(3) Increased Vehicle Operating Costs

There are two elements of costs involved here. Additional operating costs due to the diversion, and increased vehicle costs due to travel on damaged roads. While it is assumed that the level of flooding will be sufficient to halt traffic completely during the period of inundation, a further impact will be felt in the increased operating costs experienced by vehicles both as a result of more difficult operating conditions and following the degradation in the road surface. This additional cost should be included in the damage assessment. For the purposes of the evaluation it is assumed that the increased operating costs apply for the duration until the road is repaired.

The costs of increased vehicle operation are based on assumptions from the World Bank HDM III model, assuming different degrees of roughness of surfaces in a "with" and "without" situation.

On the basis of the HDM III model, it is assumed that in the "without project case" the section of road affected by flooding is in poor shape, with visible irregularities and shape defects, (this represents a "roughness " level of 71.5 to 91 m/km). In the "with project case" i.e. without flooding, the state of the road is considered as high quality asphalt road (i.e. with a specification of 21-33 m/km). The difference in vehicle operating costs between these categories of road are shown in Table 10.3.

These rates are applied to the existing and forecast traffic flows. It is assumed that damage to road surfaces will be the same in cases of present and future land use conditions, but duration of flooding will be different.

10.2.6 Other Factors

The major unquantifiable factor here is the impact on health. This is difficult to assess due to lack of sufficient data, and the problem of attributing diseases to local flooding problems, rather than other causes which may lie outside the study area.

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. This is a potential problem for which concern has been expressed. An analysis of present flooding shows that overflows from the oued are only one of several causes creating unhealthy environments.

The following are contributory factors for which solutions will need to be found:

-the overloading of networks due to encumbrance from solids - erosion of hills, as well as waste from housing and other works
-the malfunctioning of the secondary networks particularly in housing areas
-increased flows due to high rates of urbanization in previously agricultural areas
-construction of numerous obstacles and the infilling of the Oued, particularly in zones of spontaneous housing
-insufficient maintenance works

A further potential hazard is the disruption likely to be caused to the ONAS treatment plant, although the Plant itself is unlikely to be affected by flooding.

10.2.7 Summary of Coefficients used in Estimating Flood Damage

The various factors and coefficients used for estimating flood damage are summarized as follows; In view of the difficulties of forecasting inflation rates and future rates for property and commodities, due to the large influence of speculation and other factors, it would be more rational to treat these as sensitivities - the exception are wages which can be expected in line with GDP. Current rates are therefore used for the future. Damage estimates can therefore be considered to be conservative.

Summary of Coefficients Used to Estimate Flood Damage (DT)

Category	Coefficient	
	Present (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
(ii)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 Labor	0.5	2.1
* Unskilled Labor	0.16	0.7
*Tourists	1.0	4.0
(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

10.3 Evaluation of Flood Damage - Directly Flooded Areas

10.3.1 Introduction

As noted above flood prone areas can be considered under two categories. Those where flooding can be attributed 100% to overflows from the Oued Ennkhilet, and those where there are other sources as well (see Figure 10.1). In this section estimates are made for the former.

Section 10.4 presents estimates for partially affected areas. Section 10.5 summarizes the estimates for 1-yr, 10-yr and 100-yr probable floods. Detailed data is to be found in the Supporting Report.

The flooded area can be considered in two parts, the area to the west of the RVE 533 (referred to as Zone A), and the other area to the east (Zone B).

10.3.2 Zone A - Upper Ariana (Ariana Superieur)

(1) Characteristics of the Area

This is largely a residential area, planned for urban expansion. It consists of the El Madina El Fadhila. In addition to the damage caused to residents and property within the area, a large section of the side of the RVE 533 which borders the zone will be affected by the flooding.

Land use for the affected areas under a 100-yr probable flood in present and future conditions is estimated as follows;

Oued Ennkhilet -Estimated land use in the flood prone areas - Zone A (ha)

	Present land Use	Future Land Use
Residential	44.0	112.0
Agricultural	65.0	0.0
Commercial	2.0	3.0
Recreational	0.0	0.5
Wetlands	0.0	0.0
Open Space	6.0	1.0
Infrastructure(schools)	0.0	0.5
Total:	117.0	117.0

(2) Loss of Income to Residents

The range of housing consists of spontaneous, and medium to upper standard houses; there are also a few apartment blocks, and a popular housing development at the edge of the flood prone area. Data of the last Census can be considered to be outdated in terms of the composition of housing in view of the large urban expansion in the area in recent years. The area of New Ariana had an average density of 4.9 persons per household (3,045 houses, 2,783 households and a resident population of 13,722).

On the basis of densities of 120 persons per ha at present and 140 per ha in the future, population affected is estimated to be 5,280 at present and 15,680 in the future. Assuming 4.9 persons per household, the total number of households affected will be 1,080 and 3,200 respectively. It is further assumed that there will be two workers per household, i.e. 2,160 and 6,400.

An analysis of the housing data forecast for the year 2011 by ONAS, indicates that 75% of the housing will be popular housing, 17 % medium standard, and 8% high standard. These housing ratios are used as proxies for calculating lost income insofar as 75 % of the population will consist of unskilled and the rest of skilled workers.

With a duration of flooding estimated at 12 hours at present and 24 hours in 2020 under future land conditions it is assumed that two full working days will be lost. Total income losses for residents are estimated to be in present land use conditions DT18,000 for skilled and DT5,500 for unskilled labor. Under future land use conditions these figures are DT221,000 for skilled workers, and DT218,000 for unskilled workers. Total loss of income is therefore estimated to be DT23,500 under present land use conditions, and DT439,000 under future land use conditions.

(3) Damage to Residential Buildings

The breakdown by type of building estimated in the ONAS Drainage Master Plan, is used to calculate potential flood damage. These factors are applied to the number of households and the relevant damage factors per m2 are used as shown in Table 10.4.

Total damages to buildings in this zone are therefore estimated to be DT1,641,000 under present land use conditions, and DT17,104,000 under future land use conditions.

(4) Damage to Household Articles

On the basis of losses of DT350 per household damages are estimated at DT378,000 under present land use conditions, and DT1,120,000 under future land use conditions.

(5) Losses in the Industrial and Commercial Sectors

Commercial and some light industrial enterprises located along the RVE 533 will be affected by the flooding. Areas of 2 ha under present land use and 3 ha under future land use will be affected. Assuming that some 50 units will be affected, with average employees of 30, the total number affected will be 1,300. It is assumed that there will be a loss of income over two days under present land use conditions and 3 days under future conditions; it is further assumed that half the employees are skilled. Losses are estimated at DT127,300 and DT173,500 respectively.

There will also be damages to commercial and industrial buildings. Using a criteria that 80% of these surfaces will be covered by buildings, areas affected will be 16,000 m2 and 24,000 m2 respectively, resulting in damages estimated at DT240,000 and DT340,000.

(6) Losses in the Agricultural Sector

It is estimated that at present 65 ha of agricultural land in Zone A is prone to flooding. Assuming the loss of crop at an average of DT1,750 per ha. total losses at present are estimated to be DT113,750.

(7) Transport and Traffic Losses

(a) Introduction

Flooding from the Oued Ennkhilet will have a number of consequences for different types of traffic.

* The major impact will be on the RVE 533, which is expected to be affected for a period of 12 hours under present land use conditions, and 24 hours under future land use conditions. These conditions will result in diversions and some delays.
* Secondly, there will considerable inconvenience to the populations of Ariana Superieur, Raoued and parts of Borj Louzir and Soukra Chotrana.
* Thirdly, there will be a backup effect on traffic on the GP-8 which will entail considerable delays.

Assumptions are made below in order to estimate these various impacts.

(b) Traffic Flow Data

No detailed traffic counts are available for the sections of road expected to be flooded - the RVE 533 and local roads within the Zones affected. The Transport Study for Greater Tunis carried out in 1989 indicated that traffic on the GP8 in Ariana was estimated to be around 25 000 vehicles per day. In applying the GDP growth rates and the relevant growth rates for traffic flows, it is estimated that traffic will reach 46,800 v.p.d. by 2000, 69,000 v.p.d. by 2010 and 84,500 v.p.d. by the year 2020.

The structure of traffic for the GP 8 is estimated in the traffic Census as follows:

Private cars and Taxis	: 51%
Light vehicles	: 24%
Heavy Vehicles	: 22%
Buses	: 2%
Others (2 wheels)	: 1%

In applying typical occupancy rates the flow of passengers is estimated on the North-South axis to be as shown in Table 10.5 for the year 2020. It is estimated that the total number of passengers will reach around 320,000.

The RVE 533 mainly serves the residential population in the communes of Raouad, Ariana Superieur and Borj Louzir. In order to estimate the traffic movements for these areas, data concerning Ariana town is used from the Master Transport Plan for the District of Tunis. With a population of 55,289 (11,350 households), daily traffic was estimated as follows;

2 wheels	: 2,011
Public Transport	: 29,893
Private cars and taxis	: 62,123
Total:	: 94,027

According to the Traffic Census, the average journeys per person per day were estimated at 1.7 in Ariana. This ratio is applied to the populations in areas affected by the flooding. It is assumed that 50% of the population of Ariana Nord will be affected in terms of traffic movements. i.e. populations of 62,500 at present and 179,000 in the year 2020. Thus passenger movements on the RVE 533 are estimated at 105,400 per day at present, and 304,300 in the future. These estimates are used below to evaluate flood damage on the transport sector.

(c) Estimated Loss of Income due to Traffic Delays

For the GP8, it is assumed that in the event of a 100-year flood, delays to traffic will amount to 1 hour. In applying the relevant rates for the value of time to the above passenger flow, it is estimated that losses under present conditions will amount to DT31,600.

With regard to future land use conditions it is assumed that delays will reach two hours. Using future traffic estimates and incomes, losses will amount to DT905,600.

With regard to present traffic on the RVE 533 (105,400 movements per day) and assuming delays of 2 hours at present, estimated losses for the value of time are DT69,600 for skilled (private cars and taxis), and DT11,500 for unskilled labor (other transport) - a total of DT81,100 under present land use conditions.

Assuming that traffic movements will grow in line with population growth , there will be an estimated 304,000 movements per day of population in the area, of which 200,640 will be in private cars and taxis, and 103,360 in other forms of transport. Assuming 3-hour delays in the future, losses due to traffic delays are estimated at of DT1,264,000 for skilled and DT217,000 for unskilled labor - a total of DT1,481,000.

(d) Increased Vehicle Operating Costs

There is not expected to be any major damage to the RVE 533 and therefore it is not expected that there will be any increased VOCs involved. There will however be some damage to local roads resulting in higher operating costs, and a notional amount of DT10,000 is allocated to this aspect, under present conditions. In the future these costs can be expected to increase in line with traffic growth, and are estimated at DT30,000.

(e) Damage to Roads

Local roads will also be affected. In applying a ratio of 1 km of local roads per 10 ha of surface area, around 10 km of these roads will be affected. Assuming a rehabilitation cost of DT80 000 per km the total damage to local roads could be around DT800,000.

(8) Summary of Damages to Zone A

Potential flood damages in this zone under a 100-yr probable flood are summarized as follows;

Oued Ennkhilet - Zone A - Estimated Flood Damage (DT)

Category	Land Use Conditions	
	Present	Future
Losses to Residents		
Loss of Income to Residents	23,500	439,000
Damages to Household Articles	378,000	1,120,000
Damage to Residential Buildings	1,614,000	17,104,000
Losses to Industrial Sector		
Loss of Income	127,300	173,500
Damage to Buildings	240,000	360,000
Losses to Agricultural Sector	113,750	Nil
Losses in the Transport Sector		
Delays GP-1	31,600	905,600
Delays -local traffic	81,100	1,481,000
Increased VOCs	10,000	30,000
Road Rehabilitation	800,000	800,000
Total:	3,419,250	22,413,100

10.3.3 Estimation of Damages - ZONE B

(1) Characteristics of the Area

The land use of the flood prone area in a 100-yr probable flood is summarized as follows for present and future land use conditions;

Oued Ennkhilet -Estimated land use in the flood prone areas (ha)

	Present Land Use	Future Land Use
Residential	41.0	127.0
Agricultural	66.0	32.0
Commercial	0.0	0.0
Recreational	0.0	1.2
Wetlands/Inundated areas	7.0	40.0
Open Space	124.0	40.0*
Infrastructure(schools)	4.0	1.8
Total:	242.0	242.0

*Note Assigned for Petroleum Storage

Urbanization will proceed rapidly at the expense of agricultural areas and open areas. One main change of land use will the use of space for petroleum storage.

(2) Loss of Income to Residents

This zone is particularly noted for anarchic/spontaneous housing. Apart from one small area of planned housing, the majority of houses are of anarchic lower quality houses. Density in this area is less than in other parts of Ariana. According to the 1984 Census, this area had a density of 3.99 persons per household as well as fewer houses.

In estimating the population affected by potential flooding, it is proposed to use a density below that of Ariana as estimated by ONAS, i.e. 80 persons per ha. against an average of 120. On this basis, the population affected in Zone B is around 3,300 under present conditions.

Density can be expected to increase in the future and on the basis of 120 persons per ha. Population affected in the future will be around 15,000. Assuming 4.0 persons per household, the total number of households affected will be 825 at present and 3,750 in the future.

On this basis, the number of workers in the area will be 1,650 and 7,500 respectively. It is assumed that half of these workers will be unskilled, given the preponderance of anarchic housing. Duration of flooding in a 100-yr probable flood is estimated at 24 hours under present and 35 hours under future land use conditions. Two full working days will be lost as a result of the flooding.

Total income losses for residents are estimated to be in present land use conditions DT26,400 for skilled and DT8,250 for unskilled labor. Under future land use conditions these figures are DT502,500 for skilled workers, and DT165,000 for unskilled workers. Total loss of income is therefore estimated to be DT34,650 under present land use conditions, and DT667,500 under future land use conditions.

(3) Damage to Residential Buildings

825 households will be affected by flooding at present, and 3,750 in the future. These will be divided equally between social and medium standard housing, with areas of 60m2 and 100 m2 respectively. Total areas affected will be 66,000 m2 at present and 300,000 m2 in the future, resulting in damages of DT825,000 and DT6,000,000.

(4) Damage to Household Articles

On the basis of losses of DT350 per household damages are estimated at DT288,750

under present land use conditions, and DT1,312,500 under future land use conditions.

(5) Losses in the Industrial and Commercial Sectors

There will be no losses in this area.

(6) Losses in the Agricultural Sector

There are at present 66 ha of agricultural land prone to flooding in Zone B. These will reduce to 32 in the future. Assuming the loss of crop at an average of DT1,750 per ha, total losses at present are estimated to be DT115,500, and in the future at DT56,000.

(7) Transport and Traffic Losses

The losses in this sector to residents in terms of lost income and traffic delays have already been included in the estimates of Zone A. There will be additional damage to local roads. There are around 10 km of roads in Zone B. At rehabilitation costs of DT80,000 per km total cost of rehabilitation is estimated at DT800,000. With the development of the area in the future , 200 km are expected to be developed; assuming 1 km of road per 10 ha it can be expected that there will be 20 km of roads and damage will double to DT1,600,000.

A notional amount of DT10,000 under present conditions and DT20,000 under future conditions is proposed to cover increased vehicle operating costs.

(8) Summary of Damages to Zone B

Potential flood damages in a 100-yr probable flood are summarized as follows;

Oued Ennkhilet - Zone B - Estimated Flood Damage (DT)

Category	Land Use Conditions	
	Present	Future
Losses to Residents		
Loss of Income to Residents	34,650	667,500
Damages to Household Articles	288,750	1,312,500
Damage to Residential Buildings	825,000	6,000,000
Losses to Industrial Sector	Nil	Nil
Losses to Agricultural Sector	115,500	56,000
Losses in the Transport Sector		
Road Rehabilitation	800,000	1,600,000
Additional VOCs	10,000	20,000
Total:	2,073,900	9,656,000

10.3.4 Estimates of Flood Damage - Directly Flooded Areas

The total Damages estimated for the areas which where flooding is entirely due to overflows from the Oued Ennkhilet are estimates as follows:

Zone	Present Land Use Conditions (DT)	Future Land Use Conditions (DT)
A	3,419,250	22,413,100
B	2,073,900	9,656,000
Total:	5,493,150	32,069,100

Estimates for 1-yr and 10-yr probable floods are given below in Section 10.5.

10.4 Estimation of Damages - Partly Affected Areas

10.4.1 Introduction

These areas will be affected to different degrees by the flooding of the Oued Ennkhilet, since flows from other areas also contribute to the flooding. it is assumed that those nearer the Oued will be affected to a greater extent than those further away. Figures 10.1 shows the delineation of these areas.

For the purposes of the evaluation the effect of the Oued in terms of flooding impact is assumed to be 10 % of total flood damage in these areas.

The evaluation is carried out below jointly for Zones C and D together, and E and F since they are of a similar nature.

10.4.2 Assessment of Damages caused by Flooding under Present Land Use Conditions

(1) Characteristics of the Areas Affected

It is estimated that a total of 388 ha will be subject to some degree of flooding from the Oued Ennkhilet. Present land use in these areas is summarized as follows;

Oued Ennkhilet -Estimated Present land use areas partially flooded (ha)

Zones	C	D	E	F	Total:
Residential	32.0	46.0	25.0	0.0	103.0
Agricultural	0.0	16.0	75.0	32.0	123.0
Commercial	0.0	0.0	0.0	0.0	0.0
Wetlands	0.0	15.0	0.0	42.0	57.0
Open Space/Recreation	32.0	51.0	0.0	18.0	101.0
Infrastructure(schools)	4.0	0.0	0.0	0.0	4.0
Total:	68.0	128.0	100.0	92.0	388.0

It can be seen from above that 41% of the areas are at present open spaces and wetlands. The major impact of the flooding will be on the population and on agricultural areas.

