3.5 Development of Water Supply System

3.5.1 Establishment of Basic Technical Strategies

For the establishment of water supply system in the model areas, the following conditions as for technical strategies are taken into consideration:

i) The main water supply system shall be based on the source water from the exploratory wells, and the water from existing dugholes and springs shall be utilized for supplementary purpose.

ii) When the new water supply system is established, although the proposed new system is primarily dependent upon stand pipes, the water from the exploratory wells shall be fully utilized for achieving house connection system as much as possible in the rural center.

iii) The system as an urgent improvement program to be adopted this time shall be by gravity system.

iv) The future extension program, namely supply areas based on pumping system shall be implemented in accordance with increase of population and requirement for extension by the residents in the douars of remote areas.

v) The transportation of water to the neighboring communes may be allowed after the establishment of water supply system and capability of further production of water is confirmed.

vi) The proposed water supply system shall be limited to the fundamental facilities to supply water. Further extension lines, namely branch lines shall be installed in the future when requested by the inhabitants of the commune.

vii) The method of water supply to the douars shall be basically stand pipes. This method keeps the initial cost down and remain possibilities to extend branch lines in compliance with willingness and intention of the inhabitants and capability of operation and management organization to be established.

viii) In parallel with establishment of new water supply system, improvement and rehabilitation of the existing water sources and supply facilities shall be carried out on the basis of the data presented in the five years plan by the AH.

3.5.2 Establishment of Planning Parameters for Water Supply Facilities

(1) Served Population

The planned served population in each five years stages up to the target year of 2010 and planned average daily supply amount have already been represented with the service ratio of 80 percent as given in Section 3.4.

(2) Maximum Day Demand

Maximum day demand is, in general, computed multiplied average daily demand by peak factor for designing the capacities of water supply facilities. However, the seasonal difference is not shown quantitatively due to lack of data and their accuracy. Therefore, average daily water demand shall be applied to design for water supply facilities.

(3) Time Coefficient

As for determination of maximum hourly supply amount, time coefficient is generally adopted for designing pipe lines on the basis of the past time-related water consumption records. However, time of water acquisition is not certain. Thus, average hourly supply amount would be acceptable to apply for designing supply pipe lines and appurtenant facilities.

(4) Capacity of Distribution Tanks

The model areas are located in the typical rural areas and several hours are needed to access to repair or convert mechanical parts when stoppage suddenly occurs. Therefore, the capacity of 12 hours on a practical view point would be appropriate.

(5) Topographic Base Map

For preliminary design purpose, the topographic base map with the scale of 1/50,000 was adopted for preparation of the plans and hydraulic profiles for water supply facilities. For the implementation of detail design, topographic survey in the areas concerned is, first of all, necessary in the following stages.

3.5.3 Preliminary Planning of Water Supply Facilities

(1) General Plan and Hydraulic Profiles

General plans of water supply facilities for Ain Defali, Teroual, and El Biban are given in Figures 3.2 to 3.4. The proposed water supply system consists primarily of gravity system through the three model areas. Proposed distribution lines for future extension are shown by chain lines in the plans and these extension lines are to be provided by pumping system due to the topographic configuration.

(2) Exploratory Well Site Facilities

The pumping facilities provided in the exploratory wells are all submersible pumps to extract water from the wells to the main distribution tanks on top of the hills located in the vicinity of each well.

(3) Distribution Tanks

The distribution tanks are mainly divided into two categories. The one is called the main distribution tank located in the vicinity of the exploratory wells to reserve water for the entire supply area, and the other is the one provided at the end of distribution pipe lines to

provide free surface, connect proposed future extension pipe line with pumping facilities and to supply water to the douar concerned.

(4) Distribution Pipes

The PVC is generally used for the case of small diameter and house connections. The galvanized steel and asbestos cement pipes are generally used for transmission and distribution pipes, and they are domestic products.

(5) Stand Pipes

Structure of the stand pipe is reinforced concrete type having facilities of water tapping, water feeding pit for livestock and washing cloth area. The stand pipe is surrounded by net fence to protect from animal intrusion to the stand pipe area. One unit of stand pipe is basically proposed to provide in each douar.

(6) Appurtenant Works

Electric cables, posts and control panels to supply electric power to the exploratory well sites are to be provided. Access roads for installation of pipes and distribution tanks are also planned to be provided.

3.5.4 Improvement of Existing Facilities

The improvement of the existing water supply facilities is to be made on the basis of the lists provided in the five-years plan prepared by the AH as described previously.

