

Table 2.6 Estimates of Present and Future Traffic Flows on the MC 48,
1993 and 2020

Category	Occup. (person/veh)	1993		2020	
		Veh/day	Passenger	Veh/day	Passenger
A+B: 2 Wheels	1.2	2,535	3,042	6,800	8,160
C: Taxis and Private Cars	3.8	5,575	21,185	15,200	57,760
D+E: Light Trucks	2	2,946	5,892	8,050	16,100
F: Heavy Vehicles	2	870	1,740	2,300	4,600
Autobus	45	298	13,410	820	36,900
Total		12,224	45,269	33,170	123,520

Table 2.7 Estimates of Present and Future Traffic Flows on the RVE 835,
1993 and 2020

Category	Occup. (person/veh)	1993		2020	
		Veh/day	Passenger	Veh/day	Passenger
A+B: 2 Wheels	1.2	1,703	2,044	4,600	5,520
C: Taxis and Private Cars	3.8	8,634	32,809	23,500	89,300
D+E: Light Trucks	2	2,420	4,840	6,600	13,200
F: Heavy Vehicles	2	284	568	800	1,600
Autobus	45	278	12,510	750	33,750
Total		13,319	52,771	36,250	143,370

Table 2.8 Population and Employment Data for Selected Delegations in the Sousse Area

Delegation	Population	Population Employed	Unemployment Rate (%)
Hammam Sousse	20,037	6,490	9.9
Akouada	11,501	3,840	13.7
Kalaa Kebira	31,406	8,840	11.5
Kalaa Seghira	12,476	4,260	4.3
Total	75,420	24,430	

Source: Governorate of Sousse

Table 2.9 Difference in Vehicle Operating Costs in Flooded and Non Flooded Cases (TD per 1,000 vehicle/km)

Vehicle Type	Non-Flooded Case	Flooded Case	Difference
Private Car/Taxi	114.51	143.30	28.79
Bus	459.57	511.17	51.60
Light/Medium Goods	247.59	333.70	86.11
Heavy Goods	663.81	900.54	236.73

Source: World Bank H.D.M. Model

Table 2.10 Employment in the Industrial Sector in Hammam Sousse

Category	No of Enterprises	Total Employees
Agro-Industries	3	25
Construction Materials	2	28
Electrical and Mechanical	11	117
Chemical	1	10
Textiles and Leather	11	675
Miscellaneous	12	298
Total	40	1,153

Source: Industrial Promotion Agency

Table 2.11 Zone A: Estimated Loss of Income by Category of Passenger, under Present and Future Land Use Conditions

Category	Movements		Value of Time (TD)	Land Use	
	Present	Future		Present (3 days)	Future (4 days)
Tourists	12,000	20,000	4.0	144,000	320,000
Skilled Labour	20,800	69,300	2.1	131,000	582,000
Unskilled Labour	19,950	54,070	0.7	42,000	151,000
Total	52,750	143,370		317,000	1,053,000

Table 2.12 Additional Vehicle Operating Costs Per Day on RVE 835, 1993 and 2020

Vehicle Type	Difference (TD per 1,000 vehicle/km)	Daily Traffic		Costs (TD) (30 Days)	
		Present Traffic (v.p.d)	Add. VOCs (TD)	Future Traffic (v.p.d)	Add. VOCs (TD)
Private Car/Taxi	28.79	8,634	7,500	23,500	20,300
Bus	51.60	278	450	750	1,200
Light/Medium Goods	86.11	2,420	6,250	6,600	17,000
Heavy Goods	236.73	284	2,000	800	5,700
Total			16,200		44,200

Table 2.13 Additional Diversion Vehicle Operating Costs Per Day on RVE 835, 1993 and 2020

Vehicle Type	Difference (TD per 1,000 vehicle/km)	Daily Traffic		Costs (TD) (30 Days)	
		Present Traffic (v.p.d)	Add. VOCs (TD)	Future Traffic (v.p.d)	Add. VOCs (TD)
Private Car/Taxi	114.51	8,624	4,000	23,500	13,500
Bus	459.57	278	650	750	1,750
Light/Medium Goods	247.59	2,420	3,000	6,600	9,800
Heavy Goods	663.81	284	750	800	2,700
Total			8,400		27,750

Table 2.14 Industries located in Akouada and Kalaa Kebira

Category	Akouada		Kalaa Kebira	
	Number	Employment	Number	Employment
Agro-Industries	5	40	11	41
Construction Materials	5	91	1	10
Mechanical/Electrical	23	493	8	201
Chemical etc.	1	16	1	n.a.
Textile/Leather	25	1,491	19	1,065
Miscellaneous	26	1,972	8	71
Total	85	4,103	48	1,388

Source: Industrial Promotion Agency (Agence de Promotion de l'Industrie)

Table 2.15 Additional Vehicle Operating Costs over Damaged Road Surfaces on the MC48, 1993 and 2020

Vehicle Type	Difference (TD per 1,000 vehicle/km)	Daily Traffic		Costs (TD) (30 Days)	
		Present Traffic (v.p.d)	Add. VOCs (TD)	Future Traffic (v.p.d)	Add. VOCs (TD)
Private Car/Taxi	28.79	5,575	2,500	15,200	6,500
Bus	51.60	298	250	820	650
Light/Medium Goods	86.11	2,946	3,800	8,050	10,400
Heavy Goods	236.73	870	3,000	2,300	8,200
Total			9,550		25,750

Table 2.16 Additional Diversion Vehicle Operating Costs on the MC48: Present and Future Land Use Conditions

Vehicle Type	Difference (TD per 1,000 vehicle/km)	Daily Traffic		Costs (TD) (30 Days)	
		Present Traffic (v.p.d)	Add. VOCs (TD)	Future Traffic (v.p.d)	Add. VOCs (TD)
Private Car/Taxi	114.51	5,575	9,500	15,200	26,100
Bus	459.57	298	2,100	820	5,700
Light/Medium Goods	247.59	2,946	11,000	8,050	30,000
Heavy Goods	663.81	870	8,700	2,300	23,000
Total			31,300		84,800

Table 2.17 Oued Hammam: Summary of Flood Damage by Zone
One Year Flood Return Period: Present Land Use Conditions

	Zones							Total
	A	B	C	D	E	F	G	
Losses to Residents								
Loss of Income	0	0	0	0	0	0	2	2
Damage to Buildings	0	0	0	0	0	0	9	9
Damage to Household Goods	0	0	0	0	0	0	4	4
Losses to Industrial Sector								
Loss of Income	49	0	0	0	0	0	0	49
Damage to Buildings	0	0	0	0	0	0	0	0
Damage to Assets	0	0	0	0	0	0	0	0
Losses in Agriculture								
	0	3	3	0	2	5	0	13
Losses in Transport								
Passenger Delays	106	2	14	0	3	0	3	128
Increased VOCs	6	0	20	0	0	0	0	26
Road Rehabilitation	100	70	20	0	5	0	5	200
Total	261	75	57	0	10	5	23	431

Table 2.18 Oued Hammam: Summary of Flood Damage by Zone
One Year Flood Return Period: Future Land Use Conditions

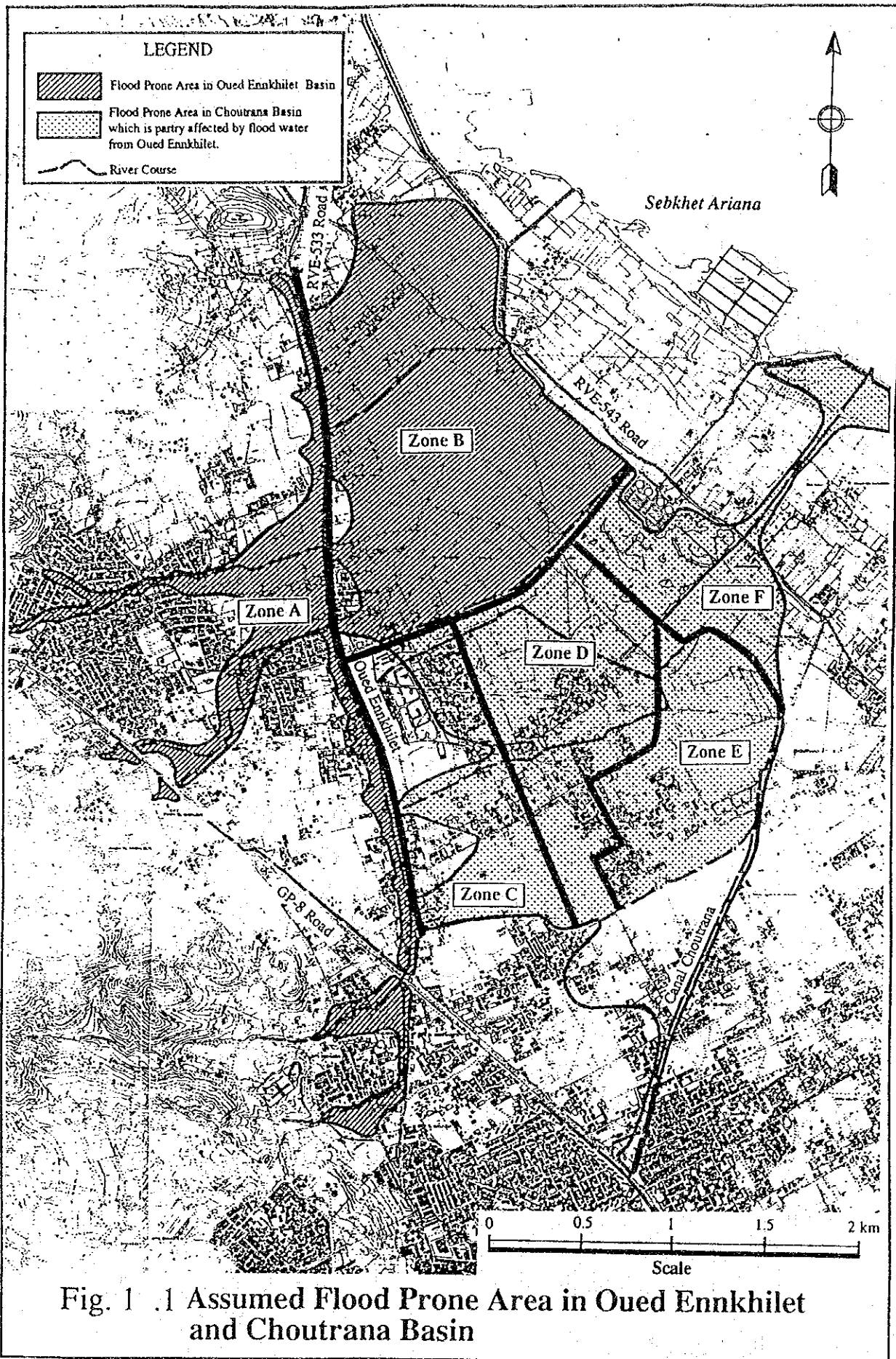
	Zones							Total
	A	B	C	D	E	F	G	
Losses to Residents								
Loss of Income	0	0	0	0	0	0	3	3
Damage to Buildings	0	0	0	0	0	0	18	18
Damage to Household Goods	0	0	0	0	0	0	7	7
Losses to Industrial Sector								
Loss of Income	97	0	0	0	0	0	0	97
Damage to Buildings	45	0	0	0	0	0	0	45
Damage to Assets	75	0	0	0	0	0	0	75
Losses in Agriculture								
	0	3	3	0	2	5	0	13
Losses in Transport								
Passenger Delays	263	11	172	0	33	0	42	521
Increased VOCs	18	0	55	0	0	0	0	73
Road Rehabilitation	0	70	20	0	5	0	5	100
Total	498	84	250	0	40	5	75	952

Table 2.19 Oued Hammam: Summary of Flood Damage by Zone
Ten Year Flood Return Period: Present Land Use Conditions

	Zones							Total
	A	B	C	D	E	F	G	
Losses to Residents								
Loss of Income	198	74	0	0	0	0	2	274
Damage to Buildings	929	88	0	0	0	0	18	1,035
Damage to Household Goods	189	19	0	0	0	0	7	215
Losses to Industrial Sector								
Loss of Income	146	96	0	0	0	0	0	242
Damage to Buildings	40	18	0	0	0	0	0	58
Damage to Assets	60	0	0	0	0	0	0	60
Losses in Agriculture	40	21	12	5	4	10	3	95
Losses in Transport								
Passenger Delays	212	3	14	0	6	0	6	241
Increased VOCs	16	0	20	0	0	0	0	36
Road Rehabilitation	200	140	20	0	10	0	10	380
Total	2,300	459	66	5	20	10	46	2,636

Table 2.20 Oued Hammam: Summary of Flood Damage by Zone
Ten Year Flood Return Period: Future Land Use Conditions

	Zones							Total
	A	B	C	D	E	F	G	
Losses to Residents								
Loss of Income	444	177	0	0	0	0	5	626
Damage to Buildings	2,465	125	0	0	0	0	36	2,626
Damage to Household Goods	580	29	0	0	0	0	4	613
Losses to Industrial Sector								
Loss of Income	291	219	0	0	0	0	0	510
Damage to Buildings	154	24	0	0	0	0	0	178
Damage to Assets	257	0	0	0	0	0	0	257
Losses in Agriculture	39	23	14	7	6	13	3	105
Losses in Transport								
Passenger Delays	527	34	172	0	56	0	69	858
Increased VOCs	36	0	55	0	0	0	0	91
Road Rehabilitation	200	140	20	0	10	0	10	380
Total	4,993	771	261	7	72	13	127	6,244



The Study on Flood Protection Program for Greater Tunis and Sousse in the Republic of Tunisia

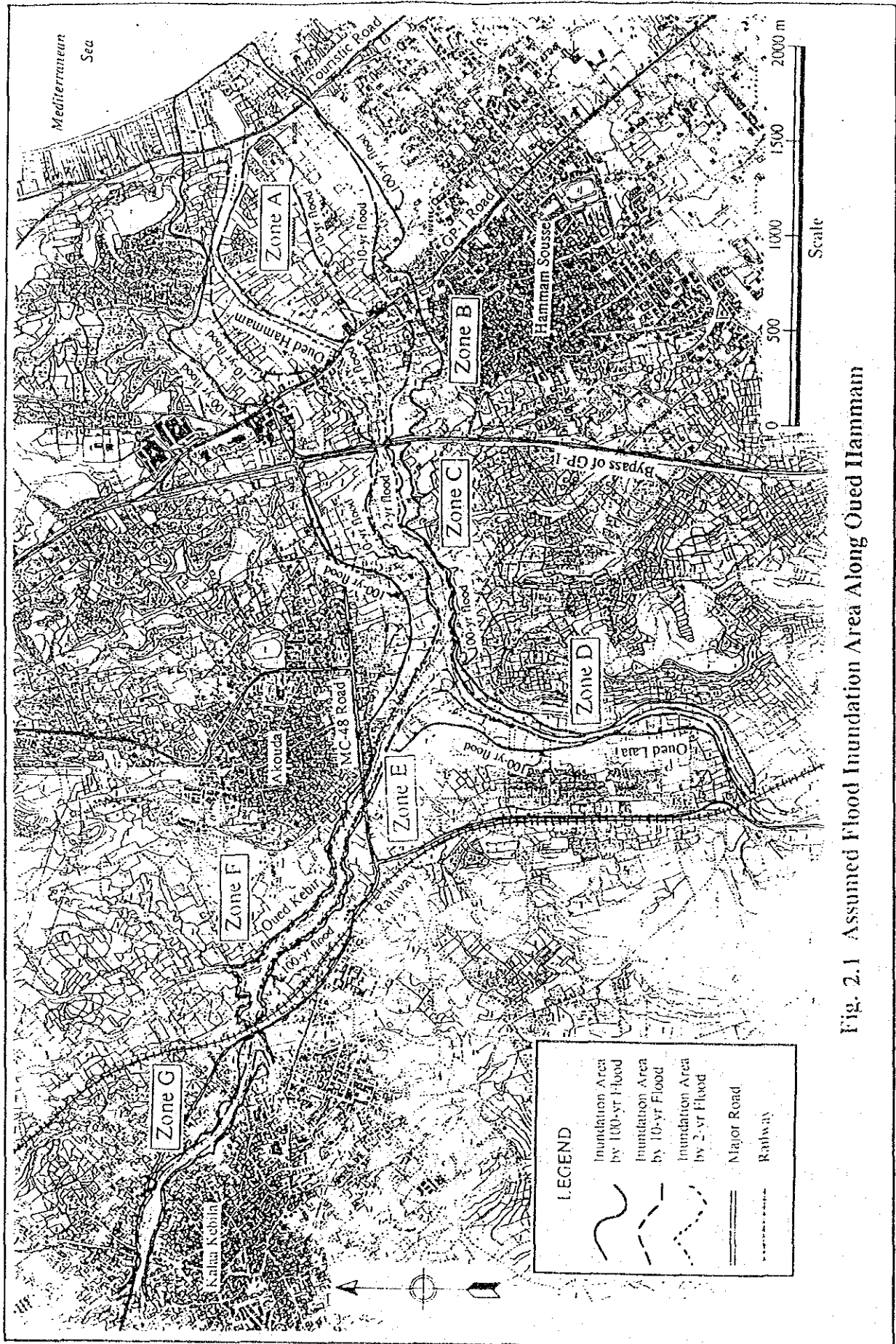


Fig. 2.1 Assumed Flood Inundation Area Along Oued Hammam

The Study of Flood Protection Proposals for Greater Dams and Sewerage in the Plain of Hammam

**THE STUDY
ON
FLOOD PROTECTION PROGRAM
FOR
GREATER TUNIS AND SOUSSE**

**D. COST ESTIMATE and CONSTRUCTION
PLAN AND SCHEDULE**

I. Cost Estimate

II. Construction Plan and Schedule

General

This supporting report aims to provide the project financial cost which have to be estimated to meet with the construction plan and time schedule, and a general guide to the construction execution following to the implementation program for the project.

