difficult to control flow compared with that of the Alternative-1.
Impacts on agriculture	—	◎The project can contribute to crop production increase	◎The project can contribute to crop production increase
Land acquisition	—	×Lands area to be acquired will be 900ha	×Lands area to be acquired will be 1,200ha
Tenanted premise for temporary construction	—	×5ha (for 10 years)	×5ha (for 10 years)
Impacts on existing economic activities	—	◎The project can provide job opportunities for the people	◎The project can provide job opportunities for the people
Impacts on existing transportation system	—	× The project can create inconvenience for road users and railway users	× The project can create inconvenience for road users and railway users
Impacts on natural environment in the target area	—	△no negative impact	△ no negative impact

[1] The cost covers the feeder canal only and it does not include cost for sprinkler and drainage system construction.

Items/ Options	Zero-option	Alternative-1 (Tunnel: Scenario-0)	Alternative-2 (Pump: Scenario-0)
Economic effect （FIRR）	―	6.3 %	--
Result of alternative examination	Irrelevant	Relevant	Irrelevant

◎: very positive, ○: relatively positive, △: no impact, ×: negative impact

*Pathways of Alternative-1 and Alternative-2 are different while those starting points and endpoints are common.

10.1.5 Scoping

The magnitude and extent of environmental impacts caused by the three scenarios of Alternative-1 would be various in proportion to the quantity of water intake. On the other hand, the anticipated environmental impact items/parameters e.g. air pollution would not be diverse among those scenarios. Therefore, hereafter, focusing on the Scenario 0, which has the largest quantity of water intake, scoping is examined as shown below.

Table. Scoping of Alternative-1 (Scenario 0)

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
1. Air Pollution	B	B	B	D	The construction vehicles could increase exhaust gas and rehabilitation works could generate dust, but these situations can be temporary.
2. Water Pollution	B	B	B	B	Construction works could cause short-term deterioration in water quality due to increased turbidity, however, it can be just tentative. There is possibility of increase of chemical usage after during the operation.
3. Waste	B	B	B	D	Construction wastes will be generated.
4. Soil Contamination / salinization	B	D	D	B	Irrigation could enhance soil salinization to some extent.
5. Noise and Vibration	D	D	D	D	Construction works can generate short-term noise and vibration. However, the works will be implemented in non-residential area.
6. Ground Subsidence	D	D	D	D	There is no extraction of groundwater which leads to ground subsidence.
7. Offensive Odor	D	D	D	D	Very low level and at non-residential area
8. Bottom sediment	D	D	D	D	Due to no construction works at bottom, no impact is expected.
9. Protected area	B	D	D	B	here is no protected area around the proposed feeder canal and irrigation area. The nearest Protected Area to the Mosul Dam is Tharthar Lake, whose source of river is mainly Wadi. In case of flood, the lake receive water from Tigris River for flood control, however, such case is not common. Therefore, there is low possibility that

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
					the Project will give impacts on the lake. However, depending on the results of SWLRI, there is possibility that flow adjustment between Tigris River and Euphrates River will be done, in that case, the Project would do. The nearest IBA to the Mosul Dam, which is located on the downstream of the dam, is Huweija Marshes. It is located on the watershed of Adhaim River that is one of tributary of the Tigris River. Therefore, any impacts on IBA by the Project are not expected. Hamizah marsh, which is located on 700km downstream of Mosul Dam by airline distance, is registered as a Ramsar site.
10. Ground water	B	B	D	B	The tunnel construction work could give adverse impacts on groundwater, however, the extent is limited.
11. Hydrological Situation	C	C	C	C	It is expected not to cause negative impacts on hydrological situation. The vested right of water for downstream was 200m^3/s before Mosul Dam construction and it is regarded as the minimam discharge. It is needed to examine whether this amount is relevant after the examination of SWLRI.
12. Topography and Geographical features	B	B	D	D	As well as No. 10 above mentioned, tunnel construction work could give adverse impact on topography.
13. Involuntary Resettlement	D	D	D	D	There is no densely populated area around the proposed feeder canal and irrigation area and construction works will be implemented at the non-residential area as much as possible. Therefore, there is no possibility of involuntary resettlement. A foot bridge as the tentative passage of railway and tentative roads will be constructed, however, the route will be proposed with careful examination not to cause involuntary resettlement. Moreover, enough clearance between the construction sites and residential area should be proposed.
14. Land Acquisition	B	B	B	B	It will be needed to acquire private farmland for the construction works.
15. Cultural heritage	C	C	C	D	Farmland in the South Jazira has been established already, there is no possibility of spoil of cultural heritage by the project. Concerning the proposed area for feeder canal construction, information of cultural heritage distribution has yet to be acquired, it is needed to study the

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
					conditions at the project implementation.
16. Landscape	D	D	D	D	According to the satellite image, there is no important landscape in and around the proposed construction sites.
17. The poor, indigenous and ethnic people	B	D	D	B	There is no detailed information of people distribution in the South Jazira. However, fair water distribution will be introduced in the area, any impacts on particular people is not expected. Since the scale of impacts on the Marsh Arab is unknown, detailed survey will be essential.
18. Livelihood	D	D	D	D	Main income source is agriculture in South Jazira and the project can contribute to their livelihood improvement.
19. Local economy	D	D	D	D	The project can improve agricultural productivity and provide job opportunity as labor.
20. Existing social infrastructures and services	B	D	B	D	As the proposed feeder canal will go across railway and road, it will take longer for the users.
21. Misdistribution of benefit and damage	B	B	B	B	In South Jazira, handful farmland of beneficiaries will be acquired for irrigation facility construction and there is limited misdistribution between benefit and damage. On the other hand, in and around the proposed feeder canal there can be persons who will lose their lands without benefit. Compensation for the affected people will be needed.
22. Social institutions	C	C	C	C	Current social institutions are not confirmed, however, the possibility of adverse impacts on existing social institution will be low.
23. Water Usage or Water Rights and Rights of Common	B	D	B	B	Due to water intake from the Mosul Dam, the project will not give negative impacts on existing water users within South Jazira area. There can be adverse impacts on the downstream of the Tigris River.
24. Gender	C	C	C	C	Since the agricultural works are covered by mainly men, the impact on women is unknown. It is needed to implement detailed study.
25. Children rights	D	D	D	D	Adverse impact on children is very limited.
26. Hazards (Risk), Infectious diseases such	C	C	C	C	It is recommended to employ workers within the project area as much as possible to minimize hazard from outside.

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
as HIV/AIDS					
27. Accidents	B	B	B	D	Accidents may occur in any construction work, careful consideration to avoid any accident is necessary.
28. Global Warming	D	D	D	D	There are no activities with constant emission of green house substances.

Rating: A: Serious impacts are expected. B: Some impacts are expected.
C: Extent of impact is unknown D: No or negligible impacts including positive impact are expected.

10.1.6 Terms of Reference for Environmental Study

If it is decided that the project will be implemented in the future, it will be needed to implement the detailed environmental study. The study will focus on the environmental parameters that show B or C in the rating in the Scoping result mentioned above. The proposed study methods and contents, namely, Terms of Reference (TOR) for the detailed environmental study are shown as below.

Table. Proposed TOR for Environmental Study

Environmental Parameters	Study Contents	Study Method
Air pollution	• Impacts caused by construction works	1. Confirmation of the construction components, construction method, construction period, scale and extent of construction works, necessary construction machinery, number of necessary vehicles, traveling pathway and so on 2. Confirmation of the current conditions in and around the construction sites such as location of schools, hospitals and residential areas 3. Hearings in and around the sites 4. Comparison of the expected situations with the Iraqi environmental standard
Water pollution	• Impacts caused by the construction works • Impacts caused by chemical use increase after irrigation launch	1. Water quality test such as Suspended Solid, hearing in and around the construction sites 2. Identification of prevention measures from water pollution applied by other projects 3. Confirmation of quantity and type of applied chemical in South Jazira 4. Confirmation whether waste water quality is complied with the national standard
Waste	• Disposal of construction waste	1. Information collection about waste management taken by other projects
Soil contamination	• Soil salinization	1. Measurement of Electric Conductivity of soil 2. Existing data collection 3. Hearing in the target area
Protected area	• Current status of the Hamizah marsh, which is a Ramsar Site and the Tharthar Lake • Utilization of the Hamizah marsh by the residents	1. Hearing in the Ramsar site and Tharthar Lake (Protected area) 2. Information exchange with other donors 3. Study of fauna and flora in the Ramsar site and Protected area
Hydrological situation	• Validity examination	1. Examination of SWLRI results

Environmental Parameters	Study Contents	Study Method
	of 200m^3/s as the minimum discharge, which was the vested right of water to the downstream before Mosul Dam construction	
Groundwater/ Topography	• Impacts on groundwater by tunnel construction works	2. Groundwater study 3. Hearing in and around construction sites
Land use	• Confirmation of area and location of land to be acquired • Land acquisition plan formulation	1. Identification of schools, hospitals, residential area and so on in and around the construction sites in the map 2. Distribution map formulation of private land and official land 3. Collection of case examples regarding land acquisition in other projects 4. Formulation of land acquisition plan based on the World Bank Operational Policy
Cultural heritage	• Existence and distribution of cultural heritage	1. Hearing in the target area, site survey 2. Existing data collection
The poor, indigenous and ethnic people	• Distribution and population of Marsh Arab, their main industries, degree of dependence on the Mesopotamia Marsh	1. Hearing in the target area, site survey 2. Existing data collection 3. Hearings from relevant institutions
Existing social infrastructures and services	• Adverse impacts on road and railway operation	1. Collection of the traffic census 2. Confirmation of number of railway users 3. Collection of railway time-table 4. Hearings from relevant institutions
Social institutions	• Number of participants, functions, structures of existing social institutions and its distribution	1. Hearing in the target area 2. Existing data collection
Water use	• Impacts on the Mesopotamia Marsh	1. Examination of necessary inflow to keep current Mesopotamia Marsh
Gender	• Impacts on women by irrigation works	1. Hearing in and around the target area
Hazards (Risk), Infectious diseases such as HIV/AIDS	• Number of infected patients	1. Hearings from relevant institutions
Accidents	• Traffic accident • Accident by construction works	1. Hearings from relevant institutions 2. Site survey

10.2 Land Acquisition and Involuntary Resettlement

10.2.1 Necessity of Land Acquisition and Involuntary Resettlement

The project has a plan to construct a series of irrigation facilities in South Jazira, e.g. canal system, drainage, sprinkler, road and so on. Some of those facilities will be constructed in the existing farmland and the proposed feeder canal will pass from the Mosul Dam to the target area. It will be needed to acquire lands for those facility constructions and proper management of them as Right of Way. However, the possibility of involuntary resettlement will be very low, since the construction sites will not be in and around residential area.

A tentative road and a footbridge as pathway of railway should be constructed during construction of the proposed feeder canal, however, no involuntary resettlement is expected, since the route/place of those tentative construction facilities will be selected considering enough clearance between those tentative constructions and surrounding residential area

10.2.2 Legal Frame Work

If land acquisition is inevitable for project implementations in Iraq, the proponent should refer to the Law No.138 (1997), which stipulates necessary procedures for land acquisition. According to the Law, prices of lands to be impounded for the project should be agreed upon among the MoWR, MoA, Ministry of Finance, and municipalities concerned.

10.2.3 Scale and Extent of Land Acquisition

As mentioned above, Scenario 0 has the largest area to be acquired among the all scenarios of Alternative-1, namely, 900ha. However, since the efforts to avoid residential area for construction sites will be made to minimize adverse impacts, it is possible not to entail involuntary resettlement by the project.

11. PROJECT EVALUATION

11.1 Conditions

Project Cost

Four (4) cases of the project cost, including 2 cases of the scenario-0 (with and without pump) with design capacity (d.c) =100m^3/s, the scenario-1 with d.c.=80m^3/s, and the scenario-2 with d.c.=60m^3/s, are estimated based on the design capacity of the irrigation facilities. The project cost consists of feeder canal, tunnel, east and west main canal, road and sprinkler systems. In case of the scenario-0, a pumping station on the west canal is included in the cost.

Following Table shows the project cost of the scenario-0, -1 and -2.

Table. Project Cost

Construction Cost Estimation (Financial Price) (1,000 ID)

No	Contract Number	Facilities	Scenario 0 (w/ Pump)	Scenario 1	Scenario 2
①	Contract No. SJA	Power Pumping Station	178,659,000	142,927,200	107,195,400
②	Contract No. SJ-1	Feeder Canal and Related Structure	159,349,200	142,433,000	127,589,100
③	Contract No. SJ-2A	Tunnel on Feeder Canal	190,244,500	173,184,000	149,462,700
④		Electrical Supply System	47,385,000	42,646,500	37,908,000
⑤	Contract No. SJ-3A	Canals, Roads and Networks (East Canal)	114,183,600	114,183,600	114,183,600
⑥	Contract No. SJ-3B:	Canals, Roads and Networks (West Canal)			
⑦	Phase 1		116,267,600	108,019,200	98,167,200
⑧	Phase 2		154,539,400	138,920,600	81,504,400
⑨	Phase 3		96,156,700	96,156,700	0
⑩	Contract No. SJ-3C	Canals, Roads and Networks (Pumped Canal)	117,949,700	0	0
⑪	Contract No. SJ-4	Pumping Station on West Canal	87,919,900	0	0
⑫	Contract No. SJ-5	Pump Houses in Sprinkler System	113,653,100	91,089,500	66,543,300
⑬	Contract No. SJ-6	Sprinkler Systems	496,675,400	397,741,400	290,117,200
⑭	Subtotal of Direct Cost		1,872,983,100	1,447,301,700	1,072,670,900
⑮	Consulting Services	10% of ⑭	187,298,300	144,730,100	107,267,100
⑯	Land Acquisition & Compensation	3% of ⑭	28,167,800	22,868,400	17,112,400
⑰	Administration Cost	3% of ⑭	28,167,800	22,868,400	17,112,400
⑱	Physical Contingency	20% of ⑭⑮⑯⑰, w/o price escalation	423,323,400	327,553,800	242,832,500
⑲	Cuctom and Duty		0	0	0
⑳	Reconstruction Levy	5% of ⑭	46,702,800	34,251,000	25,112,800
21	Subtotal	⑮～⑳	713,660,100	552,271,700	409,437,200
22	Total	⑭+21	2,586,643,200	1,999,573,400	1,482,108,100
	(in US$)	@1170ID/US$	(2,210,806)	(1,709,037)	(1,266,759)

Note: a/ Unit Costs of the East Jazira Irrigation Project are areapplied.
b/ Price escalation rate of 5.3% for local currency (L/C) and 1.8% for foreign currency (F/C) are applied to convert 2009 price to 2010 price.
c/ Foreign exchange rate of 1170ID/US$ and 0.07JPYen/ID are applied.
d/ Scenario-0 (w/o pump) case excledes the pump station cost.

11.2 Results

(1) IRR, NPV, and B/C

Based on the above mentioned conditions, a series of financial and economic analysis is conducted, and results of analysis in terms of Financial and Economic Internal Rate of Return (FIRR/ EIRR), Net Present Value (NPV), and Cost Benefit Ratio (B/C) are shown in the table below.

Table. Result of Financial and Economic Analysis: Scenario-0 w/ Pump

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	7.7%	6.5%	7.0%	6.3%	10.4%	9.8%	9.9%	9.4%
NPV	506,102,800	55,459,707	229,287,580	-13,029,471	1,691,587,018	1,441,805,313	1,489,799,519	1,249,003,218
B/C	1.19	1.02	1.09	1.00	1.67	1.57	1.59	1.49

Table. Result of Financial and Economic Analysis: Scenario-0 w/o Pump

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	8.0%	6.8%	7.3%	6.7%	10.7%	10.2%	10.3%	9.8%
NPV	622,539,457	171,896,365	345,724,237	103,407,186	1,804,678,177	1,554,896,472	1,602,890,678	1,362,094,376
B/C	1.25	1.07	1.14	1.04	1.74	1.64	1.66	1.56

Table. Result of Financial and Economic Analysis: Scenario-1

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	7.7%	6.6%	7.1%	6.4%	10.4%	9.9%	10.0%	9.5%
NPV	431,836,283	68,414,434	208,598,202	13,181,226	1,391,356,910	1,189,920,051	1,228,625,056	1,034,434,490
B/C	1.21	1.03	1.10	1.01	1.70	1.60	1.62	1.52

Table. Result of Financial and Economic Analysis: Scenario-2

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	7.6%	6.5%	7.0%	6.3%	10.3%	9.8%	9.9%	9.4%
NPV	307,017,472	30,816,867	137,356,530	-11,160,372	1,039,745,650	886,653,638	916,069,441	768,484,611
B/C	1.19	1.02	1.09	0.99	1.69	1.58	1.60	1.51

The results show that the best scenario of the project alternatives is the scinario-0 w/o pump, followed by the scenario-0 w/ pump, the scinario-1 and -2, indicating that the scale merit seems work in this project. In other words, as far as looking at the four concerned alternatives, as design capacity of irrigation facilities increases, project benefit from agricultural production also increases.

Among four (4) alternatives of the cropping patterns, ABC is the best option, followed by αβγ, XYZ, and αβγ (dry year) in the economic analysis. The ABC cropping pattern is the most profitable option when we look at agricultural productivity only. However, if we consider socio-economic conditions including accessibility to processing facility of sugar beet, additional investment is necessary to meet processing requirement of the product. On the other hand, αβγ cropping pattern is the best alternative since it considers current natural and socio-economic condition of the project site.

In all cases, FIRRs are below 6% of the policy rate of the Central Bank of Iraq, whereas all EIRRs are higher than the rate. When we considered the 6% as the opportunity cost of capital of Iraq, all cases discussed in the analysis are financially not feasible, but economically feasible. The result indicates that the project can be justifiable in view of national economy level.

(2) Sensitivity Analysis

Based on the base case discussed in the above section, sensitivity analysis is conducted. Tested cases in the sensitivity analysis are; (1) in case the project cost increases by 20%, (2) in case the project benefit decreases by 20%, and (3) combination of (1) and (2). The result is indicated in terms of EIRRs, and is summarized in the Table bellow.

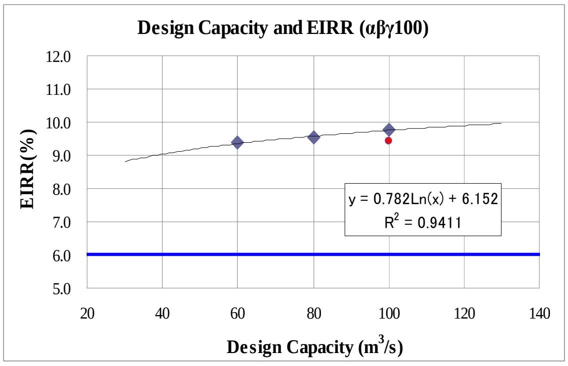
Table. Results of the Sensitivity Analysis

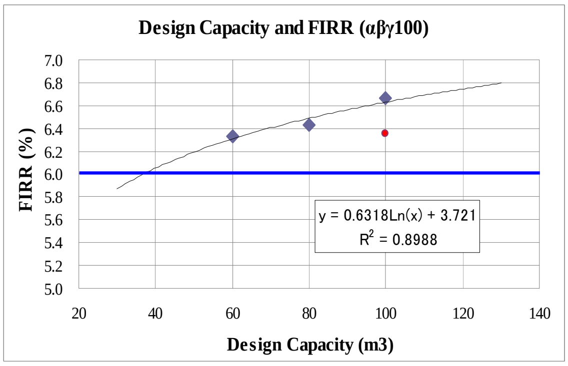
	Scenario-0 w/ Pump	Scenario-0 w/o Pump	Scenario-1	Scenario-2
Base Case	9.4%	9.8%	9.5%	9.4%
(1) 20% increase in Cost	8.0%	8.3%	8.1%	8.0%
(2) 20% decrease in Benefit	7.7%	8.0%	7.8%	7.7%
(1) + (2)	6.3%	6.7%	6.5%	6.4%

The results indicate that all EIRRs are higher than the 6%, when the project cost increases by 20%. However, when the project benefit decreases by 20%, EIRRs decline more than the first case and the scenario-2 reaches to the border line of the economical feasibility, what is the opportunity cost of capital in Iraq. It can be said that the project is more sensitive to the benefit decrease than the cost increase.

(3) Minimum Scale of the Project

When a scale merit works in the project planning, a minimum scale of the project might be an issue to be discussed. Definition of the minimum scale must be varied, but in the economic analysis, it is basically a marginal project that meets feasibility indicators. However, the marginal project can not be fined in the above results, since both IRRs are far from the marginal line of the 6%. Therefore, simple regressions between the design capacity and the FIRR/ EIRR, using logarithmic function, are conducted and the results are shown in the figures bellow. To figure out an approximate expression, the scenario-0 with pump is excluded, but is shown in red dots in the figures. According to the regression results, the minimum design capacity can be found around the 40 m^3/s in the financial and the economic analysis.





(4) Qualitative Impacts

The project benefits includes not only those economic impacts which can be express in monetary term, but also those social impacts including activation of labor market, stabilization of agricultural production, improvement of living standards, and contribution to the national food security. The project will be evaluated in consideration of those socio-economic impacts.

For example, waster shortage in Al-baaj is quite serious, which sometimes causes displacement of household to other regions. According to the governorate profile of Nineva, as a result of IDP (Internally Displaced Persons) and Returnee Assessment and developed by International Organization for Migration (IOM) in 2010, displacement due to lack of water increases recently, and Nineva is one of the most affected governorate in Iraq. The report indicated that 1,364 families in total have displaced in Ninevah due to water shortage, and most of them are in Al-baaj district. After the project, therefore, it is expected that the IDP caused by water shortage will be reduced in the project area.

In addition, Nineva governorate is the largest provider of wheat and barley in Iraq, and produces 15% and 28% of total wheat and barley production in 2007 respectively. However, yields of wheat and barley in Nineva are the lowest among all governorates since their agriculture is overly dependent on erratic rainfall, hence unstable agricultural production year by year. Therefore, the project can contribute to the national food security through providing additional wheat to the whole country. Also, partial reduction in the cost to maintain the nation-wide rationing system is expected, as a result of the project implementation.

12. RECOMMENDATIONS

12.1 Conclusions

12.1.1 Regarding decisions to be made on project development scale

The results of project evaluation made for each development scenario case and cropping pattern (αβγ100, αβγ117) are as tabulated in the following Table.

Table. Project benefits/efficiency in each Scenario case

1US$=1,170ID

Scenarios	Irrigation area (ha)	Intake design discharge (Peak) m^3/s	1)Annual water allocation (BCM)	2)Releasing volume to downstream (Incl. Power) BCM	3)Annual yield for wheat (ton)	Project cost Billion ID (Million US$)	FIRR by cropping pattern	
							αβγ100	αβγ117
Scenario-0 (With pump)	148,600	100	1.39	6.46	312,000	2,587 (1,811)	6.3%	7.0%
Scenario-1	119,000	80	1.11	6.75	245,000	2,000 (1,400)	6.4%	7.1%
Scenario-2	86,800	60	0.83	7.04	182,000	1,482 (1,037)	6.3%	7.0%
Scenario-3 (Min. scale)	59,500	40	0.48	7.41	125,000	Not examined	6.0% (estimate)	Not examined

Note: 1) Annual water allocation means irrigation water requirement in total for South Jazira area calculated with effective rainfall factor.
2) Releasing water volume to downstream area was calculated on conditions that storage volume will not be altered during the calculation period and at least 200 m^3/sec shall always be released.
3) Planned cultivation area x 5.6ton/ha (target yield in 10 years after the project completion)

In this study, two kinds of cropping patterns, namely, αβγ100 and αβγ117 are proposed for FIRR calculation as described in the above Table. In the former cropping pattern, it is planned to cultivate once in a year, which means that cropping intensity is 100%, taking consideration into the stringent water resource nationwide in the future. Based on αβγ100, the latter, namely, αβγ117, which satisfies following conditions, is proposed.

a) Annual water consumption for farming is set within the limit that the inflow to the Mosul Dam (inflow indicator) presented by MoWR is 10.1 BCM and the minimum discharge (Outflow Indicator) is 200 m^3/s.
b) The peak design discharge which determines the scales of main irrigation facilities e.g. the feeder canal and main canals is not changed.

The MoWR of GoI has declared that the final examination on the quantity of water to be availed from Mosul Dam to South Jazira Irrigation Project will have to wait for the outcomes of currently on-going study, namely "Strategy for Water and Land Resources in Iraq: SWLRI (Phase 2)". In this case, it is considered that it will take at least 2-3 years before the development scale of South Jazira Irrigation Project be decided.

While, in case if there will be no limit on the usable water resources amount, the Scenario-0 shows considerable increase of main staple food production and resultant decrease in the nation's food import can be expected. However, it is not agreeable to attach no importance to the declining inflow to Mosul Dam in future as caused by development activities in the upstream countries and negative effects by the global warming. MoWR presented the future inflow into Mosul Dam at 10.1 BCM/year as an indicator so as to apply the same for simulation study of Mosul Dam water resources operation aiming at completing the subject JICA Study. It means that current inflow into the Mosul Dam will be decreased by half and the inflow in the future is estimated on the safe side. If this will be the possible reality in near future, a project scale similar to the Scenario-3 would be recommended even with the minimum efficiency but having the project feasibility being positive, taking into consideration the future water demands in the downstream basins of the country as well as attention paid to environmental conservation of the wetlands in southern Iraq. Characteristics of those scenarios are shown in the following Table.

Table. Characteristics of Each Scenario

Scenario	Irrigation Area (net)	Design Discharge (peak)	Characteristics of each scenario
Scenario-0 (maximum scale)	148,600 ha	100 m^3/s	If there is no restriction of available water resource, the project benefit in this scenario is the highest among all scenarios and it can contribute to wheat production increase, which is important for food security. On the other hand, since it should cover the western plateau of South Jazira, which requires pump for irrigation and O & M cost. It is needed to shoulder this cost which is not needed for other scenarios. This scenario can give significant impacts on the Mosul Dam power generation, it is necessary to examine alternatives. In addition to that, there is a high possibility that it will give adverse impacts on natural and social environment downstream e.g. water utilization.
Scenario-1	119,000 ha	80 m^3/s	This scenario excludes the western plateau which needs pump irrigation from the area of Scenario-0 and its O & M cost is very small compared with one of Scenario-0. This is the most desirable scenario in terms of economic effect. In terms of project benefit, food security and environmental consideration, this is ranked between Scenario-0 and Scenario-2.
Scenario-2	86,800 ha	60 m^3/s	This scenario is ranked between Scenario-1 and Scenario-3.
Scenario-3 (minimum scale)	59,500 ha	40 m^3/s	If available water resource is limited, this is the most desirable scenario. On the other hand, the impact is the lowest in terms of project benefit and food security.

12.1.2 Roles to be played by South Jazira Irrigation Project

In accordance with the National Development Plan (NDP: 2010-2014), there exists as large as 9.3

Million ha of farm land which can be converted to irrigable condition in future including the existing irrigated areas. Of the total 9.3 Million ha, about 5.4 Million ha (58 %) is covered by the existing irrigation facilities (Actual irrigation coverage is seemed to be substantially less than the above). Besides, crops such as wheat for main staple food and barley for livestock feeding are cultivated in 4 Million ha area nation-wide, of which about 1.65 Million ha, 41 %, is in Nineva province.

While in terms of the agricultural productivity as indicated in the said NDP, the average unit yield of wheat was 2.58 ton/ha (646 kg/dunam) in Al-Najaf and Al-Qadisiyyah provinces located in the central-south part of the country, the yield at Nineva province was merely 0.68 ton/ha (169 kg/dunam), showing a big difference of 3.8 folds. Reasons behind the said difference are explained that stable irrigation water could be supplied to the farming area in case of Al-Najaf province and etc. in 2007, namely, drought year while rainfall in Nineva province was much in short.

The background of the description found in the NDP as mentioned above suggests that there is no sufficient water resources/irrigation development extended over the country at present and/or there are many areas where the existing irrigation facilities are not fully utilized in an effective manner. Further, the reason why Nineva province, in which the South Jazira Irrigation Project is being planned, is positioned as a main staple food production area with the relatively more annual rainfall of 200-400 mm in the Northern Iraq. However, without adequate irrigation facilities the province does not attain stable agricultural production and the resultant food supply.

In case if the Scenario-0 be taken up and successfully implemented under the subject Project, annually about 310,000 tons of wheat will be stably produced within the project area in future, implying that the project will produce about 18% of 1.7 Million tons to be produced under irrigation condition nation-wide to meet the target set for 2014 in the NDP.

12.2 Recommendations

(1) Issues on Water Distribution

Even though the inflow to the Mosul Dam is reduced to 10.1 BCM, it is possible to balance water demand and supply in North, Eastern and South Jazira areas on the condition that operation of the Mosul Dam power generation is cut to 35% of current water consumption (16.59BCM/year at present) by means of trade-off between irrigation and power generation. This is based on the assumption that agriculture has high priority compared with power generation. In such case, it is needed to secure alternative electric production e.g. hydro power, thermal power, gas power, import of electricity to compensate for the reduced electricity generated, in other words, trade-off among power generation industries is necessary.

Even though, the trade-off mentioned above can be established, there is a possibility that the South Jazira Irrigation Project will give some significant impacts on social and natural environment in the central and southern areas of Iraq. Therefore, effective water distribution between Jazira Areas and downstream can be regarded as a key issue for nationwide water resource allocation and this issue should be examined carefully in line with future inflow to the Mosul Dam.

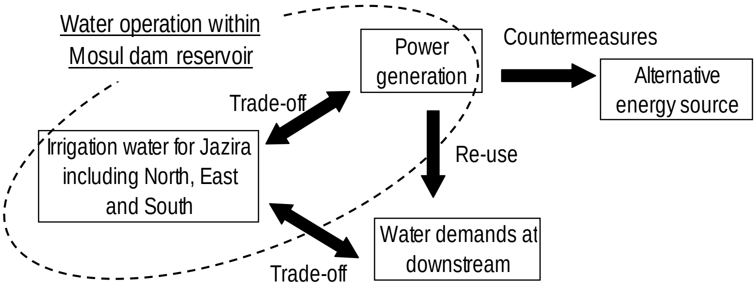


Fig. Water Resource Trade-off concerning South Jazira Irrigation Project

(2) Utilization of SWLRI Results

As mentioned in (1) above, it is expected that the SWLRI shows data which is essential for estimation of future inflow to the Mosul Dam and the minimum discharge taking consideration into nationwide water demand e.g. 1) agriculture, 2) power generation, 3) industries, 4) domestic non-commercial water and 5) conservation of the Mesopotamia Marsh. Based on the conclusion presented by the SWLRI, it is recommended that Government of Iraq will organize a committee mainly consisting of decision makers from ministries relevant to the water demand. The committee is expected to prepare a strategy of water and land development. The amount of water to be distributed to South Jazira Area and project scale will be determined based on the examination above.

(3) Examination of Annual Irrigation Water Requirement Based on Daily Basis Meteo-Hydrological Data and Soil Moisture Survey Data

In computing annual irrigation water requirement, it is important to attain higher accuracy on the quantity of seasonal crop water consumption. Under the JICA Study, the latest monthly hydrological data (1990-2009) in and around South Jazira area have been collected and the seasonal crop water requirement could be calculated. However, there were missing and vanishing of data for some of the observed periods as affected by the Iraqi war and so on and the accuracy of seasonal crop water calculated is not high enough. Moreover, the collected data were of monthly basis but not daily. For determining the facilities scale/dimensions, the peak demand for crop water consumption occurs during rainy season, it is necessary to make irrigation planning with fully grasping the rainfall pattern. Since estimation of irrigation water requirement with high accuracy may lead to possible water saving, it is recommended to continue necessary observation of meteo-hydrological data and accumulate further daily basis data as the basic need.

Given that gypsum layers are found under the sub-soil in the Project Area whereas it is planned to introduce sprinkler system in the whole Project Area, improper water spray can give adverse impact such as dissolution of the gypsum. Therefore, it is recommended to implement a detailed soil condition survey of in advance.

In order to estimate the most practical water requirement, it is recommended to collect the observation of meteo-hydrological data continuously for the purpose of re-examination of annual irrigation water requirement.

(4) Farming Training through a Pilot Farm of Leaders and Capacity Building of Leaders and Water Users' Associations

It takes several years until the completion of SWLRI, it is proposed to establish a pilot farm prior to the Project for the purpose of collection of metrological data and examination of soil conditions. Proposed farm scale is 800ha, which is the same size as actual irrigation scale and can verify a rotation block of proposed αβγ100 (8 years cycle). If water resource for the pilot farm can not be secured within the South Jazira area, it is recommended to establish the pilot farm in other areas nearby the Tigris River which have the similar characteristics with South Jazira, e.g. distribution of gypsum layers under the top soil. Proposed verification items are as shown below.

1) Collection of metrological data
2) Measurement of soil moisture change by depth caused by sprinkler irrigation
3) Confirmation of production of each crop
4) Demonstrative operation of agricultural machines, sprinkler and so on
5) Measurement of irrigation loss and calculation of irrigation efficiency
6) Demonstrative application of fertilizers and chemicals

It is supposed to have a supply side-commanding manner water allocation in Iraq and this may lead to possible un-expectedly big conveyance loss if well-organized water management by well experienced operators would not be practiced. It is then recommended that technical cooperation program and/or dispatching of related experts will be introduced for the purpose to advance establishing water users' organization as well as capacity building for extension services and water management. For this, the know-how learned from the preceding North Jazira Irrigation Project area shall be fully referred.

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ABBREVIATION

B/C	Benefit Cost Ratio
BCM	Billion Cubic Meter
BOQ	Bill of Quantities
CF	Conversion Factor
C/P	Counterpart
CRIM	Centre for Restoration of the Iraqi: Marshland
EC	Electric Conductivity
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EIS	Environmental Impact Statement
FAO	United Nations Food and Agriculture Organization
FIRR	Financial Internal Rate of Return
F/S	Feasibility Study
GB	Gypsum and Breccia
GDP	Gross Domestic Products
GIEWS	Global Information and Early Warning System, FAO
GIS	Geographic Information System
GOI	The Government of Iraq
GOJ	The Government of Japan
HH	Household
HQ	Head Quarters
HRA	High Rainfall Area
HYV	High Yield Variety
IAU	Inter-Agency Information and Analysis Unit
ICARDA	International Center for Agricultural Research in the Dry Areas
ID	Iraq Diner
IDP	Internally Displaced Persons
IEE	Initial Environmental Evaluation
IRR	Internal Rate of Return
IOM	International Organization for Migration
JICA	Japan International Cooperation Agency
JCT	Joint Technical Committee
LEPA	Low Energy Precision Application
LRA	Limited Rainfall Area
MCM	Million Cubic Meter
MESA	Mid-elevation Spray Application
MoWR	Ministry of Water Resource
MRA	Moderate Rainfall Area
MW	Megawat
NDP	National Development Plan
NPV	Net Present Value
OCHA	United Nations Office for the Coordination of Humanitarian Affaires
OFFP	Oil For Food Programme
PD	President Degree
PMF	Probable Maximum Flood
PMT	Project Management Team
PRSP	Poverty Reduction Strategy Paper
SC	Steering Committee
SCF	Standard Conversion Factor
SDI	Subsurface Drip Irrigation
SI	Supplimentary Irrigation System
SOSLR	Soil Organization of Soil and Land Reclamation
SCR	Security Council Resolution

SWLRI	Strategy for Water and Land Resources in Iraq
TDS	Total Dissolved Solids
UNDP	United Nations Development Programme
UNEP-ITCE	United Nations Environment Programme- International Environmental Technology Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commissioner for Refugees
USDA	United States Department of Agriculture
USSR	Union of Soviet Socialist Republics
VAM	Vulnerability Assessment Map, WFP
WB	The World Bank
WFP	World Food Programme

1 Dunam＝0.25ha

1 USD= 1,170 Iraq Dinar (ID)

1 USD= 82 JY

CHAPTER 1. INTRODUCTION

1.1 Background of the Study

The Republic of Iraq (hereinafter referred to as “Iraq”) has relatively rich water resources compared to other middle-eastern countries, however, the latest irrigation technique is yet to be introduced sufficiently, which leads to ineffective use of water resources. Since around 50 % of cultivable land in Iraq depends on rain water, the agricultural productivity is unstable. On the other hand, in irrigated area, issues such as poor drainage and salt injury are arisen. Agricultural sector has a tendency of decline, contribution of this sector to national GDP was decreased drastically in these 20 years. This situation causes unstable food supply and decrease of job opportunities in rural areas.

The third (3rd) National Development Strategy (2007-2010) of Iraq was established on four(4) major pillars that will govern strategic public actions for reconstruction and development (refer to column below), it emphasizes necessity to enhance agricultural sector. Improvement of agricultural technique, its extension and prompt infrastructure improvement including water resource development are essential for stable development of Iraq.

Four(4) Major Pillars of National Development Strategy

1. **Strengthening the foundations of economic growth: Enhancement of sectors of oil and gas resource development, improvement of agriculture and mines, etc.**
2. Activating the private sector: Rehabilitation of electricity power, development of communication and transportation system and so on
3. Improving the livelihood: development of water supply system, improvement of medical and educational services
4. Strengthening good governance and security: establish of administrative platform and human resource development

A series of Feasibility Studies of the irrigation projects, namely, South Jazira, North Jazira and East Jazira Irrigation Projects was done in 1980s to introduce new irrigation system from the Tigris River for the purpose of agricultural production increase and socio-economic development. The North Jazira Irrigation Project was completed in 1991 and operation of Mosul dam providing water resource for those irrigation areas above was initiated in 1985. However, the project implementation in the South and the East Jazira Irrigation Area had been suspended due to the political and social turbulence.

After the Iraqi War, the Government of Iraq (GOI) made a decision to restart the projects to strengthen the agricultural sector and food security. However, it is needed to review the F/S report in terms of safety and construction cost, which was prepared by Swiss Consultant around 20 years before, considering change of social conditions. Based on the request by the GOI, the Government of Japan (GOJ) decided to dispatch a Study Team to review the F/S report above and to propose an adequate irrigation plan in view of technique and economical efficiency taking into account change of water resource and advancement of irrigation technique, and security policy of dam (hereinafter referred to as “the Study”).

The objectives of the South Jazira Irrigation Project (hereinafter referred to as “the Project”) are 1)to promote agricultural production for the national food security, 2)to improve water use efficiency by introducing the latest irrigation technology and 3)to create job opportunities in the rural area, all in all to serve the prosperity of Iraqi people.

The Study on the Project covers the South Jazira Irrigation Area in Ninevah Governorate and reviews the F/S report taking consideration into proper water resource distribution of the Tigris River and agricultural sector development. Based on the analysis of available water resources and farming conditions in the Study Area, irrigation and agriculture development plan with high adequacy in terms of technique and economy is proposed.

1.2 Scope of the Study

Phase 1 is divided into sub-phases, namely, Phase 1-A and Phase 1-B. During Phase 1, examination of relevance and priority of the Project, grasp of current available water resource, review of the Feasibility Study and preparation of scope of works for Phase 1-B are implemented. The Team collects necessary data and implements site survey, preparation of the plan, examination of project evaluation and support of environmental and social consideration of the Project. The work schedule by sub-phase is shown as follows and schedule chart is attached in next page;

Phase 1-A: Examination of relevance/validity of irrigation development in the South Jazira, grasp of available water resources, review of the F/S, and preparation of draft scope of works for Phase 1-B.

Phase 1-B: Additional data collection/review and site survey, preparation of irrigation, analysis of project evaluation, and environmental and social consideration.

However, reasons by late progress of 1)Delays of collecting deficit part of Swiss F/S report, 2)Delays of collecting other data / information, 3)results of F/S review and 4)Progress status of “Strategy for Water and Land Resources in Iraq (SWLRI)”, scope and work schedule of the Study were changed as follows;

Phase 1-A: Examination of relevance/validity of irrigation development in the South Jazira, review of the F/S, and preparation of draft scope of works for Phase 1-B.

Phase 1-B: Grasp of available water resources for South Jazira Irrigation Project by Scenarios, preparation of irrigated agriculture plans, analysis of project evaluation, and environmental and social consideration by Scenarios.

1.3 Outline of the Survey Result

1.3.1 Review of Swiss F/S Report

(1) History of Swiss F/S Report and its issues

Since Swiss F/S study had been started in end of 1970s, it was completed in 1984. Once its main report had been prepared in 1982 by tunnel plan (Alternative-1) for feeder canal, sequentially, pump plan (Alternative-2) was made as alternative in 1984. Result of comparative study, pump alternative was proposed in 1984. Furthermore, Tunnel plan has selected after reviewing in 1995. Followings are remarkable issues during comparative studies;

1) There was no Pump plan (Alternative-2) till 1982. Two(2) cropping patterns, namely, ABC and XYZ were examined on Tunnel plan (Alterbative-1). Annual water requirement for the both patterns were exceeded a possible annual water supply volume (1.275 BCM) which recommended by water balance study (originated from the Soviet report).
2) In 1984, a comparative study had made between Tunnel and Pump plans, but project cost and IRR had not calculated on Tunnel plan.
3) Main report which should describe "conclusion" was not prepared.
4) Though the Tunnel plan has been recommended during the review of the Swiss F/S done in 1995 without calculating IRR, irrigation areas for Tunnel and Pump plans of which were 104,000 ha and 140,630 ha respectively are quite difference for the comparative study.
5) Annual water requirement volume for both plans are exceeded 1.275 BCM.

Outline of results of the F/S reviews were explained to Project Management Team (PMT) with understanding of PMT during the 3rd PMT meeting held on August in 2010. Therefore, the Study Team propose the Irrigated Agriculture plan for this Study based on the Swiss F/S report in consideration with the following aspect;

- There is no consistencies on comparative studies done among alternatives,
- Results of analyzing annual water requirement are exceeded from the precondition, and
- Alternative plans are not examined under the same condition in the Swiss F/S report.

History of the F/S report and its issues are summarized in Table 1-1.

Table 1-1 History and Issues of Swiss F/S Report

History and Issues on Swiss F/S Report

A. Pre-condition

		Remarks	Issues
1. Project area (Gross) :190,000ha (According to PMT)		It is mentioned in page 4-25, Main report that Project Area (Gross) is 213,900ha and with in the area, more than 50cm of soil depth is occupying 191,800ha.	
2. Annual available water volume	1.275 billion m3	F/S mentions the available water volume 1.275 billion m3 is according to "Water Balance Report"; namely; "General Scheme of Water Resources and Land Development in Iraq" (called "Soviet report")	1)MoWR has provided only limited portion of the Soviet report. 2)It is needed to wait for a result of "Strategy of Water and Land Resources in Iraq (SWLRI)" conducted by Italian consultants. 3)Details of "Water balance study" which is described in 'Mosul
3. Cropping Pattern	ABC pattern	A cropping pattern by higher annual water requirement than XYZ.	One of the target alterative
	XYZ pattern	A cropping pattern by lower annual water requirement than ABC with assumption that agricultural infrastructures such rural road, marketing, etc. would not be improved by the Project.	One of the target alterative
	PQR pattern	No restriction on water requirement	Out of the target alternative

B. History of F/S report

1. Year 1982

Irrigation method	Planned irrigated area: ABC pattern	Planned irrigated area: XYZ pattern	Remarks
1) Surface irrigation	125,451ha	129,354ha	Examined by within 1.275 billion m3 of annual available water volume
2) Sprinkler irrigation	142,178ha	146,601ha	Examined by within 1.275 billion m3 of annual available water volume

2. It is recommended irrigation by sprinkler for whole Project area — Reasons: 1)being care of salinity and gypsum layer due that soil depth is not enough. 2)being considered availability of annual water volume

3. Year 1982 (Main Report)

	1)ABC	2)XYZ		Issues
1) Alternatives	Tunnel	Tunnel	Pump	Pump Alternative is not available.
2) Irrigation method	Sprinkler:100%	Sprinkler:100%	Not examined	Semi detailed soil survey was not completed.
3) Irrigation area (Net)	159,700ha	159,700ha	Not examined	
4) Target soil depth	50cm	50cm	Not examined	
5) Annual water volume	1.44 M.m3	1.39 M.m3	Not examined	Both annual water volumes exceed 1.275 m3 of availability
6) Design discharge of feeder canal	135m3/s	123m3/s	Not examined	Design discharge was not calculated for ABC and XYZ under same conditions
7) Project cost	365,8081 M.ID	378,831 M.ID	Not examined	1)ABC＜2)XYZ
8) IRR	1.73%	1.19%	Not examined	IRRs were calculated by using area 152,800ha.
	Applied			

4. Appearance of Pump Alternative

5. Year 1983 :Completion of semi detailed soil survey

Depth (cm)	Planned land use (Recommended by SOSLR)	Irrigation suitability Result of Swiss consultants	Project area (Gross): Original area(a)	Project area (Gross): Expansion area(b)	Remarks
					Project area was expanded by Pump alternative.
<50	Pasture (Irrigation not applicable)	Irrigation not applicable	~~23,875ha~~	~~11,886ha~~	Area with less 50cm of soil depth was excluded.
50 - 80	Barley (Only rainfed)	Only sprinkler	54,892ha	7,291ha	Swiss consultants proposed to examine sprinkler irrigation at pilot area though SOSLR not recommended.
80 - 150	Winter crop only (by sprinkler)	Sprinkler or surface irrigation	103,401ha	20,807ha	
150 - 200	Summer / winter crop (by sprinkler)	Sprinkler or surface irrigation	22,069ha	3,762ha	
>200	Intensive agriculture (by surface irrigation)	Sprinkler or surface irrigation	16,738ha	15,718ha	
		Total	197,100ha	47,578ha	244,678ha(a+b)

SOSLR :State Organization of Soils and Land Reclamation (Organization for Implementation of Irrigation and Reclamation Project)

6. Year 1984

Cropping pattern	1)ABC	2)XYZ		Issues
1) Alternatives	Tunnel	Tunnel	Pump	
2) Irrigation method	Not examined	Sprinkler:100%	Sprinkler:100%	Facilities are designed by sprinkler:50%, surface:50%.
3) Irrigation area (Net)	Not examined	159,700ha	140,880ha	Irrigation area is selected by soil depth.
4) Target soil depth	Not examined	50cm	80cm	
5) Annual water volume	Not examined	1.40 M.m3	1.23 M.m3	Tunnel alternative exceeds available annual water volume.
6) Design discharge of feeder canal	Not examined	125m3/s	125m3/s	Facilities are designed by sprinkler:50%, surface:50%.
7) Project cost	Not examined	Not examined	315,200 M.ID	Project cost of Tunnel alternative is not calculated.
8) IRR	Not examined	Not examined	1.29%	Only IRR of Pump alternative is calculated.
			Applied	

7. Main Report (1984) Not published

8. 1995 (up-date)

Cropping pattern	1)ABC	2)XYZ		Issues
1) Alternatives	Tunnel	Tunnel	Pump	Only project cost was revised.
2) Irrigation method	Not examined	Not examined	Not examined	Not revised from 1984.
3) Irrigation area (Net)	Not examined	104,000ha (Gross: 190,000ha)	140,630ha (Gross: 190,000ha)	1)Reaon irrigation area of Tunnel alternative remarkably reduced is not clear. 2)Irrigated rate (Net/ Gross) is quite difference between Tunnel and Pump. (Tunnel alternative:55%, Pump alternative:70%)
4) Target soil depth	Not examined	Not examined	Not examined	Not revised from 1984.
5) Annual water volume	Not examined	Not examined	Not examined	Not revised from 1984.
6) Design discharge of feeder canal	Not examined	125m3/s	125m3/s	Both feeder canals are same scale even though irrigation area of Pump alternative is quite bigger than tunnel one.
7) Project cost	Not examined	85,000 M.ID	110,000 M.ID (Revised)	Tunnel＜Pump Source of cost estimate is not clear.
8) IRR	Not examined	Not examined	1.20%	Only IRR of Pump alternative is calculated.
		Applied		

9. Year 2010 (at present)

(2) Outline of the results of Swiss F/S Report

Table 1-2 Summary of Finding of Swiss F/S Report

Table 4.1-2 (1) SUMMARY OF FINDINGS

CONTENTS OF F/S	FINDINGS AND CONCERNS	ACTIONS TO BE TAKEN
1. Geology	—	
2. Soils	① With regard to satellite images seen, considerable parts of wadis have been filled by land reclamation. Therefore, it is presumed that soil depth which is a key factor to judge soil suitability for irrigation has been changed. The term soil depth here means depth from soil surface to gypsum layer.	● It is proposed that soil survey should be executed to renew the Soil Depth Map. ● It is proposed that drainage system should be considered to mitigate soil erosion.
3. Hydrology	① Data for reservoir operation to examine relevancy of annual available water volume has not yet been provided.	● It is proposed that the reservoir operation should be reviewed with ungained data to confirm adequacy.
4. Feeder Canal	① Design condition, such as design discharge, is different among three alternatives. ○Alternative-1 (Tunnel) ・MAIN REPORT (1982): Qdesign= 130m^3/s (details unknown) ・ANNEX (1984): Qdesign=125 m^3/s Anet=159,700ha, Cropping Pattern: XYZ, Inet=115.7mm (MAY), Irrigation Efficiency=0.64,Weather Condition=10% ・Updated F/S (1995): Qdesign=125 m^3/s (details unknown: Anet=104,000ha) ○Alternative-2 (Pump) ・ANNEX (1984): Qdesign=125 m^3/s Anet=160,400ha, Cropping Pattern PQR ○Alternative-3 (Gravity) ・No information	● It is proposed that alternatives should be revised by using reconsidered design discharge. ● The reason for withdrawal of the alternative 3 should be confirmed.
	② It has been for 25 years since canal route was selected. With regard to satellite images seen, road construction near canal rout and expansion of village are verified.	● It is proposed that canal route plan and alignment plan should be reconsidered by using latest topographical map.
	③ Because design slope of open canal part is too gentle as 1/10,000, cautious consideration on design and construction supervision is required.	● It is proposed that required water level at main diversion work should be examined, and that longitudinal profile of canal should be re-designed.
5. Irrigation and Drainage	① In the result of comparative study, sprinkler irrigation, other than surface irrigation was adopted. It is presumed that annual available water volume will be strictly restricted by revised annual available water volume.	● It is proposed that high-efficiency irrigation technology, such as LEPA (low energy precision application) and drip irrigation, should be introduced for water saving.

Table 4.1-2 (2) SUMMARY OF FINDINGS

CONTENTS OF F/S	FINDINGS AND CONCERNS	ACTIONS TO BE TAKEN
6. Physical Planning	① Land reclamation of entire plots had been completed, and current land use is different from the time of facility planning.	● It is proposed that facilities planning should be revised by using latest topographical map.
7. Agriculture	① Determinants of annual available water volume which are provided by Mousel Dam for South Jazira Project are not clear. Monthly available water provided by Mousel Dam is also ambiguous. ・USSR Report : 1.291BQM (System No.41 : Jazira) ・F/S : 1.275 BQM	● It is proposed that estimated annual water demand of South Jazira Project should be considered by Italian consultants who are working for SWLRI. ● It is proposed that annual available water volume should be provided by Italian consultants for Study team to draw out an adequate irrigation plan.
	② Calculated annual water demand based on planned cropping pattern and irrigated area exceeds 1.275 billion m3. ・1982 : Cropping Pattern (ABC) , Alternative – 1 (Tunnel) ⇒ 1.44 BQM ・1982 : Cropping Pattern (XYZ) , Alternative – 1 (Tunnel) ⇒ 1.39 BQM ・1984 : Cropping Pattern (XYZ) , Alternative – 2 (Pump) ⇒ 1.23 BQM	● It is proposed that cropping pattern XYZ should be revised by using current condition.
	③ Cropping pattern XYZ considered factors which can not be controlled by project but are necessary for project, such as market availability and transport capability.	
8. Markets & Prices	–	● Based on the current market conditions, all prices must be renewed . ● Marketability of agricultural products must be re-examined.
9. Organization & Management	–	● It is proposed that organization & management plan should be revised after related plans are renewed.
10. Farm Budgets	① According to F/S report, water user fee is going to be collected. However, there is no system to collect the fee in Iraq.	● Necessity of farmers' organization to maintain water courses should be discussed.
11. Alternative Agriculture plan	① This plan based on no restrictions of annual available water volume.	● There is no possibility to adopt this alternative since it is not realistic.
12. Economic & Financial Analysis	① Comparison of alternatives was not executed by same condition. Design condition, year of unit prices, and year appraised of alternatives were different. ・1982 : Cropping Pattern (ABC) , Alternative – 1 (Tunnel) ⇒ IRR=1.73% Cropping Pattern (XYZ) , Alternative – 1 (Tunnel) ⇒ IRR=1.19% ・1984 : Cropping Pattern (XYZ) , Alternative – 2 (Pump) ⇒ IRR=1.29% ・1995 : Cropping Pattern (XYZ) , Alternative – 2 (Pump) ⇒ IRR=1.20%	● It is proposed that economic and financial analysis should be revised with latest unit price, and that comparison of alternatives should be executed with same design condition and same appraisal year.

(3) Review of the Past Economic and Financial Evaluation

(a) Original F/S in 1984

Two alternative plans were economically evaluated in the original feasibility study in1984.

- Alternative 1: The gravity feeder canal with tunnel option
- Alternative 2: The pumped feeder canal option

However, these two alternatives were not evaluated on the same ground. To understand the evaluation results properly, we need to consider time sequence of the F/S. According to the Annex 12 for Economic and Financial Analysis in the Final Planning Report (1984), at the beginning, at least by the time of draft final report (1982), the feasibility study team mainly discussed and concentrated on the alternative 1 (tunnel option). However, after obtaining the new soil data in 1983, the team seems to start focusing on the alternative 2 (pump option). Following table shows evaluation summary of the alternative 1 and 2.

Table 1-3 Comparison of the Two Alternative Plans in F/S 1984 [/a]

Item	Alternative 1 (Tunnel)	Alternative 2 (Pump)
Type of Structure (length)	Gravity feeder canal w/ tunnel (60.3km inc. tunnel 19km)	Pumped feeder canal (82.15km)
Project Area	158,200ha (27 villages) with soil depth more than 50cm	140,880ha (26 villages) with soil depth more than 80cm
Cropping Pattern	ABC, XYZ, PQR	XYZ
Base Year	1980 exchange rate was applied to convert imported goods	Not clear but after 1983
Agricultural Production (at full development stage)	ABC: 46,091,000 ID XYZ: 38,175,000 ID PQR: no estimation sheet	XYZ: 34,703,000 ID/ year
Construction Cost	ABC: 365,808,000 ID XYZ: 378,831,000 ID PQR: 383,905,000 ID	XYZ: 315,2000,000 ID
Construction Period	5 years (project life 50years)	4 years (project life 50years)
EIRR	ABC: 1.7% XYZ: 1.3% PQR: 4.2%	XYZ: 1.29%
Conclusion	(PQR is economically feasible)	XYZ is the most conservative and practical

Source: Feasibility Study Report

a/ All annex reports were developed in 1984, but the main report, which is still draft only existed one, is developed in 1892.

In conclusion, the F/S recommended the alternative 2 (pumped option) with rotation XYZ. As for sensitivity analysis, only the alternative 2 with XYZ crop rotation was tested since the option was considered as the most conservative and practical.

(b) Updated F/S in 1995

The original F/S was once reviewed in 1995 by Iraq government. At that time, following points were taken into consideration.

1) Updating project costs based on current construction cost; cost for pump from the North Jazira Irrigation Project, and tunnel cost from the East Jazira Irrigation Project.

2) Updating price of imported goods by deducting current tax rate with consideration of gap between local and international prices

3) Selecting the alternative 2 (pump option) for economic evaluation with project area 140,880 ha and soil depth 50cm.

Finally, the study obtained following conclusion, in which they suggested the alternative 1 (tunnel option) as more economical option as shown in Table 1-4.

Table 1-4 Comparison of the Two Alternative Plans in Updated F/S 1995

Item	Alternative 1	Alternative 2
Type of Structure	Gravity feeder canal with tunnel	Pumped feeder canal
Project Area	No description	140,880ha w/ soil depth 80cm
Construction Cost	85,000,000 ID	110,000,000 ID
EIRR	-	PQR: 4.0% ABC: 1.7% XYZ: 1.2%
Conclusion	Tunnel option is more economical	-

1.3.2 Collected Important Data / Information during the Study

The Study Team has conducted to collect data / information from MoWR, MoP and relevant agencies by using local consultants due to security issues, also supported by JICA Iraq office. Status of important data / information collected is as follows;

(1) Necessary data / information for examination of water resources stability

<Data-1> Soviet Report: Swiss F/S report bases “Soviet Report” which probably shows the result of detailed water balance calculation for limited annual water volume to be used from the Mosul dam.

Irrigation development plan in the F/S report was formulated using 1.275 BCM of annual water volume from the Mosul dam in the basis of Soviet report. It is very important for reviewing sustainability of irrigated agriculture plan shown in the F/S Report with examination of water balance. In the result of reviewing the Soviet report, however, any evidence was not found why 1.275 BCM had been used for the annual water volume for South Jazira Project from the said report.

<Data-2>Mosul Dam Safety Annual Report: Inflow / Outflow data, dam storage volume, water level, etc. of Mosul dam are recorded.

Base on Mosul dam actual operation such as 1)inflow volume from upstream to the Dam, 2)irrigation water for North Jazira, 3)water for power generator, 4)necessary discharge to downstream and etc. in latest 10 years, appropriate annual water volume for South Jazira Irrigation Project should be examined. And those data was collected and applied for the water balance study of the Mosul dam reservoir operation.

<Data-3>Information on International Water Treaty of Tigris River: Foreseeing inflow volume to the Mosul dam in the future

If inflow volume is limited due to the results of water treaty among counties related to the Tigris River, there is a possibility that implementation of South Jazira Irrigation Project would be faded away by reducing available water volume for the Project. It is very much difficult to collect this information which is probably sensitive on the international water treaty. Since proposed annual intake water volume (1.275 BCM) for the South Jazira Project is only about 10% of average annual inflow to the Mosul dam 19.43 BCM, the JICA Study Team proposed to analyze available water volume for the Project under the condition that the inflow volume in future would not much changed.

On other hand, MoWR consulted the JICA Study Team to use 10.1 BCM/year as an Indicator for inflow in future since SWLRI has not yet been concluded.

<Data-4>Indicator for Necessary Releasing (Outflow) Volume

Addition to the above Data-3, MoWR suggested providing an Indicator for necessary releasing volume to the southern part of Iraq from Mosul dam reservoir in consideration with future demands such as agriculture, water supply, power generation, and industry as well as marshland conservation. At the end, however, MoWR indicated that the necessary releasing volume is 200 m^3/s of which flow to secure water level of intake to supply drinking water in steady to Mosul city for analyzing available water resource of the South Jazira.

(2) Necessary data / information for examination of Mosul dam safety

<Data-4>Information on construction schedule / methodology, tender document and etc. of Diaphragm Construction for Mosul dam

MoWR has not been positive to provide any information regarding on Mosul dam safety since the Study Team requested them. While view points of MoWR on both management and finance for grouting of Mosul dam foundation is excellent, there is no doubt to implement the diaphragm construction with engineering experiences of contractors which was selected under negotiation for the contract.

1.3.3 Numbers of Scenario for Irrigated Agriculture Plan

As shown in clause "1.3.2 Collected Important Data / Information during the Study", even though MoWR has shown Indicators for both inflow and outflow of Mosul dam reservoir in future, recommendable inflow and outflow will be finalized by decision makers through the conclusion of SWLRI. Therefore, MoWR requested to the JICA Study Team to prepare plural numbers of Scenario.

Due to a series of discussion between MoWR and JICA as well as the JICA Study Team, following scenarios shown in Table 1-5 are recommended to prepare the Irrigated Agriculture plan for each scenario. Outline design, cost estimate, drawings, etc. are prepared for Scenario-0, 1, 2 for Tunnel alternative and Senario-0 for Pump alternative. Scenario-3 of Tunnel alternative as minimum scale of the Project to be feasible will be examined only for water allocation of Mosul dam reservoir based on results of the project evaluation to be done for Scenario-0, 1 and 2.

Table 1-5 Numbers of Scenario

Alternatives	Scenario	Intake Volume	Beneficial Area	Irrigation Area (Gross)	Irrigation Area (Net)
1.Tunnel	Scenario-0	100 m^3/s	220,700 ha	196,400 ha	148,600 ha
	Scenario-1	80 m^3/s	179,900 ha	157,200 ha	119,000 ha
	Scenario-2	60 m^3/s	132,300 ha	114,800 ha	86,800 ha
	Scenario-3 (Tentative)	40 m^3/s	91,500 ha	78,700 ha	59,500 ha
2.Pump	Scenario -0	100 m^3/s	220,700 ha	196,400 ha	148,600 ha

Remarks: Intake volume and irrigation for Scenario-3 is tentative value at this Chapter. Values will be assumed by the results of project evaluation of 0 – 3. Final assumption will be shown in "11. Project Evaluation" of this Summary.

Table 1-6 shows consideration of area selected for each Scenario.

Table 1-6 Consideration of area selected for each Scenario

Scenarios	Consideration of area selected for each Scenario	Excluded Irrigation blocks
Scenario-0	Hole target of South Jazira Irrigation area	none
Scenario-1	To exclude pumped area located at western part of South Jazira from area of Scenario-0	P1, P2, P3, P4, P5, P6 were excluded from Scenario-0
Scenario-2	To exclude irrigation blocks located at western far from entrance point of the Feeder canal from Scenario-1	W7, W8, W9, W10, W11 were excluded from Scenario-1
Scenario-3	To exclude irrigation blocks located at eastern far from entrance point of the Feeder canal from Scenario-2	E2, E3, E4 were excluded from Scenario-2

1.3.4 Outline of Field Survey

Since it was hard to conduct field survey including questionnaire to the beneficiaries of the South Jazira by Japanese consultants due to the security restriction excepting Mosul dam, the Study team has been conducting them by using local consultants having questionnaire surveys to relevant agencies and farmers. Outline of the field survey is shown in Table 1-7.

Table 1-7 Outline of Field Survey

	Item	Plan/ Contents	Remarks
1.	**By the Study Team (Local consultants)**		
1)	GIS data information survey (To confirm land use)	11 points in North, East and South Jazira areas	Reduced from 66 to 11 points due to security concerned.
2)	GIS digitizing	Road, railway, project layout, water resources, well data, villages, irrigation, etc.	
3)	Agriculture and Socio-economy survey to the farmers	North: 6 house holds, South: 12 house holds (Total 18 HH)	Family structure, annual income, cropping pattern, agricultural input, farm products price, marketing, etc.
4)	Well survey	11 wells at 6 villages	Construction year, usage, water level, quantity, quality, etc.
5)	Market price survey	Prices of farm product, labor cost, construction materials)	
6)	Irrigation facilities survey crossing proposed structures at feeder canal	14 places	Reduced from 20 to 14 points due to security concerned.
2.	**To Administration office**		
1)	Questionnaire surveys on Agriculture	Farming system, Cropping pattern, cultivation area, yield, etc.)	
2)	Questionnaire surveys on Socio-economy	Population, poverty, GDP, labor force, price index, local budget, market price, etc.	

1.3.5 Technical Transfer during the Meetings

The JICA Study Team has given technical transfer through the several explanatory meetings of the reports such as ICR, PR, ITR, DFR, etc. where officials of MoWR, MoA, MoP as well as Project Management Team (PMT) of Ninewa province participated. In addition, the Team made opportunities to have discussion on review of Swiss F/S Report and methodology of calculation of irrigation water requirement and water balance study of Mosul dam reservoir with members of PMT, called PMT meetings of 4 times during the Survey as shown in Table 1-8.

Table 1-8 Technical Transfer during the Reports Explanatory Meetings to PMT

Date	Agencies / Offices	Outline of meeting, Technical transfer
1. June 17, 2010 At explanation of Inception Report (ICR) in Erbil	MoWR of Baghdad MoP of Baghdad PMT of Ninewa JICA Iraq office JICA Study team	1) Kick off meeting, explanation of ICR, 2) Request data / information for the Study, 3) Request on supporting local consultant activity.
2. June 30, 31, 2010 At explanation of ICR with JICA consultation mission (JICA Mission) in Erbil	MoWR of Baghdad MoP of Baghdad PMT of Ninewa JICA Iraq office JICA Mission JICA Study team	1) Confirm TOR of JICA Study team, 2) Request providing data on stability examination of Mosul dam, 3) Discuss on capacity building, 4) Confirm possibility of cancelling Phase 1-b survey due to the result of Phase 1-a, 5) Request immediate setting up Steering Committee (SC).
3. July 1, 2010 PMT 1st meeting in Erbil	PMT of Ninewa JICA Study team	1) Reconfirm required data / information, 2) Re-request filling questionnaire of agriculture and socio-economic, 3) Request providing missing pages of Swiss F/S report,

Date	Agencies / Offices	Outline of meeting, Technical transfer
		4) Discuss on necessity of providing data of Mosul dam stability, 5) Evaluate on-going North Jazira Irrigation Project (Farmers organization, etc.), 6) Request supporting Local consultant activities.
4. July 29, 2010 PMT 2nd meeting	PMT of Ninewa JICA Iraq office JICA Study team	1) Re-request data / information (latest meteorological, Soviet report, inflow/outflow data of Mosul dam, etc.), 2) Discuss on review of Swiss F/S (discrepancies among ’82, ’84, ‘95, annual consumption, irrigation efficiency, cropping pattern, etc.), 3) Discuss on results of field survey of South Jazira, 4) Participatory approach on needs of farmers by PMT member.
5. August 8, 2010 PMT 3rd meeting At explanation of Progress Report-1 in Erbil	MoP of Baghdad PMT of Ninewa DoA of Ninewa JICA Iraq office JICA Study team	1) Re-request remaining data / information, 2) Request providing data of beneficiaries and village boundary, 3) Re-request latest metrological data, Soviet report, 4) Request regarding on water treaty of Tigris rive, 5) Request study contents of SWLRI, 6) Evaluate Mosul dam operation rule, 7) Request providing information of diaphragm construction of Mosul dam, 8) Evaluate reviewing Swiss F/S report, 9) Discuss utilizing Soil map of Swiss F/S, 10) Discuss on re-alignment of feeder canal 11) Discuss proposing sprinkler irrigation 12) Evaluate national policy for selection of cropping pattern, 13) Discuss on objectives of project evaluation (entire Iraq and South Jazira area)
6. August 15, 2010 Steering Committee (SC) in Baghdad	MoWR of Baghdad MoP of Baghdad MoA of Baghdad JICA Iraq office (Not JICA Study team)	1) 1st meeting after setting up of SC, 2) Request required data for the Study by JICA Iraq office (latest meteorological, Soviet report, inflow/outflow data of Mosul dam, etc.), 3) Confirm schedule of SWLRI.
7. Nov. 11, 12, 2010 At explanation of Interim Report (ITR) in Erbil	MoWR of Baghdad (incl. NCoWRM) MoA Baghdad MoP of Baghdad PMT of Ninewa JICA Iraq office JICA Study team	1) Discuss inflow volume in future (to wait conclusion of SWLRI) 2) Discuss necessary releasing volume in future (to wait conclusion of SWLRI) 3) Confirm providing indicator for inflow and releasing volume provided by MoWR, 4) Confirm stability of Mosul dam by diaphragm to be constructed experience international contractors, 5) Discuss on regulation of Environment in Iraq, 6) Re-request important data (latest meteorological data, inflow/outflow data of Mosul dam）
8. March 16, 17, 2011 At explanation of Progress Report-2 (PR2) in Erbil PMT 4th meeting (After	MoWR of Baghdad MoA of Baghdad MoP of Baghdad PMT of Ninewa JICA Iraq office JICA Mission JICA Study team	1) Confirm inflow indicator (10.1BCM/year), 2) Confirm indicator for necessary releasing (outflow) volume is to secure portable water for Ninewa governorate (200m^3/s), 3) Discuss applying collected latest meteorological data to DFR, 4) Confirm maximum irrigation area 147,600 ha (excluding area unsuitable) will be finalized in DFR, 5) Discuss numbers of Scenario for the DFR, decide 3

Date	Agencies / Offices	Outline of meeting, Technical transfer
explanation of PR2)		scenarios (100, 80, 60 m^3/s) for Tunnel and 1 scenario for Pump alternative after discussion between MoWR and JICA as well as Study team, 6) Discuss minimum project scale to be feasible is at point of IRR 0%, 7) Confirm irrigation efficiency is 0.68 including conveyance loss, 8) Confirm beneficiaries and boundary of villages, 9) Technical transfer to PMT as follows; • Calculation of irrigation water requirement • Water balance study of Mosul dam reservoir
9. <u>July 25, 26, 2011</u> At explanation of Draft Final Report (DFR) in Baghdad	MoWR, MoA, MoP of Baghdad PMT of Ninewa JICA Iraq office JICA Study team	Main points discussed in the DFR meeting are followings; 1) Iraqi side pointed out that proposed construction period of the Project (19 years) was long, and should be revised based on the Water Resources Development Strategic Plan (2010-2014) published by MoWR. JICA team accepted that the period would be revised based on the said Plan while it should be 8 to 9 years. 2) Iraqi side requested to examine crop intensity 117% in addition to 100% in consideration of tight demand for water resources in Iraq. JICA team accepted it. 3) Iraqi side suggested that, since an impact of irrigation water on gypsum layer was not clear, construction of an experimental field towards the Project implementation to research the impact should be conducted. JICA team replied that the suggestion would be referred in the Final Report (FR). 4) Iraqi side requested to consider the construction cost of a pumping station at dam intake in the case water level of the Mosul dam was below 310 m. JICA team accepted the request and asked the Iraqi side to provide information of construction cost of the station. The Iraqi side then agreed it. 5) JICA team asked Iraqi side to provide clear definition of the 200m^3/s discharge to the downstream from the Mosul dam. The Iraqi side replied that the amount was not water release requirement, but flow volume to secure water level of intake to supply drinking water in steady. 6) Iraqi side requested JICA team to add benefit from livestock production according to the Swiss F/S report. JICA team accepted it by showing in the FR. 7) Iraqi side requested to include the full-scale EIA in the FR. JICA Team replied that both Iraqi and Japanese sides have already agreed on that scale of the Project would be decided according to the results of SWLRI being conducted by Italian consultants. Since it is very difficult to prepare a full scale EIA report at this moment, some contents of EIA reports are covered by the Study while others are not as shown in page 10-2 in Chapter 10 of the DFR, which was determined based on the discussion with JICA head office in Tokyo.
10. <u>July 27, 2011</u> Explanation to Prime Minister’s	PMAC MoWR, MoA, MoP of Baghdad	The JICA Team explained the outline of DFR to PMAC and other organizations concerned. Regarding the project scale, MoWR and Mr. Ghadhban, chairman of

Date	Agencies / Offices	Outline of meeting, Technical transfer
Advisory Commission (PMAC)	PMT of Ninewa JICA Iraq office JICA Study team	PMAC presented following comments as follows: MoWR's comment: It is difficult to scale up the project after the launch and it can spoil project efficiency and economic efficiency. Therefore, it is needed to apply maximum project scale (Scenario 0). Mr. Ghadhban's comment: Only MoWR insists on the maximization of project benefit. Other ministries /agencies, southern provinces, water users in southern area and I think the idea is not acceptable. It is necessary to discuss this matter officially within the Government of Iraq. As a personal opinion, there are two options, namely, 1) to start the project at minimum scale, which is most conservative, and to examine possibility of project progressive expansion considering the nation wide water resource conditions, or 2) no project implementation in case MoWR insists on the opposite scenario against 1) above.

NCoWRM :National Center of Water Resources Management
DoA :Department of Agriculture, MoA Ninewa Province

CHAPTER 2. CONFORMITY WITH NATIONAL PROGRAM OF IRAQ

2.1 National Development Plan (2010-2014) in Iraq

(1) Overall

The National Development Plan (2010-2014, Source: Executive Summary of NDP, MoP) shows following general objectives within next five(5) years.

1) Increase in the gross domestic product (GDP) at a rate of 9.38% per year during the plan period.
2) Generate 3 to 4.5 million new jobs based on the proportion between capital concentration and work that will be used in activities and projects adopted by the Plan.
3) Diversify the Iraqi economy through achievement of gradual increases in the rate of participation by other sectors in GDP, particularly the production, agriculture, and industrial sectors, along with tourism, which is a sector with some accomplishments and promise. It is also one of the sectors in which private sector activity plays a historically strong role. This role can be strengthened in the future both through generation of GDP and through the jobs it can generate.
4) Strengthen the role of the domestic and foreign private sectors, either in terms of the magnitude of investment anticipated within the country, estimated at about 46 percent, or in terms of job opportunities. The plan seeks to expand and diversify the activities that the private sector invests in, particularly comprehensive animal and vegetable production projects; fisheries; tourism of all kinds; conversion industries, particularly those in which Iraq has a comparative advantage; passenger transportation, merchandise, communications, as well as port and airport management; and education, health, and housing. The plan urges the government to play a strong enabling role in the area of housing to encourage both individual and private (national and foreign) sectors to invest in housing, yet recognizing that the state will retain responsibility for secure housing for vulnerable groups.
5) Improve and increase productivity and promote the concept of competition, particularly in activities enjoying a comparative advantage such as oil and gas, petrochemical industries, chemical fertilizers, cement, pharmaceutical industries, production of dates and fruits, rearing of livestock, and tourism of all kinds (recreational, religious, and historical) across all of Iraq's provinces.
6) Reduce poverty rates by 30 % from 2007 levels by focusing on comprehensive rural development and the creation of job opportunities, particularly for vulnerable groups such as youth and women, and focus on ensuring basic services, particularly educational and healthcare services, for rural areas and vulnerable groups.
7) Establish a spatial development trend characterized by fair distribution of infrastructure services and public services (water and sanitation, health, education, etc.) among all of Iraq's provinces in a manner consistent with their population size and the extent of their deprivation and need. Further, distribute production and tourism activities across the provinces in a manner consistent

with their capabilities at the state, regional, and international levels, with focus on rural areas and those urban areas that are the most deprived.

8) Establish sustainable development that balances economic, social, and environmental considerations so as to optimize use of available natural resources without undermining the right of future generations to benefit from those resources. Further to this, focus on keeping up with international developments in the areas of climate change and the use of environmentally friendly technologies.
9) Strengthen the role of local governments in developing their provinces and building capacity for coordination and complementarities, using their comparative advantages.

(2) Policy on Agriculture and Water Resources Development in Iraq

National Development Plan (2010-2014, Source: Chapter 5 of NDP, MoP) describes policy on agriculture and water resources development as below;

(Notice) Bring from NDP from Page 74 and 75 of Chapter 5, English version

Providing the required quantities and qualities of water has become one of the limitations of agricultural expansion in Iraq. Therefore, it is imperative that this be a priority in the development policies in Iraq in general and the agricultural policies in particular through a wide group of programs and procedures, as described below;

1) Reaching an agreement with the countries that share water from the Tigris and Euphrates and their tributaries (Turkey, Syria, and Iran) to do so according to international agreements and conventions to guarantee that Iraq obtains a quantitatively and qualitatively just share of water.
2) Complete the second stage of the water budget quickly (the strategic study of water and land resources) that the MoWR has undertaken for the various sectors that are beneficiaries and consumers, including agriculture, electricity, transport, swamps (Al-Ahwar), drinking, healthy water, industrial needs, and others.
3) Develop a central plan that specifies the share of water needed in all areas of arable land. Moreover, specify agricultural requirements such as machines, ratified seeds, and fertilizers. Agricultural staff should perform monitoring and evaluation to guarantee appropriate implementation hold rural inhabitants responsible for adhering to the MoWR.
4) Applying the principles of integrated management of water resources in coordination with all parties responsible for the ideal use of water resources and maintaining them, including the treatment of sewage and industrial wastewater, not letting it go into the rivers before treating it, and studying the possibility of reusing it.
5) Activating the projects of dams centrally.
6) Completing the connection of the main canals with the main outlet to rid rivers and canals from local pollution.

7) Supporting and expanding agricultural guidance, spreading the application of agricultural researchers, and expanding guidance projects so that users of water are aware of the importance of the wise use of water, ideally with the participation of the concerned ministries.
8) Strategically invest in underground water dedicating required sums to buy digging equipment and holding the MoWR solely responsible for those resources. Random expansion in digging wells should be limited by preventing private companies, and even the government companies under the control of the state's organizations, from investment except unless they have obtained approval from the MoWR.
9) Taking the limited water resources into consideration in the process of setting future agricultural policies by expanding the application of modern irrigation methods and encouraging the planting substitute crops that consume less water and can resist salinization and drought.
10) Building on the suggestions made by Turkey during water resource negotiations concerning the ideal and rational of water. This calls for focusing on the productivity of the single dunam, and it is necessary for the Ministry of Agriculture to take steps to qualify the capabilities of those who utilize the land. This would be done through increasing the production unit of the area of the crops by giving technical support, facilitating the process of obtaining the components of production like fertilizers, machines and fuel for agricultural processes, fighting the forests and the increase of buying prices of crops as a factor that participates in making peasants interested in taking care of planting their lands.
11) Establishing an information bank in the field of managing water and irrigation to use in the processes of planning, managing the demand for water for different purposes, developing the apparatuses of measuring wastes and levels and methods of collecting hydrological and climate methods about the basins of the Tigris and Euphrates, and documenting them.
12) Continuing to maintain dams and reservoirs and solving problems related to the ideal operation of water resources; building new dams to store quantities of water in suitable areas, with priority given to implementing projects that have complete feasibility studies and available financing.
13) Establishing a national project that deals with studies on international climate change, its effects on the water that comes into Iraq, and the future living conditions in light of expected scarcity.
14) Directing research studies in the concerned ministries and universities toward finding the necessary methods and applications to increase the standard of irrigation; reduce waste; use untraditional water resources like sewage and agricultural wastewater; invest in irrigated agriculture; and apply the research results at the level of pioneering projects to make them the initiative to be used by all water consumers. This requires returning to establishing research centers.
15) Considering water an important economic resource and setting a suitable price for it to maintain this wealth.
16) Giving the maintenance of projects, irrigation networks, canals, and reclaimed lands top priority and returning to the method of managing and operating them by establishing independent

authorized administrations, as it was in the Law of The Agricultural Interests.

2.2 A Water Resources Development Strategies (five-year Plan from 2010 to 2014)

A five-year Plan from 2010 to 2014 made by Ministry of Water Resources is summarized as follows;

1) The irrigated agricultural lands need more water than is available if all irrigation and reclamation projects are implemented. Therefore, the water availability is becoming a major limiting factor for agricultural production.
2) Water Resources Development Strategies should take into consideration the importance of improving water use, application of water saving technologies, implementing land reclamation projects, protecting the environment, constructing dams as required and maintaining and operating the infrastructures appropriately.
3) The Tigris and Euphrates Rivers are the main for water resources in Iraq. Most of their feeding sources are located outside the country as shown in Table 2-1.

Table 2-1 Average Inflow in Tigris River and its Tributaries from 1930 to 1990

Source: Water Resources Development Strategies (2010 to 2014), MoWR

Name of the River or Tributary	Annual Inflow (BCM)	Inflow percentage from Outside Iraq	Inflow percentage from Inside Iraq
Tigris Main River	19.43	100 %	-
Al-Khaboor	2.1	58 %	42 %
Upper Zab	14.32	42 %	58 %
Lower Zab	7.07	36 %	64 %
Al Udhaim	0.7	-	100 %
Diyala	5.86	59 %	41 %
Total	49.48	56 % Turkey 12 % Iran	32 %

4) The annual average inflow of the Euphrates River, up until 1989, was 27.40 BCM. However, from 1989 to 2005 the average annual flow at the Iraqi borders dropped to 17.4 BCM. Water inflows to the Tigris and Euphrates Rivers vary in accordance with climatic conditions and nature of water year. They fluctuate between years of high, low and dry inflows, as Table 2-2.

Table 2-2 Annual Average Flow in Tigris-Euphrates Rivers

Source: Water Resources Development Strategies (2010 to 2014), MoWR

Name of the River	Annual Average (BCM)	Wet Year(BCM)	Dry Year(BCM)
Tigris River & its Tributaries	49.48	95.68 (in 1969)	18.6 (in 1999)
Euphrates River	27.4 **(until 1989)** **17.4 (1989-2005)**	63.31 (in 1969)	9.56 (in 2001)

5) Riparian countries upstream are developing irrigation projects including the construction of dams. This has changed the flow pattern especially since 1990 as shown in Fig. 2-1. The Tigris River shows that the dry year which was continued from 1999 to 2001 occurred according to the graph.

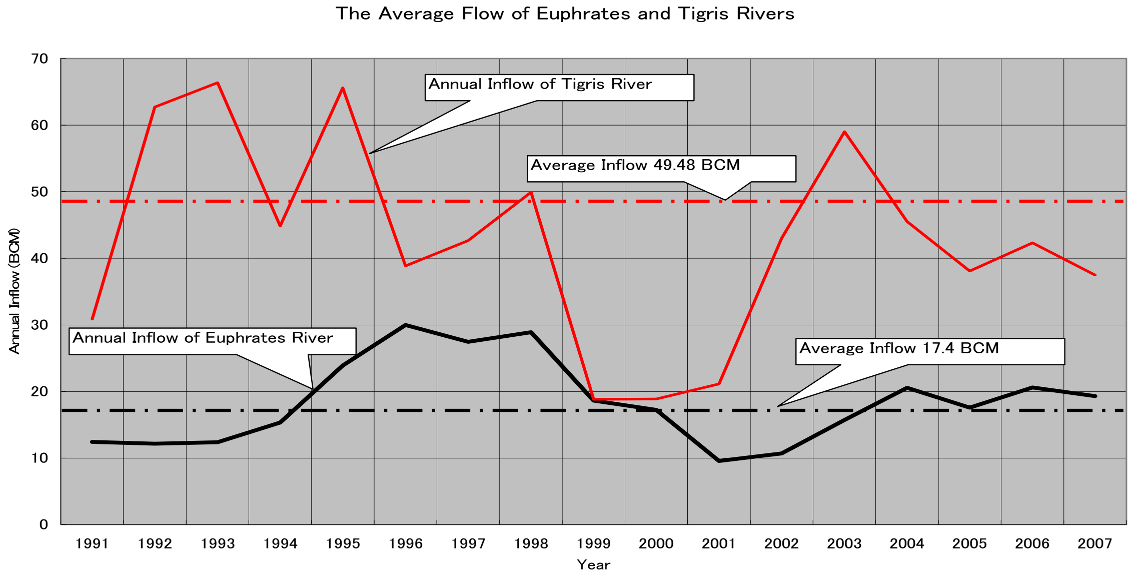

Fig. 2-1 Average Flow of Tigris-Euphrates Rivers

Source: MoWR

6) In the light of the available water resources development plans the current and expected annual flows in Iraqi rivers as shown in Table 2-3. According to this table Tigris rivers inflow shall decrease drastically by upper-stream countries developments in the future.

Table 2-3 Inflow of Tigris-Euphrates Rivers after Development

Source: Water Resources Development Strategies (2010 to 2014), MoWR

River Name	The current status	The expected inflow after development
Euphrates River Average inflow in BCM Water quality / part per million	 27.4 **(until 1989)** **17.4 (1989-2005)** 457	 8.45 (1250-1350)
Tigris River Average inflow in BCM Water quality / part per million	 19.43 250	 9.16 375
Al-Khaboor (BCM)	2.10	2.10
Upper Zab (BCM)	14.23	14.00
Lower Zab (BCM)	7.07	7.00
Al Udhaim (BCM)	0.70	0.70
Diyala (BCM)	5.86	4.00

7) Currently the total reclaimed area in Iraq is about 4.1 million dunam (1.0 million ha [this figure is shown in WRDS (2010-2014), but should be confirmed]). However 8.4million donum (2.1 million ha) is required to be reclaimed, the geographical distribution of which is as follows;
   - 0.8 million donum (0.2 million ha) to complete Irrigation projects
   - 7.6 million donum (1.9 million ha) on the Tigris and Euphrates basins to improve existing irrigation projects

8) Table 2-4 is a list of reclamation project including existing as well as new projects for the years 2010 to 2014 in Ninewa province.

Table 2-4 Area to be developed from 2010 to 2014 in Nineva Governorate

Source: Water Resources Development Strategies (2010 to 2014), MoWR

Name of the Project/ Governorate	Net Area		Area reclaimed from 2010 to 2014		Reclaimed Area (10^3 dunam)				
Nineva Governorate	10^3 dunam	ha	10^3 dunam	ha	2010	2011	2012	2013	2014
South Jazeera	416	104,000	250	62,500	40	40	50	60	60
Eastern Jazeera	215	53,750	190	47,500	30	40	40	40	40

According to the final report of the Preliminary Study for redefining The Southern Jazira Irrigation Project by Ryuichi Fukuhara, the gross of North Jazira irrigation project area is 60,000 ha, the planning Eastern Jazira irrigation project area is 75,000 ha and the South Jazira irrigation project is 190,000 ha (Gross). Then total gross irrigation area is 325,000 ha in the Jazira area.

In light of assessing the sustainability of the Jazira Irrigation Projects, since the projects will demand approximately 1.5-2.5 BCM/year, which will account for more than 10% of the average inflow to Iraq on the Tigris Rivers, the water availability for the Project must be reviewed within the frame of the national water balance along with a new National Water Master Plan.

2.3 Present Status of Water Treaty in Tigris Basin

From the long-term perspective, the hydro political security complex of the Tigris and Euphrates River basins are the most critical factor to the water availability of Iraq. Some issues have been pointed out that the Tigris and Euphrates Rivers are complicated by politically and hydrologically and the need for cooperation among riparian countries to ensure the water security and to prevent potential water-related disputes as shown in Table 2-5.

Table 2-5 Co-operational context on the Tigris

Source: German Federal Ministry of the Environment, Nature Conservation and the Nuclear Safety (2005), Status report on "Cooperation on Turkey's transboundary water"

Tigris	Basin area: 387,000 km^2, mean annual discharge 52 BCM	
Riparian position	**Basin area (% of total)** **Contribution to annual discharge**	**Main water uses**
Turkey upstream	57,600 km^2 (14.9 %) 20,840 BCM (40 %)	irrigation, hydropower
Syria -border with Turkey/Iraq	1,000 km^2 (0.3 %) -	
Iraq downstream	292,000 km^2 (75.3 %) 26,571 BCM (51 %)	Irrigation (diverts water through Thartar Canal to Euphrates), Hydropower
Iran Upstream on one tributary	- 4,689 BCM (9 %)	
Main agreements and covered issues		
None		
Disputed issues		
	No consensus on procedure No consensus on whether Euphrates-Tigris form one single watercourse system Dispute over llisu Dam construction	

2.3.1 Hydrological Environment in Iraq

The Tigris originates from a small mountain lake, south of the city of Elazig in eastern Turkey, and flows through the basaltic district of Diyarbakir. It forms the border between Turkey and Syria, and Iraq and Syria. Its two major tributaries are the Greater Zab and Lesser Zab, which join the river downstream of Mosul. The contribution of the Tigris tributaries to the river's potential is very significant and amounts to roughly 50% of the Tigris flow at Baghdad. Downstream from Baghdad the river's slope is flat and it becomes exceedingly tortuous with the Tigris joining the Euphrates to form the Shatt al-Arab watercourse at the north of Basra. Most of the water in the lower part of both of the Euphrates and Tigris are lost in a wide area of salinated marshlands. The combined area of lakes and swamps at the head of the Arabian Sea varies from 8,288 km^2 at the end of the dry season to 28,490 km^2 during spring floods.

Iraq is at the utmost downstream of the Tigris and Euphrates River basins and more than 70% of Iraq's water resources originate in Turkey; 90% of the flow of the Euphrates in Iraq originates in Turkey and Syria; and 40% of the flow of the Tigris in Iraq originates in Turkey. Essentially all of the flow of the Karkheh River that flows through marshes in southern Iraq and joins the Tigris and Euphrates originates in Iran. Major storage and irrigation project development has occurred on the headwater areas in Turkey (the GAP project), Iran (Dez and Karun projects on the tributaries of the Tigris) and in Syria that has been expanding irrigated areas along the Euphrates.

2.3.2 Water Resources Development on the Tigris and Euphrates

At present, irrigated agriculture - the greatest user of water - is unequally developed in the three major riparian states. Iraq was the forerunner, who had already 0.5 million ha irrigated lands by the Euphrates in the beginning of the 20th century. Syria started in the 1960s, and intensified irrigation in the Upper Euphrates after the completion of the Tabqa Dam in the mid 1970s. Prior to the completion of the Ataturk Dam (1990), irrigation in south-east Turkey was limited to groundwater and extended to about 114,000 ha. A major threat to water resources, and to the riparian's relations, is the envisaged enlargement of areas to be irrigated with water withdrawn from the Euphrates and the Tigris in all three countries: about 1.7 million ha in Turkey as part of the GAP project[-1], 640,000 ha in Syria and 300,000 ha in Iraq.

The major dams on the Euphrates are, Keban, Karakaya, Ataturk, Birecik and Karkamis in Turkey; Tabqa, Al-Baath and Tishreen in Syria, three more dams can be found on the Khabour river (Khabour Dam, Eastern Khabour Dam, Western Khabour Dam) in Syria. Because a large portion of Iraqi territory rarely exceeds 300 m in altitude, the topography limits the possibility of impounding the Euphrates behind large dams.

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[1] For further analysis of GAP, refer to Kolars and Mitchell (1991), The Euphrates River and the South Anatoria Development Project. As for the general information of GAP, see to the official webpage of the GAP administration of DSI

While Dokan, Darbandikhan, Diyala and Hemrin dams were built on its tributaries in Iraq, the Mosul Dam is the major water regulating structure in the main stream of the Tigris firstly ever built. In fact, the Upper Tigris had been less developed than in the Euphrates as the GAP project prioritized the developments in the Euphrates basin and Syria does have no access. After the completion of the Ataturk dam and Sanliurfa irrigation tunnels system, which are the major parts of the GAP Euphrates components, Turkey was ready to set for the major development of the Tigris, launching the construction of the Ilisu dam (with its maximum storage capacity of 10.4 BCM) in August 2006, and the Cizre dam is on the top of the waiting list. The Ilisu dam provokes the political and social controversies and attracted attentions, but the smaller Cizre dam would be hydrologically more problematic for the downstream as the Ilisu Dam is purely for the hydropower generations (1,200 MW) while the Cizre dam is for the irrigation covering 121,000 ha. For this additional irrigation, 4.3 BCM, 25% of the annual mean flow at Cizre, is planned to be diverted[-2].

Table 2-6 Tigris Basin Dam Projects of GAP[3]

Project	Installed capacity (MW)	Irrigated Area (ha)	Status
Karlkizi	204	123,965	Completed
Batman	198	37,351	Completed
Batman-Silvan	240	245,372	Planned
Garzan	89	60,000	Planned
Ilisu	1,200	n/a	Under construction
Cizre	240	121,000	Planned

[2] DSI/Ilisu Engineering Group (2001), Ilisu Dam and HEPP Project -Environmental Impact Assessment Report
[3] DSI/Ilisu Consortium (2005), Ilisu Dam and HEPP Project Update of Resettlement Action Plan

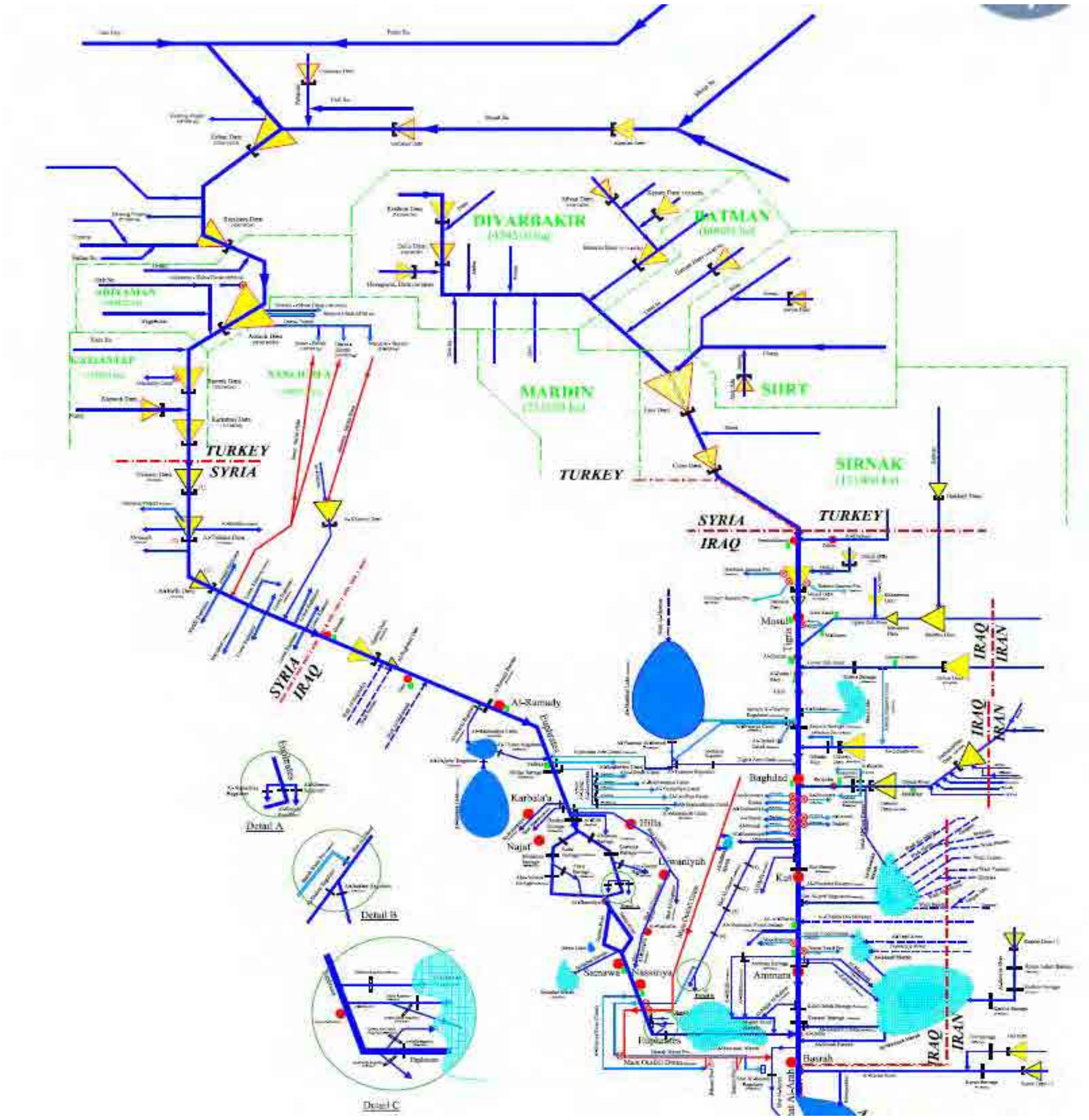


Fig. 2-2 Schematic diagram of developments on the upper Tigris

(Source: Hydrological Study Center of MoWR)

Until some years later, there will be surplus water in the Tigris and Euphrates rivers because the above-mentioned projects will take longer to implement than expected, and Iraqi water demand will not increase so rapidly due to the current situation. A shortage of water is imminent, though. This will oblige Iraq to transfer more surplus water from the Tigris to the Euphrates. Between 2020 and 2030, a water shortage on the Tigris and Euphrates will be looming along with the increasing demand in the riparian countries. In fact, an emergency is expected to take place already around 2020 because 4 BCM of water that will remain as surplus in the two rivers will not suffice for the drainage of the Tigris and Euphrates basin into the Gulf.

2.3.3 History and recent developments for water negotiations on the Tigris and Euphrates

Negotiations between Turkey and Iraq on the development of the Euphrates' water originally started in the 1940s, when the protocol annexed to the 1946 Treaty of Friendship and Good Neighborly Relations between Iraq and Turkey was agreed. The protocol provided the control and management of the Euphrates and the Tigris depending to a large extent on the regulations of flow in Turkish source areas. Turkey agreed to begin monitoring the two border-crossing rivers and to share related data with Iraq. In 1980, Turkey and Iraq further specified the nature of the earlier protocol by forming a Joint Technical Committee (JTC) on Technical issues, which Syria joined later in 1982 as well. Turkey unilaterally guaranteed to allow 15.75 BCM/year (500 m^3/s) of water across the border to Syria without any formal agreement on the sharing of the Euphrates water. This was confirmed by a bilateral Syria-Turkey protocol in 1987.

The early 1990s were a turning point when Turkey started to fill the Ataturk dam on the Euphrates in January 1990 and downstream Syria and Iraq perceived the interruption of water flow entirely for a month. Then, tripartite negotiations came to an end. Iraq and Syria temporarily established the bilateral agreement in 1990 as follows.

The Iraq water share on the border region between Iraq and Syria is 58% as a fixed annual total percentage (water year) of the water Euphrates river allowed to pass in Syria through the border with Turkey, and the Syrian share of water is the remainder quantity 42% of the water of Euphrates river allowed to pass through the border between Turkey and Syria.

The early 1990s were also important in a sense that the first Gulf war erupted and consequently Iraq was imposed the international sanctions. Iraq's isolation from the international community gave Turkey a good excuse not to negotiate water issues with "a rogue state" during the whole 90s

On the other hand, the bilateral talk between Turkey and Syria resumed in 1998 when the political Adana Agreement[4] was signed by the two parties. The agreement itself was controversial but the GAP administration contacted with the Syrian Ministry of Irrigation leading to a signature of a Joint Communiqué on August 2001 which fostered cooperation in areas such as training, technology exchange and conduct of joint projects. The document included provisions for training programs; joint projects such as a twin village project; joint irrigated agricultural research projects with twin research stations; exchange programs. It also intended to establish joint executive bodies, i.e. a Joint Technical Committee and a Steering Committee. However, until now such envisaged programs and initiatives have never materialized.

Restart of trilateral talks had to wait for the 2003 Iraq invasion. The Iraqi new administration expressed their willingness to initiate a dialogue with upstream countries along the international

[4] This was not the agreement on water issues, rather to strengthen political ties for combating against PKK, which had been supported by Syria since the early 90's.

standards, for instance, in line with the 1997 UN Convention for Non-Navigational Use of the International Waterways. In the context of the Iraqi reconstruction by the international parties, UNESCO organized an informal trilateral meeting to facilitate the dialogues in November 2005, the first time in the last 15 years. In 2006, some joint training and meeting took place supported by UNESCO and other parties.

The first official tripartite meeting was held in March 2007 in Antalya, Turkey as a part of an international conference hosted by DSI. Two(2) month later, the Joint Technical Committee was officially resumed in Damascus with a participation of Director Generals from three parties to confirm they would meet regularly to discuss the water-related issues. The ministerial meeting was also promised in the meeting.

The Ministerial meetings were held in January 2008 and February 2009 respectively. Also a special session on the Tigris and Euphrates during the 5th World Water Forum (Istanbul, March 2009) took place. There is goodwill for the future cooperation and so many issues have been discussed, just like Turkey-Syria bilateral talks, but they have not reached any additional agreement or any roadmap so far.

In light of the South Jazira Project, the Ilisu Dam had been raised during the JTC meetings; Turkey would guarantee the same amount of discharge to the downstream after the completion of the Ilisu Dam while the Cizre Dam has not appeared on the agenda as far as in the official minutes. Here is a pitfall; the Ilisu - Cizre Dam scheme is considered as one component in the GAP plan. As described in the previous subsection, the Cizre Dam projects to divert the 25% of the Tigris. Iraq should appeal the potential impact of the Cizre Dam during the trilateral talks in addition to the Ilisu Dam and the Euphrates.

Despite the efforts by the downstream countries toward adequate sharing of water resources on the Tigris and Euphrates over years, only two above-mentioned agreements (in bold) were bilaterally reached for the Euphrates. There is no basin-wide agreement, which means covering the Tigris, and no clause concerning the water quality. The impact of water resources development and management by the upstream countries is decisive to the water security of Iraq so that cooperation and information sharing for the basin-wide water resources management, in particular for the Tigris, is imperative for wise water use of the two rivers for the future, in particular for the sustainability of the South Jazira Project.

The 2008 drought in Iraq sparked new negotiations between Iraq and Turkey over trans-boundary river flows. Although the drought affected Turkey, Syria and Iran as well, Iraq complained regularly about reduced water flows. Iraq particularly complained about the Euphrates River because of the large amount of dams on the river. Turkey agreed to increase the flow several times, beyond its means in order to supply Iraq with extra water. Iraq has seen significant declines in water storage and crop yields because of the drought. To make matters worse, Iraq's water infrastructure has suffered from years of conflict and neglect.

In 2008, Turkey, Iraq and Syria agreed to restart the Joint Trilateral Committee on water for the three(3) nations for better water resources management. Turkey, Iraq and Syria signed a memorandum of understanding on September 3rd, 2009, in order to strengthen communication within the Tigris-Euphrates Basin and to develop joint water-flow-monitoring stations. On September 19th, 2009, Turkey formally agreed to increase the flow of the Euphrates River to 450 to 500 cu. cms., but only until October 20th, 2009. One of Turkey's last large GAP dams on the Tigris - the Ilisu Dam - is strongly opposed by Iraq and is the source of political strife.

As above mentioned, the flow rate from the upstream countries in the Tigris River is not stable from the reasons of both natural conditions and the political situations. Summary of meetings are shown in Table 2-7 and 2-8.

Table 2-7 The course of Joint Technical Meetings on Regional Waters

Year, Month	Substance
1962	Syria and Iraq formed a Joint Technical Committee, which had a very limited role as there were no major constructions at this time.
1972-1973	Unsuccessful attempts by Syria and Iraq to negotiate an agreement on Euphrates waters
1980	• Protocol of the Turkish-Iraqi Joint committee for Economic and Technical Cooperation • Creation of a Joint Technical Committee for Regional waters (JTC)
1982 May	• First JTC Meeting in Ankara, with experts from Turkey and Iraq • Field Trip to some Turkish project sites • Exchange of information on existing and planned projects • Iraq: river basins discussed separately; Turkey: rivers and tributaries as one basin • Preparation of detailed hydrological studies for next meeting • Renewed invitation o Syria
1982 Nov	• Second JTC Meeting in Baghdad, with experts from Turkey and Iraq • Continued exchange of information on existing and planned projects • Iraq: river basins discussed separately; Turkey: rivers and tributaries as one basin • Renewed invitation to Syria
1983 Sep	• Third JTC Meeting in Ankara, with experts from Turkey, Syria and Iraq • Syria was informed about previous JTC work, which Syria agreed it should continue • Exchange of available information on regional waters at next meeting
1984 Jun	• Fourth JTC Meeting in Baghdad, with experts from Turkey, Syria and Iraq • Field trip to an irrigation project in the Tigris basin • Continued exchange of hydrological data • Opinions on Iraq’s proposal for data required
1984 Nov	• Fifth JTC Meeting in Damascus, with experts from Turkey, Syria and Iraq • Field trip to Yarmouk Irrigation project • Discussion of ways to expand and improve exchange of hydrological and meteorological information • Turkish proposal for sub-committees (hydrology, soil, agricultural economy, engineering and planning)
1985 Jun	• Sixth JTC Meeting in Ankara, with experts from Turkey, Syria and Iraq • Field trip to Karakaya Project • Discussion on ways to expand and improve exchange of hydrological and meteorological information • Views on Turkish proposal for sub-committees: Turkey insisted on proposal while Syria and Iraq disagreed
1986 Jan	• Seventh JTC Meeting in Baghdad, with experts from Turkey, Syria and Iraq • Field trip to barrages under construction (Kufa and Abbasiya)

Year, Month	Substance
	• Discussion of ways to expand and improve exchange of hydrological and meteorological information • Turkish statement regarding impoundment of Karakaya reservoir • Importance of regional water pollution investigations, exchange of related data
1986 Jun	• Eighth JTC Meeting in Damascus, with experts from Turkey, Syria and Iraq • Field trip to sections of the Euphrates Projects near Raqqa and Deirezzor • Discussion of ways to expand and improve exchange of hydrological and meteorological information • Importance of regional water pollution investigations, exchange of related data • Exchanged information on progress in construction of dams • Iraq informed on impoundment of Kadassiya • Proposals by all three countries studied: agreement on hydrological and meteorological items, but not on other items
1986 Nov	• Ninth JTC Meeting in Ankara, scheduled at the Eighth JTC Meeting
1988 Jan	• Tenth JTC Meeting in Baghdad, with experts from Turkey, Syria and Iraq • Field trip to the new Hindiya Barrage project on the Euphrates River • Continued exchange of hydrological and meteorological information • Exchanged information on present situation o dam construction and reservoir impoundment • Discussed different viewpoints concerning the work of the JTC • Took note on the joint measurements of the Euphrates discharges at Belkiskoy, Jarablus and Kadahyeh, which bad been performed by Turkish and Syrian sides for four runs, with the presence of Iraqi observers for the third run
1988 Nov	• Eleventh JTC Meeting in Damascus, with experts from Turkey, Syria and Iraq • Discussion of ways to expand and improve exchange of hydrological and meteorological information • Exchanged information on present situation o dam construction and reservoir impoundment • Discussed different viewpoints concerning the work of the JTC • Wish to intensify meetings to fulfill determined tasks of the JTC
1989 Mar	• Twelfth JTC Meeting in Ankara, with experts from Turkey, Syria and Iraq • Field trip to Ataturk Dam Project • Exchanged hydrological data • Exchanged information on progress in construction of dams • Discussed mechanism for studying water requirements of the three countries: no progress achieved, need to intensify efforts to reach common viewpoint
1989 Apr	• Thirteenth JTC Meeting in Baghdad, with experts from Turkey, Syria and Iraq • Field trip to Saddam project on the Tigris Rivers and to pumping station of North Jazira Irrigation Project in Ninevah Governorate • Exchanged hydrological data: Turkey agreed to provide hydrological & meteorological information for better management during the drought for the current water year • Exchanged information on progress in construction of dams • Iraq informed on Thartar and Main Outfall Drain projects • Did not reach common understanding on: • Whether Euphrates and Tigris should be viewed separately or as one basin; • Methodology to study and assess factors related to the mandate of the JTC
1989 Dec	• Fourteenth JTC Meeting in Damascus, with experts from Turkey, Syria and Iraq • Exchanged hydrological and meteorological data • Exchanged information on progress in construction of dams • Turkey informed on initiation of impounding Ataturk reservoir • Syria and Iraq asked Turkey to shorten the closure period for the impoundment • Turkey: not technically possible, has already been fixed for a minimum range
1990 Mar	• JTC Meeting in Ankara, with experts from Turkey, Syria and Iraq • Turkey's proposal for scientific research regarding water use rejected • Syria and Iraq insisted on agreement on water distribution instead of more studies
1990 May	• JTC Meeting, with experts from Turkey, Syria and Iraq • Iraq demanded an increase of the Euphrates flow to 700m3/s
1992 Sep	• JTC Meeting in Damascus, with experts from Turkey, Syria and Iraq

Year, Month	Substance
	• Syria and Iraq reiterated call for a trilateral agreement • Turkey argued that the 1987 quota agreement was equitable and adequate for the downstream needs, and that Syria and Iraq should use water more efficiently
2007 May	• JTC Meeting in Damascus, with experts from Turkey, Syria and Iraq • Three parties agreed to reactivate the JTC • Ministerial Meeting was scheduled in July 2007

Table 2-8 The Course of Tripartite Ministerial Meetings on Regional Transboundary Watercourses

Year	Substance
1988 Nov	**First Ministerial Meeting**
May 1989	Scheduled Ministerial Meeting did not take place
1990 Jun	**Second Ministerial Meeting** in Ankara, with Irrigation Ministers from Turkey, Syria and Iraq • Turkey defined the Euphrates flows as “transboundary waters” while Syria and Iraq consider the Euphrates River to be “international”. • Turkey’s Three-staged Plan for Optimum, Equitable and Reasonable Utilization of the Transboundary Watercourses of the Tigris-Euphrates Basin • Iraqi proposal that Turkey will release not less than 700 m^3/s at the Turkish-Syrian border until a final agreement on water distributions has been reached
2001 Jan	**Affirmation of the not-public agreement between Syria and Iraq (from April 1990) for sharing Euphrates waters** Syria would receive 42% and Iraq 58% of annual flows (from Turkey to Syria), regardless of quantity.
2007 Mar	**Ministerial Meeting** in Antalya, with Ministers from Turkey, Syria and Iraq • Agreed to have a high-level meeting in Damascus to reactivate the JTC
2008 Jan	**Ministerial Meeting** in Ankara, with Ministers from Turkey, Syria and Iraq (postponed from July 2008 due to the political tension between Turkey and Iraq regarding PKK issues) • Turkey informed the construction of the Ilisu Dam on the Tigris • Turkey guaranteed that the same amount would be discharged to the downstream after the completion of the Ilisu Dam • Iraq proposed to set up the joint research project on the utilization of the Tigris and Euphrates waters • Iraq insisted that issued should be settled according to the international law of watercourses • Turkey offered the study visit to the GAP area in April 2008
2009 Feb	**Ministerial Meeting** in Damascus, with Ministers from Turkey, Syria and Iraq • Turkey invited Syria and Iraq to the special session of the 5th World Water Forum • Iraq proposed to have next meeting in Baghdad

2.4 Food Issues

2.4.1 Import and Export

Major import items of Iraq are food, medicine, and manufacturing goods. Among top 20 food items imported, cereals and cereal products including wheat flour consist of 45% in 2007, followed by cigarette, palm oil, beverage and chicken meet. Import amount in 2008 is 50 billion US$, and main country origins are Syria (26%), Turkey (20%), United States (11%), Jordan (6%), and China (6%). Following table shows top 10 imported food commodities of Iraq in 2007.

On the other hand, primary export goods of Iraq are crude oil, crude materials (excluding fuels), food and live animals. Amount of total export is 58.81 billion US$ in 2008, of which crude oil makes up 84%. As for food items, date is the principal export goods of Iraq. Main export partners are United States (39%), India (12%), Italy (10%), and South Korea (7%) in 2008.

2.4.2 Consumption

According to FAO's food balance sheet 2000, which is only available data set for Iraq citizens' food consumption, per capita daily calorie intake is 2,197 kcal./capita/day, lower than the world average of 2,725 kcal./capita/day as shown in Table 2-9. Calorie intake from wheat is remarkably high, holding 50% of daily calorie intake in Iraq. Also, rice accounts for 16% of total calorie intake in a day. In total, Iraqi peoples take around 70% of daily calorie from cereals. Consumption of livestock products is quite lower than the world average.

Table 2-9 Per Capita Daily Calories Intakes From Selected Food Items (2000)

item	Food Consumption (kcal/capita/day)			
	Iraq		World	
Grand Total	2,197	(100%)	2,725	(100%)
Vegetal Products	2,109	(96%)	2,270	(83%)
Animal Products	88	(4%)	455	(17%)
Wheat	1,085	(49%)	544	(20%)
Rice (Milled Equivalent)	350	(16%)	541	(20%)
Barley	59	(3%)	7	(0%)
Potatoes	12	(1%)	60	(2%)
Sugar (Raw Equivalent)	105	(5%)	194	(7%)
Pulses	15	(1%)	56	(2%)
Vegetable Oils	308	(14%)	246	(9%)
Vegetables	42	(2%)	71	(3%)
Tomatoes	11	(1%)	8	(0%)
Onions	2	(0%)	8	(0%)
Vegetables, Other	30	(1%)	55	(2%)
Fruits - Excluding Wine	96	(4%)	76	(3%)
Meat	31	(1%)	208	(8%)
Milk - Excluding Butter	37	(2%)	120	(4%)

FAOSTAT, FAO Statistics Division (2010)

2.4.3 Self-sufficiency in Food

Even though wheat is the most important staple food for Iraqi peoples, consuming twice of the world average, Iraq is the world's seventh-largest import country of wheat, according to USDA estimation in 2009. Iraq produces wheat around 300 thousand tons per year, on average between 1989 and 2000, but wheat consumption is 11 times larger than its production, resulting in only 9% of self-sufficiency rate of wheat.

On the other hand, self-sufficiency rate of barley is 72%, contributing to increase self-sufficiency rate of cereals. However, since consumption amount of barley itself is relatively smaller, self-sufficiency rate of cereals is still 20% in total. According to FAO/ GIEWS statistics, this rate has been increasing during the last decade, but still fluctuating around 30%.

It should be noted that the self-sufficiency rate of wheat in the table below might be underestimation, if we focus on the recent year's figures, since wheat production at national level is

1,255 thousand ton in 2007. In the same year, volume of import is 2,424 thousand as Table 2-10 indicated. Even though we do not know the stock and other use of wheat in the year 2007, total consumption of wheat must be around 3,600 thousand ton, hence self-sufficient rate is estimated at around 35% in 2007. Anyway, both data indicated that production of wheat in Iraq is far below than the self-sufficiency level even in the last decade.

Table 2-10 Food Balance in Iraq (1000 ton)

Item /a	Production (+)	Import (+)	Stock and Other Use (+)	Export (-)	Consumption (=)			Self-sufficiency
						kg/person/yea	Waste	
1 Wheat	300	3,313	-170	0	3,443	130.8	216	8.7%
2 Rice	40	1,011	-235	0	815	34.8	12	4.9%
3 Barley - excluding	400	203	-50	0	553	6.5	30	72.3%
4 Maize	53	0	10	0	63	0.6	2	84.1%
5 Potatoes	200	16		0	216	5.9	21	92.6%
6 Sugar Beet	8	0		0	8			100.0%
7 Pulses	29	10	0	0	40	1.6	1	72.5%
8 Sunflowerseed	66				66	0.9	2	100.0%
9 Cottonseed	12				12			100.0%
10 Tomatoes	500	45	0	0	545	21.6	51	91.7%
11 Onions	40	3	0	0	43	1.7	4	93.0%
13 Beef and Veal	48	0	0	0	48	2.1		100.0%
14 Mutton & Goat Meat	29	0	0		29	1.2		100.0%
15 Poultry Meat	50	2	0		52	2.3		96.2%

Source: FAOSTAT Database, FAO

a/ Item 1 to 7 is average 1989 - 2000. From 8 to 16 is figures in 2000.

In spite of the above serious condition, all Iraqi peoples can access to these staples due to the nation-wide rationing system starting from 1991, after the economic sanction decided by the united nations. Since then, all Iraqi citizens can obtain, without charge, the same amount of basic foods, including wheat flour, rice and cooking oils. At present, 9 kg/month/person of wheat flour and 3 kg/month/person of rice, for example, is freely provided to all population through food coupon system. This amount would be enough large, since it is estimated that the food coupon can supply 80% of annual wheat consumption of average Iraqi citizens.

In 2008 and 2009, serious drought took place in the study area, and farmers can not earn income from their crop production, according to the questionnaire survey organized by the Study Team in 2010. However, the rationing system works well to prevent farmers and Iraqi citizens from serious famine.

2.4.4 Nineva's Contribution to the National Food Consumption

Nineva governorate is the largest provider of wheat and barley in Iraq, and produces 15% and 28% of total wheat and barley production in 2007 respectively. In view of cultivated land of wheat and barley, Ninewa account for 30% of the total area for wheat and 58% of the country's total production area of barley.

However, yields of wheat and barley in Nineva are the lowest among all governorates since their agriculture is overly dependent on erratic rainfall, hence unstable agricultural production year by year. This fact indicates that current productivity of cereals in Nineva is quite low but having a room to increase its productivity through production enhancement including irrigation projects.

In 2010, Ministry of Trade purchases 1,825 thousand ton of wheat, equivalent to 983 billion ID, from farmers in the entire country, and Nineva is the largest wheat suppliers among 18 governorates, according to an announcement of the Ministry of Trade. The government's purchasing price in 2010 is estimated at 539 ID/ kg.

According to the crop plan in the original Swiss F/S, production volume of wheat at full development stage will be 356,900 t/year, which is equivalent to 20% of total production of wheat in 2010.

2.5 Validity of the Project in National Development Plan

In the above mentioned, as the targets in "National Development Plan (NDP)", "Water Resources Development Strategies (2010-2014)" and issues on food self-sufficiency are summarized below, the South Jazira Irrigation Project is verified to conform with national policy;

1) NDP focus on reducing poverty in the country with creating new jobs through agricultural development projects by supporting local government with improving necessary infrastructure.
2) "Policy on Water Resources Development in Iraq" states having consensus regarding water volume and quality with upper stream countries of Tigris-Euphrates rivers (Turkey, Syria, Iran) for the agriculture and water resources development by use of natural sources.
3) Also, "the Policy" mentions to save water by introducing modern irrigation techniques in consideration with limited water resources and to improve land productivity through technical transfer on the field of fertilizer application, agricultural machinery, pest control.
4) Iraq depends on import wheat which is staple food for the country. Rate of food self-sufficiency for grain including barley is only 30%.
5) Nineva governorate is the largest provider of wheat and barley in Iraq, and produces 15% and 28% of total wheat and barley production in 2007 respectively. However, land productivity of Nineva is much less than an average of the country which is only 50% of unit yield for wheat.

On the other hands, as shown in "2.3 Present Status of Water Treaty in Tigris Basin", followings are the some issues to complete the Study for the South Jazira Irrigation Project.

a) Since water treaty among countries is not making good progress particularly in Tigris, inflow volume to the Mosul dam will be possibly limited in the future.
b) Information concerning volume of discharge to the downstream of Tigris river is not yet clear, which will be possibly affected to the marsh of Southern Iraq in terms of natural environment.

CHAPTER 3. CONDITIONS OF THE STUDY AREA

3.1 Natural Conditions

3.1.1 Climate

(1) General Conditions

The Climate of Iraq has been classified as continental. However, it is modified by the presence of the Arabian Gulf and especially the Mediterranean Sea, making it in the northern part of the country resembles the Mediterranean type during the winter.

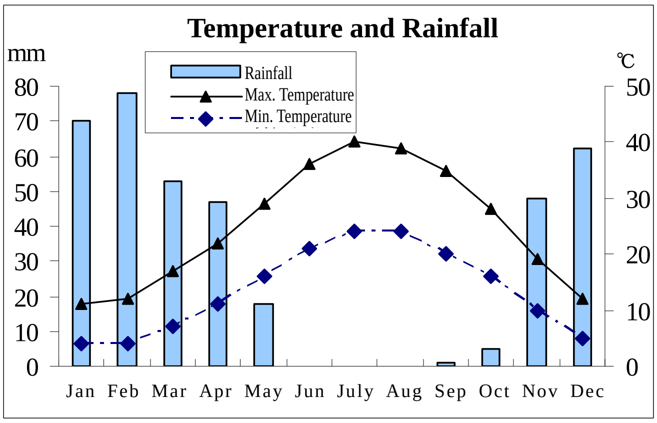


Fig. 3.1-1 Temperature and Rainfall in Mosul

The summer months, from June to September, are completely dry with extremely high temperatures and very low relative humidity. In October and November, temperature drop and showers occur with increasing frequency. Lowest air temperatures are reached from December to February, with minimum temperatures occasionally below zero. About 80% of the rainfall is distributed fairly evenly over the period from December to April. From March to May, rainfall is again of the more showery type and sometimes accompanied by thunder and even hail. And during May, rainfall ceases completely and temperature rise quickly.

(2) Collected Meteorological Data

The meteorological data of Mosul, Tel Afar, Sinjar, Baghdad and other available stations relevant to the Project area for the recent 20 years from 1990 – 2009 were collected from Ministry of Transport (MOT), which observes weather and manage meteorological data, through MoWR

The following items shall be collected in each station.