(2) Estimates of population affected

A total of 103 ha of residential land will be affected. It is evident that areas C and D which are closer to the major roads have a higher density of population than areas E and F. In using the average density estimated for Ariana by ONAS (120 per ha) for the former and 100 persons per ha for the latter, total population affected is estimated to be around 9,500 in areas C and D, and 2,500 in areas E and F. These had high densities according to the 1984 Census (5.25 persons per household in Soukra, 5.45 in Chotrana, and 4.81 in Borj Louzir). Assuming an average of 5 persons per household, the total number of households are estimated at 1,900 and 500 respectively.

(3) Loss of Income to Residents

Under a 100-yr probable flood, duration of flooding is estimated at 24 hours under present and 35 hours under future land use conditions. Assuming a 50:50 breakdown between skilled and unskilled labor, and flood duration over two days, income losses are estimated at DT80,000 for areas C and D, and DT21,000 for areas E and F.

(4) Damage to Residential Buildings

In areas C and D there appears to be less spontaneous housing than in areas E and F. For the former, it is assumed that only 20% of the housing is spontaneous, while in the latter the majority, 80% is assumed. On this basis housing areas affected is estimated to be 152,000 m2 of medium standard housing and 23 000 m2 of lower standard housing in areas C and D, and 24,000 m2 of lower standard and 10,000 m2 of medium standard housing. Applying damage factors of DT25/m2 and DT15/m2 respectively, damage to buildings is estimated at DT4,145,000 in Areas C and D, and DT610,000 in areas E and F.

(5) Damage to Household Articles

On the basis of a loss of DT350 per household damage is estimated at DT665,000 for Zones C and D, and DT350,000 for Zones E and F.

(6) Losses in the Industrial and Commercial Sectors

No losses are expected in these sectors.

(7) Agricultural Areas

On the basis of the loss of one harvest at an average value of DT1,750 per ha losses are estimated at DT28,000 in zones C and D, and DT188,000 for Zones E and F.

(8) Damage to Roads

Local roads will be affected by floods. It is estimated that in areas C and D there are approximately 15 km of roads. At rehabilitation costs of DT80,000 total damages are estimated at DT1,200,000. Areas E and F have sparse population at the moment. Total roads are estimated at 5 km. Damages are estimated at DT400,000

(9) Summary of Flood Damages under Present Land Use Conditions

Total flood Damages in partially affected areas in a 100-yr probable flood under present conditions are estimated as follows;

	Areas C and D (DT)	Areas E and F (DT)
Loss of Income to residents	80,000	21,000
Damage to Buildings	4,150,000	610,000
Damage to Household Articles	665,000	350,000
Damage in Agricultural areas	28,000	188,000
Damage to Roads	1,200,000	400,000
Total:	6,123,000	1,569,000

In applying a factor of 10 % total damages caused by flooding from the Oued Ennkhilet are estimated at DT772,000.

10.4.3 Assessment of Damages caused by Flooding under Future Land Use Conditions

(1) Characteristics of the Areas Affected

It is estimated that a total of 388 ha. will be subject to some degree of flooding from the Oued Ennkhilet. Future land use in these areas is summarized as follows;

Oued Ennkhilet -Estimated Future land use in the flood prone areas (ha)

Zones	C	D	E	F	Total:
Residential	64.0	57.0	53.0	0.0	174.0
Agricultural	0.0	0.0	0.0	14.0	14.0
Commercial	0.0	0.0	0.0	0.0	0.0
Wetlands	0.0	38.0	40.0	28.0	106.0
Infrastructure(schools)	4.0	9.0	0.0	0.0	13.0
Open space/recreation	0.0	24.0	7.0	*50.0	81.0
Total:	68.0	128.0	100.0	92.0	388.0

*Note : Area reserved for Petroleum Storage

It can be seen from above that residential areas have increased substantially at the expense of agricultural lands, which are expected to be almost non existent. Open and recreational land has also reduced by over 25%.

(2) Estimates of Population Affected

The rapid increase in population will result in 174 ha of residential areas in the future -121 ha in zones C and D, and 53 ha in zones E and F. In using the average density estimated for Ariana by ONAS of 140 per ha in the future, total population affected is estimated to be around 17,000 in areas C and D, and 7,500 in areas E and F. Assuming an average of 5 persons per household, the total number of households are estimated at 3,400 and 1,500 respectively.

(3) Loss of Income to Residents

Assuming a 50:50 breakdown between skilled and unskilled labor, and flood duration over two days, income losses are estimated at DT605,000 for areas C and D, and DT267,000 for areas E and F.

(4) Damage to Residential Buildings

In evaluating damages in the future it is assumed that all houses in areas C and D will be of medium standard On this basis housing areas affected are estimated to be 340,000 m2. Applying damage factors of DT25/m2 damage to buildings is estimated at DT8,500,000 For areas E and F it is assumed that all new building will be of medium type construction, and the ratio of spontaneous housing to total will drop to 25%. There will therefore be 112,500 m of medium type, and 22,500 m2 of lower standard housing. Damage to buildings is therefore estimated at DT3,150,000.

(5) Damage to Household Articles

On the basis of a loss of DT350 per household damage is estimated at DT1,200,000 for Zones C and D, and DT525,000 for Zones E and F.

(6) Losses in the Industrial and Commercial Sectors

No losses are expected in these sectors.

(7) Agricultural Areas

There will be no agricultural areas in areas C and D, and only 14 ha. in areas E and F. On the basis of the loss of one harvest at an average value of DT1,750 per ha. losses are estimated at DT24,500 for Zones E and F.

(8) Transport and Traffic Losses

Local roads will be affected by floods. In applying a factor of 1 km of local roads for every 5 ha. total roads in areas C and D are expected to be around 25 km. At rehabilitation costs of DT80,000, total damages are estimated at DT2,000,000. In areas E and F there will be 53 ha of constructed areas, and 10 km of local roads. Total damages in this are will be DT800,000.

(9) Summary of Flood Damages under Future Land Use Conditions

Total flood Damages in partially affected areas under future conditions in a 100-yr probable flood are estimated as follows;

	Areas C and D (DT)	Areas E and F (DT)
Loss of Income to residents	600,000	267,000
Damage to Buildings	8,500,000	3,150,000
Damage to Household Articles	1,200,000	525,000
Damage in Agricultural areas	Nil	25,000
Damage to Roads	2,000,000	800,000
Total:	12,300,000	4,767,000

Assuming damages of 10 % by Oued Ennkhilet, total damages are estimated at DT1,707,000.

10.5 Estimate of Total Damages

10.5.1 Potential Damages in a 100-yr Probable Flood

The estimate of total flood damages caused by the Oued Ennkhilet in flood prone areas is estimated as follows;

(DT)

Areas	Present Land Use	Future Land Use
Directly Flooded Areas	5,493,000	32,069,000
Indirectly Flooded Areas	773,000	1,707,500
Total:	6,266,000	33,776,000

10.5.2 Potential Damages in 1-yr and 10-yr Probable Floods

Based on estimates of areas and duration of flooding for these cases as estimated in Chapter 7, potential damages under present and future land use conditions are shown below: Details of estimates are to be found in the Supporting Report.

(Unit:DT)

Areas	Present Land Use		Future Land use	
	1-yr	10-yr	1-yr	10-yr
Directly Flooded Areas	921,000	2,499,00	4,998,000	14,712,000
Partially Flooded areas	133,000	331,000	364,000	885,000
Total:	1,054,000	2,830,000	5,344,000	15,597,000

CHAPTER 11 COST ESTIMATE

11.1 Project Cost

The project cost for the Oued Ennkhilet scheme has been worked out as tabulated in Tables 11.1, 11.2, and summarized below excluding price and phisical contingencies:

First stage	: DT 11,540,000
Second stage	: DT 8,960,000
Total	: DT 20,500,000

11.2 Conditions for Cost Estimate

(1) Price level : January 1994

(2) Exchange rate : US$1.0 = DT1.0 = ¥110.0

(3) The project cost was estimated divided into foreign and local currency portions assuming certain percent of it taking into accounts following factors:
- availability of skilled, semi-skilled and common laborers in Tunisia,
- productivity and availability of construction materials in Tunisia, and
- productivity and availability of construction plant and equipment.

Major work items of foreign currency portion (F.C.) and local currency portion (L.C.) are as follows:

Excavation by equipment	: F.C. 70 %, L.C. 30 %
Embankment	: F.C. 70 %, L.C. 30 %
Concrete	: F.C. 60 %, L.C. 40 %

(4) implementation period is 57 months for the first stage work starting from April 1994, and construction is 30 months from middle of 1996.

(5) Tunisian value added tax was accounted and incorporated into the local portion.

(6) No interest during construction was accounted.

(7) The project cost is composed of the following:

- Direct construction cost,
- Land acquisition and compensation costs,
- Government administration expenses,
- Engineering services expenses, and
- Price and physical contingencies.

11.3 Cost Estimate

Direct construction cost and land acquisition cost are estimated by multiplying unit cost and work quantities which are worked out from the feasibility design. Administration and engineering expenses are estimated in proportion to direct construction cost. Price contingency is estimated applying the following rate which is assumed by consumer price index in Tunisia and Japan.

Local portion : 6.2 % per annum
Foreign portion : 2.3 % per annum

Physical contingency is estimated at 15 % of the total construction cost.

11.4 Disbursement Schedule

An annual disbursement schedule was provided following to the proposed implementation and construction schedule as shown in Table 11.3 for the first stage construction of the Oued Ennkhilet scheme and summarized below, excluding price and physical contingencies.

Year	F.C. (DT1,000)	L.C. (DT1,000)	Total (DT1,000)
1994	0	16	16
1995	234	3,861	4,095
1996	885	708	1,593
1997	2,018	1,542	3,560
1998	1,289	987	2,276
Total:	4,426	7,114	11,540

11.5 Operation and Maintenance Costs

Annual operation and maintenance costs are estimated at 2.0 % and or DT130,000 of the direct construction cost for the first stage of Oued Ennkhilet scheme.

CHAPTER 12 CONSTRUCTION PLAN AND SCHEDULE

12.1 Implementation Plan

12.1.1 Implementation Schedule

The structure measures for flood protection has been proposed by stage-wise construction of river structures for the Oued Ennkhilet, and be completed by the year 2000 and 2020 for 10-year and 100-year probable floods respectively. An implementation schedule for the first stage is provided on the basis of the such basic strategy and importance of the project as shown in Fig.12.1, and summarized below.

Stage/Activity	Timing	Duration (month)
First stage		
* Financial arrangement	1994	8
* Detailed design, add. survey, and P/Q for tender	1995	12
* Tender and contract	1996	6
* Construction of Oued Ennkhilet	1996-1998	30

12.1.2 Financial Source

Required fund for the project implementation would basically be arranged from the frame of national budget of the Tunisian Government, and one part by supporting loan from a donor country and or an agency.

12.1.3 Mode of Construction

The construction works will be conducted by selected contractor(s) through international competitive bidding accompanying with pre-pre qualification of bidders.

12.1.4 Implementation Organization

Urban Hydraulic Division of MOEH would act as a core agency of project implementation as shown in Fig 12.2. Major role of MOEH is ;

- financial arrangement,

- administration to conduct detailed design by consultant/s, to perform international competitive bidding and selection of contractor, and
- to administrate and supervise the construction works.

12.2 Construction Plan

12.2.1 Basic Policy for Construction Execution

Following basic policy or approach are proposed to be applied to conduct the various kind of construction works since the project situates in the urbanized or semi-urbanized area.

- to ensure urban environment
- to avoid adverse effect to tourists
- to eliminate traffic congestion
- to use excavated soil effectively
- to perform the construction works throughout the year

12.2.2 Construction Method for Oued Ennkhilet Scheme

The proposed structure measures for flood protection of the Oued Ennkhilet scheme are summarized and tabulated as follows.

Structures	Type/Length	Major Works
Ennkhilet main	improvement 2,695 m type : earth for d/s culvert, u/s	excavation, 47,200 m3 embankment, 34,700 m3 concrete, 1,470 m3 bridge RV-543, 600 m2 bridge RV-533, 360 m2 drainage sluice,5 nos.
Canal C1	improvement 1,573 m type : earth	excavation, 21,500 m3 embankment, 22,900 m2 drainage sluice,5 nos.
Canal R2	improvement 918 m type : earth	excavation, 2,600 m3
Canal G1	improvement 1,113 m type : earth	excavation, 7,040 m3
Canal G2	improvement 1,255 m type : earth	excavation, 3,030 m3
Canal G1'	improvement 299 m type : earth	excavation, 1,400 m3

Diversion No.3	construction, 3,800 m type : earth	excavation, 51,600 m3 embankment, 25,700 m3 bridge RVE-543, 516 m2 ONAS sewers drainage sluice,6 nos.
Diversion No.4	construction, 288 m type : box culvert	excavation, 5800 m3 concrete, 1,130 m3
Retarding Basin A	new construction type : concrete wall	excavation, 1,100 m3 concrete, 260 m3
Retarding Basin G	new construction type : pond	excavation, 25,600 m3
Retarding Basin I	new construction type : pond	excavation, 42,700 m3
Retarding Basin J1	new construction type : pond	excavation, 24,100 m3

Required major work volumes in the first stage are 240,000 m3 of excavation, 85,000 m3 of embankment and 4,000 m3 of concreting excluding bridges.

Ennkhilet main

Improvement works of the Ennkhilet main (E1 and E2) will be conducted from downstream towards upstream. Channel excavation and embankment will be carried out concurrently, so that excavated soils could be used for the fill materials to the maximum extent. No borrowed soil would be required for the fill materials since sufficient volume from the excavation in stretch E1 and E2 is expected. Middle capacity class of earth moving equipment would be planned for this improvement works. No dredging method is applied due to site condition. Drainage sluice and inspection road groveling for both banks are to be constructed after the completion of levee embankment.

A single type concrete box culvert of 485 m long is planed to be constructed at E11 stretch of the upstream Ennkhilet main. The works will be made in parallel with E1 and E2 improvement works. Ready mixed concrete would be used for 1,470 m3 in total of concrete work. The improvement of Ennkhilet main is scheduled to be completed in about one year period starting from initial stage.

Bridge renewal requires at RV-533 and RV-543 following to the channel improvement. Temporary bridge will be provided during the construction to eliminate traffic

congestion. The bridge renewal will be made within one dry season from February to August for each bridge.

Canals, C1, R2, C4, G1, G1' & G2

A construction order of these canals would be Canal C1 the first, that connects the Oued Ennkhilet main and Diversion Channel No.4, then Canal R2 and others. Major works are excavation of 36,000 m3 and embankment of 23,000 m3 which will be carried out by using light class equipment shifting from canal to canal with a crew from economical point of view. The embankment work requires only at Canal C1 which will be filled by excavated soil at the site. Excessive soil will be utilized effectively for land reclamation in the vicinity and others. Work period would be about one year in total for these six (6) canals construction.

Retarding Basins, A, G, I & J1

The proposed Retarding Basin A is concrete wall type and, others G, I and J1 are pond type. These four (4) retarding basins situate close to GP-8 road, then careful site operation is required for construction execution.

Major construction works are excavation of 93,000 m3 approx. in total for 3 basins and 260 m3 of concreting for Retarding Basin A. A construction order will be Retarding Basin G first, then I and J1 will follow which require mostly earth moving. The construction of Retarding Basin A, consisting mainly of concrete work, will be made in parallel with other 3 basins that have different type of jobs. Excavated soils will also be utilized effectively. One year work period will be required for 4 retarding basins construction by using middle capacity class earth moving equipment.

Diversion Channels

Diversion Channel No.3

The Diversion Channel No.3 is planned to be constructed connecting the Sebkhet Ariana and middle reach of the Oued Ennkhilet having 3,800 m long in total via existing Choutrana canal. Gravel-metalled inspection road at right and left bank levees are provided. Out of 3,800 m long, 1,939 m of the upstream portion is a new construction section, and the remaining 1,861 m is the Choutrana canal improvement section. The channel is trapezoidal-shaped and earth-lining type.

The construction works will be conducted from downstream towards upstream. The works will be carried out divided into two (2) work sections which one is a new construction portion of 1,939 m, and 1,861 m portion of remaining Choutrana canal improvement, providing two crews with equipment concurrently started from an initial stage. Swamp type bulldozer and middle capacity class earth moving equipment will be applied for the construction of this channel.

Major works of Diversion Channel No.3 are excavation and embankment of 52,000 m3 and 26,000 m3 respectively. Fill materials of levee embankment will be the excavated ones at channels with treatment to meet the specification required.

A bridge on RVE-543 requires to be renewed following to the improvement of Choutrana canal. Temporary bridge would be provided during construction.

The ONAS's sewerage canal and pipe, and other crossing facilities would require to be rerouted following to the channel improvement of Diversion Channel No.3. According to the MOEH, required works for rerouting such public crossing facilities are conducted by respective agencies concerned by the project budget.

Construction of Diversion Channel No. 3 would be a critical path work in the Oued Ennkhilet scheme which requires 2.5 years' work period.

Diversion Channel No.4

The Diversion Channel No.4 of 288 m long is planned to be constructed by a single type concrete box culvert having 3.4 m width and 2.2 m height, that connect Canals C1 and G1 crossing RVE-533 road. Major works are excavation of 5,800 m3 and concreting of 1,130 m3. Construction of Diversion Channel No. 4 will be conducted in parallel with the Canal C1 construction.

