MINISTRY OF PUBLIC WORKS & HOUSING
THE HASHEMITE KINGDOM OF JORDAN

STUDY REPORT ON THE PROJECT FOR CONSTRUCTION OF KING HUSSEIN BRIDGE IN THE HASHEMITE KINGDOM OF JORDAN

JUNE, 1999

JAPAN INTERNATIONAL COOPERATION AGENCY
NIPPON KOEI CO., LTD.

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PREFACE

In response to a request from the Government of the Hashemite Kingdom of Jordan, the Government of Japan decided to conduct a basic design study on the project for construction of the King Hussein bridge in the Hashemite Kingdom of Jordan and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Jordan a study team from November 27 to December 26, 1998.

The team held discussions with the officials concerned of the Government of Jordan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Jordan in order to discuss a draft design, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Hashemite Kingdom of Jordan for their close cooperation extended to the teams.

June 1999

Kimio Fujita
President
Japan International Cooperation Agency

June 1999

LETTER OF TRANSMITTAL

We are pleased to submit to you the basic design study report on the project for construction of the King Hussein bridge in the Hashemite Kingdom of Jordan.

This study was conducted by Nippon Koei Co., Ltd., under a contract to JICA, during the period from November 11, 1998 to June 30, 1999. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Jordan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

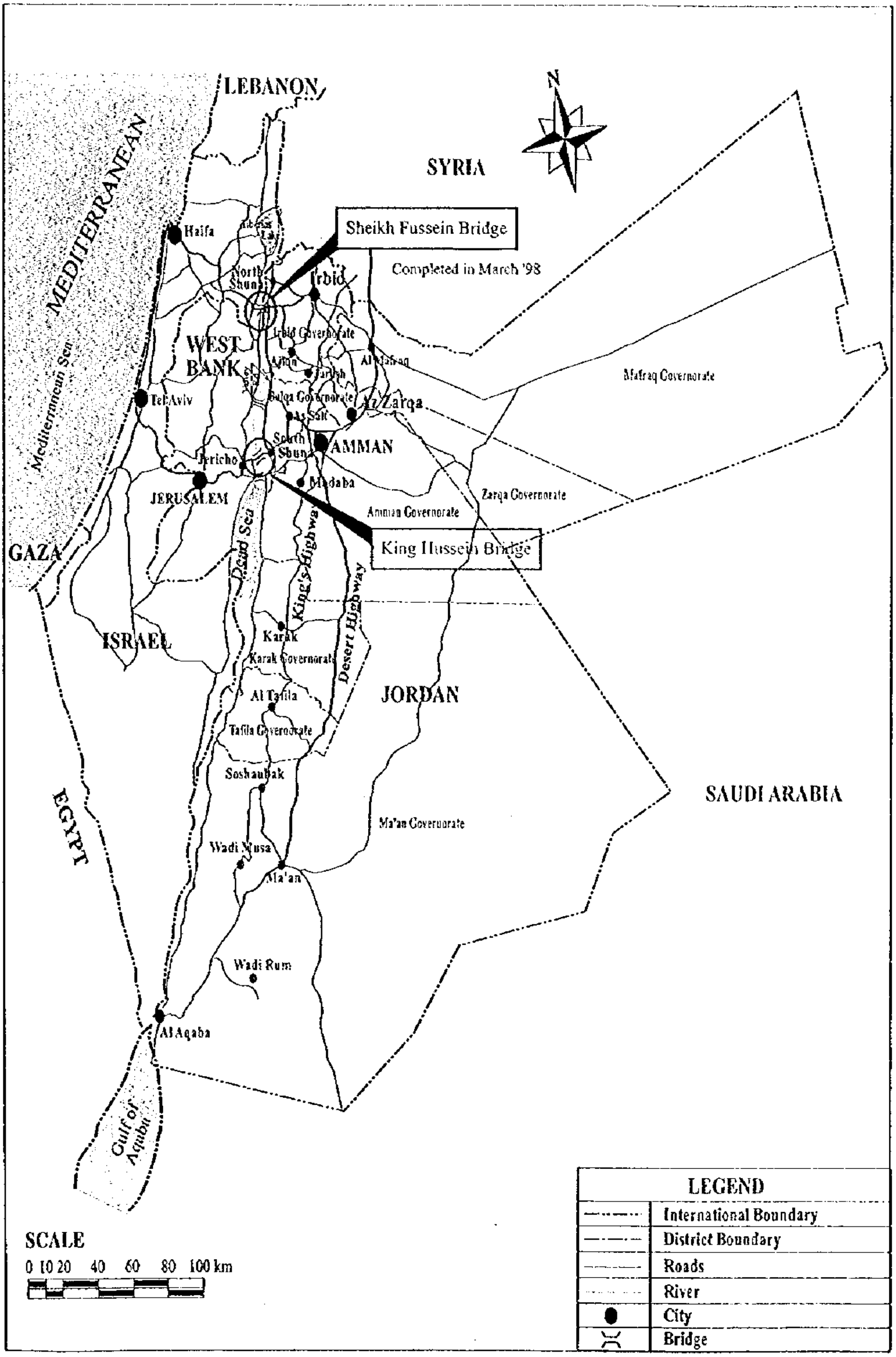
Finally, we hope that this report will contribute to further promotion of the project.

Very truly yours,

K. Matsuzawa

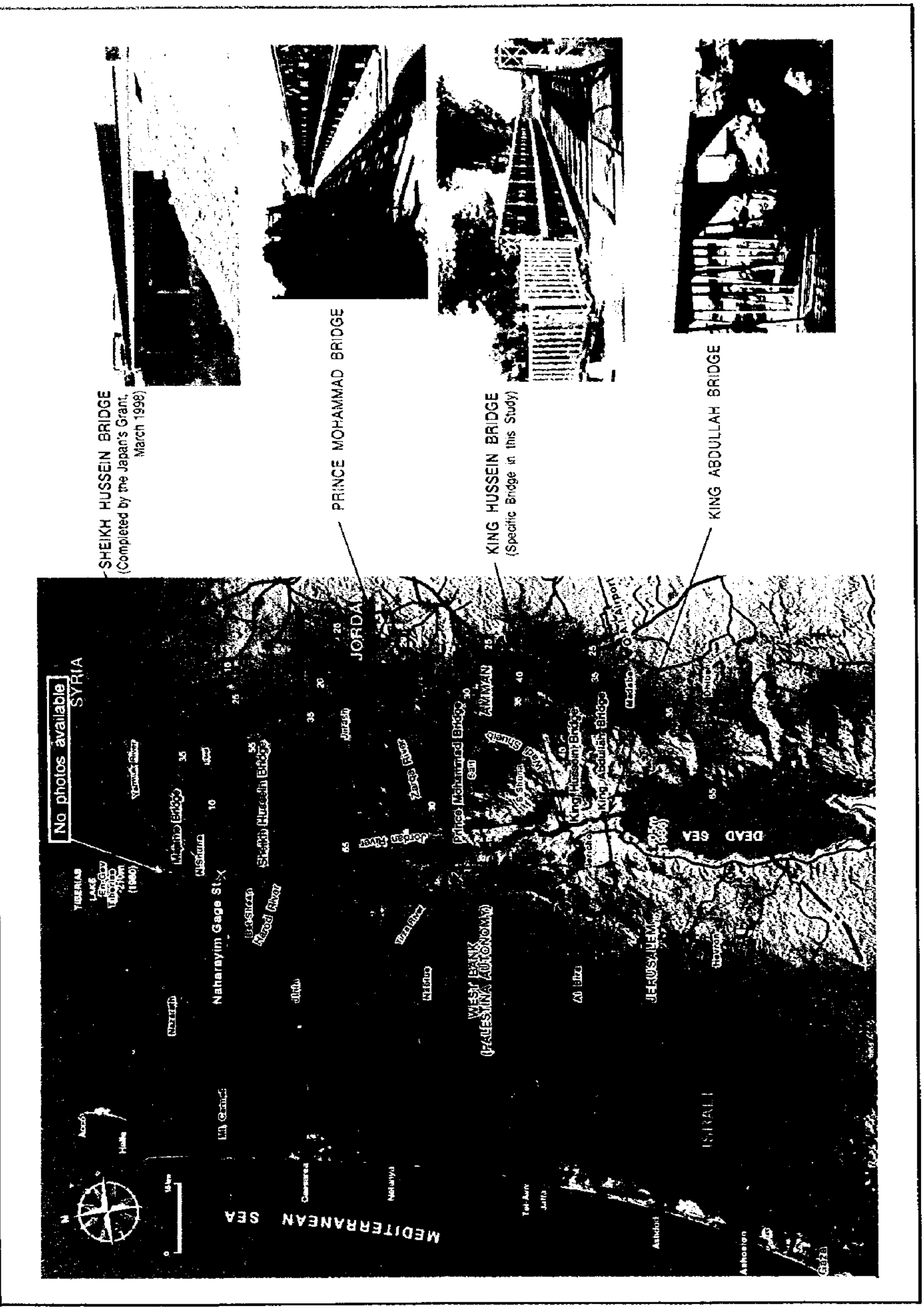
Katsufumi Matsuzawa
Project Manager
Basic design study team on
The project for construction of the King Hussein bridge
In the Hashemite Kingdom of Jordan
Nippon Koei Co., Ltd.

FRONTISPIECE - 1



PROJECT LOCATION MAP

FRONTISPIECE-2



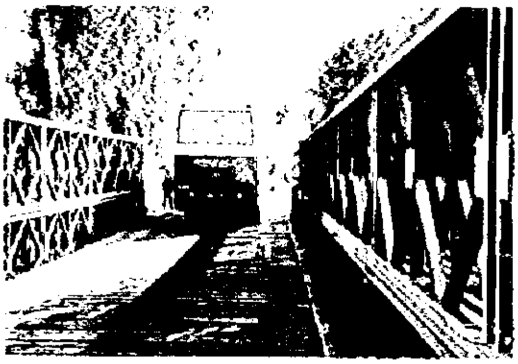
FRONTISPIECE-3

PERSPECTIVE VIEW OF THE PROPOSED KING HUSSEIN BRIDGE

Existing King Hussein Bridge viewed from the watch tower on the Jordanian Side

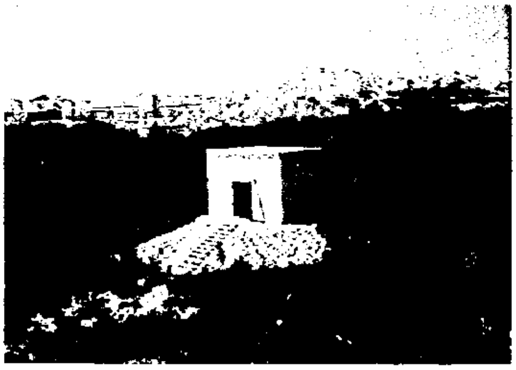
Existing King Hussein Bridge viewed from the upstream

Upstream view of the Jordan River



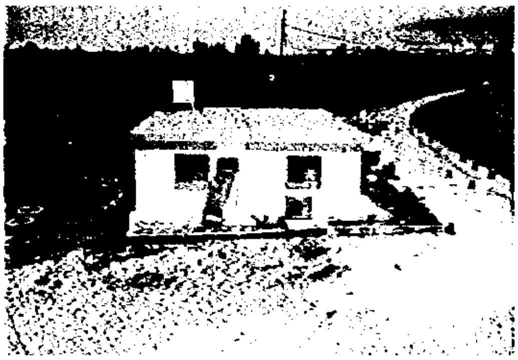
The existing Bailey bridge allows only one vehicle to pass

Wooden decks



Water gage station on the Jordanian side
(to be removed)

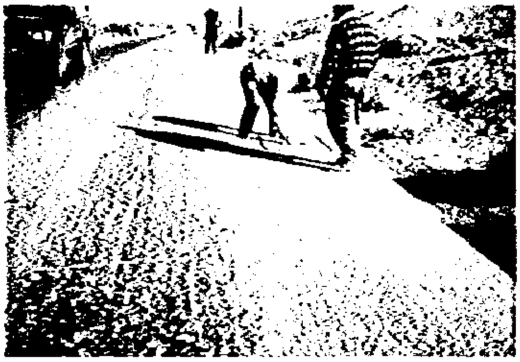
Watch tower on the Jordanian side
(to be removed)



Military office on the Jordanian side

Passport control office on the Jordanian
side near bridge

Area where de-mining was completed



Existing road

Construction of King Hussein Bridge in the Hashemite Kingdom of Jordan

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ABBREVIATIONS

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
AF	Arab Fund
ASTM	American Standards for Testing and Materials
CIDA	Canadian International Development Agency
EL	Elevation
E/N	Exchange of Notes
EFF	Extended Fund Facility
EIB	European Investment Bank
GDP	Gross Domestic Products
GNP	Gross National Products
HSD	Highway Studies Directorate
HWL	High Water Level
IMF	International Monetary Fund
JD	Jordan Dinar
JICA	Japan International Cooperation Agency
MWL	Maximum Water Level
MPWH	Ministry of Public Works and Housing
OD	Origin and Destination
ODA	Official Development Assistance
OECF	Overseas Economic Cooperation Fund
OPEC	Organization of Petroleum Exporting Countries
PC	Prestressed Concrete
RC	Reinforced Concrete
ROW	Right of Way
UNDP	United Nations Development Programme
USAID	US Agency for International Development
WB	World Bank

CHAPTER 1 BACKGROUND OF THE PROJECT

In May 1995, the Government of the Hashemite Kingdom of Jordan made a request to the Government of Japan for the construction of two bridges over the Jordan River: King Hussein (Allenby) and Sheikh Hussein bridges. The Government of Japan, having made the decision to examine the viability of the two bridges requested, entrusted a Basic Design Study to the Japan International Cooperation Agency (JICA). The Basic Design Study was carried out from December 1995 to July 1996 with a number of discussions with the concerned officials from the Governments of Jordan and Israel. The Study concluded that the necessity of both bridges was extremely high and the implementation of the Sheikh Hussein Bridge should precede that of the King Hussein (Allenby) Bridge taking into consideration the progress of the peace process in the related areas. Accordingly, the construction of the Sheikh Hussein Bridge commenced April 1997 and was completed by March 1998.

As for the implementation of the King Hussein Bridge, the Government of Japan decided to conduct another study to refine the previous study. JICA conducted a Basic Design Study from November 1998 to June 1999.

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Objectives of the Project

The King Hussein Bridge is located over the Jordan River between Jordan and West Bank, and plays an important role for the movement of people and commodities in the areas. The existing King Hussein Bridge, a 4.5m wide Bailey bridge built temporarily in 1968, is insufficient for the structural functions and traffic capacities. Moreover, as the existing bridge is built at a low elevation, the bridge was inundated during flooding resulting in severe disruption of traffic flows.