The practical works to be done for rehabilitation of dug holes are such as 1) repair of walls, 2) provision of roof on the dug hole, 3) provision of cover on the dug hole, 4) provision of hand pumps, 5) provision of concrete stages for sanitary purpose, 6) provision drains. Whereas, for springs, 1) provision of water tanks with concrete structure, 2) provision of conduction pipes from the spring to the tank, 3) provision of roof, 4) provision of concrete stage for sanitary purpose, 5) provision of drains, are to be equipped.

3.5.5 Operation and Maintenance Plan

In order to supply potable water satisfactory for water demand and water quality standard with adequate pressure, water supply facilities are required to be constantly maintained in a condition able to enhance the function of the system.

(1) Control of Water Quantity

Monitoring and estimation of the balance between water demand and supply are required for distributing water to all the supply areas equally and suitably. For this purpose, measurement of flow rate, pressure and water storage are carried out. On the basis of the data obtained by the measurements, operation and maintenance works are provided efficiently to cope with the variation of water distribution quantity. Water leakage is

checked from time to time in the process of flow rate control in order to prevent loss and contamination of water, and lowering effectiveness and damages on devices.

(2) Control of Water Quality

Testing of water quality is constantly carried out for water source as well as for taps at the end of distribution facilities. The deterioration of water quality is not only due to pollution of water source but also brought from occurrence of negative pressure in pipes resulting in suction of contaminated water from surrounding soils.

(3) Well Sites

Flow rate of groundwater and water level in production well should be constantly measured. Excessive extraction may bring about break of balance between extraction and recharge, and clogging of strainer.

It is preferable to provide net fence and drainage facilities around wells and pumping facilities for preventing damages on the facilities as well as for environmental protection at the well site.

(4) Pumps

Submersible pumps are planned to be equipped on production wells. Pumps are also planned at distribution tanks in the case of extension of water supply system. For proper operation of the pumps, operating conditions should be constantly checked in terms of electric voltage and current, fluctuation of water pressure, and performance of control panels, cables and motors. Periodical maintenance of equipment and supply of spare parts are also important.

(5) Distribution Tanks and Pipes

In order to maintain the function of distribution tanks, it is preferable to provide recorders for checking a storage amount and to conduct leakage survey from tank.

For operation and maintenance works of distribution pipelines, it is necessary to provide milestones along the pipeline, at the valves and location of the pipes, in order to effectuate maintenance works.

It is also important to keep accessibility to distribution tanks and pipelines without any delay of maintenance works.

