Flood water level of the Sebkhet Ariana is simulated by applying the 100-yr probable flood. The simulation is conducted by flood routine method in conditions of the present river facilities and future land use. As a result, it is obvious that a maximum flood water level during the flood reaches at around El. 0.72 m with the existing outlet structures. This level is less than the assumed allowable flood water level of the Sebkhet Ariana (El. 0.8 m) which is judged from topographic map of 1/5000 scale, survey result for the Oued Ennkhilet and site reconnaissance. Also, it appears that it takes more than 200 years until the storage volume beneath the assumed initial water level of EL.0.4 m will be filled with sediment deposit. It is conceived that no flood damage in the surrounding area of the Sebkhet Ariana will occur under the above condition, therefore periodical maintenance is recommended at the outlet of the Sebkhet Ariana during rainy season.

(2) Oued Hammam

Through the comparative studies, river improvement works between the Touristic road and Bypass road of GP-1 on the Oued Hammam, on the lower reach of the Oued Kebir and the upper most stretches of the Oued Kebir are recommended to include the flood control plan for the Oued Hammam Basin. Considering the land use conditions and topographical conditions, further preliminary design for flood control plan is executed.

Basic design conditions and criterion described above are applied for the preparation of the flood control plan.

By applying the design criteria and flood runoff distribution, preliminary design and the construction volume estimate are executed for each canal. Figs.-33, -34 -41 and -42 show the general plan, longitudinal profile and typical cross sections of the selected river improvement plan respectively. Principal features are summarized in Table -4.

10) Flood Damage

(1) Oued Ennkhilet

Estimates the potential flood damage in flood prone areas of the Oued Ennkhilet was made. The evaluation is carried out for areas where the floods can be solely attributed to overflow from the oued, as well as those where the floods are due partly to water flows from the oued, but also to flows from other sources. The former (Zones A and B) are estimated at 359 ha, and the latter (Zones C, D, E and F) at 388 ha.

Flood damage has been assessed in categories related to residential, industrial, commercial and, agricultural areas; the analysis also considers the effect of flooding on roads and transport movements. Residential areas affected, particularly in the immediate vicinity of the oued, include large areas of spontaneous housing, which have lead to uncontrolled development of

public areas; and the fragmentation of property. A major consequence has been increased flooding due to drainage problems, and pollution of agricultural areas. Increasing urbanization is a phenomenon which is likely to carry on in the potentially floodable areas in the Ariana/Chotrana district, and is reflected in the rapid increase in residential lands at the expense of agricultural land. With regard to economic activities in the flood prone areas, a considerable number of commercial and industrial enterprises on the RVE 533 will be affected , and there will be a loss to agricultural crops. With regard to transportation, the main impact will be felt on the RVE 533, with secondary impact on traffic on the GP 8. Secondary roads will also be affected, particularly in Borj Louzir and Choutrana.

The major unquantifiable impact is the effect on health. Interviews with the Health Authorities indicate that flooding and stagnant water has not hitherto caused the contraction of any serious water-borne diseases among residential populations, but that this is a potential problem if drainage is not improved.

The various factors and coefficients used for estimating flood damage are summarized in Table -5. The evaluation of damages to the different sectors is based on land use for the areas under present and future conditions for the different zones as shown in Tables -6 and -7.

The impact of 100-yr flood conditions flooding on directly flooded areas (Zones A and B) is estimated to be TD5,493,000 under present, and TD32,069,000 under future land use conditions. The major impact of flooding will be reflected in damages to residential buildings, which are estimated at TD2,439,000 (61% of total damages) under present conditions, and TD23,104,000 (72% of total damages) in the future, reflecting the rapid urbanization of the area. Damages and losses in the transport sector are estimated at TD1,732,700 (32%) and TD4,836,600 (15%) in the future.

With regard to other areas, it is assumed that Zones C and D will be more directly affected in view of their proximity to the Oued Ennkhilet, than Zones E and F. It is assumed that 10 % of these damages are due to flooding from the Oued Ennkhilet. The major element of losses will be damage to buildings which represent 62% of all damages under present conditions, and 68% in the future. Road damages are estimated at 21% and 16% respectively.

Total flood damages caused by the Oued Ennkhilet in flood prone areas under 100-yr flood conditions are estimated as follows;

(Unit:TD)

Areas	Present Land Use	Future Land Use
Directly flooded areas	5,493,000	32,049,000
Indirectly flooded areas	773,000	1,707,000
Total:	6,266,000	33,776,000

Under 1-yr and 10-yr floods, damages are estimated as follows;

(Unit:TD)

Areas	Present Land Use		Future Land Use	
	1-yr	10-yr	1-yr	10-yr
Directly flooded areas	921,000	2,499,000	4,998,000	14,712,000
Indirectly flooded areas	133,000	331,000	346,000	885,000
Total:	1,054,000	2,830,000	5,344,000	15,597,000

(2) Oued Hammam

The areas affected by flooding in the Oued Hammam lie within the Communes of Hammam Sousse, Akouda, and Kalaa Kebira. The assessment of damages is estimated for different sections of the oued. The zone of influence of potential flooding will extend beyond the flood-prone areas since it will indirectly affect the populations in the Communes located in the vicinity. The population of the three Communes is expected to exceed 200,000 by the year 2020.

One of the major consequences will be the disruption to local and through traffic, in terms of delays through the flooding of roads. Estimates are made for the GP-1, the By-pass to the GP-1, and the RVE-845, and the MC-48. The methodology for estimating flood damage is based on impacts in the residential areas, industrial and commercial sectors, and agriculture. Estimates are made on the basis of a 100-year flood, under present and future land use conditions. Damage in residential areas are assessed in terms of income foregone, damage to buildings, and loss of household articles. Losses to industry and commercial enterprises are based on loss of income for workers, actual damage to the physical assets of a company. Losses to agriculture are based on damage to crops, notably olives and vegetables. Losses to transport are based on road damage, traffic delays, and additional vehicle operating costs due to diversion and operating on damaged surfaces. It is proposed that a bridge replace the crossing of the Oued Hammam on the RVE-845 Tourist road. This is costed at DT2.1 million.

There are a number of effects which have not been costed due to difficulties of quantification. These include health impacts, inconvenience and adverse publicity, particularly on tourism. A further potential hazard is the damage and disruption likely to be caused to the ONAS sewage treatment plant located at the side of the oued.

Given the different socio-economic mix of parts of the Oued Hammam, it is convenient to analyze the damage attributable to potential flooding in several distinct areas. For each case assessments are made on the basis of present and future land use conditions and in the context of a 100-yr flood, 10-yr flood and 1-yr flood. The various factors and coefficients used for estimating flood damage are summarized in Table -8. The land use characteristics of the flood prone areas in the zones are estimated under present and future characteristics as shown in Tables -9 and -10.

The overall potential damage likely to be caused in the Oued Hammam under a 100-year flood is estimated at DT6,805,000 under present land use conditions, and DT15,306,400 under future land use conditions. In a 10-yr probable flood damages are estimated at DT2,636,000 and DT6,244,000 respectively. The relevant assessment for a 1-yr flood are DT431,000 and DT952,000. Details by zone under a 100-yr flood are summarized in Table -11, and under 1-yr and 10-yr floods in Table -12. It can be seen from the table that nearly 80% of the damages occur in Zone A.

Under a 100-yr flood situation and in present land use conditions, nearly half (48%) of the losses arise from the transport sector, and 26% from the damage to residential buildings. Under future land use conditions, damage to residential buildings is the largest category (37%), while the losses from the transport sector account for 31% of flood damages.

11) Cost Estimate and Construction Plan

(1) Oued Ennkhilet

Project Cost

Flood control plans in the Oued Ennkhilet basin and surrounding basins have been formulated by the Tunisian government basically for the 10-yr flood, and some stretches have already been improved on this basis. Then flood control plan against the 10-yr flood is also adopted in this study for the first stage development considering the coincidence with the existing plan through the discussion and consultation among staff concerned. In addition to this, 100-yr flood that is often applied for the basic flood control plan at the major cities in foreign countries, is adopted for the future second stage development. The project financial costs for both stages were worked out as follows with its price level of January 1994.

Project Financial Cost of the Oued Ennkhilet Scheme

(unit : 1,000 DT)

Cost Items	1st Stage	2nd Stage
1. Direct construction cost	6,502	7,467
2. Land acquisition and compensation costs	3,738	0
3. Government's administration expenses	325	373
4. Engineering services expenses	975	1,120
5. Price contingency	1,712	-
6. Physical contingency	1,841	-
Total	15,094	8,960*

* : The contingency cost is not estimated since implementaion schedule of the 2nd stage can not be fixed yet.

Construction Plan and Schedule

First stage of the Oued Ennkhilet scheme is proposed to be implemented in four and a half years starting from 1994 to 1998, and second stage is assumed to be completed in indefinitive future.

The construction works will be conducted by selected contractor(s) through international competitive bidding, under financing by the Tunisian national budget and supporting loan from foreign donor country or agency. Hydraulic Division of MOEH will be the core of the project implementation.

Construction works should be conducted under the basic considerations, 1) to avoid adverse effect to tourists, 2) to ensure urban environment, and 3) to eliminate traffic congestion since the site is located in the urban area.

First stage construction works are scheduled to be completed within thirty months' total work period for the improvement of the Oued Ennkhilet main stretches, and construction of flood diversion channels and retarding basins. The works will be commenced from middle of 1996 after completing the clearance of pre-construction activities.

Improvement of the Ennkhilet main stretches (2.7 km) and the construction of Diversion Channel No.3 (3.8 km) will be carried out in parallel from downstream toward upstream in an initial stage. The works for main stretches and retarding basins and Diversion Channel No.4 will be done step by step by shifting crews and equipment. Public and crossing facilities will be relocated by respective agencies concerned with the budget of this project.

(2) Oued Hammam

Project Cost

The project financial cost for the Oued Hammam scheme has been worked out as follows with its price level of January 1994.

Project Financial Cost of the Oued Hammam Scheme

(unit : 1,000 DT)

Cost Items	1st Stage	2nd Stage
1. Direct construction cost	6,323	656
2. Land acquisition and compensation costs	362	0
3. Government's administration expenses	316	33
4. Engineering services expenses	948	98
5. Price contingency	1,228	-
6. Physical contingency	1,235	-
Total	10,413	787*

* : The contingency cost is not estimated since implementaion schedule of the 2nd stage can not be fixed yet.

Construction Plan and Schedule

First stage of the Oued Hammam scheme is proposed to be implemented in four and a half years starting from 1994. It includes the pre-construction activities, and actual construction works will require about thirty months starting from 1996. Second stage will be commenced indefinitive future with its construction period of two and a half years.

The construction works will be conducted by selected contractor(s) through international competitive bidding, under financing by the Tunisian national budget and supporting loan from foreign donor country or agency. Hydraulic Division of MOEH will be the core of the project implementation.

Since the project site is located at touristic zone, the construction works should be conducted in due consideration to avoid adverse effect, to ensure environment, to eliminate traffic congestion, and others.

Improvement works of main stretches in first stage (4.5 km in total) will be conducted from downstream toward upstream dividing into several working sections. In the lower stretch, swamp type equipment and clamshell will be required for the channel excavation. Bridges crossing the main roads such as Touristic road, GP 1 and MC 48, will be the critical path of this project. Due consideration is required to evade traffic congestion during the bridge construction.

12) Economic Evaluation

(1) Oued Ennkhilet

The implementation schedule of the second stage development for 100-yr flood control plan can not be fixed yet, so that the economic evaluation is carried out only for the first stage development for 10-yr flood control plan. The annual average benefit is defined as the reduction of probable flood damage under the with- and the without-project situations. On the basis of the estimated damages of each probable flood, annual average benefit for 10-yr probable flood was estimated to be DT1,447,000 in the present land use condition and to be DT7,721,000 in the future land use condition.

The economic costs of the project are nominal figures that duly reflect the true economic value of goods and services involved. Transfer items such as taxes and duties imposed on construction materials and equipment are excluded from the elements of financial cost. It is assumed that 10% of the financial construction cost is deemed as the transfer items. Then, economic cost of the Oued Ennkhilet flood control project for the 10-yr probable flood was estimated to be DT12,475,000.

Economic internal rate of return (EIRR) is introduced as an indicator of the economic evaluation and following assumptions are applied.

i) Project life is fixed for 50 years.

ii) Five (5) years from 1994 to 1998 are required for the implementation of project including pre-construction activities such as financial arrangement, detailed design, and tender and contract.

iii) Economic benefit is increased linearly from just after the completion of the first stage development to the year of 2020, and is constant after the year of 2020.

iv) 2.0 % of the direct construction cost is required for operation and maintenance cost.