The Project aims to replace the existing temporary bridge with a new permanent bridge, construct an approach road at an elevation sufficiently high enough above the flood level, and improve the existing access road so as to achieve smooth traffic flows as well as provide a safe road against floods.

2.2 Basic Concept of the Project

The components of the project facilities have changed from the original request by the Jordanian Government to the present Study as follows.

(1) Facilities requested by the Government of Hashemite Kingdom of Jordan in May 1995

a) Construction of a 4-lane concrete bridge over the Jordan River, adjacent to the existing Bailey Bridge,

b) Construction of a 10 km access road with 4 lanes, connecting the new bridge with the Main Valley Highway (so-called Kings Highway or South Shuna - North Shuna Highway), and

c) Construction of the regular border facilities.

(2) Facilities concluded in the Previous Basic Design Study by JICA in March 1996

After the request, the Government of Jordan completed the expansion work of the border facilities located about 2 km from the South Shuna Intersection, and then withdrew an item for construction of the regular border facilities from the requested items. Accordingly, the main components of the Project were changed to the following:

a) Construction of a 4-lane concrete bridge over the Jordan River, about 30 m upstream of the existing Bailey bridge,

b) Construction of the following roads, connecting Jordan and West Bank through the new bridge:

- New construction of a 4-lane Approach Road on the Jordanian side: 850m from the abutment on the Jordanian side to the connecting point with the existing road.
- New construction of a 4-lane Approach Road on the West Bank side: 250 m from the abutment on the West Bank side to the connecting point with the existing road.
- Improvement of the 2-lane Access Road on the Jordanian side: 7.7 km from the connecting point with the Approach Road to the South Shuna Intersection.

(3) Facilities refined by the JICA Study in June 1999

On the basis of the engineering surveys for the Project site conducted from November to December in 1998 and subsequent study in Japan, the facilities proposed in the Previous Basic Design Study were refined as follows:

a) Construction of a 120m long 4-lane concrete bridge over the Jordan River, about 30 m upstream of the existing Bailey Bridge

b) Construction of the following roads, connecting Jordan and West Bank through the new bridge

- New construction of a 4-lane Approach Road on the Jordanian side: 769m from the abutment on the Jordanian side to the connecting point with the existing road.
- New construction of a 4-lane Approach Road on the West Bank side: 20 m, the minimum requirement to construct the abutment.
- Improvement of the 2-lane Access Road on the Jordanian side: 7.6 km from the connecting point with the Approach Road to the South Shuna Intersection.

The components of the Project in the original request, the Previous Basic Design Study and Present Study are summarized in Table 2.2.1.

Table 2.2.1 Components of the Request

Facilities	Original Request (May 1995)	Previous JICA Basic Design Study (March 1996)	Present JICA Study (June 1999)
Bridge	4-lane concrete bridge	4-lane concrete bridge	4-lane concrete bridge
Approach Roads	None	4 lanes, consisting of: Jordanian side = 350m West Bank side = 250m	4 lanes, consisting of: Jordanian side = 769m West Bank side = 20m
Access Road	4 lanes, 10 km	2 lanes, 7.7 km	2 lanes, 7.6 km
Border Facilities	Passenger Terminal Building	Not required	Not required

2.3 Basic Design

2.3.1 Design Principles

(1) Natural Characteristics

1) Climate

The Jordan Valley's rainy season lasts about 5 months, from November to March, while the rest of the year is the drought season. During the drought season, the temperature sometimes rises over 40°C in the daytime and therefore in regards to the bridge construction special emphasis should be placed on the quality control especially in placing concrete and curing thereof. On the other hand, floods are likely to occur during the rainy season when foundation work experiences much more difficulties.

2) Subsoil Conditions at the King Hussein Bridge Site

The subsoil exploration in the Previous Basic Design Study has revealed that the bearing strata of the proposed bridge are relatively deep. In addition, the riverbed materials of the Jordan River, mainly silt, are prone to erosion. Accordingly, foundation type would have to be stable even when local scour occurs around piers.

3) Jordan River

The Jordan River is characterized as flood-prone, with the latest floods taking place in January 1995.

As the project site is located in a politically long-disputed area, the existing hydrographic data of the Jordan River are not sufficient. The available hydrographic data for planning the King Hussein Bridge are limited to the following:

- Data at King Hussein Bridge site: annually maximum discharges were recorded from 1932 to 1958, which contain those after completion of Tiberius Dam in the late 1950s.
- Data at the Naharayim gauge station: the Israeli government authority continuously records the annually maximum discharges. The gauge station is located downstream from the confluence of the Jordan and Yamuluk Rivers, near and upstream of the Sheikh Hussein Bridge and about 90 km north of the King Hussein Bridge site.
- Recent Floods at King Hussein Bridge site: January 1995. The Landsat TM data are available.

4) Earthquakes

As the Jordan Valley has experienced earthquakes in the past, seismic forces should be taken into consideration in the bridge design: statically equivalent horizontal force of at least 0.2 of the dead load would have to be considered.

(2) Social Conditions

The following social conditions should be considered for the construction plan:

- Islam is the dominant religion in Jordan, so due consideration should be taken for the preparation of the construction schedule, especially during Ramadan month and subsequent Eid holidays.
- As the Project site is located in the long-disputed area divided by the Jordan River, there is a high risk of unexploded mines in the site. It is very crucial to detect and de-mine any unexploded mines before starting the Project.
- Many historical places of Christianity and Judaism exist near the Project site. In addition, Bethlehem-2000 is planned. These might attract many tourists to Jordan, West Bank, and Israel, so

special arrangements should be made to maintain the road open to public traffic throughout the construction periods.

(3) Construction Conditions

1) Special Arrangements

As discussed earlier, the Project site is located in a peculiar area which requires the following, in addition to the normal civil works:

- Clear the unexploded mines
- Permission of personnel to work in the Project site
- Safeguard the project site by fences
- Parallel construction with the concerned parties of the connecting road project on the West Bank side

2) Circumstances of Construction Conditions

Mechanized construction methods are generally used in Jordan, and relatively high levels of construction practices have been confirmed through the previous project under Japan's grant, the Sheikh Hussein Bridge.

Water in the Jordan River is not favorable for the use of concrete work because of salt content, and therefore water for construction use would have to be obtained from the Jordan Valley (King Abdullah) Canal.

Course and fine aggregates for concrete and asphalt works would be obtained from the Sheravati quarry, about 20 km away from the Project site, and from which aggregates were used for the Sheikh Hussein Bridge Project. Further, it is noted that fine aggregates and boulder/stone would be obtained in the wadi near Station 6 km in the Project site.

As with the Sheikh Hussein Bridge Project, all taxes imposed by the Government of Jordan would have to be exempted as in any case of execution under grant aid schemes of foreign countries.

3) Local Contractor

Contractors capable of constructing bridges, highways and buildings are registered in the list of the Ministry of Public Works and Housing (MPWH). Class-1A and 1B contractors on the list would be able to participate in the Project as subcontractors of a Japanese construction firm. The Class-1A and 1B contractors are registered in accordance with the amount of paid capital, equipment, turnover, managial staff number, technical staff number, experiences, office area. The following Table 2.3.1 shows the numbers of Class-1A and 1B contractors as of June 1999.

Table 2.3.1 Registered Contractors

	Road Works	Bridge Works
Class-1A	4 firms	4 firms
Class-1B	12 firms	-

Source: MPWH

(4) Capacity of Road and Bridge Maintenance

Existing roads and bridges are well maintained by MPWH. No serious issue is anticipated for the future maintenance of the facilities being constructed by the Project. The following table shows the capacity of the maintenance department of MPWH:

Table 2.3.2 Capacity of Road Maintenance

Description	Outline
Technical Staff	147 mechanics, consisting of: Category 1 (experienced more than 15years): 42 Category 2 (experienced 10 – 14 years): 54 Others: 51
Heavy Machinery	255 in total, consisting of: Wheel Loader: 67 Motor Grader: 25 Bulldozer: 33 Vibration Roller: 98 Hydraulic Excavation: 4 Portable Compressor: 28
Vehicles	425 in total, consisting of: Sedan: 28 4 Wheel Drive: 105 Bus: 19 Mini-bus: 7 4 WD Single/Double Cabin: 149 Dump Truck: 56 Water Sprinkler: 26 Trailer: 6 Fuel Tanker: 16

Source: MPWH

2.3.2 Selection of Optimum Project Scheme

(1) Principles of Bridge and Road Designs

As concluded by the Previous Basic Design Study in March 1996 as well as by the present Study, the following are the principles in designing the King Hussein Bridge, approach road and access road.

1) Bridge

- The required number of lanes, which dominates the bridge width, should be determined taking into consideration not only the present traffic volume but also future demands.
- The bridge would have to be so designed to withstand a 50-year probable flood, and earthquakes in addition to ordinary loads.

2) Roads

Roads consist of approach roads and access roads. Approach road is defined as new construction of part of the road from the abutment to the conjunction with the existing road, and access road is the widening portion of the existing road.

- The lane number of access roads should be determined so as to satisfy the short-term (10 years after completion) traffic demands.
- As the King Hussein Bridge site is located in about a 1 km wide flood-prone area, the height of the approach road embankment should satisfy an appropriate free-board to avoid the negative effect by inundation. The future expansion of the approach road width would be difficult in such an area. In this regard, the approach road of the King Hussein Bridge meets the required lane number as with the bridge taking into consideration not only the present traffic volume but also future traffic demands.

3) River Protective Measures

The present Study proposes to apply an appropriate bridge length from the economic point of view. Actually, the Jordan River spreads about 1km wide in relatively shallow depths once floods take place while the opening at the bridge (bridge length) is much reduced from the actual river width during flooding. Accordingly, due treatment of the river-section should be made to protect the bridge structures against the effects of local scour of the riverbed materials, which might be caused by a rapid water flow at the bridge location where the river width is reduced.

As with the design principles of the bridge structures, a 50-year probable flood would be considered for this purpose.

(2) Design Standards and Criteria to be Applied

1) Bridge Design

a) According to the Jordanian standards, namely "Specifications for Highways and Bridge Construction Volume (I) to (IV), MPWH, 1991", the bridges should be designed to carry the live load of 1.5 times of HS-20 as specified by AASHTO.

b) Basic seismic coefficient of 0.2, statically equivalent horizontal force, should be considered.

c) The vertical clearance above the high water level (EL – 376.713 m, 50-year probable flood, bridge length = 120m) to the bottom face of the girder should be not less than 100cm.

d) Design calculation should be based on the bridge design specifications adopted by Japan Road Association 1995.

e) Foundation should be so designed as to withstand against the local scour around piers: Estimated scour level = EL – 391.00m

f) Riverbed protective measure by dumped stone should be designed to prevent the local scour.

g) Slope protection by riprap around abutments should be provided to prevent erosion.

2) Road

a) Road design should be in accordance with the Jordanian standards.

b) In the case of the approach road, in which embankment would be constructed in a flood-prone area, pipe culverts should be allocated at approximate intervals of 80 to 100m, according to the requirements of the Jordanian standards.

c) Some parts of the access road would run parallel with the Wadi Shueib which may cause the erosion of embankment slopes. The new alignment of the access road should be planned apart from the wadi as much as possible to eliminate the risk of erosion.

d) New center-line of the access road on the Jordanian side should be at least at the existing road center line which is the center of right-of-way (ROW).

e) As with the case of the bridge abutments, slope protection by riprap should be provided for the approach road.

(3) Basic Data for Facility Design

This subsection deals with the basic data used to decide the appropriate sizes of the facilities being constructed by the Project. Basic data in this connection are:

- Traffic Demand Forecast to decide the widths of the bridge, approach roads and access road
- Hydrographic analyses to decide the bridge length, river protection measures

These items were incorporated into the Previous Basic Design Study. The present Study refines and / or verifies the results obtained in the Previous Basic Design Study.

1) Traffic Demand Forecast

A) Outcomes in the Previous Basic Design Study

a) Purpose

Demand forecast was carried out to obtain basic data for designing the facilities of the King Hussein and Sheikh Hussein bridges.

As for the King Hussein Bridge, the analysis was carried out considering the following aspect of induced traffic, which is deemed to be major traffic flow on the bridge.

i) Induced traffic

It is expected that the opening of the bridge between Jordan and West Bank over the Jordan River in the peaceful international relation would induce a large traffic volume that is suppressed to date. The traffic that would be realized with the opening of the bridge in the peaceful environment of international relation was defined as induced traffic and analysis of this type of traffic was carried out in the present Study.

ii) Estimation of induced traffic volume

The induced traffic volume was estimated by applying the Gravity Model where the magnitude of the national economies and international travel distance are two of the explanatory variables as explained below:

$$T(i, j) = E(i) \times [(a \times E(j)^{b}) \div D(i,j)^{c}]$$

Where,

T(i, j)	:	Traffic volume between nation (i) and nation (j)
E(i)	:	Magnitude of economic activity of nation (i), measured in terms of gross domestic product (GDP)
E(j)	:	Magnitude of economic activity of nation

(j), measured in terms of GDP

D(i, j) : Travel time between nation (i) and nation (j), measured in terms of hour

a, b, c : Parameters

Parameters for this model were estimated by the Least Square Method using international Origin-Destination matrices available at the Al Ramtha Customs Office and macro-economic data of related nations and international travel time matrices especially established for this purpose. As a result, structure of the model was determined as shown below:

(Passenger vehicle and bus)

$$T(i, j) = E(i) \times [(7.093 \times E(j)^{0.423}) \div D(i, j)^{-2.708}]$$

$$R = 0.790$$

(Truck)

$$T(i, j) = E(i) \times \{(5.218 \times E(j)^{0.678}) \div D(i, j)^{-2.122}]$$

$$R = 0.940$$

Future international traffic volume was obtained by inputting future magnitude of economic activities of corresponding nations and their travel distances realized with the introduction of the new bridges.

iii) Study Result

Traffic volume of the bridge was forecasted as shown in Table 2.3.3. According to the table, traffic volume on the King Hussein Bridge in 1998, which was a proposed opening year of the bridge, was estimated at about 5,908.

Table 2.3.3 Future Traffic Volume at King Hussein Bridge
Estimated by Previous Basic Design Study

(Unit: AADT)

		1998	2000	2007	2017	2027
Induced Traffic	Passenger Car	4,630	5,626	9,146	18,313	36,667
	Truck	1,278	1,629	2,890	6,552	14,858
	Total	5,908	7,255	12,036	24,865	51,525
Required Lanes		2	2	2	4	4

Source: Basic Design Study Report on the Project for Construction of King Hussein Bridge and Sheikh Hussein Bridge in the Hashemite Kingdom of Jordan, March 1996, JICA

B) Refinement by the Present Basic Design Study

The results of A) were reviewed since the implementation of the King Hussein Bridge had been delayed. Present traffic Origin-Destination (OD) surveys were conducted at the borders of Al Ramtha, Jabeer (of which operation was started in 1998), Sheikh Hussein Bridge and King Hussein Bridge in order to confirm or verify the results of the traffic demand forecast conducted in the Previous Basic Design Study.