The construction of the section under RVE-533 road will be carried out in two or three steps to eliminate traffic congestion. Ready mixed concrete will also be used.

12.3 Construction Time Schedule

12.3.1 Time Schedule

Fig.12.3 shows a proposed construction time schedule for the first stage construction of the Oued Ennkhilet scheme. The schedule was provided taking into accounts the following factors.

- to realize the proposed flood protection measures in an early stage
- to minimize construction cost
- weather
- to eliminate traffic congestion

The construction period is proposed at 30 months starting from middle 1996 after the clearance of preconstruction activities to the end of 1998. A critical path work on the Oued Ennkhilet scheme would be the construction of Diversion Channel No.3 of 3.8 km long.

12.3.2 Milestones

Following to the proposed flood protection plan and construction schedule, completion time of the following structures would be the key milestones.

* Downstream Ennkhilet E1 & E2, Canal C1, Diversion No.4 and Canal G1 Route

Stretch E1 & E2	: August 1997
Canal C1	: End 1996
Diversion Channel No.4	: End 1996
Canal G1	: May 1997
Retarding Basin A	: April 1997

* Diversion Channel No.3 and Stretch E11 Route

Diversion Channel No.3	: August 1997
Stretch E11	: August 1997
Retarding Basin G	: May 1997
Retarding Basin I	: January 1998
Retarding Basin J1	: May 1998

CHAPTER 13 ECONOMIC EVALUATION

13.1 Estimate of Annual Average Benefit

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, the annual average benefit is calculated by the following formula.

$$B = \sum_{i=1}^{n} 1/2\left[D(Q_{i-1}) + D(Q_i)\right] \bullet \left[P(Q_{i-1}) + P(Q_i)\right]$$

where,

B	:	Annual average benefit
D(Qi-1), D(Qi)	:	Flood Damage caused by the floods with Qi-1 and Qi discharges, respectively
P(Qi-1), P(Qi)	:	Probabilities of occurrence of Qi-1 and Qi discharges, respectively
n	:	Number of floods applied

According to the flood damage studied in Chapter 10, annual average benefit for 10-yr probable flood are estimated to be DT1,447,000 in the present land use condition and to be DT7,721,000 in the future land use condition.

13.2 Economic Project Cost

The economic costs of the project are nominal figures that duly reflect the true economic value of goods and services involved. These costs are used only for the economic evaluation of the project. Transfer items such as taxes and duties imposed on construction materials and equipment, including government subsidy and contractor's profit, are excluded from the elements of financial cost. It is assumed that 10% of the financial construction cost is deemed as the transfer items.

Land has to be acquired for project implementation, and its economic value is considered to correspond to the production foregone by the project, which is reflected by the price. Land acquisition cost is then included in the economic cost.

Then, economic cost of the Oued Ennkhilet flood control project for the 10-yr probable flood is estimated to be DT12,475,000.

13.3 Economic Evaluation

The project is evaluated from the economic view point by figuring out the viability in terms of economic internal rate of return (EIRR). All the monetary calculation is based on the price level of January 1994, and the project life (for economic evaluation) is fixed for 50 years.

The calculation of EIRR is based on the cost and benefit streams that is prepared from the above-said economic cost and the annual average benefit in accordance with the implementation schedule. The implementation schedule is prepared in Chapter 12, and the river improvement works are assumed to be completed by the year 1998 for 10-yr flood and by a certain time in the future for 100-yr flood respectively. The operation and maintenance cost is taken for 2.0 % of the accumulated direct construction cost in the respective year.

The cost and benefit stream prepared for the Oued Ennkhilet flood control project is shown in Tables 13.1, and the estimated EIRR become 24.6 %. It is considered that this project is economically feasible.

TABLES

Table 1.1 Structure of Industrial Production in the Delegations of Ariana and North Ariana

	Ariana		North Ariana	
Sector	Number	Employees Number	Number	Employees Number
Agro-Industries	33	439	22	254
Construction Mat.	10	209	11	127
Electr/Mech	12	361	35	807
Chemical, etc.	4	18	9	96
Textiles/Leather	70	2,412	73	2,006
Miscellaneous	14	138	31	625
Total:	143	3,577	181	3,915

Table 2.1 In-situ Permeability Test Result

Boring No.	Test section (m)	Permeability coefficient (cm/sec)
SC1	0.0 - 5.0	1.70E-07
	5.0 - 10.0	4.70E-07
SC2	0.0 - 5.0	1.62E-06
	5.0 - 10.0	5.02E-07
SC3	0.0 - 5.0	1.10E-08
	5.0 - 10.0	1.60E-07
SC4	0.0 - 5.0	2.20E-07
	5.0 - 10.0	5.00E-07
SC5	0.0 - 5.0	6.60E-08
	5.0 - 10.0	4.40E-07
SC6	0.0 - 5.0	3.90E-07
	5.0 - 10.0	3.20E-07

Table 2.2 Summary of Laboratory Test on Samples in Oued Ennkhilet Basin

Sample		MC	Gs	Gradation			Atterberg limits			Compaction		k	qu
No.	Depth(m)			gravel	sand	sl/cl	LL	PL	Ip	OMC	MDD		
TR1	0.0-2.5	3.3	2.67	1.5	41.0	57.5	30.6	15.6	15.0	8.4	1.83	5.8E-8	-
TR2	0.7-3.0	7.6	2.69	23.0	23.0	54.0	43.6	21.2	22.4	14.6	1.82	7.7E-9	-
TR4	0.3-1.9	12.5	2.69	3.0	15.0	82.0	43.2	19.0	24.2	18.6	1.68	3.6E-9	-
TL1	0.0-3.0	17.4	2.64	0.0	94.0	6.0	NP	NP	NP	8.4	1.70	6.7E-4	-
TL2	0.5-2.2	26.7	2.68	0.0	2.0	98.0	57.0	22.0	35.0	21.1	1.62	9.4E-8	-
TL3	0.6-2.4	24.8	2.68	0.0	1.0	99.0	61.5	23.4	38.1	21.5	1.58	4.9E-9	-
TL3	2.4-3.0	20.9	2.66	6.0	78.0	22.0	20.2	NP	NP	11.2	1.90	8.3E-4	-
SC3	8.3-8.5	-	-	-	-	-	-	-	-	-	-	-	73.4
SC6	1.5-1.7	-	-	-	-	-	-	-	-	-	-	-	232.6

Legend

MC : Moisture content (%)
Gs : Specific gravity
sl/cl : Silt & clay content (%)
LL : Liquid limit (%)
PL : Plastic limit (%)

OMC : Optimum moisture content (%)
MDD : Maximum dry density (t/m3)
k : Permeability coefficient (cm/sec)
qu : Compressive strength of rock (kg/cm2)

Table 3.1 Basic Condition of Rational Formula

1) Rational Formula

$$Q = \frac{1}{3.6} \cdot f \cdot i \cdot A$$

Q : peak discharge (m^3/s)
f : runoff coefficient
i : rainfall intensity in time T_c (mm/hr)
A : catchment area (km^2)

2) Runoff Coefficient (f)

Land Use Type	Present Condition	Future Condition
ZONE 1 : Urban center areas, Commercial areas, High density residential areas	0.6	0.8
ZONE 2 : Low density residential areas	0.5	0.6
ZONE 3 : Industrial areas	0.6	0.6
ZONE 4 : Agricultural lands, Open spaces	0.2	0.2
ZONE 5 : Water surfaces	1.0	1.0

3) Time of Concentration (T_c)

$$T_c = T_i + T_f$$

T_c : time of concentration (min)
T_i : inlet time (min)
T_f : flow time (min)

$$T_i = 0.01947 \left(\frac{L_0}{\sqrt{S}} \right)^{0.77}$$

L_0 : overland flow length (m)
S : average basin slope

$$T_f = \frac{1}{60} \sum \frac{L_i}{v_i}$$

L_i : length in channel (m)
v_i : average velocity (m/s)

4) IDF curve formula

Station : Tunis-Carthage (1970 - 1990)

$$i = \frac{403.7 \times T^{0.31}}{t^{0.83}}$$

i : average rainfall intensity (mm/hr)
T : return period (year)
t : rainfall duration (min)

Table 3.2 Runoff Coefficient of the Oued Ennkhilat and the Sebkhat Ariana Basin

Oued Ennkhilat Basin				Present Land Use Condition						Future Land Use Condition					
Basin Code	Area (sq.km)	Ground El. Max. (mNGT)	Ground El. Min. (mNGT)	Zone 1 f=0.60 (sq.km)	Zone 2 f=0.50 (sq.km)	Zone 3 f=0.60 (sq.km)	Zone 4 f=0.20 (sq.km)	Zone 5 f=1.00 (sq.km)	Weighted f	Zone 1 f=0.60 (sq.km)	Zone 2 f=0.60 (sq.km)	Zone 3 f=0.60 (sq.km)	Zone 4 f=0.20 (sq.km)	Zone 5 f=1.00 (sq.km)	Weighted f
1	0.15	58	9	0.03			0.12		0.28	0.06			0.07		0.52
2	0.36	86	13	0.05	0.01		0.30		0.26	0.09	0.01		0.26		0.36
3	0.04	15	9	0.04			0.00		0.60	0.04			0.00		0.60
4	0.09	15	7	0.04			0.05		0.38	0.07			0.02		0.67
5	1.62	235	19	0.05	0.02		1.55		0.22	0.58	0.02		1.02		0.42
6	0.20	45	7	0.10			0.10		0.40	0.17			0.03		0.71
7	0.25	184	40				0.25		0.20	0.01			0.24		0.22
8	0.46	125	8		0.05		0.41		0.23	0.33			0.13		0.63
9	0.34	92	8	0.05			0.29		0.25	0.29			0.05		0.71
10	0.36	15	5	0.15			0.21		0.37	0.34	0.01		0.01		0.78
11	0.62	20	4	0.33			0.29		0.41	0.43	0.19		0.00		0.74
12	0.39	110	18		0.05		0.34		0.24	0.28			0.11		0.63
13	0.07	23	12		0.01		0.06		0.24	0.07			0.00		0.80
14	1.09	236	35				1.09		0.20	0.01			1.08		0.21
15	0.62	160	19		0.17		0.45		0.28	0.34			0.28		0.53
16	0.12	26	12	0.05			0.07		0.37	0.12			0.00		0.80
17	0.80	50	4	0.66			0.14		0.53	0.66	0.14		0.00		0.77
18	0.17	11	3	0.03			0.14		0.27	0.05	0.12		0.00		0.66
19	0.92	201	40				0.92		0.20				0.92		0.20
20	0.22	122	19	0.13			0.09		0.44	0.20			0.02		0.75
21	0.20	175	30				0.20		0.20	0.02			0.18		0.26
22	0.12	66	19	0.11			0.01		0.57	0.12			0.00		0.80
23	0.47	71	3	0.29			0.18		0.45	0.35	0.11		0.01		0.74
24	0.12	11	2	0.02			0.10		0.27	0.06	0.06		0.00		0.70
25	1.02	186	30				1.02		0.20				1.02		0.20
26	0.90	116	2	0.13			0.77		0.26	0.67			0.23		0.65
27	0.04	10	2				0.04		0.20	0.04			0.00		0.80
28	0.05	6	2				0.05		0.20	0.05			0.00		0.80
29	0.21	122	24				0.21		0.20	0.03			0.18		0.29
30	0.36	73	3		0.06		0.30		0.25	0.35			0.01		0.78
31	0.43	73	3	0.12			0.31		0.31	0.42			0.01		0.79
32	1.11	186	24				1.11		0.20				1.11		0.20
33	0.31	80	7		0.11		0.20		0.31	0.16			0.15		0.51
34	0.84	60	1	0.20			0.64		0.30	0.76			0.08		0.74
35	0.46	6	1				0.46		0.20				0.46		0.20
36	0.10	6	3	0.04			0.06		0.36	0.10			0.00		0.80
37	0.17	5	2	0.10			0.07		0.44	0.17			0.00		0.80
38	0.28	5	1	0.08			0.20		0.31	0.28			0.00		0.80
39	0.53	4	1		0.05		0.48		0.23	0.05			0.48		0.26
40	0.51	2	1		0.06		0.45		0.24	0.09		0.42	0.00		0.64
Total	17.12	236	1	2.80	0.59	0.00	13.73	0.00	0.28	7.88	0.66	0.42	8.16	0.00	0.50
51	1.07	6	2	0.44			0.63		0.36	0.78			0.29		0.64
52	0.70	6	2	0.25			0.45		0.34	0.50	0.14		0.06		0.71
53	6.22	14	2	3.28	0.56		2.38		0.44	4.68	1.04		0.50		0.72
54	1.44	2	1			0.06	1.38		0.22			0.42	1.02		0.32
Total	9.43	14	1	3.97	0.56	0.06	4.84	0.00	0.39	5.96	1.18	0.42	1.87	0.00	0.65
51-54	9.43	14	1	3.97	0.56	0.06	4.84		0.39	5.96	1.18	0.42	1.87		0.65
61	4.37	8	1	1.55	0.05		2.77		0.35	3.07	0.31		0.99		0.65
62	4.78	15	1	0.65	0.03		4.10		0.26	2.16	0.03		2.59		0.47
63	15.33	125	1	5.74	0.60	0.10	8.89		0.36	7.18	1.28	0.50	6.37		0.53
64	2.87	4	1				2.87		0.20				2.87		0.20
65	5.69	95	1	0.62	0.35		4.72		0.26	2.05	0.79		2.85		0.47
66	7.12	15	1				7.12		0.20				7.12		0.20
67	1.86	176	1	0.20			1.66		0.24	0.25			1.61		0.28
68	1.94	146	1	0.18			1.76		0.24	0.23			1.71		0.27
69	4.64	120	1	0.15			4.49		0.21	0.30			4.34		0.24
70	5.92	5	1	0.42			5.50		0.23	1.04			4.88		0.31
Total	63.95	176	1	13.48	1.59	0.16	48.72	0.00	0.29	22.24	3.59	0.92	37.20	0.00	0.44
1-40	17.12	236	1	2.80	0.59		13.73		0.28	7.88	0.66	0.42	8.16		0.50
51-70	63.95	176	1	13.48	1.59	0.16	48.72		0.29	22.24	3.59	0.92	37.20		0.44
80	36.46	-	-				0.00	36.46	1.00				0.00	36.46	1.00
Total	117.53	236	1	16.28	2.18	0.16	62.45	36.46	0.51	30.12	4.25	1.34	45.36	36.46	0.62

Note) Zone 1 : Urban center, Commercial and High density residential areas
Zone 2 : Low density residential areas
Zone 3 : Industrial areas
Zone 4 : Agricultural lands and Open spaces
Zone 5 : Water surfaces

Table 3.3 Calculated Basic Flood Runoff In Oued Ennkhilet Basin (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.8	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.28	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.6	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.62	0.24	40	2.3	2.6	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	32	1.0	1.2	1.6	2.0	2.7	3.3	4.1
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	Dam - J	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
17	7-9	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
18	1-9	3.51	0.25	40	4.7	5.7	7.6	9.4	12.5	15.5	19.2
19	1-10	3.87	0.25	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
20	1-11	4.49	0.26	74	4.0	4.9	6.5	8.1	10.7	13.3	16.5
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Ain Snoussi Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.69	0.24	33	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	33	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	1-17	7.58	0.29	74	7.0	8.6	11.4	14.1	18.8	23.3	28.9
31	1-18	7.75	0.29	81	6.7	8.1	10.8	13.4	17.8	22.1	27.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	1-23	9.68	0.30	81	8.6	10.5	14.0	17.3	23.0	28.5	35.4
42	1-24	9.80	0.30	90	8.0	9.7	13.0	16.1	21.4	26.5	32.8
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	1-26	11.72	0.29	90	9.2	11.3	15.0	18.6	24.7	30.6	37.9
48	1-27	11.76	0.29	92	9.1	11.1	14.8	18.3	24.3	30.1	37.4
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	1-33	14.23	0.28	92	10.6	13.0	17.3	21.4	28.4	35.2	43.7
60	1-34	15.07	0.28	107	9.9	12.1	16.1	20.0	26.5	32.9	40.8
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
62	36-37	0.27	0.41	36	0.6	0.8	1.0	1.2	1.6	2.0	2.5
63	36-38	0.55	0.36	49	0.9	1.1	1.4	1.8	2.4	3.0	3.7
64	39	0.59	0.23	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	36-39	1.09	0.30	64	1.2	1.4	1.9	2.3	3.1	3.9	4.8
66	36-40	1.59	0.28	75	1.4	1.7	2.3	2.8	3.8	4.7	5.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.28	107	11.3	13.8	18.3	22.7	30.2	37.4	46.4

Table 3.3 Calculated Basic Flood Runoff in Oued Ennkhilet Basin (2/2)