On the basis of these assumptions, economic evaluation was executed and EIRR of 24.6 % was obtained for the Oued Ennkhilet flood control plan (Ref. to Table -13). In addition to this, sensitivity analysis was also carried out and the results are follows;

Case 1	Cost increase of 20 % ----------	EIRR=21.4 %
Case 2	Cost decrease of 20 % ----------	EIRR=29.1 %
Case 3	Benefit increase of 20 % ----------	EIRR=28.4 %
Case 4	Benefit decrease of 20 % ----------	EIRR=20.6 %
Case 5	Cost increase of 20 % and benefit decrease of 20 % -------	EIRR=18.0 %

Judging from the results of these evaluations, implementation of the flood control plan for the Oued Ennkhilet is considered economically feasible. EIRR in the Feasibility Study became higher than that of the Master Plan by the following reasons;

i) Construction cost was decreased by adopting the river diversion plan to the other river basin.

ii) It was clear that the flood water from the Oued Ennkhilet causes flood damage not only in the Oued Ennkhilet basin but also in the neighboring river basin. These flood damages could be counted as the benefit of the project.

(2) Oued Hammam

On the basis of the same assumption as described above, economic evaluation was executed. Annual average benefits for 10-yr probable flood are estimated to be DT1,015,000 in the present land use condition and to be DT2,328,000 in the future land use condition. And, economic cost of the Oued Hammam flood control project for the 10-yr probable flood is estimated to be DT8,368,000. EIRR of 17.4 % was obtained for the Oued Hammam flood control plan (Ref. to Table -14). In addition to this, sensitivity analysis was also carried out and the results are follows;

Case 1	Cost increase of 20 % ----------	EIRR=14.8 %
Case 2	Cost decrease of 20 % ----------	EIRR=21.4 %
Case 3	Benefit increase of 20 % ----------	EIRR=20.9 %
Case 4	Benefit decrease of 20 % ----------	EIRR=14.0 %
Case 5	Cost increase of 20 % and benefit decrease of 20 % -------	EIRR=11.9 %

Judging from the results of these evaluations, implementation of the flood control plan for the Oued Hammam is considered economically feasible.

6. Conclusions and Recommendations

1) Through the comparative studies on conceivable alternative plans of flood protection for the Oued Ennkhilet and the Oued Hammam, the following are finally selected as recommendable ones from technical and economical viewpoints.

Oued Ennkhilet

The case of "Combination of Diversion Channels No.3 and No.4, and Retarding basins A, G, I and J1". The project financial costs and economic internal rate of return (EIRR) are;

- The project financial cost for the first and second stages are estimated at;

First stage	: DT15,094,000.-
Second stage	: DT 8,960,000.-
Total	: DT24,054,000.-

- EIRR for the implementation of first stage work is calculated at 24.6 %.

Oued Hammam

The case of "River improvement works only between the Touristic road and Bypass road of GP-1 on the Oued Hammam, on the lower reach of the Oued Kebir and the upper-most stretches of the Oued Kebir." The project financial costs and EIRR are;

- The project financial cost for the first and second stages are estimated at;

First stage	: DT10,413,000.-
Second stage	: DT ,787,000.-
Total	: DT11,200,000.-

- EIRR for the implementation of first stage work is calculated at 17.4 %.

2) As a result of the study, it was confirmed that the flood protection plans proposed are technically sound and economically feasible. Then it is strongly recommended MOEH to take immediately necessary actions for further steps such as securing finance, land acquisition of proposed retarding basins and river stretches, and so forth. It is recommendable the first stage to be implemented in near future in view of urgency of such flood protection measures for these oueds.

TABLES

Table -1 Screening of Prospective Retarding Basin for Alternative Study

Number of Retarding Basin	Type	Catchment Area (km2)	Construction Cost of Retarding Basin (DT 1,000) (A)	Decreased River Improvement Cost by Retarding Basin (DT 1,000) (B)	Retarding Basin Cost less Decreased River Impro. Cost (DT 1,000) (C)=(A)-(B)	Costs Ratio (D)=(A)/(B)	Selected Retarding Basin	Remarks
Ain Snoussi	Dam	1.09	58.0	174.1	-116.1	0.33	Existing	Existing retarding basin constructed by the Ministry of Agriculture.
A	Dam	0.92	42.9	118.1	-75.2	0.36	O	It shows a high economic advantage.
B	Dam	1.11	741.8	82.6	659.2	8.98		It shows a low economic advantage.
C	Dam	0.21	123.2	8.7	114.5	14.16		It shows a low economic advantage.
D	Dam	1.02	251.5	33.3	218.2	7.55		It shows a low economic advantage.
E	Dam	0.2	114.0	18.0	96.0	6.33		It shows a low economic advantage.
F	Dam	0.25	84.2	22.3	61.9	3.78		It shows a low economic advantage.
G	Pond	1.62	467.9	1,486.9	-1,019.0	0.31	O	It shows a high economic advantage. Further study in combination with Retarding Basin I is required.
H	Pond	0.36	1,119.6	152.2	967.4	7.36		It shows a low economic advantage.
I	Pond	2.46	1,752.0	1,476.4	275.6	1.19	O	It shows a relatively high economic advantage. Further study in combination with Retarding Basins G, J1 and diversion plan is required.
J1	Pond	1.05	580.3	930.5	-350.2	0.62	O	It shows a high economic advantage. Further study in combination with Retarding Basin I and diversion plan is required.
J2	Pond	0.34	-	-	-	-		It is a prospective retarding basin site, however this site is discarded for alternative study because housing development at the site was commenced during the Study.
K	Pond	0.71	2,014.5	632.3	1,382.2	3.19		It shows a low economic advantage.
L	Pond	3.09	1,053.8	533.6	520.2	1.97	O	It shows a relatively high economic advantage. Further study in combination with Retarding Basin M, Ain Snoussi Dam and diversion plan is required.
M	Pond	1.93	460.4	197.4	263.0	2.33	O	It shows a relatively high economic advantage. Further study in combination with Retarding Basins A, L and diversion plan is required.
N1	Pond	1.92	1,170.8	119.4	1,051.4	9.81		It shows a low economic advantage.
N2	Pond	0.57	712.3	48.2	664.1	14.78		It shows a low economic advantage.

Table -2 Summary of Comparative Study on Alternative Plans

Alternative Plan	Direct Construction Cost + Land Acquisition Cost (1,000 DT)				Remarks	Ranking	
	River Improvement	Diversion	Retarding Basin	Total		Group	Total
River Improvement Plan							
1. Alt. Div. 0	9,659	0	0	9,659	Only River Impr.	(1)	9
Diversion + River Improvement Plan							
2. Alt. Div. 3	7,615	671	0	8,286	Div.3 + River Impr.	(4)	5
3. Alt. Div. 4	8,356	586	0	8,942	Div. 4 + River Impr.	(6)	7
4. Alt. Div. 5	8,450	597	0	9,047	Div. 5 + River Impr.	(7)	8
5. Alt. Div. 2 & 3	7,486	885	0	8,371	Div. 2 & 3 + River Impr.	(5)	6
6. Alt. Div. 3 & 4	6,689	1,168	0	7,857	Div. 3 & 4 + River Impr.	(2)	3
7. Alt. Div. 3 & 5	6,663	1,210	0	7,873	Div. 3 & 5 + River Impr.	(3)	4
8. Alt. Div. 3, 4 & 5	6,203	1,558	0	7,761	Div. 3, 4 & 5 + River Impr.	(1)	2
Retarding Basin + Diversion + River Improvement Plan							
9. Alt. U-1 + D-5	4,216	515	1,914	6,644	R.B-A,G,I&J1 + Div.3&4 + River Impr.		1
- Upstream Basin							
9.1 Alt. U-1	403	44	1,848	2,294	R.B-G,I&J1 + Div.3 + River Impr.	(1)	
9.2 Alt. U-2	403	509	1,421	2,333	R.B-G,I&J1 + Div.2&3 + River Impr.	(2)	
9.3 Alt. U-3	1,581	446	355	2,382	R.B-G + Div.3 + River Impr.	(3)	
- Downstream Basin							
9.4 Alt. D-1	3,451	0	1,169	4,621	R.B-A,L&M + River Impr.	(2)	
9.5 Alt. D-2	4,108	0	917	5,025	R.B-A&L + River Impr.	(6)	
9.6 Alt. D-3	3,552	421	917	4,890	R.B-A&L + Div.5 + River Impr.	(5)	
9.7 Alt. D-4	3,655	471	503	4,629	R.B-A&M + Div.4 + River Impr.	(3)	
9.8 Alt. D-5	3,813	471	66	4,350	R.B-A + Div.4 + River Impr.	(1)	
9.9 Alt. D-6	3,814	851	66	4,730	R.B-A + Div.4&5 + River Impr.	(4)	

Note : "River Impr." = River Improvement , "Div." = Diversion , "R.B" = Reatarding Basin

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (1/13)

Oued Ennkhilet Main

Stretch E-1 (from Sebkhet Ariana to junction with Canal C1)

First Stage

(1)	River improvement	Design discharge : 40 m3/s Type : trapezoidal earth-lining Bottom width : 21 m Length : 1,115 m Excavation : 25,700 m3 Embankment : 22,200 m3 Bank protection : 60 m on both bank
(2)	Bridge for RVE-543 Road	Width : 12 m Length : 50 m
(3)	Drainage Sluiceway	1 no

Second Stage

(1)	River improvement	Design discharge : 75 m3/s Type : trapezoidal earth-lining Bottom width : 40 m Length : 1,115 m Excavation : 21,200 m3

Stretch E-2 (from junction with Canal C1 to junction with Canal R2)

First Stage

(1)	River improvement	Design discharge : 24 m3/s Type : trapezoidal earth-lining Bottom width : 9 m Length : 1,095 m Excavation : 14,200 m3 Embankment : 12,500 m3 Bank protection : 70 m on both bank
(2)	Bridge for RVE-533 Road	Width : 12 m Length : 30 m
(3)	Drainage Sluiceway	4 nos

Second Stage

(1)	River improvement	Design discharge : 50 m3/s Type : trapezoidal earth-lining Bottom width : 20 m Length : 1,095 m Excavation : 18,100 m3

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (2/13)

Stretch E-3 (from junction with Canal R2 to junction with Canal N1)

First Stage	No river improvement
Second Stage	
(1) River improvement	Design discharge : 28 m3/s Length : 70 m Twin type of concrete box culvert width : 3.9 m & height : 2.7 m Excavation : 2,200 m3 Concrete : 570 m3

Stretch E-4 and E-5 (from junction with Canal N1 to junction with Canal G2)

First Stage	No river improvement
Second Stage	
(1) River improvement	Design discharge : 16 m3/s Length : 561 m Single type of concrete box culvert Width : 4.3 m & height : 2.7 m Excavation : 9,600 m3 Concrete: 2,700 m3

Stretch E-6 (from junction with Canal G2 to Diversion No.4)

First Stage	No river improvement
Second Stage	No river improvement

Stretch E-7 (from Diversion No.4 to Jct. with Canal G1)

First Stage	Included in Diversion No.4
Second Stage	Included in Diversion No.4

Stretch E-8 (from junction with Canal G1 to Diversion No.3)

First Stage	No river improvement
Second Stage	
(1) River improvement (To construct additional concrete box culvert)	Design discharge : 7 m3/s Existing culvert : 3.5 m3/s Additional culvert : 3.5 m3/s Length : 984 m Single type of concrete box culvert Width : 2.3 m & height : 1.6 m Excavation : 12,800 m3 Concrete : 2,800 m3

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (3/13)

Stretch E-9 (from Diversion No.3 to junction with Canal C3)

First Stage	No river improvement
Second Stage	
Downstream half	
(1) River improvement	Design discharge : 12 m3/s Length : 366 m Single type of concrete box culvert Width : 4.3 m & height : 2.2 m Excavation : 8,500 m3 Concrete : 1,650 m3
Upstream half	
(1) River improvement	Design discharge : 12 m3/s Length : 626 m Single type of concrete box culvert Width : 2.9 m & height : 2.2 m Excavation : 11,600 m3 Concrete : 2,250 m3

Stretch E-10 (from junction with Canal C3 to Retarding basin I under GP-8 Road)

First Stage	No river improvement
Second Stage	
(1) River improvement	Design discharge : 7 m3/s Length : 32 m Single type of concrete box culvert Width : 2.0 m & height : 2.2 m Excavation : 600 m3 Concrete : 125 m3

Stretch E-11 (from Retarding basin I to Jct. with Canal C5)