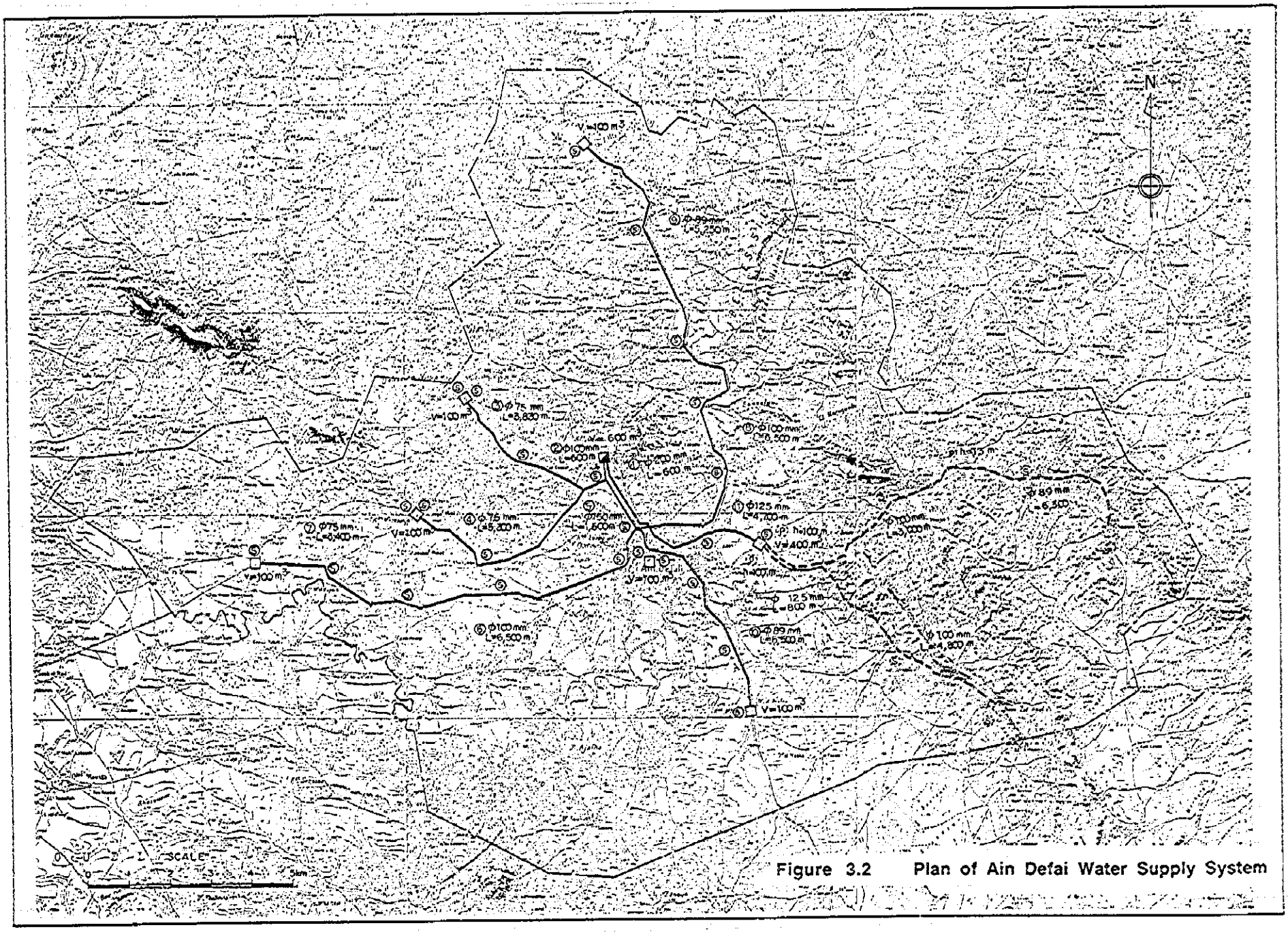


Figure 3.2 Plan of Ain Defai Water Supply System

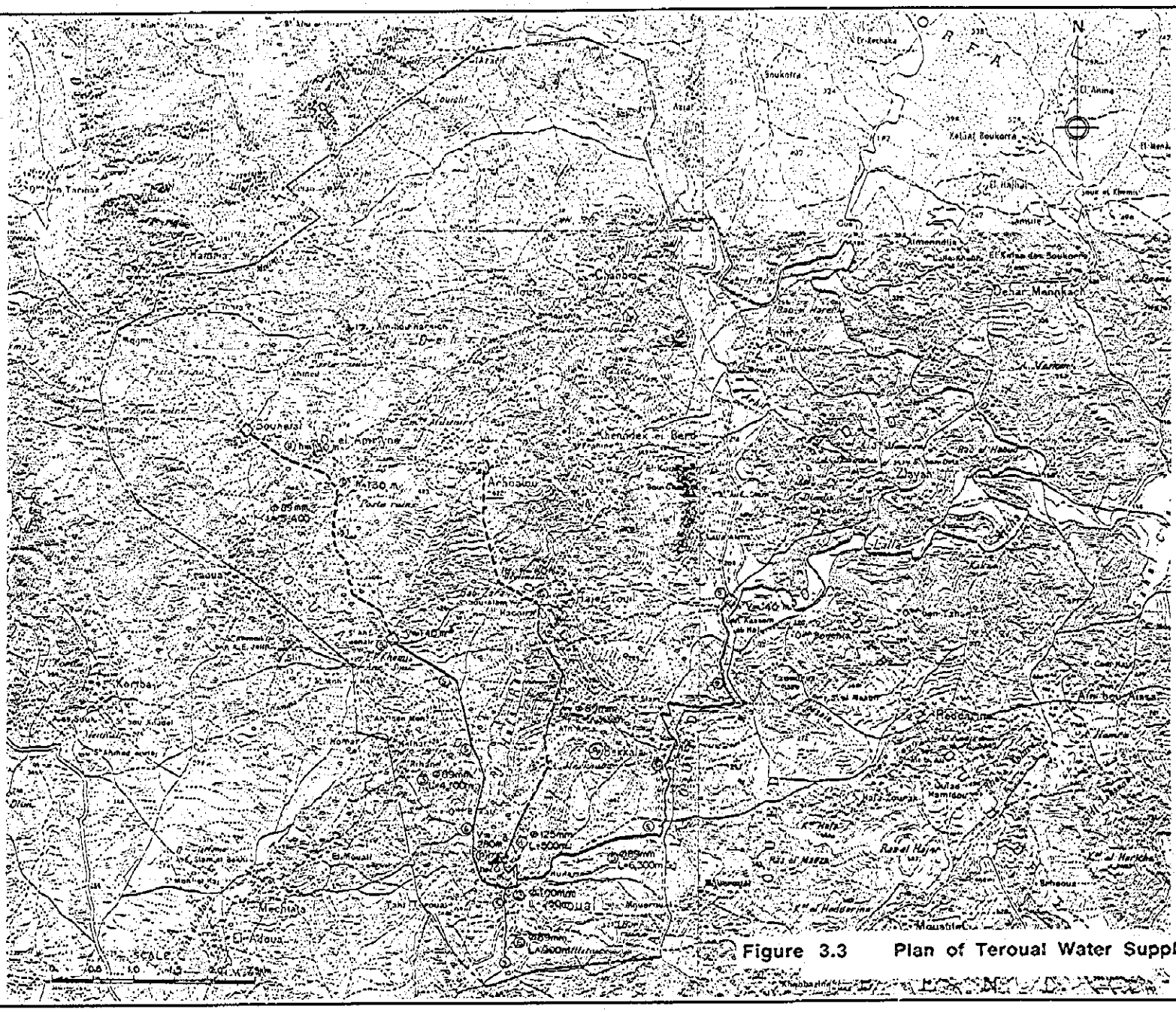


Figure 3.3 Plan of Teroual Water Supply System

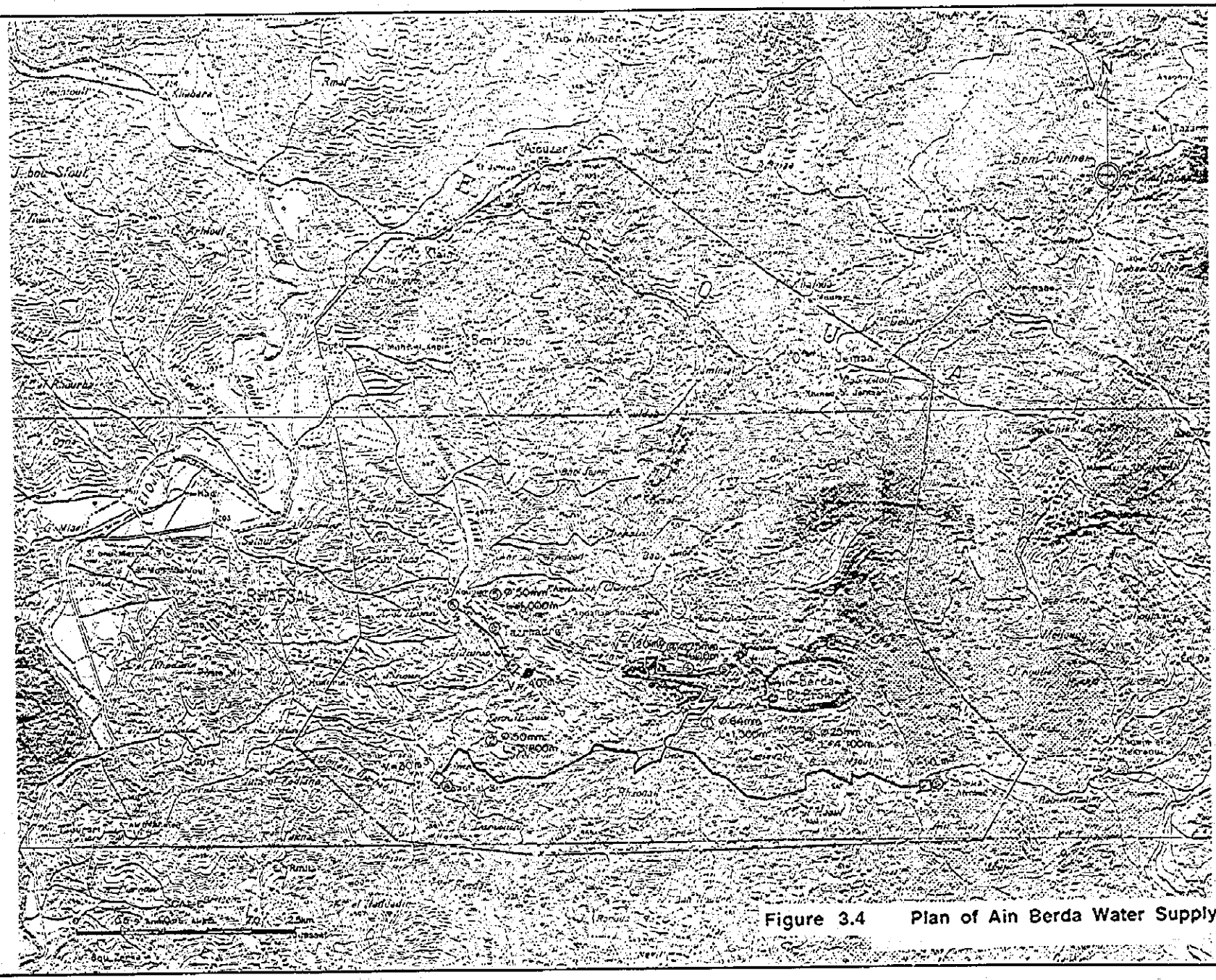


Figure 3.4 Plan of Ain Berda Water Supply System

3.6 Preliminary Cost Estimate

3.6.1 Conditions of Cost Estimate

(1) Composition of the Project Cost

The project cost constitutes the following cost components:

i) Direct construction cost
ii) Land acquisition and compensation costs
iii) Administration expenses for executing agency
iv) Engineering services expenses
v) Price contingency
vi) Physical contingency.