Runoff Calculation by Rational Method (Future Land Use Condition)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	32	2.2	2.7	3.6	4.5	6.0	7.4	9.2
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	Dam - J	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
17	7-9	1.05	0.56	32	3.8	4.6	6.1	7.6	10.1	12.5	15.5
18	1-9	3.51	0.49	40	9.2	11.2	14.9	18.4	24.5	30.3	37.6
19	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
20	1-11	4.49	0.55	74	7.9	9.6	12.8	15.9	21.1	26.1	32.4
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.83	0.36	33	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	33	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	1-17	7.58	0.53	74	12.9	15.7	20.6	25.6	34.3	42.5	52.8
31	1-18	7.75	0.53	81	12.2	14.9	19.8	24.5	32.6	40.3	50.0
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	1-23	9.68	0.51	81	14.7	17.9	23.8	29.4	39.1	48.5	60.1
42	1-24	9.80	0.52	90	13.9	16.9	22.5	27.9	37.0	45.9	56.9
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	1-26	11.72	0.50	90	15.9	19.4	25.8	32.0	42.6	52.7	65.4
48	1-27	11.76	0.50	92	15.7	19.1	25.5	31.6	41.9	52.0	64.4
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-39	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.85	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-39	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	28-39	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	1-33	14.23	0.49	92	18.6	22.7	30.2	37.4	49.7	61.6	76.4
60	1-34	15.07	0.50	107	17.7	21.6	28.8	35.7	47.4	58.7	72.9
61	36	0.10	0.80	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
62	36-37	0.27	0.80	38	1.2	1.5	1.9	2.4	3.2	4.0	4.9
63	36-38	0.55	0.80	49	2.0	2.4	3.2	4.0	5.3	6.6	8.1
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	36-39	1.06	0.54	64	2.1	2.6	3.4	4.2	5.6	7.0	8.6
66	36-40	1.59	0.57	75	2.9	3.5	4.7	5.8	7.7	9.5	11.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.50	107	20.2	24.6	32.7	40.5	53.9	66.7	82.8

Table 3.4 Calculated Basic Flood Runoff in Sebkhet Ariana Basin

Runoff Calculation by Rational Method (Present Land Use)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
	1-40	17.12	0.28	122	10.1	12.3	16.4	20.4	27.0	33.5	41.6
81	51	1.07	0.36	55	1.6	1.9	2.6	3.2	4.2	5.2	6.5
82	52	0.70	0.34	59	0.9	1.1	1.5	1.8	2.5	3.0	3.8
83	53	6.22	0.44	148	4.9	6.0	8.0	9.9	13.2	16.3	20.2
84	51-53	7.99	0.42	148	6.0	7.4	9.8	12.1	16.1	20.0	24.8
85	51-54	9.43	0.39	172	5.8	7.1	9.5	11.7	15.6	19.3	24.0
86	61	4.37	0.36	154	2.7	3.2	4.3	5.4	7.1	8.8	10.9
87	62	4.76	0.26	86	3.5	4.3	5.7	7.1	9.4	11.6	14.4
88	63	15.33	0.36	135	10.7	13.1	17.4	21.5	28.6	35.5	44.0
89	64	2.87	0.20	59	2.2	2.7	3.6	4.5	5.9	7.3	9.1
90	65	5.69	0.26	52	6.3	7.7	10.3	12.7	16.9	21.0	26.0
91	66	7.12	0.20	46	6.8	8.2	11.0	13.6	18.1	22.4	27.7
92	67	1.86	0.24	40	2.4	2.9	3.9	4.8	6.4	7.9	9.8
93	68	1.94	0.24	34	2.8	3.5	4.6	5.7	7.6	9.4	11.7
94	69	4.64	0.21	58	3.8	4.7	6.2	7.7	10.2	12.6	15.7
95	70	5.92	0.23	118	3.0	3.6	4.8	5.9	7.9	9.8	12.1
	51-54,61-70	63.95	0.29	172	29.5	35.9	47.8	59.2	78.7	97.5	120.9
	1-40,51-54,61-70	81.07	0.29	172	37.3	45.5	60.6	75.1	99.7	123.6	153.3
96	60	36.46	1.00	172	57.9	70.6	93.9	116.4	154.7	191.7	237.7
97	1-40,51-54,61-70,60	117.53	0.51	172	95.2	116.1	154.4	191.4	254.3	315.1	390.9

Runoff Calculation by Rational Method (Future Land Use Condition)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
	1-40	17.12	0.50	122	18.1	22.1	29.3	36.3	48.3	59.9	74.2
81	51	1.07	0.64	55	2.8	3.4	4.5	5.6	7.5	9.3	11.5
82	52	0.70	0.71	59	1.9	2.3	3.1	3.9	5.1	6.4	7.9
83	53	6.22	0.72	148	8.1	9.8	13.1	16.2	21.5	26.7	33.1
84	51-53	7.99	0.71	148	10.2	12.4	16.6	20.5	27.3	33.8	41.9
85	51-54	9.43	0.65	172	9.7	11.9	15.8	19.6	26.0	32.2	40.0
86	61	4.37	0.65	154	4.9	6.0	8.0	9.9	13.2	16.4	20.3
87	62	4.76	0.47	86	6.3	7.7	10.3	12.8	16.9	21.0	26.0
88	63	15.33	0.53	135	15.8	19.2	25.6	31.7	42.1	52.2	64.8
89	64	2.87	0.20	59	2.2	2.7	3.6	4.5	5.9	7.3	9.1
90	65	5.69	0.47	52	11.5	14.0	18.6	23.0	30.6	37.9	47.1
91	66	7.12	0.20	46	6.8	8.2	11.0	13.6	18.1	22.4	27.7
92	67	1.86	0.28	40	2.8	3.4	4.5	5.6	7.4	9.2	11.4
93	68	1.94	0.27	34	3.2	3.9	5.2	6.4	8.5	10.6	13.1
94	69	4.64	0.24	58	4.4	5.3	7.1	8.8	11.6	14.4	17.9
95	70	5.92	0.31	118	4.0	4.9	6.5	8.0	10.6	13.2	16.4
	51-54,61-70	63.95	0.44	172	44.7	54.5	72.5	89.8	119.4	147.9	183.5
	1-40,51-54,61-70	81.07	0.45	172	58.0	70.7	94.0	116.5	154.8	191.8	237.9
96	60	36.46	1.00	172	57.9	70.6	93.9	116.4	154.7	191.7	237.7
97	1-40,51-54,61-70,60	117.53	0.62	172	115.8	141.2	187.7	232.6	309.1	383.1	475.2

Table 3.5 Calculated Flood Runoff in Oued Ennkhilet Basin with Existing Flood Control Facilities (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.8	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.26	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.5	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.82	0.24	40	2.3	2.8	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	32	1.0	1.2	1.6	2.0	2.7	3.3	4.1
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	Dam - J	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
17	7-9	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
18	1-9	3.51	0.25	40	4.7	5.7	7.6	9.4	12.5	15.5	19.2
19	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
20	1-11	4.49	0.28	74	4.0	4.9	6.5	8.1	10.7	13.3	16.5
21	14	1.09	0.20	12	3.2	3.6	5.1	6.3	8.4	10.4	13.0
22	Ain Snoussi Dam	1.09	0.20	12	0.2	0.2	0.2	0.2	0.2	0.2	0.2
23	14-15	1.71	0.23	25	1.4	1.7	2.2	2.7	3.7	4.5	5.6
24	14-16	1.83	0.24	33	1.3	1.6	2.2	2.7	3.6	4.4	5.5
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	39	2.0	2.5	3.3	4.1	5.4	6.7	8.3
28	12-17	3.09	0.31	52	3.3	4.0	5.3	6.5	8.7	10.8	13.4
29	Dam - L	3.09	0.31	52	3.3	4.0	5.3	6.5	8.7	10.8	13.4
30	1-17	7.58	0.29	74	6.4	7.8	10.4	12.9	17.2	21.3	26.4
31	1-18	7.75	0.29	81	6.1	7.5	9.9	12.3	16.4	20.3	25.2
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	46	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	46	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	1-23	9.68	0.30	81	7.9	9.6	12.8	15.9	21.1	26.2	32.4
42	1-24	9.80	0.30	90	7.3	9.0	11.9	14.8	19.6	24.3	30.1
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	1-26	11.72	0.29	90	8.4	10.2	13.6	16.8	22.4	27.7	34.4
48	1-27	11.76	0.29	92	8.3	10.1	13.4	16.6	22.1	27.3	33.9
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	1-33	14.23	0.28	92	9.6	12.0	15.9	19.7	26.2	32.5	40.3
60	1-34	15.07	0.28	107	9.5	11.6	15.5	19.2	25.5	31.6	39.2
61	35	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
62	36-37	0.27	0.41	38	0.6	0.8	1.0	1.2	1.6	2.0	2.5
63	36-38	0.55	0.36	49	0.9	1.1	1.4	1.8	2.4	3.0	3.7
64	39	0.53	0.23	84	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	36-39	1.08	0.30	64	1.2	1.4	1.9	2.3	3.1	3.9	4.8
66	36-40	1.59	0.28	75	1.4	1.7	2.3	2.8	3.8	4.7	5.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.28	107	10.6	12.9	17.1	21.2	28.2	35.0	43.4

Table 3.5 Calculated Flood Runoff in Oued Ennkhilet Basin with Existing Flood Control Facilities (2/2)

Runoff Calculation by Rational Method (Future Land Use Condition)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	32	2.2	2.7	3.6	4.5	6.0	7.4	9.2
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	Dam - J	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
17	7-9	1.05	0.56	32	3.8	4.6	6.1	7.6	10.1	12.5	15.5
18	1-9	3.51	0.49	40	9.2	11.2	14.9	18.4	24.5	30.3	37.6
19	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
20	1-11	4.49	0.55	74	7.9	9.6	12.8	15.9	21.1	26.1	32.4
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	0.2	0.2	0.2	0.2	0.2	0.2	0.2
23	14-15	1.71	0.33	25	2.6	3.2	4.2	5.2	6.9	8.6	10.6
24	14-16	1.83	0.36	33	2.6	3.2	4.3	5.3	7.0	8.7	10.8
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	33	4.6	5.6	7.4	9.2	12.2	15.2	18.8
28	12-17	3.09	0.51	52	5.7	7.0	9.3	11.5	15.3	19.0	23.6
29	Dam - L	3.09	0.51	52	5.7	7.0	9.3	11.5	15.3	19.0	23.6
30	1-17	7.58	0.53	74	12.0	14.7	19.5	24.2	32.2	39.9	49.4
31	1-18	7.75	0.53	81	11.7	14.2	18.9	23.4	31.1	38.6	47.9
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	1-23	9.68	0.51	81	14.0	17.1	22.7	28.2	37.4	46.4	57.6
42	1-24	9.80	0.52	90	13.0	15.9	21.1	26.2	34.8	43.1	53.5
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	1-26	11.72	0.50	90	15.3	18.7	24.8	30.8	40.9	50.7	62.9
48	1-27	11.76	0.50	92	15.1	18.4	24.5	30.3	40.3	50.0	62.0
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.85	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	28-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	1-33	14.23	0.49	92	17.9	21.8	29.0	36.0	47.8	59.2	73.5
60	1-34	15.07	0.50	107	17.5	21.3	28.3	35.1	46.6	57.8	71.6
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
62	36-37	0.27	0.60	36	1.2	1.5	1.9	2.4	3.2	4.0	4.9
63	36-38	0.55	0.60	49	2.0	2.4	3.2	4.0	5.9	6.6	8.1
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	36-39	1.06	0.54	64	2.1	2.6	3.4	4.2	5.6	7.0	8.6
66	36-40	1.59	0.57	75	2.9	3.5	4.7	5.8	7.7	9.5	11.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.50	107	19.6	23.9	31.8	39.5	52.4	65.0	80.6

Table 3.6 Calculated Flood Runoff with Diversion 3 Plan (1/3)

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 3 (Upper reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.96	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.96	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.8	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.28	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.5	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.82	0.24	40	2.3	2.8	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	32	1.0	1.2	1.6	2.0	2.7	3.3	4.1
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	Dam - J	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
17	7-9	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
18	1-9	3.51	0.25	40	4.7	5.7	7.6	9.4	12.5	15.5	19.2
19	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
70	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
82	1-10,52	4.57	0.27	66	3.4	4.2	5.5	6.9	9.1	11.3	14.0
81	51	1.07	0.36	55	1.6	1.9	2.6	3.2	4.2	5.2	6.5
83	53	6.22	0.44	148	4.9	6.0	8.0	9.9	13.2	16.3	20.2
84	1-10,51-53	11.86	0.37	148	7.9	9.6	12.8	15.9	21.1	26.1	32.4
85	1-10,51-54	13.30	0.36	172	7.4	9.0	12.0	14.9	19.7	24.5	30.4

Runoff Calculation by Rational Method

Alt. - Diversion 3 (Upper reaches) (Future Land Use Condition)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.96	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.96	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	32	2.2	2.7	3.6	4.5	6.0	7.4	9.2
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	Dam - J	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
17	7-9	1.05	0.56	32	3.6	4.6	6.1	7.6	10.1	12.5	15.5
18	1-9	3.51	0.49	40	9.2	11.2	14.9	18.4	24.5	30.3	37.6
19	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
70	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
82	1-10,52	4.57	0.54	66	6.8	8.3	11.1	13.7	18.3	22.6	28.1
81	51	1.07	0.64	55	2.8	3.4	4.5	5.6	7.5	9.3	11.5
83	53	6.22	0.72	148	8.1	9.8	13.1	16.2	21.5	26.7	33.1
84	1-10,51-53	11.86	0.64	148	13.7	16.7	22.2	27.5	36.5	45.2	56.1
85	1-10,51-54	13.30	0.61	172	12.9	15.7	20.9	25.9	34.4	42.7	52.9

Table 3.6 Calculated Flood Runoff with Diversion 3 Plan (2/3)

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 3 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.41	42	1.3	1.6	2.1	2.6	3.5	4.3	5.3
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Ain Snousel Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.83	0.24	30	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	39	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	11-17	3.71	0.33	52	5.2	6.4	8.5	10.5	14.0	17.4	21.5
31	11-18	3.88	0.33	59	4.9	6.0	8.0	9.9	13.2	16.4	20.3
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	11-23	5.61	0.32	59	7.2	8.8	11.6	14.4	19.2	23.8	29.5
42	11-24	5.93	0.32	68	6.5	7.9	10.6	13.1	17.4	21.6	26.7
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	11-26	7.65	0.30	68	8.1	9.9	13.1	16.2	21.6	26.7	33.2
48	11-27	7.89	0.30	70	7.9	9.7	12.9	15.9	21.2	26.2	32.5
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	11-33	10.36	0.28	70	9.7	11.9	15.8	19.5	26.0	32.2	39.9
60	11-34	11.20	0.29	85	9.3	11.3	15.0	18.6	24.7	30.7	38.0
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
71	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
62	36-37	0.27	0.41	36	0.6	0.8	1.0	1.2	1.6	2.0	2.5
72	36-37	0.27	0.41	36	0.6	0.8	1.0	1.2	1.6	2.0	2.5
63	36-38	0.55	0.36	49	0.9	1.1	1.4	1.8	2.4	3.0	3.7
64	39	0.53	0.23	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	36-39	1.08	0.30	64	1.2	1.4	1.9	2.3	3.1	3.9	4.8
66	36-40	1.59	0.28	75	1.4	1.7	2.3	2.8	3.8	4.7	5.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.28	85	10.6	12.9	17.2	21.3	28.3	35.0	43.4

Table 3.6 Calculated Flood Runoff with Diversion 3 Plan (3/3)

Runoff Calculation by Rational Method (Future Land Use Condition)

Alt. - Diversion 3 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.74	42	2.3	2.9	3.8	4.7	6.3	7.8	9.6
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.83	0.36	33	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	33	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	11-17	3.71	0.55	52	8.7	10.7	14.2	17.6	23.4	29.0	35.9
31	11-18	3.88	0.55	59	8.2	10.0	13.4	16.6	22.0	27.3	33.8
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.6	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	11-23	5.81	0.51	59	11.4	14.0	18.6	23.0	30.6	37.9	47.0
42	11-24	5.93	0.52	68	10.6	12.9	17.2	21.3	28.3	35.0	43.4
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	11-26	7.65	0.49	68	13.2	16.1	21.4	26.5	35.3	43.7	54.2
48	11-27	7.89	0.49	70	13.0	15.8	21.0	26.0	34.6	42.9	53.2
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.85	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	28-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	11-33	10.36	0.48	70	16.7	20.3	27.0	33.5	44.5	55.1	68.4
60	11-34	11.20	0.50	85	16.0	19.5	25.9	32.1	42.6	52.9	65.5
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
71	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
62	36-37	0.27	0.60	38	1.2	1.5	1.9	2.4	3.2	4.0	4.9
72	36-37	0.27	0.60	38	1.2	1.5	1.9	2.4	3.2	4.0	4.9
63	36-38	0.55	0.60	49	2.0	2.4	3.2	4.0	5.3	6.6	8.1
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	36-39	1.08	0.54	64	2.1	2.6	3.4	4.2	5.6	7.0	8.6
66	36-40	1.59	0.57	75	2.9	3.5	4.7	5.8	7.7	9.5	11.8
67	35	0.46	0.20	55	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.50	85	18.9	23.0	30.6	38.0	50.5	62.5	77.5

Table 3.7 Calculated Flood Runoff with Diversion 4 Plan (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Alt. Diversion 4