First Stage	
(1) River improvement	Design discharge : 7 m3/s Length : 485 m Single type of concrete box culvert Width : 2.2 m & height : 2.0 m Excavation : 7,300 m3 Concrete : 1,470 m3
Second Stage	
(1) River improvement (To construct additional concrete box culvert)	Design discharge : 14 m3/s First stage : 7 m3/s Additional culvert : 7 m3/s Length : 485 m Single type of concrete box culvert Width : 2.2 m & height : 2.0 m Excavation : 5,800 m3 Concrete : 1,470 m3

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (4/13)

Canal C1

Stretch C1-1 (from junction with Oued Ennkhilet to junction with Canal C2)

First Stage

(1)	River improvement	Design discharge : 22 m3/s Type : trapezoidal earth-lining Bottom width : 11 m Length : 535 m Excavation : 8,600 m3 Embankment : 8,700 m3 Bank protection : 30 m on both bank
(2)	Drainage Sluiceway	2 nos

Second Stage

(1)	River improvement	Design discharge : 35 m3/s Type : trapezoidal earth-lining Bottom width : 18 m Length : 535 m Excavation : 4,500 m3

Stretch C1-2 (from junction with Canal C2 to Diversion Route No.5)

First Stage

(1)	River improvement	Design discharge : 20 m3/s Type : trapezoidal earth-lining Bottom width : 10 m Length : 469 m Excavation : 6,300 m3 Embankment : 8,500 m3
(2)	Drainage Sluiceway	2 nos

Second Stage

(1)	River improvement	Design discharge : 35 m3/s Type : trapezoidal earth-lining Bottom width : 18 m Length : 469 m Excavation : 4,100 m3

Stretch C1-3 (from Diversion Route No.5 to junction with Diversion No.4)

First Stage

(1)	River improvement	Design discharge : 16 m3/s Type : trapezoidal earth-lining Bottom width : 4 m Length : 573 m Excavation : 6,600 m3 Embankment : 5,700 m3 Bank protection : 30 m on both bank

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (5/13)

(2)	Drainage Sluiceway	1 no
Second Stage		
(1)	River improvement	Design discharge : 35 m3/s Type : trapezoidal earth-lining Bottom width : 11 m Length : 573 m Excavation : 6,400 m3

Stretch C1-4 (from junction with Diversion No.4 to Upstream)

First Stage	No river improvement
Second Stage	No river improvement

Canal R2

Stretch R2-1 (from junction with Oued Ennkhilet to junction with Canal N2)

First Stage		
(1)	River improvement	Design discharge : 12 m3/s Type : trapezoidal earth-lining Bottom width : 2 m Length : 220 m Excavation : 600 m3 Bank protection : 30 m on both bank
Second Stage		
(1)	River improvement	Design discharge : 24 m3/s Type : rectangular concrete wall Bottom width : 6 m & height : 2.0 m Length : 220 m Excavation : 2,500 m3 Concrete : 660 m3

Stretch R2-2 Downstream (Downstream half between Jct. with Canal N2 and U/S end)

First Stage		
(1)	River improvement	Design discharge : 8 m3/s Type : trapezoidal earth-lining Bottom width : 2 m Length : 370 m Excavation : 1,000 m3 Bank protection : 80 m on both bank
(2)	Small bridge	Type : Concrete box culvert Width : 4.3 m & height : 2.3 m Length : 8 m 4 sites

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (6/13)

Second Stage		
(1)	River improvement	Design discharge : 16 m3/s Type : rectangular concrete wall Bottom width : 4.3 m & height : 2.0 m Length : 338 m Excavation : 3,200 m3 Concrete : 870 m3

Stretch R2-2 Upstream (Upstream half between junction. with Canal N2 and U/S end)

First Stage		
(1)	River improvement	Design discharge : 8 m3/s Type : trapezoidal earth-lining Bottom width : 2 m Length : 328 m Excavation : 1,000 m3 Bank protection : 10 m on both bank
(2)	Small bridge to quarry	Type : Concrete box culvert Width : 3.2 m & height : 1.8 m Length : 12 m 1 site
Second Stage		
(1)	River improvement	Design discharge : 16 m3/s Type : rectangular concrete wall Bottom width : 3.2 m & height : 1.5 m Length : 316 m Excavation : 2,100 m3 Concrete : 600 m3

Canal G2

Stretch G2-1 Downstream (D/S between junction with Ennkhilet and junction with tributary)

First Stage		
(1)	River improvement	Design discharge : 7 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 1.0m Length : 559 m Excavation : 1,600 m3 Bank protection : 20 m on both bank
(2)	Small bridge	Twin type of Concrete box culvert Width : 2.4 m & height : 1.7 m Length : 8 m 1 site

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (7/13)

Second Stage		
(1)	River improvement	Design discharge : 14 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 1.4 m Length : 559 m Excavation : 850 m3
Stretch G2-1 Midstream (M/S between junction with Ennkhilet and junction with tributary)		
First Stage		
(1)	River improvement	Design discharge : 7 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 0.9m Length : 499 m Excavation : 1,100 m3 Bank protection : 40 m on both bank
(2)	Small bridge	Twin type of concrete box culvert Width : 2.2 m & height : 1.5 m Length : 8 m 2 sites
Second Stage		
(1)	River improvement	Design discharge : 14 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 1.2 m Length : 499 m Excavation : 400 m3
Stretch G2-1 Upstream (U/S between junction with Ennkhilet and junction with tributary)		
First Stage		
(1)	River improvement	Design discharge : 7 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 0.8m Length : 197 m Excavation : 330 m3
Second Stage		
(1)	River improvement	Design discharge : 14 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 1.1 m Length : 197 m Excavation : 350 m3
Stretch G2-2 (from junction with tributary to upstream)		
First Stage		No river improvement
Second Stage		
(1)	Small bridge	Twin type of Concrete box culvert Width : 1.8 m & height : 1.3 m Length : 8 m

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (8/13)

Canal G1

Stretch G1-1 Downstream (D/S half between junction Ennkhilet and junction with Canal G1')

First Stage

(1)	River improvement	Design discharge : 12 m3/s Type : trapezoidal earth-lining Bottom width : 2 m Length : 890 m Excavation : 1,800 m3 Bank protection : 30 m on both bank
(2)	Bridge	Type : Concrete box culvert Width : 4.0 m & height : 2.1 m Length : 17 m 1 site

Second Stage

(1)	River improvement	Design discharge : 24 m3/s Type : rectangular concrete wall Bottom width : 4.0 m & height : 1.8 m Length : 873 m Excavation : 7,300 m3 Concrete : 2,000 m3

Stretch G1-1 Upstream (U/S half between junction Ennkhilet and junction with Canal G1')

First Stage

(1)	River improvement	Design discharge : 12 m3/s Type : trapezoidal earth-lining Bottom width : 2 m Length : 223 m Excavation : 340 m3 Bank protection : 20 m on both bank
(2)	Bridge	Type : Concrete box culvert Width : 3.6 m & height : 2.1 m Length : 8 m 1 site

Second Stage

(1)	River improvement	Design discharge : 24 m3/s Type : rectangular concrete wall Bottom width : 3.6 m & height : 1.8 m Length : 215 m Excavation : 1,800 m3 Concrete : 470 m3

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (9/13)

Stretch G1-2 (from junction with Canal G1' to GP-8)

First Stage		No river improvement
Second Stage		
(1)	River improvement	Design discharge : 12 m3/s Type : rectangular concrete wall Bottom width : 2.2 m & height : 1.8 m Length : 480 m Excavation : 4,900 m3 Concrete : 840 m3
(2)	Bridge	Type : Concrete box culvert Width : 2.2 m & height : 2.1 m Length : 8 m 2 site

Canal G1' (from junction with Canal G1 to GP-8)

First Stage		
(1)	River improvement	Design discharge : 10 m3/s Type : trapezoidal earth-lining Bottom width : 2 m Length : 299 m Excavation : 1,400 m3 Bank protection : 20 m on both bank
(2)	Bridge	Type : Concrete box culvert Width : 3.2 m & height : 2.1 m Length : 8 m 1 site
Second Stage		
(1)	River improvement	Design discharge : 20 m3/s Type : rectangular concrete wall Bottom width : 3.2 m & height : 1.8 m Length : 299 m Excavation : 2,400 m3 Concrete : 610 m3

Canal C4 (from Retarding Basin I to Retarding Basin G)

First Stage		No river improvement
Second Stage		
(1)	River improvement (To construct additional concrete box culvert)	Design discharge : 5 m3/s Existing culvert : 2.6 m3/s Additional culvert : 2.4 m3/s Length : 555 m Single type of concrete box culvert Width : 1.2 m & height : 1.2 m Excavation : 4,600 m3 Concrete : 1,050 m3

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (10/13)

Flood Diversion No.3

Stretch Div.3 D/S (from Sebkhet Ariana to junction with tributary)

First Stage

(1)	River improvement	Design discharge : 22 m3/s Type : trapezoidal earth-lining Bottom width : 14 m Length : 1,861 m Excavation : 43.000 m3 Embankment : 15,500 m3 Bank protection : 100 m on both bank
(2)	Bridge for RVE-543 Road	Width : 12 m Length : 43 m
(3)	Rehabilitation of ONAS Sewage Canal	Length : 50 m
(4)	Rehabilitation of ONAS Sewage Pipe	Length : 50 m
(5)	Drainage Sluiceway	4 nos

Second Stage

(1)	River improvement	Design discharge : 50 m3/s Type : trapezoidal earth-lining Bottom width : 34 m Length : 1,861 m Excavation : 53,000 m3

Stretch Div.3 U/S (from junction with tributary to junction with Oued Ennkhilet)

First Stage

(1)	River improvement	Design discharge : 5 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 1.3 m Length : 1,939 m Excavation : 8,600 m3 Embankment : 10,200 m3 Bank protection : 70 m on both bank
(2)	Small bridge	Twin type of concrete box culvert Width : 3.0 m & height : 2.2 m Length : 8 m 3 sites
(3)	Bridge for RVE-533 Road	Type : Concrete box culvert Width : 2.5 m & height : 2.2 m Length : 25 m
(4)	Drainage Sluiceway	2 nos

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (11/13)

Second Stage

(1)	River improvement	Design discharge : 12 m3/s Type : trapezoidal earth-lining Bottom width : 2 m & depth : 1.9 m Length : 1,939 m Excavation : 8,400 m3
(2)	Bridge for RVE-533 Road (Additional culvert)	Type : Concrete box culvert Width : 3.5 m & height : 2.2 m Length : 25 m

Flood Diversion No.4 (from junction with Canal C1 to junction with Oued Ennkhilet)

First Stage

(1)	River improvement	Design discharge : 16 m3/s Length : 288 m (incl. under RVE-533) Single type of concrete box culvert width : 3.4 m & height : 2.2m Excavation : 5,800 m3 Concrete : 1,130 m3

Second Stage

(1)	River improvement (To construct additional concrete box culvert)	Design discharge : 35 m3/s First stage : 16 m3/s Additional culvert : 19 m3/s Length : 288 m (incl. under RVE-533) Single type of concrete box culvert width : 3.8 m & height : 2.2m Excavation : 4,900 m3 Concrete : 1,200 m3

Retarding Basin - A

First Stage

(1)	Type	Concrete wall dam
(2)	Dimension	Dam crest elevation : EL.43.0 m Maximum storage volume : 7,800 m3 Dam height : 4.5 m Dam crest length : 40 m Orifice size : 0.2 m x 0.2 m
(3)	Work Volume	Excavation volume : 1,100 m3 Concrete volume : 260 m3 Screen weight : 1.2 ton
(4)	Hydraulic Design	Peak discharge of inflow (10-yr) : 5.4 m3/s Peak discharge of outflow (10-yr) : 0.2 m3/s Maximum water level : EL.41.5 m

Second Stage

(1)	Extension Work	Extension of Orifice
(2)	Dimension	Orifice size : 0.6 m x 0.6 m
(3)	Hydraulic Design	Peak discharge of inflow (100-yr) : 10.9 m3/s Peak discharge of outflow (100-yr) : 1.9 m3/s Maximum water level : EL.42.6 m

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (12/13)