As with the Previous Basic Design Study, future traffic volumes were estimated using the gravity model. The results are summarized in Table 2.3.4.

Table 2.3.4 Future Traffic Volume at King Hussein Bridge
Estimated by the Present Study

(Unit: AADT)

		Observed	Forecasted			
		1998	2000	2007	2017	2027
Induced Traffic	Passenger Car	*1,684	5,902	8,835	18,733	41,375
	Truck	** 725	1,839	3,321	7,803	18,488
	Total	2,409	7,741	12,156	26,536	59,863
Required Lanes		2	2	2	4	4

Note: * = including buses that carry passengers for departure and return without passengers.

** = Vehicle number controlled by the transport agreement between the concerned governments.

Source: Study Team

2) Hydrographic Study

A) Outcomes of the Previous Basic Design Study

a) Design Discharge

i) Calculation based on Uniform Flow

The calculation of uniform flow is made to obtain the peak runoff corresponding to the flood level in January 1995, which was at EL – 377.7 m based on the Landsat TM-data analysis as well as an interview survey at the site. As a result, the peak runoff of 1,740 m3/sec is obtained on the assumption that the roughness coefficient n is 0.035 and slope is 1/520 (average slope from Tiberias Lake to the King Hussein Bridge). The results of the uniform flow calculation are shown in Table A6-1 of the Previous Basic Design Study Report.

ii) Calculation corresponding to the Discharge of Sheikh Hussein Bridge

The 50-year probable peak runoff of 1,300 m3/sec was informed by an Israeli consultant for the Sheikh Hussein Bridge, which has an approximate catchment area of 10,800 km2 while the King Hussein has catchment area of 14,300 km2. As such, the peak runoff of 1,720 m3/sec for the King Hussein Bridge is obtained as the equivalence by multiplying the peak runoff for the Sheikh Hussein Bridge with the fraction of the respective catchment areas.

As a result, the discharge volume of 1,740 m3/sec was adopted in the Previous Basic Design Study.

b) High Water Level

The water levels by the bridge lengths are obtained in Figure 2.3.1.

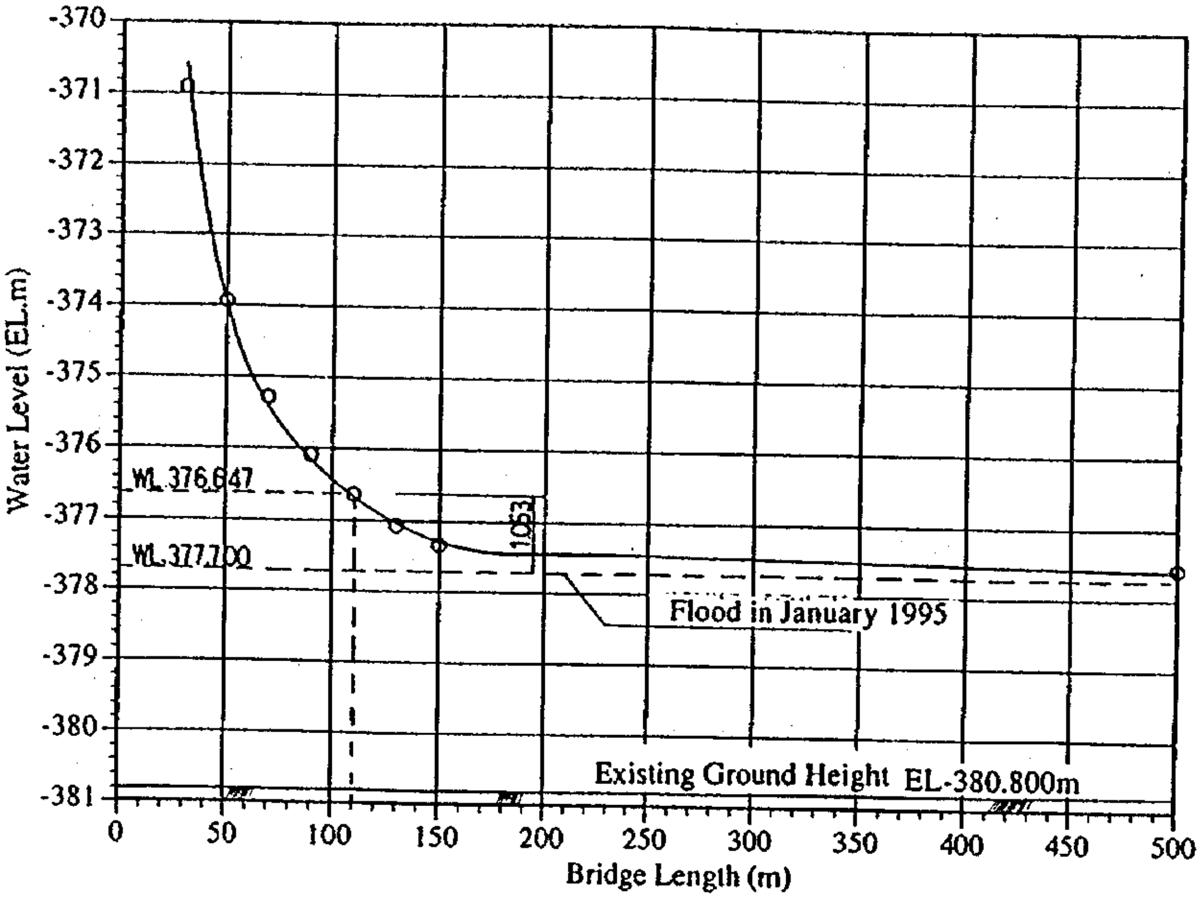


Figure 2.3.1 HWLs Calculated by the Previous Basic Design Study

B) Review of the Previous Basic Design Results

a) Design Discharge

Annual maximum discharge data from 1932 to 1958 are available for the Jordan River at King Hussein Bridge. Six different probability analysis methods were used to estimate the 50-year probable design discharge based on these annual maximum discharge data. Discharge volumes are summarized in Table 2.3.5.

Table 2.3.5 Discharge Volumes by Various Formula

Return Period (Year)	Iwai Method	Ishihara & Takase	Gumbel	Generalized Extreme Value Distribution	Sqrt-exponential Type Maximum Distribution	Log Pearson Distribution
1.01	411.2	384.3	522.6	375.3	512.1	423.9
2.00	1,065.3	1,071.8	1,028.9	1,074.4	1,014.7	1,071.2
5.00	1,322.0	1,322.9	1,331.6	1,337.5	1,384.4	1,335.8
10.00	1,460.9	1,454.7	1,532.0	1,468.5	1,657.1	1,468.9
20.00	1,578.0	1,563.9	1,724.2	1,569.2	1,939.4	1,573.4
30.00	1,639.8	1,620.8	1,834.8	1,618.1	2,110.9	1,625.4
50.00	1,712.5	1,687.1	1,973.1	1,671.2	2,334.7	1,683.5
100.0	1,803.8	1,769.5	2,159.5	1,730.9	2,652.8	1,751.6
Coefficient of Determinant	0.0289	0.0275	0.0508	0.0271	0.0683	0.0309
Correlation of Coefficient	0.9906	0.9916	0.9883	0.9942	0.9798	0.9942
Evaluation	○	○		◎		○

From the coefficient of the determinant and correlation of the coefficient, the methods of the Generalized Extreme Value Distribution, Iwai, Ishihara & Takase and Log Pearson Distribution show good results. Accordingly, the discharge volume at the King Hussein Bridge would be from 1,683.5 m3/sec to 1,712.5 m3/sec for the return period of 50 years.

Consequently, it is verified that the discharge volume of 1,720 m3/sec obtained in the Previous Basic Design Study is reasonable.

b) Design High Water Level

i) Non-uniform Flow Calculation

Non-uniform flow calculation was conducted based on the discharge volume of 1,720 m3/sec and topographic data obtained in the present Study. As a bottle-neck of water flow exists about 10km downstream of the King Hussein Bridge, the following were assumed to blend well with the discharge volume and topography.

- Roughness coefficient = 0.06
- Grade of water surface = 1 / 7,750
- Discharge = 1,720 m^3/sec
- Water Level = EL – 377.7 m

ii) Water Level for Bridge Design

The water levels by bridge lengths were obtained by considering the effects of sudden contraction and sudden enlargement in addition to the earlier mentioned non-uniform flows. The results are shown in Table 2.3.6 and Figure 2.3.2, and details are as per Appendix 6.

Table 2.3.6 Relationship between Water Levels and Maximum Water-flow Velocities (Return period = 50 years)

Bridge Length (m)	Water Level (EL, m)	Max Flow Velocity (m/sec)
30.0	- 368.304	8.430
50.0	- 372.005	6.742
70.0	- 373.518	6.073
90.0	- 375.799	4.435
100.0	- 376.258	3.803
110.0	- 376.559	3.224
120.0	- 376.713	2.909
130.0	- 376.862	2.554
150.0	- 377.011	2.123

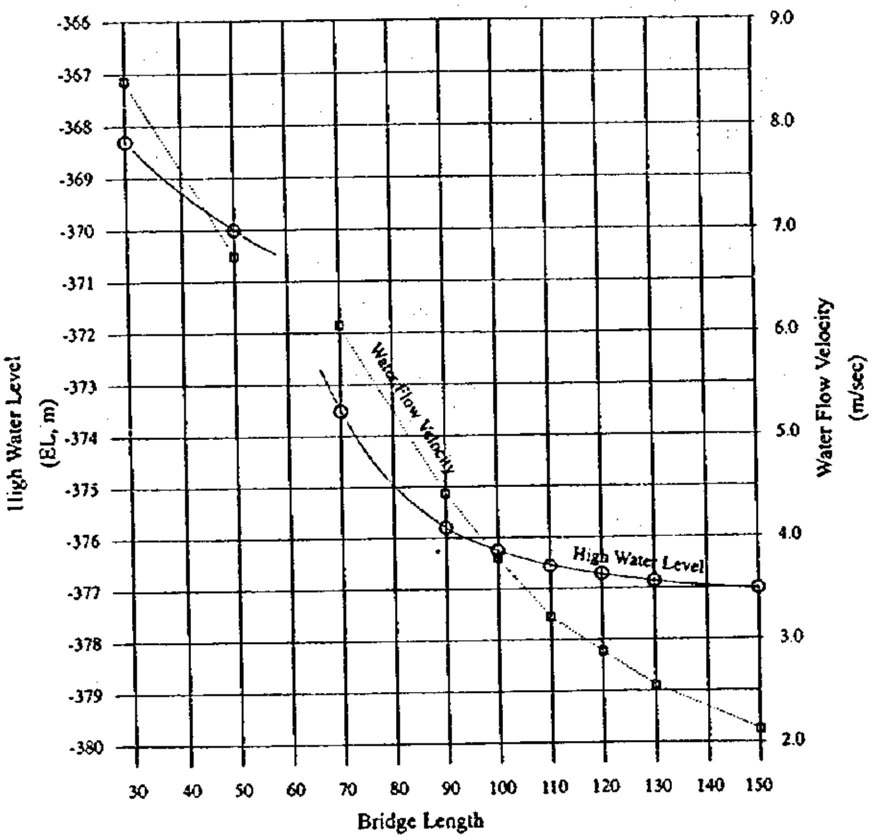


Figure 2.3.2 HWLs and Water Flow Velocities Reviewed by the Present Study

(4) Bridge

1) Bridge Location

The road will cross the Jordan River at the point of 8.457 km from the South Shuna intersection. The location of the proposed King Hussein Bridge will be 30 m upstream of the existing Bailey bridge as shown in Figure 2.3.3. The bridge location was unanimously decided in January 1996 among the participants from the concerned officials and Study Team. The main reason for the new bridge location is to avoid the risks of the remainder of unexploded mines that were placed in the forest downstream.

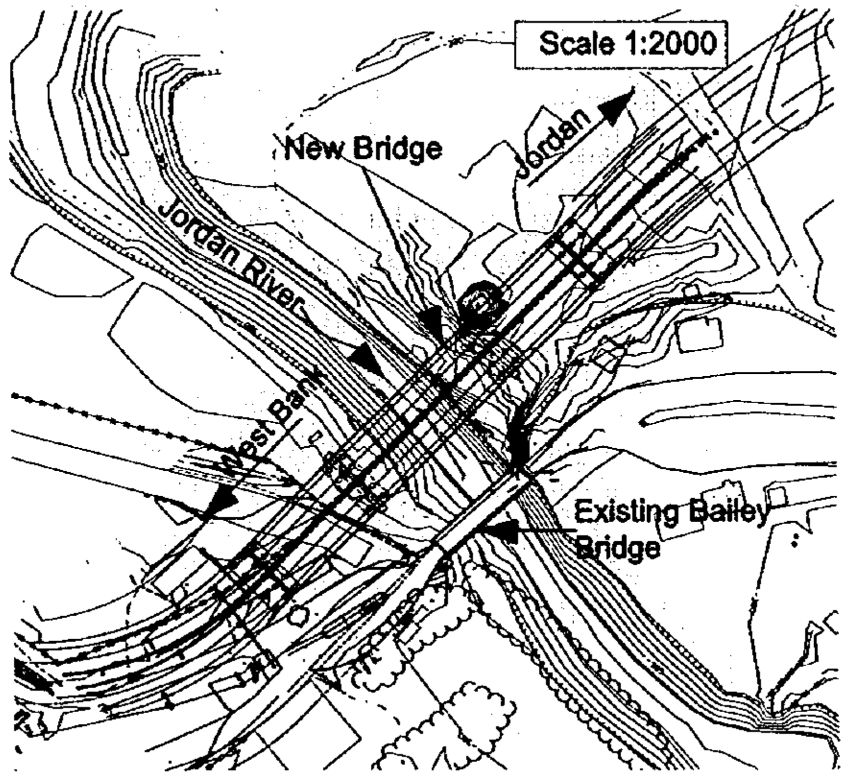


Figure 2.3.3 Location of Proposed King Hussein Bridge

2) Bridge Length

The Jordan River at the King Hussein Bridge site is characterized as flood-prone, but the existing bridge length is only 30.5m. The elevations of the existing bridge and access roads are much lower than the high water level and therefore the river water sometimes overflows these facilities during flooding.