(2) Price Level

Price level is to be set as of January 1996 for the cost estimate.

(3) Exchange Rates

The exchange rates are set as follows referring the " International Financial Statistics" in January 1996.

i) US $ 1.0 = DH 8.6 = Yen 100.0
ii) DH 1.0 = Yen 11.6

(4) Devaluation

As Moroccan Dirhams are stable to the US Dollar in recent years, devaluation factor was not incorporated with the price escalation rate, accordingly.

(5) Foreign and Local Currency

The project cost was estimated dividing into foreign and local currency portions (FC and LC) taking into account the following factors:

i) Availability of skilled labors in Morocco
ii) Availability and productivity of construction materials in Morocco
iii) Availability of plant and equipment in Morocco for construction execution.

(6) Value Added Tax

Value added tax (VAT) currently adopted in Morocco was as follows:

i)	VAT for sales activity	:	19.0 %
ii)	VAT for construction activity	:	14.0 % .

(7) Interest During Construction

No interest during construction period was taken into account.

3.6.2 Approaches to Cost Estimate

(1) Macro Basis Unit Costs for Rural Water Supply Project

Macro basis unit costs were applied for due comprehensive cost study on rural water supply in the Pre-Rif region.

(2) Direct Construction Cost

The direct construction cost consists of 1) mobilization and preparatory works, 2) civil works, 3) mechanical works including water transmission and distribution pipe lines, 4) building works, and 5) procurement of electro-mechanical facilities. These costs were estimated applying the following three methods.

i) Unit Construction Costs to be Multiplied by Work Quantities
ii) Statistical Method Using Cost Data of Other Similar Projects
iii) Quotations from Supplier, Distributors or Sole Agents

(3) Land Acquisition and Compensation Costs

The great majority of the land in the model areas is owned by the communal authorities. The land acquisition cost, due to this reason, was not taken into consideration in the cost estimate, and neither is subsequent compensation cost.

(4) Administration Expenses for Executing Agency

Administrative expenses for implementing the project by the executing agency was estimated as a proportion to the direct construction cost applying 10 percent. These expenses were incorporated into the local currency portion.

(5) Engineering Services Expenses

The engineering services expenses were estimated at 20 percent of the direct construction cost to cover basic design, tender design and construction supervision by foreign and local consulting engineers. Of the expenses, 70 and 30 percents were applied to foreign and local currency portions, respectively.

(6) Price Contingency

Price contingency is to cover increment portion in the market price of materials, equipment and labor charges. The price contingencies for foreign and local currency

portions were estimated on the basis of the consumer price index of G7 countries in the last five years. Consequently, the following price escalation rates were incorporated into the cost estimate.

i) Foreign currency portion : 2.9 % p.a.
ii) Local currency portion : 6.0 % p.a.

(7) Physical Contingency

Physical contingency was provided to cope with unforeseen physical conditions, such as minor differences between actual and estimated quantities, omissions of work items, incidental pay items occurred, possible changes in plans, and other uncertainties. The physical contingency was estimated at 15 percent to the base project cost and incorporated into both foreign and local currency portions.

3.6.3 Project Cost Estimate

The project cost has been worked out for 2 cases that one is to supply by gravity system and gravity plus forced supply by pumps as presented below, according to the implementation schedule.

Table 3.14 Project Cost

Gravity

US$1.0 = DH8.6 = ¥100.0 (Jan..1996)

No.	Project Cost Items	Foreign Currency Portion (1,000 US$)	Local Currency Portion (1,000 DH)	Total Equivalent (1,000 DH)
1	Direct construction cost <1	4,839	15,563	57,272
2	Land acquisition and compensation costs <2	0	0	0
3	Administration expenses <3	0	5,727	5,727
4	Engineering services expenses <4	932	3,436	11,454
	(Total as base cost)	(5,771)	(24,816)	(74,449)
5	Price contingency <5	411	3,618	7,153
6	Physical contingency <6	927	4,265	12,240
	Project cost	7,110	32,700	93,842