Maximum sunshine hours (hr/day)
Actual sunshine hours (hr/day)
Short-wave radiation at top of atmosphere (cal・cm-2 day-1)
Estimated incoming short-wave radiation (cal・cm-2 day-1)
Mean Temperature （℃）
Maximum Temperature （℃）
Minimum Temperature （℃）
Mean relative humidity （%）
Vapor pressure (mbar)
Vapor pressure deficit (mbar)
Wind speed (m/s)
Class A pan evaporation (mm・month-1)

3.1.2 Tendency of Temperature Fluctuation

Monthly mean temperature of latest collected data (1982 - 2009) is a little higher than the data of Swiss F/S study (1969 - 1980) and its fluctuation is shown in Fig. 3.1-2.

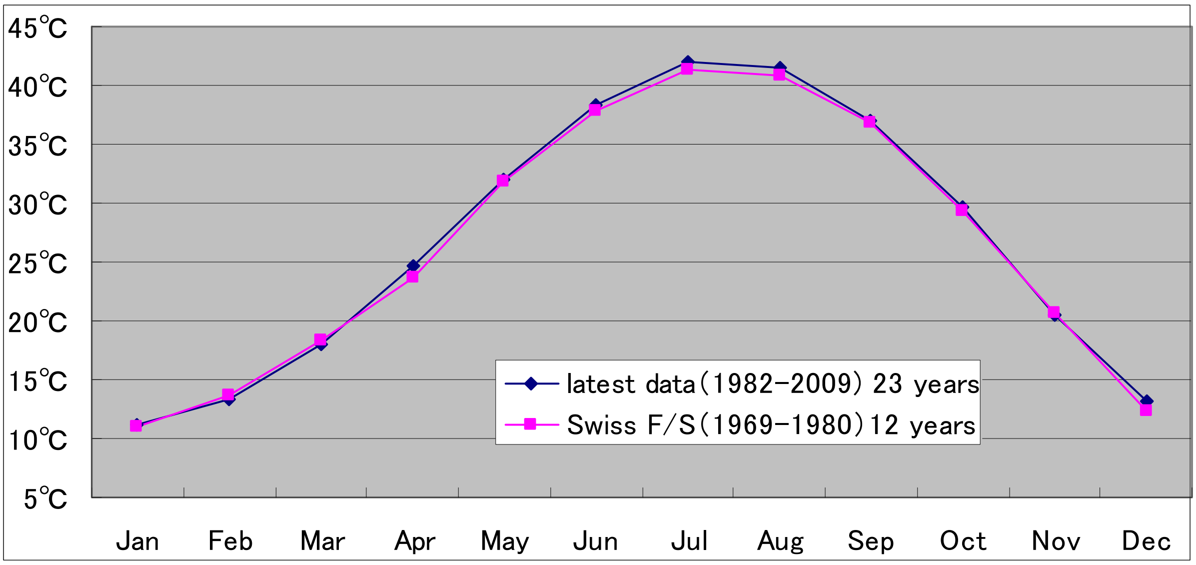


Fig. 3.1-2 Comparison of Temperature Fluctuation at Telafar station between Swiss F/S study data and latest collected data (source: MOT)

3.1.3 Trend of Precipitation Fluctuation

Fig. 3.1-3 shows comparison of the monthly mean rainfall at Telfar station between Swiss F/S study data (1969 - 1980) and latest collected data (1982 - 2009). Amount of total annual rainfall is 212 mm by latest collected data, which is 65 % of 328 mm by the Swiss F/S data. This figure shows the amount of rainfall is on a declining trend in recent years.

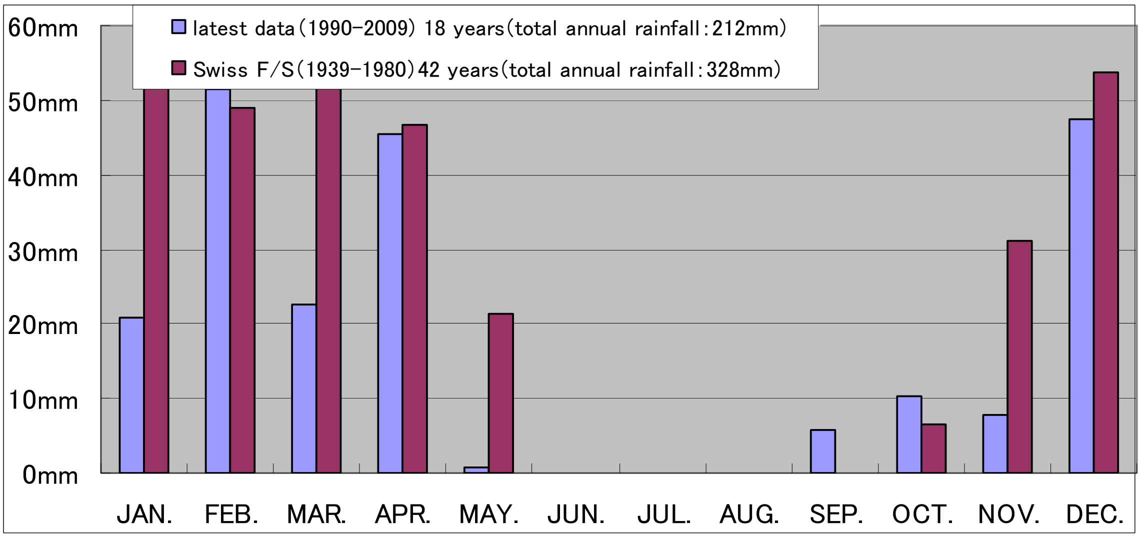


Fig. 3.1-3 Comparison of Rainfall Fluctuation at Telafar station between Swiss F/S data and latest collected data (source: MOT)

Tendency of the recent annual rainfall of the northern cities in Iraq is shown in Fig 3.1-4.

According to the Figure, recent annual rainfall in Dohouk is about one third of 10 years before. And the ranges of annual amount of rainfall in Mosul and Erbil are from 200 mm to 500 mm. However, the long-term change tendency doesn't have a big characteristic. Rainfalls in 1999 and 2007 are remarkably lower by 50 % of the average at Mosul. Therefore, the Tigris River flow infused by the tendency of rainfall shows 18.6 BCM in the lowest happened in 1999.

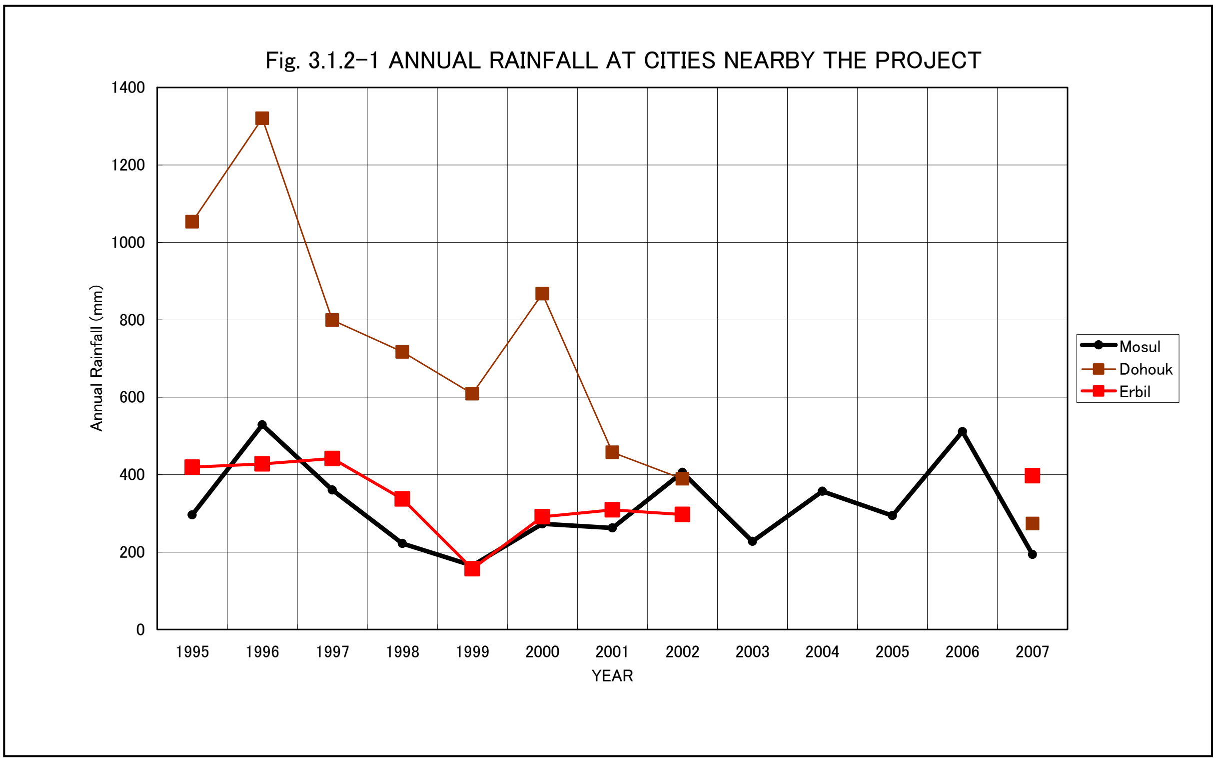


Fig. 3.1-4 Current Tendency of Rainfall (Source: MoWR)

3.1.4 Hydrology

(1) Surface runoff in the Project area

During the Swiss F/S in late 1979 to early 1980, stream flow gauging was initiated at 3 sites in the Project area. In December 1980, water level reading started at a four(4) sites shown in Table 3.1-1.

Table 3.1-1 Gauging Stations at F/S (Source: Swiss F/S Report)

Gauge	Wadi	Catchments Area Km^2
Tel Abda	Al Tharthar	2,320
Shwa	Al Tharthar	851
Tel Hassar	Morgada	123
Al Tatsah	Abdan	553

Monthly specific discharge for three(3) stations are shown in Table 3.1-2

Table 3.1-2 Monthly Specific Discharge in l/s/km^2 (Source: Swiss F/S Report)

Gauge	1980						1981		
	Jan	Feb	Mar	Apr	Dec	Year	Jan	Feb	Mar
Tel Abda	0.03	2.0	0.64	0.88	0.64	3.55	0.49	0.58	0.5
Shwa	N.A	N.A	1.2	N.A	0.31	1.51	0.25	0.45	N.A
Tel Hassar	N.A	N.A	2.0	N.A	0.36	2.36	0.46	0.09	0.06

The annual runoff height of each station can be 11mm of Tel Abda, 4 mm of Shwa and 6 mm of Tel Hassar by calculating from the annual discharge in 1980. These figures which mean runoff discharge in the Project area are very small and surface water can not be competent water resource. Any recent observation relating to the surface runoff in the Project area can not be found.

3.1.5 Topography and Geology

(1) Topography (Geography)

(a) Ground Configuration

Fig. 3.1-5 shows topography in and around the project area and feeder canal alignments. The ground of the project area is gently sloping to the south. The feeder canal alignment runs in the area where hills and low relief valleys repeatedly distributes.

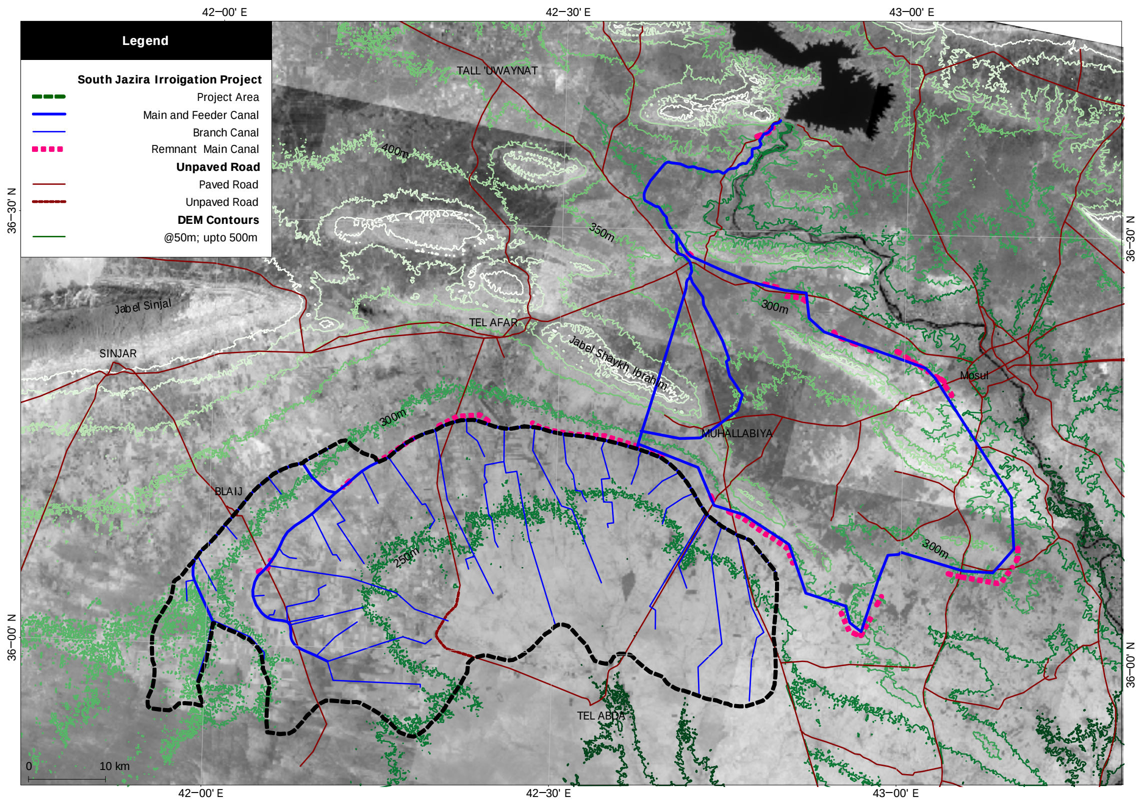


Fig. 3.1-5 Topographic Map in and around the Project Area

(b) Watershed and Wadi

Most of the project area belongs to the Wadi Tharthar watershed, whereas the south west part does to the Euphrates river watershed as shown in Fig.3.1-6. There are no perennial streams. All water courses are wadi.

(c) Villages, Agricultural Roads and Lands in the Project Area

Villages and settlements are scattered in the project area as in Fig.3.1-7. Some of them have no or few residents at present. Systematic agricultural roads develop as shown in Fig.3.1-7 and regular configurations of farmlands surrounded by the roads distribute. Some parts of the roads and farmlands are created on buried wadi as shown in Fig.3.1-8. There are typical geometric patterns in the agricultural field of the Project area as shown in Fig.3.1-9.

(d) Center Pivot Sprinkler Irrigation Farms, Qanats in and near the Project Area

Center pivot sprinkler irrigation farms are slightly identified in and around the project area as shown in Fig.3.1-10 and Fig.3.1-11. Lateral move sprinkler is also found as shown in Fig.3.1-12. A series of vertical wells of qanat are identified in and around the project area. Most of qamats may be not used at present, according to information on a topographic map (1/100k, NIMA map).

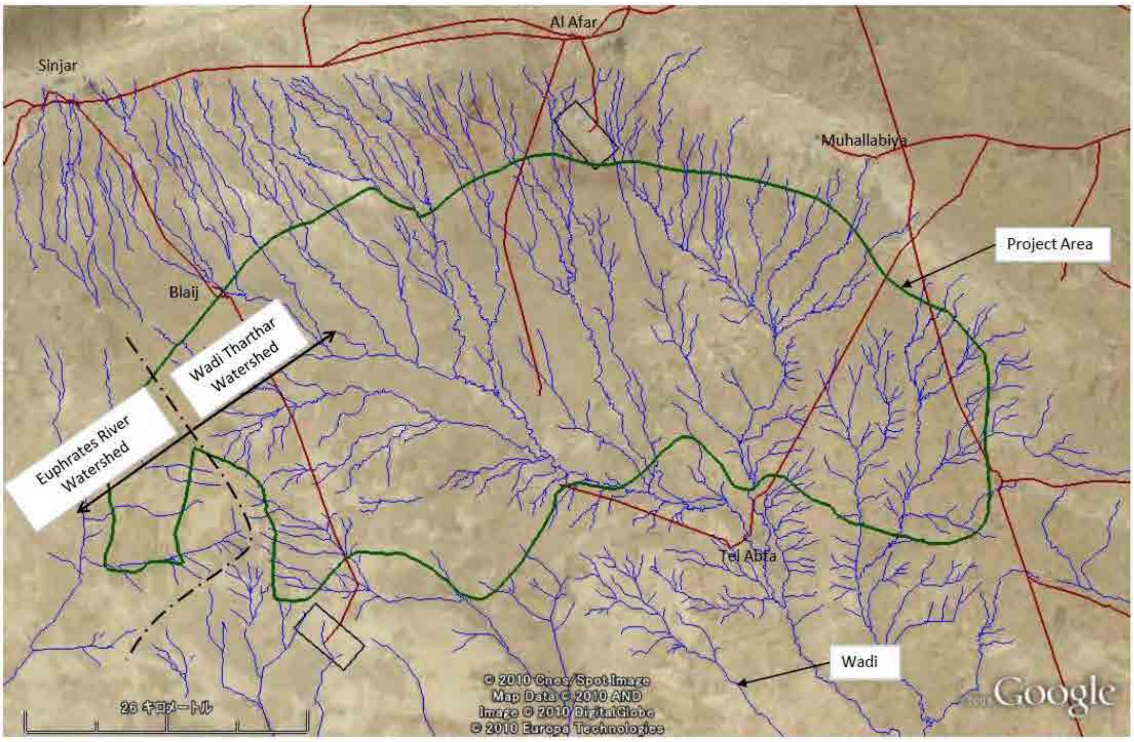


Fig. 3.1-6 Wadi and Watershed in the Project Area

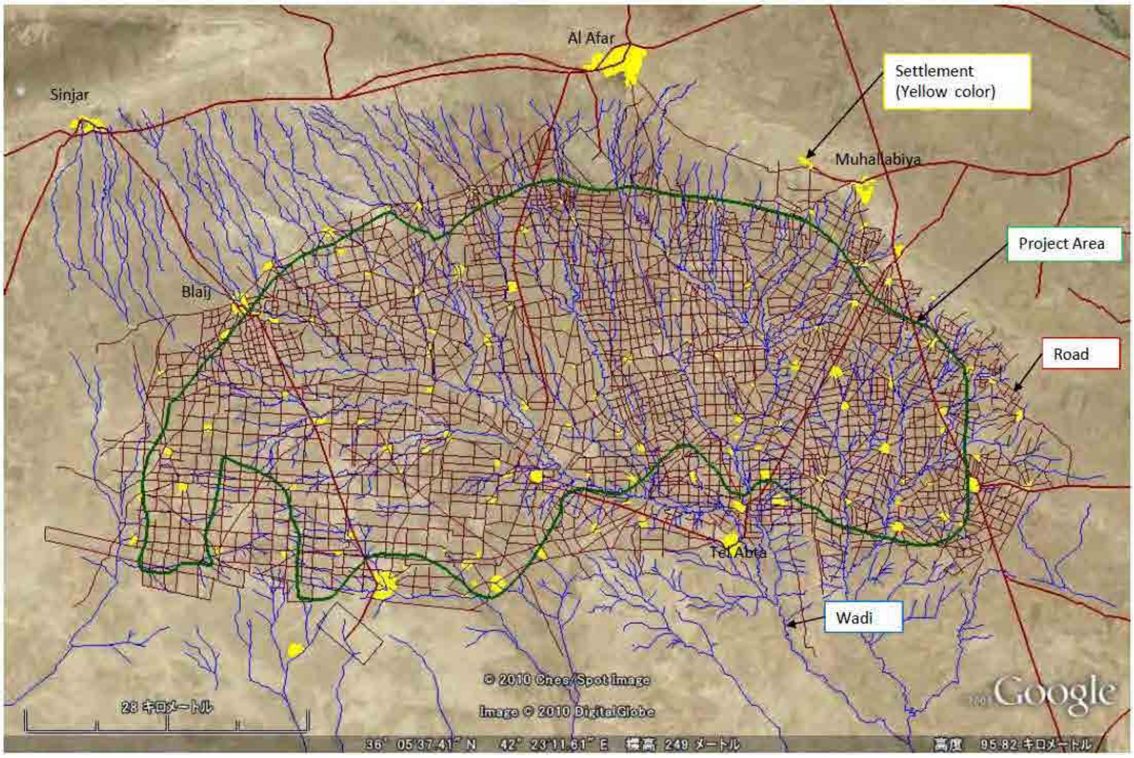


Fig. 3.1-7 Distribution of Roads and Villages in the Project Area

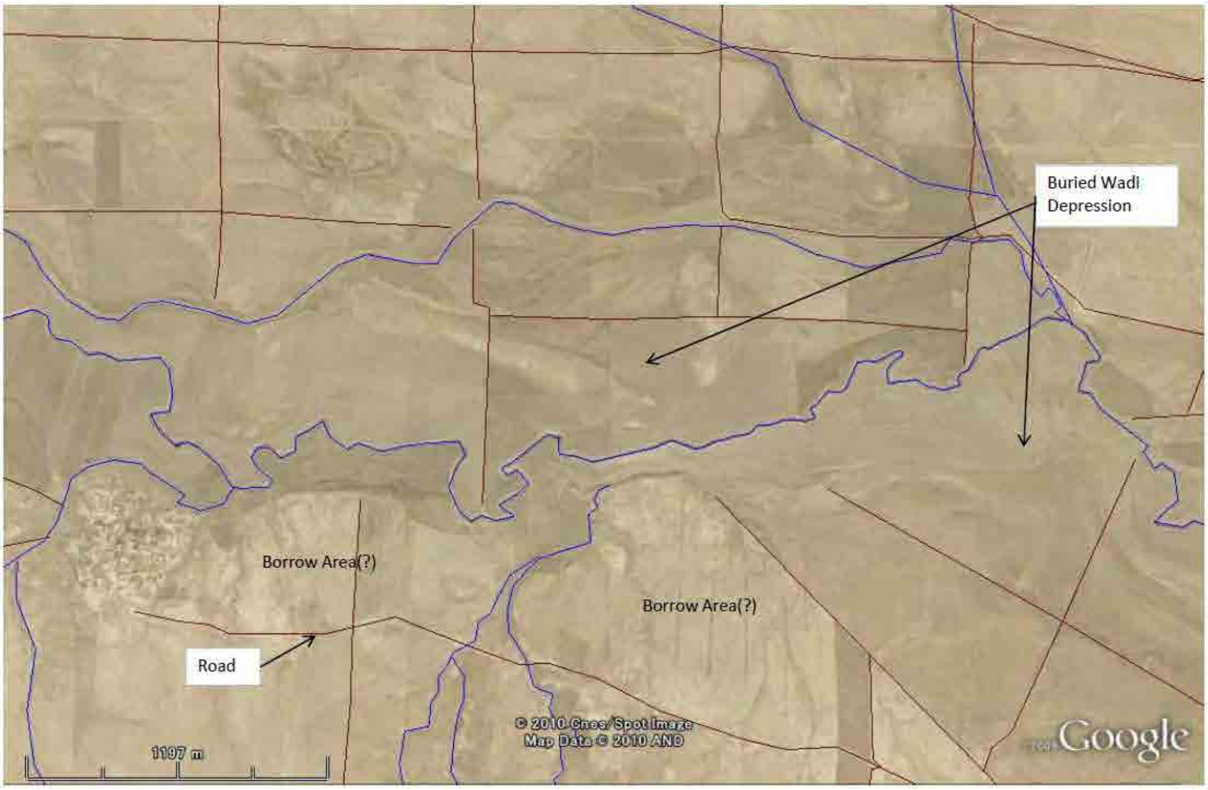


Fig. 3.1-8 Agricultural Land on buried Wadi

Fig. 3.1-9 Examples of Configuration of Agricultural Land in the Project Area

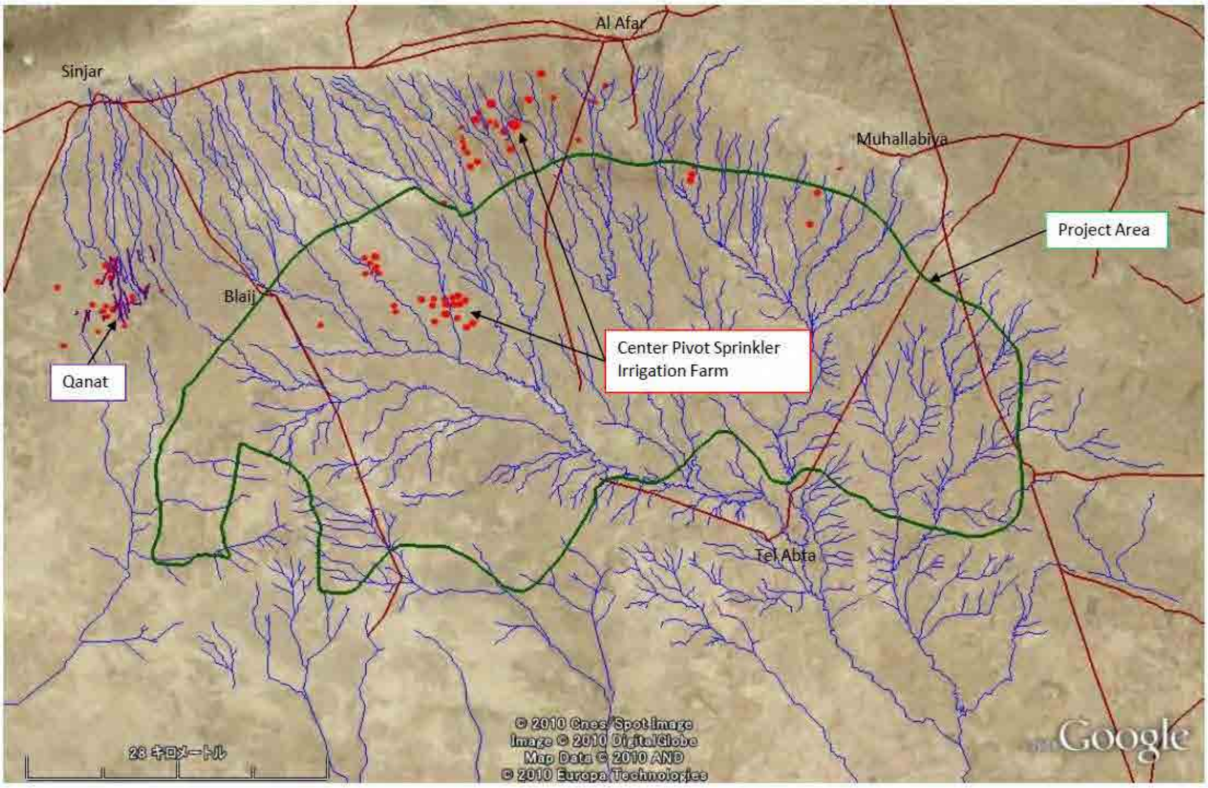


Fig.3.1-10 Center Pivot Sprinkler Irrigation Farms and Qanats in and near the Project Area

Fig. 3.1-11 Example of Center Pivot Sprinkler Irrigation Farms in the Project Area

(Photo by a surveyor dispatched by the JICA Study Team, July 2010; see Fig.3.4-11 for the location)

Fig. 3.1-12 Lateral Moves near a Deep Well in Ussaila Village in the South of the Project Area

(2) Geology

Fig.3.1-13 shows a geological map around the project area and the feeder canal. Fig. 3.1-12 shows Geological section of the project area.

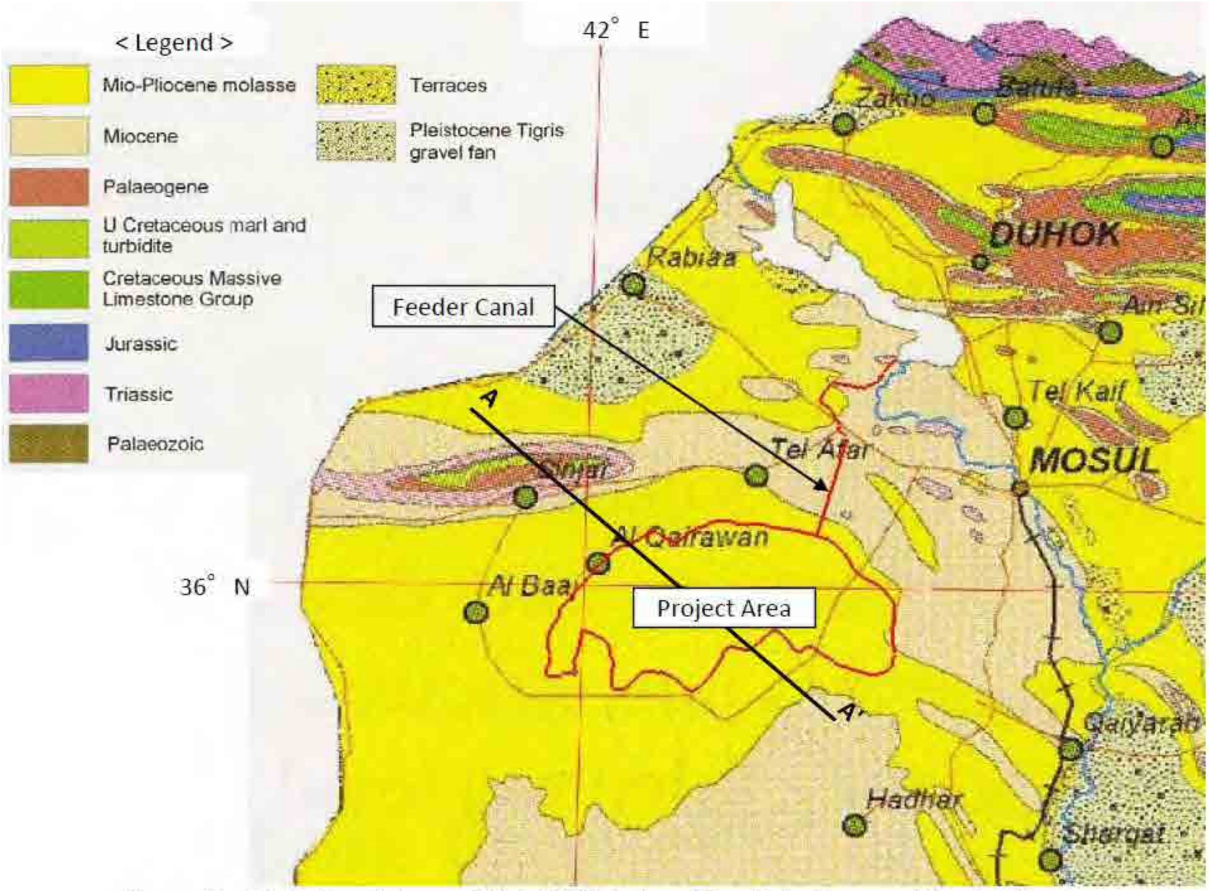
In the Project Area, it is reported that there are almost no outcrops. Gypsiferous overburden covers most ground. Claystone, sandstone and marl of Upper Fars Formation (or Injana Formation in the recent name) mainly underlie the overburden. The yellow color area in Fig.3.1-13 consists mainly of this formation.

Fig.3.1-14 to Fig.3.1-16 show geological sections along the feeder canal alignment. In the alignment, Marls, gypsum and limestone of Lower Fars Formation (or Fatha Formation) of Miocene Age mainly underlies. The beige colored area in Fig.3.1-13 shows this formation. This formation also constitutes the foundation of Mosul dam

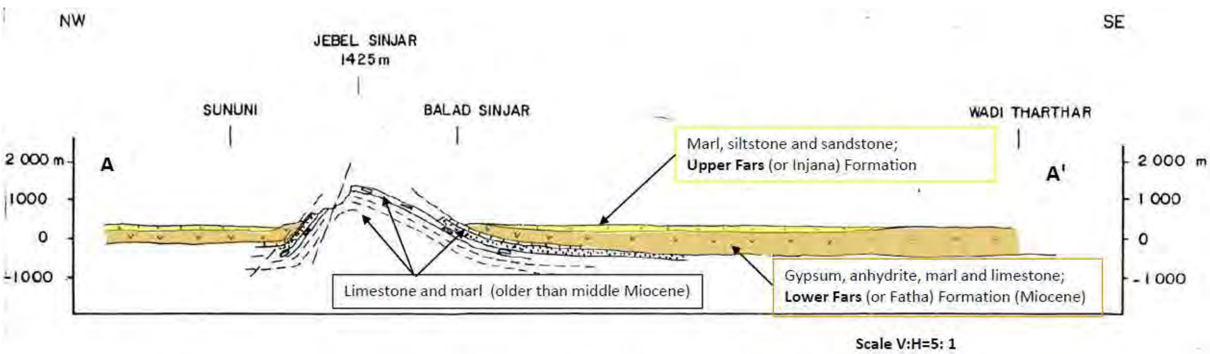
Gypsum and Sulphate-rich groundwater in the bedrock and overburden give some significant problems on construction of canals and irrigation. Anhydrite reacts with water and makes gypsum, resulting in swelling pressure in tunnel. Sulphate-rich water attacks concrete and destroys the structure.

Gypsum layer in soil prevents plant roots from extending further due to the hardness. The layer in soil dissolves with excess irrigation water and induces so-called “hydro-compaction”.

The result of drilling investigation for the Sheik Ibrahim Tunnel shows that the rock rating based on the RMR system (Rock Mass Rating system by Bienawski, 1976) counts 40 to 62, meaning “fair” to “good” rock and requiring medium or light steel support except near portals if the conventional tunneling method is used. Bitumen was found in the joints of drilled core and caring against petro-gas may be required in tunnel construction.



Source: Saad Z. Jassim and Jeremy C. Goff (2006) Geology of Iraq, Dorin, Prague and Moravian Museum

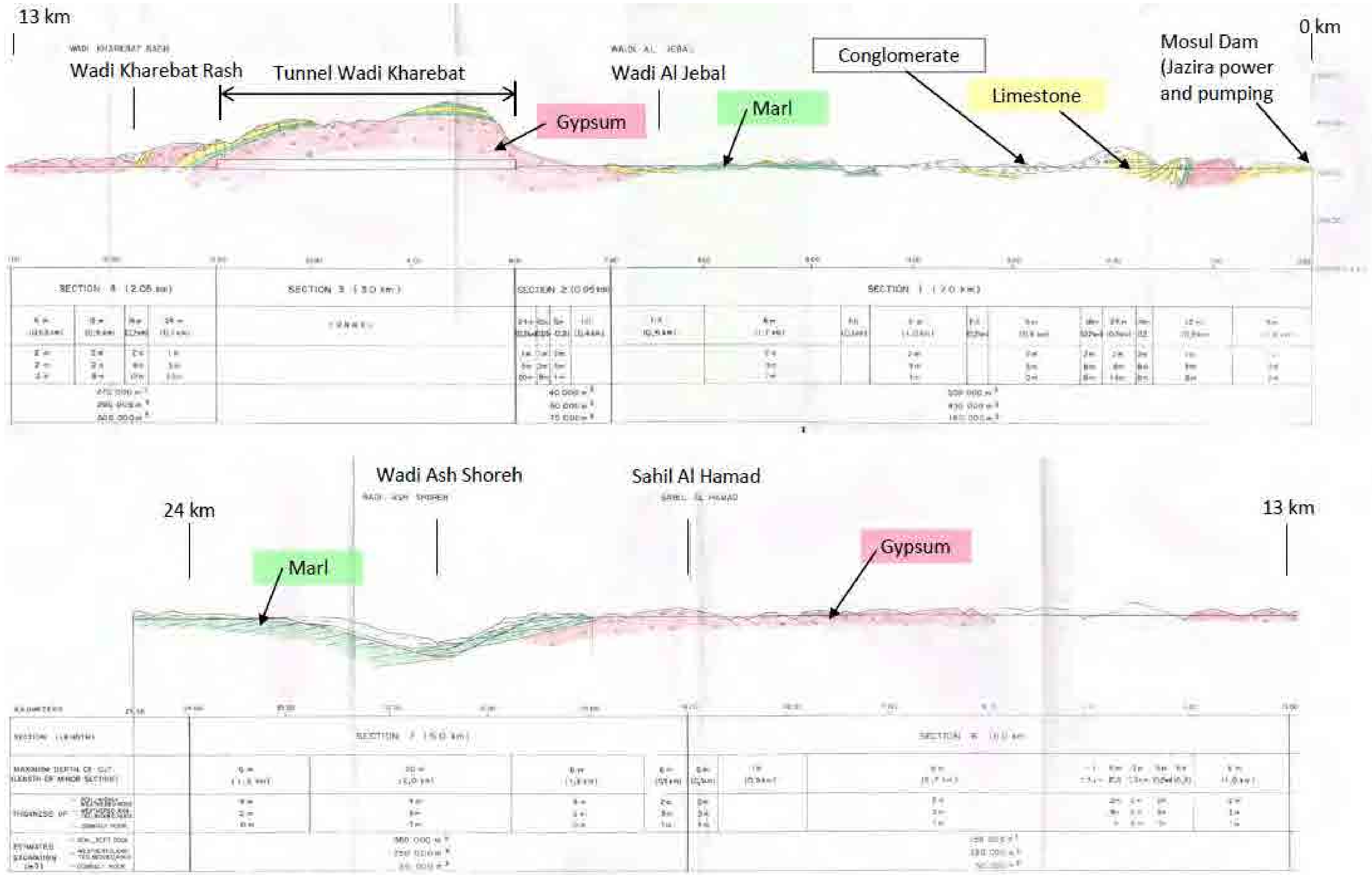


SYMBOL	FORMATION	LITHOLOGY
	UPPER FARS	SANDSTONE, SILTSTONE, MARL
	LOWER FARS	GYPSUM/ANHYDRITE, MARL, LIMESTONE
	JERIBE	MASSIVE LIMESTONE
	JADDALA	MARL, LIMESTONE
	SINJAR	HARD LIMESTONE
	SHIRANISH	MARL, LIMESTONE

FAULT

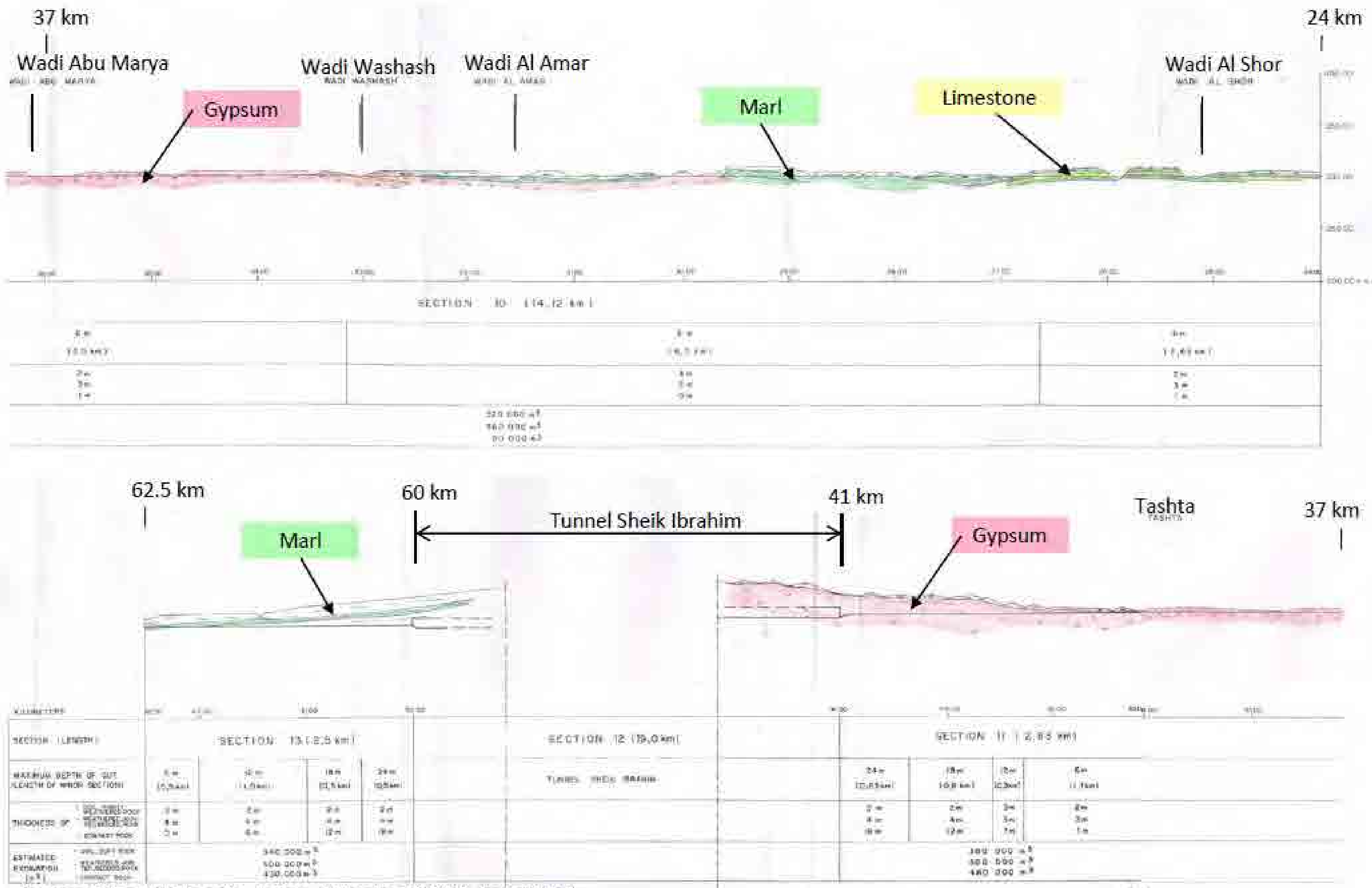
Source: The F/S Report, Annex 1 Geology, retouched.

Fig. 3.1-13 Geological Section of the Project Area



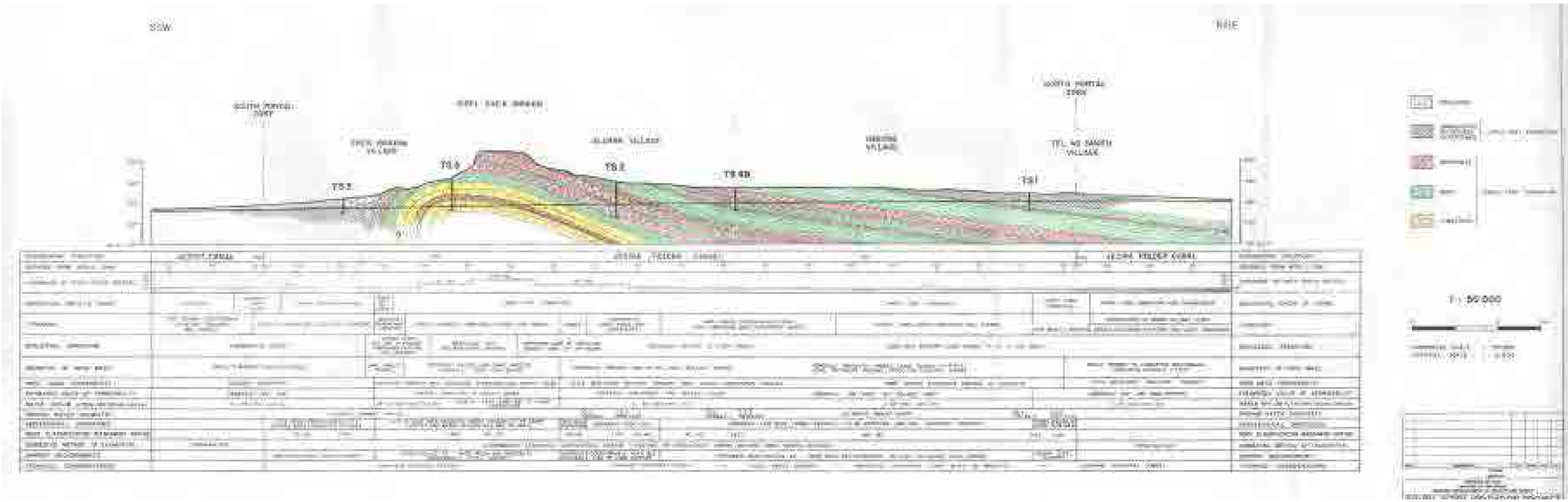
Source: The F/S Report , Annex 1 Geology ,1984. Retouched.

Fig. 3.1-14 Geological Section along the Feeder Canal (1)

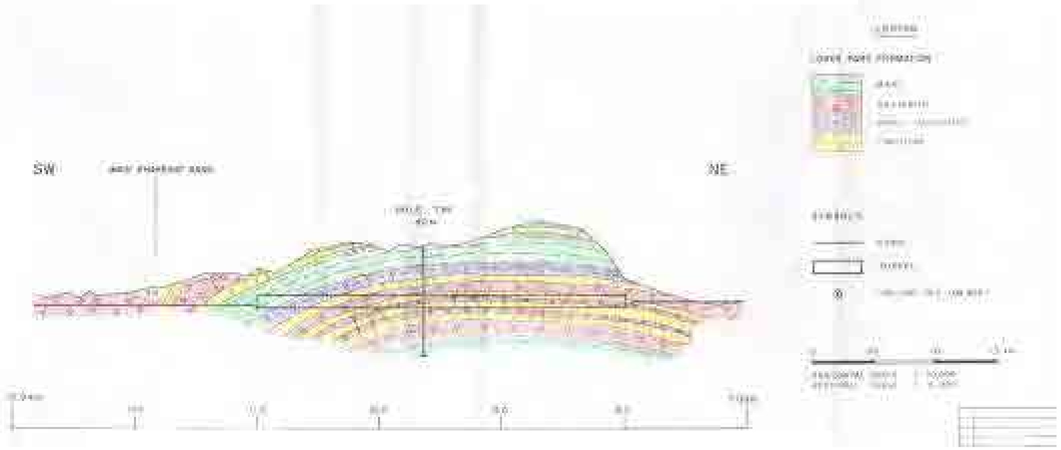


Source: The F/S Report , Annex 1 Geology ,1984. Retouched.

Fig. 3.1-15 Geological Section along the Feeder Canal (2)



Sheik Ibrahim Tunnel (41 km – 60 km)



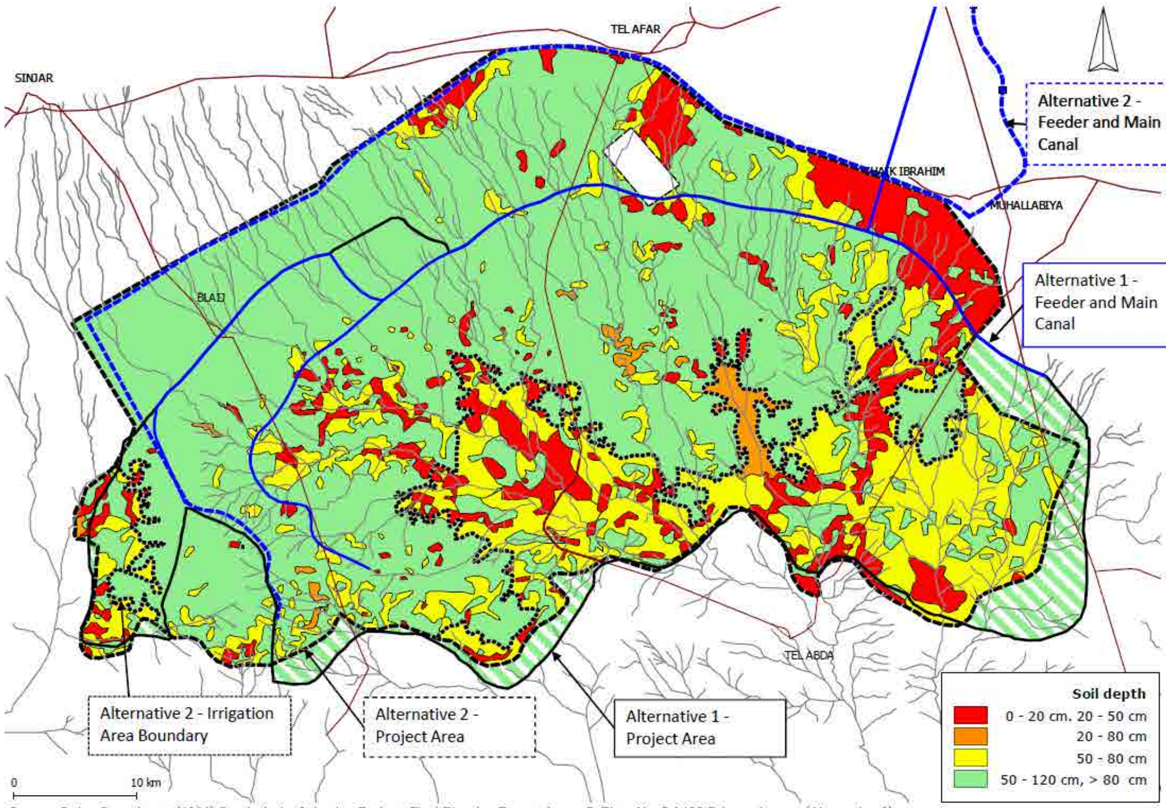
Kharebat Rash Tunnel (7.95 km to 10.95 km)

Source: The F/S Report Annex 1 Geology, 1984 (retouched)

Fig. 3.1-16 Geological Section along the Feeder Canal (3)

3.1.6 Soil

In the Project area, gypsiferous soil mainly underlies. Stony soils are found in the gently sloping foot of mountains. In the Swiss F/S, the project area is mainly determined based on soil depth map which was made by the semi-detailed survey of the State Organization for Soil and Land Reclamation (SOSLR). Fig.3.1-17 shows a soil depth map traced from “Plate 5.4.100 Primary Layout of Alternative 2”. The original “soil depth map SOSLR” is unavailable because of missing.



Source: Swiss Consultants (1984) South Jazira Irrigation Project, Final Planning Report Annex 5, Plate No. 5.4.100 Primary Layout (Alternative 2)
Dijla Center for Studies & Designs of Irrigation Projects (1990) South Jazira Irrigation Project, General Layout

Fig. 3.1-17 Soil Depth Map in the Project Area

3.2 Socio-economical Conditions

3.2.1 Population

(1) Population in Nineva governorate and Iraq

It was 1997 that the last nationwide population census was conducted in Iraq, and population in Nineva governorate was around 2,043,000 at that time, 9% of the total population. Based on this figure, the population of the Nineva governorate in 2007 is estimated at 2,811,000 with even break gender distribution. According to the estimates, 39% of the population is living in rural area, whereas the rests are residents in urban area.

Table 3.2-1 Population in Nineva Governorate and Iraq

	Population	Male	Female	Rural		Urban	
				Population	(%)	Population	(%)
Iraq	29,682,081	(50%)	(50%)	9,929,248	(33%)	19,752,833	(67%)
Ninevah	2,811,091	(50%)	(50%)	1,104,435	(39%)	1,706,656	(61%)

Table 3.2-2 Population by District in Nineva Governorate（2008）

	District	population	Number of Household	Per Household
1.	Mosul	1,719,860	322,295	5.3
2.	Al-hamdaniah	132,297	24,322	5.4
3.	Tallkif	133,465	22,834	5.8
4.	Al-shikhan	45,809	7,573	6.0
5.	Makhmour	113,109	19,438	5.8
6.	Telafar	372,366	61,208	6.1
7.	Sinjar	241,334	34,475	7.0
8.	Al-hadhar	65,540	8,909	7.4
9.	Al-baaj	145,634	19,892	7.3
	Total (Ninevah)	2,969,414	520,946	5.7

Source：Population Statistics based on Food coupon in 2008, Nivevah governorate, MoWR

According to Table 3.2-2, Mosul has the largest population, estimated at 1,720,000, followed by Telafar, Sinjar and Al-Baaj and Al-hadhar among four districts related to the study area. Mosul is the capital of the Ninevah governorate and Mosul city is the third largest city in the country. Mosul and Talafar are relatively urbanized district, whereas majority of population in Sinjar and Al-Baaj are living in rural area. Other demographic characteristics of the governorate, including ethnic group, religion and language, are summarized in the Table 3.2-3. This characteristics shows Nineva governorate consists of wide variety of ethnic groups

Table 3.2-3 Demographic Characteristics of the Nineva Province

Characteristics	Name
Ethnic Group	Kurds, Arabs, Assyrians, Yazidis, Shabaks, Turkmen, Mandeans, Armenians
Religion	Muslim, Christian, Shabak, Yazidism, Mandeanism
Language	Arabic, Kurdish, Assyrian, Aramaic, Turkmeni, Shabaki, Yazidi, Armenian, Mandean Aramaic

(2) Village, Population

Table 3.2-4 shows population by district and village in the Study area which summarized by using statistical data provided by Project Management Office (PMT). Project area is covered by four(4) districts (Telafar, Sinjar, Al-hadhar, and Al-baaj) and 90 villages with 107,215 people.

Table 3.2-4 Population by Village and District in the Project Area

Source: Project Management Office (PMT)

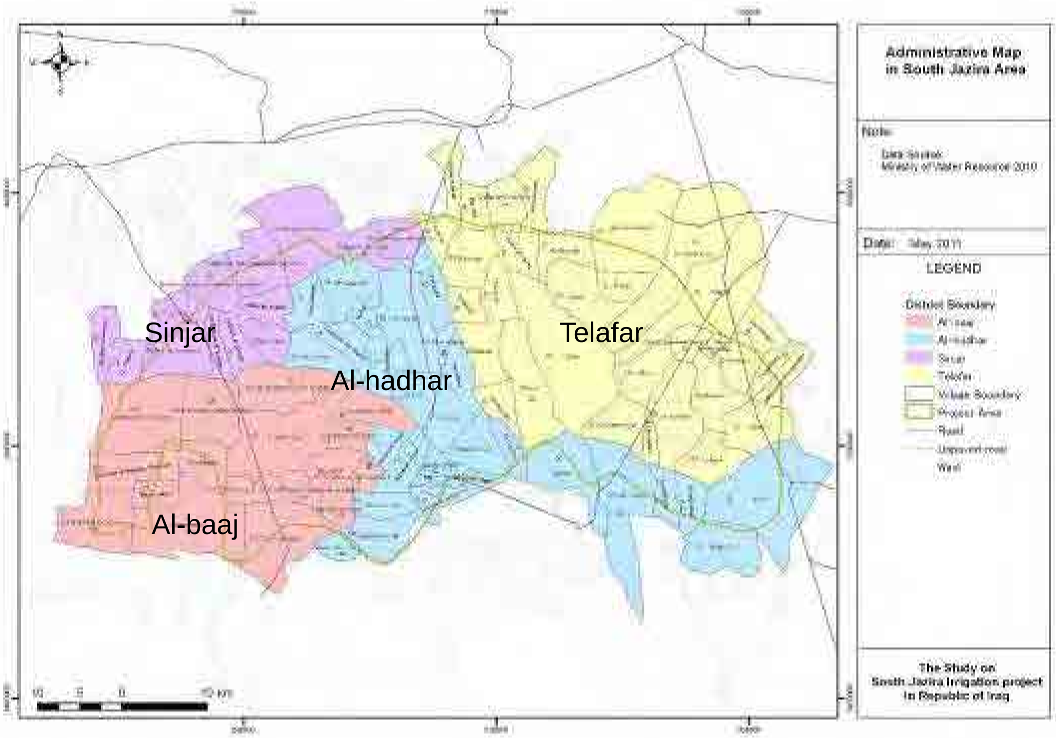
	Map no.	Name of Village	Population
Telafar District			
1	14	Telafar al-junoobiya	1,100
2	16	Tal awwad	1,100
3	18	Kasr mihrab	1,550
4	20	Tai azzo	950
5	22	Efraye	2,150
6	23	Baswa	1,450
7	24	Al-mustah	1,095
8	27	Ebair	5,650
9	28	Abdan	2,900
10	29	Al-hamrah	2,100
11	30	Sheikh ibraheem	3,800
12	32	Al-mazreeb	1,600
13	33	Tal jamal	1,550
14	36	Esheriat	1,000
15	45	Emgair	1,100
16	51	Al-mahalabiya	14,000
17	52	Addaya	2,000
18	61	Humr al-saray	1,500
19	68	Ein afar	500
20	77	Um ehjara	1,150
21	78	Um al-ganateer&targ al-baboor	1,250
22	79	Al-thalathat	50
23	80	Al-tassa	950
24	81	Um shneen	250
25	83	Tal eshhab	500
26	84	Kharbat al-yazeedie	625
27	87	Egzail	1,200
28	88	Seeta	575
29	89	Tal esmeer	750
30	90	Tuffaha	1,500
31	91	Al-aghas	2,500
32	92	Al-khathrafiya	400
Subtotal		**(32 villages)**	**58,795**

	Map no.	Name of Village	Population
Sinjar District			
1	28	Seabayat rash (seabayat harroosh)	1,350
2	29	Seabayat garbiya (seabayat ammash)	1,500
3	30	kharaag Al-amood	2,500
4	31	Ehthail al-sharqy	700
5	33	Abu breej	1,000
6	49	Ein al-hissan al-janooby	500
7	50	Shweerat abu zaid	1,050
8	61	Tal Aagool	1,100
9	62	Bleej	3,000
10	65	Ehthail al-wusta	600
11	79	Kharab echab	600
12	80	Ehthail al-kabeer	3,500
Subtotal		**(12 villages)**	**17,400**

	Map no.	Name of Village	Population
Al-hadhar District			
1	25	Al-bootha	750
2	67	Tal gazal	1,100
3	68	Abu sanam	1,500
4	69	Tal AL-Jarabee	250
5	70	Tal azeez	50
6	71	Meedan kuly	1,000
7	72	Esluby	150
8	73	Saddahiya	250
9	74	Tarteeat tal dagash	300
10	75	Sadhan	180
11	76	Al-kamashly	500
12	77	Youstabbah	600
13	78	Abu raseen	400
14	81	Eseelah	350
15	88	Ejya	1,000
16	93	Al-turkmaniya	950
17	94	I mmfallaga	1,000
18	96	Al-jazzera	150
19	96	Tal faris	1,300
20	97	Al-athathah	1,100
21	141/51	Jazzerat sinjar	700
22	142/51	Jazzerat sinjar	800
23	143/51	Jazzerat sinjar	250
24	144/51	Jazzerat sinjar	750
25	146/51	Jazzerat sinjar	500
26	147/51	Jazzerat sinjar	550
27	149/51	Jazzerat sinjar	600
28	150/51	Jazzerat sinjar	50
29	154/51	Jazzerat sinjar	500
Subtotal		**(29 vilages)**	**17,580**

	Map no.	Name of Village	Population
Al-baaj District			
1	105/51	Khrbat al-theeba/al-hasoon	450
2	119/51	Jleemeed & um ehjara	1,100
3	120/51	Kharbat al-theeba/Haloosh	1,100
4	121/51	Mator najris	1,300
5	122/51	Al-ebsaisa	650
6	124/51	Beer shafy	600
7	130/51	Thray al-garah	2,500
8	131/51	Karkashy & al-sultan	1,000
9	133/51	Thray al garah/Tal al-dhili	150
10	135/51	Thalja al-sharqiya&al-garbiya	700
11	136/51	Um al-zanabeer & Um hachin	1,300
12	137/51	Al-sukkariya	800
13	138/51	Abu elhaf	150
14	139/51	Emkeebart al-soan	250
15	140/51	Tal gazal & darak	1,000
16	145/51	Khaznat harroosh	350
17	148/51	Boothat muhammed salih	40
Subtotal		**(17 villages)**	**13,440**

Total of 4 District (90 villages)	**107,215**



Source: Project Management Office (PMT)

Fig. 3.2-1 Boundary of 4districs and Villages in the Project Area

(3) Beneficial Area and Population by Scenarios

Irrigation area and number of beneficiary are different from each scenario as shown in Table 3.2-5, because the available amount of water resources in South Jazira has not been fixed yet.

Table 3.2-5 Beneficial Area and Population by Scenarios

Scenario	Scenario-0		Scenario -1		Scenario -2		Scenario -3 (provisional)	
Village	Irrigation Area (ha)	Beneficiary	Irrigation Area (ha)	Beneficiary	Irrigation Area (ha)	Beneficiary	Irrigation Area (ha)	Beneficiary
1.Telafar	73,600	39,410	73,600	39,420	73,700	39,410	47,700	29,040
2.Sinjar	19,000	8,290	4,900	1,990	2,300	770	2,300	770
3.Al-hadhar	55,200	13,630	54,300	13,460	38,600	9,160	28,500	6,680
4.Al-baaj	48,600	9,770	24,400	4,510	200	70	200	70
Total	196,400	71,100	157,200	59,380	114,800	49,410	78,700	36,560

Remark: 1) Irrigation Area is identified in the soil depth of more than 50 cm, however, the number of beneficiary includes the area of more and less than 50 cm of soil depth.

2) The value of scenario-3 is provisional and it will be determined after the Project evaluation of scenario 0 to 2 will be calculated.

3.2.2 Land Distribution

According to the Baseline Farming Systems Survey, conducted by ICARDA-Iraq-Australia Project in 2005, three types of land tenure are observed in the Ninevah governorate; 1) privately owned land, 2) rented land from government or individuals, and 3) share-cropped land. The survey divides the governorate into 4 agro-ecological/ rainfall zones, namelly HRA (high raifall area, >450mm/year), MRA (moderate rainfall area, 350-450 mm/year), LRA (limited rainfall area, 200-350 mm/year), and SI (supplimentary irrigation system). The South Jazira is included in the LRA, while East and North Jazira are included in the MRA.

According to the survey result, the privately owned land is dominant type of land tenure in the HRA and SI, whereas the share-cropped land is the most important type in the MRA. In the LRA, the rented land is the most important land tenure type, accounting for 50%, followed by the share-cropped land (32%) and the privately owned land (18%).

There is an interesting tendency in land holding size from north to south in the governorate. The land holding size in the southern part is larger than that in the northern part, reflecting availability of rainfall. Current land distribution status in the study area is now requested to the Ninevah Governorate through Ministry of water resource.

3.2.3 Poverty

Poverty line in Iraq is estimated at 76,896 ID (about US$ 66) per person per month, or US$ 2.2 /person/day, according to a survey result conducted by Ministry of Planning and Development Cooperation, released on 21st of May, 2009. The survey indicated that the poverty headcount ratio, percentage of population below the national poverty line, is 20-25% on average in Iraq. The ratio is higher in rural area than urban area, and higher in the Southern region than the Northern region. However, it is said that actual rates must be higher than the survey result, since the state-run food rationing program strongly supports poor people in Iraq. The current food distribution system was started on 1995, and has provided food coupon to all Iraqi to assist their basic commodity consumption.

In 2003, median of household income in the Nineva governorate is 1,998,000 ID/year, which is 10% lower than that of the national average. According to WFP/ VAM data (2007), the poorest quintile earns 22% of income at entire Iraq level, whereas the poorest quintile in Ninevah governorate earns only 4% of income, indicating larger income disparity and existence of relatively higher income earners in Nineva governorate than the national level.

However, income level of peoples in the study area seems quite low. Among four districts related to the study, the lowest per capita income quintile of Talafar is the highest (57%) comparing to other districts (22-27%). The lowest per capita expenditure quintile also indicates same tendency, and the figure in Talafar district is the highest among the related four districts.

According to the questionare survey conducted by the JICA Study Team on July 2010, average household income of farmers in North and South Jazira area are 19,000,000 ID (16,000 USD)/year and 8,433,000 ID/year respectively. These figures exceed Nineva’s median of household income. However, when we convert them to the same order of the poverty line, all 6 farm households in the North exceed the line, whereas 7 households out of 12 fall in the below poverty line in the South.

This fact indicats that the sevior liiving condition for the farmers in the South Jazira area.

3.2.4 Gender

Illiteracy rate of women (30%) is higher than that of men (12%) in Ninevah governorate, and both figures are higher than the National average. Among four districts, female illiteracy rate is quite high in Sinjar (57%), followed by Talafar (32%), Al-Baaj (30%), and Mosul (24%).

The reason for the higher illiteracy rate in Sinjar is conceivably related to the low educational level of women in this district. According to the WFP statistics, percentage of women (more than 10 years old) with less than primary education in Sinjar is the highest (72%), followed by Talafar (66%), Al-Baaj (53%), and Mosul (52%). For male, 41% receives less than primary education, which is lower than the figure of women (58%), but higher than the all Iraq level (31%).

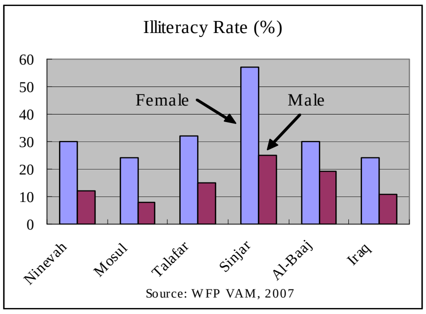


Fig. 3.2-2 Illiteracy Rate in Nievah Governorate

Regarding economic activity, women in Ninevah is less participated in, comparing to the whole country level. Among four districts, the rate of women's labor participation is the lowest in Al-Baaj, which is located in the most remote area from the governorate capital, Mosul city. Male's unemployment rate in the governorate is 13% in 2007, almost same to the national average, whereas women's rate is 35%, 2.7 times higher than the male's. Following table shows gender gap in economic activity.

Table 3.2-6 Gender Gap in Economic Activity (%)

Indicator	Ninevah	Mosul	Talafar	Sinjar	Al-Baaj	Iraq
Female Labor Paerticipation (15-64)	8	10	5	6	3	18
Male Labor Paerticipation (15-64)	85	86	81	78	90	81
Female Unemployment (15-64)	35	40	13	14	36	13
Male Unemployment (15-64)	13	12	21	9	3	12

Srouce: WFP VAM 2007

Male farmers take major role in farming activities in the Ninevah governorate. According to the Baseline Farming Systems Survey in 2005, 84% of farm activities are conducted by male, whereas female and children contribute 12% and 4% of the activities respectively.

3.3 Infrastructure

(1) Domestic Water

Water availability is still serious problem in the entire Iraq. Around one fourth of households in Ninevah governorate are not connected to the water network, according to the WFP statistic in 2007. The rate is exactly same to the national average, but regional disparity in the governorate is quite large.

In the governorate capital of Mosul, for example, almost all households (93%) are connected to the water network, while the network coverage rate is 0% in Al-Baaj and 17% in Sinjar district. In Al-Baaj and Sinjar district, 65% and 72% of households respectively take domestic water from stream, well, and/or water tanker.

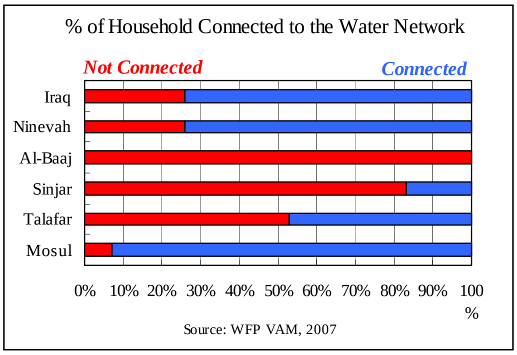


Fig. 3.3-1 Connection to the Water Network

According to the questioner survey in the North Jazira area and the South Jazira area, conducted by the JICA Study Team in July 2010, all farmers in the North (6) use well for drinking water, whereas farmers in the South (12) buy drinking water from water tank truck. A water quality test in the South Jazira, conducted by the Study Team, indicated that the water from well in the South is not suitable for drinking and irrigation due to salinity problem.

The waster shortage in Al-Baaj is quite serious, which sometimes causes displacement of household to other regions. According to the governorate profile of Nineva, as a result of IDP (Internally Displaced Persons) and Returnee Assessment and developed by International Organization for Migration (IOM) in 2010, displacement due to lack of water increases recently, and Nineva is one of the most affected governorate in Iraq. The report indicated that 1,364 families in total have displaced in Nineva due to water shortage, and most of them are in Al-Baaj district.

(2) Electricity

Unstable electricity supply is also quite serious in Iraq. According to WFP/ VAM statistic in 2007, 52% of households suffer from long-time (more than 11 hours) power cut or no connection to the electricity network at whole country level, whereas around 30% of households in Ninevah governorate meet the same problem. Among four districts related to the South Jazira study area, 100% of households in Sinjar and Al-Baaj face the long-time power cut or no network connection, while only 26% and 50% of households in Talafer and Mosul meet the same problem.

To cope with the frequent failure in power supply, 43% of households in Ninevah ready up alternative source of electricity such as diesel generator. As for districts in the study area, 90% of households do not have alternative source of electricity, followed by 49% in Sinjar and 37% in Al-Baaj district. Households in Mosul district are relatively well prepared against the power cut, since 93% of households have alternative power source.

(3) Sanitary and Health

Even though sanitary condition has been improving after the war, 26% of households in the Ninevah governorate still use inadequate method including hole or nothing for the sanitation purpose. This figure is more than three times higher than that of national average. In Mosul, nobody uses such way of sanitation, whereas 12% and 10% of households still use the unsanitary way in the related four districts.

As for chronic malnutrition, urban populations are relatively in a good condition comparing with rural residents. According to the WFP/ VAM statistics, 30% of individuals suffer in Ninevah governorate, but around 50% of individuals have the problem in Sinjar and Talafar district, followed by 42% in Al-Baaj and 27% in Mosul.

(4) Education

A baseline survey for farming systems in Ninevah governorate, conducted by ICARDA-Iraq-Australia Project in 2005, indicates educational level of farmers. According to the result, 49% of farmers completed primary education only (6 years of schooling), whereas around 10% and 15% of farmers completed secondary school and high-school respectively. In addition, around 7% of farmers are the university graduates, and only 19% of the farmers are illiterate.

3.4 Information on Availability of Water Resources

3.4.1 Outlines of Jazira (North, East and South) Irrigation Project

Currently the agricultural production in the North of Iraq is vulnerable and impacts for the national food security as a whole. The South Jazira Irrigation Project has been planned also in this regard, located to the southwest of Mosul city in Ninevah Government extending from the Sinjar Mountain at the northern tip of Wadi Tharthar on the right bank of Tigris River within Telafar district. It is the biggest part among the three components of Jazira Irrigation Project attached to the Mosul Dam Development Project planned during 1970s namely; the North (completed), East (under construction) and South Jazira Irrigation Projects. The water allocations for all of three (3) projects are depended on the reservoir of the Mosul Dam shown in Table 3.4-1.

Table 3.4-1 Outlines of Jazira Irrigation Scheme of the Mosul Dam Project

	Total irrigated area (ha)	Length of Feeder canal (km)	Max water intake (m^3/s)	Main crops	Status
North	60,000[1]	60 [2]	30 (planned to increase up to 45[1])	Wheat, Barley, tomato, potato and others	Completed in 1985-1991
East	75,000	82.1[3]	60[5]	Wheat, Barley tomato, potato and others	Under Construction
South	190,000 (gross) 104,000 (net)	60.3[4]	125	Wheat, Barley, tomato, potato and others	Planned

1. The design discharge is 45.0m3/s from the peak monthly discharge in April.
2. A total length of main canals as there is no feeder canal in the North Jazira
3. Include 2 tunnels, a total length of 3.07km
4. Include a planned 19km long tunnel (Route 1)
5. 60 m3/s sounds reasonable for the planned irrigated area.

3.4.2 Water Demand in the Downstream of Mosul Dam

(1) Outflow rate to be considered water utilization on the downstream side of the dam

Descriptions relating to project operation and water management in "Sadam Dam O&M Manual (1989) Final Report and As-built Drawings Vol. 1 by Swiss Consultants" are summarized below;.

1) The water demand of the downstream areas is not yet known. It is fixed as high as the water management can allow it, in the range of 300 – 350 m3/s guaranteed minimum outflows in the dry season. This figure allows flexibility for the further study of the water resources.
2) When dams are constructed on the river or the flow is diverted to irrigation schemes, part of the natural boundary conditions is changed and new ones are introduced, and therefore, the discharge of the river is changed, too. To investigate the consequences of this change, a mathematical model is used.
3) In the mathematical model the water balance equation is formulated. The natural discharge which represents the input of the model is increased or decreased according to the boundary conditions which are introduced to simulate natural and human influences on the river flow.
4) The water balance equation is formulated for a single element. This element represents a certain river stretch, and the natural runoff is described by the hydrologic records of an upstream and a downstream station. The natural discharge at these two stations is represented by the discharge of the Tigris River at Mosul gauging station.
5) The natural flow is modified by the construction of the Mosul Dam. Directly from the reservoir, the required flow for irrigation purposes is diverted. The return flow is mainly caused from leakage of the diversion channels and therefore it is assumed to be constant during the whole year.
6) The reservoir outflow consists of the discharge through the turbines and the spill water. The discharge through the turbines is dependent on the installed capacity in the power station, the desired generation of firm power, the natural reservoir inflow and the elevation of the water surface in the reservoir.
7) The modified stage outflow which approximately corresponds to the discharge at Mosul Town consists of the reservoir outflow and the return flow from the diversion channels.
8) Storage optimization has been performed using the mathematical model described in the above. The result can show desired reservoir outflow is 330 m^3/s.

As mentioned the above, a continuous minimum irrigation discharge of 330 m^3/s into Tigris River to the downstream of the Mosul dam should be desired. This means annual outflow rate downstream can be more than 10.4 BCM (= 330 m^3/sec ×86,400 sec ×365 days), since in winter season the outflow may be less and in summer season it may be more outflow than the minimum discharge of 330 m^3/s. This annual reservoir outflow is equivalent to approximately half of the annual flow into the Mosul Dam.

However, it is not found that the value came from where and how much intake rates for the North and the East Jazira Irrigation Project Areas was considered.

This figure comes from only the convenience of reservoir operation without considering the conditions of the downstream area of the dam. Essentially the responsible outflows downstream should be determined after considering the demands downstream of the dam.

(2) Comparison with Water Balance Study Reports

Swiss F/S report might not include the Water Balance Study. It has done concurrently by Soviet at the same time of the F/S. MoWR provided limited portions of the report which Soviet had made as General Scheme of Water Resources and Land Development in Iraq, Stage II (Moscow-Baghdad 1982) to the JICA Study Team.

Therefore, the Team can not find whether that value is suitable or not as water demand in the downstream area of Mosul dam.

Table 3.4-2 shows Irrigation Water Requirements and Design Discharge of Irrigation System, and Fig.3.4-1 shows Comparison of the monthly requirements by cropping patterns between F/S reports and Soviet report.

First of all net irrigation area of the Jazira Project is 183,250 ha (= 23,250 + 160,000) and the total annual requirement is 1,430.28 billion m^3/year (=139.68 + 1,290.6) from Table 3.3-10. Depending on the information from Iraqi side, the gross irrigation area of the South is 190,000 ha and the North is 60 thousand ha and the East is 75,000 ha. Totally the project gross area of the recent information becomes 325,000 ha and both irrigation areas and requirements adopted in Soviet report are too small comparing with the current figures.

Then Soviet report might underestimate the agricultural requirements of the whole Jazira irrigation project for Mosul dam. Fig. 3.4-2 shows that there are the different in the cropping patterns between the Soviet report and Swiss F/S report relating to the South Jazira irrigation project. The water requirements and design discharge also become different between two(2) reports.

It is recommended that the above discrepancy between the plan of irrigation projects and the water balance studies should be dissolved. In addition, “Strategy for Water and Land Resources in Iraq (SWLRI)” of which outline is summarized below, shall be studied.

Table 3.4-2 Irrigation Water Requirement and Design Discharge shown in Soviet Report

Irrigation Water Requirements and Design Discharges of Irrigation Systems in the Year 2000 by USSR Report*

System No.	Irrigation System	Net irrigation area		Average monthly water requirements 10^6 m^3												Year total	Irrigation sysytem efficiency	Mean weighted irrigation rate, gross 10^3 m^3/don	Max. average monthly discharge m^3/sec	
		(10^3 don.)	(10^3 ha)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	10^6 m^3				
		①	②=①÷4	③	④	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭=Σ③~⑬	⑮	⑯=⑭÷①	⑰	
38	Dohouk	12.6	3.15	2.41	1.01	0	0	0	0.04	0.7	1.56	2.71	3.12	2.67	2.33	16.55	0.64	1.32	1.17	Jul.
39	Shemal	80	20	17.23	9.92	0	0	0	0.54	6.77	18.4	26.67	24.98	20.44	14.14	139.09	0.64	1.73	10.29	Jun
40	Eastern Jazira	93	23.25	22.27	12.29	0	0	0	0.13	7.13	23.37	23.87	17.59	15.7	17.33	139.68	0.65	1.5	9.21	Jun
41	Jazira	640	160	160.55	84.49	5.36	3.51	51.62	105.03	165.48	189.57	162.16	128.63	112.4	121.8	1290.6	0.64	2.02	70.77	May
Sub-Total(40,41)		733	183.25	182.82	96.78	5.36	3.51	51.62	105.16	172.61	212.94	186.03	146.22	128.1	139.13	1430.28				
42	Small farms from the Mosul dam up to the Greater Zab river mouth	37.9	9.475	6.14	2.17	0	0	0	0.82	5.54	12.33	26.82	28.47	21.81	11.21	115.31	0.64	3.04	10.63	Jul
43	Small farms at springs in the Neinewa muhafadha in the Tigris river basin	12.7	3.175	1.66	0.41	0	0	0	0.11	1.64	3.94	6.94	7.29	5.93	3.33	31.25	0.7	2.46	2.72	Jul
44	Small farms at wells in the Neinewa muhafadha in the Tigris river mouth	15.1	3.775	1.97	0.49	0	0	0	0.12	1.95	4.68	8.25	8.66	7.05	3.96	37.15	0.7	2.46	3.23	Jul
45	Small farms at springs in the Neinewa muhafadha in the Greater Zab river basin	1.1	0.275	0.15	0.04	0	0	0	0.01	0.16	0.36	0.63	0.66	0.54	0.3	2.85	0.7	2.59	0.25	Jul

Sourse; 'GENERAL SCHEME OF WATER RESOURCES AND LAND DEVELOPMENT IN IRAQ' STAGE Ⅱ Volume Ⅲ WATER RESOURCES UTILIZATION Appendix 23.4

Monthly water requirements (mm)

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Year	Cropping Pattern
USSR Report	gross	100.3	52.8	3.4	2.2	32.3	65.6	103.4	118.5	101.4	80.4	70.3	76.1	806.6	unknown
	net	64.2	33.8	2.1	1.4	20.6	42.0	66.2	75.8	64.9	51.5	45.0	48.7	516.2	
F/S Report	net	39.7	34.9	10.5	2.0	23.1	60.7	98.7	128.2	79.3	51.0	43.7	38.0	609.8	ABC
	net	40.1	35.8	13.0	2.1	24.2	61.5	97.2	115.7	62.9	48.9	47.8	42.2	591.4	XYZ

USSR Report;General Scheme of Water Resources and Land Development in IRAQ STAGE Ⅱ(MOSCOW-BAGHDAD 1982)

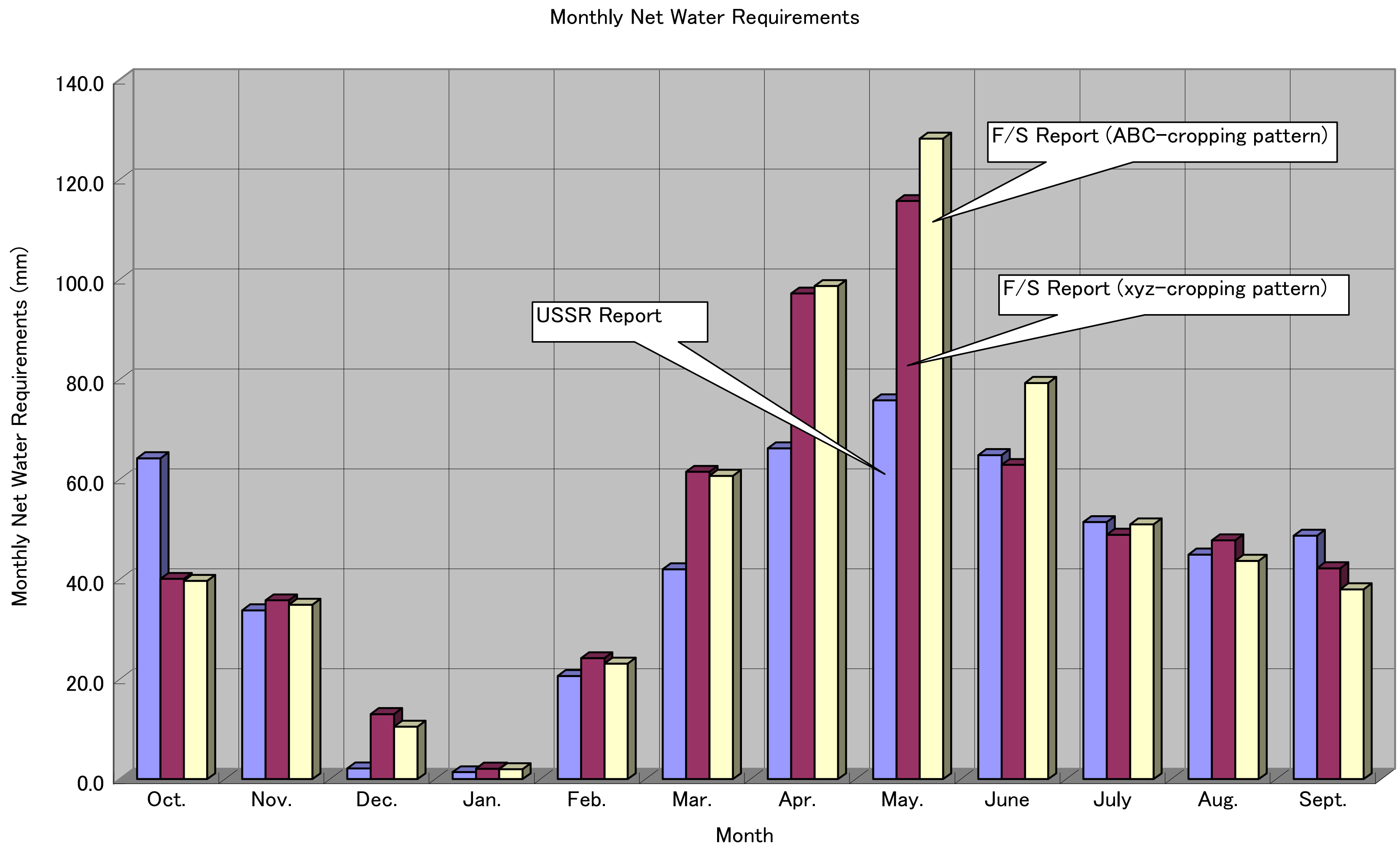


Fig. 3.4-2 Comparison of the monthly requirements by the cropping patterns in the South Jazira

3.4.3 Availability of surface water in the South Jazira project area

During the feasibility study, water samples for the determination of chemical and sedimentological properties of the discharges and wadis and springs were taken at various sites and flow conditions. The quality of surface water depends on two parameters: the location (geology of the catchments) and the flow conditions (flood, recession after a flood, low flow, probably also beginning or end of flow season) The result of water qualities monitoring is shown in Table 3.4-3.

Table 3.4-3 Results of water qualities monitoring

SOUTH JEZIRA IRRIGATION PROJECT: WATER ANALYSES

Sampling Site	Flow*)	Date of Sampling	pH	EC	Ca	Mg	Na	K	SO_4	Cl	CO_3	HCO_3	BO_3	TSS	S.S.	SAR	Class (acc. USDA)
				mmho/cm	me/l	me/l	me/l	me/l	me/l	me/l	me/l	me/l	me/l	ppm	ppm		
WADI THARTHAR, TEL ABTA	I	18.12.79	7.6	3.4	15.32	6.91	17.16	0.32	26.25	11.2	1.28	3.2	0.16	2 872	603	5.15	C4-S2
WADI THARTHAR, TEL ABTA	I	18.12.79	7.3	3.4	15.51	6.98	17.16	0.214	26.1	10.36	-	2.6	0.20	2 920	557	5.12	C4-S2
WADI THARTHAR, TEL ABTA	F	15.02.80	7.7	2.1	14.46	4.83	4.6	0.2	16.75	3.36	0.16	2.4	0.34	1 680	1 683	1.481	C3-S1
WADI THARTHAR, TEL ABTA	I	16.02.80	7.6	2.76	20.57	6.07	6.69	0.16	25.63	5.88	0.16	2.4	0.6	2 160	1 289	1.833	C4-S1
WADI THARTHAR, TEL ABTA	F	17.02.80	7.5	1.81	10.47	3.36	5.07	0.16	12.1	4.34	0.16	1.6	0.34	1 392	4 530	1.928	C3-S1
WADI THARTHAR, TEL ABTA	I	02.05.80	-	16.1	40.0	66.0	102.4	0.2	92.0	105.0	-	2.2				1.70	C4-S2
WADI MARGHADA, HASSAR	F	17.02.80	7.9	1.0	7.63	1.84	0.89	0.09	7.75	0.42	-	1.4	0.22	776	1 942	0.409	C3-S1
WADI MARGHADA, HASSAR	I	18.02.80	7.7	1.24	9.6	2.44	1.34	0.09	9.38	1.26	0.16	1.6	0.34	1 052	412	0.546	C3-S1
WADI MARGHADA, HASSAR	I	23.02.80	7.6	1.14	9.8	1.96	0.98	0.09	10.0	0.98	-	1.0	0.14	988	616	0.404	C3-S1
WADI THARTHAR, SHWA	I	22.02.80	7.6	10.9	15.68	37.54	72.46	0.2	63.75	59.5	0.32	3.6	1.12	8 120	1 126	14.047	C4-S4
WADI THARTHAR, SHWA	I	24.02.80	7.6	9.1	14.88	29.13	57.97	0.14	47.5	54.6	-	1.6	0.82	6 676	459	12.357	C4-S4
WADI THARTHAR, SHWA	L	02.05.80	-	18.3	30.0	110.0	155.0	0.2	28.0	155.0	-	2.2				18.53	C4-S4
TEL AFAR, SPRING		08.03.80	7.4	2.57	26.55	6.74	0.84	0.09	31.5	1.4	-	2	0.28	2 420	121	0.206	C4-S1
MUHALLABIYA, SPRING		08.03.80	7.7	2.62	26.55	8.32	0.63	0.06	33.75	0.7	0.32	2.2	0.22	2 548	169	0.151	C4-S1
SHAIK IBRAHIM, SPRING		06.03.80	7.8	2.6	25.41	8.16	0.58	0.09	31.5	0.7	-	2.6	0.18	2 842	95	0.142	C4-S1
ZIMBAR, SPRING		06.03.80	7.8	2.38	25.54	5.28	0.48	0.09	30.0	0.63	0.16	1.8	0.34	2 316	100	0.122	C4-S1
AL BUKHUR, SPRING		06.03.80	7.8	2.79	25.54	11.06	0.89	0.08	33.75	0.98	-	2.4	0.22	3 176	215	0.208	C4-S1
WADI THARTHAR, HATRA**)	-	17.02.76	7.6		22.4	29.9	65.5		54.4	54.8		3.0					
WADI THARTHAR, HATRA**)	-	20.04.76	7.6		12.2	6.8	13.0		19.1	10.9		-		2 187			
WADI THARTHAR, HATRA	L	02.05.80	-	16.5	34.0	66.0	105.8	0.3	90.0	103.0	-	2.8				14.85	C4-S4

*) Flow: F Flood
I Intermediate
L Low

**) From Agrovodcomplect
USDA: United States Department of Agriculture

From the results given in Table 3.4-3, it can be seen that with respect to the salinity hazard, the surface water samples can all be classified in the classes “high” to “very high” salinity hazard whereas with respect to the sodium hazard, they belong mostly to the classes “low” to “medium” except for the samples taken at Shwa and Hatra which even belong to the “very high” salinity hazard. The high salinity hazard is mainly due to the calcium-sulphate (CaSO4) component in the water samples. However, at Shwa, the water of Wadi Tharthar appears to be sodium-rich throughout the year.

Thus, this surface water from the project area itself could only be used occasionally and under very special circumstances for irrigation purposes. Only plants with good to high salt tolerance and definitely no sodium sensitive crops may be cultivated. Furthermore, a good drainage of the soils is of utmost importance and excess water should be provided for leaching.

According to Swiss F/S, Al Sawaf estimates the surface runoff as 15% of precipitation, whereas other researcher assumed in Hatra Dam Study, a mean annual runoff volume of 86 MCM at Hatra Dam Site in al-Jazira region, which equals a runoff height of 17mm/year or about 5% of the precipitation. These figures as runoff coefficient are small.

As a conclusion from aforesaid, it can be stated that the storage of surface water for irrigation could only significantly contribute to a better water supply of the project area and is, therefore, not recommended.

3.4.4 Availability of Groundwater in South Jazira Area

(1) Available Data

(a) Well Data of F/S Report

The following numbers of well data are presented in Annex 3 of the F/S report:

In the project area	Shallow well	22 (18)
	Deep well	13 (10)
Out of the project area	Deep well	52 (45)

The figure in bracket shows the number of wells which locations are identified in the attached map. The data includes a formation name of target aquifer to take water, pH, EC, TDS, concentrations of the main ions and SAR. Fig.3.4-3 and Fig. 3.4-4 show location of wells and range of EC for shallow wells and deep wells respectively.

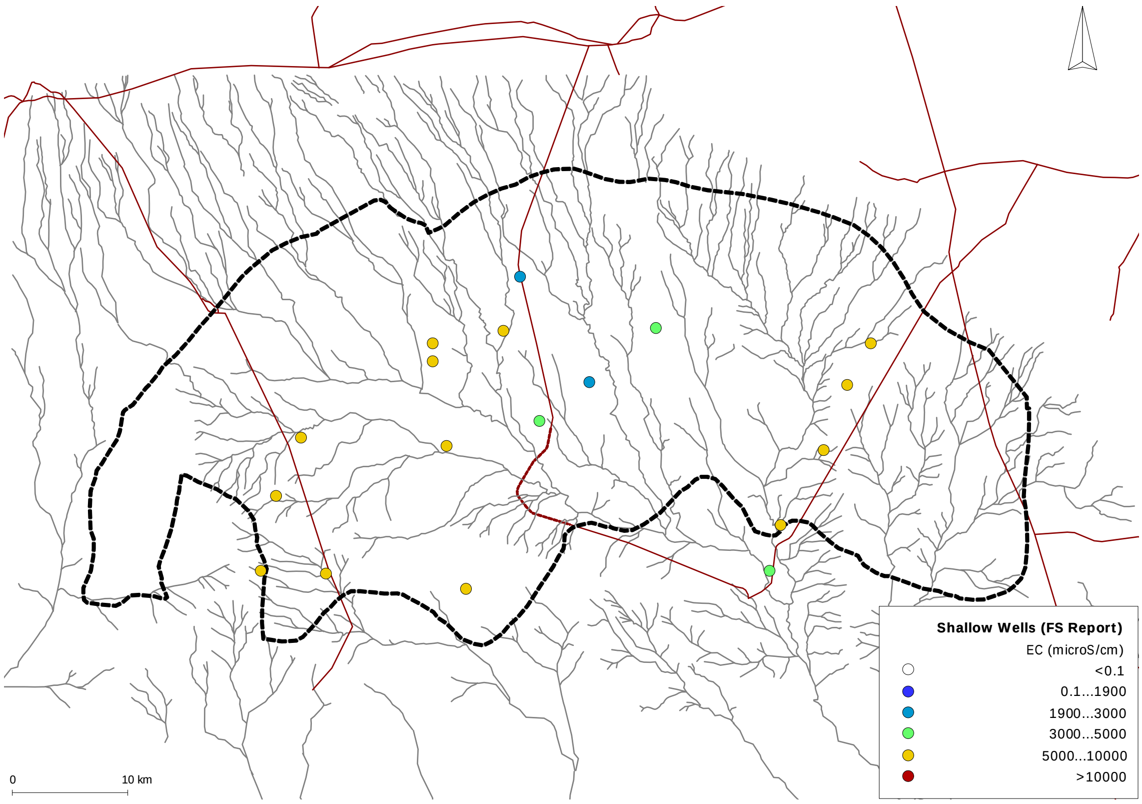


Fig. 3.4-3 Electric Conductivity of Shallow Well Water (Data by the F/S report,1984)

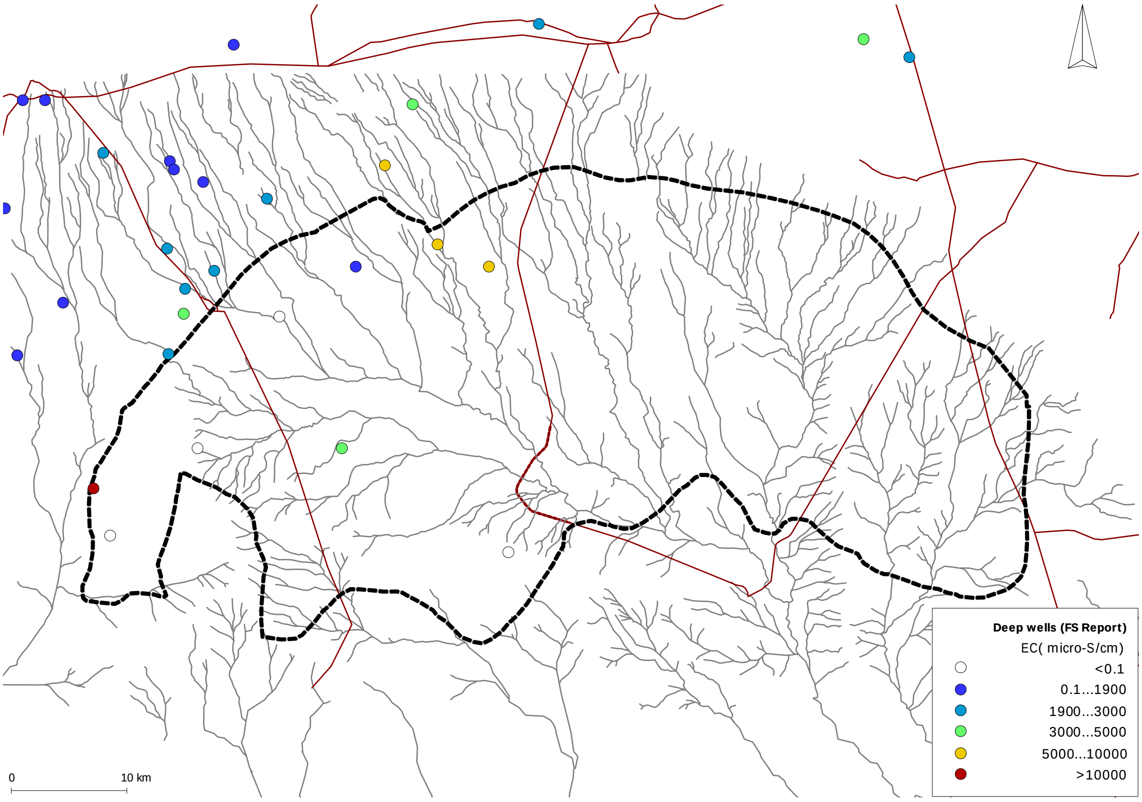


Fig. 3.4-4 Electric Conductivity of Deep Well Water (Data by the F/S Report, 1984)

(b) Well Data of MoWR

Deep well data at 286 points in and around the project area are provided by MoWR, in July 2010. The data contains ground elevation, static water level, dynamic water level, EC, TDS and coordinates of the location. However some fundamental data like discharge, well diameter, screen depth and year of well construction are not included.

Fig.3.4-5 to Fig.3.4-11 shows distribution of values of well depth, water elevation, static water level, dynamic water level, drawdown, EC and TDS of the wells.

Note: In the following Figures, white circles show having no data for the item.

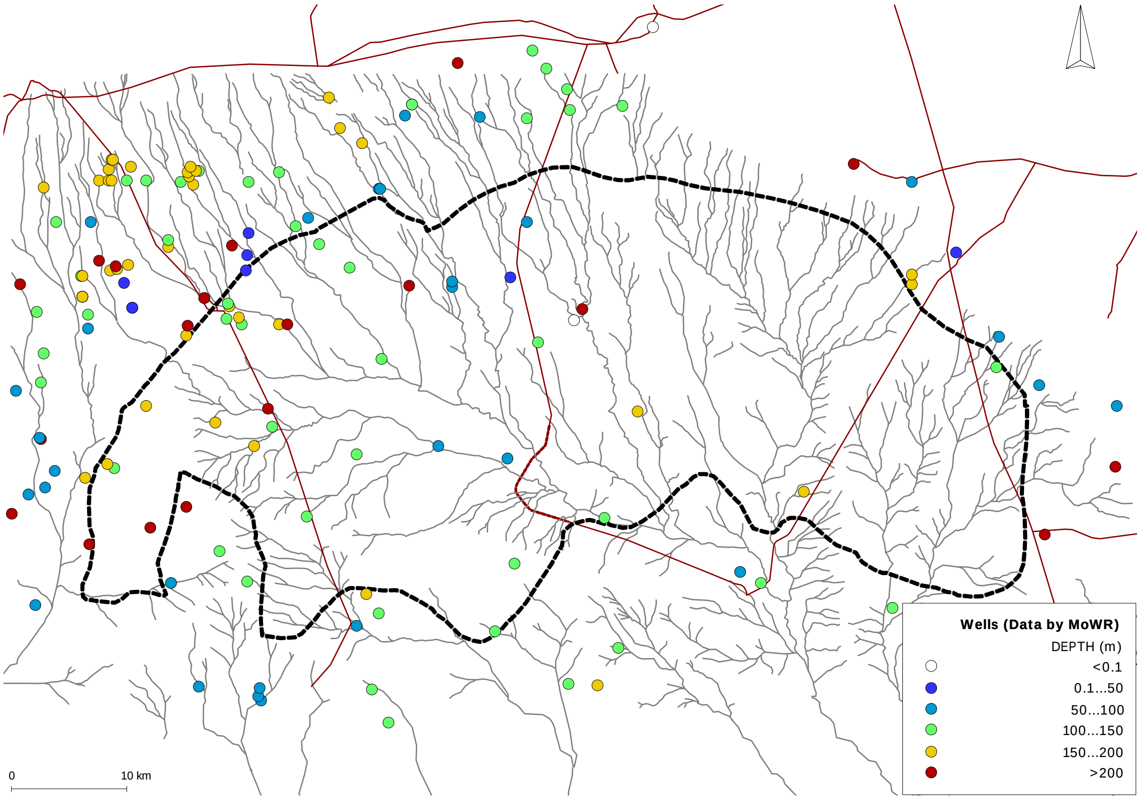


Fig. 3.4-5 Depth of Deep Well (Data by MoWR, 2010)

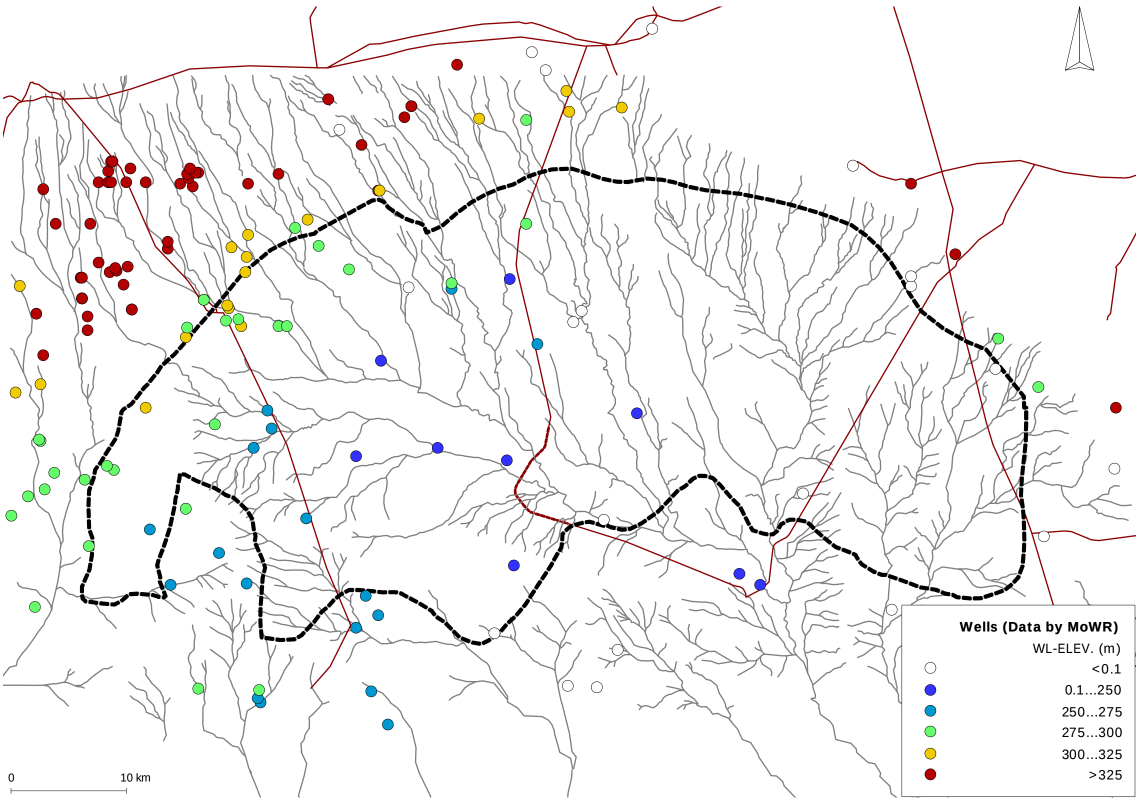


Fig. 3.4-6 Elevation of Water Level of Deep Wells (Data by MoWR,2010)

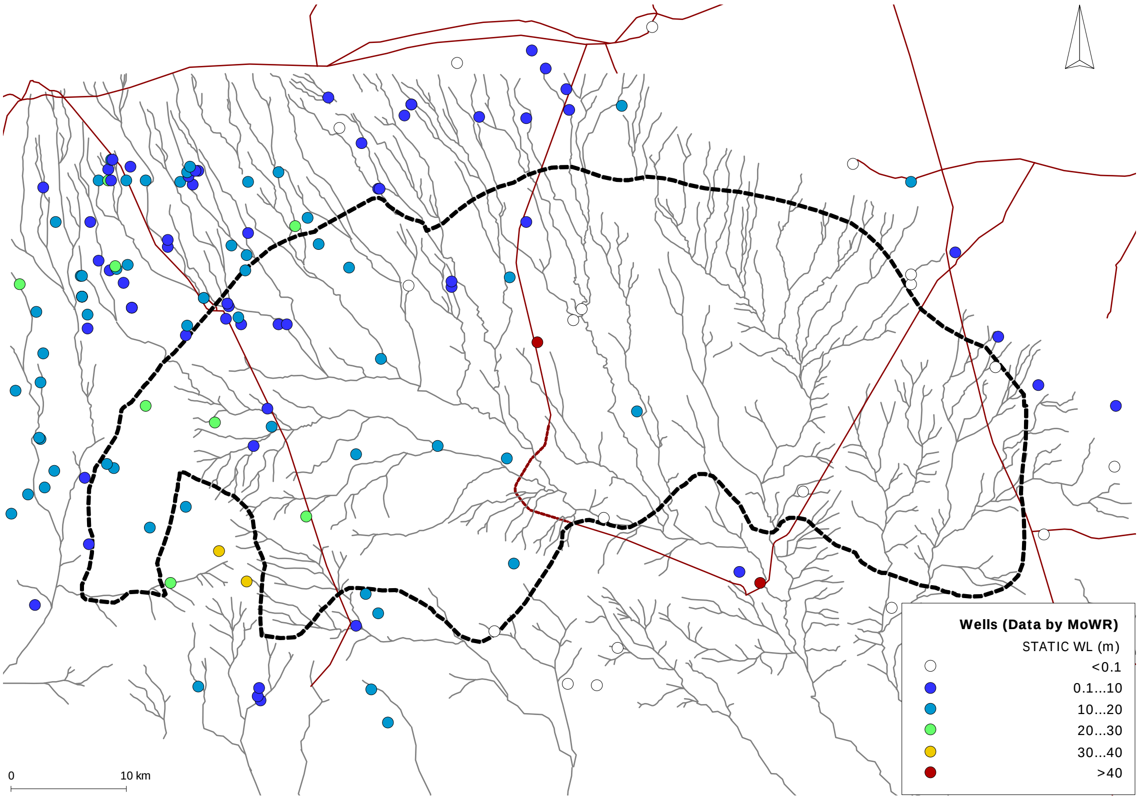


Fig. 3.4-7 Static Water Level of Deep Wells (Data by MoWR, 2010)

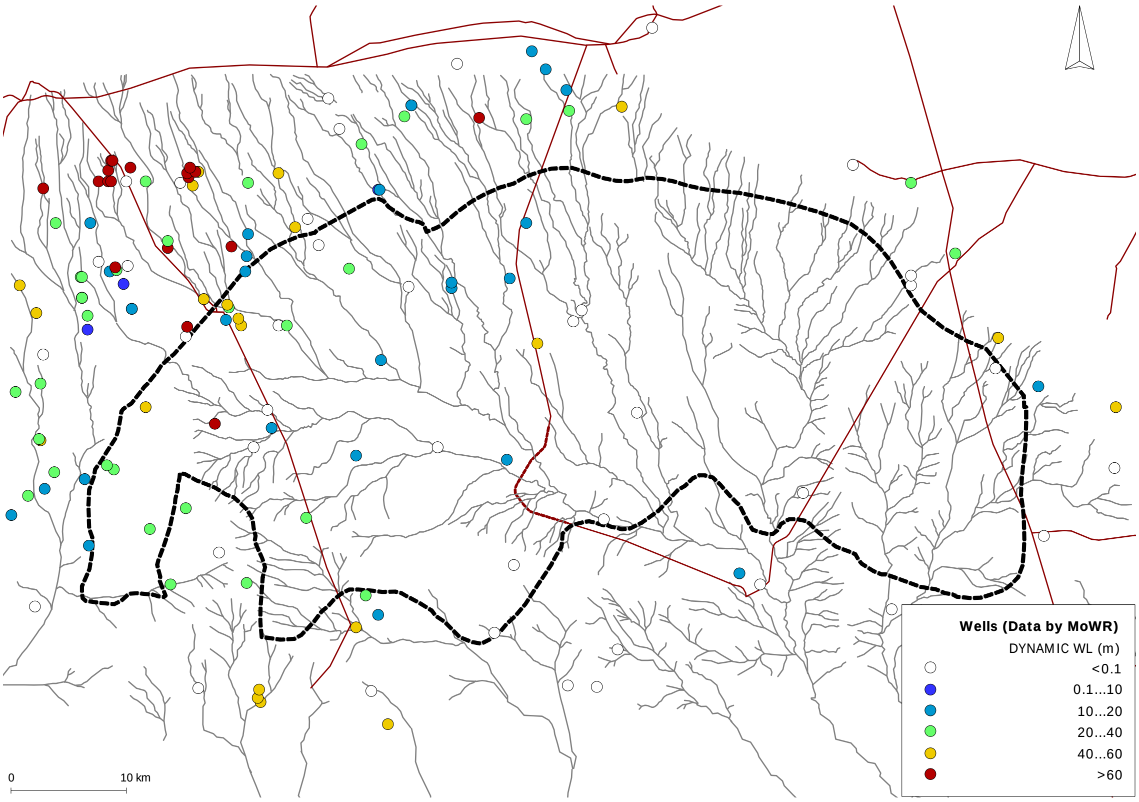


Fig. 3.4-8 Dynamic Water Level of Deep Wells (Data by MoWR, 2010)

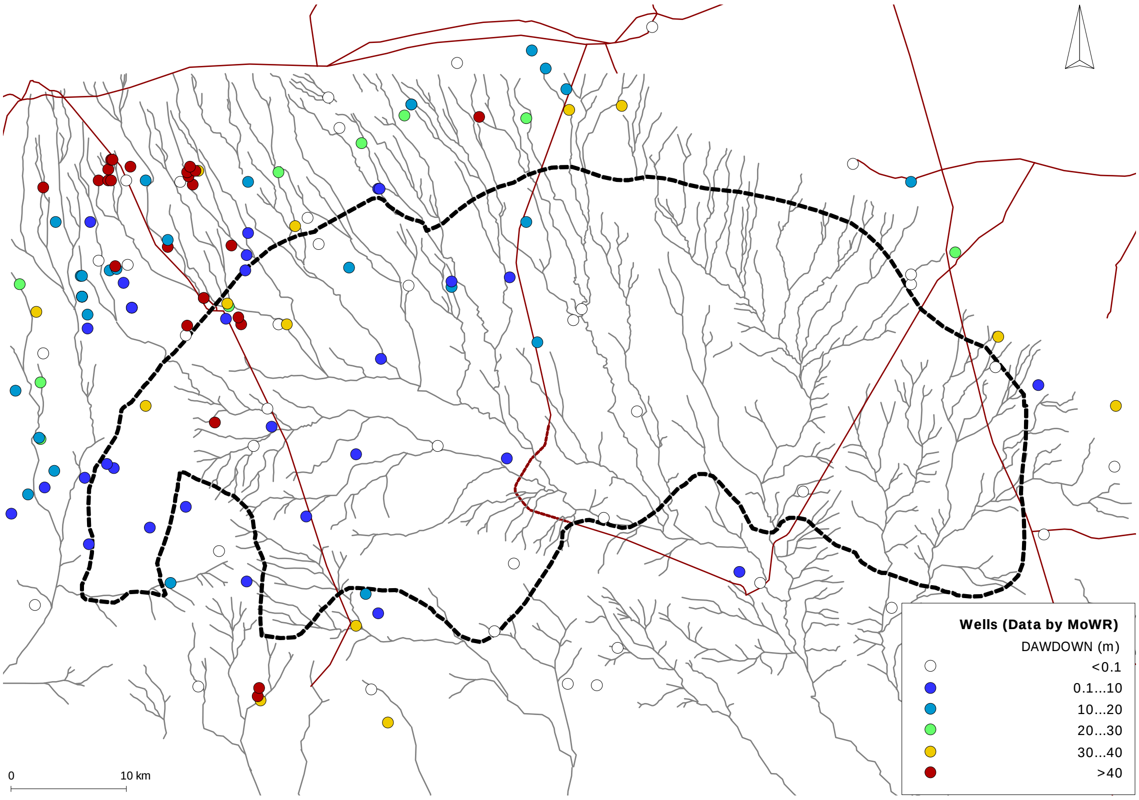


Fig. 3.4-9 Drawdown of Deep Wells (Data by MoWR, 2010)

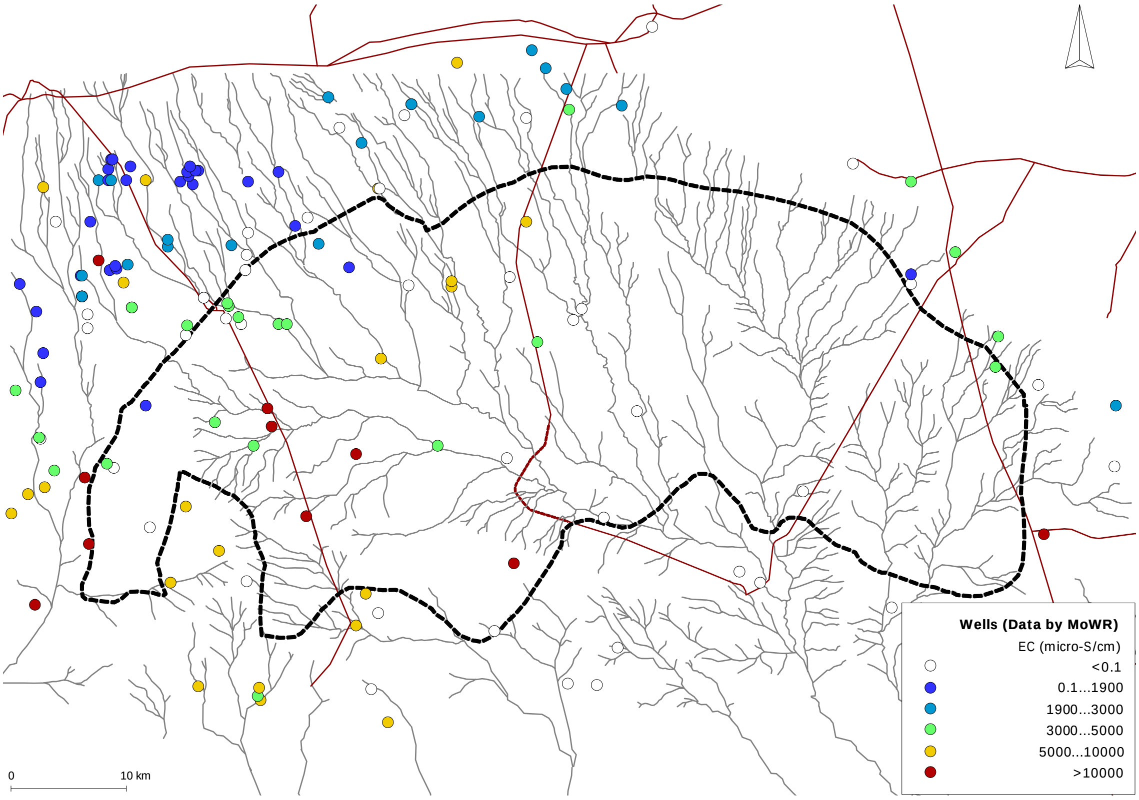


Fig. 3.4-10 Electric Conductivity of water of Deep Wells (Data by MoWR, 2010)

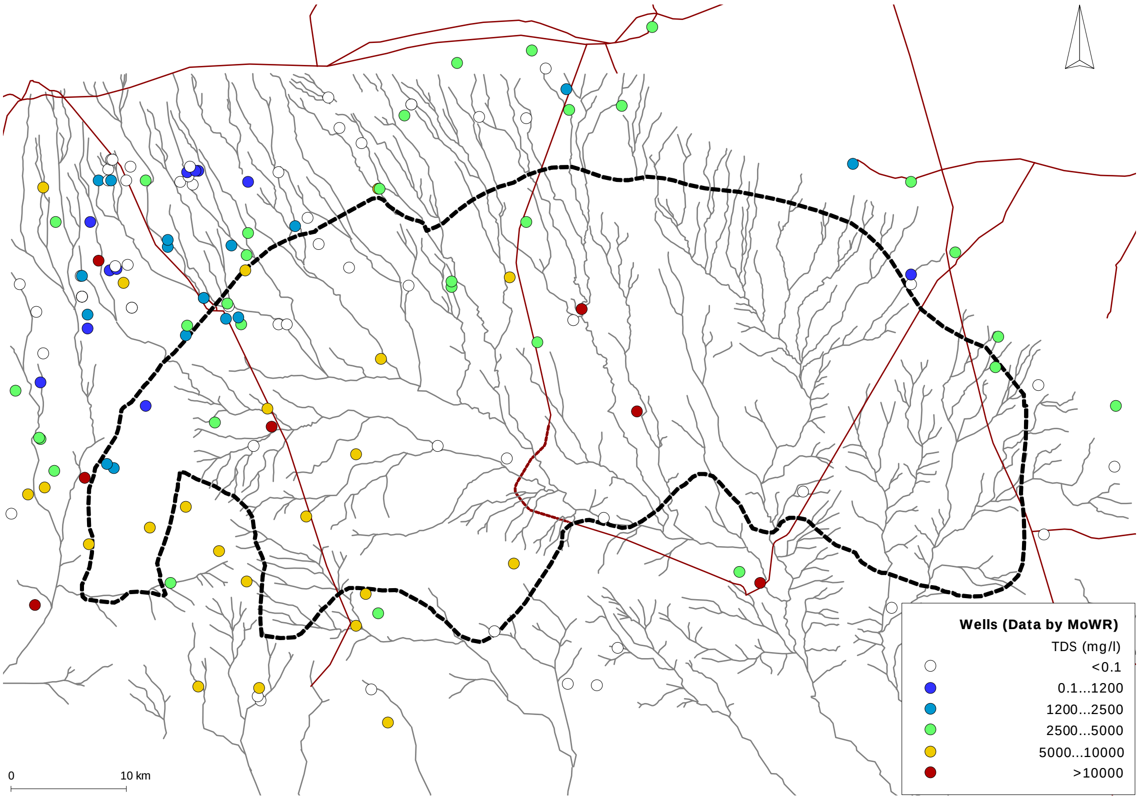


Fig. 3.4-11 Total Resolved Solids of Water of Deep Wells (Data by MoWR, 2010)

(c) Sample Well Survey

The study team carried out well survey with a questionnaire at six villages in the project area. Fig.3.4-11 shows the locations. In the survey, first the surveyor visited the village and made hearing to an appropriate villager with a questionnaire of water use shown in Table 3.4-4 (left). Then if it is found that there is a well in the village, he visited representative well(s) and conducted measurement and hearing on the well with form shown Table 3.4-4 (right). Number of wells to be visited is limited to two per village due to time and security constraint.

Table 3.4-5 shows the results of the interview on water use of villages. Table 3.4-6 shows the results of well survey.

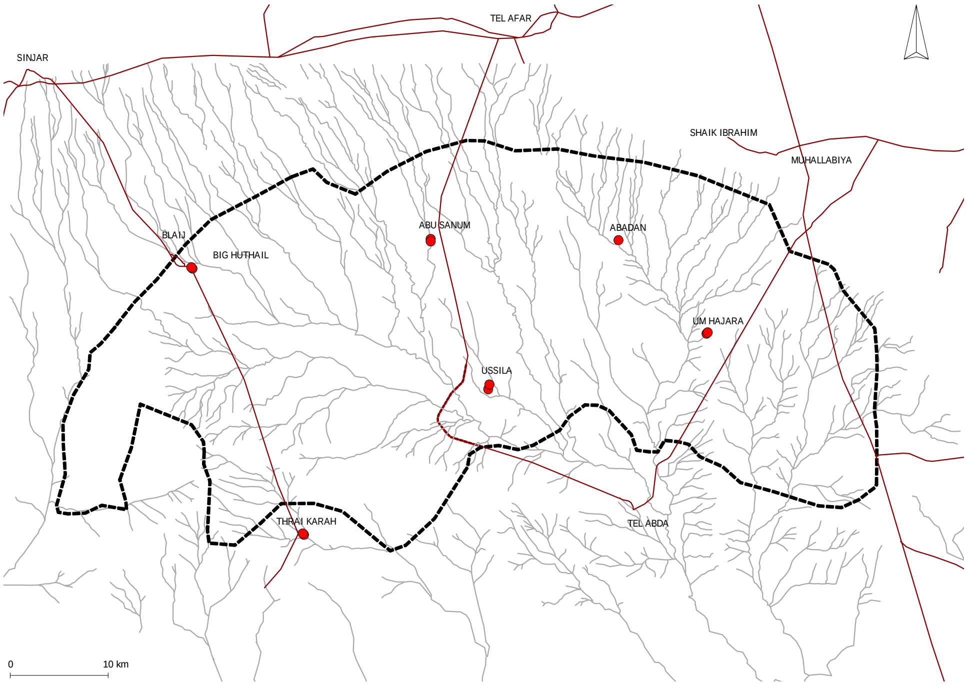


Fig. 3.4-12 Locations of Well Survey

Table 3.4-4 Questionnaires of Well Survey

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SURVEY FORM FOR **VILLAGE**

Date	20 / 07 / 2010
Surveyor	Ali H. Agoob & Shehab A. Fattah

General	1.Village name	Usaila
	2. Nahia	Tall abta
	3. qadha	Hatra
	4. GPS Location Latitude	3992706
	Longitude	264748
	Elevation	237m
	5. Population Number of families	65
	Average persons per family	10
	6. Area of farm land (donum)	12000
Water use	7. Source of Water (Groundwater /River water/ Rain) For drinking	Buying water from tanker
	For Animals	Deep & shallow wells
	For irrigation	Rain & deep wells
	For household	From tanker
	For Other purpose	Shallow & deep wells
	What purpose ?	Construction homes by clay
	8. Number of Shallow Well(s)	10
	Purpose(s)	For animals
	Approximate depth of wells (m)	8 m
	9. Number of deep well(s)	6
	Purpose(s)	For animals & irrigation
	Approximate depth of wells (m)	90 m
	10. Number of spring(s)	------------
	Purpose(s)	------------
	Other groundwater source(s)	------------
	Purpose(s)	------------

JICA

The Preparatory Study on South Jaziera Irrigation Project

SURVEY FORM FOR WELL

Date	20/07/2010
Surveyor	Ali H. Agoob & Shehab A. Fattah

General	1.Well Number	1
	2.Location Village	Abu sanam
	Nahia	Tall Abta
	Qadha	Hatra
	3. GPS Location Latitude	4007497
	Longitude	258875
	Elevation	273
	4. Name of – owner	Sheikh. Zaid Ibrahem Hammad
	5. Year of construction	1989
Use	6.Purpos of use	For irrigation and animals
	7. When and how often the well is used ?	- Every 10 day in winter to irrigation five donums from malt. - Once or twice in day to fill tanker (10000 L) for animals.
Well	8. Type of well (Dug/Drilld/Combined)	Drilled
	9. Ddiameter (m)	0.35 m (12 inch)
	10.Depth of well (m)	90
	11. Diffrence between well head and ground (m)	0.3
	12. Depth to water table from ground	2.40
	By measuring or hearing ?	measuring
Pump & Discharge	13. Type of pump	Diver
	14. Diameter of discharge pipe	2.5 inch
	15. Discharge (l/s)	3 l/s
	by measuring or hearing?	By hearing
Quality	16. quality	pH=7 EC=8 mS, t=21'c
Remark and Sketch	Photo No.	GEDC0100 ,GEDC0102

Note: The well in north of village.