On the other hand, the proposed new bridge along with the approach road would be built as permanent structures that project above water surface in a sufficient freeboard above the high water level. In the present Study, due consideration of river characteristics was taken to decide the bridge length in order to minimize the negative effects when the river width reduces by constructing the bridge and approach road.

The following factors were taken into account for determining the bridge length.

- Vertical Clearance between HWL and Girder Bottom
- Local Scour Depth around Piers by Rapid River Flow

i) Vertical Clearance

Any specific requirement for the vertical clearance above the high water level is not stipulated in the Jordanian standards. In case of the Sheikh Hussein Bridge, a vertical clearance of 60 cm (for the 50-year probable discharge = 1,300 m^3/sec) was decided for the bridge design. Differences of river conditions at the sites between the King Hussein Bridge and Sheikh Hussein Bridge are summarized in Table 2.3.7.

Table 2.3.7 Difference of River Conditions

	Sheikh Hussein Bridge	**King Hussein Bridge**
Hydrographic Data	Recorded continuously at the Naharayim Water Gauge Station.	Old data is available, from 1932 to 1958.
River Conditions	No flood takes place. Not so many trees are occupying along the river, and the risk of floating/drift wood seems less.	The river likely causes flood and widely spread like a lake. A number of trees occupy the riverside, and the high risk of floating/drift wood is anticipated.
Design Discharge (50 year return period)	1,300 m^3/sec	1,720 m^3/sec

Source: Study Team

As stated in this table, the Jordan River would become like a lake when floods take place. The flood-prone area occupies up to 20 km from the King Hussein Bridge as shown in Figure 2.3.4, where a number of trees exist, and accordingly the King Hussein Bridge might have a high risk of driftwood. In this regard, the King Hussein Bridge has higher risk of driftwood than the Sheikh Hussein Bridge.

From the engineering view points, the King Hussein Bridge would have to be designed to maintain much more vertical clearance than the Sheikh Hussein Bridge since the former has less hydrographic data, high risk of driftwood, etc.

As already discussed, the Jordanian standards has no specific stipulation about the vertical clearance above the high water level. Therefore, the Japanese standards were adopted to determine the vertical clearance of the King Hussein Bridge. The requirements of the vertical clearance in the Japanese standards are shown in Table 2.3.8. From this, the vertical clearance of 1.0 m was determined for the design of the King Hussein Bridge.

Table 2.3.8 Required Clearances by Discharges

Description	**1**	**2**	**3**	**4**	**5**	**6**
Design Discharge (m^3/sec)	200 or less	200 to less than 500	**500 to less than 2,000**	2,000 to less than 5,000	5,000 to less than 10,000	10,000 or more
Vertical Clearance (m)	0.6	0.8	**1.0**	1.2	1.5	2.0

Source: Legislation of River Management Facilities by the Japan River Association

As with the Previous Basic Design Study that requires the minimum clearance of 2.0 m above the flood level in January 1995, the respective clearances above the 50-year probable flood are summarized in the line c) of Table 2.3.9 for the bridge lengths of 110m, 120m and 130m. In this case, the bridge length of 110m cannot satisfy the vertical clearance of 1.0m above the 50-year probable flood.

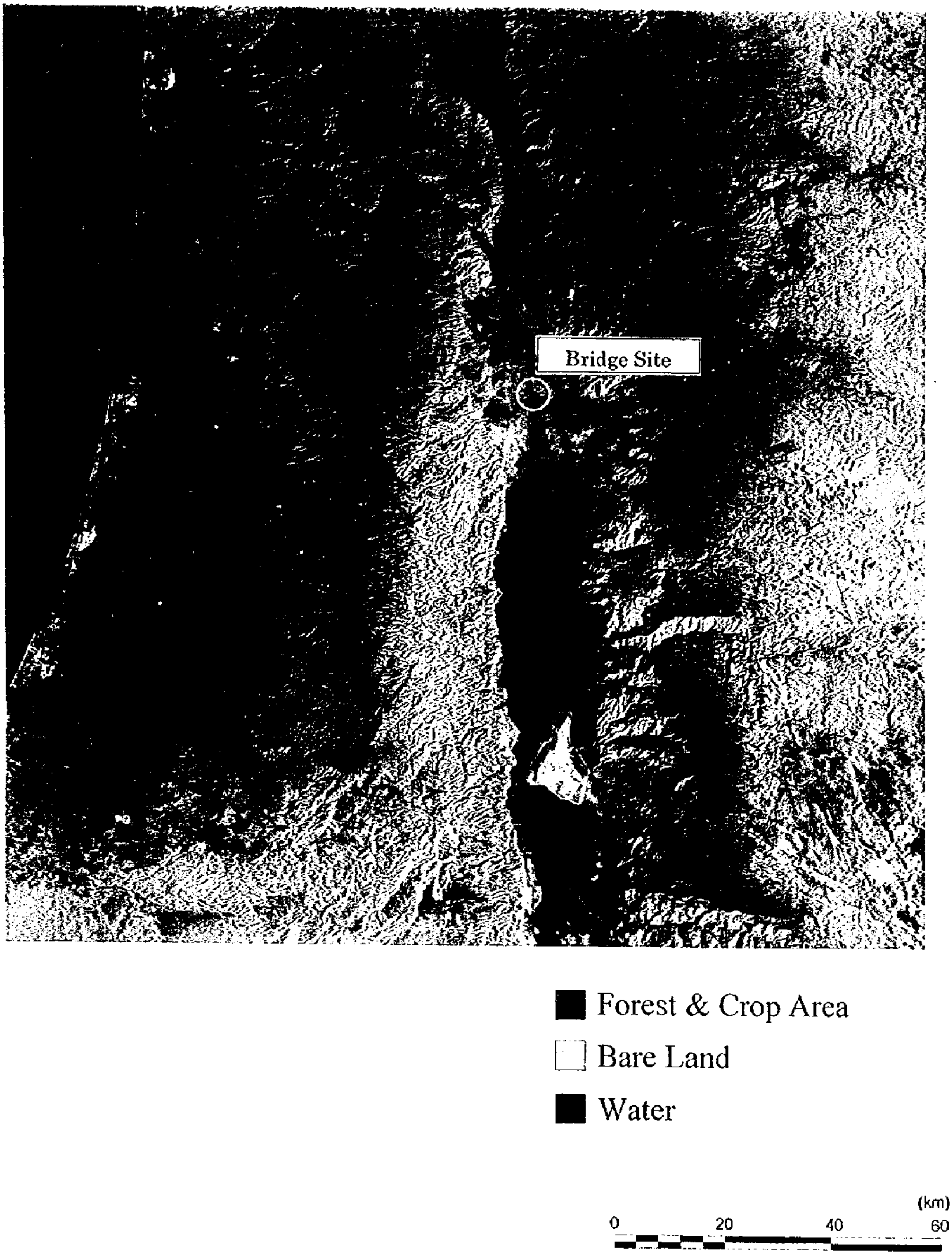


Figure 2.3.4 Landsat TM Image of Jordan
(Landsat TM data, January 1995)

Table 2.3.9 Clearances by Bridge Lengths

	110m	120	130m
a) Elevation of girder bottom, having a 2m clearance above the flood in January 1995 (m)	EL – 375.700	EL – 375.700	EL – 375.700
b) Elevation of 50-year probable flood (m)	EL – 376.559	- 376.713	EL – 376.862
c) Clearance above 50-year probable flood (m)	0.859	1.013	1.162

Structural depth consisting of pavement thickness, cross-fall and girder depth for the bridge lengths of 110m to 130m is the same. Comparing the cases of bridge length of 120m and 130m which satisfy the vertical clearance requirements above the 50-year probable flood, the bridge length of 120m is more advantageous from the view point of construction cost.

Consequently, the bridge length of 120m is favorable.

ii) Effects of Local Scour by Rapid Water Flow

Local scour depths for the bridge lengths of 110m, 120m and 130m were calculated on the basis of the diagrams in the Data Book ISSN0386-5878 by the Research Bureau of the Ministry of Construction, Japan and a summary of the results is shown in Table 2.3.10. The diagrams used in the present Study are attached in Appendix 7.

[Assumption] Riverbed Elevation: EL – 387.1 m

Pier Width: 2.5 m

Size of Riverbed Materials: 100 μ

Table 2.3.10 Local Scour by Bridge Lengths

Bridge Length	Water Level (EL, m)	Water Depth (m)	Flow Velocity (m/sec)	Froude Number	Ratio of Scour / (Pier Width): Z/D	Scour Depth (m)	Scour Level (EL, m)
110m	- 376.559	10.541	3.224	0.317	1.6	4.3	- 391.4
120m	- 376.713	10.387	2.909	0.288	1.5	3.75	- 390.8
130m	- 376.862	10.238	2.554	0.255	1.4	3.5	- 390.6

Remark: Ratio of Z/D was obtained from the diagrams in the Data Book by the Research Bureau of the Ministry of Construction, Japan.

From the above, the bridge lengths of 120m and 130m are more advantageous than that of 110m in terms of scour depths, 0.6m and 0.8m respectively. The difference of scour depths between the bridge lengths 120m and 130 are relatively small, 0.2m only.

As a result of i) and ii) of the above, it was recommended by the Study Team that the bridge length be 120m with a vertical clearance of 1.0m above a 50-year probable flood.

3) Sizes of Proposed Bridge

i) Bridge Length

As discussed in (4) 2), the bridge was determined at 120 m on the technical view point.

ii) Center Span Length and Span Arrangement

A span length of 52m, which eliminates the construction of piers in the river, was determined for the center span since it would be technically difficult to clear unexploded mines in the water. When the center span length is 50 m or more, a three span bridge would be favorable from a structural point of view.

As for the span arrangement, the following is proposed in case of the bridge length of 120 m and three span continuous structures:

Span Arrangement = 34m + 52m + 34m

iii) Bridge Width

On the basis of the traffic demand forecast, the proposed bridge is designed as two lane dual carriage-ways (4 lanes).

Table 2.3.11 Summary of Future Traffic Volumes

(Unit: AADT)

	1998	2000 (Opening)	2007 (After 7 years)	2017 (After 17 years)	2027 (After 27 years)
Future traffic volume estimated in the Previous B/D, March 1996	5,908	7,255	12,036	24,865	51,525
Future traffic volume estimated in the preset Study, March 1999	(1,549 observed)	7,741	12,156	26,536	59,863

The bridge should have a 3.0m wide median strip according to the usual practice in Jordan. However, the bridge width is to be reduced by using a New-Jersey type block instead.

The bridge should have 1.5m wide sidewalks on both sides.

Subsequently, the total width was determined at 18.9m as shown in Figure 2.3.5.

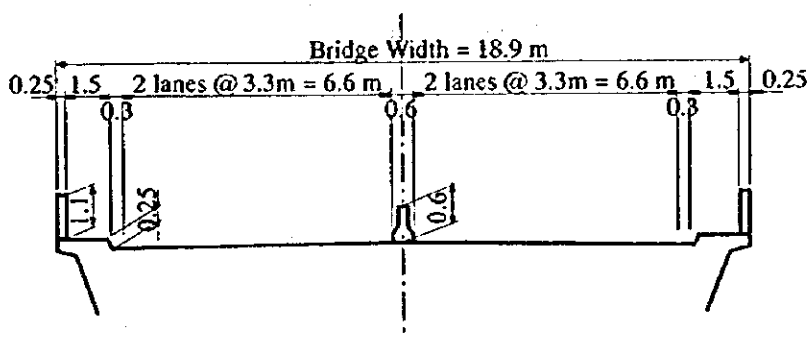


Figure 2.3.5 Cross Section of King Hussein Bridge

iv) Cross-fall and Longitudinal Grade

- Cross-fall = ± 2.0%
- Longitudinal Grade = ± 2.95% (This was tentatively decided between the Israeli consultant and Study team and subject to change through finalization of the alignment.)

4) Bridge Type Selection

i) Superstructure

Conceivable options of the structural types are as follows:

Option-1	:	Prestressed Concrete (PC) Box Girder with Rigid Frame
Option-2	:	PC Connection I-girder
Option-3	:	PC Extra-dosed Girder

As a result of the overall assessment including the structural characteristics, construction methods, future maintenance, aesthetics and economic aspects, the PC extra-dosed girder (Option-3) was recommended as the proposed bridge type for the King Hussein Bridge by the Previous Basic Design Study.

The comparison of the three options is summarized in Figure 2.3.6.

ii) Foundation Type Selection

The bearing strata, which contains intermediate layers of silty clay and clay intercalated with each other, exists about 30m below the ground surface. Silty clay and clayey soils are likely eroded or scoured by rapid water flow in flood time. Accordingly, a spread foundation (direct foundation) system is not recommendable.

In the Previous Basic Design Study, 1.2m dia. Cast-in-place reinforced (RC) piles were selected as the recommended foundation from the view points of economy and construction speed in the case that the construction of the King Hussein Bridge would be carried out in parallel with that of the Sheikh Hussein Bridge.

However, the implementation of the King Hussein Bridge was delayed due to the social and political atmosphere in the region. In this regard, comparative studies were made in the present Study taking the conceivable foundation type options into consideration for the case that the King Hussein Bridge would be implemented independently. A summary of the comparisons is shown in Figure 2.3.7.

As a result, 1.5m dia. Cast-in-place RC piles were recommended.