Gravity + Pumps

US$1.0 = DH8.6 = ¥100.0 (Jan. 1996)

No.	Project Cost Items	Foreign Currency Portion (1,000 US$)	Local Currency Portion (1,000 DH)	Total Equivalent (1,000 DH)
1	Direct construction cost <1	6,401	19,868	74,917
2	Land acquisition and compensation costs <2	0	0	0
3	Administration expenses <3	0	7,492	7,492
4	Engineering services expenses <4	1,220	4,495	14,983
	(Total as base cost)	(7,621)	(31,855)	(97,392)
5	Price contingency <5	543	4,638	9,307
6	Physical contingency <6	1,225	5,474	16,005
	Project cost	9,388	41,966	122,703

Note: <1 : including Value Added Tax of 14.0% in local currency portion
<2 : no account, the land owned by each commune
<3 : 10% of total direct construction cost
<4 : 20% of total direct construction cost for basic design, detailed design and construction supervision, and 70% FC and 30% LC
<5 : 2.9% and 6.0% for foreign and local currency portion respectively
<6 : 15 % to the sum of base cost and price contingency

3.6.4 Operation and Maintenance Costs

Annual operation and maintenance costs were estimated divided into gravity supply system and gravity plus pumping system as summarized below.

Table 3.15 Opeation and Maintenance Cost

		Operation Cost Gravity	Operation Cost Gravity + Pumps
Ain Defali	:	DH 222,000	DH 435,000
Teroual	:	DH 375,000	DH 790,000
Ain Berda	:	DH 78,000	DH 78,000
Total	:	DH 675,000	DH 1,303,000

		Maintenance Cost Gravity	Maintenance Cost Gravity + Pumps
Ain Defali	:	DH 272,500	DH 362,300
Teroual	:	DH 129,000	DH 220,500
Ain Berda	:	DH 144,200	DH 144,200
Total	:	DH 545,700	DH 727,000

3.7 Construction Plan and Procurement of Equipment and Materials

The construction works of water supply facilities will be implemented in twelve months work period for the respective model areas taking into account the required work terms and its quantities, procurement period of materials from offshore market, weather and other conditions affecting the construction execution. The rehabilitation works of existing facilities will be carried out in parallel with the construction of water supply facilities. The most of materials and equipment for construction will be available in Morocco, while the electrical and mechanical equipment will be procured from foreign countries. Preliminary design features of water supply facilities summarized in the Section 4.5.