For Water Use of Village

For Well

Table 3.4-5 Results of Hearing on Water Use in Village (Source: JICA Study)

Date		20 / 07 / 2010	20 / 07 / 2010	21 / 07 / 2010	21 / 07 / 2010	20 / 07 / 2010	20 / 07 / 2010
Surveyor		Ali H. Agoob & Shehab A. Fattah	Ali H. Agoob & Shehab A. Fattah	Ali H. Agoob & Shehab A. Fattah	Ali H. Agoob & Shehab A. Fattah	Ali H. Agoob & Shehab A. Fattah	Ali H. Agoob & Shehab A. Fattah
General	1.Village name	Abadan	Abu Sanam	Big Huthail	Trai Karah	Um Hajara	Usaila
	2. Nahia	-----------	Tall abta	Qairawan	------------	Muhalabya	Tall abta
	3. qadha	Tallafar	Hatra	Sinjar	Ba'aj	Mosul	Hatra
	4. GPS Location Latitude	4007021	4006756	4004552	3977469	3998006	3992706
	Longitude	278008	259186	234507	245932	287138	264748
	Elevation	255m	274m	317 m	274m	246 m	237m
	5. Population Number of families	1	130	400	380	100	65
	Average persons per family	22	12	8	10	12	10
	6. Area of farm land (donum)	16000	16000	12000	50000	16000	12000
Water use	7. Source of Water (Groundwater /River water/ Rain) For drinking	Buying water from tanker	Buying water from tanker	Buying water from tanker	Buying water from tanker	Buying water from tanker	Buying water from tanker
	For Animals	shallow well	Deep & shallow wells	Shallow wells	Shallow wells	Shallow wells	Deep & shallow wells
	For Irrigation	Rain	Rain & deep wells	Rain	Rain	Rain	Rain & deep wells
	For household	shallow well	From tanker	From tanker	From tanker	From tanker	From tanker
	For Other purpose	Shallow	Shallow & deep wells	Shallow	Shallow	Shallow	Shallow & deep wells
	What purpose ?	Construction homes by clay	Construction homes by clay	Construction homes by clay	Construction homes by clay	Construction homes by clay	Construction homes by clay
	8. Number of Shallow Well(s)	1	40	100	200	30	10
	Purpose(s)	For animals	For animals	For animals	For animals	For animals	For animals
	Approximate depth of wells (m)	5 m	30 m	7 m	7-14 m	7 m	8 m
	9. Number of deep well(s)	zero	2	zero	zero	---------------	6
	Purpose(s)	--------------	For animals & Irrigation	-----------	-----------	---------------	For animals & Irrigation
	Approximate depth of wells (m)	--------------	90 m	-------------	-------------	---------------	90 m
	10. Number of spring(s)	--------------	--------------	--------------	--------------	--------------	--------------
	Purpose(s)	-------------	-------------	-------------	-------------	-------------	-------------
	11. Other groundwater source(s)	-------------	-------------	-------------	-------------	-------------	-------------
	Purpose(s)	-------------	-------------	-------------	-------------	-------------	-------------

Table 3.4-6 Results of Well Survey (Source: JICA Study)

Table 3.3-14 Results of Well Survey

Date		20/07/2010	20/07/2010	20/07/2010	20/07/2010	20/07/2010	21/07/2010	21/07/2010	21/07/2010	21/07/2010	20/07/2010	21/07/2010
Surveyor		Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.	Ali H. Agoob & Shehab A.
General	1.Well Number	1	1	10	5	7	1	2	1	2	1	8
	2.Location											
	Village	Abadan	Abu sanam	Abu sanam	Um Hajara	Um Hajara	Big Huthail	Big Huthail	Thrai Karah	Thrai Karah	Ussaila	Ussaila
	Nahia	------------	Tall Abta	Tall Abta	Muhalabia	Muhalabia	Qairawan	Qairawan	------	------	Tall Abta	Tall Abta
	Qadha	Talaffar	Hatra	Hatra	Musol	Musol	Sinjar	Sinjar	Ba`aj	Ba`aj	Hatra	Hatra
	3. GPS Location											
	Latitude	4007383	4007497	4007241	3997967	3998014	4004552	4004600	3977456	3977593	3992320	3992774
	Longitude	278072	258875	258895	287153	287283	234507	234473	245964	245874	264772	2264950
	Elevation	258	273	275	246	241	317	320	245874	245874	239	240
	4. Name of – owner	Saud Az Aldeen	Sheikh. Zaid Ibrahem	Sheikh. Zaid Ibrahem	Ubaid Hassan Khleef	Muhamad Hassan Hussin	Mukhtar. Nawaf Ahmed	Satam Ahmed	Hamdon Khalaf Muhamad	Fahad Shehatha taher	Sheikh. Aafet ugab Hammad	Sheikh. Aafet Ugab Thabet
	5. Year of construction	2001	1989	1994	1980	1990	2003	1997	2008	2004	2003	1982
Use	6.Purpos of use	For animals	For irrigation and animals	For animals	For animals	For animals	For animals	For animals	For animals	For animals	For irregation	For animals
	7. When and how often the well is used ?	Five run in day at least for animals.(every once approximately 200 liters)	- Every 10 day in winter to irrigation five donums from malt. - Once or twice in day to fill tanker (10000 L)	Five run in day at least for animals.(every once approximately 500 liters)	Five run in day at least for animals.(every once approximately 100 liters)	Five run in day at least for animals.(every once approximately 100 liters)	Five run in day at least for animals.(every once approximately 50 liters)	Five run in day at least for animals.(every once approximately 50 liters)	Five run in day at least for animals.(every once approximately 50 liters)	Five run in day at least for animals.(every once approximately 50 liters)	Every 10 day in winter to irrigation ten donums from malt.	Five run in day at least for animals.(every once approximately 500 liters)
Well	8. Type of well (Dug/Drilld/Combined)	Dug by hands	Drilled	Dug by hands	Dug by hands	Dug by hands	Dug	Dug by hand	Drilled	Drilled	Drilled	Dug by hands
	9. Diameter (m)	1 * 1.5 m	0.35 m (12 inch	1 m	1 m	1 m	12 inch	1 m	8 inch	8 inch	12 inch	1 m
	10.Depth of well (m)	5	90	5	7	7	30 m	7 m	26	25	85	8
	11. Diffrence between well head and ground	zero	0.3	0.3	----	----	zero	Zero	zero	zero	0.2	0.4
	12. Depth to water table from ground	3.9 m	2.4	4	5.9	6	6	5.5	7	4.9	5.8	5.4
	By measuring or hearing	measuring	measuring	measuring	measuring	measuring	measuring	measuring	measuring	measuring	measuring	measuring
Pump & Discharge	13. Type of pump	MONDA	Diver	EAGLE G 50	Small Elc. pump	Small Elc. pump	Small elc. Pump (china)	MARQUOS water pump	Small diver	Small Elc. motor	Diver	EAGLE G 50
	14. Diameter of discharge pipe	2 inch	2.5 inch	2 inch	3/4 inch	3/4 inch	1 inch	3/4 inch	3/4 inch	3/4 inch	4 inch	2 inch
	15. Discharge (l/s)	3 l/s	3 l/s	3 l/s	0.8 l/s	0.8 l/s	1 l/s	0.8 l/s	1 l/s	0.8 l/s	4 l/s	3 l/s
	by measuring or hearing?	By hearing	By hearing	By hearing	By hearing	By hearing	By hearing	Typed in plate name	By hearing	By hearing	By hearing	By hearing
Quality	16. Quality	pH=7.3 EC=5.1 mS, t=21.9°c	pH=7 EC=8 mS, t=21°c	pH=7.3 EC=8.5 mS, t=22°c	pH=7.3 EC=7.7 mS, t=22°c	pH=7.2 EC=7.5 mS, t=22°c	pH=6.9 EC=7.5 mS, t=22°c	pH=6.9 EC=7.3 mS, t=22°c	pH=7.5 EC=5.3 mS, t=22°c	pH=7.6 EC=5.4 mS, t=21°c	pH=7.7 EC=8.5 mS, t=22°c	pH=7.5 EC=4.5 mS, t=20.3°c
Photo No.		GEDC0130 GEDC0132	GEDC0100, GEDC0102	GEDC0097, GEDC0099	GEDC0136, GEDC0135	GEDC0143, GEDC0145	GEDC0182 GEDC0183	GEDC0186 GEDC0190	GEDC0162 GEDC0163	GEDC0166 GEDC0167	GEDC0153 GEDC0157	GEDC0150 GEDC0151

Source: The JICA Study Team, 2010

(2) Present Groundwater Use

From the data shown above, the following condition of groundwater use in the project area is found;

(a) Shallow Wells

A shallow well is a dug well with 5 to 10m in depth. Water level lies about 4m to 7m from the ground. Electric conductivity of the water ranges 4,500 to 8,500 micro-S/cm. The water is used mainly for animals. It is used also for household and for house construction with clay. Every village has as many shallow wells as population.

(b) Deep Wells

A deep well is mainly a drilled well with 30 to 250m in depth. Water level varies about 3m to 30m from the ground. Electric conductivity of the water ranges mostly 3,000 to 10,000 micro-S/cm. It is lower in the north-western part of the project area around Balaj town. The water is used for animals and irrigation.

(c) Drinking Water

For drinking, water is supplied by a tanker with payment.

(3) Availability of Groundwater

(a) Water Quality

Electric conductivity 3,000 micro-S/cm is a guideline to judge if the water is available for irrigation. If the value exceeds it, crop production may reduce. Considering this, most groundwater in the project area is not suitable for irrigation.

(b) Groundwater Recharge

If we use groundwater for a large irrigation project, the water must be supplied sustainably. The recharge source of the groundwater in the area is rainfall in the project area and in the northern adjacent area. The groundwater recharge in the project area is roughly calculated as follows:

Average annual rainfall	330mm
Average annual groundwater recharge rate	10%

(The values from the F/S Report Annex 3 Hydrology; considered to be reasonable)

Then,

Average annual groundwater water height	33mm
Average daily groundwater recharge per km^2	
30mm/ 1000mm/m /365days x 1000000m^2/km^2 =	90m^3/day/km^2

Average daily groundwater recharge per the project area

82m^3/day/km^2 x 2,200 km^2 (gross project area) =	198,000 m3/d
=	approx. 2.3 m^3/s

The groundwater recharge is too small to compare with the maximum water requirement of the Project, 125m^3/s. Even if considering groundwater recharge in the upstream area of the Project area, it must be far from the requirement.

(c) Conclusion

From water quality and groundwater recharge points of view, groundwater cannot be a main source.

3.5 Information on Agricultural Activities

3.5.1 Land Use

(1) Land use - 01 (Rural area and urban area)

Land use in four(4) districts within the Project area is shown as Table 3.5-3. Rural area looks dominant and urban area is only 11% (=284,875/2,574,380). On the other hand, because average farm land area which one farmer possesses is 15.9 ha/farm, most farmer in Project area operate his large-sized farms.

Table 3.5-1 Numbers and Area of Land Owners by Urbanization

（Unit: person, donum（= 0.25ha））

District	Total		Rural		Urban	
	Land Owners	Area	Land Owners	Area	Land Owners	Area
Mousel	14,860	774,259	12,502	602,112	2,358	172,147
Sinjar	7,258	464,913	7,252	464,787	6	126
Talaafar	11,386	686,324	9,948	574,741	1,438	111,583
Al Baaj	6,319	648,884	6,308	647,865	11	1,019
Totals	39,823	2,574,380	36,010	2,289,505	3,813	284,875

Source: Ministry of Planning

(2) Land use - 02 (Agriculture and non-agriculture)

Major crops are wheat and barley with rain-fed. Most farmers own livestock and they feed their livestock with residues of agricultural product, such as leaf and stem. Farmers hire agricultural labors to continue relatively large scale extensive farming. Number of farmers and number of non-farmers in 4 districts related to the Project area is in Table 3.5-2. As it says, portion of farmers (99%) is dominant.

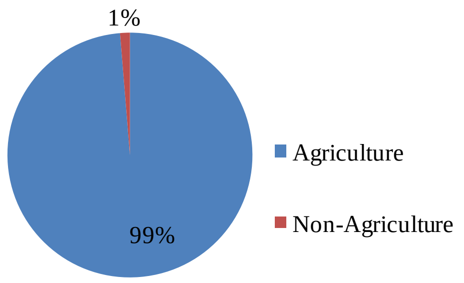
Table 3.5-2 Number of Owners by their Profession

(Unit: Person)

District	Total No. of Owners	Agriculture No. of Owners	Non-Agriculture No. of Owners
Mousel	14,860	14,637	223
Sinjar	7,262	7,185	77
Talaafar	11,403	11,260	143
Al Baaj	6,320	6,244	76
Totals	39,845	39,326	519

Source: Ministry of Planning

Fig. 3.5-1 Composition Rate
(Agriculture and Non-agriculture)



Source: Ministry of Planning

Type and gender ratio of farmers in 4 districts within the Project area is in Table 3.5-3. The number of permanent farmers is three times larger than that of temporarily farmers who have land use permission. Number of labor force shares the largest portion in the three(3) categories. Gender ratio is the equivalent in any categories.

Table 3.5-3 Number of Family by Work Location and Gender

(Unit: Person)

District	No. of Owners			Permanent		Temporary		Working outside their land	
	Total	Male	Female	Male	Female	Male	Female	Male	Female
Mousel	76,526	36,688	39,838	6,207	6,965	16,127	16,923	14,354	15,950
Sinjar	42,267	20,918	21,349	2,251	2,399	7,901	7,831	10,766	11,119
Talaafar	51,113	25,331	25,782	5,641	5,984	11,027	10,902	8,663	8,896
Al Baaj	32,068	14,850	17,218	2,063	2,536	5,869	6,204	6,918	8,478
Totals	201,974	97,787	104,187	16,162	17,884	40,924	41,860	40,701	44,443

Source: Ministry of Planning

(3) Land use-03 (Land owner)

Individual farmers shares 89% (=2,286,645/2,574,380) of farmland in 4 districts within the Project area. Average possessed area of agricultural agent is 104.8 donum (=277,321/2,645). It is the largest average. The second position is individual farmer with 61.9 donum (=2,286,645/36,944). The third position is farmers' group with 44.7 donum (=10,414/233).

Table 3.5-4 Number of Land Owners by Management Style of Tenure

(Unit: Person, Donum (= 0.25 ha))

District	Total		By Farmer		By Agent		By Group	
	No. of Land Owners	Area	No. of Land Owners	Area	No. of Land Owners	Area	No. of Land Owners	Area
Mousel	14,860	774,259	13,879	692,187	891	78,975	89	3,097
Sinjar	7,258	464,913	7,140	455,948	80	7,670	38	1,295
Talaafar	11,386	686,324	10,620	619,132	672	62,340	94	4,852
Al Baaj	6,319	648,884	5,305	519,378	1,002	128,336	12	1,170
Totals	39,823	2,574,380	36,944	2,286,645	2,645	277,321	233	10,414

Source: Ministry of Planning

3.5.2 Main Crops

(1) Main crops in the Project area

Main crops in the Project area are wheat and barley. Unit yield and cultivated area, which are found by farm survey, as show in Table 3.5-5;

Table 3.5-5 Results of Farm Survey: Cultivated Land

(Unit: ha)

	1	2	3	4	5	6	7	8	9	10	11	12	Average
Wheat							11.8	100	25	15	8.8	8.8	28.2
Baley	231.3	162.5	30	50	15	15	10	225	45	25	8.8	8.8	68.9

Total crop yield of wheat and barley in South Jazira area in 2008 and 2009 were 0, and the average yield in 2010 is 200 kg/donum (800 kg/ha) in South Jazira area. It is below 30% of average yield in North Jazira area. Crop yield in South Jazira area is nothing or very little so that crop yield without irrigation project is considered as nothing in F/S report. With regard to satellite images, a few irrigation facilities, such as center pivot or lateral type sprinkler, have a place in the Project area. It is presumed that they are supplemental irrigation system in winter season.

(2) Popular crops in four(4) districts within the Project area

Popular Corps in four districts within the Project area are in Table 3.5-6. Most popular crop is cereal which includes wheat and barley. It is considered that wheat is as principal food and barley is as feed crop for live stock. Each district has characteristic feature in planting area for each crop.

In Mousel district onions, beans, vegetables and feeder crops are popular while oil production crops are not major. Onions and oil production crops are popular in Sinjar district. On the other hand, vegetables and oil production crops are popular in Talaafar district. Al Baaj district concentrates on cereal planting.

Table 3.5-6 Planed Area by Crop Types

（Unit: Donum（=0.25ha））

District	Grains	Crops for Industrial Production		Tubercular and Onions	Legumes	Vegetables	Fodder Crops
		Oil Production	Mainly				
Mousel	634,619	926	9,952	3,437	11,838	10,232	1,102
Sinjar	341,361	1,358	88	2,606	722	3,995	20
Talaafar	615,707	1,259	-	802	-	29,943	-
Al Baaj	518,672	312	-	900	792	3,886	-
Totals	2,110,359	3,855	10,040	7,745	13,352	48,056	1,122

Source: Ministry of Planning

(3) Main livestock in the Project area

Livestock number owned by interviewed farmers is show in Table 3.5-7. At the farm survey, sheep and cow are affirmed as livestock. Currently in the South Jazira area animal industry is thriving. It seems that farmers who do not own livestock offer agricultural residues to livestock farmers.

Table 3.5-7 Result of Farm Survey: Number of Animals

	1	2	3	4	5	6	7	8	9	10	11	12	Average
Sheep	15	0	0	0	50	800	0	300	0	200	0	0	113.8
Cow	0	0	0	0	0	0	0	2	0	0	0	0	0.2

(4) Main livestock in 4 districts within the Project area

Number of livestock and owners in 4 districts within the Project area is in the Table 3.5-8. Sheep holds first rank in the number. Goat holds second rank and cow holds third rank. However, the rank of cow and goat in Mosul district has reverse trend. It is thought that considerable amounts of consumption of dairy products in Mosul city affect the number of livestock in Mosul district.

Table 3.5-8 Number of Owners and Animals by their Species

District	Cow		Buffalo		Sheep		Goat	
	No. of Owners	Number of Animals	No. of Owners	Number of Animals	No. of Owners	Number of Animals	No. of Owners	Number of Animals
Mousel	6,127	18,895	257	6,110	3,115	180,190	1,450	12,391
Sinjar	514	1,290	-	-	3,786	134,260	2,810	24,314
Talaafar	2,391	6,837	10	84	3,968	191,042	1,626	12,528
Al Baaj	121	361	-	-	3,049	292,491	1,352	11,477
Totals	9,153	27,383	267	6,194	13,918	797,983	7,238	60,710

Source: Ministry of Planning

3.5.3 Cropping Pattern

According to farm survey (listening from farmers), cropping pattern in Project area is as follows. Rain-fed wheat and barley are planted once in winter season. Although all works depend upon the weather, usually seeding period is from late October to late April, and harvesting period is from early May to middle of June.

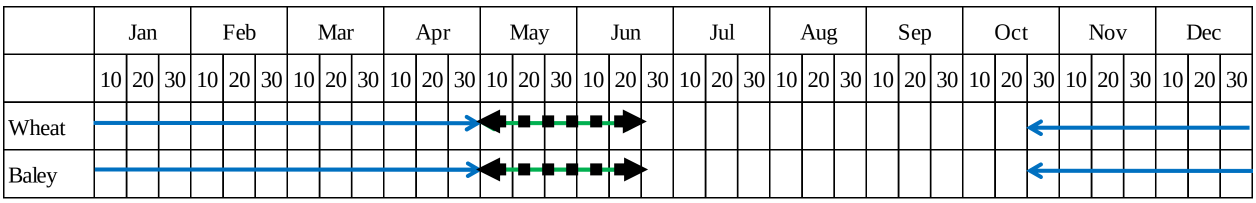


Fig. 3.5-2 Result of Farm Survey: Cropping Patterns

Grazing by residues starts after harvest and ends before sowing time in the next year. According to the result of farm survey, this cropping and grazing pattern has been most popular pattern in the Project area for long time. It is considered that there has been no change since F/S enforced.

3.5.4 Cultivation Area of Irrigated and Rainfed Lands

(1) Current situation of irrigation in Project area (Result of farm survey)

According to F/S report (1982), the Project area is 213,900 ha and is classified as rain-fed cultivation area. Farmers who were interviewed by farm survey did not have irrigation facilities. Because it is difficult to find suitable water resource for irrigation in Project area, classification by F/S report is adequate. However, some farmers may apply irrigation facilities because satellite images of the Project area show trace of irrigation.

During farm survey a lateral type tractor sprinkler was found in the Project area and information of it is in table below. Irrigation area is limited within 10% of whole cultivation area which owner of sprinkler has because of shortage of irrigation water. It is considered that farmers in the Project area may have irrigation facilities and have experience of irrigation but it is not usual.

Table 3.5-9 Information from Sprinkler Owner (Supplemental Farm Survey)

Residential Term	from	1957
Possessed Area	donum	1,000
Cultivation Area	donum	2,300
Irrigation Area	donum	250
Irrigation Introduction Term	years	8
Number of Irrigation Facility	set	1
Type of Irrigating Facility		Tractor Lateral Sprinkler
Length of Boom	meter	350
Irrigation Season		Supplemental Irrigation in Winter
Irrigated Crops		Wheat and Barley
Average Topsoil Depth	meter	0.6
Planned Crops after Project		Vegetables, Fruits, Fodder Crops
Number of Sheep		300（just after shipped）

(2) Current situation of irrigation around the Project Area

Cultivation area of main crops by irrigation or rain-fed in 4 districts within the Project area is shown in Table 3.5-10. Most area is rainfed and irrigation area is limited within 1 %.

Table 3.5-10 Number and Area of Users by Irrigation and Crop Types

(Unit: Person, Donum（=0.25ha））

District	Irrigation Method	Wheat		Barley		Corn		Others	
		No. of Owners	Area	No. of Owners	Area	No. of Owners	Area	No. of Owners	Area
Mousel	Irrigated	0	0	0	0	52	292	2	11
	Rainfed	6,334	322,961	1,521	311,355	0	0	0	0
	Total	6,334	322,961	1,521	311,355	52	292	2	11
Sinjar	Irrigated	474	6,133	291	3,070	11	257	21	301
	Rainfed	3,822	209,946	2,518	121,326	0	0	20	327
	Total	4,296	216,079	2,809	124,396	11	257	41	628
Talaafar	Irrigated	5	175	1	36	4	40	3	47
	Rainfed	5,378	457,826	3,931	157,518	0	0	1	65
	Total	5,383	458,001	3,932	157,554	4	40	4	112
Al Baaj	Irrigated	76	2,854	51	3,324	8	158	8	326
	Rainfed	2,551	250,994	2,410	251,896	3	45	77	9,075
	Total	2,627	253,848	2,461	255,220	11	203	85	9,401
Total	Irrigated	555	9,162	343	6,430	75	747	34	685
	Rainfed	18,085	1,241,727	10,380	842,095	3	45	98	9,467
	Total	18,640	1,250,889	10,723	848,525	78	792	132	10,152

Source: Minisitry of Planning

3.5.5 Availability of Agricultural Machinery

(1) Agricultural Machinery in Project Area (Result of Farm Survey)

According to farm survey, most farmers use agricultural machinery for plowing and harrowing of topsoil, fertilizer and pesticide application, harvesting, and conveyance. Because average farm area is large, it is supposed that tractor, plow, rotary, speed sprayer, combine, and track are used. Specifications of these machineries are not clear. Style of introduction of agricultural machinery, such as possession, lease, or work commission, is not found.

(2) Agricultural Machinery around Project Area (Statistical Data)

Number of agricultural machinery in Ninevah governorate is shown in Table 3.5-11. Because number of tractor and number of plow which is attachment of tractor, it is supposed that both machineries are work together. It says that irrigation is not popular because number of sprinkler is less than 1 % of number of tractor.

Table 3.5-11 Number of Owners and Agricultural Machinery using by the Supplier

The Types of the Machinery and Machines	No. of Owners	No. of Owned Machines	The number of machines used last year				
			Owned by the Farmer	Owned by Land Owner	Owned by Private Sector	Owned by Government	Others
Tractor	56,600	10,820	10,382	1,419	46,793	200	1,242
Leveling Machinery	13,862	3,995	3,870	372	8,854	183	988
Machinery for Opening the canals	3,965	1,283	1,259	151	2,414	33	138
Crop sowing machinery	17,929	2,741	2,122	391	14,852	109	486
Plows	51,660	5,055	2,819	489	46,611	153	977
Electric Water Pumps	1,704	1,110	1,061	303	303	11	77
Diesel Water Pumps	8,632	5,406	5,190	944	3,069	23	77
Generators	1,153	504	501	27	569	12	77
Reaper	34,366	3,229	2,927	539	33,936	196	1,206
Sprinkler Irrigation system or drip	536	133	228	28	320	13	66
Harvester	34,984	3,405	3,103	543	34,145	240	1,404
Transportation	27,118	8,576	9,485	3,830	18,450	181	1,243
Others	686	326	332	39	309	6	33

Source: Ministry of Planning

3.5.6 Farm Survey of South Jazira

(1) Objective of Farm Survey

The Study team executed sample survey by interviewer to grasp current situation of farmers in Project area, such as family size, size of farm, main crops, cropping pattern, planting area, crop production, and income. Objective of survey was clarification of farmers' issues or possibility of improvement.

(2) Location and number of villages

Location of survey points are shown in Table 3.5-3. Farm Survey and Well Survey were executed at same 6 villages. Two farmers were selected randomly and interviewed in each village so that number of survey was 12.

(3) Items for Survey

Interviewer made small talk first and did not show questionnaire so that farmers were free of tension. Collected information was organized in sheets. Items of survey and organized sheets are shown as follows;

1) Farmers' Family: age, family composition, income etc.
2) Public Service: potable water, electricity, sewage etc.
3) Farming: main crops, planting area, unit yield, agricultural machinery etc.

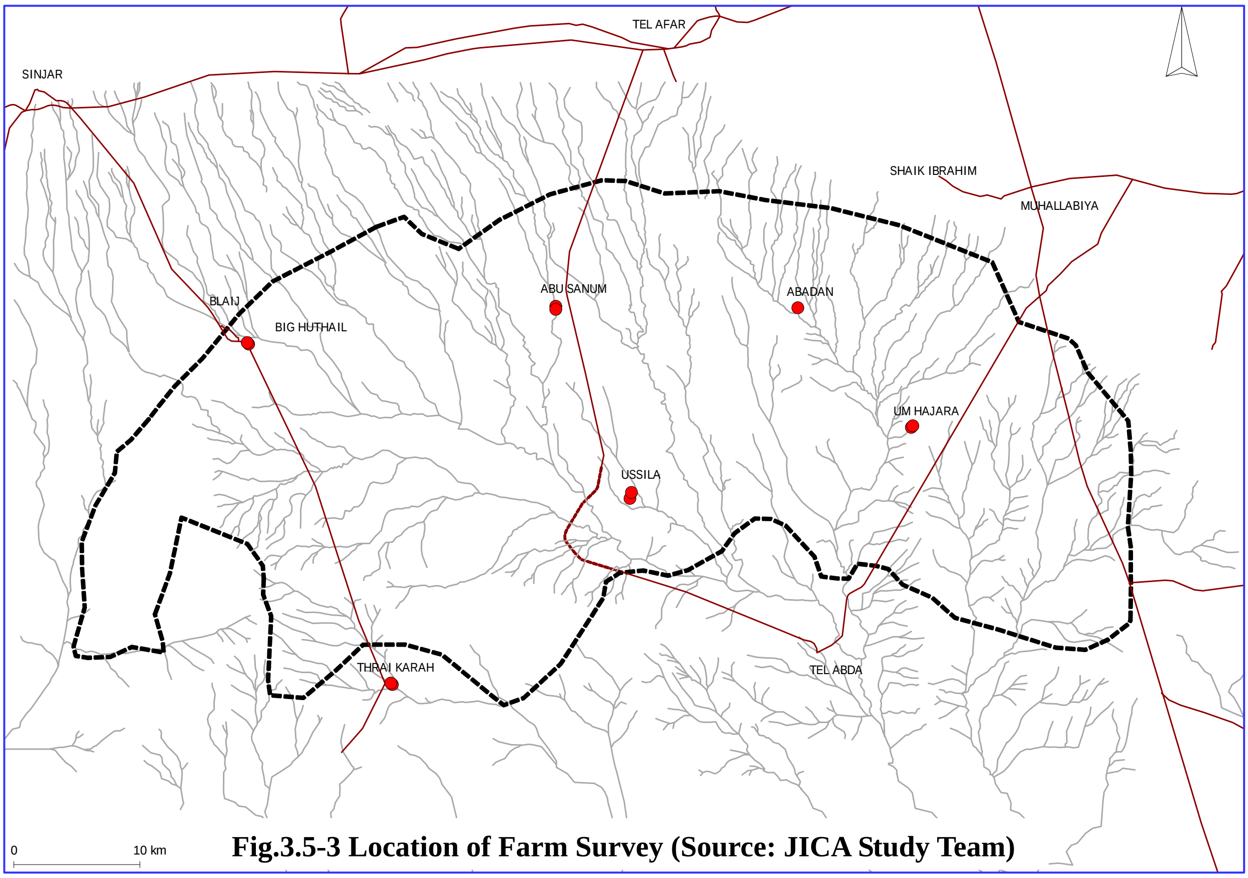


Fig.3.5-3 Location of Farm Survey (Source: JICA Study Team)

(4) Summary of farm survey result

Table 3.5-14 shows summary of farm survey result. Unit yield of wheat is lower than North Jazira area one (refer to "Chapter 4 Lessons and Learned from North Jazira Irrigation Project") due to rainfed agriculture.

Table 3.5-12 Summary of Farm Survey

○Farmers

Question	No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Age		76	46	48	57	65	70	28	65	52	52	42	80	56.8
Family	Person	15	13	13	10	6	6	7	10	12	12	6	15	10.4
Income	Million ID/year	24.0	15.0	4.5	6.0	3.0	22.0	5.7	22.0	10.0	7.0	4.0	3.0	10.5
Village scale	Household	80	80	40	40	300	300	70	70	120	120	50	50	110.0

○Main Crops

Question	No.	1	2	3	4	5	6	7	8	9	10	11	12	Average
Wheat: Area	ha							11.8	100.0	25.0	15.0	8.8	8.8	28.2
:Yield	kg/ha							800	800	800	800	800	800	400.0
Barley: Area	ha	231.3	162.5	30.0	50.0	15.0	15.0	10.0	225.0	45.0	25.0	8.8	8.8	68.9
:Yield	kg/ha	800	800	800	800	800	800	800	800	800	800	800	800	800.0
Sheep	Head	15				50	800		300		200			113.8

JICA Study Team Farm Survey（July, 2010）

(5) Organized sheet of farm survey

Organized sheet of farm survey is shown in Fig. 3.5-6.

14 Type of Drinking Water in the Village — Tunkers for water supplying
- Ground water
- Water Network System
- Well
- Surface water

15.Drinking Water Quality (degree of slinity and turbidity) — No serious problem and it can be consider not effective

16.Cost of Drinking water — 100,000 ID/Tunker

17.Is there any waste water Services (Brief description) — No,There is no waste water services

3. Agriculture and Water Recources Sector

1.Farmer Area with Existing Irrigation Facilities :

1.1 Presently cultivated	650 D
1.2 Presently irrigated	0 D
1.3 Presently not-irrigated due to	0 D
1.4 Presently not-irrigated due to other problems	0 D

In South Jazira, the land irrigated fully from the the water well and rainfall because no other source for irrigation water and the supplying of water from Farmer's well always to be for short time because most well pumps need continuous electricity . Moreover it will always 100% of the land farmed with two major crops wheat and barley because of these two crops have possible total dependence on rainfall water in irrigation, while there is very little area from the whole land farmed by the fruit and vegetables.

1.5 Irrigated Crops — 1-Barley

2.Present Agricultural Conditions **(if there any problems or concerns)**

3.Present Cultivated Area (D) and Crop Yields

	Crop-1	Crop-2	Crop-3	Total
crop name	Barley			
cultivated area (D)	650			
cultivated amount (ton)	130			
crop yield (ton/D)	200 Kg/D			
self consumption rate (%)	0%			

4.Present Cropping Calendar

	Crops	J. F. M	A. M. J.	J. A. S.	O. N. D.
1.	Barley				
2.					
3					
4.					

Note : P ; Planting, H ; Harvesting

Sample P H

5.Present state of salinity and alkalinity problems
1- present area damaged by salinity and alkanity ? — 0 D
2- persentage of both salinity and alkanity of the above area ? — 0%
3- list the major corrps agricluterd and damaged by this problem ? — None
4- list the major corrps agricluterd and not damaged by this problem ? — Barley
5- what plan suggested to solve this problem ? Limited Problem and in the Future it will needed to construct drainage canals

6- type of effectness by this problem
a- slight b-serious

6.Present and expected water source (type & estimated availability)
1- type of water sources ? 1-precipitation 2-Well
2- irrigated area using different type of other water sources ?
3- rated discharge m3/sec ? For each type
4- conditions of each type ? 1- very good 2- good 3- bad 4- very bad

Questionaire of Agriculture Sector

1. Intervie	Mahammed Hussain Khlaif	**Date**	16.07.2010	**Village Name**	Um Hijara Lowe
	Sub-district Name		AL-Mahallabia	**District Name**	Mosul Center

2.Demography and Infrastructures

1. Farmer's Age — 46 years
2. No. of Farmer Family — 13 — Sons 7 — Daughters 4
3. Number of the workers in the Family — 4
4. Farmer's Education leverl
   - Uneducated
   - Can read and write
   - Primary education
   - Secondary education
   - Higher education
5. Econmaic Activities of Farmer Family
   - Type of econmaic activities
     - Agriculture
     - Agro-industry
     - Industry
     - Commerce
     - Public Service
     - others
6. Average annual income of Farmer Family — 15,000,000 ID/Year
   - (1) average annual income by source in past five years (05,06,07,08,09)
     - a- manfacturing
     - b- agricltures (farming) — 15,000,000 ID
     - c- livestock — 0
     - d- chicken farms
     - e- agriculture (as labor force)
   - (2) average annual expenditures by major catogries in past five years (05,06,07,08,09)
     - a- family expenditures monthly — 550,000 ID/Month
     - b- energy sector for electricity — 100,000 ID/Year
     - c- Transportation — 450,000 ID/Year
     - d- maintance of his michnary — 0
     - e- farm preparation — 1,200,000 ID
     - f- expenditures
     - g- Taxes — No Taxes Since 2003 Till Now
   - In case the farmer is not farming only 1 D or 5D for his farm land explain the reason
7. Farmer machniary
   - Transportation car
   - Agriculture Machniary
   - Industrial Machniary
   - Others

8.Total Population of the villages — 400 person
9.No. of farmers in the villages — 80
10.How many people have left from the villages in last five years ?
- 1- no. of families — 7
- 2- no. of young men (age16-30) — 14

11.Type of electrcity Sources in the Village
- a- On site generator
- b- Transmission from Powerhous

12.Stability of electrcity — Shutting Down 6 hours for each 2 hours's oparating.
13.Montly cost of electricity — 28000 ID — Share Gerotaor and the price of 1 Ampere ranged between 7500 ID to 7000 ID

7.4 Price of Crops

1. Farm Gate Price (Buying rate from farmers)	ID / ton		330
2. Market Price at Shops	ID / ton		450

7.5 Crop Yields	ton / D		200 Kg/D
7.6 Gross Farm Income per Dunm	ID / D		66000
7.7 Net Crop Benefit (Item 7.6)-(Item 7.3)	**ID / D**		**-24900**

8.Availability of Farmer's Association(with Brief Explanation of those Associations.)

a- Year of establishment **There is no Farmer's Association**

b- Number of members

c- Membership fee

d- Major activities of the association

9.Is there any govermental support regarding the farm inputs (like fertilizer, seeds ..etc) Yes, Seeds only

10. How many cattles do you have and how to breeding ? (keep them in his backyard or depasturage)

Name	Number (head)	Breeding Method	Number sold in 2009	Earnings from the livestock in 2009 (ID)
sheeps	0	☐ depasturage	0	0
Cow	0	☐ keep in backyard,	0	0

11. Farm Market Production Alwa AL-Mosul

1.What are the major Markets in the area ?

2.what are the marketing crops ? Wheat and Barrlay

3.Means of transportation to the market (truck, animal cart, tractor, etc.) Trucks

4.Is there any association for crops marking No

5.what is the main govermental market in the area for major crops(wheat and Barrlay) **Tall-Abta Granary**

12.Agriculture Facilities and Equipments

1.How many agriculture equipments in the village ? a- 2 Tractors Ferguson type
b- 1 Harvesters Ferguson type

2.what pouplar fertilizer used in the area ? List it for each crops with (Kg/Dunm) listed in item 7.1

Remarks :

The tractor Item under farm inputs per Dunm article 7.1 included :

1- Core plugger

2- batwing Mower

3- Box blade

4- Finish Mower

5- Grader blade

7.Farm Inputs Survey of Major Crops

7.1 Farm Inputs per Dunm

			Name of Crop		Barley
Farm machinery	Tractor		hrs. /D		30 min
	Harvester		hrs. /D		30 min
	Transportation		hrs. /D		30 min
	Others ___Fuel__		hrs. /D		20 L
Labor Input		Common labor	man-day /D		3
Animal forces		Name : _____	animal-day /D		0
Seed			kg /D		30
Fertilizer		Name :super phosphate	kg /D		0
Pesticide		Name: Topic,Logran	unit /D		0

7.2 Unit Rate for the above

Farm machinery	Tractor	ID / hr.		20000
	Harvester	ID / hr.		34000
	Transportation	ID / hr.		1500
	Others Fuel	ID / hr.		750
Labor Input	Common labor	ID / day		12000
Animal forces	Name :	ID / day		
Seed		ID / kg		330
Fertilizer	Name :super phosphate	ID / kg		1000
Pesticide	Name: Topic,Logran	ID /Gallon		2500

7.3 Unit Production Cost

Farm machinery		Tractor	ID / hr.		10000
		Harvester	ID / hr.		17000
		Transportation	ID / hr.		3000
		Others Fuel	ID / hr.		15000
Labor Input		Common labor	ID / day		36000
Animal forces		Name :	ID / day		0
Seed			ID / kg		9900
Fertilizer		Name :super phosphate	ID / kg		0
Pesticide		Name: Topic,Logran	ID / unit		0
	Total	**ID/D**	**ID / D**		**90900**

Fig. 3.5-4 Organized Sheet of Farm Survey

3.6 Present Condition of Mosul Dam

The reservoir water of Mosul Dam is the main source for South Jazira Irrigation Project. The water must be supplied to the project area sustainably with a required amount. Ordinarily stability of water source is checked about the amount. In case of the Mosul Dam reservoir, however, not only amount of water but also stability of the dam itself are a great concern, while the dam foundation has a special type of geology a part of which resolves into water. It describes the outline of Mosul Dam at present and in future on its stability with its general features as well.

Note: The following description is written based on the references presented at the end of this chapter.

3.6.1 Outline of Mosul Dam

(1) Main Features

Mosul Dam is located on the Tigris River 50 km northwest of Mosul city. The main structures of Mosul dam and their features are as shown in Fig. 3.6-1 and Table 3.6-1. The dam is of rockfill type with height of 113m as shown in Fig.3.6-2. The Mosul Dam reservoir has a huge capacity with 11.1 BCM at normal operation level. It is ranked as the fourth largest dam in the Middle East, measured by reserve capacity. It is constructed in 1981 to 1986 by the group of German-Italian companies with the design by Swiss Consultants consortium. The main supervisor is the Swiss group and the daily supervision was done by Swiss and Yugoslav companies. Design and construction were reviewed by a Board of Experts which meeting was held 30 times from 1979 through 1989.

Fig. 3.6-1 Layout of Main Structures of Mosul Dam

Table 3.6-1 Main data of Mosul Dam

Item		Data	Item		Data
Dam	Height	113m	Reservoir	Maximum storage	13.1 BCM
	Type	Rockfill dam		Normal storage	11.1 BCM
	Crest length	3,600m		Dead storage	2.95 BCM
	Crest width	10m		Maximum Level	EL338.0m
	Crest level	EL341 m		Normal operation level	EL330.0m
Service Spillway	Max. discharge	12,600m^3/sec		Minimum operation level	EL300.0m
	Type	5 radial gates	Power facility	Generator capacity	187.5MW×4
Emergency Spillway	Max. discharge	4,000m^3/sec		Annual power production	2,420 Gwh
	Crest length	400m		Intake	7.0m×10.5m× 4 gates
Bottom Outlet	Max. discharge	2,440 m3/s	Jazira intake	Max. discharge	170 m3/s

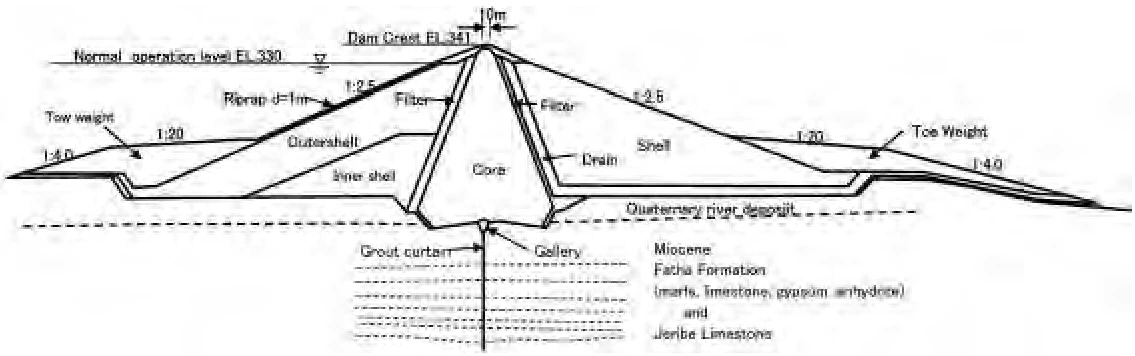


Fig. 3.6-2 Schematic Section of Mosul Dam

(2) Purposes

The purpose of construction of the dam is mainly for flood control, irrigation and power generation.

(a) Flood control

Storage with 2,030 MCM is available for flood control between reservoir levels 330 a.s.l. (Normal operation level) and 335 m a.s.l. (Maximum water level). This storage reduces the danger of floods in downstream area on Tigris River, especially in Mosul city.

(b) Irrigation

Three big irrigation projects - South, North and East Jazira Irrigation Projects - presuppose their main water source on the reservoir. According to their present plans, the total intake in maximum for the three projects reaches 230 m^3/s.

The reservoir guarantees minimum outflow of 300 – 350 m^3/s in the dry season for downstream water use including irrigation (the original project plan).

(c) Power Generation

Power generation schemes of Mosul dam are shown in Fig. 3.6-3. There are four(4) schemes;

Mosul 1 – Mosul Dam Main Scheme	750 MW
Mosul 2 – Regulating Scheme	60 MW
Mosul 3 – Pumped Storage Scheme	200 MW
Mosul 4 – Jazira Power and Pumping Station	21 MW

Expected average annual power production is estimated at 2,420 GWh. The generated power by the schemes is sent to Mosul city, Dohok city and adjacent communities.

Only the above "Mosul 4 scheme" - Jazira Power and Pumping Station (see Appendix B Fig. B-3)" is not constructed yet. This station will be constructed at the head point of the feeder canal for South Jazira Irrigation Project. This station works as a pump when the reservoir level is not enough to supply water to the canal by gravity.

Mosul Dam reservoir is biggest in Iraq. Its huge capacity and generated power are essential for the Iraqi society.

(3) Dam

Fig. 3.6-4 shows the general plan and typical section of Mosul Dam. Table 3.6-2 shows data of the dam structure. The Dam is of rock fill type*[1] with consisting of a main dam and a saddle dam. The main dam is 113m in height and 2,210 m in length. The saddle dam is approximately 17 m in height and 1,270 m in length. The total length of dams with the spillway measures approximately 3,600 m.

The Dam is constructed mainly with sandy silt*[2] for the core and processed river gravel and conglomerate for the shell. Filters and drain are allocated between the two zones with the grain-size-controlled gravel. The core is impermeable with average permeability $k=1.8x10^{-6}$ cm/s by in-situ test, weareas the shell is permeable with permeability ranging $k=3x10^{-1}$ to $1.5x10^{-2}$ cm/s by in-situ test.

Toe weight is placed on the foot of both side slopes with random materials, mainly excavated marls, to prevent from slip along clayey weak layers in the foundation.

The dam structures are designed to accommodate a peak ground acceleration of 0.15g.

*[1] The permeable shell occupies more than a half of the total volume.
*[2] The clay materials may be clayey sand and sandy clay judging from the laboratory data, according to Washington Group International and Black & Veatch (2005).

(4) Appurtenant Structures

Mosul Dam is equipped with the following appurtenant structures (see Fig. 3.6-1 for location and Appendix B Fig. B-2 for features);

(a) For Flood Discharge

- Spillway

- Emergency Spillway (Fuse Plug Spillway)

Normally the service spillway discharges floods. 10,000 year flood (peak inflow 15,000 m^3/s) can be discharged with two(2) gates closed (spillway discharge 6,700 m^3/s). Emergency spillway functions only for the probable maximum flood (PMF; peak inflow 27,000 m^3/s), when 1 gate is closed (spillway discharge 10,600 m^3/s; emergency spillway 4,000 m^3/s).

(b) For Irrigation

- Jazira Intake
- Jazira Tunnel

Water for South Jazira Irrigation Project is supplied through these structures (see Fig. 3.6-3, Fig. 3.6-4 and Appendix B Fig. B-3). The Jazira Power and Pumping Station will be constructed at the outlet of the Jazira Tunnel (see Fig. 3.6-5 and Appendix B Fig. B-3 to Fig. B-5). The tunnel ends at the bypass shaft of the station at present.

(c) For Power Generation

- Power Intakes
- Power Tunnels
- Surge Tanks
- Power House
- Tailrace Channel
- Switchyard

The total maximum intake discharge is 1,120 m3/s at reservoir water level 330 m a.s.l. and 840 m^3/s at reservoir water level 300 m a.s.l.

(d) For Water Discharge/ Emergency Discharge

- Bottom outlet (with intake, culverts, guard gates, tunnels and regulating gates)

Bottom outlet is operated to discharge water to downstream when all units of the power station are out of operation during dry season or in case of the emergency drawdown of the reservoir. The maximum discharge capacity is 2,435 m^3/s at reservoir water level 330 m a.s.l. and 1,770 m^3/s at reservoir water level 300 m a.s.l.

(5) Geology and Foundation Treatment

(a) Topography

Mosul Dam is constructed on Tigris River which runs between a tableland on the left bank and a hill on the right bank. The table land has gently undulated ground with 320 to 350 m in elevation. The hill on the right bank spreads west and north with top elevation of around 580 m. Tigris River has its bed on approximately 250m in elevation.

(b) Geology

Table 3.6-5 shows geological formations and its lithology in the Mosul dam site. Appendix B Fig. B-7 shows the geological section along the dam axis. Appendix B Fig. B-6 is an original lithostratigraphic table on the figure.

Note: Fig. 3.6-5 has been made based on Table 3.6-6 for clearer reading and understanding of the descriptions.

1) Geology Distribution and Structure

<u>Overburden</u>

Pleistocene terrace deposits distribute at different elevations along the Tigris River. They mainly consist of sandy gravel and cemented conglomerate. The lower terraces along the river course are underlain mainly by sandy silt. The existing river channel is filled by loose sand and gravel. At the main dam site, the sandy silt covers the conglomerate.

Among the sediments, the sandy silt was used for core material. The sand, gravel and conglomerate were used for coarse materials for dam and/or concrete aggregate.

<u>Bedrock</u>

The bedrock comprises well-bedded layers mainly of marl, limestone and anhydrite/Gypsum, which belong to ***Lower Fars Group*** of lower to middle Miocene and ***Jeribe - Euphrates Limestone Formation*** of Oligocene to lower Miocene.

Lower Fars Group is divided into three sub-formations:

- ***Upper Marl Seires***
- ***F-bed***
- ***Lower Marl Series***

Upper Marl Series consists mainly of weathered clayey marls. F-bed is a good key bed limestone with 20 to 40 m in thickness. These two layers extend widely under the left bank. The head structure of the spillway lies on F-bed.

Lower Marl Series is main foundation of the main dam. It has many gypsum/anhydrite layers intercalated by marl, chalky limestone and limestone layers. Four(4) notable gypsum/anhydrite layers or complexes of layers are reported with names of GB0 to GB3, which are good key beds in the site. The lower part is called Chalky Series including chalky marl to limestone with GB0. The middle and upper part is named Clayey Series which contains clayey mars and many gypsum/anhydrite layers including GB1, GB2 and GB3. The gypsum/anhydrite layer shows breccia appearance with clayey matrix in a portion where karstification develops.

Note: “GB” is a combination of the head letters of words “Gypsum” and “Breccia”.

Jeribe - Euphrates Limestone Formation is divided into three sub-formations:

- ***Jeribe Limestone***
- ***"Bauxite"***
- ***Jaddala - Sinjar Series***

Jeribe Limestone and ***Jaddala - Sinjar Series*** consist mainly of limestone to dolomatic limestone. The "***bauxite***" is a nickname of the layer because it shows brown clay appearance.

2) Geologic Structure

The right abutment is an axial part of the Dair Melah anticline (or Butmah anticline) plunging east, that is, to the left bank. Therefore, the layers dip gently to the left along the dam axis as understood from Appendix B Fig. B-6, and also they dip to the both sides of dam, to the upstream in the upstream area and to the downstream in the downstream area in general.

In the left abutment, layers dip slightly downstream or lie flat. The Jebel Taira anticline runs NEE –SWW direction off 3 km southeast of the main dam (Appendix B Fig. B-6). The spillway and the saddle dam are located in a flat topographic area between the two anticline hills.

3) Karstification

<u>Karst Line and Karstified Rock</u>

Karstification is a process of change of rock mass by dissolution of soluble rocks into water to produce hollows, caves or caverns which are often connected and form characteristic "karst" topography like a series of sinkholes (dorines). In and around the dam site, karstification develops in all area. The boundary between fresh rock mass and karstified one is called the "***Karst Line***". Depth of the karst line ranges down to 40m to 150m from the ground surface as shown in Appendix B Fig. B-6. It is located especially deep in the right bank. Main soluble rock is reported to be gypsum/ anhydrite, but most formations suffer from karstification. Especially, ***F-bed*** limestone is highly karstified.

<u>Time of Karstification</u>

It is believed that most karstification in the dam site has occurred before the dam construction in long geologic years. However, it is considered that dissolution of gypsum is accelerated by the impoundment of the reservoir. In order to reduce the dissolution speed, deep curtain grouting has been implemented after construction of dam to date. The red points in the Appendix B Fig. B-7 show point where large grout take was required. The points located mainly around the Karst line in the river portion. Some points are grouted repeatedly during years. This implies that once created grout curtain is damaged due to dissolution of gypsum in the rock in the curtain.

<u>Permeability</u>

Permeability of rock is clearly different in lower and upper sides of the karst line. Above it, Lugeon value is high and it is permeable, whereas, below it, the most of voids are cemented with gypsum/anhydrite and it is impermeable. F-bed limestone, other vuggy limestones and breccia of gypsum layer show high permeability.

<u>Sinkhole</u>

After impoundment of reservoir, sinkholes shown in Appendix B Fig. B-8 have appeared on ground. Most underground spaces of all sinkholes are considered to be created geo-historically before the impoundment. It is concluded that the right bank sinkholes appeared with induction by water level fluctuation of the downstream regulatory reservoir based on water level measurement in the sinkhole. The left bank ones are believed to have appeared due to progress of underground dissolution and erosion with increased groundwater flow from the main reservoir.

<u>Seepage</u>

Main seepage points in downstream area shown in the Appendix B Fig. B-9. It is reported that among them, seepages at two points on the right bank, RSS1 and RSS2 are not connected to the main reservoir. The three seepages located around downstream of spillway fluctuate with the main reservoir level, so that the water must comes from the reservoir. The water may come mainly through the heavily-karstified F-bed limestone. Seepage through the foundation of the main dam may issue mainly into the downstream coffer dam pond.

(c) Foundation Treatment

1) Excavation

<u>Dam Sheet</u>

Foundation geology of the main dam sheet is schematically illustrated in Appendix B Fig. B-2.

/ Core /

In the design stage, the core of dam is planned to be placed on the Pleistocene conglomerate or the bedrock - Lower Fars Group. In the construction stage, the conglomerate is judged to be unsuitable for core sheet, so that all core lies on the bedrock.

/ Shell /

The shell of dam is placed on the Pleistocene conglomerate or the bedrock. The alluvial fine deposits are removed from the sheet.

/ Toe Weight /

Only top-soil is removed in the Toe Weight area.

<u>Foundation of Appurtenant Structures</u>

The appurtenant structures are placed on the bedrock. The head structure and a large part of the chute of the spillway are founded on F-bed limestone.

2) Grouting

Deep Curtain Grouting

Deep grout curtain was constructed with grouting to control seepage through foundation of the dam and abutments. The grouting has been continued to date to compensate deterioration of the curtain due to dissolution of gypsum.

/Alignment/

Fig. 3.6-14 shows the alignment as of 1988. The alignment reaches to 5,500m in total length and covers the most distance between the two anticlines on both sides. The curtain grouting alignment is divided and numbered at every 36 m in the main and coffer dam parts and at every 24 m in the extension parts. Grouting work is carried out and managed with the divided units.

/ Grout Holes Arrangement /

The standard arrangement of grout holes in the main dam is shown in Fig. 3.6-15. The curtain constitutes three rows of holes in the main dam part, whereas it has two rows in the saddle dam part and one row in the extension parts.

/ Depth/

The curtain covers at least the karstified section above the karst line, though the detailed depths of holes are unknown because of limitation of provided data. The approximate depth of the curtain as of 1988 may be as follows:

Main dam part	60m (left bank) - 130 m (right bank)
Saddle dam part	60m - 80m

Deepest bottom level of the curtain may be around 140 m.a.s.l. This means the level is approximately 200 m deeper than the dam crest.

After the construction, the depth of the curtain may be extended.

/Completion Criteria/

In the construction stage, the following completion criteria of curtain grouting were adopted;

Upper 30 meters	90% of all stages < 2 Lugeon
	100% of all stages < 5 Lugeon
Below 30 meters	90% of all stages < 5 Lugeon
	100% of all stages < 10 Lugeon

/Grout Mix/

Grout mix of C/W = 3/1 to 1/1 with usually 4% of bentonite was used in the construction. Bentonite gel, low viscous silica gel and chemical grout were partially used for residual portions not reaching the completion criteria. After construction, standard mix (C/W=1:1 with 4% of bentonite) and massive grout (3 parts sand added to the standard mix) are used for the maintenance grouting.

Blanket and Contact Grouting

Blanket/contact grouting was intensively carried out on the foundation of structures. As shown in Fig. 3.6-7, the holes are arranged in a network of triangle with 3m spacing. In the core trench, 20 rows of blanket grout holes are used for the grouting in maximum. Depth of holes ranges 10 to 25 m. Contact grouting was implemented around the gallery in radial directions.

(6) Monitoring System

Table 3.6-7 shows monitoring items, instruments and measurement frequency of Mosul Dam. As understood from the table, many monitoring measurements have been conducted by MoWR after the dam construction. The measurements are categorized as follows;

- Measurements with installed instruments in dam, spillway and foundation
  (see Appendix B Fig. B-10 to Fig. B-12 for the instrument arrangement)
- Geodedic survey on displacement of surfaces
- Seepage monitoring on discharge and water quality
  (see Appendix B Fig. B-9 for the monitoring locations)
- Sinkhole monitoring on settlement
  (see Appendix B Fig. B-8 for the sinkhole locations)

Among the measurement, piezometer reading in the grouting gallery is daily conducted. This measurement is very important, because the result is used for judging whether the grout curtain is deteriorated or not. If the deterioration is recognized, maintenance grouting is implemented to the grouting section. The piezometers are installed in diagonal holes on both side of the deep grout curtain. If the piezometer is damaged due to grouting work, new one is installed immediately.

3.6.2 Current Operation and Maintenance

(1) Staff of Mosul Dam Office

Mosul Dam is operated and maintained by Mosul Dam Project Management, State Commission of Dams and Reservoirs, MoWR. The office comprises the following staff;

Table 3.6-2 Staff of the Mosul Dam Management Office (as of 2004)

	Number	Remarks
Expert Engineer	1	Dam manager
Engineers	46	
Geologist	7	
Technicians	339	
Administrators	32	
Total	425	

Source: MoWR

They have been managing the dam since 1988. Their works contain operation and maintenance of power and discharge facilities, monitoring of the dam - especially on stability, and implementation of the maintenance grouting. The ability of staff for the operation and maintenance is often praised by international experts like a panel of experts by Washington Group International and Black & Veatch (2005). The present dam manager, Mr. Abudlkhalik Thanoon Ayoub, keeps the position since 1998. A report says on the maintenance grouting that "Mr. Ayoub has proven invaluable as Mosul Project Manager" and that "the workforce is well trained and experienced with existing equipment, materials, and processes".

(2) Reservoir Level

Fig. 3.6-8 shows variation of the annual maximum and minimum water levels at Mosul Dam Reservoir.

(a) Maximum Level

After completion of dam in 1986, the reservoir experiences 327 to 330 m a.s.l at annual maximum level, except 1999. There was no operational limit on the maximum level until 2005. The last year when the level reached the normal operation level 330 m a.s.l is 1996.

After 2005, the maximum level has been controlled keeping less than 319 m a.s.l., because it was found that concentration of sulfate ion in the downstream seepages increases greatly if the water level exceeds 319 m a.s.l, and dissolution of gypsum in the foundation may be accelerated.

(b) Minimum Level

The annual minimum water level varies between 305 and 314m. The level is higher than the minimum operation level by 5m or more, but is lower than the water level of the South Jazira Feeder Canal, 310m (see Appendix B Fig. B-5), in many years. This means that pumping would be required in some period of most years for intake to the South Jazira Feeder Canal.

(3) Reservoir Inflow and Outflow

Fig. 3.6-9 shows variation of the monthly inflow and outflow at Mosul dam reservoir. The inflow value fluctuates largely in a year and in years. Before dam construction, discharge at Mosul dam decreased to around 100 to 200 m^3/s in dry season. After construction, Discharge of downstream of Mosul Dam has increased to about 300 to 400 m^3 in the same season due to the efficiency of the storage.

Fig. 3.6-10 shows variation of the annual inflow volume to Mosul dam reservoir. The annual inflow is much larger than the requirement of South Jazira Project, 1.275 BCM. However, in some draught years, it is less than the assumed responsible discharge to downstream, $330m^3/s$ (10.04 BCM).

(4) Monitoring

Monitoring results on dam stability are reported as follows;

<u>Piezometric Heads near the grout curtain</u>

Piezimeters are installed on upstream and downstream sides of the deep grout curtain in every section of grouting alignment. Fig. 3.6-11 shows "grout curtain efficiency" at a day in 2008. The efficiency is defined by the following formula:

Efficiency = (Head difference between the two piezometers)/(Head difference between the main reservoir and regulatory reservoir)

The high value of efficiency is considered the curtain of a target section keeps good quality to shut seepage water. On the contrary, if the value is small, it is judged some deterioration occurred on the curtain. The maintenance grouting is implemented for the section immediately.

/Seepage Discharge and Water Quality/

Appendix B Fig. B-13 shows variation of discharge and water quality of the main seepages in 2008 (see Fig. 3.6-13 for the location).

(a) Discharge

The discharges fluctuated clearly in response to the main reservoir water level at "***access gallery seepage point", "seepage point no.1***" and "***seepage point no.3***" (see the upper graph of the figure).

(b) Total Resolved Solid

Concentrations of the total dissolved solids fluctuate irregularly, but it looks there is correlation to the main reservoir level at "***seepage point no.1***" and "***seepage point no.3***" (see the middle graph of the figure). Fluctuation of other points looks having reverse correlation with the main reservoir level, especially at "***coffer dam no.6 point***", where the seepage water is considered mainly from the main dam foundation and dam body.

(c) Sulphate Ion (SO42-)

The sulphate ion is one of main constituents of gypsum (Ca SO_4 with someH_2O). The concentration at every point looks having no relation with the reservoir level or it looks having the reverse correlation (see the lower graph of the figure).

(d) Electric Conductivity(EC)

There area no ECs reported. EC is a fundamental item to guess the total concentration of dissolved solids. The measurement is robust, not as chemical analysis. EC should be reported as well.

The positive correlation may indicate that there are some seepage paths from the reservoir to the seepage points. The reverse correlation may imply that staying time in the foundation might affect the solution of gypsum.

<u>Displacement of Dam Body</u>

Appendix B Fig. B-14 shows settlement of the dam crest after dam completion. It continues little by little even at present, but there is no meaningful increase which suggests sudden foundation collapse like the sinkhole creation.

Settlement of Gallery

Appendix B Fig. B-15 shows settlement of the grouting gallery after dam completion. The trend is similar to the crest settlement mentioned above.

(5) Maintenance of Grout Curtain

Curtain grouting by the original construction contractor continued to 1988. After then, grouting had been carried out by the Ministry of Water Resources. The grouting work has been operated 24 hours per day, 6 days per week from 1988 to the present. The number of grout rigs was reported to be 12 in 2005, among which 7 are in gallery and 5 are on open ground. Ten(10) powerful most-recent- type new machines has been added in 2009.

The equipment for the "***Intelligrout***" had been supplied by US government, which could provide advanced way of grouting management. However it is placed unused in storehouse because of supplier's deficiency. Without the equipment, the grouting work looks going efficiently with well trained workers as far as going through the monitoring results.

Appendix B Fig. B-16 shows the annual grout take after the dam completion. There is a decreasing tendency on it and, after 1999 the amount keeps 3000 to 2000 tons/year. This implies the maintenance grouting has been done with efficiency.

(6) Stability Situation of Mosul Dam

As far as going through the monitoring results reported in the annual safety report of Mosul dam in 2008, there are no sings to indicate instability of the dam body.

3.6.3 Present and Planed Measures for Dam Stability

(1) Problem Origin on Dam Safety

It is obvious that the problem origin on stability of Mosul dam is the foundation which contains soluble gypsum in water. As far as the reservoir continues to supply seepage water through the foundation, the gypsum layer continues to melt. It is impossible to perfectly refill all voids made by the melting, even if any measures would be taken. This means Mosul dam has a life. However if we could reduce the seepage amount, the life would be made longer.

(2) Present Measures (Short Term Measures)

Maintenance grouting has been implemented intensively ever after the construction of dam with the ordinary grouting method as mentioned above. It can be said this measure is successful, because there are no signs on instability of the dam body at present - 24 years after dam construction. MoWR will continue this work until realization of the "permanent solution" which means a measure to drastically reduce seepage water through the foundation.

(3) Planned Measures (Long Term Measures)

(a) Endeavor for the Permanent Solution

The seepage problem of Mosul dam foundation has been recognized from just after construction by MoEW and relevant people, and they have been pursuing a perfect method to control the seepage water. The following methods had been already proposed before 1993:

- Injection of bitumen
- Covering the upstream surface of the main dam body and adjacent reservoir bottom and slopes with impervious sheet
- Installation of diaphragm wall at a few alternative locations
- Construction of tunnels into the gypsum layers to replace it for impervious concrete body and to grout (freezing is proposed for tunneling)

In 2003, US Army Corps of Engineering conducted safety inspection of Mosul dam. In May 2005, Washington Group International and Black & Veach (WII/BV JV) committed by US Department of Defense submitted a report on the Mosul dam safety (WII/BV JV, 2005). The JV first considered application of diaphragm for improvement of the seepage treatment of Mosul dam. On the course of the work, they made hearing to the three leading companies in the world which could construct diaphragm wall in such an existing dam (Bauer of Germany, Soletanche of France and Trevi of Italy). As a result of hearing, the JV denied construction of diaphragm, because the required depth (200 m) is too large to compare with the maximum depth experienced by the time (150 m) and the target rock to be excavated has too large strength to compare with the capacity of the existing machines. Instead of construction of diaphragm, the JV proposed reinforcement of the maintenance grouting. In addition, it proposed consideration of raising the height of Badush dam which is located between Mosul dam and Mosul city for mitigation of the failure risk of the dam. This topic will be described later.

In 2005, MoEW established an international panel of experts to serve for keeping Mosul dam stability which is similar to the global dam expert council before 1990 for the Mosul dam construction. The panel proposed to keep the reservoir water level below EL. 319 m and perform geo-rader investigation to detect cavities. The reservoir level has been maintained below the level to date.

In the last meeting held in May 2007, the panel proposed that the seepage problem of Mosul dam should be solved with construction of diaphragm with about 200m depth located in the front side (upstream side) of the dam (MoEW ‘s paper for JICA,2008).

After the proposal, MoEW has taken the following steps to make a contract for the construction of diaphragm (Ministry News, 2008 – 2010, MoEW‘s paper for JICA, 2008 and Italic web site information);

- Conference on the permanent solution of Mosul Dam foundation Problem with construction companies and experts in the world (at Istanbul on Feb. 8th to 10th, 2008)

- Meeting in MoEW for the Diaphragm Design and the tender in corporation with the international panel of experts (maybe in 2008)
- Invitation of 60 companies in the world to design and construction of diaphragm (maybe in 2008)
- Meeting with the companies who sent a proposal in response to the invitation (at Amman in maybe 2008).
- Reception of Updated Proposals.
- Establishment of technical committee in the ministry to select companies for the contract (maybe in 2008)
- Requirement to three selected candidate companies for the detail quotation and time table with technical proposal for the construction with the deadline assigned at Jan. 15th, 2009.
- Negotiation with finally selected two candidate companies, Bauer of Germany and Trevi of Italy, and Recommendation to the two companies to make a consortium.
- Final technical and financial negotiation with the selected companies as implementation for the Council of Ministers decision No. 375 of 2009 (at Amman on Dec. 18th to 21st, 2009)

In an early month of 2010, Minister of Water Resources and Ministry of Planning and Development visited Mosul Dam and mentioned as follows:

"During the coming period, we hope that we start the execution of the permanent solution after the approval of the concerned official sectors ……. By executing the permanent solution of the dam foundation, we can exploit Mosul dam maximum power to generate electrical power, ensure water storage and reduce the costs. "

"The MoEW executed important and strategic projects in Ninawa Governorate including the Northern Al-Jazeera Irrigation Project and starting the execution of the first stage of the Southern Al-Jazeera Irrigation Project which is a gigantic irrigation project that will be good omen for the governorate and the source of food security for the entire Iraq.

These comments symbolize a strong will of the Iraq government for the construction of the diaphragm as the permanent solution and large expectation of the resulting effect including realization of the South Jazeera Irrigation Project.

(b) Diaphragm Construction Plan

<u>Outline of Plan</u>

Installation of diaphragm wall is being planned for the "permanent solution". Outline of the work plan is as follows:

Construction cost	Three Billion US dollars
Construction period	6 – 7 years
Start year of construction	2010 or 2011

Contractor	Consortium of Bauer (Germany) and Trevi (Italia)
Maximum wall depth	250m
Position of wall	11.3 m upstream from the dam axis (see Fig. 3.6-27)
Construction platform	Crated on the upstream side dam body created at EL. 330 by excavation and embankment (see Fig. 3.6-27). (The dam body above EL.334 will be cut tentatively to make wide construction road and space)
Thickness of wall	1.5m
Kind of wall	Concrete diaphragm
Equipment type	The “hydromill” type (supposed; Bedrock is cut with hard bits mounted on a disk like a gear; see Fig. 3.6-28)

Problems of the Construction

There are many obstacles to go over for implementation of the diaphragm work such as:

- How prevent leakage of slurry?
- How maintain construction accuracy at a deep portion to ensure segments connection?
- How construct the wall around the structures like power and bottom outlet tunnels?
- Can the equipment fit to the large strength of the rock?

Among these matters, the first and the second ones are essential for making an effective cutoff wall, but the detail is not provided. The third and the forth matters depend on the ability of equipment and could be overcome with technical innovation.

Ability of the Contracted Companies

There are three main companies in the world which produce and use the “hydromill” type machines: Bauer (Germany), Trevi (Italy) and Soletanche (France). These companies are internationally leading on foundation construction and engineering. The contracted two companies are both included in them and have experience of the diaphragm construction for the following dam:

Bauer – Periboka Dam, Qubec, Canada, where the maximum wall depth is 116 m and the rock strength exceeds partly 200 Mpa. Also some sites in Australia and South Africa.

Trevi – Wolf Creek Dam (U.S.A), W.F. George Dam (U.S.A) and Arapini Dam (New Zealand). The maximum wall depth experienced is 120 m, though it is not for dam.

Though the two companies were reluctant to construct the diaphragm at Mosul dam because of technical difficulty when WII/BV asked in 2005, they have finally contracted for the construction. This must mean that they have confidence to develop innovated machines and implementation of the work for Mosul dam.

(c) Badush Dam

Badush dam is under construction and located between Mosul dam and Mosul city as shown in Fig. 3.6-29. Because of its location, raising the dam height to mitigate impact of Mosul dam failure is proposed mainly by foreign experts (WII/BV JV, 2005).

The dam features of original design are shown in Table 3.6-3. The dam is originally planned as a regulatory dam to produce hydropower and to regulate the tailwater for the Mosul dam. The dam body is a combination of concrete dam (hollow buttress type) and fill dam with two saddle dams. The concrete dam part occupies 240m of 3,686 m crest length and is equipped with a spillway, 4 power intake and conduits and 8 bottom outlets.

The construction work started in 1987 and stopped in 2003. By the time, some embankment of the fill dam part and fundamental work for the concrete dam were finished as seen in the satellite image shown in Appendix B Fig. B-17 and B-18. This dam site has a peculiar problem on Hydrosulfide (H_2S) gas issue. A countermeasure against inhalation of the gas and impact of the gas on the concrete and steel is a big concern on the work. MoEW entrusted an American consultant company (Concord) to review and evaluate the original design and the completed works, and to perform necessary preparation works to restart the project (MoEW 's paper for JICA, 2008).

It is said that it would cost about $300 million to complete the initial design, whereas it requires additional $10 billion to expand the dam size in order to partially mitigate a Mosul Dam failure (Wikipedia, 2010). MoWR has no will to change the dam size at present, and it is focusing to ensuring the stability of Mosul Dam itself.

Table 3.6-3 Badush Dam Main Features

Item	Value	Unit
Design flood Lvel	250.0	m a.s.l
Normal reservoir level	245.5	m a.s.l
Minimum reservoir level	243.8	m a.s.l
Total capacity at 307m a.s.l	10	BCM
Max. spillwat capacity	4,000	m^3/s
Max. outlet capacity	8,000	m^3/s
Power plant discharge capacity	1,100	m^3/s
Installed power capacity	170	MW
Length of dam crest	3,686	m
Spillway crest level	300	m a.s.l
Max.height of dam	102	m

Source: http://www.medingegneria.it/files/download/BADUSH.pdf

(4) Conclusion

The Iraq government has a strong will to ensure the stability of Mosul dam with the diaphragm construction which is considered to be the “permanent solution” being pursued for long time. The construction will be done by two of leading companies in the world on foundation engineering and construction. In addition, the powerful maintenance grouting can continue further in future, if required. Therefore it is considered that the stability of Mosul dam which is the source of South Jazeera Irrigation Project can be kept as far as Iraq Government holds a strong will for the stability with international technical cooperation.

Mosul dam is a precious and essential property of Iraq. We hope the big challenge for the construction of diaphragm will finish successfully and the life of the dam becomes much longer.

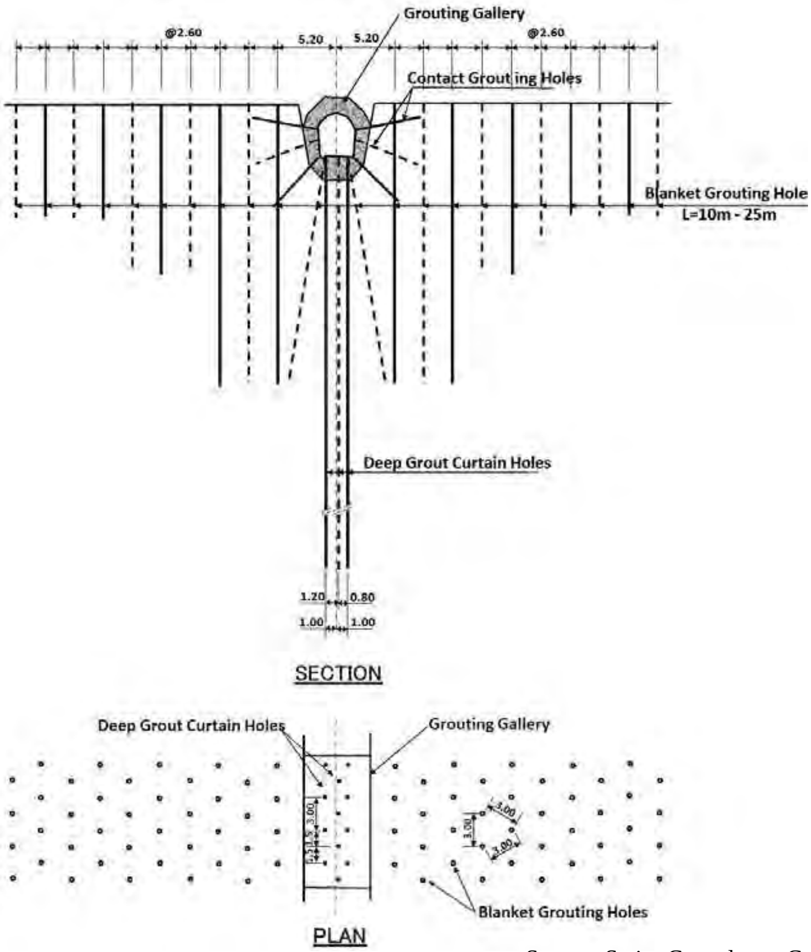
Fig. 3.6-3 Jazira Intake

Fig. 3.6-4 Trashrack of Jazira Intake

Fig. 3.6-5 Site of Jazira Power and Pumping Station (June, 2010)

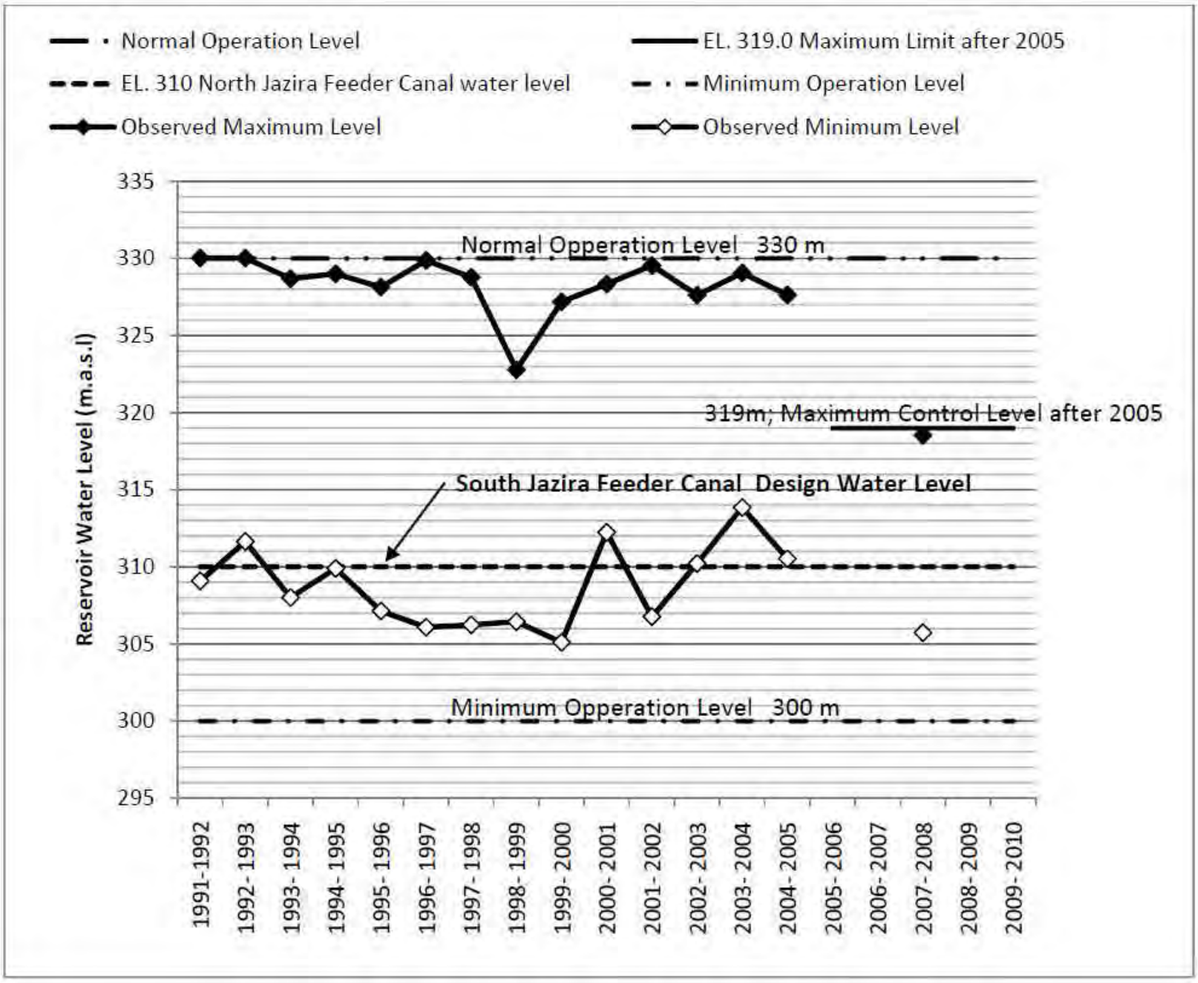
(Start Point of the feeder canal of South Jazira Irrigation Project)

Fig. 3.6-6 Location of Deep Grout Curtain



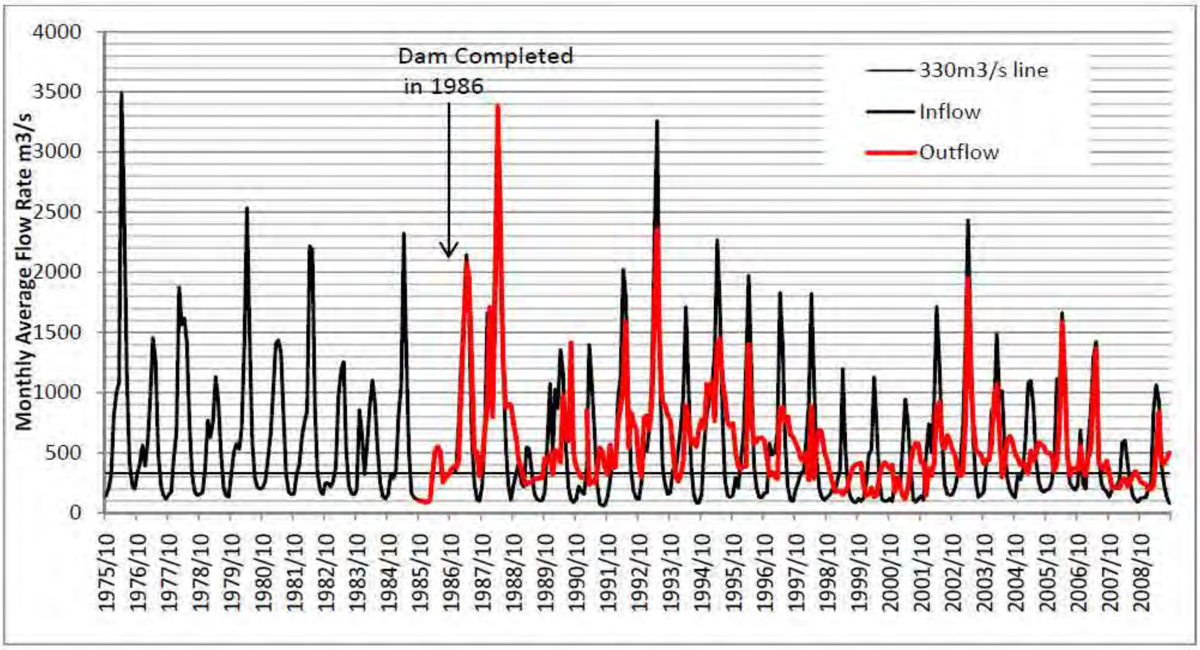
Source: Swiss Consultants Consortium, 1989.

Fig. B-12 Locations of Open Piezometers



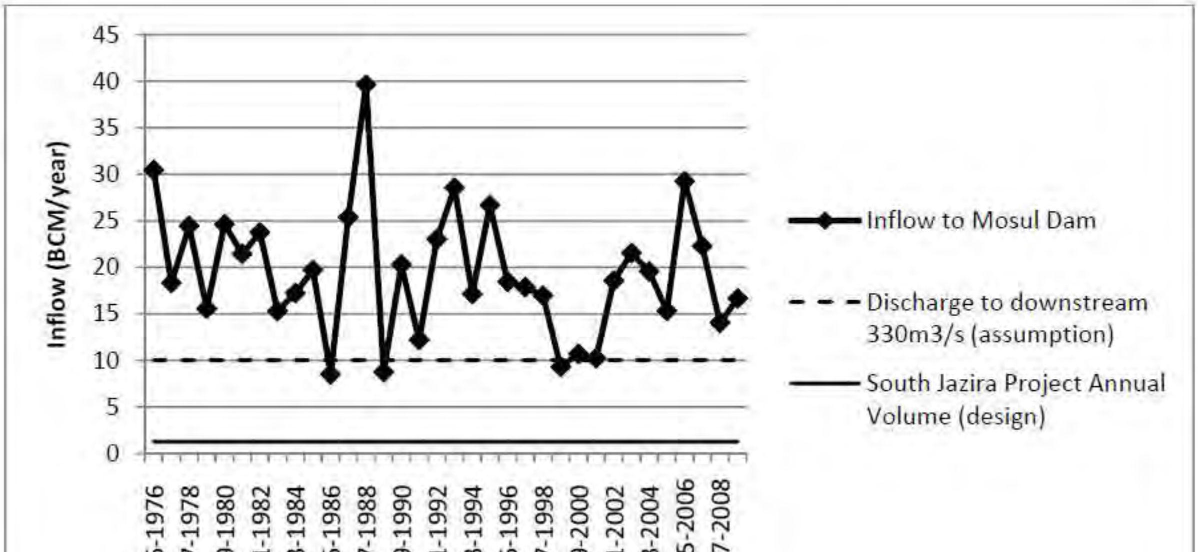
Source: Provided data to JICA from MoWR, 2005 and 2009.

Fig. 3.6-8 Annual Maximum and Minimum Water Level at Mosul Dam



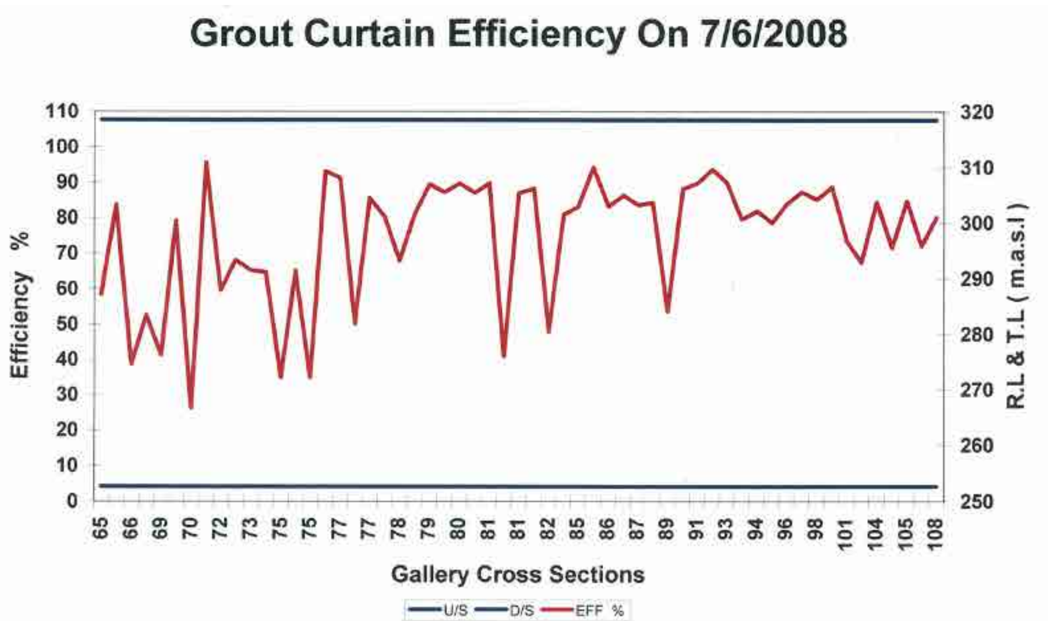
Source: Provided data to JICA from MoWR, 2008 and 2010.

Fig. 3.6-9 Monthly Average Inflow and Outflow at Mosul Dam



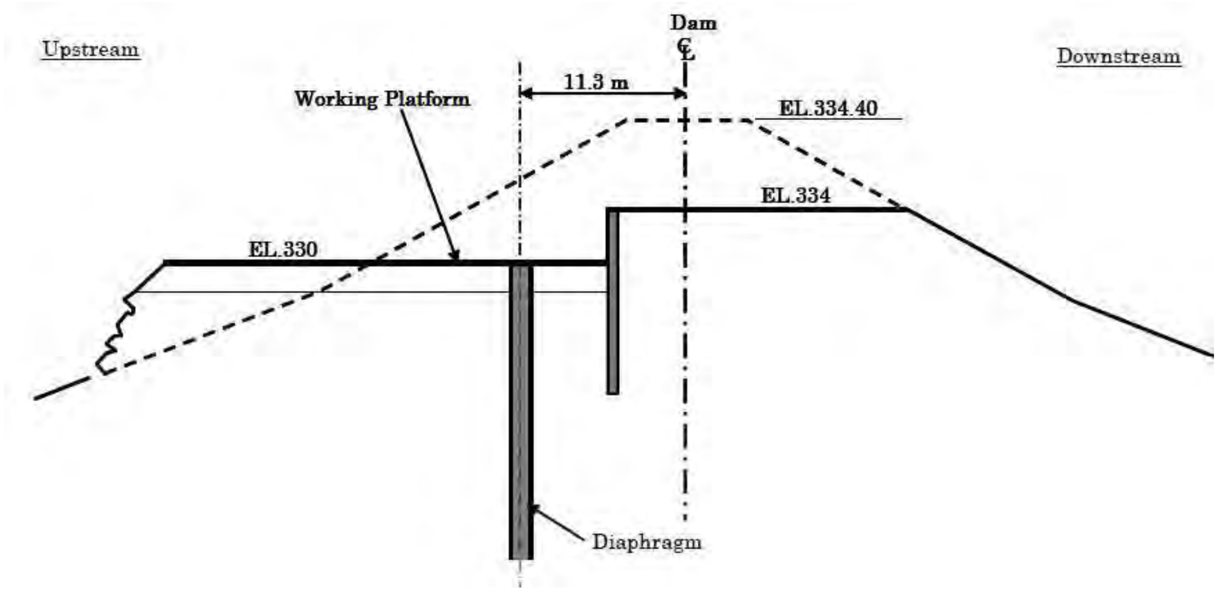
Source: Provided data to JICA from MoWR, 2008 and 2009.

Fig. 3.6-10 Annual Inflow to Mosul Dam



Source: Mosul Dam Annual Safety Report, 2008.

Fig. 3.6-11 Grout Curtain Efficiency on 7/6/2008



(Source: A local source)

Fig. 3.6-12 Location of Diaphragm and Working Platform Plan

Fig. 3.6-13 "Hydromill Type" Equipment for Diaphragm Construction

3.7 Needs of Beneficiaries of North and South Jazira Irrigation Project Areas

As security reason, it was difficult to discuss with beneficiary farmers directly about necessity of irrigation project so that Study Team collected the information from PMT members who must know current situation of Project area. At the end of the progress meeting, PMT and other participants were asked the following two questions and wrote their answer and reason on the card.

Question 1 : Do you think South Jazira Project is necessary?

Question 2 : Do beneficiary farmers need South Jazira Project?

Answer and reason of PMT member and two local consultants who attended the farm survey are shown below. All answers to question 1 were positive. It is natural because responders know the effects of irrigation at North Jazira Project.

Also all answers to question 2 were positive. And main reason for question 2 was farmers' revenue growth. If farmers are sensitive in the revenue, public relationship activity of Project is effective to acquire farmers' cooperation for maintaining terminal canal system and saving irrigation water. It seems that experimental farm proposed in F/S report is valid.

Table 3.7-1 Needs for Project (hearing from PMT)

Q1: Is this Project necessary	Q2: Are farmers need this Project
Necessary Because it is useful for farmer	Yes Because farmer need to increase income
Necessary Because it is useful for farmer	Farmers need it Because farmer increase their income
Necessary Farmer needs this project	Yes
Yes It is very important	Farmers need it
Yes Useful for farmer	Yes For irrigation enhancement all area
Yes Project is benefit of farmers	Yes Famer need it so much to increase their income
Yes It is useful to farmer for irrigation	Yes Farmer needs project to increase income
Yes Useful for farmers	Yes Farmers need it
Yes Necessary, very important	Yes They need it

Source: Result of Workshop at meeting with PMT

CHAPTER 4. LESSONS AND LEARNED FROM NORTH JAZIRA IRRIGATION PROJECT

4.1 Achievement of Operation

4.1.1 Numbers of Farmers, Irrigation Area

Number of Farmers in North Jazira Irrigation Project area is 3,074 households in 2002 and initial irrigation area was 19,775 ha in 1992, then increased gradually and reached 52,175 ha in 1995. Peak level continued until 1997, and decreased subsequently to 47,413 ha in 2002.

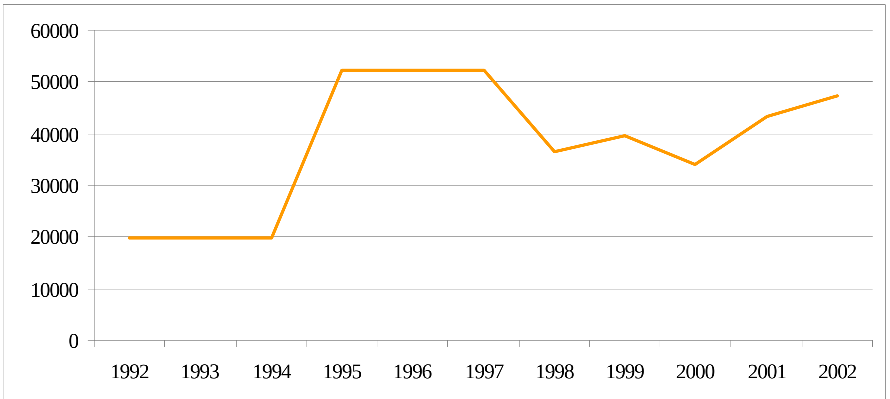


Fig. 4-1 Irrigation Area (ha)

4.1.2 Production

(1) Comparison between North and South Jazira area

Unit yield (average of 1998-2008) of main crops is shown in Table 4-1 and 4-2. Unit yield of wheat, barley, and sugar beet of North Jazira area are smaller than planned unit yield of South Jazira area, while unit yield of sunflower of North Jazira area is equivalent to that of South Jazira area.

Table 4-1 Result of North Jazira Project

1998-2008	Average Unit Production (kg/ha)
Wheat	1,200 - 2,000
Barely	1,000 - 1,600
Potatoes	20,000 - 24,400
Sugar beet	8,000 - 16,000
Sunflower	1,600 - 2,000
Vegetable	10,000 - 16,000

Source: Report of North Jazira Irrigation Project

Table 4-2 Plan of South Jazira Project

	Average Unit Production (kg/ha)
Wheat	2,800 - 5,600
Barely	2,400 - 5,200
Potatoes	0 - 0
Sugar beet	28,800 - 46,000
Sunflower	800 - 2,400
Vegetable	0 - 0

Source: Swiss F/S Report

(2) Comparison between North and South Jazira areas base on farm survey

For the purpose of comparing productivity between North and South Jazira areas, farm survey is also carried out at North Jazira Irrigation area (refer to “Chapter 3 Table 3.5-14”). Table 4-3 shows unit yield of wheat and barley in the North Jazira area.

Table 4-3 Unit Yield of North Jazira Irrigation Area (Result of Farm Survey)

Question	No.	1	2	3	4	5	6	Average
Wheat: Area	ha	12.5	12.5	12.5	12.5	37.5	10.3	16.3
:Yield	kg/ha	3,200.0	3,360.0	2,800.0	2,880.0	1,600.0	2,928.0	2,794.7
Barley: Area	ha	12.5	7.5	7.5	11.5	37.5	2.5	13.2
:Yield	kg/ha	1,600.0	2,240.0	2,000.0	2,160.0	1,680.0	2,400.0	2,013.3

JICA Study Team Farm Survey（July, 2010）

Average unit yield about 2,800 kg/ha of wheat in North Jazira is mostly equal to minimum yield of South Jazira shown in the Swiss F/S Report. And about 2,000 kg/ha of barley is almost middle level unit yield between North and South of which shows in the report of North Jazira irrigation project and Swiss F/S report respectively.

4.2 Main Crops and Cropping Pattern

Major winter crops are wheat, barley, potatoes, sugar beet, beans, and forage crops, while major summer crops are corn and fodder crops. Composition rate of plantings crops in each seasons are shown in table below. Total plantings crops ratio is 123%.

Table 4-4 Cropping Plan (Winter and Summer Crop)

	Winter Crop	Summer Crop
Wheat	48%	
Suger beet	19%	
Potatos	10%	
Beans	10%	
Fodder	13%	13%
Corn		10%
Total	100%	23%

4.3 Water Management

(1) Irrigation Methodology

Most area of project irrigated by sprinkler machines (liner move sprinkler system),The area of one unit farm is between (50~150) ha, many farmers are responsible about one sprinkler machine that works according to a special table of time prepared for this purpose.

Fig.4-2 Liner move sprinkler system(1)

Fig. 4-3 Liner move sprinkler system(2)

Fig. 4-4 Liner move sprinkler system(4)

Fig. 4-5 Liner move sprinkler system(3)

(2) Efficiency

Irrigation efficiency in the North Jazira Irrigation Project is as shown in Table 4-5.

Table 4-5 Efficiency of North Jazira Irrigation Project

Application efficiency		Irrigation efficiency		
Sprinkler	75 %		Sprinkler	Gravity
Gravity	60%	Main canal	0.71	0.56
Canal conveyance efficiency		Lateral	0.63	0.51
Main canal	95 %	Water course	0.60	0.48
Lateral	90 %			
Water course	94 %			

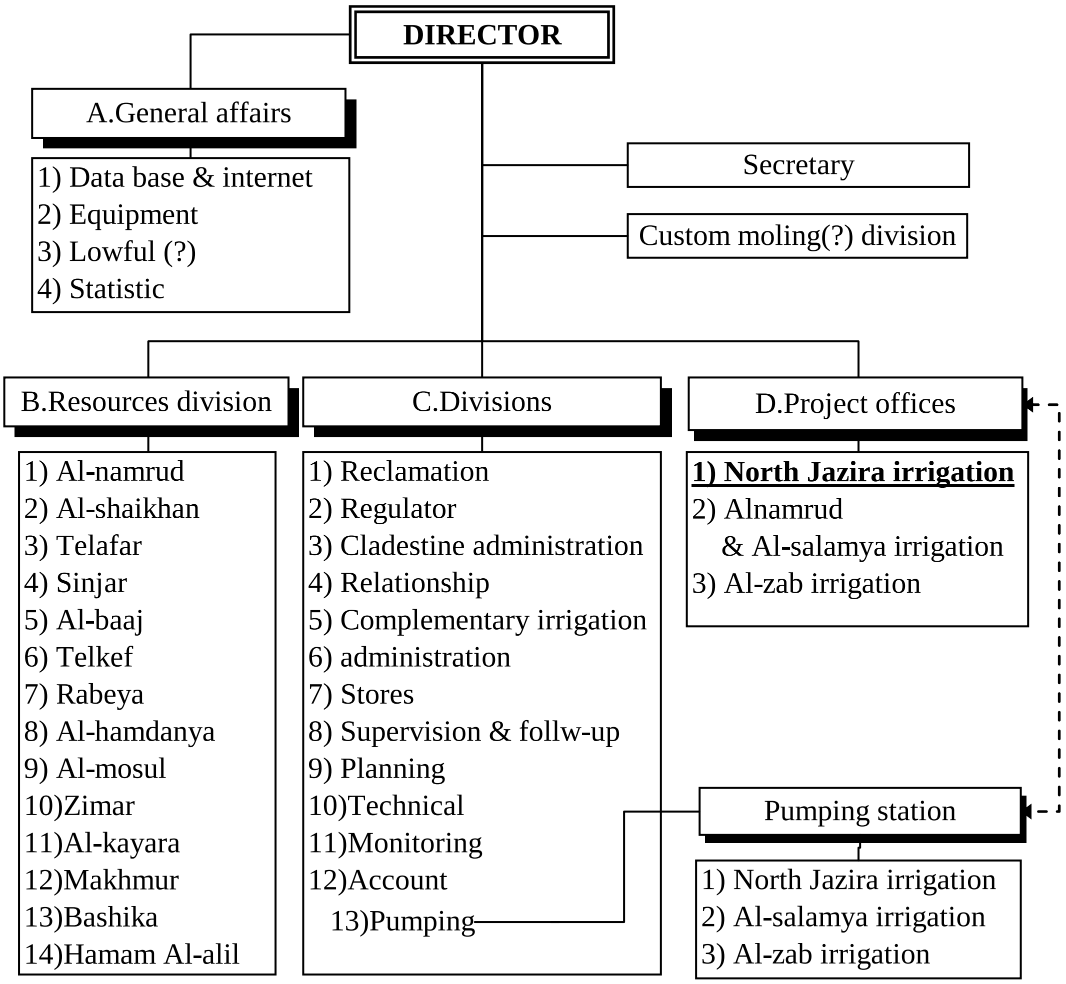
Source : Design criteria (China State Construction Corporation , 1986)

(3) Water Users' Association, Water Fee

As a result of survey to farmers (6 villages) and listening to PMT, water users' association etc. are not organized. As a result of survey farmers (6 villages) and listening to PMT, water fee is free. Construction and maintenance of agricultural facilities are all being executed by the State. Tax to the beneficiaries and water fee are free. Also the beneficiaries can affect by aid of country in the purchase of fertilizers and seeds.

4.4 Conditions of Operation and Maintenance (O&M) and Organization

O&M works for the North Jazira Irrigation Project is managed by the Directorate of Water Resources in Nineva. Fig. 4-6 shows the organization of the Directorate. Under the Director of the Directorate, there are mainly four(4) Divisions/offices of 'A.General Affairs', 'B.Resources Division', 'C.Divisions' and 'D.Project Offices', among which the 'C.Divisions' is the core to handle irrigation development, planning for regulator/intakes and pumping scheme, construction as well as follow-up and monitoring for the entire Nineva province. For each of districts extending over the province, 'B.Resources Division' is responsible and performing for project base resources management and O&M activities. Within the Province, as many as three(3) large scale irrigation projects are operated with having each of the 'D.Project Office'. One of those is the North Jazira Irrigation Project Office. While each of the Project Offices is attached with pumping station, however, the O&M works on the pumping station is not done by the Project Office but by the '13)Pumping Division under the C.Divisions' with due collaboration with each of the project office.



Source: PMT in Nineva

Fig. 4-6 Organization Chart of Directorate of Water Resources in Nineva

Table 4-6 shows the personnel allocation under the North Jazira Irrigation Project Office. The Project Office is in charge of overall project O&M and there are additional offices exclusively for O&M of each of pumping stations with having engineers for irrigation, mechanical and electrical field as supported by technicians. Further, for the O&M and maintenance of sprinklers, there assigned an independent office in charge of stock control/management, inspection/maintenance and repairs in case of damages/mal-functioning.

Table 4-6 Personnel allocation under North Jazira Irrigation Project and MoWR Personnel in Nineva province

Categories	North Jazira Irrigation Project Office					DOWR office in Nineva
	1)O&M office	2)Main pomp station	3)Secondary pump station	4)Sprinkler O&M office	Total	
Irrigation Eng.	11 (Incl. Manager 1)	2	1	―	14	178 (Engineer)
Mechanical Eng.	1	5	1	―	7	
Agronomy	8	―	―	―	8	
Electrical Eng.	1	7 (Incl. Manager 1)	3	―	11	
Account executive	―	―	―	1	1	13
Administrative responsible	1	―	―	1	2	5
Administrative officer	2	―	―	2	4	
Technician	23	14	11	16	64	84
Computer worker	―	1	―	―	1	
Skilled labour	35	3	13	―	51	91
Labour	―	3	―	13	16	7
Typist	―	1	―	―	1	―
Stores responsible	2	―	―	3	5	―
Driver	15	1	―	―	16	―
Total	99	37	29	36	201	378

Source: North Jazira Irrgation Project, O&M, Directorate of Water Resources in Nineva

Moreover, the North Jazira Irrigation Project Office is provided with the following O&M machineries and equipment and takes responsibilities for regular O&M, re-dredging of canals and repairing of facilities under the project.

Vehicles for O&M/monitoring, Backhoe (Large and medium size), Bulldozer,
Loader, Fuel tank, Dump truck and concrete Mixer, etc.

Further to mention, based on the data/information provided by the PMT, the North Jazira Irrigation Project Office possesses as many as 250 units of sprinkler equipment and assuming the full coverage of irrigation service for the recorded-maximum cropping acreage of 52,000 ha with the irrigation ratio of 1:1 by surface irrigation and sprinkler irrigation, the average irrigation service coverage by 1 unit of sprinkler is calculated to be about 100 ha per annum.

In addition to the above, the Table 4-7 shows relevant data/information on O&M cost. In the year 2009, about 381,000 USD was collected from the farmer water users as water fee (As per the interview from PMT, water fee has not been collected.), however the amount is limited only to some 12 % of the annual O&M cost including the electricity and the balance is covered by the government budget.

Table 4-7 Data/Information on O&M Cost (2009)

Description	1 ID=1,180USD
1. O&M cost of annum	1,525,000 USD
2. Electricity fee per annum	1,678,000 USD
Total	3,203,000 USD
3. Water charge	381,000 USD (12%)

Source: North Jazira Irrigation Project, O&M,
Directorate of Water Resources in Nineva

CHAPTER 5. AVAILABLE WATER OF THE MOSUL DAM

5.1 Water Balance in the Swiss F/S Report :<u>in relation with the Soviet Report</u>

The F/S report on the South Jazira irrigation project made by Swiss Consultant did not discuss water balance computation of the Mosul Dam as the water resource. Water balance throughout the country is examined in as called Soviet Report, namely, ”General Scheme of Water Resources and Land Development in IRAQ STAGE (MOSCOW-BAGHDAD, 1982)”, it seems that the Jazira Irrigation Project is integrated into the whole country water resource plan.

Information and data, which have been collected, show that the water requirement and designed discharge (peak discharge) in the Swiss F/S report seemingly differ from those in the Soviet Report.

Table 5.1-1 shows a comparison between the irrigation water requirements as indicated in the Soviet report and the design discharge (Peak) of the facilities, while the Table 5.1-1 compares the monthly crop water consumption as discussed in the Swiss F/S with the one presented in the Soviet report.

From the Table 5.1-1 of the Soviet report, the irrigation service area in South and East Jazira projects can be confirmed as 183.25 thousand ha (= 23.25 +160). Also, the total annual irrigation water requirement can be computed as 1,430.28 x 109 m^3/year (=139.68+1290.6).

At the start of the subject JICA Study, the total area of the whole Jazira was assumed to be 190,000 ha with the breakdown of 60,000 ha by North and 75,000 ha by East plus the South. In this case the total irrigation area which depends the water source on Mosul Dam comes out as 325,000 ha in total, which is much larger than the area indicated by the Soviet report.

Fig. 5.1-1 shows the differences found in the monthly consumption amounts between the Soviet report and the Swiss F/S for the irrigation planning for the South Jazira Irrigation Project. Differences are there on the irrigation water requirements and the design discharges.

As discussed in the foregoing, the Swiss F/S does not necessarily coincide with the Soviet report, which seemed to be the basis of water source planning under the F/S, in examining the irrigation water requirements too.

In the Soviet report, it can be known that professional engineers surveyed/investigated several numbers of irrigation systems and for concluding the irrigation water requirement, the following basic data were used for their calculation;

1) Net irrigation water requirement of major crops
2) Cropping patterns to determine the averaged net water requirement
3) Loss of irrigation system including percolation losses at canals and fields
4) Operation loss at the practicing irrigation system

As is the case, it seems that differences were induced as compared with the F/S where water requirements were calculated on individual service area basis.

Concerning the study on water source operation, a mathematic model was developed by using a programming language of Fortran-4. By using this model, dam operation calculations had been conducted individually for each of dam/reservoir on Tigris, Euphrates and Diyala rivers. However, this could not lead to obtain adequate outcome for the water source operation covering the whole Iraq, and a new model to calculate in an integrated manner covering all the 3 systems has been built up to date.

However, it is difficult to extract the results of water source operation on small dams from the Soviet report. As of today, it is considered that the Soviet report is the latest outcome of study discussing the water source operation covering the entire basins of Iraq. However, considering the actual situation of changes happening such as development activities in the upstream riparian countries, irregular river run-offs affected by climate changes caused by global warming as well as increasing water consumption everywhere and etc. it is considered necessary to have at the earliest a holistic water source operation plan newly conceived based on the said changes.

Table 5.1-1 Irrigation water requirements and the design discharge (Peak) as indicated in the Soviet report

Irrigation Water Requirements and Design Discharges of Irrigation Systems in the Year 2000 by USSR Report*

System No.	Irrigation System	Net irrigation area		Average monthely water requirements 10^6 m^3												Year total	Irrigation sysytem efficiency	Mean weighted irrigation rate, gross 10^3 m^3/don	Max. average monthly discharge m^3/sec	
		(10^3 don.)	(10^3 ha)	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	10^6 m^3				
		①	②=①÷4	③	④	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫	⑬	⑭=Σ③~⑬	⑮	⑯=⑭÷①	⑰	
38	Dohouk	12.6	3.15	2.41	1.01	0	0	0	0.04	0.7	1.56	2.71	3.12	2.67	2.33	16.55	0.64	1.32	1.17	Jul.
39	Shemal	80	20	17.23	9.92	0	0	0	0.54	6.77	18.4	26.67	24.98	20.44	14.14	139.09	0.64	1.73	10.29	Jun
40	Eastern Jazira	93	23.25	22.27	12.29	0	0	0	0.13	7.13	23.37	23.87	17.59	15.7	17.33	139.68	0.65	1.5	9.21	Jun
41	Jazira	640	160	160.55	84.49	5.36	3.51	51.62	105.03	165.48	189.57	162.16	128.63	112.4	121.8	1290.6	0.64	2.02	70.77	May
Sub-Total(40,41)		733	183.25	182.82	96.78	5.36	3.51	51.62	105.16	172.61	212.94	186.03	146.22	128.1	139.13	1430.28				
42	Small farms from the Mosul dam up to the Greater Zab river mouth	37.9	9.475	6.14	2.17	0	0	0	0.82	5.54	12.33	26.82	28.47	21.81	11.21	115.31	0.64	3.04	10.63	Jul
43	Small farms at springs in the Neinewa muhafadha in the Tigris river basin	12.7	3.175	1.66	0.41	0	0	0	0.11	1.64	3.94	6.94	7.29	5.93	3.33	31.25	0.7	2.46	2.72	Jul
44	Small farms at wells in the Neinewa muhafadha in the Tigris river mouth	15.1	3.775	1.97	0.49	0	0	0	0.12	1.95	4.68	8.25	8.66	7.05	3.96	37.15	0.7	2.46	3.23	Jul
45	Small farms at springs in the Neinewa muhafadha in the Greater Zab river basin	1.1	0.275	0.15	0.04	0	0	0	0.01	0.16	0.36	0.63	0.66	0.54	0.3	2.85	0.7	2.59	0.25	Jul

Sourse; 'GENERAL SCHEME OF WATER RESOURCES AND LAND DEVELOPMENT IN IRAQ' STAGE Ⅱ Volume Ⅲ WATER RESOURCES UTILIZATION Appendix 23.4

Monthly water requirements (mm)

		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June	July	Aug.	Sept.	Year	Cropping Pattern
USSR Report	gross	100.3	52.8	3.4	2.2	32.3	65.6	103.4	118.5	101.4	80.4	70.3	76.1	806.6	unknown
	net	64.2	33.8	2.1	1.4	20.6	42.0	66.2	75.8	64.9	51.5	45.0	48.7	516.2	
F/S Report	net	39.7	34.9	10.5	2.0	23.1	60.7	98.7	128.2	79.3	51.0	43.7	38.0	609.8	ABC
	net	40.1	35.8	13.0	2.1	24.2	61.5	97.2	115.7	62.9	48.9	47.8	42.2	591.4	XYZ

USSR Report;General Scheme of Water Resources and Land Development in IRAQ STAGE Ⅱ (MOSCOW-BAGHDAD 1982)

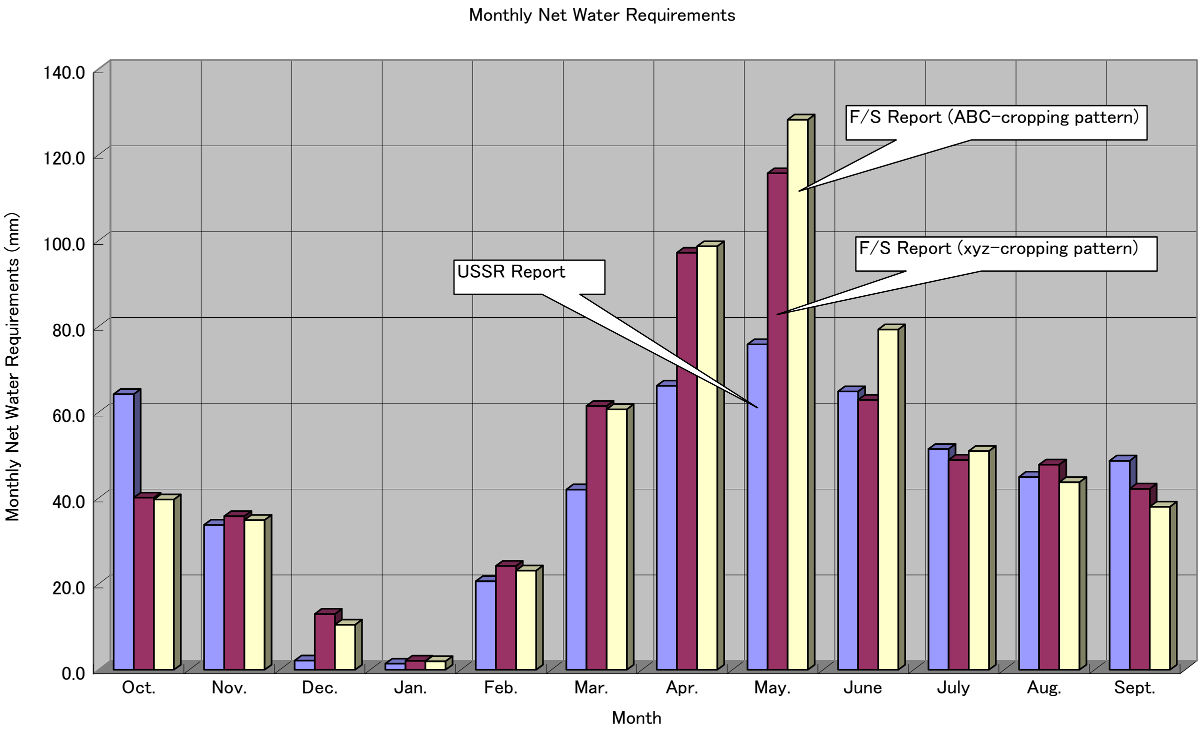


Fig. 5.1-1 Comparison of monthly crop water consumption between Swiss F/S and Soviet report

Initially, the JICA Team thought to examine the Project on "Strategy for Water and Land Resources in Iraq (SWLRI)". The SWLRI Study was initiated by MoWR in May 2005. The Study is divided into two phases, namely, Phase I and Phase II. Phase I was started in 2005 July by support of USAID and it was planned to be completed until 2006 September.

According to the MoWR, Italian Consultants was supposed to be in charge of Phase II of SWRLI and substantial project name is "Consulting Services for the Development of a Water Resources Decision Support System (DSS) for the Ministry of Water Resources in Iraq". The project is consulting service for the decision support system as the project name implies.

According to the Terms of Reference of the project, the Italian Consultant is responsible for Water Resources Decision Support System establishment, while upgrading of existing simulation model and calculation of water use by using the model are not included in it. The work will be done in Phase II of SWLRI by USAID from autumn of 2010 and will be completed in three years.

And Grasp of current conditions concerning countrywide water and land resource, and development of water use estimation system have been being under the support of USAID, the United States Army Corps of Engineers and so on since 2004. It is necessary to wait for the completion of Phase 2 to acquire further information.

The UNDP Iraq office arranged the consulting service by the Italian Consultant for MOWR and the service of Italian Consultant has already been started by the kick-off meeting on 15th April 2010 in

Amman. The service period consists of inception and study for 3 months and 21 months, respectively.

The DSS to be developed provides model tool by using internet environment, GIS and JAVA. It is also expected that the DSS imports SWLRI to the system. Personnel of MoWR try to establish an upgraded system which enables to share information and predict water use both inside and outside of the country.

At any rate, it is necessary to complete a water source operation plan which covers the ultimate water allocation for the country as a whole so as to finalize an appropriate irrigation planning for the areas as served by Mosul Dam. Due to the various development activities by the upstream riparian countries and effects by climate changes as caused by global warming, there have been considerable changes in river run-off and demands/consumption on the other hand. In addition, careful attention shall be paid to the water supply to the downstream wetlands as well and it is necessary to wait for the conclusions to be brought about by the SWLRI-2 for furthering the subject study on the manner of water source operation which fully incorporates such changes as mentioned above.

5.2 Examination on Actual Operation of the Mosul Dam: <u>in relation with the Safety Annual Report</u>

At the next step, the Study Team will calculate the water balance by using dam operation data in case that whole irrigation water for the South Jazira is taken from the Mosul Dam. It will be possible to examine the relevance of water balance computation based on the calculation.

The Mosul Dam annual report in 2008 shows water level, reservoir storage and water balance of main reservoir. Reservoir storage can be calculated based on the reservoir storage on the previous day and water balance. It is possible to verify the degree of observatory accuracy by comparing the estimated reservoir storage with actual one. Reservoir storage can be calculated as follows;

Calculated reservoir storage: Calculated reservoir storage on the previous day + Variation of the reservoir storage on the day

Variation of the reservoir storage on the day: Qin－Qout

Qin: Inflow to the main dam on the day

Qout: Outflow from the main dam on the day

(= Irrigation water for the South Jazira + Water requirement for power generation + Outflow from the bottom discharge facility + Outflow from the spillway）

For example, there is 6.40MCM error between calculated and actual one in one month, namely, January 2008 as shown in Table 2-1. The ratio of the error against the reservoir storage is around 0.1% (=6.40/5006), which is negligible, it can be judged that the examination method above by using calculated reservoir storage is applicable.

Data of outflow from the Regulating Dam are shown in the Annual report. The values shown in the report can be regarded as substantial outflow from the Mosul Dam. Considering that these figures do not show much difference from the total amount of outflow very much, it can be thought that it is not necessary to consider reservoir affect at the Regulating Dam in the downstream.

The regulating reservoir is located at 8 km downstream from Mosul Dam and functions to release irrigation water to downstream areas continuously through regulating the daily fluctuations of voluminous outflow from Mosul Dam.

The bottom discharge facility is used in dry season and during power generation failure to run off water and it also can be used in case of emergent outflow. The maximum outflows were recorded at 2,435m^3/s and 1,770m^3/s when water levels were 330 m.a.s.l. and 300 m.a.s.l., respectively. According to the information gathered, the maximum discharge namely, 2,280 m^3/ was recorded on 16th April, 2003, which is within the realm of maximum outflows above.