Figure 2.3.6 Comparison of Superstructure Type Options

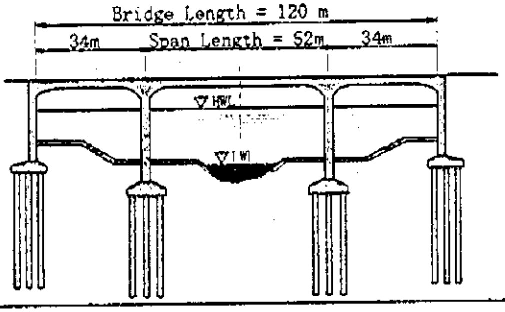
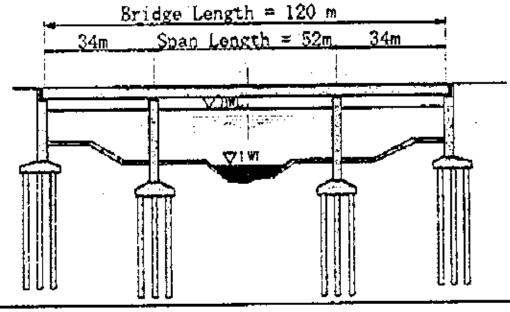
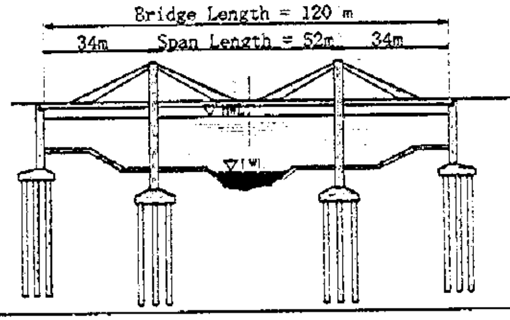
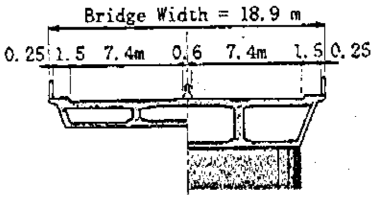
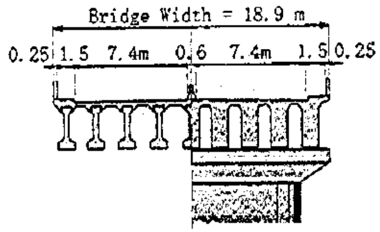
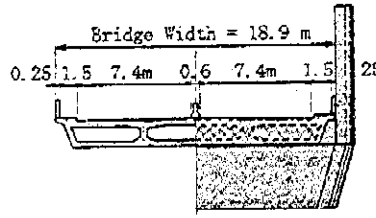
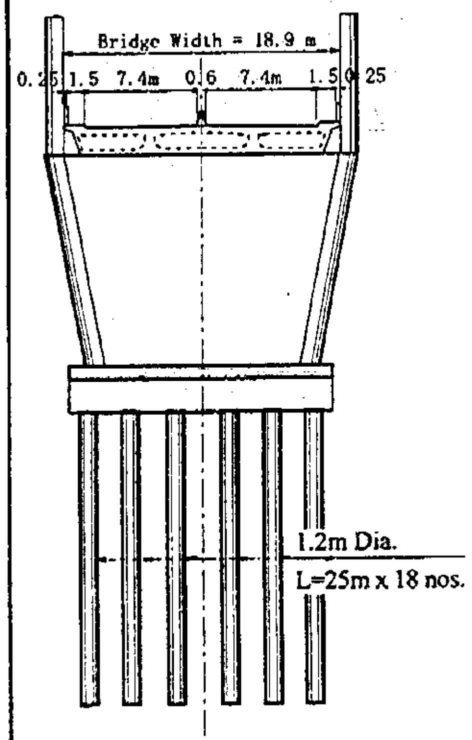
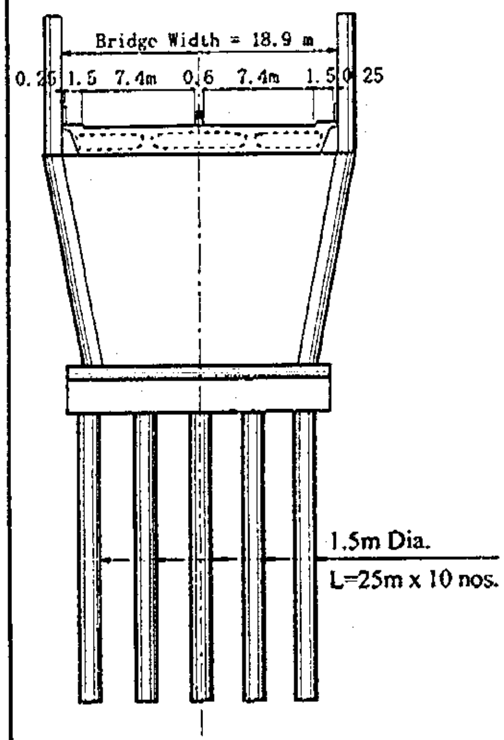
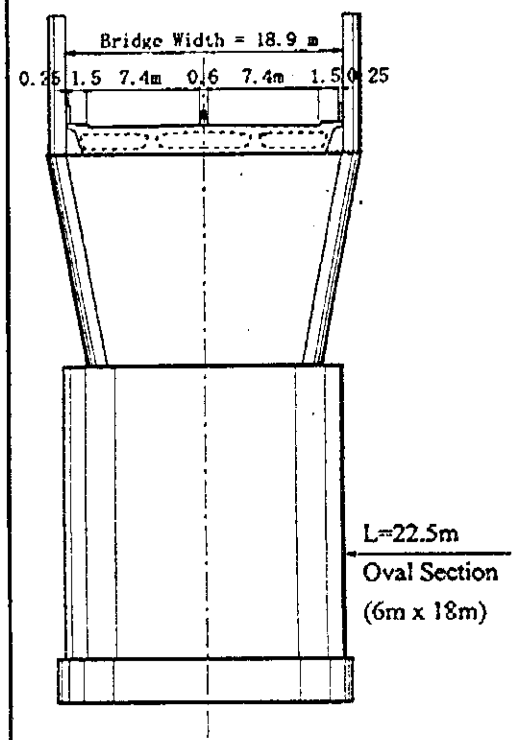
		OPTION-1	OPTION-2	OPTION-3
General View	Side View	3 Span Continuous Rigid Frame 	PC Connecting Girder Bridge 	PC Extra-dosed Girder Bridge 
	Cross Section			
Structural Characteristics		Prestressed concrete box girder (post-tensioning) having the rigid frame system with substructure which can eliminate the expansion joints and bearings. Largest girder depth among others. So, the cost of approach road is the highest among the options.	Connection beam system that consists of precast prestressed concrete I-girders and cast-in-place concrete of the connection part and deck slabs. Firstly this bridge is constructed as a simple girder system during erection period, then completed as continuous girder system after the cast-in-place concrete work.	Difference of conventional PC box girders is to arrange the diagonal cables outside the main girders. As prestressing forces of the diagonal cables work effectively to reduce the required section of main girders, the depth of girder is the minimum among 3 options. Accordingly, the height of approach road embankment decreases.
Construction Method		Full scaffolding method can be applied since the clear height of the girder is relatively less. As the structural system is rigid frame, special emphasis should be placed upon the concrete curing work to avoid shirinkage cracks.	This system requires the most simple and easiest erection method.	Full scaffolding method can be applied since the clear height of the girder is relatively less. Full scaffolding method can be applied since the clear height of the girder is relatively less.
Construction Cost		As the girder depth is higher than other options, the total costs of the bridge and approach road becomes high. 3rd Best	As the girder depth is higher than the Option-3, the total costs of the bridge and approach road becomes higher than the Option-3. 2nd Best	Least construction cost among 3 options.
Others		No expansion joints and no bearings would reduce the maintenance costs in the future. Aesthetics: Good	This bridge system has bearings and expansion joints at piers and abutments. Therefore maintenance for bearings and expansion joints are required. Aesthetics: Not attractive	This bridge system has bearings and expansion joints at piers abutments. Therefore minor maintenance for bearings and expansion joints are required. Aesthetics: Best
Overall Evaluation		Advantageous for future maintenance, but costly than Option-3.	Too conventional and inferior in technology impact.	● Recommended

Figure 2.3.7 Comparison of Foundation Type Options

	Option-1 Cast-in-place RC Pile 1.2 m Dia.	Option-2 Cast-in-place RC Pile 1.5m Dia.	Option-3 Open Caisson
Outline of Foundation			
Cost Aspect	Most costly among 3 options. About 24% higher than Option-2.	Least cost.	2nd less cost. About 3% higher than Option-2.
Construction Practice	Normal practice of piling work. Re'd period = 1.5 months	Normal practice of piling work. Re'd period = 1.0 months	Earth anchor & jack-down method. Re'd period = 2.0 months
Overall Evaluation	△	◎ Recommended	△

(5) Approach Road and Access Road

1) Locations of Approach and Access Roads

The following definition was made in the Previous Basic Design Study:

- Approach Road: Road section being constructed in flood area from the abutment of the bridge to the conjunction of existing road.
- Access Road: Road improvement section from the starting point at the South Shuna intersection to the conjunction of the approach road

2) Lengths of Approach and Access Roads

Additional topographic surveys on both sides of the Jordan River were conducted from November to December 1998 to finalize the road lengths. As a result, the following were decided:

i) Roads on the Jordan Side

- Approach Road : 769m long 4-lane road (new construction)
- Access Road : about 7.6km long 2-lane road (widening)

ii) Road on the West Bank Side

The road length on the West Bank side is determined as the minimum requirement for the abutment construction.

- Approach Road : 20m long 4-lane road (new construction)
- Access Road: None

The configuration of the location of approach road and access road is shown in Figure 2.3.8, and the main points of these roads are summarized below.

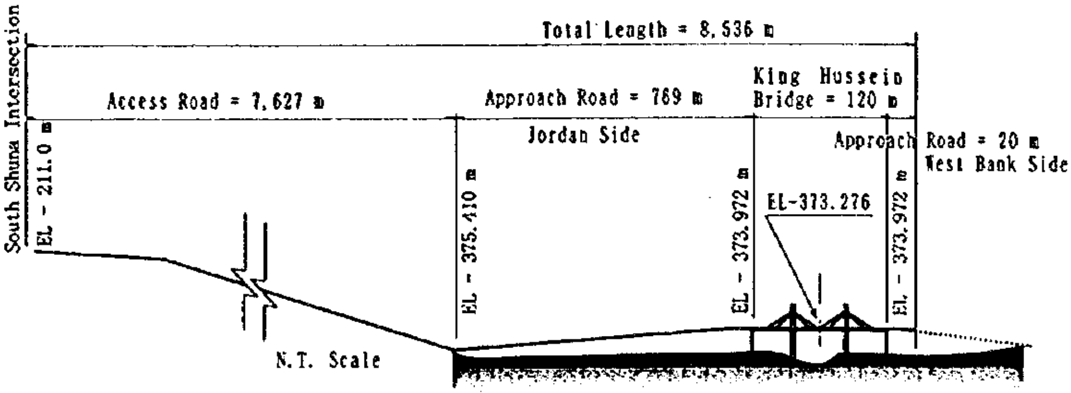


Figure 2.3.8 Relationship of Approach & Access Roads

3) Approach and Access Roads proposed by the Present Study

The access road was designed to have 2 lanes while the approach roads, of which future widening might be very difficult, was to have 4 lanes.

(A) Approach Road

a) Typical Cross Section

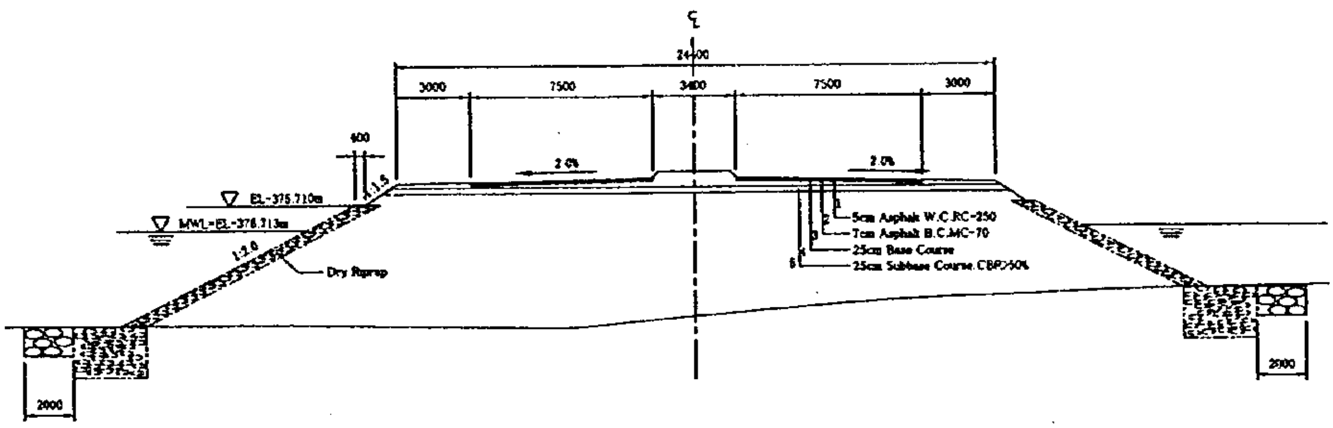


Figure 2.3.9 Typical Cross Section of Approach Road

b) Structures required for Approach Road

i) Slope Protection

Dry riprap at a thickness of 60cm would be constructed to protect the embankment slopes around abutments.
Class-C Stone should be used for the materials of the riprap in strict compliance with the Jordanian Standards.

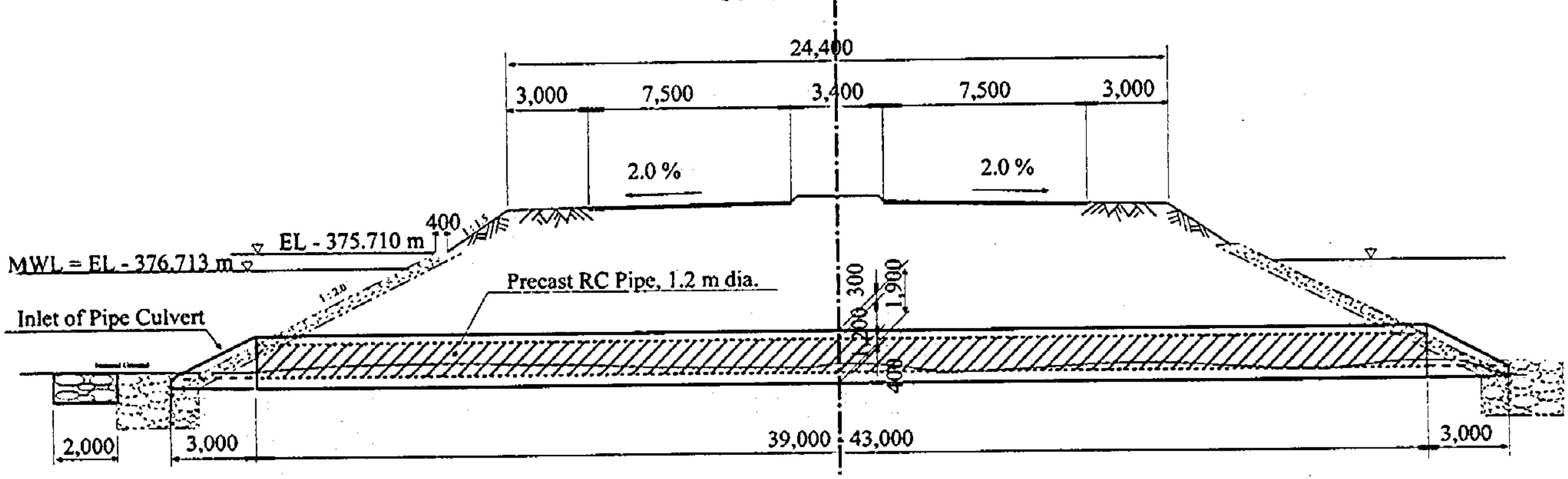
ii) Pipe Culverts for Water Balance

As the approach road passes through an inundation area, pipe culverts for balancing water is recommended in accordance with the Jordanian Standards. A conceptual drawing is shown in Figure 2.3.10. The culverts would also be useful for the animals to underpass the approach road as the area is a habitat for many kinds of wild animals.