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. I	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.8	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.26	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.5	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.82	0.24	40	2.3	2.8	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	32	1.0	1.2	1.6	2.0	2.7	3.3	4.1
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	Dam - J	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
17	7-9	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
18	1-9	3.51	0.25	40	4.7	5.7	7.6	9.4	12.5	15.5	19.2
19	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
70	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
20	1-11	4.49	0.28	74	4.0	4.9	6.5	8.1	10.7	13.3	16.5
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Ain Snoussi Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.83	0.24	33	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	33	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	1-17	7.58	0.29	74	7.0	8.6	11.4	14.1	18.8	23.3	28.9
31	18	0.17	0.27	27	0.3	0.4	0.5	0.7	0.9	1.1	1.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	18-23	2.10	0.31	49	3.0	3.6	4.8	6.0	8.0	9.9	12.2
42	18-24	2.22	0.31	57	2.7	3.3	4.4	5.5	7.3	9.0	11.2
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	18-26	4.14	0.27	57	4.4	5.4	7.2	8.9	11.9	14.7	18.2
48	18-27	4.18	0.27	58	4.4	5.4	7.2	8.9	11.8	14.6	18.1
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.8	5.8	7.7	9.5	11.8
59	18-33	6.65	0.26	58	6.8	8.3	11.0	13.6	18.1	22.4	27.8
60	18-34	7.49	0.26	74	6.2	7.6	10.1	12.5	16.6	20.6	25.6
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
71	1-17,36	7.68	0.30	79	7.0	8.5	11.3	14.0	18.6	23.1	28.7
62	1-17,36-37	7.85	0.30	88	6.5	8.0	10.6	13.1	17.4	21.6	26.8
72	1-17,36-37	7.85	0.30	88	6.5	8.0	10.6	13.1	17.4	21.6	26.8
63	1-17,36-38	8.13	0.30	97	6.2	7.6	10.1	12.5	16.6	20.6	25.6
64	39	0.53	0.23	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	1-17,36-39	8.66	0.29	97	6.4	7.8	10.4	12.9	17.1	21.2	26.3
66	1-17,36-40	9.17	0.29	105	6.4	7.8	10.3	12.8	17.0	21.1	26.1
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.28	105	11.5	14.0	18.6	23.1	30.6	38.0	47.1

Table 3.7 Calculated Flood Runoff with Diversion 4 Plan (2/2)

Runoff Calculation by Rational Method (Future Land Use Condition)

Alt. Diversion 4

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	32	2.2	2.7	3.6	4.5	6.0	7.4	9.2
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	Dam - J	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
17	7-9	1.05	0.56	32	3.8	4.6	6.1	7.6	10.1	12.5	15.5
18	1-9	3.51	0.49	40	9.2	11.2	14.9	18.4	24.5	30.3	37.6
19	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
70	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
20	1-11	4.49	0.55	74	7.9	9.6	12.8	15.9	21.1	26.1	32.4
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.83	0.36	33	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	33	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	1-17	7.58	0.53	74	12.9	15.7	20.9	25.8	34.3	42.5	52.8
31	18	0.17	0.66	27	0.8	1.0	1.3	1.7	2.2	2.7	3.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	18-23	2.10	0.46	48	4.4	5.4	7.2	8.9	11.8	14.6	18.2
42	18-24	2.22	0.47	57	4.1	5.1	6.7	8.3	11.1	13.7	17.0
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	18-26	4.14	0.44	57	7.2	8.8	11.7	14.5	19.3	24.0	29.7
48	18-27	4.18	0.45	58	7.4	9.0	11.9	14.8	19.7	24.4	30.2
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.85	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.9	9.0	11.2	14.9	18.4	22.8
58	28-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	18-33	6.65	0.45	58	11.7	14.3	19.0	23.6	31.3	38.8	48.1
60	18-34	7.49	0.49	74	11.5	14.0	18.7	23.1	30.7	38.1	47.2
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
71	1-17,36	7.68	0.53	79	12.3	15.0	20.0	24.8	32.9	40.8	50.6
62	1-17,36-37	7.65	0.54	88	11.7	14.3	19.0	23.6	31.4	38.9	48.2
72	1-17,36-37	7.65	0.54	88	11.7	14.3	19.0	23.6	31.4	38.9	48.2
63	1-17,36-38	8.13	0.55	97	11.4	13.9	18.5	23.0	30.5	37.8	46.9
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	1-17,36-39	8.66	0.53	97	11.7	14.3	19.0	23.6	31.3	38.8	48.1
66	1-17,36-40	9.17	0.54	105	11.8	14.4	19.2	23.8	31.6	39.2	48.6
67	35	0.46	0.20	56	0.4	0.5	0.8	0.7	1.0	1.2	1.5
68	1-40	17.12	0.50	105	20.5	25.0	33.2	41.2	54.7	67.8	84.1

Table 3.8 Calculated Flood Runoff with Diversion 5 Plan (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Alt. Diversion 5

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.9	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.28	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.5	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.82	0.24	40	2.3	2.8	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	32	1.0	1.2	1.6	2.0	2.7	3.3	4.1
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	Dam - J	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
17	7-9	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
18	1-9	3.51	0.25	40	4.7	5.7	7.6	9.4	12.5	15.5	19.2
19	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
70	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
20	1-11	4.49	0.28	74	4.0	4.9	6.5	8.1	10.7	13.3	16.5
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Ain Snoussi Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.83	0.24	33	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	33	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	1-17	7.58	0.29	74	7.0	8.6	11.4	14.1	18.8	23.3	28.9
31	1-18	7.75	0.29	81	6.7	8.1	10.8	13.4	17.8	22.1	27.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	1-23	9.68	0.30	81	8.6	10.5	14.0	17.3	23.0	28.5	35.4
42	24	0.12	0.27	25	0.3	0.3	0.4	0.5	0.7	0.8	1.0
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	24-26	2.04	0.23	43	2.4	2.9	3.8	4.7	6.3	7.8	9.7
48	24-27	2.08	0.23	44	2.4	2.9	3.8	4.7	6.3	7.8	9.7
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	24-33	4.55	0.24	45	5.3	6.4	8.6	10.6	14.1	17.5	21.7
60	24-34	5.39	0.25	60	5.1	6.3	8.3	10.3	13.7	17.0	21.1
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
71	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
62	36-37	0.27	0.41	38	0.6	0.8	1.0	1.2	1.6	2.0	2.5
72	1-23,36-37	9.95	0.30	90	8.1	9.9	13.2	16.3	21.7	26.9	33.3
63	1-23,36-38	10.23	0.30	98	7.8	9.5	12.6	15.6	20.8	25.7	31.9
64	39	0.53	0.23	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	1-23,36-39	10.76	0.30	98	8.2	10.0	13.3	16.4	21.8	27.1	33.6
66	1-23,36-40	11.27	0.29	107	7.7	9.4	12.5	15.5	20.6	25.5	31.6
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.28	107	11.3	13.8	18.3	22.7	30.2	37.4	46.4

Table 3.8 Calculated Flood Runoff with Diversion 5 Plan (2/2)

Runoff Calculation by Rational Method (Future Land Use Condition)

Alt. Diversion 5

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	32	2.2	2.7	3.6	4.5	6.0	7.4	9.2
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	Dam - J	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
17	7-9	1.05	0.56	32	3.8	4.6	6.1	7.6	10.1	12.5	15.5
18	1-9	3.51	0.49	40	9.2	11.2	14.9	18.4	24.5	30.3	37.6
19	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
70	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
20	1-11	4.49	0.55	74	7.9	9.6	12.8	15.9	21.1	26.1	32.4
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.83	0.36	33	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	33	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	1-17	7.58	0.53	74	12.9	15.7	20.8	25.8	34.3	42.5	52.8
31	1-18	7.75	0.53	81	12.2	14.9	19.8	24.5	32.6	40.3	50.0
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	1-23	9.68	0.51	81	14.7	17.9	23.8	29.4	39.1	48.5	60.1
42	24	0.12	0.70	25	0.7	0.8	1.1	1.3	1.8	2.2	2.7
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	24-26	2.04	0.43	43	4.4	5.4	7.1	8.9	11.8	14.6	18.1
48	24-27	2.08	0.44	44	4.5	5.5	7.3	9.1	12.0	14.9	18.5
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.9	5.4	7.1	8.8	11.0
52	31-33	1.85	0.38	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	28-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	24-33	4.55	0.44	45	9.7	11.8	15.7	19.5	25.8	32.0	39.7
60	24-34	5.39	0.49	60	10.1	12.3	16.3	20.2	26.9	33.3	41.3
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
71	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
62	36-37	0.27	0.60	38	1.2	1.5	1.9	2.4	3.2	4.0	4.9
72	1-23,36-37	9.95	0.52	90	14.1	17.2	22.9	28.3	37.6	46.6	57.8
63	1-23,36-39	10.23	0.53	98	13.7	16.8	22.3	27.6	36.7	45.5	56.4
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	1-23,36-39	10.76	0.52	98	14.2	17.3	23.0	28.5	37.9	46.9	58.2
66	1-23,36-40	11.27	0.52	107	13.8	16.8	22.4	27.7	36.9	45.7	56.7
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	1-40	17.12	0.50	107	20.2	24.6	32.7	40.5	53.9	66.7	82.8

Table 3.9 Calculated Flood Runoff with Diversion 1 and 3 Plan

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 1 and 3 (Upper reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.8	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.28	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.5	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.82	0.24	40	2.3	2.8	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	32	1.0	1.2	1.6	2.0	2.7	3.3	4.1
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	7-9	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
17	Dam - J	1.05	0.23	32	1.5	1.9	2.5	3.1	4.1	5.1	6.4
18	1-9	3.51	0.25	40	4.7	5.7	7.6	9.4	12.5	15.5	19.2
19	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
70	1-10	3.87	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
82	1-10,52	4.57	0.27	88	3.4	4.2	5.5	6.9	9.1	11.3	14.0
81	51	1.07	0.36	55	1.6	1.9	2.6	3.2	4.2	5.2	6.5
83	53	6.22	0.44	148	4.9	6.0	8.0	9.9	13.2	16.3	20.2
84	1-10,51-53	11.86	0.37	148	7.9	9.6	12.8	15.9	21.1	26.1	32.4
85	1-10,51-54	13.30	0.35	172	7.4	9.0	12.0	14.9	19.7	24.5	30.4

Runoff Calculation by Rational Method (Future Land Use Condition)

Alt. - Diversion 1 and 3 (Upper reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	32	2.2	2.7	3.6	4.5	6.0	7.4	9.2
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	7-9	1.05	0.56	32	3.8	4.6	6.1	7.6	10.1	12.5	15.5
17	Dam - J	1.05	0.56	32	3.8	4.6	6.1	7.6	10.1	12.5	15.5
18	1-9	3.51	0.49	40	9.2	11.2	14.9	18.4	24.5	30.3	37.6
19	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
70	1-10	3.87	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
82	1-10,52	4.57	0.54	88	6.8	8.3	11.1	13.7	18.3	22.6	28.1
81	51	1.07	0.64	55	2.8	3.4	4.5	5.6	7.5	9.3	11.5
83	53	6.22	0.72	148	8.1	9.8	13.1	16.2	21.5	26.7	33.1
84	1-10,51-53	11.66	0.64	148	13.7	16.7	22.2	27.5	36.5	45.2	56.1
85	1-10,51-54	13.30	0.61	172	12.9	15.7	20.9	25.9	34.4	42.7	52.9

Table 3.10 Calculated Flood Runoff with Diversion 2 and 3 Plan

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 2 and 3 (Upper reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
2	Dam - H	0.36	0.26	10	1.6	1.9	2.6	3.2	4.2	5.2	6.5
3	2-3	0.40	0.29	14	1.5	1.8	2.4	3.0	3.9	4.9	6.1
4	1	0.15	0.28	11	0.7	0.8	1.1	1.3	1.7	2.2	2.7
5	1-3	0.55	0.29	14	2.0	2.5	3.3	4.1	5.4	6.7	8.3
6	1-4	0.64	0.30	24	1.6	1.9	2.5	3.1	4.2	5.2	6.4
7	5	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
8	Dam - G	1.62	0.22	30	2.4	2.9	3.9	4.8	6.4	8.0	9.9
9	5-6	1.82	0.24	40	2.3	2.8	3.8	4.7	6.2	7.7	9.6
10	1-6	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
11	Dam - I	2.46	0.26	40	3.4	4.2	5.5	6.9	9.1	11.3	14.0
12	7	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
13	Dam - F	0.25	0.20	7	1.1	1.4	1.8	2.3	3.0	3.7	4.6
14	7-8	0.71	0.22	27	1.2	1.4	1.9	2.3	3.1	3.8	4.7
15	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
16	Dam - J	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
17	9	0.34	0.26	10	1.5	1.8	2.4	3.0	4.0	4.9	6.1
18	1-6,9	2.80	0.26	40	3.9	4.7	6.3	7.8	10.4	12.8	15.9
19	1-6,9-10	3.16	0.27	56	3.4	4.2	5.6	6.9	9.2	11.4	14.1
69	7-8	0.71	0.22	40	0.8	1.0	1.4	1.7	2.2	2.8	3.4
70	1-10	3.67	0.26	56	4.1	4.9	6.6	8.2	10.8	13.4	16.7
82	1-10,52	4.57	0.27	88	3.4	4.2	5.5	6.9	9.1	11.3	14.0
81	51	1.07	0.36	55	1.6	1.9	2.6	3.2	4.2	5.2	6.5
83	53	6.22	0.44	148	4.9	6.0	8.0	9.9	13.2	16.3	20.2
84	1-10,51-53	11.86	0.37	148	7.9	9.6	12.8	15.9	21.1	26.1	32.4
85	1-10,51-54	13.30	0.35	172	7.4	9.0	12.0	14.9	19.7	24.5	30.4

Runoff Calculation by Rational Method

Alt. - Diversion 2 and 3 (Upper reaches) (Future Land Use Condition)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
1	2	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
2	Dam - H	0.36	0.36	10	2.2	2.7	3.5	4.4	5.8	7.2	9.0
3	2-3	0.40	0.40	14	2.0	2.5	3.3	4.1	5.4	6.7	8.4
4	1	0.15	0.52	11	1.2	1.5	2.0	2.4	3.2	4.0	5.0
5	1-3	0.55	0.44	14	3.1	3.8	5.0	6.2	8.2	10.2	12.7
6	1-4	0.64	0.47	24	2.5	3.0	4.0	4.9	6.5	8.1	10.1
7	5	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
8	Dam - G	1.62	0.42	30	4.6	5.6	7.5	9.3	12.3	15.2	18.9
9	5-6	1.82	0.45	40	4.4	5.3	7.1	8.8	11.7	14.4	17.9
10	1-6	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
11	Dam - I	2.46	0.46	40	6.0	7.4	9.8	12.1	16.1	20.0	24.8
12	7	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
13	Dam - F	0.25	0.22	7	1.2	1.5	2.0	2.5	3.3	4.1	5.1
14	7-8	0.71	0.49	27	2.6	3.1	4.2	5.2	6.9	8.5	10.5
15	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
16	Dam - J	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
17	9	0.34	0.71	10	4.1	5.0	6.6	8.2	10.9	13.5	16.7
18	1-6,9	2.80	0.49	40	7.3	8.9	11.9	14.7	19.5	24.2	30.0
19	1-6,9-10	3.16	0.52	56	6.6	8.1	10.7	13.3	17.7	21.9	27.2
69	7-8	0.71	0.49	40	1.9	2.3	3.0	3.7	5.0	6.1	7.6
70	1-10	3.67	0.51	56	8.0	9.7	12.9	16.0	21.3	26.3	32.7
82	1-10,52	4.57	0.54	88	6.6	8.3	11.1	13.7	18.3	22.6	28.1
81	51	1.07	0.64	55	2.8	3.4	4.5	5.6	7.5	9.3	11.5
83	53	6.22	0.72	148	8.1	9.8	13.1	16.2	21.5	26.7	33.1
84	1-10,51-53	11.86	0.64	148	13.7	16.7	22.2	27.5	36.5	45.2	56.1
85	1-10,51-54	13.30	0.61	172	12.9	15.7	20.9	25.9	34.4	42.7	52.9

Table 3.11 Calculated Flood Runoff with Diversion 3 and 4 Plan (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 3 and 4 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.41	42	1.3	1.6	2.1	2.6	3.5	4.3	5.3
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Ain Snoussi Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.80	0.24	33	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	39	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	11-17	3.71	0.39	52	5.2	6.4	8.5	10.5	14.0	17.4	21.5
31	18	0.17	0.27	27	0.3	0.4	0.5	0.7	0.9	1.1	1.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	18-23	2.10	0.31	48	3.0	3.6	4.8	6.0	8.0	9.9	12.2
42	18-24	2.22	0.31	57	2.7	3.3	4.4	5.5	7.3	9.0	11.2
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	18-26	4.14	0.27	57	4.4	5.4	7.2	8.9	11.9	14.7	18.2
48	18-27	4.18	0.27	58	4.4	5.4	7.2	8.9	11.8	14.6	18.1
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	18-33	6.65	0.26	59	6.8	8.3	11.0	13.6	18.1	22.4	27.8
60	18-34	7.49	0.26	74	6.2	7.6	10.1	12.5	16.6	20.6	25.6
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
-	Div. 4 (11-17)	3.71	0.39	57	4.9	5.9	7.9	9.8	13.0	16.1	20.0
71	11-17,36	3.81	0.33	57	5.0	6.1	8.1	10.0	13.3	16.5	20.5
62	11-17,36-37	3.98	0.34	66	4.8	5.8	7.7	9.6	12.7	15.8	19.5
72	11-17,36-37	3.98	0.34	66	4.8	5.8	7.7	9.6	12.7	15.8	19.5
63	11-17,36-38	4.26	0.33	74	4.5	5.5	7.3	9.0	12.0	14.9	18.5
64	39	0.53	0.23	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	11-17,36-39	4.79	0.32	74	4.9	6.0	8.0	9.9	13.1	16.2	20.1
66	11-17,36-40	5.30	0.31	83	4.8	5.8	7.8	9.6	12.8	15.8	19.6
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.28	83	10.8	13.2	17.5	21.7	28.8	35.7	44.3