Retarding Basin - G		
First Stage		
(1)	Type	Pond type
(2)	Dimension	Pond area : 0.66 ha
		Maximum storage volume : 17,400 m3
		Pond bed elevation : EL.16.7 m
		Average pond height : 5.3 m
		Orifice size : 0.55 m x 0.55 m
(3)	Work Volume	Excavation volume : 25,600 m3
		Concrete volume : 40 m3
		Screen weight : 1.4 ton
(4)	Hydraulic Design	Peak discharge of inflow (10-yr) : 9.3 m3/s
		Peak discharge of outflow (10-yr) : 1.5 m3/s
		Maximum water level : EL.20.7 m
Second Stage		
(1)	Extension Work	Extension of pond and construction of new outlet structure with same dimension as in the first stage
(2)	Dimension	Pond area : 1.26 ha
		Maximum storage volume : 37,500 m3
		Pond bed elevation : EL.16.7 m
		Average pond height : 5.2 m
		Orifice size : 0.55 m x 0.55 m
(3)	Work Volume	Excavation volume : 27,600 m3
		Concrete volume : 40 m3
		Screen weight : 1.4 ton
(4)	Hydraulic Design	Peak discharge of inflow (100-yr) : 18.9 m3/s
		Peak discharge of outflow (100-yr) : 2.8 m3/s
		Maximum water level : EL.20.7 m
Retarding Basin - I		
First Stage		
(1)	Type	Pond type
(2)	Dimension	Pond area : 1.45 ha
		Maximum storage volume : 22,500 m3
		Pond bed elevation : EL.7.1 m
		Average pond height : 3.3 m
		Orifice size : 0.6 m x 0.6 m
(3)	Work Volume	Excavation volume : 42,700 m3
		Concrete volume : 30 m3
		Screen weight : 0.8 ton
(4)	Hydraulic Design	Peak discharge of inflow (10-yr) : 5.8 m3/s
		Peak discharge of outflow (10-yr) : 1.2 m3/s
		Maximum water level : EL.9.0 m
Second Stage		
(1)	Extension Work	Extension of orifice
(2)	Dimension	Orifice size : 1.7 m x 1.7 m
(3)	Hydraulic Design	Peak discharge of inflow (100-yr) : 11.6 m3/s
		Peak discharge of outflow (100-yr) : 6.6 m3/s
		Maximum water level : EL.9.0 m

to be continued

Table -3 Principal Features of River Improvement for the Oued Ennkhilet (13/13)

Retarding Basin - J1

First Stage		
(1)	Type	Pond type
(2)	Dimension	Pond area : 1.47 ha
		Maximum storage volume : 19,600 m3
		Pond bed elevation : EL.7.2 m
		Average pond height : 2.8 m
		Orifice size : 0.4 m x 0.4 m
(3)	Work Volume	Excavation volume : 24,100 m3
		Concrete volume : 80 m3
		Screen weight : 0.7 ton
(4)	Hydraulic Design	Peak discharge of inflow (10-yr) : 7.6 m3/s
		Peak discharge of outflow (10-yr) : 0.5 m3/s
		Maximum water level : EL.8.7 m
Second Stage		
(1)	Extension Work	Extension of Pond & orifice
(2)	Dimension	Pond area : 2.35 ha
		Maximum storage volume : 32,100 m3
		Pond bed elevation : EL.7.2 m
		Average pond height : 2.8 m
		Orifice size : 1.4 m x 1.4 m
(3)	Work Volume	Excavation volume : 15,200 m3
(4)	Hydraulic Design	Peak discharge of inflow (100-yr) : 15.5 m3/s
		Peak discharge of outflow (100-yr) : 3.9 m3/s
		Maximum water level : EL.8.7 m

Table -4 Principal Features of River Improvement for the Oued Hammam (1/3)

Stretch H-1 (Oued Hammam from river mouth to GP-1 Road)

First Stage

(1)	River improvement	Design discharge : 200 m^3/s Bottom width : 36 m Length : 572 m Excavation : 15,100 m^3 Bank protection : 300 m on both bank
(2)	Bridge for Touristic Road	Width : 26 m Length : 84 m

Stretch H-2 (Oued Hammam from GP-1 Road to Bypass Road of GP-1 Road)

First Stage

(1)	River improvement	Design discharge : 90 m^3/s Bottom width : 33 m Length : 560 m Excavation : 37,800 m^3 Embankment of dike : 2,500 m^3 Bank protection : 60 m on both bank
(2)	Bridge for GP-1 Road	Width : 12 m Length : 48 m
(3)	Drainage Sluiceway	2 nos

Second Stage

(1)	River improvement	Design discharge : 200 m^3/s Length : 560 m Embankment of dike : 4,600 m^3

Stretch H-3 (Oued Hammam from Bypass Road of GP-1 to Junction with Oued Kebir)

First Stage

(1)	River improvement	Design discharge : 90 m^3/s Bottom width : 33 m Length : 565 m Excavation : 18,700 m^3 Embankment of dike : 2,600 m^3 Bank protection : 50 m on both bank
(2)	Drainage Sluiceway	2 nos

Second Stage

(1)	River improvement	Design discharge : 200 m^3/s Length : 565 m Embankment of dike : 3,800 m^3

to be continued

Table -4 Principal Features of River Improvement for the Oued Hammam (2/3)

Stretch H-4 (Oued Laia from Junction with Oued Kebir to Upstream)

First Stage

(1)	River improvement	Design discharge : 65 m^3/s Bottom width : 8 m Length : 250 m Excavation : 1,900 m^3 Embankment of dike : 2,600 m^3 Bank protection : 30 m on both bank
(2)	Drainage Sluiceway	2 nos

Second Stage

(1)	River improvement	Design discharge : 140 m^3/s Bottom width : 20 m Length : 250 m Excavation : 2,700 m^3

Stretch K-1 (Oued Kebir from Junction with Oued Hammam to MC-48 Road)

First Stage

(1)	River improvement	Design discharge : 60 m^3/s Bottom width : 7 m Length : 884 m Excavation : 23,300 m^3 Embankment of dike : 8,100 m^3 Bank protection : 60 m on both bank
(2)	Bridge for MC-48 Road	Width : 15 m Length : 30 m
(3)	Drainage Sluiceway	2 nos

Second Stage

(1)	River improvement	Design discharge : 130 m^3/s Bottom width : 18 m Length : 884 m Excavation : 22,300 m^3

Stretch K-4 (Oued Kebir from Railway to Junction with Oued Seghir)

First Stage

(1)	River improvement	Design discharge : 45 m^3/s Bottom width : 6.5 m Length : 84 m Excavation : 1,600 m^3 Embankment of dike : 700 m^3 Bank protection : 60 m on both bank
(2)	Bridge for MC-48 Road	Width : 12 m Length : 27 m

to be continued

Table -4 Principal Features of River Improvement for the Oued Hammam (3/3)

Second Stage		
(1)	River improvement	Design discharge : 100 m^3/s Bottom width : 17 m Length : 84 m Excavation : 600 m^3
Stretch K-5 (Oued Kebir from Junction with Oued Seghir to Upstream)		
First Stage		
(1)	River improvement	Design discharge : 35 m^3/s Bottom width : 4.5 m Length : 1,532 m Excavation : 14,900 m^3 Embankment of dike : 10,300 m^3 Bank protection : 130 m on both bank
(2)	Culvert for Small Road	Twin type, width : 4 m & height : 2.6 m Length : 8 m 2 site
(3)	Drainage Sluiceway	2 nos
Second Stage		
(1)	River improvement	Design discharge : 75 m^3/s Bottom width : 12 m Length : 1,532 m Excavation : 21,300 m^3 Bank protection : 100 m on both bank
(2)	Culvert for Small Road to add existing culverts	Single type, width : 4 m & height : 2.6 m Length : 8 m Number : 10 nos (5 site on both banks)

Table-5 Summary of Coefficients Used to Estimated Flood Damage

(Unit: DT)

Category	Coefficient	
	Future (1993)	Future (2020)
1. Residential Areas		
(i) Damage to Buildings		
* Popular/Spontaneous Housing	15/m2	15/m2
* Medium Standard	25/m2	25/m2
* High Standard	35/m2	35/m2
(ii) Damage to Household Articles (per household)	350	350
(iii) Loss of Income to Households (DT per day)		
* Skilled	16	67
* Unskilled	5	22
2. Industrial Sector		
(i) Damage to Buildings	15/m2	15/m2
(ii) Loss of Income to Workers		(as per households)
3. Agricultural Sector (per hectare)		
(i) Value of Olive Crops	1,600	1,600
(ii) Value of Vegetable Crops	1,800	1,800
(iii) Average Loss per ha	1,750	1,750
4. Transport		
(i) Rehabilitation of Roads (per km)		
* Primary	120,000	120,000
* Secondary	80,000	80,000
* Agricultural Roads	25,000	25,000
(ii) Traffic Delays/Value of Time (DT per hour)		
* Skilled Labour	0.50	2.10
* Unskilled Labour	0.16	0.70
* Tourists	1.00	4.00
(iii) Additional Vehicle Operating Costs (DT per 1,000 km)		
* Private Cars/taxis	28.79	28.79
* Buses	51.60	51.60
* Light/Medium trucks	86.11	86.11
* Heavy trucks	236.73	236.73

Table 6 Oued Ennkhilet - Estimated Land Use in the Flood Prone Areas under Present Land Use Conditions

(Unit: ha)

	Zones					
Land Use	A	B	C	D	E	F
Residential	44.0	41.0	32.0	46.0	25.0	0.0
Agricultural	65.0	66.0	0.0	16.0	75.0	32.0
Commercial	2.0	0.0	0.0	0.0	0.0	0.0
Recreational	0.0	0.0	0.0	0.0	0.0	0.0
Wetlands	0.0	7.0	0.0	15.0	0.0	42.0
Open Space	6.0	124.0	32.0	51.0	0.0	18.0
Infrastructure (schools)	0.0	4.0	4.0	0.0	0.0	0.0
Total:	117.0	242.0	68.0	128.0	100.0	92.0

Table 7 Oued Ennkhilet - Estimated Land Use in the Flood Prone Areas under Future Land Use Conditions

(Unit: ha)

	Zones					
Land Use	A	B	C	D	E	F
Residential	112.0	127.0	64.0	57.0	53.0	0.0
Agricultural	0.0	32.0	0.0	0.0	0.0	14.0
Commercial	3.0	0.0	0.0	0.0	0.0	0.0
Recreational	0.5	1.2	0.0	0.0	7.0	0.0
Wetlands	0.0	40.0	0.0	38.0	40.0	28.0
Open Space	1.0	40.0	0.0	24.0	0.0	50.0
Infrastructure (schools)	0.5	1.8	4.0	9.0	0.0	0.0
Total:	117.0	242.0	68.0	128.0	100.0	92.0

Table-8 Summary of Coefficients Used to Estimated Flood Damage

(Unit: DT)

Category	Coefficient	
	Future (1993)	Future (2020)
1. Residential Areas		
(i) Damage to Buildings		
* Popular/Spontaneous Housing	15/m2	15/m2
* Medium Standard	25/m2	25/m2
(ii) Damage to Household Articles (per household)	350	350
(iii) Loss of Income to Households (DT per day)		
* Skilled	16	67
* Unskilled	5	22
2. Industrial Sector		
(i) Damage to Buildings	15/m2	15/m2
(ii) Loss of Income to Workers		(as per households)
3. Agricultural Sector (per hectare)		
(i) Value of Olive Crops	1,600	1,600
(ii) Value of Vegetable Crops	1,200	1,200
4. Transport		
(i) Rehabilitation of Roads (per km)		
* Primary	120,000	120,000
* Secondary	80,000	80,000
* Agricultural Roads	25,000	25,000
(ii) Traffic Delays/Value of Time (DT per hour)		
* Skilled Labour	0.50	2.10
* Unskilled Labour	0.16	0.70
* Tourists	1.00	4.00
(iii) Additional Vehicle Operating Costs (DT per 1,000 km)		
* Private Cars/taxis	28.79	28.79
* Buses	51.60	51.60
* Light/Medium trucks	86.11	86.11
* Heavy trucks	236.73	236.73

Table-9 Oued Hammam - Present Land Use Characteristics

(Unit: ha)

Land Use	Zones						
	A	B	C	D	E	F	G
Agricultural	107	23	25	13	5	12	5
Urban	30	10	3	0	1	1	1
Open	16	6	10	6	5	3	6
Total:	153	39	38	19	11	16	12

Table-10 Oued Hammam - Future Land Use Characteristics

(Unit: ha)

Land Use	Zones						
	A	B	C	D	E	F	G
Agricultural	74	20	25	15	7	13	5
Urban	70	16	6	0	3	1	2
Open	16	6	10	6	5	3	6
Total:	160	42	41	21	15	17	13

Table-11 Oued Hamman - Evaluation of Flood Damage in the Flood Prone Areas (100-yr Flood)

(Unit: DT1,000)

Zone	Present Land Use	Future Land Use
A	5,405.0	12,530.0
B	845.7	1,296.4
C	264.6	745.5
D	30.0	34.5
E	111.0	409.0
F	69.5	73.0
G	79.0	218.0
Total:	6,804.8	15,306.4