- Diameter of pipe culverts: 1.2 m
- Intervals of pipe culverts: 100.0 m

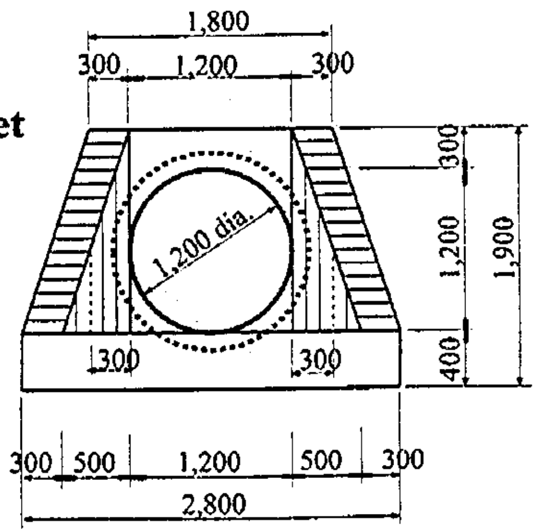
TYPICAL CROSS SECTION AT PIPE CULVERT

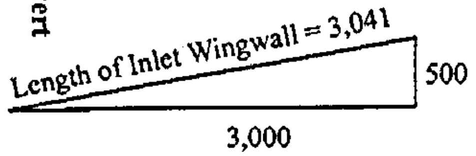
Scale: 1/200



Details of Inlet

Scale: 1/50





Quantity of Pipe Culvert, per Meter

1) Precast Pipe, 1.5 m dia. : 1 nos.
2) Concrete, F28 = 180 kg/m2 : 1.881 m3

Quantity of Inlet, per Each

1) Concrete, F28 = 180 kg/cm2 : 4.128 m3
2) Stone Pitching, Class C = 10 m3

Figure 2.3.10 Pipe Culvert

(B) Access Road

a) Typical Cross Section

The Project, so far, is to construct 2 lanes only while the other 2 lanes would be constructed at an appropriate time in the future depending on the traffic volumes. The typical cross section is shown in Figure 2.3.11.

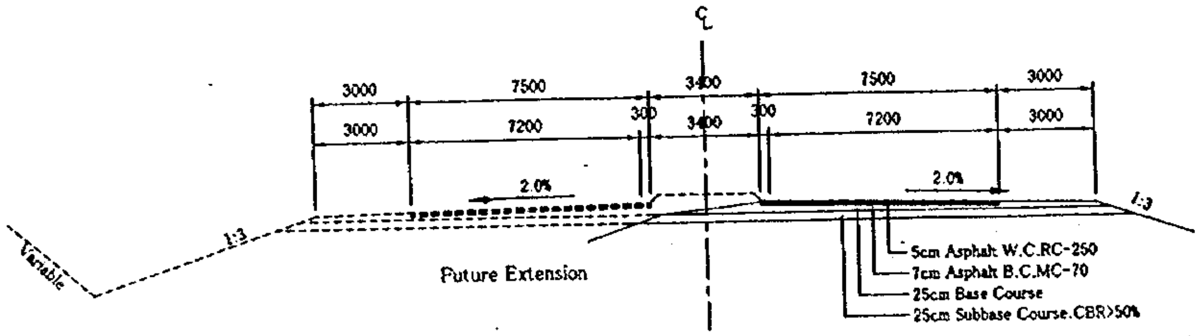


Figure 2.3.11 Typical Cross Section of Access Road

b) Relation between Existing and New Pavement Structures

According to the verbal information from MPWH that the center of the ROW is just on the centerline of the existing road, the relationship between the existing road pavement and new road pavement under the Project is generally outlined as shown in Figure 2.3.12.

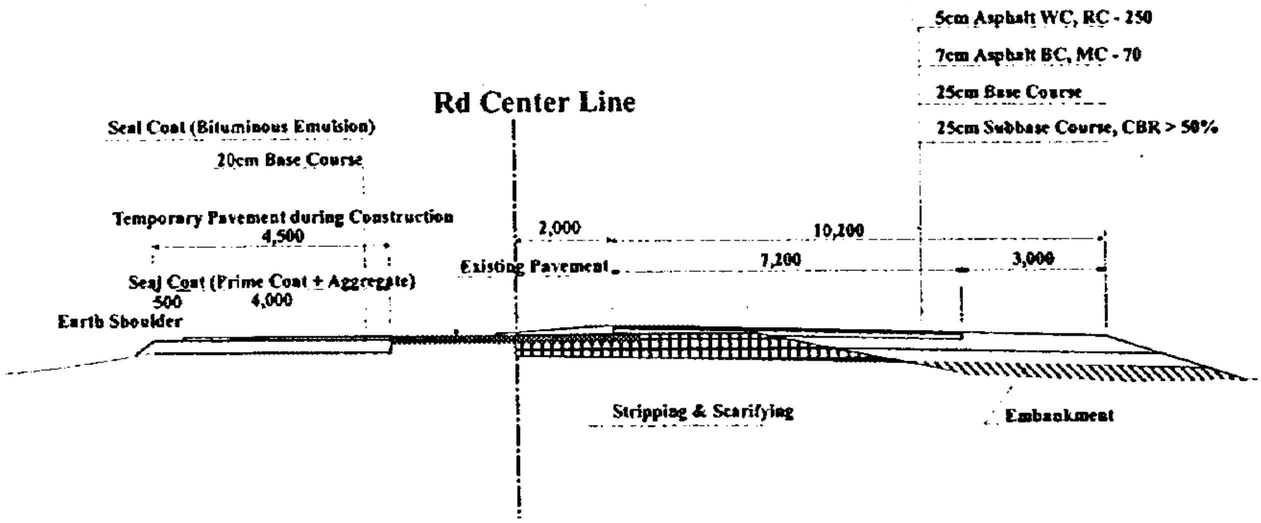


Figure 2.3.12 Relationship between Existing and New Pavement Structures

(6) River Improvement Work

1) Riverbed Protective Measure against Scour

Considering the risk of scour during a flood, the required average size (dm) of the dumped stone is estimated at 50 cm against the rapid water flow of 2.909m/sec. Hence, Class-C Stone stipulated by the Jordanian Standards should be used for this purpose.

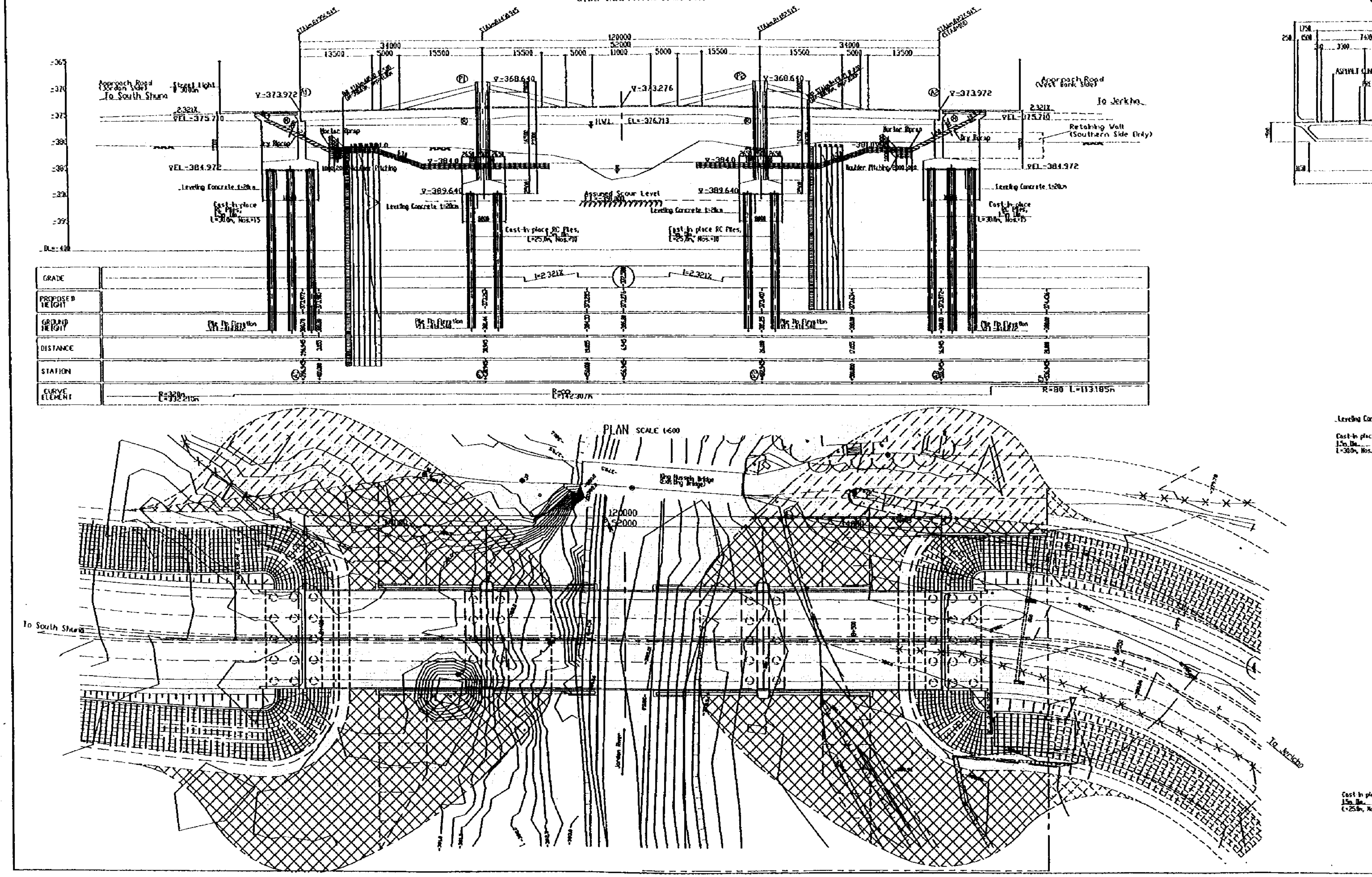
2) Slope Protection around Abutments

Dry riprap at a thickness of 70cm would be constructed to protect the embankment slopes around abutments. Class-C Stone should be used for the materials of the riprap in strict compliance with the Jordanian Standards. The conceptual drawing is shown in Figure-2.3.15.

(7) Drawings

General plans of the bridge and approach road are shown in Figure 2.3.13 and 2.3.14 respectively. Other drawings are as per Appendix 8.