Table 3.11 Calculated Flood Runoff with Diversion 3 and 4 Plan (2/2)

Runoff Calculation by Rational Method *(Future Land Use Condition)*

Alt. - Diversion 3 and 4 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.74	42	2.3	2.9	3.8	4.7	6.3	7.8	9.6
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Shouwai Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.83	0.36	33	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	39	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	11-17	3.71	0.55	52	8.7	10.7	14.2	17.6	23.4	29.0	35.9
31	18	0.17	0.66	27	0.8	1.0	1.3	1.7	2.2	2.7	3.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.99	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.99	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	18-23	2.10	0.46	48	4.4	5.4	7.2	8.9	11.8	14.6	18.2
42	18-24	2.22	0.47	57	4.1	5.1	6.7	8.3	11.1	13.7	17.0
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	18-26	4.14	0.44	57	7.2	8.8	11.7	14.5	19.3	24.0	29.7
48	18-27	4.18	0.45	58	7.4	9.0	11.9	14.6	19.7	24.4	30.2
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.85	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	28-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	18-33	6.65	0.45	58	11.7	14.3	19.0	23.6	31.3	38.8	48.1
60	18-34	7.49	0.48	74	11.5	14.0	18.7	23.1	30.7	38.1	47.2
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
-	Div. 4 (11-17)	3.71	0.55	57	8.1	9.9	13.1	16.3	21.7	26.8	33.3
71	11-17,36	3.81	0.55	57	8.3	10.2	13.5	16.7	22.2	27.6	34.2
62	11-17,36-37	3.98	0.56	66	7.8	9.6	12.7	15.8	20.9	25.9	32.2
72	11-17,36-37	3.98	0.56	66	7.8	9.6	12.7	15.8	20.9	25.9	32.2
63	11-17,36-38	4.26	0.58	74	7.9	9.6	12.8	15.9	21.1	26.2	32.4
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	11-17,36-39	4.79	0.54	74	8.3	10.1	13.4	16.6	22.1	27.4	34.0
66	11-17,36-40	5.30	0.55	83	8.5	10.3	13.8	17.0	22.6	28.1	34.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.50	83	19.3	23.5	31.3	38.7	51.5	63.8	79.1

Table 3.12 Calculated Flood Runoff with Diversion 3 and 5 Plan (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 3 and 5 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.41	42	1.3	1.6	2.1	2.6	3.5	4.3	5.3
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Arri Shousai Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.83	0.24	33	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	33	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	11-17	3.71	0.33	52	5.2	6.4	8.5	10.5	14.0	17.4	21.5
31	11-18	3.88	0.33	59	4.9	6.0	8.0	9.9	13.2	16.4	20.3
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	11-23	5.81	0.32	59	7.2	8.8	11.6	14.4	19.2	23.8	29.5
42	24	0.12	0.27	25	0.3	0.3	0.4	0.5	0.7	0.8	1.0
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	24-26	2.04	0.23	43	2.4	2.9	3.8	4.7	6.3	7.8	9.7
48	24-27	2.08	0.23	44	2.4	2.9	3.8	4.7	6.3	7.8	9.7
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-33	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-33	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	24-33	4.55	0.24	45	5.3	6.4	8.6	10.6	14.1	17.5	21.7
60	24-34	5.39	0.25	60	5.1	6.3	8.3	10.3	13.7	17.0	21.1
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
71	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
62	36-37	0.27	0.41	38	0.6	0.8	1.0	1.2	1.6	2.0	2.5
-	Div. 5 (11-23)	5.81	0.32	67	6.5	7.9	10.5	13.0	17.3	21.4	26.5
72	11-23,36-37	6.08	0.33	67	7.0	8.5	11.3	14.0	18.6	23.1	28.6
63	11-23,36-38	6.36	0.33	76	6.6	8.0	10.7	13.2	17.5	21.7	27.0
64	39	0.53	0.23	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	11-23,36-39	6.69	0.32	76	6.9	8.4	11.2	13.9	18.4	22.8	28.3
66	11-23,36-40	7.40	0.31	84	6.6	8.1	10.7	13.3	17.6	21.9	27.1
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.29	84	10.7	13.0	17.3	21.5	28.5	35.4	43.9

Table 3.12 Calculated Flood Runoff with Diversion 3 and 5 Plan (2/2)

Runoff Calculation by Rational Method (Future Land Use Condition)

Alt. - Diversion 3 and 5 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.74	42	2.3	2.9	3.8	4.7	5.3	7.8	9.6
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.80	0.36	33	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	33	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	11-17	3.71	0.55	52	8.7	10.7	14.2	17.6	23.4	29.0	35.9
31	11-18	3.86	0.55	59	8.2	10.0	13.4	16.6	22.0	27.3	33.8
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.46	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	11-23	5.81	0.51	59	11.4	14.0	18.6	23.0	30.6	37.9	47.0
42	24	0.12	0.70	25	0.7	0.8	1.1	1.3	1.8	2.2	2.7
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	24-26	2.04	0.43	43	4.4	5.4	7.1	8.9	11.8	14.6	18.1
48	24-27	2.06	0.44	44	4.5	5.5	7.3	9.1	12.0	14.9	18.5
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.85	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	26-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	24-33	4.55	0.44	45	9.7	11.8	15.7	19.5	25.8	32.0	39.7
60	24-34	5.39	0.49	60	10.1	12.3	16.3	20.2	26.9	33.3	41.3
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
71	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
62	36-37	0.27	0.60	36	1.2	1.5	1.9	2.4	3.2	4.0	4.9
-	Div. 5 (11-23)	5.81	0.51	67	10.3	12.6	16.7	20.7	27.5	34.1	42.3
72	11-23,36-37	6.08	0.53	67	11.2	13.7	18.2	22.5	29.9	37.1	46.0
63	11-23,36-38	6.36	0.54	76	10.7	13.1	17.4	21.6	28.7	35.6	44.1
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	11-23,36-39	6.89	0.52	76	11.2	13.7	18.2	22.5	29.9	37.1	46.0
66	11-23,36-40	7.40	0.53	84	11.3	13.8	18.3	22.7	30.2	37.4	46.4
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.50	84	19.1	23.3	30.9	38.3	51.0	63.1	78.3

Table 3.13 Calculated Flood Runoff with Diversion 3, 4 and 5 Plan (1/2)

Runoff Calculation by Rational Method (Present Land Use)

Alt. - Diversion 3, 4 and 5 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.41	42	1.3	1.6	2.1	2.6	3.5	4.3	5.3
21	14	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
22	Am Snouser Dam	1.09	0.20	12	3.2	3.8	5.1	6.3	8.4	10.4	13.0
23	14-15	1.71	0.23	25	3.1	3.8	5.0	6.2	8.3	10.2	12.7
24	14-16	1.83	0.24	33	2.7	3.3	4.5	5.5	7.3	9.1	11.3
25	12	0.39	0.24	9	1.7	2.1	2.8	3.5	4.6	5.7	7.1
26	12-13	0.46	0.24	14	1.4	1.7	2.3	2.8	3.8	4.7	5.8
27	12-16	2.29	0.24	39	3.4	4.2	5.6	6.9	9.2	11.4	14.1
28	12-17	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
29	Dam - L	3.09	0.31	52	4.1	5.0	6.7	8.3	11.0	13.6	16.9
30	11-17	3.71	0.33	52	5.2	6.4	8.5	10.5	14.0	17.4	21.5
31	18	0.17	0.27	27	0.3	0.4	0.5	0.7	0.9	1.1	1.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.25	26	2.2	2.6	3.5	4.4	5.8	7.2	8.9
35	21	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
36	Dam - E	0.20	0.20	7	0.9	1.1	1.5	1.8	2.4	3.0	3.7
37	21-22	0.32	0.34	14	1.4	1.7	2.2	2.8	3.7	4.6	5.7
38	19-22	1.46	0.27	26	3.0	3.7	4.9	6.0	8.0	9.9	12.3
39	19-23	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
40	Dam - M	1.93	0.31	48	2.7	3.3	4.4	5.5	7.3	9.1	11.3
41	18-23	2.10	0.31	48	3.0	3.6	4.8	6.0	8.0	9.9	12.2
42	24	0.12	0.27	25	0.3	0.3	0.4	0.5	0.7	0.8	1.0
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
46	Dam - N1	1.92	0.23	43	2.2	2.7	3.6	4.5	5.9	7.3	9.1
47	24-26	2.04	0.23	43	2.4	2.9	3.8	4.7	6.3	7.8	9.7
48	24-27	2.06	0.23	44	2.4	2.9	3.8	4.7	6.3	7.8	9.7
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.22	29	2.2	2.7	3.5	4.4	5.8	7.2	8.9
52	31-33	1.85	0.24	41	2.3	2.8	3.8	4.7	6.2	7.7	9.5
53	29	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
54	Dam - C	0.21	0.20	7	1.0	1.2	1.5	1.9	2.5	3.1	3.9
55	29-30	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
56	Dam - N2	0.57	0.23	27	1.0	1.2	1.6	1.9	2.6	3.2	4.0
57	29-39	2.42	0.24	41	3.0	3.7	4.9	6.1	8.1	10.0	12.5
58	28-38	2.47	0.24	45	2.9	3.5	4.6	5.8	7.7	9.5	11.8
59	24-39	4.55	0.24	45	5.3	6.4	8.6	10.6	14.1	17.5	21.7
60	24-34	5.39	0.25	60	5.1	6.3	8.3	10.3	13.7	17.0	21.1
61	36	0.10	0.36	27	0.3	0.3	0.4	0.5	0.7	0.9	1.1
-	Div. 4 (11-17)	3.71	0.33	57	4.9	5.9	7.9	9.8	13.0	16.1	20.0
71	11-17,36	3.81	0.33	57	5.0	6.1	8.1	10.0	13.3	16.5	20.5
62	11-17,36-37	3.98	0.34	66	4.8	5.8	7.7	9.6	12.7	15.8	19.5
-	Div. 5 (18-23)	2.10	0.31	56	2.6	3.2	4.3	5.3	7.0	8.7	10.8
72	11-23,36-37	6.08	0.33	66	7.1	8.6	11.4	14.2	18.8	23.4	29.0
63	11-23,36-38	6.36	0.33	74	6.7	8.2	10.9	13.5	17.9	22.2	27.6
64	39	0.53	0.29	64	0.4	0.5	0.7	0.9	1.2	1.5	1.8
65	11-23,36-39	6.89	0.32	74	7.1	8.6	11.4	14.2	18.8	23.3	29.0
66	11-23,36-40	7.40	0.31	83	6.7	8.1	10.8	13.4	17.8	22.1	27.4
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.28	83	10.8	13.2	17.5	21.7	28.8	35.7	44.3

Table 3.13 Calculated Flood Runoff with Diversion 3, 4 and 5 Plan (2/2)

Runoff Calculation by Rational Method (Future Land Use Condition)

Alt. - Diversion 3, 4 and 5 (Lower reaches)

Calc. Point	Sub-basin Combination	Total Area (sq.km)	Runoff Coeff. f	Design tc (min)	Calc. Q(1.05) (cu.m/s)	Calc. Q(2) (cu.m/s)	Calc. Q(5) (cu.m/s)	Calc. Q(10) (cu.m/s)	Calc. Q(25) (cu.m/s)	Calc. Q(50) (cu.m/s)	Calc. Q(100) (cu.m/s)
20	11	0.62	0.74	42	2.3	2.9	3.8	4.7	6.3	7.8	9.6
21	14	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
22	Ain Snoussi Dam	1.09	0.21	12	3.3	4.0	5.4	6.7	8.9	11.0	13.6
23	14-15	1.71	0.33	25	4.4	5.4	7.2	8.9	11.9	14.7	18.2
24	14-16	1.83	0.36	39	4.1	5.0	6.7	8.3	11.0	13.6	16.9
25	12	0.39	0.63	9	4.5	5.5	7.3	9.1	12.1	15.0	18.5
26	12-13	0.46	0.66	14	3.9	4.7	6.3	7.8	10.3	12.8	15.9
27	12-16	2.29	0.42	39	6.0	7.3	9.8	12.1	16.1	19.9	24.7
28	12-17	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
29	Dam - L	3.09	0.51	52	6.8	8.2	11.0	13.6	18.0	22.4	27.7
30	11-17	3.71	0.55	52	8.7	10.7	14.2	17.6	23.4	29.0	35.9
31	18	0.17	0.66	27	0.8	1.0	1.3	1.7	2.2	2.7	3.4
32	19	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
33	Dam - A	0.92	0.20	12	2.7	3.2	4.3	5.4	7.1	8.8	10.9
34	19-20	1.14	0.31	26	2.7	3.3	4.4	5.4	7.2	8.9	11.1
35	21	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
36	Dam - E	0.20	0.26	7	1.2	1.4	1.9	2.4	3.1	3.9	4.8
37	21-22	0.32	0.45	14	1.9	2.3	3.0	3.8	5.0	6.2	7.7
38	19-22	1.46	0.34	26	3.8	4.6	6.1	7.6	10.1	12.5	15.5
39	19-23	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
40	Dam - M	1.93	0.44	48	3.9	4.7	6.3	7.8	10.4	12.9	16.0
41	18-23	2.10	0.46	48	4.4	5.4	7.2	8.9	11.8	14.6	18.2
42	24	0.12	0.70	25	0.7	0.8	1.1	1.3	1.8	2.2	2.7
43	25	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
44	Dam - D	1.02	0.20	15	2.5	3.0	4.0	4.9	6.6	8.1	10.1
45	25-26	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
46	Dam - N1	1.92	0.41	43	4.0	4.8	6.4	7.9	10.6	13.1	16.2
47	24-26	2.04	0.43	43	4.4	5.4	7.1	8.9	11.8	14.6	18.1
48	24-27	2.08	0.44	44	4.5	5.5	7.3	9.1	12.0	14.9	18.5
49	32	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
50	Dam - B	1.11	0.20	17	2.4	2.9	3.9	4.8	6.4	8.0	9.9
51	32-33	1.42	0.27	29	2.7	3.3	4.3	5.4	7.1	8.8	11.0
52	31-33	1.86	0.39	41	3.8	4.6	6.1	7.6	10.1	12.5	15.5
53	29	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
54	Dam - C	0.21	0.29	7	1.4	1.7	2.2	2.8	3.7	4.6	5.7
55	29-30	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
56	Dam - N2	0.57	0.60	27	2.5	3.1	4.1	5.1	6.7	8.4	10.4
57	29-33	2.42	0.44	41	5.6	6.8	9.0	11.2	14.9	18.4	22.8
58	28-33	2.47	0.45	45	5.4	6.6	8.7	10.8	14.4	17.8	22.1
59	24-33	4.55	0.44	45	9.7	11.8	15.7	19.5	25.8	32.0	39.7
60	24-34	5.39	0.49	60	10.1	12.3	16.3	20.2	26.9	33.3	41.3
61	36	0.10	0.60	27	0.6	0.7	1.0	1.2	1.6	2.0	2.4
-	Div. 4 (11-17)	3.71	0.55	57	8.1	9.9	13.1	16.3	21.7	26.8	33.3
71	11-17,35	3.81	0.55	57	8.3	10.2	13.5	16.7	22.2	27.6	34.2
62	11-17,36-37	3.98	0.56	66	7.8	9.6	12.7	15.6	20.9	25.9	32.2
-	Div. 5 (18-23)	2.10	0.46	56	3.9	4.7	6.3	7.8	10.4	12.9	16.0
72	11-23,36-37	6.08	0.53	66	11.3	13.8	18.4	22.8	30.3	37.5	46.5
63	11-23,36-38	6.36	0.54	74	11.0	13.4	17.8	22.1	29.3	36.4	45.1
64	39	0.53	0.26	64	0.5	0.6	0.8	1.0	1.3	1.6	2.0
65	11-23,36-39	6.89	0.52	74	11.5	14.0	18.6	23.0	30.6	37.9	47.0
66	11-23,36-40	7.40	0.53	83	11.4	13.9	18.5	22.9	30.5	37.8	46.8
67	35	0.46	0.20	56	0.4	0.5	0.6	0.7	1.0	1.2	1.5
68	11-40	13.25	0.50	83	19.3	23.5	31.3	38.7	51.5	63.8	79.1

Table 4.1 Present Land Use Proportion in the Study Area of Ariana Community

	Goveronorate of Ariana						Goveronorate of Tunis	
	Raoued	Ariana Superior	Bori Louzir	Ariana Medina	Soukra	Sabkhet Ariana	La Marsa	Total
Residential	4.5km2	0.5km2	2.3km2	2.2km2	1.7km2	–	6.4km2	17.6km2
Commercial	–	–	–	0.1km2	–	–	0.2km2	0.3km2
Administrative / Institutional	0.1km2	0.1km2	–	0.5km2	0.1km2	–	0.4km2	1.2km2
Recreational	–	–	–	0.1km2	0.3km2	–	0.5km2	0.9km2
Industrial	–	–	–	–	0.1km2	–	0.05km2	0.15km2
Agricultural	10.1km2	–	2.7km2	–	9.0km2	–	8.1km2	29.9km2
Green Area	6.3km2	4.3km2	–	–	–	–	4.5km2	15.1km2
Open Space	9.0km2	0.4km2	1.1km2	0.2km2	–	–	3.0km2	13.7km2
ONAS	0.2km2	–	–	–	–	–	1.0km2	1.2km2
Historic sites	–	–	–	–	–	–	1.0km2	1.0km2
Sebkhet Ariana	–	–	–	–	–	36.5km2	–	36.5km2
Total	30.2km2	5.3km2	6.1km2	3.1km2	11.2km2	36.5km2	25.1km2	117.5km2