The project has two (2) schemes of 1) flood protection for the Oued Enkhilet and Sebkhet Ariana in Greater Tunis area, and 2) flood protection for the Oued Hammam in Greater Sousse area. Stage-wise development is recommended that the first stage for 10-year flood and the second stage for 100-year flood. Target year to complete these two stages are before 2000 and 2020, respectively.

Following to the feasibility design for the first stage development, a construction plan and schedule has been prepared for the required project's construction works on the flood protection measures for 10-year flood. The project financial cost was worked out in line with the proposed construction plan and schedule.

This supporting report is composed of two (2) sections, Section I. Cost Estimate, and Section II. Construction Plan and Schedule.

Section II. describes a proposed construction plan and time schedule which is the indispensable conditions for the project financial cost estimate, among those of 1) implementation plan, 2) method for construction works, 3) construction time schedule for the proposed construction plan and schedule, and 4) conditions for construction execution which are necessary to study in preparing the plan and schedule.

Section I. describes the project financial cost with its estimate conditions and assumptions. The direct construction cost estimates in this section based on the proposed construction plan and schedule, and cost survey made at the site during December 1993 to January 1994 by the JICA Study Team.

**D. COST ESTIMATE and CONSTRUCTION
PLAN AND SCHEDULE**

I. COST ESTIMATE

THE STUDY
ON
FLOOD PROTECTION PROGRAM
FOR
GREATER TUNIS AND SOUSSE

**D. COST ESTIMATE and CONSTRUCTION
PLAN AND SCHEDULE**

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I. COST ESTIMATE

1.1 Project Financial Cost

The project cost on both scheme for the Oued Enkhilet and the Oued Hammam has been worked out as tabulated in Tables 1.1 to 1.4, and is summarized below:

Scheme	Project Cost (DT1,000)		Second stage without Contingencies
	First stage with Contingencies	First stage without Contingencies	
Oued Enkhilet	15,094	11,504	8,960
Oued Hammam	10,413	7,950	787
Total	25,507	19,490	9,747

Estimate conditions and approaches are described hereinafter.

1.2 Conditions and Assumptions for Cost Estimate

(1) Price level : January 1994

(2) Exchange rate

US\$ 1.0 = DT 1.0

US\$ 1.0 = ¥ 110.0

DT 1.0 = ¥ 110.0

(3) The project cost estimates divided into foreign and local currency portions assuming to finance the implementation fund by foreign donor/s to the foreign currency portion.

The unit construction costs are divided into the foreign and local currency portions with certain ratio of it which is decided taking into accounts the following factors.

- 1) availability of skilled, semi-skilled and common laborers in Tunisia
- 2) productivity and availability of construction material in Tunisia
- 3) productivity and availability of constructional plant and equipment

The ratios of foreign and local currency portions were estimated as assumed and tabulated in Table 1.11, and the following major construction work items were based on the factors indicated above and referring data of Radis-Goulette Bridge Project by JICA in 1990 and others.

<u>Work Items</u>	<u>Foreign currency (%)</u>	<u>Local currency (%)</u>
* excavation by equipment	70	30
* embankment	70	30
* concreting	60	40
* masonry	50	50
* backfill	60	40
* sod facing	40	60
* gravelling	60	40
* asphalt pavement	60	40
* piling	70	30

(4) Implementation and construction period

Total implementation period is 57 months starting from April 1994 with financial arrangement. Construction period is 30 months starting from July 1996 to the end of 1998.

(5) Tunisian Value Added Tax (TVA) of 17 % was incorporated into the local currency portion of direct construction cost.

(6) No interest during construction was taken into account.

1.3 Composition of the Project Financial Cost

The project cost is consisting of the following cost items:

(1) Direct cost

Direct construction cost

- preparatory and temporary works for access roads, contractor's camp and office, power supply, water supply, communication and other incidental works for execution of direct construction works
- direct construction works for civil, mechanical and electrical works, and relocation cost of public facilities including contractor's site expenses, overhead and profits.

(2) Indirect cost

Land acquisition and compensation costs

- land acquisition for right-of-way of rivers and others
- compensation cost for house evacuation, borrow pits, and others

Administration expenses

administration cost for Tunisian Government for the project implementation

Engineering services expenses

cost for additional survey, detailed design and construction supervision by consultant/s

Price contingency

Physical contingency

1.4 Cost Estimate

1.4.1 Direct Construction Cost

(1) Preliminary and general

These costs are to cover for the preparatory and temporary works for the construction works. Major items are construction roads, power supply, water supply and contractor's base camp. The costs are estimated by lump sum basis.

(2) Direct construction works

Civil works

Direct construction cost for civil works was estimated by unit cost basis multiplied the work quantity of respective work item which worked out from the feasibility design. The unit cost of respective work item was determined based on the collected cost data such as MOA's Ain Snoussi Dam and EL Hammam Oued Dam, ONAS's Greater Tunis drainage system master plan, MOEH's Oued Sousse flood protection plan,

JICA's Radis - Goulette bridge with its review and analysis, and survey of current cost in Tunisia.

Unit cost of respective construction work items for this feasibility study are shown in Table 1.11, and is briefly described below for major work items.

<u>Work Item</u>	<u>Unit</u>	<u>Unit Price (DT)</u>
river channel excavation,	m3	5.0
levee embankment by excavated soil,	m3	5.0
levee embankment by borrowed soil,	m3	6.0
structure concrete, (350 kg/m3, w/form work)	m3	120.0
reinforcement steel bar,	ton	1,100.0
backfill,	m3	4.0
masonry,	m3	40.0
gabion,	m3	50.0

Tables 1.15 and 1.16 show a breakdown of unit cost for channel excavation and levee embankment as reference purpose.

The element of unit cost among 1) labor cost, 2) material price, 3) equipment cost, and 4) contractor's overhead and profits. The basic cost of three (3) elements of labor, material and equipment is tabulated in Tables 1.12, 1.13 and 1.14, and briefly explained below.

Labor wage

The labor cost is incorporated into the local currency portion. Required laborers are available and it is expected to be employed all kind of workers in Tunisia.

There are two (2) kinds of minimum wage system in Tunisia, one is hourly basis for occasional employees and the other is monthly basis as for permanent employees of administrative and or technical workers. Both wage system includes Provisional Complementary Indemnity (ICP) of 69.16 %.

Labor wage for this project applies the rate of occasional employees due to the limited work period of project's construction works. Basic salaries for occasional employees are assumed and tabulated in Table 1.12 together with minimum wage rates.

Unit price of construction material

Unit prices of construction materials currently prevailing in Tunisia has been surveyed by collection of data from MOEH, MOA, ONAS, contractors and others in December 1993 and tabulated in Table 1.13.

The construction material prices in the unit cost are incorporated into the foreign and local currency portions with certain percent of the price based on the productivity in Tunisia of the said material. Basically, local product material is incorporated into the local portion, and imported one is foreign portion.

Equipment cost

Equipment cost estimates by hourly or daily basis on the basis of purchase price and equipment's life. The cost comprises by depreciation cost, maintenance and repair cost and management cost. Table 1.14 indicates an hourly cost for equipment which applied in the proposed construction plan as for reference. Equipment cost incorporates to foreign portion mostly.

Contractor's site expenses, overhead and profits

This is the cost for contractor's overhead at head office, site expenses, profits and other incidentals, and assumes of about 30 %.

2) Mechanical and electrical works

Required mechanical and electrical works are installation of screens in retarding basins. This cost is estimated by referring to current market prices in Tunisia and Japan, and incorporated into foreign portion mostly.

3) Public utilities

The costs for crossing facilities of public utilities are estimated by lump sum basis. The relocation or renewal works of public utilities will be carried out by respective agencies directly or through contractor under the agency. Under the such conditions, the relocation or renewal costs is treated as the provisional sum which will be separate payment to the respective agencies by the engineer's representative of this project.

1.4.2 Land Acquisition and Compensation Costs

These cost has been estimated as summarized in Table 1.8 on the basis of prevailing current unit cost of land and building in the proposed area for structures or facilities, as listed below, to be constructed, classifying 1) residential land, 2) agricultural land, and 3) commercial land and incorporated into the local currency portion.

Land acquisition

- right-of-way for the river, canal, diversion channel and other area for permanent structures
- the area for retarding basin including reservoir
- waste locations for spoil materials

Compensation

- soil material borrows
- house evacuation in the diversion channel route

1.4.3 Administration Expenses

Tunisian Government's administration expenses for the project implementation is estimated in proportion to the direct construction cost. 5 % of direct construction cost was applied, and incorporated into the local currency portion.

1.4.4 Engineering Services Expenses

Engineering services expenses are estimated in proportion to the direct construction cost to cover the detailed design and construction supervision. 15 % was applied including price and physical contingencies in first stage, and incorporated into the foreign currency portion of 80 % and remaining to the local portion excluding Tunisian value added tax. In second stage, also 15 % was assumed but not included price and physical contingencies due to unknown factors for actual implementation.

1.4.5 Price Contingency

The price contingency was provided by adopting increasing and or decreasing rates of consumer price index (CPI) in Tunisia and Japan divided into the foreign and local currency portions. The rates applied for estimate are as follows:

foreign currency portion : 2.3 %

local currency portion : 6.2 %

Consumer price index, increased percent % (1985 = 100)

	<u>1989</u>	<u>1990</u>	<u>1991</u>	<u>1992</u>	<u>1993*</u>	<u>Average</u>
Tunisia:	+7.4	+6.8	+8.2	+5.4	+3.1	6.2
Japan :	+2.3	+3.1	+3.3	+1.7	+1.2	2.3

Source : International Financial Statistics, Dec.1993

* Note : as of August 1993 and Sept. 1993 in Tunisia and Japan respectively.

1.4.6 Physical Contingency

Physical contingency was provided to cover minor differences in actual and estimated quantities, omissions of minor items of work incidental to pay items, difficulties unforeseeable at the site, possible minor changes in plans, and other uncertainties. 15 % of total for direct construction cost, land acquisition, administration and price contingencies was applied.

1.5 Annual Disbursement Schedule

Annual disbursement schedules of the project cost has been provided for respective scheme by the following disburse rate in each year for the first stage according to the proposed implementation and construction schedules.

<u>Cost Items</u>	<u>Disburse Ratio (%)</u>				
	<u>1994</u>	<u>1995</u>	<u>1996</u>	<u>1997</u>	<u>1998</u>
Direct construction	0	0	20	50	30
Land acquisition	0	100	0	0	0
Administration	5	20	30	20	25
Engineering services	0	30	20	25	25

Annual disbursement in the first stage is summarized as follows for the Oueds Enkhilet and Hammam schemes including price and physical contingencies.

Disbursement Schedule (Unit : 1,000)

Year	Oued Ennkhilet			Oued Hammam		
	F.C (US\$)	L.C (DT)	Total (DT)	F.C (US\$)	L.C (DT)	Total (DT)
1994	0	20	20	0	20	20
1995	234	4,993	5,227	228	608	836
1996	1,054	960	2,014	1,050	907	1,957
1997	2,490	2,233	4,723	2,484	2,100	4,584
1998	1,604	1,506	3,110	1,598	1,419	3,017
Total	5,382	9,712	15,094	5,360	5,054	10,414

1.6 Operation, Maintenance and Replacement Costs

These costs represent anticipated yearly expenditures for 1) wages and salaries, 2) cost of facilities, equipment, operating costs, materials and supplies, 3) cost of repairs and 4) replacement costs.

1.6.1 Operation and Maintenance Costs

An estimate is made for peoples needed to operate the project, and to add costs for equipment and materials needs, office requirements and communication needs. Much of maintenance expense is a part of routine operation of the project and is performed by the staff for the project operation. However, there are occasional needs for extra maintenance work which may be required as a result of unusual storm damage or infrequent repairs of any nature. It is not easy to estimate these expenses. Here, annual maintenance and operation expenses estimate by a percentage of construction cost referring some guidelines. 2.0 % was applied for both Oueds Ennkhilet and Hammam schemes in first stage, and worked out as follows:

Oued Ennkhilet : DT130,000/year

Oued Hammam : DT127,000/year

1.6.2 Replacement Costs

Replacement is required on parts subject to wear or obsolescence. These major replacement should be provided for by setting aside each year an amount which will build up sufficiently to cover the replacement cost when it occurs at the expected time in the future. Only the replacement cost for steel made screens to equip with the retarding basins will have to be considered in first stage with useful life of 20 years. The construction cost for these screens is estimated at DT8,200 in 1994 price level.

Table 1.1 Summary of Project Cost, Enkhilet 1st Stage

Cost Items	(US\$1.0 = DT1.0)		
	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
1. Direct construction cost <1	3,646	2,856	6,502
2. Land acquisition and compensation costs	0	3,738	3,738
3. Government's administration expenses <2	0	325	325
4. Engineering services expenses <3	780	195	975
Sub-total	4,426	7,114	11,540
5. Price contingency <4	356	1,356	1,712
6. Physical contingency <5	600	1,241	1,841
Total	5,382	9,711	15,093

- Notes
- <1 : including TVA
 - <2 : 5 % of direct construction cost
 - <3 : 15 % of direct construction cost for detailed design and const. supervision including price and physical contingencies, 80 % of F.C
 - <4 : 2.3 % F.C and 6.2 % L.C p.a.
 - <5 : 15 % of total 1+2+3+5

Table1.2 Summary of Project Cost, Hammam 1st Stage

(US\$1.0 = DT1.0)

Cost Items	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
1. Direct construction cost <1	3,643	2,680	6,323
2. Land acquisition and compensation costs	0	362	362
3. Government's administration expenses <2	0	316	316
4. Engineering services expenses <3	759	190	948
Sub-total	4,402	3,548	7,950
5. Price contingency <4	356	872	1,228
6. Physical contingency <5	600	635	1,235
Total	5,358	5,055	10,413

- Notes
- <1 : including TVA
 - <2 : 5 % of direct construction cost
 - <3 : 15 % of direct construction cost for detailed design and const. supervision including price and physical contingencies, 80 % of F.C
 - <4 : 2.3 % F.C and 6.2 % L.C p.a.
 - <5 : 15 % of total 1+2+3+5

Table 1.3 Summary of Project Cost, Ennkhilet 2nd Stage

Cost Items	(US\$1.0 = DT1.0)		
	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
1. Direct construction cost <1	4,140	3,327	7,467
2. Land acquisition and compensation costs	0	0	0
3. Government's administration expenses <2	0	373	373
4. Engineering services expenses <3	896	224	1,120
Total	5,036	3,924	8,960

- Notes
- <1 : including TVA
 - <2 : 5 % of direct construction cost
 - <3 : 15 % of direct construction cost for detailed design and const. supervision excluding price and physical contingencies, due to unknown factor, 80 % of F.C

Table 1.4 Summary of Project Cost, Hammam 2nd Stage

Cost Items	(US\$1.0 = DT1.0)		
	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
1. Direct construction cost <1	364	292	656
2. Land acquisition and compensation costs	0	0	0
3. Government's administration expenses <2	0	33	33
4. Engineering services expenses <3	79	20	98
Total	443	344	787

- Notes
- <1 : including TVA
 - <2 : 5 % of direct construction cost
 - <3 : 15 % of direct construction cost for detailed design and const. supervision excluding price and physical contingencies, due to unknown factor, 80 % of F.C

Table 1.5 Annual Disbursement Schedule, Ennkhilet 1st Stage

Cost Items	unit (F.C: 1,000 US\$, L.C & Total: 1,000 DT)													
	1994		1995		1996		1997		1998		1997		1998	
	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C
1. Direct construction cost <1	3,646	2,856	6,502	0	0	0	0	729	571	1,823	1,428	1,094	857	
2. Land acquisition and compensation costs	0	3,738	3,738	0	0	3,738	0	0	0	0	0	0	0	0
3. Government's administration expenses <2	0	325	325	0	16	0	65	0	98	0	65	0	81	
4. Engineering services expenses <3	780	195	975	0	0	234	59	156	39	195	49	195	49	
Sub-total *	4,426	7,114	11,540	0	16	0	3,803	729	669	1,823	1,493	1,094	938	
5. Price contingency <4	356	1,356	1,712	0	1	0	487	52	132	173	406	131	329	
6. Physical contingency <5	600	1,241	1,842											
Total	5,383	9,711	15,094											

Notes <1 : including TVA

<2 : 5 % of direct construction cost

<3 : 15 % of direct construction cost for detailed design and construction supervision including price and physical contingencies, 80 % F.C

<4 : 2.3 % F.C & 6.2 % L.C p.a., period for 1994-1998

<5 : 15 % of total 1+2+3+5, period for 1994-1998

* : Sub-total in each year (1994-1998) excludes E/S cost (item 4).