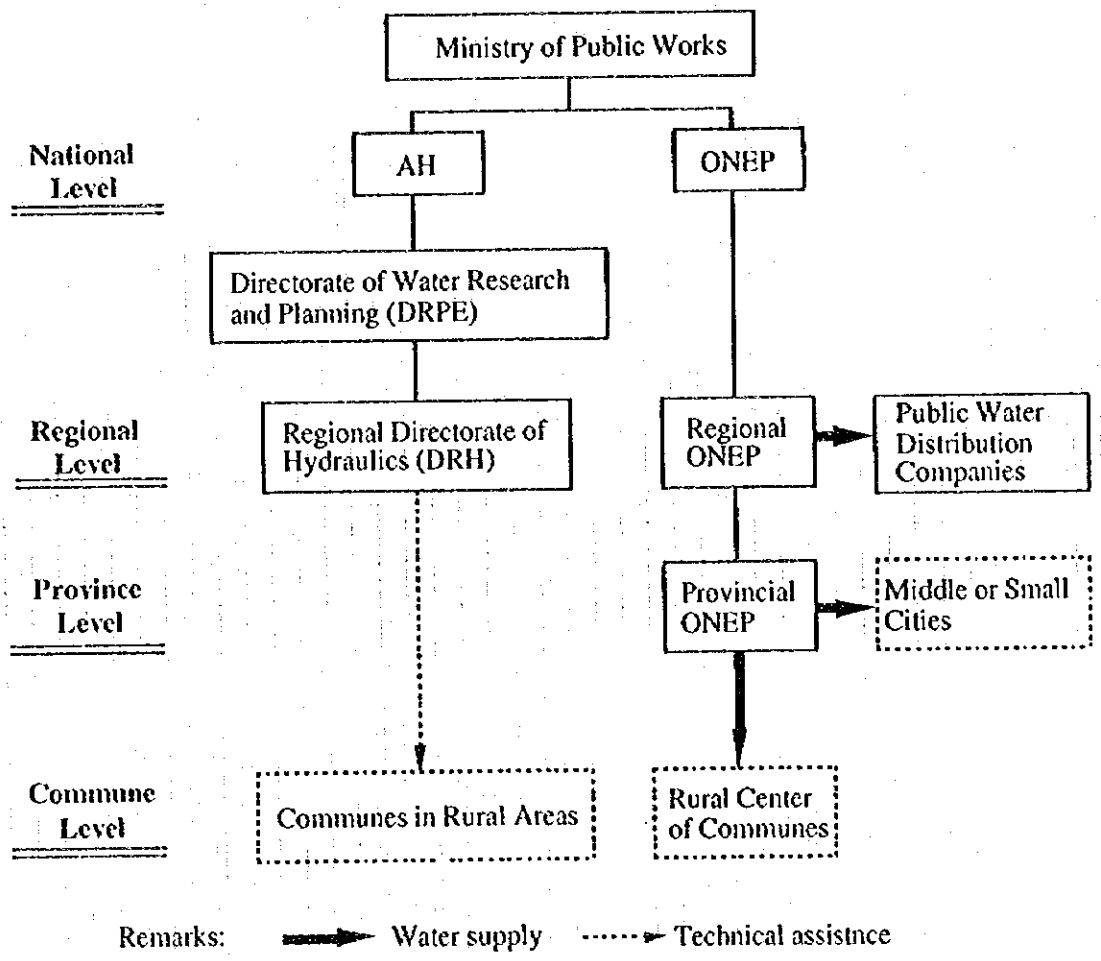
3.8 Project Evaluation

3.8.1 Organizational Structure

(1) Present conditions

The Ministry of Public Works comprising the Administration of Hydraulic (AH) and the National Office of Portable Water Supply (ONEP) is the government agency for development of the water sector. The AH is primarily in charge of water resource development and the ONEP is in charge of water supply development. The following figure illustrates the framework of organizations concerning to water supply in urban and rural areas.

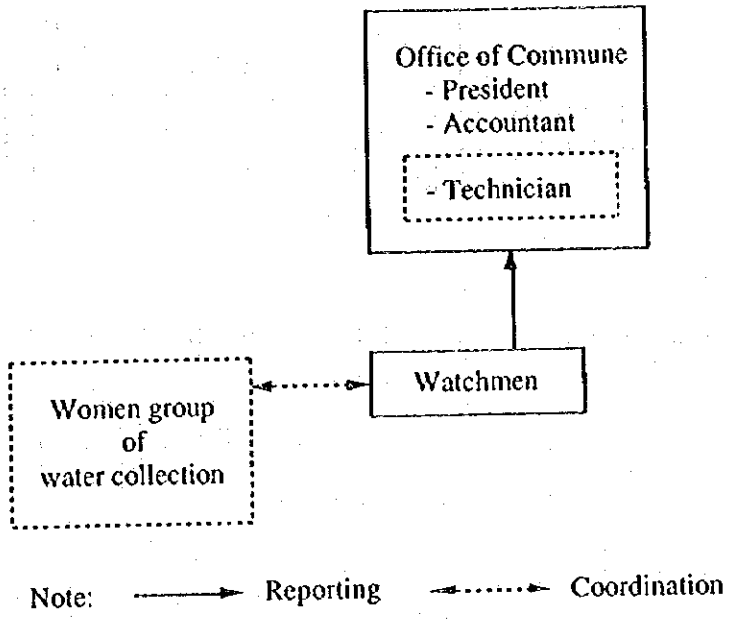
Figure 3.5 Organizational Structure of Water Supply



(2) Site Operation in the Model Areas

The rural water supply in the model areas will be operated by the offices of communes in Ain Defali, Teroual and El Bibane. The following figure shows the proposed structure of site operation in the model areas.

Figure 3.6 Organizational Structure of Site Operation



3.8.2 Water Tariff

The capacity-to-pay was reported to be DH 60 in Ain Defali, DH 26 in Teroual, and DH 30 in El Bibane. Accordingly the ratio of capacity-to-pay out of household expenditures on the monthly basis is calculated to be 4.0 percent in Ain Defali, 2.1 percent in Teroual and 2.5 percent in El Bibane.

The monthly water demand per household is estimated based on projection of unit water demand. Water consumption per household consisting of domestic and livestock use is extremely small in the range from 3.3 m^3 to 6.4 m^3 per month. Water demand is assumed to increase marginally in the future at an annual growth rate around 2 percent.

The following assumptions are made in order to estimate the average water rate per m^3 based on capacity-to-pay for the period from 1995 to 2010.

i) Affordable expenditure of a household for water will increase at an annual growth rate of 3 percent.

ii) Both affordable expenditure and water demand are discounted by 12 percent to estimate the present worth of them.

iii) Present worth of expenditure is divided by that of water demand in order to estimate the average water rate per m^3.