Source: calculated by the study team

Table 4.2. Future Land Use Proportion in the Study Area of Ariana Community

	Goveronorate of Ariana						Governorate of Tunis	Total
	Raoued	Ariana Superior	Bori Louzir	Ariana Media	Soukra	Sebkhet Ariana	La Marsa	
Residential	7.2km2	1.8km2	5.3km2	2.4km2	2.1km2	-	8.9km2	27.7km2
high density	0.4km2	-	0.6km2	0.2km2	0.2km2	-	-	1.4km2
medium density	6.6km2	1.6km2	4.7km2	1.2km2	0.9km2	-	2.0km2	17.0km2
low density	-	-	-	-	0.8km2	-	6.7km2	7.5km2
Mixed use	-	-	-	0.2km2	0.2km2	-	0.2km2	0.6km2
Ariana center	-	0.2km2	-	0.7km2	-	-	-	0.9km2
Media type	0.2km2	-	-	0.1km2	-	-	-	0.3km2
Commercial	0.05km2	-	0.05km2	0.1km2	-	-	0.2km2	0.4km2
Administrational / Institutional	0.35km2	0.3km2	0.2km2	0.5km2	0.1km2	-	0.5km2	1.9km2
Recreational	1.3km2	2.5km2	0.15km2	0.1km2	0.5km2	-	1.3km2	5.9km2
sports/activities	0.5km2	-	0.15km2	0.1km2	0.05km2	-	0.3km2	1.1km2
parks	0.8km2	2.5km2	-	-	0.45km2	-	0.2km2	4.0km2
touristic	-	-	-	-	-	-	0.8km2	0.8km2
Industrial	-	-	-	-	-	-	0.5km2	0.5km2
Agricultural	5.2km2	-	-	-	8.2km2	-	6.3km2	19.7km2
Green area	6.2km2	0.7km2	-	-	-	-	3.1km2	10.0km2
Inundated zone	10.7km2	-	0.4km2	-	0.3km2	-	1.6km2	13.3km2
Reserved/ cemetry	-	-	-	-	-	-	0.2km2	0.2km2
Historic sites	-	-	-	-	-	-	1.0km2	1.0km2
ONAS	-	-	-	-	-	-	1.0km2	1.0km2
Petrolium storage	0.8km2	-	-	-	-	-	-	0.8km2
Sebkhet Ariana	-	-	-	-	-	35.4km2	-	35.4km2
Total	31.8km2	5.3km2	6.1km2	3.1km2	11.2km2	35.4km2	24.6km2	117.5m2

Source : Calculated by the study team

Table 6.1 Characteristics of Wetlands of Greater Tunis Area

Aspect	Sebkhet Ariana	Sebkhet Sijoumi	Tunis Lake
Area	8x4 km; 2500 ha	9x4 km; 300 ha	10x5 km; 4100 ha
Altitude	0-50 m	0-50 m	0-50 m
Site Description	Geology (recent alluvial/lacustral deposits) Water Chemistry (saline) Hydrology (water level varies with rainfall) Depth-fluctuations/permanence (dries out completely most summers leaving thick salt crust; shallow)	Geology (a closed basin, recent alluvial and lacustral deposits); water chemistry (saline but variable); hydrology (inflow of polluted water prevents it from drying in summer); Depth/fluctuation/permanence (permanent in winter, dry in summer with salt crust, wastewater areas remain wet and marshy throughout, very shallow, < 1.4 m)	Geology (on alluvial plain with sediment transported by Oued Mejerdah and Miliane), receives most of capital's waste water and is very eutrophic (south lake); Salinity higher than in Gulf of Tunis because of wastewaters, salinity 35-44 g/l; Hydrology (localised exchange of water between north and south lake via causeway , and canals to the sea.
Floral value		Atriplex amplexicaulis, A. glauca	Phytoplankton 100-400 mg/m Chl.a
Faunal value	Brine shrimp, copepods, rotifers and nematodes. Important for migrating and wintering waterfowl; 1987: 11,557 Anatids, 2458 flamingoes, 3800 little stint, 20 grebes and many thousands of waders; Totalling upto 17,000 birds. Flamingoes have nested on the lake and the crane (Grus grus) used the lake as a roosting place; now due to disturbances there have been no crane for last five years: Interchange of birds with Tunis lake and Sebkhet Sijoumi; number of breeding birds is very small because of human activities around the Sebkhet.	Very important for birds. The marshy areas are major wader stopover sites during migration. Interchange of birds with Sebhket Ariana and Tunis Lake. Flamingoes and waders in large nos. (up to 25,000). Sewage outlet from the Bardo and Melassine area attract dabbling ducks and waders. The Sebkhet is particularly important for birds with the reclamation of Tunis north lake. Flamingo nos. are dictated by availability of water. Breeding birds are very rare as people cross the water easily and this disturbs the bird population.	Crustaceans in salines; fish: eel, mullet, loup, daurade, shrimp Important for wintering birds; flamingoes (5000), ducks (20000), waders (10,000) Fulica atra (20,000); Breeding colonies of Little Egret
Conservation Measures	Legal status (unprotected but hunting is prohibited); management plan (none); Should be declared a Ramsar protected site because of bird nos. and species, and its relationship with Tunis lake and Sebket Sijoumi	Legal status (unprotected but hunting is prohibited; management plan (none); Should be declared a Ramsar protected site because of bird nos. and species, and its relationship with Tunis lake and Sebket Ariana.	Legal status (unprotected but hunting is prohibited); management plan (none); Should be declared a Ramsar protected site because of bird nos. and species, and its relationship with Sebkhet Sijoumi and Sebket Ariana.
Hydrological values	Used to be almost rainfed, but presence of a purification plant has resulted in sporadic discharge of water. The plant's settling ponds are a great source of bird diversity.	Inflow of wastewater from Tunis attracts very rich bird populations.	Lake is never dry; Polluted waters of South lake attract very large no. of birds.
Socio-economic values	The Sebkhet could form part of a wetland educational center for Tunis school children; great potential due to proximity to Tunis; Scientific work: surveys of wintering waterfowl have been carried out since 80s.	Enormous potential for the development of educational facilities and a visitor center for Tunis.	Enormous potential for the development of educational facilities and a visitor center for Tunis.
Land Tenure	State ownership	State ownership	State ownership
Land Use	On site salt pans (1 x 1.5 km), water purification plant, rubbish tipping; In catchment (urbanization, quarrying, industry, agriculture, roads, forests)	On site (rubbish tipping, constructed station for composting on east shore and car wrecking on the south shore. Also used for disposal of urban wastewater from Tunis. In catchment (urbanization on north shore, tree plantations on eastern shore and olive groves to the west.	Significant industrial and domestic wastewater discharge into South lake; North lake cleaned up and land reclaimed for urbanization; cleaner North lake is attracting fewer birds.
Disturbances and Threats	Encroachment for urban development and increased pressures from tourism develop.	Pollution and rubbish tipping, urban effluent; breeding flamingoes disturbed by humans.	
References	Scott (1980), Ben Abdelkader (1985), Gaultier (1987)	Scott(1980), Ben Abdelkader (1985), Gaultier (1987), Monval & Pirot (1989)	Scott(1980), Ben Abdelkader (1985), Gaultier(1987), Monval & Pirot (1989)

Source: Friends of the Birds, Tunis (1993)

Table 6.2 Maximum and Average Bird Counts in the Last Five Years (1989-1993) in Wetlands of Greater Tunis

Site	Species		Frequency.	Maximum	Average Nos.
	Scientific Name	Common Name	of Counts	Number	in recent 5 years
Sebkhet	Aythya Fuligula		5	8	2
Ariana	Tadorna Tadorna	Shelduk		506	251
	Anas Species			100	20
Tunis Lake	Anas Acuta	Duck	5	1,250	520
	Aythya ferina	Pochard		5,150	1,386
	Anas Clypeata	Shoveler		6,540	2,008
	Anas Platyrhynchos	Mallard		60	31
	Aythya Fuligula			350	71
	Anas Crecca	Winter teal		350	153
	Tadorna Tadorna	Shelduk		260	113
	Anas Strepera			7	2
	Fulica Atra			21,800	5,750
	Anas Penelope			650	265
	Aythya Ferina	Pochard	5	150	52
Sebkhet	Tadorna Tadorna	Shelduk	5	4,000	2,067
Sijoumi	Anas Clypeata	Shovler		3,600	2,080
	Anas Crecca	Teal		500	140
	Anas Acuta	Duck		1,000	276
	Fulica Atra			2,500	715

Source: Friends of the Birds, Tunis, 1993

Table 6.3 Environmental Impact Assessment Matrix for Oued Ennkhilet and Sebkhet Ariana Study Area

	Environmental parameters																					
	Natural physical resources					Natural ecology				Economic values					Socio-economic/quality of life							
Project Component	Watershed erosion	Surface water hydrology	Surface water quality	Ground water	Soil erosion	Green area	Freshwater fisheries	Marine fisheries	Land use changes	Roads	Drainage/flooding	Canal/weir maintenance	Employment opportunities	(short term)	Public health	Water supplies	Cultural building/sights	Recreation	Environmental aesthetics	Transportation disruption	Air pollution	Noise pollution
Proposed works (Post Construction effects)																						
(1) River improvement works by excavation, backfilling and concreting along GP8 and Road 533	N	1	1	N	1	2	N	N	N	1	2	1	N		2	N	N	2	2	N	N	N
(2) Construction of flood diversion channel of 4 km length from Road 533 to Sebkhet Ariana	N	1	1	N	1	2	N	N	N	1	2	1	N		2	N	N	2	2	N	N	N
(3) Widening of river channel along road 533	N	1	1	N	1	1	N	N	N	1	2	1	N		2	N	N	2	2	N	N	N
(4) Improvement of outlet facilities of Sebkhet Ariana crossing the public roads.	N	1	1	N	1	N	N	N	N	1	2	1	N		2	N	N	2	2	N	N	N
(5) Excavated soil at the proposed retarding basins (pond type G,H,I,J,K,L,M,N) will be utilized as fill material for dam type retarding basin (A,B,C,D,E, & F)	N	N	N	N	1	N	N	N	N	N	2	1	N		2	N	N	2	2	N	N	N
Type of Works (During Construction Effects)																						
(1) Excavation & fill by tight to middle classes of earthmoving equipment	(1)	N	N	N	(1)	(1)	N	N	N	N	N	(1)	2		(1)	N	N	(1)	(1)	(1)	(1)	(1)
(2) Piling work using pile driver or vibration hammer	(1)	N	N	N	(1)	(1)	N	N	N	N	N	(1)	2		(1)	N	N	(1)	(1)	(1)	(1)	(1)
(3) Soil transportation	(1)	N	N	N	N	N	N	N	N	N	N	(1)	2		(1)	N	N	N	(1)	(1)	(1)	(1)
(4) Concreting	N	N	N	N	N	N	N	N	N	N	N	(1)	2		N	N	N	N	(1)	(1)	(1)	(1)

Notes: Levels of effects

N = No significant effect. 1 = Slight effect 2 = Significant effect 3 = Major effect

Parentheses indicate negative or adverse effect

Table 6.4 Environmental mitigation measures for possible negative impacts during construction of flood protection works

Possible negative impacts during construction works	Mitigation measures
Disruption of transportation and possible occurence of accidents	Appropriate diversion, supervision and security arrangements for traffic control at construction site with adequate signs and manpower.
Air pollution due to construction works and transportation of construction materials.	Appropriate mitigation measures like regular sprinkling of water at construction site.
Noise pollution	Avoid working at night in or near densely populated areas. Determine work shifts to cause minimum noise pollution.
Conservation of river bank soil	Use appropriate construction methods to minimize soil erosion and create suitable landscaping.
Public health hazard	Construct clean and adequate temporary quarters for labor force employed for construction works with adequate sanitation facilities.

Table 7.1 Flood Inundation Area and Duration of Oued Ennkhilet

Zone-A (Refer to Fig.10.1)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	5	7	1	13	2	24	0	0	24	3
2	9	13	1	23	3	36	0	0	36	5
5	14	20	2	36	4	47	0	0	47	8
10	18	26	2	46	5	58	0	1	59	10
25	28	39	4	71	8	81	0	1	82	15
50	37	52	5	94	10	105	0	1	106	20
100	46	65	6	117	12	116	0	1	117	24

Zone-B (Refer to Fig.10.1)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	9	13	27	49	4	33	8	20	61	7
2	14	20	40	74	6	45	11	28	84	11
5	18	26	53	97	9	58	14	36	108	14
10	23	33	66	122	11	71	18	45	134	18
25	29	43	86	158	15	91	22	57	170	25
50	36	53	105	194	20	110	27	69	206	30
100	45	66	131	242	24	129	32	81	242	35

Zone-C&D (Refer to Fig.10.1)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	17	3	20	40	4	34	0	16	50	7
2	25	5	30	60	6	47	0	22	69	11
5	33	6	40	79	9	61	0	28	89	14
10	41	8	49	98	11	74	0	34	108	18
25	54	10	64	128	15	94	0	44	138	25
50	66	13	79	158	20	114	0	53	167	30
100	82	16	98	196	24	134	0	62	196	35

Zone-E&F (Refer to Fig.10.1)

Return Period (year)	Present Land Use Condition					Future Land Use Condition (2020)				
	Flood Area (ha)				Duration (hours)	Flood Area (ha)				Duration (hours)
	Urban	Agricul.	Open	Total		Urban	Agricul.	Open	Total	
1.05	5	22	12	39	4	13	4	31	48	7
2	8	32	18	58	6	19	5	44	68	11
5	10	43	24	77	9	24	6	57	87	14
10	13	54	30	97	11	29	8	69	106	18
25	16	70	39	125	15	37	10	88	135	25
50	20	86	48	154	20	45	12	107	164	30
100	25	107	60	192	24	53	14	125	192	35

Table 8.1 10-yr Flood Runoff Distribution for Screening of Retarding Basin

(Unit : m3/s)

Stretch	w/o R.B	Ain Snoussi		R.B-A		R.B-B		R.B-C		R.B-D		R.B-E		R.B-F		R.B-G		R.B-H		R.B-I		R.B-J		R.B-K		R.B-L		R.B-M		R.B-N1		R.B-N2	
No.	Peak Q	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.	Peak Q	Differ.
E-1	40.5	39.5	1.0	39.9	0.6	39.4	1.1	40.5	0.0	39.6	0.9	40.5	0.0	40.5	0.0	37.4	3.1	40.5	0.0	35.4	5.1	38.0	2.5	38.0	2.5	33.2	7.3	36.7	3.8	36.7	3.8	39.2	1.3
E-2	37.4	36.0	1.4	36.4	1.0	36.6	0.8	36.9	0.5	36.2	1.2	36.9	0.5	37.4	0.0	33.8	3.6	36.5	0.9	31.6	5.8	34.7	2.7	34.7	2.7	29.3	8.1	33.0	4.4	33.0	4.4	35.9	1.5
E-3	32.0	30.8	1.2	30.8	1.2	32.0	0.0	32.0	0.0	31.0	1.0	31.5	0.5	32.0	0.0	28.2	3.8	31.0	1.0	25.8	6.2	28.6	3.4	28.6	3.4	23.6	8.4	27.3	4.7	29.4	2.6	32.0	0.0
E-4	29.4	28.2	1.2	28.7	0.7	29.4	0.0	29.4	0.0	29.4	0.0	29.4	0.0	29.2	0.2	25.5	3.9	28.9	0.5	22.8	6.6	26.3	3.1	26.3	3.1	20.4	9.0	25.8	3.6	29.4	0.0	29.4	0.0
E-5	29.4	28.2	1.2	28.7	0.7	29.4	0.0	29.4	0.0	29.4	0.0	29.4	0.0	29.2	0.2	25.5	3.9	28.9	0.5	22.8	6.6	26.3	3.1	26.3	3.1	20.4	9.0	25.8	3.6	29.4	0.0	29.4	0.0
E-6	25.8	24.2	1.6	25.8	0.0	25.8	0.0	25.8	0.0	25.8	0.0	25.8	0.0	25.4	0.4	21.5	4.3	25.1	0.7	18.8	7.0	22.3	3.5	22.3	3.5	18.4	7.4	25.8	0.0	25.8	0.0	25.8	0.0
E-7	25.8	24.2	1.6	25.8	0.0	25.8	0.0	25.8	0.0	25.8	0.0	25.8	0.0	25.4	0.4	21.5	4.3	25.1	0.7	18.8	7.0	22.3	3.5	22.3	3.5	18.4	7.4	25.8	0.0	25.8	0.0	25.8	0.0
E-8	18.4	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	17.8	0.6	11.4	7.0	16.9	1.5	8.5	9.9	12.1	6.3	15.2	3.2	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0
E-9,D/S	18.4	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	17.8	0.6	10.9	7.5	16.9	1.5	7.0	11.4	12.1	6.3	15.1	3.3	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0
E-9,U/S	18.4	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0	17.8	0.6	10.9	7.5	16.9	1.5	7.0	11.4	12.1	6.3	15.1	3.3	18.4	0.0	18.4	0.0	18.4	0.0	18.4	0.0
E-10	12.1	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	6.2	5.9	10.6	1.5	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0	12.1	0.0
E-11	6.2	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	2.8	3.4	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0	6.2	0.0
C1-1	5.8	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0	5.8	0.0
C1-2	4.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0	4.0	0.0
C1-3	2.4	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0	2.4	0.0
C1-4	1.2	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0	1.2	0.0
G2-1,D/S	7.8	7.8	0.0	6.0	1.8	7.8	0.0	7.8	0.0	7.8	0.0	7.3	0.5	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0
G2-1,M/S	7.8	7.8	0.0	6.0	1.8	7.8	0.0	7.8	0.0	7.8	0.0	7.3	0.5	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0
G2-1,U/S	7.8	7.8	0.0	6.0	1.8	7.8	0.0	7.8	0.0	7.8	0.0	7.3	0.5	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0	7.8	0.0
G2-2	5.4	5.4	0.0	2.5	2.9	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0	5.4	0.0
G1-1,D/S	13.6	11.5	2.1	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0
G1-1,U/S	13.6	11.5	2.1	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0	13.6	0.0
G1-2	8.9	5.3	3.6	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0	8.9	0.0
G1'	9.1	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0	9.1	0.0
C3-1	7.6	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	6.8	0.8	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	3.1	4.5	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0
C3-2	4.5	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	3.7	0.8	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0	4.5	0.0
C-4	9.3	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	1.5	7.8	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0	9.3	0.0
R2-1	11.2	11.2	0.0	11.2	0.0	8.8	2.4	10.4	0.8	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	11.2	0.0	7.6	3.6
R2-2,D/S	7.6	7.6	0.0	7.6	0.0	5.2	2.4	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0
R2-2,U/S	7.6	7.6	0.0	7.6	0.0	5.2	2.4	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0	7.6	0.0