Table-12 Oued Hamman - Evaluation of Flood Damage in Flood Prone Areas, (1-yr and 10-yr Floods)

(Unit: DT1,000)

Area	Present Land Use Condition		Future Land Use Condition	
	1-yr	10-yr	1-yr	10-yr
A	261	2,030	498	4,993
B	75	459	84	771
C	57	66	250	261
D	0	5	0	7
E	10	20	40	72
F	5	10	5	13
G	23	46	75	127
Total:	431	2,636	952	6,244

Table-13 Cost Benefit Streams for Oued Ennkhilet Flood Control Project

EIRR = 24.6% (Unit : 1,000 DT)

No.	Year	Cost			Benefit	Net Benefit
		Construction	O&M	Total		
1	1994	19	0	19	0	-19
2	1995	4,666	0	4,666	0	-4,666
3	1996	1,673	23	1,696	663	-1,033
4	1997	3,732	82	3,814	1,327	-2,487
5	1998	2,385	117	2,502	1,990	-512
6	1999		117	117	2,653	2,536
7	2000		117	117	2,894	2,777
8	2001		117	117	3,136	3,019
9	2002		117	117	3,377	3,260
10	2003		117	117	3,618	3,501
11	2004		117	117	3,860	3,743
12	2005		117	117	4,101	3,984
13	2006		117	117	4,342	4,225
14	2007		117	117	4,584	4,467
15	2008		117	117	4,825	4,708
16	2009		117	117	5,066	4,949
17	2010		117	117	5,307	5,190
18	2011		117	117	5,549	5,432
19	2012		117	117	5,790	5,673
20	2013		117	117	6,031	5,914
21	2014		117	117	6,273	6,156
22	2015		117	117	6,514	6,397
23	2016		117	117	6,755	6,638
24	2017		117	117	6,997	6,880
25	2018		117	117	7,238	7,121
26	2019		117	117	7,479	7,362
27	2020		117	117	7,720	7,603
28	2021		117	117	7,720	7,603
29	2022		117	117	7,720	7,603
30	2023		117	117	7,720	7,603
31	2024		117	117	7,720	7,603
32	2025		117	117	7,720	7,603
33	2026		117	117	7,720	7,603
34	2027		117	117	7,720	7,603
35	2028		117	117	7,720	7,603
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50	2043		117	117	7,720	7,603

Table-14 Cost Benefit Streams for Oued Hammam Flood Control Project

EIRR = 17.4% (Unit : 1,000 DT)

No.	Year	Cost			Benefit	Net Benefit
		Construction	O&M	Total		
1	1994	18	0	18	0	-18
2	1995	774	0	774	0	-774
3	1996	1,627	23	1,650	317	-1,333
4	1997	3,629	80	3,709	634	-3,075
5	1998	2,320	114	2,434	951	-1,483
6	1999		114	114	1,268	1,154
7	2000		114	114	1,318	1,204
8	2001		114	114	1,369	1,255
9	2002		114	114	1,419	1,305
10	2003		114	114	1,470	1,356
11	2004		114	114	1,520	1,406
12	2005		114	114	1,571	1,457
13	2006		114	114	1,621	1,507
14	2007		114	114	1,672	1,558
15	2008		114	114	1,722	1,608
16	2009		114	114	1,773	1,659
17	2010		114	114	1,823	1,709
18	2011		114	114	1,874	1,760
19	2012		114	114	1,924	1,810
20	2013		114	114	1,975	1,861
21	2014		114	114	2,025	1,911
22	2015		114	114	2,076	1,962
23	2016		114	114	2,126	2,012
24	2017		114	114	2,177	2,063
25	2018		114	114	2,227	2,113
26	2019		114	114	2,278	2,164
27	2020		114	114	2,328	2,214
28	2021		114	114	2,328	2,214
29	2022		114	114	2,328	2,214
30	2023		114	114	2,328	2,214
31	2024		114	114	2,328	2,214
32	2025		114	114	2,328	2,214
33	2026		114	114	2,328	2,214
34	2027		114	114	2,328	2,214
35	2028		114	114	2,328	2,214
.	.		.	.	.	.
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.	.		.	.	.	.
50	2043		114	114	2,328	2,214

FIGURES

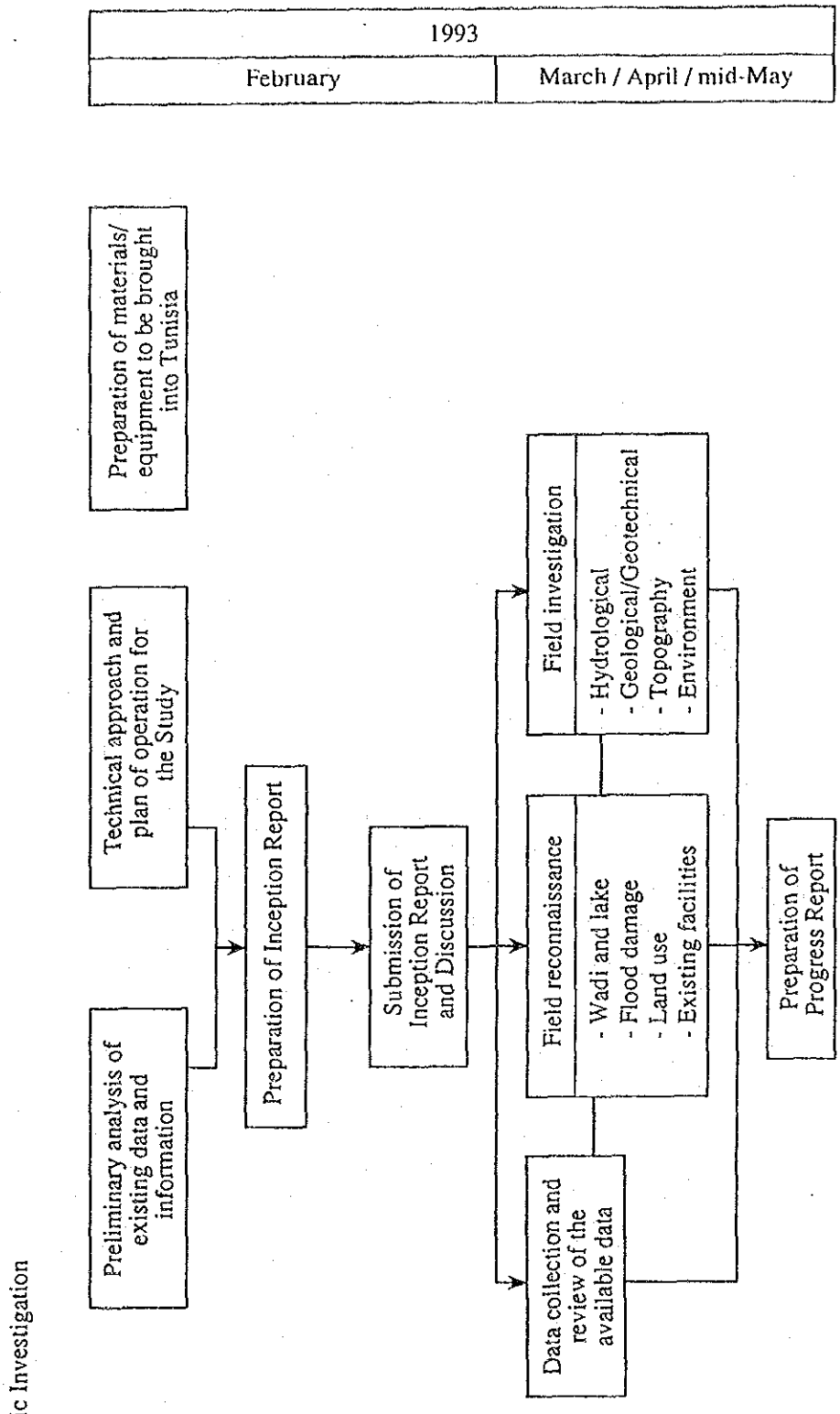

Fig.-1 Work Flow Chart of the Study (1/3)

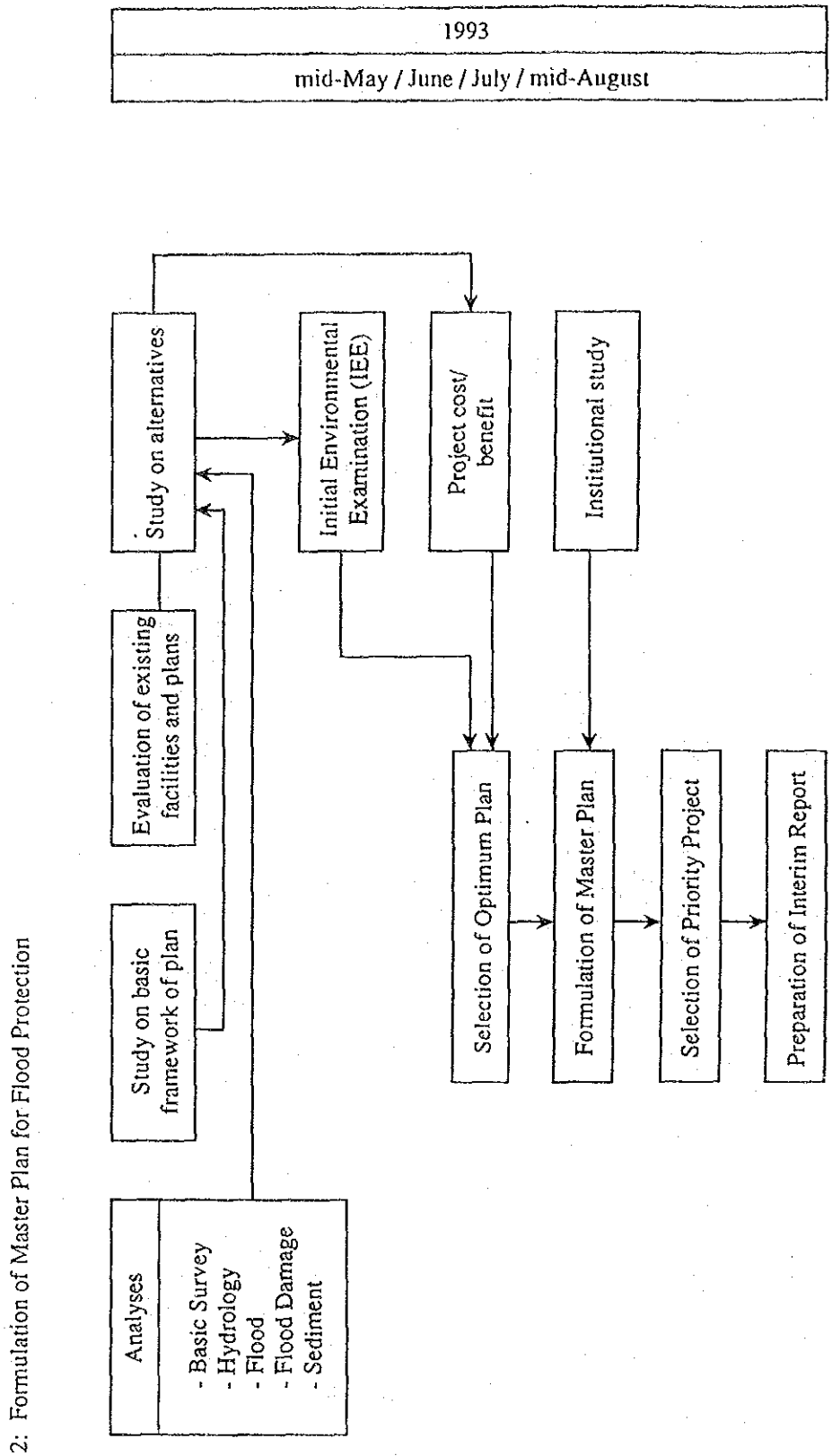

Fig.-1 Work Flow Chart of the Study (2/3)