Table 5.2-1 Annual Dam Operation Report and Verification of Water Balance (based on the data in 2008)

DATA From Annual Report
Jan. in 2008 4957.1

DATE	MAIN RESERVOIR			MAIN DAM					Regulating Dam				
	W.L	STORAGE	INFLOW	OUTFLOW (m3/s)					OUTFLOW (m3/s			Calculated Storage (MCM)	
	m.a.s.l	MCM	m3/s	Gazira	Bottom	Spillway	Power	Total	Regulating Dam			(MCM)	
	①	②	③	④	⑤	⑥	⑦	⑧	⑨		⑩=③−⑧×0.0864	⑪=V_{i-1}+⑩	Difference (MCM)⑫=②−⑪
1	309.88	4957.1	210	0			207	207	200		0.26	4957.36	−0.26
2	309.88	4957.1	199	0			198	198	200		0.09	4957.45	−0.35
3	309.87	4954.8	180	0			204	204	200		−2.07	4955.37	−0.57
4	309.87	4954.8	190	0			187	187	200		0.26	4955.63	−0.83
5	309.86	4952.5	175	0			200	200	200		−2.16	4953.47	−0.97
6	309.86	4952.5	188	0			187	187	200		0.09	4953.56	−1.06
7	309.85	4950.1	240	0			267	267	200		−2.33	4951.22	−1.12
8	309.86	4952.5	216	0			187	187	200		2.51	4953.73	−1.23
9	309.88	4957.1	232	0			177	177	200		4.75	4958.48	−1.38
10	309.92	4966.4	298	0			188	188	200		9.50	4967.99	−1.59
11	309.98	4980.4	368	0			204	204	200		14.17	4982.16	−1.76
12	310.17	5001.8	523	0			273	273	273		21.60	5003.76	−1.96
13	310.14	5018.5	387	0	192		0	192	186		16.85	5020.60	−2.10
14	310.17	5026.7	293	0	208		0	208	200		7.34	5027.95	−1.25
15	310.23	5040.1	359	0	183		7	190	200		14.60	5042.55	−2.45
16	310.27	5049.7	277	0	133		30	163	200		9.85	5052.40	−2.70
17	310.26	5047.3	238	0	233		30	263	200		−2.16	5050.24	−2.94
18	310.26	5047.3	174	0			171	171	200		0.26	5050.50	−3.20
19	310.25	5044.9	214	0			239	239	279		−2.16	5048.34	−3.44
20	310.23	5040.1	213	0			266	266	300		−4.58	5043.76	−3.66
21	310.2	5032.9	165	0			245	245	221		−6.91	5036.85	−3.95
22	310.17	5025.7	169	0			248	248	200		−6.83	5030.02	−4.32
23	310.13	5016.1	119	0			225	225	200		−9.16	5020.86	−4.76
24	310.13	5016.1	122	0			120	120	200		0.17	5021.04	−4.94
25	310.11	5011.3	144	0			197	197	200		−4.58	5016.46	−5.16
26	310.09	5006.6	153	0			204	204	200		−4.41	5012.05	−5.45
27	310.08	5004.2	187	0			212	212	200		−2.16	5009.89	−5.69
28	310.07	5001.8	164	0			190	190	200		−2.25	5007.64	−5.84
29	310.06	4999.4	171	0			196	196	200		−2.16	5005.48	−6.08
30	310.05	4999.4	204	0			202	202	200		0.17	5005.66	−6.26
31	310.09	5006.6	301	0			216	216	200		7.34	5013.00	−6.40
Average(m3/s)			228.16				176.68	207.3	208.4				
Total(MCM/month)			611.11				473.21	555.2	558.1		55.90		

1) Observed water level in the main reservoir
2) Observed reservoir storage of the main reservoir
3) Inflow to the main reservoir
4) Quantity of diversion for irrigation in the North Jazira area
5) Inflow at the bottom intake facility
6) Outflow at the spillway
7) Quantity of diversion for power generation
8) Total amount of the diversion and the outflow = 4)+5)+6)+7)
9) Outflow at the Regulation Reservoir in the downstream
10) Variation of reservoir storage
11) Reservoir storage on the previous day + Variation of reservoir storage
12) Difference between 2)observed reservoir storage and 11) estimated reservoir storage

5.3 Examination of Water Resource Operation

In reviewing water resource management in South Jazira Irrigation Area, some findings on the use of water resource as shown in the following have been presented by the MoWR.

5.3.1 View of the MoWR on inflow into Mosul Dam as well as discharge to the downstream in future

1) Average inflow from Tigris River basin during the period of 1931 - 2010 has been recorded as 20.1 BCM/year.

2) More recent average inflow into Mosul Dam observed during 1999 - 2010 has been 14.95 BCM/year where reduction has been considered due to the effect of exploitation in Turkish basin though it is thought that the effect has also been brought about by global warming effect and long-term climatic trends.

3) According to reports with regard to Ilisu Dam publicized in an internet information site as well as research reports by Ministry of Foreign Affairs, the annual water consumption in Tigris River consists of 6.5 BCM/year for irrigating over 635,000 ha of the perimeter within Turkish territory and 2.0 BCM/year for irrigating 200,000 ha in Syrian territory. Moreover, 1.50 BCM/year has annually been evaporated from the surface of Turkish dams. Accordingly, while water treaty among upstream countries is not stated, the total water consumption of this river basin is estimated at 10.1 BCM/year (＝20.1-6.5-2.0-1.5), namely, about a half of 20.1 BCM/year as referred to in 1).

4) As regards the future necessary releasing (outflow) volume to the southern part of Iraq from Mosul dam, MoWR suggested providing an Indicator for it in consideration with future demands such as agriculture, water supply, power generation, and industry as well as marshland conservation. At the end, however, MoWR indicated that the necessary releasing volume is 200 m^3/s for portable water of Nineva governorate for analyzing available water resource of the South

Jazira.

5.3.2 Operation Rules /Regulations of Mosul Dam

The followings are the operation rules of Mosul Dam presented by MoWR.

1) Rule of water intake: During last winter period terminated on June 1st, water is reserved so that water level reaches WL 330m as an ordinary operation water level (for recent 5 years it has been managed at WL 319m owing to the safety control of the Dam).

2) Rule of water discharge: It is discharged to meet various water demands arising from southern as well as middle parts of Iraq. During last summer period terminated on November 1st stored water level is kept at WL 307 - 310m procuring both water required for irrigating North Jazira Irrigation Area and for power generation. In this connection, in the case of serious drought, operative water level is further lowered.

Fig. 5.3-1 shows a rule-curve for Mosul Dam presented in a reference by Water Control Center (Technical Data for Dams, Reservoirs & Main Control Structures with mean monthly flow-rate and water quality for Main Water Resources).

In this regard, calculating from the annual water volume reserved at WL 330m (reserved water volume: 11.11 BCM), the reserved water storage corresponding to WL 307m (reserved water volume 4.307 BCM) is calibrated at about 6.803 BCM (=11.11-4.307), while the ratio to future inflow, namely 10.1 BCM, is equal to 1.48 (= 10.1/6.803).

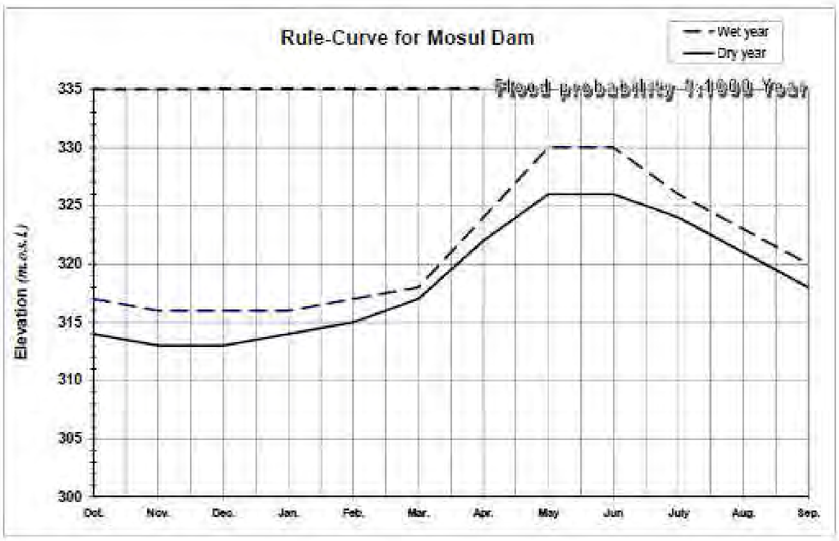


Fig. 5.3-1 Rule-curve for Mosul Dam

5.4 Examination on the dam operation

5.4.1 Preconditions for the examination

(a) Required water for crop-irrigation

Estimation and determination of irrigation water requirement for South Jazira Irrigation Area requires a farming plan, crops and irrigation facilities to be equipped. Examination on the required irrigation water is tried with the following monthly water requirement by 3 irrigation sub-areas (North, East and South) in Jazira Irrigation Area as shown in Table 5.4-1.

Table 5.4-1 Monthly Irrigation Water Requirement (Plan)

Month	North Jazira Irrigation		East Jazira Irrigation		South Jazira Irrigation		Total of Jazira	
	MCM	m^3/sec	MCM	m^3/sec	MCM	m^3/sec	MCM	m^3/sec
Oct.	83.14	31.03	58.06	21.60	116.10	43.33	257.30	95.96
Nov.	78.05	30.11	11.05	4.26	103.61	39.97	192.71	74.34
Dec.	0.56	0.21	-	-	37.61	14.04	38.17	14.25
Jan	3.34	1.25	-	-	6.08	2.26	9.42	3.51
Feb	31.07	12.84	6.37	2.63	69.43	28.69	106.87	44.16
Mar	107.72	40.20	44.93	16.77	177.96	66.44	330.61	123.41
Apr	116.21	45.00	104.37	40.26	281.30	108.52	501.88	193.78
May	88.52	33.05	142.77	53.30	334.82	125.00	566.11	211.35
Jun	65.14	25.13	139.90	53.90	182.03	70.22	387.07	149.25
Jul	74.80	27.93	115.79	43.23	141.50	52.83	332.09	123.99
Aug	75.49	27.99	105.13	39.25	138.34	51.65	318.96	118.89
Sep	49.50	19.09	62.88	24.26	122.12	47.11	234.50	90.46
Year	773.54		791.25		1,710.90		3,275.69	
(%)	23.6		24.2		52.2		100.0	

Source: excerpt from data received from PMT on June 28th 2010

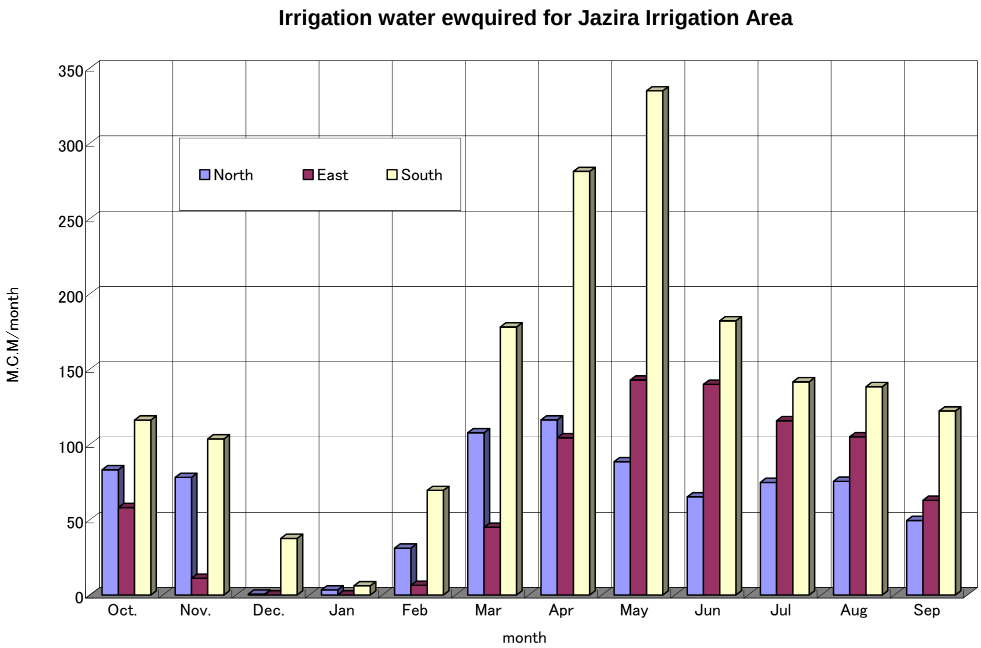


Fig. 5.4-1 Irrigation water required for Jazira Irrigation Area

The total irrigation water volume required for irrigating 3 sub-areas comes to 3.276 BCM, accounting for 16.3 % of the total annual inflow into Mosel Dam, namely 20.1 BCM. 32.4% of the estimated future annual inflow affected by further development in the upstream of river basin as well as by global warming effect, namely 10.1 BCM, thus the rate of irrigation water requirement to the total inflow will get higher level. This required water is equivalent to around a half of the managed water storage at WL 307 - WL 330m, namely 6.803 BCM.

Besides, a farm management plan has been newly proposed for South Jazira Irrigation Project area under the present study where crop water requirements have been reviewed and modified based on the latest meteorological data collected and updated irrigation efficiencies.

(b) Water Level (WL) – Storage Volume curve, and W.L - Storage Area curve

Water level (WL) - reservoir area curve and WL - reserved volume curve of Mosul Dam are contained in "SADAM DAM, OPERATION & MAINTENANCE MANUAL Volume 3" as shown in Fig. 5.4-2.

According to this data, as to sedimentation of Mosul Dam, at the present stage after 50 years since the Dam has been put into operation, the initial effective storage volume of 8.2 BCM has been assumed to get reduced to 7.3 BCM, or 0.9 BCM has already been reduced by the sedimentation.

As concern the effective storage has been reduced attributable to sedimentation in the dam, it will be considered necessary to verify it by means of sounding survey etc, but here, the estimated relationship between WL - Storage volume or Storage Water Area is merely presented based on the already publicized references. The publicized relation between WL - Storage volume is given in the Table 5.4-2;

Table 5.4-2 Relationship between water level - storage volume

Water Level (WL) (m.a.s.l)	Classified water level	Storage volume (BCM)
335.0	Max. water level	13.14
330.0	Normal water level	11.11
317.5	Spillway sill level	6.95
300.0	Min. water level	2.95

From the 4 water levels tabulated above, the following polynomial equations can be derived as follows;

<u>Storage Volume</u>: $V(h)=2.02254\times10^{-5}h^3-0.0157012\,h^2+4.1369h-371.04$

where V(h): storage volume at the water level "h" (unit: BCM)

h: stored water level (m.a.s.l)

In a similar manner;

<u>Storage Water Level</u>: $h(V)=0.0079\,V^3-0.33372\,V^2+7.0669V+281.85$

where h(V): water level at storage volume "V" (unit: m.a.s.l)

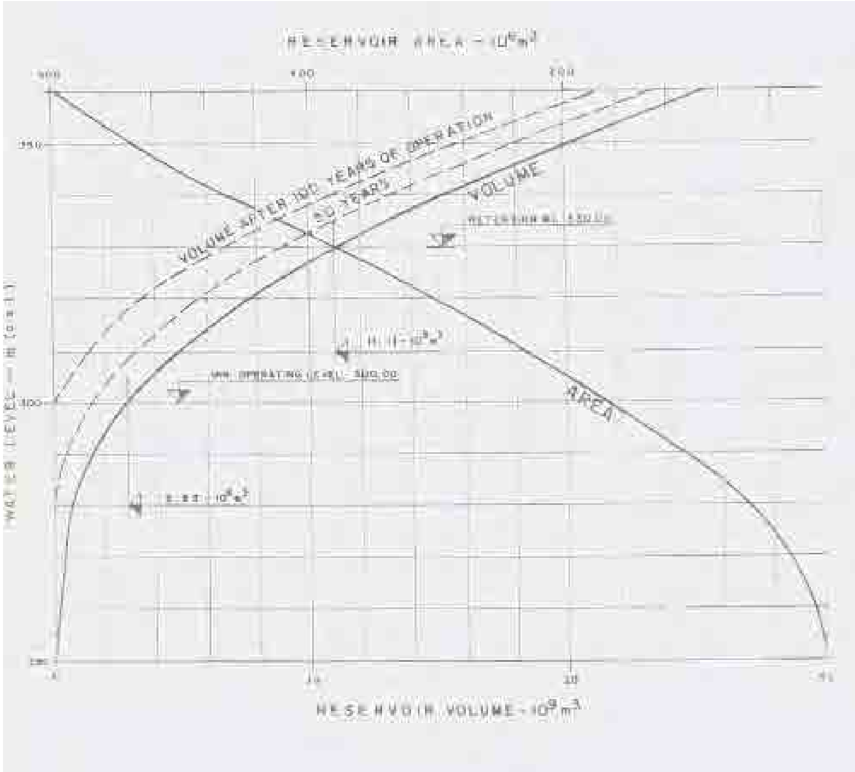
V: water volume (BCM)

As the relationship between water level and storage surface area can be derived by differentiating the polynomial expression derived above; V(h) once by h, namely;

Storage Area: A(h)=dV(h)/dh

$= 6.06762 \times 10 - 5h^2 - 0.03140240h + 4.1369$

where A(h): water surface area at water level "h" (BSM $= 10^3 km^2 = 10^9 m^2$)



Source: SADAM DAM, OPERATION & MAINTENANCE MANUAL Volume 3

Fig. 5.4-2 H(height) – V(volume) and A(area) curves of Mosul Dam

MOSUL DAM

- Coordinate N 36.63° E 42.82°
- A 100 *(m)* height, high-zoned earth embankment
- A 10 *(m)* width, 3.6 *(km)* length crest leveled at 343.20 *(m.o.s.l.)*
- Max. reservoir level 338.00 *(m.o.s.l.)*
- Normal operation level *(N.O.L.)* 330.00 *(m.o.s.l.)*
- Min. operation level 300.00 *(m.o.s.l.)*
- Max. Storage at max. reservoir level 13.14×10^9 *(m^3)*
- Normal storage at normal operation level 11.11×10^9 *(m^3)*
- Dead storage 2.95×10^9 *(m^3)*

Spillway

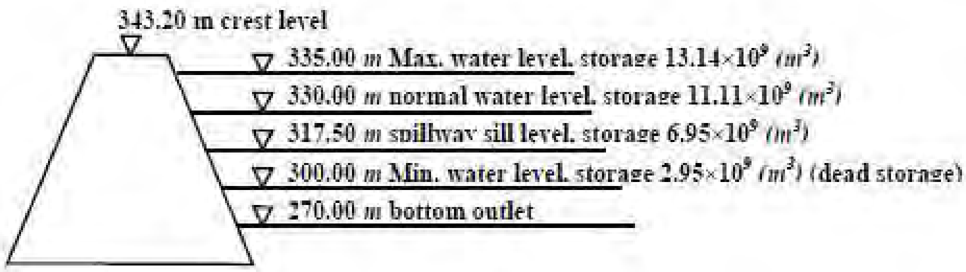
- 5 radial (tainter) gated concrete-lined chute with a ski-jump section for energy dissipation, each 13.3 × 13.5 *(m)*
- Spillway sill level 317.50 *(m.o.s.l.)*
- Max. designed discharge at max. Reservoir level 13000 *(m^3/sec.)*
- Fuse-plugged spillway has 400 *(m)* length at the max. Reservoir level with a discharge of 4000 *(m^3/sec.)*

Power House

- 4 Francis turbine generator units, each 187.5 *MW*
- 4 Francis vertical turbine can provide 3420 *million kwh*
- Power intake gates 7.0 × 10.5 *(m)*

Bottom Outlets

- Two bottom outlets located at the left of the power station, hydraulically operated and radial (tainter gates controlled the outlets with a combined discharge of 2600 *(m^3/sec.)*



Source: Technical Data for Dams, Reservoirs &Main Control Structures with mean monthly flow-rate and water quality for Main Water Resources

Fig. 5.4-3 Relation of H(height) – V(volume) at Mosul Dam

Since it is convenient for calculating operating dimensions in examining water management/ water resource operation to preliminarily deriving equations that give relationship between WL - Storage Volume as well as Storage Area, it is to utilize the above derived one for further calculations. In this context, since evaporation loss from dam surface is considered proportional to the storage area, it is also required to derive estimation formula for storage area.

(c) Reservoir loss by water surface evaporation

By means of the data contained in SAFETY ANNUAL REPORT OF MOSUL DAM, Year 2008, water balance has been identified through the following calibration equations based on the data concerning observation data on inflow/outflow of the main dam.

Change in the dam storage=inflow－outflow (intake and spilling discharge)－reservoir loss

Water storage in this term=Water storage in the last term＋Change in storage

＝Water storage in the last term＋Inflow－Outflow－Reservoir loss

◆ Reservoir loss＝Water storage in the last term－Water storage in this term＋Inflow－Outflow

Based on the above given equations, the amount of reservoir loss is calculated by month. As the reservoir loss, evaporation from the reservoir surface and seepage loss etc. are included, where seepage loss has been observed through leakage water observation.

Although it is rather difficult to accurately grasp leakage volume through the dam body, observation of leakage water by conducting/ collecting leakage water at 3 sites in the downstream of Mosul Dam as well as of water level in a coffer-dam. Volume of leakage changes in linkage with water level in the reservoir. Out of the observation records in 2008, leakage volume, when the water level was recorded highest, amounted to 19.48 l/sec, 87.99 l/sec, 72.34 l/sec in total 179.81 l/sec. Even if this order of water leakage continues for a year, the annual leakage came to only 5.67 MCM ($=179.81\times86{,}400\times365\text{days}/1{,}000\times10^{-6}$). This amount is equivalent to only 0.069% against the effective storage volume of Mosul Dam 8.16 BCM, so this order of leakage is not a problem for water balance or dam operation. Though the observation data may possibly include measuring errors, here reservoir loss is estimated mainly from surface evaporation by month through the use of observation performance (monthly calculation result is attached in the Appendix-A).

Checking the result of estimation on monthly reservoir loss, volume of loss recorded in May seems queer as indicated in Fig. 5.4-4, so this value will be amended as shown in the figure after concluding that the queerness of the value for May might stem from observation errors. As the result, annual volume of reservoir loss is evaluated at around 600 MCM.

Table 5.4-3 Estimation of Reservoir Loss by referring to Annual Report on Mosul Dam in 2008

		Jan.	Feb.	Mar.	Apr.	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
Cumulative difference on the end of month between observed and calculated storage (MCM)		-6.40	-17.24	-46.56	-97.79	-134.47	-232.67	-344.51	-433.61	-498.06	-534.31	-550.89	-561.12	
Monthly difference between observed and calculated storages＝Reservoir loss (MCM)		6.40	10.83	29.32	51.23	36.68	98.21	111.83	89.10	64.46	36.25	16.58	10.23	561.12
Revised reservoir loss (MCM)		6.40	10.83	29.32	51.23	75.00	98.21	111.83	89.10	64.46	36.25	16.58	10.23	599.44
Monthly mean storage level		310.1	310.3	311.9	315.5	317.9	318.3	317.0	314.5	311.8	309.5	307.9	306.5	312.60
Storage surface area (km^2)		233.5	235.1	245.2	269.0	285.8	289.2	279.6	262.5	244.7	230.1	220.4	212.0	
Monthly reservoir loss	(m/month)	0.0274	0.0461	0.1196	0.1904	0.2624	0.3396	0.4000	0.3394	0.2634	0.1575	0.0752	0.0483	2.2694
	(mm/day)	0.9	1.6	3.9	6.3	8.5	11.3	12.9	10.9	8.8	5.1	2.5	1.6	

Note; Reservoir area A(Billion m^2) is calculated by the following equation $A=6.06762e\text{-}5h^2-0.0314024h+4.1369$ where x: Resevoir water level(m)

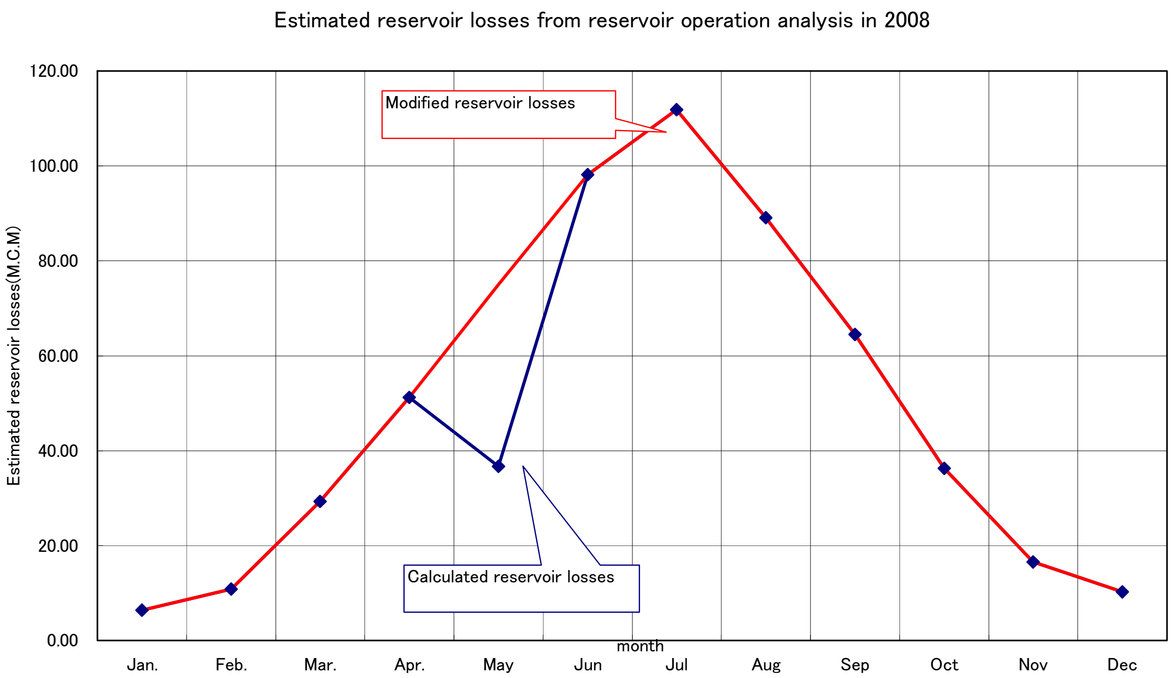


Fig. 5.4-4 Estimation on Reservoir Loss

As mentioned above, extent of leakage volume observed in Mosul Dam is little as compared to the storage volume, however, it is difficult to completely detect all the leakage loss. Therefore, reservoir loss as calculated above is interpreted as including such seepage loss.

(d) Inflow data

Change in annual inflow into Mosul dam is shown in Fig. 5.4-5 (where hydrologic year starts in October and end up in next September). Here, a declining trend of inflow can be identified either by moving average or by linear regression as the cause of decline, exploitation in the states located in the upstream basin and also long-term climatic change, however it is difficult to specify contributions of individual factors to the total change. According to linear regression, it is understood that the rate of annual decline is assumed at 0.145 BCM. Assuming that this declining rate would continue and the inflow in around 1975 is evaluated at 22 BCM or the value of the intercept, in about year 2050 or around 75 years ahead, the inflow will be calculated at a half, or 11 BCM.

Actually, however, in the case that the fluvial discharge is affected by such artificial development as irrigation projects in the states located in upstream basin, the pattern of inflow change does not indicate a linear trend, but seems to decline as the exploitation activities progress. As regards inflow volume, examination will be planned in cases where current inflow continues or where inflow decreases in future.

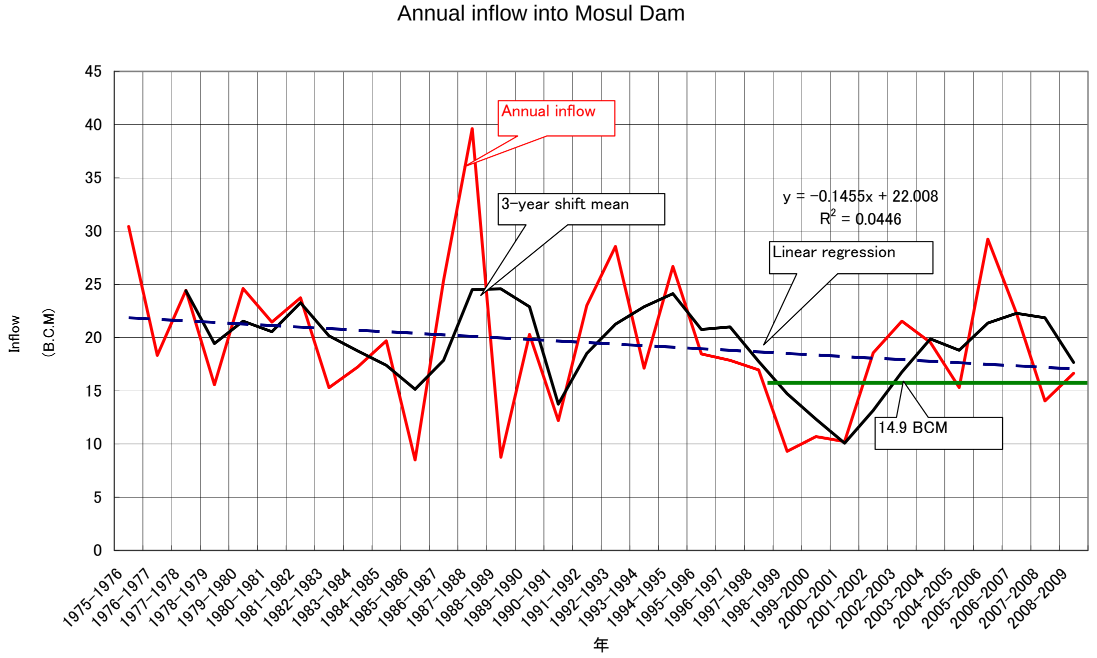


Fig. 5.4-5 Trend of annual inflow

5.4.2 Examination by Operation Record

Based on the data for 6-year operation record of the dam during ’93 - ’98 examination has been made by changing conditions.

(1) Performances of dam operation

A calculation table is shown in Table 5.4-4 to 5.4-8 where operation performances are monthly recorded. A diagram of dam operation performances is given in Fig. 5.4-6. Water levels of storage for this period were kept below WL 307m given in the rule-curve, an also below WL 306m. On the other hand, WL 330m was never realized during this period.

As shown in Fig. 5.4-7, mean annual changes for 6 years illustrates a pattern showing that inflow exceeds outflow with rising water level during the period from January to May, but for other months, stored water is consumed, thus giving a typical dam-operation pattern. As the performance of water intake into North Jazira Irrigation Area, intake was recorded during the period from April to October or November.

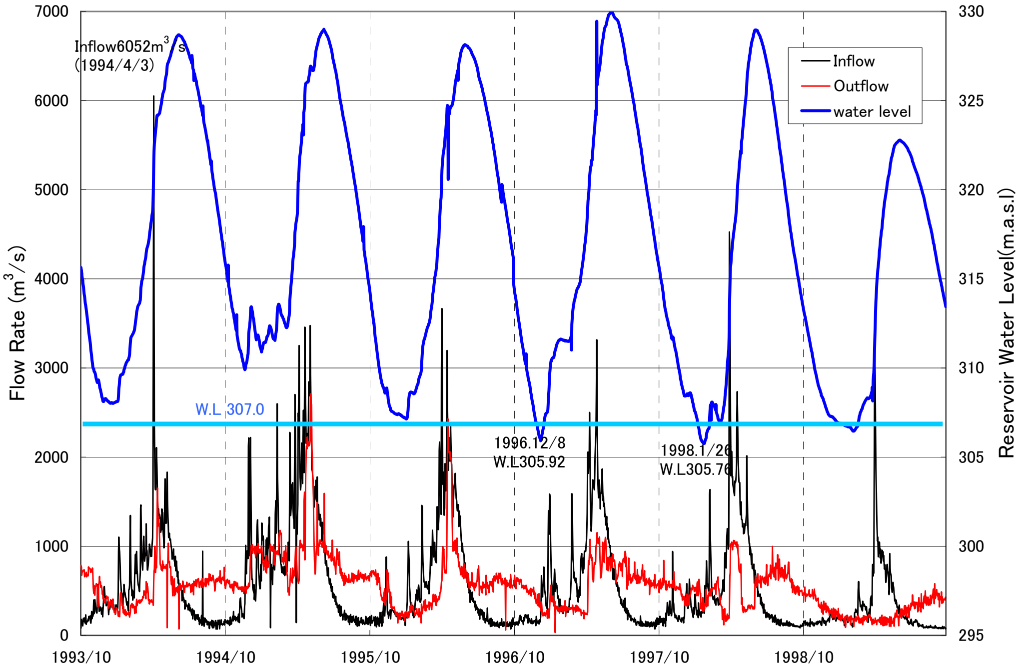


Fig. 5.4-6 Diagram of Dam Operation Performance for 6 years during ’93 - ’98

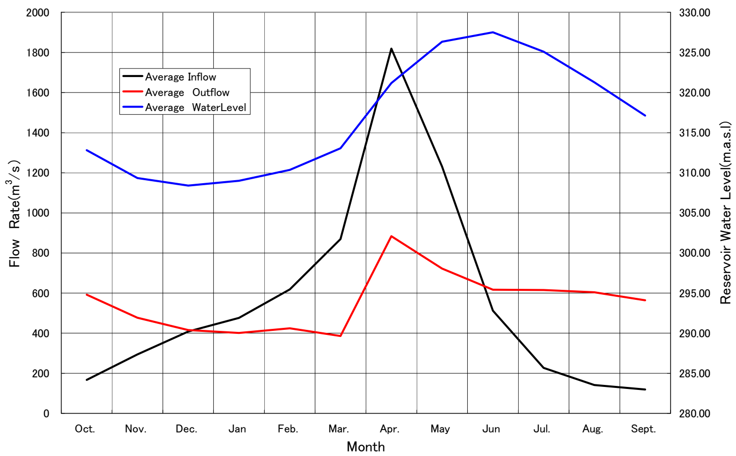


Fig. 5.4-7 Mean Annual Changes during the Period ’93 - ’98

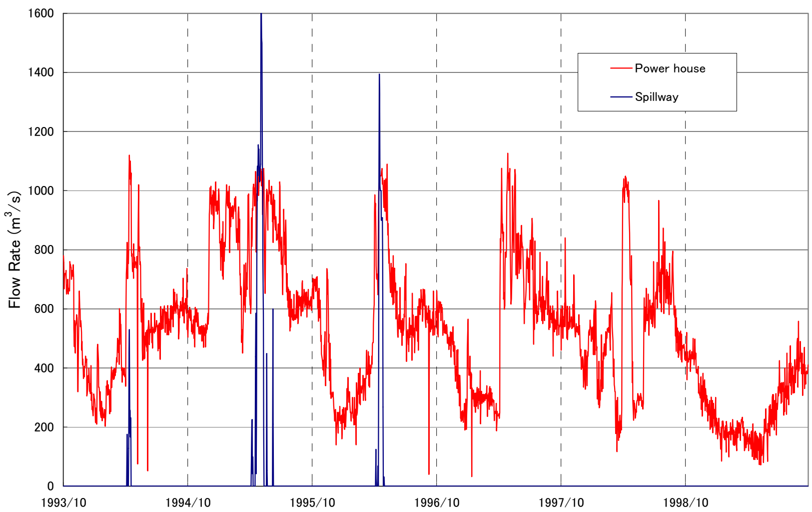


Fig. 5.4-8 Changes in discharged amount from Spillway and Water volume for Power generation

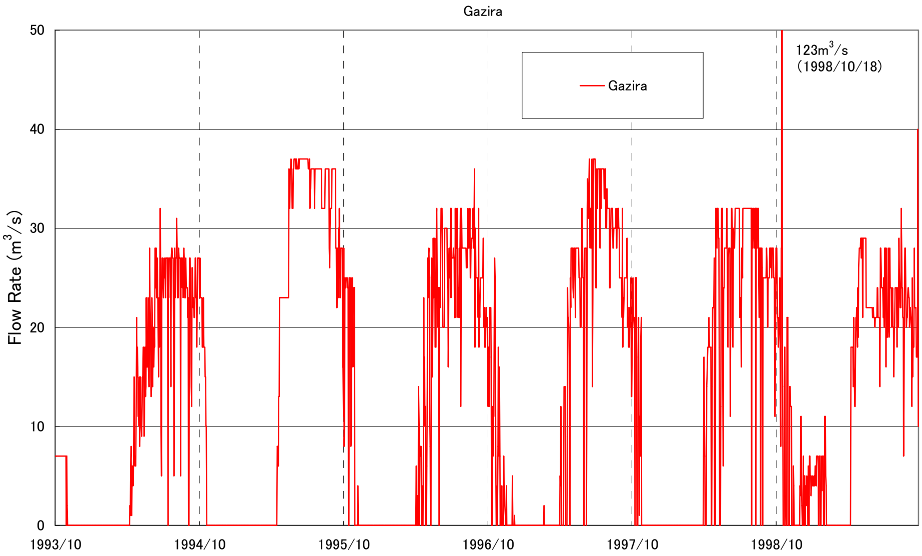


Fig. 5.4-9 Water Intake Performances to North Jazira Irrigation Area

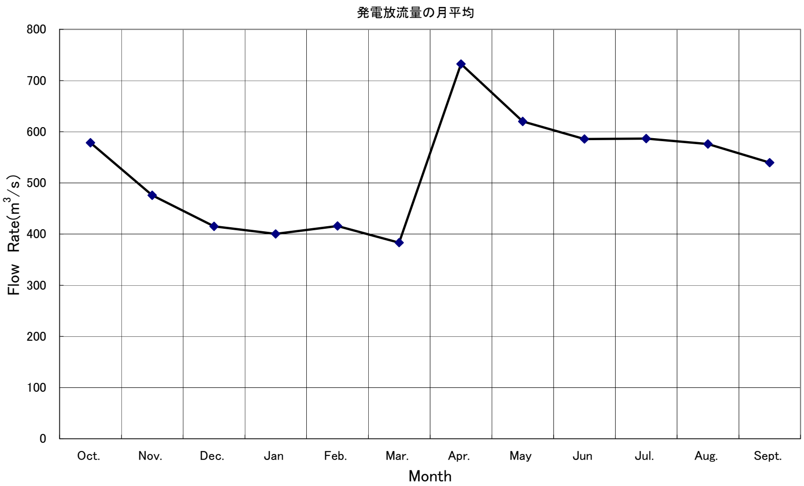


Fig. 5.4-10 Monthly Average for Discharge of Power Generation

Table 5.4-4 Monthly Total of Dam Operation Performances (Reservoir Water Level)

		Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.
1993-1994	Max	315.64	309.97	308.29	310.64	313.81	318.78	325.62	328.56	328.69	327.63	324.70	320.52
	Min	310.08	308.11	308.01	308.11	310.77	314.15	319.08	325.83	327.69	324.79	320.66	316.09
	Aver	312.89	309.01	308.10	309.70	312.50	316.51	323.88	327.48	328.36	326.35	322.80	318.36
1994-1995	Max	315.96	311.91	313.44	312.37	313.58	318.36	326.10	328.73	329.00	327.36	323.52	319.36
	Min	311.85	309.90	310.97	310.90	311.54	312.26	318.48	326.27	327.46	323.65	319.53	314.68
	Aver	313.90	310.72	312.19	311.71	312.70	314.65	323.35	327.46	328.51	325.53	321.61	317.10
1995-1996	Max	314.53	309.26	307.51	309.04	312.48	319.57	324.97	328.14	328.12	326.76	323.63	320.30
	Min	309.35	307.53	307.19	307.14	309.10	312.56	320.25	325.09	326.87	323.76	319.30	316.15
	Aver	311.83	308.35	307.36	308.31	310.97	315.48	323.45	327.00	327.65	325.31	321.57	318.22
1996-1997	Max	314.66	310.80	309.62	311.62	313.28	317.12	329.45	329.85	329.96	328.66	324.84	320.30
	Min	310.21	306.65	305.92	310.02	311.01	313.47	317.33	326.13	328.75	324.98	320.43	316.15
	Aver	312.34	308.34	307.04	311.05	311.73	314.99	321.58	328.33	329.57	326.82	322.68	318.22
1997-1998	Max	316.01	312.10	308.98	307.64	308.09	313.16	322.21	328.67	328.97	327.43	323.05	317.86
	Min	312.18	309.08	307.77	305.76	306.24	306.97	314.34	322.69	327.52	323.21	318.01	313.87
	Aver	313.96	310.76	308.46	306.47	307.39	308.39	318.71	326.12	328.49	325.50	320.58	315.83
1998-1999	Max	313.74	310.11	307.74	306.92	307.63	309.54	319.62	322.68	322.78	322.04	319.93	316.79
	Min	310.26	307.78	306.93	306.66	306.45	307.67	309.75	319.75	322.09	320.00	316.91	313.44
	Aver	312.01	308.82	307.25	306.80	306.81	308.30	316.13	321.58	322.55	321.06	318.48	315.07
Average	Max	315.09	310.69	309.26	309.71	311.48	316.09	324.66	327.77	327.92	326.65	323.28	319.19
	Min	310.66	308.18	307.80	308.10	309.19	311.18	316.54	324.29	326.73	323.40	319.14	315.06
	Aver	312.82	309.34	308.40	309.00	310.35	313.05	321.18	326.33	327.52	325.10	321.29	317.13

Table 5.4-5 Monthly Total of Dam Operation Performances (Inflow Volume in m^3/sec)

		Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.
1993–1994	Max	267	571	432	1101	1345	1462	6052	1831	716	357	945	174
	Min	80	208	233	274	395	732	981	726	286	122	77	69
	Aver	173	345	331	508	659	960	1742	1109	460	228	168	128
1994–1995	Max	267	2216	2219	1325	2597	2702	3458	3475	1377	478	246	212
	Min	112	143	385	85	688	142	1134	1231	429	171	120	103
	Aver	167	540	843	911	1064	1277	2167	1848	834	316	184	152
1995–1996	Max	255	878	272	1054	1457	2170	3667	1817	728	307	191	195
	Min	95	103	111	193	372	526	1328	729	282	127	86	71
	Aver	165	301	210	422	628	1135	2031	1280	462	218	130	122
1996–1997	Max	230	229	1586	1539	1589	943	3317	2131	1004	416	216	195
	Min	115	110	129	255	245	373	945	1021	354	163	102	71
	Aver	162	170	536	528	479	669	1802	1457	647	265	139	122
1997–1998	Max	387	940	630	563	1636	4526	4245	2014	800	257	181	138
	Min	101	149	140	200	339	340	1354	735	248	122	102	83
	Aver	203	262	334	312	609	820	1965	1135	460	198	134	108
1998–1999	Max	184	202	286	256	603	794	3357	916	340	180	120	109
	Min	98	108	149	110	93	144	699	311	121	97	80	73
	Aver	131	144	195	177	267	356	1205	557	211	135	93	85
Average	Max	265	839	904	973	1538	2100	4016	2031	828	333	317	171
	Min	100	137	191	186	355	376	1074	792	287	134	95	78
	Aver	167	294	408	476	618	870	1819	1231	512	227	142	119

Table 5.4-6 Monthly Total of Dam Operation Performances (Outflow Volume in m^3/sec)

		Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.
1993–1994	Max	787	660	440	480	403	601	1651	1035	608	637	690	764
	Min	657	320	238	210	203	352	338	85	72	456	539	498
	Aver	714	501	342	288	328	436	882	654	529	572	609	621
1994–1995	Max	628	587	1030	1020	1176	1005	2225	2708	1593	971	698	731
	Min	471	470	548	700	790	450	584	688	832	561	586	600
	Aver	570	530	927	870	961	722	1259	1469	978	769	632	659
1995–1996	Max	734	736	319	368	400	550	2429	1090	738	780	697	682
	Min	441	297	140	192	140	290	600	638	504	449	486	58
	Aver	646	452	237	265	292	396	1352	837	597	568	621	568
1996–1997	Max	673	563	467	565	391	337	1152	1103	910	942	823	682
	Min	522	355	190	32	211	187	233	644	587	516	560	458
	Aver	584	474	285	340	300	275	725	891	765	725	658	582
1997–1998	Max	840	715	562	627	611	655	1063	421	691	999	855	635
	Min	478	440	328	265	320	117	623	255	293	558	608	448
	Aver	582	546	442	449	487	302	918	310	578	712	703	525
1998–1999	Max	541	519	330	303	226	233	226	284	339	465	520	579
	Min	381	237	181	91	99	120	108	101	106	263	299	319
	Aver	456	359	261	196	177	187	163	172	256	345	400	427
Average	Max	701	630	525	561	535	564	1458	1107	813	799	714	679
	Min	492	353	271	248	294	253	414	402	399	467	513	397
	Aver	592	477	416	401	424	386	883	722	617	615	604	564

Table 5.4-7 Monthly Total of Dam Operation Performances (Intake for North Jazira in m^3/sec)

		Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.
1993–1994	Max	7	0	0	0	0	0	21	28	32	28	31	27
	Min	0	0	0	0	0	0	0	8	5	0	5	0
	Aver	7	0	0	0	0	0	6	15	21	24	25	22
1994–1995	Max	27	0	0	0	0	0	23	37	37	37	36	36
	Min	0	0	0	0	0	0	0	23	36	32	26	16
	Aver	12	0	0	0	0	0	8	29	37	36	34	30
1995–1996	Max	28	4	0	0	0	0	23	32	32	32	36	32
	Min	0	0	0	0	0	0	0	0	0	12	18	18
	Aver	19	0	0	0	0	0	5	21	25	26	28	24
1996–1997	Max	27	16	5	0	2	0	25	32	37	37	34	32
	Min	0	0	0	0	0	0	0	20	0	24	24	18
	Aver	13	2	0	0	0	0	8	26	27	34	30	24
1997–1998	Max	25	0	0	0	0	0	27	32	32	32	32	28
	Min	0	0	0	0	0	0	0	0	11	16	0	20
	Aver	13	0	0	0	0	0	13	22	28	30	26	26
1998–1999	Max	123	21	11	7	11	0	24	29	28	28	32	40
	Min	0	0	0	0	0	0	0	19	14	15	7	10
	Aver	18	5	3	5	1	0	11	26	22	22	23	21
Average	Max	40	7	3	1	2	0	24	32	33	32	34	33
	Min	0	0	0	0	0	0	0	12	11	17	13	14
	Aver	14	1	1	1	0	0	9	23	27	29	28	24

Table 5.4-8 Monthly Total of Dam Operation Performances (Power Generation in m^3/sec)

		Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.
1993-1994	Max	780	660	440	480	403	601	1120	1020	586	610	667	737
	Min	650	320	238	210	203	352	338	75	52	429	512	498
	Aver	707	501	342	288	328	436	801	639	508	548	584	600
1994-1995	Max	605	587	1030	1020	1015	989	1073	1075	1030	937	662	695
	Min	471	470	548	700	790	450	584	652	795	525	550	572
	Aver	558	530	927	870	912	704	904	967	914	733	598	629
1995-1996	Max	709	736	319	368	400	550	1075	1090	738	753	667	660
	Min	441	297	140	192	140	290	600	614	476	422	460	40
	Aver	627	452	237	265	292	396	914	815	572	542	593	545
1996-1997	Max	661	547	462	565	391	337	1127	1075	882	906	791	660
	Min	505	355	190	32	211	187	229	616	550	480	530	440
	Aver	572	472	285	340	300	275	718	865	738	692	628	558
1997-1998	Max	840	715	562	627	611	655	1049	421	670	967	827	610
	Min	0	0	0	0	0	0	0	0	11	16	0	20
	Aver	569	546	442	449	487	302	906	288	550	682	677	499
1998-1999	Max	520	498	330	300	226	233	211	262	313	450	500	558
	Min	360	237	181	85	99	120	90	72	84	240	275	307
	Aver	438	354	257	191	175	187	151	147	234	322	377	406
Average	Max	686	624	524	560	508	561	943	824	703	771	686	653
	Min	405	280	216	203	241	233	307	338	328	352	388	313
	Aver	578	476	415	400	416	383	732	620	586	587	576	539

At the stage of F/S, 330m^3/sec was employed as an indicator for outflow from Mosul Dam to its downstream basin, however, in actual operation some cases have been observed in which outflow below 100m^3/sec were recorded as indicated in Table 5.4-6. As to water volume for power generation, it has a peak requirement on average in April, then the demand grow smaller month after month with a fluctuation span of 400 to 700m^3/sec. As shown in Table 5.4-9, errors in water balance in the case of actual measurement are mostly ranged within around 1%, but in some cases it exceeds a few percent.

Table 5.4-9 Calculated and Observed Reservoir Volume by Month

Year	Month	Observed volume (MCM) ②	Calculated vplume (MCM) ⑪=V_{i-1}+⑩	Difference ⑫=②-⑪	Ratio ⑫/②
1993	10	5004.2	5038.11	-33.91	0.68%
	11	4585.3	4599.42	-14.12	0.31%
	12	4551.4	4555.66	-4.26	0.09%
1994	1	5138.3	5140.48	-2.18	0.04%
	2	5934.2	5939.49	-5.29	0.09%
	3	7321.2	7337.25	-16.05	0.22%
	4	9520.0	9548.42	-28.42	0.30%
	5	10572.0	10738.84	-166.84	1.58%
	6	10254.0	10393.67	-139.67	1.36%
	7	9233.9	9333.24	-99.34	1.08%
	8	7891.1	8052.73	-161.63	2.05%
	9	6548.7	6613.50	-64.80	0.99%
	10	5434.0	5471.21	-37.21	0.68%
	11	5448.8	5458.97	-10.17	0.19%
	12	5217.3	5223.47	-6.17	0.12%
1995	1	5382.3	5326.60	55.70	1.03%
	2	5622.8	5631.56	-8.76	0.16%
	3	7197.5	7109.74	87.76	1.22%
	4	9686.0	9550.43	135.57	1.40%
	5	10635.0	10701.72	-66.72	0.63%
	6	10171.0	10261.84	-90.84	0.89%
	7	8850.7	8958.89	-108.19	1.22%
	8	7545.8	7651.47	-105.67	1.40%
	9	6164.7	6231.83	-67.13	1.09%
	10	4833.9	4874.92	-41.02	0.85%
	11	4423.3	4444.41	-21.11	0.48%
	12	4348.7	4350.64	-1.94	0.04%
1996	1	4761.8	4769.47	-7.67	0.16%
	2	5592.4	5601.95	-9.55	0.17%
	3	7557.9	7573.47	-15.57	0.21%
	4	9494.8	9316.05	178.75	1.88%
	5	10414.0	10682.02	-268.02	2.57%
	6	9959.0	10063.48	-104.48	1.05%
	7	8887.1	9021.21	-134.11	1.51%
	8	7476.5	7572.35	-95.85	1.28%
	9	6565.6	6319.09	246.51	3.75%
	10	5035.7	5435.57	-399.87	7.94%
	11	4232.5	4247.13	-14.63	0.35%
	12	4986.7	4903.31	83.39	1.67%
1997	1	5369.9	5490.07	-120.17	2.24%
	2	5796.0	5803.80	-7.80	0.13%
	3	6838.5	6852.41	-13.91	0.20%
	4	9606.0	9628.27	-22.27	0.23%
	5	11054.0	11121.02	-67.02	0.61%
	6	10642.0	10750.13	-108.13	1.02%
	7	9298.2	9408.29	-110.09	1.18%
	8	7820.2	7908.37	-88.17	1.13%
	9	6565.6	6627.71	-62.11	0.95%
	10	5516.5	5549.80	-33.30	0.60%
	11	4771.1	4781.50	-10.40	0.22%
	12	4476.0	4481.31	-5.31	0.12%
1998	1	4100.4	4109.06	-8.66	0.21%
	2	4390.4	4397.18	-6.78	0.15%
	3	5765.5	5778.59	-13.09	0.23%
	4	8454.3	8478.89	-24.59	0.29%
	5	10613.0	10666.14	-53.14	0.50%
	6	10193.0	10307.92	-114.92	1.13%
	7	8705.0	8815.35	-110.35	1.27%
	8	7094.4	7181.25	-86.85	1.22%
	9	5949.8	6012.41	-62.61	1.05%
	10	5047.3	5078.72	-31.42	0.62%
	11	4478.2	4491.83	-13.63	0.30%
	12	4292.1	4304.02	-11.92	0.28%
1999	1	4234.6	4242.12	-7.52	0.18%
	2	4445.3	4453.88	-8.58	0.19%
	3	4878.1	4898.30	-20.20	0.41%
	4	7572.9	7579.22	-6.32	0.08%
	5	8532.0	8602.36	-70.36	0.82%
	6	8341.1	8415.27	-74.17	0.89%
	7	7687.5	7778.12	-90.62	1.18%
	8	6778.8	6866.70	-87.90	1.30%
	9	5838.2	5891.47	-53.27	0.91%

(2) Examination from dam operation performances

Data on dam operation performances for 6 years are summarized in Table 5.4-10. During this period, it has been found that inflow and outflow had mostly been well-balanced, where dam storage was operated in a range of WL 306.0 – 330 m by thoroughly utilizing storage effect of the reservoir, the water source. At current stage where irrigation water for North Irrigation Area has not yet reached its peak demand, currently available outflow to downstream basin (= outflow through the spillway + water for power generation + difference in water balance) is averaged at 17.61 BCM.

Table 5.4-10 Result of Water Balance by Examining Dam Operation Performances (Unit: BCM)

Year	Inflow (BCM)	Outflow (BCM)					In - Out (BCM)	Available water volume to discharge to
		Gazira	Bottom	Spillway	Power	Total		
1993 ~ 1994	17.84	0.32	0.00	0.19	16.53	17.04	0.80	17.63
1994 ~ 1995	27.00	0.49	0.17	2.24	24.27	27.16	-0.16	26.35
1995 ~ 1996	18.67	0.39	0.00	1.12	16.48	17.99	0.67	18.27
1996 ~ 1997	18.32	0.43	0.00	0.00	16.96	17.39	0.93	17.99
1997 ~ 1998	17.12	0.41	0.00	0.00	16.79	17.20	-0.09	16.70
1998 ~ 1999	9.31	0.42	0.00	0.00	8.53	8.95	0.36	8.90
Average	18.04	0.4097	0.03	0.59	16.59	17.62	0.42	17.61

(3) Examination on Overall Water Balance

Result of examining overall water balance by dam operation performances is summarized in Table 5.4-11.

Table 5.4-11 Influence of Change in Inflow on Water Balance (Unit: BCM)

(Unit :BCM)

<table>
<tr><th colspan="3" rowspan="2">Average performance of annual inflow (a)</th><th colspan="4">Planned irrigation water (b)</th><th rowspan="2">Power generation (c)</th><th rowspan="2">Inflow Total d:(b+c)</th><th rowspan="2">Balance e:(a-d)</th><th rowspan="2">Available outflow (c+e)</th></tr>
<tr><th>North</th><th>East</th><th>South</th><th>Total</th></tr>
<tr><td>Case-A</td><td>1931-2010</td><td>:20.10</td><td rowspan="4">0.77</td><td rowspan="4">0.79</td><td rowspan="4">1.71[1)]</td><td rowspan="4">3.28</td><td rowspan="4">16.59</td><td rowspan="4">19.87</td><td>0.23</td><td>16.82</td></tr>
<tr><td>Case-B</td><td>1993-1999</td><td>:18.04</td><td>▲1.83</td><td>14.76</td></tr>
<tr><td>Case-C</td><td>1999-2010</td><td>:14.95</td><td>▲4.92</td><td>11.67</td></tr>
<tr><td>Case-D</td><td>Estimated inflow in future</td><td>:10.10</td><td>▲9.77</td><td>6.82</td></tr>
</table>

Remark 1) Value 1.71 BCM was based on the Swiss F/S report.

As shown in "Case A", provided that the inflow is 20.10 BCM, outflow of 16.82 BCM can be discharged to downstream even with current discharge for power generation and delivery of fully-planned irrigation water.

As shown in "Case B", provided that the inflow is 18.04 BCM, it is required to control the scale of the designed irrigation plan for Jazira Irrigation Areas to 44% of the original one if current water for power generation should be procured. Inversely, if water for power generation is restrained for giving priority to the irrigation plan, it will be necessary to limit water for powerhouse to 89% of current supply, namely 14.76 BCM.

As shown in "Case C", provided that the inflow is 14.95 BCM, the irrigation plan for Jazira Irrigation Areas becomes impossible in the case that current water for power generation is maintained. However, if priority is given to the irrigation plan and water for powerhouse is to be curtailed, necessity arises to limit water for power generation within 70% of current supply, or 11.67 BCM.

As shown in "Case D", provided that the inflow is 10.10 BCM with the consideration on future exploitation of irrigation in the countries located in the upstream, irrigation plan for Jazira Irrigation Areas will not be able to realize. But if priority is given to the irrigation plan while scale of power generation is controlled, water for power generation will have to be controlled at 41 % of the current supply, namely 6.82 BCM.

As cited above, it has been made clear that result of evaluation on inflow deeply affects the scale of irrigation plan for Jazira Irrigation Areas.

Here, interrelationship of water for power generation as well as that for water distribution to current irrigation areas located in the downstream with this irrigation plan is important, however, at any rate the necessity of promoting nation-wide water-saving irrigation has more clearly been identified in the agricultural sector that is the largest consumer of surface water, covering the whole territory of Iraq. In this connection, this overall examination has omitted the part for reservoir loss.

(4) Examination of water balance based on dam operation performances for 6 years

Water balance has been examined based on dam operation performances for 6 years, 1993 to 1999, on the following conditions;

1) Calculation was made on the unit, "day".
2) Reservoir loss was calculated in consideration with the result of evaluation on water level by means of interrelationship formulae; water level (WL) - Storage volume and WL - Storage area as well as with change in storage surface area so that the loss was reflected in water balance.
3) As to the estimation of reservoir loss, the loss predicted from the result of dam operation performances in 2008 was adopted.
4) As for the operation of the reservoir, it was decided to lower the minimum water level to WL300 m.
5) As irrigation water requirement and water volume for power generation, it was assumed to take pre-determined volumes, and any failure of intake occurring below the minimum water level WL300m was counted as deficit.

In examining water balance, several conditions were assumed by case, and the results of calculations were summarized into summing-up tables and resulting diagrams of dam operation.

Also, the conditions adopted in each case and the results of the evaluation are summarized in Table 5.4-12.

Table 5.4-12 Conditions Employed in Each Case and Evaluation of the Results

Case	Condition of inflow (Mean annual inflow)	Scale of irrigation (Mean annual intake)	Water for power generation		Mean annual deficit	Evaluation
			Condition	(Mean annual water use)		
Case 1-1	Average performance (18.0BCM)	100% (3.28BCM)	Average performance	(16.6BCM)	1.7BCM	Given priority to irrigation, power generation is required to control.
Case 1-2			Performance + stop in water deficit	(14.9BCM)	0 BCM	Given priority to irrigation, power generation should be stopped in water deficit.
Case 1-3			96% of average performance + stop in water deficit	(14.3BCM)	0 BCM	Given priority to irrigation, even with power at 96% of average performance, power should be stopped in water deficit.
Case 2-1		50% (1.64BCM)	Average performance	(16.6BCM)	0.3BCM	Given priority to power, even with 50% of planned irrigation scale, power generation will be deficit.
Case 3-1	Future inflow (10.1BCM)	100% (3.28BCM)	Average performance	(16.6BCM)	9.5BCM	Given priority to irrigation, serious influence is raised in power generation.
Case 3-2		0% (0 BCM)	Average performance	(16.6BCM)	6.7BCM	Even stop irrigation, influence is raised in power generation.
Case 3-3		100% (3.28BCM)	35% of average performance	(5.8BCM)	0 BCM	Given priority to irrigation, power generation should be reduced by 35%

Table 5.4-13 Water Balance in Case 1-1
(By Actual Inflow, Irrigation: 100%, Power: 100%)

Table Summary of Water Balance in Case1-1

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	17.84	0.77	0.79	1.71	3.27	0.00	0.00	16.53	19.81	0.66	0.00	−2.63	4.32	6.95	−2.63
1994-1995	27.00	0.77	0.79	1.71	3.27	0.00	0.00	24.27	27.55	0.60	0.56	−0.58	3.74	4.32	−0.58
1995-1996	18.67	0.77	0.79	1.71	3.27	0.00	0.00	16.48	19.75	0.59	1.46	−0.22	3.52	3.74	−0.22
1996-1997	18.32	0.77	0.79	1.71	3.27	0.00	0.00	16.96	20.24	0.58	1.97	−0.52	2.99	3.52	−0.53
1997-1998	17.12	0.77	0.79	1.71	3.27	0.00	0.00	16.79	20.07	0.54	3.45	−0.04	2.95	2.99	−0.04
1998-1999	9.31	0.77	0.79	1.71	3.27	0.00	0.00	8.53	11.81	0.48	2.98	0.00	2.95	2.95	0.00
Total	108.27	4.64	4.74	10.26	19.65	0.00	0.00	99.56	119.22	3.46	10.41	−4.00	20.47	24.47	−4.00
Average	18.04	0.77	0.79	1.71	3.27	0.00	0.00	16.59	19.87	0.58	1.74	−0.67	3.41	4.08	−0.67

Table 5.4-14 Water Balance in Case 1-2
(By Actual Inflow, Irrigation: 100%,
Power: 100% but stop power in the case water deficit arises)

Table Summary of Water Balance in Case1-2

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	17.84	0.77	0.79	1.71	3.27	0.00	0.00	16.53	19.81	0.66	0.00	−2.63	4.32	6.95	−2.63
1994-1995	27.00	0.77	0.79	1.71	3.27	0.00	0.00	23.71	26.98	0.60	0.00	−0.58	3.74	4.32	−0.58
1995-1996	18.67	0.77	0.79	1.71	3.27	0.00	0.00	15.02	18.30	0.59	0.00	−0.22	3.52	3.74	−0.22
1996-1997	18.32	0.77	0.79	1.71	3.27	0.00	0.00	14.99	18.27	0.58	0.00	−0.52	2.99	3.52	−0.53
1997-1998	17.12	0.77	0.79	1.71	3.27	0.00	0.00	13.35	16.63	0.54	0.01	−0.04	2.95	2.99	−0.04
1998-1999	9.31	0.77	0.79	1.71	3.27	0.00	0.00	5.60	8.88	0.48	0.05	0.00	2.95	2.95	0.00
Total	108.27	4.64	4.74	10.26	19.65	0.00	0.00	89.21	108.86	3.46	0.06	−4.00	20.47	24.47	−4.00
Average	18.04	0.77	0.79	1.71	3.27	0.00	0.00	14.87	18.14	0.58	0.01	−0.67	3.41	4.08	−0.67

Table 5.4-15 Water Balance in Case 1-3
(By Actual Inflow, Irrigation: 100%,
Power: 95% but stop power in the case water deficit arises)

Table Summary of Water Balance in Case1-3

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	17.84	0.77	0.79	1.71	3.27	0.00	0.00	15.87	19.15	0.68	0.00	−1.99	4.96	6.95	−1.99
1994-1995	27.00	0.77	0.79	1.71	3.27	0.00	0.00	22.76	26.04	0.67	0.00	0.30	5.26	4.96	0.30
1995-1996	18.67	0.77	0.79	1.71	3.27	0.00	0.00	14.42	17.69	0.70	0.00	0.27	5.53	5.26	0.27
1996-1997	18.32	0.77	0.79	1.71	3.27	0.00	0.00	14.39	17.67	0.71	0.00	−0.06	5.48	5.53	−0.05
1997-1998	17.12	0.77	0.79	1.71	3.27	0.00	0.00	12.82	16.10	0.70	0.00	0.32	5.80	5.48	0.32
1998-1999	9.31	0.77	0.79	1.71	3.27	0.00	0.00	5.38	8.65	0.66	0.00	0.01	5.81	5.80	0.01
Total	108.27	4.64	4.74	10.26	19.65	0.00	0.00	85.64	105.29	4.12	0.00	−1.14	32.84	33.98	−1.14
Average	18.04	0.77	0.79	1.71	3.27	0.00	0.00	14.27	17.55	0.69	0.00	−0.19	5.47	5.66	−0.19

Table 5.4-16 Water Balance in Case 2-1
(By Actual Inflow, Irrigation: 50%, Power Generation: 100%)

Table Summary of Water Balance in Case2-1

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	17.84	0.39	0.40	0.86	1.64	0.00	0.00	16.53	18.17	0.71	0.00	−1.04	5.91	6.95	−1.04
1994-1995	27.00	0.39	0.40	0.86	1.64	0.00	0.00	24.27	25.91	0.71	0.00	0.38	6.27	5.91	0.36
1995-1996	18.67	0.39	0.40	0.86	1.64	0.00	0.00	16.48	18.11	0.71	0.00	−0.16	6.11	6.27	−0.16
1996-1997	18.32	0.39	0.40	0.86	1.64	0.00	0.00	16.96	18.60	0.68	0.00	−0.95	5.16	6.11	−0.95
1997-1998	17.12	0.39	0.40	0.86	1.64	0.00	0.00	16.79	18.43	0.59	0.52	−1.39	3.77	5.16	−1.39
1998-1999	9.31	0.39	0.40	0.86	1.64	0.00	0.00	8.53	10.17	0.53	1.11	−0.27	3.49	3.77	−0.28
Total	108.27	2.32	2.37	5.13	9.82	0.00	0.00	99.56	109.39	3.94	1.63	−3.44	30.71	34.17	−3.46
Average	18.04	0.39	0.40	0.86	1.64	0.00	0.00	16.59	18.23	0.66	0.27	−0.57	5.12	5.70	−0.58

Table 5.4-17 Water Balance in Case 3-1
(By Future inflow, Irrigation: 100%, Power Generation: 100%)

Table Summary of Water Balance in Case3-1

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	10.10	0.77	0.79	1.71	3.27	0.00	0.00	16.53	19.81	0.43	6.14	−4.00	2.95	6.95	−4.00
1994-1995	10.10	0.77	0.79	1.71	3.27	0.00	0.00	24.27	27.55	0.40	17.85	0.00	2.95	2.95	0.00
1995-1996	10.10	0.77	0.79	1.71	3.27	0.00	0.00	16.48	19.75	0.40	10.06	0.00	2.95	2.95	0.00
1996-1997	10.10	0.77	0.79	1.71	3.27	0.00	0.00	16.96	20.24	0.40	10.54	0.00	2.95	2.95	0.00
1997-1998	10.10	0.77	0.79	1.71	3.27	0.00	0.00	16.79	20.07	0.42	10.38	0.00	2.95	2.95	0.00
1998-1999	10.10	0.77	0.79	1.71	3.27	0.00	0.00	8.53	11.81	0.51	2.21	0.00	2.95	2.95	0.00
Total	60.60	4.64	4.74	10.26	19.65	0.00	0.00	99.56	119.22	2.56	57.17	−4.00	17.70	21.70	−4.00
Average	10.10	0.77	0.79	1.71	3.27	0.00	0.00	16.59	19.87	0.43	9.53	−0.67	2.95	3.62	−0.67

Table 5.4-18 Water Balance in Case 3-2
(By Future inflow, Irrigation: 0%, Power Generation: 0%)

Table Summary of Water Balance in Case3-2

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	10.10	0.00	0.00	0.00	0.00	0.00	0.00	16.53	16.53	0.47	2.90	−4.00	2.95	6.95	−4.00
1994-1995	10.10	0.00	0.00	0.00	0.00	0.00	0.00	24.27	24.27	0.40	14.57	0.00	2.95	2.95	0.00
1995-1996	10.10	0.00	0.00	0.00	0.00	0.00	0.00	16.48	16.48	0.42	6.79	0.00	2.95	2.95	0.00
1996-1997	10.10	0.00	0.00	0.00	0.00	0.00	0.00	16.96	16.96	0.42	7.28	0.00	2.95	2.95	0.00
1997-1998	10.10	0.00	0.00	0.00	0.00	0.00	0.00	16.79	16.79	0.45	7.14	0.00	2.95	2.95	0.00
1998-1999	10.10	0.00	0.00	0.00	0.00	0.00	0.00	8.53	8.53	0.59	1.51	2.49	5.44	2.95	2.49
Total	60.60	0.00	0.00	0.00	0.00	0.00	0.00	99.56	99.56	2.74	40.19	−1.51	20.19	21.70	−1.51
Average	10.10	0.00	0.00	0.00	0.00	0.00	0.00	16.59	16.59	0.46	6.70	−0.25	3.37	3.62	−0.25

Table 5.4-19 Water Balance in Case 3-3
(By Future Inflow, Irrigation: 100%, Power Generation: 35%)

Table Summary of Water Balance in Case3-3

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④～⑥)	⑧	⑨	⑩	⑪=Σ(⑦～⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_i$	⑯=②$_{i-1}$−②$_i$
1993−1994	10.10	0.77	0.79	1.71	3.27	0.00	0.00	5.79	9.06	0.72	0.00	0.32	7.27	6.95	0.32
1994−1995	10.10	0.77	0.79	1.71	3.27	0.00	0.00	8.49	11.77	0.63	0.00	−2.30	4.97	7.27	−2.30
1995−1996	10.10	0.77	0.79	1.71	3.27	0.00	0.00	5.77	9.05	0.61	0.00	0.44	5.41	4.97	0.44
1996−1997	10.10	0.77	0.79	1.71	3.27	0.00	0.00	5.94	9.21	0.63	0.00	0.26	5.67	5.41	0.26
1997−1998	10.10	0.77	0.79	1.71	3.27	0.00	0.00	5.88	9.15	0.64	0.00	0.30	5.97	5.67	0.30
1998−1999	10.10	0.77	0.79	1.71	3.27	0.00	0.00	2.99	6.26	0.76	0.00	3.08	9.05	5.97	3.08
Total	60.60	4.64	4.74	10.26	19.65	0.00	0.00	34.85	54.50	4.00	0.00	2.10	38.34	36.24	2.10
Average	10.10	0.77	0.79	1.71	3.27	0.00	0.00	5.81	9.08	0.67	0.00	0.35	6.39	6.04	0.35

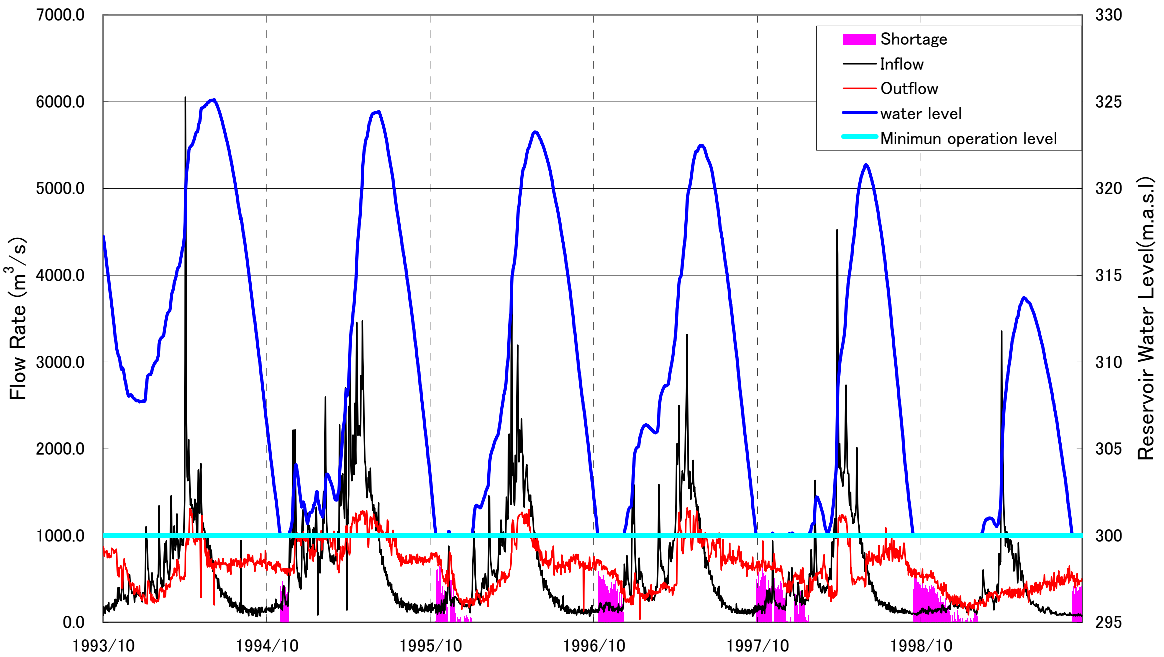


Fig. 5.4-11 Water Balance in Case 1-1
(By Actual Inflow, Irrigation: 100%, Power: 100%)

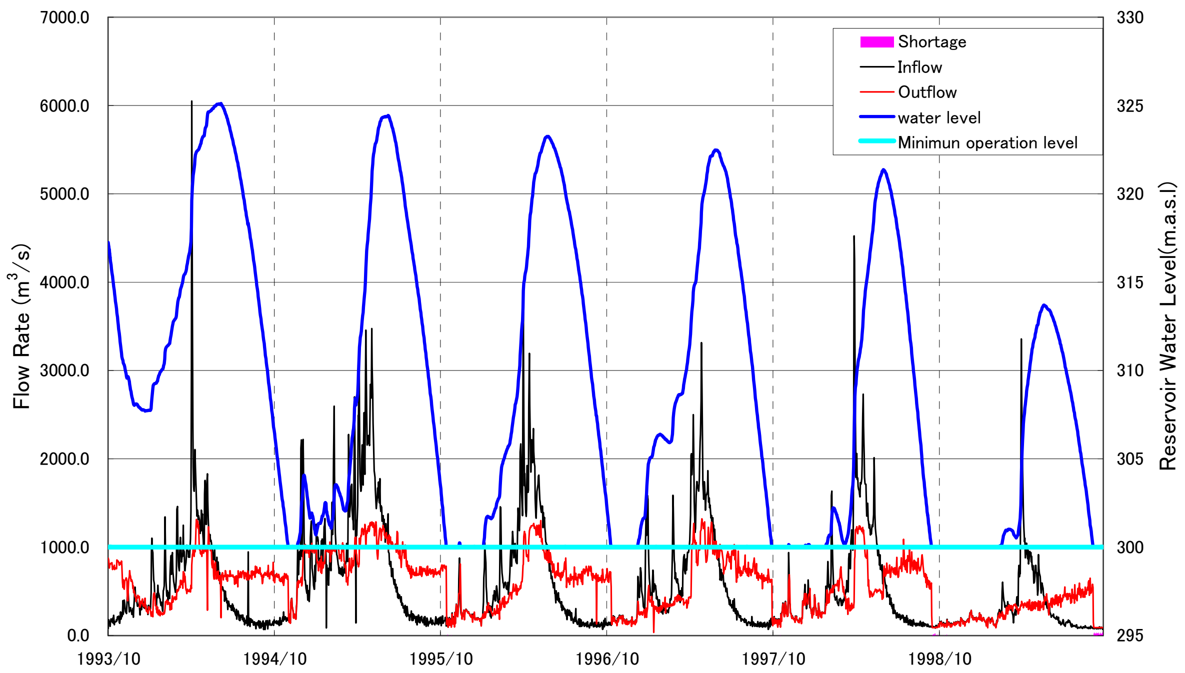


Fig. 5.4-12 Water Balance in Case 1-2
(By Actual Inflow, Irrigation: 100%,
Power: 100% but stop power in the case water deficit arises)

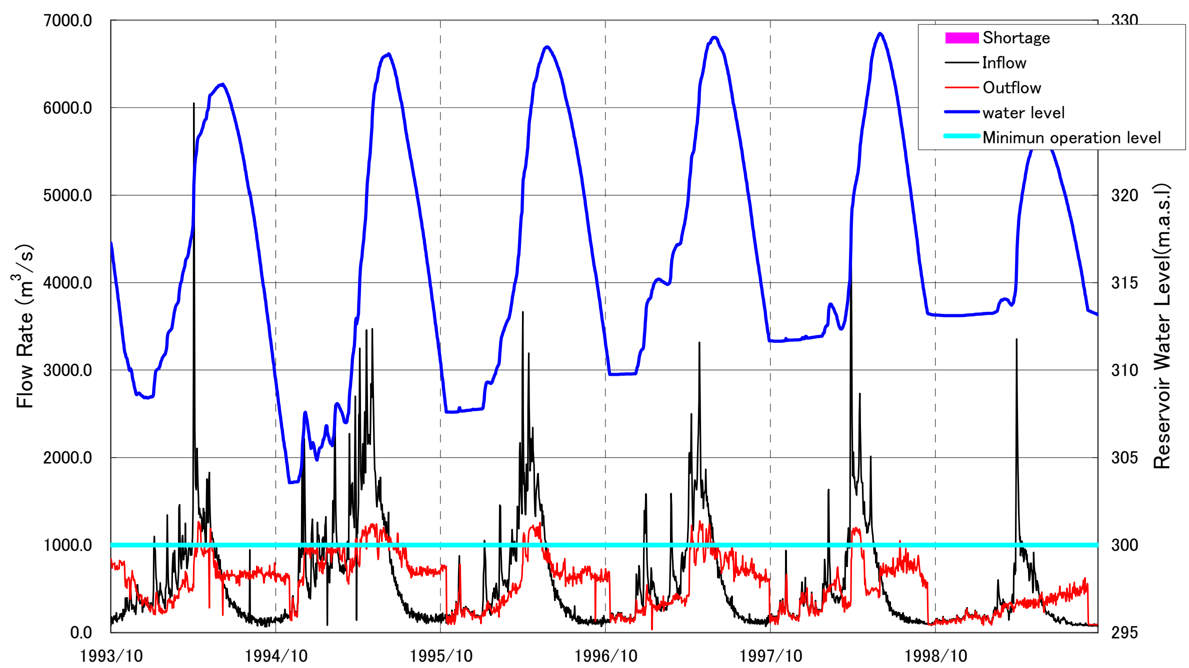


Fig. 5.4-13 Water Balance in Case 1-3
(By Actual Inflow, Irrigation: 100%,
Power: 96% but stop power in the case water deficit arises)

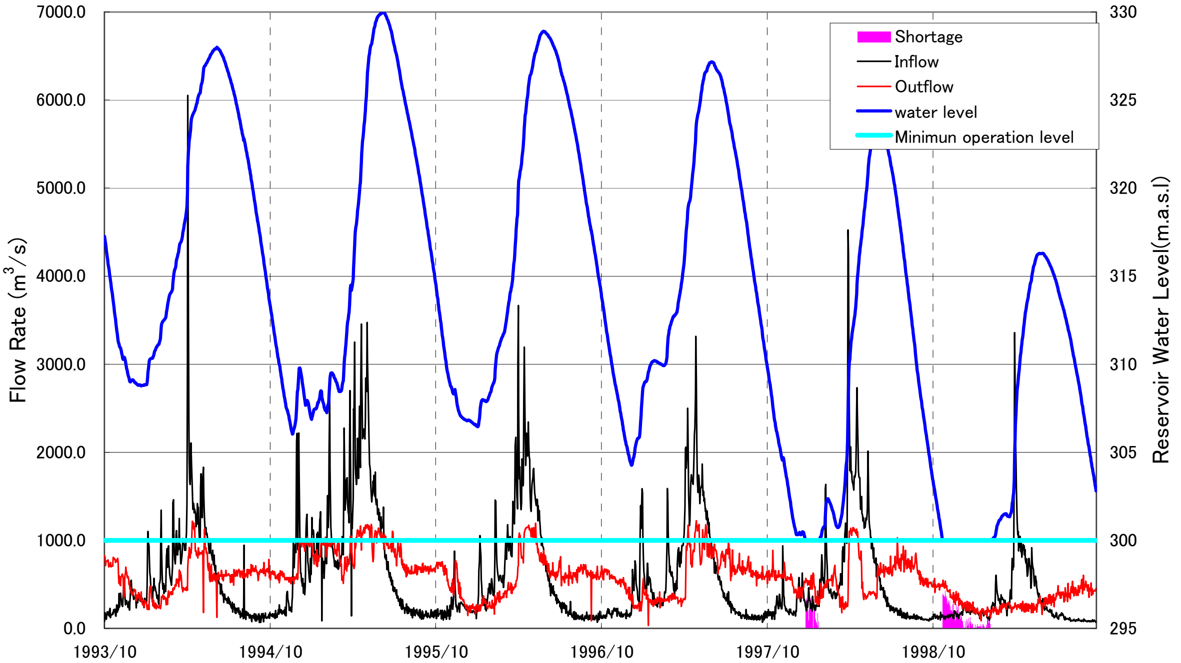


Fig. 5.4-14 Water Balance in Case 2-1
(By Actual Inflow, Irrigation: 50%, Power Generation: 100%)

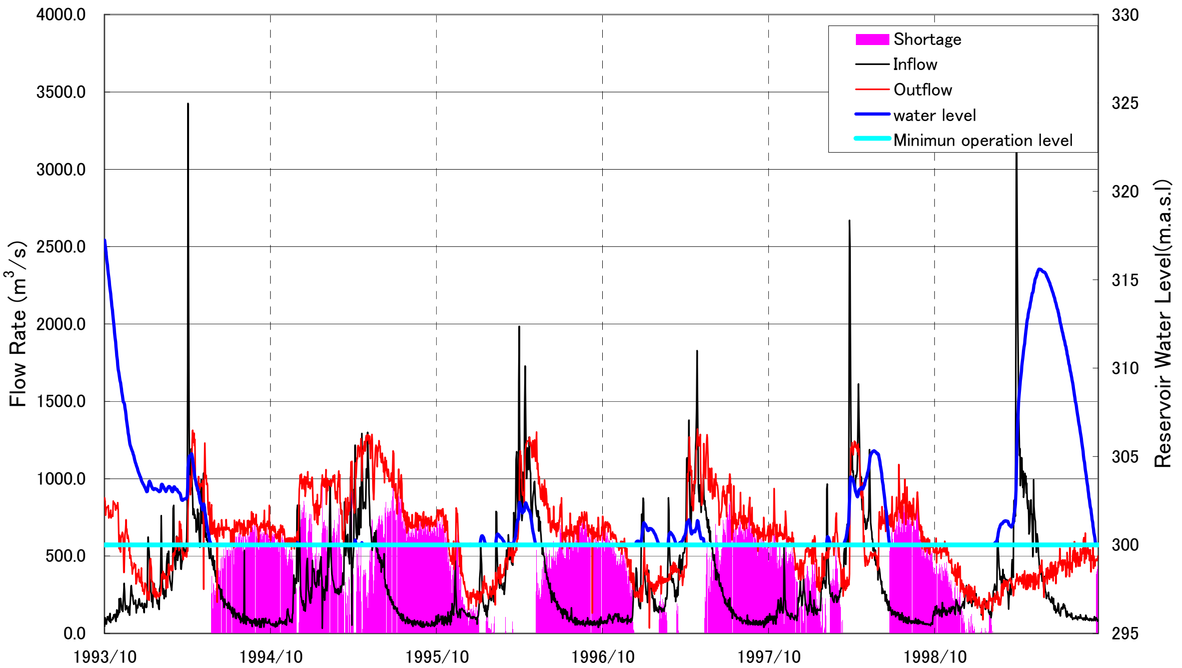


Fig. 5.4-15 Water Balance in Case 3-1
(By Future inflow, Irrigation: 100%, Power Generation: 100%)

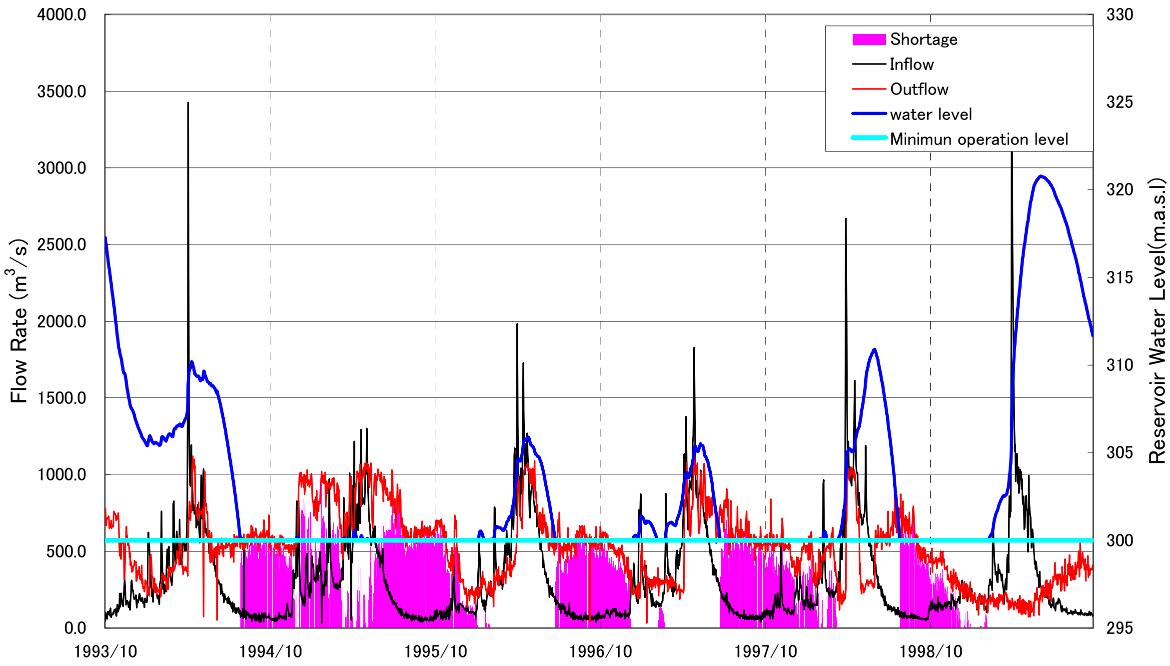


Fig. 5.4-16 Water Balance in Case 3-2
(By Future inflow, Irrigation: 0%, Power Generation: 100%)

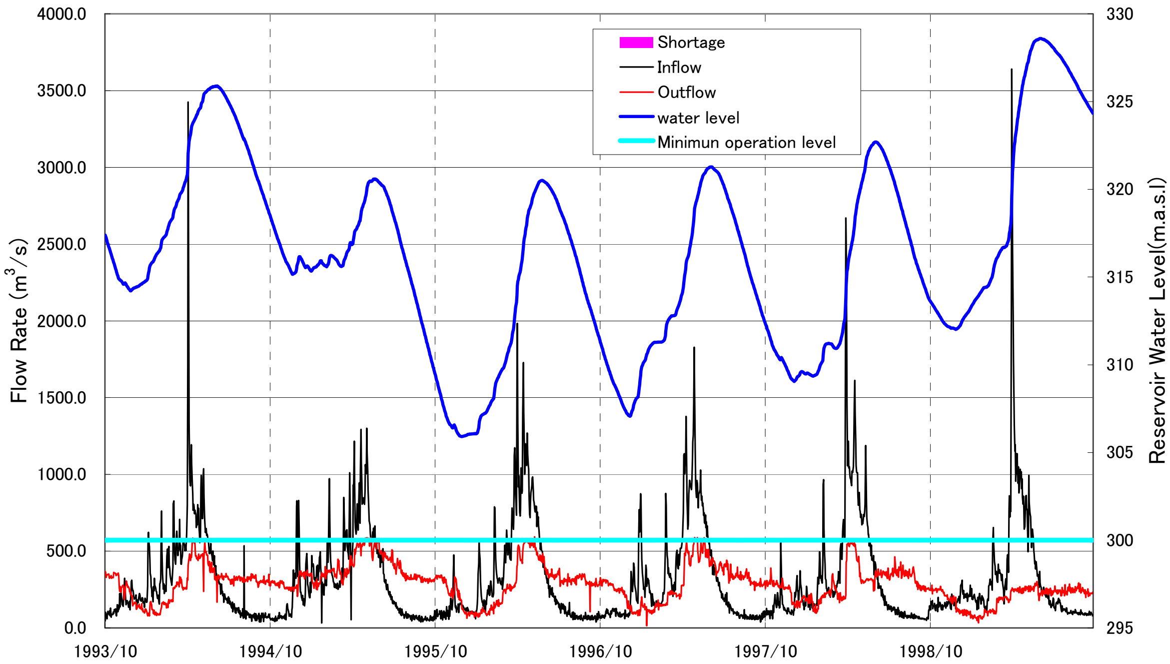


Fig. 5.4-17 Water Balance in Case 3-3
(By Future Inflow, Irrigation: 100%, Power Generation: 35%)

5.5 Priority of Water Resources Utilization (1. Flood control, 2. Agriculture, 3. Power)

Mosul Dam is a multi-purpose dam for flood control, irrigation and power generation. In the "Operation & Maintenance Manual for Sadam Dam (Former name of Mosul Dam)", the priorities for each purpose are specified as the followings;

1) Highest priority is given to flood control. Within the limit of design as storage level shall not exceed the maximum level, flood control is to be given with the highest priority in it's operation.
2) Irrigation water is to be secured as maximum as possible. All the irrigation water required shall be guaranteed as much as possible, though depending in practice on the actually prevailing situation of inflow and storage volume.
3) Power generation shall follow the water release plan for irrigation purpose. Only in the cases that there is a surplus in storage volume or release for flood control is necessary, the said rule 2) will not apply.

At any dams, flood control comes first with the 1st priority seconded by any of water uses. For Mosul too, same idea is applied for the safety of the downstream areas.

Of the irrigation and power generation, higher priority is given to the irrigation purpose. As is the case, the priority order is indicated as the following.

Flood control > Irrigation water > Power generation

In addition, the operation manual indicates the manner of regulating scheme as follows. The project is composed of the following 3 schemes.

1) Main scheme (Mosul Dam): By means of large scale reservoir, required storage volume would be fully provided. Power station is so designed that peak energy be produced.
2) Regulating scheme: Located about 8 km downstream of Mosul Dam, regulate the voluminous daily fluctuation of released water and secure continuous supply of at least 330 m^3/sec irrigation water to downstream areas
3) Pumped storage scheme: Built on the right bank of Mosul Dam, water pumped up during night time and contributes 200 MW additional power generation during the peak demand in daytime.

As above-mentioned, the plan was to secure at least 330 m^3/sec of irrigation water for the downstream irrigation areas under the circumstances at that time, however, the basis of 330 m^3/sec is not confirmed.

It was in the meeting with the PMT that confirmation was made on the water right that downstream of the Mosul Dam has the vested water right of 200 m^3/sec. Concerning this, it is interpreted at the moment that in future water release volume at least 200 m^3/sec is definitely necessary including the water for irrigation purpose.

5.6 Availability of Water Resources by Scenarios (Scenario-0,1,2)

(1) Conditions for examination

Water balance was examined based on the actual dam operation data (1993-1999) with the following conditions applied;

1) Calculation was made on daily basis.
2) Using the co-relation of water level-storage volume and of water level-storage surface area, the water level was assessed in combination with the storage water surface area and the storage loss was estimated to be incorporated in the water balance.
3) For storage loss, the loss assumed from actual operation results in 2008 was adopted.
4) In the dam/reservoir operation, the low water level was set at W.L 300 m.
5) Intakes were fixed at the designed amount for both irrigation and power generation. In case intake could not be materialized due to the water level lower than 300 m, the deficits were accumulated as deficit amount.
6) For the amount of release water to downstream areas, the calculation results which can secure 200 m^3/sec be adopted.

(2) Proposed irrigation water requirement for South Jazira Irrigation Project

In this report, a new farm management plan has been proposed for South Jazira Irrigation Project where crop water requirement has been reviewed /modified based on the latest meteorological data and updated irrigation efficiency.

In the Table 5.6-1, case numbers are given for each area depending on the irrigation areas assumed by applying the results of the said proposal. The crop intensity of this case is 100%.

The irrigation water requirements as presented here are as given in the Table 5.4-1. Factors of effective rainfall are taken into account and the service area is fixed at smaller than the original plan.

Table 5.6-1 Irrigation water requirement in South Jazira area (Proposed)

Scenario	Scenario-0		Scenario-1		Scenario-2	
Area (ha)	148,600		119,000		88,800	
Month	M.C.M	m^3/sec	M.C.M	m^3/sec	M.C.M	m^3/sec
Oct	72.5	27.1	58.1	21.7	43.3	16.2
Nov	62.3	24.0	49.9	19.2	37.2	14.4
Dec	26.1	9.7	20.9	7.8	15.6	5.8
Jan	19.9	7.4	15.9	6.0	11.9	4.4
Feb	62.6	25.9	50.1	20.7	37.4	15.5
Mar	156.0	58.2	124.9	46.6	93.2	34.8
Apr	227.6	87.8	182.2	70.3	136.0	52.5
May	223.4	83.4	178.9	66.8	133.5	49.8
Jun	200.9	77.5	160.9	62.1	120.1	46.3
Jul	166.8	62.3	133.5	49.9	99.7	37.2
Aug	130.9	48.9	104.8	39.1	78.2	29.2
Sep	41.5	16.0	33.2	12.8	24.8	9.6
Total/Average	1,390.4	44.0	1113.5	35.3	830.9	26.3

(3) Cases examined and the results

The inflow into Mosul Dam from Tigris River is fixed at 10.1 BCM/year as projected for future, and an examination on the water balance shall be made through applying the irrigation water requirements for each scenario for the South Jazira area as shown in the Table 5.6-1.

Water released to the downstream of the dam shall not be less than 200 m^3/sec and the same (Water release for power generation) was so adjusted that the water level at the beginning and the one at the last day of operation (Computing) shall be more or less to be the same during the examination period of 1993-1999.

The manner of adjustment can be explained as the following. The daily water release amount shall be reduced by multiplying some coefficients on the actually measured water release amount to the downstream, and if in case the value is less than 200 m^3/sec, it was adjusted to be 200 m^3/sec, where a certain coefficient could be worked out through try-and-error computations so as to make the water levels at the beginning and the last day of computation be almost the same. This implies that there is no change in the storage volume during the computation period and each item of incomings and outgoings shall be balanced.

Table 5.6-2 shows the results of examination on each scenario. Also, the summary tabulation on the outcome of water balance for each scenario is presented in the Tables 5.6-3 to 5.6-6. Further, the Fig. 5.6-1 to 5.6-4 illustrate the results of computations on water source operation.

In each scenario, there occurred no water shortage during the examined period.

For the release (Power generation) to the downstream area, more than 200 m^3/sec was conditioned for the whole period and the computation results showed a balance in incoming and outgoing without shortage in all scenarios.

However, the releases to downstream areas ranges from 6.46-7.04 BCM for the cases of scenario 0-2 against the present actual volume of 16.59 BCM, showing the performance less than half at 39-42 % only.

Table 5.6-2 irrigation water requirements for each scenario for the South Jazira area

Scenario	Irrigation area (ha)	Inflow (BCM)	Intake volume from the Dam (BCM)						Storage loss (BCM)	Deficit (BCM)
			North	East	South	Irrigation water (Sub-total)	Power generation (Releasing)	Intake volume (Total)		
0	148,600	10.1	0.77	0.79	1.39	2.95	6.46	9.41	0.69	0.0
1	119,000				1.11	2.68	6.75	9.42	0.68	0.0
2	86,800				0.83	2.40	7.04	9.44	0.66	0.0

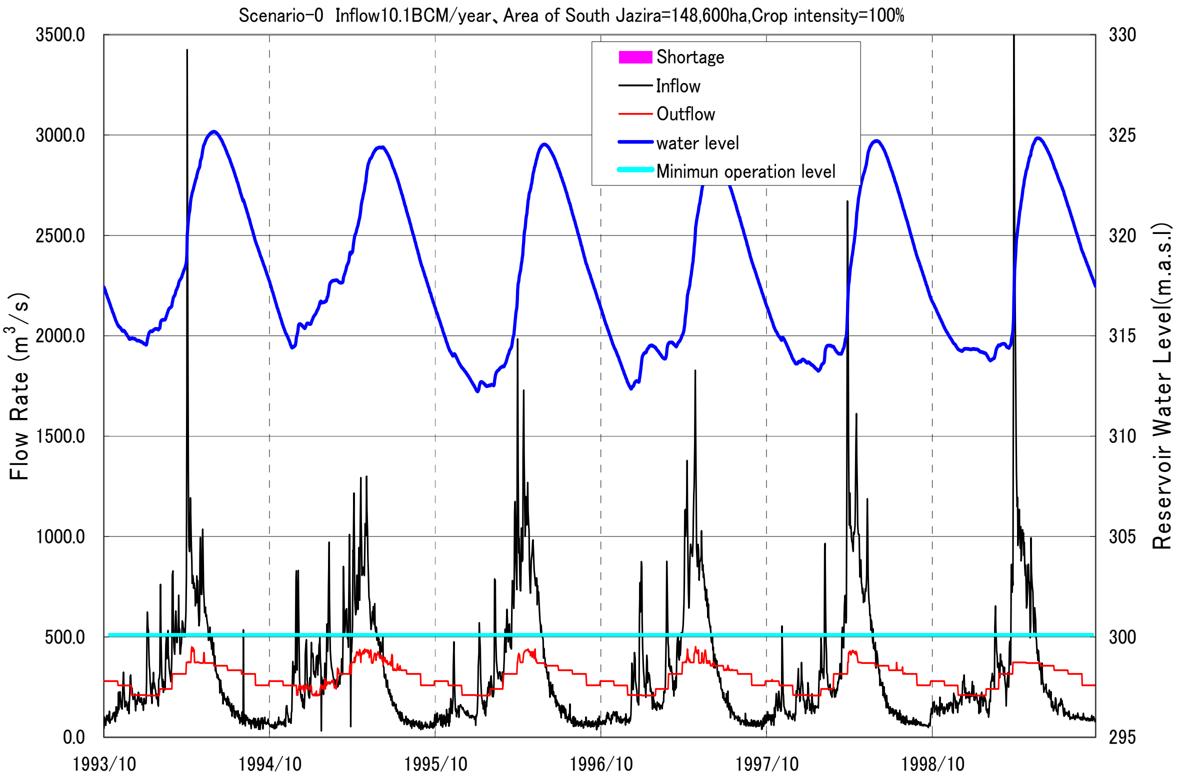


Fig. 5.6-1 Result of computations on water source operation for Scenario-0

Table 5.6-3 outcome of water balance for scenario-0

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③−⑪−⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$−②$_{i}$
1993-1994	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.35	9.31	0.70	0.00	0.09	7.04	6.95	0.09
1994-1995	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.80	9.75	0.69	0.00	-0.35	6.69	7.04	-0.35
1995-1996	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.46	9.42	0.68	0.00	0.00	6.69	6.69	0.00
1996-1997	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.42	9.37	0.68	0.00	0.05	6.74	6.69	0.05
1997-1998	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.40	9.35	0.69	0.00	0.06	6.80	6.74	0.06
1998-1999	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.31	9.26	0.69	0.00	0.15	6.95	6.80	0.15
Total	60.60	4.64	4.74	8.34	17.73	0.00	0.00	38.73	56.46	4.14	0.00	0.00	40.91	40.91	0.00
Average	10.10	0.77	0.79	1.39	2.95	0.00	0.00	6.46	9.41	0.69	0.00	0.00	6.82	6.82	0.00

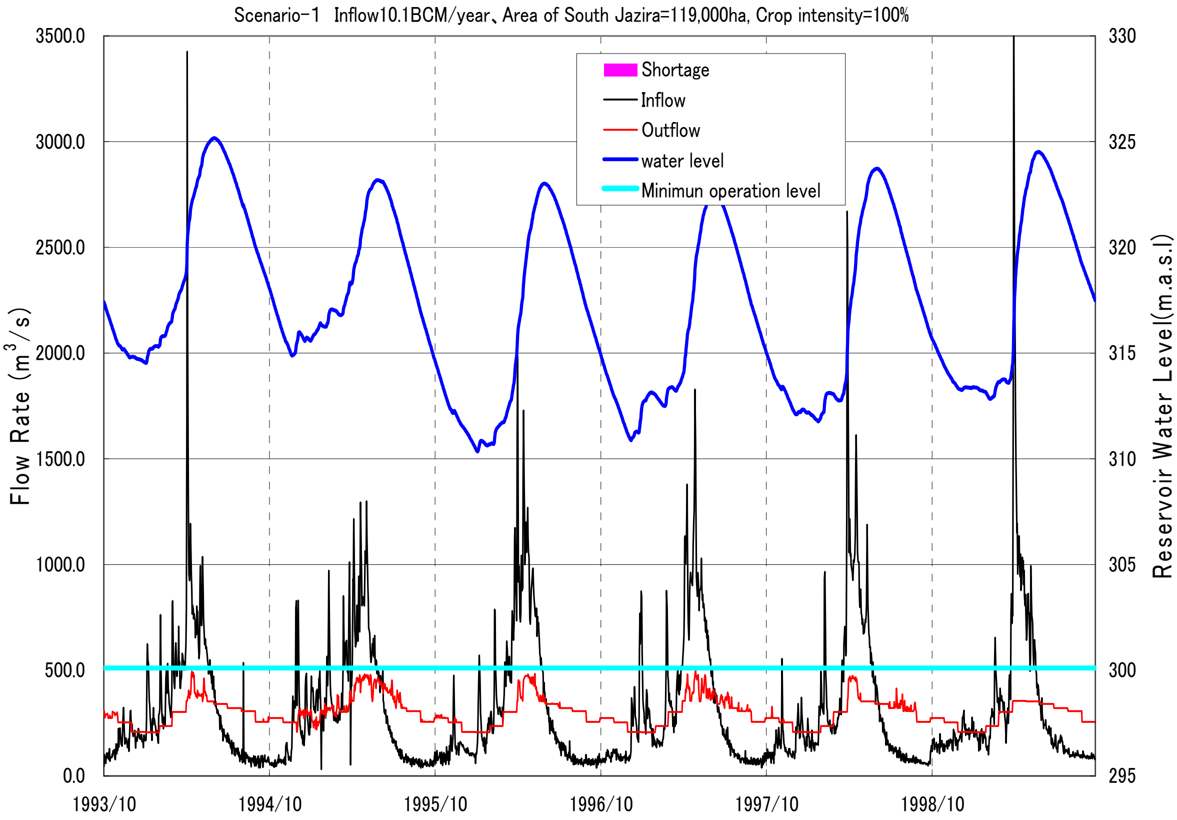


Fig. 5.6-2 Result of computations on water source operation for Scenario-1

Table 5.6-4 outcome of water balance for scenario-1

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③-⑪-⑫+⑮	$②_{i-1}$	$②_i$	$⑯=②_{i-1}-②_i$
1993-1994	10.10	0.77	0.79	1.11	2.68	0.00	0.00	6.53	9.20	0.71	0.00	0.19	7.14	6.95	0.19
1994-1995	10.10	0.77	0.79	1.11	2.68	0.00	0.00	7.67	10.35	0.67	0.00	-0.92	6.22	7.14	-0.92
1995-1996	10.10	0.77	0.79	1.11	2.68	0.00	0.00	6.68	9.36	0.66	0.00	0.08	6.30	6.22	0.08
1996-1997	10.10	0.77	0.79	1.11	2.68	0.00	0.00	6.73	9.40	0.66	0.00	0.04	6.34	6.30	0.04
1997-1998	10.10	0.77	0.79	1.11	2.68	0.00	0.00	6.57	9.25	0.67	0.00	0.18	6.52	6.34	0.18
1998-1999	10.10	0.77	0.79	1.11	2.68	0.00	0.00	6.31	8.98	0.69	0.00	0.43	6.95	6.52	0.43
Total	60.60	4.64	4.74	6.68	16.07	0.00	0.00	40.48	56.55	4.05	0.00	0.00	39.47	39.47	0.00
Average	10.10	0.77	0.79	1.11	2.68	0.00	0.00	6.75	9.42	0.68	0.00	0.00	6.58	6.58	0.00

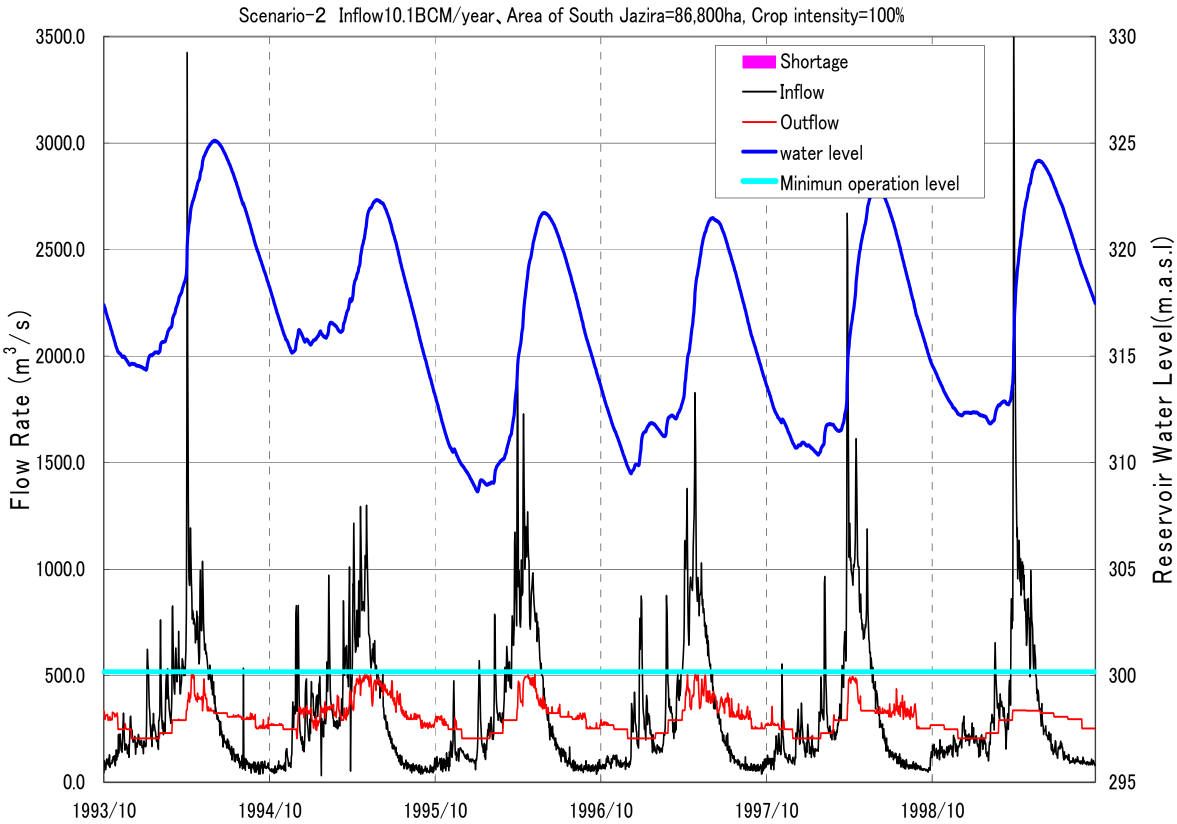


Fig. 5.6-3 Result of computations on water source operation for Scenario-2

Table 5.6-5 outcome of water balance for scenario-2

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③-⑪-⑫+⑮	$②_{i-1}$	$②_i$	⑯=$②_{i-1}$-$②_i$
1993-1994	10.10	0.77	0.79	0.83	2.40	0.00	0.00	6.76	9.15	0.71	0.00	0.24	7.19	6.95	0.24
1994-1995	10.10	0.77	0.79	0.83	2.40	0.00	0.00	8.39	10.78	0.66	0.00	-1.34	5.85	7.19	-1.34
1995-1996	10.10	0.77	0.79	0.83	2.40	0.00	0.00	6.95	9.35	0.64	0.00	0.11	5.96	5.85	0.11
1996-1997	10.10	0.77	0.79	0.83	2.40	0.00	0.00	7.04	9.43	0.64	0.00	0.03	5.99	5.96	0.03
1997-1998	10.10	0.77	0.79	0.83	2.40	0.00	0.00	6.81	9.20	0.65	0.00	0.24	6.23	5.99	0.24
1998-1999	10.10	0.77	0.79	0.83	2.40	0.00	0.00	6.31	8.70	0.68	0.00	0.72	6.95	6.23	0.72
Total	60.60	4.64	4.74	4.99	14.37	0.00	0.00	42.25	56.62	3.98	0.00	0.00	38.17	38.17	0.00
Average	10.10	0.77	0.79	0.83	2.40	0.00	0.00	7.04	9.44	0.66	0.00	0.00	6.36	6.36	0.00

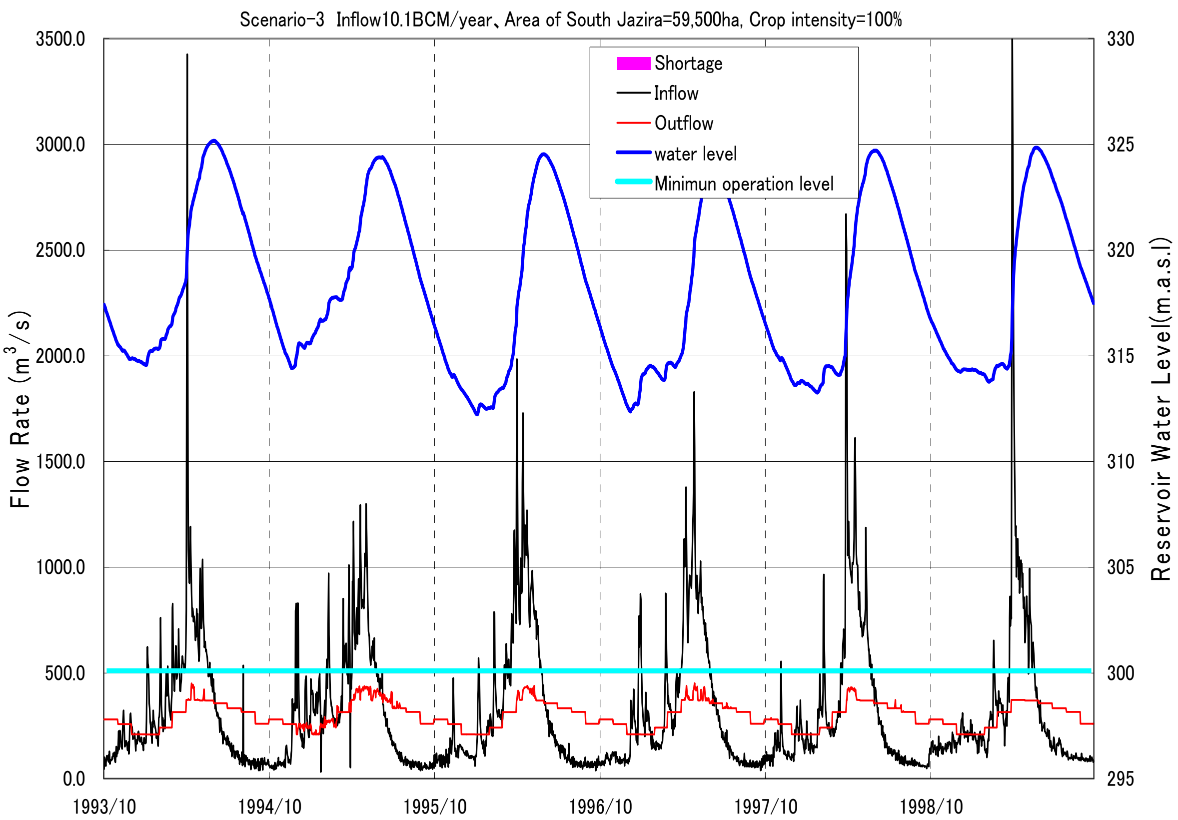


Fig. 5.6-4 Result of computations on water source operation for Scenario-3

Table 5.6-6 outcome of water balance for scenario-3

Year	Inflow	Outflow(BCM)								Res. Loss	Shortage	Cange of Storage	Storage at the end of the year	Storage at the end of the prior year	Change of Storage
	(BCM)	NorthJazira	EastJazira	SouthJazira	Intake for Irr.	Bottom Outlet	Spill	Power	Total	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)	(BCM)
	③	④	⑤	⑥	⑦=Σ(④~⑥)	⑧	⑨	⑩	⑪=Σ(⑦~⑩)	⑭	⑮	⑯=③-⑪-⑫+⑮	②$_{i-1}$	②$_{i}$	⑯=②$_{i-1}$-②$_{i}$
1993-1994	10.10	0.77	0.79	0.56	2.12	0.00	0.00	7.01	9.14	0.71	0.00	0.26	7.21	6.95	0.26
1994-1995	10.10	0.77	0.79	0.56	2.12	0.00	0.00	9.02	11.14	0.65	0.00	-1.68	5.52	7.21	-1.69
1995-1996	10.10	0.77	0.79	0.56	2.12	0.00	0.00	7.22	9.35	0.62	0.00	0.13	5.66	5.52	0.14
1996-1997	10.10	0.77	0.79	0.56	2.12	0.00	0.00	7.35	9.47	0.62	0.00	0.01	5.67	5.66	0.01
1997-1998	10.10	0.77	0.79	0.56	2.12	0.00	0.00	7.06	9.18	0.64	0.00	0.28	5.95	5.67	0.28
1998-1999	10.10	0.77	0.79	0.56	2.12	0.00	0.00	6.31	8.43	0.67	0.00	1.00	6.95	5.95	1.00
Total	60.60	4.64	4.74	3.34	12.72	0.00	0.00	43.97	56.70	3.91	0.00	0.00	36.96	36.96	0.00
Average	10.10	0.77	0.79	0.56	2.12	0.00	0.00	7.33	9.45	0.65	0.00	0.00	6.16	6.16	0.00

5.7 Summarization of study results

(1) Effects by changes of run-off of Tigris river on irrigation development in Jazira area and power generation (Water amount to be released to downstream)

The following effects are expected in future in case the inflow into Mosul Dam be reduced to 10.1 BCM/year due to the water resources development in upstream countries and the climatic changes.

1) There will be no shortage of water if irrigation plans be operated with the original Swiss F/S or similar and the released water to downstream (Power generation and etc.) be fixed at 35 % only of the actual performance ever (16.59 BCM/year). However, it implies a drastically huge reduction of released water amount and it will surely cause serious effects on the power generation outputs as well as on the various water uses in the downstream basins.

2) Fig. 5.7-1 shows relationships and structure of problems on water resources as served by Mosul Dam. It is considered necessary to take actions to cope with the to-be-reduced run-off of Tigris River by all the parties concerned including those non-agricultural sectors.

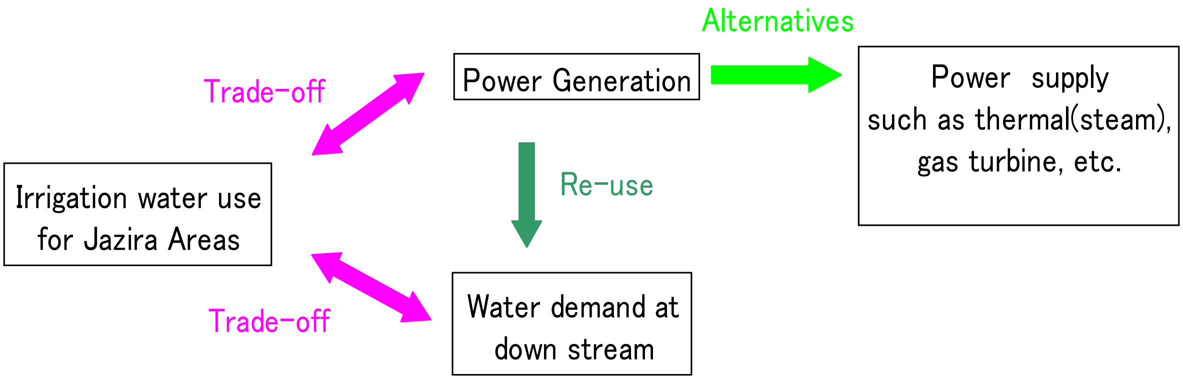


Fig. 5.7-1 Problem structure on reducing run-off of Tigris River

(2) Water balance study on Mosul Dam with higher priority given to irrigation and limit on the release to downstream

Irrigation water requirement for South Jazira area was examined with applying the cropping pattern proposed under this study and irrigation efficiency, the latest meteo-hydrological data and the manner as proposed by FAO. Further, with a condition that 200 m^3/sec as the minimum shall be released to downstream, an examination was made whether or not there occur any problematic results in the water source operation even in the case the inflow into Mosul Dam be reduced to only 10.1 BCM/year.

The examination was made on the 4 cases corresponding to the scenarios 0, 1, 2 and 3 in a way that irrigation areas were varied. The results are as shown in the Table 5.6-2 where water balances are maintained without having shortages in each scenario.

However, the results show much less water released to downstream being only 40-45 % against the actual performance ever with 6.67-7.41 m^3/sec of release for scenarios 0-3 against the present performance of 16.59 m^3/sec.

Accordingly, it can be noted that irrigation water requirement for Jazira area could be secured through reducing the power generation and downstream release amount equivalent to the reduced inflow (About a half) to Mosul Dam plus the newly required irrigation water for Jazira area.

(3) Water source operation plan viewing the water allocation for the whole Iraq

As described in (2) above, it is possible to secure irrigation water requirement for Jazira area with having the minimum water release of 200 m^3/sec to downstream areas if considering the water operation served by Mosul Dam only.

However, it is noted that the issues of water allocation for the whole basin of Iraq shall be verified after obtaining the study results by the presently on-going “Strategy for Water and Land Resources in Iraq : SWLRI (Phase II)”.

(4) Necessity for study on new dam operation rule

When inflow into a dam be reduced by half, the speed of water level recovery will be slowed down and storage water level may not be regained so as to make it difficult to avail the desired storage function, though it depends on the scale of reservoir and intake volumes, in the case that present performance of water use is adopted.

The Fig. 5.7-2 shows an example of reservoir operation in case of reduced inflow by half and as can be seen the water level hardly rises up after consuming the stored volume during the early stage of the first year.

The Fig. 5.7-3 shows the case with the same volume of water use but with having inflow of 20.1 BCM/year where situation of dam/reservoir operation is completely different and the storage function is fully utilized.

In view of the effective use of stored water energy, higher water level setting is preferable in realizing power generation with high efficiency, lower pumping cost and also the more economical water conveyance for irrigation. While, by lower water level setting may cause increasing of flood control capacity and reducing of water leakages from dam body and foundations and evaporation from the stored water surface.

In combination with the need for study on water operation for the entire country as a whole, it is necessary to fix new reservoir operation rules suited to the projected declining inflow as an important issue for the future.