Table 1.6 Annual Disbursement Schedule, Hammam 1st Stage

Cost Items	unit (F.C: 1,000 US\$, L.C & Total: 1,000 DT)															
	F.C (US\$)		L.C		Total (DT)		1994		1995		1996		1997		1998	
	(DT)		(DT)		(DT)	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	F.C	L.C	
1. Direct construction cost <1	3,643	2,680	6,323	0	0	0	0	729	536	1,822	1,340	1,093	804			
2. Land acquisition and compensation costs	0	362	362	0	0	362	0	0	0	0	0	0	0			
3. Government's administration expenses <2	0	316	316	0	16	63	0	95	0	63	0	63	0	79		
4. Engineering services expenses <3	759	190	948	0	0	228	57	152	38	190	47	190	47			
Sub total *	4,402	3,548	7,950	0	16	425	729	631	1,403	1,822	1,403	1,093	883			
5. Price contingency <4	356	872	1,228	0	1	54	52	125	382	173	382	131	310			
6. Physical contingency <5	600	635	1,234													
Total	5,358	5,054	10,412													

Notes <1 : including TVA

<2 : 5 % of direct construction cost

<3 : 15 % of direct construction cost for detailed design and const. supervision including price and physical contingencies, 80 % F.C

<4 : 2.3 % F.C & 6.2 % L.C p.a., period for 1994-1998

<5 : 15 % of total 1+2+3+5, period for 1994-1998

* : Sub total in each year (1994-1998) excludes E/S cost (item 4).

Table 1.7 Direct Construction Cost

Cost Items	(US\$1.0 = DT1.0)		
	F.C (1,000 US\$)	L.C (1,000 DT)	Total (1,000 DT)
Ennkhilet, 1st stage			
1. preliminary & general	150	100	250
2. construction cost	3,496	1,811	5,307
sub total	3,646	1,911	5,557
TVA,17 %		945	945
Total	3,646	2,856	6,502
Ennkhilet, 2nd stage			
1. preliminary & general	25	10	35
2. construction cost	4,115	2,232	6,347
sub total	4,140	2,242	6,382
TVA,17 %		1,085	1,085
Total	4,140	3,327	7,467
Ennkhilet, 1st+2nd	7,786	6,183	13,969
Hammam, 1st stage			
1. preliminary & general	150	100	250
2. construction cost	3,493	1,661	5,154
sub total	3,643	1,761	5,404
TVA,17 %		919	919
Total	3,643	2,680	6,323
Hammam, 2nd stage			
1. preliminary & general	25	10	35
2. construction cost	339	187	526
sub total	364	197	561
TVA,17 %		95	95
Total	364	292	656
Hammam, 1st+2nd	4,007	2,972	6,979
Ennkhilet+Hammam, 1st & 2nd	11,793	9,155	20,948
<< First stage >>			
1. preliminary & general	300	200	500
2. O.Ennkhilet	3,496	1,811	5,307
3. Oued Hammam	3,493	1,661	5,154
sub total	7,289	3,672	10,961
TVA,17 %		1,863	1,863
total	7,289	5,535	12,824
<< Second stage >>			
1. preliminary & general	50	20	70
2. O.Ennkhilet	4,115	2,232	6,347
3. Oued Hammam	339	187	526
sub total	4,504	2,439	6,943
TVA,17 %		1,180	1,180
total	4,504	3,619	8,123
G.total, 1st & 2nd	11,793	9,155	20,948

Table 1.8 Land Acquisition and Compensation Cost
First and Second Stage

(unit: 1,000 DT)			
Stage/Scheme	Land Acquisition (DT)	Compensation (DT)	Total (DT)
<< First stage >>			
Oued Enkhilet	3,358	380	3,738
Oued Hammam	187	175	362
Total	3,545	555	4,100
<< Second stage >>			
	0		0

Unit cost of land acquisition and compensation

scheme/stretch	land acquisition (DT/m ²)	compensation (D/m ²)
(Oued Enkhilet)		
Enkhilet main, E1	5.00	200.00
Enkhilet main, E2	5.00	200.00
Canal, C1-1	5.00	200.00
Canal, C1-2	5.00	-
Canal, C1-3	5.00	-
G2-1, Canal downstream	25.00	-
G2-1, Canal middlestream	25.00	-
F. Diversion 3, d/s	7.00	200.00
F. Diversion 3, u/s	15.00	-
Retrading basin G	30.00	-
Retarding basin I	50.00	-
Retarding basin J1	25.00	-
(Oued Hamman)		
H-2, residential area	10.00	250.00
H-2, agricultural area	2.00	-
H-3, agricultural area	5.00	-
H-4, agricultural area	5.00	-
K-1, agricultural area	5.00	-

Table 1.9 Priced Bill of Quantities for Oued Enkhilet and Oued Hammam in First Stage (1/7)

(US\$ 1.0 = DT 1.0 = Y 110.0)								
Item No.	Work Items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
1	Preliminary & general							
	1) temporary access	L.S	-	-	70,000	-	40,000	
	2) power supply	L.S	-	-	40,000	-	25,000	
	3) water supply	L.S	-	-	30,000	-	15,000	
	4) communication	L.S	-	-	10,000	-	10,000	
	5) contractor's base camp.office etc..	L.S	-	-	60,000	-	50,000	
	6) exploratory exca.	L.S	-	-	20,000	-	15,000	
	7) other incidentals	L.S	-	-	70,000	-	45,000	
	total of 1				300,000		200,000	500,000
2	Oued Enkhilet							
2.1	Oued Enkhilet							
2.1.1	Oued Enkhilet main							
	1) channel excavation	cu.m	39,900	4	139,650	2	59,850	
	2) embank. levee	cu.m	34,700	4	121,450	2	52,050	
	3) masonry	cu.m	630	20	12,600	20	12,600	
	4) gabion	cu.m	590	25	14,750	25	14,750	
	5) sod facing	sq.m	39,100	0	15,640	1	23,460	
	6) gravelling for inspection road	cu.m	2,660	12	31,920	8	21,280	
	7) exca. for structure	cu.m	7,300	4	30,660	2	13,140	
	8) gravel bedding	cu.m	140	12	1,680	8	1,120	
	9) lean concrete, with formwork,150 kg/m3	cu.m	70	48	3,360	32	2,240	
	10) structure concrete w/formwork,350kg/m3	cu.m	1,470	72	105,840	48	70,560	
	11) re-bar	ton	117	770	90,090	330	38,610	
	12) backfill	cu.m	3,500	2	8,400	2	5,600	
	13) drainage sluice (1.5 m*1.5 m)	nos	5	9,000	45,000	6,000	30,000	
	14) road bridge	m2	960	700	672,000	300	288,000	
	15) demolishing, bridge and culvert	m3	940	15	14,100	15	14,100	
	16) miscellaneous works (5 % of above)	L.S			65,357		32,368	
	amount of 2.1.1				1,372,497		679,728	2,052,225
2.1.2	Canal, C1							
	1) channel excavation	cu.m	21,500	4	75,250	2	32,250	
	2) embank. levee	cu.m	22,900	4	80,150	2	34,350	
	3) masonry	cu.m	300	20	6,000	20	6,000	
	4) gabion	cu.m	280	25	7,000	25	7,000	
	5) sod facing	sq.m	27,500	0	11,000	1	16,500	
	6) gravelling for inspection road	cu.m	1,890	12	22,680	8	15,120	
	7) drainage sluice (1.5 m * 1.5 m)	nos	5	9,000	45,000	6,000	30,000	
	8) miscellaneous works (5 % of above)	L.S			12,354		7,061	
	amounts of 2.1.2				259,434		148,281	407,715
2.1.3	Canal, R2							
	1) channel excavation	cu.m	2,600	4	9,100	2	3,900	
	2) masonry	cu.m	360	20	7,200	20	7,200	
	3) gabion	cu.m	475	25	11,875	25	11,875	
	4) sodfacing	sq.m	5,700	0	2,280	1	3,420	

Table 1.9 Priced Bill of Quantities for Oued Enkhilet and Oued Hammam in First Stage (2/7)

Item No.	Work Items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
				(US\$ 1.0 = DT 1.0 = Y 110.0)				
5)	gravel, inspection road	cu.m	1,120	12	13,440	8	8,960	
6)	structure excavation	cu.m	800	4	3,360	2	1,440	
7)	gravel bedding	cu.m	21	12	252	8	168	
8)	lean concrete with formwork, 150 kg/m3	cu.m	11	48	528	32	352	
9)	structure concrete w/formwork,350 kg/m3	cu.m	193	72	13,896	48	9,264	
10)	re-bar	ton	18	770	13,860	330	5,940	
11)	backfill	cu.m	340	2	816	2	544	
12)	demolishing, bridge	cu.m	82	15	1,230	15	1,230	
13)	miscellaneous works (5 % of above)	L.S			3,892		2,715	
amounts of 2.1.3					81,729		57,008	138,737
2.1.4 Canal, G1								
1)	channel excavation	cu.m	2,140	4	7,490	2	3,210	
2)	gabion	cu.m	225	25	5,625	25	5,625	
3)	masonry	cu.m	153	20	3,060	20	3,060	
4)	sod facing	sq.m	6,400	0	2,560	1	3,840	
5)	gravel,inspec. road	cu.m	1,370	12	16,440	8	10,960	
6)	structure excavation	cu.m	520	4	2,184	2	936	
7)	gravel bedding	cu.m	12	12	144	8	96	
8)	lean concrete with formwork, 150 kg/m3	cu.m	6	48	288	32	192	
9)	structure concrete w/formwork,350 kg/m3	cu.m	105	72	7,560	48	5,040	
10)	re-bar	ton	10	770	7,700	330	3,300	
11)	backfill	cu.m	205	2	492	2	328	
12)	demolishing, bridge	cu.m	45	15	675	15	675	
13)	miscellaneous works (5 % of above)	L.S			2,711		1,863	
amounts of 2.1.4					56,929		39,125	96,054
2.1.5 Canal, G1'								
1)	channel excavation	cu.m	1,400	4	4,900	2	2,100	
2)	gabion	cu.m	90	25	2,250	25	2,250	
3)	masonry	cu.m	56	20	1,120	20	1,120	
4)	sod facing	sq.m	1,500	0	600	1	900	
5)	structure exca.	cu.m	150	4	630	2	270	
6)	gravel bedding	cu.m	3	12	36	8	24	
7)	lean concrete with formwork,150 kg/m3	cu.m	2	48	96	32	64	
8)	structure concrete w/formwork,350kg/m3	cu.m	30	72	2,160	48	1,440	
9)	re-bar	ton	3	770	2,310	330	990	
10)	backfill	cu.m	60	2	144	2	96	
11)	miscellaneous works (5 % of above)	L.S			712		9,254	
amounts of 2.1.5					14,958		18,508	33,466
2.1.6 Canal, G2								
1)	channel excavation	cu.m	3,030	4	10,605	2	4,545	
2)	gabion	cu.m	270	25	6,750	25	6,750	
3)	masonry	cu.m	184	20	3,680	20	3,680	
4)	sod facing	sq.m	5,210	0	2,084	1	3,126	
5)	gravel,inspec. road	cu.m	1,270	12	15,240	8	10,160	
6)	structural exca.	cu.m	450	4	1,890	2	810	
7)	gravel bedding	cu.m	14	12	168	8	112	
8)	lean concrete with formwork,150 kg/m3	cu.m	6	48	288	32	192	

Table 1.9 Priced Bill of Quantities for Oued Enkhilet and Oued Hammam in First Stage (3/7)

Item No.	Work Items	Unit	Q'ty	(US\$ 1.0 = DT 1.0 = Y 110.0)				
				Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
9)	structure concrete w/formwork,350 kg/m3	cu.m	119	72	8,568	48	5,712	
10)	re-bar	ton	10	770	7,700	330	3,300	
11)	backfill	cu.m	140	2	336	2	224	
12)	demolishing, bridge	cu.m	50	15	750	15	750	
13)	miscellaneous works (5 % of above)	L.S			2,903		1,968	
amounts of 2.1.6					60,962		41,329	102,291
2.1.7 flood diversion No.3								
1)	channel excavation	cu.m	51,600	4	180,600	2	77,400	
2)	embank. levee	cu.m	25,700	4	89,950	2	38,550	
3)	masonry	cu.m	750	20	15,000	20	15,000	
4)	gabion	cu.m	770	25	19,250	25	19,250	
5)	sod facing	sq.m	42,200	0	16,880	1	25,320	
6)	gravel. inspec.road	cu.m	4,550	12	54,600	8	36,400	
7)	gravel bedding for culvert	cu.m	26	12	312	8	208	
8)	structure excavation	cu.m	1,120	4	4,704	2	2,016	
9)	lean concrete with formwork,150 kg/m3	cu.m	13	48	624	32	416	
10)	structure concrete w/formwork,350kg/m3	cu.m	240	72	17,280	48	11,520	
11)	re-bar	ton	20	770	15,400	330	6,600	
12)	backfill	cu.m	370	2	888	2	592	
13)	demolishing, bridge	cu.m	100	15	1,500	15	1,500	
14)	drainage sluice (1.5 m*1.5 m)	nos	6	9,000	54,000	6,000	36,000	
15)	improvement ONAS's sewage open canal	lin.m	50	400	20,000	300	15,000	
16)	improvement ONAS's sewage pipe	lin.m	50	400	20,000	300	15,000	
17)	bridge,RV-543	sq.m	520	700	364,000	300	156,000	
18)	miscellaneous works (5 % of above)	L.S			43,749		22,839	
amounts of 2.1.7					918,737		479,611	1,398,348
2.1.8 Flood diversion No.4								
1)	structure excavation	cu.m	5,800	4	24,360	2	10,440	
2)	gravel bedding	cu.m	120	12	1,440	8	960	
3)	lean concrete with formwork,150 kg/m3	cu.m	60	48	2,880	32	1,920	
4)	structure concrete w/formwork,350 kg/m3	cu.m	1,130	72	81,360	48	54,240	
5)	re-bar	ton	96	770	73,920	330	31,680	
6)	backfill	cu.m	2,300	2	5,520	2	3,680	
7)	miscellaneous works (5 % of above)	L.S			9,474		5,146	
amounts of 2.1.8					198,954		108,066	307,020
2.1.9 Retarding basin A (dam reservoir type)								
1)	excavation	cu.m	800	4	2,800	2	1,200	
2)	masonry	cu.m	30	20	600	20	600	
3)	gabion	cu.m	80	25	2,000	25	2,000	
4)	structure excavation	cu.m	600	4	2,520	2	1,080	
5)	gravel bedding	cu.m	10	12	120	8	80	
6)	lean concrete with formwork,150 kg/m3	cu.m	10	48	480	32	320	
7)	structure concrete w/formwork,350 kg/m3	cu.m	260	72	18,720	48	12,480	
8)	re-bar	ton	13	770	10,010	330	4,290	

Table 1.9 Priced Bill of Quantities for Oued Ennkhilet and Oued Hammam in First Stage (4/7)