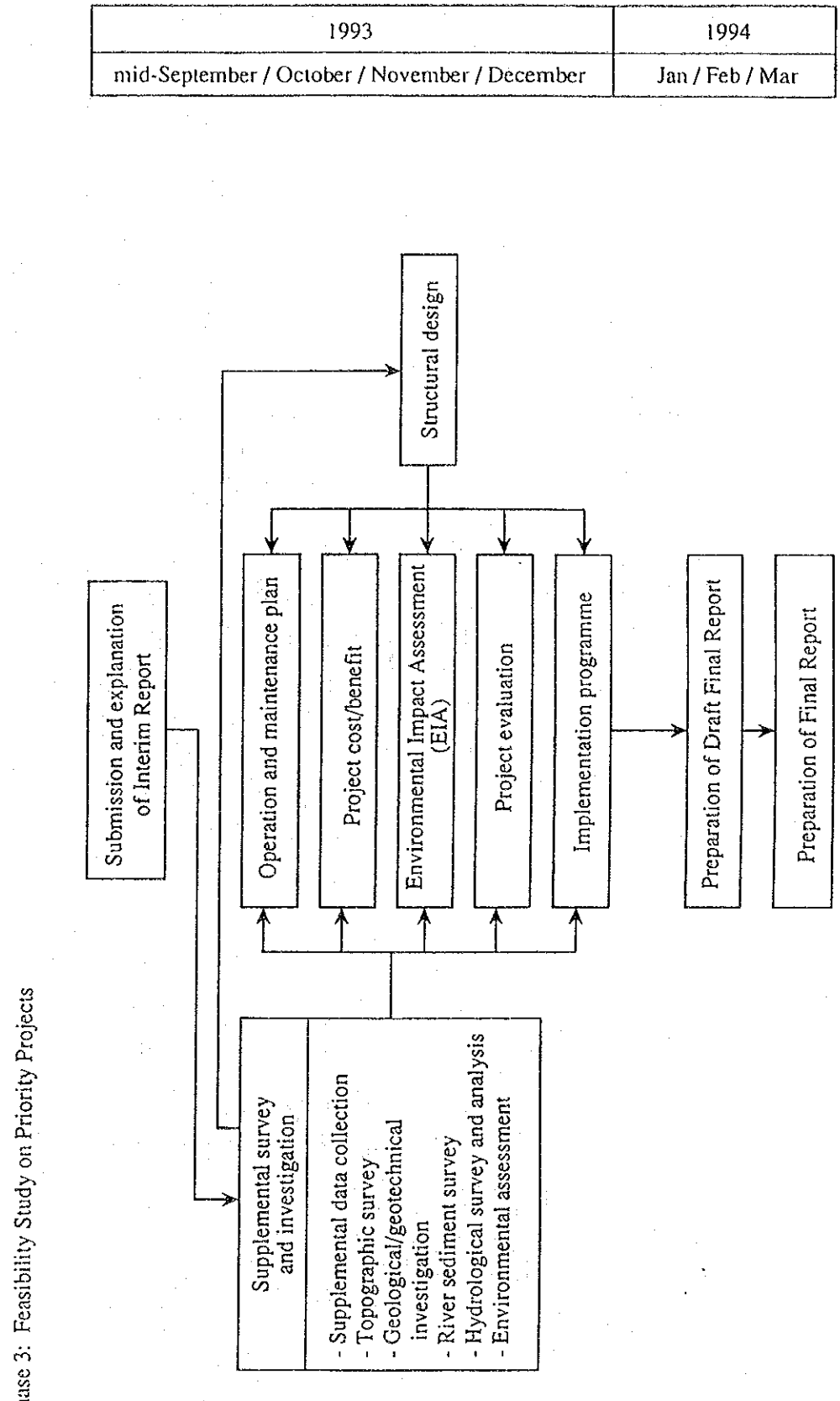

Fig.-1 Work Flow Chart of the Study (3/3)