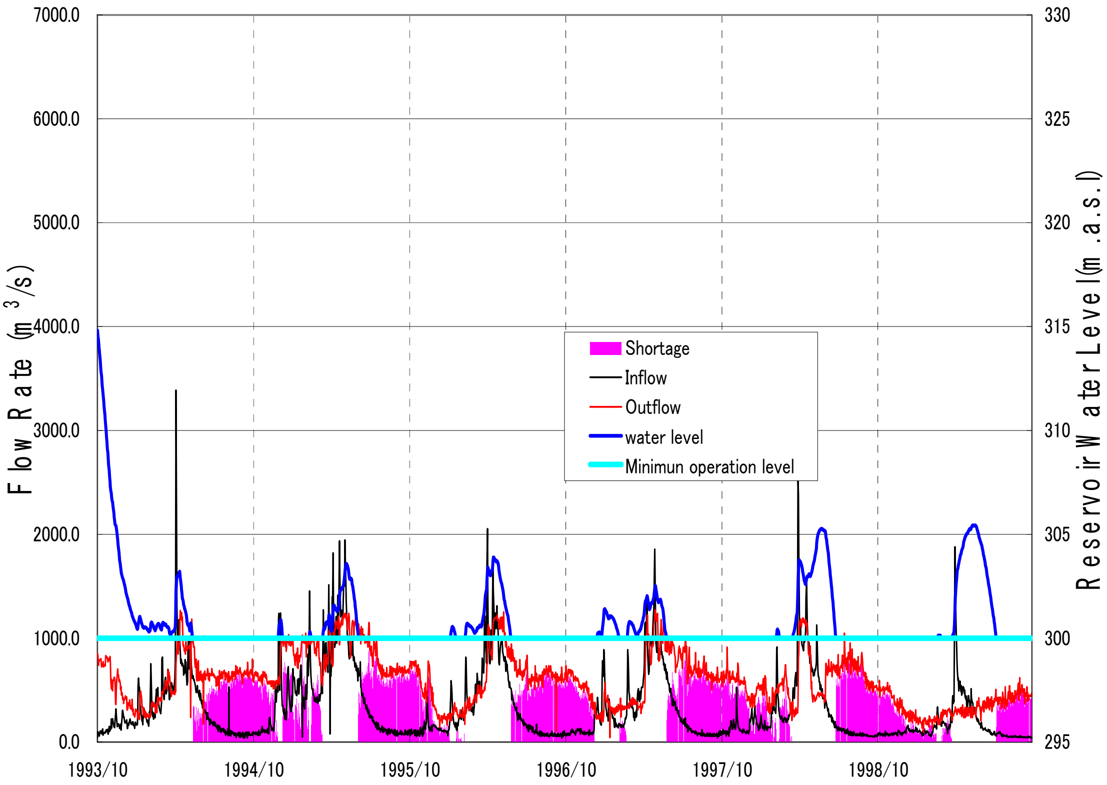


Fig. 5.7-2 Example of reservoir operation in case of reduced inflow by half

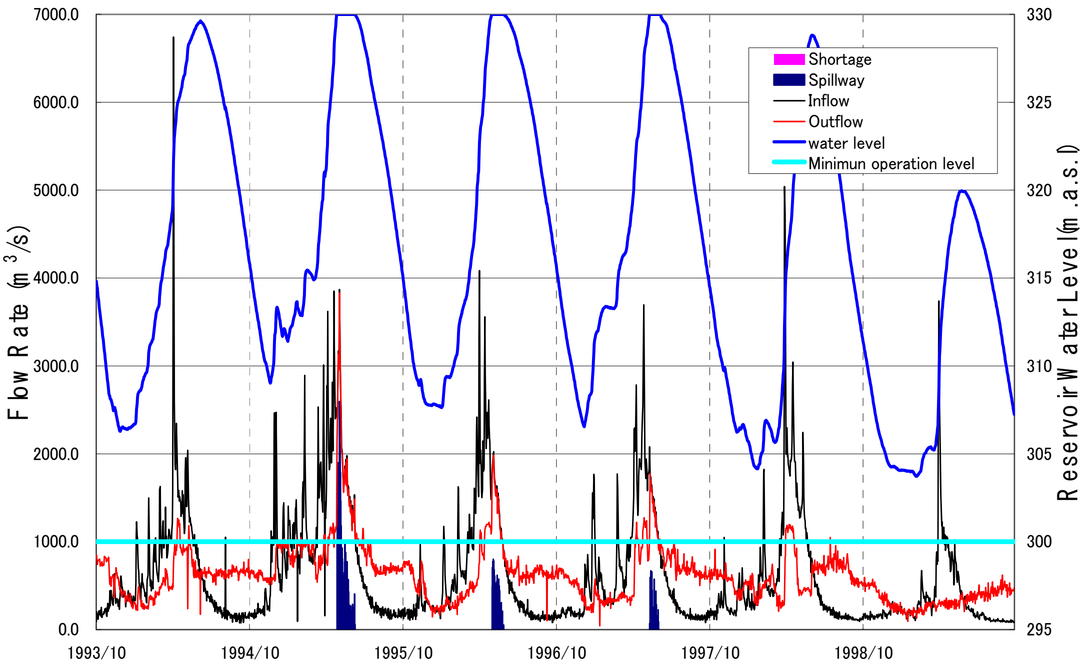


Fig. 5.7-3 Case with the same volume of water use but with having inflow of 20.1 BCM/year

CHAPTER 6. IRRIGATED AGRICULTURE PLAN

6.1 Irrigation Service Area

6.1.1 Updating the map of surface soil depth

It is confirmed by the satellite images that the farm lands in the South Jazira area have been readjusted and also there are small and mid-scale wadi in the existing farming area. If these wadi had been reclaimed during the land readjustment, the surface soil depth of the farm lands may have been partially changed. Therefore, the Study Team measured the surface soil depth of the farmlands around the wadi and compared the difference between the measurement and the data on the existing map of the surface soil depth in order to judge the necessity of updating the map.

(1) Area of the Soil Survey

Following table and map show the location of the small and mid scale wadi for the survey and the stations of the measurement. At first 4 stations were randomly selected on the wadi and the surface soil depths of the center and the both banks of the wadi at each station were measured. Then soil samples were collected from 2 stations selected among the four and their soil fertility was tested.

(2) Method of Measurement

The measurement of the surface soil depth was carried out by auger boring. Total number of the measurement point was 12 (3 points, namely the center and the both sides of the wadi x 4 randomly selected stations). The depth was measured up to the layer of gypsum or 2.0 meters.

Soil sampling was carried out by pit excavation at 2 points. The depth of excavation was up to the layer of gypsum or 2.0 meters and the thickness of each layer was measured and their color was observed. Following are the items tested on the samples:

1) Cation Exchange Capacity (CEC)
2) Content of Phosphorus (P)
3) Content of Nitrogen (No_3)

(3) Result of the Measurement

Following Table 6.1-1 shows the comparison between the result of the measurement and the data on the map. As there is no significant gap between the data, it is judged that the updating the map is not necessary.

Table 6.1-1 Comparison of Surface Soil Depth: Soil Survey and the Map of Surface Soil Depth

Location		Survey Result cm	Surface Soil Depth Map cm	Consistency with the Map
Survey Point No.		Depth :A	Depth :B	Survey result is within the range
A1.1.1.	Right Bank	200.0	more than 80.0	○
A1.1.2.	Center	120.0	more than 80.0	○
A1.1.3.	Left Bank	90.0	more than 80.0	○
A2.1.1.	Right Bank	90.0	more than 80.0	○
A2.1.2.	Center	200.0	more than 80.0	○
A2.1.3.	Left Bank	140.0	more than 80.0	○
A7.1.1.	Right Bank	60.0	50.0～80.0	○
A7.1.2.	Center	170.0	50.0～80.0	×
A7.1.3.	Left Bank	150.0	50.0～80.0	×
P1.2.2.	Soil Sampling	130.0	50.0～80.0	×
P2.2.2.	Soil Sampling	90.0	more than 80.0	○
				Consistency ratio = 72.7%

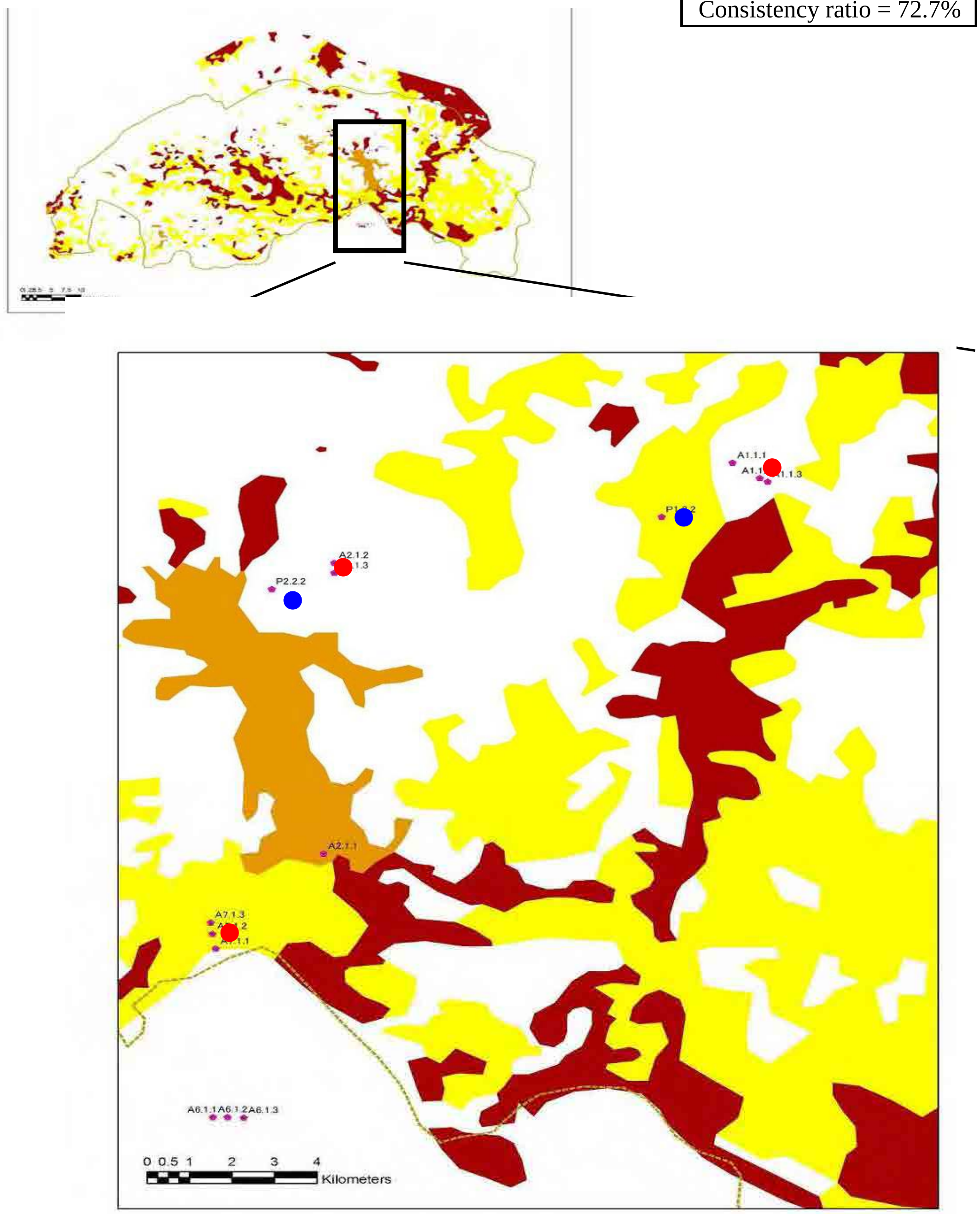


Fig. 6.1-1 Location Map of the Soil Survey

6.1.2 Approximate identification of the irrigation service area based on the map of surface soil depth

Areas classified by the thickness of surface soil coverage were measured on maps and shown as in the Table 6.1-2. The Swiss F/S designates those areas as having the surface soil deeper than 50 cm to be suitable for irrigation with assuming the water-saving irrigation by sprinkler. In this case, as large as 89 % of the whole area is considered suitable for irrigation. In the North Jazira Project area, surface irrigation has been practiced in combination, but in the subject South Jazira area, there found gypsum layer under the surface soil, and the surface irrigation manner shall not be introduced in the area. Especially, it is necessary to avoid surface irrigation in the areas where the thickness of surface soil is less than 50 cm.

Table 6.1-2 Area by Surface Soil Depth

Surface Soil Depth					Surface Soil Depth [accumulated amount]		
Range of Soil Depth (cm)			Area measure from the Map (ha)	Share (%)	Range of Soil Depth (cm)	Area measure from the Map (ha)	Share (%)
80.0	～		143,500	65.0	80.0 ～	143,500	65.0
50.0	～	80.0	52,900	24.0	50.0 ～	196,400	89.0
0.0	～	50.0	24,300	11.0	0.0 ～	220,700	100.0

6.1.3 Exclusion of the area unsuitable for irrigation

The areas unsuitable for irrigation are excluded from the irrigation service area. These areas are wadi, residential area, commercial area, lands for roads and railways, and other off-farm lands, that can be identified by the satellite images. The location and area unsuitable for irrigation are estimated based on the following criteria:

1) Wadi: 20m from the center of the wadi to both sides
2) Residential area / commercial area: the areas identified by the satellite images
3) Lands for roads: 20 m from the center of the land to both sides
4) Lands for railways: 10m from the center of the land to both sides
5) Other off-farm lands: the areas identified by the satellite images

Fig. 6.1-2 shows the location of the areas unsuitable for irrigation and the Table 6.1-3 summarizes the area and share of each land suitable / unsuitable for irrigation measured based on the map.

Table 6.1-3 Area to be Excluded and their Share

		Area (ha)	Share (%)	Remark	
①	Project Area	220,700	100.00		
②	Total area and share to be excluded	42,162	19.10	Total of 1)～5)	
1)	Wadi	34,065	15.44	Length of Wadi	1,703,258m
2)	Residential areas	3,723	1.69	Residential Area	3,723ha
3)	Roads	4,374	1.98	Length of Roads	218,707m
4)	Railways	0	0.00	Length of Railways	0ha
5)	Other off-farm lands	0	0.00	Off-farm Land	0ha
③	Target area for cultivation	178,538	80.90	⑧＝①－⑦	⑧÷①

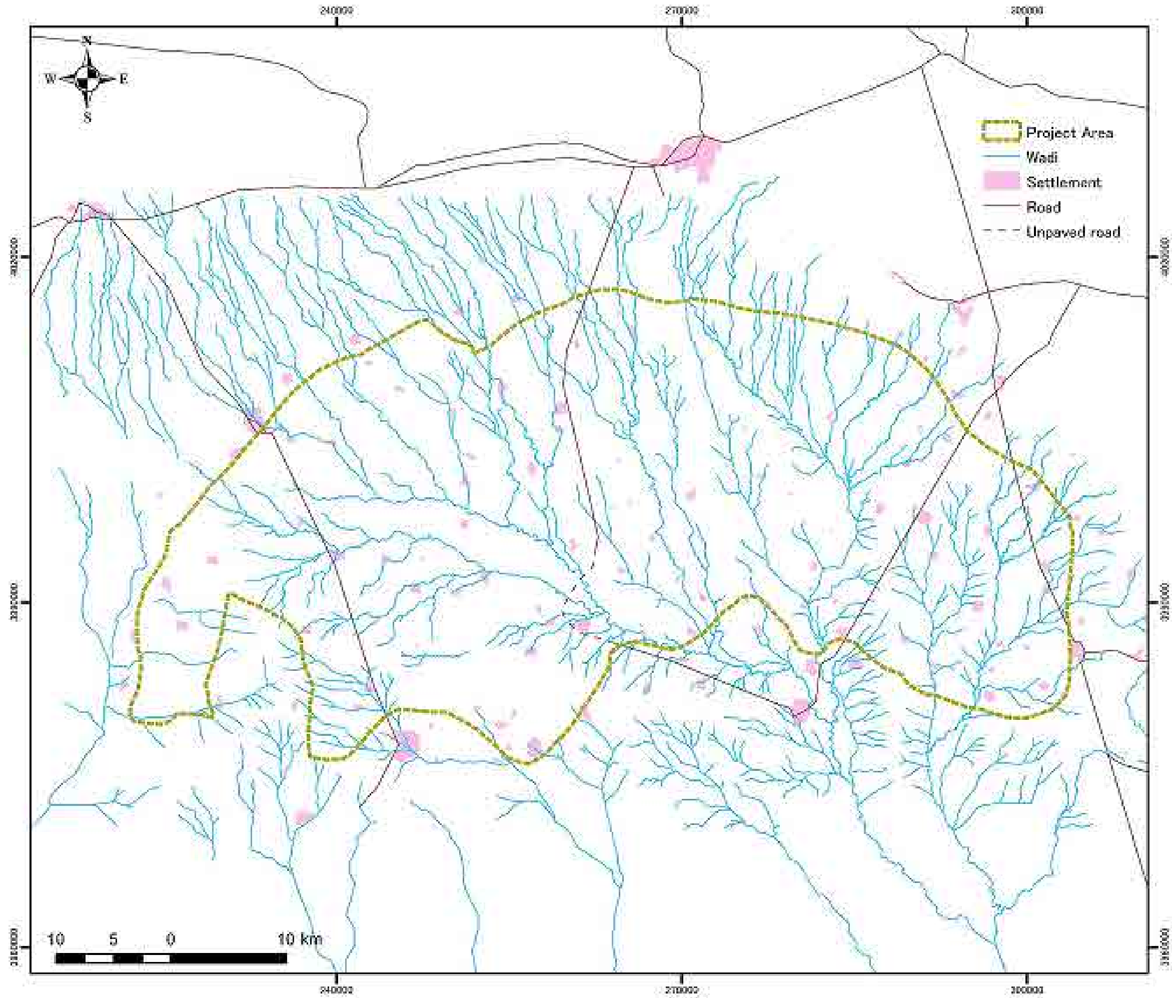


Fig. 6.1-2 Location Map of Area Suitable / Unsuitable for Irrigation

6.1.4 Establishment of Model Farm and Estimation of Cultivated Area

Ratio of site area reduction is estimated by the following; firstly establishing a model farm divided into blocks for crop rotation and secondly measuring the areas of gross farmland, suitable for farm land and reduction (canals, roads, and other areas unable to put in cultivation). As the result, area of suitable farm land is 93.5% as shown in Table 6.1-4. Following shows the specification of the model farm;

(1) Farmland

a. Size: 2,000m×500m

b. No. of blocks and crop rotation: 8 blocks per farmland with 8-year crop rotation

c. Layout of blocks: 4 lines × 2 rows

(2) Lateral road (center of the farmland running across the lines)

a. Total width: 6.50＋1.00+1.00＝8.50m

b. Roadway width: 6.50m (designed with 2 lanes and large-size truck to pass)
2.50m×2 trucks＋0.30+0.50+0.30＝6.10m→6.50m

c. Shoulder: 1.00m

(3) Management road (Across the row, and the edge of the farm across the line)

a. Total width: 4.50＋0.50+0.50＝5.50m

b. Roadway width: 4.50m (designed with 2 lanes and passenger car and small-size truck)
1.70m×2 cars＋0.30+0.50+0.30＝4.50m

c. Shoulder: 0.50m

(4) Irrigation Canal

○ Design discharge

a. Max. discharge: 39mm/5-day

b. Water requirement per block: q ＝39/5×(500×2000)/1000＝7800m^3/day/block
＝0.090m^3/s→0.1m3/s

c. Design discharge: Branch canal Q1 ＝2blocks×q＝0.2m^3/s
Farm ditch Q2 ＝8blocks×q＝0.8m^3/s

○ Canal cross-section

i. Basin conditions

a. Canal type: Reinforced concrete
Cast-in-place in order to prevent the foundation from washing away by water leakage

b. Canal slope: I=1/5000 (setting value) according to terrain slope

c. Coefficient of roughness: n＝0.015 according to the cast-in place concrete

d. Required water depth more than 0.5 m to apply for farm ditch considering the suction pump

ii. Uniform flow calculation

The cross-section of the canal was determined by carrying out the uniform flow calculation based on the above basic conditions.

(5) Drainage canal

○ Design discharge

a. Because the rainfall is negligible to the water requirement, the design discharge is set as a whole amount of the irrigation water

b. Design drainage discharge: Q3＝0.8m^3/s（＝Q2）

○ Drain cross-section

i. Basic conditions

a. Canal type; Earth canal
Drainage canal is designed as earth canal from the economic point of view since the damages by flood are not anticipated.

b. Canal slope; I=1/5000 (setting value) according to terrain slope

c. Coefficient of roughness; n=0.025 according to the earth straight with little weeds

ii. Uniform flow calculation

The cross-section of the drainage canal was determined by carrying out the uniform flow calculation based on the above basic conditions.

(6) Work area etc.

Work area is deigned with 500m wide × 50m long taking into account the repair work of sprinkler.

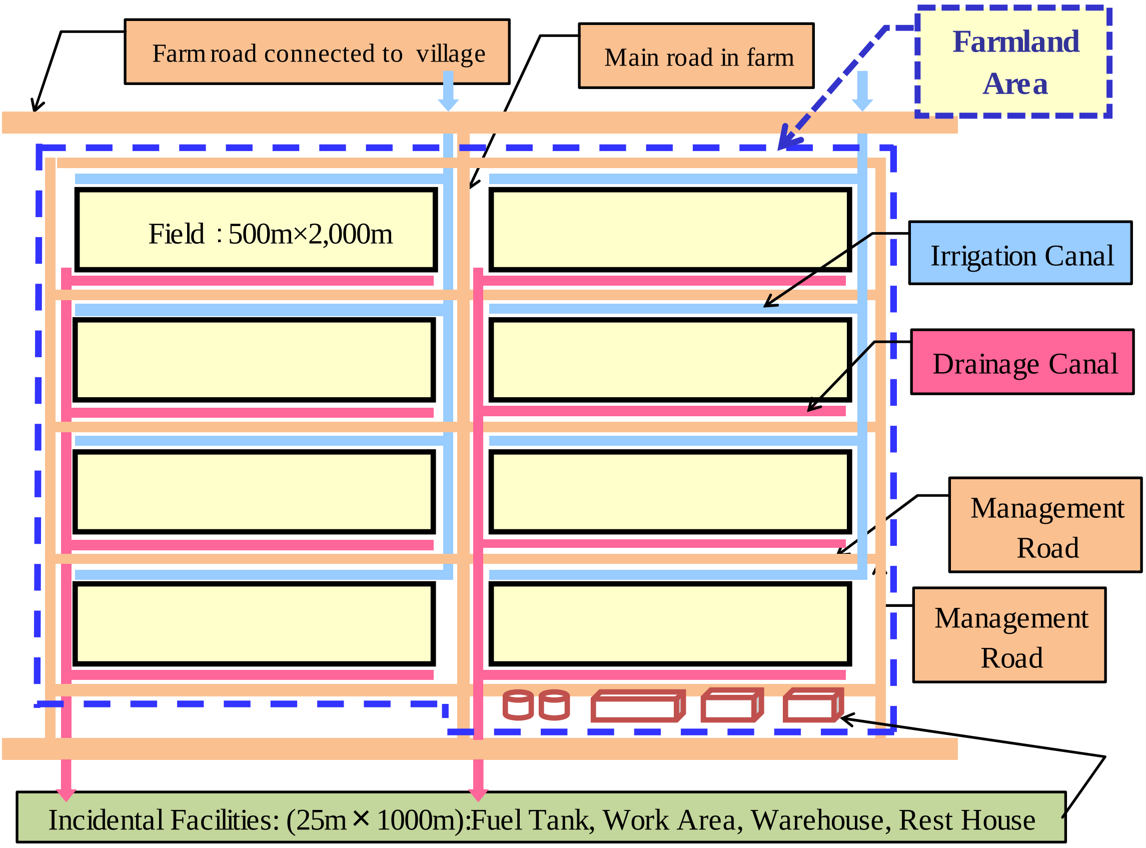
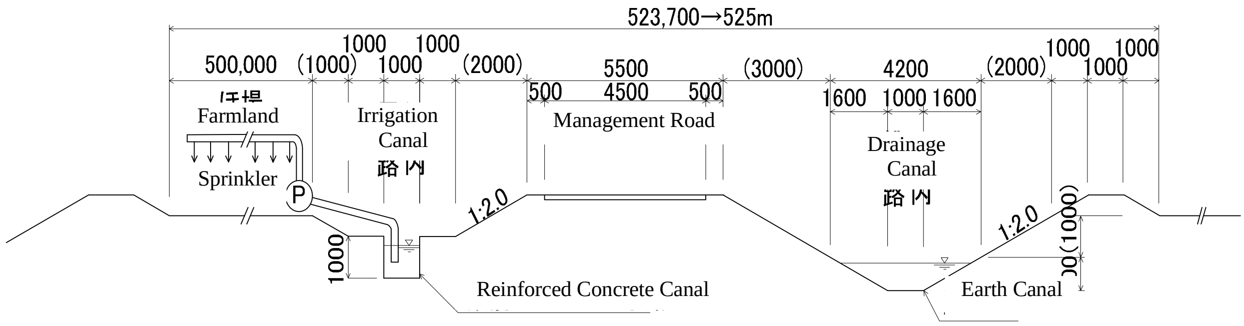


Fig. 6.1-3 Illustration of the Model Farm with Crop Rotation

Table 6.1-4 Ratio of cultivation area measured from the Model farm

Description	Area (ha)	Ratio (%)	Remarks
1)Farmland area	855.8	100.0	Measured by map
2)Cultivation area	800.0	93.5	Measured by map
3) Excluded Area (road, canal, etc.)	55.8	6.5	Measured by map

○Longitudinal direction



○Transversal direction

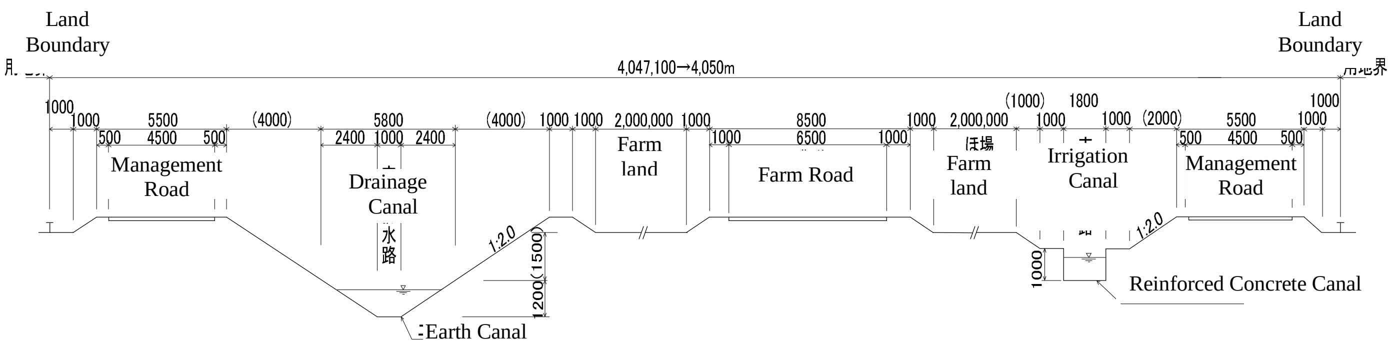


Fig. 6.1-4 Cross-section of Canals and Roads of the Model Farm

6.1.5 Estimated irrigation area (Cultivation area)

In the estimation, factors on the ratio of cultivation area and the thickness of surface soil were taken into consideration and the results are as shown in the Table 6.1-5. The farm area with having surface soil thickness more than 50 cm is estimated at 196,400 ha, and multiplying the above-stated factors with it, the suitable farm land area and the irrigation area (cultivation) are estimated at 158,900 ha and 148,600 ha, respectively.

Table 6.1-5 Estimated irrigation area (Cultivation area)

Description	Area (ha)	Remarks
1)Area with more than 50cm of surface soil depth	196,400	
2)Cultivated area (land for agricultural use)	158,900	Share for cultivated area=80.9%
3) Irrigation service sera	148,600	Share for irrigation service area within cultivated area=93.5%

6.1.6 Ratio of Cultivated Area on the D/D Drawings

A part of D/D drawings (Showing field plot boundary of beneficiary area) for South Jazira Irrigation Project area was sampled and on the map the farm land area and the irrigation area (Cultivation) were measured. The farm land area discussed here is composed of 1) irrigation (Cultivation) area, 2) area used for canal and farm road and 3) waste land for wadi and roads. In this case, the ratio of irrigation (Cultivation) area was 69.1 % (=Irrigation area/the whole area) It can be judged that there is no substantial difference as compared with the above-noted ratio of 75.6 % (80.9 % x 93.5 %)

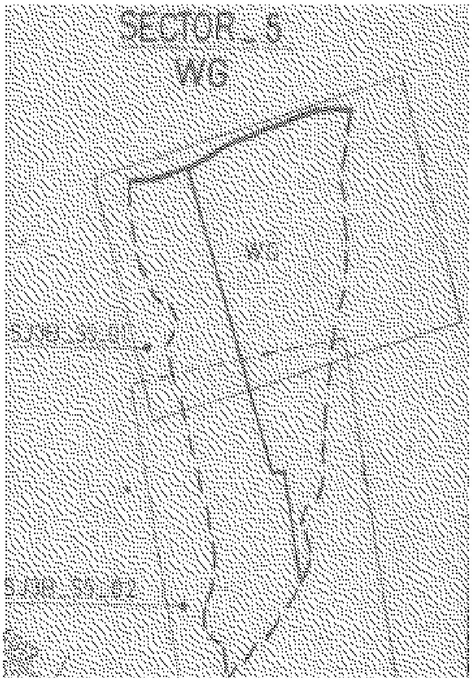


Fig. 6.1-5 D/D Drawings to calculate the ratio of cultivation area

Table 6.1-6 Ratio of cultivation area measured from D/D drawings

Description	Area (ha)	Remarks
1)Gross area (block unit)	4,600	Measured from map
2) Irrigation Service Area	3,180	Measured from map

6.2 Meteorological condition and crop water consumption in the project area

6.2.1 Arrangement and analysis on the meteorological data

As can be seen in the Fig. 6.2-1, there is no observation stations within the project area. In the northern neighboring areas, there are observation stations existing in East-West direction. In terms of the topography, there is the Sinjar mountain range with some peaks higher than 1,000 m elevation and generally the northern part is higher in the elevation.

Fig. 6.2-1 Location map of meteorological observation stations

During the survey period of the subject Study, data were collected from five(5) stations, four(4) as the neighboring to the project area such as Mosul, Telafar, Sinjar and Al-baaj and one(1) as the comparison purpose at Baghdad. The locations and the elevations of said 5 stations are as shown in Table 6.2-1.

Table 6.2-1 Locations of meteorological observation stations

Stations	Location		Elevation (m)
	Latitude.	Longitude.	
Mosul*	36°19’	41°50’	223
Telafar	36°22’	42°38’	400
Singer*	36°19’	43°09’	538
Al-baaj	36°00’	41°40’	320
Baghdad*	33°20’	44°24’	34

Source :”General Scheme of Water Resources and Land Development in IRAQ Vol. I Book 1 Climate and Water Resources and others

The data collection was made to cover the period of 1990-2009, but data for some periods are missing in most of the stations. Particularly in the year 2003, data are missing and/or get scattered and lost in most of the stations due to the negative effects by the Iraqi war.

It was tried to collect daily basis data but in fact the data collected are of monthly basis for which the status of collection is presented in the Table 6.2-2. There are few observations on sunshine duration and radiations and in the recent past only a limited data could be availed just at Mosul. Observation data collected are as compiled in the Appendix.

Table 6.2-2 Summary of observation data collected

Items	Locations	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09
Monthly Rainfall	Mosul														×						
	Sinjar	×													×						
	Baghdad		×												×	×					
	Telaffar														×	×					
Monthly Evaporation	Mosul										×				×	×	×	×	×	×	
	Sinjar	×						×	×	×	×	×	×	×	×	×	×	×	×	×	×
	Baghdad		×												×	×	×	×	×	×	
	Telaffar							×	×	×	×	×	×	×	×	×	×	×	×	×	×
Sun Shine Duration	Mosul	×	×	×	×	×	×	×	×	×	×				×						
	Sinjar	×	×	×	×	×	×	×	×	×	×		×	×	×	×					
	Baghdad	×	×	×	×	×	×	×	×	×	×				×	×		×			
	Telaffar	×	×	×	×	×	×	×	×	×	×		×	×	×	×	×			×	
Radiation	Mosul	×	×	×	×				×	×		×	×	×	×		×	×	×		×
	Sinjar	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
	Baghdad	×	×		×	×	×	×	×			×	×	×	×	×	×	×	×	×	×
	Telaffar	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×	×
Mean Min & Max Temp.	Mosul														×						
	Sinjar	×													×	×					
	Baghdad														×						
	Telaffar														×	×	×		×		
	Baaj										×		×	×	×	×		×			
Relative Humidity	Mosul														×	×	×				
	Sinjar	×							×				×	×	×	×					
	Baghdad												×		×	×					
	Telaffar												×	×	×	×	×	×	×		×
	Baaj												×	×	×	×		×			
Wind Speed	Mosul														×	×	×				
	Sinjar	×							×						×	×					×
	Baghdad		×											×	×	×					
	Telaffar												×	×	×	×	×	×	×		×
	Baaj												×	×	×	×		×			
Vapor Pressure	Mosul														×	×	×		×		
	Sinjar	×						×					×		×	×		×	×		
	Baghdad		×												×	×					
	Telaffar												×		×	×	×	×	×	×	×
	Baaj	×	×	×									×		×			×	×		

Legends ; × Partly or completely missed
Completely gained

Note : Observation data are under the control by the MoT.

6.2.2 Examination of rainfall in the project area

(1) Rainfall observation

Monthly basis rainfall data at Mosul, Telafar, Sinjar, and Baghdad were collected for the period to cover 1990-2009. Fig. 6.2-2 shows the annual rainfall in a time series as computed from the monthly data. The Fig. suggests the decreasing tendency of annual rainfall year by year due to the drought conditions in recent years.

By using the regression formula, the data of each station were arranged and presented as in the Table 6.2-3. As can be seen from the Table, the line shows minus tendency, backing up the reducing annual rainfall year by year. Except Baghdad, all other stations show reducing of rainfall by 10 mm/annum. This is equivalent to about 3 % rainfall reduction per year.

Table 6.2-3 Regression formula of annual rainfall

Location	Regression formula	R^2
Mosul	y= -9.9802x+20,302	0.1905
Sinjar	y= -13.511x+27,361	0.2772
Telafar	y= -10.951x+22,190	0.2915
Baghdad	y= -2.3414x+4,786.5	0.1403

Remarks : y :Annual rainfall、 x : year

Baghdad is located far away from Mosul by about 350 km distance in South-south-east direction with having about 100 mm of annual rainfall showing different rainfall characteristics as compared with Mosul, Telafar and Sinjar located at the northern part where the annual rainfall amounts to about 150-650 mm.

The co-relations were examined based on the annual rainfall available duration for each station. As the results, the co-relations can be indicated by co-efficient as Table 6.2-4.

Table 6.2-4 Co-relationship matrix by annual rainfall

	Mosul	Sinjar	Baghdad	TelAffar
Mosul	1			
Sinjar	0.874442	1		
Baghdad	0.677447	0.4894	1	
TelAffar	0.879649	0.948281	0.518813	1

The Table above indicates that the fluctuations of annual rainfall at Baghdad are different from the observation data in other stations with having low co-efficient, but, the mutual co-efficient among Mosul, Telafar and Sinjar is high at 0.87. Especially the one between Telafar and Sinjar is quite high at 0.94. From the same analysis, Mosul is somewhat different from Telafar and Sinjar in their fluctuation characteristics.

In the Fig. 6.2-3, the annual rainfall observed at Mosul is shown as vertical axis and horizontally Telafar, Sinjar and Baghdad are shown to indicate the co-relations (Distributions). Within the range of larger annual rainfall, the annual rainfall at Mosul is the largest followed by Sinjar, Telafar and Baghdad in order.

The Fig. 6.2-4 is the isohyetal map as presented in the 1982 Soviet report. This map was prepared based on the then available limited observation data and the reliability on detailed particulars is considered rather low.

When reading the annual rainfall from the map, each of stations shows the following annual rainfall amount.

Mosul : 380 mm
Sinjar : 400 mm or more
Telafar : 330 mm

Sinjar is located at the mountain-foot and elevation is high to have more rainfall, but in recent years, Mosul shows the highest among the three(3) stations as followed by Sinjar and Telafar, indicating somewhat different result from the one indicated in the Fig. 6.2-4.

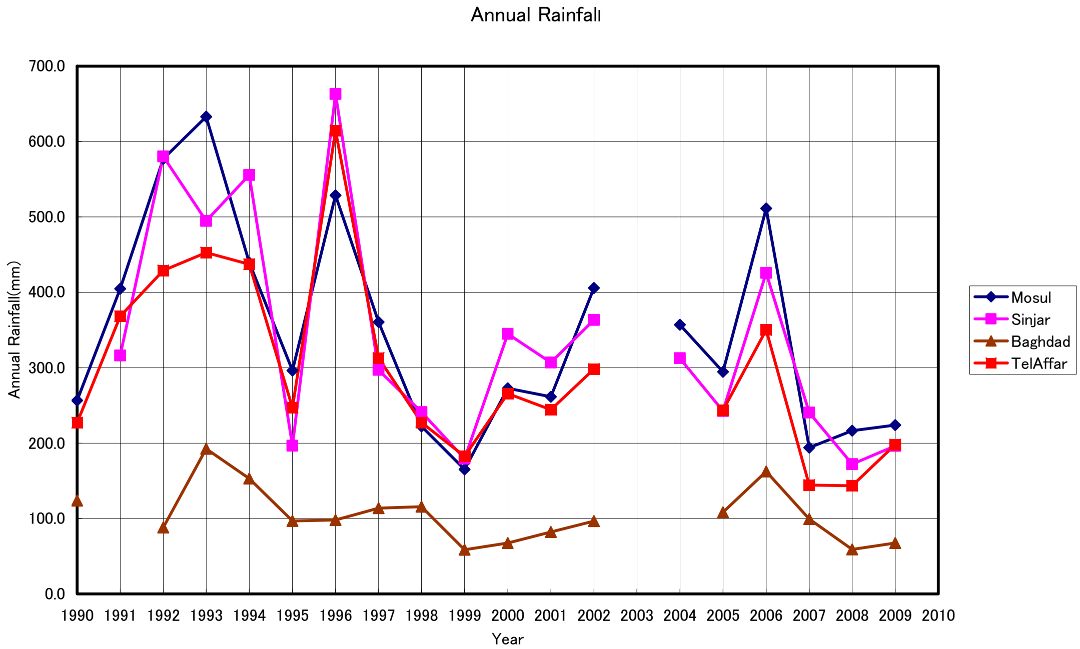


Fig. 6.2-2 Time series of annual rainfall at each station

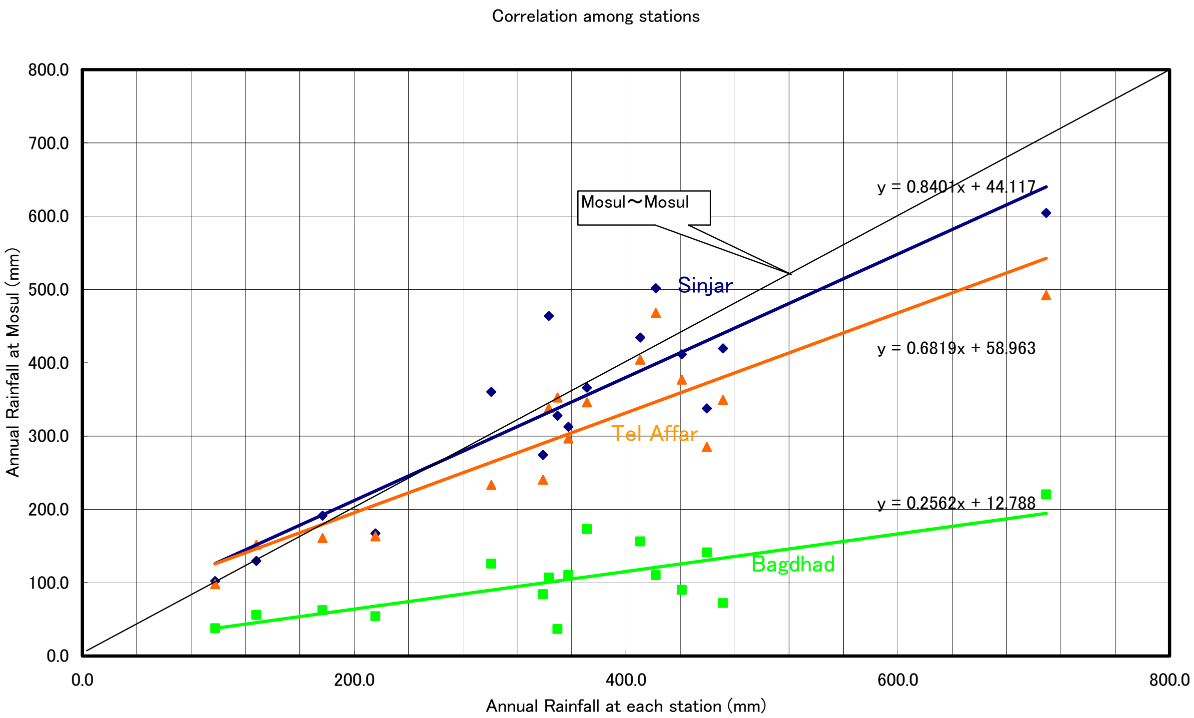


Fig. 6.2-3 Co-relations of observed rainfall

From the Fig. 6.2-4, it can be read that the annual rainfall at the South Jazira project area is in the range of 250 mm-350 mm with the average at 300 mm. When compare the average of project area 300 mm with the observation stations concerned, the ratios are confirmed as follows.

Mosul	: 0.79 (=300/380)
Sinjar	: <0.75 (=300/400 or more)
Telafar	: 0.91 (=300/330)

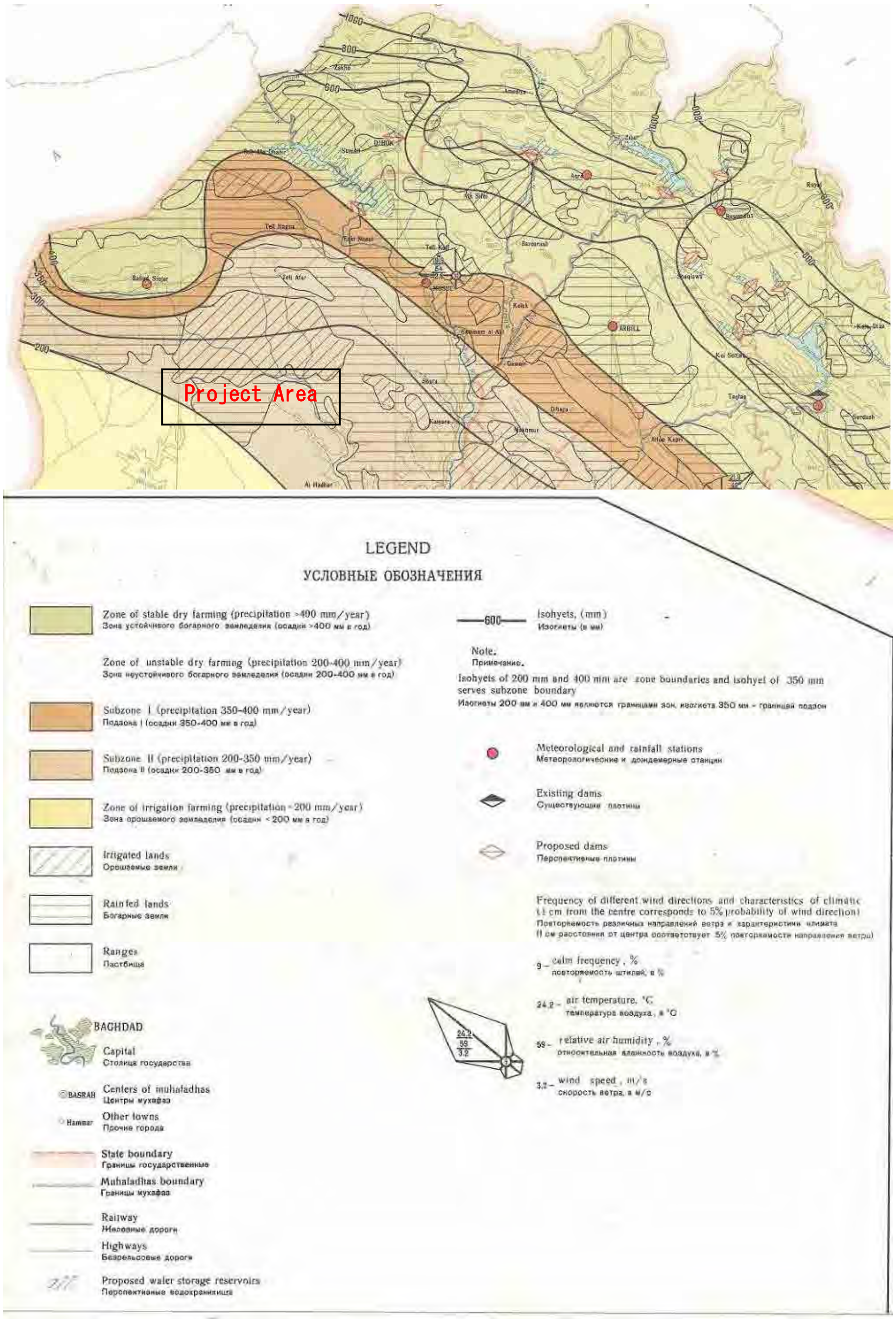


Fig. 6.2-4　Isohyetal map in and around the project area
Source : "General Scheme of Water Resources and Land Development in IRAQ"

(2) Estimation method of annual rainfall at the project area

Based on the examinations made there-above, the annual rainfall for the project area shall be estimated with applying the following method.

“The observation data at Telafar shall be adopted with multiplying the factor of 0.91”

The reasons/justifications are explained as follows.

1) There is no meteorological observation station in the project area and it is necessary to estimate the annual rainfall based on the observation records of the stations located nearby. As the existing stations are located at north even away from the northern part of the project area, common estimation method like the Thiessen method can not be adopted to grasp the areal rainfall. (Stations existing at the south of project area are located quite far from the project area.)

2) Sinjar station is located at the mountain-foot with higher elevation and can not be adopted to represent the project area.

3) Observed data at Mosul show rather low co-relation with Sinjar and Telafar as analyzed and located far away from the other observation stations with having distance from the center of Jazira area, it is not justified to adopt the Mosul data for estimation.

4) Telafar is judged to be most reasonable among all to represent the project area situation, since Telafar is the nearest to the project area, it shows high co-relation with Sinjar but the elevation is not such high as Sinjar. As is the case, to reflect the difference from the project area, 0.91 multiplier factor be applied to the Telafar data as referring the analysis result presented in Soviet report.

In this connection, it is noted that relevant description is made in the F/S report as follows.

The data obtained at the Telafar meteorological observation station are most reliable and accurate. This station represents the project area at the most with the best condition. The station was established in April 1969 as an agricultural meteorological observation station with having applied research institute for natural resources and environment.

Taking into consideration the assessment at the time of F/S, it can be judged reasonable to adopt the observation data at Telafar for the subject study.

(3) Estimation of probable areal rainfall

Monthly basis rainfall data at Telafar are obtained for the period of 20 years from 1990 to 2009 except the missing of years 2003 and 2004. The full data are arranged as shown in the Table 6.2-5. As discussed in (2) above, the mean rainfall at Telafar be multiplied with 0.91 factor and shown as in Table 6.2-5.

Table 6.2-5 Summary of monthly rainfall at Telafar

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2005	2006	2007	2008	2009	Average	*0.91
Jan	40.7	13.4	75.7	60.2	93.8	19.3	235.5	34.6	99.1	26.1	46.6	29.2	28.3	120.0	103.1	19.9	24.6	1.0	59.5	54.2
Feb	69.4	31.9	113.7	47.2	43.3	84.0	42.5	88.1	22.2	36.4	10.8	36.2	8.3	58.0	82.9	45.5	26.9	33.3	48.9	44.5
Mar	21.4	215.1	30.9	16.3	78.6	75.2	127.8	37.7	30.3	64.0	34.4	69.4	116.2	13.4	10.2	30.2	40.1	24.0	57.5	52.3
Apr	48.4	14.9	18.0	112.3	30.6	27.7	18.7	16.9	18.2	10.1	23.0	25.5	27.4	1.0	56.4	17.0	0.0	42.7	28.3	25.7
May	1.7	8.1	25.7	92.1	6.2	0.4	14.5	1.8	38.1	0.0	0.4	27.1	3.4	20.5	3.0	26.1	0.2	0.0	15.0	13.6
Jun	0.0	0.0	0.6	0.0	0.0	13.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.8	0.8
Jul	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2
Aug	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0
Sep	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	11.4	0.8	0.7
Oct	2.3	18.8	0.0	13.8	22.7	0.0	3.3	31.5	3.0	16.0	2.8	4.3	12.3	0.0	55.5	2.0	9.6	18.1	12.0	10.9
Nov	0.0	7.4	77.6	63.1	82.5	20.6	8.3	38.4	0.0	11.1	53.6	13.4	10.7	22.7	4.0	2.4	19.0	15.8	25.0	22.8
Dec	43.2	58.5	86.7	47.6	79.4	6.7	162.0	63.8	12.1	18.7	94.2	39.2	91.5	6.8	35.2	1.1	22.3	51.8	51.2	46.6
Annual	227.1	368.1	428.9	452.6	437.1	247.1	614.4	312.8	227.3	182.4	265.8	244.3	298.1	243.6	350.3	144.2	143.5	198.1	299.2	272.3
*0.91	206.7	335.0	390.3	411.9	397.8	224.9	559.1	284.7	206.8	166.0	241.9	222.3	271.3	221.7	318.8	131.2	130.6	180.3	272.3	

The mean annual rainfall in the area is accumulated as 272 mm/annum and the monthly fluctuations are as indicated in Fig. 6.2-5.

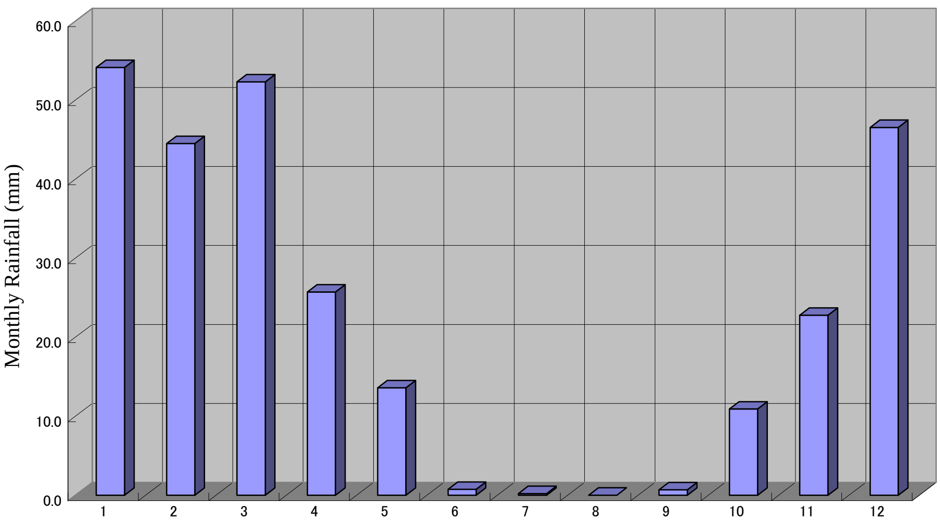


Fig. 6.2-5 Monthly distribution of rainfall in the area

FAO defines by probability of exceedance three(3) different rainfall years as “Drought year”, “Ordinary year” and “Wet year”.

1) 80 % probability of exceedance implies that 4 years out of 5 years show the rainfall amount more than the probability value and the subject 1 year is the drought year to be the standard year for determining the scale of irrigation system.

2) 50 % probability is considered to be an ordinary year and the 20 % probability as wet year.

In order to calculate the probable rainfall, the annual rainfall data as shown in the Table 6.2-5 shall be re-arranged in descending order and the probability value be computed with the following formula.

Probability P = 100 m/ (N+1)

Where, N : Sample size

m : Ranking in descending order

Examination results as above shall be indicated in the Table 6.2-6. Then, the results as indicated in the Table 6.2-6 shall be plotted on logarithm paper to seek the 80 % probability in general. However, here in this examination, the Fig. 6.2-7 is prepared to show the co-relation based on the Table 6.2-6 and calculated each of probabilities as 80 %, 50 % and 20 %.

Table 6.2-6 Re-arrange of annual rainfall in descending order and calculation of probability

Descending Order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
Year	1996	1993	1994	1992	1991	2006	1997	2002	2000	1995	2001	2005	1998	1990	2009	1999	2007	2008	Average
Annual Rainfall (mm)	559.1	411.9	397.8	390.3	335.0	318.8	284.7	271.3	241.9	224.9	222.3	221.7	206.8	206.7	180.3	166.0	131.2	130.6	272.3
Propability (%)	5	11	16	21	26	32	37	42	47	53	58	63	68	74	79	84	89	95	

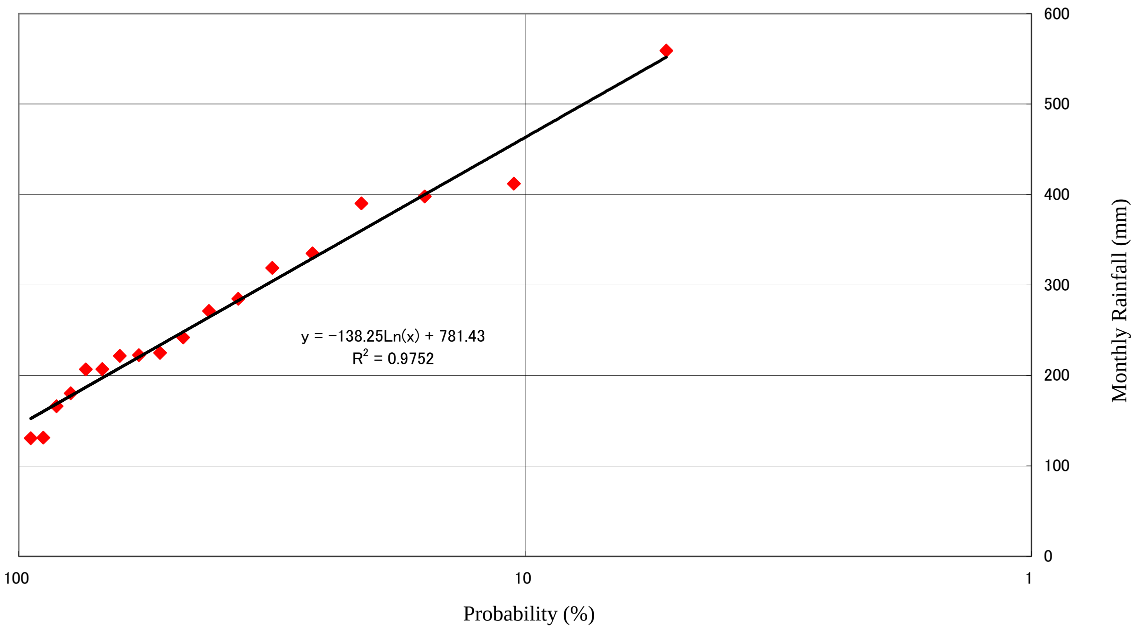


Fig. 6.2-6 Estimation of probable rainfall

From the Fig. 6.2-6, it can be read that the estimation by regression formula is also reasonable and when calculating the probable rainfall by regression formula, the results come out as shown in the Table 6.2-7. In the Table 6.2-7, probable rainfall at the time of F/S is shown. The calculation results this time shows 80-90 % of F/S values with smaller rainfall amount.

Table 6.2-7 Summary of probable rainfall calculated

Classifications	Probable rainfall at project area(mm/annum) x 0.91	Probable rainfall at Telafar (F/S) (mm/annum)
Drought year (80 % P)	175	220
Ordinary year (50 % P)	240	300
Wet year (20 % P)	367	410

For the project area, the monthly basis probable rainfall shall be calculated based on the probable annual rainfall by applying the following formula. The following shows the case of drought year. For the ordinary year and wet year too, the same idea shall be applied. The results, monthly basis probable rainfall shall be presented in Table 6.2-8.

$$P_{idry} = P_{iav} \text{ x } P_{dry}/P_{av}$$

Where, P_{iav} : Mean monthly rainfall of i_{th} month (mm)

P_{idry} :Monthly rainfall (i_{th} month) in drought year (mm)

P_{av} :Mean annual rainfall (mm)

P_{dry} :Annual rainfall in drought year (mm)

Table 6.2-8 Calculation result of probable monthly rainfall

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Monthly average	54.2	44.5	52.3	25.7	13.6	0.8	0.2	0.0	0.7	10.9	22.8	46.6	272.3
Dry year	34.9	28.7	33.7	16.6	8.8	0.5	0.1	0.0	0.4	7.0	14.7	30.0	175.4
Wet year	73.0	60.0	70.6	34.7	18.4	1.0	0.3	0.0	0.9	14.7	30.7	62.8	367.1
Normal year	47.8	39.3	46.2	22.7	12.0	0.7	0.2	0.0	0.6	9.6	20.1	41.1	240.4

(4) Evaporation

Table 6.2-9 shows the evaporation re-arranged as the monthly mean within the period observation data are available. The annual evaporation at Telafar is known to be quite large at 3,400 mm.

Table 6.2-9 Observation results of monthly evaporation

Month	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Annual
Sinjar	52.9	69.7	128.3	187.2	322.7	475.9	546.5	515.6	392.1	255.7	104.3	52.9	3103.8
Tel Afar	48.9	67.1	124.9	185.4	355.8	520.2	599.5	588.1	456.0	279.5	124.8	56.6	3406.8
Baghdad	65.3	98.7	179.0	251.8	372.5	477.6	522.1	466.1	346.1	222.3	109.8	74.5	3185.9
Mosul	32.7	49.8	93.5	138.3	245.4	343.9	384.2	344.4	251.0	148.7	66.1	32.5	2130.6

(5) Sunshine duration and radiation

The Table 6.2-10 shows the sunshine duration (hours/day) for each of observation stations. Here, means shall be calculated from the data with monthly records and adopted the mean annual as the accumulation of the same. In Table 6.2-10, the results of observation are shown but there is no much difference among the stations.

Table 6.2-10 Sunshine durations (2000-2009)　Unit : hours/day

観測所	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC	Average
Mosul	6.0	5.9	7.4	7.7	9.8	11.6	11.6	10.7	9.8	7.9	7.2	5.7	8.4
Sinjar	6.3	6.0	7.3	7.9	9.6	11.5	11.7	10.9	9.7	7.9	7.1	5.4	8.4
Baghdad	6.2	6.0	7.3	8.0	10.0	11.3	11.8	10.8	9.5	7.9	7.0	5.1	8.4
TelAffar	6.2	5.9	7.1	8.0	9.9	11.2	11.7	10.9	9.7	7.9	6.9	5.1	8.4

Results of observations on radiation (Mw/cm^2) are availed only at Baghdad and Mosul. The radiation at Baghdad is bigger than Mosul.

Table 6.2-11 Means of observed radiation

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Average
Mosul	196.9	279.8	367.5	459.0	556.5	631.1	608.4	554.7	479.1	341.5	234.4	179.0	398.3
Baghdad	286.7	376.1	479.0	568.6	646.8	720.3	708.8	639.2	527.7	409.9	320.7	258.5	495.2

(6) Mean maximum and minimum temperature

The means of maximum and minimum monthly temperature have been calculated in so far as the data are available and presented in the Table 6.2-12.　The maximum and minimum are the highest in the month of July.

Table 6.2-12 Mean maximum and minimum temperature (*C)

	Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVR
Min. Temp.	Mosul	2.2	3.3	6.6	11.2	16.1	21.3	25.2	24.2	19.2	13.8	7.5	3.8	12.9
	Tel Afar	3.3	4.3	7.6	12.6	18.2	24.1	27.7	27.3	23.3	17.0	10.1	5.0	15.0
	Singer	3.8	5.2	8.7	14.0	19.7	25.9	29.6	29.2	25.2	18.8	10.8	6.2	16.4
	Baaji	2.2	3.5	6.5	11.8	17.7	21.9	25.3	24.3	20.1	15.3	8.1	4.2	13.4
	Baghdad	4.0	5.8	9.9	15.4	20.5	23.7	25.9	25.2	21.1	16.4	9.8	5.5	15.3
Max. Temp.	Mosul	12.5	14.8	19.3	25.4	33.0	39.5	42.9	42.7	38.1	30.6	21.0	14.3	27.8
	Tel Afar	11.4	13.3	18.0	24.6	32.0	38.4	42.1	41.6	37.1	29.9	20.3	13.6	26.9
	Singer	10.8	12.8	17.1	23.7	30.2	36.3	39.9	39.4	35.0	28.2	19.5	13.3	25.5
	Baaji	12.1	14.5	19.1	25.6	32.7	38.6	42.2	41.6	36.9	30.5	20.9	14.7	27.5
	Baghdad	15.6	18.6	23.7	30.2	36.7	41.5	44.2	43.7	40.1	33.5	23.6	17.5	30.8

(7) Relative humidity

The relative humidity is presented as the monthly mean within the period data are available and shown in the Table 6.2-13.　The relative humidity is high during the Winter and low in the Summer.

Table 6.2-13 Relative humidity (%)

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVR
Mosul	78.9	73.3	67.4	62.2	43.4	27.9	25.4	26.9	31.5	45.7	64.9	78.4	52.2
Tel Afar	76.8	69.7	60.7	54.6	35.9	24.0	21.9	22.8	24.1	37.3	57.1	75.2	46.7
Singer	68.2	61.9	55.0	47.4	33.6	23.3	21.1	22.1	25.0	37.3	52.5	66.3	42.8
Baaji	74.8	68.3	58.9	51.8	38.8	28.5	27.5	28.4	30.5	39.7	57.8	72.1	48.1
Baghdad	71.6	59.7	50.5	41.7	31.7	25.2	24.8	26.8	31.8	42.3	58.2	69.6	44.5

(8) Wind velocity

There found possibilities of deviations of observation results as derived from the difference of observation position (Locations) and therefore re-confirmation of observation manner is seemed necessary.

Table 6.2-14 Wind velocity (m/sec)

Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVR
Mosul	1.0	1.3	1.4	1.6	1.9	1.8	1.7	1.5	1.2	0.9	0.8	1.0	1.3
Tel Afar	4.1	4.4	4.4	4.5	5.2	5.3	5.5	5.2	4.9	4.2	3.9	3.7	4.6
Singer	1.8	2.4	2.7	3.1	3.8	4.2	4.3	3.7	3.1	2.2	1.6	1.6	2.9
Baaji	1.8	1.8	2.2	2.4	2.7	3.1	3.3	2.9	2.4	1.9	1.4	1.5	2.3
Baghdad	2.5	2.9	3.2	3.2	3.3	3.9	4.0	3.5	2.8	2.6	2.5	2.5	3.1

(9) Steam pressure

The steam pressure is high in the Summer time and low in the Winter time with the highest peak in August.

Table 6.2-15 Steam pressure (mbar)

Month	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEP.	OCT.	NOV.	DEC.	Aver.
BAGHDAD	8.3	8.2	9.2	11.2	11.8	12.3	13.8	14.3	13.2	12.5	10.8	9.3	11.3
SINJAR	6.6	6.8	7.8	9.5	10.1	10.4	12.0	12.3	10.9	10.4	8.9	7.7	9.4
MOSUL	7.7	8.2	9.7	12.1	12.3	11.7	13.3	13.6	11.6	11.1	9.8	8.6	10.9
TELAFFAR	7.6	7.6	8.8	11.0	10.5	10.0	11.4	11.8	10.1	9.9	9.1	8.6	9.7
BAAJI	8.1	7.6	8.4	10.5	11.8	12.2	13.8	14.2	11.8	10.9	9.3	8.1	10.6

6.2.3 Calculation of relative evapo-transpiration (Potential)

(1) Estimation method based on meteorological data/information

The penman formula is to estimate the potential evaporation by combining the heat budget method and the air dynamics. The potential evaporation is defined as “Evapo-transpiration loss of water from the land surface fully covered by vegetation in case sufficient water be supplied” and indicates the maximum amount of evaporation the atmosphere requires. Therefore, in fact, the actual evaporation is less than the value estimated by Penman method. In order to obtain the actual evaporation from the potential, it is necessary to multiply the experimental factor (f). Penman (1948) confirmed the (f) factor at Rothamstead in UK at 0.75 as the annual mean with the seasonal breakdown as follows;

Winter (Nov. - Feb.)	: 0.6
Spring (Mar. - Apr.)	: 0.7
Fall (Sept. - Oct.)	: 0.7
Summer (May -Aug.)	: 0.8

In Japan, the annual mean of 0.6-0.7 are usually applied in many cases, but, each area/locality have their own correction factors due to the different vegetation conditions in each area.

FAO recommends the Penman-Monteith method as the only standard method to acquire the evapo-transpiration value with the following reasons. The FAO recommendation is derived from the result of comparison study on the researches made by using lysimeter by ASCE (American Society of Civil Engineers) and EC.

1) *he Penman method alone causes excessively higher value in many cases and it is necessary

to make partial corrections on the effects by winds.

2) Radiation method leads to comparatively acceptable results in the wet land case where factors on air dynamics are relatively small, but in case of dry area, it estimate the evapo-transpiration at too small.
3) Temperature method requires some adjustment to reflect the local characteristics to get satisfactory results from experiences.
4) The Penman-Monteith method causes relatively higher accuracy both in dry and wet lands to be accepted with due satisfaction.

In view of the above, this study adopts the Penman-Monteith method to estimate the relative evapo-transpiration for crops.

(2) Calculation of relative evapo-transpiration for crops

The following meteorological data collected at Telafar and arranged are used to estimate the relative evapo-transpiration by Penman-Monteith method.

Table 6.2-16 Summary of meteorological observation data

Item	Min. Temp.	Max. Temp.	Relative Humidity	Wind Speed	Sunshine
Month	℃	℃	%	km/day	hours
Jan	3.3	11.4	76.8	233.3	6.35
Feb	4.3	13.3	69.7	250.6	9.99
Mar	7.6	18.0	60.7	250.6	11.86
Apr	12.6	24.6	54.6	250.6	15.30
May	18.2	32.0	35.9	267.8	17.95
Jun	24.1	38.4	24.0	293.8	21.04
Jul	27.7	42.1	21.9	293.8	19.63
Aug	27.3	41.6	22.8	293.8	17.89
Sep	23.3	37.1	24.1	267.8	15.97
Oct	17.0	29.9	37.3	241.9	11.02
Nov	10.1	20.3	57.1	207.4	7.81
Dec	5.0	13.6	75.2	250.6	5.77
Average	15.0	26.9	46.7	258.5	13.4

In the calculation operation, the CROPWAT program (Ver. 8.0 for Windows) as provided by FAO was used. The calculation results are as shown in Table 6.2-17 and Fig. 6.2-7. The annual fluctuation shows the highest in July by 11.8 mm/day and continuously fluctuates till it declines to the minimum at 1.28 mm/day. The annual mean is 6 mm/day and between the maximum and the minimum, difference reaches almost at 10 times (Max:11.8 mm, Min:1.28mm).

Table 6.2-17 Calculation results of relative evapo-transpiration

Month	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
ET_0(mm/day)	1.28	2.02	3.38	5.46	8.39	11.17	11.8	11.01	8.64	5.41	2.66	1.46	6.06

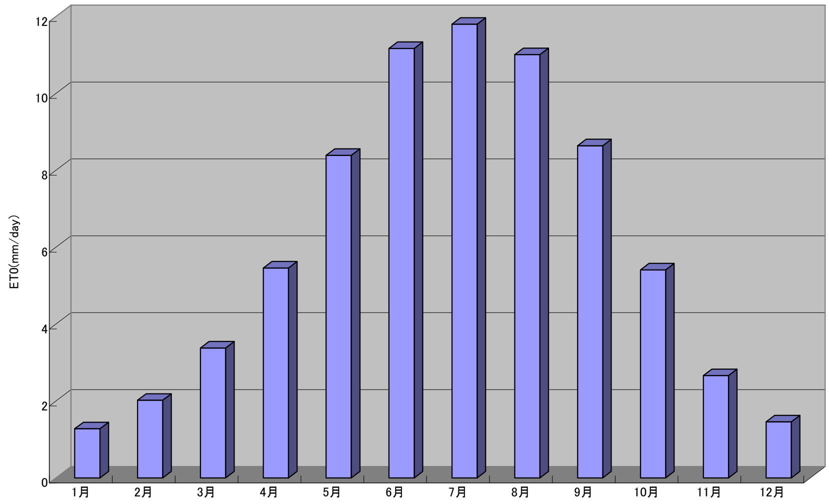


Fig. 6.2-7 Annual distribution of ET0

(3) Estimation of crop water consumption

In the estimation of crop consumption, farm management plan has to be reflected and therefore the details are to be presented in Clause 6.3

(4) Estimation of effective rainfall

AS can be seen from the Table 6.2-5, of the total mean annual rainfall of 272 mm in the area, most of them appear in November-April period. It is important to utilize this rainfall for the crop production, and therefore in considering the water source management, irrigation water requirement shall be fixed after deducting the effective rainfall amount from the calculated evapo-transpiration amount.

FAO suggests several estimation methods of effective rainfall, of which the one developed by the Bureau of soil Conservation, US Department of Agriculture with due analysis on as many as 22 locations for the period of 50 years is to be adopted as can be calculated by CROPWAT program.

The calculation formula is as shown in the following.

$$\text{Peff} = \text{Pmon} \times (125 - 0.2 \times \text{Pmon}) / 125 \qquad \text{Pmon} < 250 \text{ mm}$$
$$= 125 + 0.1 \times \text{Pmon} \qquad \text{Pmon} > 250 \text{ mm}$$

Where, Peff : Effective rainfall
Pmon : Monthly rainfall

The result of estimation of effective rainfall in drought year is as shown in the Table 6.2-17. The effective rainfall is largely affected by the rainfall pattern and the manner of farm management too and it is desirable to examine further based on the daily basis rainfall data and the investigation results of soil moisture contents.

Table 6.2-18 Results of estimation of effective rainfall

Month	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	34.9	28.7	33.7	16.6	8.8	0.5	0.1	0	0.4	7	14.7	30	175.4
Effective Rainfall (mm)	33	27.4	31.9	16.2	8.7	0.5	0.1	0	0.4	6.9	14.4	28.6	168.1

Further to the above, as mentioned in 6.2, it is desirable to judge the scale of irrigation facilities after examining the occurrence frequency of peak requirement through conducting an irrigation simulation based on the daily basis data reflecting the rainfall pattern so as to grasp fully the effective rainfall.

Under the present study, however, the above is an issue to be solved in future due to the unavailability of the required daily basis data. As is the case, it was so decided under this study that the condition of zero effective rainfall shall be adopted in judging the scale of irrigation facilities.

6.3 Formulation of Farming Plan

6.3.1 Selection of Major Crops

In the Swiss F/S, cropping patterns are examined with having as many as 12 kinds of crops. Under the JICA Study, 1) higher-priority-given plans were reviewed/confirmed, 2) actual planting performance at the irrigated agriculture in nearby area was generally grasped and 3) hearing from the persons concerned was undertaken, and the justification of crops selected by Swiss F/S was generally confirmed. In addition, such potential crops were selected to be newly introduced and added in the proposed cropping pattern.

(1) XYZ pattern and ABC pattern in the Swiss F/S report

Following Table 6.3-1 shows the ABC pattern and XYZ pattern of crops in the Swiss F/S report. The two patterns consist of the almost same crops each other but the share of each crop area differs. The cops have been selected considering the climate, soil depth, actual practice of cropping, demand, and crop water consumption in the Project area and these preconditions are still valid at present.

The difference between ABC and XYZ patterns depends on whether to consider the external conditions such as transportation of agricultural produce and the water consumption by crop. For instance, the harvesting period of sugar beet is short and there is no facility for preservation. Therefore, the produce harvested in the Project area has to be immediately transported to the sugar factories, otherwise it is required to improve the road from the South Jazira to Mosul city or to establish storage / sugar factory in the Project area. The improvement of these infrastructures is necessary for ABC pattern to ensure the benefit, but it is an external condition for the Project. As for XYZ pattern, it is aimed at ensuring the benefit without such road improvement or storage / sugar factory establishment by reducing the cropping area of sugar beet.

Table 6.3-1 Cropping Area per 100 ha

		ABC（ha）	XYZ(ha)	XYZ-ABC(ha)
		Cropping Area	Cropping Area	Difference
1	Winter alphalpha	14.6	16.7	2.1
2	Sugar beet	22.9	4.2	∆18.7
3	Wheat	29.2	41.7	12.5
4	Barley	16.7	20.8	4.1
5	Field beans	8.3	8.3	0.0
6	Oat	1.0	4.2	3.2
7	Vetch	1.0	4.2	3.2
8	Berseem	6.3	-	∆6.3
9	Potato	-	-	-
	Winter total	100.0	100.0	-
10	Summer alphalpha	12.5	12.5	-
11	Cotton	1.5	2.1	0.6
12	Maize	0.1	-	∆0.1
13	Sunflower	0.1	-	∆0.1
14	Chick pea	0.3	2.1	1.8
	Summer total	14.5	16.7	2.2
	Total	114.5	116.7	2.2

(2) Crops Recommended by the Upper Level Plan

The National Development Plan (2010-2014), "Chapter 5 Agriculture and Water Resources" recommends wheat, barley, potato, tomato, onion and rice in winter season, and maize and dates in summer season.

(3) Crops being Cultivated in the North Jazira Area

According to the report on the North Jazira area, the actually cultivated crops are wheat, barley, potato, sugar beet, sunflower and other vegetables.

(4) Summary of the Candidate Crops

Referring to the information of the Project area as well as the above information, proposed crops are selected. Following table shows the candidate crops and the reasons of selection or non-selection.

Table 6.3-2 Possibility of introducing crops

		Grounds Document				Possibility of Introduction	Reason of Selection / Non-selection
		F/S ABC	F/S XYZ	National Five-Year Pla	North Jazira		
	Winter Crop						
1	Winter alphalpha	○	○			○	Fodder for livestock, major industry in the Project area
2	Sugar beet	○	△		○	○	Actually cultivated in the Project area
3	Wheat	○	○	○	○	○	To secure staple food
4	Barley	○	○	○	○	○	Fodder for livestock, major industry in the Project area
5	Field beans	○	○			○	Actually cultivated in the Project area
6	Oat	○	○			○	Fodder for livestock, major industry in the Project area
7	vetch	○	○			○	Fodder for livestock, major industry in the Project area
8	Berseem	○				○	Fodder for livestock, major industry in the Project area
9	Potato			○	○	○	Actually cultivated in the Project area
10	Tomato			○			Labor will get short
11	Onion			○			Labor will get short
12	Rice			○			It may affect the layer of gypsum
13	Winter fruits						Water consumption is high
	Summer Crop						
14	Summer alphalpha	○	○			○	Fodder for livestock, major industry in the Project area
15	Cotton	○	○			○	Supply source of materials for major products in Mosul
16	Chick pea	○	○			○	Actually cultivated in the Project area
17	Maize	○		○		○	To secure staple food
18	Sunflower	○			○	○	Supply source of food oil
19	Summer fruits						Water consumption is high
	Perenial Crop						
20	Dates			○			Water consumption is high

6.3.2 Cropping Pattern

Cropping schedules of the selected crops as discussed in the foregoing sections are as shown in the Table 6.3-3. Growing periods for crops were referred to the Swiss F/S and the ones not appearing in the F/S report, the periods were newly fixed based on hearings and the FAO's technical manual No.56 (FAO Irrigation and Drainage Paper No.56). In case the growing periods proposed by Swiss F/S do not correspond to those mentioned in the FAO manual, length of mid-season stage was adjusted referring to the Swiss F/S. While for the starting time of planting, considerations were so given that the seasonal water consumption and the gross water consumption per annum will not be very large. That is, the timing was selected at the time of less ET_0, relative evapo-transpiration. Discussions will be made in the followings concerning the seasonal and annual crop consumptions and ET_0. Further, the sowing and seedling periods were estimated to be shorter than the F/S, since the working efficiency of farm machineries would be much improved by introducing large-size field plot under the Project. The growing periods for crops, and sowing and seedling periods mentioned in the Swiss F/S were revised as shown in Table 6.3-4 and Table 6.3-5, respectively.

Table 6.3-3 Cropping pattern of introduced crop

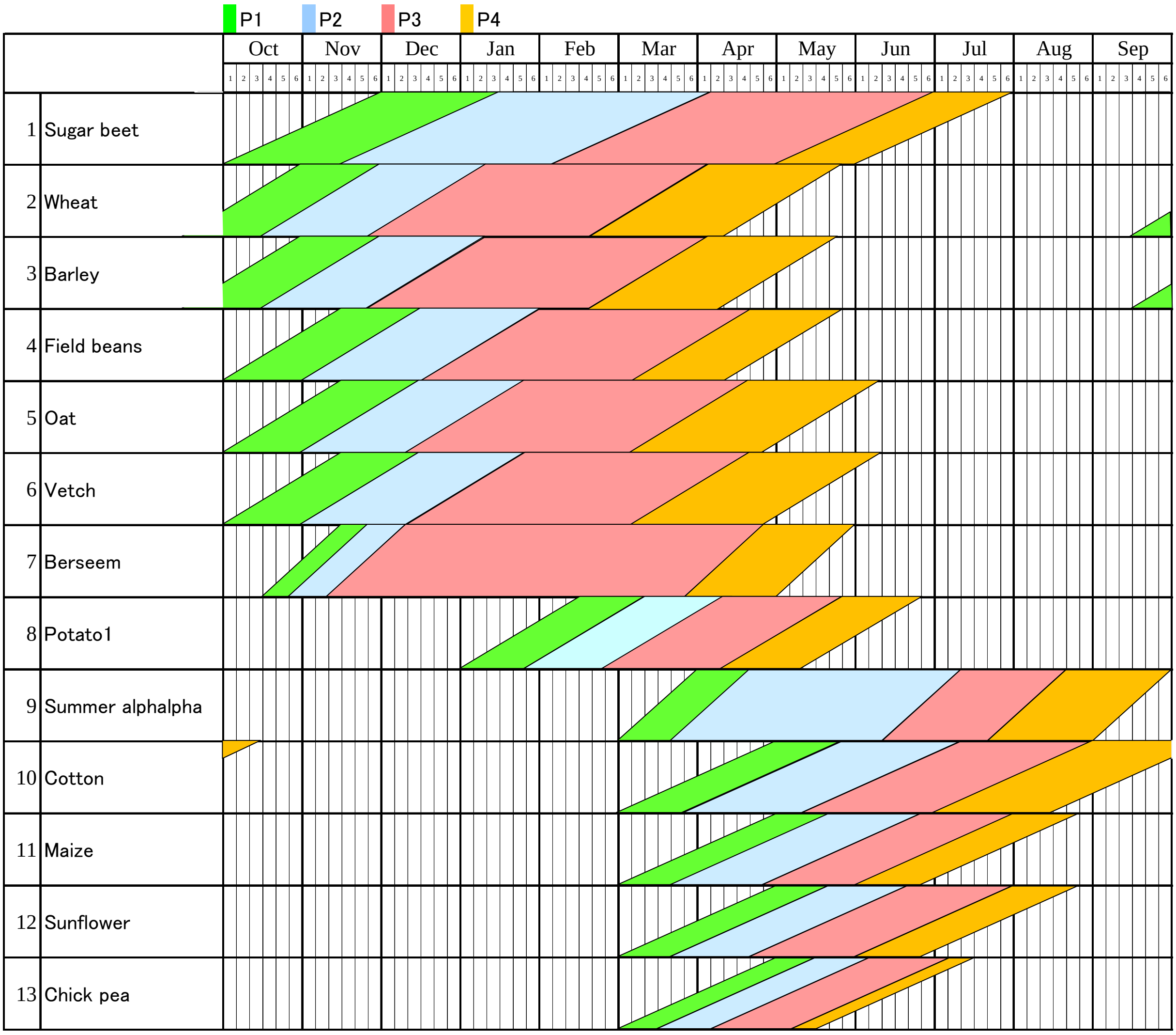


Table 6.3-4 Proposed Growing Periods for Crops

		Seeding Term					Source			Reference
		Month & 1/6 month					Swiss F/S		North	
	Crop	Month	1/6		Month	1/6	Annex 5	Annex 7	Jazira	
1	Winter alphalpha	9	1	→	9	1		Sep. 1st		Annex 7
2	Sugar beet	10	1	→	10	1	Oct. 1st	Oct. 1st		Annex 7
3	Wheat	11	1	→	9	5	Nov. 1st	Nov. 1st		Front located by considering ET0
4	Barley	11	1	→	9	5	Nov. 1st	Nov. 1st		Front located by considering ET0
5	Field beans	11	1	→	10	1	Nov. 1st	Nov. 1st		Front located by considering ET0
6	Oat	10	1	→	10	1	Oct. 1st	Oct. 1st		Annex 5 & Annex 7
7	Vetch	10	1	→	10	1	Oct. 1st	Oct. 1st		Annex 5 & Annex 7
8	Berseem	10	4	→	10	4		Oct. 16th		Annex 7

		Seeding Term					Source			Reference
		Month & 1/6 month					Swiss F/S		North	
9	Potato	1	1	→	1	1			Jan. 1st	Hearing of North Jazira
10	Summer alphalpha	3	1	→	3	1				6 month for winter and other for summer
11	Cotton	3	1	→	3	1	Apr. 1st*	Mar. 1st		Annex 7
12	Maize	3	1	→	3	1	Jul. 1st*	Mar. 1st		Annex 7
13	Sunflower	3	1	→	3	1	Mar. 1st	Mar. 1st		Annex 5 & Annex 7
14	Chick pea	3	1	→	3	1	Mar. 1st	Mar. 1st		Annex 5 & Annex 7

*Data in Annex 5 is different from data in Annex 7.

Table 6.3-5 Proposed Sowing and Seedling Periods for Crops

		Period			Source			Reference
		1/6month			Swiss F/S		North	
	Crop	Shifting of seeding			Annex 5	Annex 7	Jazira	
1	Winter alphalpha	6	→	6		6		Annex 7
2	Sugar beet	12	→	12	12	12		Annex 7
3	Wheat	12	→	9	*11**	12		Cut down by improvement of machine efficiency
4	Barley	12	→	9	*11**	12		
5	Field beans	6	→	6	*8**	6		Annex 7
6	Oat	9	→	9	*8**	9		Annex 7
7	Vetch	9	→	9	*8**	9		Annex 7
8	Berseem	6	→	6		6		Cut down by improvement of machine efficiency
9	Potato		→	9			9	Hearing of North Jazira
10	Summer alphalpha		→	6		6		Same as winter alphalpha
11	Cotton	12	→	12	*9**	12		Annex 7
12	Maize	12	→	12	*6**	12		Annex 7
13	Sunflower	12	→	12	*6**	12		Annex 7
14	Chick pea	12	→	12	*6**	12		Annex 7

*Data in Annex 5 is different from data in Annex 7.

6.3.3 Plan of Production

(1) Cropping Area by Cropping Pattern

Following Table 6.3-4 shows the cropping areas of XYZ, ABC and the pattern with additional candidate crops to XYZ. Crop rotation in the Swiss F/S is planned as 8 year-rotation of one block of 100ha (2,000m×500m), hence one unit of crop rotation is 800ha. Furthermore, each XYZ and ABC pattern consists of 3 units of crop rotation, namely 2,400ha (800ha×3) as a total crop rotation block.

Cropping area of ABC and XYZ patterns made by Swiss F/S andαβγ100 (modified XYZ patern) proposed by the JICA Team are shown in Table 6.3-6. The proposed crop intensity of αβγ is 100%, namely, one crop cultivation per year. Cropping areas and 8-years rotation cropping patterns are shown in Table 6.3-7 and Table 6.3-8, respectively.

Table 6.3-6Cropping Area by Crop in the Rotation Block (Cultivated Area: 2,400ha)

Crops		Cropping Area（ha）		
		ABC	XYZ	αβγ100
1	Winter alphalpha	350	400	-
2	Sugar beet	550	100	200
3	Wheat	700	1,000	900
4	Barley	400	500	300
5	Field beans	200	200	100
6	Oat	25	100	100
7	Vetch	25	100	100
8	Berseem	150	-	100
9	Potato	-	-	100
	Winter total	2,400	2,400	1,900
10	Summer alphalpha	300	300	400
11	Cotton	37	50	25
12	Maize	3	-	25
13	Sunflower	3	-	25
14	Chick pea	8	50	25
	Summer total	350	400	500
	Total	2,750	2,800	2,400

Table 6.3-7 Cropping Area of αβγ (Cultivated Area: 2,400ha)

Crops		Cropping Area（ha）		
		α100	β100	γ100
1	Winter alphalpha	-	-	-
2	Sugar beet	100	100	-
3	Wheat	200	300	400
4	Barley	100	100	100
5	Field beans	-	100	
6	Oat	-	50	50
7	Vetch	-	50	50
8	Berseem	50		50
9	Potato	50	-	50
	Winter total	500	700	700
10	Summer alphalpha	200	100	100
11	Cotton	25	-	-
12	Maize	25	-	-
13	Sunflower	25	-	-
14	Chick pea	25	-	-
	Summer total	300	100	100
	Total	800	800	800

Table 6.3-8 Cropping Pattern of αβγ (Cultivated Area: 2,400ha)

* α100-pattern

Month: Oct, Nov, Dec, Jan, Feb, Mar, Apr, May, Jun, Jul, Aug, Sep

Field	1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year
1	Sugar beet	Wheat	Wheat	Barley	Berseem / Potato	Summer alphalpha	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea
2	Wheat	Wheat	Barley	Berseem / Potato	Summer alphalpha	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea	Sugar beet
3	Wheat	Barley	Berseem / Potato	Summer alphalpha	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea	Sugar beet	Wheat
4	Barley	Berseem / Potato	Summer alphalpha	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea	Sugar beet	Wheat	Wheat
5	Berseem / Potato	Summer alphalpha	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea	Sugar beet	Wheat	Wheat	Barley
6	Summer alphalpha	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea	Sugar beet	Wheat	Wheat	Barley	Berseem / Potato
7	Summer alphalpha	Cotton / Maize & Sunflower / Chick pea	Sugar beet	Wheat	Wheat	Barley	Berseem / Potato	Summer alphalpha
8	Cotton / Maize & Sunflower / Chick pea	Sugar beet	Wheat	Wheat	Barley	Berseem / Potato	Summer alphalpha	Summer alphalpha

* β100-pattern

Month / Field	1st year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1					Sugar beet							
2				Wheat								
3				Wheat								
4				Wheat								
5				Barley								
6				Field beans								
7				Oat & Vetch								
8									Summer alphalpha			

Month / Field	2nd year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Wheat								
3				Wheat								
4				Barley								
5				Field beans								
6				Oat & Vetch								
7									Summer alphalpha			
8					Sugar beet							

Month / Field	3rd year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Wheat								
3				Barley								
4				Field beans								
5				Oat & Vetch								
6									Summer alphalpha			
7					Sugar beet							
8				Wheat								

Month / Field	4th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Barley								
3				Field beans								
4				Oat & Vetch								
5									Summer alphalpha			
6					Sugar beet							
7				Wheat								
8				Wheat								

Month / Field	5th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Barley								
2				Field beans								
3				Oat & Vetch								
4									Summer alphalpha			
5					Sugar beet							
6				Wheat								
7				Wheat								
8				Wheat								

Month / Field	6th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Field beans								
2				Oat & Vetch								
3									Summer alphalpha			
4					Sugar beet							
5				Wheat								
6				Wheat								
7				Wheat								
8				Barley								

Month / Field	7th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Oat & Vetch								
2									Summer alphalpha			
3					Sugar beet							
4				Wheat								
5				Wheat								
6				Wheat								
7				Barley								
8				Field beans								

Month / Field	8th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1									Summer alphalpha			
2					Sugar beet							
3				Wheat								
4				Wheat								
5				Wheat								
6				Barley								
7				Field beans								
8				Oat & Vetch								

* γ100-pattern

Month / Field	1st year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Wheat								
3				Wheat								
4				Wheat								
5				Barley								
6				Oat & Vetch								
7				Berseem		Potato						
8									Summer alphalpha			

Month / Field	2nd year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Wheat								
3				Wheat								
4				Barley								
5				Oat & Vetch								
6				Berseem		Potato						
7									Summer alphalpha			
8				Wheat								

Month / Field	3rd year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Wheat								
3				Barley								
4				Oat & Vetch								
5				Berseem		Potato						
6									Summer alphalpha			
7				Wheat								
8				Wheat								

Month / Field	4th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Wheat								
2				Barley								
3				Oat & Vetch								
4				Berseem		Potato						
5									Summer alphalpha			
6				Wheat								
7				Wheat								
8				Wheat								

Month / Field	5th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Barley								
2				Oat & Vetch								
3				Berseem		Potato						
4									Summer alphalpha			
5				Wheat								
6				Wheat								
7				Wheat								
8				Wheat								

Month / Field	6th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Oat & Vetch								
2				Berseem		Potato						
3									Summer alphalpha			
4				Wheat								
5				Wheat								
6				Wheat								
7				Wheat								
8				Barley								

Month / Field	7th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1				Berseem		Potato						
2									Summer alphalpha			
3				Wheat								
4				Wheat								
5				Wheat								
6				Wheat								
7				Barley								
8				Oat & Vetch								

Month / Field	8th year											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1									Summer alphalpha			
2				Wheat								
3				Wheat								
4				Wheat								
5				Wheat								
6				Barley								
7				Oat & Vetch								
8				Berseem		Potato						

(2) Present Yield (Rain-fed Yield) and Proposed Yield(Irrigated Yield)

Proposed yield of the Swiss F/S is adopted for this Project as the relevance of this yield has been confirmed from the hearing of the concerned personnel.

It has been confirmed from the hearing of the concerned personnel that the farmer beneficiaries are dependent on rain-fed agriculture at present as well as the time of the Swiss F/S survey period. The sample farm household survey also follows the same state. As the rainfall is not much changed from time of Swiss F/S, the yield (0) of the Swiss F/S report is adopted for the present yield.

It would be required to obtain statistical data (production by crop for at least recent 5 years) in order to examine the relevance of the present yield level in the Swiss F/S, but the data is not available so far.

Table 6.3-9 Crop Yield (Present and Proposed)

Crops		Present Yield	Proposed Yield	Remark
		kg/ha	kg/ha	
1	Winter alphalpha	-	7,000	
2	Sugar beet	-	46,000	
3	Wheat	-	5,600	
4	Barley	-	5,200	
5	Field beans	-	2,800	
6	Oat	-	7,600	
7	Vetch	-	7,600	
8	Berseem	-	8,400	
9	Potato	-	20,000	Minimum yield of North Jazira
10	Summer alphalpha	-	7,000	
11	Cotton	-	2,800	
12	Maize	-	6,000	
13	Sunflower	-	2,400	
14	Chick pea	-	2,400	

(3) Production by Crop per Crop Rotation Block

The yield proposed by the Swiss F/S is used as the target yield for this Study. Concerning some crops which are not mentioned in the Swiss F/S, the yields in North Jazira are applied. Relevance of those yields was approved by the PMT members, since there are some farmers gain the same level of proposed yield. It is needed to satisfy following conditions for achievement of the target:

- Acquirement of water management techniques
- Improvement of irrigation techniques of the farmers
- Input of fertilizers and chemicals

- ♦ Acquirement of proper cultivation techniques e.g. application of fertilizers and chemicals

According to the Swiss F/S, it will take 20 years after the completion of the Project to achieve the target production volume which is shown in following table. Given that most of the farmers in the Project Area operate extensive rainfed agriculture, it takes long years to satisfy the conditions mentioned above and to achieve the goal. Therefore, it is proposed to implement a series of trainings, e.g. cultivation and water management in the pilot farm and it is assumed the target production will be accomplished in 10 years after the start of Project.

Production by crops is calculated by multiplying cropping intensity per block with proposed yield as shown in Table 6.3-10.

Table 6.3-10 Crop Production of Rotation Block (Cultivated Area 2,400ha)

Crops		Proposed Yield	Cropping Area（ha）			Production（ton/Year）		
		kg/ha	ABC	XYZ	αβγ100	ABC	XYZ	αβγ100
1	Winter alphalpha	7,000	350	400	-	2,450	2,800	-
2	Sugar beet	46,000	550	100	200	25,300	4,600	9,200
3	Wheat	5,600	700	1,000	900	3,920	5,600	5,040
4	Barley	5,200	400	500	300	2,080	2,600	1,560
5	Field beans	2,800	200	200	100	560	560	280
6	Oat	7,600	25	100	100	190	760	760
7	Vetch	7,600	25	100	100	190	760	760
8	Berseem	8,400	150	-	100	1,260	-	840
9	Potato	20,000	-	-	100	-	-	2,000
10	Summer alphalpha	7,000	300	300	400	2,100	2,100	2,800
11	Cotton	2,800	37	50	25	103	140	70
12	Maize	6,000	3	-	25	16	-	150
13	Sunflower	2,400	3	-	25	6	-	60
14	Chick pea	2,400	8	50	25	19	120	60

(4) Cropping area by Crop in Drought Year (Cultivated Area 2,400ha)

The cropping pattern is proposed considering 80% possibility drought year. Therefore, it is possible to cultivate proposed crops as scheduled even in drought year, which occurs at the frequency of once in five years. However, it is needed to reduce irrigation area according to the available water resource in severe drought year. Since it is difficult to predict occurrence of drought beforehand, decision on whether it is needed to reduce the irrigation area will be made based on the observation of precipitation and water level of the Mosul Dam. In case of unexpectedly severe drought, firstly, irrigation for summer vegetables (field beans, maize, and chick pea) and industrial crops (sugar beet, cotton, and sunflower) will be discontinued, secondly, one for feed crops (barley, summer alphalpha, oat, vetch, berseem) will be stopped. In case of much severe drought, irrigation area of staple food, namely, wheat will be reduced.

6.3.4 Seasonal Water Consumption

(1) Basic Formula of Seasonal Water Consumption

The Swiss F/S adopted the Pen-man formula for calculating the seasonal crop water consumption. While the JICA Study employs the Pen-man-Montis formula for the calculation as recommended by FAO with the following reasons as 1) Reappearance ratio is high, 2) service area is upland field and 3) reliability is high. The said two formulas uses the same relations among the unit duty of water, effective rainfall and crop factors though the calculation formula for the relative evapo-transpiration is different. The basic formula showing the relations is as indicated below.

In (Unit water requirement) ＝ ETcrop － Pe

ETcrop (Crop evapo-transpiration) ＝ ET_0 × Kc

ET_0: Evapo-transpiration for related crops

Pe: Effective rainfall

Kc: crop coefficient

(2) Data used for Estimating Seasonal Water Consumption

1) Evapo-transpiration for related crops (ET_0)

ET_0, relative evapo-transpiration derived from the Swiss F/S (Pen-man) and CROPWAT (Pen-man-Montis) are as shown in the Table 6.3-7. The difference between the two is about 5 % only in terms of the annual total. While for the maximum value, the ET_0 by CROPWAT is larger than Swiss F/S by 15 % with the occurrence appeared in July in both cases.

In general, it is said that the ET_0 by Pen-man formula will appear larger than that of Pen-man-Montis. However, the comparison in the Table below shows the reversed result, probably due to the factors of different meteorological data used.

Under the present study, rainfall was fixed at zero so as to avoid gaining excessively large project benefits for evaluation. For the wind velocity, the Swiss F/S value was referred as the collected data are unknown with the elevation of velocity measurements. Further, it is noted that the monthly data derived from Telafar Station was input for the calculation by CROPWAT program.

Table 6.3-11 Calculated ET_0 (mm/month)-and ET_0 (mm/month) in the Swiss F/S

ET_0	Calculation	Formula	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total mm/year
Swiss F/S	F/S report	Penman	190.0	106.0	51.0	49.0	59.0	103.0	147.0	226.0	276.0	316.0	314.0	261.0	261.0
Study Team	CROP WAT	Penman - Monteith	168.0	80.1	45.6	39.7	56.3	104.5	163.5	260.4	335.4	365.8	341.0	259.2	259.2

2) Crop coefficient (Kc)

Crop coefficient Kc and staged crop growth periods are decided based on the FAO's technical manual No.56 (FAO Irrigation and Drainage Paper No.56), considering area to be applied and sowing period. The applied figures for each of crops are shown below.

Table 6.3-12 Crop growth stage-wise period (5 days unit)

Unit: 1/6 month

	Crop	Total Period	P1	P2	P3	P4	Source
1	Winter alphalpha	36	1	4	2	2	Swiss F/S, FAO No.56（Alfalfa）*4times
2	Sugar beet	48	9	16	17	6	Swiss F/S
3	Wheat	41	6	8	17	10	Swiss F/S
4	Barley	41	6	8	17	10	Swiss F/S
5	Field beans	38	6	9	16	7	Swiss F/S
6	Oat	41	6	8	17	10	Swiss F/S
7	Vetch	41	6	8	17	10	Swiss F/S
8	Berseem	39	2	3	27	7	Swiss F/S、FAO No.56（Bermuda）
9	Potato	26	5	6	9	6	North Jazira、FAO No.56（Potato: Arid）
10	Summer alphalpha	36	1	4	2	2	Swiss F/S, FAO No.56（Alfalfa）*4times
11	Cotton	33	5	9	10	9	Swiss F/S
12	Maize	23	4	7	7	5	Swiss F/S
13	Sunflower	23	4	6	8	5	Swiss F/S
14	Chick pea	15	3	4	6	2	Swiss F/S

Table 6.3-13 Kc value at the start and the end

	Crop	Kc ini	Kc mid	Kc end	Source
1	Winter alphalpha	0.98	0.98	0.98	FAO No.56（Alfalfa, Weighted Average）
2	Sugar beet	0.35	1.20	1.00	FAO No.56（Potato, note5）
3	Wheat	0.70	1.15	0.25	FAO No.56（Winter Wheat non frozen）
4	Barley	0.30	1.15	0.25	FAO No.56（Barley）
5	Field beans	0.40	1.10	0.30	FAO No.56（Lentil）
6	Oat	0.30	1.15	0.25	FAO No.56（Oat）
7	Vetch	0.30	1.15	0.25	FAO No.56（Oat）
8	Berseem	0.40	1.15	1.10	FAO No.56（Berseem individual,）
9	Potato	0.50	1.15	0.75	FAO No.56（Potato）
10	Summer alphalpha	0.98	0.98	0.98	FAO No.56（Alfalfa, Max）

	Crop	Kc ini	Kc mid	Kc end	Source
11	Cotton	0.35	1.20	0.70	FAO No.56（Cotton max）
12	Maize	0.30	1.15	1.05	FAO No.56（Sweet Corn）
13	Sunflower	0.35	1.15	0.35	FAO No.56（Sunflower, note9）
14	Chick pea	0.50	1.15	1.10	FAO No.56（Peas Fresh）

3) Effective rainfall (Pe)

The effective rainfall (Pe) as adopted by the Swiss F/S and the effective rainfall as adopted by this study are shown in the Table 6.3-14. Through multiplying the factor 0.91 as suggested by Swiss F/S, the rainfall of Telafar was converted to the rainfall at the Project beneficiary area. The results of conversion shows the annual mean rainfall of 272.3 mm/annum which is quite similar to the one in F/S report at 282.0 mm. Assuming the drought year but the rainfall amount still allow plants growing, the effective rainfall remains at smaller than the mean annual rainfall. The study team obtains input average monthly rainfall to CROPWAT program to get effective rainfall as result of calculation.

Table 6.3-14 Pe (effective rainfall (mm/month)) in the Study and Pe-in the Swiss F/S

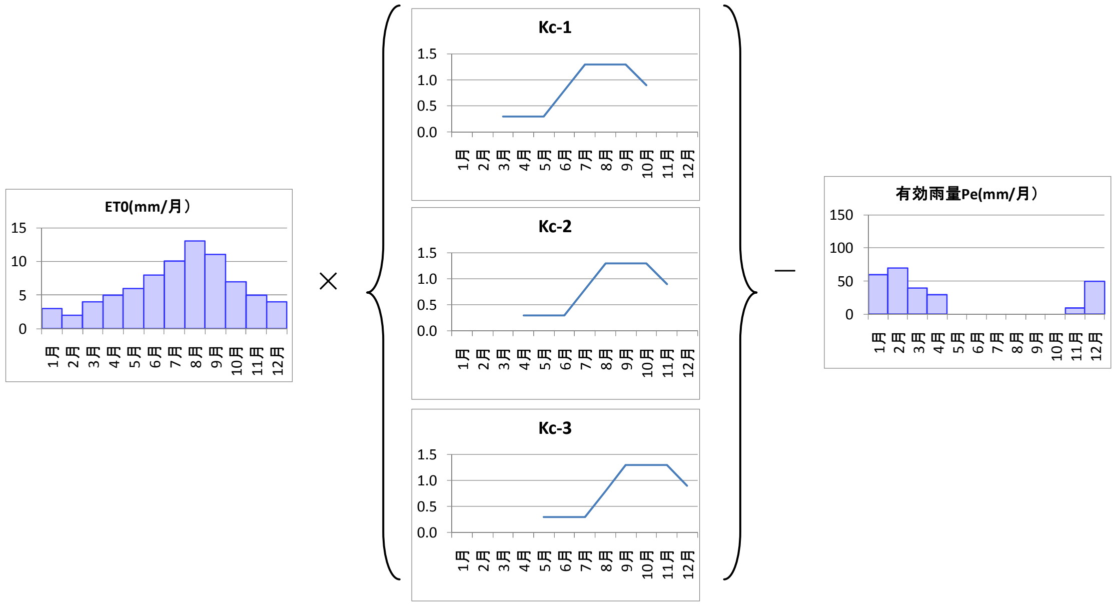
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total mm/year
Swiss F/S	Average Rainfall	5.0	22.0	49.0	50.0	41.0	49.0	49.0	17.0	0.0	0.0	0.0	0.0	282.0
	Effective Rainfall: Pe（80% probability）	0.0	14.0	14.0	12.0	10.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	58.0
Study Team	Average Rainfall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Effective Rainfall: Pe（by CROPWAT）	6.9	14.4	28.6	33.0	27.4	31.9	16.2	8.7	0.5	0.1	0.0	0.4	168.1

* Average rainfall of study area is calculated by multiplication of average rainfall in Tel Afar station and conversion coefficient (0.91).

(3) Estimation of ETcrop considering the Cropping Period

Proposed farming plan in this Project is to establish crop rotation system with 100ha (2,000m×500m) as a unit. Each crop operation will be carried out in series and therefore, sowing and planting operation will take long time (from 6 five-day to 12 five-day from the beginning to the end). For this reason, on the farm plot sown or planted in the early time and the plot sown or planted in the late time, ET_0 and Pe at the stage of crop growth will be different and that will affect the net water requirement (In).

In order to consider this fact, unit water requirement per five-day is estimated by the period of sowing or planting as follows and summed up to come up with the total unit water requirement per five-day, illustration as shown in Fig. 6.3-1.



Remarks: ET_0 to multiply and Pe to deduct will differ according to the earliness and lateness of sowing or planting period

Fig. 6.3-1 Illustration of ETcrop calculation

The Swiss F/S adopted the same idea as mentioned above. The "Periods for activities to be done in order" under the subject Study has been fixed taking into account the seasonal crop water consumption as shown in the Table 6.3-11 on the basis of the "Periods for activities to be done" indicated in the Swiss F/S. The outcomes under the present study are as shown in the Table 6.3-3.

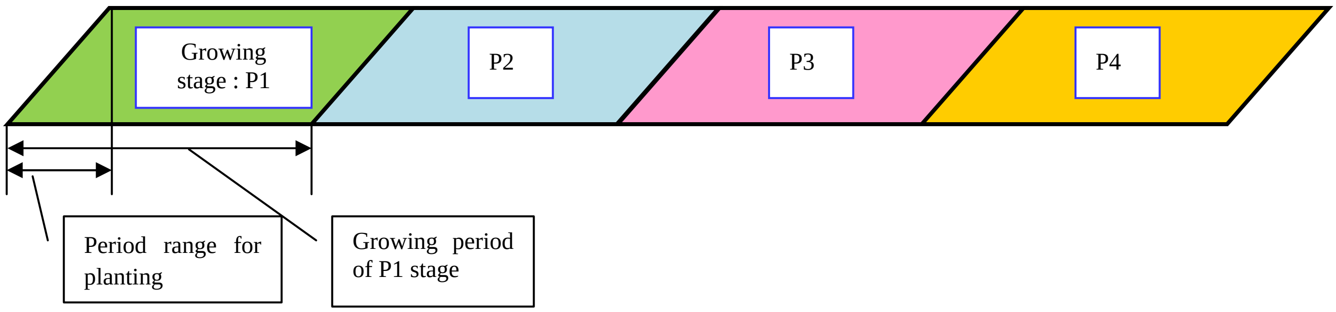


Figure 6.3-2 Growing Stage and Period Range for Planting

(4) Setting of Irrigation Efficiency

The irrigation efficiency adopted is not clearly described in the Swiss F/S. However, if calculating backward, it can be assumed that 0.64 of efficiency was adopted. This is an average of 0.68, by sprinkler and 0.60, by surface irrigation. It is noted that the efficiency values are of irrigation loss inclusive from the intake up to the terminal at the field.

Under the subject study, introducing of large scale self-propelled sprinkler system is considered aiming at higher workability at the large size cultivation field and higher water use efficiency for limited resources, and then, the irrigation efficiency of 0.68 shall be adopted. The irrigation efficiency includes not only irrigation loss caused by water spray but also conveyance loss. The calculation process is as shown below:

Table 6.3-15 Irrigation efficiencies in South Jazira

Irrigation Efficiencies		Remarks
Application efficiency (e_a)	0.80	Sprinkler system is planned.
Watercourse efficiency (e_b)	0.95	Watercourse should be lined.
Conveyance efficiency (e_c)	0.90	Distribution system should be lined.
Project efficiency (e_p)	0.68	$=e_a \times e_b \times e_c$

6.3.5 Irrigated Agriculture Plan by Scenarios (Scenario-1,2,3)

Calculation was made to obtain the seasonal crop water consumption by using the CROPWAT program as recommended by FAO. Input data and calculation results are as follows.

(1) Input data

Input meteorological data for calculating ET_0 are as follows. For rainfall, zero (0) was input. Further, those items to be input for calculating ETcrop were shown in Table 6.3-12, Table 6.3-13 and Table 6.3-5.

Table 6.3-16 Location of Telafar Station

Country	:Iraq	Elevation	:400 m
Observed location	:Telafar	Latitude	:36.37
		Longitude	:42.24

Table 6.3-17 Meteorological data at Telafar Station

	Min. temperature C	Max. temperature C	Humidity %	Wind speed km/day	Sunshine hours
January	3.3	11.4	76.8	233.3	6.35
February	4.3	13.3	69.7	250.6	9.99
March	7.6	18.0	60.7	250.6	11.86
April	12.6	24.6	54.6	250.6	15.30
May	18.2	32.0	35.9	267.8	17.95
June	24.1	38.4	24.0	293.8	21.04
July	27.7	42.1	21.9	293.8	19.63
August	27.3	41.6	22.8	293.8	17.89
September	23.3	37.1	24.1	267.8	15.97
October	17.0	29.9	37.3	241.9	11.02
November	10.1	20.3	57.1	207.7	7.81
December	5.0	13.6	75.2	250.6	5.77

(2) Effective rainfall

In order to calculate the seasonal water intake from Mosul Dam, the effective rainfall as discussed in the foregoing (Table 6.3-9) shall be adopted. While for determining the scale of hydraulic facility (i.e. design discharge of feeder canal), zero effective rainfall shall be applied to estimate the seasonal crop water requirement and the maximum value is fixed as the design discharge. This is a countermeasure to the prevailing condition that there are lacks of data/information about the rainfall and water holding capacity of soils in the project area.

(3) Relative evapo-transpiration (ET_0) and Crop evapo-transpiration (ETcrop)

The ET_0 resulted from CROPWAT program calculation is as shown in Table 6.3-7. The water duty shown in the Table 6.3-18 indicates the requirement at the field and therefore more quantity of water is required when considering the irrigation efficiency.

Table 6.3-18 MonthlyUnit Water Requirement (ETcrop and ET0)

Crops	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total mm/year
Winter alphalpha	165.1	80.7	45.1	39.4	55.7	35.4	0.0	0.0	0.0	0.0	0.0	141.3	562.7
Sugar beet	16.6	22.7	21.2	29.7	59.0	127.2	201.0	305.1	247.2	67.2	0.0	0.0	1,096.9
Wheat	70.9	66.4	48.5	46.2	65.6	107.0	86.9	22.3	0.0	0.0	0.0	9.3	523.1
Barley	37.2	43.8	44.6	46.2	65.6	107.0	86.9	22.3	0.0	0.0	0.0	4.0	457.6
Field beans	37.7	41.2	41.6	44.2	63.0	104.6	58.5	1.1	0.0	0.0	0.0	0.0	391.9
Oat	19.1	30.6	37.7	45.4	65.8	116.0	118.2	51.2	0.9	0.0	0.0	0.0	484.9
Vetch	19.1	30.6	37.7	45.4	65.8	116.0	118.2	51.2	0.9	0.0	0.0	0.0	484.9
Berseem	11.1	59.5	53.0	46.4	66.0	123.4	186.5	99.1	0.0	0.0	0.0	0.0	645.0
Potato	0.0	0.0	0.0	8.5	36.4	110.4	189.0	204.1	49.6	0.0	0.0	0.0	598.0
Summer alphalpha	0.0	0.0	0.0	0.0	0.0	67.3	164.3	260.8	337.2	369.4	336.0	84.5	1,619.5
Cotton	3.6	0.0	0.0	0.0	0.0	12.2	66.6	216.6	386.4	434.2	309.1	94.3	1,523.0
Maize	0.0	0.0	0.0	0.0	0.0	11.1	74.5	238.7	373.3	245.6	43.4	0.0	986.6
Sunflower	0.0	0.0	0.0	0.0	0.0	12.9	83.7	251.4	344.0	188.9	21.6	0.0	902.5
Chick pea	0.0	0.0	0.0	0.0	0.0	19.8	113.6	247.1	165.0	13.8	0.0	0.0	559.3
ET0	168.0	79.8	45.6	39.7	56.3	104.8	163.5	260.1	335.1	365.8	341.3	259.2	2,219.1

6.3.6 Measures against Gypsum Layers by means of Adjustment of Irrigation Intensity

It was confirmed that there are layers of gypsum in the Project Area. If sufficient water is irrigated there, peroration water can reach to the layers of gypsum and dissolve them, which can lead to differential settlement in the farmlands. Therefore, following countermeasures are proposed:

1) Only farmlands which have gypsum layers at deep layer can be irrigated
2) Irrigation plan (irrigation intensity and irrigation interval) considering water holding capacity of soil is proposed

In "Chapter 6.1 Irrigation Service Area", farmlands which have deeper soil layers than 50cm is decided as irrigation targets, therefore, this definition can be applied in 1) above mentioned.

Concerning 2) above, it is needed to limit irrigation volume to the consumable amount by the evapo-transpiration and to keep percolation water from reaching to the gypsum layers. In other words, it is proposed to irrigate a small amount of water at short interval. Moreover, it is necessary to measure soil water holding capacity in advance, it is recommended to include it in the measurement items, which will be implemented in the pilot farm.

6.4 Irrigated agriculture plans for each Scenario

Through multiplying the cropping acreages with the monthly water duty by CRPWAT, the seasonal crop water consumption can be computed. On this basis, the annual water consumption (Gross intake per annum) and the seasonal peak consumption (Design discharge) shall be worked out. The results may differ depending on the acreages to be irrigated. Under the present study, four (4) scenarios were fixed for different irrigation areas and the corresponding seasonal consumption shall be calculated.

It is noted that the annual total of crop water consumption (Intake quantity per annum) is the accumulation of the seasonal crop water consumptions as computed by CROPWAT program with the inputs of effective rainfall based on the monthly basis rainfall data. While for the seasonal (Peak) consumption (Design discharge) is the maximum consumption quantity as resulted by CROPWAT computation with zero effective rainfall.

6.4.1 Irrigation areas

The four(4) scenarios discussed under the subject project will cover the following irrigation acreages. The Scenario-0 shall cover the whole area as same with the Swiss F/S case. The Scenario-1 is the case excluding the plateau area (Pumping is needed.) at the western part of the beneficiary area. While for the Scenarios 2 and 3, the irrigation areas will be further decreased due to the assumed difficult situations on water resources utilization in and around the project area.

Table 6.4-1 Irrigation areas for each scenario (ha)

	Scenario-0	Scenario-1	Scenario-2	Scenario-3
Irrigation Service Area	148,600	119,000	86,800	59,500

6.4.2 Seasonal Water Consumption and Annual Total Water Consumption Considering Effective Rainfall

The proportions of planted area for each crop shall refer to the “Table 6.3-4 Crop rotation block” and applying the cropping pattern αβγ100, unit water duty of each crop, irrigation acreages and irrigation efficiency of 0.68, the seasonal crop water consumptions for each scenario are calculated as indicated in the following table. This consumption water volume is regarded as water intake volume at the Mosul Dam.

(1) Sceanrio-0: irrigation area is 148,600ha

In case of the scenario-0 in which the irrigation area becomes the largest, the gross annual water intake reaches at 1,390 Million m^3/annum and the amount will decrease in accordance with the decrease in irrigation area. During the period of July-August, the relative evapo-transpiration, ET0 of crops becomes the highest, but, the seasonal consumption amount is comparatively small with having a limited planted area.

Table 6.4-2 (a) Annual Water Consumption (BCM/year) of Scenario-0: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝148,600													
Scenario-0	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	73	62	26	20	63	156	228	223	201	167	131	41	1,390

(2) Scenario-1: irrigation area is 119,000ha

Scenario-1 targets the Project Area excluding western plateau where pump is needed. The total annual water intake reaches at 1,113 Million m^3/annum.

Table 6.4-2 (b) Annual Water Consumption (BCM/year) of Scenario-1: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝119,000													
Scenario-1	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	58	50	21	16	50	125	182	179	161	134	105	33	1,113

(3) Scenario -2: irrigation area is 86,800ha

Scenario-2 plans to irrigate 86,800ha and the total annual water intake is 812 Million m^3/annum.

Table 6.4-2 (c) Annual Water Consumption (BCM/year) of Scenario-2: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝86,800													
Scenario-2	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	42	36	15	12	37	91	133	130	117	97	76	24	812

(4) Scenario-3: irrigation area is 59,500ha

The service area of Scenario is 59,500ha and the total annual water intake is 557 Million m^3/annum.

Table 6.4-2 (d) Annual Water Consumption (BCM/year) of Scenario-3: Monthly Water Consumption with Effective Rainfall

Irrigation Area＝59,500													
Scenario-3	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Annual Water Consumption
Water Consumption (BCM/month)	29	25	10	8	25	62	91	89	80	67	52	17	557

6.4.3 Maximum discharge: Water Consumption with Applying Zero Effective Rainfall

The maximum amount of water consumption with applying zero effective rainfall, which can be regarded as the design discharge, is calculated. For the estimation of effective rainfall, it is needed to calculate water balance on a daily basis by input of soil water holding capacity and daily rainfall. Since such data are not collected, effective rainfall is not considered in the calculation on the safe side and design discharges are calculated with applying zero effective rainfall.

(1) Scenario-0: irrigation area is 148,600ha

Since the maximum monthly discharge calculated is at 100.4 m^3/sec, the design discharge is set at 100 m^3/sec. The crop intensity becomes high in winter when Crop evapo-transpiration (ETo) is low and monthly discharge becomes biggest in April.

Table 6.4-3 (a) Design Discharge (m^3/sec) of Scenario-0: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝148,600													
Scenario-0	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m^3/sec)	30.6	32.9	27.5	28.2	42.2	84.0	100.4	90.1	77.7	64.4	50.5	16.1	100.4

(2) Scenario-1: irrigation area is 119,000ha

Since the maximum monthly discharge calculated at 80.4 m^3/sec, the design discharge is set at 80 m^3/sec.

Table 6.4-3 (b) Design Discharge (m^3/sec) of Scenario-1: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝119,000													
Scenario-1	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m^3/sec)	24.5	26.3	22.0	22.6	33.8	67.3	80.4	72.2	62.2	51.6	40.4	12.9	80.4

(3) Scenario-2: irrigation area is 86,800ha

Since the maximum monthly discharge calculated at 58.6 m^3/sec, the design discharge is set at 60 m^3/sec.

Table 6.4-3 (c) Design Discharge (m^3/sec) of Scenario-2: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝86,800													
Scenario-2	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m^3/sec)	17.9	19.2	16.1	16.5	24.7	49.1	58.6	52.7	45.4	37.6	29.5	9.4	58.6

(4) Scenario-3: irrigation area is 59,500ha

Since the maximum monthly discharge calculated at 40.2 m^3/sec, the design discharge is set at 40 m^3/sec.

Table 6.4-3 (d) Design Discharge (m^3/sec) of Scenario-3: Maximum Discharge with Zero Effective Rainfall

Irrigation Area＝59,500													
Scenario-3	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Peak Intake
Seasonal Discharge (m^3/sec)	12.2	13.2	11.0	11.3	16.9	33.6	40.2	36.1	31.1	25.8	20.2	6.4	40.2

6.5 Impacts on Livestock Farming by the Project

(1) Effects by the Irrigation Project

Livestock farming is richly operated in the South Jazira, and barley and residuum of wheat are utilized for animal feeding staff. The project can contribute to promotion of the livestock farming in South Jazira as follows:

① Increase of feed crop production
② Provision of water for livestock
③ Stable feed crop production

Concerning ① mentioned above, total income is regarded as project effect as well as other crops. In case of ② above, it is difficult to estimate the effect caused by change of water resource (from salty underground water to little salty river water). The calculation method to estimate the quantitative effect of ③ mentioned above has yet to be established, however, it is possible to examine the qualitative ones. The effects are described as below.

(2) Effects by Stable Feed Crop Production

1) Reduction of feed crop transportation cost

Since feed crop production depends on rainfall, the production can be decreased in drought year, which leads to shortage of animal feeding staff. If livestock farmers in the area purchase feed crops from other areas to supply a deficit at present, they can save transportation cost by purchase of feed crops in the area after the project completion.

2) Expansion of size of business

The livestock farmers can control their livestock numbers as scheduled by stable supply of feed crops by the Project. It means that they can expand their sizes of business in line with available amount of feed crops and they will not have to sell their livestock at the low price in drought years, which will lead to improvement and stability for the farmers' house incomes.

3) Introduction of big livestock

Stable supply of feed crops and water for livestock enable the livestock farmers to introduce big livestock, namely, beef cattle and dairy cow instead of goats and sheep, which can contribute to income improvement.

CHAPTER 7. OUTLINE DESIGN OF FEEDER CANAL

7.1 General Outline of Canal System

Feeder canal is an irrigation water conveyance system from Mosul Dam built on the Tigris River as the water source to South Jazira Irrigation Project area located about 60 km South-west from the Dam. Intake facilities for South Jazira area have ever been planned as follows by the preceding "Mosul Scheme 4 of the Mosul Dam Project" and the same will constitute the basics for the present planning as shown in Fig. 7.1-1.

1) Components of intake facilities: Intake work at Dam - Feeder tunnel - Pumping Station /By-pass pipeline - Transition
2) Transfer water level: WL 310.00 m

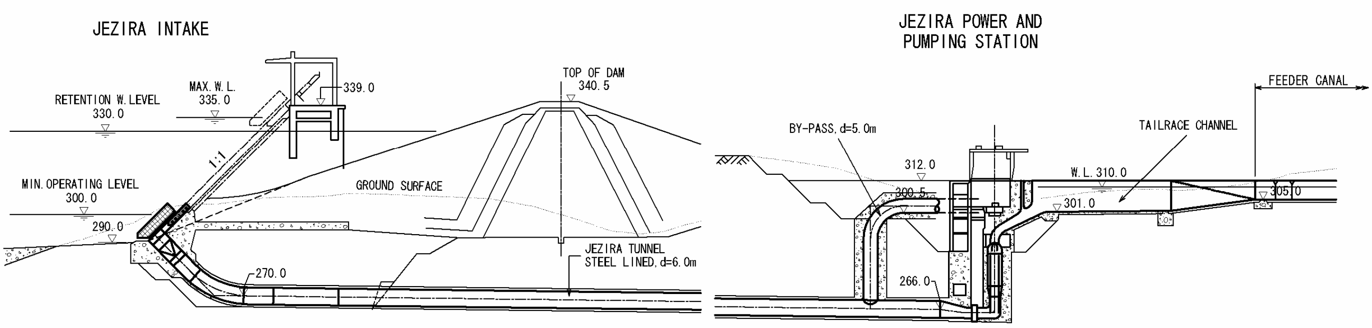


Fig. 7.1-1 Map showing the outline of Intake Facilities

The subject system of feeder canal is planned applying the concept of water control by upstream water level with supply-side commanding water management system.