GENERAL VIEW OF KING HUSSEIN BRIDGE



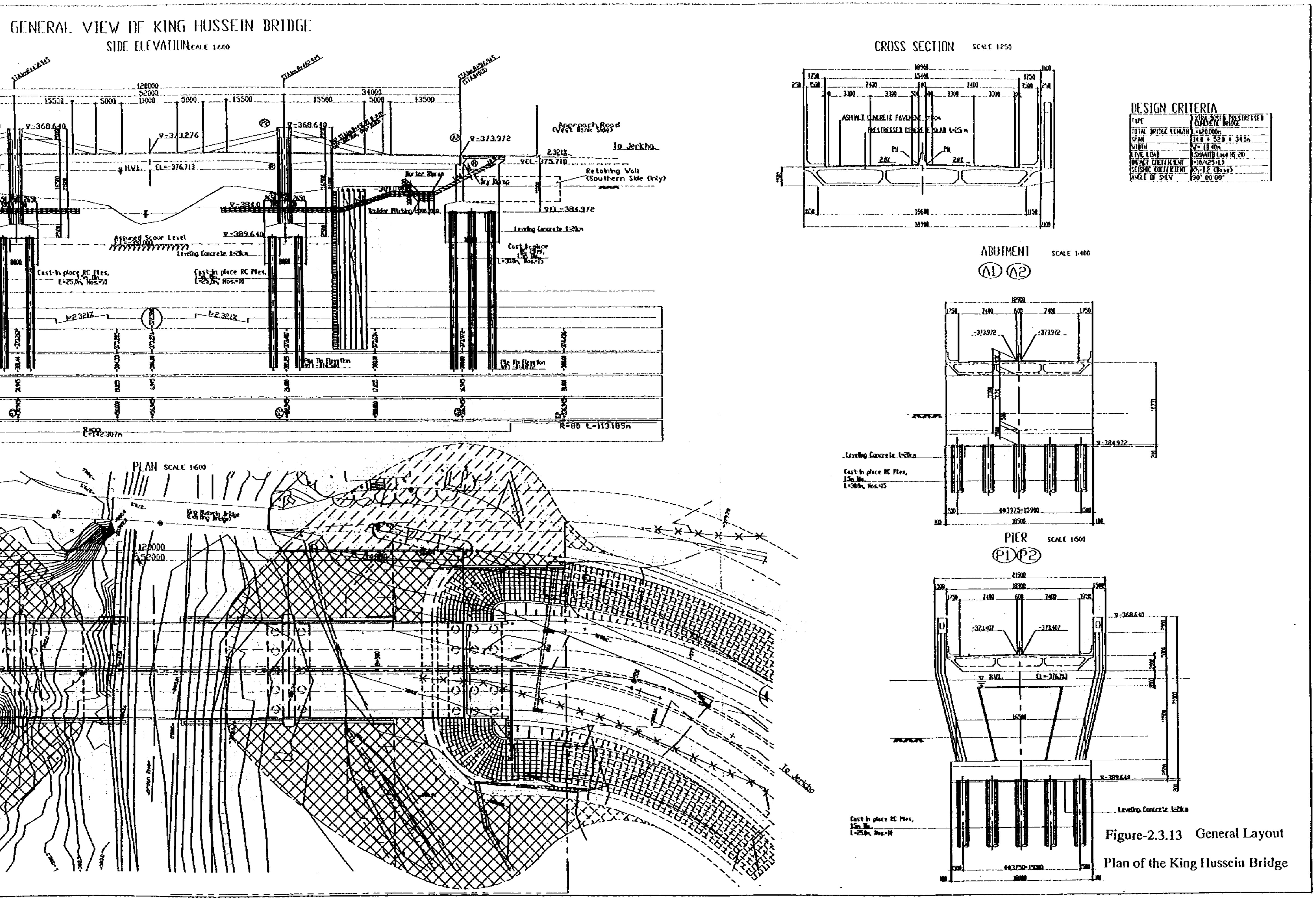


Figure-2.3.13 General Layout Plan of the King Hussein Bridge

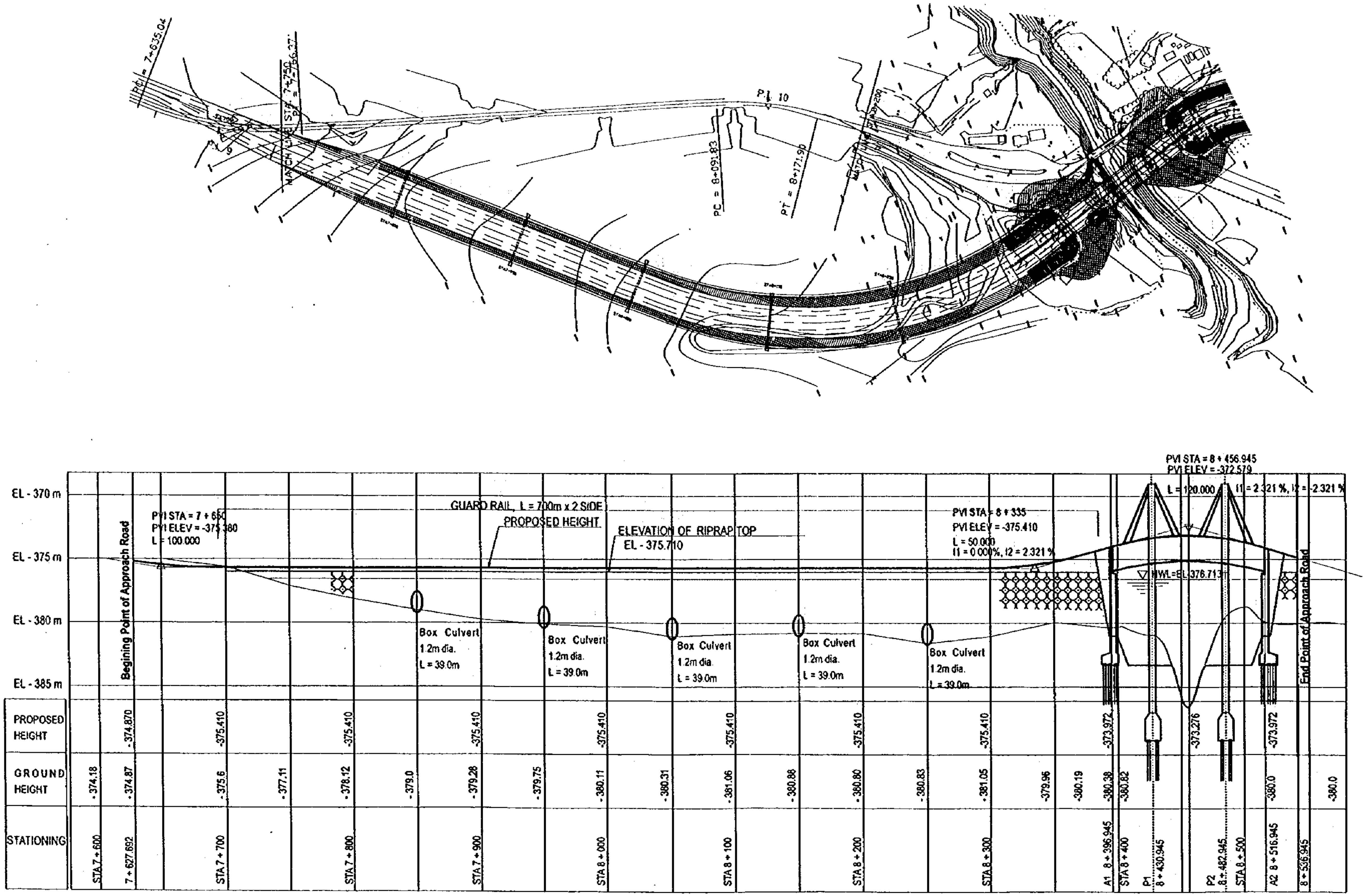
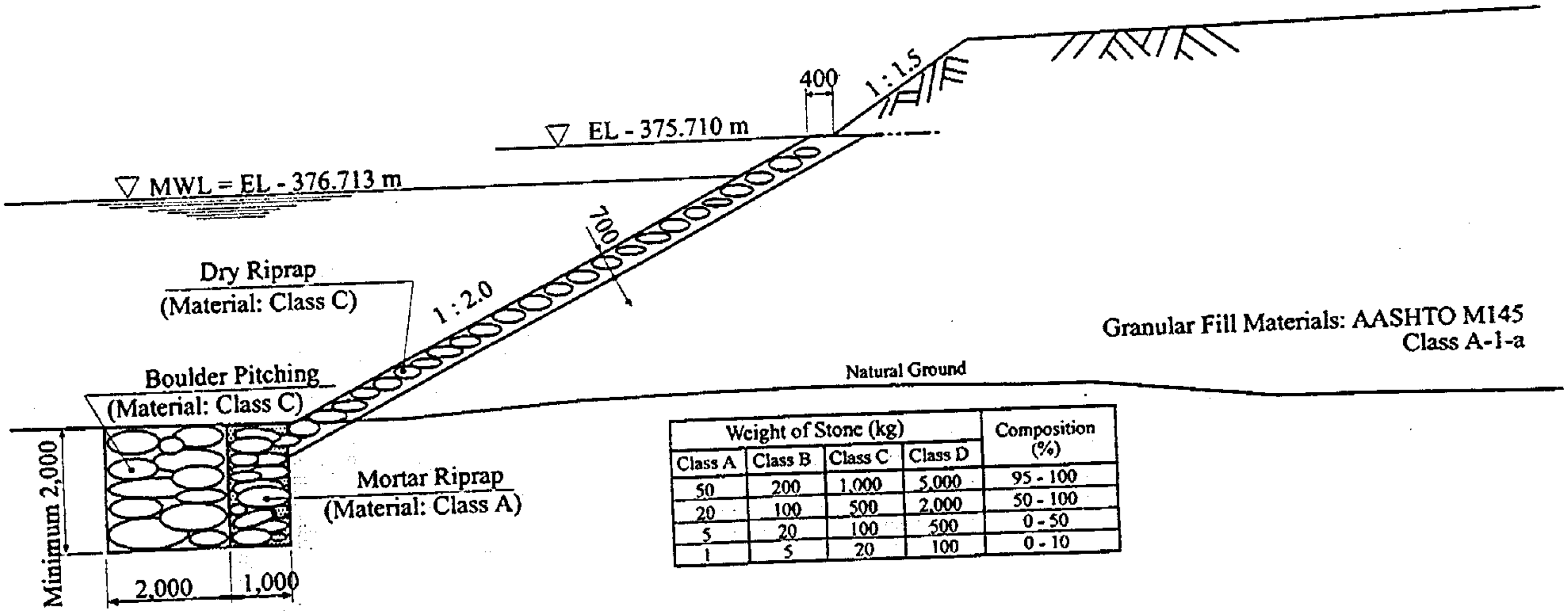


Figure 2.3.14 General Layout Plan of Approach Road

Scale: 1/100



Weight of Stone (kg)				Composition (%)
Class A	Class B	Class C	Class D	
50	200	1,000	5,000	95 - 100
20	100	500	2,000	50 - 100
5	20	100	500	0 - 50
1	5	20	100	0 - 10

Figure-2.3.15 Slope Protection around Abutment

CHAPTER 3 IMPLEMENTATION PLAN

3.1 Implementation Plan

3.1.1 Implementation Concept

(1) Implementation Method

An implementation plan has been studied assuming that the Project will be executed under the grant aid from the Japanese Government and has been made taking the following conditions into consideration:

(i) As Jordan holds relatively high level of engineering standard in their civil engineering undertakings, a Jordanian contractor registered as Grade-1A or 1B might be employed during the implementation of the project as a sub-contractor,

(ii) In principle, materials and equipment for the construction will be procured in Jordan. However, those materials and equipment that are scarce in Jordan will be mobilized from Japan,

(iii) The construction work will be carried out throughout the year, except on the two Eid Holidays.

(iv) The existing road would have to be opened to public traffic. During the Bethlehem-2000, special care should be placed upon such public traffic. Temporary pavement, consisting of 20cm base course and seal coat, should be placed on one side of the existing shoulder if the 2-lane carriages cannot be maintained for the public traffic.

(v) Execution of the work will proceed so as not to disrupt present activities at the security office that is located near the existing bridge.

(vi) The execution of the project will proceed paying attention to the environment and ecology near the site.

(vii) The coordination and appropriate preparatory work are essential to carry out the smooth execution of the interfaces with the concerned organization, which may carry out the construction works on the West Bank side.

(viii) Some portions of river improvement work will not be covered by the Project, because the construction work might be hampered by the existing facilities such as Bailey bridge, existing roads and offices of border securities. The Jordanian Government should carry out the river improvement work of such portions in the future.

(2) Implementation Plan

Major work items for the Project are described in Table 3.1.1.

Table 3.1.1 Items of Construction Works

Facility	By Japan's Grant	By the Concerned Organization of Jordan	By the Concerned Organization of West Bank
Bridge	All the bridge works, which include: - Cast-in-place RC pile - Tower and abutment - Extra-dosed girder	- None	- None
Approach Road	120m on the Jordanian side and 20m on the West Bank side from each abutment, which include: - Embankment - Slope protection by riprap - Asphalt pavement - Road lighting	- None	Connection road, starting at 20m from the abutment on the West Bank, towards the West Bank Border Terminal. The work includes: - Embankment - Slope protection by riprap - Asphalt pavement - Road lighting
Access Road	Jordanian side only, which includes: - Improvement of alignment - Asphalt pavement - Road lighting	- None	- None
River Improvement Work	River improvement work on the Jordanian and West Bank sides from the existing bridge towards upstream, which includes: - Riverbed treatment - Dumped stone on riverbed surface around piers and abutments - Slope Protection by dry riprap around abutments	River improvement work on the Jordanian side and West Bank side from the existing bridge towards down-stream, which includes: - Riverbed treatment - Dumped stone on riverbed surface around pier and abutment	
Others	- None	- Land acquisition, clearance of unexploded mines and installation of fences - Relocation of water gauge station of JMBA as well as watchtower and other facilities of the Defense Army - Relocation of electric and telephone cables - Dismantling of existing Bailey bridge	- Land acquisition, clearance of unexploded mines and installation of fences - Relocation watchtower and other facilities of the Defense Army

Source: Study Team

3.1.2 Implementation Condition

To implement the Project, the following factors, which concern the coordination of the work areas, construction methods, procurement of material, and so on must be considered:

i) As the Project site is located between Jordan and West Bank, close communication between the concerned organizations is required for smooth and prompt implementation of the Project. In particular, in the issuance of entrance permission and labor management, an organized coordination system and schedule will have to be established,

ii) Location of the temporary yards has to be decided through the examination of flood level of the Jordan River,

iii) Bridge engineers who are responsible for foundation work and superstructure work will be dispatched from Japan. The construction materials and machinery, which are not available Jordan, will be transported from Japan. Procurement and mobilization of these materials and machinery on schedule is very important for the smooth implementation of the Project,

iv) Public utilities such as power cables and telephone cables have to be replaced partially. This replacement work must be carried out so as not to disrupt the construction work of the Project.

3.1.3 Scope of Work

Scope of the work for the project implementation is described as follows:

(1) Consulting Services

The services will cover the following:

- Supplementary topographic survey for the area where clearing and grubbing work is undertaken by the concerned governments to confirm the removal of unexploded mines.
- Detailed design
- Preparation of Tender Documents

- Cost estimation
- Construction supervision
- Defect liability inspection

(2) Construction

- To construct a 4-lane 120m long bridge
- To construct an approach road (4-lane, West Bank side: 20 m, Jordan side: 769 m)
- To construct an access road (2-lane, Jordan side: 7.6 km)

3.1.4 Consulting Services

Immediately after signing the Exchange of Notes (E/N), the contract for engineering consulting services should be signed. The services will cover the detailed design, cost estimation, preparation of tender/contract documents, tendering and construction supervision.

The required Japanese staff and their responsibilities are described below:

(i) Team Leader

Responsible for all the activities of consulting services during the detail design and construction.

(ii) Bridge Engineers

Responsible for the design of the superstructure, substructure and foundation of the bridge in the detailed design stage and responsible for supervising the bridge and structural works during the construction stage.

(iii) Highway Engineer

Responsible for design of the approach and access roads in the detailed design stage and responsible for supervising the road works during the construction stage.

(iv) Construction Planner/Cost Estimator

Responsible for the preparation of a detailed implementation plan including the review of project costs made in the basic design stage.

(v) Soil/Material Engineer

Responsible for checking and advising the quality control of the materials for the bridge structure, approach and access roads.

3.1.5 Procurement Plan

The construction materials to be used for the Project are mostly available in Jordan. However, some of the materials are recommended to be procured in Japan as shown in Table 3.1.2.

As for construction machinery, the procurement schedule is shown in Table 3.1.3.