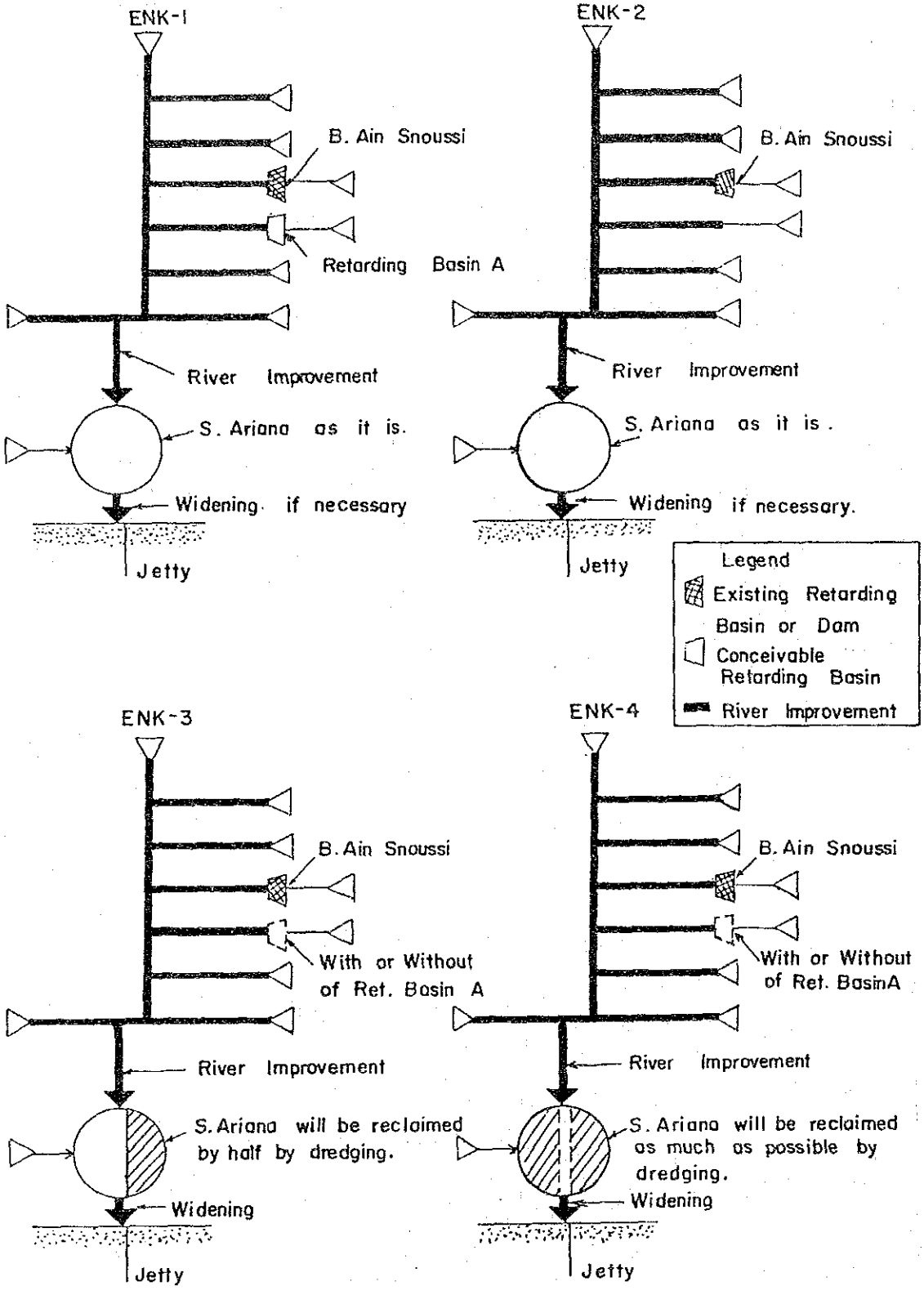

Fig.-2 Alternative Cases for Oued Ennkhilet and Sebkhet Ariana

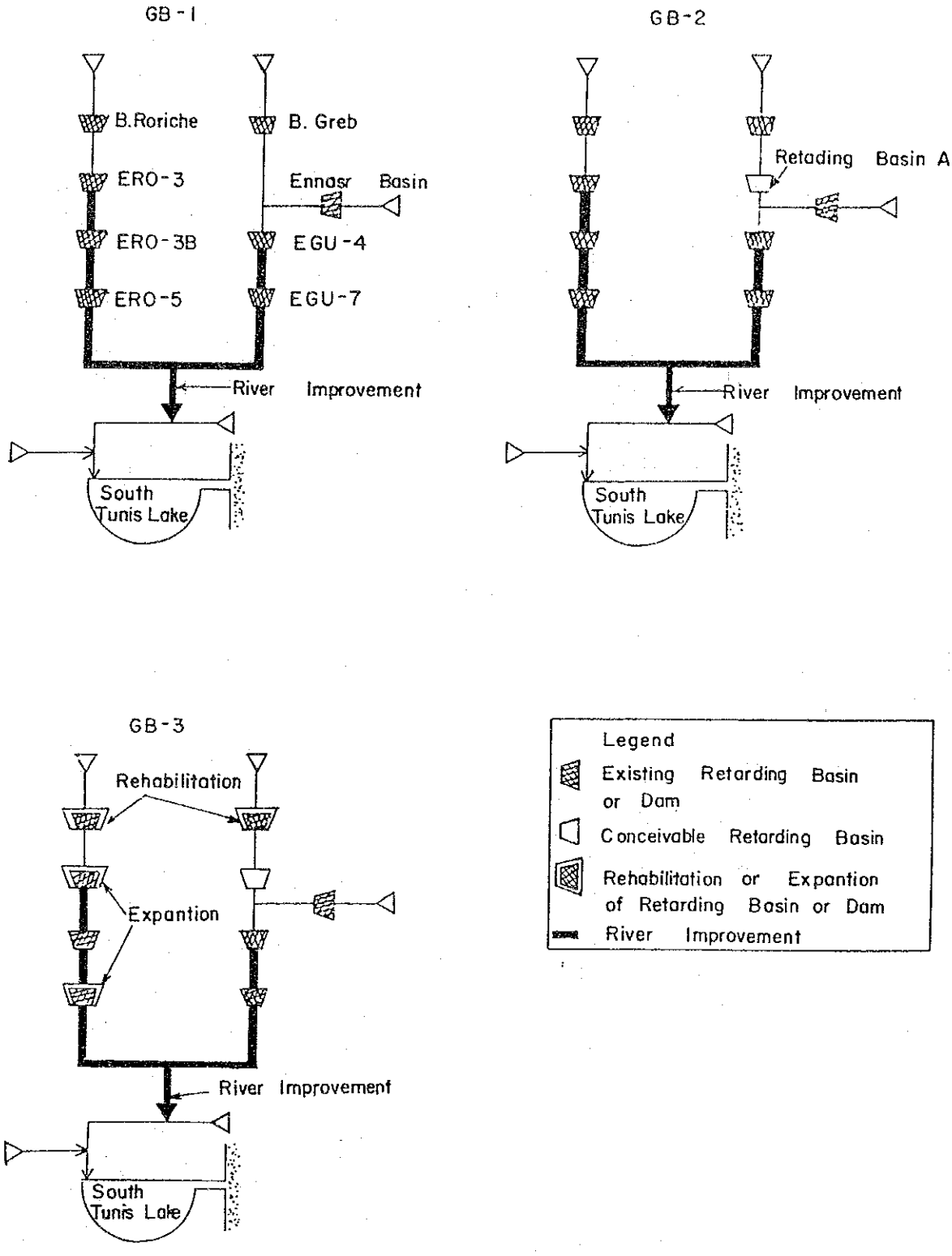

Fig.-3 Alternative Cases for Oued Greb

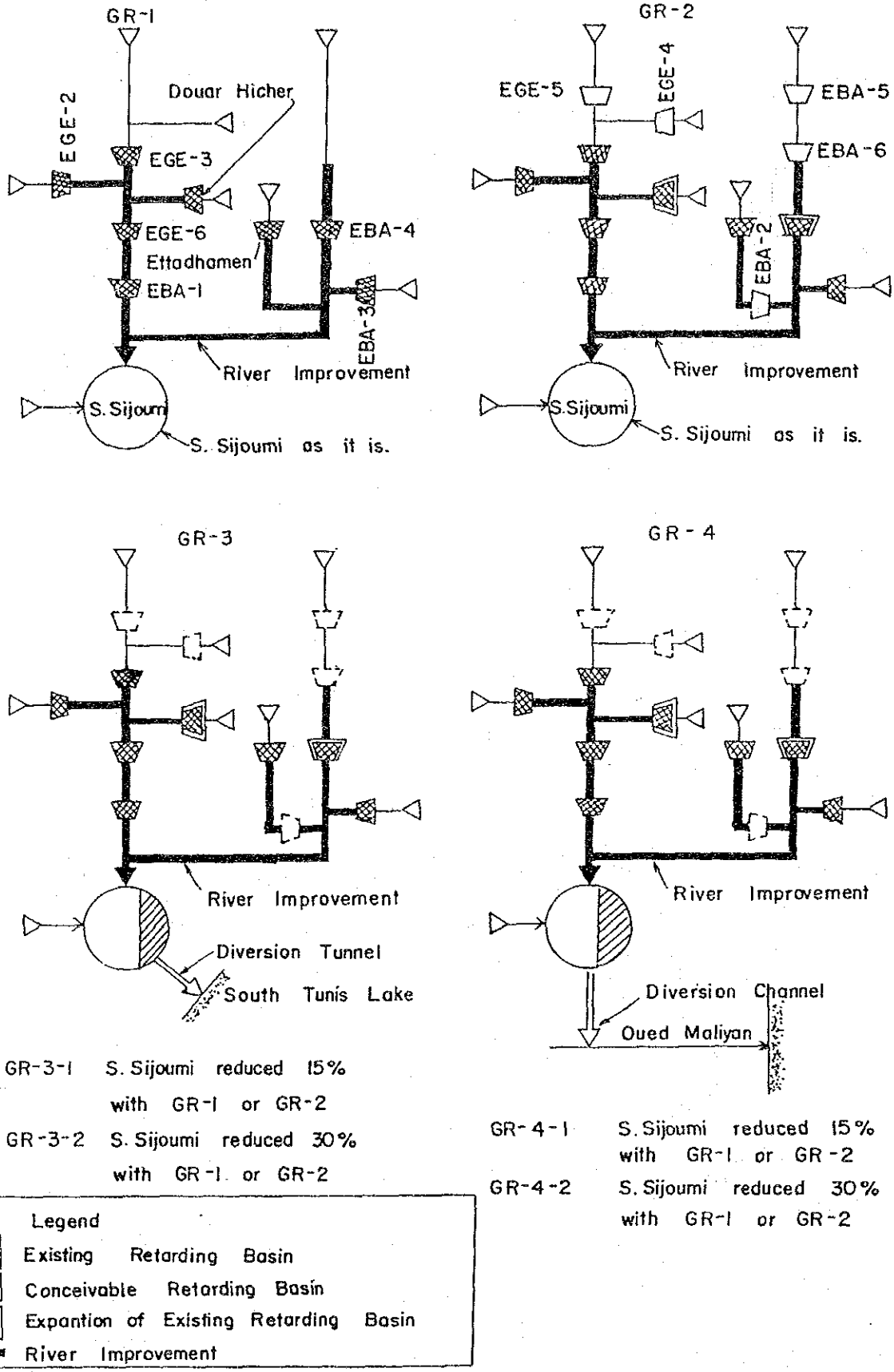

Fig.-4 Alternative Cases for Oued Gariana and Sebkhet Sijoumi

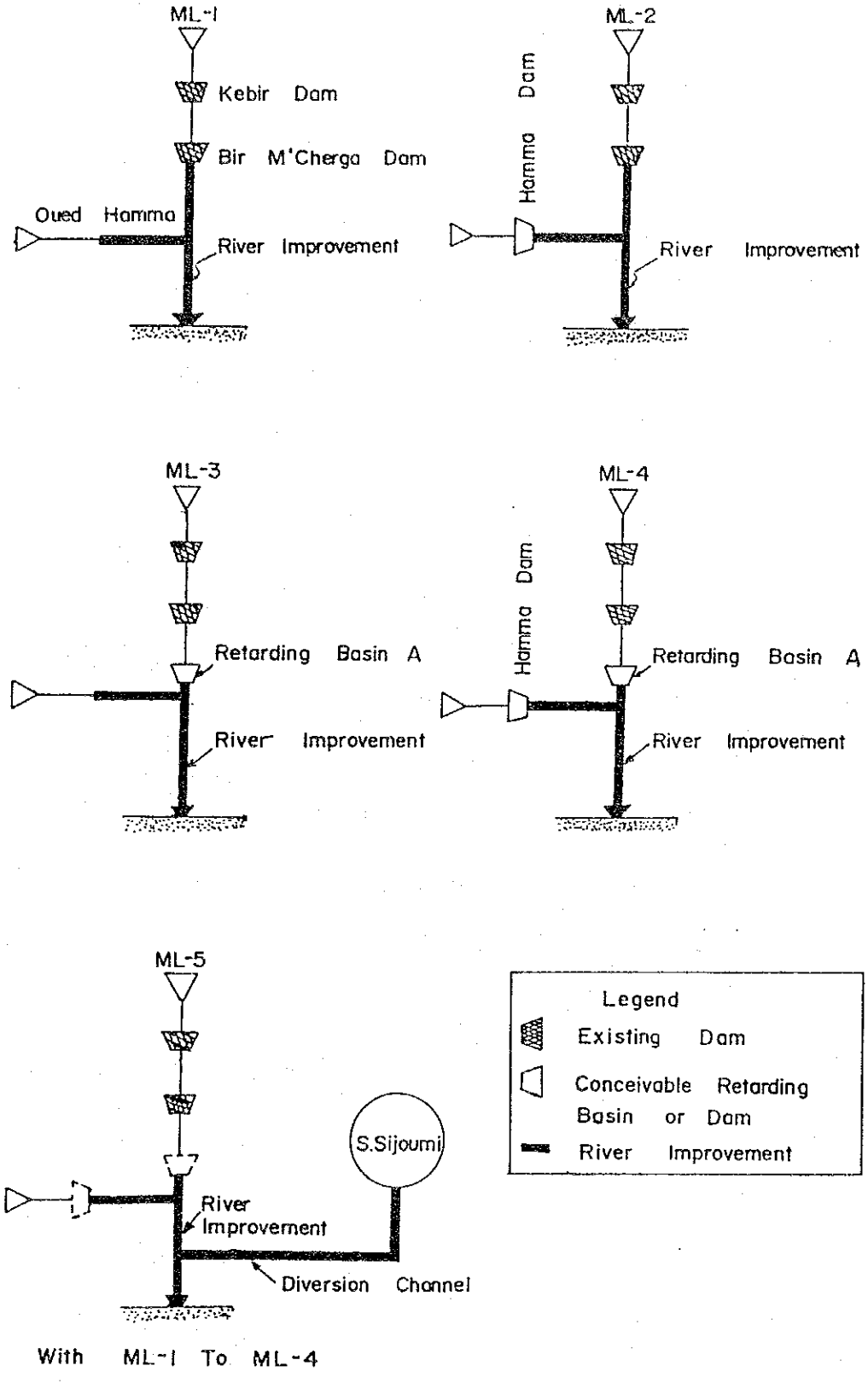

Fig.-5 Alternative Cases for Oued Maliyan

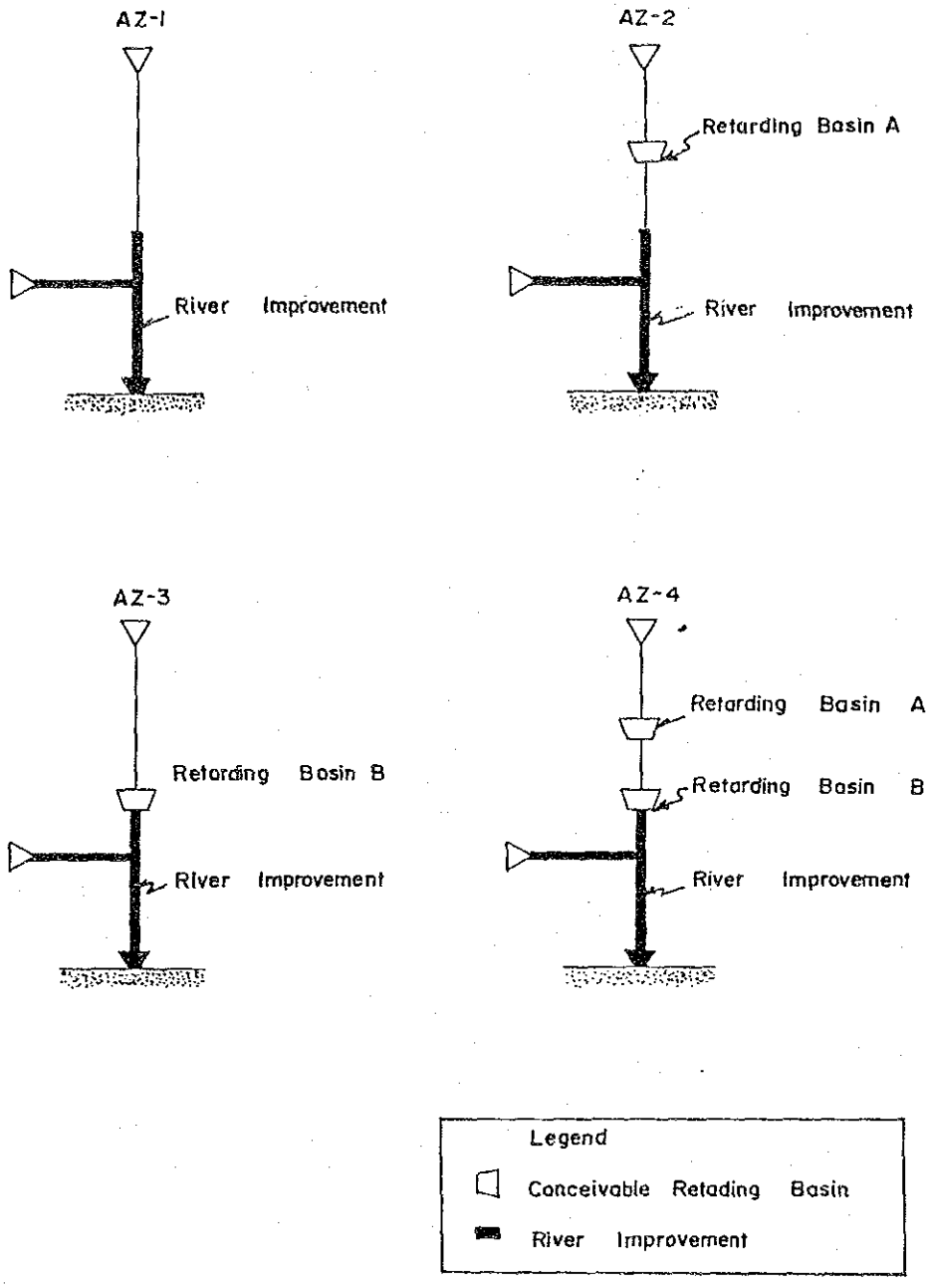