1) The system is of large scale and long distance open canal for water conveyance.
2) Transfer water level at the start of feeder canal is to be controlled /regulated under dam operation side.
3) Water resource at the dam reservoir is in very tight situation.

7.2 Calculation of Design Discharge

The design discharge of feeder canal can be obtained by the following formula and the design discharge for the Scenario-0, Scenario-1 and Scenario-2 are as indicated in Table 7.2-1.

Design discharge (m^3/sec) = Maximum water requirement (m^3/sec/ha) / Irrigation efficiency x Irrigation area (ha)

Table 7.2-1 Design discharge of feeder canal for each scenario

Scenario	Unit water requirement (m^3/sec/ha)	Irrigation efficiency	Irrigation area (ha)	Design discharge (m^3/s)
0	0.0004594	0.68	148,600	100
1			119,000	80
2			86,800	60

7.3 Alternative Design

7.3.1 Selection of alternative designs

Concerning the water conveyance to South Jazira area, a comparison study is made to fix the ultimate feeder canal system based mainly on the Swiss F/S (1984) and Iraqi D/D report (1991). Matters to be paid with due attention in selecting the alternatives are as follows;

1) Water source is Mosul Dam and the transfer water level is fixed at WL. 310.00m.
2) Topographically, plateaus are extended from Mosul Dam with the elevations ranging EL 300.00-EL 320.00m, and there is Mt Jabel Shekh Ibrahim with the peak elevation over 550.00 m located at the northern part of the beneficiary area.
3) The project beneficiary area is provided with considerable elevation difference ranging from EL. 220.00 to EL. 320.00m.
4) Water level required at the diversion site located at the northern part of the beneficiary area is approximately WL. 297.50 m.

As the water conveyance system between the 37 km position of the feeder canal to the diversion site at the upstream-most of beneficiary area, two (2) alternatives, namely, tunnel by-passing and pumping scheme can be considered.

Alternative 1: Tunnel
Alternative 2: Pumping

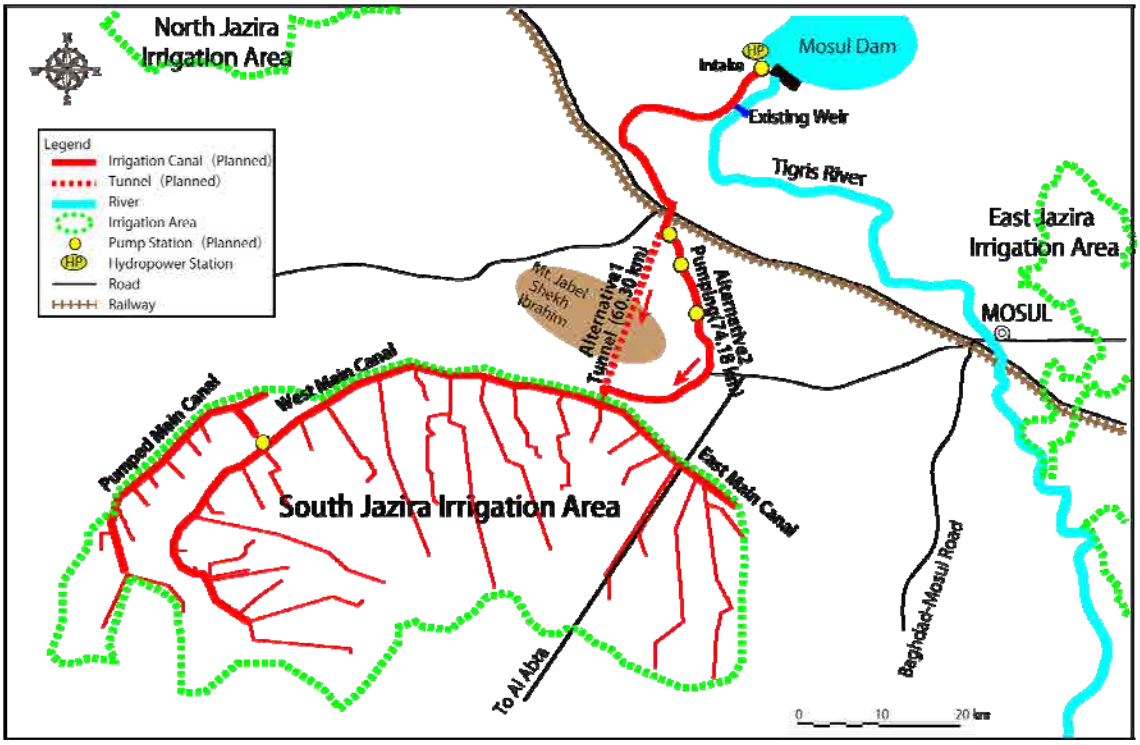
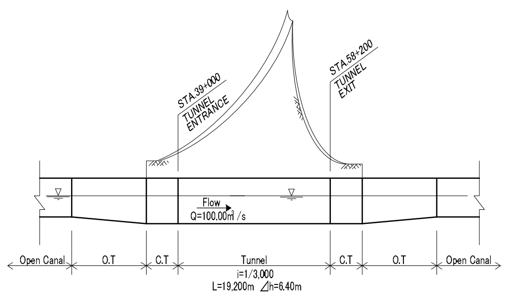
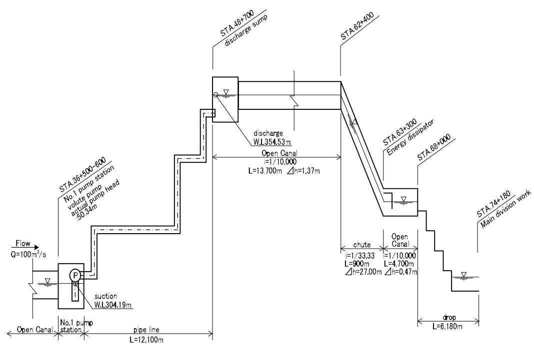


Fig. 7.3-1 Schematic Drawing of the Alternatives for Water Conveyance System

7.3.2 Determination of Water Conveyance System by Feeder Canal

Table 7.3-1 shows all the items examined for comparison of alternatives selected. Through the comparison studies as made, the tunnel system shall be selected with advantages in economic aspect (Initial cost and running cost) as well as the easiness in O&M works.

Table 7.3-1 Composition of Alternatives for Water Conveyance System

<table>
<tr><th colspan="2">Items</th><th>Tunnel</th><th>Pumping</th></tr>
<tr><td rowspan="2">Composition of works</td><td>Main Features</td><td>▪ Open canal for flat land and tunnel for mountainous portions
▪ Minimum distance to the diversion point at upstream beneficiary area.
▪ Design discharge：Q＝100m^3/sec
▪ Tunnel works
Non-pressure tunnel：standard horse-shoe type（2R horse-shoe）
2R＝7.90m</td><td>▪ Detour mountainous portion and feed the water to diversion point by pumping through plateau area
▪ Design discharge：Q＝100m^3/sec
▪ Pump Spec（High lift）
Type：centrifugal pump
Actual head：68m
Number of unit : 11 units (including one unit as a spare)
Discharge：10m^3/sec/unit
Dia.：φ1,900mm×φ1,500mm
Power output：9,200kw/unit</td></tr>
<tr><td>Drawings</td><td>
</td><td>
</td></tr>
<tr><td rowspan="2">O&M</td><td>Easiness</td><td>▪ Easy</td><td>▪ Difficult</td></tr>
<tr><td>Comments</td><td>▪ In principle, maintenance free.
▪ Easy in inspection and repairing as compared with pumping case.
▪ By controlling water level, the discharge can be controlled without difficulty.</td><td>▪ Necessary to assign supervising. electrical/mechanical engineers and no much advantage in O&M.
▪ There are many consumable spare parts in pumping devices.
▪ No safety in pressured pipes in case of sudden stoppage and starting of pumps.
▪ To control the discharge control on water level, pump units number and number of rotation is necessary to be inferior in easier water management practice.</td></tr>
<tr><td colspan="2">Economic Aspect</td><td>・Cheaper initial cost than pump

Construction Cost :333 Billion ID
Low Cost
(1.00)</td><td>▪ Higher initial cost than tunnel and moreover, energy cost is needed for operation.

Construction Cost :465 Billion ID
High Cost
(1.40)</td></tr>
<tr><td colspan="2">Environmental Consideration</td><td>Land acquisition is needed for the feeder canal construction, however, the area is 900ha, which is small compared with the that of Alternative-2.</td><td>The land area to be acquired for feeder canal construction is 1,200ha, which can give more adverse effect on social environment than Alternative-1.</td></tr>
<tr><td colspan="2">Result</td><td>◎</td><td>△</td></tr>
</table>

7.4 Study on the Route of Feeder Canal

7.4.1 Basic ideas

Routing for the feeder canal shall be determined in a way that the system may be provided with the higher stability in terms of hydraulics through taking due considerations of roads network and villages/residential areas as confirmed by satellite images available and based mainly on the study results on the routings by the Swiss F/S (1984) and the Iraqi D/D report (1991).

For securing stabilized hydraulic condition for the system, the center line of the feeder canal shall follow the following requirements;

1) Minimum radius : Radius of routing center line shall be larger than 10 times of canal width (Water surface)
2) Max bend angle : (θ) shall be less than 60°
3) Alignment in case of turning side by side : If bending part turns side by side, avoid to connect bend by bend by inserting straight line of longer than 6 B

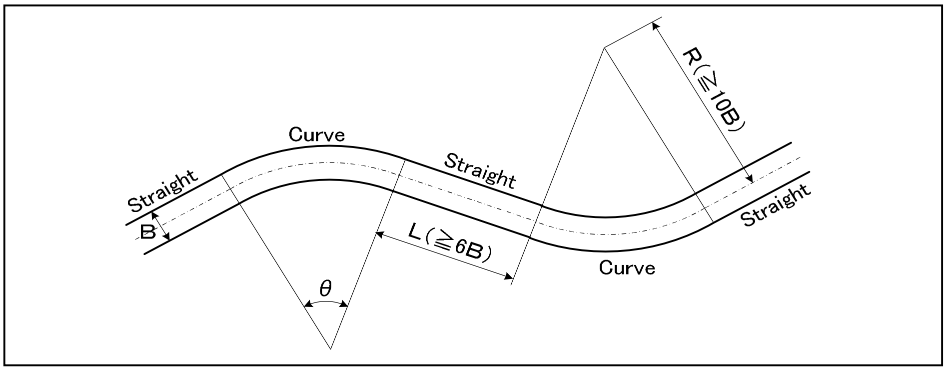


Fig. 7.4-1 Illustration on How to Set the Center Line for Design

7.4.2 Open canal section

The routing for the open canal section shall be determined taking into account the latest topographic conditions prevailing and the development condition of the area based on the basic ideas as mentioned. The sections of feeder canal routing where revisions were made are as shown in the Drawings as attached with the reasons for revising as indicated in the following Table 7.4-1.

Table 7.4-1 Result of the Study on the Line of the Feeder Canal (Section: 0.0km - 39.0km)

Alternative	Location	Reason for Change	Remark
ALT 1	Around 1km	To secure the length of straight line (more than 6B) between the curves	G-A-2-3/10
ALT 2	Around 3km	To avoid crossing the existing road	G-A-2-3/10
ALT 3	Around 4.5km	To set radius of curve (more than 10B) and curvedness (less than 60°)	G-A-2-4/10
ALT 4	Around 6km	To set radius of curve (more than 10B) and curvedness (less than 60°)	G-A-2-4/10
ALT 5	Around 8km	To set radius of curve (more than 10B) and curvedness (less than 60°)	G-A-2-5/10
ALT 6	Around 9km	To secure the length of straight line (more than 6B) between the curves	G-A-2-5/10
ALT 7	Around	To avoid longitudinal adjacency with the existing road (about 0.7km)	G-A-2-5/10

	11km		
ALT 8	Around 19km	To avoid adjacency with the village (about 0.4km)	G-A-2-6/10
ALT 9	Around 24km	To set curvedness (les than 60°)	G-A-2-7/10
ALT 10	Around 31-33km	To avoid adjacency with the village	G-A-2-8/10
ALT 11	Around 33-37km	To divert westward to avoid the village and highway lamps	G-A-2-9/10
ALT 12	Around 37-39km	To avoid longitudinal adjacency with wadi (about 2.5km)	G-A-2-10/10

7.4.3 Tunnel plan

Tunnel alignment shall be layout at the upstream part of beneficiary area (Main diversion work) with the least distance, paying due attentions on the following items.

1) Basically, a straight line shall be adopted judging from the topographical and geological conditions of the natural ground and the easiness in construction works.
2) In order to prevent from collapsing of natural ground surface slope and distorted pressure action on tunnel, layout in parallel with land sliding area and mountain slope shall be avoided. The layout is preferable at the symmetrical center of natural ground with right angle where geological condition is stable with low earth pressure.
3) The portal of tunnel is the place facing unstable earth pressure always, therefore, in layout, collapsed soil ground, talus cone and valleys in which effects of rainfall is very likely shall be avoided.
4) Locations shall be so selected that the noise and vibration at the tunnel portal will not cause disturbances on the villages nearby.

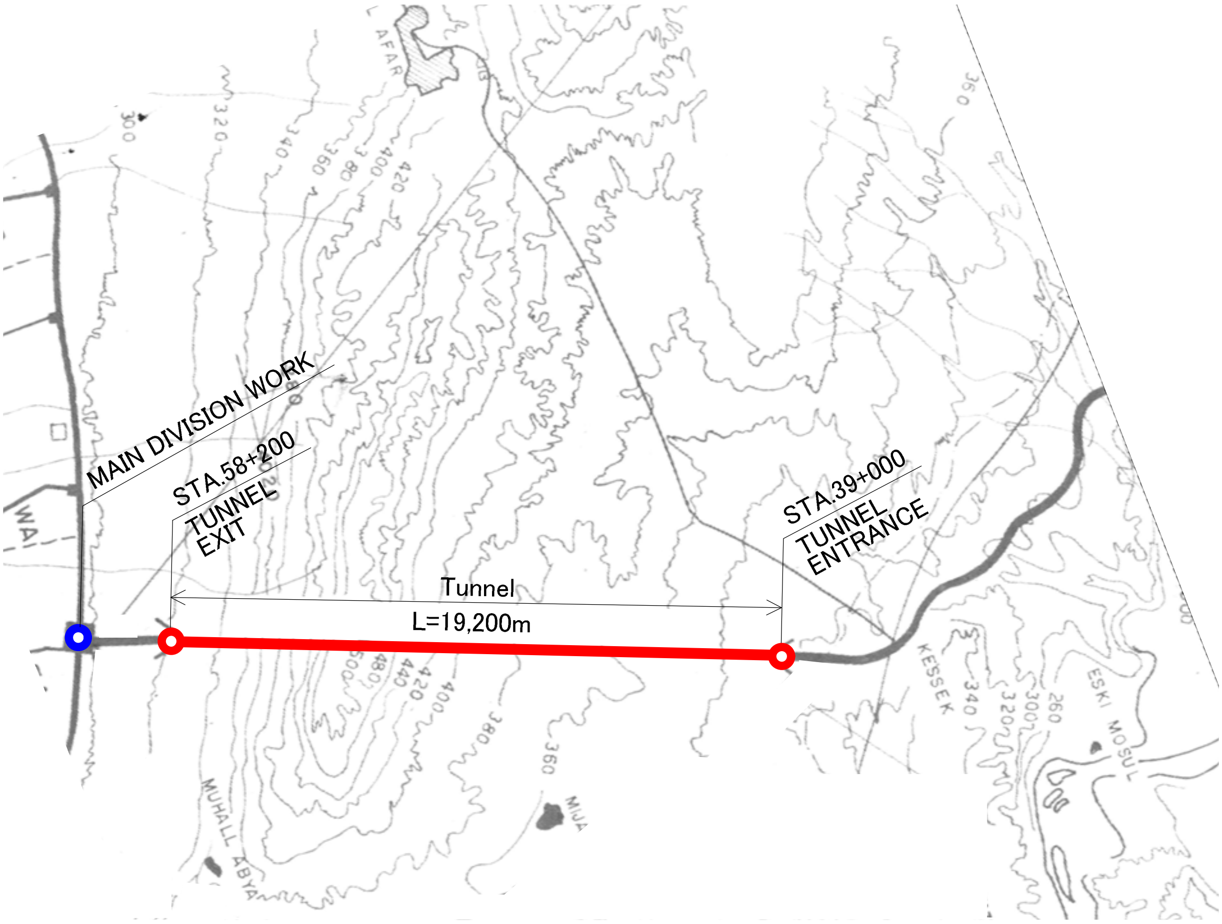


Fig. 7.4-2 Layout of tunnel alignment

7.4.4 Pumping scheme

Routing of feeder canal in case of pumping scheme was selected to detour on the comparatively lower elevated plateau (About EL. 360 m) situated at the eastern side of Mt. Jabel Shekh Ibrahim (EL. 550 m plus) in the northern part of the beneficiary area and connect with the upstream part of the beneficiary area (Main diversion work).

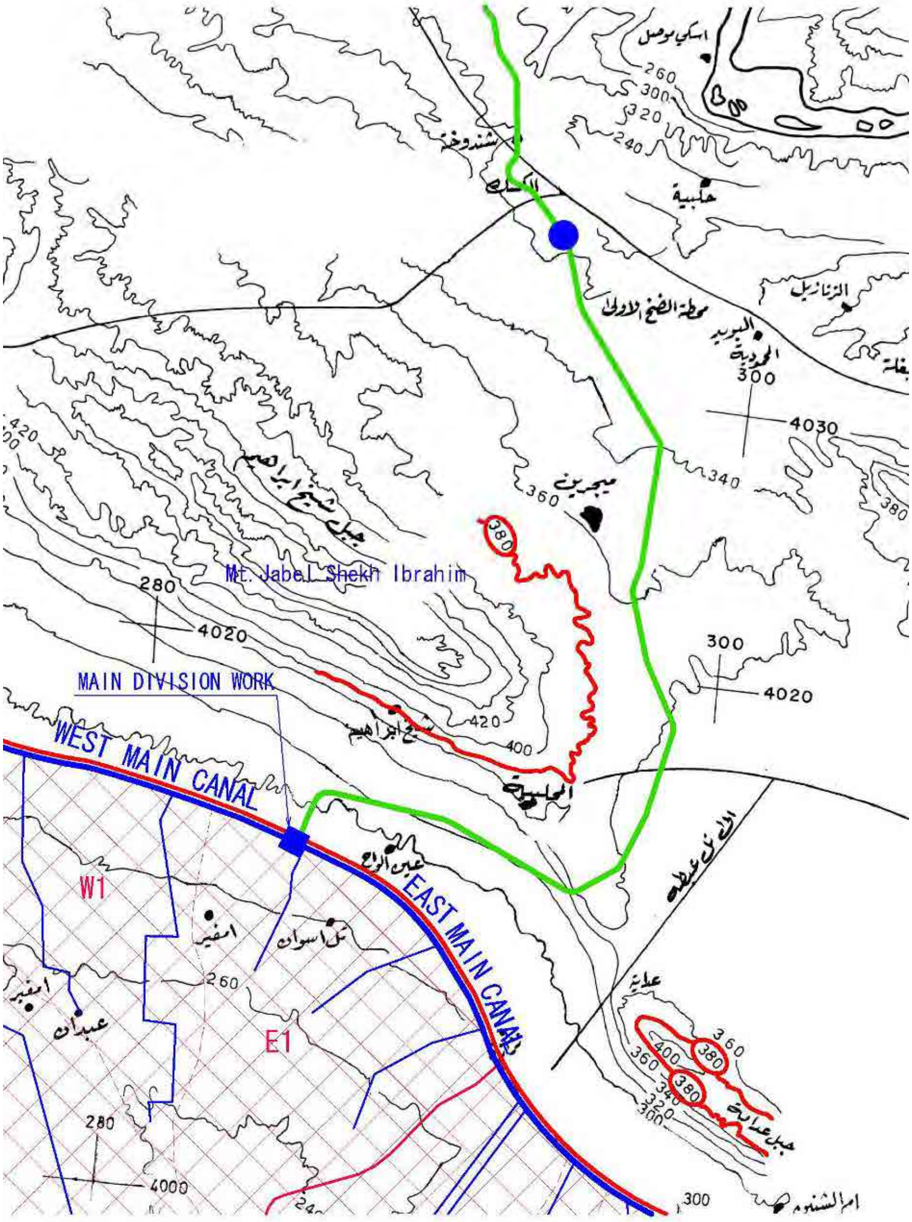


Fig. 7.4-3 Layout of pumping rout

7.5 Designing of Feeder Canal by Scenarios

7.5.1 Open Channel

(1) Examination of Open canal section

The cross-section of open canal shall be of uniformed flow and economically advantageous by adopting a trapezoidal figure allowing the minimum excavation volume and length for lining based on the averaged ground level of the open canal cross-section.

1) Formula : Basically applying the Manning formula

$Q = A \times V$

$V = 1/n \times R^{2/3} \times I^{1/2}$: Manning formula

Where, Q : Discharge (m^3/sec)

A : Section area of flow (m^2)

V : Mean velocity (m/sec)

n : Roughness coefficient n=0.015 (Concrete lining)

R : Hydraulic radius (m), R=Section area (A)/Wetted perimeter (P)

I : Invert gradient

P : Wetted perimeter

2) Free board :

Free board shall be determined taking into account the variations of roughness coefficient, water surface raising by velocity potential and water surface trembling as indicated in the following formula. In addition, the design discharge shall cover 20 % or more of the water flow so as to cope with the unexpected situation the canal will encounter.

$Fb = 0.05 \times d + 0.5 \times hv + hw$

Where, Fb : Free board (m)

D : Water depth of design discharge

hv : velocity potential $hv = V^2/2g$

hw : Free board for water surface trembling

Based on the above, major dimensions of open canal for each scenario shall be confirmed as the following Table 7.5-1.

Table 7.5-1 Major dimensions of open canal

Dimension			Scenerio-0	Scenerio-1	Scenerio-2
Canal bed width:	B	(m)	5.00	4.00	4.00
Water depth	d	(m)	5.51	5.22	4.58
Canal free board	Fb	(m)	0.49	0.48	0.42
Wall hight (d+Fb)	H	(m)	6.00	5.70	5.00

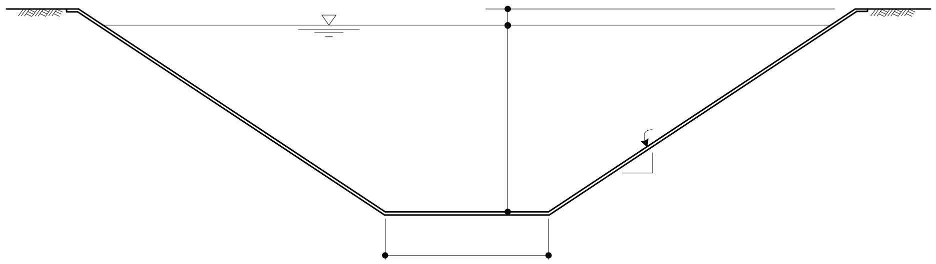


Table 7.5-2 Calculation of open canal by Scenarios

Scenario 0 (Q= 100 m^3/s)

I	n	m
0.0001	0.015	1.5

B (m)	d (m)	A (m^2)	P (m)	R (m)	v (m/s)	Q (m^3/s)	Fr	Fb (m)	H (m)	Qmax (m^3/s)	Qmax/Q (%)	V (m^3)	L (m)
4.00	5.771	73.041	24.808	2.944	1.369	100.029	0.182	0.486	6.30	121.949	121.9	84.735	26.715
4.50	5.639	73.073	24.832	2.943	1.369	100.038	0.184	0.480	6.20	123.505	123.5	85.560	26.854
5.00	5.511	73.112	24.870	2.940	1.368	100.023	0.186	0.473	6.00	120.436	120.4	84.000	26.633
5.50	5.388	73.180	24.927	2.936	1.367	100.027	0.188	0.467	5.90	121.606	121.6	84.665	26.773
6.00	5.269	73.258	24.998	2.931	1.365	100.015	0.190	0.461	5.80	122.608	122.6	85.260	26.912

Scenario 1 (Q= 80 m^3/s)

I	n	m
0.0001	0.015	1.5

B (m)	d (m)	A (m^2)	P (m)	R (m)	v (m/s)	Q (m^3/s)	Fr	Fb (m)	H (m)	Qmax (m^3/s)	Qmax/Q (%)	V (m^3)	L (m)
3.00	5.495	61.778	22.813	2.708	1.295	80.016	0.177	0.468	6.00	98.125	122.7	72.000	24.633
3.50	5.356	61.776	22.811	2.708	1.295	80.016	0.179	0.461	5.90	99.722	124.7	72.865	24.773
4.00	5.222	61.792	22.828	2.707	1.295	80.011	0.181	0.454	5.70	97.287	121.6	71.535	24.552
4.50	5.093	61.826	22.863	2.704	1.294	80.004	0.183	0.447	5.60	98.517	123.1	72.240	24.691
5.00	4.970	61.901	22.920	2.701	1.293	80.033	0.185	0.441	5.50	99.590	124.5	72.875	24.831

Scenario 2 (Q= 60 m^3/s)

I	n	m
0.0001	0.015	1.5

B (m)	d (m)	A (m^2)	P (m)	R (m)	v (m/s)	Q (m^3/s)	Fr	Fb (m)	H (m)	Qmax (m^3/s)	Qmax/Q (%)	V (m^3)	L (m)
3.00	4.847	49.781	20.476	2.431	1.205	60.005	0.175	0.429	5.30	73.622	122.7	58.035	22.109
3.50	4.712	49.796	20.489	2.430	1.205	60.009	0.177	0.423	5.20	74.847	124.7	58.760	22.249
4.00	4.583	49.838	20.524	2.428	1.204	60.025	0.180	0.416	5.00	72.673	121.1	57.500	22.028
4.50	4.459	49.890	20.577	2.425	1.203	60.025	0.182	0.410	4.90	73.557	122.6	58.065	22.167
5.00	4.340	49.953	20.648	2.419	1.201	60.016	0.184	0.404	4.80	74.294	123.8	58.560	22.307

Q $= A \cdot v$

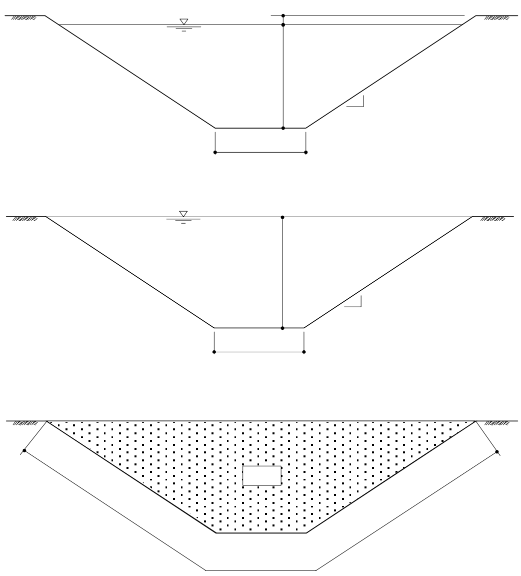
v $= 1/n \cdot R^{2/3} \cdot I^{1/2}$: Manning's formula

Fr $= v / \sqrt{(g \cdot d)}$

Fb $= 0.05 \cdot d + 0.5 \cdot v^2 / (2g) + 0.15$

where,

- Q : Discharge (m^3/sec)
- v : Mean velocity (m/sec)
- I : Hydraulic gradient (canal bed slope)
- R : Hydraulic radius (m) $R = A / P$
- n : Coefficient of roughness
- A : Cross-section area (m) $A = (B + d \cdot m) \cdot d$
- P : Watted perimeter (m)
- B : Canal bed width (m)
- d : Water depth (m)
- Fr : Froude number
- Fb : Freeboad (m)
- Qmax : Maximum capacity of canal (m^3/sec)
- g : Acceleration of gravity (=9.8m/sec^2)



【Reference：Examination of pipeline structure】

Generally, trapezoidal cross section is proposed for designing of big scale water conveyance systems such as the proposed feeder canal as far as there is no constraint e.g. land acquisition. Given that water resource in the Study Area is very limited, appropriate structure to reduce the conveyance loss (evapotranspiration) is examined as follows:

〈Conditions〉

- Design discharge：Scenario 0 ⇒ $Q=100m^3/s \times (1-\alpha)$

  α ：Ratio of reduced evapotranspiration
- Invert gradient： I =1/10,000
- Material and diameter of pipeline: steal pike, ϕ 3,500mm

1) Rough estimation of reduced evapotranspiration

Since there is no observation data in and around the proposed feeder canal, data at the neighboring observation station (at Telafer) is applied for rough estimation of evapotranspiration in the proposed feeder canal. The water surface area of the feeder canal is calculated as follows:

A = around 21.5m (width of surface water)×around 39km (length of feeder canal) = $840,000m^2$

Table 7.5-3 Monthly Evapotranspiration

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total
Monthly evapotranspiration (mm/month)	48.9	67.1	124.9	185.4	355.8	520.2	599.5	588.1	456.0	279.5	124.8	56.6	3,406.8
1) Evapotranspiration in the feeder canal (‘$000m^3$/month)	41.1	56.4	104.9	155.7	298.9	437.0	503.6	494.0	383.0	234.8	104.8	47.5	2,861.7
2) Monthly water consumption (hundred m^3/month)	91	131	228	258	173	110	73	50	66	123	113	95	1,512
1) / 2) ×100 (%)	0.05	0.04	0.05	0.06	0.17	0.40	0.69	0.99	0.58	0.19	0.09	0.05	0.19

2) Design discharge considering reduction of evapotranspiration

Estimated percentages of evapotranspiration to the water consumption are very small, e.g. they area 0.19%, 0.99% and 0.06%, for annual average, maximum value and that in April (discharge is designed based on the data in April), respectively. Considering those situations mentioned above, the reduction of evapotranspiration is negligible for facility scale examination. Therefore, the correction coefficient, namely, α is set at 0.0.

$\therefore \quad Q = 100m^3/s \times (1-0.0) = 100m^3/s$

3) Examination of pipeline cross section

Following the Hazen-Williams formula, pipeline cross section is calculated considering that the pipeline shall manage the design discharge ($100m^3/s$) by means of the total energy[1] between the feeder

[1] Total energy: sum of potential head, pressure head and velocity head

canal starting point and tunnel starting point. In addition, it is based on the premise that steal pipe which has a diameter of 3,500mm is applied.

Applied formula： $V=0.849 \cdot C \cdot R^{0.63} \cdot I^{0.54}$ ・・・・・・・・ Hazen-Williams formula

V: mean flow velocity (m/s)

C: Coefficient of flow velocity (C=130)

R: hydraulic radius (R=D/4=3.50/4=0.875m)

I: hydraulic gradient

Applicable head: En = 310.00 – 304.11 = 5.887 m

・Total energy at the starting point of the feeder canal EnL1=310.000m

・Total energy at the starting point of the tunnel EnL2=304.113m

If 10% of frictional loss is counted as other losses, hydraulic gradient is estimated as follows:

En = Ｉ ×L×1.10 (L: length of pipeline, L=39,000m)

∴ Ｉ = 5.887/39,000/1.10 = 1/7,287

Therefore, the number of steal pipe, which can manage design discharge (Q=100m^3/s) and has a diameter of 3,500mm, is calculated at 13.

V=0.833 m/s

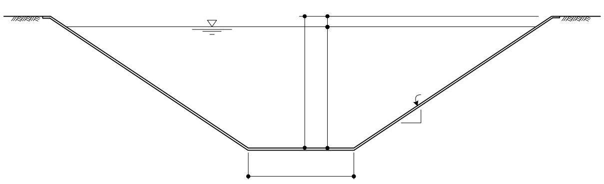
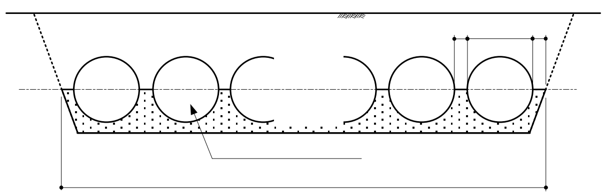
Discharge per pipeline Q=8.014 m^3/s

Necessary number of pipelines n=100/8.014 =12.5 ⇒ 13

4) Comparison result

The cross section of open canal and pipeline are compared in terms of economic aspect as shown in Table 7.5-4. It shows that it is not practical to apply pipeline system considering its cross section area, number and cost. Moreover, since the reduction of transportation loss of the feeder canal is very limited as mentioned above, the open canal can be applied.

Table 7.5-4 Comparison of open canal and pipeline cross section

	Cross section of open canal	Cross section of pipeline
Outline drawings		
Economic aspect	Construction cost：152 Billion ID Priced moderately （1.00）	Construction cost：1,322Billion ID Costly （8.70）

Remarks: approximate construction cost mentioned above covers only 39km interval until the tunnel starting point.

(2) Preliminary construction planning for open canal sections

The alignments of open canal are mainly located on the rolling plains, detouring the villages/communities and there are many up-and-downs with relatively steep slopes. This will naturally require large scale cut and fill works in the construction of open canals. In the following section, the preliminary construction method and scheduling for open canal works shall be discussed.

1) Construction method

a) Excavation

The excavation material along the canal alignment is mainly sand and silt though soft rock excavation is necessary for some parts, and there will be no serious effects on the neighboring even large scale excavation be practiced. Therefore, unsupported excavation method shall be employed. The level of canal shall be the formation and the excavation areas be divided into two, the first one from the ground level to the canal level and the second from the canal level to the bottom. The first section shall be the advancing excavation work.

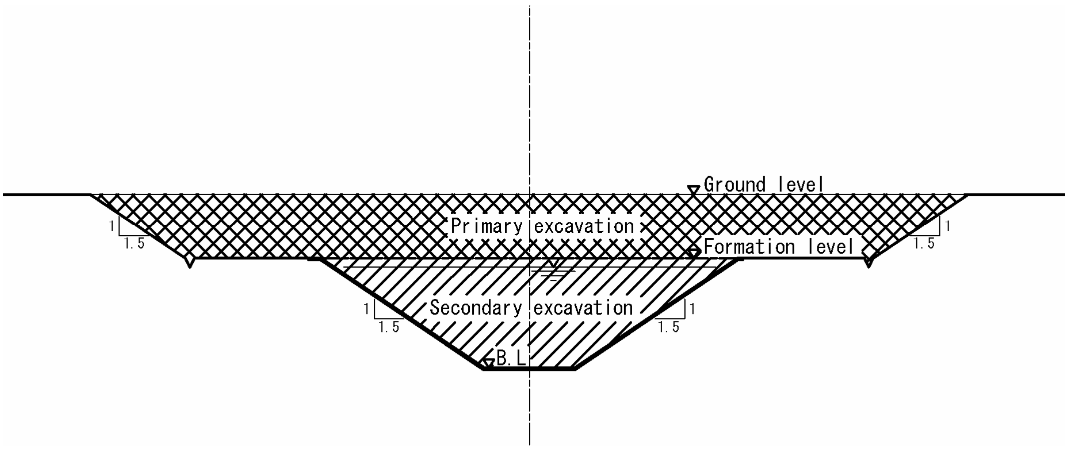


Fig. 7.5-1 Cross Section of Excavation

For the machineries to be used for excavation works, 32 ton class bulldozer (Standard type) shall be used both for the first and second excavation as there are working place with 4 m width secured and the volume of earth material excavated becomes quite considerable at more than 10,000 m^3.

First excavation; Pulling by bulldozer + Loading and hauling by 10 t dump
Second excavation; Same above

For the machinery for rock excavation, a bulldozer with ripper attachment shall be used for assume soft rocks with limited volume to be excavated.

b) Embankment

4 m width working space is secured for embankment work of canal and the volume of works is large scale with more than 10,000 m^3, the spraying, grading and compacting of the embankment material shall be done by using 21 ton bulldozer (Standard type). For compaction, density controls shall be made on the filled up ground and the canal embankment, taking into consideration on the importance of canal structure and the use of embankment as O&M road.

Embankment work ; Material spreading/grading and compaction (Density control)

c) Construction road (Temporary)

The berm provided for vehicle passing under the first going excavation shall be utilized for canal construction purpose.

d) Temporary deposit of excavated material and stock yard

The canal route is aligned on the rolling topography with steep up-and –downs, in the construction of canal, cut and fill sections will be complicatedly mixed up. Accordingly in view of cost saving as much as possible, the excavated materials shall be temporarily deposited on both sides of the alignment and re-used as embankment materials. As well, other necessary materials shall be temporarily deposited on the both sides of the canal alignment.

e) Formation/slope trimming

In order to secure stable basis for concrete lining, trimming shall be provided for the formation and slope of canal.

f) Lining

Concrete placing shall be made for lining of slopes by using slope form (Movable form) and after lining work on side slopes, concrete placing shall be made on the invert portion. For side slope lining, concrete placing shall be done on a panel by panel pattern (No continuous placing) with having the curing period of 2 days. The lining panel as the standard shall have the width of 3.0 m with the longitudinal joint interval of 3.0 m as well.

g) Under-drain work

The subject canal is for water supply purpose and necessary to be water tight structure. In this case, when canal water level draws down, the lining work might be damaged or lifted due to the uplifting. It is therefore necessary to stabilize the lining work by providing under-drain for the purpose of uplifting pressure relief on the lined surface.

2) Construction schedule

For the purpose of overall construction scheduling, the schedule per a unit cycle (@ 100 m) shall be fixed for each type of canal works and based on this dividing of construction sections shall be determined.

a) Scheduling per a unit cycle (100 m each)

The work items for each type of canal works and required number of days to complete the work by applying the said construction method are as indicated in the following Tables.

In the practice, the number of days needed fro cut and fill works will be the critical conditions, and therefore, 1 working unit shall advance the cut and fill works as followed by 2 working units for concrete lining woks. The schedules for each scenario of works per a unit cycle are as presented in the Table 7.5.5.

Table 7.5-5 (1) Schedule per a unit cycle (100 m)（Scenario 0）

Canal Type	Length(ｍ)	Number of days Required per cycle	Number of set	Gross Period	Remarks
TYPE1 (CUT)	20,231	cut work：26days	203	14year 6month)	1 team
		Lining work：23days	203	12year10month	2 team
TYPE2 (FILL)	5,410	embankment work ：28days	55	4year 3month	1 team
		Lining work：21days	55	3year 2month	2 team
TYPE3 (CUT&FILL)	12,940	Cut and fill work ：21days	130	7year 6month	1 team
		Lining work：20days	130	7year 2month	2 team
Total	38,581	－	－	26year 2month	1 team

Table 7.5-5 (2) Schedule per a unit cycle (100 m)（Scenario 1）

Canal Type	Length(ｍ)	Number of days Required per cycle	Number of set	Gross Period	Remarks
TYPE1 (CUT)	20,431	cut work：24days	205	13year 6month	1 team
		Lining work：22days	205	12year 5month	2 team
TYPE2 (FILL)	5,580	embankment work：27days	56	4year 2month	1 team
		Lining work：20days	56	3year 1month	2 team
TYPE3 (CUT&FILL)	12,570	切･embankment work：21days	126	7year 3month	1 team
		Lining work：19days	126	6year 7month	2 team
Total	38,581	－	－	24year11month	1 team

Table 7.5-5 (3) Schedule per a unit cycle (100 m)（Scenario 2）

Canal Type	Length(ｍ)	Number of days Required per cycle	Number of set	Gross Period	Remarks
TYPE1 (CUT)	20,631	cut work：22days	207	12year 6month	1 team
		Lining work：22days	207	12year 6month	2 team
TYPE2 (FILL)	6,470	embankment work：25days	65	4year 6month	1 team
		Lining work：20days	65	3year 7month	2 team
TYPE3 (CUT&FILL)	11,480	切･embankment work：19days	115	6year 0month	1 team
		Lining work：18days	115	5year 8month	2 team
Total	38,581	－	－	22year11month	1 team

b) Dividing of construction sections

The overall construction period for the open canal construction works is adjustable by dividing the working sections (Extension and composition of working units). Therefore, dividing shall be so designed that the open canal works shall be completed within the construction period for the tunnel works, the critical work under the project construction schedule.

Table 7.5-6 Section dividing plan

	Total length of open canal (km)	Gross period	Number of sections	Approx. length per section (km)	Regional period per section	Required period for tunnel works
Scenario 0	38.6	26 year 2 month (314month)	6	6.5	4 years and 5months (53 months)	4 years and 6months (54 months)
Scenario 1	38.6	24 year 11 month (299month)	6	6.5	4 years and 2months (50 months)	4 years and 3months (51 months)
Scenario 2	38.6	22 year 11 month (275month)	6	6.5	3 years and 10 months (46 months)	3 years and 10months (46 months)

7.5.2 Tunnel

(1) Longitudinal profile

In case considering the whole of feeder canal system as one hydraulic unit, the tunnel works will cause higher cost than open canal. Then, when discussing the gradient of longitudinal profile of tunnel, it is necessary to minimize the cross-section of tunnel by setting the gradient as steep as possible by using the maximum head available in the tunnel section. Based on the results of hydraulic calculation as indicated in the following (3), the gradient of tunnel profile shall be fixed at I = 1/3,000 for each scenario.

(2) Examining of tunnel cross-section

The cross-section of tunnel shall be determined through examining the characteristics on hydraulics and structural necessity, easiness in construction and the economy point of view. Representing all, the scenario 0 (Q = 100m^3/sec) be examined to fix the cross-section and the result s are as presented in the Table 7.5-8. Standard horse-shoe type (2R) (Non-pressured) shall be adopted due to the advantages in free selection of geological conditions and less inner section area (Excavation volume). Those tunnel cross-sections for each scenario case shall be shown in the Table 7.5-7.

Table 7.5-7Tunnel cross sections for each scenario

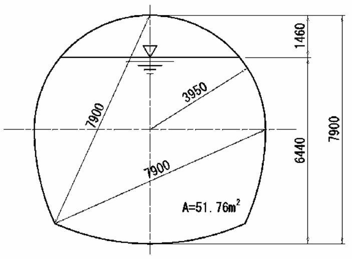
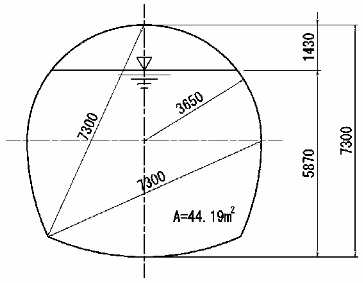
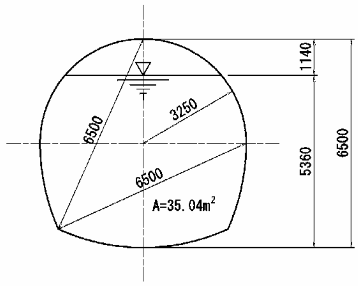
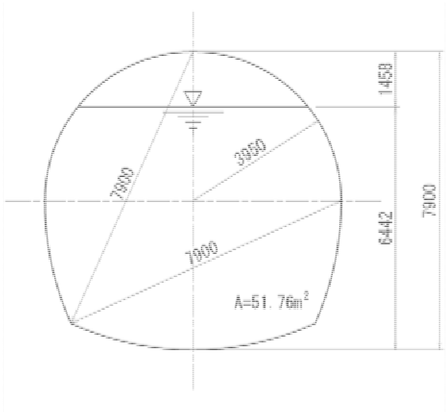
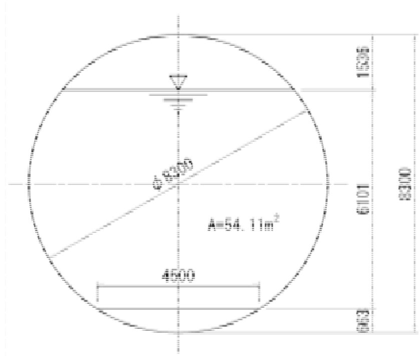
Scenario-0	Scenario-1	Scenario-2
Discharge Q=100m^3/sec 2R=7.90m Inner Cross-section A=51.76m^2	Discharge Q=80m^3/sec 2R=7.30m Inner Cross-section A=44.19m^2	Discharge Q=60m^3/sec 2R=6.50m Inner Cross-section A=35.04m^2
		

Table 7.5-8 Comparative Study of the Cross-section of Tunnel

Item		CASE 1 (Adopted)	CASE 2
Shape of Cross-section	Outline	Free-flow Tunnel: Standard Horseshoe Shape (2R Horseshoe Shape)	Free-flow Tunnel: Round Shape (with invert)
		2R＝7.9m	φ8.30m
		Inner Cross-section Area A＝51.76m^2	Inner Cross-section A＝54.11m^2
	Schematic Illustration		
Hydraulic Characteristics	Discharge	100m^3/s	same as on the left
	Coefficient of Roughness	0.015 (Concrete Lining)	same as on the left
	Canal Gradient	1/3,000	same as on the left
	Water Depth	6.442m	6.101m
	Velocity	2.196m/s (1.6 times to Open Channel)	2.213m/s (1.6 times to Open Channel)
	Velocity Head	0.246m	0250m
	Freeboard (d/D=0.8～0.83)	1.458m d/2R=0.82	1.536m d/D=0.80
	Froude Number	0.264≦0.54	0.267≦0.54
	Discussion	・There is no problem with discharge-duration ◎	・There is no problem with discharge-duration ◎
Structural Characteristics		・Relatively bigger tensile stress occurs at the junction of sidewall and deck slab compared to the round shape. But as the shapes of sidewall and invert are circular arc, it has an advantage of structural characteristics. ○	・It is the most advantageous structural characteristics as the external force is effected mostly as axial force. ◎
Construction	Excavation Method	・Parallel use of partial face tunneling machine and blasting excavation	・TBM due to round face excavation
	Evaluation	・The speed of excavation is not fast due to partial tunneling by moving the arm. However, it makes it possible to excavate arbitrary cross-section. ・By prallel use of blasting excavation, it is easier to adjust geological changes. ◎	・The cost of TBM is generally high due to using large-scale machine. In case the excavation method has to be changed e.g. due to encounter hard ground beyond the ability of the machine, it would cause increase of construction cost. ・Round shape makes it difficult to set forms and cast concrete in the lower part than spring line. ・Casting invert concrete makes it easy to carryout muck and concrete, and carryingin concrete. ○
Economic Aspect		・Considering the excavation method and the fact that the inner cross-section is smaller than round shape, the cost will be lower than the round shape. ◎	・The cost will be higher than the standard horseshoe shape because the inner cross-section is larger than standard horseshoe shape and use of TBM. ・In cas the ground condition is good, high speed tunneling will be made possible. In this case the cost can be lower because of the economy of scale. ○
Determination		◎ (Adopted)	○

(3) Hydraulic calculation

1) Shape of transition

a) Open transition

The shape of open transition shall be of trapezoidal-straight line and the length be obtained in a way that the angle by side wall and canal center line (Reducer angle) shall be less than 10 *.

L = B-b/2cotQ

Where, L :Length of open transition (m)

B :Width of water surface of open canal (m)

b :Width of water surface of closed transition (m)

θ :Reducer angle (Less than 10°)

b) Closed transition

Closed transition has the functions to maintain smooth flow of water and contribute for longer life of structure and reducing the water head loss. Thereby, it is necessary to provide a closed transition between the open transition and the main body of the horse-shoe type tunnel itself. As the shape of tunnel cross-section is of horse-shoe type, the length shall be determined at about the same of 2R of the tunnel.

2) Calculation for elevation of canal invert

Table 7.5-9(1) Calculation for elevation of canal invert (Scenario 0)

Station	Item	Length	Gradient	Water depth (m)	Velocity head (m)	Loss head (m)	Energy hight	Water level (m)	Invert level (m)
STA.38+961				5.511	0.095		304.186	304.091	298.580
	Transition	39.0				0.027			
STA.39+000				6.442	0.246		304.159	303.913	297.471
	Tunnel	19,200.0	1/3,000			6.400			
SAT.58+200				6.442	0.246		297.759	297.513	291.071
	Transition	39.0				0.037			
STA.58+239				5.511	0.095		297.722	297.627	292.116

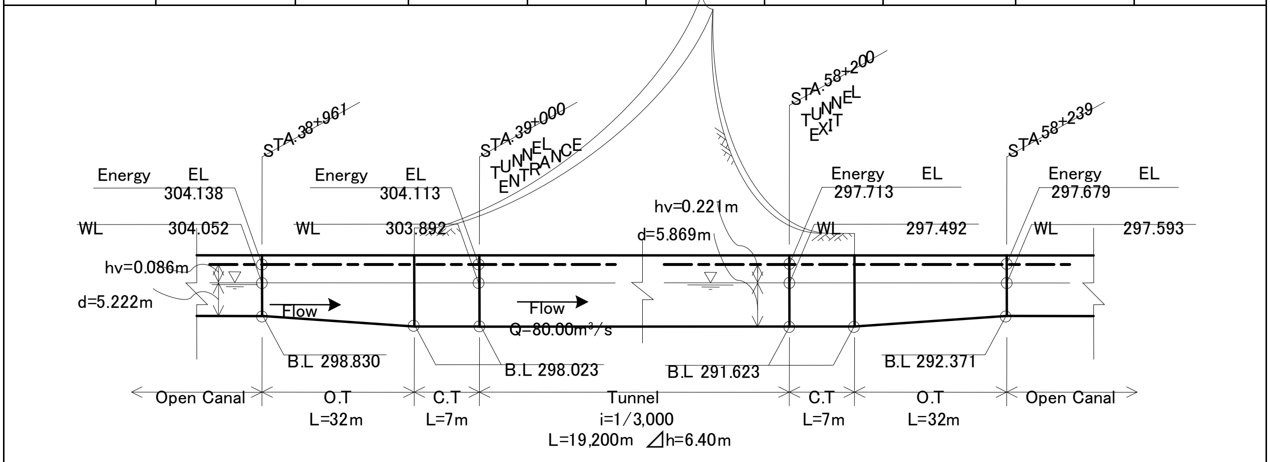


Table 7.5-9 (2) Calculation for elevation of canal invert (Scenario 1)

Station	Item	Length	Gradient	Water depth (m)	Velocity head (m)	Loss head (m)	Energy hight	Water level (m)	Invert level (m)
STA.38+961				5.222	0.086		304.138	304.052	298.830
	Transition	39.0				0.025			
STA.39+000				5.869	0.221		304.113	303.892	298.023
	Tunnel	19,200.0	1/3,000			6.400			
SAT.58+200				5.869	0.190		297.713	297.492	291.623
	Transition	39.0				0.034			
STA.58+239				5.222	0.086		297.679	297.593	292.371

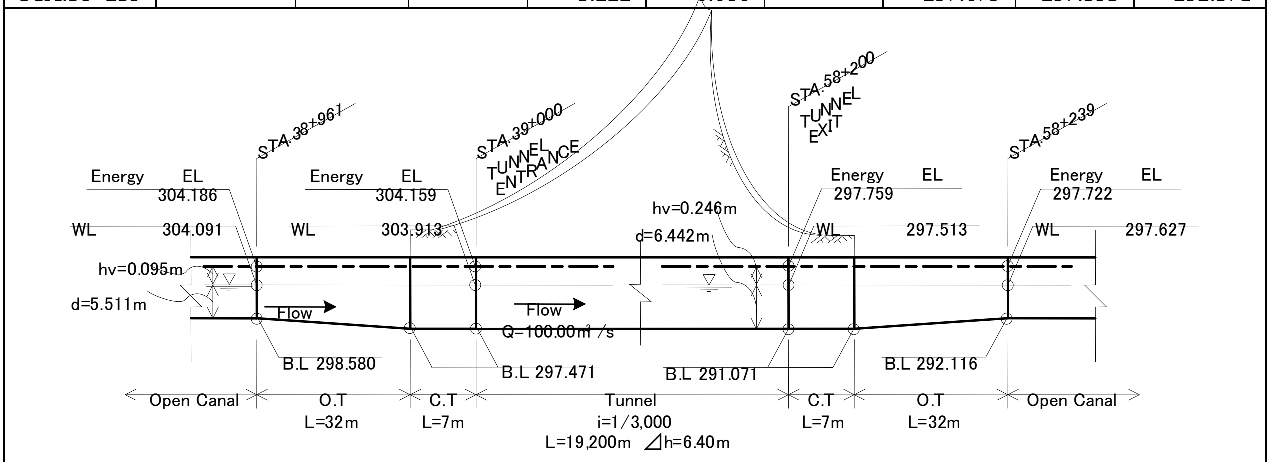
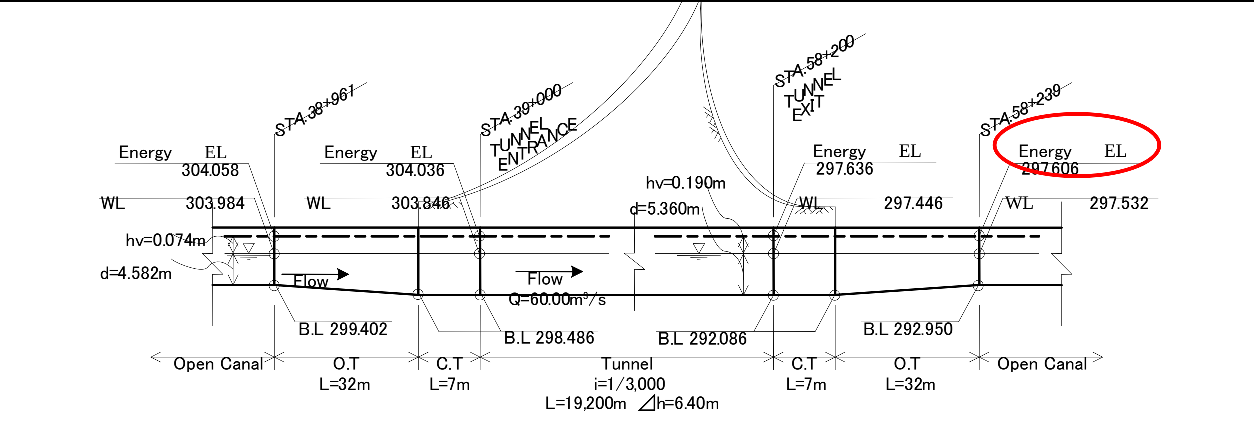


Table 7.5-9 (3) Calculation for elevation of canal invert (Scenario 2)

Station	Item	Length	Gradient	Water depth (m)	Velocity head (m)	Loss head (m)	Energy hight	Water level (m)	Invert level (m)
STA.38+961				4.582	0.074		304.058	303.984	299.402
	Transition	39.0				0.022			
STA.39+000				5.360	0.190		304.036	303.846	298.486
	Tunnel	19,200.0	1/3,000			6.400			
SAT.58+200				5.360	0.190		297.636	297.446	292.086
	Transition	39.0				0.030			
STA.58+239				4.582	0.074		297.606	297.532	292.950



(4) Construction Method of the Tunnel

For the construction method, it should take into consideration that the designed tunnel is relatively wide in cross-section such as 2R standard horseshoe shape (2R = 6.50m) and the inner cross-section area (A = 35.04 m^2). Also considering the following reasons, New Austrian Tunneling Method (NATM Method) is adopted for the construction.

1) This method is to build flexible structure support so that the behavior of the structure is integrated with the ground. Hence this method is superior for the structural stability of the tunnel for long term.
2) The method has advantage for construction and economy compared with other rigid structure support, as the looseness of the ground becomes smaller and time for self-sustainability of the unlined tunnel surface is longer with this method. That can make the unit length of excavation longer to other methods.
3) As the flexible structure can reduce the thickness of concrete, it gives economic advantage.
4) The method has been adopted for many tunnels of middle and large cross-section.

(5) Tunnel Type

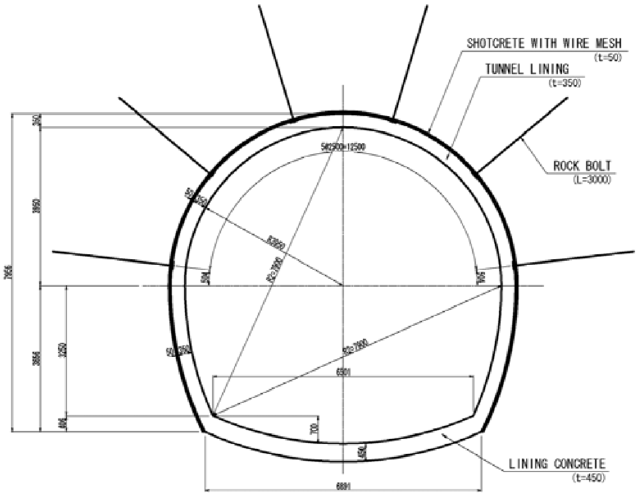
Tunnel type is determined based on the Rock Mass Rating System (RMR), which was proposed as a result of the past geological survey. The tunnel type is classified into three: from TYPE 1 to TYPE 3, as the class of rock mass in the section of the tunnel is from II to IV (RMR value by Bineawski).

Table 7.5-10RMR Value, Construction Method of Tunnel and Support

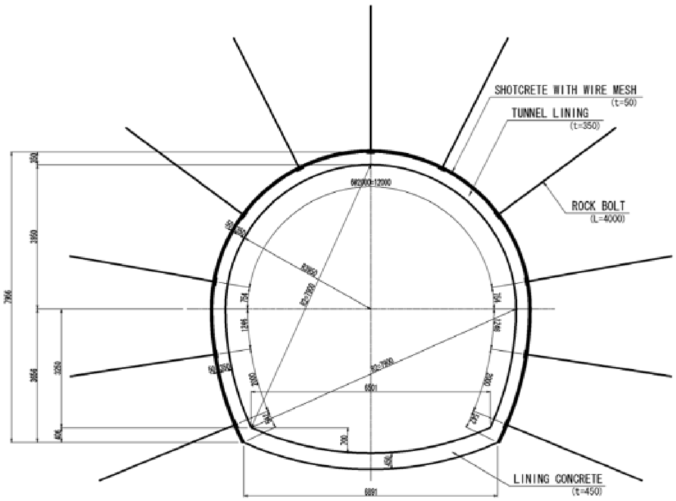
Tunnel Type	Class of Rock Mass	Excavation	Support		
			Rock Bolt (R 20mm, whole area adhesion)	Shotcrete	Steel frame
	I Very good RMR:81-100	Full-face excavation Length of excavation: 3m	Generally not required except for local bolt driving		
TYPE 1	II Good RMR: 61-80	Full-face excavation Length of excavation: 1.0-1.5m Complete support from the face to 20m behind	Drive 3m-bolts at intervals of 2.5m to the roof locally. Use metal mesh as required	Shotcrete the roof with the thickness of 50mm as required	Not required
TYPE 2	III Fair RMR: 41-60	Bench method to let the upper half precede for 1.5-3m Cast support after each blasting excavation. Complete support from the face to 10m behind.	Drive 4m-bolts at intervals of 1.5-2m to the entire roof and sidewalls. Use metal mesh on the roof	Shotcrete the roof with the thickness of 50-100mm, and the sidewalls with 30mm	Not required
TYPE 3	IV Bad RMR: 21-40	Bench method to let the upper half precede for 1.0-1.5m Cast support from the face to 10m behind simultaneously with excavation	Drive 4-5m-bolts at intervals of 1.0-1.5m to the entire roof and sidewalls. Use metal mesh on the roof	Shotcrete the roof with the thickness of 100-150mm, and the sidewalls with 100mm	Use light weight steel at intervals of 1.5m as required
	V Very bad RMR:<20	Multiple bench method to let the upper half precede for 1.0-1.5m Cast support simultaneously with excavation. Shotcrete immediately after blasting excavation.	Drive 5-6m-bolts at intervals of 1.0-1.5m to the entire roof and sidewalls. Use metal mesh on the roof Drive bolts to foot wall	Shotcrete the roof with the thickness of 150-200mm, the sidewalls with 150mm and the face with 50mm.	Use heavy weight steel and steel short strut at intervals of 0.75m. Use fore-poling as required Cast them by inverter

Tunnel type by Scenarios are shown in Fig. 7.5-2

TYPE 1



TYPE 2



TYPE 3

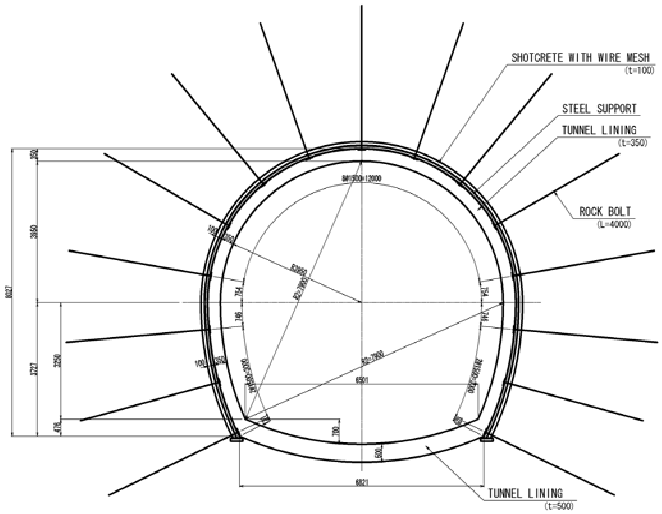
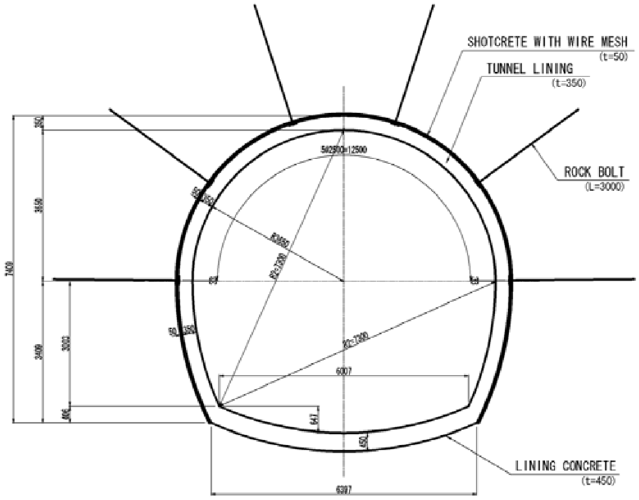
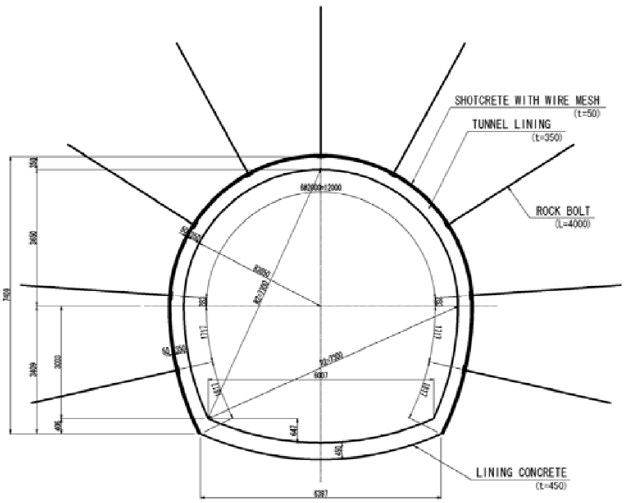


Fig. 7.5-2(1) Tunnel type (Scenario-0)

TYPE 1



TYPE 2



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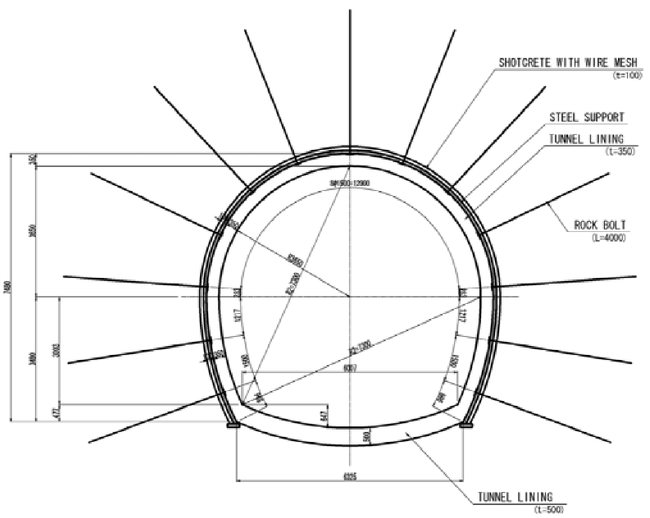
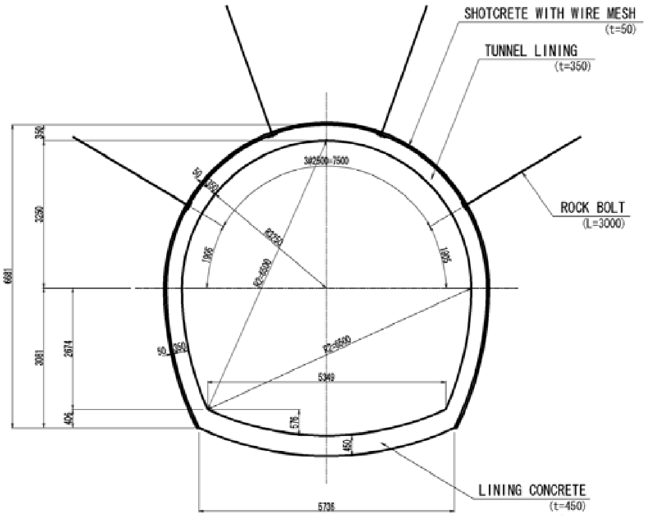
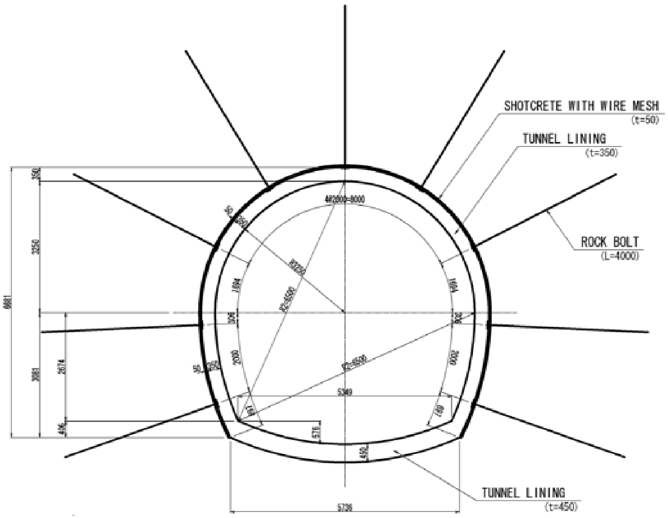


Fig. 7.5-2(2) Tunnel type (Scenario-1)

TYPE 1



TYPE 2



TYPE 3

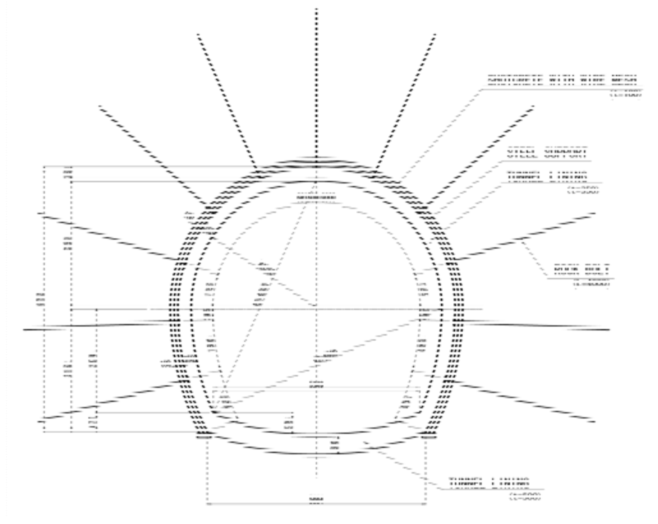


Fig. 7.5-2(3) Tunnel type (Scenario-2)

(6) Excavation method / construction method

In tunneling works, the selection of excavation method and construction method is extremely important as the suitability of the method selection will largely affect on the economy, easiness in construction and the safety of the tunneling work as a whole. As is the case, it is necessary to select the excavation method and construction method which will lead to safety and economical undertakings for the tunneling works as a whole.

Further, it is necessary to make a construction planning to enable efficient excavation work progress by introducing large construction machineries in case of the subject large size tunnel.

(a) Manner of excavation

Judging from the working efficiency and the easiness in construction, the excavation method shall be compared by blasting and/or by tunneling machines. The details on unconfined compressive strength of rocks to be excavated are not known. However, the strength of DOLOMITE which is supposed to be the base rock is around qu=57.6N-mm2 (MPa) and it can be considered that the damages on cutter head would be less and excavation by machine shall be taken up, where loosing of natural ground may be prevented and the work can be done with higher safety.

TBM machine is applicable, as mentioned above, just for the normal round-shape section and the machine has some weak points as follows. In case if excavation work encounter any rocks harder than the capacity of TBM machine, the excavation method might be forced to be changed and the construction cost be much increased.

In view of the above considerations, under the subject project, excavation by machine: Free cross-section excavator shall be selected. In this case, when encountering any of hard rocks, quickly blasting method can be employed. Moreover, the total length of this tunnel is such large scale as 19 km and in case if the natural ground is of stabilized one without much variations, the TBM enabling a high speed excavation progress may be advantageous economically.

As is the case, at the stage of D/D for the subject project implementation, detailed economic evaluation is necessary as comparing the TBM and the free section tunneling machine based on the detailed geological data to be availed.

Table 7.5-11 Result of Soil Survey

FORMATION	ROCK TYPE	SPECIFIC GRAVITY kg/m3	UNIAXIAL COMPRESS. STRENGTH N/mm2	ULTRASONIC DATA Vp m/s	Vs m/s	ELASTICITY MODULUS E N/mm2	LOS ANGELES ABRASION %	SWELLING STRAIN INDEX %	MAXIMUM SWELLING PRESSURE MN/m2	QUARTZ CONTENT %	MINERALOGICAL COMPOSITION (X-RAY ANALYSIS)	REBOUND HARDNESS 1)
UPPER FARS FORMATION	SANDSTONE	2170 (TS5)	5.16 (TS5)	2310 (TS5)	1480 (TS5)	6600 (TS5)					5 ; 13	5 : 13
	CLAYEY SANDSTONE	2080 (TS5)	5.43 (TS5)	760 (TS5) 2110 (TS5)	490 (TS5) 870 (TS5)	2000 (TS5)		axial :0,36) radial:0) (TS5)	0,45(TS5)	17	Quartz 17% Illite 25% Calcite 23% Montm. 15% Plagioclase 7% Chlorite 15%	30
	CLAYSTONE	2120 (TS5)	4.37 (TS5)			1200 (TS5)						
LOWER FARS FORMATION	CLAYEY MARL	2310 (TS1) 2280 (TS1)	1.88 (TS1) 2.26 (TS1)	1980 (TS1)	1740 (TS1)	1100 (TS1) 770 (TS1)						
	MARL								0	10	Quartz 10% Dolomit 23% Chlorite 30% Albit 6% Illite 30%	36 ; 40
	CALCARE-OUS MARL							axial :0) radial:0) (TS4B)	0			
	MARLY GYPSUM	2410 (TS3)	13.1 (TS3)			44500 (TS3)		axial :4,70) radial:2,70) (TS4B)	1,2 (TS4B)	5	Gypsum 85% Montmorillonite 10% Quartz 5%	
	MARLY AN-HYDRITE						35.6% (TS4B)	axial :0) radial:0) (TK1)	0(TK1)	0	Anhydrite 90% Montmorillonite 10%	
	GYPSUM									0	Gypsum 90% Chlcrite 10%	13 ; 38
	AN-HYDRITE							axial :0) radial:0) (TK1)	0(TK1)			
	LIME-STONE						33.9% (TS3)					39 ; 48
	MARLY/DO-LOMITIC LIMESTONE	2400 (TS3)	3.16 (TS3)	3280 (TS3) 1640 (TS3)	2800 (TS3)			axial :0,07) radial:0) (TS 3)	0 (TS3)			
	DOLOMITE	2370 (TS3)	57.6 (TS3)		31000 (TS3)					0	Dolomite 80% Calcite 23% Gypsum 1 - 2" Organ.Material 3%	

(b) Excavation method

The excavation method directly effects on the safety and economy of the construction works. In selecting the method, therefore, a careful study is needed in considering the scale, size of cross-section and the shape, natural ground condition as well as construction period available. Among others, the relation between the cross-section size and the stability of the natural ground is the primary points to decide the selection. Normally, staged construction plan shall be examined to secure stability at the face and the nearby areas and based on this selection shall be made on the combination of construction machineries and hauling method of excavated materials (Muck). Besides, it is noted that the change of excavation method during the course of construction work will cause considerable increase of labor input and construction cost, and careful handling is necessary to avoid such substantial loss of time in the project construction schedule. (Ref. Table 7.5-10)

Under the subject design for this study, the full face excavation method was selected for the type-1 tunnel and the half-by-half parallel excavation method through bench-cut method shall be adopted for the type-2 and type-3 with the following reasons.

1) Geological condition for this tunnel is judged basically dense and hard in the fresh rocks but application of full-face excavation for the whole of profile may be difficult due to the shallow over-burden at the portal and also to the situation of natural ground in general. Thereby, it is considered appropriate to adopt the upper half advancing bench cut excavation method for the Type 2 and Type-3 sections corresponding to the portal portion and the weathered rock portion.
2) In case of cross-sectional area as 30-50 m^2 of this tunnel, stabilities of the face and the excavation heading are considered not problem-making and, therefore, no dividing by center wall is needed.

Further dividing of cross-section of heading will make it difficult to introduce additional machines with uneconomical results.

3) Bench-cut method is a standard one having the records of performances ranging from earth/sand natural ground to hard rock natural ground and considered suitable for tunneling works under the subject project implementation.

(c) Haulage system in tunnel interior

Tunnel haulage is considered either by rail system or rubber-tyred system of which features are as indicated as shown in Table 7.5-12

Table 7.5-12 Comparison of tunnel haulage methodology

Items	Rubber-tyred system	Rail system
Tunnel bed condition	● Work site should be in solid condition since dump truck directly enters into tunnel interior (Need for complete drainage). ● Not applicable in case of muddying at tunnel bed due to spring water.	● Rails be laid on ties and no concentration of point load will occur requiring no much conditions of tunnel bed.
Required facilities	● Light site installations is sufficient.	● Laying of rails is time-consuming work. ● Facilities and site needed are of some scales/size.
Easiness in construction	● When loaded once in interior, can be hauled out to spoil bank directly (One stop). ● Less limit in gradient ● For ventilation, the equipment be large.	● After hauling out by loco. another loading on dump another loading on dump Truck is necessary (Two stops) ● Gradient should be less than 2.0 %. ● *For ventilation, the equipment can be small.

Based on the above, the rubber-tyred haulage system shall be adopted for the subject tunneling works which is superior in easiness in construction and higher workability with having smaller and less temporary facilities for tunneling works.

4) Procedure of tunnel support works

As the construction method for the subject tunneling work, spray concrete/rock-bolt method (NATM) was selected. Accordingly, it is important to provide supports immediately after excavation and unite into a piece the supports with the natural ground so that the natural ground in and around the excavation site could be stabilized.

Hereunder, the Figure 7.5-3 shows the steps of construction for the standard support works, while the Figure 7.5-4 shows the construction order for the TYPE 3 tunnel by applying the half face parallel driving method with advancing bench-cut on upper face.

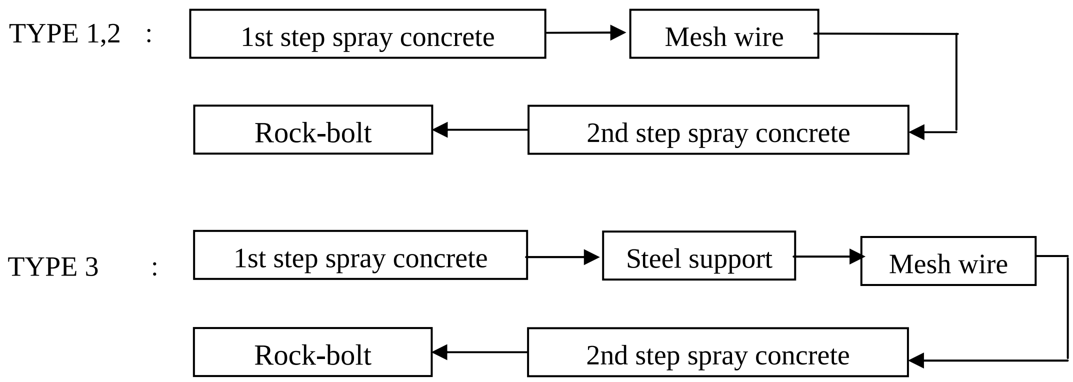


Fig. 7.5-3 Procedure of tunnel support works

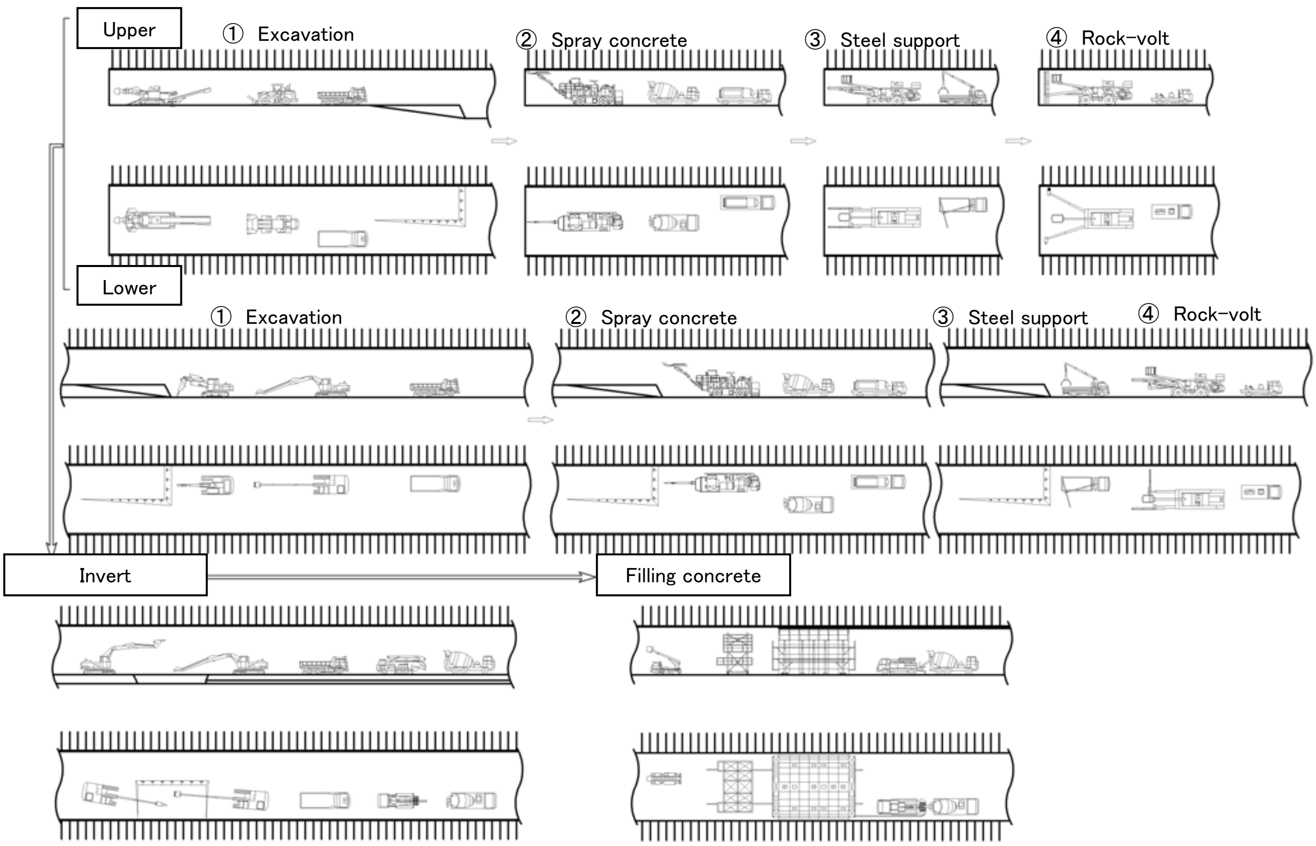


Fig. 7.5-4 Construction procedure of bench-cut method (Parallel advancing of upper and lower half faces)

(7) Construction scheduling

Given that the length of proposed tunnel is 19km, which needs long construction period, it can lead to delay of whole feeder canal construction. Therefore, it is needed to shorten the tunnel construction period for early benefit generation corresponding to the Agriculture Development Plan of Ninevah Governorate (Five-Year Plan of Water Resource Development Strategy). Therefore, it is proposed to divide the construction section into four sub-sections by setting three pit mouths, namely, the entrance, exit and way point of the tunnel. Contents of the proposed sub-sections and their length are shown in Table 7.5-13.

Table 7.5-13 Sections for tunneling works and the lengths

Sub-sections	Length and Station Nos.	Remarks
1st section (downstream)	L＝ 5,000m (No.39 ⇒ No.44)	TYPE3 : L＝1,800m (No.39～No.40+800) TYPE1 : L＝3,200m (No.40+800～No.44)
2nd section (upstream)	L＝ 4,100m (No.48+100 ⇒ No.44)	TYPE1 : L＝4,100m (No.48+100～No.44)
3rd section (downstream)	L＝ 4,100m (No.48+100 ⇒ No.52+200)	TYPE1 : L＝4,100m (No.48+100～No.52+200)
4th section (upstream)	L＝ 6,000m (No.58+200 ⇒ No.52+200)	TYPE3 : L＝3,200m (No.58+200～No.55) TYPE2 : L＝1,900m (No.55～No.53+100) TYPE1 : L＝ 900m (No.53+100～No.52+200)

① Preparatory works

The duration of preparatory works to be done prior to the tunneling work is estimated at 3 months.

② Tunneling

For tunneling works, required number of days for excavation and lining is worked out on the basis of the daily work progress to be attained in average during the whole period and based on this the construction scheduling shall be worked out.

Those intervals between the classified work items shall be as follows.

*Upper half face support-Lower half face cut/support : 0.5 M
*Completion of lower half face excavation – Finishing secondary lining : 1.0 M

<Excavation work>

Based on the cycle time computations, the monthly progress to be used in construction scheduling is as shown in the Table 7.5-14.

Table 7.5-14 (1) Excavation cycle time (Scenario-0)

Work Items / Pattern of support works	Daily Progress		Monthly Progress		
	Upper half	Lower half	Upper half	Lower half	
	m／day		m／month		
TYPE 1	4.1		94.8		Full face
TYPE 2	6.6	6.6	152.4	152.4	Parallel advancing by both upper and lower half
TYPE 3	5.3	5.3	127.8	127.8	Parallel advancing by both upper and lower half

Table 7.5-14 (2) Excavation cycle time (Scenario-1)

Work Items / Pattern of support works	Daily Progress		Monthly Progress		
	Upper half	Lower half		Upper half	
	m／day		m／month		
TYPE 1	4.5		103.0		Full face
TYPE 2	7.1	7.1	164.0	164.0	Parallel advancing by both upper and lower half
TYPE 3	5.5	5.5	127.2	127.2	Parallel advancing by both upper and lower half

Table 7.5-14 (3) Excavation cycle time (Scenario-2)

Work Items / Pattern of support works	Daily Progress		Monthly Progress		
	Upper half	Lower half		Upper half	
	m／day		m／month		
TYPE 1	5.1		116.8		Full face
TYPE 2	8.2	8.2	188.9	188.9	Parallel advancing by both upper and lower half
TYPE 3	6.1	6.1	140.6	140.6	Parallel advancing by both upper and lower half

<Concrete lining>

12.0 m x 1/2.0 times/day x 23 days = 138.0 m/M (6.00 m/day)

*Specs of slide central is of l=12.0 m.

③ Cleaning work

It is estimated that cleaning works as removing of temporary facilities will take about 1 month period.

④ Construction scheduling

For each scenario, the construction schedules are estimated as the followings.

Scenario-0 : 4years and 6month (54 months)
Scenario-1 : 4years and 3months (51months)
Scenario-2 : 3years and 10months (46months)

Table 7.5-15 (1) Construction Scheduling for Tunneling Works (Scenario-0)

Sections	Work items	1st year	2nd year	3rd year	4th year	5th year
1st section (No.39⇒No.44)	Preparatory works					
	Excavation	TYPE 3	TYPE 1			
	Lining					
	Cleanup					
2nd section (No.48+100⇒No.44)	Preparatory works					
	Inclined shaft					
	Excavation	TYPE 1				
	Lining					
	Cleanup					
3rd section (No.48+100⇒No.52+200)	Preparatory works					
	Inclined shaft					
	Excavation	TYPE 1				
	Lining					
	Cleanup					
4th section (No.58+200～No.52+200)	Preparatory works					
	Excavation	TYPE 3		TYPE 2	TYPE 1	
	Lining					
	Cleanup					

Table 7.5-15 (2) Construction Scheduling for Tunneling Works (Scenario-1)

Sections	Work items	1st year	2nd year	3rd year	4th year	5th year
1st section (No.39⇒No.44)	Preparatory works					
	Excavation	TYPE 3	TYPE 1			
	Lining					
	Cleanup					
2nd section (No.48+100⇒No.44)	Preparatory works					
	Inclined shaft					
	Excavation	TYPE 1				
	Lining					
	Cleanup					
3rd section (No.48+100⇒No.52+200)	Preparatory works					
	Inclined shaft					
	Excavation	TYPE 1				
	Lining					
	Cleanup					
4th section (No.58+200～No.52+200)	Preparatory works					
	Excavation	TYPE 3		TYPE 2	TYPE 1	
	Lining					
	Cleanup					

Table 7.5-15 (3) Construction Scheduling for Tunneling Works (Scenario-2)

Sections	Work items	1st year	2nd year	3rd year	4th year	5th year
1st section (No.39⇒No.44)	Preparatory works					
	Excavation	TYPE 3	TYPE 1			
	Lining					
	Cleanup					
2nd section (No.48+100⇒No.44)	Preparatory works					
	Inclined shaft					
	Excavation	TYPE 1				
	Lining					
	Cleanup					
3rd section (No.48+100⇒No.52+200)	Preparatory works					
	Inclined shaft					
	Excavation	TYPE 1				
	Lining					
	Cleanup					
4th section (No.58+200〜No.52+200)	Preparatory works					
	Excavation	TYPE 3		TYPE 2	TYPE 1	
	Lining					
	Cleanup					

7.5.3 Pump facilities

(1) Location of pump station

Conditions for determining the location of pump stations are as follows.

- ✓ The route should be selected with which the alignment would differ from tunneling at the station No. 36 or nearby and detour the mountain area to connect with the diversion point at the upstream of beneficiary area.
- ✓ The longitudinal profile of the alignment shows a convex figure and the elevation difference between the starting point of different route (No.36 or nearby) and the highest point of the pipeline is about 50 m.
- ✓ The highest elevation point is to appear at the section near the station No. 48 and the following section is substituted by open canal (Chute and drop structures) to be connected with the diversion point.
- ✓ Large scale pump facilities with a large capacity is required to satisfy the design discharge of 100 m^3/sec.

In view of the above, the location of pump station shall be examined with comparison for the following 2 cases.

- Plan A : 3 stations

Pumping stations shall be planned at 3 locations of No.37 + 700, No.41 +500 and No. 48 + 0. Each station shall have the lift capacity of H=17 m and among each station, open canal is availed for water conveyance.

- Plan B : 1 station

1 station is located at No. 36 + 500. The lift shall be H=50 m and pressured pipeline is provided for water conveyance to the station No. 48 + 700.

(2) Number of pump units

The number of pump units per station is to be determined through examining various relevant factors as capacities of wide-use pumps, flexibility to cope with the seasonal fluctuations of discharges, easiness in operation and maintenance (Availability of spare-parts and risk diversification during the damages occurred and etc. Under the subject study, it was so decided to plan as many as 11units of pumps (including one unit as a spare) per a station with the number of experiences of 10 m^3/sec capacity as large scale pumping project in the past.

- Design discharge per a station: Q = 100 m^3/sec
- Pump capacity/ unit: Q = 10 m^3/sec/unit
- Number of units /station: N = 11 units (including one unit as a spare)

(3) Determination of pump type

The design discharge and actual head (Lift) are the main factors to be considered in determining the pump type of which details are as shown in the Table 7.5-16.

Table 7.5-16 Main factors in determining pump type

Item / Location of Pump	Discharge (m^3/sec)	Suction Water Level (W.L)	Discharge Level (W.L)	Actual head(m)	Remarks
Plan A					
No.1(No.37+700)	100	304.07	321.07	17.00	
No.2(No.41+500)	100	320.71	337.71	17.00	
No.3(No.48+0)	100	337.08	354.08	17.00	
Plan B					
No.1(No.37+700)	100	304.19	354.53	50.34	

The pump type and the capacity of the facilities are as shown in the Table 7.5-17.

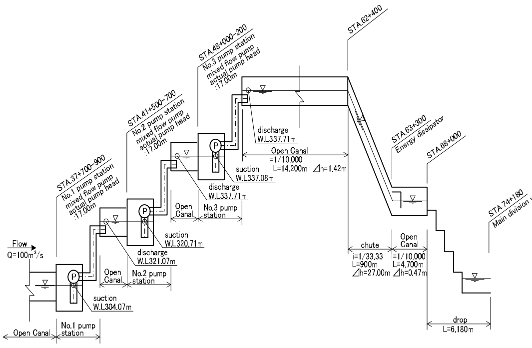
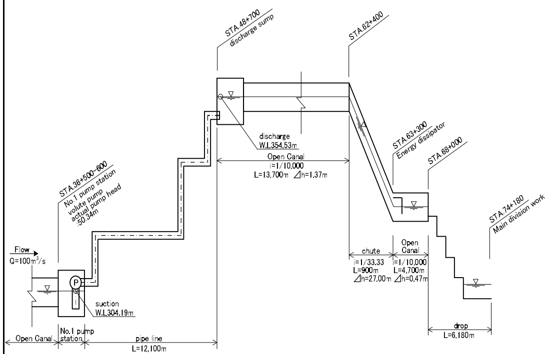
Table 7.5-17 Pump type and capacities

Plan A（3 stations）						
Item	code	Unit	No.1 station	No.2 station	No.3 station	Remarks
Station			No.37+700	No.41+500	No.48+000	
Number of unit		unit	11	11	11	Including one unit as a spare
Discharge per unit	Q	m^3/min	600	600	600	
Pump type			Inclined vertical	Inclined vertical	Inclined vertical	
Actual head	h1	m	17.00	17.00	17.00	
Pipe laying loss	h2	m	2.50	2.50	2.50	
Total head	H	m	19.50	19.50	19.50	
Dia.		mm	2,200	2,200	2,200	
Generator output		kw	2,600	2,600	2,600	=0.163･Q･H/(np･ng)×1.05
Pump efficiency	np		0.85	0.85	0.85	
Trans efficiency	ng		0.95	0.95	0.95	
Plan B（1 station）						
Item	code	Unit	No.1 station			Remarks
Station			No.36+500			
Number of unit		unit	11			Including one unit as a spare
Discharge per unit	Q	m^3/min	600			
Pump type			Centrifugal			Vertical shaft type single suction
Actual head	h1	m	50.34			
Pipe laying loss	h2	m	20.87			⊿HF=17.37m(φ2,400)
Total head	H	m	71.21			
Dia.		mm	1,900×1,500			
Generator output		kw	9,320			0.163･Q･H/np/ng×1.05
Pump efficiency	np		0.865			
Trans efficiency	ng		0.95			

(4) Determination of water conveyance system by pump

The results of comparison studies on 2 cases of pump station locations are presented in the Table 7.5-18. From the comparison, the Plan B, 1 station plan is selected as the manner of water conveyance by pump, which is more advantageous than Plan A in O & M easiness and higher economic viability.

Table 7.5-18 Comparison of Alternatives on Number of Pump Stations

<table>
<tr><th colspan="2">Items</th><th>Alternative A (3 Stations)</th><th>Alternative B (1 Station)</th></tr>
<tr><td rowspan="2">Composition of Works</td><td>Main Features</td><td>▪ 3 steps of low lift pump be provided for pumping water to open canal at the highest level.
▪ Design Discharge：Q＝100m³/sec
▪ Pump Specs（Low lift pump）
Type：Inclined vertical pump
Actual head：17m×3 steps
Number of unit : 11 units ×3 steps (including one unit as spare)
Discharge：10m³/sec/ unit
Dia.：φ2,200
Power output：2,200kw/ unit</td><td>▪ 1 step of high lift pump and pump up the water to the highest level by pipeline.
▪ Design Discharge：Q＝100m³/sec
▪ Pump Specs（High lift pump）
Type：Centrifugal pump
Actual head：68m
Number of unit : 11 units (including one unit as spare)
Discharge：10m³/sec/ unit
Dia.：φ1,900mm×φ1,500mm
Power output：9,200kw/unit</td></tr>
<tr><td>Drawings</td><td>
</td><td>
</td></tr>
<tr><td rowspan="2">O&M</td><td>Easiness</td><td>▪ Difficult</td><td>▪ Easier than A due to less number of pump unit</td></tr>
<tr><td>Comments</td><td>▪ Need to assign electrical/mechanical engineers for each of 3 stations and not advantageous in O&M.
▪ Due to more number of pump units as compared to alternative B, inferior in O&M aspect with more consumables.
▪ To control discharge, operation on water level, number of units and adjustment on rotation are necessary.
▪ Collaborations among the stations are necessary, requiring more sophisticated operation techniques in O&M works.</td><td>▪ Advantageous with less number of pumping equipment than A.
▪ Inferior tin safety of pipeline structure in case of sudden stoppage and starting.
▪ For discharge control, not easy operation is required, but easier than A with less number of stations.
▪ Pumping efficiency is higher than A though not much.</td></tr>
<tr><td colspan="2">Economic Aspect</td><td>Construction cost :511Billion ID
High Cost
(1.10)</td><td>Construction cost :465Billion ID
Low Cost
(1.00)</td></tr>
<tr><td colspan="2">Result</td><td>△</td><td>◎</td></tr>
</table>

7.6 Appurtenant Structures

Fig. 7.6-1 shows the layout of all the appurtenant structures.

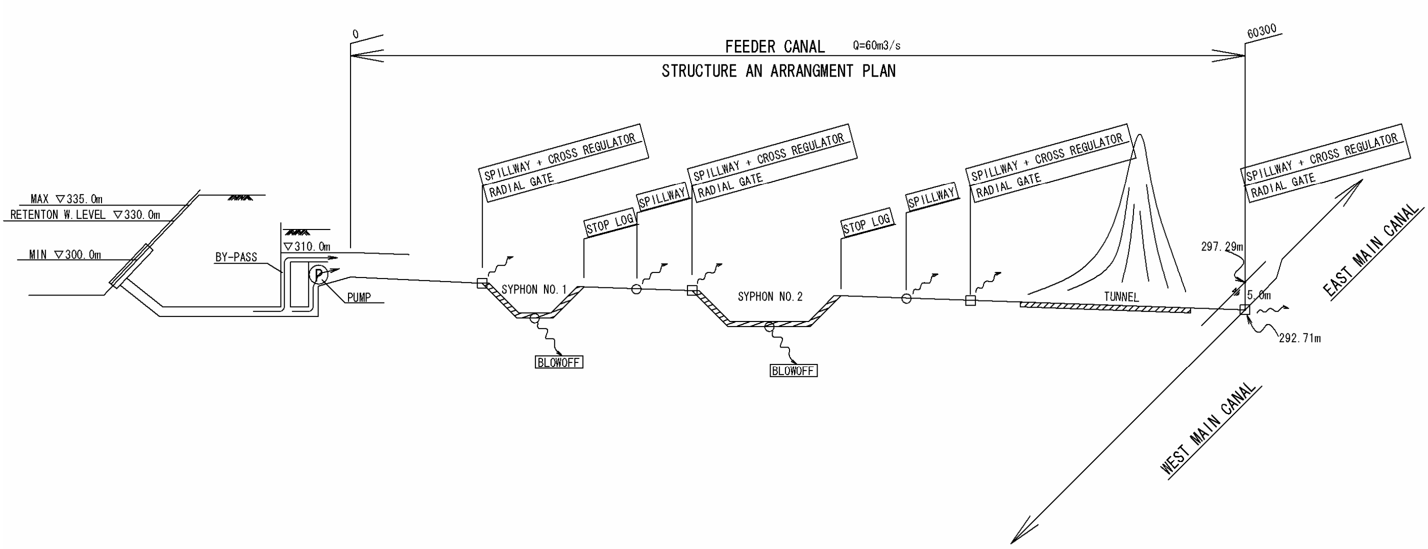


Fig. 7.6-1 Layout of All the appurtenant Structures

(1) Siphon

The siphons to be designed in this Project are so large as inner radius of 6,400 mm and the lengths of 880 m and 1,700 m respectively, and also inner pressure of around 0.2 Mpa would occur. Therefore, the round shape cast-in-place reinforced concrete siphon is adopted, which is structurally and hydraulically advantageous.

Table 7.6-1 Determination of Siphon Works

Scenario	Item	Siphone No.1 (SABURINA) No.4+620～No.5+500	Siphone No.2 (SHOREA) No.19+400～No.21+100	Remarks
Scenario 0	Inner diameter	ϕ 8,100mm	ϕ 8,100mm	
	Length	800m	1,700m	
Scenario 1	Inner diameter	ϕ 7,300mm	ϕ 7,300mm	
	Length	800m	1,700m	
Scenario 2	Inner diameter	ϕ 6,400mm	ϕ 6,400mm	
	Length	800m	1,700m	

(2) Crossing Work for Wadi

42 sites of crossing work for wadi (excluding 2 sites of siphon) are designed.

Table 7.6-2(1) Determination of the Length and Cross Scale of Crossing Work for Wadi （Scenario 0）

Survey Point	Canal Land Level EL1 (m)	River Bed Level EL2 (m)	freeboard F (m)	Crossing-section of Crossing Work B (m)	×	H (m)	×	L (m)	×	N	Remark
No. 0 + 0	304.37	304.00	1.00	2.00	×	2.00	×	75.00	×	1	
No. 0 + 430	304.33	299.10	3.40	1.50	×	1.50	×	84.60	×	2	
No. 0 + 700	304.30	308.00	1.00	1.50	×	1.50	×	75.00	×	2	
No. 1 + 400	304.23	304.00	1.00	2.00	×	2.00	×	75.00	×	2	
No. 3 + 110	304.06	298.00	3.10	2.50	×	2.50	×	83.40	×	2	
No. 5 + 80	273.10	269.00	0.50	3.00	×	3.00	×	46.50	×	8	
No. 5 + 840	303.02	300.00	1.20	1.50	×	1.50	×	75.80	×	1	
No. 6 + 90	302.99	305.50	1.00	2.50	×	2.50	×	75.00	×	2	
No. 6 + 280	302.97	305.00	1.00	2.50	×	2.50	×	75.00	×	2	
No. 7 + 150	302.89	310.20	1.00	1.50	×	1.50	×	75.00	×	1	
No. 7 + 540	302.85	293.40	7.60	1.50	×	1.50	×	101.40	×	2	
No. 8 + 110	302.79	290.00	10.90	1.50	×	1.50	×	114.60	×	2	
No. 8 + 640	302.74	305.00	1.00	1.50	×	1.50	×	75.00	×	2	
No. 8 + 810	302.72	300.00	1.00	1.50	×	1.50	×	75.00	×	2	
No. 11 + 30	302.50	304.80	1.00	2.50	×	2.50	×	75.00	×	1	
No. 11 + 460	302.45	295.80	3.60	2.50	×	2.50	×	85.40	×	2	
No. 12 + 210	302.38	302.00	1.00	1.50	×	1.50	×	75.00	×	1	
No. 12 + 690	302.33	300.00	1.00	2.00	×	2.00	×	75.00	×	1	
No. 13 + 290	302.27	301.10	1.00	2.50	×	2.50	×	75.00	×	1	
No. 14 + 290	302.17	300.00	1.00	1.50	×	1.50	×	75.00	×	1	
No. 14 + 920	302.11	293.00	4.40	4.00	×	4.00	×	88.60	×	3	
No. 16 + 40	302.00	303.40	1.00	2.50	×	2.50	×	75.00	×	1	
No. 16 + 850	301.92	293.10	5.80	2.50	×	2.50	×	94.20	×	1	
No. 17 + 250	301.88	293.90	5.50	2.00	×	2.00	×	93.00	×	1	
No. 18 + 410	301.76	296.00	2.90	2.50	×	2.50	×	82.60	×	1	
No. 18 + 850	301.72	298.80	1.10	1.50	×	1.50	×	75.40	×	1	
No. 20 + 150	280.10	277.00	0.50	2.00	×	2.00	×	46.50	×	10	
No. 21 + 940	300.42	297.00	1.50	1.50	×	1.50	×	77.00	×	2	
No. 22 + 990	300.31	301.00	1.00	1.50	×	1.50	×	75.00	×	1	
No. 23 + 890	300.22	289.00	4.00	6.00	×	6.00	×	87.00	×	4	
No. 24 + 410	300.17	294.00	1.00	5.00	×	5.00	×	75.00	×	5	
No. 25 + 450	300.07	296.70	1.00	2.50	×	2.50	×	75.00	×	2	
No. 26 + 470	299.96	300.00	1.00	2.50	×	2.50	×	75.00	×	1	
No. 28 + 290	299.78	297.80	1.00	2.00	×	2.00	×	75.00	×	1	
No. 28 + 550	299.76	296.10	1.30	2.00	×	2.00	×	76.20	×	1	
No. 29 + 130	299.70	295.50	1.20	2.50	×	2.50	×	75.80	×	2	
No. 30 + 20	299.61	303.00	1.00	1.50	×	1.50	×	75.00	×	1	
No. 30 + 580	299.55	300.50	1.00	1.50	×	1.50	×	75.00	×	1	
No. 30 + 750	299.54	298.00	1.00	2.50	×	2.50	×	75.00	×	2	
No. 33 + 390	299.14	306.00	1.00	2.00	×	2.00	×	75.00	×	2	
No. 33 + 800	299.10	303.00	1.00	2.50	×	2.50	×	75.00	×	2	
No. 34 + 30	299.08	302.50	1.00	2.50	×	2.50	×	75.00	×	2	
No. 35 + 920	298.89	305.00	1.00	4.00	×	4.00	×	75.00	×	3	
No. 36 + 650	298.81	307.50	1.00	4.00	×	4.00	×	75.00	×	3	

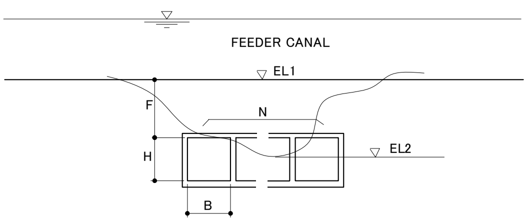


Table 7.6-2(2) Determination of the Length and Cross Scale of Crossing Work for Wadi (Scenario 1)

Survey Point	Canal Land Level EL1 (m)	River Bed Level EL2 (m)	freeboard F (m)	Crossing-section of Crossing Work B (m)	×	H (m)	×	L (m)	×	N	Remark
No. 0 + 0	304.67	304.00	1.00	2.00	×	2.00	×	71.90	×	1	
No. 0 + 430	304.63	299.10	3.70	1.50	×	1.50	×	82.70	×	2	
No. 0 + 700	304.60	308.00	1.00	1.50	×	1.50	×	71.90	×	2	
No. 1 + 400	304.53	304.00	1.00	2.00	×	2.00	×	71.90	×	2	
No. 3 + 110	304.36	298.00	3.40	2.50	×	2.50	×	81.50	×	2	
No. 5 + 80	273.10	269.00	0.50	3.00	×	3.00	×	46.50	×	8	
No. 5 + 840	303.31	300.00	1.50	1.50	×	1.50	×	73.90	×	1	
No. 6 + 90	303.28	305.50	1.00	2.50	×	2.50	×	71.90	×	2	
No. 6 + 280	303.26	305.00	1.00	2.50	×	2.50	×	71.90	×	2	
No. 7 + 150	303.18	310.20	1.00	1.50	×	1.50	×	71.90	×	1	
No. 7 + 540	303.14	293.40	7.90	1.50	×	1.50	×	99.50	×	2	
No. 8 + 110	303.08	290.00	11.20	1.50	×	1.50	×	112.70	×	2	
No. 8 + 640	303.03	305.00	1.00	1.50	×	1.50	×	71.90	×	2	
No. 8 + 810	303.01	300.00	1.20	1.50	×	1.50	×	72.70	×	2	
No. 11 + 30	302.79	304.80	1.00	2.50	×	2.50	×	71.90	×	1	
No. 11 + 460	302.74	295.80	3.90	2.50	×	2.50	×	83.50	×	2	
No. 12 + 210	302.67	302.00	1.00	1.50	×	1.50	×	71.90	×	1	
No. 12 + 690	302.62	300.00	1.00	2.00	×	2.00	×	71.90	×	1	
No. 13 + 290	302.56	301.10	1.00	2.50	×	2.50	×	71.90	×	1	
No. 14 + 290	302.46	300.00	1.00	1.50	×	1.50	×	71.90	×	1	
No. 14 + 920	302.40	293.00	4.70	4.00	×	4.00	×	86.70	×	3	
No. 16 + 40	302.29	303.40	1.00	2.50	×	2.50	×	71.90	×	1	
No. 16 + 850	302.21	293.10	6.10	2.50	×	2.50	×	92.30	×	1	
No. 17 + 250	302.17	293.90	5.80	2.00	×	2.00	×	91.10	×	1	
No. 18 + 410	302.05	296.00	3.20	2.50	×	2.50	×	80.70	×	1	
No. 18 + 850	302.01	298.80	1.40	1.50	×	1.50	×	73.50	×	1	
No. 20 + 150	280.10	277.00	0.50	2.00	×	2.00	×	46.50	×	10	
No. 21 + 940	300.67	297.00	1.80	1.50	×	1.50	×	75.10	×	2	
No. 22 + 990	300.56	301.00	1.00	1.50	×	1.50	×	71.90	×	1	
No. 23 + 890	300.47	289.00	4.20	6.00	×	6.00	×	84.70	×	4	
No. 24 + 410	300.42	294.00	1.00	5.00	×	5.00	×	71.90	×	5	
No. 25 + 450	300.32	296.70	1.00	2.50	×	2.50	×	71.90	×	2	
No. 26 + 470	300.21	300.00	1.00	2.50	×	2.50	×	71.90	×	1	
No. 28 + 290	300.03	297.80	1.00	2.00	×	2.00	×	71.90	×	1	
No. 28 + 550	300.01	296.10	1.50	2.00	×	2.00	×	73.90	×	1	
No. 29 + 130	299.95	295.50	1.50	2.50	×	2.50	×	73.90	×	2	
No. 30 + 20	299.86	303.00	1.00	1.50	×	1.50	×	71.90	×	1	
No. 30 + 580	299.80	300.50	1.00	1.50	×	1.50	×	71.90	×	1	
No. 30 + 750	299.79	298.00	1.00	2.50	×	2.50	×	71.90	×	2	
No. 33 + 390	299.39	306.00	1.00	2.00	×	2.00	×	71.90	×	2	
No. 33 + 800	299.35	303.00	1.00	2.50	×	2.50	×	71.90	×	2	
No. 34 + 30	299.33	302.50	1.00	2.50	×	2.50	×	71.90	×	2	
No. 35 + 920	299.14	305.00	1.00	4.00	×	4.00	×	71.90	×	3	
No. 36 + 650	299.06	307.50	1.00	4.00	×	4.00	×	71.90	×	3	

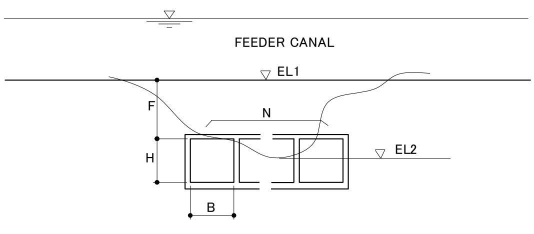
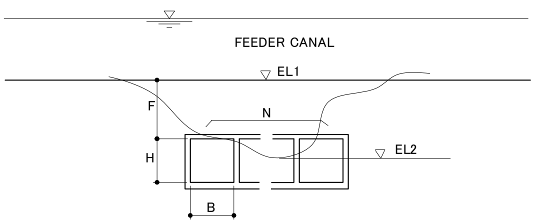


Table7.6-2(3) Determination of the Length and Cross Scale of Crossing Work for Wadi (Scenario 2)

Survey Point	Canal Land Level EL1 (m)	River Bed Level EL2 (m)	freeboard F (m)	Crossing-section of Crossing Work B (m)	×	H (m)	×	L (m)	×	N	Remark
No. 0 + 0	305.32	304.00	1.00	2.00	×	2.00	×	67.00	×	1	
No. 0 + 430	305.28	299.10	4.40	1.50	×	1.50	×	80.60	×	2	
No. 0 + 700	305.25	308.00	1.00	1.50	×	1.50	×	67.00	×	2	
No. 1 + 400	305.18	304.00	1.00	2.00	×	2.00	×	67.00	×	2	
No. 3 + 110	305.01	298.00	4.10	2.50	×	2.50	×	79.40	×	2	
No. 5 + 80	273.10	269.00	0.50	3.00	×	3.00	×	46.50	×	8	
No. 5 + 840	303.92	300.00	2.10	1.50	×	1.50	×	71.40	×	1	
No. 6 + 90	303.89	305.50	1.00	2.50	×	2.50	×	67.00	×	2	
No. 6 + 280	303.87	305.00	1.00	2.50	×	2.50	×	67.00	×	2	
No. 7 + 150	303.79	310.20	1.00	1.50	×	1.50	×	67.00	×	1	
No. 7 + 540	303.75	293.40	8.50	1.50	×	1.50	×	97.00	×	2	
No. 8 + 110	303.69	290.00	11.80	1.50	×	1.50	×	110.20	×	2	
No. 8 + 640	303.64	305.00	1.00	1.50	×	1.50	×	67.00	×	2	
No. 8 + 810	303.62	300.00	1.80	1.50	×	1.50	×	70.20	×	2	
No. 11 + 30	303.40	304.80	1.00	2.50	×	2.50	×	67.00	×	1	
No. 11 + 460	303.35	295.80	4.60	2.50	×	2.50	×	81.40	×	2	
No. 12 + 210	303.28	302.00	1.00	1.50	×	1.50	×	67.00	×	1	
No. 12 + 690	303.23	300.00	1.00	2.00	×	2.00	×	67.00	×	1	
No. 13 + 290	303.17	301.10	1.00	2.50	×	2.50	×	67.00	×	1	
No. 14 + 290	303.07	300.00	1.30	1.50	×	1.50	×	68.20	×	1	
No. 14 + 920	303.01	293.00	5.30	4.00	×	4.00	×	84.20	×	3	
No. 16 + 40	302.90	303.40	1.00	2.50	×	2.50	×	67.00	×	1	
No. 16 + 850	302.82	293.10	6.70	2.50	×	2.50	×	89.80	×	1	
No. 17 + 250	302.78	293.90	6.40	2.00	×	2.00	×	88.60	×	1	
No. 18 + 410	302.66	296.00	3.80	2.50	×	2.50	×	78.20	×	1	
No. 18 + 850	302.62	298.80	2.00	1.50	×	1.50	×	71.00	×	1	
No. 20 + 150	280.10	277.00	0.50	2.00	×	2.00	×	46.50	×	10	
No. 21 + 940	301.22	297.00	2.30	1.50	×	1.50	×	72.20	×	2	
No. 22 + 990	301.11	301.00	1.00	1.50	×	1.50	×	67.00	×	1	
No. 23 + 890	301.02	289.00	4.80	6.00	×	6.00	×	82.20	×	4	
No. 24 + 410	300.97	294.00	1.10	5.00	×	5.00	×	67.40	×	5	
No. 25 + 450	300.87	296.70	1.30	2.50	×	2.50	×	68.20	×	2	
No. 26 + 470	300.76	300.00	1.00	2.50	×	2.50	×	67.00	×	1	
No. 28 + 290	300.58	297.80	1.00	2.00	×	2.00	×	67.00	×	1	
No. 28 + 550	300.56	296.10	2.10	2.00	×	2.00	×	71.40	×	1	
No. 29 + 130	300.50	295.50	2.10	2.50	×	2.50	×	71.40	×	2	
No. 30 + 20	300.41	303.00	1.00	1.50	×	1.50	×	67.00	×	1	
No. 30 + 580	300.35	300.50	1.00	1.50	×	1.50	×	67.00	×	1	
No. 30 + 750	300.34	298.00	1.00	2.50	×	2.50	×	67.00	×	2	
No. 33 + 390	299.96	306.00	1.00	2.00	×	2.00	×	67.00	×	2	
No. 33 + 800	299.92	303.00	1.00	2.50	×	2.50	×	67.00	×	2	
No. 34 + 30	299.90	302.50	1.00	2.50	×	2.50	×	67.00	×	2	
No. 35 + 920	299.71	305.00	1.00	4.00	×	4.00	×	67.00	×	3	
No. 36 + 650	299.63	307.50	1.00	4.00	×	4.00	×	67.00	×	3	



(3) Crossing Work for Oil Pipeline

3 sites of crossing work for oil pipeline are designed.

Table 7.6-3(1) Determination of the Length and Cross Scale of Crossing Work for Oil Pipeline (Scenario 0)

Survey Point	Canal Land Level (m)	Top Level of Pipe (m)	Crossing-section of Crossing Work							Remark
			B (m)	×	H (m)	×	L (m)	×	N	
No. 21 + 660	300.44	300.04	3.10	×	1.90	×	68.50	×	1	1st location
No. 21 + 680	300.44	300.04	1.50	×	1.00	×	68.50	×	1	
No. 25 + 970	300.01	306.91	4.50	×	5.40	×	28.30	×	3	2nd location

Table 7.6-3(2) Determination of the Length and Cross Scale of Crossing Work for Oil Pipeline (Scenario 1)

Survey Point	Canal Land Level (m)	Top Level of Pipe (m)	Crossing-section of Crossing Work							Remark
			B (m)	×	H (m)	×	L (m)	×	N	
No. 21 + 660	300.69	300.04	3.10	×	1.90	×	66.60	×	1	1st location
No. 21 + 680	300.69	300.04	1.50	×	1.00	×	66.60	×	1	
No. 25 + 970	300.26	306.91	4.50	×	5.40	×	27.30	×	3	2nd location

Table 7.6-3(3) Determination of the Length and Cross Scale of Crossing Work for Oil Pipeline (Scenario 2)

Survey Point	Canal Land Level (m)	Top Level of Pipe (m)	Crossing-section of Crossing Work							Remark
			B (m)	×	H (m)	×	L (m)	×	N	
No. 21 + 660	301.24	300.04	3.10	×	1.90	×	64.50	×	1	1st location
No. 21 + 680	301.24	300.04	1.50	×	1.00	×	64.50	×	1	
No. 25 + 970	300.81	306.91	4.50	×	5.40	×	27.30	×	3	2nd location

(4) Crossing Work for Railway

1 site of crossing work for railway is designed.

Table 7.6-4(1) Determination of the Length and Cross Scale of Crossing Work for Railway (Scenario 0)

Survey Point	Canal Land Level (m)	Top Level of Pipe (m)	Bridge			Remark
			L (m)	×	N	
No. 37 + 650	298.85	317.70	20.00	×	3	

Table 7.6-4(2) Determination of the Length and Cross Scale of Crossing Work for Railway (Scenario 1)

Survey Point	Canal Land Level (m)	Top Level of Pipe (m)	Bridge			Remark
			L (m)	×	N	
No. 37 + 650	299.10	317.70	20.00	×	3	

Table 7.6-4(3) Determination of the Length and Cross Scale of Crossing Work for Railway (Scenario 2)

Survey Point	Canal Land Level (m)	Top Level of Pipe (m)	Bridge			Remark
			L (m)	×	N	
No. 37 + 650	299.65	317.70	20.00	×	3	

(5) Crossing Work for Road

8 sites of crossing work for road are designed.

Table 7.6-5(1) Determination of the Length and Cross Scale of Crossing Work for Road (Scenario 0)

Survey Point	Canal Land Level (m)	Level of Road (m)	Difference (m)	Length of Crossing (m)	Bridge L (m)	×	N	TYPE	Remark
No. 10 + 770	302.52	313.50	10.98	37.90	20.00	×	1	II - i	B=5m
No. 11 + 940	302.41	305.60	3.19	30.00	20.00	×	1	II - ii	B=5m (road raising)
No. 12 + 380	302.36	311.40	9.04	32.10	20.00	×	1	II - i	B=5m
No. 13 + 650	302.24	314.80	12.56	42.70	20.00	×	2	II - i	B=5m
No. 26 + 630	299.95	309.50	9.55	33.70	20.00	×	1	II - i	B=5m
No. 29 + 760	299.63	307.10	7.47	27.40	20.00	×	1	II - i	B=5m
No. 33 + 100	299.30	312.50	13.20	44.60	20.00	×	2	I - i	B=9m
No. 35 + 440	299.07	321.60	22.53	72.60	20.00	×	3	I - i	B=9m

Table 7.6-5(2) Determination of the Length and Cross Scale of Crossing Work for Road (Scenario 1)

Survey Point	Canal Land Level (m)	Level of Road (m)	Difference (m)	Length of Crossing (m)	Bridge L (m)	×	N	TYPE	Remark
No. 10 + 770	302.81	313.50	10.69	36.10	20.00	×	1	II - i	B=5m
No. 11 + 940	302.70	305.60	2.90	30.00	20.00	×	1	II - ii	B=5m (road raising)
No. 12 + 380	302.65	311.40	8.75	30.30	20.00	×	1	II - i	B=5m
No. 13 + 650	302.53	314.80	12.27	40.80	20.00	×	2	II - i	B=5m
No. 26 + 630	300.20	309.50	9.30	31.90	20.00	×	1	II - i	B=5m
No. 29 + 760	299.88	307.10	7.22	25.70	20.00	×	1	II - i	B=5m
No. 33 + 100	299.55	312.50	12.95	42.90	20.00	×	2	I - i	B=9m
No. 35 + 440	299.32	321.60	22.28	70.80	20.00	×	3	I - i	B=9m

Table 7.6-5(3) Determination of the Length and Cross Scale of Crossing Work for Road (Scenario 2)

Survey Point	Canal Land Level (m)	Level of Road (m)	Difference (m)	Length of Crossing (m)	Bridge L (m)	×	N	TYPE	Remark
No. 10 + 770	303.42	313.50	10.08	34.20	20.00	×	1	II - i	B=5m
No. 11 + 940	303.31	305.60	2.29	30.00	20.00	×	1	II - ii	B=5m (road raising)
No. 12 + 380	303.26	311.40	8.14	28.40	20.00	×	1	II - i	B=5m
No. 13 + 650	303.14	314.80	11.66	39.00	20.00	×	2	II - i	B=5m
No. 26 + 630	300.75	309.50	8.75	30.30	20.00	×	1	II - i	B=5m
No. 29 + 760	300.43	307.10	6.67	24.00	20.00	×	1	II - i	B=5m
No. 33 + 100	300.10	312.50	12.40	41.20	20.00	×	2	I - i	B=9m
No. 35 + 440	299.87	321.60	21.73	69.20	20.00	×	3	I - i	B=9m

(6) Footbridge

3 sites of footbridge are designed.