Item No.	Work Items	Unit	Q'ty	(US\$ 1.0 = DT 1.0 = Y 110.0)				
				Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
9)	backfill	cu.m	200	2	480	2	320	
10)	mechanical works ,screen	ton	1	1,600	1,920	400	480	
11)	miscellaneous works (5 % of above)	L.S			1,983		1,143	
	amounts of 2.1.9				41,633		23,993	65,625
	2.1.10 Retarding basin,G (pond type)							
1)	excavation	cu.m	25,600	4	89,600	2	38,400	
2)	masonry	cu.m	80	20	1,600	20	1,600	
3)	sod facing	sq.m	2,900	0	1,160	1	1,740	
4)	gravel,inspect. road	cu.m	150	12	1,800	8	1,200	
5)	structure excavation	cu.m	160	4	672	2	288	
6)	gravel bedding	cu.m	10	12	120	8	80	
7)	lean concrete with formwork,150 kg/m3	cu.m	10	48	480	32	320	
8)	structure concrete w/formwork,350 kg/m3	cu.m	40	72	2,880	48	1,920	
9)	re-bar	ton	2	770	1,540	330	660	
10)	backfill	cu.m	140	2	336	2	224	
11)	mechanical works ,screen	ton	1	1,600	2,240	400	560	
12)	miscellaneous works (5 % of above)	L.S			5,121		2,350	
	amounts of 2.1.10				107,549		49,342	156,891
	2.1.11 Retarding basin, I (pond type)							
1)	excavation	cu.m	42,700	4	149,450	2	64,050	
2)	masonry	cu.m	30	20	600	20	600	
3)	sod facing	sq.m	3,100	0	1,240	1	1,860	
4)	gravel,inspec.road	cu.m	150	12	1,800	8	1,200	
5)	structure excavation	cu.m	50	4	210	2	90	
6)	gravel bedding	cu.m	10	12	120	8	80	
7)	lean concrete with formwork,150 kg/m3	cu.m	10	48	480	32	320	
8)	structure concrete w/formwork,350 kg/m3	cu.m	30	72	2,160	48	1,440	
9)	re-bar	ton	2	770	1,155	330	495	
10)	backfill	cu.m	20	2	48	2	32	
11)	mechanical works ,screen	ton	1	1,600	1,280	400	320	
12)	miscellaneous works (5 % of above)	L.S			7,927		3,524	
	amounts of 2.1.11				166,470		74,011	240,482
	2.1.12 Retarding basin, J1 (pond type)							
1)	excavation	cu.m	24,100	4	84,350	2	36,150	
2)	masonry	cu.m	90	20	1,800	20	1,800	
3)	sod facing	sq.m	1,660	0	664	1	996	
4)	gravel,inspec.road	cu.m	220	12	2,640	8	1,760	
5)	structure excavation	cu.m	70	4	294	2	126	
6)	gravel bedding	cu.m	10	12	120	8	80	
7)	lean concrete with formwork,150 kg/m3	cu.m	10	48	480	32	320	
8)	structure concrete w/formwork,350 kg/m3	cu.m	80	72	5,760	48	3,840	
9)	re-bar	ton	4	770	3,080	330	1,320	
10)	backfill	cu.m	50	2	120	2	80	

Table 1.9 Priced Bill of Quantities for Oued Ennkhilet and Oued Hammam in First Stage (5/7)

Item No.	Work Items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
				(US\$ 1.0 = DT 1.0 = Y 110.0)				
11)	mechanical works screen	ton	1	1,600	1,120	400	280	
12)	micellaneous works (5 % of above)	L.S			5,021		2,338	
	amounts of 2.1.12				105,449		49,090	154,539
	2.1.13 Crossing facilities other than bridge							
1)	water supply pipes (SONEDE's)	P.S	-	-	25,000	-	11,000	
2)	power distribution lines (STEG's)	P.S	-	-	50,000	-	15,000	
3)	telephone lines (PTT's)	P.S	-	-	16,000	-	7,200	
4)	gas supply line (STEG's)	P.S	-	-	10,000	-	5,000	
5)	private crossing facilities	L.S	-	-	10,000	-	5,000	
	amounts of 2.1.13				111,000		43,200	154,200
	sub total of 2.1				3,496,302		1,811,290	5,307,592
	total of 2				3,496,302		1,811,290	5,307,592
3	Oued Hammam							
3.1	Oued Hammam							
	3.1.1 stretch H-1							
1)	channel excavation	cu.m	15,100	4	52,850	2	22,650	
2)	masonry	cu.m	2,000	20	40,000	20	40,000	
3)	gabion	cu.m	1,350	25	33,750	25	33,750	
4)	sod facing	sq.m	8,200	0	3,280	1	4,920	
5)	bridge for touristic road, W26m*L84m w/approach road	sq.m	2,184	700	1,528,800	300	655,200	
6)	miscellaneous works (5 % of above)	L.S	-	-	82,934	-	37,826	
	amount of 3.1.1				1,741,614		794,346	2,535,960
	3.1.2 stretch H-2							
1)	channel excavation	cu.m	37,800	4	132,300	2	56,700	
2)	embankment, levee	cu.m	2,500	4	8,750	2	3,750	
3)	masonry	cu.m	330	20	6,600	20	6,600	
4)	gabion	cu.m	270	25	6,750	25	6,750	
5)	sod facing	sq.m	6,000	0	2,400	1	3,600	
6)	gravel for inspection road	cu.m	670	12	8,040	8	5,360	
7)	drainage sluice (W1.5m*H1.5m*L15m)	nos.	2	9,000	18,000	6,000	12,000	
8)	bridge for GP-1 road (W12m*L48m), w/approach road	sq.m	580	700	406,000	300	174,000	
9)	demolishing bridges	cu.m	100	15	1,500	15	1,500	
10)	miscellaneous works (5 % of above)	L.S	-	-	29,517	-	13,513	
	amount of 3.1.2				619,857		283,773	903,630
	3.1.3 stretch H-3							
1)	channel excavation	cu.m	18,700	4	65,450	2	28,050	

Table 1.9 Priced Bill of Quantities for Oued Ennkhilet and Oued Hammam in First Stage (6/7)

Item No.	Work Items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
2)	embankment,levee	cu.m	2,600	4	9,100	2	3,900	
3)	masonry	cu.m	270	20	5,400	20	5,400	
4)	gabion	cu.m	220	25	5,500	25	5,500	
5)	sod facing	sq.m	6,200	0	2,480	1	3,720	
6)	gravel for inspection road	cu.m	600	12	7,200	8	4,800	
7)	drainage sluice (W1.5m*H1.5m*L15m)	nos.	2	9,000	18,000	6,000	12,000	
8)	miscellaneous works (5 % of above)	L.S	-	-	5,657	-	3,169	
	amount of 3.1.3				118,787		66,539	185,325
	sub total of 3.1				2,480,258		1,144,658	3,624,915
3.2 Oued Laia								
3.2.1 stretch H-4								
1)	channel excavation	cu.m	1,900	4	6,650	2	2,850	
2)	embankment,levee	cu.m	2,600	4	9,100	2	3,900	
3)	masonry	cu.m	160	20	3,200	20	3,200	
4)	gabion	cu.m	130	25	3,250	25	3,250	
5)	sod facing	sq.m	5,150	0	2,060	1	3,090	
6)	gravel for inspection road	cu.m	300	12	3,600	8	2,400	
7)	drainage sluice (W1.5m*H1.5m*L15m)	nos.	2	9,000	18,000	6,000	12,000	
8)	miscellaneous works (5 % of above)	L.S	-	-	2,293	-	1,535	
	amount of 3.2.1				48,153		32,225	80,000
	sub total of 3.2				48,153		32,225	80,378
3.3 Oued Kebir								
3.3.1 stretch K-1								
1)	channel excavation	cu.m	23,300	4	81,550	2	34,950	
2)	embankment,levee	cu.m	8,100	4	28,350	2	12,150	
3)	masonry	cu.m	320	20	6,400	20	6,400	
4)	gabion	cu.m	260	25	6,500	25	6,500	
5)	sod facing	sq.m	15,400	0	6,160	1	9,240	
6)	gravel for inspection road	cu.m	1,060	12	12,720	8	8,480	
7)	drainage sluice (W1.5m*H1.5m*L15m)	nos.	2	9,000	18,000	6,000	12,000	
8)	bridge, MC-48 road (W15m*L30m) with approach road	sq.m	450	700	315,000	300	135,000	
9)	demolishing,bridges	cu.m	260	15	3,900	15	3,900	
10)	miscellaneous works (5 % of above)	L.S	-	-	23,929	-	11,431	
	amount of 3.3.1				502,509		240,051	742,560
3.3.2 stretch K-4								
1)	channe excavation	cu.m	1,600	4	5,600	2	2,400	
2)	embankment, levee	cu.m	700	4	2,450	2	1,050	
3)	masonry	cu.m	290	20	5,800	20	5,800	
4)	gabion	cu.m	270	25	6,750	25	6,750	
5)	sod facing	sq.m	900	0	360	1	540	
6)	gravel for inspection road	cu.m	100	12	1,200	8	800	

Table 1.9 Priced Bill of Quantities for Oued Enkhilet and Oued Hammam in First Stage (7/7)

Item No.	Work Items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
				(US\$ 1.0 = DT 1.0 = Y 110.0)				
7)	bridge, MC-48 (W12m*L27m) with approach road	sq.m	330	700	231,000	300	99,000	
8)	miscellaneous works (5 % of above)	L.S	-	-	12,658	-	5,817	
	amount of 3.3.2				265,818		122,157	387,975
	3.3.3 stretch K-5							
1)	channel excavation	cu.m	14,900	4	52,150	2	22,350	
2)	embankment,levee	cu.m	10,300	4	36,050	2	15,450	
3)	masonry	cu.m	630	20	12,600	20	12,600	
4)	gabion	cu.m	590	25	14,750	25	14,750	
5)	sod facing	sq.m	17,500	0	7,000	1	10,500	
6)	gravel, inspection road	cu.m	1,840	12	22,080	8	14,720	
7)	structure excavation	cu.m	650	4	2,730	2	1,170	
8)	gravel bedding for culvert	cu.m	15	12	180	8	120	
9)	lean concret with formwork,150 kg/m3	cu.m	8	48	384	32	256	
10)	structure concrete w/formwork,350 kg/m3	cu.m	130	72	9,360	48	6,240	
11)	re-bar	ton	13	770	10,010	330	4,290	
12)	backfill	cu.m	100	2	240	2	160	
13)	drainage sluice	nos.	2	9,000	18,000	6,000	12,000	
14)	demolish,bridges	cu.m	80	15	1,200	15	1,200	
15)	miscellaneous works (5 % of above)	L.S	-	-	9,337	-	5,790	
	amount of 3.3.3				196,071		121,596	317,667
	sub total of 3.3				964,398		483,804	1,448,202
	total of 3				3,492,808		1,660,686	5,153,495
	Total, 1 to 3				7,289,110		3,671,977	10,961,087
	TVA, 17 %						1,863,385	1,863,385
	Grand total				7,289,110		5,535,362	12,824,472

Table 1.10 Priced Bill of Quantities for Oued Ennkhilet and Oued Hammam in Second Stage (1/5)

Item No.	Work items	Unit	Q'ty	(US\$ 1.0 = DT 1.0 = Y 110.0)				
				Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
1	preliminary & general							
	1) access roads	L.S	-	-	15,000	-	5,000	
	2) power supply	L.S	-	-	5,000	-	5,000	
	3) water supply	L.S	-	-	5,000	-	3,000	
	4) communication	L.S	-	-	5,000	-	2,000	
	5) other incidentals	L.S	-	-	20,000	-	5,000	
	total of 1				50,000		20,000	70,000
2	Oued Ennkhilet							
2.1	Oued ennkhilet main							
	1) channel excavation	cu.m	39,300	4	137,550	2	58,950	
	2) sod facing	sq.m	14,900	0	5,960	1	8,940	
	3) structure excavation	cu.m	51,100	4	214,620	2	91,980	
	4) gravel bedding	cu.m	1,199	12	14,388	8	9,592	
	5) lean concrete with formwork,150 kg/m3	cu.m	600	48	28,800	32	19,200	
	6) structure concrete w/formwork,350kg/m3	cu.m	11,565	72	832,680	48	555,120	
	7) re-bar	ton	998	770	768,460	330	329,340	
	8) backfill	cu.m	22,478	2	53,947	2	35,965	
	9) bridge demolish	cu.m	1,890	15	28,350	15	28,350	
	10) miscellaneous works (5 % of above)	L.S			104,238		56,872	
	amount of 2.1				2,188,993		1,194,309	3,383,302
2.2	Canal C1							
	1) channel exca.	cu.m	15,000	4	52,500	2	22,500	
	2) sod facing	sq.m	10,500	0	4,200	1	6,300	
	3) miscellaneous works (5 % of above)	L.S			2,835		1,440	
	amount of 2.2				59,535		30,240	89,775
2.3	Canal C4							
	1) structure exca.	cu.m	4,600	4	19,320	2	8,280	
	2) gravel bedding	cu.m	110	12	1,320	8	880	
	3) lean concrete with formwork,150 kg/m3	cu.m	53	48	2,544	32	1,696	
	4) structure concrete w/formwork,350kg/m3	cu.m	1,050	72	75,600	48	50,400	
	5) re-bar	ton	84	770	64,680	330	27,720	
	6) backfill	cu.m	2,600	2	6,240	2	4,160	
	7) miscellaneous works (5 % of above)	L.S			8,485		4,657	
	amount of 2.3				178,189		97,793	275,982
2.4	Canal R2							
	1) gravel,inspec.road	cu.m	1,070	12	12,840	8	8,560	
	2) structure exca.	cu.m	7,800	4	32,760	2	14,040	
	3) gravel bedding	cu.m	450	12	5,400	8	3,600	
	4) lean concrete with formwork,150 kg/m3	cu.m	224	48	10,752	32	7,168	
	5) structure concrete w/formwork,350kg/m3	cu.m	2,130	72	153,360	48	102,240	
	6) re-bar	ton	149	770	114,730	330	49,170	
	7) backfill	cu.m	3,410	2	8,184	2	5,456	
	8) miscellaneous works (5 % of above)	L.S			16,901		9,512	

Table 1.10 Priced Bill of Quantities for Oued Ennkhilet and Oued Hammam in Second Stage (2/5)

Item No.	Work items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
amount of 2.4					354,927		199,746	554,673
2.5 Canal G1								
1)	gravel,inspec.road	cu.m	1,890	12	22,680	8	15,120	
2)	structure exca.	cu.m	14,250	4	59,850	2	25,650	
3)	gravel bedding	cu.m	650	12	7,800	8	5,200	
4)	lean concrete with formwork,150 kg/m3	cu.m	328	48	15,744	32	10,496	
5)	structure concrete w/formwork,350kg/m3	cu.m	3,360	72	241,920	48	161,280	
6)	re-bar	ton	236	770	181,720	330	77,880	
7)	backfill	cu.m	6,620	2	15,888	2	10,592	
8)	bridge demolish	cu.m	40	15	600	15	600	
9)	miscellaneous works (5 % of above)				27,310		15,341	
amount of 2.5					573,512		322,159	895,671
2.6 Canal G1'								
1)	structure exca.	cu.m	2,400	4	10,080	2	4,320	
2)	gravel bedding	cu.m	120	12	1,440	8	960	
3)	lean concrete with formwork,150 kg/m3	cu.m	60	48	2,880	32	1,920	
4)	structure concrete w/formwork,350 kg/m3	cu.m	610	72	43,920	48	29,280	
5)	re-bar	ton	43	770	33,110	330	14,190	
6)	backfill	cu.m	1,250	2	3,000	2	2,000	
7)	miscellaneous works (5 % of above)	L.S			4,722		2,634	
amount of 2.6					99,152		55,304	154,455
2.7 Canal G2								
1)	channel exca.	cu.m	1,600	4	5,600	2	2,400	
2)	masonry	cu.m	110	20	2,200	20	2,200	
3)	gabion	cu.m	180	25	4,500	25	4,500	
4)	sod facing	sq.m	7,170	0	2,868	1	4,302	
5)	structure exca.	cu.m	220	4	924	2	396	
6)	gravel bedding	cu.m	7	12	84	8	56	
7)	lean concrete with formwork,150 kg/m3	cu.m	4	48	192	32	128	
8)	structure concrete w/formwork,350kg/m3	cu.m	66	72	4,752	48	3,168	
9)	re-bar	ton	5	770	3,850	330	1,650	
10)	backfill	cu.m	80	2	192	2	128	
11)	bridge demolish	cu.m	50	15	750	15	750	
12)	miscellaneous works (5 % of above)	L.S			1,296		984	
amount of 2.7					27,208		20,662	47,870
2.8 Flood diversion No.3								
1)	channel exca.	cu.m	61,400	4	214,900	2	92,100	
2)	sod facing	sq.m	25,500	0	10,200	1	15,300	
3)	structure exca.	cu.m	600	4	2,520	2	1,080	
4)	gravel bedding	cu.m	10	12	120	8	80	
5)	lean concrete with formwork,150 kg/m3	cu.m	5	48	240	32	160	
6)	structure concrete w/formwork,350kg/m3	cu.m	100	72	7,200	48	4,800	
7)	re-bar	ton	9	770	6,930	330	2,970	
8)	backfill	cu.m	250	2	600	2	400	
9)	miscellaneous works (5 % of above)	L.S			12,136		5,845	