Fig.-6 Alternative Cases for Oued Ain Zerga

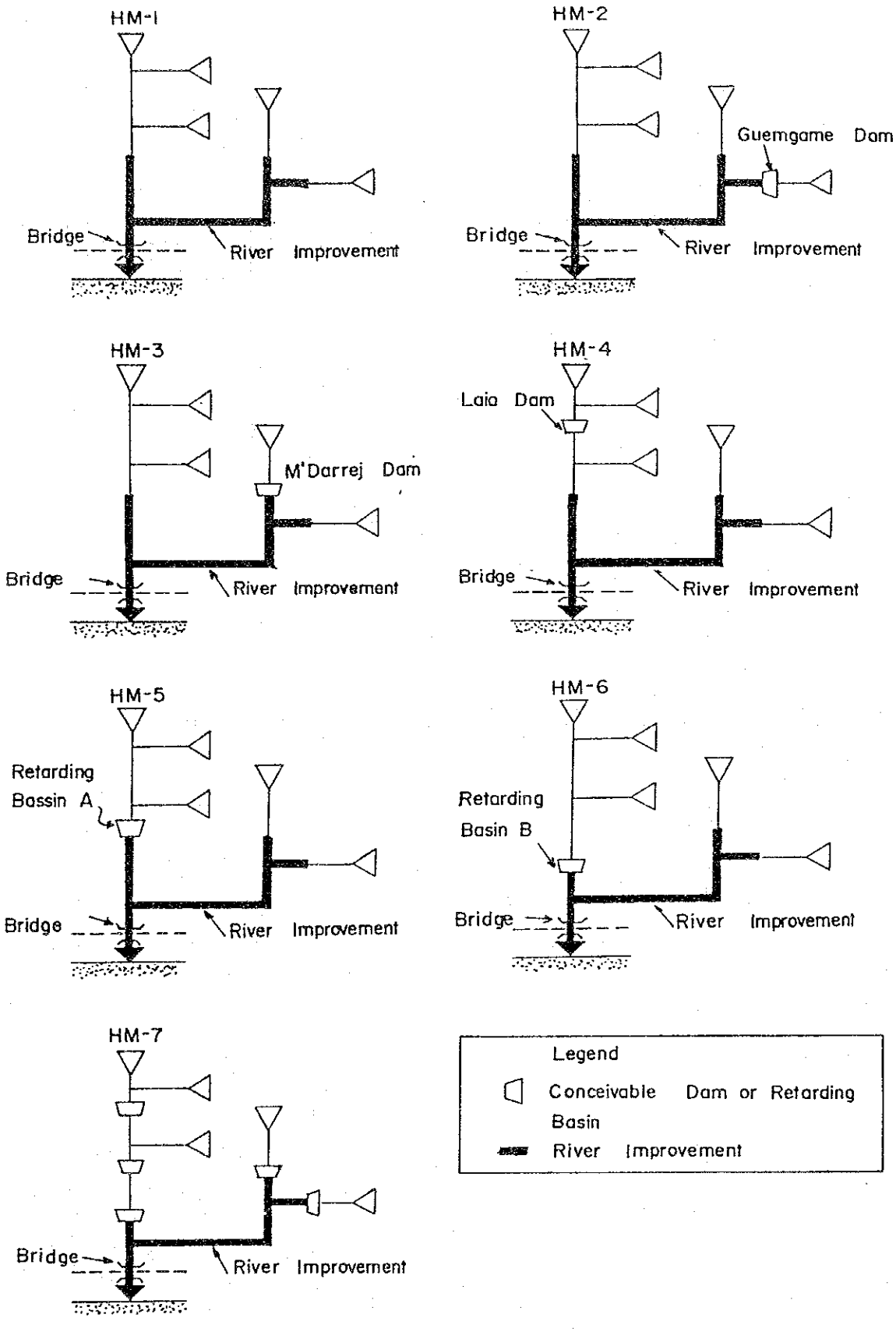

Fig.-7 Alternative Cases for Oued Hammam

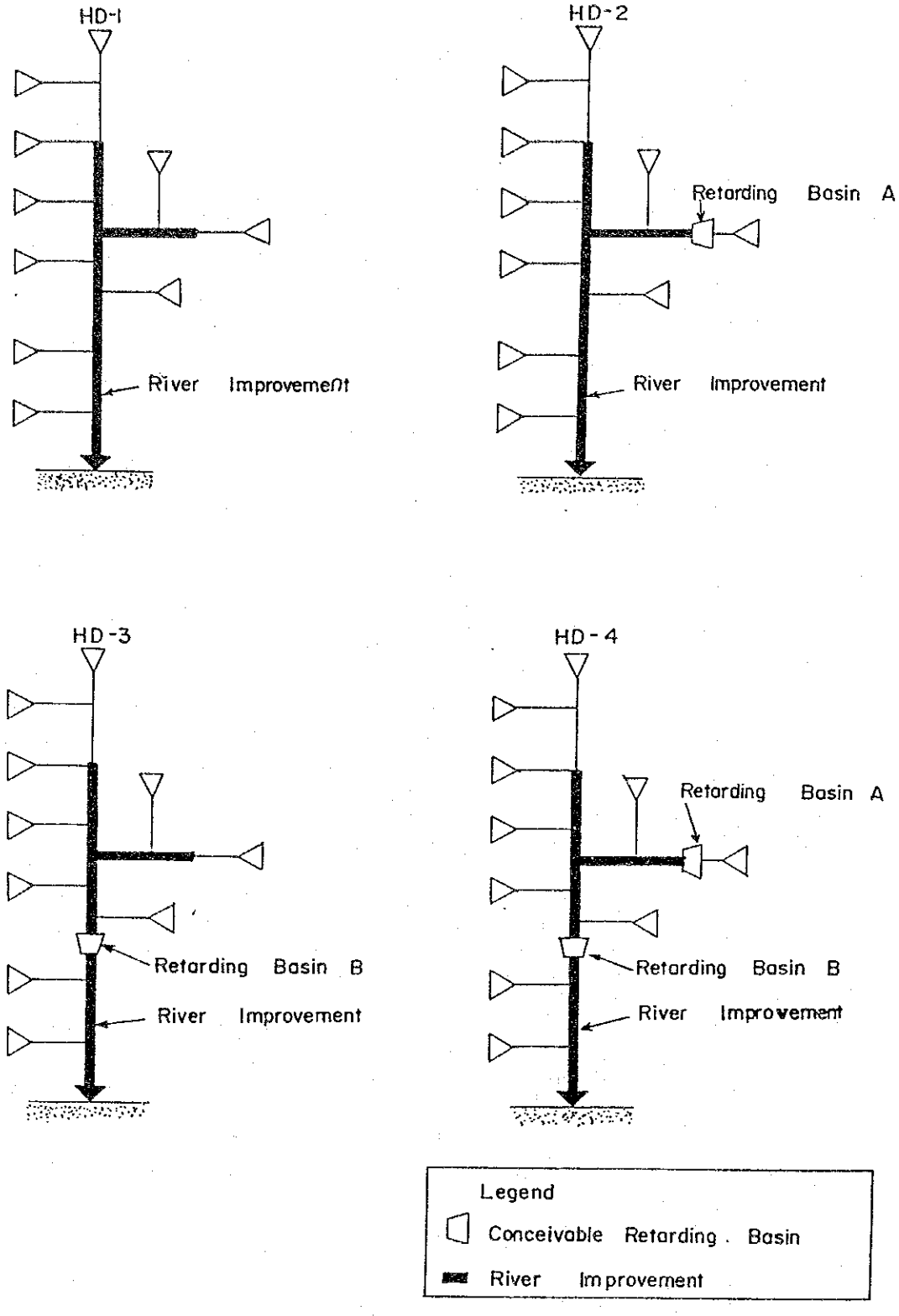

Fig.-8 Alternative Cases for Oued Hamdoun

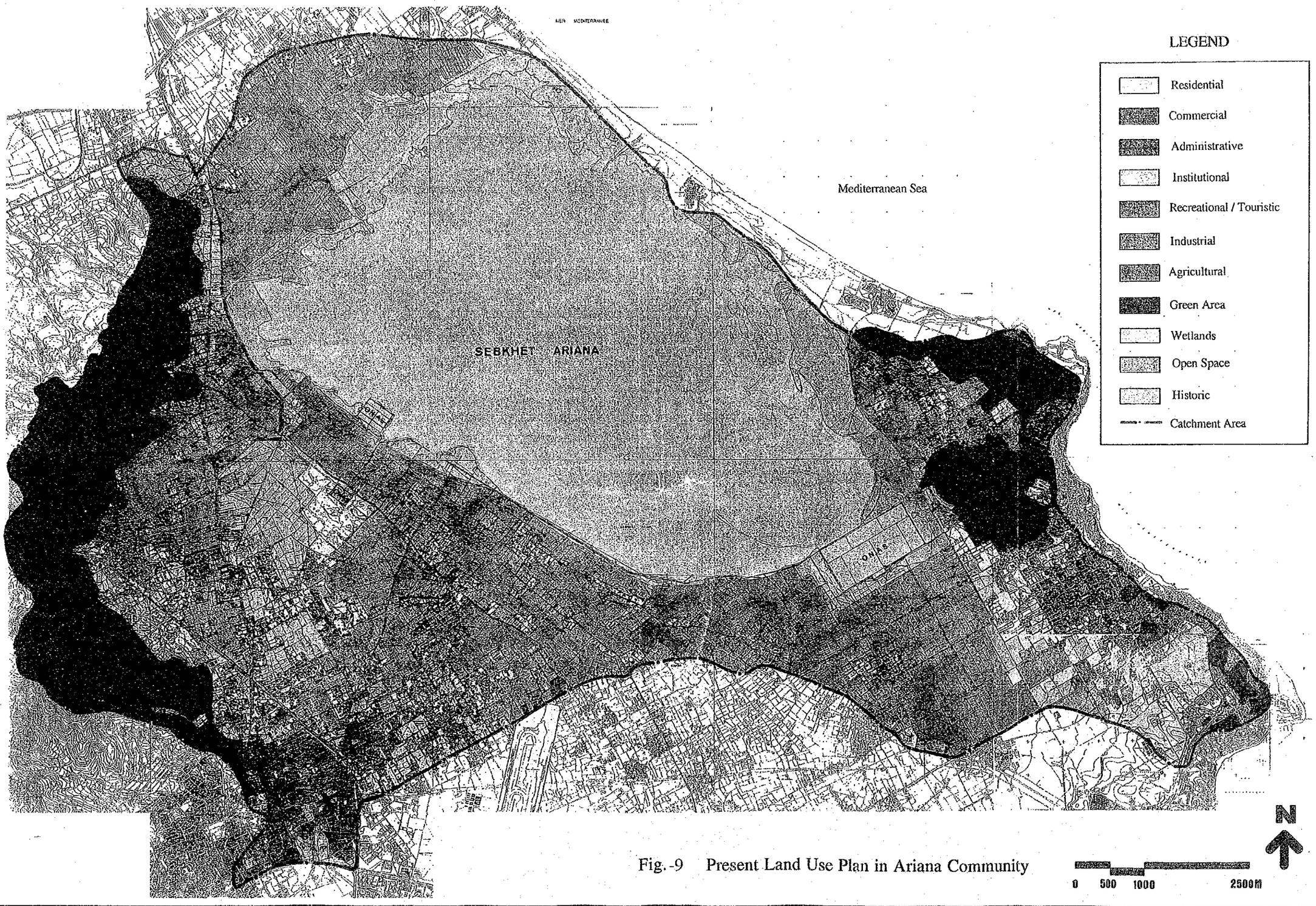

Fig.-9 Present Land Use Plan in Ariana Community

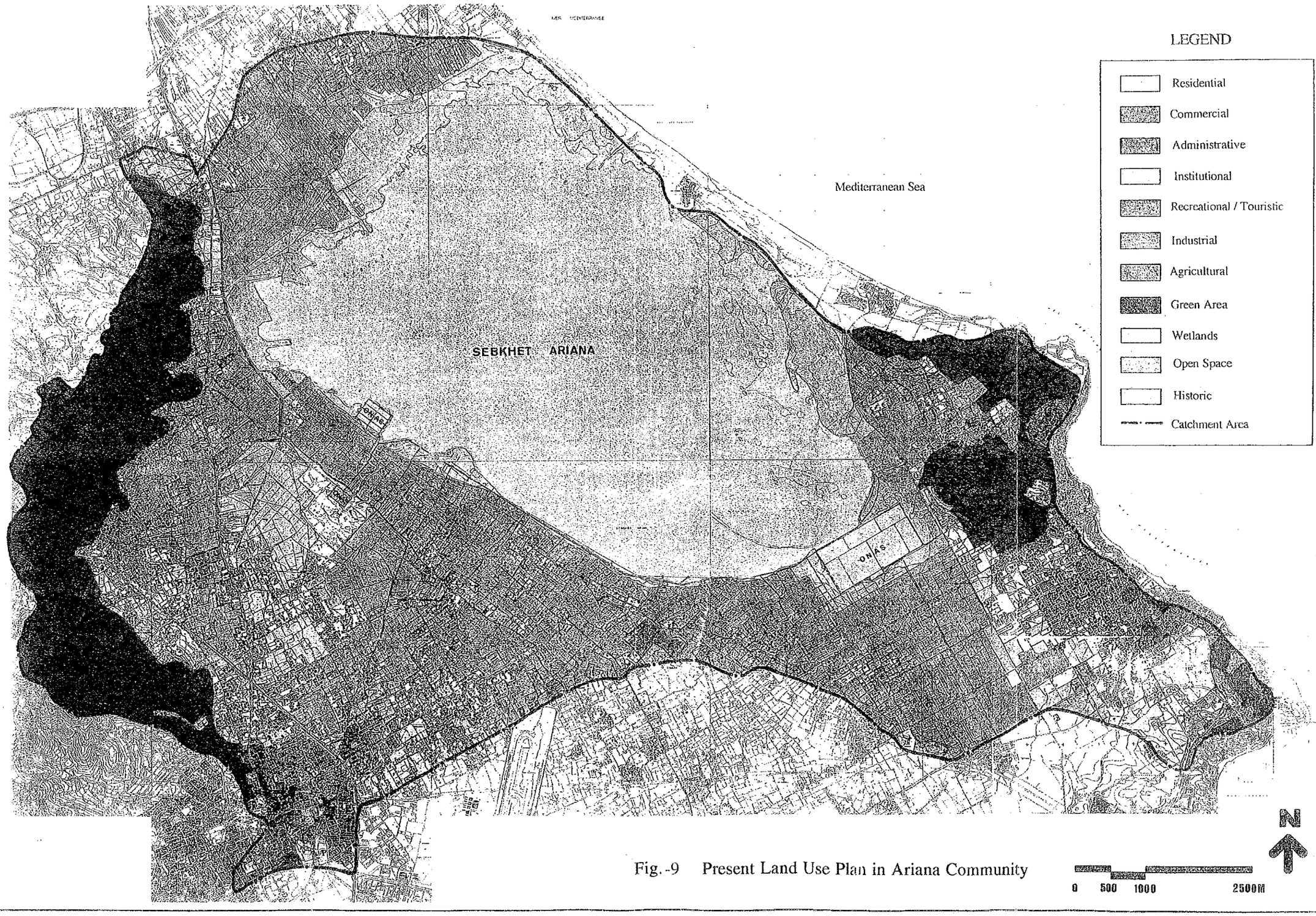

Fig.-9 Present Land Use Plan in Ariana Community