Table 7.6-6 (1) Determination of the Length and Cross Scale of Footbridge (Scenario 0)

Survey Point	Canal Land Level (m)	Level of Road (m)	Difference (m)	Length of Crossing (m)	Bridge L (m)	×	N	Remark
No. 16 + 730	301.93	306.93	5.00	20.00	23.00	×	1	
No. 26 + 200	299.99	304.99	5.00	20.00	23.00	×	1	
No. 28 + 350	299.78	304.78	5.00	20.00	23.00	×	1	

Table 7.6-6 (2) Determination of the Length and Cross Scale of Footbridge (Scenario 1)

Survey Point	Canal Land Level (m)	Level of Road (m)	Difference (m)	Length of Crossing (m)	Bridge L (m)	×	N	Remark
No. 16 + 730	302.22	307.22	5.00	19.00	23.00	×	1	
No. 26 + 200	300.24	305.24	5.00	19.00	23.00	×	1	
No. 28 + 350	300.03	305.03	5.00	19.00	23.00	×	1	

Table 7.6-6 (3) Determination of the Length and Cross Scale of Footbridge (Scenario 2)

Survey Point	Canal Land Level (m)	Level of Road (m)	Difference (m)	Length of Crossing (m)	Bridge L (m)	×	N	Remark
No. 16 + 730	302.83	307.83	5.00	19.00	23.00	×	1	
No. 26 + 200	300.79	305.79	5.00	19.00	23.00	×	1	
No. 28 + 350	300.58	305.58	5.00	19.00	23.00	×	1	

(7) Operation Facilities

1) Spillway

Table 7.6-7(1) Location of Spillway (Scenario 0)

Survey Point	Length of Section (m)	Canal Land Level (m)	Capacity (m3/s)	Length of Crest (m)	Remark
No. 4 + 620	4620	303.91	9.00	57.00	cum Siphon 1
No. 12 + 690	8070	302.33			
No. 19 + 400	6710	301.66			cum Siphon 2
No. 25 + 450	6050	300.07			
No. 30 + 700	5250	299.54			cum Wasteways
No. 60 + 270	29570	291.78			branch point of EAST and WEST

Table 7.6-7(2) Location of Spillway (Scenario 1)

Survey Point	Length of Section (m)	Canal Land Level (m)	Capacity (m3/s)	Length of Crest (m)	Remark
No. 4 + 620	4620	304.21	17.00	107.00	cum Siphon 1
No. 12 + 690	8070	302.62			
No. 19 + 400	6710	301.95			cum Siphon 2
No. 25 + 450	6050	300.32			
No. 30 + 700	5250	299.79			cum Wasteways
No. 60 + 270	29570	292.07			branch point of EAST and WEST

Table 7.6-7(3) Location of Spillway (Scenario 2)

Survey Point	Length of Section (m)	Canal Land Level (m)	Capacity (m3/s)	Length of Crest (m)	Remark
No. 4 + 620	4620	304.86	12.00	76.00	cum Siphon 1
No. 12 + 690	8070	303.23			
No. 19 + 400	6710	302.56			cum Siphon 2
No. 25 + 450	6050	300.87			
No. 30 + 700	5250	300.34			cum Wasteways
No. 60 + 270	29570	292.71			branch point of EAST and WEST

2) Wasteway

Table 7.6-8(1) Location of Wasteway (Scenario 0)

Survey Point	Length of Section (m)	Canal Land Level (m)	Capacity (m3/s)	Remark
No. 4 + 620	4620	303.91	100.00	cum Siphon 1
No. 19 + 400	14780	301.66		cum Siphon 2
No. 30 + 700	11300	299.54		right upstream of tunnel (wadi possible to discharge)
No. 60 + 270	29570	291.78		branch point of EAST and WEST

Table 7.6-8(2) Location of Wasteway (Scenario 1)

Survey Point	Length of Section (m)	Canal Land Level (m)	Capacity (m3/s)	Remark
No. 4 + 620	4620	304.21	80.00	cum Siphon 1
No. 19 + 400	14780	301.95		cum Siphon 2
No. 30 + 700	11300	299.79		right upstream of tunnel (wadi possible to discharge)
No. 60 + 270	29570	292.07		branch point of EAST and WEST

Table 7.6-8(3) Location of Wasteway (Scenario 2)

Survey Point	Length of Section (m)	Canal Land Level (m)	Capacity (m3/s)	Remark
No. 4 + 620	4620	304.86	60.00	cum Siphon 1
No. 19 + 400	14780	302.56		cum Siphon 2
No. 30 + 700	11300	300.34		right upstream of tunnel (wadi possible to discharge)
No. 60 + 270	29570	292.71		branch point of EAST and WEST

CHAPTER 8. OUTLINE DESIGN OF IRRIGATION FACILITIES

8.1 Irrigation Network

Irrigation network will be designed taking into account layout of branch canal.

(1) Irrigation Area

Table 8.1-1 Irrigation Area by Blocks

Share of Cultivated Area ③	75.6%

Main Canal	Area Name	Soil Depth Area (≧50cm) ①	Area Suitable for Irrigation ②	Sinario 0 Q=100m^3/s	Sinario 1 Q=80m^3/s	Sinario 2 Q=60m^3/s
East Main Canal	E1	8,600	6,500	6,500	6,500	6,500
	E2	15,300	11,500	11,500	11,500	11,500
	E3	6,700	5,100	5,100	5,100	5,100
	E4	14,100	10,700	10,700	10,700	10,700
Wast Main Canal	W1	7,700	5,800	5,800	5,800	5,800
	W2	12,200	9,200	9,200	9,200	9,200
	W3	17,500	13,300	13,300	13,300	13,300
	W4	20,700	15,600	15,600	15,600	15,600
	W5	4,800	3,700	3,700	3,700	3,700
	W6	7,200	5,400	5,400	5,400	5,400
	W7	6,300	4,800	4,800	4,800	
	W8	8,100	6,100	6,100	6,100	
	W9	7,900	6,000	6,000	6,000	
	W10	6,400	4,900	4,900	4,900	
	W11	13,700	10,400	10,400	10,400	
Pumped Main Canal	P1	3,600	2,700	2,700		
	P2	6,000	4,600	4,600		
	P3	6,000	4,500	4,500		
	P4	6,500	4,900	4,900		
	P5	7,700	5,800	5,800		
	P6	9,400	7,100	7,100		
TOTAL		196,400	148,600	148,600	119,000	86,800

Area Suitable for Irrigation ② ＝Soil Depth Area (≧50cm) ① × Share of Cultivated Area ③ / 100

(2) Irrigation Water

Irrigation water of main canal will be calculated based on maximum daily consumptive water use, irrigation efficiency and irrigation area and the calculation process is shown below;

Irrigation water amount of Main Canal (m^3/s)

=Maximum daily consumptive water use (m^3/sec/ha) / Irrigation efficiency × Irrigation area (ha)

Irrigation efficiency : 0.68

(3) Irrigation Network

Irrigation Network by scenarios is as shown in Fig. 8.1-1 to 8.1.3.

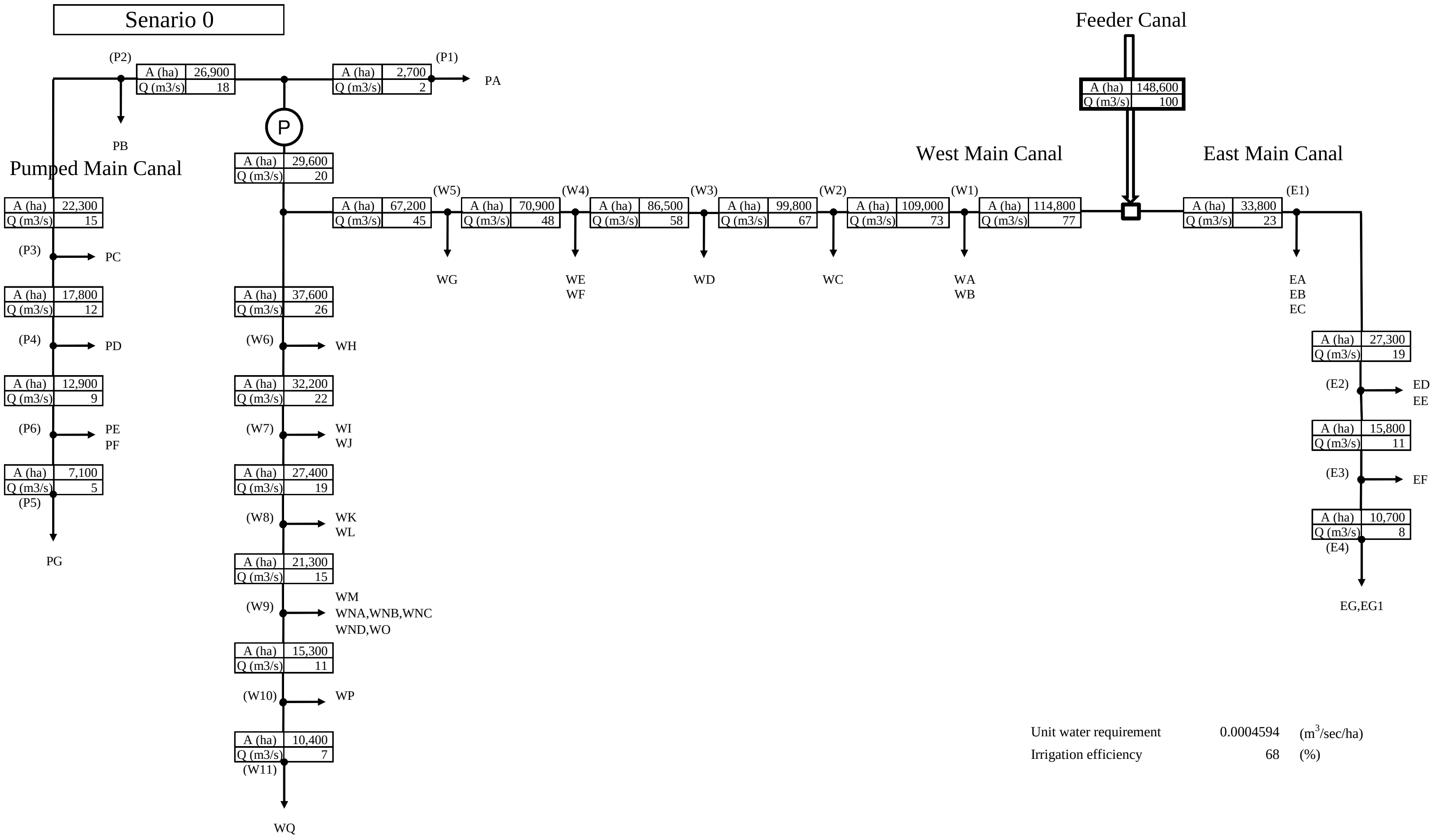
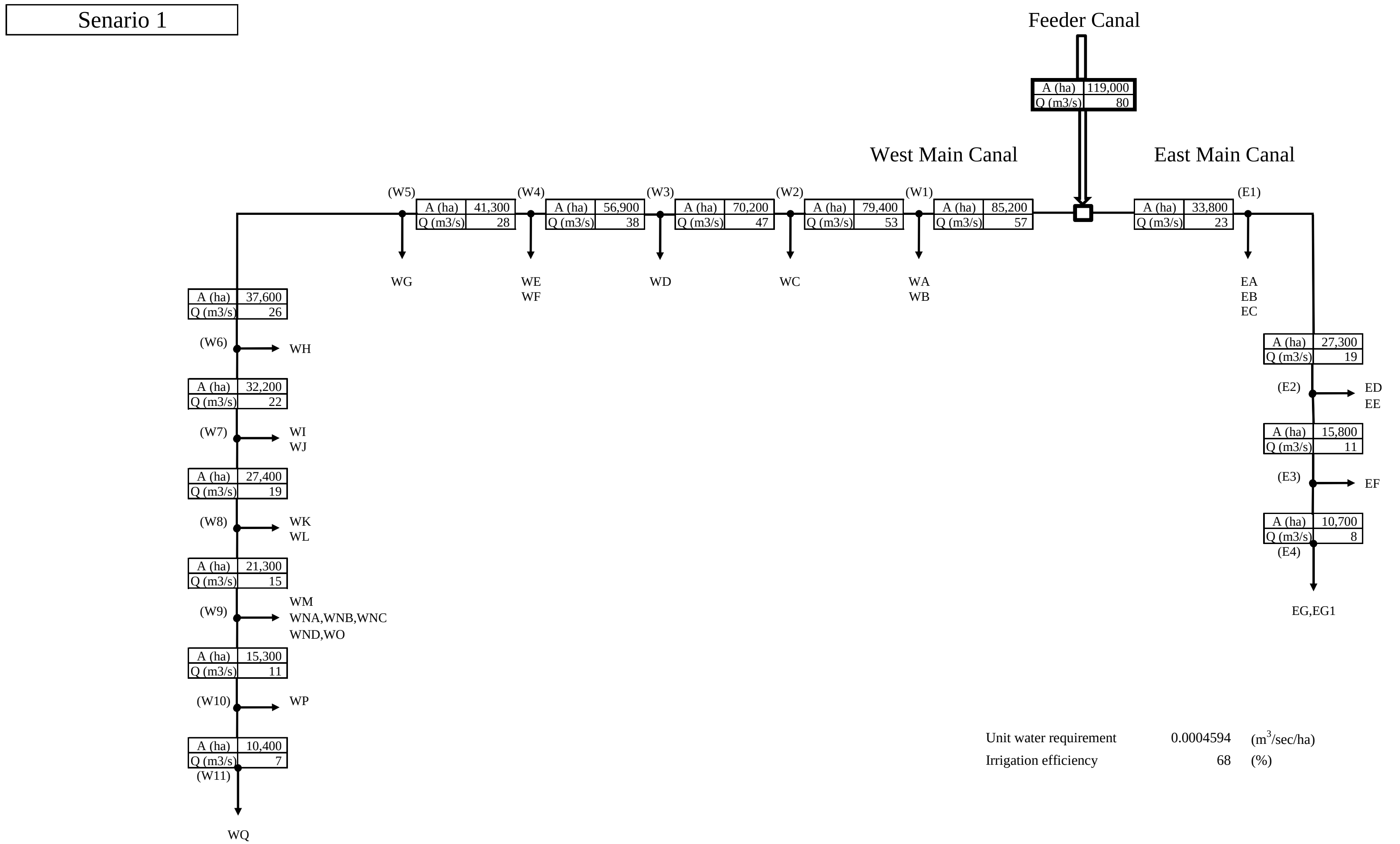
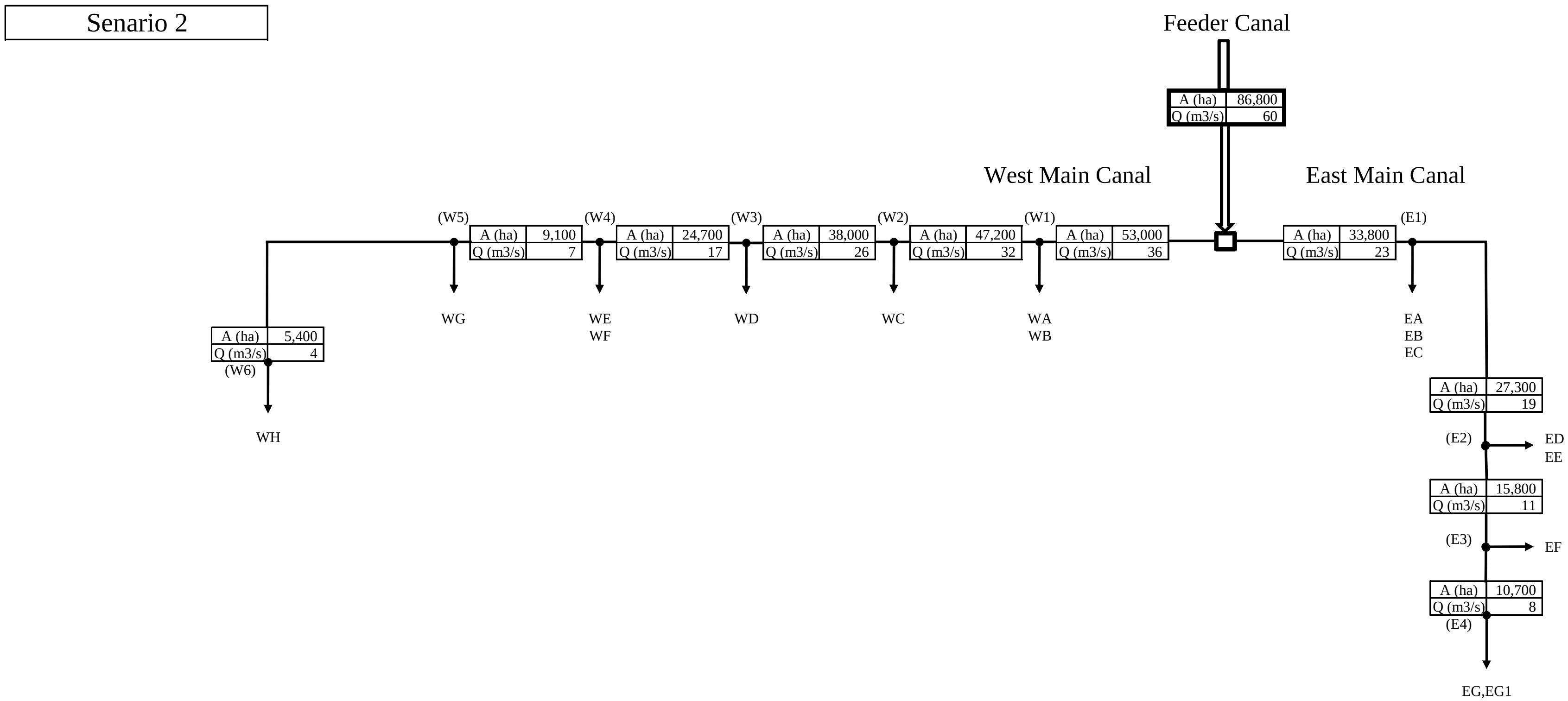


Fig. 8.1-1 Irrigation Network (Scenario 0)



Unit water requirement	0.0004594	(m^3/sec/ha)
Irrigation efficiency	68	(%)

Fig. 8.1-2 Irrigation Network (Scenario 1)



Unit water requirement	0.0004594	(m^3/sec/ha)
Irrigation efficiency	68	(%)

Fig. 8.1-3 Irrigation Network (Scenario 2)

8.2 Preliminary Design of Main Canal

Preliminary design of tunnel route will be drawn up.

The cross section of main canal shall be of uniformed flow and economically advantageous by adopting a trapezoidal figure allowing the minimum excavation volume and length for lining based on the same cross section as feeder and open canal.

Dimension of cross section for main canal by scenarios are as shown in Table 8.2-1 to 8.2-3.

Table 8.2-1 Dimension of Cross Section for Main Canal (Scenario 0)

TYPE		HYDRAULIC DATA				GEOMETRICAL DATA				
		Q m3/s	S m/m	n	v m/s	Fr	B m	d m	Fb m	H m
EAST CANAL	EMC_01	23	0.0005	0.015	1.729	0.37	2.50	2.26	0.34	2.60
	EMC_02	19	0.0005	0.015	1.647	0.37	2.50	2.06	0.32	2.40
	EMC_03	11	0.0005	0.015	1.431	0.36	2.40	1.60	0.28	1.90
	EMC_04	8	0.0005	0.015	1.328	0.34	1.70	1.52	0.27	1.80
WEST CANAL	WMC_01	77	0.00005	0.015	0.974	0.14	9.40	4.77	0.41	5.20
	WMC_02	73	0.00005	0.015	0.961	0.14	9.20	4.68	0.41	5.10
	WMC_03	67	0.00005	0.015	0.940	0.14	9.10	4.50	0.40	4.90
	WMC_04	58	0.00005	0.015	0.905	0.14	8.90	4.21	0.38	4.60
	WMC_05	48	0.00005	0.015	0.863	0.14	8.30	3.92	0.37	4.30
	WMC_06	45	0.00005	0.015	0.849	0.14	8.10	3.83	0.36	4.20
	WMC_07	26	0.00005	0.015	0.735	0.14	7.40	2.98	0.31	3.30
	WMC_08	22	0.00005	0.015	0.705	0.13	7.00	2.79	0.30	3.10
	WMC_09	19	0.00005	0.015	0.685	0.13	5.80	2.78	0.30	3.10
	WMC_10	15	0.00005	0.015	0.650	0.13	4.50	2.70	0.30	3.00
	WMC_11	11	0.00005	0.015	0.606	0.12	3.10	2.60	0.29	2.90
	WMC_12	7	0.00005	0.015	0.540	0.12	2.90	2.13	0.26	2.40
PUMPED MAIN CANAL	PMC_1	2	0.0001	0.015	0.512	0.15	1.60	1.17	0.22	1.40
	PMC_2	18	0.0001	0.015	0.888	0.17	3.50	2.69	0.30	3.00
	PMC_3	15	0.0001	0.015	0.850	0.17	2.90	2.60	0.30	2.90
	PMC_4	12	0.0001	0.015	0.805	0.16	2.20	2.50	0.29	2.80
	PMC_5	9	0.0001	0.015	0.749	0.16	2.10	2.22	0.28	2.50
	PMC_6	5	0.0001	0.015	0.646	0.16	1.80	1.75	0.25	2.00

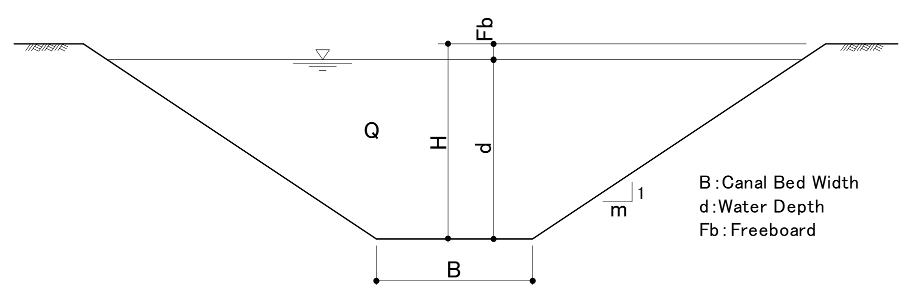


Table 8.2-2 Dimension of Cross Section for Main Canal (Scenario 1)

TYPE		HYDRAULIC DATA				GEOMETRICAL DATA				
		Q m3/s	S m/m	n	v m/s	Fr	B m	d m	Fb m	H m
EAST CANAL	EMC_01	23	0.0005	0.015	1.729	0.37	2.50	2.26	0.34	2.60
	EMC_02	19	0.0005	0.015	1.647	0.37	2.50	2.06	0.32	2.40
	EMC_03	11	0.0005	0.015	1.431	0.36	2.40	1.60	0.28	1.90
	EMC_04	8	0.0005	0.015	1.328	0.34	1.70	1.52	0.27	1.80
WEST CANAL	WMC_01	57	0.00005	0.015	0.902	0.14	8.70	4.21	0.38	4.60
	WMC_02	53	0.00005	0.015	0.886	0.14	8.40	4.11	0.38	4.50
	WMC_03	47	0.00005	0.015	0.860	0.14	8.00	3.93	0.37	4.30
	WMC_04	38	0.00005	0.015	0.816	0.14	7.30	3.65	0.35	4.00
	WMC_05	28	0.00005	0.015	0.756	0.13	6.50	3.25	0.33	3.60
	WMC_06	26	0.00005	0.015	0.742	0.13	6.30	3.17	0.32	3.50
	WMC_07	22	0.00005	0.015	0.712	0.13	5.90	2.98	0.31	3.30
	WMC_08	19	0.00005	0.015	0.691	0.13	4.80	2.97	0.31	3.30
	WMC_09	15	0.00005	0.015	0.652	0.12	4.10	2.78	0.30	3.10
	WMC_10	11	0.00005	0.015	0.602	0.12	4.00	2.40	0.28	2.70
	WMC_11	7	0.00005	0.015	0.540	0.12	2.90	2.13	0.26	2.40

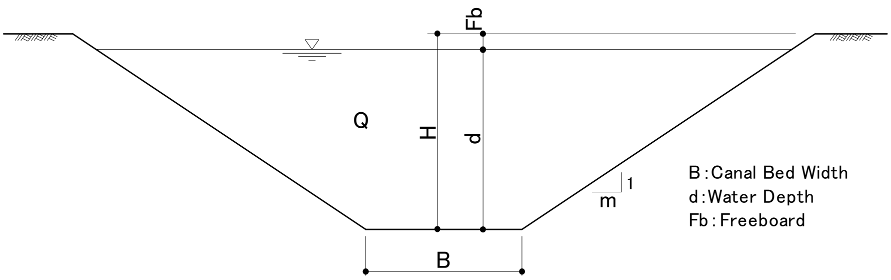
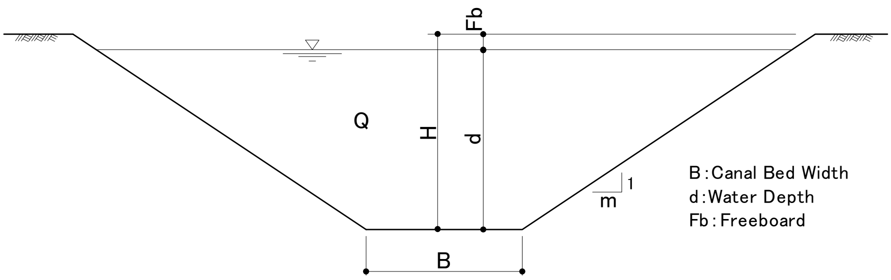


Table 8.2-3 Dimension of Cross Section for Main Canal (Scenario 2)

TYPE		HYDRAULIC DATA				GEOMETRICAL DATA				
		Q m3/s	S m/m	n	v m/s	Fr	B m	d m	Fb m	H m
EAST CANAL	EMC_01	23	0.0005	0.015	1.729	0.37	2.50	2.26	0.34	2.60
	EMC_02	19	0.0005	0.015	1.647	0.37	2.50	2.06	0.32	2.40
	EMC_03	11	0.0005	0.015	1.431	0.36	2.40	1.60	0.28	1.90
	EMC_04	8	0.0005	0.015	1.328	0.34	1.70	1.52	0.27	1.80
WEST CANAL	WMC_01	36	0.00005	0.015	0.804	0.14	7.30	3.55	0.34	3.90
	WMC_02	32	0.00005	0.015	0.782	0.13	6.70	3.45	0.34	3.80
	WMC_03	26	0.00005	0.015	0.742	0.13	6.30	3.17	0.32	3.50
	WMC_04	17	0.00005	0.015	0.664	0.13	6.00	2.59	0.29	2.90
	WMC_05	7	0.00005	0.015	0.538	0.12	3.40	2.02	0.26	2.30
	WMC_06	4	0.00005	0.015	0.470	0.11	2.30	1.74	0.24	2.00



8.3 Drainage System

It is considered that present drainage condition has less influence to farming because groundwater level in the beneficial area of the project is a few meters beneath the surface of the ground according to well survey. However, it will be feared that groundwater level will be raised by capillary action caused by rising of amount of water in the soil along with the supply of irrigation water

Eluviation of gypsum layer spread under the topsoil will be caused by rising of groundwater level and it will also lead to roughness of the land of canal, roads and farm land. Therefore, drainage system will be adopted to avoid the rain water or excessive amounts of irrigation water not to influence to conservation of farm land, growing harvest and work efficiency of farm equipment.

Drainage system will be set up to create water dispersion from farmland to avoid stagnant rain water in the farm land taking into account the land features of the beneficial area. Drainage water flows to field drain first and then goes to branch drain through collector drain, and finally water reach to wadi

Most of the beneficial area belongs to Wadi Thartar watershed and drainage water reach to Thartar Lake through each wadi. Drainage system is as shown in Fig. 8.3-1.

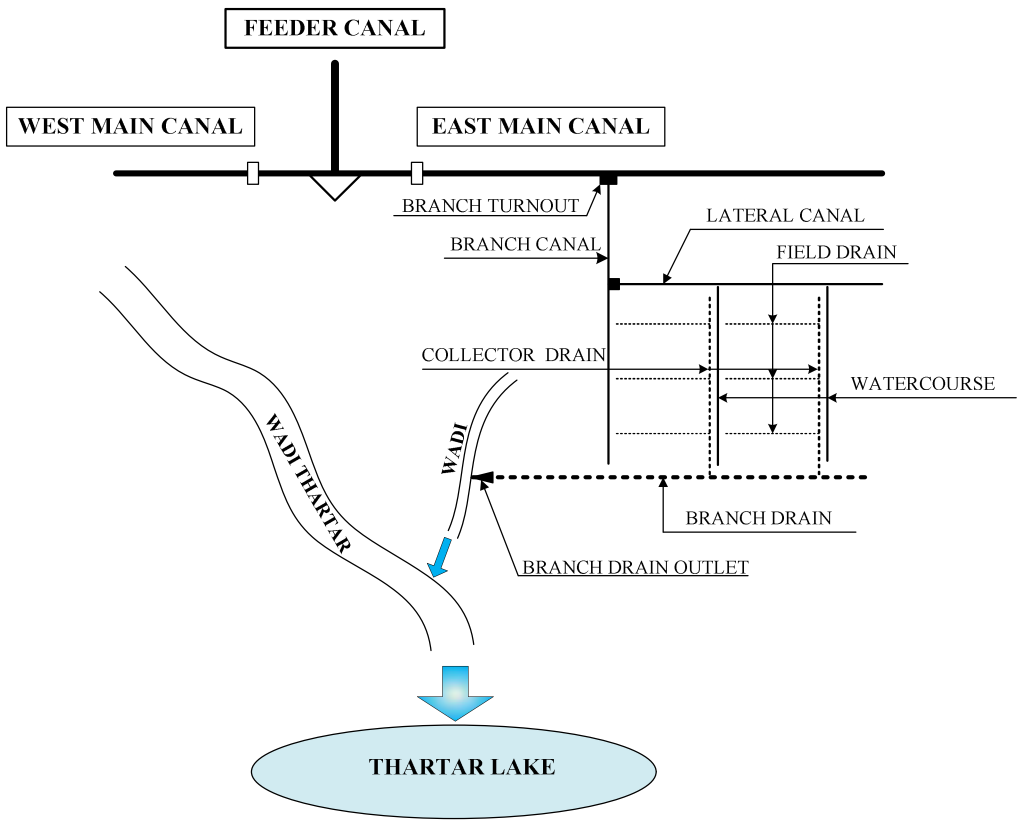


Fig. 8.3-1 Drainage System

CHAPTER 9. PROJECT IMPLEMENTATION PLAN

9.1 Construction Schedule

Implementation schedule of the Project is as shown in following Tables.

Table 9.1-1(1) Implementation Schedule (Scenario 0 : with Pump)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										12
Canals, Roads and Networks (Pumped Canal)										12
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

Table 9.1-1(2) Implementation Schedule (Scenario 0 : without Pump)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										12
Canals, Roads and Networks (Pumped Canal)										12
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

Table 9.1-2 Implementation Schedule (Scenario 1)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										12
Canals, Roads and Networks (Pumped Canal)										
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

Table 9.1-3 Implementation Schedule (Scenario 2)

Operation	0	1	2	3	4	5	6	7	8	Rotation Block
Power & pumping station										
Feeder Canal & related structure										
Tunnel on Feeder Canal										
Electrical supply system										
Canals, Roads and Networks (East Canal)										14
Canals, Roads and Networks (West Canal)										
Phase 1										12
Phase 2										12
Phase 3										
Canals, Roads and Networks (Pumped Canal)										
Pumping Station on West Canal										
Pump Houses in Sprinkler System										
Sprinkler Systems										

9.2 Project Cost

Cost estimation in each of Scenarios is shown in Table 9.2-1.

Table 9.2-1 Cost estimation in each of Scenarios

Contract No.		Scenario 0		Scenario 1		Scenario 2	
		ID	$	ID	$	ID	$
No. SJ-1	FEEDER CANAL	140,351,353,000	9,705,000	125,362,334,000	8,754,000	112,193,014,000	7,934,000
No. SJ-2A	TUNNEL ON FEEDER CANAL	172,928,828,000	6,843,000	156,929,573,000	6,664,000	134,776,504,000	6,333,000
No. SJ-3A	CANALS,ROADS AND NETWORKS (EAST CANAL)	101,033,326,000	6,545,000	101,033,326,000	6,545,000	101,033,326,000	6,545,000
No. SJ-3B	CANALS,ROADS AND NETWORKS (WEST CANAL)						
Phase 1		96,309,475,000	12,471,000	89,565,505,000	11,508,000	81,626,714,000	10,255,000
Phase 2		130,344,194,000	14,514,000	117,166,245,000	13,051,000	70,243,332,000	6,329,000
Phase 3		85,402,240,000	5,229,000	85,402,240,000	5,229,000	—	—
No. SJ-3C	CANALS,ROADS AND NETWORKS (PUMPED CANAL)	105,626,775,000	5,646,000	—	—	—	—
No. SJ-4	PUMPING STATION ON WEST CANAL	4,766,018,000	69,603,000	—	—	—	—
No. SJ-5	PUMP HOUSES FOR SPRINKLER SYSTEMS	9,703,622,000	86,843,000	7,791,793,000	69,589,000	5,712,033,000	50,819,000
No. SJ-6	SPRINKLER SYSTEMS	203,410,000	416,823,000	162,892,000	333,795,000	118,815,000	243,474,000
No.SJA	POWER AND PUMPING STATION	—	150,000,000	—	120,000,000	—	90,000,000
	ELECTRICAL SUPPLY SYSTEM	45,000,000,000	—	40,500,000,000	—	36,000,000,000	—
TOTAL COST OF THE PROJECT		891,669,241,000	784,222,000	723,913,908,000	575,135,000	541,703,738,000	421,689,000

9.3 Operation and Maintenance (O&M)

9.3.1 Outline

While O&M is divided into two(2) categories, one is for water management to distribute appropriate water amount to farm lands and the other is to maintain function of irrigation facilities properly.

(1) Water management

Since “Supply-driven canal system” is adopted by controlling discharge at the Mosul dam, it is important to distribute irrigation water rationally and properly to the vast beneficial areas of the Project. Basic process of the water management is as follows;

1) In-charge of dam operation at intake should decide the releasing amount of irrigation water based on the request from the demand side of beneficiaries' group by weekly.
2) Based on the above decision, in-charge of water control should make schedule of water distribution including gate operation plan.
3) The above water distribution plan should be informed to all over the operators at main and branch as well as terminal canals thoroughly.

(2) Maintenance of irrigation facilities

Maintenance aiming for proper and safe operation of the irrigation facilities is categorized by stages of 1)operation, 2) inspection and 3)repair and replacing.

Since the above stage, "3)repair and replacing" is required large investment for long term and / or large scale of replacement, it should be out of the scope. Then, outline for O&M of the facilities in two(2) stages of 1)operation, 2)checking is as shown in Table 9.3-1.

Table 9.3-1 Outline of O&M for the irrigation facilities

<table>
<tr><th colspan="3">cycle
Item</th><th>During operation</th><th>Regularly (daily/weekly)</th><th>Monthly</th><th>Yearly</th></tr>
<tr><td rowspan="2">Facilities,</td><td>Movable facilities</td><td>1)Gate
2)Valve
3)Pump
4)Sprinkler
5)Remote control
6)Measurement equipment</td><td>checking during operation

at trouble</td><td>Regular inspection

Maintenance</td><td>Regular check

Regular maintenance</td><td>Overhaul

Replacement partly</td></tr>
<tr><td>Facilities</td><td>1)Irrigation canal
2)Drainage canal
3)Road
4)Architect</td><td></td><td>Patrol
1)removal of driftwood</td><td>Patrol</td><td>Patrol
1)Remove the weeds
2)De-silting
3)Repair of pavement
4)Others</td></tr>
<tr><td colspan="3">Management of the facilities</td><td>Operation management</td><td colspan="3">Inspection / Maintenance</td></tr>
</table>

9.3.2 Management system and Man-Month Schedule

On the basis of the above outline of water management and maintenance of facilities, organization chart of management structure is proposed as shown in Fig. 9.3-1 and man-month schedule of regional office is shown in Table 9.3-2 and 9.3-3.

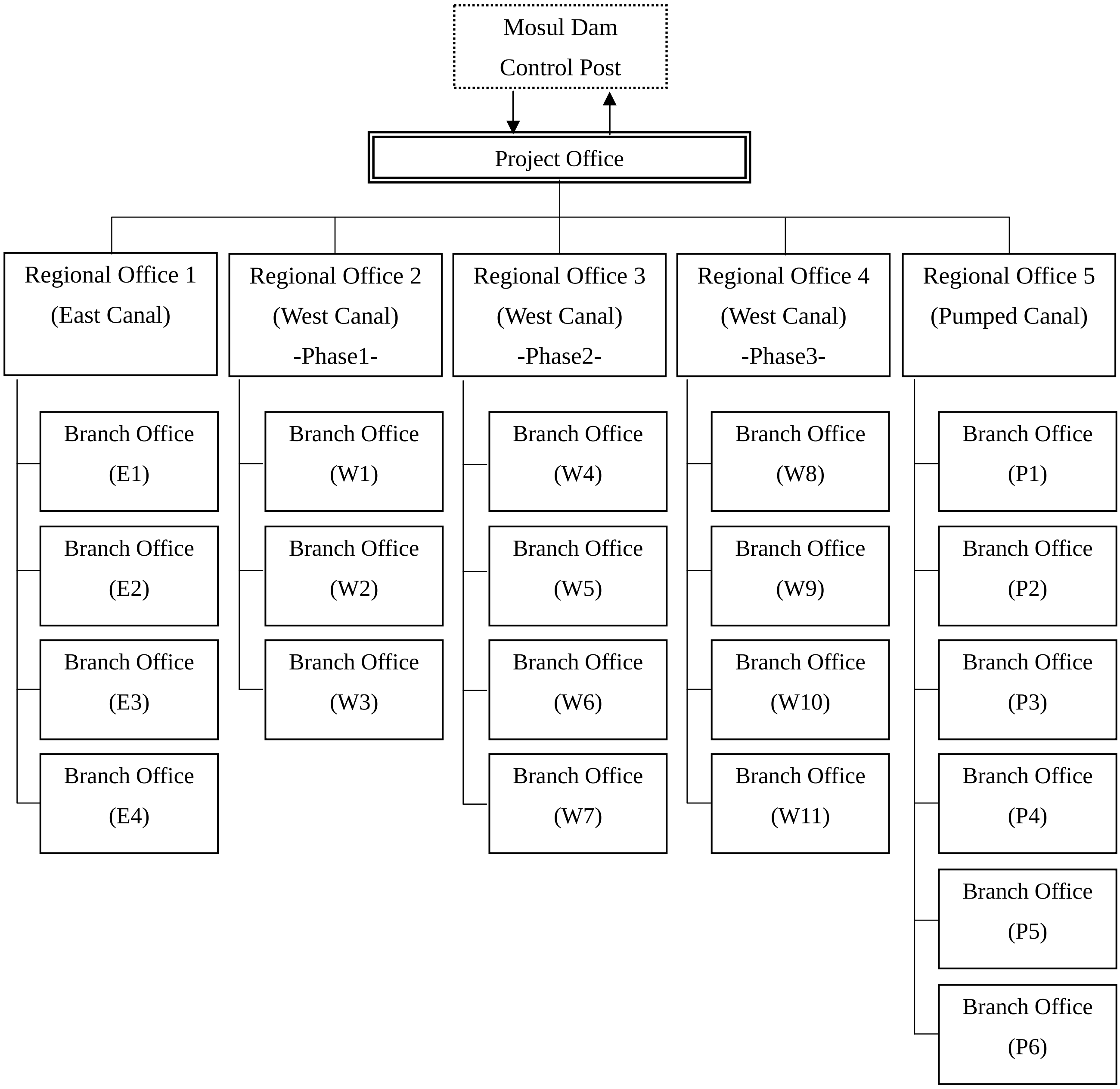


Fig. 9.3-1 Organization chart of management structure

Table 9.3-2 Man-Month schedule（Project office）

Staff Description	Number	Scenario 0	Scenario 1	Scenario 2
Chief Engineer	1	1	1	1
Civil Engineer	2	2	2	2
Hydrological Engineer	1	1	1	1
Electro/Mechanical Engineer	1	1	1	1
Technicians	2	2	2	2
Procurement Officer	1	1	1	1
Accountant	1	1	1	1
Bookkeepers	2	2	2	2
Secretary	1	1	1	1
Clerks	9	9	9	9
Messenger	1	1	1	1
(TELECONTROL SECTION)				
Systems Analyst	1	1	1	1
Electronics Engineer	1	1	1	1
Programmer	1	1	1	1
Maintenance Technician	1	1	1	1
Operators	8	8	8	8
(PUMP SECTION)				
Technicians	3	3	3	3
Skilled Labor	3	3	3	3
Semi-skilled Labor	3	3	3	3
(FEEDER CANAL SECTION)				
Engineer	1	1	1	1
Water Management Operator	2	2	2	2
(BUILDING MAINTENANCE SECTION)				
Technician	1	1	1	1
Storekeeper	1	1	1	1
Skilled labor	3	3	3	3
Semi-skilled Labor	3	3	3	3
Unskilled Labor	2	2	2	2
Clerk	1	1	1	1
(EQUIPMENT SECTION)				
Technician	1	1	1	1
Mechanic	1	1	1	1
Storekeeper	1	1	1	1
Clerk	1	1	1	1
Skilled Labor	1	1	1	1
Operators/Drivers	6	6	6	6
Unskilled Labor	3	3	3	3

Table 9.3-3 Man-Month schedule（Regional office）

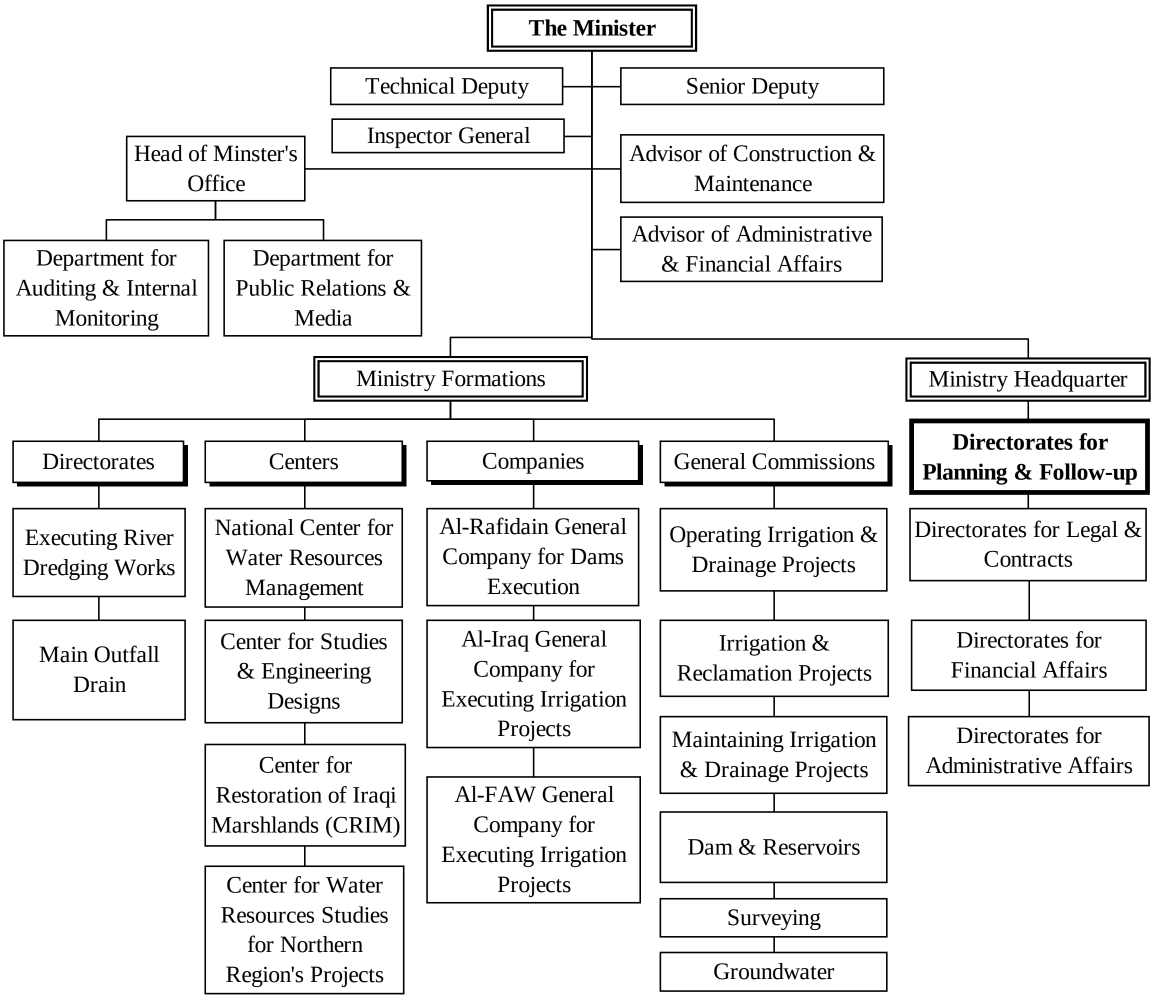
Staff Description	Number	Scenario 0	Scenario 1	Scenario 2
Regional Director	1	5	4	3
Engineering Manager	1	5	4	3
Assistant Regional Engineer	1	5	4	3
Technicians	2	10	8	6
Water Management Operator	1	5	4	3
Transport Supervisor	1	5	4	3
Administrator	1	5	4	3
Personal and training Officer	1	5	4	3
Assistant Personnel Officer	1	5	4	3
Accountant	1	5	4	3
Planning and Follow Up	2	10	8	6
Bookkeeper	1	5	4	3
Secretary	1	5	4	3
Veterinary Officer	2	10	8	6
Veterinary Technician	5	25	20	15
Project Farm Supervisor	1	5	4	3
Chief Co-operative Inspector	1	5	4	3
Chief Extension Officer	1	5	4	3
Agricultural Machinery Supervisor	1	5	4	3
Clerks	5	25	20	15
Typists	3	15	12	9
Messengers	2	10	8	6
Unskilled labor	8	40	32	24
(ENGINEERING STATION)				
Station Manager	1	5	4	3
Storekeeper	1	5	4	3
Clerk	1	5	4	3
Mechanic	2	10	8	6
Equipment operator/driver	10	50	40	30
Unskilled Labor	5	25	20	15
(BUILDING MAINTENANCE SECTION)				
Technician	1	5	4	3
Storekeeper	1	5	4	3
Skilled labor	3	15	12	9
Semi Skilled Labor	3	15	12	9
Unskilled Labor	2	10	8	6

9.4 Project Implementation Structure

9.4.1 Implementation Agencies

The Ministry of Water Resources (MOWR) of GOI is directly responsible for the Project implementation of which the Ministry's organization chart is shown as in the Fig. 9.3-1. "Centers" is one of the four(4) core Ministry Formations under MOWR where such institutions for survey and research on water resources development and management are clustered. Among others, the "National Center for Water Resources Management" participated in a series of discussion meetings for explanation/reviewing of reports submitted stage by stage during the course of subject study and also provided the study team with valuable advices on projection of Mosul Dam inflow and outflow in future. It is, therefore, expected that the National Center will play an important role in verifying the usable water resources volume towards successful project implementation.

Further to mention, the "Directorate for Planning & Follow-up" is positioned as Ministry Headquarter to be in charge of planning and monitoring on overall national policy on water resources development and management. The said Directorate assumes the member-ship of the Steering Committee organized for the South Jazira Irrigation Project.



Source: MOWR, GOI

Fig. 9.4-1 Organization chart of MOWR

The number of personnel employed by MOWR reveals at about 25,000 nation-wide as shown in the Table 9.4-1. Of the total, more or less 30 % are of engineering and/or professional designations and assigned at the Ministry's central office at Baghdad and Directorate offices in each governorate. Of the total, as much as 70 % of personnel is shared by regular employment officials.

Table 9.4-1 Number of personnel under MOWR (2010)

Categories	Engineer	Technician	Sub-total	Administrative, others	Total
1) Permanent	3,119	3,417	6,536	10,420	16,956 (68.7%)
2) Temporary	121	136	257	630	887
3) Contract	104	263	367	2,813	3,180
4) Employee	19	111	130	3,538	3,668
Total	3,363	3,927	7,290 (29.5%)	17,401	24,691

Source: MOWR, GOI

9.4.2 Capacity of Implementation Agencies

The annual budgets allocated for MOWR and MOA, Ministry of Agriculture, one of the members of SC, are as shown in the Table 9.4-2. Steady growth of the budgets allocated for both Ministries can be observed from the Table.

Table 9.4-2 Budgets allocated for MOWR and MOA (2006-2011)

Unit: Billion ID, 1USD=1,170 ID

Financial year	MOWR	MOA	National budget (as reference)
2006	299.7	36.7	46,449
2007	338.7	62.8	47,970
2008	1,057.1	179.4	81,900
2009	701.1	181.9	78,390
2010	1,161.7	209.4	86,229
2011	1,376.5	321.8	80,028

Source: MOWR, MOP, and HP of MOF, GOI

As per the NDP (2010-2014), GOI aims at the target of annual mean GDP growth at 9.38 % per annum and expects due contribution by agriculture/fishery sector accordingly. However, the share by the said sector during the last 5 years period had been declined from 14.3 % in 2003 to 9.2 % in 2007 as indicated in Table 9.4-3. Moreover, the share is projected to be further decreased in future as shown in the said Table.

Table 9.4-3 Changes of GDP share by agriculture/fishery sector

(Unit: Billion ID, at year 1988 prices)

	Performance					Estimation (Increase by ratio of 9.38%)					
Year	2003	2004	2005	2006	2007	2009	2010	2011	2012	2013	2014
GDP	26,990	41,608	43,439	47,851	48,511	54,654	59,781	65,388	71,522	78,230	85,568
Agriculture sector	3,850	4,522	5,940	6,196	4,480	4,443	4,465	4,898	5,143	5,400	5,670
Ratio	14.3%	10.9%	13.7%	12.9%	9.2%	8.1%	7.8%	7.5%	7.2%	6.9%	6.6%

Source: National Development Plan (201102014), GOI

While GOI emphasizes the importance of manufacturing sector (Including oil and electric power) in it's investment plan under the NDP with the remarkable share as large as 30 % towards the overall improvement and re-construction of national socio-economic infrastructure, the share by the agriculture sector is also considerably high at 9.5 % with paying due attention to the national food security.

Table 9.4-4 Sector-wise development budget in Iraq

(Unit: Billion ID 1USD=1,170 ID)

	Sector /Financial year	2011-14	(%)	2010	2011	2012	2013	2014
1.	**Agriculture**	**11,115**	**(9.5)**	**1,238**	**2,284**	**2,720**	**2,342**	**2,531**
2.	Industry (incl. Oil, Electricity)	35,100	(30.0)	7,509	6,510	6,615	6,394	8,072
3.	Transportation & communication	10,530	(9.0)	1,271	1,951	2,126	2,326	2,855
4.	Construction, building & services	19,890	(17.0)	6,119	5,964	3,846	2,145	1,815
5.	Education	5,850	(5.0)	877	1,373	1,305	1,213	1,082
6.	Province development	14,625	(12.5)	2,500	3,031	3,031	3,031	3,031
7.	Kurdistan region	19,890	(17.0)	-	-	-	-	-
	Total	117,000	(100)	(19,515)	(21,113)	(19,643)	(17,452)	(19,388)

Source: National Development Plan (2010-2014), GOI

The annual investment budgets for water resources development/improvement during the period 2010-2014 by the MOWR are as shown in the Table 9.4-5. Five year's total budget reveals at 32,500 Billion ID (Approx. 28 Billion USD), of which about 49 % is allocated for "Item 2.Irrigation and drainage" so as to achieve as large as 1 million ha irrigation development in the planned 5 years period. The irrigation and drainage development item is followed by the cost item for "Item 1. Dam & reservoir (33 %)". The total of the said two(2) items exceeds 80 % of the total. It is considered that the budget for the South Jazira Irrigation Projects is included in the "Item 2. Irrigation & drainage projects".

Table 9.4-5 MOWR's yearly budget for development/investment (2011-2014)

(Unit: Billion ID, 1USD=1,170 ID)

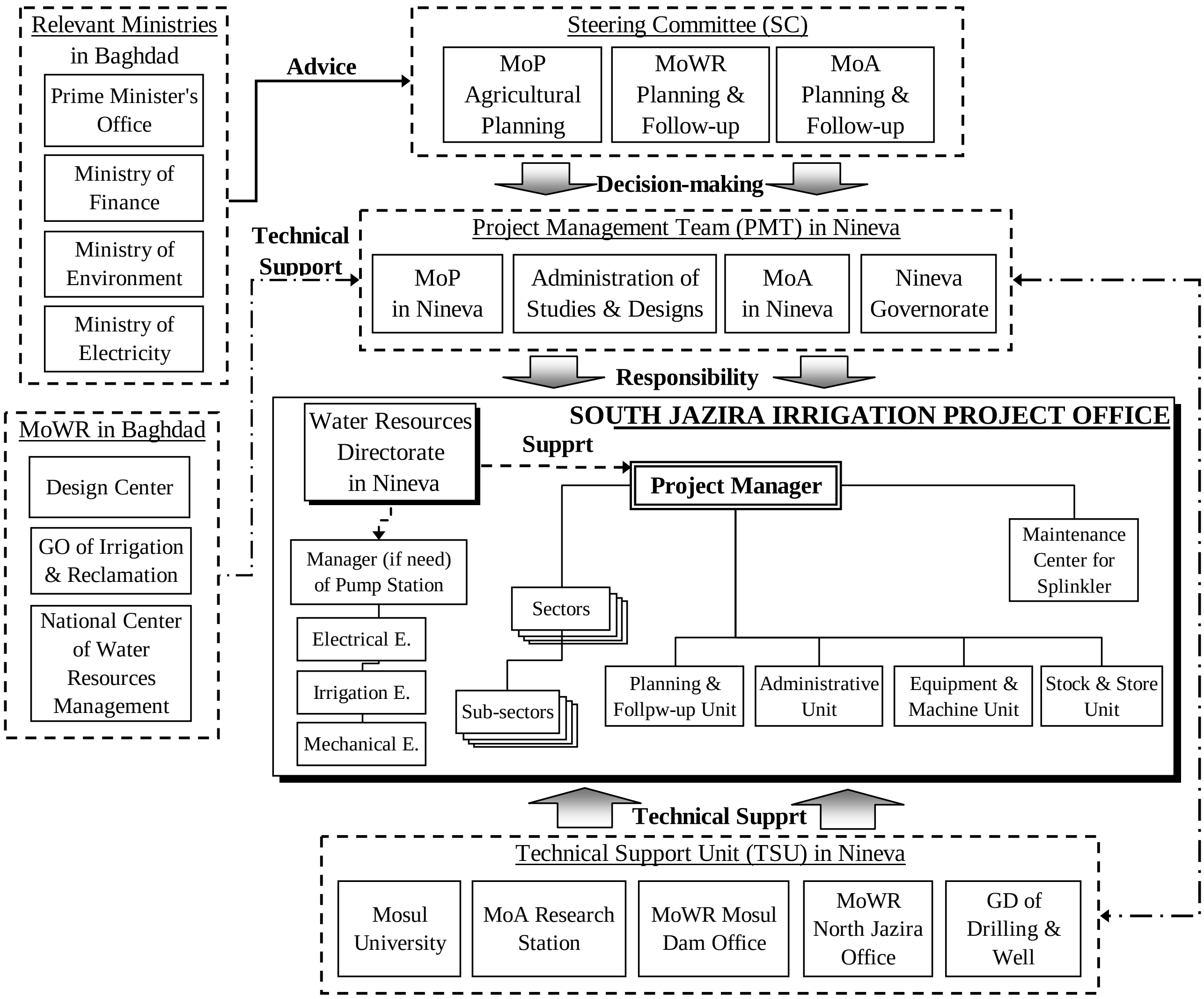
	Financial year	2011-14	(%)	2010	2011	2012	2013	2014
1.	Dams & reservoirs	10,817	(33.3)	2,329	2,852	2,620	1,675	1,342
2.	Irrigation & drainage projects Reclaiming area (unit: 1,000 ha)	16,020 (1,001)	(49.2)	2,436 (152)	3,040 (190)	3,304 (207)	3,580 (224)	3,660 (229)
3.	Outfall drain	584	(1.8)	179	99	108	108	90
4.	Operating irrigation & reclamation projects	1,205	(3.7)	223	238	255	270	220
5.	Maintaining irrigation & drainage project	1,156	(3.6)	277	248	208	209	214
6.	Directorate for executing river dredging works	256	(0.8)	91	72	50	28	15
7.	Center for restoration of Iraqi marshlands (CRIM)	83	(0.3)	20	18	15	15	15
8.	Center for studies & engineering designs	49	(0.2)	10	10	10	10	10
9.	Surveying	15	(0.0)	3	3	3	3	3
10.	National center for water resources management	121	(0.4)	26	30	33	15	18
11.	Directorate for main outfall drain	177	(0.5)	51	27	25	37	37
12.	Groundwater (5,000 nos.)	752	(2.3)	125	130	148	158	191
13.	Ministry head office	1,263	(3.9)	253	253	253	253	253
	Total	32,497	(100)	6,023	7,018	7,029	6,360	6,068

Source: Water Resources Development Strategies (2010-2014), MOWR, GOI

In view of the policies involved in the NDP, personnel availability and budget allocation in future as confirmed above, it can be judged that GOI is provided with sufficient capability to implement the subject South Jazira Irrigation Project.

9.4.3 Project Implementation Structure (Draft)

Based on the Project Implementation Structure as indicated in the Minutes of Discussions signed and exchanged by and between the project executing agencies concerned of GOI and the JICA Fact Finding Mission on July 2009, the following project implementation structure as Fig. 9.4-2 is proposed.



Source: Added to "the Chart of Proposed Implementation Structure of the Project" in the Minutes of Discussions, on Fact Finding Meeting, July 2009」

Fig. 9.4-2 Project implementation structure (draft)

CHAPTER 10. ENVIRONMENTAL AND SOCIAL CONSIDERATION (EIA Report)

10.1 Pre-condition for Environmental and Social Consideration

(1) Contents of EIA Report Stipulated by JICA

According to "the Japan Bank for International Cooperation Guidelines for Confirmation of Environmental and Social Considerations, 2002", all kinds of projects are sorted into any of Category A, Category B and Category C, taking consideration into potential environmental impacts, magnitude and scale of the projects and so on. Based on the Guideline, the project is classified into Category A, which is likely to have significant adverse impacts on the environment, the proponent of the Project is requested to prepare an EIA report. In general, there is no significant difference between Iraqi EIA report contents and Japanese ones. Therefore, the Guideline mentioned above can be applicable for the Study. According to the M/M on the Study exchanged in August 2010 between Iraqi side (MoP, MoWR and MoA) and JICA, the EIA shall be carried out by the MoWR, and the JICA Study Team shall support this process.

At this moment, the decision on whether the Project would be implemented, has yet to be made. In addition to that, due to the security issues in Iraq, it is difficult to implement detailed site surveys. Therefore, it is proposed to prepare a part of the EIA report based on the secondary data during the Study and to implement a full-scale EIA after the final decision on the project implementation as needed. Detail contents of EIA report stipulated by JICA are shown below and a part of items are not covered by the Study and they will be examined in the full-scale EIA.

Contents of EIA Report Stipulated by JICA

I. Environmental and Social Consideration

1) Description of the proposed project
2) Baseline data:
   Relevant physical, biological and socio-economic conditions of the Project Area; physical relationship between the project site and sanctuaries or national parks to be affected, if any
3) Policy, legal and administrative framework in the recipient country:
   Outline of environmental legal system, procedures to be taken, survey items, format, necessary documents, EIA process, agreement on water use of international rivers and so on
4) Analysis of alternatives including zero-option
5) Scoping:
   Identification of survey items to be studied through EIA, examination of scale and magnitude of probable environmental impacts
6) Preparation of Terms of Reference (TOR) for EIA:
   Presentation of concrete study method by each study item
7) *Arrangement of Environmental Study results: not covered by the Study*
8) *Analysis of Environmental Study result: not covered by the Study*
9) *Cost estimation for mitigation measures: not covered by the Study*
10) *Monitoring Plan formulation: not covered by the Study*
11) *Consultation meetings with stakeholders: not covered by the Study*

II. Land Acquisition and Involuntary Resettlement

1) Necessity of land acquisition and involuntary resettlement
2) Legal framework on land acquisition and involuntary resettlement in the recipient country
3) Scale and extents of land acquisition and involuntary resettlement for the project
4) *Compensation for lands and supports: not covered by the Study*
5) *Mechanism for handling complaints: not covered by the Study*
6) *Implementation structure: not covered by the Study*
7) *Implementation schedule: not covered by the Study*
8) *Cost and financial resources: not covered by the Study*
9) *Monitoring structure and monitoring format: not covered by the Study*
10) *Consultation with affected people: not covered by the Study*

III. Others

1) *Monitoring format (draft): not covered by the Study*
2) Environmental checklist

The Study examines the Alternative-1 (the Tunnel Plan which has three kinds of scenarios) and Alternative-2 (the Pump Plan which has one scenario), this chapter discusses the anticipated environmental impacts, which can be caused by the Project.

(2) Conditions of the Mesopotamia Marshes

The Mesopotamia Marsh is said as the model of Eden and it owns very rich and diversified eco-system. It consisted of mainly three marshes, namely, Central Marshes, Al-Hawizeh Marshes and

Al-Hammar Marshes. However, according to UNEP (2001), around 90% of the Marsh was dried up due to the large scale water drainage from the Marsh and a series of constructions that prevented water inflow into the Marsh in and after 1970s for the large scale of agricultural development (see Figure 10.1-1 and 10.1-2). It caused significant damages to flora and fauna that ranged in the Marsh and the people who depended on the Marsh.

So far, a large variety of trials for the Marsh restoration and income generation has been implemented by some countries/international organizations such as USAID, Italian Ministry of Environment and Territory, Government of Canada, the Government of Japan. Al-Hawizeh Marshes was registered as a Ramsar site in 2007 and it is only one Ramsar site in Iraq.

It is estimated that 19.6 BCM water flow should be secured for the Marsh conservation by MoWR (UNESCO International Hydrological Programme Iraq Country Report, 2007, MoWR).

Figure 10.1-1 Locations of a series of dam watershed of Tigris River and Euphrates River

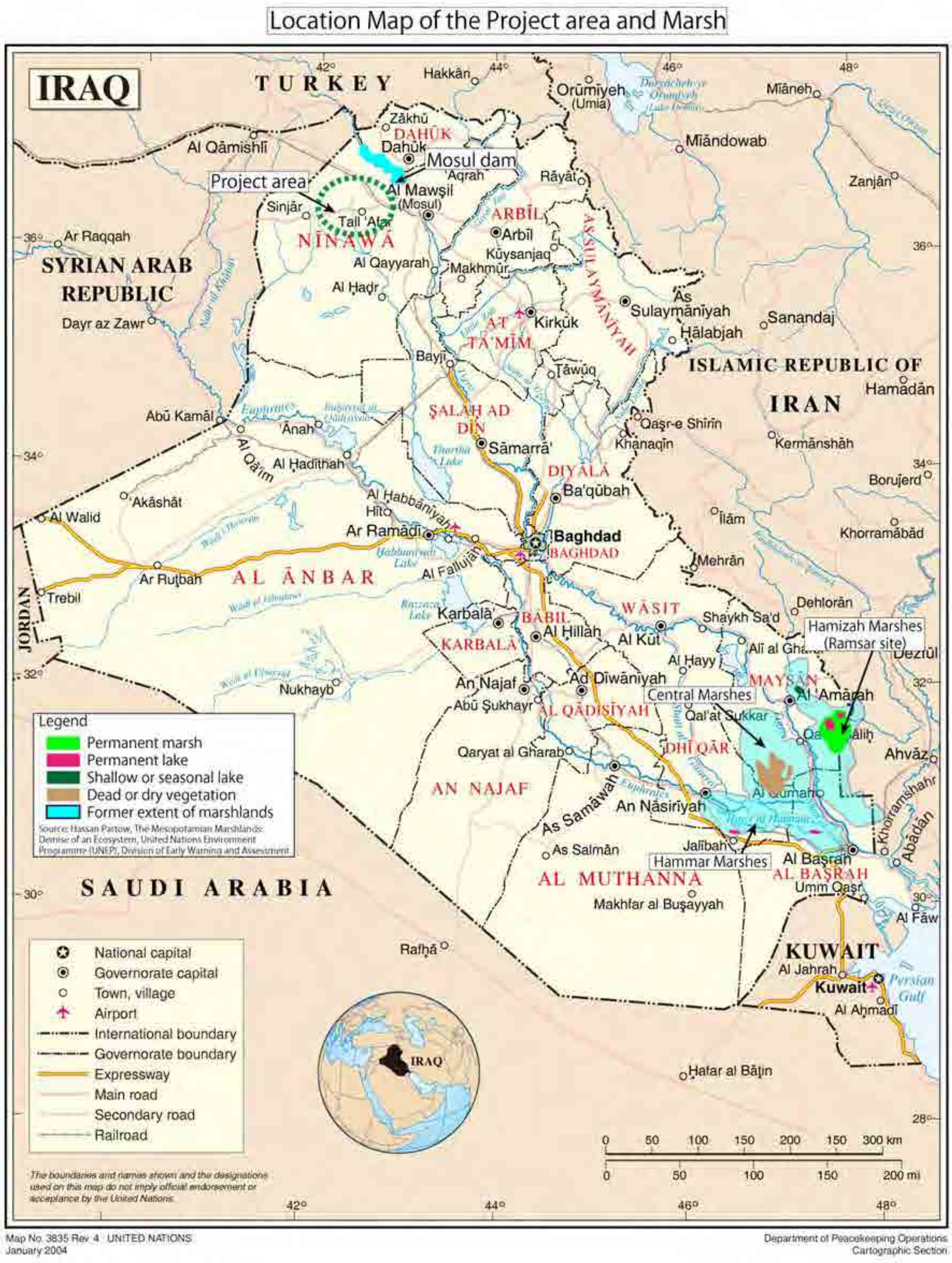


Figure 10.1-2 Location of Mosul Dam and the Mesopotamia Marsh

If a certain amount of water is taken from the Mosul Dam for irrigation in the South Jazira, discharge into the downstream will be decreased than current one. Given that the Mosul Dam is 700km away by airline distance from the Mesopotamia Marsh and there are many existing irrigation facilities as shown in Figure10.1-1, it can be said that it is very difficult to identify the anticipated impacts on environment in the downstream by the irrigation of South Jazira. In addition, it is necessary to wait for results of SWLRI by Italian Consultant, which examines water balance/distribution. After the decision making of the Project implementation, this issue will be examined.

10.1.1 Description of Proposed Project

The proposed main project components are as follows:

Table 10.1-1 Main Components of the Proposed Project

Facilities	Scale	Remarks
Feeder canal	Alternative-1:Tunnel Plan (Scenario 0) Feeder canal: 60.30km long Tunnel length: 19.1km long for all the Scenarios Tunnel cross section; Scenario 0: 2R=7.90m, A=51.76m^2 Scenario 1: 2R=7.30m, 44.19m^2 Scenario 2: 2R=6.50m, 35.04m^2 Alternative-2: Pump Plan (Scenario 0) Feeder canal 74.18km long, one pump system and 10 volute pumps	Since both of the proposed alternatives go across the railway and road, it is needed to prepare tentative constructions. In case of Alternative-2, electrical consumption and area of land acquired will be more that those in case of Alternative-1.
Main Canal	Scenario 0: Three lines of canal 122.1km long and one pump system Scenario 1: Two lines of canal 94.4km long Scenario 2: Two lines of canal 57.1km long	It is needed to acquire land for the proposed main canal construction.
Branch Canal	Scenario 0: 39 lines of canal 363.3km long Scenario 1: 32 lines of canal 329.9km long Scenario 2: 20 lines of canal 257.2km long	It is needed to acquire land for the proposed branch canal construction.
Pump	Alternative-2: 11 units of pumps (φ1,900mm × φ1,500mm)	
Sprinkler	Scenario 0: 1,500 sets Scenario 1: 1,200 sets Scenario 2: 900 sets	

10.1.2 Baseline Data of Environmental and Social Conditions

(1) Natural Conditions

Climate of Iraq is classified as continental and it is influenced by the Arabian Gulf and especially, by the Mediterranean Sea. The climate in winter season resembles the Mediterranean type. It is very hot with extremely high temperature and very low humidity from June to September. In October and November, temperature drops and showers occur with increasing frequency. Lowest air temperature reaches from December to February, with minimum temperatures occasionally below zero. About 80% of the rainfall is distributed evenly over the period from December to May. During May, rainfall ceases completely and temperature rise quickly.

The ground of the Project Area is gently sloping to the south. The feeder canal alignment runs in the area where hills and low relief valleys repeatedly distribute. Most of the Project Area belongs to the

Wadi Tharthar watershed whereas the southwest part does to the Euphrates river watershed. All of courses are Wadi.

Villages and settlements are scattered in the Project Area and there are little residents in some villages. Systematic agricultural roads are developed in all the area and regular configurations of farmlands surrounded by the agricultural roads range. Some parts of the roads and farmlands were created by reclamation of wadi. There are typical geometric patterns in the agricultural field of the Project Area. Center pivot sprinkler irrigation farms by means of groundwater are identified in and around the Project Area.

Bacically, due to the limited available water in South Jazira Area, the irrigation water will be consumed within the area. However, when it rains heavily, there would be cases that unused water in the area will be drained into outside of the area. The drained water will be discharged into small Wadi if the water is not evaporated on the way to destinations, and the drained water will flow into the Tharthar Wadi and finally it will reach the Tharthar Lake.

(2) Social Conditions

The Project Area covers four districts, namely, Telafar, Sinjar, Al-hadhar and Al-baaj. According to the data provided by PMT, the number of villages in the area and population are 90 and 107,215, respectively.

Most of the residents in the Project Area are farmers (99%) , which means that the major industry in the Project Area is agriculture. The average farmland holding size is 15.9ha/person (=63.6 donum), which can be thought that there area many large-scale farmers. Agriculture in the area is relatively extensive and large-scale, there are many cases that farmers need to employ labor forces. Generally, farm households cultivate their farms for an indefinite term, the number of those farmers is three times of ones who cultivate based on contracts for a fixed period of time. Cultivated land by individual farmers account for 89% of whole Project Area. Farmland sizes per land owner are 26.2ha (=104.8 donum), 15.48ha (=61.9 donum) and 11.18ha (=44.7 donum) for of corporate body (agent), individual and group, respectively.

There are three types of land tenure are observed in the Ninevah Province; 1) privately owned land, 2) lease of lands from government or individuals, and 3) share-cropped land (ICARDA-Iraq-Australia Project, 2005). The survey divides the province into 4 agro-ecological/ rainfall zones, namely HRA (high rainfall area, >450mm/year), MRA (moderate rainfall area, 350-450 mm/year), LRA (limited rainfall area, 200-350 mm/year), and SI (supplementary irrigation system).

The South Jazira belong to the LRA, where the short-term land lease is the most common system, accounting for 50%, followed by the long-term share-cropped land (32%) and the privately owned land (18%). According to the survey above mentioned, the privately owned land is dominant under the good conditions such as HRA and SI, whereas the share-cropped land is the most important in the difficult conditions such as LRA. There is a tendency that the land holding size in the southern part is larger than that in the northern part, reflecting less availability of rainfall in the southern area.

According to the questionnaire survey conducted by the JICA Study Team in July 2010, average household income of farmers in North and South Jazira area are 19,000,000 ID/year and 8,433,000 ID/year, respectively. While incomes of all 6 farm households interviewed in the North exceed the poverty line, 7 households out of 12 ones in the South live on less than poverty line. This fact indicates the severe living conditions of farmers in the South Jazira Area.

(3) **Gender Issues**

Illiteracy rate of women (30%) is higher than that of men (12%) in Ninevah Province. Regarding economic activity, women in Ninevah is less participated in, comparing to the whole country level. Among four districts, the rate of women’s labor participation is the lowest in Al-Baaj, which is located in the remotest area from the district capital, Mosul city. Male’s unemployment rate in the district is 13% in 2007, almost same as the national average, whereas women’s rate is 35%, 2.7 times higher than the male’s one.

Male farmers play major roles in farming activities in the Ninevah Province. According to the Baseline Farming Systems Survey in 2005, large scale farming with agricultural machines are conducted by male, whereas female participate in manual procedures such as harvesting of vegetables and cotton. Both are engaged in raising of goats and sheep while women are mainly in charge of breeding of cattle and chicken in their home gardens, milking and processing of house consumption stock farm products such as butter. According to the Baseline Survey mentioned above, 84% of farm activities are conducted by male, whereas works shouldered by female and children account for 12% and 4%, respectively.

(4) Land Use

It is difficult to confirm the detailed land use situation in the Project Area due to the security issue. However, it is judged from the satellite image that the land is mainly used for agricultural purpose while some villages are scattered, probably, national parks, protected area and important fauna and so on are not distributed in the area. In addition, the lands in and around of the proposed feeder canal between the Mosul Dam and the Project Area are also used as farmlands while some parts are desert area, in general. It can be thought that there is no important natural and cultural resource apart from farmlands to be affected by the Project in terms of environmental consideration.

(5) Main Crops in the Project Area

Main crops in the Project Area are wheat and barley, while industrial crop, onions, beans, vegetables are also cultivated. However, the crop productivity in South Jazira is low, showing average yield is only 200kg/donum in 2001, which corresponded to less than 30% of that in the North Jazira. Moreover, officially, the productions of wheat and barley in 2008/2009 are recorded as zero. According to the Swiss F/S report, the reason why for this situation is that it is difficult to harvest those crops annually and the production is very limited even though the farmers can harvest in the area.

(6) Current Situation of Irrigation in Project Area

According to F/S report (1982), the Project Area is 213,900 ha and classified as rain-fed cultivation area. Farmers who were interviewed by the JICA Team did not have irrigation facilities. Given that it is difficult to find water resource for irrigation in the Project Area, it can be said that the F/S report is adequate. Probably, very limited farmers can access to irrigation facilities, considering that satellite images of the Project Area show trace of irrigation, it seems uncommon. The conditions regarding use of chemicals and fertilizers in South Jazira are not confirmed. However, since irrigation farming in South Jazira is very limited as mentioned above, it can be thought that application of fertilizers and chemicals for agriculture in the area is not common. Moreover, given that the number of irrigation facilities is small, there is a possibility that irrigation right in the area rarely exists and works.

10.1.3 Policy, Legal and Administrative Framework in Iraq

(1) Governmental Organizations Responsible for Environmental Consideration

In June 1972, the first organization which was responsible for environmental consideration in Iraq, namely, Environmental Directorate was established under the Ministry of Health. In 1986, Law for Protection and Improvement of Environment was constituted and Environmental Protection Centre (EPC) was established. The Law for Protection and Improvement of Environment was revised in 1997 and EPC was transformed into the Environmental Protection and Improvement Directorate (EPID). In 2001, the Law for Protection and Improvement of Environment was revised again, authorities and responsibilities of EPID were expanded. At the same time, the EPID became an independent organization from the Ministry of Health. Furthermore, the Environmental Protection and Improvement Council (EPIC), which consists of governmental organizations, representatives of NGOs and various experts, was established at the central level, while EPID local offices in 15 provinces were founded.

After the war against the USA in 2003, the Ministry of Environment (MoE) was newly set up in September 2003. The MoE has a mission to protect environment and the people in Iraq from pollutions and risks. In addition, environmental standard setting, policy formation and modification of laws are parts of their tasks. It is responsible for concerns in various sectors such as economic development, energy, transportation, agriculture, industry, trade

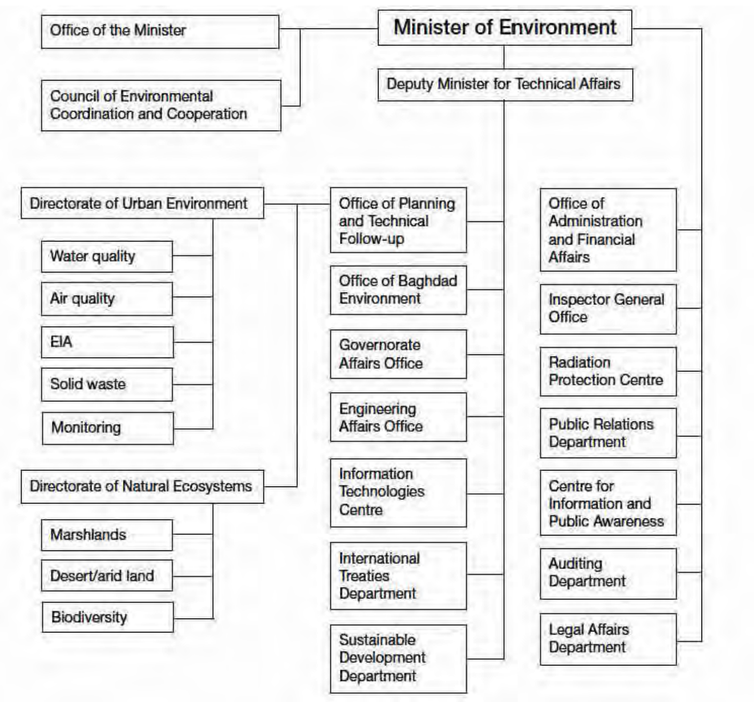


Figure 10.1-3 Organization Chart of MoE

and so on. The organization chart of the MoE is shown in the Figure10.1-3. Moreover, the Law for Protection and Improvement of Environment was revised once again in 2005, the draft final version of the law is available at present (see Appendix-F).

(2) Law on Environmental Impact Assessment

1) General Laws on Environmental Consideration

As of October 2010, authorized laws on environmental conservation in Iraq are as shown below. Law No. 27: Protection and Improvement of the Environment prohibits anybodies except authorized companies and individuals to hunt wildlife, describes the importance of protection of wildlife, while it does not mention about natural habitat areas, national parks and so on. "Regulation of Natural Protected Areas" has been drafted already, some efforts for natural environment conservation are promoted in Iraq

［Laws promulgated by the Ministry of Environment］

- Law No.17 of 2010: Wild Animal Protection Law
- Law No.27 of 2009: Protection and Improvement of the Environment
- Law No.37 of 2008: Creation of MOE
- Law No.1 of 2002: Safety Instructions for the Use of Asbestos
- Law No.2 of 2001: Preservation of Water Resources
- Law No.99 of 1980: Protection from Ionic Radiation
- Instructions on the Contamination Limits in Pursuance to Law No. 25 of 1967 on the Protection of Rivers (and Instruction corrections)

［Laws Effecting the Environment Promulgated by other Ministries］

- Order No.74 of 2010: Supports Instruction No. 11 of 1992
- Law No.29 of 2009: Regulation of Landfills (updates Law No. 67 of 1986)
- Law No.17 of 2009: Establishment of Aquaculture Operations (formerly Law No. 995 of 1985)
- Law No.30 of 2009: Law of Forests and Nurseries
- Law No.30 of 2009: Forest Law (formerly Law No. 75 of 1955)
- Law No.48 of 2007: Iraq joining the Regional Commission on Fish Traps
- Law No.12 of 1995: Maintenance of Networks of Irrigation and Drainage
- Instruction No. 11 of 1992: Prohibition of Plant Importation into Iraq
- Law No.13 of 1981: Agricultural Research and Water Resources Center
- Law No.89 of 1981: Public Health (drinking water provision, sanitation and environmental monitoring)
- Law No.64 of 1965: Cities Land Use
- Law No.106 of 1965: Rangelands and their Protection

Following laws are drafted, however, they are yet to be approved:

- Regulation of Natural Protected Areas
- Regulation of Hunting Activity

2) Laws on EIA

The Chapter Six, Item-15 of the law above emphasizes the necessity of Environmental Impact Assessment (EIA) prior to project implementation. Some environmental studies based on the existing data have been implemented, however, no full-scale EIA level studies are not done. As for 2010, operational guideline describing EIA procedures and proceeding is still under preparation.

The Study Team received the comment that it is needed to implement EIA for the Study at the meeting on Interim Report in November 2010. In addition to that, it is necessary to include following contents for EIA report of any irrigation projects according to the Letter No.549 issued by the MoWR.

- General description of the project
- Objectives and positive impacts of the project
- Probable adverse effects caused by the project
- Mitigation and prevention measures against the adverse effects
- Monitoring of environmental impacts during construction and other periods
- Conclusion and recommendation

As mentioned before, EIA was supposed to be implemented by MoWR and the JICA Study Team shall support this process. However, SWLRI is still ongoing, right conditions to implement EIA by MoWR have yet to be fulfilled.

(3) Environmental Standards

Many of environmental standards in Iraq were established in 1960s and they are still effective. Applicable standards for the Study are National Standards for Ambient Air Quality, Water Quality Standards, Effluent Standard and Noise Level Measurement outside Buildings Measurement. They are shown as follows:

Table 10.1-2 Iraqi National Standards for Ambient Air Quality

No	Pollutants	Measurement Method	Standards (ppm)	Standards (μg/m^3)	International Guideline* (μg/m^3)
1	Sulfur Dioxide (SO_2)	1 hr 24 hrs 1 year	0.1 0.04 0.018		- 20 -
2	Carbon Monoxide (CO)	8 hrs 1 hr	10 35		
3	Nitrogen Dioxide (NO_2)	24 hrs 1 year	0.05 0.04		1 hr : 200 1 year : 40
4	Ozone (O_3)	1 hr	0.06		8 hrs : 100
5	Suspended Particle Matters < 10μ (PM_{10})	24 hrs		150	
6	Suspended Particle Matters < 25μ (PM_{25})	24 hrs 1 year		65 15	50 20
7	Total Suspended Particles (TSP)	24 hrs 1 year		350 150	

No	Pollutants	Measurement Method	Standards (ppm)	Standards (μg/m^3)	International Guideline* (μg/m^3)
8	Dust	30 days		10 ton/km^2/month in residential area 20 ton/km^2/month in industrial area	
9	Hydrocarbon (HC)	3 hrs	0.24	160	
10	Lead (Pb)	24 hrs 3 months 1 year		2 1.5 1	
11	Benzene	1 year		0.003 mg/m^3	
12	Dioxin	1 year		0.6 Bg/m^3	

Source: North Refines Company 2009
*EHS (Environmental, Health and Safety) General Guideline (April 2007, IFC; International Finance Cooperation)/ WHO Guideline

Table 10.1-3 Water Quality Standard in Iraq

Parameters (mg/l)	Water Source				FAO Guideline*
	A-1: Rivers	A-2: Streams	A-3: Lakes	A-4: Springs	
pH	6.5-8.5	6.5-8.5	6.5-8.5	-	6.0-8.5
Dissolved Oxygen	>5	>5	>5	-	-
BOD	<3	<3	<3	-	-
Ammonium NH_4^+	1	1	1	1	0-5
Cyanide CN^-	0.02	0.02	0.02	0.02	-
Phenol	0.005	0.005	0.005	0.005	-
Lead	0.05	0.05	0.05	0.05	-
Arsenic	0.05	0.05	0.05	0.05	-
Mercury	0.001	0.001	0.001	0.001	-
Cadmium	0.005	0.005	0.005	0.005	-

Source: Regulation for Protecting Rivers No.25 (1967)

*FAO, 1994, Water Quality for Agriculture

Table 10.1-4 Effluent Standard in Iraq

Parameter (mg/l)	B-1 Drainage into water resources	B-2 Drainage into public sewage	B-3 Drainage into the drainer	B-4 Drainage into marsh	IFC EHS Guideline*
Temperature	35 degree>	45 degree>	-	-	-
pH	6-9.5	6-9.5	-	-	6-9
Suspended Solid	60>	750>	-	-	50
BOD	40>	1,000>	-	-	30
COD ($K_2Cr_2O_7$)	100>	-	-	-	125
Cyanide	0.05>	0.5>	-	-	-
Phenol	0.01-0.05	5-10	-	-	-
Lead	0.1>	0.1>	-	-	-
Arsenic	0.05>	0.05>	-	-	-
Mercury	0.005>	0.001>	-	-	-
Cadmium	0.01>	0.1>	-	-	-

Source: Regulation for Protecting Rivers No.25 (1967)
*General EHS Guidelines: Environmental Wastewater and Ambient Quality (2007), “Indicative Values for Treated Sanitary Sewage Discharges”

Table 10.1-5 Noise Level Measurement outside Buildings Measurement

Unit: dB

Location	Iraqi Standard		WHO Guideline*	
	Night	Morning	Daytime (07:00-22:00)	Nighttime (22:00-07:00)
Hospital and Resting Areas	40	50	-	-
Residential area inside City	45	60	55	45
Residential area outside City	45	55	55	45
Hotels	50	55	-	-
Schools, Nurseries, Universities and Educational Centers	45	55	55	45
Industrial & Public Areas	65	70	70	70
Service and Trading Areas	60	65	70	70
Private Areas: Airports Train stations Ports	60	70	-	-
Educational & Cultural Areas	50	60	55	45
Tourist Areas	50	60	-	-
Resident Location inside Industrial Areas	45	60	55	45

Source: Iraq Noise Prevention Law (1966)

* WHO (1999), Guidelines for Community Noise[1]

(4) Protected Areas and Ecologically Important Areas in Iraq

As mentioned above, the law on Protected Areas in Iraq has yet to be approved, however, seven Protected Areas including the Ramsar Site (described in 10.1 (2)) are listed as Protected Areas in the World Database on Protected Areas[2]. The nearest Protected Area to South Jazira is the Tharthar Lake and it is located on around 280km away from the Mosul Dam by airline distance. The main water source of the lake is surrounding Wadis, and water from the Tigris River rarely flows into the lake except for flood control. Other Protected Areas excluding the Ramsar Site are located on the watershed of the Euphrates River, therefore, the direct impacts by the Project on those Protected Areas will be limited. Still, since SWLRI examines water balance and distribution between those two rivers, the conditions will depend on the examination results.

Birdlife International[3] implements some activities to conserve birds, their habitats and global biodiversity in the world and selects habitats of globally threatened species**,** restricted-range species biome-restricted species and so on as Important Bird Areas (IBAs). There are 42 IBAs in Iraq at present, a project called as the Key Biodiversity Area Project targeting those IBAs has been conducted by Nature Iraq (a NGO in Iraq). Among the IBAs that are located on downstream of the Mosul Dam, the nearest one is the Huweija Marshes, which is around 200km away by airline distance. The IBA is located on the watershed of the Adhaim River, which is a tributary of the Tigris River. Given that the river joins in the mainstream of the Tigris River 70km downstream of Samara and the Huweija

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[1] This guideline is also applied in the IFC EHS General Guideline.

[2] It was established by the World Conservation Monitoring Centre under the UNEP and World Commission on Protected Areas of IUCN (International Union for Conservation of Nature and Natural Resources).

[3] BirdLife International is an NGO, whose headquater is located in Cambridge, UK.

Marshes is located on upstream of the junction point, it can be said that the impact on the Huweija Marshes by the Project is not expected.

Distribution maps of the Protected Areas and IBAs in Iraq are shown as follows:

Fig 10.1-4 Protected Area in Iraq

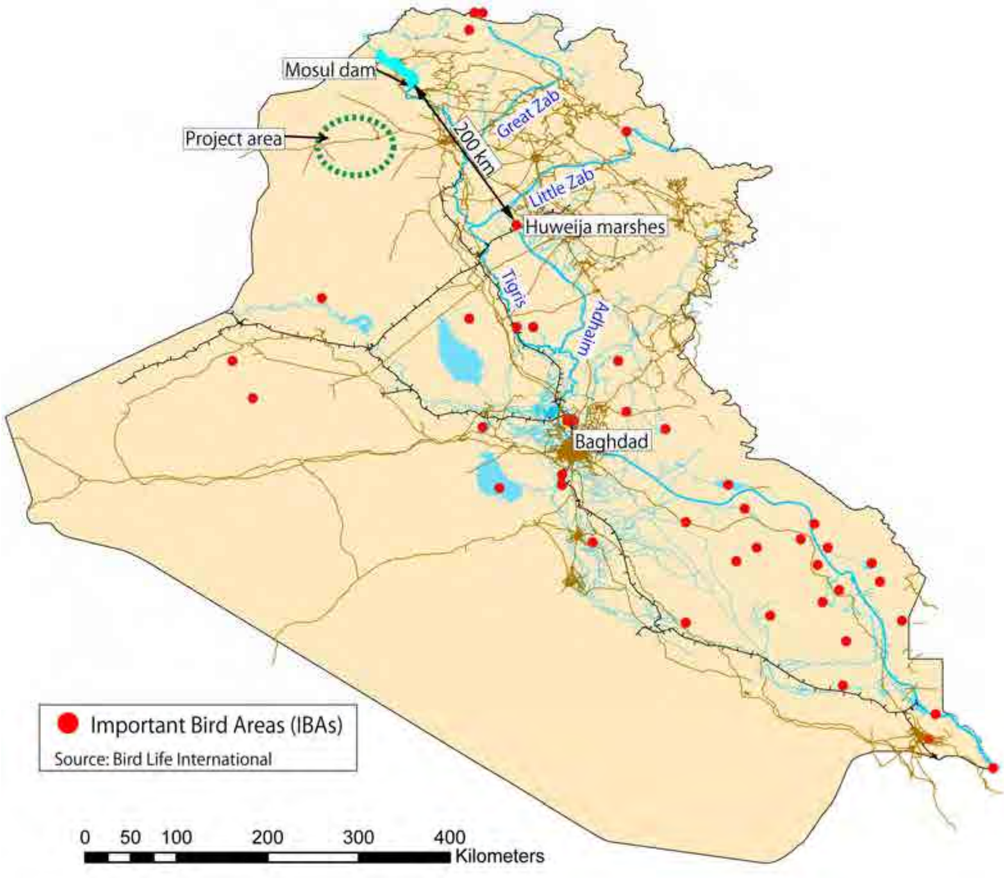


Fig 10.1-5 Important Bird Areas in Iraq

10.1.4 Analysis of Alternatives including Zero-option

(1) Scenarios and Alternatives

The Study mainly examines the Alternative-1 (Tunnel Plan) and the Alternative-2 (Pump Plan), the Alternative-1 has three (3) kinds of scenarios (Scenario 0, Scenario 1 and Scenario 2, while the Alternative-2 has only one scenario as shown below:

Alternative	Scenario	Quantity of water intake
Alternative-1: tunnel	Scenario 0	$100m^3/s$
Alternative-1: tunnel	Scenario 1	$80m^3/s$
Alternative-1: tunnel	Scenario 2	$60m^3/s$
Alternative-2: pump	Scenario 0	$100m^3/s$

The scale of anticipated environmental impacts can be different depending on the scenarios within the Alternative-1. For example, the more water is taken from the Mosul Dam, the more area can be irrigated, which will lead to more land acquisition due to bigger scale construction of irrigation facilities. However, the anticipated environmental parameters will not be diverse among the scenarios mentioned above. Therefore, the Scenario 0 is regarded as the representative among three (3) scenarios of Alternative-1 hereinafter. Three (3) options, namely, 1) Zero-option (no project implementation), 2) Alternative-1 (Scenario 0 of Tunnel Plan, quantity of water intake: $100m^3/s$) and 3) Alternative-2 (Pump Plan, quantity of water intake: $100m^3/s$) are examined in terms of environmental impacts, economical efficiency, technical aspects and so on.

(2) Zero-option

If the project is not implemented, no adverse impacts on the environment will be anticipated. In such case, the current low agricultural productivity will not be improved.

(3) Alternative-1: Tunnel Plan

Alternative-1 is due to divert water from the Mosul Dam power plant to the starting point of main canal in South Jazira. Since the feeder canal will reach to the destination by the construction of tunnel through Mt. Jabel Shekh Ibrahim, the distance will be 60.3km, which is shorter than that of Alternative-2. The maintenance fee during the operation will be relatively small, since it will utilize gravity instead of electricity. It is not necessary to assign any technical engineers to maintain the system. Moreover, it is relatively easy to control flow.

According to the satellite image, current conditions around the Mt. Jabel Shekh Ibrahim such as land use can be judged as farmland or dessert, and no dense population area or lakes and forest are can be observed. Therefore, negative impacts on environment around the construction sites will not be significant. Since farmlands are found to some extent, it is recommended to not to construct irrigation facilities in the private farmlands. The tunnel construction can give impacts on groundwater to some extent, however, the tunnel will be built through the rock bed, which will not lead to significant impact such as big-scale water level down of groundwater.

(4) Alternative-2: Pump Plan

The Alternative-2 proposes to divert water into Jazira by the establishment of one pump system. Electric expense will be necessary for the daily pump operation and it will be costly compared with that of Alternative-1. Moreover, the proposed length of feeder canal is 74.18km, which is longer by 14km than that of Alternative-1. As a result, land area to be acquired will be much larger than that of Alternative-1.

(5) Common Environmental Impacts by the Alternative-1 and Alternative-2

Both Alternative-1 and Alternative-2 will go across the road and railway from the same starting point. It is needed to build temporary construction road during the construction period, in addition to that, a foot bridge as the tentative passage of railway also will have to be designed. As a result, the situation will create inconvenience for users of the road and railway to some extent during the construction phase.

Both alternatives have a plan to intake water for irrigation in South Jazira, which can lead to give some impacts on downstream. However, as mentioned before, all irrigation projects in the Tigris River basin can give impacts on the downstream, it is very difficult to identify impacts by the Project itself. In addition to that, since countrywide water balance is under examination by SWLRI, it is needed to wait for the results. Therefore, this issue will be examined after the decision whether the Project will be implemented.

Summarized examination result of the proposed alternatives is shown in the following table. At this moment, it can be said that the optimum alternative is Alternative-1 compared with Alternative-2 and Zero-option.

Table 10.1-6 Examination of the Proposed Alternatives

Items/ Options	Zero-option	Alternative-1 (Tunnel: Scenario-1)	Alternative-2 (Pump: Scenario-0)
Start and endpoint of feeder canal *	—	Start : Mosul Dam power plant, Endpoint: starting point of main canal in South Jazira	Start : Mosul Dam power plant, Endpoint: starting point of main canal in South Jazira
Length of feeder canal	—	60.3km	74.18 km
Irrigation area	0ha	148,600 ha	148,600 ha
Pathway of feeder canal	—	The feeder canal will go across the road, railway and Mt. Jabel Shekh Ibrahim.	The feeder canal will go across the road and railway.
Land use in and around project area	—	Farmland or desert	Farmland or desert
Project cost[4]		333 Billion ID	465 Billion ID
Operation and Maintenance	—	△Operation and maintenance is relatively easy and its cost is also low compared with that of the Alternative-2 due to the gravity utilization. Moreover, control of flow is also easy.	×Electricity expense and cost for spare parts are high due to use of pump. Assignment of electric and mechanical engineers is needed for the system management. Furthremore, it is difficult to control flow compared with that of the Alternative-1.
Impacts on agriculture	—	◎The project can contribute to crop production increase	◎The project can contribute to crop production increase
Land acquisition	—	×Lands area to be acquired will be 900ha	×Lands area to be acquired will be 1,200ha
Tenanted premise for temporary construction	—	×5ha (for 10 years)	×5ha (for 10 years)
Impacts on existing economic activities	—	◎The project can provide job opportunities for the people	◎The project can provide job opportunities for the people
Impacts on existing transportation system	—	× The project can create inconvenience for road users and railway users	× The project can create inconvenience for road users and railway users
Impacts on natural environment in the target area	—	△no negative impact	△ no negative impact
Economic effect （FIRR）	—	6.3 %	--
Result of alternative examination	Irrelevant	Relevant	Irrelevant

◎: very positive, ○: relatively positive, △: no impact, ×: negative impact
*Pathways of Alternative-1 and Alternative-2 are different while those starting points and endpoints are common.

[4] The cost covers the feeder canal only and it does not include cost for sprinkler and drainage system construction.

Irrigation area, number of beneficiaries, and land area to be acquired area for 3 scenarios are shown as below. The study does not examine which is the most optimum scenario among them.

Table 10.1-7 Comparison among the Scenario of Alternative-1

Alternative	Scenario	Land to be acquired	Tenanted premise for temporary construction	Irrigation area	Number of beneficiaries
Alternative-1	Scenario - 0	900 ha	4.92ha (for 10 years)	196,400ha	71,100
Alternative-1	Scenario - 1	750 ha	3.84ha (for 9 years)	157,200ha	59,400
Alternative-1	Scenario - 2	600 ha	3.16ha (for 8 years)	107,600ha	49,400

10.1.5 Scoping

The magnitude and extent of environmental impacts caused by the three scenarios of Alternative-1 would be various in proportion to the quantity of water intake. On the other hand, the anticipated environmental impact items/parameters e.g. air pollution would not be diverse among those scenarios. Therefore, hereafter, focusing on the Scenario 0, which has the largest quantity of water intake, scoping is examined as shown below.

Table 10.1-8 Scoping of Alternative-1 (Scenario 0)

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
1. Air Pollution	B	B	B	D	The construction vehicles could increase exhaust gas and rehabilitation works could generate dust, but these situations can be temporary.
2. Water Pollution	B	B	B	B	Construction works could cause short-term deterioration in water quality due to increased turbidity, however, it can be just tentative. There is possibility of increase of chemical usage after during the operation.
3. Waste	B	B	B	D	Construction wastes will be generated.
4. Soil Contamination / salinization	B	D	D	B	Irrigation could enhance soil salinization to some extent.
5. Noise and Vibration	D	D	D	D	Construction works can generate short-term noise and vibration. However, the works will be implemented in non-residential area.
6. Ground Subsidence	D	D	D	D	There is no extraction of groundwater which leads to ground subsidence.
7. Offensive Odor	D	D	D	D	Very low level and at non-residential area
8. Bottom sediment	D	D	D	D	Due to no construction works at bottom, no impact is expected.
9. Protected area	B	D	D	B	There is no protected area around the proposed feeder canal and

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
					irrigation area. The nearest Protected Area to the Mosul Dam is Tharthar Lake, whose source of river is mainly Wadi. In case of flood, the lake receive water from Tigris River for flood control, however, such case is not common. Therefore, there is low possibility that the Project will give impacts on the lake. However, depending on the results of SWLRI, there is possibility that flow adjustment between Tigris River and Euphrates River will be done, in that case, the Project would do. The nearest IBA to the Mosul Dam, which is located on the downstream of the dam, is Huweija Marshes. It is located on the watershed of Adhaim River that is one of tributary of the Tigris River. Therefore, any impacts on IBA by the Project are not expected. Hamizah marsh, which is located on 700km downstream of Mosul Dam by airline distance, is registered as a Ramsar site.
10. Ground water	B	B	D	B	The tunnel construction work could give adverse impacts on groundwater, however, the extent is limited.
11. Hydrological Situation	C	C	C	C	It is expected not to cause negative impacts on hydrological situation. The vested right of water for downstream was $200m^3/s$ before Mosul Dam construction and it is regarded as the minimam discharge. It is needed to examine whether this amount is relevant after the examination of SWLRI.
12. Topography and Geographical features	B	B	D	D	As well as No. 10 above mentioned, tunnel construction work could give adverse impact on topography.
13. Involuntary Resettlement	D	D	D	D	There is no densely populated area around the proposed feeder canal and irrigation area and construction works will be implemented at the non-residential area as much as possible. Therefore, there is no possibility of involuntary resettlement. A foot bridge as the tentative passage of railway and tentative roads will be constructed, however, the route will be proposed with careful examination not to cause involuntary resettlement. Moreover, enough clearance between the construction sites and residential area should be proposed.

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
14. Land Acquisition	B	B	B	B	It will be needed to acquire private farmland for the construction works.
15. Cultural heritage	C	C	C	D	Farmland in the South Jazira has been established already, there is no possibility of spoil of cultural heritage by the project. Concerning the proposed area for feeder canal construction, information of cultural heritage distribution has yet to be acquired, it is needed to study the conditions at the project implementation.
16. Landscape	D	D	D	D	According to the satellite image, there is no important landscape in and around the proposed construction sites.
17. The poor, indigenous and ethnic people	B	D	D	B	There is no detailed information of people distribution in the South Jazira. However, fair water distribution will be introduced in the area, any impacts on particular people is not expected. Since the scale of impacts on the Marsh Arab is unknown, detailed survey will be essential.
18. Livelihood	D	D	D	D	Main income source is agriculture in South Jazira and the project can contribute to their livelihood improvement.
19. Local economy	D	D	D	D	The project can improve agricultural productivity and provide job opportunity as labor.
20. Existing social infrastructures and services	B	D	B	D	As the proposed feeder canal will go across railway and road, it will take longer for the users.
21. Misdistribution of benefit and damage	B	B	B	B	In South Jazira, handful farmland of beneficiaries will be acquired for irrigation facility construction and there is limited misdistribution between benefit and damage. On the other hand, in and around the proposed feeder canal there can be persons who will lose their lands without benefit. Compensation for the affected people will be needed.
22. Social institutions	C	C	C	C	Current social institutions are not confirmed, however, the possibility of adverse impacts on existing social institution will be low.
23. Water Usage or Water Rights and Rights of Common	B	D	B	B	Due to water intake from the Mosul Dam, the project will not give negative impacts on existing water users within South Jazira area. There can be adverse impacts on the downstream of the Tigris River.
24. Gender	C	C	C	C	Since the agricultural works are covered by mainly men, the impact on women is unknown. It is needed to implement detailed study.

Environmental Parameters	Overall Rating	Construction period		Operational period	Brief description
		Tunnel	Feeder canal		
25. Children rights	D	D	D	D	Adverse impact on children is very limited.
26. Hazards (Risk), Infectious diseases such as HIV/AIDS	C	C	C	C	It is recommended to employ workers within the project area as much as possible to minimize hazard from outside.
27. Accidents	B	B	B	D	Accidents may occur in any construction work, careful consideration to avoid any accident is necessary.
28. Global Warming	D	D	D	D	There are no activities with constant emission of green house substances.

Rating: A: Serious impacts are expected. B: Some impacts are expected.
C: Extent of impact is unknown D: No or negligible impacts including positive impact are expected.

10.1.6 Terms of Reference for Environmental Study

If it is decided that the project will be implemented in the future, it will be needed to implement the detailed environmental study. The study will focus on the environmental parameters that show B or C in the rating in the Scoping result mentioned above. The proposed study methods and contents, namely, Terms of Reference (TOR) for the detailed environmental study are shown as below. Since the Environmental Standards for air pollution and waste water quality have been already acquired, the TOR does not include the information collection of those standards. The environmental study will be implemented in South Jazira area, the Tharthar Lake, the Hamizah Marsh, and in and around construction sites.

Table 10.1-9 Proposed TOR for Environmental Study

Environmental Parameters	Study Contents	Study Method
Air pollution	• Impacts caused by construction works	1. Confirmation of the construction components, construction method, construction period, scale and extent of construction works, necessary construction machinery, number of necessary vehicles, traveling pathway and so on 2. Confirmation of the current conditions in and around the construction sites such as location of schools, hospitals and residential areas 3. Hearings in and around the sites 4. Comparison of the expected situations with the Iraqi environmental standard
Water pollution	• Impacts caused by the construction works • Impacts caused by chemical use increase after irrigation launch	1. Water quality test such as Suspended Solid, hearing in and around the construction sites 2. Identification of prevention measures from water pollution applied by other projects 3. Confirmation of quantity and type of applied chemical in South Jazira 4. Confirmation whether waste water quality is complied with the national standard
Waste	• Disposal of construction	1. Information collection about waste management

Environmental Parameters	Study Contents	Study Method
	waste	taken by other projects
Soil contamination	• Soil salinization	1. Measurement of Electric Conductivity of soil 2. Existing data collection 3. Hearing in the target area
Protected area	• Current status of the Hamizah marsh, which is a Ramsar Site and the Tharthar Lake • Utilization of the Hamizah marsh by the residents	1. Hearing in the Ramsar site and Tharthar Lake (Protected area) 2. Information exchange with other donors 3. Study of fauna and flora in the Ramsar site and Protected area
Hydrological situation	• Validity examination of 200m^3/s as the minimum discharge, which was the vested right of water to the downstream before Mosul Dam construction	1. Examination of SWLRI results
Groundwater/ Topography	• Impacts on groundwater by tunnel construction works	1. Groundwater study 2. Hearing in and around construction sites
Land use	• Confirmation of area and location of land to be acquired • Land acquisition plan formulation	1. Identification of schools, hospitals, residential area and so on in and around the construction sites in the map 2. Distribution map formulation of private land and official land 3. Collection of case examples regarding land acquisition in other projects 4. Formulation of land acquisition plan based on the World Bank Operational Policy
Cultural heritage	• Existence and distribution of cultural heritage	1. Hearing in the target area, site survey 2. Existing data collection
The poor, indigenous and ethnic people	• Distribution and population of Marsh Arab, their main industries, degree of dependence on the Mesopotamia Marsh	1. Hearing in the target area, site survey 2. Existing data collection 3. Hearings from relevant institutions
Existing social infrastructures and services	• Adverse impacts on road and railway operation	1. Collection of the traffic census 2. Confirmation of number of railway users 3. Collection of railway time-table 4. Hearings from relevant institutions
Social institutions	• Number of participants, functions, structures of existing social institutions and its distribution	1. Hearing in the target area 2. Existing data collection
Water use	• Impacts on the Mesopotamia Marsh	1. Examination of necessary inflow to keep current Mesopotamia Marsh
Gender	• Impacts on women by irrigation works	1. Hearing in and around the target area
Hazards (Risk), Infectious diseases such as HIV/AIDS	• Number of infected patients	1. Hearings from relevant institutions
Accidents	• Traffic accident • Accident by construction works	1. Hearings from relevant institutions 2. Site survey

10.2 Land Acquisition and Involuntary Resettlement

10.2.1 Necessity of Land Acquisition and Involuntary Resettlement

The project has a plan to construct a series of irrigation facilities in South Jazira, e.g. canal system, drainage, sprinkler, roads and so on. Some of those facilities will be constructed in the existing farmland and the proposed feeder canal will pass from the Mosul Dam to the target area. It will be needed to acquire lands for those facility constructions and proper management of them as Right of Way. However, the possibility of involuntary resettlement will be very low, since the construction sites will not be in and around residential area. In addition to that, a tentative road and a footbridge as pathway of railway should be constructed during construction of the proposed feeder canal, however, no involuntary resettlement is expected, since the route/place of those tentative construction facilities will be selected considering enough clearance between those tentative constructions and surrounding residential area

10.2.2 Legal Frame Work

(1) Law on Land Acquisition

If land acquisition is inevitable for project implementations in Iraq, the proponent should refer to the Law No.138 (1997), which stipulates necessary procedures for land acquisition. According to the Law, prices of lands to be impounded for the project should be agreed upon among the MoWR, MoA, Ministry of Finance, and municipalities concerned.

(2) JICA Policies on Land Acquisition and Involuntary Resettlement

The key principle of JICA policies on involuntary resettlement is summarized below.

Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project level. Compensation must be based on the full replacement cost as much as possible. Compensation and other kinds of assistance must be provided prior to displacement.

For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A. In preparing a resettlement action plan, consultation must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socio-economic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advantage of such benefits.

Eligibility of Benefits include, the Project Affected People (PAP) who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who do not have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

Provide support for the transition period (between displacement and livelihood restoration)

Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; Institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and detailed Financial Plan etc.

10.2.3 Scale and Extent of Land Acquisition

As mentioned above, Scenario 0 has the largest area to be acquired among the all scenarios of Alternative-1, namely, 900 ha. However, since the efforts to avoid residential area for construction sites will be made to minimize adverse impacts, it is possible not to entail involuntary resettlement by the project.

10.2.4 Compensation for the Land Acquisition

At present, public security is not enough good to implement site survey for the land acquisition in the field. In addition to that, the SWLRI by the Italian Consultants is going on, which will take at least several years to be completed. Therefore, it is needed to wait for the study completion and to examine the results subsequently. Based on the examination, it is possible to propose a concrete plan to support/

compensate the affected people, however, this work is not covered by the study.

10.2.5 Complaint Processing System

As mentioned above, examination of support/compensation plan formulation for the affected people is not covered by the study. Therefore, the complaint processing system is not discussed by the study.

10.2.6 Implementation Structure

Since support/compensation for the affected people is not examined during the study, implementation structure for t support/compensation is not examined by the study.

10.2.7 Implementation Schedule

This issue will be examined after the decision whether the project will be implemented. It is discussed by the subsequent study, not by this study.

10.2.8 Cost and Financial Resources

Since concrete measures of support/compensation for the affected people are not examined by the study, cost and financial resources for the matters are not discussed during the study. At the project implementation stage, it is needed to examine cost and financial resource for that.

10.2.9 Monitoring Structure and Monitoring Format

Since concrete measures of support/compensation for the affected people are not examined by the study, formulation of monitoring structure and monitoring format is not covered by the study.

10.2.10 Consultation

The study does not organize consultation meetings with the people, it is necessary to hold a series of meetings to get agreement in the subsequent study after the decision of project implementation.

10.3 Environmental Check List

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
1 Permits and Explanation	(1) EIA and Environmental Permits	1) Have EIA reports been officially completed? 2)Have EIA reports been approved by authorities of the host country's government? 3) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? 4) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	Since the study is the preparatory one before the decision making of the project implementation, a full-scale EIA report is not covered by the study.

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	(2) Explanation to the Public	1) Are contents of the project and the potential impacts adequately explained to the public based on appropriate procedures, including information disclosure? Is understanding obtained from the public? 2) Are proper responses made to comments from the public and regulatory authorities?	Consultation meetings with the people in the target area will be organized after the decision of project implementation.
2 Mitigation Measures	(1) Water Quality	1) Are considerations given to water pollution of the surrounding water bodies, such as rivers and groundwater by the effluents or leachates from irrigation ponds? Are adequate use/disposal standards for chemicals, such as fertilizers and agrochemicals established? Is a framework established to increase awareness of the standards among farmers? 2) Do effluents and ambient water quality of the surrounding water bodies comply with the country's effluent standards and ambient water quality standards?	Appropriate application of fertilizers and chemicals will be publicized as best one can after the decision of project implementation. Probably, the direct impacts on water quality of downstream by the project will be limited, since most of the irrigation water will be consumed within the area. Only when it rains intensively, unused water which contain little chemical and fertilizer will be dischared into outside. It will not cause severe impacts..
	(2) Soil Contamination	1) Is there a possibility that impacts in irrigated lands, such as salinization of soils will result? 2) Are adequate measures taken to prevent soil contamination of irrigated lands by agrochemicals, heavy metals and other hazardous substances?	Promotion of water saving irrigation can suppress soil salinization to some extent. Appropriate chemical application should be promoted to minimize adverse impacts on soil.
	(3) Subsidence	1) In the case of extraction of a large volume of groundwater	It is not planned to use groundwater for the project.
3 Natural Environment	(1) Protected Areas	1) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	There is a Ramsar site which is located on 700km away by airline distance from the Mosul Dam. However, impacts on the Ramsar site by the project is not examined by the study . There is a Protected Area, namely, the Tharthar Lake, 280km away by airline distance from the dam. Given that the main water source of the lake is Wadi intead of the Tigris River, direct impact by the Project is not expected at present. Still, it is needed to confirm results of SWLRI.
	(2) Ecosystem	1) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? 2) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? 3) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the	The nearest IBA to the Mosul Dam among the IBAs that area located on downstream of the dam is the Huweija Marshes, which is around 200km away by airline distance from the dam. It is located on the watershed of the Adhaim

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
		impacts on the ecosystem? 4) Is there a possibility that the amount of water (e.g., surface water, groundwater) used by the project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms? 5) Is there a possibility that installation of structures, such as intake weirs will block the movement of the migratory fish species (such as salmon, trout and eel that move between rivers and the sea for spawning)? Are adequate measures taken to reduce the impacts on these species?	River, which joins to the mainstream of Tigris 70km downstream of Samara. Therefore, the water intake from the Mosul Dam will not give eny impacts on the IBA.
4 Social Environment	(1) Resettlement	1) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? 2) Is adequate explanation on relocation and compensation given to affected persons prior to resettlement? 3) Is the resettlement plan, including proper compensation, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? 4) Does the resettlement plan pay particular attention to vulnerable groups or persons, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? 5) Are agreements with the affected persons obtained prior to resettlement? 6) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? 7) Is a plan developed to monitor the impacts of resettlement?	Involuntary resettlement by the project is not expected, however, land acquisition for construction of irrigation facilities will be needed. It is recommended to use official land for the construction as much as possible to avoid acquisition of private lands. Detailed study will be done after the decision whether the project will be implemented and consultation meetings with the people will be organized. Those procedures are not covered by the study.
	(2) Living and Livelihood	1) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? 2) Are proper allotments, such as water rights allotment in the project area made? Is there a possibility that the allotments will result in inequitable distribution or usurpation of water rights and available resources? 3) Is there a possibility that the amount of water used (surface water, groundwater) by the project will adversely the downstream fisheries and water uses? 4) Is there a possibility that water-borne or water-related diseases (e.g., schistosomiasis, malaria, filariasis) will be introduced? Is adequate consideration given to public health education, if necessary?	The project can contribute to crop production increase and improvement of job opportunities.
	(3) Heritage	1) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage sites? Are adequate measures considered to protect these sites in accordance with the country's laws?	Adverse impacts on the cultural heritages by the project are not anticipated.
	(4) Landscape	1) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	Adverse impacts on the landscape by the project are not anticipated.
5. Others	(1) Impacts during	1) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water,	The target area does not have densely settled area,

Category	Environmental Item	Main Check Items	Confirmation of Environmental Considerations
	Construction	dust, exhaust gases, and wastes)? 2) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? 3) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? 4) If necessary, is health and safety education (e.g., traffic safety, public health) provided for project personnel, including workers?	construction works will not be in and around the residential area. Therefore, direct negative impacts on social environment by the construction works will be very low. Important natural environment around the construction sites do not range. To avoid involuntary resettlement and land acquisition for the temporary construction, it is needed to determine route of those constructions and to prepare enough clearance between residential area and the construction sites.
	(2) Monitoring	1) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? 2) Are the items, methods and frequencies included in the monitoring program judged to be appropriate? 3) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? 4) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	Planning of concrete support and compensation for the affected people is not coved by the study. Monitoring structure and monitoring format will be prepared after the decision whether the project will be implemented.

* This checklist is based on the checklist format prepared by JICA.

CHAPTER 11. PROJECT EVALUATION

11.1 Conditions

(1) Basic Policy of the Analysis

The irrigation project creates various sorts of impacts, including increase in production volume of agricultural products, creation of working opportunities for farm labors, stabilization of people's life in the dry area, and putting a brake on domestic displacement due to water shortage. Project evaluation in this chapter mainly focuses on incremental agricultural and livestock benefit which can be expressed in monetary terms.

By implementing the Irrigation Project, stable supply of irrigation water, even in the dry season, will be materialized, which in turn results in increase in crop intensity and yield of production. As a result, volume of agricultural production in the project area will be increased, and farm income for individual household will also be increased. In addition, it is expected that, due to increase in fodder crop production and stabilization of feed supply, semi-intensive sheep raising and introduction of dairy farming will be promoted.

The economical and financial feasibility of the project will be discussed by comparing incremental project benefits and project costs. From the cost side, three (3) alternative cases of the project component, namely scenario-0, scenario-1, and scenario-2, are estimated based on the available water volume and design capacity of irrigation facilities. However, to identify the minimum scale of project, it is necessary to establish one more case study, say, Scenario-0 (without pump) case, by excluding a cost for pumping station in the western highland area from the original Scenario-0 (hereinafter referred to as Scenario-0 with pump). The cost for pumping station in the western highland is relatively high, which makes difficulty in comparing with the scenario-1 and -2 under the same condition. Therefore, from the cost side, totally four (4) alternative cases are analyzed.

Whereas from the benefit side, four (4) cases of the cropping pattern, including cropping pattern ABC, XYZ, αβγ100 and αβγ117, are analyzed in the project evaluation. The cropping pattern ABC and XYZ are quoted from the Swiss F/S. The pattern αβγ100 is recommended by the Study Team, and is 100% crop intensity. The αβγ117 is a pattern which maximizes crop intensity within the range of design capacity of the project. As shown in the table below, crop intensity of theαβγ117 is 117%.

Table 11-1 Crop Area of the Cropping Pattern αβγ117

	Crops	Cropping Area (ha)				Refference
		α117	β117	γ117	Total (αβγ117)	αβγ100
1	Winter alphalpha	200	100	100	400	-
2	Sugar beet	100	100	-	200	200
3	Wheat	200	300	400	900	900
4	Barley	100	100	100	300	300
5	Field beans	-	100		100	100
6	Oat	-	50	50	100	100
7	Vetch	-	50	50	100	100
8	Berseem	50		50	100	100
9	Potato	50	-	50	100	100
	Winter total	700	800	800	2,300	1,900
10	Summer alphalpha	200	100	100	400	400
11	Cotton	25	-	-	25	25
12	Maize	25	-	-	25	25
13	Sunflower	25	-	-	25	25
14	Chick pea	25	-	-	25	25
	Summer total	300	100	100	500	500
	Total	1,000	900	900	2,800	2,400

The evaluation will be conducted by estimating those economic indicators including internal rate of return (IRR), net present value (NPV) and cost-benefit ratio (B/C).

Basic conditions for the project evaluation are as follows.

1) Base year of the project evaluation is set for 2010. All prices estimated in the past will be converted to the base year by applying price escalation rates including consumers' price index (CPI).

2) On the contrary, all future expenses and incomes of the project are converted to the present value, using discount rate of 6%. The rate is derived from the policy rate of the Central Bank of Iraq.

3) Actual market prices are applied in the financial analysis, whereas economic prices are adopted in the economic analysis. To convert the market (financial) prices to the economic prices, a standard conversion factor (SCF) of 0.95 is applied. The SCF is estimated after due consideration of market distortion factors, including trade subsidies, tariffs and levies. According to Iraq Trade Information Center (ITIC), 5% of Reconstruction Levy (RL) is laid on imported goods, whereas other custom tariffs, duties, import/ export taxes and surcharges are suspended with some exceptional cases including the vehicle entry inspection fee and the export tariff of scrap metal.

4) Transfer items including interests, taxes, and subsidies are eliminated from the financial prices to obtain the economic prices, since these items are just transferred among entities in view of national economy level. Price escalation is not taken into consideration in both financial and economic prices, but physical contingency are estimated in the both analysis.

5) The economic price of traded goods is obtained from the international market that is considered as more ideal market than internal market. On the other hand, economic price of non-traded

goods is obtained from the internal market, and is converted from financial price by applying SCF.

6) Valuations of traded goods, such as wheat and barley, are estimated based on import parity (border parity) values. To obtain the economic price of wheat and barley at the project site, CIF (Cost Insurance and Freight) values, transportation costs, and other handling charge from the port are taken into consideration.

(2) Project Cost

Four (4) cases of the project cost, including 2 cases of the scenario-0 (with and without pump) with design capacity (d.c) =100m^3/s, the scenario-1 with d.c.=80m^3/s, and the scenario-2 with d.c.=60m^3/s, are estimated based on the design capacity of the irrigation facilities. The project cost consists of power pumping station, feeder canal, tunnel, electric supply system, east and west main canal, road and sprinkler systems. In case of the scenario-0, a pumping station on the west canal is included in the cost. Main conditions for estimating the project cost are as follows;

1) The project costs in this analysis are estimated based on unit costs of the East Jazira Irrigation Project, and are converted from 2009 price to the 2010 price by applying price escalation rate of 5.3% for local currency portion and 1.8% for foreign currency portion.