Table 1.10 Priced Bill of Quantities for Oued Enkhilet and Oued Hammam in Second Stage (3/5)

Item No.	Work items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
				(US\$ 1.0 = DT 1.0 = Y 110.0)				
	amount of 2.8				254,846		122,735	377,580
2.9	Flood diversion No.4							
	1) structural exca.	cu.m	4,900	4	20,580	2	8,820	
	2) gravel bedding	cu.m	130	12	1,560	8	1,040	
	3) lean concrete with formwork,150 kg/m3	cu.m	65	48	3,120	32	2,080	
	4) structure concrete w/formwork,350kg/m3	cu.m	1,200	72	86,400	48	57,600	
	5) re-bar	ton	108	770	83,160	330	35,640	
	6) backfill	cu.m	1,900	2	4,560	2	3,040	
	7) miscellaneous works (5 % of above)	L.S			9,969		5,411	
	amount of 2.9				209,349		113,631	322,980
2.10	Retarding basin G							
	1) excavation	cu.m	27,600	4	96,600	2	41,400	
	2) masonry	cu.m	30	20	600	20	600	
	3) sod facing	sq.m	1,300	0	520	1	780	
	4) gravel,inspec. road	cu.m	50	12	600	8	400	
	5) structure exca.	cu.m	160	4	672	2	288	
	6) gravel bedding	cu.m	10	12	120	8	80	
	7) lean concrete with formwork,150 kg/m3	cu.m	10	48	480	32	320	
	8) structure concrete w/formwork,350kg/m3	cu.m	40	72	2,880	48	1,920	
	9) re-bar	ton	2	770	1,540	330	660	
	10) backfill	cu.m	140	2	336	2	224	
	11) mechanical works ,screen	ton	1	1,600	2,240	400	560	
	12) miscellaneous works (5 % of above)	L.S			5,329		2,362	
	amount of 2.10				111,917		49,594	161,511
2.11	Retarding basin J1							
	1) excavation	cu.m	15,200	4	53,200	2	22,800	
	2) masonry	cu.m	70	20	1,400	20	1,400	
	3) sod facing	sq.m	470	0	188	1	282	
	4) miscellaneous works (5 % of above)	L.S			2,739		1,224	
	amount of 2.11				57,527		25,706	83,234
	total of 2				4,115,155		2,231,877	6,347,032
3	Oued Hammam							
3.1	Oued Hammam							
	3.1.1 stretch H-2							
	1) embankment,levee	cu.m	4,600	4	16,100	2	6,900	
	2) sod facing	sq.m	3,800	0	1,520	1	2,280	
	3) gravel for inspection road	cu.m	670	12	8,040	8	5,360	
	4) miscellaneous works (5 % of above)	L.S			1,283		727	
	amount of 3.1.1				26,943		15,267	42,210
	3.1.2 stretch H-3							

Table 1.10 Priced Bill of Quantities for Oued Ennkhilet and Oued Hammam in Second Stage (4/5)

Item No.	Work Items	Unit	Q'ty	Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
	1) embankment, levee	cu.m	3,800	4	13,300	2	5,700	
	2) sod facing	sq.m	2,900	0	1,160	1	1,740	
	3) gravel for inspection road	cu.m	600	12	7,200	8	4,800	
	4) miscellaneous works (5 % of above)				1,083		612	
	amount of 3.1.2				22,743		12,852	35,595
	sub total of 3.1				49,686		28,119	77,805
3.2	Oued Lala							
	3.2.1 stretch H-4							
	1) channel excavation	cu.m	2,700	4	9,450	2	4,050	
	2) gravel for inspection road	cu.m	1,500	12	18,000	8	12,000	
	3) miscellaneous works (5 % of above)				1,373		803	
	amount of 3.2.1				28,823		16,853	45,675
	sub total of 3.2				28,823		16,853	45,675
3.3	Oued Kebir							
	3.3.1 stretch K-1							
	1) channel excavation	cu.m	22,300	4	78,050	2	33,450	
	2) sod facing	sq.m	9,500	0	3,800	1	5,700	
	3) miscellaneous works (5 % of above)				4,093		1,958	
	amount of 3.3.1				85,943		41,108	127,050
	3.3.2 stretch K-4							
	1) channel excavation	cu.m	600	4	2,100	2	900	
	2) sod facing	sq.m	300	0	120	1	180	
	3) miscellaneous works (5 % of above)				111		54	
	amount of 3.3.2				2,331		1,134	3,465
	3.3.3 stretch K-5							
	1) channel excavation	cu.m	21,300	4	74,550	2	31,950	
	2) masonry	cu.m	490	20	9,800	20	9,800	
	3) gabion	cu.m	450	25	11,250	25	11,250	
	4) sod facing	sq.m	13,400	0	5,360	1	8,040	
	5) structure excavation	cu.m	1,800	4	7,560	2	3,240	
	6) gravel bedding	cu.m	38	12	456	8	304	
	7) lean concrete with formwork, 150 kg/m3	cu.m	19	48	912	32	608	
	8) structure concrete w/ formwork, 350 kg/m3	cu.m	370	72	26,640	48	17,760	
	9) re-bar	ton	35	770	26,950	330	11,550	
	10) backfill	cu.m	250	2	600	2	400	
	11) miscellaneous works (5 % of above)				8,204		4,745	
	amount of 3.3.3				172,282		99,647	271,929
	sub total of 3.3				260,555		141,889	402,444
	total of 3				339,064		186,860	525,924

Table 1.10 Priced Bill of Quantities for Oued Enkhilet and Oued Hammam in Second Stage (5/5)

Item No.	Work items	Unit	Q'ty	(US\$ 1.0 = DT 1.0 = Y 110.0)				
				Foreign Currency		Local Currency		Total Equiv. (DT)
				Unit (US\$)	Amount (US\$)	Unit (DT)	Amount (DT)	
	total of 1 to 3, 2nd stage				4,504,219		2,438,737	6,942,956
	TVA, 17 %						1,180,302	1,180,302
	Grand total				4,504,219		3,619,039	8,123,258

Table 1.11 Unit Cost of Major Work Items

(DT1.0 = US\$1.0)

No.	Construction Work Items	Unit	Unit Cost (DT)	Foreign Currency Portion		Local Currency Portion	
				(%)	(US\$)	(%)	(DT)
1.	stripping	m2	1.0	70	0.7	30	0.3
2.	channel excavation	m3	5.0	70	3.5	30	1.5
3.	exca. retarding basin	m3	5.0	70	3.5	30	1.5
4.	structure excavation	m3	6.0	70	4.2	30	1.8
5.	rock excavation	m3	10.0	70	7.0	30	3.0
6.	levee embankment by excavated soil	m3	5.0	70	3.5	30	1.5
7.	levee embankment by borrowed soil, L=2 km	m3	6.0	70	4.2	30	1.8
8.	masonry	m3	40.0	50	20.0	50	20.0
9.	gabion	m3	50.0	50	25.0	50	25.0
10.	backfill	m3	4.0	60	2.4	40	1.6
11.	sod facing	m2	1.0	40	0.4	60	0.6
12.	concrete, 350 kg/m3 cement w/formwork	m3	120.0	60	72.0	40	48.0
13.	concrete, 150 kg/m3 cement w/formwork	m3	80.0	60	48.0	40	32.0
14.	re-bar	ton	1,100.0	70	770.0	30	330.0
15.	formwork, class 1	m2	15.0	60	9.0	40	6.0
16.	gravel metalling	m3	20.0	60	12.0	40	8.0
17.	asphalt pavement	m2	3.0	60	1.8	40	1.2
18.	box culvert, W 1m*H 1m,1-lane	m	550.0	50	275.0	50	275.0
19.	box culvert, W 2m*H 2m,1-lane	m	1,400.0	50	700.0	50	700.0
20.	box culvert, W 4m*H 2m,2-lane	m	2,600.0	50	1,300.0	50	1,300.0
21.	drain pipe,concrete,500 mm	m	90.0	50	45.0	50	45.0
22.	drain pipe,concrete,800 mm	m	170.0	50	85.0	50	85.0
23.	drain pipe,concrete,1000 mm	m	250.0	50	125.0	50	125.0
(detour or relocate cost of crossing facilities)							
1.	roads,MC48,35,RV533,543	m	600.0	60	360.0	40	240.0
2.	bridge, RC-T type	m2	900.0	70	630.0	30	270.0
3.	electric line,high voltage	100 m	12,000.0	70	8,400.0	30	3,600.0
4.	telephone line	100 m	2,400.0	70	1,680.0	30	720.0
5.	water pipe	m	120.0	70	84.0	30	36.0
6.	sewer pipe	m	40.0	50	20.0	50	20.0

Table 1.12 Labourer's Wages

Occasional Employee

Classification	Minimum Wage <3			Applied this project (DT/month)
	<1 Hourly (mil/hr)	<2 Daily (DT/day)	<2 Monthly (DT/m)	
* common labour	776.0	6.21	161.41	250
* specialized labour	808.0	6.46	168.06	300
* worker's mate	836.0	6.69	173.89	300
* skilled labour, 1st category	870.0	6.96	180.96	350
* skilled labour, 2nd category	911.0	7.29	189.49	400
* skilled worker 1, highly skilled	956.0	7.65	198.85	500
* foreman, 1st grade	1,086.0	8.69	225.89	600
* foreman, 2nd grade	1,109.0	8.87	230.67	650
* foreman, 3rd grade	1,139.0	9.11	236.91	700

- notes <1 : 1) Grid of salaries for occasional employees to be applicable from 1st May 1994. millimes/hour (DT 1.0=1,000 millimes)
 2) National collective agreement of building and civil engineering
 3) The salaries of this grid include provisional complementary indemnity (ICP) instituted by the decree no. 81-437 of 7th April 1981 and completed by the decree no. 82-501 of the 16th March 1982
- <2 : 8 hours * hourly wage, and 26 day * daily wage assumed and approx.
- <3 : source, Journal Officiel de la Republique Tunisienne 14 September 1993, (grid no.1)

Administrative and Technical Employee (Permanent)

(Minimum Wage <2)

Service Length (year)	Salary in each grade (millimes/month) <1 (category of wokers)								
	1	(2-4)	5	(6-9)	10	(11-14)	15	(16-18)	19
0-2	157,032	184,949	255,011	331,844	456,970				
8-10	165,784	194,398	271,358	357,106	495,623				
15-18	167,081	203,985	283,618	374,178	524,613				
24-	168,395	210,623	298,378	391,250	553,602				

- note <1 : 1) Grid of salaries of administrative & technical employee monthly basis, 48 hours/week, to be applicable from May 1st 1994. Included ICP.
 2) National collective agreement of building and civil engineering
 3) Each grade is decided upon negotiation with owner regarding employee's carrier, skillfulness, study and others
- <2 : source, Journal Officiel de la Republique Tunisienne 14 September 1993 (grid no.2)

Table 1.13 Unit Prices of Construction Materials

No.	Materials	Unit	Unit Price (DT)
1	portland cement	t	51.0
2	white cement	t	208.0
3	admixture	kg	6.0
4	ordinary sand	m3	1.6
5	sand for asphalt	m3	3.5
6	gravel, 3-8mm	m3	6.2
7	gravel, 5-16 mm	m3	7.7
8	gravel, 12-25 mm	m3	6.6
9	coarse aggregate	m3	6.0
10	masonry stone	m3	6.2
11	rubble stone	m3	3.3
12	reinforcement steel bar, round	t	560.0
13	" , deformed, 8 mm * 12 m	t	600.0
14	" , deformed, 16 mm * 12 m	t	600.0
15	" , deformed, 32 mm * 12 m	t	600.0
16	structural steel, U-type (80-120 mm*3 mm t*12 m)	t	650.0
17	structural steel, I-type (80-120 mm*3 mm t* 12 m)	t	650.0
18	angle steel, 60*60 mm*6 mmt * 6 m	t	650.0
19	cast iron	t	235.0
20	black sheet metal, 3m*1.5m*10mm	t	730.0
21	undulated sheet metal (3m*0.90*45/100)	t	1347.0
22	flat galvanized sheet metal (2m*1m*10-10)	t	1235.0
23	steel sheetpile	sq.m	30.0
24	timber for formwork	m3	460.0
25	fuel(diesel oil)	m3	310.0
26	petrol (kerosine)	m3	180.0
27	gasoline, super	m3	570.0
28	gasoline, normal	m3	530.0
29	grease	kg	1.5
30	asbesto pipe, 300 mm * 4 m	pc.	74.0
31	PVC pipe, 32 mm * 4 m	pc.	11.0
32	PVC pipe, 200 mm * 4 m	pc.	32.0
33	brick, 6 holes, 1000 pcs.	-	85.0
34	bitumen, 80-100	t	150.0
35	cut back, 01	t	234.0
36	electric charge	kwh	0.07
37	transportation fee (any kind of transportation)	t.km	0.08
38	ready mixed concrete, 350 kg/cm2 w/transport within 20 km	m3	65.0

Table 1.14 Hourly Cost of Major Construction Equipment
(reference only)

Equipment	Purchase Cost (DT)	Economical Life		Hourly Cost			Total (DT)
		(year)	(hour)	Depreciation <1 (DT)	Repair & Maintenance <2 (DT)	Management <3 (DT)	
1 excavator, 1.0 m3	140,000	5	6,000	21.0	12.6	5.8	39.4
2 swamp bulldozer, 16 t	150,000	5	6,000	22.5	13.5	6.3	42.3
3 bulldozer, 11 t	100,000	5	6,000	15.0	9.0	4.2	28.2
4 crawler loader, 1.0 m3	90,000	6	6,000	13.5	8.1	4.5	26.1
5 crawler loader, 2.0 m3	170,000	6	6,000	25.5	15.3	8.5	49.3
6 dump truck, 10 t	80,000	4	6,500	11.1	6.6	2.5	20.2
7 vib. roller, 10 t	100,000	6	6,000	15.0	9.0	5.0	29.0
8 water tanker, 8 kl	60,000	5	6,000	9.0	5.4	2.5	16.9
9 clamshell, 0.6 m3	200,000	7	6,000	30.0	18.0	11.7	59.7
10 concrete mixer, 0.5 m3	5,000	3	3,000	1.5	0.9	0.3	2.7
11 agitator truck, 3.2 m3	60,000	5	5,000	10.8	6.5	3.0	20.3
12 motor grader, 3.1 m	100,000	6	6,000	15.0	9.0	5.0	29.0
13 truck crane, 10 t	110,000	7	7,000	14.1	8.5	5.5	28.1
14 truck crane, 20 t	200,000	7	7,000	25.7	15.4	10.0	51.1
15 truck crane, 30 t	300,000	7	7,000	38.6	23.1	15.0	76.7
16 ordinary truck, 6 t	60,000	4	6,000	9.0	5.4	2.0	16.4
17 tamper, 60 kg	2,000	2	2,000	0.9	0.5	0.1	1.5
18 welder, 100 A	3,000	3	3,000	0.9	0.5	0.2	1.6
19 breaker, 20 kg	2,000	2	2,000	0.9	0.5	0.1	1.5
20 submersible pump, 1.5 m3/min.	2,000	4	4,000	0.5	0.3	0.1	0.8
21 diesel generator, 20 kva	15,000	6	6,000	2.3	1.4	0.8	4.4
22 diesel generator, 50 kva	25,000	6	6,000	3.8	2.3	1.3	7.3

note. <1 : salvage value of 10 % of purchase cost

<2 : 60 % of purchase cost

<3 : 5 % of purchase cost per annum

Table 1.15 Breakdown of Unit Cost for Channel Excavation
per 60 m³ - reference purpose -

(excavate and loading by excavator, hauling by d. truck
till stockyard, spreading by bulldozer at stockyard)

Cost Components	Unit	Q'ty	Unit Price (DT)	Amount (DT)
1. labour cost				
foreman	hour	1.00	3.40	3.40
operator	hour	1.40	2.40	3.36
driver	hour	4.60	1.90	8.74
common labour	hour	2.00	1.20	2.40
amount				17.90
2. equipment cost				
excavator, 1.0 m ³	hour	1.00	39.40	39.40
swamp bulldozer, 16 t	hour	0.30	42.30	12.69
dump truck, 10 t	hour	4.60	20.20	92.92
amount				145.01
3. material cost				
fuel	lit.	55.00	0.31	17.05
lubricants(20 % of fuel)	l.s	-	-	3.41
amount				20.46
sub total				183.37
4. contractor's overhead & profit,& tax (50 % of 1-3)				91.69
total				275.06
unit cost/m ³				4.58 → DT 5.0/m ³ (w/allownace)

Table 1.16 Breakdown of Unit Cost for Levee Embankment
per 74 m³ - reference purpose -

(loading by crawler loader at stockyard, hauling by dump
truck w/500 m and compact by bulldozer and V.roller)

Cost Components	Unit	Q'ty	Unit Price (DT)	Amount (DT)
1. labour cost				
foreman	hour	1.00	3.40	3.40
operator	hour	2.80	2.40	6.72
driver	hour	5.00	1.90	9.50
common labour	hour	2.00	1.20	2.40
amount				22.02
2. equipment cost				
crawler loader, 1.0 m ³	hour	0.80	26.10	20.88
dump truck, 10 t	hour	4.40	20.20	88.88
bulldozer, 11 t	hour	1.00	28.20	28.20
vibration roller, 10 t	hour	1.00	29.00	29.00
water tanker, 8 kl	hour	0.60	16.90	10.14
amount				177.10
3. material cost				
fuel	lit.	55.00	0.31	17.05
lubricants(20 % of fuel)	l.s	-	-	3.41
amount				20.46
sub total				219.58
4. contractor's overhead & profit,& tax (50 % of 1-3)				109.79
total				329.37
unit cost/m ³				4.45 -> DT 5.0/m ³ (w/allowance)

**D. COST ESTIMATE and CONSTRUCTION
PLAN AND SCHEDULE**

II. CONSTRUCTION PLAN AND SCHEDULE

THE STUDY
ON
FLOOD PROTECTION PROGRAM
FOR
GREATER TUNIS AND SOUSSE

**D. COST ESTIMATE and CONSTRUCTION
PLAN AND SCHEDULE**

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II. CONSTRUCTION PLAN AND SCHEDULE

2.1 General Description of the Project

The flood protection program for the Greater Tunis and Sousse has been formulated the priority project for both Tunis and Sousse basins through the master plan study and succeeding feasibility study. The priority project is the Oued Ennklehith and Sebkheth Ariana for the Greater Tunis, and Oued Hammam for the Greater Sousse. The feasibility study was carried out since September 1993 for these priority projects under the following basic design conditions and criterion.