Table 3.1.2 Procurement of Construction Materials

Description	Procured in Jordan	Procured in Japan
Cement	O	
Reinforcing bar	O	
Crushed stone, Sand	O	
Asphalt, Asphalt Emulsion	O	
Shaped Steel, Steel Sheet Pile	O	
PC Cable, Tendon		O
PC Sheath		O
PC Anchor		O
Asphalt Mixture	O	
Concrete Admixture	O	
Expansion Joints		O
Bearings		O
Steel Form	O	
Timber	O	
Materials for scaffolding	O	

Source: Study Team

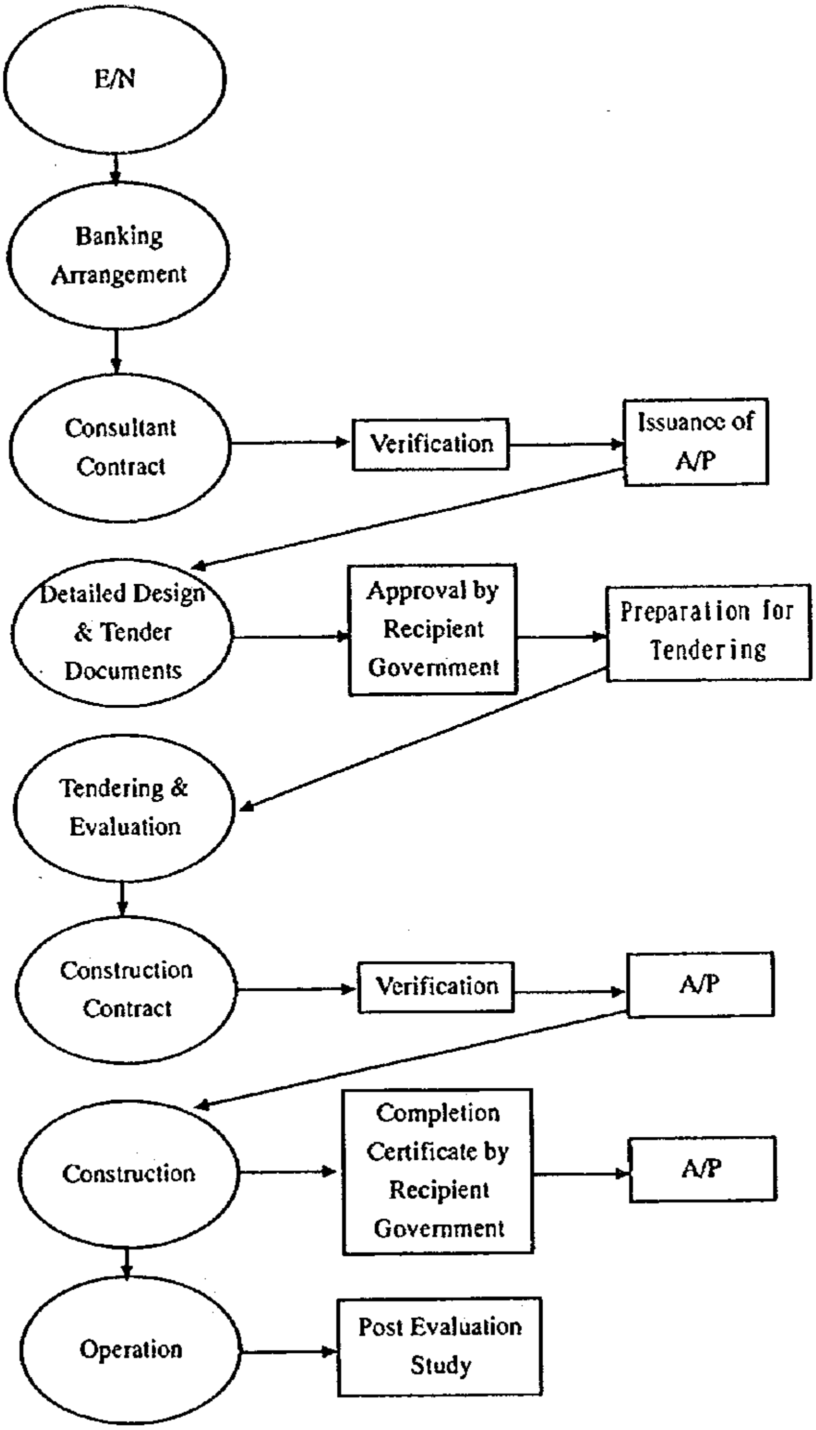
Table 3.1.3 Procurement of Construction Machinery

	Specification	Procured in Jordan	Procured in Japan
Dump Truck	11 ton	O	
Bulldozer	15 ton, 21 ton	O	
Backhoe	0.6 m^3	O	
Vibrating Roller	0.8 - 1.1 ton	O	
Truck Crane	20 - 22, 15 - 16 ton	O	
Crawler Crane	40 ton	O	
Vibro Hammer	40 kW	O	
Water Jet	150 kg/cm^2		O
Tamper	60 - 100 kg	O	
Asphalt Finisher	2.4 - 5.0 m	O	
Concrete Pump	60 m^3/h	O	
Welding Set	250 A	O	
Center Hole Jack	50 ton, 200 ton		O
Road Sprinkler	5.5 - 6.5 kl	O	
Tractor Shovel	14 m^3	O	
Tire Roller	8 - 20 ton	O	
Tamper	60 kg	O	
Concrete Bucket	0.6 m^3	O	
Road Roller	10 - 12 t	O	
Generator (1)	125 kVA	O	
Generator (2)	50 kVA	O	
Water Pump	50*20 mm	O	
Concrete Vibrator		O	
Grouting Pump	200 lit.	O	
Grouting Mixer	2.2 kW	O	
Cram Shell Grabbing Crane	0.8 m3	O	
Oil Hydraulic Pump	1.5 kW	O	
Reverse Circulation Drill	60 - 100 kg		O
Concrete Mixing Plant	45 m^3/h	O	
Agitator Car	0.3 m^3	O	

Source: Study Team

3.1.6 Implementation Schedule

The implementation schedule for the detailed design and construction was prepared taking into consideration the procedure of the Japanese Grant Aid System as shown in Figure 3.1.1.



Notes: (1) E/N: Exchange Notes
(2) A/P: Authorization to Pay

Figure 3.1.1 Procedure of Japanese Grant Aid Program

Each phase is broadly divided into three stages as shown below:

Stage 1: Contract with the consultant and the detailed design

After signing the contract with the selected Japanese consulting firm, the detailed design will be carried out by the consultant, including the preparation of the tender/contract documents, drawings and cost estimate. The direct contract system will be applied to procure the consultant.

Stage 2: Pre-qualification, Tendering, and Contract with the Contractor

After discussion with and approval by JICA pertaining to the evaluation of the items for the pre-qualification (P/Q) of tenderers for the construction work, the P/Q activities will be carried out in Japan by the consultant on behalf of the Government of Jordan to select the qualified tenderers.

In the tendering operation, the principle of general competitive bidding will be applied to select a Japanese contractor for the construction work. Evaluation of the tenders and selection of the contractor will be performed in Japan by representatives of the Government of Jordan and the consultant in the presence of JICA officials. Negotiation with the selected contractor and signing of the contract will be also held in Japan. The direct contract system currently in use will be applied to obtain the Contractor.

At the time of the signing of the contract, the Government of Jordan will establish a banking arrangement with a bank in Japan to open accounts for the purpose of receiving the funds granted by the Government of Japan, and making payment to the Japanese consultant and contractor. This banking arrangement will serve as the basis for the Government of Jordan to issue the Authorization to Pay (A/P) that is required for use by the Japanese consultant as well as for use by the Japanese contractor who will have to obtain export licenses for equipment and materials.

Such a banking arrangement will also be used to receive payments as stipulated in the contract terms and should be established within one month after the signing of the E/N. It is noted that the Japanese consultant and contractor will able to carry out their responsibilities only after receiving the verified contract and A/P.

The next step is a verification to be conducted by the Government of Japan. In this step, the contents of the contracts are examined for their conformity to the provisions of the E/N, which is requisite for the contract to be effective.

Stage 3 Construction Work

The construction period will be 11 months for the bridge, including such works as preparatory work, construction of temporary yard, bridge substructure, bridge superstructure, access road, and demobilization. The implementation schedule for construction is shown in Figure 3.1.2 on page 3-11.

3.1.7 Obligations of the Recipient Country

For the implementation of the Project, the Government of Jordan will undertake the following:

(1) Undertakings required for construction work

- Land acquisition
- Land lease for temporary facilities
- Clearing and grubbing of the site including removal of unexploded mines on the approach
- Construction/improvement of border facilities which are not covered by Japanese Grant Aid
- Connection of utilities capable to the Project site
- Dismantle of the existing Bailey bridge

(2) Administration work

- To furnish data necessary for the detailed design and construction supervision,
- To bear commission for the banking services based on the Banking Arrangement,
- To ensure prompt unloading and customs clearance at the port of disembarkation in Jordan for the equipment, materials and machinery required for the Project,
- To ensure tax exemption for the consultant and the contractor engaged in the Project,

- To issue visas, traffic certificates, and other certificates necessary for the execution of the project to the consultant and the contractor,
- To ensure contractual payments to the consultants and the contractor,
- To bear expenses required for the proper and effective maintenance after completion of the project, and
- To bear all the expenses necessary for the execution of the project other than those to be borne by the Grant Aid.

(3) Expenditures to be borne by Jordan Government

In connection with the implementation of the Projects the following expenditures were estimated:

Table 3.1.4 Expenditure by Jordan Government

Item	Unit	Approx. Quantity	U. Price (JD)	Amount ('000JD)	Remarks
Land Acquisition and Compensation	Sq. m	68,000	1.00	68.0	Source of unit price: JVA (Jordan Valley Authority)
Relocation of Water Gage Station nearby the Bridge	Lump Sum	1		70.0	
Relocation of Watch-tower of the Army	Lump Sum	1		20.0	
Relocation of Electricity Cable & Posts	m	8,500	15.00	127.5	Source of unit price: NEPCO
Relocation of Telephone Cable & Posts	m	6,000	10.00	60.0	
Installation of Fence	L. m	2,000	20.00	40	Bulldozer: 4nos. x 6days
Clearance of Unexploded Mines	Lump Sum	1		5.0	Completed in March 1999
Total				305.5	

Notes: 1) Quantities are estimated by the Study Team and just indicative.

2) Prices in the table are estimated by MPWH and include the taxes both for imported and locally purchased items.

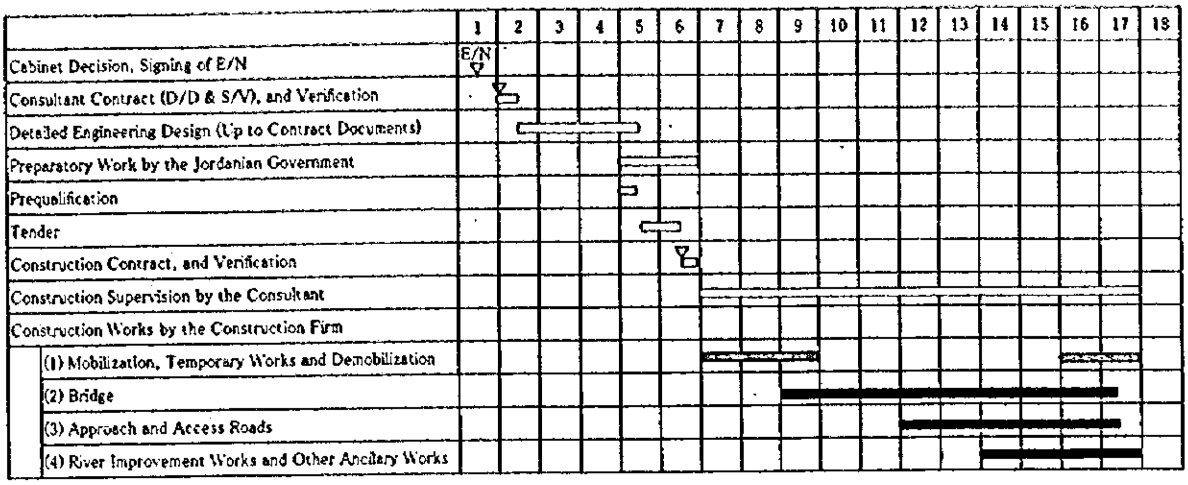
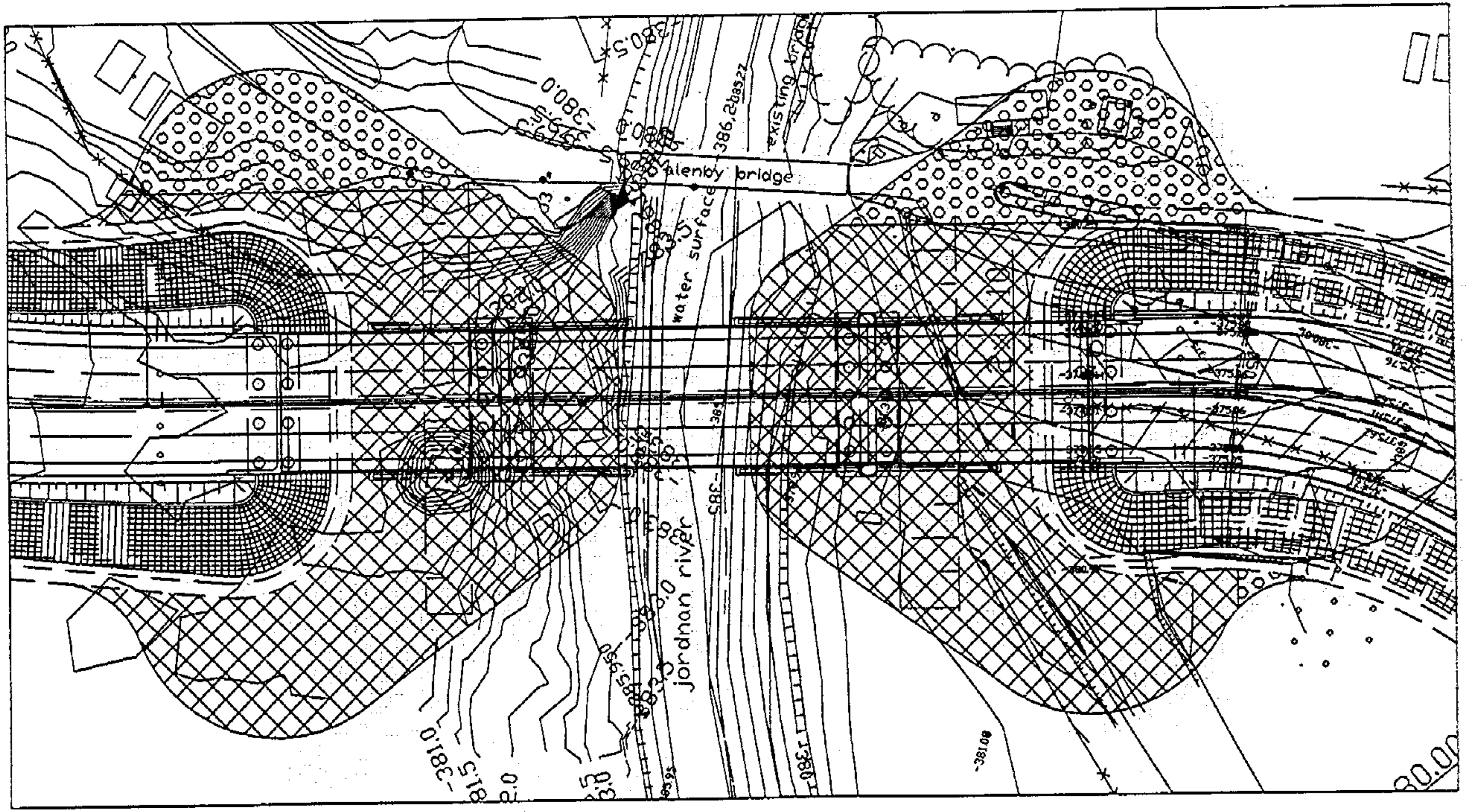


Figure 3.1.2 Implementation Schedule

(4) Riverbed Protection after Completion of the Project

The outline of the riverbed protection work is shown in Figure 3.1.3.

The portion from the existing Bailey bridge towards downstream, as hatched in the drawing, should be constructed after the completion of the Japanese Grant Aid. The construction of such a portion should be by the concerned authorities of the West Bank.



Riverbed Protection by the Project

Riverbed Protection after Completion of the Project

+ Proposed Construction Area of Riverbed Protection

Figure 3.1.3 Riverbed Protection