2) 10% of consulting fee, 20% of physical contingency, 3% of land acquisition and compensation, and 3% of administration fee are adopted in the both economic and financial analysis. The financial costs of these items are converted to the economic costs by applying 0.95 of SCF.

3) 5% of reconstruction levy (RV) is laid on imported goods (foreign currency portion) in the financial analysis, whereas the RV is eliminated in the economic analysis since the RV is transfer item from a view of national economy. Local currency portion in the financial analysis is converted to the economic price by applying the SCF, while the foreign currency portion in the financial analysis is directly applied to the economic analysis since the foreign market is regarded as more competitive.

4) Annual disbursement of the project costs are corresponding to the construction schedule of the project facilities. Construction periods of all cases are 8 years.

Following table shows the project cost of the scenario-0, -1 and -2.

Table 11-2 Project Cost by Scenario

Construction Cost Estimation (Financial Price) (1,000 ID)

No	Contract Number	Facilities	Scenario 0 (w/ Pump)	Scenario 1	Scenario 2
①	Contract No. SJA	Power Pumping Station	178,659,000	142,927,200	107,195,400
②	Contract No. SJ-1	Feeder Canal and Related Structure	159,349,200	142,433,000	127,589,100
③	Contract No. SJ-2A	Tunnel on Feeder Canal	190,244,500	173,184,000	149,462,700
④		Electrical Supply System	47,385,000	42,646,500	37,908,000
⑤	Contract No. SJ-3A	Canals, Roads and Networks (East Canal)	114,183,600	114,183,600	114,183,600
⑥	Contract No. SJ-3B:	Canals, Roads and Networks (West Canal)			
⑦	Phase 1		116,267,600	108,019,200	98,167,200
⑧	Phase 2		154,539,400	138,920,600	81,504,400
⑨	Phase 3		96,156,700	96,156,700	0
⑩	Contract No. SJ-3C	Canals, Roads and Networks (Pumped Canal)	117,949,700	0	0
⑪	Contract No. SJ-4	Pumping Station on West Canal	87,919,900	0	0
⑫	Contract No. SJ-5	Pump Houses in Sprinkler System	113,653,100	91,089,500	66,543,300
⑬	Contract No. SJ-6	Sprinkler Systems	496,675,400	397,741,400	290,117,200
⑭	Subtotal of Direct Cost		1,872,983,100	1,447,301,700	1,072,670,900
⑮	Consulting Services	10% of ⑭	187,298,300	144,730,100	107,267,100
⑯	Land Acquisition & Compensation	3% of ⑭	28,167,800	22,868,400	17,112,400
⑰	Administration Cost	3% of ⑭	28,167,800	22,868,400	17,112,400
⑱	Physical Contingency	20% of ⑭⑮⑯⑰, w/o price escalation	423,323,400	327,553,800	242,832,500
⑲	Cuctom and Duty		0	0	0
⑳	Reconstruction Levy	5% of ⑭	46,702,800	34,251,000	25,112,800
21	Subtotal	⑮～⑳	713,660,100	552,271,700	409,437,200
22	Total	⑭+21	2,586,643,200	1,999,573,400	1,482,108,100
	(in US$)	@1170ID/US$	(2,210,806)	(1,709,037)	(1,266,759)

Note: a/ Unit Costs of the East Jazira Irrigation Project are areapplied.
b/ Price escalation rate of 5.3% for local currency (L/C) and 1.8% for foreign currency (F/C) are applied to convert 2009 price to 2010 price.
c/ Foreign exchange rate of 1170ID/US$ and 0.07JPYen/ID are applied.
d/ Scenario-0 (w/o pump) case excledes the pump station cost.

(3) Project Benefit

The main economic benefit will be generated from increase in crop production. The production increase is materialized through increase in crop yield and expansion of planted area. On one hand, the former will be achieved through construction of irrigation facilities, appropriate water management plan by enhancing operation and management ability of the facilities, and preventing damages caused by water shortages. On the other hand, the latter includes expansion of planting area by applying additional irrigation water.

The project benefits will be estimated by comparing the with project case and the without project case. At the time of the original F/S conducted by the Swiss Consultants, it was assessed that the "present" farming activities were ignorable since agricultural income was practically naught due to unstable rainfall, and the condition is also adopted in this analysis since farming situation in the project site has not been changed. Four (4) cases of cropping patterns (Pattern ABC, XYZ, αβγ100, and αβγ117) are discussed in the evaluation. Followings are the basic conditions for estimating the project benefit. Also, a table for project benefit from crop production per rotation block is shown below.

1) Market prices of agricultural products are used in the financial analysis, whereas a SCF is applied to estimate economic price of the products, except for that of wheat and barley which are estimated from the border parities.

2) Proposed yields of planned crops are future projection under the irrigated agriculture, and are quoted from the original feasibility study conducted by Swiss consulting firm. Exceptionally, projected yield of potato is derived from actual practices in the North Jazira Irrigation Project site. The proposed yield will be at maximum after 20 years from the first year of irrigation.

3) Production costs of the with project case are estimated based on the farm household survey conducted by the JICA Study Team, and the original F/S conducted by the Swiss consulting firm.

4) Number of crop rotation block (9,600 donum/ block, or 2,400 ha/ block), which is the basis of incremental project benefit, will be gradually increased as sprinkler system in the field being established. Total number of the rotation block in the scenario-0 is 62, and that in scenario-1 and -2 are 50 and 36 respectively.

5) The project benefit starts generating after 10 years from commencement of the construction.

Table 11-3 Incremental Benefit from Crop Production per Rotation Block

		Incremental Benefit per Crop Rotation Block (1,000 ID)							
		Financial Price				Economic Price			
		ABC	XYZ	αβγ 117	αβγ 100	ABC	XYZ	αβγ 117	αβγ 100
1	Winter Alphalpha	415,800	475,200	475,200	-	410,900	469,600	469,600	-
2	Sugar Beet	1,939,300	352,600	705,200	705,200	2,255,000	410,000	820,000	820,000
3	Wheat	1,673,840	2,391,200	2,152,080	2,152,080	2,784,320	3,977,600	3,579,840	3,579,840
4	Barley	665,920	832,400	499,440	499,440	1,154,560	1,443,200	865,920	865,920
5	Broad Bean	348,960	348,960	174,480	174,480	353,600	353,600	176,800	176,800
6	Oat	34,190	136,760	136,760	136,760	45,800	183,200	183,200	183,200
7	Vetch	32,630	130,520	130,520	130,520	44,320	177,280	177,280	177,280
8	Berseem	192,180	-	128,120	128,120	198,960	-	132,640	132,640
9	Potato	-	-	299,880	299,880	-	-	391,560	391,560
10	Summer Alphalpha	384,000	384,000	512,000	512,000	378,600	378,600	504,800	504,800
11	Cotton	120,191	162,860	81,430	81,430	122,316	165,740	82,870	82,870
12	Maize	2,757	-	26,510	26,510	2,736	-	26,310	26,310
13	Sunflower	3,012	-	28,960	28,960	2,980	-	28,650	28,650
14	Chick Pea	12,770	80,820	40,410	40,410	12,836	81,240	40,620	40,620
Total		5,825,549	5,295,320	5,390,990	4,915,790	7,766,928	7,640,060	7,480,090	7,010,490

On the other hand, it is also expected that, increase in fodder crop production and stable supply of fodder crop promote semi-intensive sheep raising and encourage farmers to introduce dairy farming in the study area. Basic figures of the semi-intensive sheep raising and the dairy farming in the Swiss F/S repot are applied to the analysis. Followings are the basic conditions for estimating the project benefit.

1) The semi-intensive model of sheep rising in the Swiss F/S is used to estimate net benefit from sheep production, in addition to applying 2010 unit price of livestock related material and products. 5 years are required to expand the business model to target farmers. It is assumed that 50% of farmers accept the semi-intensive sheep production in those areas close to Mosul city,

where crop production and dairy farming will be rather promoted.

2) The dairy farming model with 100 cows in the Swiss F/S is applied to estimate net benefit from dairy production, and 2010 unit price of dairy products and production materials were used for the analysis. The dairy production unit will be established in every 800ha (3 unit per rotation block) in consideration of surplus production capacity of fodder crops.

11.2 Results

(1) IRR, NPV, and B/C

Based on the above mentioned conditions, a series of financial and economic analysis is conducted, and results of analysis in terms of Financial and Economic Internal Rate of Return (FIRR/ EIRR), Net Present Value (NPV), and Cost Benefit Ratio (B/C) are shown in the table below.

Table 11-4 (1) Result of Financial and Economic Analysis: Scenario-0 w/ Pump

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	7.7%	6.5%	7.0%	6.3%	10.4%	9.8%	9.9%	9.4%
NPV	506,102,800	55,459,707	229,287,580	-13,029,471	1,691,587,018	1,441,805,313	1,489,799,519	1,249,003,218
B/C	1.19	1.02	1.09	1.00	1.67	1.57	1.59	1.49

Table 11-4 (2) Result of Financial and Economic Analysis: Scenario-0 w/o Pump

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	8.0%	6.8%	7.3%	6.7%	10.7%	10.2%	10.3%	9.8%
NPV	622,539,457	171,896,365	345,724,237	103,407,186	1,804,678,177	1,554,896,472	1,602,890,678	1,362,094,376
B/C	1.25	1.07	1.14	1.04	1.74	1.64	1.66	1.56

Table 11-4 (3) Result of Financial and Economic Analysis: Scenario-1

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	7.7%	6.6%	7.1%	6.4%	10.4%	9.9%	10.0%	9.5%
NPV	431,836,283	68,414,434	208,598,202	13,181,226	1,391,356,910	1,189,920,051	1,228,625,056	1,034,434,490
B/C	1.21	1.03	1.10	1.01	1.70	1.60	1.62	1.52

Table 11-4 (4) Result of Financial and Economic Analysis: Scenario-2

	Financial Analysis				Economic Analysis			
	ABC	XYZ	αβγ117	αβγ100	ABC	XYZ	αβγ117	αβγ100
IRR	7.6%	6.5%	7.0%	6.3%	10.3%	9.8%	9.9%	9.4%
NPV	307,017,472	30,816,867	137,356,530	-11,160,372	1,039,745,650	886,653,638	916,069,441	768,484,611
B/C	1.19	1.02	1.09	0.99	1.69	1.58	1.60	1.51

The results show that, when we look at cropping pattern αβγ100, the best scenario of the project alternatives is the scenario-0 w/o pump, followed by the scenario-1, the scenario-0 w/ pump, and -2, indicating that the scale merit seems work in this project. In other words, as far as looking at the four concerned alternatives, as design capacity of irrigation facilities increases, project benefit from agricultural production also increases.

Among four (4) alternatives of the cropping patterns, ABC is the best option, followed by αβγ117, XYZ, and αβγ100 in the economic analysis. The ABC cropping pattern is the most profitable option when we look at agricultural productivity only (ignoring limitation of water resources). However, if we consider socio-economic conditions including accessibility to processing facility of sugar beet, additional investment is necessary to meet processing requirement of the product. On the other hand, αβγ100 cropping pattern is the best alternative since it considers current natural and socio-economic condition of the project site.

In all cases, EIRRs are higher than the 6% of the policy rate of the Central Bank of Iraq. When we considered the 6% as the opportunity cost of capital of Iraq, all cases discussed in the analysis are economically feasible. The result indicates that the project can be sufficiently justifiable in view of national economy level.

(2) Sensitivity Analysis

Based on the base case discussed in the above section, sensitivity analysis is conducted. Tested cases in the sensitivity analysis are; (1) in case the project cost increases by 20%, (2) in case the project benefit decreases by 20%, and (3) combination of (1) and (2). The results of cropping pattern αβγ100 are indicated in terms of EIRRs, and are summarized in the table bellow.

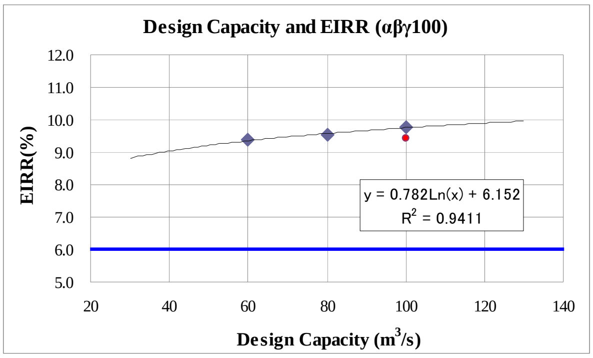
Table 11-5 Results of the Sensitivity Analysis

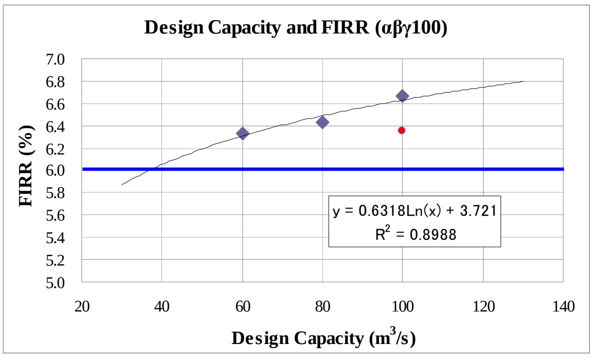
	Scenario-0 w/ Pump	Scenario-0 w/o Pump	Scenario-1	Scenario-2
Base Case	9.4%	9.8%	9.5%	9.4%
(1) 20% increase in Cost	8.0%	8.3%	8.1%	8.0%
(2) 20% decrease in Benefit	7.7%	8.0%	7.8%	7.7%
(1) + (2)	6.3%	6.7%	6.5%	6.4%

The results indicate that all EIRRs are higher than the 6%, when the project cost increases by 20%. On the other hand, when the project benefit decreases by 20%, all EIRRs are also higher than the rate 6%, but EIRRs decline more than the first case. It can be said that the project is more sensitive to the benefit decrease than the cost increase. In the case of the project cost increases by 20% in addition to the benefit decreases by 20%, all EIRRs are above the opportunity cost of capital.

(3) Minimum Scale of the Project

When a scale merit works in the project planning, a minimum scale of the project might be an issue to be discussed. Definition of the minimum scale must be varied, but in the economic analysis, it is basically a marginal project that meets feasibility indicators. However, the marginal project can not be fined in the economic results, since both IRRs are far from the marginal line of the 6%. Therefore, simple regressions between the design capacity and the FIRR/ EIRR, using logarithmic function, are conducted and the results are shown in the figures bellow. To figure out an approximate expression, the scenario-0 with pump is excluded, but is shown in red dots in the figures. According to the regression results, the minimum design capacity can be found around the 40 m^3/s in the financial analysis.





(4) Qualitative Impacts

The project benefits includes not only those economic impacts which can be express in monetary term, but also those social impacts including activation of labor market, stabilization of agricultural production, improvement of living standards, and contribution to the national food security. The project will be evaluated in consideration of those socio-economic impacts.

For example, waster shortage in Al-Baaj is quite serious, which sometimes causes displacement of household to other regions. According to the governorate profile of Ninevah, as a result of IDP (Internally Displaced Persons) and Returnee Assessment and developed by International Organization for Migration (IOM) in 2010, displacement due to lack of water increases recently, and Ninevah is one of the most affected governorate in Iraq. The report indicated that 1,364 families in total have displaced in Ninevah due to water shortage, and most of them are in Al-Baaj district. After the project, therefore, it is expected that the IDPs caused by water shortage will be reduced in the project area.

Also, it is expected that reduction in the IDPs caused by water shortage results in decrease of cultivation abandonment, which in turn increase vegetation coverage on the surface ground and mitigate soil runoff from farmland. As a result, farmland aridification and desertification of farmland will be mitigated.

In addition, Ninevah governorate is the largest provider of wheat and barley in Iraq, and produces 15% and 28% of total wheat and barley production in 2007 respectively. However, yields of wheat and barley in Ninevah are the lowest among all governorates since their agriculture is overly dependent on erratic rainfall, hence unstable agricultural production year by year. Therefore, the project can contribute to the national food security through providing additional wheat to the whole country. Also, partial reduction in the cost to maintain the nation-wide rationing system is expected, as a result of the project implementation.

CHAPTER 12. RECOMMENDATION

12.1 Conclusions

12.1.1 Regarding decisions to be made on project development scale

The results of project evaluation made for each development scenario case and cropping pattern (αβγ100, αβγ117) are as tabulated in the Table 12-1.

Table 12-1 Project benefits/efficiency in each Scenario case

1US$=1,170ID

Scenarios	Irrigation area (ha)	Intake design discharge (Peak) m^3/s	1)Annual water allocation (BCM)	2)Releasing volume to downstream (Incl. Power) BCM	3)Annual yield for wheat (ton)	Project cost Billion ID (Million US$)	FIRR by cropping pattern	
							αβγ100	αβγ117
Scenario-0 (With pump)	148,600	100	1.39	6.46	312,000	2,587 (1,811)	6.3%	7.0%
Scenario-1	119,000	80	1.11	6.75	245,000	2,000 (1,400)	6.4%	7.1%
Scenario-2	86,800	60	0.83	7.04	182,000	1,482 (1,037)	6.3%	7.0%
Scenario-3 (Min. scale)	59,500	40	0.48	7.41	125,000	Not examined	6.0% (estimate)	Not examined

Note: 1) Annual water allocation means irrigation water requirement in total for South Jazira area calculated with effective rainfall factor.
2) Releasing water volume to downstream area was calculated on conditions that storage volume will not be altered during the calculation period and at least 200 m^3/sec shall always be released.
3) Planned cultivation area x 5.6ton/ha (target yield in 10 years after the project completion)

In this study, two kinds of cropping patterns, namely, αβγ100 and αβγ117 are proposed for FIRR calculation as described in Table 12-1. In the former cropping pattern, it is planned to cultivate once in a year, which means that cropping intensity is 100%, taking consideration into the stringent water resource nationwide in the future. Based on αβγ100, the latter, namely, αβγ117, which satisfies following conditions, is proposed.

① Annual water consumption for farming is set within the limit that the inflow to the Mosul Dam (inflow indicator) presented by MoWR is 10.1 BCM and the minimum discharge (Outflow Indicator) is 200 m^3/s.

② The peak design discharge which determines the scales of main irrigation facilities e.g. the feeder canal and main canals is not changed.

The MoWR of GoI has declared that the final examination on the quantity of water to be availed from Mosul Dam to South Jazira Irrigation Project will have to wait for the outcomes of currently on-going study, namely "Strategy for Water and Land Resources in Iraq: SWLRI (Phase 2)". In this case, it is considered that it will take at least 2-3 years before the development scale of South Jazira Irrigation Project be decided.

While, in case if there will be no limit on the usable water resources amount, the Scenario-0 shows considerable increase of main staple food production and resultant decrease in the nation's food import can be expected. However, it is not agreeable to attach no importance to the declining inflow to Mosul Dam in future as caused by development activities in the upstream countries and negative effects by the global warming. MoWR presented the future inflow into Mosul Dam at 10.1 BCM/year as an indicator so as to apply the same for simulation study of Mosul Dam water resources operation aiming at completing the subject JICA Study. It means that current inflow into the Mosul Dam will be decreased by half, and the inflow in the future is estimated on the safe side. If this will be the possible reality in near future, a project scale similar to the Scenario-3 would be recommended even with the minimum efficiency but having the project feasibility being positive, taking into consideration the future water demands in the downstream basins of the country as well as attention paid to environmental conservation of the wetlands in southern Iraq. Characteristics of those scenarios are shown in Table 12-2.

Table 12-2 Characteristics of Each Scenario

Scenario	Irrigation Area (net)	Design Discharge (peak)	Characteristics of each scenario
Scenario-0 (maximum scale)	148,600 ha	100 m^3/s	If there is no restriction of available water resource, the project benefit in this scenario is the highest among all scenarios and it can contribute to wheat production increase, which is important for food security. On the other hand, since it should cover the western plateau of South Jazira, which requires pump for irrigation and O & M cost. It is needed to shoulder this cost which is not needed for other scenarios. This scenario can give significant impacts on the Mosul Dam power generation, it is necessary to examine alternatives. In addition to that, there is a high possibility that it will give adverse impacts on natural and social environment downstream e.g. water utilization.
Scenario-1	119,000 ha	80 m^3/s	This scenario excludes the western plateau which needs pump irrigation from the area of Scenario-0 and its O & M cost is very small compared with one of Scenario-0. <u>This is the most desirable scenario in terms of economic effect.</u> In terms of project benefit, food security and environmental consideration, this is ranked between Scenario-0 and Scenario-2.
Scenario-2	86,800 ha	60 m^3/s	This scenario is ranked between Scenario-1 and Scenario-3.
Scenario-3 (minimum scale)	59,500 ha	40 m^3/s	If available water resource is limited, this is the most desirable scenario. On the other hand, the impact is the lowest in terms of project benefit and food security.

12.1.2 Roles to be played by South Jazira Irrigation Project

In accordance with the National Development Plan (NDP: 2010-2014), there exists as large as 9.3 Million ha of farm land which can be converted to irrigable condition in future including the existing irrigated areas. Of the total 9.3 Million ha, about 5.4 Million ha (58 %) is covered by the existing irrigation facilities (Actual irrigation coverage is seemed to be substantially less than the above). Besides, crops such as wheat for main staple food and barley for livestock feeding are cultivated in 4 Million ha area nation-wide, of which about 1.65 Million ha, 41 %, is in Nineva province.

While in terms of the agricultural productivity as indicated in the said NDP, the average unit yield of wheat was 2.58 ton/ha (646 kg/dunam) in Al-Najaf and Al-Qadisiyyah provinces located in the central-south part of the country, the yield at Nineva province was merely 0.68 ton/ha (169 kg/dunam), showing a big difference of 3.8 folds. Reasons behind the said difference are explained that stable irrigation water could be supplied to the farming area in case of Al-Najaf province and etc. in 2007, namely, drought year while rainfall in Nineva province was much in short.

The background of the description found in the NDP as mentioned above suggests that there is no sufficient water resources/irrigation development extended over the country at present and/or there are many areas where the existing irrigation facilities are not fully utilized in an effective manner. Further, the reason why Nineva province, in which the South Jazira Irrigation Project is being planned, is positioned as a main staple food production area with the relatively more annual rainfall of 200-400 mm in the Northern Iraq. However, without adequate irrigation facilities the province does not attain stable agricultural production and the resultant food supply.

In case if the Scenario-0 be taken up and successfully implemented under the subject Project, annually about 310,000 tons of wheat will be stably produced within the project area in future, implying that the project will produce about 18% of 1.7 Million tons to be produced under irrigation condition nation-wide to meet the target set for 2014 in the NDP.

12.2 Recommendations

(1) Issues on Water Distribution

Even though the inflow to the Mosul Dam is reduced to 10.1 BCM, it is possible to balance water demand and supply in North, Eastern and South Jazira areas on the condition that operation of the Mosul Dam power generation is cut to 35% of current water consumption (16.59BCM/year at present) by means of trade-off between irrigation and power generation. This is based on the assumption that agriculture has high priority compared with power generation. In such case, it is needed to secure alternative electric production e.g. hydro power, thermal power, gas power, import of electricity to compensate for the reduced electricity generated, in other words, trade-off among power generation industries is necessary.

Even though, the trade-off mentioned above can be established, there is a possibility that the South Jazira Irrigation Project will give some significant impacts on social and natural environment in the central and southern areas of Iraq. Therefore, effective water distribution between Jazira Areas and downstream can be regarded as a key issue for nationwide water resource allocation and this issue should be examined carefully in line with future inflow to the Mosul Dam.

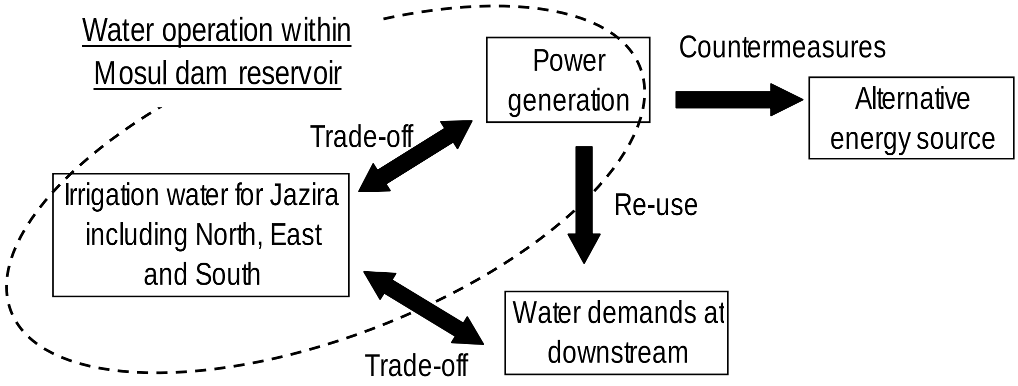


Fig. 12-1 Water Resource Trade-off concerning South Jazira Irrigation Project

(2) Utilization of SWLRI Results

As mentioned in (1) above, it is expected that the SWLRI shows data which is essential for estimation of future inflow to the Mosul Dam and the minimum discharge taking consideration into nationwide water demand e.g. 1) agriculture, 2) power generation, 3) industries, 4) domestic non-commercial water and 5) conservation of the Mesopotamia Marsh. Based on the conclusion presented by the SWLRI, it is recommended that Government of Iraq will organize a committee mainly consisting of decision makers from ministries relevant to the water demand. The committee is expected to prepare a strategy of water and land development. The amount of water to be distributed to South Jazira Area and project scale will be determined based on the examination above.

(3) Examination of Annual Irrigation Water Requirement Based on Daily Basis Meteo-Hydrological Data and Soil Moisture Survey Data

In computing annual irrigation water requirement, it is important to attain higher accuracy on the quantity of seasonal crop water consumption. Under the JICA Study, the latest monthly hydrological data (1990-2009) in and around South Jazira area have been collected and the seasonal crop water requirement could be calculated. However, there were missing and vanishing of data for some of the observed periods as affected by the Iraqi war and so on and the accuracy of seasonal crop water calculated is not high enough. Moreover, the collected data were of monthly basis but not daily. For determining the facilities scale/dimensions, the peak demand for crop water consumption occurs during rainy season, it is necessary to make irrigation planning with fully grasping the rainfall pattern. Since estimation of irrigation water requirement with high accuracy may lead to possible water saving, it is recommended to continue necessary observation of meteo-hydrological data and accumulate further daily basis data as the basic need.

Given that gypsum layers are found under the sub-soil in the Project Area whereas it is planned to introduce sprinkler system in the whole Project Area, improper water spray can give adverse impact such as dissolution of the gypsum. Therefore, it is recommended to implement a detailed soil condition survey of in advance.

In order to estimate the most practical water requirement, it is recommended to collect the observation of meteo-hydrological data continuously for the purpose of re-examination of annual irrigation water requirement.

(4) Farming Training through a Pilot Farm of Leaders and Capacity Building of Leaders and Water Users' Associations

It takes several years until the completion of SWLRI, it is proposed to establish a pilot farm prior to the Project for the purpose of collection of metrological data and examination of soil conditions. Proposed farm scale is 800ha, which is the same size as actual irrigation scale and can verify a rotation block of proposed αβγ100 (8 years cycle). If water resource for the pilot farm can not be secured within the South Jazira area, it is recommended to establish the pilot farm in other areas nearby the Tigris River which have the similar characteristics with South Jazira, e.g. distribution of gypsum layers under the top soil. Proposed verification items are as shown below.

1) Collection of metrological data
2) Measurement of soil moisture change by depth caused by sprinkler irrigation
3) Confirmation of production of each crop
4) Demonstrative operation of agricultural machines, sprinkler and so on
5) Measurement of irrigation loss and calculation of irrigation efficiency
6) Demonstrative application of fertilizers and chemicals

It is supposed to have a supply side-commanding manner water allocation in Iraq and this may lead to possible un-expectedly big conveyance loss if well-organized water management by well experienced operators would not be practiced. It is then recommended that technical cooperation program and/or dispatching of related experts will be introduced for the purpose to advance establishing water users' organization as well as capacity building for extension services and water management. For this, the know-how learned from the preceding North Jazira Irrigation Project area shall be fully referred.

ANNEX

Minutes of Meetings

for

The Preparatory Survey

on

South Jazira Irrigation Project

in Republic of Iraq

Agreed upon between

The Government of Republic of Iraq

and

Japan International Cooperation Agency

Baghdad, Republic of Iraq

August, 2010

for

Mr. Masaaki Matsushima
Chief Representative, JICA Iraq Office

Assist.

Mr. Mahdi H. Ali
Chief Engineer, Head of Follow up Section
Ministry of Planning

Mr. Sami Muhi Alddin Hassan
Assistant Director General, Commission for Execution of Irrigation and Reclamation Projects
Ministry of Water Resources

Eng. Shawkat S. Jameel
Head of Section for Water Management
Director of Agro-Metrology Program
Ministry of Agriculture

Preface

Based on the Minutes of Discussions dated July 2, 2009 on Fact Finding Meeting for South Jazira Irrigation Project (hereinafter referred to as "the Project") between the Government of Republic of Iraq (hereinafter referred to as "GOI") and Japan International Cooperation Agency (hereinafter referred to as "JICA"), and in response to the Iraqi Prime Ministers Office Advisory Commission's Letter Ref.: I/340 dated July 21, 2009, JICA decided to send a consultation mission (hereinafter referred to as "the JICA Mission") headed by Mr. Yoshiyuki Goya, Executive Technical Advisor to the Director General of Rural Development Department, JICA, to the Republic of Iraq from June 25 to July 1, 2010.

The JICA Mission held a series of discussions with relevant organizations of the GOI to develop implementing arrangements of a further survey (hereinafter referred to as "the Preparatory Survey") for reviewing the Feasibility Study of the Project completed in 1984 and redefining the scope of the Project. After the visit of the JICA Mission, additional discussions have been made between the representatives of JICA Iraq Office and the Iraqi side, and the both sides agree to the scope and implementing arrangements of the Preparatory Survey as described in the Appendix 1.

Meanwhile, JICA dispatched a consultant team for the Preparatory Survey (hereinafter referred to as "the JICA Survey Team") to the Republic of Iraq in June, 2010. The JICA Survey Team submitted the Inception Report (hereinafter referred to as "IC/R") to the concerned people of the Iraqi side in Erbil for their discussions. The IC/R was not presented only in Erbil, but also in Baghdad to the Iraqi officials concerned by the representatives of JICA Iraq Office. The contents of the IC/R were accepted in principle by the Iraqi side.

The JICA Mission joined the discussions related to the IC/R in Erbil and exchanged views and opinions with the Iraqi side about the way how the Preparatory Survey should be conducted. The main points raised in the discussions are summarized in the Appendix 2.

Appendix 1: Scope and Implementing Arrangements of the Preparatory Survey
Appendix 2: Main Points Discussed
Appendix 3: List of Attendants of the Meetings

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Appendix 1

SCOPE AND IMPLEMENTING ARRANGEMENTS OF THE PREPARATORY SURVEY

I. BACKGROUND AND OBJECTIVES OF THE PREPARATORY SURVERY

Iraq has relatively abundant water and fertile lands in the region, which have enabled Iraq to irrigate arid plains over history and make the agricultural sector one of the most important pillars of the country's socio-economy until nowadays. The sector is estimated to engage 20% of employment and 30% of the whole population in its related sectors, still being the second largest sector following the oil sector.

During the last decades, however, the political and social turmoil has fiercely weakened the agricultural sector. Damages of infrastructures drove its chronic salinity problems to the worst and delay of updating the knowledge and techniques of natural resources management dropped the agricultural productivity drastically, leaving abandoned lands. As a result, agricultural production levels have been declining since early 1990's and the agricultural contribution to the national GDP has gone down from 25% in 1992 to nearly 10% in 2008. The economy has lost its diverse sources of dynamism and been monopolized by the crude oil production. Such decline of the agricultural sector has threatened the basic food supply to the local population and jeopardized some social conditions such as weakness of the job opportunities, the national food security and the sustainable use of natural resources. These have become serious impediments of reconstruction in post-conflict Iraq. Conversely, current vulnerabilities of the Iraq's agricultural sector are reflected in high unemployment rates in rural areas, high portion of the population under the food insecurity or malnutrition, high dependency on food import, low agricultural productivity and low water use efficiency.

To revive and strengthen the agricultural sector is therefore one of the prerequisites to stabilize the country and to vitalize its economy. To that end, the GOI takes a set of actions placing a top priority to boost agricultural production in a sustainable way by introducing the latest advancements in irrigation technologies and natural resources management. Main targeted crops in this endeavor are wheat and barley, which are strategic crops for the national food security but largely cultivated by the rain-fed practices in the north of Iraq with low productivity and vulnerability to climate conditions.

In order to address the current vulnerabilities of the agricultural sector and to improve the national food security, the GOI has decided to update the feasibility study of South Jazira Irrigation Project. The South Jazira Irrigation Project was originally developed as an integral part of the Mosul Dam Development Project in the early 80's concurrently with the North Jazira and the East Jazira Irrigation Projects. These three irrigation projects were designed to obtain water from the Mosul Dam reservoir to reclaim the new irrigated areas for the purpose of increasing strategic crop production in Ninevah governorate. Due to intermittent wars and economic sanctions, although the Mosul Dam commenced its operation in 1985 and the North Jazira Irrigation Project was completed in 1991, the South and East Jazira Irrigation Projects were frozen during the last two decades.

South Jazira Irrigation Project site, is located in Ninevah Governorate, the important agricultural area for major crops, where features the above-mentioned vulnerabilities in terms of the agricultural sector as well as the social conditions. It serves 32% of the national barley production and 20% of the national wheat production but agricultural productivity is less than national average because of dependency on rain-fed cultivation. The national average of wheat productivity as of 2004 is 1.36 ton/ha while 0.85 ton/ha in Ninevah. (for instance, the national average of wheat productivity

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1992-2002 are 0.67 ton/ha by rain-fed and 1.28 ton/ha by irrigation). It is estimated that 45% of its employment is engaged in agriculture but the unemployment rate (13% for male and 35% for female) is higher than the national average of 12% for male and 13% for female.

Under these circumstances, in order to achieve the development goals addressing the current conditions, the existing Feasibility Study (hereinafter referred to as "F/S") completed in 1984 by Swiss Consultants and updated by Dijla State Company in 1991 must be reviewed and upgraded.

The Preparatory Survey shall be thus implemented based on official intention of GOI to request for conducting F/S review and redefining the scope of the Project.

The Preparatory Survey mainly provides "Phase 1" defined in Minutes of Discussions on Fact Finding Meeting agreed between GOI and JICA on July 2, 2009, namely contains 1) the review of the existing F/S (Phase 1-a) and 2) redefining scope of the Project based on the result of Phase1-a (Phase1-b). The implementation of Phase 1-b shall be determined based on an evaluation of the review of F/S as the final product of Phase 1-a.

Ⅱ. SURVEY AREA

Mosul Dam and its beneficial areas for agriculture (South, North and East Jazira), Nineveh Governorate

Ⅲ. SCOPE OF THE PREPARATORY SURVEY

A. Terms of Reference
The Preparatory Survey shall undertake the following tasks:

A. Review of the F/S (Phase1-a)
A-1 Reassessment of the priority and necessity of the Project
- A-1-1. To review the Iraqi policies and strategies for water and land resources as well as for agriculture and to reframe the priority and necessity of the project in the current context
- A-1-2. To conduct the baseline survey of current situation and issues in the project area
    - a) To confirm natural conditions of project area
    - b) To confirm socio-economic conditions of project area and Ninevah Governorate
    - c) To confirm current status of agricultural sector and identify issues of project area and its vicinity
    - d) To assess local farmers' needs for development of irrigation facilities
- A-1-3. To analyze the current situation of North Jazira Irrigation Project as the basis for updating of South Jazira Irrigation Project Plan
- A-1-4. To collect the current information of the water regime of the Tigris and to identify the issues
- A-1-5. To review other international partners' policies and activities for relevant sectors in Iraq

A-2 Engineering Review of the F/S
- A-2-1. To analyze the hydrological conditions of the Tigris and the Mosul Dam
- A-2-2. To collect all available information and to monitor on-going and planned activities concerning operational procedures, dam safety and risk mitigation measures for further assessment on the Mosul Dam stability
- A-2-3. To assess the available water for the Project, paying due consideration on water balance in the downstream
- A-2-4. To review the F/S with a special focus on the sustainability of resources and the latest advancements in the irrigation technologies and practices

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B-1-1.To redefine the Project scope to optimize the water use and to maximize agricultural production with regard to economic and financial consideration.

B-1-2.To develop alternative development plans, depending on the availability of resources

B-1-3.To estimate total project cost and annual fund requirements in a cash flow

B-1-4.To propose technical capacity building activities supplemental to develop necessary capabilities to carry out the project

B-2 To propose an effective scheme for project implementation and O&M

B-2-1.Implementation structure

a) To review the technical capacity of executing agency and supporting agencies

b) To review the financial capacity of executing agency and supporting agencies

c) To propose implementation structure in consideration of related organizations and their role, clarifying their responsibility.

B-2-2.O&M structure

a) To identify issues of O&M on North Jazira irrigation facilities and farmers' needs

b) To propose sustainable systems for O&M of the project facilities and action plan based on SoW B-2-2 a)

B-2-3 Assistance to Farmers

a) To propose necessary farming assistance to local farmers

B-3 Evaluation of the proposed project

B-3-1.To set up the indicative criteria and methods for the evaluation of the proposed project

B-3-2.To calculate Economic / Financial Internal Rate of Return (EIRR/FIRR)

B-3-3.To conduct ex-ante evaluation

C. Review of environmental and social considerations (Phase1-a and 1-b)

C-1 To collect necessary information for category classification in the guidelines and prepare an environmental checklist including following points

C-1-1.To assess potential environmental impacts and collect additional information to support implementation of Environmental Impact Assessment (EIA) process.

C-1-2.To assess potential social impacts and collect additional information to support implementation of Social Impact Assessment.

C-2 To confirm compliance status of the proposed project designs in the Preparatory Survey with JICA Environmental Guidelines and Iraqi national regulations

Environmental Impact Assessment shall be carried out by the Ministry of Water Resources (hereinafter referred to as "MOWR") on the basis of the results of the review of the F/S. The Preparatory Survey Team shall support the MOWR.

The EIA should include following items:

(1) Executive summary shall include significant findings and recommended actions

(2) Policy, legal and administrative framework shall include discussion on the policy, legal and administrative framework within which EIA shall be carried out

(3) Project description shall be made of proposed project components and its geographic, ecological, social aspect. It shall also include map showing project site and the affected area by the Project. It shall also include the needs for any resettlement or social development plan.

(4) Baseline data shall describe relevant physical, biological and socio-economic conditions. Data should be relevant to decisions about project site, design, operation, or mitigative measures.

(5) Environmental Impacts shall include prediction and assessment of the proposed project's likely positive and negative impacts in quantitative terms. Negative Environmental Impacts shall be categorized into mitigable and non-mitigable impacts and mitigative measures shall be identified.

(6) Analysis of alternatives shall include comparison of followings;

1) Technology, design and operation including the without-project condition in terms of their potential environmental impacts,
2) Feasibility of mitigating impacts,
3) Capital and recurrent costs,
4) Suitability under local conditions, and
5) Institutional, training and monitoring requirements.

The analysis shall state the bases for selecting particular project design and offer justification for the approaches.

(7) Environmental Management Plan (EMP) shall describe mitigation, monitoring and institutional measures to be taken during construction and O&M to eliminate adverse impacts, and to mitigate them to acceptable levels.

(8) Consultation shall include views of affected people, local NGOs and regulatory agencies in a form of record of meetings.

B. Desirable Specialists for the Preparatory Survey

JICA selected and dispatched a survey team to carry out the Preparatory Survey. The JICA Sirvey Team includes the following specialists.

- Irrigation and Drainage
- Water Resource/Hydrology
- Dam/Geology
- Irrigation Facilities
- Agriculture/Land Use
- GIS
- Environmental Assessment
- Socio-Economy/Project Evaluation

The assignment of the specialists may be subject to change. The JICA Survey Team may engage local consultants, and/or other supporting staffs.

. SCHEDULE OF THE PREPARATORY SURVEY

The Preparatory Survey will be carried out in accordance with the tentative schedule attached in the Annex 1. The schedule may be subject to change during the course of the Preparatory Survey.

. REPORTS

JICA will prepare and submit following reports in both English and Arabic to GOI.

1. Inception Report:
   30 copies will be submitted at the commencement of the first work period in Iraq. Inception Report shall include Work Plans, details of approach and methods to be adapted.

2. Progress Report (1):
   30 copies will be submitted and discussed at the final stage of the first work period in Iraq. Progress Report (1) shall includes draft results of Phase1-a.

3. Interim Report:
   30 copies will be submitted at the beginning of Phase1-b. Progress Report (1) will be finalized as Interim Report after due discussions with the steering committee in Iraq and with the Japanese side.

4. Progress Report II:

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30 copies will be submitted at the final stage of the second work period in Iraq. Progress Report II shall include draft results of Phase1-b.

5. Draft Final Report:
   30 copies will be submitted after the second work period in Iraq. GOI shall submit its comments within three weeks after the receipt of the Draft Final Report.

6. Final Report:
   50 copies will be submitted within two weeks after the receipt of the comments on the Draft Final Report.

VI. ADMINISTRATIVE STRUCTURE FOR THE PREPARATORY SRUVEY

1. Steering Committee
   For the effective implementation of the Preparatory Survey, a Steering Committee (SC) is set up, consisting of the following organizations;
   1) Ministry of Water Resources
      General Directorate of Planning and Follow-up
   2) Ministry of Agriculture
      General Directorate of Planning and Follow-up
   3) Ministry of Planning
      General Directorate of Agricultural Planning
   4) Prime Minister Advisory Board
      Agriculture Initiatives
   5) JICA Survey Team
   6) JICA Iraq Office

   * In addition, persons who are designated by the Chairperson of SC may attend SC meetings.

   SC will meet whenever the necessity arises, and its functions are as follows;
   1) To evaluate the review of F/S as the final product of Phase 1-a and determine whether to implement Phase 1-b of the Survey
   2) To review the overall progress of the Survey as well as its achievements.
   3) To examine and exchange opinions on major issues arising from Project Management Team (PMT), which is described below, or in connection with the Preparatory Survey and to recommend appropriate measures.
   4) To be responsible for the high-level coordination with relevant ministries and authorities of GOI such as Ministry of Finance and Ministry of Environment.
   5) To discuss the issues pertinent to the smooth implementation of the Preparatory Survey.

2. Project Management Team
   In order to address technical and operational issues for the Preparatory Survey, a Project Management Team (PMT) is set up, consisting of the following organizations;
   1) Ministry of Water Resources
      Water Resource Directorate in Ninevah
      Administration of Studies and Design
   2) Ministry of Agriculture
      Ninevah Branch
   3) Ninevah Governorate
   4) JICA Survey Team

   * In addition, persons who are designated by the chairperson of PMT may attend the PMT meetings.

PMT will meet whenever the necessity arises, and its functions are as follows;

1) To provide data and information to the JICA Survey Team.
2) To report the progress of the Preparatory Survey to SC regularly.
3) To examine and exchange opinions on technical and operational issues arising from or in connection with the Preparatory Survey and to recommend appropriate measures.
4) To coordinate with local representatives of relevant ministries or organizations as well as with local authorities.
5) To discuss the issues pertinent to the smooth implementation of the Preparatory Survey.

PMT shall formulate the Technical Support Unit (TSU) as a technical resource pool for the PMT to utilize local expertise necessary for the Preparatory Survey. PMT shall invite relevant persons to TSU from such organizations as Mosul University, MoA Research Station, MoWR Mosul Dam Office, MoWR North Jazira Office and GD of Drilling and Wells in accordance with the issues to arise.

VII. UNDERTAKINGS OF THE GOVERNMENT OF REPUBLIC OF IRAQ

MoWR shall act as a primary counterpart agency to the JICA Survey Team in close collaboration with Ministry of Agriculture (hereinafter referred to as "MoA") and Ministry of Planning ("MoP"), and also as a coordinating body with other organizations concerned for the smooth implementation of the Preparatory Survey.

MoWR, MoA and MoP shall, at their own expense, provide the JICA Survey Team with the following items in cooperation with other organizations concerned:

(1) security-related information to ensure the safety of the JICA Survey Team;
(2) information to obtain medical service;
(3) data and information related to the Preparatory Survey;
(4) designation of appropriate counterpart personnel for the Preparatory Survey;
(5) entry permits necessary for the survey team members to conduct field surveys; and
(6) support in obtaining other privileges and benefits if necessary.

GOI shall assist the JICA Survey Team in custom clearance, exempt from any duties with respect to equipment, instruments, tools and other articles to be brought into and out of Iraq in connection with the implementation of the Survey.

GOI shall bear claims, if any arises, against the members of the JICA Survey Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in implementation of the Preparatory Survey, except when such claim arise from gross negligence or willful misconduct on the part of the member of the JICA Survey Team.

VIII. CONSULTATION

JICA and GOI shall consult with each other in respect of any matter that may arise from or in connection with the Preparatory Survey.

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THE MAIN POINTS DISCUSSED

1. Since the feasibility of the Project should be totally examined by the appropriateness of the Project plan, the JICA Mission requested the Iraqi side to provide sufficient necessary information and data to the JICA Survey Team. The JICA Mission pointed out that any lack of information and data related to the items described in 2. would make the final appraisal of the Project difficult.
2. The JICA Mission emphasized that following items should be studied.
   A) At the farmland
      - Farming plan (vegetation, farmers' organization, agricultural disseminations, marketing, farmers' intention and motivation, water tariff, farmers' income improvement, etc.)
      - Specification of the irrigation (benefit area/irrigation area, water consumption/requirement, water efficiency, irrigation rotation, water use for farming household and livestock, etc.)
      - Irrigation system (farm pond, pressurization pumping unit, irrigation devices/machines, etc.)
      - Operation and maintenance of irrigation system
      - Necessity of farmland consolidation
      - Project cost

   B) Canal/Tunnel
      - Design and its specification, hydrology, type of construction
      - Project cost

   C) Water Resource
      - Reservoir control and management
      - Measures for stability of the reservoir (current situations of grouting and a plan of underground wall including management structure, technology applied for the construction, construction cost, construction period, etc.)
3. The Iraqi side agreed with the importance of relevant data and information and promised to do their best for providing them to the JICA Survey Team through necessary procedures.
4. Both the JICA Mission and the Iraqi side confirmed that the Iraqi officials concerned would be expected to have opportunities for capacity development through working together with the JICA Survey Team. The Iraqi side showed its great expectation on such opportunities.
5. Both the JICA Mission and the Iraqi side reconfirmed that the Preparatory Survey is divided into the following two phases;

   (1) Phase1-a: Review of the existing F/S: and

   (2) Phase1-b: Redefining scope of the Project (Proposal of an appropriate irrigation project)

   The JICA Mission explained that there might be a possibility that JICA would not implement Phase1-b, if any feasible irrigation project would not be found during Phase1-a. Both sides agreed that the decision on whether to go to Phase1-b or not would be made based upon evaluation of the results of Phase1-a.

6. It was agreed between the JICA Mission and the Iraqi side that SC should be established as soon as possible. The both sides confirmed that the names and designations of SC members would be reviewed and reconsidered by the Iraqi side, which would be shared with JICA. Chairperson of SC would be identified in the course of the reconsideration. The same procedures would be made for the membership of PMT as well.
7. The JICA Mission explained that the JICA Survey Team had set up their office in Erbil and they would mainly work in the City. The JICA Mission also mentioned that due to current security conditions of Iraq the JICA Survey Team had called on a local consultant firm to conduct some field surveys for them. The JICA Mission requested for the Iraqi side's understanding and necessary arrangement on this matter. The Iraqi side replied that they would facilitate communications between the JICA Survey Team and the Iraqi side and they would also accommodate the activities made by the local consultant firm, if they would receive an official request from the JICA Survey Team.

END

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Appendix 3

LIST OF ATTENDANTS

Iraqi Side

Prime Minister's Office

Mr. Thamir A. Ghadhban, Chairman of Prime Minister Advisory Board, Head of the Monitoring Committee
Mr. Hussein Ali Jabir, Executive Director of Higher Committee for Agricultural Initiative

Ministry of Planning

Ms. Huda A. Malik, Director General of International Cooperation Directorate
Ms. Eqood Al-Saad, Head of Human Development Division
Mr. Husham Qasim Saudi, Director General of Agriculture Planning Department
Mr. Mahdi H. Ali, Chief Engineer (Civil Engineering), Head of Followup Section in Agriculture Planning Department

Ministry of Water Resources

Mr. Salar Bakr Sami, Director General of Planning and Follow-up
Mr. Sami Muhi Alddin Hassan, Assistant Director General, Commission for Execution of Irrigation and Reclamation Projects
Ms. Khalida Nafe' Ayob, Senior Chief Engineer, Planning and Follow-up Office
Mr. Abdulkhlik Thanoon Ayoub, Mosul Dam Manager
Mr. Ghanim Mohammed Hussein, Senior Chief Engineer, Studies and Design Center
Mr. Riyadh Ezulddin Ali, Deputy of Mosul Dam Manager
Mr. Abdul Jajied, Engineer, Ninevah Work Resources (in charge of North Jazira Irrigation Project)

Ministry of Agriculture

Japanese Side

JICA Consultation Mission

Mr. Yoshiyuki Goya, Team Leader
Dr. Shigeru Tani, Dam Specialist
Ms. Michiko Umezaki, Planning and Coordination

JICA Iraq Office

Mr. Masaaki Matsushima, Chief Representative
Ms. Mariko Senda, Project Formulation Advisor
Mr. Kazuyoshi Yamashita, Project Formulation Advisor
Mr. Jalal M. Abdullah Sendory, Senior Program Manager

JICA Preparatory Survey Team

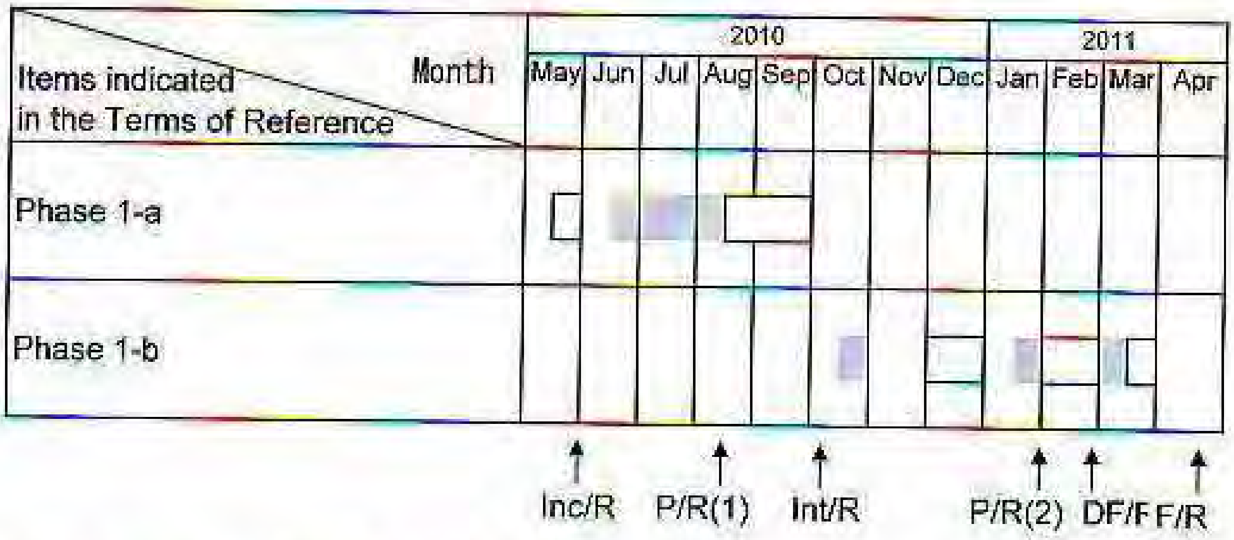
Mr. Kazumitsu Tsumura, Team Leader/Irrigation and Drainage
M. Futoshi Kuromi, Water Resource/Hydrology
Mr. Shigeru Sugiyama, Dam/Geology
Mr. Kenji Miyazaki, Irrigation Facilities
Mr. Toshihiko Kuno, Agriculture/Land Use

MoA

Annex 1

Tentative Schedule

Preparatory Survey on South Jazira Irrigation Project



Draft Final Report (DF/R) and Final Report (F/R) will be prepared in Japan after the completion of the work in Iraq.

work period in Iraq

work period in Japan

Japan International Cooperation Agency
Iraq Office

22 December 2010
Ref. No.: JICA/IRQ 2010-47

Mr. Salar Bakr Sami
Director General of Planning and Follow-up
Ministry of Water Resources
Baghdad, Republic of Iraq

Re: Minutes of Meetings for Interim Report Meeting for the Preparatory Survey on South Jazira Irrigation Project

Dear Mr. Salar,

First of all, I would like to express my sincerest appreciation for your continuous support for the captioned survey.

JICA and the Survey Team had had a series of discussions at the request of the Iraqi side in the interim report meeting in November which is described in the Minutes of Meeting as "1-1: Water Allocation," "1-2: Minimum scale of the Project" and "1-3: Scenarios of the Project scale" in Annex 1.

We are pleased to inform you that JICA would like to supplement Terms of References (TOR) for the Survey Team to meet the said request.

Followings are major clarified points between JICA and the Survey Team. You are kindly requested to acknowledge and share these points among Iraqi ministries concerned, and please submit the requested data and information at the soonest possible to the Survey Team. The detailed list of requested data and information is shown in Annex 2.

1. **Proposed Data and Projects indicated in the Final Report**

   JICA and the Survey Team would like to indicate data and proposed projects in the Final Report as follows:

   1) Water Allocation for the Project:

      The Survey Team is to analyze this feasible allocation for the project with indicators of the inflow to the Mosul dam and the discharge to the downstream;

2) Feasible Scale of the Project:
   The most feasible scale of the project (Tunnel Plan and Pump Plan) will be indicated based on the abovementioned water allocation;
3) Scenarios of the Project Scale:
   JICA and the Survey Team will indicate several proposed projects for the Tunnel Plan only; and
4) Minimum Scale of the Project:
   The most minimum scale of the project to be feasible will be indicated based on the abovementioned water allocation and scenarios for the Tunnel Plan.

2. Schedule of the Survey

JICA and the Survey Team would like to offer the change of the schedule due to supplement TOR. It would be much appreciated if the Iraqi side could accept the change of the schedule as follows:

1) in late February 2011: Submission of the Progress Report (2)
   Holding of the meeting in Erbil
2) in the end of April 2011: Completion of the Survey

As a result, total period of the Survey will be postponed for one month from original schedule, only if requested data and information listed in Annex 2 will be provided to the Survey Team at the earliest possible.

If you have any inquiries, please do not hesitate to contact us at any time. We are always grateful for all your efforts for facilitating the implementation of the survey as ever.

Sincerely yours,

for

Masaaki Matsushima
Chief Representative

C.C.
- Ministry of Planning
- Ministry of Agriculture
- JICA Headquarters
- JICA Survey Team

Annex 1

Minutes of Meetings
for
The Preparatory Survey
on
South Jazira Irrigation Project
in Republic of Iraq

Agreed upon among
Ministry of Planning (MoP), Ministry of Water Resources (MoWR) and
Ministry of Agriculture (MoA), the Government of Republic of Iraq
and
JICA Study Team for the Preparatory Survey
on South Jazira Irrigation Project

Erbil, Republic of Iraq

November 2010

Preface

Based on the Minutes of Meetings on August 2010 for the Preparatory Survey (hereinafter referred to as "Study") on South Jazira Irrigation Project (hereinafter referred to as "Project") agreed upon between the Government of Republic of Iraq (hereinafter referred to as "GOI") and Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA dispatched the JICA Study Team for the Project (hereinafter referred to as "JICA Team") for the explanatory of an Interim Report of the Study (hereinafter referred to as "It/R").

The JICA Team held a series of discussions in the meeting on November 11 and 12 in 2010 (hereinafter referred to as "Meeting") with Ministry of Planning (MoP), Ministry of Water Resources (MoWR) and Ministry of Agriculture (MoA) of the GOI (hereinafter referred to as "Iraqi Officials") on the It/R consisting of 1) Results of Phase 1-A study, 2) Scope and contents of Phase 1-B Study and 3) Operational plan of Phase 1-B and so on. After the discussions, both sides of the JICA Team and the Iraqi Officials (hereinafter referred to as "both sides") confirmed the main points discussed in the Meetings as summarized in the Attachment-1.

Attachment-1: Main points discussed in the Meetings
Attachment-2: List of attendance in the Meeting

Attachment-1

Main points discussed in the Meetings

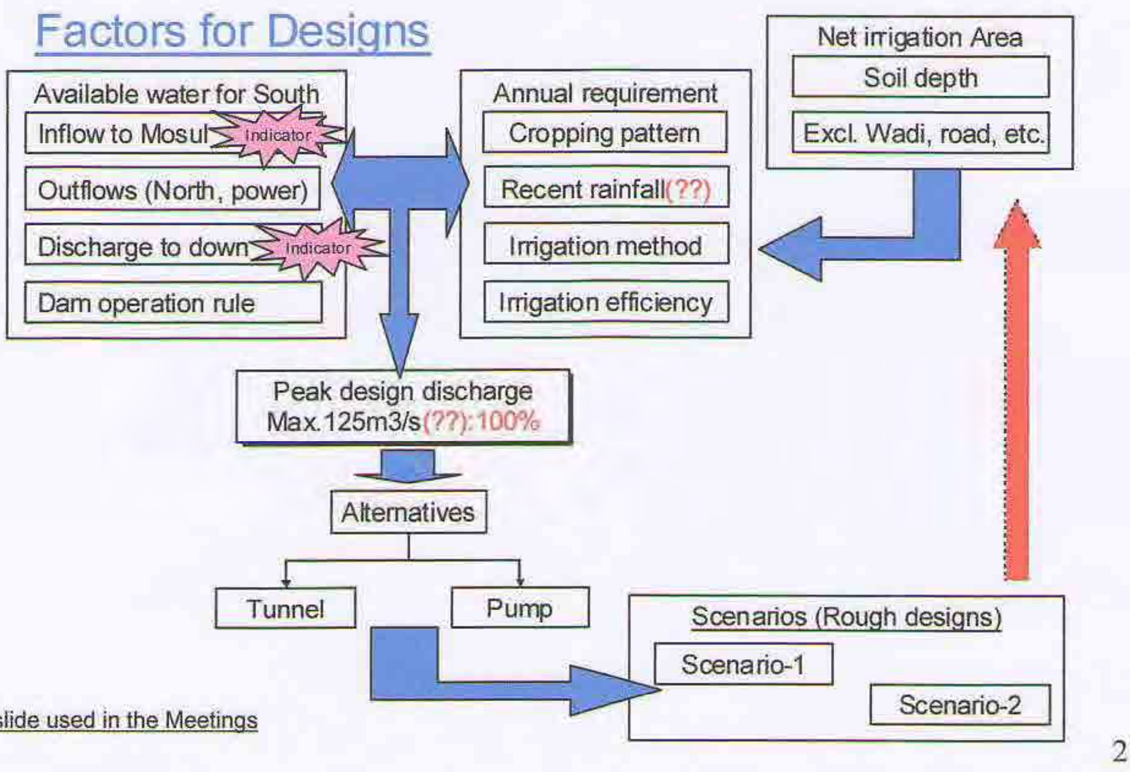
1. Examination of Annual Water Requirement for the Project

1-1. Intake volume for the South Jazira Irrigation Project (water allocation for the Project);

JICA Team requested to the Iraqi Officials to confirm by well discussions between MoWR and MoA that "Water Treaty" to be agreed upon among upstream counties in the near future would not affects an intake volume for the South Jazira Irrigation Project, since it has been essential to decide the project scale such as irrigation area, sectional profile of feeder canal and pump scale, etc. to be planned during the Phase 1-B Study.

The Iraqi Officials expressed that forecasting annual inflow (which is currently 19.43 BCM in average) to the Mosul dam reservoir and necessary discharge to the downstream of Tigris river (Swiss consultants recommend 330 m^3/s in minimum based on dam operation rule) could not be provided without conclusions of "Strategy Study for Water and Land Resources in Iraq (SWLRI)" being conducted by Italian consultants and scheduled to be taken 2 to 3 years. Instead, the Iraqi Officials promised to provide indicators of the inflow and the discharge to the JICA Team.

Both sides confirmed the indicators being provided should be with reliable reasons to evaluate them, and 125 m^3/s of peak discharge for the feeder canal or 1.275 BCM of annual water requirement for the Project recommended in the Swiss F/S report, would be reduced by the results of the Phase 1-B Study.



A slide used in the Meetings

1-2. Minimum scale of the Project;

The Iraqi Officials requested to JICA Team to prepare minimum scales of the Project to be feasible in consideration with such proposed irrigation area, annual water requirement, intake volume, construction cost, etc. for the both alternatives on Tunnel and Pump plans.

1-3. Scenarios of the Project scale

Moreover, the Iraqi Officials expressed that other scenarios in selected alternative (Tunnel plan or Pump plan) should be prepared by JICA Team in consideration with the SWLRI being concluded later on. Also, the Iraqi Officials mentioned those scenarios would be applied for viability of water resources management plan in Iraq to be set up in the future.

JICA Team responded the above matters including item 1), 2) and 3) would be reported to JICA Consultation Committee in Tokyo while they have been beyond the description in the JICA TOR (Terms of Reference) to the JICA Team.

2. Formulation of Farming Program

JICA Team requested following data/ information to the Iraqi Officials;

1) Population data of all villages where the Project area covers, and
2) Information of relation among villages, sub district and district.

The Iraqi Officials suggested as follows;

1) Scale of a rotation block should be larger than JICA Team proposed (500 x 350m) in consideration with existing cultivation unit.
2) Live stock development plan should be designed based on Swiss F/S report.

Both side agreed following terms;

1) Cropping pattern XYZ should be set up as basic pattern and revised in consideration with current situation of infrastructure, agricultural development plan in Iraq, and successful crop in North Jazira Project.
2) Farm lands located at high-pitched slope should be eliminated from the target irrigation area other than Wadi, residential areas, roads, etc.

3. Natural and Social Environmental Conditions

3-1. Environmental Impact Assessment (EIA)

The Iraqi Officials stated EIA would be required for the Project.

And JICA Team requested following data/ information to the Iraqi Officials;

1) As an example, EIA of existing other project, and

2) Information of consultants farm which contracted to EIA.

3-2. Procedure on land acquisition

Both sides discussed following terms;

1) Low No.138 (1977) describes land acquisition procedure concerned.
2) Low No.138 regulates that price of land being impounded should be agreed upon among MoWR, MoA, Ministry of Finance, and municipality.
3) Organization of stakeholder meeting on land acquisition is not regulated by law, however, Prime Minister's Act recommends to be obligated by MoWR, local government and land owners.
4) 19.6 BCM as described in "UNESCO International Hydrological Program Iraq Country Report, 2007" indicates the initial volume to recover marshlands. Less annual water volume is required to maintain the marshland.
5) Appropriate annual water volume, both to recover and to maintain marshlands will be provided by SWLRI in the future.

4. Stability of the Mosul Dam

Both sides confirmed that the Mosul dam could be stable with 1)construction of diaphragm, 2)maintaining grouting, 3)strong will of the GOI for the stability, and 4)international technical cooperation.

5. Scope and Contents of Phase 1-B Study

JICA Team explained outline for scope and contents of Phase 1-B, and also mentioned the detailed scope would be finalized after discussions with JICA Tokyo. And the Iraqi Officials understood them.

6. Data/information Collection for the Further Study

In the basis of the above discussions, JICA Team requested to the Iraqi Officials to provide additional data/ information.

The Iraqi Officials requested to JICA Team to submit list of data/ information with priority by official letter.

7. Schedule for Further Phases of the Study

JICA Team explained that Phase 1-B Study would be proceeded and its Progress report(2) would be provided in January 2011. The Iraqi Officials requested to JICA Team that the Progress report(2) should be delivered to the Iraqi Officials by two(2) weeks before the explanatory meeting.

Attachment-2

List of attendance in the Meeting

Title of Meeting : Explanation of Interim Report **(1st Day)**
Date: 11/November/2010. Place Erbil international Hotel

No.	Name	Position
1	Sami Muhi Alddin	Assistant Director General, MOWR
2	Khalida Nafie Ayoub	Chief Engineer, MOWR
3	Moaid K. Mahmoud	Chief Engineer, MOWR.
4	Alaa Turki Khudhair	Engineer, NCOWR, MOWR
5	Shawkat S. Jameel	Head of Section for Water management, MOA
6	Mahdi H. Ali	Assistant Chief Engineer, MOP
7	Ghanim M. H.	Manager, Project Management Team (PMT)
8	Namir Al-Sarraf	PMT
9	Wail Thaker	PMT
10	Abdol Maijied Zoba	PMT
11	Kazuyosh Tamashita	Representative, JICA Iraq Office
12	Nadim Habib	Dar Al Handasah
13	Zaid S. Ali	Dar Al Handasah
14	Omar N. M.	Dar Al Handasah
15	Ali Al Bazzaz	Dar Al Handasah
16	Kazumitsu Tsumura	Team Leader, JICA Study Team
17	Shigeru Sugiyan	Dam, Geology, JICA Study Team
18	Kenji Miyazali	Irrigation and Drainage, JICA Study Team
19	Toshihiko Kuno	Agriculture, Land use, JICA Study Team

Title of Meeting : Explanation of Interim Report **(2nd Day)**
Date: 12/November/2010. Place Erbil international Hotel

No.	Name	Position
1	Sami Muhi Alddin	Assistant Director General, MOWR
2	Khalida Nafie Ayoub	Chief Engineer, MOWR
3	Moaid K. Mahmoud	Chief Engineer, MOWR.
4	Alaa Turki Khudhair	Engineer, NCOWR, MOWR
5	Shawkat S. Jameel	Head of Section for Water management, MOA
6	Mahdi H. Ali	Assistant Chief Engineer, MOP
7	Ghanim M. H.	Manager, Project Management Team (PMT)
8	Namir Al-Sarraf	PMT
9	Wail Thaker	PMT
10	Abdol Maijied Zoba	PMT
11	Kazuyosh Tamashita	Representative, JICA Iraq Office
12	Nadim Habib	Dar Al Handasah
13	Omar N. M.	Dar Al Handasah
14	Ali Al Bazzaz	Dar Al Handasah
15	Kazumitsu Tsumura	Team Leader, JICA Study Team
16	Shigeru Sugiyan	Dam, Geology, JICA Study Team
17	Kenji Miyazali	Irrigation and Drainage, JICA Study Team
18	Toshihiko Kuno	Agriculture, Land use, JICA Study Team

Annex 2

Confirmation on Response by MoWR

	Description
JICA Team requested (Nov.15)	**Priority-1. Indicators for inflow to the Mosul dam reservoir and discharge to the downstream as shown at "Item 1-1. of Main points discussed in the Meetings" of this Minutes of Meetings.** **(1) The inflow data into the Mosul dam reservoir after the developments by Turkey.** JICA Team requests the inflow data into the Mosul dam reservoir that MoWR assumed the effects by the upper countries' developments with some documents that shows the reasons and methodology. If the data is shown on daily base, electrical digital data is convenient for JICA Team to analyze them.
MoWR answered (Dec.05)	**Priority 1 –1** - Regarding item No 1, the inflow data into the Mussol Dam reservoir after the development projects in Turkey and Syria: 1. The general average for the inflow of Tigris River for the period (1931-2010) was 20.1 BCM/year including Khabour tributary, measured at the location of Tigris River in Mussol, and after the dam construction in 1985 measured in Tigris River at the downstream of the Dam. 2. It is to be noted that due to the development project in Turkey as well as to the general warming and the meteorological changes for the period (1999-2010), the inflow in the Tigris River at the downstream of the dam reached 14.95 BCM/year. 3. Some reports published on the internet and among them (Ilicu dam report and a report for a study done by the Turkish Ministry of Foreign Affairs), that the consumption in Turkey from the Tigris river will reach approximately 6.5 BCM/year to irrigate agricultural areas exceeding 635,000 ha and that the consumption in Syria will exceed 2 BCM/year to irrigate agricultural areas exceeding 200,000 ha and that the losses due to evaporation in the Turkish dams will reach 1.5 BCM/year. Thus, and due also to the missing water sharing agreements taking into account the actual situation, the development plan and all the uses, it is probable that the inflow to the Tigris inside the Country will be around half the quantity noted in Item 1 above.
JICA Team re-requests (Dec.13)	**Please refer to the item 1-1. "Minutes of Meeting (M/M) for Interim Report Meeting" dated on 8 December 2010 (Ref. No. JICA/IRQ 2010-43).** **An indicator of the inflow to the Mosul dam reservoir is calculated by the above explanation as below;** **20.1 BCM – (6.5 + 2 + 1.5) =10.1 BCM. It will be around half the quantity noted in item 1 above.** **Do you accept that 10.1 BCM/year is the Indicator of annual inflow to the Dam?**

JICA Team requested (Nov.15)	**Priority-1. Indicators for inflow to the Mosul dam reservoir and discharge to the downstream as shown at "Item 1-1. of Main points discussed in the Meetings" of this Minutes of Meetings.** **(2) The outflow (discharge) data to the downstream of the Mosul dam reservoir after the developments in Iraq in the future.** JICA Team requests the necessary outflow to the downstream area of the Mosul dam reservoir in consideration with the planned water allocation of whole Iraq. It should be the daily, monthly and annual lowest release at the Mosul dam to downstream. JICA Team needs some documents that explain the reasons and methodology. If the data are shown on daily base, electrical digital data is convenient for JICA Team to analyze them.

MoWR answered (Dec.05)	**Priority 1 - 2:** Regarding the outflow of Mussol dam, we would like to clarify that most of the inflow in the Tigris River at the dam's downstream passes at the dam's upstream (after deducting losses due to evaporation and the uses in North Jazira Project), taking into account the following two principal seasonal plans to operate the dam: 1. Filling Plan: In this operation the dam is filled up to reach the normal operation level of the dam, which is 330 m above sea level, at the end of the winter season at June 1st, but due to the stability issue of the dam a maximum filling level of 319 m was observed lately. This level is temporary as the consolidation works will start next year in order to resume the operations according to the original operation levels. 2. Emptying Plan: During this operation the water is released to cater for the different needs in the Center and South parts of the Country keeping in mind to keep a level between (307 and 310 m) at the end of the summer season, 1st of Nov. Keeping these levels is necessary for the sustainable operation of North Jazira irrigation Project and the electrical generation units. Levels may be lower than that as it already happened in severe drought years. We would like also to point out that Mussol dam operation is linked to the operation of the system formed by the Tigris and Euphrates basins (The upper Zab tributary, operation of the Tharthar lake, Haditha dam and Habanieh lake).
JICA Team re-requests (Dec.13)	**Please refer to the "item 1-1." in the M/M.** **We could not find any Indicator for discharge to the downstream of Mosul Dam. You are kindly requested to provide us the Indicator for it, in consideration with water demands such as irrigation, domestic, industrial water, etc. including marshland conservation at downstream of Tigris-Euphrates rivers, so that JICA Team can start to simulate the available water volume for the South Jazira Irrigation Project by examining outflow of North & East Jaziras, from spillway and bottom, for power generation and so on, after collecting "inflow and outflow data" which is described in Priority-3 as below.**

JICA Team requested (Nov.15)	**Priority-2. Meteorological data for the calculation of irrigation water requirement.** The meteorological data of Mosul, Tel Afar, Sinjar, Baaj and Baghdad stations relevant to the Project area for **recent 19 years (1981 - 2009)** should be collected and compared these data with the previous one. Data of Baghdad is also needed in comparison of the trends between time of Swiss F/S and current condition. Since there were several drought years during the latest 10 years, the JICA Team judges that the longer-term records should be necessary, and request the data after Swiss consultants collected on F/S report. The following items shall be collected in each station on daily base;
MoWR answered (Dec.05)	**Priority 2:** Regarding the requested metrological data (2nd item), the Board of consultants coordinated with Ministry of Transport (the relevant administration to provide these data) in order to facilitate obtaining these data.
JICA Team re-requests (Dec.13)	**When do you expect that these data is obtained from Ministry of Transport?**

JICA Team requested (Nov.15)	**Priority-3. The actual inflow and outflow data relating to the Mosul dam reservoir after the completion of construction (1986) on daily base.** **(1) Discrepancy between Annual report and data provided by MoWR** JICA Team has obtained the actual inflow and outflow data from MoWR for the latest 10 years. However, some discrepancy of outflow data sources was found as shown in below Table **(in red collar);** Outflow from the bottom discharge facility were 133-233m^3/s during January 13 to 17 2008 according to the Annual Report in 2008, while data provided by the MoWR shows 0 m^3/s on the same period. **(2) Additional data to be required from 1986 to September 1999** Data shown in the above Table from 1 to 8 are required in additional, data observed since 1986 when dam construction completed till September 1999. Electrical digital data is convenient for JICA Team to analyze them.
MoWR answered (Dec.05)	**Priority 3**: Regarding the third item, both clause 1 and 2, regarding Mussol Dam, the Project Direction of Mussol dam has already been asked to provide this data to the PMT Director Mr. Ghanim Mohammed Hussein who will provide it to you. It is to be noted that this data is under preparation at the present time at Mussol dam Directory as this data in large and concerns several years..
JICA Team re-requests (Dec.13)	**When do you expect that these data is prepared by PMT Director?**

JICA Team requested (Nov.15)	**Priority-4. Some documents or information relating to SWLRI, Phase II** JICA Team has obtained some information relating to Inception Phase Report of Consulting Services for the Development of a Water Resources Decision Support System (DSS) being conducted by Italian, Ministry of Foreign Affairs Cooperation. JICA Team needs to know the result or activities relating to SWLRI Phase II, such as the Inception, Interim, Progress reports, so on.
MoWR answered (Dec.05)	**Priority 4**: Regarding Item 4 about the interim reports of the Strategic Study for Water and Land Resources (SWLRI) - Phase 2, it is to be noted that the Italian Consultant did not start the study and no report is available at present. What is ready is only the scope of the study and the team's tasks. (Copy Attached).
JICA Team re-requests (Dec.13)	**We have already received a report for the scope of the SWLRI.** **We deeply appreciate your cooperation.**

JICA Team requested (Nov.15)	**Priority-5. Agriculture data** 1) Property and agriculture data in 2008 by district level 2) Property and agriculture data in 2009 by district level ● Provided "Property and Agriculture Data in 2008 & 2009" does not cover district level but governorate level only. 3) Population data of all villages where the Project area covers. 4) Information of villages related to the Project, sub district and district should be provided.
MoWR answered (Dec.05)	

JICA Team re-requests (Dec.13)	**We can not find any response for Priority-5.** **You are kindly requested to confirm "Item 2. Formulation of Farming Program" in the M/M and "Priority-5. Agriculture data" in the list of necessary data/ information for the further Phase 1-B Study.**

JICA Team requested (Nov.15)	**Priority-6. Soviet Report (Additional requests)**
MoWR answered (Dec.05)	**Priority 5:** Regarding the Soviet reports done in year 1982, as detailed in your letter Item 6, we handed to Mr. Omar Natik the requested volumes.
JICA Team re-requests (Dec.13)	**We have already received additional Soviet Report.** **We deeply appreciate your cooperation.**

JICA Team requested (Nov.15)	**Priority-7. Natural and social Environmental conditions** And JICA Team requested following data/ information to the Iraqi Officials; 1) As an example, EIA of existing other project, and 2) Information on consultant's farm which contracted to EIA.
MoWR answered (Dec.05)	
JICA Team re-requests (Dec.13)	**We can not find any response for Priority-7.** **You are kindly requested to confirm "Item 3-1. EIA" in the M/M and "Priority-7. Natural and social Environmental conditions" in the list of necessary data/ information for the further Phase 1-B Study.**

(end)

Japan International Cooperation Agency
Iraq Office

4 April 2011
Ref. No.: JICA/IRQ 2011-1

Mr. Salar Bakr Sami
Director General of Planning and Follow-up
Ministry of Water Resources
Baghdad, Republic of Iraq

Re: Memorandum of Discussions for Progress Report (2) Meeting on the Preparatory Survey on South Jazira Irrigation Project

Dear Mr. Salar,

First of all, we would like to express our sincere thanks for your kind cooperation and support for the captioned survey.

We are pleased to submit a Memorandum of Discussions for Progress Report (2) Meeting, which was held in Erbil on 16 and 17 March, as per attached.

Meantime, while we are expecting the next meeting on Draft Final Report will be held somewhere around the beginning of June (5 and 6 June as a present probability), prior consultation about logistical details such as date, place etc. will be forthcoming at a later date.

Thank you very much in advance for your kind cooperation and assistance as ever.

Sincerely yours,

Masaaki Matsushima
Chief Representative

JAPAN INTERNATIONAL COOPERATION AGENCY
JICA
IRAQ OFFICE

c.c.:
- Ministry of Planning
- Ministry of Agriculture
- JICA Headquarters
- JICA Survey Team

Memorandum of Discussions
for
The Preparatory Survey
on
South Jazira Irrigation Project
in Republic of Iraq

Agreed upon among
Ministry of Planning (MoP), Ministry of Water Resources (MoWR) and
Ministry of Agriculture (MoA), the Government of Republic of Iraq
and
JICA Study Team for the Preparatory Survey
on South Jazira Irrigation Project

Erbil, Republic of Iraq

March 2011

Preface

Based on the Minutes of Meetings on August 2010 for the Preparatory Survey (hereinafter referred to as “Study”) on South Jazira Irrigation Project (hereinafter referred to as “Project”) agreed upon between the Government of Republic of Iraq (hereinafter referred to as “GOI”) and Japan International Cooperation Agency (hereinafter referred to as “JICA”), JICA dispatched the JICA Study Team for the Project (hereinafter referred to as “JICA team”) to explain and discuss an Progress Report (2) of the Study (hereinafter referred to as “P/R2”).

The JICA team held a series of discussion in the meeting on March 16 and 17 in 2011 (hereinafter referred to as “Meeting”) with Ministry of Planning (MoP), Ministry of Water Resources (MoWR) and Ministry of Agriculture (MoA) of the GOI (hereinafter referred to as “Iraqi side”) on the P/R2 consisting of 1)Status of data / information collection after Interim Report Meeting (hereinafter referred to as “IT/R-M”), 2)Results and findings of the Study after the IT/R-M and 3)Recommendations to be presented in the draft Final Report (F/R) and so on. After the discussions, both sides of the JICA team and the Iraqi side (hereinafter referred to as “Both sides”) confirmed the main points discussed in the Meeting as summarized in the Attachment-1.

Attachment-1: Main points discussed in the Meeting
Attachment-2: List of attendance of the Meeting

Main points discussed in the Meetings

1. Confirmation of data / information provided by the Iraqi side after the IT/R-M

1-1. Indicator for inflow to the Mosul dam;

Both sides confirmed that value of indicator for future annual inflow to the Mosul dam provided by the Iraqi side through letter no. 24264 dated on December 5, 2010, would be 10.1 BCM/year estimated as follows.

	Annual inflow
Average annual inflow	20.1 BCM
1) Development in Turkey	−6.5 BCM
2) Development in Syria	−2.0 BCM
3) Evaporation losses	−1.5 BCM
Inflow indicator in future	**10.1 BCM**

1-2. Indicator for necessary releasing (outflow) volume

(1) The Iraqi side expressed that they can not provide indicator of necessary releasing volume since SWLRI (Strategy Study for Water and Land Resources in Iraq) being conducted by Italian consultant has not yet been concluded. Also, the Iraqi side noted that the minimum releasing volume should be maintained more than 200 m^3/s of domestic water to Mosul city as a vested right. It will be calculated 6.3 BCM (200 m^3/s x 86,400 seconds x 365 days) by converting to annual volume.

(2) The JICA team apologized that a letter with number 594 shown in below regarding on Indicators which was sent by MoWR dated on January 10, 2011, had not been referred in the Study due to careless mistake of the JICA team.

However, the JICA team understands that the figures shown in the below letter such as 7.5 BCM/year, between 8 and 12 BCM/year and 8 BCM/year are just water demands in the downstream, and not indicators for the releasing volume of the Mosul dam. Therefore, the JICA team shall follow the conditions shown in the above "item 1-2.(1)" for the further Study to simulate the Scenarios.

<EXTRACT>

Ministry of Water Resources
Department of Planning and Follow-up/Follow up Section
Number 594
Date: 10-01-2011

Subject: South Jazira Irrigation Project/Request for Information
Greetings…
Further to our letter 24264 dated 5/12/2010 and reference to your electronic letter dated 22/12/2010, we point out the following:

1. As per paragraph (1-1) of your letter, the outflow volume of 10.1 BCM/year is correct based on the adopted assumptions in the analysis of the future inflows in Tigris River, in the absence of treaties.
2. Regarding paragraph (2-1) of your letter: The adopted principles for Mussol Dam operation and the relation with the system of dams and reservoirs on Tigris and Euphrates basins were already clarified in paragraph 3 of our referenced letter. The water supply for different uses is determined by the yearly water revenues and the effective water reserves in dams and reservoirs. The operation planning for the summer agricultural season is based on the real reserves at May 30th of each year and in coordination with Ministry of Agriculture in order to fix the agricultural areas to be irrigated. Moreover there are other needs, as follows:
   a. Daily needs, like potable water, industrial and environmental needs and others: Around 7.5 BCM/year.
   b. Marshlands relief: Between 8 and 12 BCM/year
   c. Losses due to evaporation in dams, based on the reservoir level and its area: Around 8 BCM/Year.

We point out that the above quantities may vary depending on the nature of the hydraulic year starting October 1st and finishing September 30th of the next year, depending if it is a drought year or normal or exceptionally flooded. Then the operations planning is set up based on this and with many alternatives.

1-3. Inflow / outflow data of the Mosul dam operation

Both sides confirmed the JICA team will utilize inflow / outflow data during October 1993 to September 1999 (for 6 years), out of the data between 1993 and 2009 provided by MoWR, for analyzing actual operation performance and water balance of the Mosul dam.

1-4. Latest meteorological data concerning the Project

Both sides confirmed the JICA team will utilize meteorological data from 1990 to 2009, provided by Ministry of Transport (MoT) through MoWR for calculation of seasonal crop water requirement prior to use CROPWAT methodology.

1-5. Population data and district boundary of the Project area

Both sides confirmed data for population and district boundary concerning the Project area provided by PMT should be applied to estimate beneficiaries of the Project rather than the one provided by MoA. On the other hand, as for numbers of farmers, MoA data shall be adopted after recomposing that.

1-6. Calculation of net irrigation area

Both sides confirmed that net irrigation area should be calculated based on the surface soil depth map shown in the Swiss F/S report, in consideration of the result of soil survey conducted by the JICA team.

2. Outline of water resources availability in future

Both sides confirmed in the case that inflow to the Mosul dam would be reduced to 10.1 BCM in future, current performance of power generation could not be maintained and water distribution to the downstream would be insufficient, if priority of water allocation would be given to agriculture (irrigation).

Also, Iraqi side expressed priority should be given to 1)Flood control, 2)Agriculture, and 3)Power generation in order.

3. Irrigated agriculture plan

3-1. Maximum irrigation service area

Both sides confirmed, if water resources were not limited, the maximum net irrigation area in the Project would be 147,600 ha by following considerations;

Description	Area[1)]	Ratio[2)]	Remarks
1) Gross project area	220,800 ha		
2) Suitable for irrigation	178,638 ha	80.9 %	Excluded area of wadi, residential, road, etc.
3) Area for farmland	167,026 ha	93.5 %	Excluded area of road, canal, etc.
4) Surface soil depth	148,653 ha	89.0 %	Excluded less 50 cm
Max. net irrigation area	**147,600 ha**	**67 %**	

Remarks 1), 2); figures between 1) and 2) are not matched due to round up numbers.

3-2. Cropping pattern

The JICA team recommended applying an improved XYZ cropping pattern, namely αβγ, taking consideration into water saved irrigation, and the Iraqi side agreed to it.

3-3. Calculation of seasonal crop water consumption

The JICA team explained seasonal crop water consumption was calculated by applying rainfall (Pe), evapo-transpiration (ET_0), crop coefficient (Kc), of which values shown in the Swiss F/S report were due since the latest meteorological data in monthly provided by MoT through MoWR was not in time. Both sides confirmed the above value should be replaced by the latest data with using CROPWAT methodology in monthly base at draft F/R. Moreover, the JICA team recommended the Iraqi side to apply daily base data to acquire higher accurate result in prior to project implementation.

3-4. Irrigation efficiency

The JICA team recommended adopting irrigation efficiency 0.68 by applying sprinkler irrigation.

4. Irrigation water availability and irrigation service area by scenarios

The Iraqi side recommended “Scenario 0, 1 and 2” for preparing the outline design including drawing, cost estimate and project evaluation while the JICA team introduced following four(4) scenarios. Then, the JICA team agreed to it.

Unit: BCM/year

Scenario	Inflow in future	Planned annual irrigation water for Jaziras				Water for power (releasing volume)	Irrigation area	Intake discharge
		North (fixed)	East (fixed)	South	Total			
Scenario 0	10.10	0.77	0.79	0.99	2.55	6.81	147,000 ha	100 m^3/s
Scenario 1				0.79	2.35	7.01	118,200 ha	80 m^3/s
Scenario 2				0.58	2.14	7.23	86,300 ha	60 m^3/s
Scenario 3				0.40	1.96	7.42	59,100 ha	40 m^3/s

5. Facilities plan and project evaluation

The JICA team explained status and progress of facility planning, in addition to further study and design to be carried out as shown in the following table, and the Iraqi side showed understanding of it.

Scenario	0	1	2
Design discharge	100 m^3/s	80 m^3/s	60 m^3/s
Alternatives of feeder canal	1) Tunnel 2) Pump	Tunnel	Tunnel

Furthermore, the Both sides confirmed the minimum project scale should be found at the point of IRR 0 %.

6. Discussion on recommendation (draft) to be presented in the F/R

The JICA team proposed following recommendations in draft during the Meeting;

6-1. Appropriate Feasibility Study (F/S)

F/S should be made in linkage of concerning subjects such a)Water availability, b)Farming planning, c)Facility designing, d)Cost estimate, and e)Project evaluation by same design condition and appraisal year.

6-2. Water balance study of the Mosul dam reservoir

1) *SWLRI should indicate future inflow volume to the Mosul dam and necessary releasing volume to the downstream considering of a)Agriculture (Irrigation), b)Power generation, c)Industry, d)Water supply, and e)Conservation of marshlands.*
2) *Long term inflow/outflow data of the Mosul dam reservoir is required for the "up-dating dam operation rule" in consideration of forecasting influence of global warning and climate change.*

6-3. Irrigated agriculture planning

1) *Meteorological data in daily base should be recorded at appropriate stations and analyze them for setting up crop water consumption prior to utilize "CROPWAT" methodology.*
2) *Practical operation of water management will be needed to maintain proper farming and irritation facilities by well organized farmers' group for water saving.*

6-4. Irrigation facility planning

Information on topographical and geological conditions of the Project area should be updated for detailed design (D/D) of the next stage.

6-5. Water resources development / management in nation wise for the future

1) *Priority of the agricultural water utilization should be given in consideration of meteorological conditions by nation wise.*
2) *Concerning water resources development / management, multiple linkages among sectors such as agriculture (irrigation), energy, water supply, industry, etc. is essential considering through the financial balance in Iraq.*

6-6. Recommendation (draft)

1) Water saving irrigation such as sprinkler, drip, etc. should be applied in nation wise, not only in Jazira irrigation project areas.

2) Ministries concerning on water resources in Iraq should have well discussions on the water treaty among upstream counties of Tigris basin resolutely through scientific engineering.

3) Master Plan (M/P) on water resources development as well as management should be built taking into consideration water demands of entire country in Iraq.

The Iraqi side has given the following comments to the above recommendations (draft);

1) To the "Item 6-3.2)", MoA noted that pilot farm should be set up at the beginning of the Project implementation in prior to build capacity of water users' association (WUA).

2) To the “Item 6-5.2) and 6-6.”, MoWR noted those are seems to general recommendations while conclusions of the Study has not presented yet at the present and the conclusions of the Study should be connected to the recommendations.

7. Technical transfer

Followings are subjects of technical transfer from the JICA team to the Project Management Team (PMT);

1) Calculation of irrigation water requirement

2) Water balance study of the Mosul dam

Attachment-2

List of attendance of the Meeting

Title of Meeting : Explanation of Progress Report (2): **1st Day**
Date: 16/March/2011, Place Nobel Hotel, Erbil

No.	Name	Position
1	KhalidaNafieAyoub	ChiefEngineer,MOWR
2	ShawkatS.Jameel	HeadofSectionforWatermanagement,MOA
3	MahdiH.Ali	AssistantChiefEngineer,MOP
4	GhanimM.H.	Manager,ProjectManagementTeam(PMT)
5	NamirAl-Sarraf	PMT
6	WailThaker	PMT
7	AbdolMaijiedZoba	PMT
8	JaffasSadeek	MinistryofAgriculture,DirectorofNinewa
9	MasaakiMatsushima	ChiefRepresentative,JICAIraqOffice
10	KazuyoshYamashita	Representative,JICAIraqOffice
11	JalalM.AbdullahSendory	SeniorProgrammeManager,JICAIraqOffice
12	NadimHabib	DarAlHandasah
13	OmarN.M.	DarAlHandasah
14	KazumitsuTsumura	TeamLeader,JICAStudyTeam
15	FutoshiKuromi	WaterResources/Hydrology,JICAStudyTeam
16	KenjiMiyazali	IrrigationandDrainage,JICAStudyTeam
17	ToshihikoKuno	Agriculture,Landuse,JICAStudyTeam

Title of Meeting : Explanation of Progress Report (2): **2nd Day**
Date: 17/March/2011, Place Nobel Hotel, Erbil

No.	Name	Position
1	KhalidaNafieAyoub	ChiefEngineer,MOWR
2	ShawkatS.Jameel	HeadofSectionforWatermanagement,MOA
3	MahdiH.Ali	AssistantChiefEngineer,MOP
4	GhanimM.H.	Manager,ProjectManagementTeam(PMT)
5	NamirAl-Sarraf	PMT
6	WailThaker	PMT
7	AbdolMaijiedZoba	PMT
8	JaffasSadeek	MinistryofAgriculture,DirectorofNinewa
9	KazuyoshYamashita	Representative,JICAIraqOffice
10	NadimHabib	DarAlHandasah
11	OmarN.M.	DarAlHandasah
12	KazumitsuTsumura	TeamLeader,JICAStudyTeam
13	FutoshiKuromi	WaterResources/Hydrology,JICAStudyTeam
14	KenjiMiyazali	IrrigationandDrainage,JICAStudyTeam
15	ToshihikoKuno	Agriculture,Landuse,JICAStudyTeam

Memorandum of Discussions for The Preparatory Survey on South Jazira Irrigation Project in Republic of Iraq

Agreed upon among
Ministry of Water Resources (MoWR), Ministry of Agriculture (MoA) and
Ministry of Planning (MoP), the Government of Republic of Iraq
and
JICA Study Team for the Preparatory Survey
on South Jazira Irrigation Project

Baghdad, Republic of Iraq

July 2011

Preface

Based on the Minutes of Meetings on August 2009 for the Preparatory Survey (hereinafter referred to as "the Study") on South Jazira Irrigation Project (hereinafter referred to as "the Project") agreed upon between the Government of Republic of Iraq (hereinafter referred to as "GOI") and Japan International Cooperation Agency (hereinafter referred to as "JICA"), JICA dispatched the JICA Study Team for the Preparatory Survey on the Project (hereinafter referred to as "JICA team") to explain and discuss an Draft Final Report of the Study (hereinafter referred to as "DFR").

JICA team held a series of discussion in the meeting on July 25 and 26 in 2011 (hereinafter referred to as "Meeting") with Ministry of Water Resources (MoWR), Ministry of Agriculture (MoA) and Ministry of Planning (MoP) of the GOI (hereinafter referred to as "Iraqi side") on the DFR consisting of 1) Results of the Study, 2) Questions and answers to the results and 3) schedule of Final Report (FR) to be submitted and so on. After the discussions, both sides of the JICA team and the Iraqi side (hereinafter referred to as "Both sides") confirmed the main points discussed in the Meeting as summarized in the Attachment-1.

Attachment-1: Main points discussed in the Meeting
Attachment-2: List of attendance of the Meeting
Attachment-3: Detailed comments made by Iraqi side on the DFR and actions to be taken for them by JICA team prior to finalize the FR
Attachment-3-1: Additional comments made by Iraqi side through letter 17988 dated on August 2, 2011.
Attachment-3-2: Comments made by Iraqi side made in the DFR Meeting, held on July 25 and 26, 2011.

Attachment-1

Main points discussed in the DFR Meeting

Main points discussed in the Meeting are followings; Detailed comments made by Iraqi side on the DFR and actions to be taken for them by JICA team prior to finalize the FR, are shown in the Attachement-3.

1. Comments made by Iraqi side and responses by JICA team

1-1. Period of construction schedule

Iraqi side pointed out that proposed construction period of the Project (19 years) was long, and should be revised based on the Water Resources Development Strategic Plan (2010-2014) published by MoWR. JICA team accepted that the period would be revised based on the said Plan while it should be 8 to 9 years.

1-2. Crop intensity recommended by JICA team

Iraqi side requested to reduce crop intensity from 117% to 100% in consideration of tight demand for water resources in Iraq. JICA team accepted it.

1-3. Experimental field (Timing of establishing a pilot irrigation farm)

Iraqi side suggested that, since an impact of irrigation water on gypsum layer was not clear, construction of an experimental field towards the Project implementation to research the impact should be conducted. JICA team replied that the suggestion would be referred in the FR.

1-4. Pumping station at Intake of the Mosul dam

Iraqi side requested to consider the construction cost of a pumping station at dam intake in the case water level of the Mosul dam was below 310 m. JICA team accepted the request and asked the Iraqi side to provide information of construction cost of the station. The Iraqi side then agreed it.

1-5. Necessary releasing volume to the downstream

JICA team asked Iraqi side to provide clear definition of the 200m^3/s discharge to the downstream from the Mosul dam. The Iraqi side replied that the amount was not water release requirement, but flow volume to secure water level of intake to supply drinking water in steady.

1-6. Drainage System

Iraqi side requested to consider drainage system in the project facilities, due in consideration of their experience in the North Jazira Irrigation Project. JICA team accepted the request should be referred in the FR.

1-7. Drought management

Iraqi side requested, as a remarks from Italian consultants, that drought management should be added in the FR since the issue was quite important to discuss how manage irrigation water in the drought year. JICA team accepted the request and assured to refer the on-farm level management in the drought year in the FR.

1-8. Benefit of Livestock Production

Iraqi side requested JICA team to add benefit from livestock production according to the Swiss F/S report. JICA team replied that the livestock production was not direct benefit from supplying irrigation water by the Project, however, indirect benefit not only from increase in fodder crop production but also from other activities including provision of veterinary services. Then, JICA team replied to refer the issue as a qualitative impact of the Project in the FR.

1-9. EIA Study

Iraqi side requested to include the Environmental Impact Assessment (EIA) in the FR, since the issue was quite important to apply Japanese Yen Loan. JICA team replied that the EIA had to be conducted by the Iraqi side, and JICA team have not been enough time to carry out it since the Study would be terminated by the end of August 2011.

1-10. Comments from Italian consultants of SWLRI

Followings are comments mentioned by Italian consultants of SWLRI study in the Meeting;

1) It is expected SWLRI would provide preliminary idea of water allocations in Iraq after three(3) months from July 2011 since the SWLRI study had just started.

2) The Italian consultants mentioned, since there are many other important projects in whole Iraq other than South Jazira area, the Project scale should be selected from scenarios recommended in the SWLRI study.

2. Additional comments and submission of the Final Report (FR)

2-1. Submission of the FR

Both sides confirmed that the Iraqi side would submit their additional comments in a written manner by August 1, 2011 in addition to the comments in the Meeting, and JICA team would reply their actions to be taken as soon as possible. Then, the Both sides confirmed that the

FR would be submitted to the Iraqi side through JICA head quarter in Tokyo in October 2011.

2-2. Title and format of the FR

Iraqi side requested JICA team to change title of the FR to “Planning Report” or something else to bring out better understanding of stage of the Project. Also, the Iraqi side requested to make single sided report with separate volume by chapters. JICA team replied to follow the JICA’s guideline and would discuss with JICA head quarter in Tokyo.

Attachment-2

List of attendance of the Meeting

Title of Meeting : DFR explanatory meeting (**1st Day)**
Date: July 25, 2011, P lace Ministry of Water Resources in Baghdad

No.	Name	Position
1.	Salar Bakr Sami	Director General of Planning & Follow-up, MoWR
2.	Sami Muhi Alldi	Deputy General Director of Reclamation and Irrigation Project, MoWR
3.	Khalida Nafie	Chief Engineer, MoWR
4.	Moaid K. Mahmood	National Center for Water Resource Management, MoWR
5.	Alaa Turki Khudair	NCOWRM, MoWR
6.	Suhair Salman	Assistant Director General of Planning and Follow-up Directorate, MoWR
7.	Mr. Shawkat, S. Jameel	Head of Section for Water Management, MoA
8.	Mahdi H. Ali	HD of follow up section, MoP
9.	Haji Hasan Peso	Member of National Program Control, MoP
10.	Abdul Aziz Muhammed	Head of Study Department in Mosul Governorate Council
11.	Mahmod Shaker	Deputy Manager, Mosul Resources, MoWR
12.	Ghanim M.H.	Manager, PMT, MoWR
13.	Abed Al-Majied Zoba	Member of PMT, MoWR
14.	Namir M. Al-Sarref	Member of PMT, MoWR
15.	Ahmed Hattab	Sales Manager
16.	Kefah	SIGMA Company
17.	Shaymaa Fadhil	Senior Translator
18.	Kazuyoshi Yamashita	Project Formulation Advisor, JICA Iraq Office
19.	Ali T. Al-Swad	Program officer, JICA Iraq Office
20.	Kazumitsu Tsumura	JICA Study Team
21.	Toshihiko Kuno	JICA Study Team
22.	Futoshi Kuromi	JICA Study Team
23.	Kenji Miyazaki	JICA Study Team
24.	Kotaro Kikuchi	JICA Study Team
25.	Omar Natiq	Dar Al-handasah
26.	Mustafa S. Jasim	Senior/ Dar Al-handasah

Title of Meeting : DFR explanatory meeting (**2nd Day)**
Date: July 26, 2011, P lace Ministry of Water Resources in Baghdad

No.	Name	Position
1.	Salar Bakr Sami	Director General of Planning & Follow-up, MoWR
2.	Sami Muhi Alldi	Deputy General Dorector of Reclamation and Irrigation Project, MoWR
3.	Raad A. Jalil	D.G. of Center Study & Design, MoWR
4.	Khalida Nafie	Chief Engineer, MoWR
5.	Moaid K. Mahmood	National Center for Water Resource Management, MoWR
6.	Alaa Turki Khudair	NCOWRM, MoWR
7.	Suhair Salman	Assistant Director General of Planning and Follow-up Directorate, MoWR
8.	Mr. Shawkat, S. Jameel	Head of Section for Water management, MoA
9.	Mahdi H. Ali	Head of Department, Follow-up Section, MoP
10.	Haji Hasan Peso	Member of National Program Control, MoP
11.	Abdul Aziz Muhammed	Head of Study Department in Mosul Governorate Council
12.	Mahmod Shaker	Deputy Manager, Mosul Resources, MoWR
13.	Ghanim M.H.	Manager, PMT, MoWR
14.	Abed Al-Majied Zoba	Member of PMT, MoWR
15.	Namir M. Al-Sarref	Member of PMT, MoWR
16.	Osama Jameel	Directorate of Agricultural Office, Mosul, MoA
17.	Kazuyoshi Yamashita	Project Formulation Advisor, JICA Iraq Office
18.	Ali T. Al-Swad	Program officer, JICA Iraq Office
19.	Kazumitsu Tsumura	JICA Study Team
20.	Toshihiko Kuno	JICA Study Team
21.	Futoshi Kuromi	JICA Study Team
22.	Kenji Miyazaki	JICA Study Team
23.	Kotaro Kikuchi	JICA Study Team
24.	Omar Natiq	Dar Al-handasah
25.	Mustafa S. Jasim	Senior/ Dar Al-handasah

Detailed comments made by Iraqi side on the DFR and actions to be taken for them by JICA Team prior to finalize the Final Report (FR)

Additional comments made by Iraqi side through letter 17988 dated on August 2, 2011.

	Comments from Iraqi side	Action to be taken by JICA team
1.	Referring to the meeting on the 25th & 26th of July 2011, where all notes and points were discussed and viewed for the Draft Final Report (DFR) of South Jazira Irrigation Project.	
2.	In addition to the mentioned above, we would like to emphasize on the followings;	
a)	Clarify the technical and economical justifications for identifying Scenarios to the agricultural areas and not only according to certain ratios.	Explanation on identification of areas for each Scenario will be added in the Final Report (F/R).
b)	Include in the final recommendations the justifications for postponing the choices of Scenarios till the completion of the SWLRI being conducted by "Italian consultant".	Merits and demerits for each Scenario will be shown in the recommendation of FR.
c)	The economic comparison did not include the costs of the main pumping station to be used at the main intake of the Project, when the water level is low.	The cost of main pumping station will be added to the Project cost and the economic evaluation will be revised in the FR.
d)	To clarify in details the need of constructing the experimental farm and farm by a Pilot Project, as Mr. Salar named in the meeting, in the Project area especially soil contains gypsum. Also it is needed to clarify the outlet and inlet effects of this farm on the Project area.	Experimental farm will be proposed in the FR, however, outlet and inlet effects will not be clarified since JICA team cannot confirm through the site visit any further.
e)	Add a proposal to reduce rates of crop intensity to 100% instead of 117% for all the Scenarios and determine the share of water and drainage for the Project and the economic side.	It will be revised in the FR.
f)	It is important to have the actual unit prices of the construction items in line of the current situation.	Construction cost was estimated by referring cost of East Jazira Project in 2009 and escalation of the price was considered converting to 2010 price.
g)	The possibility of adopting an alternative for conveying water through pipes for the feeder canal.	The possibility will be mentioned in the FR, however, pipe line will not be adopted for the project facility.
h)	Revise construction period of the Project which unjustified due to long time.	It will be revised by referring to Water Resources Strategy (2010-14)
i)	We clarified that the 200m^3/s represents only the minimum operation discharge for the potable water station of Mosel city and if the discharge dropped from 200m^3/s, the stations operation will be stopped. The minimum required discharge of the downstream is much	JICA team understood it. 200m^3/s was used just for simulation of the Mosul dam reservoir as Indicator of releasing volume to the downstream. This releasing volume should be

	higher than 200m^3/s and it will be indicated later in the strategic study.	modified after conclusion of the SWLRI.
j)	There are discrepancies in the numbers between the DFR and the sent report (Power Point) for presentation purpose which requires a correction.	The sent report is correct. The discrepancies will be corrected in the FR.
k)	We noticed the lack of site visits to the Project area by the foreign consultants. We noticed also the lack of studying the ground water levels in the Project area, therefore the recommendation of constructing drainage channels didn't come. This subject should be treated in the FR for its importance and the necessary time for construction of the drainage system should be set.	JICA team believes that lack of site visit by the foreign consultants was covered by local consultants. Outline of the drainage system will be proposed in the FR
l)	The consultant confirmed that he didn't perform the field visit of the Project for the common used crops in the Project and its productivity especially for wheat, which requires more detailed clarifications about the consultant's theory on the possibility of production increase.	Productivity of the crops was set up based on a series of the discussions with Project Management Team (PMT). More details will be described in the FR.
m)	With respect to the expected water revenue of 10BCM per year, we would like to clarify that this number is theoretical and there is no agreements about it and cannot be adopted in any future planning.	The JICA team has understood it since initial stage of the Study. 10BCM is adopted for only simulation of the Mosul dam reservoir.
n)	Clarifying the additions to the maximum discharge, which include evaporation, leakage and others from the canals.	Losses such as evaporation and leakages from the canal are included in conveyance loss of the canals.

Attachment-3-2

Detailed comments made by Iraqi side on the DFR and actions to be taken for them by JICA Team prior to finalize the Final Report (FR)

Comments made by Iraqi side made in the DFR Meeting, held on July 25 and 26, 2011.

	Comments from Iraq side	page	Action to be taken	
1 Ministry of Water Resources				
1	Construction period should be cut down.		According to WRDS, construction period will be abbreviated to eight years.	
2	Crop intensity should be 100%.		Will establish new cropping pattern with 100% crop intensity.	
3	Calculation process of irrigation efficiency, which is 0.68, should be described.		Will show calculation process.	
4	Irrigation may destroy gypsum layer. The way how to deal with gypsum layer should be described.		The description will be added in the final report.	If irrigation water quantity and cycle are appropriate, water in the soil do not reach gypsum layer. To realise this the study team propose the followings. 1) Will establish appropriate irrigation intensity by considering water-holding capacity. The water-holding capacity of the soil in the Project area will be measured by the pilot farm activities. 2) Only land of which surface soil thickness is more than 50cm will be selected as the Project area.
5	Construction cost of pumping system at intake should be accounted for the Project cost.		The cost will be accounted to the Project cost.	
6	Drainage plan in the Project area should be described.		The description will be added in the final report.	1) Drainage canals are planned in the farm area. 2) Drainage water from farm area flows into small wadi near the farm area. 3) Small wadi flows into wadi tharutharu and run off outside of the Project area.
7	The way how to achieve the high yield plan should be mentioned.		The description will be added in the final report.	After irrigation starts, it takes 20 years for production to reach planned level. During 20 years the following activities should be continued 1) Farmers learn irrigated agriculture on the job training and by the training program. 2) Farmers learn farming
8	Possibility of application of pipeline system, which is considered as water saving method, should be described.		The description will be added in the final report.	Considering the scale of design discharge, pipeline system will be costly.
9	The section which describes water treaty between Turkey and Iraq should be deleted.		Discuss with JICA and follow it decision.	
10	Considering the level of this study, title of study is inappropriate. It should be the Planning Study.		Discuss with JICA and follow it decision.	
11	Period of average inflow, described as 20.1BCM, should be from 1931 to 2010.		It will be revised.	
12	Drought year management should be described.		Drought management in farm plot will be described.	Intensity of drought is estimated by water level of dam reservoir before planting. If intensity is not strong, only 1) will be executed. If intensity is high, 1) and 2) will be executed. 1) High water consumption crop, such as sugar beet, cotton, and other summer crops, should be given up to plant. 2) Relate to intensity, total planted area should be shrieked.
13	Discharge as 200m3/sec provided by MoWR is not water release requirement but necessary discharge to keep intake water level for potable water of Mosul city.		The Study team has understood since this condition was provided.	By water balance simulation, it is found that discharge of all scenarios have not been below the 200 m3/sec.
2 Nineva Governorate				
1	As the Project impact, the follows should be described. (1) Production of principal food such as wheat will be increased and production of fodder such as barley will be secured. (2) Employment opportunity in the Project area will increase. (3) Internally		The description will be added in the final report.	
2	Possibility of application of pipeline system, which is considered as water saving method, should be described.		Mentioned above	

	Comments from Iraq side	page	Action to be taken	
3 Ministry of Planning				
1	Construction period should be cut down.		Mentioned above	
4 Ministry of Agriculture				
1	Calculation process of irrigation efficiency, which is 0.68, should be described.		Mentioned above	
2	Reduction of inflow from Syria is described as 2.0 BCM. It should be changed to 1.2 BCM.		This comment is not acceptable because 2.0 BCM was provided by MoWR as a indicator.	
3	Quality of translation to Arabic should be improved.		The study team concentrate on improving quality of Arabic summery.	
5 Other				
1	Is the pilot farm constructed before the decision making of the Project implementation or after that ? Propose the pilot farm plan.		In the Study, a pilot farm is constructed in the early stage at the place where all facilities are completed because most experimental activities require water. However, if SWLRI takes 2 to 3 years to bring result, there is sufficient time to carry out p	Case 1 : Pilot farm is constructed within the Project area. Canal system and pump system are required to convey irrigation water. Detail plan is described in the final report. Case 2 : Pilot farm is constructed outside the Project area. It should be near water sources. Site whose feature of soil, climate, and land slope are similar to the Project area should be selected. Site should be near the water resources.
2	Plan for livestock should be descried. Benefit of its plan should be accounted to the Project benefit.		Benefit of livestock should not be accounted to the project benefit because it is not direct benefit.	Qualitative description of impact on livestock farm will be attached.
3	Final report should be published as one-side copy. Summary and each chapter should be independent book. Reports should be compiled by hardcover		The study team will discuss with JICA and follow it decision.	
4	Summery should be condensed to 10 pages.		The study team is going to submit short version and attached it at top of report.	
6 PMT in Nineva Governorate (Mr. Ghanem)				
1	Land productivity in English is not correct (not "single donum").	S-6	Apply the same term in NDP	
2	Not "Gross", but "Net".	S-8	Use "Gross", since the WRDS use "Gross"	
3	Should review sentence. Applied inflow from Syria is not final figure.	S-10	Make it clear that the applied inflow from Syria is temporal figure.	
4	There must be missing table.	S-12	Rectify the error.	
5	Please change to "NDP focus on reducing poverty".	S-12	Rectify the error.	
6	Please change to ""use fertilizer to increase productivity".	S-13	Rectify the defect.	fertilizer production → fertilizer application
7	Please change to "On the other hands".	S-13	Rectify the error.	
8	A word "Mesopotamia" is not correct.	S-13	Will check original, and rectify if necessary.	
9	Years must be reverse:(1982-2009) and (1969-1980)	S-14	Rectify the error.	
10	No foot note to "60,000"	S-20	Rectify the error.	
11	What is source of "rainfall 15%"?	S-21	Mention the source of the figure.	
12	What is "mio"?	S-21	it stand for "million".	use "million"
13	"50kg/ha" is not equal to "200kg/donum"	S-22	Rectify the error.	Change to "800kg/ha(200kg/donum)"
14	"and" is wrong, should be "are".	S-23	"and" is correct, but will change better sentence.	the project area is 213,900 ha and is classified as …
15	It is not appropriate sentence.	S-26	Will delete 3.6.2. and 3.6.3.	
16	Title of the table should not be "South", but "North".	S-30	Rectify the error.	
17	Should change from "in Jazira" to "in South and East Jazira"	S-31	Rectify the error.	

		Comments from Iraq side	page	Action to be taken	
	18	Please change:WL310m → WL319m	S-34	Rectify the error.	
	19	Should revise sentence.	S-34	Rectify the error.	
	20	Please change:6.7 BCM → 6.803 BCM	S-35	Rectify the error.	
	21	Please change foot note:by PMT → by Swiss F/S	S-36	Rectify the error.	
	22	Please change:m3/sec → BCM (2 places)	S-43	Rectify the error.	
	23	Please rectify total volume of irrigation water in the table.	S-43	Rectify the error.	
	24	bring "suitable/ unsuitable for irrigation" into line with the description of %.	S-45	Rectify the error, 80.9% → 80.9% / 19.1%	
	25	Change Japanese to English.	S-46	Rectify the error.	
	26	Maximum length of farm plot will be set as 2km taking into consideration of canal inclination	S-46	Change to a model which consider the canal inclination.	
	27	Change Japanese in the figure to English.	S-49	Rectify the error.	
	28	Change Japanese in the figure to English.	S-50	Rectify the error.	
	29	What is the meaning of "10 folds"?	S-51	Rectify the sentence.	Average is 6.06mm/day, Max is 11.80mm/day, and Minimum is 1.28mm/day respectively
	30	Please clearly state that updated crop coefficient is used in the report.	S-57	Add the statement.	
	31	Please update the crop coefficiency in the table.	S-57	Update	
	32	There is no figure for average rainfall in the table.	S-58	Rectify the error.	
	33	Calculation basis of irrigation efficiency (0.68) must be mentioned in the report.	S-59	Mentioned above	
	34	Please specify description for the irrigable area per unit volume of water	S-61	Rectify a statement.	
	35	Please specify description for the unit of figure in each scenario	S-61	Rectify a statement.	
	36	Please specify description for the irrigable area per unit volume of water	S-62	Rectify a statement.	
	37	Please specify description for the unit of figure in each scenario	S-62	Rectify a statement.	
	38	Explanation for open-canal option is not necessary	S-64	Delete.	three (3) alternatives of gravity flow, tunnel → two (2) alternatives of tunnel
	39	Explanation for open-canal option is not necessary	S-64	Delete.	Delete the paragraph
	40	What is "fro flat"?	S-65	Rectify a statement.	fro flat → flow flat
	41	Please change Japanese to English	S-67	Change to English	
	42	Reason for selecting trapeziform of irrigation canal must be stated	S-67	The reason will be mentioned.	Please see the main report, Table 7.5-2 in 7.5.1.(1)Examination of Open canal section.
	43	Please change the statement.	S-68	Delete from SUMMARY, and change the statement in the main report.	Statement for tunnel construction plan in the main report will be changed based on the change of construction schedule with corresponding to the WRDS.
	44	Missing table?	S-68	Delete the word for indicating the table.	
	45	Both plan should included cost for a pump	S-70	Add the cost	
	46	Electricity cost for irrigation facilities should be included	S-92	Add the cost	
	47	Please add benefit from livestock production	S-95	Livestock production is not direct benefit of the project, and will not be included in the project evaluation. But it can be a qualitative benefit of the project and JICA Team will state it in the final Report.	

Comments from Iraq side			page	Action to be taken	
7	PMT (from Mr. Ghanem): Chapter 1;				
	1	Figure in the table should be changed: 14.0 M.m3 and 12.3 M.m3	1-4	Rectify the error.	1.4 BCM and 1.23 BCM are correct.
	2	Delete the lowest row in the table	1-12	Date and item number will be rectified.	Add a sentence of this meeting (8.→9.)
8	PMT (from Mr. Ghanem): Chapter 2;				
	1	Please change: 27.4→17.4, 1969→1969-1989	2-4	Modify for easy understanding	
	2	The figure must be the same as table 2-3	2-5	ditto	
	3	Not "Gross", but "Net"	2-6	No need to change since original source (the WRDS) also said "Gross".	
	4	Persian Gulf must be Arabian Gulf	2-7	Rectify the error.	
9	PMT (from Mr. Ghanem): Chapter 3;				
	1	Change to "Moslem, Christian, Yazidism, Mandeanism"	3-16	Rectify the statement.	
10	PMT (from Mr. Ghanem): Chapter 10;				
	1	change year: 2011→2010	10-9	Rectify the error.	
11	PMT (from Mr. Ghanem): Chapter 12;				
	1	Please add technical background to each statement	12-6	This part is just a summary of the former section, and all technical backgrounds are mentioned in the former section. However, the statement will be changed due in consideration of better understanding.	

2. List of Attendance

Prime Minister Office Advisory Commission (PMAC)

Thamir A. Ghadhban	Chairman
Hussein Ali Jeber	Advisor, Agriculture Initiative
Ali Al Shammary	Advisor, Economics Advisor)
Huda A. Malik	D.G. of International Cooperation
Ikram Kasim	PMAC
Sadeq B. Jawad	Expert, Agriculture Initiative

Ministry of Water Resources (MOWR)

Salar Bakr Sami	D.G. of Planning & Follow – up
Sami Muhi Alldi	Deputy D.G, Reclamation and Irrigation Project
Abdulkhlik Thanoon Ayoub	Mosul Dam Manager
Raad A. Jalil	D.G. of Center Study & Design
Suhair Salman	Assistant D.G, Planning and Follow-up Directorate
Khalida Nafie	Chief Engineer
Riyadli Ezulddin Ali	Deputy of Mosul Dam Manager
Abdul Jaliced	Engineer, Nineva Work Resources, North Jazira Irrigation
Moaid K. Mahmood	National Center for Water Resource Management (NCOWRM)
Alaa Turki Khudair	NCOWRM

Ministry of Planning (MOP)

Eqood Al-Saad	Head of Human Development Division
Husham Qasim Saudi	Director General of Agriculture Planning Department
Mahdi H. Ali	Head of Follow-up Section in Agriculture Planning Department
Haji Hasan Peso	Member of National Program Control
Aseel A. Fattah	MOP

Ministry of Agriculture (MOA)

Shawkat, S. Jameel	Head of Section for Water Management
Kutaiba M. Hassan	D.G. Planning

Nineva, Project Management Office, MOWR

Mahmod Shaker	Deputy Manager, Mosul Resources, MOWR
Ghanim M.H. AL. Badrany	Manager, PMT, MOWR
Nadira Abbas	Chief Senior Engineer, MOWR
Abed Al-Majied Zoba	Member of PMT, MOWR
Wail Th. Neimatallah	Member of PMT
Namir M. Al-Sarref	Member of PMT

Radwan N. Khalil	Member of PMT, Engineer
Mohamed Salih	Member of PMT, Chief Senior Engineer
Salim Y. Othman	Member of PMT, Senior Chief Engineer
Ghanim J. Ayoob	Member of PMT, Senior Chief Geologist
Rayian A. Muhssn	Member of PMT, Chief Engineer
Wail Thaker	Member of PMT
Abdul Majied	Member of PMT, Engineer Water Resources / Nineva
Shaymaa Fadhil	Senior Translator

Nineva Province, MOA

Jaffer Sadeeq	Director of Agricultural Office, MOA
Osama Jameel	Directorate of Agricultural Office, MOA

Mosul Governorate Council

Abdul Aziz Muhammed	Head of Study Department in Mosul Governorate Council

SIGMA Company

Ahmed Hattab	Sales Manager
Kefah	SIGMA Company

Embassy of Japan

Hideyuki Urata	Counselor
Yuichi Yamada	First Secretary

JICA Iraq Office

Masaaki Matsushima	Chief Representative
Kazuyoshi Yamashita	Project Formulation Advisor
Mariko Senda	Project Formulation Advisor
Shotaro Ono	Representative
Kenichi Sasaki	Project Formulation Advisor
Jalal M. Abdullah Sendory	Senior Programme Manager
Amozhgar M. Hawezy	Project Assistant
Ali Talib Al. Aswad	Local Consultant

JICA Study Team

Kazumitsu Tsumura	Team Leader/ Irrigation and Drainage, JICA Study Team
Kenji Miyazaki	Water Resource/ Hydrology, JICA Study Team
Shigeru Sugiyama	Dam/ Geology, JICA Study Team
Futoshi Kuromi	Irrigation Facilities, JICA Study Team
Toshihiko Kuno	Agriculture/ Land Use, JICA Study Team
Kotaro Kikuchi	Socio-economy/ Project Evaluation, JICA Study Team

DAR Al-handasah

Nabil Y Haddad	Director of Operation
Nadim Habib	Project Manager
Zaid Sardar Ali	Deputy Project Manager
Ahmed A Kadouri	IT Engineer
Omar Natiq	Agronomist
Mustafa S. Jasim	Senior Engineer
Abdulkhalil M. J.	Member of PMT, Engineer Dar Al Handasah
Ali Al Bazaz	Water Resources Engineer
Hunar A. Saleem	GIS
Sam Chahine	Cost Analysis
Ammar Jassim	Environmental Engineer
Alice Avedessian	Secretary