- 1) Basic design flood of 100-year flood for the rivers and those secondary channels.
- 2) Tertiary or drainage channels of 10-year flood.
- 3) Stage-wise development as ;
 - first stage development by 10-year flood for river improvement,
 - 100-year flood for dam and retarding basin even in the first stage development, and
 - to acquire the river or channel width sufficiently by 100-year flood for future development.

2.2 Principal Features of the Project

The proposed structure features are tabulated as follows for the both schemes of the Oued Ennkhelet with the Sebkheth Ariana and the Oued Hammam.

First Stage

Oued Ennkhelet scheme

1. Oued Ennkhelet Main

Type	: trapezoidal earth lining and box culvert
Length, improvement	: 2695 m
Bridge renewal	: 2-set, RV-543 & 533
Drainage sluice const.	: 5-place

2. Canals

Type of canal	: trapezoidal earth lining
Canal C1, length	: 1573 m
Drainages	: 5-place

Canal R2, length	: 918 m
Bridge	: 5-place
Canal G1, length	: 1113 m
Bridge	: 2-place
Canal G2, length	: 1255 m
Bridge	: 3-place
Canal G1', length	: 299 m
Bridge	: 1-place

3. Flood diversions

Diversion No.3, type	: trapezoidal earth lining
Length	: 3800 m
Bridge	: 5-place, RV-543, 533 & others
Sewer	: 1-lot, ONAS's sewerage facilities
Drainage s.	: 6-place
Diversion No.4, type	: concrete box culvert
Length	: 288 m

4. Retarding basins

Retarding basin A	: concrete wall dam type, storage capacity of 7800 m ³
Retarding basin G	: pond type, storage capacity of 17400 m ³
Retarding basin I	: pond type, storage capacity of 22500 m ³
Retarding basin J1	: pond type, storage capacity of 19600 m ³

5. Crossing facilities

: 1-lot for water pipes, electric power distribution lines, phone lines and others

Oued Hammam Scheme

1. Oued Hammam

Stretch H-1, location	: river mouth to GP-1 road
Dimension	: length=572 m, b.width=36m, bank protection:300 m
both	
Crossing	: bridge for touristic road type, RC-T, W=26 m, L=84 m
Stretch H-2, location	: GP-1 to GP-1 Bypass
Dimension	: length=560 m, b.width=33 m
Crossing	: bridge for GP-1 road type, RC-T, W=12 m, L=48 m
Structure	: drainage sluice way * 2 sets
Stretch H-3, location	: GP-1 Bypass to confluence of Oued Kebir
Dimension	: length=565 m, b.width=33 m, & bank protection of 50
m	both
Structure	: drainage sluice way * 2 sets

2. Oued Laia

Stretch H-4, location	: confluence with O.Kebir to upstream
Dimension	: length=250 m, b.width=8 m, and bank protection of 30
m	both

Structure : drainage sluice way * 2 sets

3. Oued Kebir

Stretch K-1, location : confluence with O.Laia to MC-48 cross point
Dimension : length=884 m, b.width=7 m, and bank protection of 60
m : both
Crossing : bridge for MC-48, type RC-T, W=15 m, L=30 m
Structure : drainage sluiceway * 2 sets
Stretch K-4, location : railway cross point to confluence with O.Seghir
Dimension : length=84 m, b.width=6.5 m, and bank protection of
60 m both
Crossing : bridge for MC-48, type RC-T, W=12 m, L=27 m
Stretch K-5, location : confluence with O.Seghir to upstream
Dimension : length=1532 m, b.width=4.5 m, and bank protection of
130 m both
Structure : drainage culvert * 2 sets drainage sluiceway * 2 sets

Second Stage

Oued Ennkhilet scheme

1. Oued Ennkhilet : bottom widening by excavation & concreting for box
culverts
2. Canal, C1 : bottom widening by excavation
3. Canal, R2 : widening by construction of rectangular concrete
wall
4. Canal, G2 : deepening by excavation and construction of box culvert
5. Canal, G1 : widening by construction of concrete wall
6. Canal, G1' : widening by construction of concrete wall
7. Canal, C4 : construction of box culvert
8. Flood diversion No.3 : bottom widening by excavation
9. Flood diversion No.4 : construction, additional culvert
10. Retarding basin, A : orifice extension
11. Retarding basin, G : extension of pond & orifice by excavation and
concreting
12. Retarding basin, I : extension of orifice
13. Retarding basin, J1 : extension of pond and orifice by excavation and
concreting

Oued Hammam scheme

stretch H-2, Oued Hammam : heightening levee of 560 m
stretch H-3, Oued Hammam : heightening levee of 565 m
stretch H-4, Oued Laia : bottom widening to 20 m and levee embankment for
1557 m length
stretch K-1, Oued Kebir : bottom widening to 18 m for 884 m length
stretch K-4, Oued Kebir : bottom widening to 17 m for 17 m length
stretch K-5, Oued Kebir : bottom widening to 12 m for 1532 m and bank
protection of 100 m, and 10 sets of culverts

2.3 Implementation Plan

2.3.1 Implementation Schedule

The structure measures for flood protection has been proposed by stage-wise development on Oued Enkhilet and Hammam schemes, and these are to be completed by the year 1998 for 10-yr flood and by a certain time in the future for 100-yr flood respectively. An implementation schedule for the first stage is provided as shown in Fig.2.1. It is summarized as follows.

First stage

<u>Stage & Activity Items</u>	<u>Timing</u>	<u>Duration</u>
* Financial arrangement	1994	8 months
* Detailed design with additional survey and P/Q for Tenderer	1995	12 "
* Tender/contract	1996	6 "
* Construction		
Oued Enkhilet/Sebkhet Ariana	1996-1998	30 "
Oued Hammam	1996-1998	30 "

2.3.2 Financial Source

The fund required for the project implementation will be provided by the Tunisian Government's national budget and supporting loan from donor countries and or agencies. The fund will have to be provided on the following items :

- construction works
- land acquisition and compensation
- administration expenses for the Tunisian government
- engineering services expenses for detailed design with additional survey, investigation and construction supervision
- price and physical contingencies

2.3.3 Mode of Construction

The construction works will be performed by selected contractor(s) upon international competitive bidding with a pre-qualification procedure of tenderers.

2.3.4 Implementation Organization

Fig.2.2 shows a proposed implementation organization. The Urban Hydraulic Division of Ministry of Equipment and Housing will be the core of organization for the project implementation. MOEH's major roll will be;

- 1) financial arrangement both for local and foreign funds,
- 2) administration to conduct the detailed design and additional fields survey and investigation which would be carried out by selected consultant/s,
- 3) to perform the international tender including the pre-qualification,
- 4) to select tenderer/s and arrange contracts, and
- 5) to administrate and supervise the construction works.

2.4 Construction Plan

2.4.1 Basic Policy for Construction Execution

The following basic policy or approach is proposed to apply to conduct the various kind of construction works of the project taking into account the project scale with its work volume, site conditions, conditions for construction execution, and other factors affecting the execution of the works in the first stage.

- 1) to conduct the construction concurrently at Enkhilet and Hammam Sousse
- 2) to perform the construction works throughout the year, and to make concentration in dry and semi-dry season in February to August for Enkhilet and February to October for Hammam
- 3) to use excavated soil effectively
- 4) to use the borrowed soil for the levee embankment in case of shortage from the excavation
- 5) to use ready mixed concrete of existing factories
- 6) to ensure urban environment
- 7) to avoid adverse effect to tourists
- 8) to eliminate traffic congestion
- 9) to carried out reroute or renewal of crossing facilities by respective agencies concerned under budgeting by this project

2.4.2 Preparatory Works

Following preparatory works are required to provide and or carried out in initial stage of construction to commence the main construction works in timely and smoothly.

(1) Access and construction roads

No special off-site work is required to access to the site for mobilization of equipment since the construction sites of the Oued Enkhilet and the Oued Hammam situate in urbanized area and is accessible easily. However, temporary inner access roads will be required to provide for construction use.

(2) Electric power

The construction site is ready serving electric power with 220 V by STEG. Required power could be expanded from public distribution line at respective site in consultation with the STEG.

(3) Water supply

Water for construction use would be taken from river or lake by pump up, and be hauls to each work site by water tanker. Moistening treatment work at the earth fill sites would be main water supply work.

(4) Communication

Public telephone system is serving in the project site by PTT which could be expanded to the construction office in site.

(5) Temporary facilities

The following construction facilities will be required to provide by the contractor at site in Enkhilet and Hammam as contractor's base camp and temporary during the execution of construction works.

- site office
- warehouse
- repair shop and motor pool
- testing laboratory
- other incidentals

2.4.3 Oued Enkhilet

(1) General

The Oued Enkhilet and Sebkhet Ariana basin is located at the North of Greater Tunis, and the Oued Enkhilet itself situates at the West of this basin having 21 km of river length and 17.1 km² of catchment area. Sprolling or rapid urbanization is being progressing in this basin. The Oued Enkhilet is collecting water from other oueds and runs along the RVE-533 road, and flowing into the Sebkhet Ariana. Peak discharge of flood runoff into the Sebkhet Ariana at 100-year and 10-year return periods are 50 m³/s and 24 m³/s under present land use, and 80 m³/s and 40 m³/s for future land use.

MOEH is implementing the river improvement works for the Oued Enkhilet from the upstream reaches towards the downstream along the RVE-533 road since 1990. First and second phase have been completed in 1992 with the improved stretch length of 2,500 m approx. with DT2.2 million construction cost which mainly occupies by concrete pipes and rectangular culverts.

The following structure measures are planned for the flood protection of the Oued Enkhilet and Sebkhet Ariana in first stage.

- 1) improvement of Oued Enkhilet main of 2.7 km
- 2) canals improvement of 5.2 km, C1, C4, R2, G1, G1' and G2
- 3) construction of two (2) flood diversion channels at; Diversion Channel No.3 of 3.8 km by trapezoidal earth lining, and Diversion Channel No.4 of 288 m by concrete box culvert
- 4) retarding basins at 4 places; dam type Retarding Basin A and pond type Retarding Basins G, I and J1
- 5) construction of drainage sluices
- 6) relocate for crossing facilities such as bridges, sewers at GP 8, RV 533, RV 543 and canals

(2) River channel improvement

Oued Enkhilet main stream

The improvement length of Oued Enkhilet in first stage is 2.7 km approx. in total at downstream and upstream with the following stretches which locating in urbanized area.

<u>Stretch</u>	<u>Location</u>	<u>Type</u>	<u>Length</u>	<u>Bottom width.</u>
E-1	S.Ariana to C1 canal	trapezoidal earth	1,115 m	21 m
E-2	C1 canal to R2 canal	trapezoidal earth	1,095 m	9 m
E-11	R.basin I to C5 canal	box culvert	485 m	W2.2m*H2.0m

The proposed profile to improve the Oued Enkhilet is single river section having bottom width of 9.0 to 21.0 m and slope of 1 to 2 with sod facing. All the inspection road is provided at both banks. Major work items are river channel excavation, levee embankment, masonry, gabion and gravelling for the inspection roads.

Improvement works of E1 and E2 will be conducted from downstream towards upstream. Excavated soil at the channel will have to be used for the levee embankment material upon temporary stock for adjustment of moisture contents. Borrowed soil at TL-2 will be used as for the levee embankment in case of shortage from the channel excavation. Construction of box culvert at E11 would be carried out in parallel with E1 and E2 works by using ready mixed concrete. Balance of soil is as follows:

excavation at E1 and E2	: 39900 m3
embankment at E1 and E2	: 34700 m3
balance	:+ 5200 m3

The channel excavation and levee embankment would be carried out by a combination of 16 tons class swamp type bulldozer, 1.0 m3 class excavator, 10 tons class dump truck, 11 tons class bulldozer and 10 tons class vibration roller. The channel excavation at lower stretch will be carried out from the both right and left banks by long arm excavator. Excavated soil at channel hauls to temporary stockyards which will provide within 500 m distance, then filled for levee after moistening treatment. No dredging method is applied due to shortage of river flow.

Improvement for the Oued Enkhilet main would be scheduled in 1-year work period started with initial stage, and standard progress of excavation and embankment at E1 and E2 would be 30 m³/hr and 25 m³/hr.

Canals

The following six (6) canals are planned to be improved in the first stage. The profile of each canal is as follows.

<u>Profile</u>	<u>Type</u>	<u>Capacity</u> (m ³ /s)	<u>Length</u> (m)	<u>Bottom w.</u> (m)	<u>Slope</u>	<u>Exca.</u> (m ³)	<u>Embank.</u> (m ³)
C1	earth	22-16	1,573	4-11	1:2	21,500	22,900
R2	earth	12-8	918	2	1:2	2,600	protect
G1	earth	12	1,113	2	1:2	2,140	protect
G1'	earth	10	299	2	1:2	1,400	protect
G2	earth	7	1,255	2	1:2	3,030	protect
<u>Total:</u>			<u>5,158</u>			<u>30,670</u>	<u>22,900</u>

The C1 canal will be constructed firstly and to be connected with the downstream stretch of the Oued Enkhilet main stream. The construction of R2 and other canals (C4, G1, G1' and G2) will follow the C1 canal by shifting working crews. The levee embankment will be carried out by using excavated soils at these canals. Improvement works of canal excavation and embankment will be carried out by using light class equipment and manual power.

(3) Retarding basin

Two (2) types and four (4) numbers of retarding basins are provided at upstream of the Oued Enkhilet main stream adjacent to GP-8 national road. Proposed profile of these basins is as follows:

Retarding Basin A (dam type)

Location	: upstream of canal G2
Reservoir capacity	: 7,800 m ³
Dam type	: concrete wall dam
Dam height/crest length	: 4.5 m/40.0 m
Concrete volume	: 260 m ³

Retarding Basins G,I, and J1 (pond type)

<u>Basin</u>	<u>Location</u>	<u>Capacity</u> (m ³)	<u>Area</u> (ha)	<u>Exc. Vol.</u> (m ³)
G	Canal C4	17,400	0.66	25,600
I	Canal C4	22,500	1.45	42,700
J1	Canal C3	19,600	1.47	24,100
<u>Total:</u>		<u>59,500</u>	<u>3.58</u>	<u>92,400</u>

Concreting for Retarding Basin A will be done by using ready mixed concrete since six (6) factories are operating in Tunis. They are also serving transportation and placement of concrete by 3.0 m³ agitator truck and concrete pump car of 40 to 80 m³/hr capacity. Excavated soils at ponds, 92,400 m³ in total, will be utilized effectively by land reclamation and others after further study in detailed design stage.

Excavation works for retarding basins will be carried out in the order of G, I and J1 by combination of bulldozer of 11 to 20 tons class, crawler loader of 1.0 to 2.0 m³ class, dump truck of 10 tons class by shifting crew and equipment. Hauling distance of excavated material will be obtained within 2.5 km for land reclamation and other purposes.