Note : "R.B" = Retarding Basin, "Peak Q" = Peak Discharge, "Differ." = Difference of Discharge between in case with and without Retarding Basin

Table 8.2 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 8.3 Flood Runoff Distribution of Alternative Diversion Plan

Stretch No.	Distributed Flood Discharge (m3/s)							
	Alt. Div.0	Alt. Div.3	Alt. Div.4	Alt. Div.5	Alt. Div.2&3	Alt. Div.3&4	Alt. Div.3&5	Alt. Div.3.4&5
E-1	40	40	40	40	40	40	40	40
E-2	40	35	24	22	35	24	22	22
E-3	35	26	16	10	26	16	10	10
E-4	30	22	9	1.4	22	9	1.4	1.4
E-5	30	22	9	28	22	9	22	9
E-6	24	16	1.8	24	16	1.8	16	1.8
E-7	24	16	24	24	16	16	16	16
E-8	20	3.5	20	20	3.5	3.5	3.5	3.5
E-9,D/S	20	20	20	20	16	20	20	20
E-9,U/S	20	20	20	20	16	20	20	20
E-10	14	14	14	14	14	14	14	14
E-11	7	7	7	7	7	7	7	7
C1-1	6	6	26	30	6	18	24	24
C1-2	4	4	26	30	4	18	24	24
C1-3	2.4	2.4	26	2.4	2.4	18	2.4	18
C1-4	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
G2-1,D/S	8	8	8	8	8	8	8	8
G2-1,M/S	8	8	8	8	8	8	8	8
G2-1,U/S	8	8	8	8	8	8	8	8
G2-2	6	6	6	6	6	6	6	6
G1-1,D/S	12	12	12	12	12	12	12	12
G1-1,U/S	12	12	12	12	12	12	12	12
G1-2	6	6	6	6	6	6	6	6
G1'	10	10	10	10	10	10	10	10
C3-1	9	9	9	9	9	9	9	9
C3-2	5	5	5	5	6	5	5	5
C-4	10	10	10	10	10	10	10	10
R2-1	12	12	12	12	12	12	12	12
R2-2,D/S	8	8	8	8	8	8	8	8
R2-2,U/S	8	8	8	8	8	8	8	8
Div. 2,D/S	0	0	0	0	6	0	0	0
Div. 2,M/S	0	0	0	0	6	0	0	0
Div. 2,U/S	0	0	0	0	6	0	0	0
Div. 3,D/S	22	28	22	22	28	28	28	28
Div. 3,U/S	4	20	4	4	16	20	20	20
Div. 4	0	0	26	0	0	18	0	18
Div. 5,D/S	0	0	0	30	0	0	24	9
Div. 5,U/S	0	0	0	30	0	0	24	9

Table 8.4 Flood Runoff Distribution of Alternative Retarding Basin Plan

Stretch/ Facility	Distributed Flood Discharge (m3/s)								
	Alt. U-1	Alt. U-2	Alt. U-3	Alt. D-1	Alt. D-2	Alt. D-3	Alt. D-4	Alt. D-5	Alt. D-6
E-1	-	-	-	28	30	30	35	40	40
E-2	-	-	-	22	24	22	18	24	22
E-3	-	-	-	14	16	10	9	14	10
E-4	-	-	-	8	12	1.4	1.8	8	1.4
E-5	-	-	-	8	12	12	1.8	8	8
E-6	-	-	-	6	6	6	1.8	1.8	1.8
E-7	-	-	-	6	6	6	16	16	16
E-8	-	-	-	3.5	3.5	3.5	3.5	3.5	3.5
E-9,D/S	3	3	14	-	-	-	-	-	-
E-9,U/S	3	3	14	-	-	-	-	-	-
E-10	1.2	1.4	7	-	-	-	-	-	-
E-11	7	7	7	-	-	-	-	-	-
C1-1	-	-	-	6	6	14	16	16	22
C1-2	-	-	-	4	4	14	16	16	20
C1-3	-	-	-	2.4	2.4	2.4	16	16	16
C1-4	-	-	-	1.2	1.2	1.2	1.2	1.2	1.2
G2-1,D/S	-	-	-	7	7	7	7	7	7
G2-1,M/S	-	-	-	7	7	7	7	7	7
G2-1,U/S	-	-	-	7	7	7	7	7	7
G2-2	-	-	-	2.8	2.8	2.8	2.8	2.8	2.8
G1-1,D/S	-	-	-	12	12	12	12	12	12
G1-1,U/S	-	-	-	12	12	12	12	12	12
G1-2	-	-	-	6	6	6	6	6	6
G1'	-	-	-	10	10	10	10	10	10
C3-1	0.5	0.4	0.5	-	-	-	-	-	-
C3-2	8	6	8	-	-	-	-	-	-
C-4	2.6	2.6	2.6	-	-	-	-	-	-
R2-1	-	-	-	12	12	12	12	12	12
R2-2,D/S	-	-	-	8	8	8	8	8	8
R2-2,U/S	-	-	-	8	8	8	8	8	8
Div. 2,D/S	-	6	-	-	-	-	-	-	-
Div. 2,M/S	-	6	-	-	-	-	-	-	-
Div. 2,U/S	-	6	-	-	-	-	-	-	-
Div. 3,D/S	22	24	26	-	-	-	-	-	-
Div. 3,U/S	5	7	14	-	-	-	-	-	-
Div. 4	-	-	-	-	-	-	16	16	16
Div. 5,D/S	-	-	-	-	-	12	-	-	8
Div. 5,U/S	-	-	-	-	-	12	-	-	8
Ain Snoussi	-	-	-	Exist	Exist	Exist	Exist	Exist	Exist
R.B-A	-	-	-	Required	Required	Required	Required	Required	Required
R.B-B	-	-	-	-	-	-	-	-	-
R.B-C	-	-	-	-	-	-	-	-	-
R.B-D	-	-	-	-	-	-	-	-	-
R.B-E	-	-	-	-	-	-	-	-	-
R.B-F	-	-	-	-	-	-	-	-	-
R.B-G	Required	Required	Required	-	-	-	-	-	-
R.B-H	-	-	-	-	-	-	-	-	-
R.B-I	Required	Required	-	-	-	-	-	-	-
R.B-J	Required	Required	-	-	-	-	-	-	-
R.B-K	-	-	-	-	-	-	-	-	-
R.B-L	-	-	-	Required	Required	Required	-	-	-
R.B-M	-	-	-	Required	-	-	Required	-	-
R.B-N1	-	-	-	-	-	-	-	-	-
R.B-N2	-	-	-	-	-	-	-	-	-

Table 8.5 Construction Cost of Alternative Diversion Plan

Stretch No.	Construction Cost (DT 1,000)							
	Alt. Div.0	Alt. Div.3	Alt. Div.4	Alt. Div.5	Alt. Div.2&3	Alt. Div.3&4	Alt. Div.3&5	Alt. Div.3,4&5
E-1	786	786	786	786	786	786	786	786
E-2	619	563	439	415	563	439	415	415
E-3	178	127	92	67	127	92	67	67
E-4	1,054	867	480	0	867	480	0	0
E-5	70	58	32	65	58	32	58	32
E-6	710	537	0	710	537	0	537	0
E-7	40	30	40	40	30	30	30	30
E-8	1,555	0	1,555	1,555	0	0	0	0
E-9,D/S	613	613	613	613	559	613	613	613
E-9,U/S	709	709	709	709	634	709	709	709
E-10	129	129	129	129	129	129	129	129
E-11	403	403	403	403	403	403	403	403
C1-1	176	176	250	266	176	219	243	243
C1-2	159	159	222	235	159	196	215	215
C1-3	192	192	339	192	192	294	192	294
C1-4	0	0	0	0	0	0	0	0
G2-1,D/S	188	188	188	188	188	188	188	188
G2-1,M/S	220	220	220	220	220	220	220	220
G2-1,U/S	3	3	3	3	3	3	3	3
G2-2	104	104	104	104	104	104	104	104
G1-1,D/S	389	389	389	389	389	389	389	389
G1-1,U/S	107	107	107	107	107	107	107	107
G1-2	182	182	182	182	182	182	182	182
G1'	130	130	130	130	130	130	130	130
C3-1	0	0	0	0	0	0	0	0
C3-2	0	0	0	0	0	0	0	0
C-4	437	437	437	437	437	437	437	437
R2-1	113	113	113	113	113	113	113	113
R2-2,D/S	264	264	264	264	264	264	264	264
R2-2,U/S	132	132	132	132	132	132	132	132
Div. 2,D/S	0	0	0	0	140	0	0	0
Div. 2,M/S	0	0	0	0	154	0	0	0
Div. 2,U/S	0	0	0	0	31	0	0	0
Div. 3,D/S	0	187	0	0	187	187	187	187
Div. 3,U/S	0	483	0	0	373	483	483	483
Div. 4	0	0	586	0	0	498	0	498
Div. 5,D/S	0	0	0	203	0	0	187	146
Div. 5,U/S	0	0	0	394	0	0	353	244
Improve.Cost	9,659	7,615	8,356	8,450	7,486	6,689	6,663	6,203
Diversion Cost	0	671	586	597	885	1,168	1,210	1,558
Total Cost	9,659	8,286	8,942	9,047	8,371	7,857	7,873	7,761

Note: "Improve. Cost"=River Improvement Cost, "Diversion Cost"=Construction Cost of Diversion Channel

Table 8.6 Construction Cost of Alternative Retarding Basin Plan

Stretch/ Facility	Construction Cost (DT 1,000)								
	Alt. U-1	Alt. U-2	Alt. U-3	Alt. D-1	Alt. D-2	Alt. D-3	Alt. D-4	Alt. D-5	Alt. D-6
E-1	-	-	-	633	659	659	722	786	786
E-2	-	-	-	415	439	415	359	439	415
E-3	-	-	-	79	92	67	64	79	67
E-4	-	-	-	0	558	0	0	0	0
E-5	-	-	-	0	37	37	0	0	0
E-6	-	-	-	0	0	0	0	0	0
E-7	-	-	-	0	0	0	30	30	30
E-8	-	-	-	0	0	0	0	0	0
E-9,D/S	0	0	448	-	-	-	-	-	-
E-9,U/S	0	0	608	-	-	-	-	-	-
E-10	0	0	122	-	-	-	-	-	-
E-11	403	403	403	-	-	-	-	-	-
C1-1	-	-	-	176	176	203	211	211	235
C1-2	-	-	-	159	159	182	189	189	202
C1-3	-	-	-	192	192	192	282	282	282
C1-4	-	-	-	0	0	0	0	0	0
G2-1,D/S	-	-	-	180	180	180	180	180	180
G2-1,M/S	-	-	-	211	211	211	211	211	211
G2-1,U/S	-	-	-	3	3	3	3	3	3
G2-2	-	-	-	87	87	87	87	87	87
G1-1,D/S	-	-	-	389	389	389	389	389	389
G1-1,U/S	-	-	-	107	107	107	107	107	107
G1-2	-	-	-	182	182	182	182	182	182
G1'	-	-	-	130	130	130	130	130	130
C3-1	0	0	0	-	-	-	-	-	-
C3-2	0	0	0	-	-	-	-	-	-
C-4	0	0	0	-	-	-	-	-	-
R2-1	-	-	-	113	113	113	113	113	113
R2-2,D/S	-	-	-	264	264	264	264	264	264
R2-2,U/S	-	-	-	132	132	132	132	132	132
Div. 2,D/S	-	140	-	-	-	-	-	-	-
Div. 2,M/S	-	154	-	-	-	-	-	-	-
Div. 2,U/S	-	31	-	-	-	-	-	-	-
Div. 3,D/S	0	64	125	-	-	-	-	-	-
Div. 3,U/S	44	120	321	-	-	-	-	-	-
Div. 4	-	-	-	-	-	-	471	471	471
Div. 5,D/S	-	-	-	-	-	155	-	-	143
Div. 5,U/S	-	-	-	-	-	266	-	-	237
Ain Snoussi	-	-	-	Exist	Exist	Exist	Exist	Exist	Exist
R.B-A	-	-	-	66	66	66	66	66	66
R.B-B	-	-	-	-	-	-	-	-	-
R.B-C	-	-	-	-	-	-	-	-	-
R.B-D	-	-	-	-	-	-	-	-	-
R.B-E	-	-	-	-	-	-	-	-	-
R.B-F	-	-	-	-	-	-	-	-	-
R.B-G	355	355	355	-	-	-	-	-	-
R.B-H	-	-	-	-	-	-	-	-	-
R.B-I	971	855	-	-	-	-	-	-	-
R.B-J	522	212	-	-	-	-	-	-	-
R.B-K	-	-	-	-	-	-	-	-	-
R.B-L	-	-	-	851	851	851	-	-	-
R.B-M	-	-	-	253	-	-	437	-	-
R.B-N1	-	-	-	-	-	-	-	-	-
R.B-N2	-	-	-	-	-	-	-	-	-
Improve. Cost	403	403	1,581	3,451	4,108	3,552	3,655	3,813	3,814
Diversion Cost	44	509	446	0	0	421	471	471	851
R.B Cost	1,848	1,421	355	1,169	917	917	503	66	66
Total Cost	2,294	2,333	2,382	4,621	5,025	4,890	4,628	4,350	4,730

Note : "Improve. Cost" = River Improvement Cost, "Diversion Cost" = Construction Cost of Diversion Channel, "R.B Cost" = Construction Cost of Retarding Basin

Table 8.7 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 10.1 Industrial Zone at Charguia/Ariana : Employment by Subsector, 1990

Subsector	Units	Employees	Employees per Unit
Agriculture/Food	148	2,687	18.16
Building Materials /Construction	32	690	21.56
Mechanical/Electrical	75	2,820	37.60
Chemicals/Plastics	22	343	15.59
Textiles/Leather	209	10,558	50.52
Others	84	1,811	21.56
TOTAL:	570	18,909	33.17

Table 10.2 Commune of Ariana : Estimated Agricultyral Production and Productivity

Crop	Area Cultivated (ha)	Production (ton)	Productivity (ton/ha)
Winter Crops	3,000	27,050	9.02
Summer Crops (Vegetables)	6,500	123,300	18.97
Irrigated Cereals (Haboub)	2,800	8,900	3.18
Animal Feedstuff	2,500	11,250	4.50
Cotton	80	160	2.0
Root Crops	100	3,500	35.0

Source : Note Relating to the flood Prone Areas ofSoukra-Chotrana, Ministry of Interior, District of Tunis

Table 10.3 Difference In Vehicle Operating Costs In Flooded And Non Flooded Cases (DT per 1,000 vehicle/km)

Vehicle Type	Non-flooded Case	Flooded Case	Difference
Private Car/Taxi	114.51	143.3	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

Table 10.4 Zone A : Estimated Areas and Damages to Buildings

Category	Present Land Use H/holds (No)	Areas (m2)	Damages DT(1,000)	Future Land Use H/holds (No)	Areas (m2)	Damages DT(1,000)
Popular	810	48,600	729.0	2,400	144,000	2,160.0
Medium	184	18,400	460.0	544	544,000	13,600.0
High	86	12,900	451.5	256	38,400	1,344.0
TOTAL:			1,641.0			17,104.0

Table 10.5 Oued Ennkhilet - Estimate Of Daily Passenger Flow on the GP 8 - 2020

Category	Vehicles	Occup. Rate	Total Passengers
Passenger and taxis	43,100	3.8	163,780
Buses	1,700	45	76,500
Light vehicles	20,300	2.0	40,600
Heavy vehicles	18,600	2.0	37,200
2 wheels	800	1.5	1,200
TOTAL:	84,500		319,280

Table 11.1 Summary of Project Cost, Ennkhilet 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	3,646	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

Table 11.2 Summary of Project Cost, Ennkhilet 2nd 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	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 11.3 Annual Disbursement Schedule, Ennkhilet 1st Stage

unit (F.C: 1,000 US$, L.C & Total: 1,000 DT)

	Cost Items	F.C	L.C	Total	1994		1995		1996		1997		1998	
					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	0	3,738	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 13.1 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