Work period will be 4, 6 and 3 months for G, J and J1 basin respectively with a standard progress of excavation of 60 m³/hr by using the fleet mentioned above.

(4) Flood diversion channel

Flood diversion channel is planned at two (2) places that one is to be connected between S. Ariana and middle reach of Oued Enkhilet through existing canal Choutrana with 3.8 km long, and other one is to be connected between C1 canal and middle reach of Oued Enkhilet with the following profiles.

<u>No.</u>	<u>Type</u>	<u>Capacity</u> (m ³ /s)	<u>Length</u>	<u>Bottom w.</u> (m)	<u>Slope</u> (m)	<u>Exca.</u> (m ³)	<u>Embank.</u> (m ³)
3	earth lining d/s,	22.0	1,861	14	1:2	43,000	15,500
	earth lining u/s,	5.0	1,939	2	1:2	8,600	10,200
4	box culvert	16.0	288	(W3.4*H2.2)		5,800	1,130 (concrete)

The Diversion Channel No.4 will be constructed in parallel with the C1 canal improvement to connect to downstream stretch of the Oued Enkhilet via C1 canal. The Diversion Channel No.3 construction proceeds from the Sebkhiet Ariana and from connecting point with Choutrana canal separately toward upstream by 2 crews

providing a temporary access and construction road. One year work period will be required for Diversion Channel No.3 construction which will be carried out in 1997 dry season intensively. Excavated soil would be utilized effectively for land reclamation in and around construction area.

The works will be carried out by a combination of swamp type bulldozer of 16 tons class, excavator of 1.0 to 2.0 m³ class and dump truck of 10 tons class. A standard progress of excavation is assumed at 60 m³/hr.

(5) Crossing facilities

Public facilities crossing the rivers, canals, diversion channels are required to be shifted or to be renewed according to the improvement plan. These are road bridges, syphons, water supply pipes, electric distribution lines, telephone lines, sewers and other private facilities. The reroute or renewal works for these facilities will be carried out by respective agencies concerned under funding by this project, according to the MOEH. In this feasibility study stage, following information were given for budgeting purpose. Further investigation and study are required in the detailed design stage.

<u>Structures</u>	<u>First Stage</u>	<u>Second Stage</u>
<u>Bridge (under MOEH)</u>		
Oued Enkhilet	2-place RVE-543*1, W12 m*L50 m RVE-533*1, W12 m*L30 m	
Canal R2	5-place by box culvert W4.3m*H2.3m*L8m*4 W3.2m*H1.8m*L12m*1	
Canal G2	3-place by box culvert W2.4m*H1.7m*L8m*2 W2.2m*H1.5m*L8m*1	2-place by box culvert W1.8m*H1.3m*L8m*2
Canal G1	2-place by box culvert W4m*H2.1m*L17m*1 W3.6m*H2.1m*L8m*1	2-place by box culvert W3.6m*H2.1m*L8m*2
Canal G1'	1-place by box culvert W3.2m*H2.1m*L8m*1	
Diversion No.3	3-place, RC-T & culvert W12m*L43m*1 at RVE-543 W3m*H2.2m*L8m*1 W2.5m*H2.2m*L25m*1 at RVE-533	1-place box culvert W3.5m*H2.2m*L25*1

The Oued Hammam improvement plan amongs the improvement of the Oued Hammam, Laia and Kebir. The proposed improvement plan are stage-wised to first and second to protect for 10-year and 100-year probable floods, and its structure measure are summarized as follows.

First stage

- river improvement of Oued Hammam for 1.7 km in length for stretches H-1,2 & 3
- river improvement of Oued Laia for 250 m in length for stretch H-4
- river improvement of Oued Kebir for 2.5 km in length for stretches K-1,4 & 5
- bridge construction at 4 places on touristic road, GP-1 and MC-48 (2-place)
- construction of drainage sluices of 10 sets
- culverts construction at 2 sites

Second stage

- levee heightening in stretch H-2 & 3 of Oued Hammam
- widening bottom width to 20 m and levee heightening in stretch H-4 of Oued Laia
- widening bottom width to 18 m stretch K-1 of Oued Kebir
- widening bottom width to 17 m stretch K-4 of Oued Kebir
- widening bottom width to 12 m stretch K-5 of Oued Kebir

(2) River improvement

The construction sites of the Oueds Hammam and Kebir situate in urbanized or semi-urbanized area, and in agricultural area for the Oued Laia. Total improvement length of the first stage is about 4.5 km, and 1.7 km, 250 m and 2.5 km for the Oueds Hammam, Laia and Kebir respectively.

Proposed river section is a single section having the bottom width of 36 m to 33 m for the Oued Hammam, 8 m for the Oued Laia and 4.5 m to 6.5 m for the Oued Kebir in first stage improvement. Levee construction is required at the stretch of H-2, H-3, H-4 , K-1, K-4 and K-5 having slope of 1 to 2 with sod facing. Inspection road is provided on the levees for both banks with gravel metalling.

Major work items and its work quantities required for three (3) rivers improvement in the first stage are tabulated as follows:

stretch	length (m)	excavation channel (m3)	embankment levee (m3)	masonry (m3)	concrete (m3)
H-1 Hammam	572	15,100	-	2,000	-
H-2 Hammam	560	37,800	2,500	330	-
H-3 Hammam	565	18,700	2,600	270	-
H-4 Laia	250	1,900	2,600	60	-
K-1 Kebir	884	23,300	8,100	320	-
K-4 Kebir	84	1,600	700	290	-
K-5 Kebir	1,532	14,900	10,300	630	140
Total	4,447	116,000	27,400	4,000	140

Channel excavation

The excavation area in downstream stretches H-1, H-2 and H-3 of the Oued Hammam, are covered by bushes and small trees and swampy throughout the year. The upstream river channels of the Oueds Laia and Kebir are covered by bushes and dry condition in dry season and be used as roads. The channel excavation will be conducted from downstream towards upstream by several crews by step by step as shown in Fig.2.3.

Total work quantity of the channel excavation is estimated at 116,000 m³ in bank measure for all stretches of 3 rivers. The excavated soil at the channel will be used as the levee embankment material. Excessive soil from the excavation should be used effectively such as land reclamation in and around the construction sites.

In wet area of stretches H-1, H-2 and H-3, the channel excavation will be carried out by a combination of clamshell of 0.6 to 1.0 m³ class, 1.0 m³ long arm excavator and 10 tons dump truck. Excavation will be done from left and right banks. In dry area of upstream stretches H-4, K-1, K-4 and K-5, 1.0 m³ class excavator and 10 tons dump truck will be applied. Excavated soil will be stocked temporarily to treat for moistening before use as for levee fill material.

A standard progress of excavation would be 35 m³/hr in 28 months work period with condition that annual workable day of 283 days or 1,400 hours (283 x 5 hrs/day in net).

$$116,000 \text{ m}^3 / 1400 \text{ hr} \times 2.5 \text{ year} = 33 \rightarrow 35 \text{ m}^3/\text{hr}$$

Required number of equipment will be one (1) set for excavation and loading, and three (3) units for hauling dump truck to keep standard progress by assuming production rate of equipment as shown in Table 1-1.

Levee embankment

The levee embankment will be conducted in parallel with the channel excavation. Total levee embankment volume is estimated 27,400 m³ in bank measure. The source of embankment material is the soil from channel excavation and from borrow pits. Priority is to given to the excavated one from economical point of view. The proposed borrows situate between GP-1 and the confluence with the Oued Kebir and the distance to the levee embankment site is approximately 3.0 km. The soil characteristics of proposed borrows are summarized as follows:

<u>Location/Abbreviation</u>	<u>Type</u>	<u>Natural Moisture Contents (%)</u>	<u>Permeability Coefficients (cm/s)</u>
Left.bank, Hammam, SL-1	CL	7-12	5*10 ⁻⁵
Right.bank, Hammam, SL-2	CL(upper)	7-12	- ditto -
	SM(lower)	7-12	- ditto -
Right.bank, Hammam, SL-3	SP	6	5*10 ⁻³
Right.bank, Hammam, SL-4	SM	7-12	5*10 ⁻⁵

Drying treatment will be required for borrowed soils of SL-1, SL-2 and SL-4 which have higher moisture contents than their optimum ones. For SL-4, clay lining is recommended due to lower natural moisture contents and erodible nature.

Equipment combination of levee embankment would be 1.0 m³ class crawler loader at temporary stockyards of excavation work and or borrow pits for loading, 10 tons class dump truck for hauling, 11 tons class bulldozer and vibrating roller and 8 kl class water tanker for spreading and compaction works.

A standard progress of levee embankment will be 20 m³/hr in one year's net work period.

$$27,400 \text{ m}^3 / 1400 \text{ hr} = 19.6 \rightarrow 20 \text{ m}^3/\text{hr}$$

Masonry

Masonry works of 4,000 m³ in total work volume will be done by equipment and manual power following to the levee embankment.

Concrete

Ready mixed concrete will be utilized for the required concrete works since three (3) factories are being operated in Sousse of which hauling distance is 5 km to 20 km from the placing sites. They are serving transportation and placement with 3.0 m³ agitator trucks and 30 to 60 m³/hr concrete pumps. A mixture of 350 kg/m³ of concrete is as follows.

sand : 600 kgs, gravel G1(4mm-12 mm):640 kgs, gravel G2 (12 mm - 20 mm) : 660 kgs, cement : 350 kgs, water : 160 kgs.

(3) Bridge

Following to the river improvement, four (4) bridges of reinforced concrete and T-steel girder (RC-T) type are planned to be constructed in the first stage as tabulated below:

<u>River/Location</u>	<u>Newly/Renewal</u>	<u>Width</u> (m)	<u>Length</u> (m)
O.Hammam/touristic road	newly	26.0	84.0
O.Hammam/GP-1 road	newly	12.0	48.0
O.Kebir/MC-48	renewal	15.0	30.0
O.Kebir/MC-48	renewal	12.0	27.0

A construction order of 4 bridges will be touristic road first, GP-1 road second, and MC-48 bridges third, and concurrently considering present traffic, bridges dimensions and other factors. The work period assumes two and a half years for 4 bridges, two years for touristic road and GP-1 and a half year for MC-48 road bridges. The bridge construction works would be carried out under the control of MOEH.

(4) Drainage sluice

The construction of drainage sluice will be conducted after the completion of levee. Dimension of sluice is 1.5 m wide, 1.5 m high and 15.0 m long approximately. Numbers of sluice are 4 sets at the Oued Hammam, 2 sets at the Oued Laia and 4 sets at the Oued Kebir in the first stage.

(5) Crossing facilities

Same procedures are taken to construct crossing facilities in the Oued Enkhilet, and in the Oueds Hammam, Laia and Kebir.

2.5 Construction Time Schedule

(1) Time schedule

Fig.2.3 shows a proposed construction time schedule for the first stage of the project. The schedule was provided taking into account the following factors:

- to realize and to maximize the proposed flood protection measure in an early stage
- to minimize construction cost by shifting materials, gangs and equipment effectively
- weather
- to eliminate traffic congestion

The construction period is estimated at 30 months for the entire project. The works will be commenced from middle 1996 and be completed by the end of 1998. Pre-construction procedures such as clearance of financial arrangement, detailed design with additional survey and tendering, etc. are not included in the period.

Critical path work would be the construction of Diversion Channel No.3 of 3.8 km long approximately on the Oued Ennkhilet scheme, and four (4) bridges (each one set at touristic road and GP-1, and 2 sets for MC-48 road) construction on the Oued Hammam scheme.

(2) Milestone

Following to the proposed flood protection plan, the key milestones would be as follows.

Oued Ennkhilet:

* Construction or improvement of 1) downstream stretches of the Oued Ennkhilet main stream E1 and E2 --> Canal C1 --> Diversion Channel No.4 --> Canals G1 and G2 and Retarding Basin A, and 2) Canal Choutrana --> Diversion Channel No.3 --> upstream stretch of the Oued Ennkhilet main stream.

Completion time of these structures are proposed as follows.

<u>Location/Structure</u>	<u>Completion Time</u>
Downstream stretches, E1 & E2	: August 1997
Canal C1	: End 1996
Diversion Channel No.3	: August 1997
Diversion Channel No.4	: End 1996
Canal G2	: October 1997
Retarding Basin A	: End 1996
Upstream stretch, E11	: August 1997
Retarding Basin G	: May 1997
Retarding Basin I	: January 1998
Retarding Basin J1	: May 1998

Oued Hammam:

* Completion time of 4 bridges.

Touristic road bridge	: End August 1997
GP-1 road bridge	: End June 1998
MC-48 road bridges	: End December 1998

2.6 Conditions for Construction Execution

The following conditions and assumptions affecting the construction execution are taken into consideration in preparing the proposed construction plan and schedule. These conditions and assumptions were described referring to the results of the study and the field investigation made by the JICA Study Team.

2.6.1 Topography, Geology, Meteorology and Hydrology

Oued Enkhilet and Sebkhiet Ariana Basins

The Oued Enkhilet basin lies between 36°0' and 37°0' of north latitude, and 9°30' and 10°20' of east longitude. The Oued Enkhilet basin is largely divided into two topographical conditions, one is gentle sloped hills and the other is alluvial plain. Maximum height of hill is 240 m approx. above the sea level.

The geology of the hills consists of the marl, clay-stone, limestone, and their weathered soils. The alluvial plain consists of sand layer covered with clayey soil layer varying its thickness from a few tens cm to a few meters.

The monthly average mean temperature ranges 11.6 °C in January to 27.6 °C in August.

Average monthly relative humidity varies 61.3 % in July to 81.3 % in January at Tunis Carthage station. Monthly sunshine duration ranges 138.1 in January to 332.7 hours in July at Tunis Carthage.

The catchment area of the Oued Enkhilet and Sebkhet Ariana is 17.1 km² and 33.7 km² respectively. Mean annual rainfall in the Greater Tunis basin is about 380 mm to 540 mm. The average annual maximum daily rainfall in this basins varies 29 mm to 108 mm. The average monthly rainfall depth varies 5.2 mm in August to 83.3 mm in December at the Tunis-Carthage station that is near to the Oued Enkhilet basin.

Generally rainfall characteristics in Tunis is that it has heavy rainfall within few days in the beginning of rainy season, September to January, and not heavy but much rainfall with long duration in the end of rainy season.

As for water level of the Mediterranean Sea and the Sebkhet Ariana, it is found the sea level is +0.4 m and the water level of the sebkhet is +0.8 m.

Oued Hammam Basin

The Oued Hammam basin lies between 35°35' and 35°55' of north latitude, and 10°20' and 10°40' of east longitude. The Oued Hammam basin is located at northwestern and western region of the Greater Sousse with a catchment area of 222 km². The topography of Hammam Sousse basin is a flat alluvial plain developed between the Quaternary fluvial low hills undulated very gently. High hills are comparatively developed on the right bank and river mouth area.

The Oued Hammam basin consists the alluvial deposits of alternation of sand and clay layers of 10 - 15 m depth, and the fluvial deposits of the similar alternation of sand and clay layers below and both side hills. Some soft rock outcrops of the marl are found in the higher hills near the river mouth.

Average monthly mean temperature ranges 12.1 °C in January to 27.9 °C in August at Monastir stations. Average monthly relative humidity varies from 63.4 % in July to 72.4 % in January at Monastir station. Monthly sunshine duration ranges from 158.1 hours in December to 342.6 hours in July at Monastir station.

Catchment area of the Oued Hammam is 222 km². Mean annual rainfall in the Greater Sousse basin is 330 mm to 340 mm approximately. Average monthly rainfall depth is 1.1 mm in July and 64.7 mm in December at the Sousse station during 1986 to 1991.

2.6.2 Construction Contractor

MOEH takes registration system of contractors for the execution of the construction works handled and managed as public works. The registered contractors are divided into five (5) categories by their corresponding upper limit of contract amount.

For MOEH's hydraulic works, the number of registered contractors in category 5 (without limit of contract amount) is as follows as of December 1993.

General contractor	:	19 contractors
Pipe lying	:	23 contractors
Hydraulic structures	:	13 contractors
Drainage works	:	16 contractors
Large bridges	:	14 contractors

2.6.3 Labor Force

The following skilled or semi-skilled labor force will be required for execution of the construction works.

- foreman for civil works
- operator for construction equipment
- driver for vehicles
- mechanic
- electrician
- carpenter
- re-bar fixer
- mason
- form worker
- plumber

It seems that these kind of workers are available locally with satisfaction of capability and quantitatively without seasonal variation including common laborers. Most of skilled workers, such as heavy equipment operator, mechanic, electrician are being employed by general contractor. Common laborers are employed by the contractor via local government office in Ariana for present construction works (Dec. 1993) at the upstream the Oued Enkhilet under MOEH.

Working conditions under MOEH's public project are ;

- work in Sunday is prohibited by law.
- daily working time is 7:30 to 16:30 including 1.0 hour lunch time (8 hours/day in net).
- 48 hours per week including Saturday
- monthly minimum work time is 208 hours (26 days x 8 hrs/day)
- monthly maximum work time is 258 hours including over time of 50 hours as maximum by the decree in Tunisia.

2.6.4 Construction Material

Major construction materials required for the construction works other than embankment soil will be cement, aggregates, timber, fuel and lubricants, asphalt, reinforcement steel bar, structural steel and steel sheetpile. These materials could be procured at domestic market with enough quality and quantity. However, some materials not being produced in Tunisia, such as structural steel, lubricants and others are to be procured from abroad having sufficient delivery time for its procurement.

No concrete mixing plant would be required since concrete works in the project is small quantity. Ready mixed concrete is also available at Tunis and Hammam Sousse. At Tunis, six (6) ready mixed concrete factories are being operated, and it could be obtained within 20 km from the Ennkhilet site with sufficient quality and quantity from these factories.

While, river and or mountainous sand and quarried rock are being used as fine and coarse aggregates at ready mixed concrete factories both in Tunis and Sousse. In Sousse, rock quarry sites are far locating at Kairouan area in 80 km west of Sousse (IMC quarry, near Houareb dam). A limestone quarry near to the Oued Ennkhilet is operating having 3 sets of aggregate plants of 500 t/h, 200 t/h and 80 t/h and produces 0 to 40 mm size of aggregates. The aggregate price is DT4.0/m³ to DT7.0/m³ at the quarry site including tax. The bench cut method applies for the quarry development.

2.6.5 Construction Equipment

Recently, mechanized construction is broadly applied in public and private construction fields in Tunisia. No manufacturer exists for construction equipment in Tunisia. Accordingly, imported construction plant and equipment are obtainable from local market with its spare parts through local agents or dealers. Delivery time of fast

moving spare parts are acceptable, while longer period will be required for other spare parts. Most popular equipment in Tunisia is wheel type excavator, motor grader, rear dump truck and middle class bulldozer.

It seems that no lease company exists on construction plant and equipment. It is general information that the contractor who accepted or to wish the contract and have insufficient fleet negotiates and to borrow the required equipment from other contractor(s) with charge, according to the information by the governmental officials.

Maintenance and repair are being carried out by owned mechanic and electrician in regularly for owned equipment by contractor, rock quarry developer, ready mixed concrete factory owner. An overhaul of equipment orders to agent or dealer.

2.6.6 Workable Day

Annual workable day at the construction site of the Oueds Enkhilet and Hammam has been assumed as 271 and 283 days respectively.

2.6.7 Swell and Shrinkage Factors of Material

The following swell and shrinkage factors of materials are taken into consideration in studying the planning of construction equipment and manual works.

<u>Material</u>	<u>Loose/Bank</u>	<u>Compacted/Bank</u>
common soil	1.20	0.90
sand	1.20	0.95
weathered rock	1.30	1.15
hard rock	1.60	1.25

2.6.8 Hourly Production Rate of Construction Equipment

An hourly production rate of construction equipment was assumed as shown in Table 1.1 to estimate its required number within the work period.

2.6.9 Public Facilities

(1) Seaport and Airport

Two (2) major seaports locate in Tunis under OPNT (Office des Ports Nationaux Tunisiens, National Office of Port Tunisia) having sufficient capacity and facilities to

handle the cargoes. One is Tunis seaport which situates at west side of the South Tunis lake, and other one is port La Goulette which situates at east side of Tunis in the Gulf of Tunis. The distance to the junction of GP 8 and RVE533 is 10 km and 20 km from Tunis port and La Goulette port respectively for the handling of goods for the Enkhilet scheme, and is 140 km to the Hammam scheme.

The Tunis-Carthage international airport locates at east-north of central Tunis with 5 km of linear distance. In Sousse, Monastir international airport is available locating at east-east-south of central Sousse with 10 km of linear distance. The airports are under OPAT (Office des Ports Aeriens Tunisiens, Office of Tunisian Airports).

(2) Roadway/Railway

National highway of GP 8 and main connecting road of RVE533 run the Enkhilet and Ariana construction area. The effective width is 6.0 m and 5.0 m with shoulder of each 1.0 m for GP 8 and RV 533 respectively, paved by concrete and well maintained by MOEH.

National highway of GP 1 connecting Tunis and Sousse. In Sousse, Touristic road, GP 1, Bypass of GP 1 and MC 48 roads run in the construction site. These roads have enough width for equipment mobilization, and are well maintained by MOEH.

Two (2) railway systems are under services in Tunisia that one is in metro Tunis by STML (Societe Tunisienne du Metro Leger, Tunisian Company of Railway), and the other one is serving connecting major city of Tunisia including between Tunis and Sousse by SNCFT (Societe Nationale des Chemins de fer Tunisiens, National Tunisian Company of Railways).

(3) Water supply

The construction area are being served by piped water under SONEDE (Societe Nationale d'exploitation et de Distribution des Eoux, National Company of Exploitation and distribution of Water).

(4) Electricity/Gas

The construction area are being served by 220-v power supply by STEG (Societe Tunisienne d'Electricite et de Gaz, Tunisian Company for electricity and Gas) of the government agency.

(5) Communication

Public telephone system are well developed and serving at the project area by PTT (Poste Telegraphe Telephone) of the Government agency.

(6) Sewerage

Municipal sewerage in Tunis and Sousse is developed and maintained by ONAS (Office National d'Assainissement, National Office for Sewerage).

Table 2.1 Hourly Production Rate of Equipment (1/2)

(1) excavator/loader for excavation and loading

$$Q = (3600 * q * E) / C_m$$

where, Q=hourly production rate (m³/hr)
 q=exca. & loading volume per one cycle (m³)
 $q = 0.98 * q_1$, q_1 =bucket capacity
 E=work efficiency
 C_m=cycle time (sec)
 C_m=30 sec by 90 degree turn

equipment	q	E	C _m	Q
excavator, 1.0 m ³	0.98	0.5	30	60 m ³ /h
excavator, 0.6 m ³	0.59	0.5	30	35 m ³ /h
crawler loader, 1.0 m ³	0.98	0.6	25	85 m ³ /h
crawler loader, 2.0 m ³	1.96	0.6	30	140 m ³ /h

(2) bulldozer for excavation

$$Q = (60 * q * E) / C_m$$

where, Q=hourly production rate (m³/hr)
 q=excavation volume per one cycle (m³)
 $q=11 \text{ t} : 1.95 \text{ m}^3, 16 \text{ t (swamp)} : 2.93 \text{ m}^3, 21 \text{ t} : 4.33 \text{ m}^3$
 E=work efficiency
 C_m=cycle time (min.)
 $C_m = 0.038 * l + 0.2$
 l=length per excavation (m)=20 m

equipment	q	E	C _m	Q
bulldozer, 11 t	1.95	0.6	1.34	53 m ³ /h
swamp bulldozer, 16 t	2.93	0.6	1.34	80 m ³ /h
bulldozer, 21 t	4.33	0.6	1.34	116 m ³ /h

Table 2.1 Hourly Production Rate of Equipment (2/2)

(3) dump truck for hauling

$$Q = (60 \cdot q \cdot E) / C_m$$

where, Q=hourly hauling volume (m³)

q=hauling capacity of dump truck (m³), 0.55*ton

E=work efficiency

C_m=cycle time (min.)

C_m=xL + y

x=hauling coefficient, 4.6

L=hauling distance, 0.5 km

y=loading coefficient, 13 by crawler loader, 18 by backhoe excavator

equipment	q	E	C _m	Q
dump truck, 10 t (loading by crawler loader)	5.5	0.8	15.3	17 m ³ /h
dump truck, 10 t (loading by excavator)	5.5	0.8	20.3	13 m ³ /h
dump truck, 8 t (loading by crawler loader)	4.4	0.8	15.3	14 m ³ /h
dump truck, 8 t (loading by excavator)	4.4	0.8	20.3	10 m ³ /h
dump truck, 20 t (loading by crawler loader)	11.0	0.8	15.3	35 m ³ /h

(4) bulldozer and vibratory roller for compaction

$$Q = (V \cdot W \cdot D \cdot E) / N$$

where, Q=hourly production (m³/hr)

V=compaction speed (m/hr)

W=effective compaction width per one time (m)

D=thickness after compaction (m)

E=work efficiency

N=number of passage of compaction per layer

equipment	V	W	D	E	N	Q
bulldozer, 11t	3,500	0.7	0.3	0.6	6	74 m ³ /h
vibratory roller, 10 t	1,000	1.8	0.3	0.5	6	45 m ³ /h

Fig-2.1 Implementation Schedule, First Stage


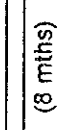
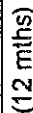
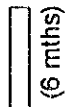
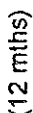




Descriptions	1st Year	2nd Year	3rd Year	4th Year	5th Year	Remarks
	1994	1995	1996	1997	1998	
I. Preconstruction Activities						
(1) Feasibility Study						
(2) Financial Arrangement						w/Selection of consultant
(3) Detailed Design w/add. Survey						w/ tender documents &
(4) Tender and Contract						P/Q for tenderer
(5) Land Acquisition						
II. Construction						
(1) Oued Enkhilet/Sebkhet Ariana						
(2) Oued Hammam						

Fig- 22 Implementation Organization

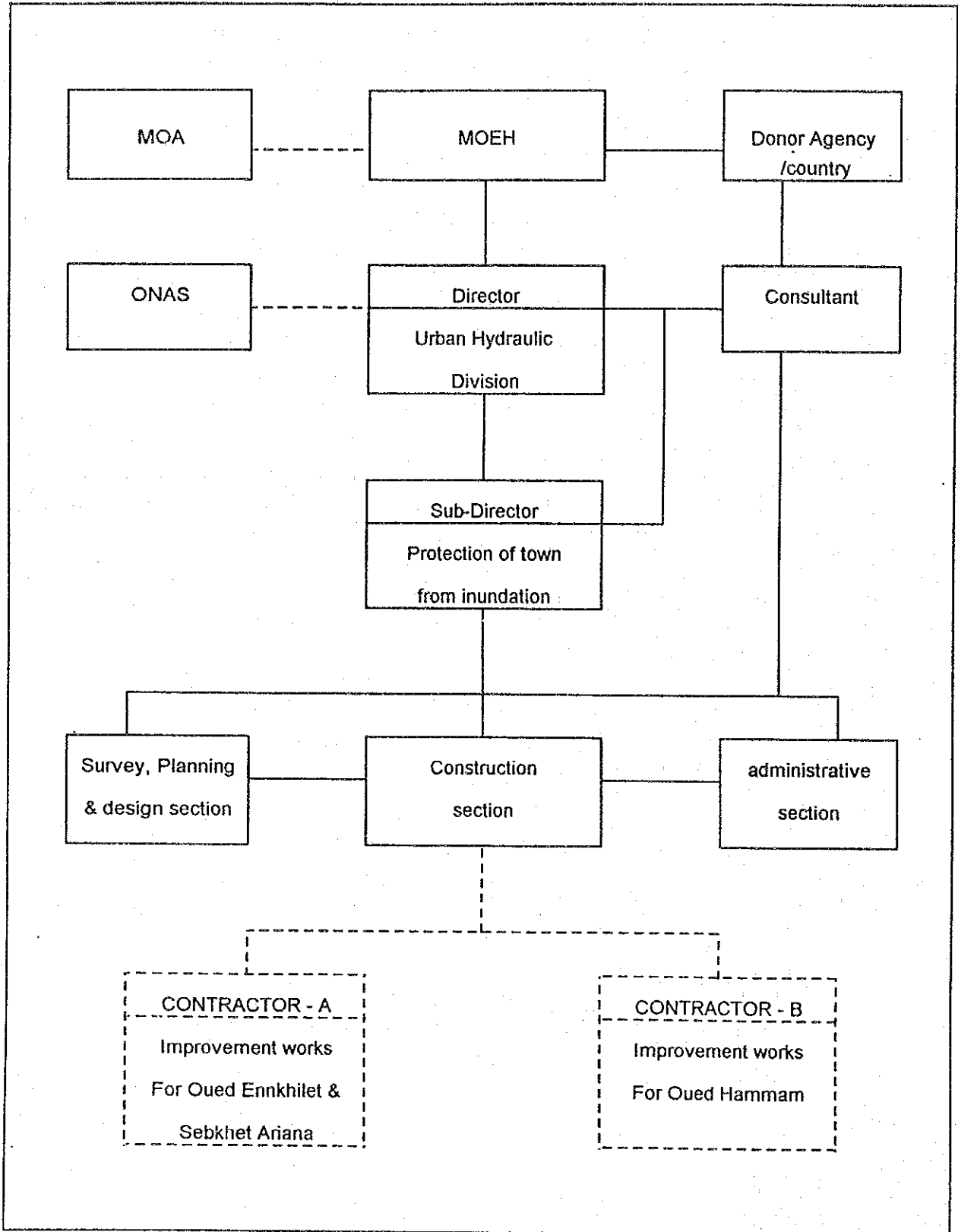


Fig-2.3 Construction Time Schedule, First Stage

Construction Work Items	Unit	Q'ty	1996												1997												1998											
			J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D						
1. Preparatory Works			[Shaded]																																			
2. Oued Ennkhilet			[Shaded]																																			
2.1 Oued Ennkhilet Main			[Shaded]																																			
- River Improvement	lin.m	2695	[Shaded]																																			
- Bridge, RVE-543 & 533	nos	2	[Shaded]																																			
- Drainage Sluice	nos	5	[Shaded]																																			
2.2 Canal, C1			[Shaded]																																			
- Canal Improvement	lin.m	1573	[Shaded]																																			
- Drainage Sluice	nos	5	[Shaded]																																			
2.3 Canal, R2			[Shaded]																																			
- Canal Improvement	lin.m	918	[Shaded]																																			
- Bridge (Culvert)	nos	5	[Shaded]																																			
2.4 Canal, G1			[Shaded]																																			
- Canal Improvement	lin.m	1113	[Shaded]																																			
- Bridge (Culvert)	nos	2	[Shaded]																																			
2.5 Canal, G2			[Shaded]																																			
- Canal Improvement	lin.m	1255	[Shaded]																																			
- Bridge (Culvert)	nos	3	[Shaded]																																			
2.6 Canal, G1'			[Shaded]																																			
- Canal Improvement	lin.m	299	[Shaded]																																			
- Bridge (Culvert)	nos	1	[Shaded]																																			
2.7 Flood Diversion N° 3 (trapezoidal earth lining)	lin.m	3800	[Shaded]																																			
- Diversion construction	nos	5	[Shaded]																																			
- Bridge, RVE-543, 533, Others	L.S	-	[Shaded]																																			
- ONAS Sewage Facilities reroute	nos	6	[Shaded]																																			
- Drainage Sluice	nos	6	[Shaded]																																			
2.8 Flood Diversion N° 4 (Box culvert)	lin.m	288	[Shaded]																																			
- Diversion construction			[Shaded]																																			
2.9 Retarding Basin A (Concrete Wall Dam)	cu.m	260	[Shaded]																																			
- Concrete			[Shaded]																																			
2.10 Retarding Basin G (Pond Type)	cu.m	25600	[Shaded]																																			
- Excavation			[Shaded]																																			
2.11 Retarding Basin I (Pond Type)	cu.m	42700	[Shaded]																																			
- Excavation			[Shaded]																																			
2.12 Retarding Basin J1 (Pond Type)	cu.m	24100	[Shaded]																																			
- Excavation			[Shaded]																																			
2.13 Other Crossing Facilities	L.s	-	[Shaded]																																			
3. Oued Hammam			[Shaded]																																			
3.1 Oued Hammam, Stretch H-1	lin.m	572	[Shaded]																																			
3.1 Oued Hammam, Stretch H-2	lin.m	560	[Shaded]																																			
3.1 Oued Hammam, Stretch H-3	lin.m	565	[Shaded]																																			
3.2 Oued Laya, Stretch H-4	lin.m	250	[Shaded]																																			
3.3 Oued Kebir, Stretch K-1	lin.m	884	[Shaded]																																			
3.3 Oued Kebir, Stretch K-4	lin.m	84	[Shaded]																																			
3.3 Oued Kebir, Stretch K-5	lin.m	1532	[Shaded]																																			
3.4 Bridge, touristic road	set	1	[Shaded]																																			
3.5 Bridge, GP-1	set	1	[Shaded]																																			
3.6 Bridge, MC-48	set	2	[Shaded]																																			
3.7 Other Crossing Facilities	L.s	-	[Shaded]																																			

Legend: [Shaded] : rainy season

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