The capacity-to-pay-based water rates per m^3 result in high prices, DH 14.3 per m^3 in Ain Defali, DH 6.5 per m^3 in Teroual and DH 9.2 per m^3 in El Bibane.

3.8.3 Financial Evaluation

(1) Financial Cash Flow

The commune offices in the model areas are proposed to be implementing bodies of water supply projects. Financial cash flows are prepared for two cases. One is that an implementing body is responsible for all project costs including O&M costs. The other is that an implementing body is responsible for direct construction and O&M costs only. The government (i.e. AH) is responsible for financial mobilization of the other costs. The following table shows the results of FIRR based on two scenarios of financial cash flows.

Table 3.16 Financial Internal Rate of Return

Water Supply Schemes/Two Cases	Ain Defali		Teroual		El Bibane	
	FIRR (%)	Accumulation of net revenue (million DH)	FIRR (%)	Accumulation of net revenue (million DH)	FIRR (%)	Accumulation of net revenue (million DH)
Gravity + Pumping						
All project costs	0.7	5	-	-37		
Direct construction cost only	5.1	26	-	-27		
Gravity only						
All project costs	0.9	5	-	-22	-	-4
Direct construction cost only	5.2	21	-	-16	0.0	0

Note: (-) means negative value of FIRR.

The less cost scheme (Gravity only) shows marginally higher FIRRs, which is proved by the case of Ain Defali. Financial viability does not make any difference between Gravity and Pumping Scheme, and Gravity Scheme.

The FIRR of Ain Defali in the case of direct construction cost only turns out to be marginally feasible for both schemes of Gravity and Pumping, and Gravity only. This is ascribed to the relatively high water tariff in Ain Defali. The other cases are not financially feasible.

Nevertheless project revenue in all cases can afford expenses of operation and maintenance costs. The financial cash flows of Ain Defali (Gravity + Pumping) are shown in Table 3.17 through 3.18.

(2) Prospect for Loan Repayment

Loan repayment is taken into account for the case of Gravity and Pumping with direct construction cost only in Ain Defali. The loan conditions considered are as follows.

Table 3.19 Loan Conditions

Financial source	Interest (%)	Grace (Grace)	Repayment	Amount
Semi-government	10	3	20	15 % of cost
External soft loan	3	5	20	85 % of cost

The semi-government loans are assumed to be lent to the implementing bodies from the Funds for Commune Equipment (FEC). Both grace and repayment period of the FEC are the likely loan conditions. An interest rate of 10 % per annum is based on the prevailing condition. The loan conditions of external source are assumed to be those of the most concessionary bilateral source.

As shown in Table 3.20, net revenue turns out to be negative 2002 through 2007. But accumulation of net revenue during repayment period continues to be positive, resulting in the amount of DH 5.7 million in 2016. This indicates that the case of Ain Defali with direct construction cost only can sustain loan conditions established.

3.8.4 Economic Evaluation

(1) Project Effect and Economic Benefits

The project effects to be expected will be:

i) Cost saving of water transportation due to installment of public stand-pipes,
ii) Improvement of public hygiene due to supply of clean portable water, and
iii) Positive effect on women in development (WID).

Both the second and third items are characteristically regarded as the qualitative effects. The quantifiable effect is expected to be cost saving of water collection. The annual benefits (1995) are estimated given below.

Table 3.21 Annual Full Benefit (1995)

Unit : DH

Commune	Gravity + Pumping	Gravity only
Ain Defali	2,526,270	2,102,400
Teroual	562,040	281,020
El Bibane	-	466,020

(2) Economic Cash Flow

The following table shows the results of EIRR on the basis of the above assumption.

Table 3.22 Economic Internal Rate of Return

Commune	Gravity + Pumping		Gravity only	
	EIRR	Accumulation of net benefits (million DH)	EIRR	Accumulation of net benefits (million DH)
Ain Defali	0.6	4	1.9	9
Teroual	-	-28	-	-18
El Bibane			-	-1

Note: (-) means negative value of EIRR.

There is no substantial difference of EIRRs estimated between two schemes, Gravity and Pumping, and Gravity only. The water supply project of Ain Defali in the case of Gravity only shows the highest EIRR (1.9%) but results in the marginal value. The economic cash flow of Ain Defali in the case of gravity and pumping is shown in Table 3.23.

3.8.5 Socio-Economic Impacts

(1) Economic Impacts

Most profound impact brought about by rural water supply will be possibly the increase in agricultural production. The construction of small scale canals would revive the abandoned crops due to water shortage. The reduction of time spent for water collection would give local women the opportunity of working in the part-time income-earning activity such as crafting works.

(2) Impacts on Household

The positive impact is likely to be more considerable in mountainous area such as El Bibane and Ain Defali where existing water points are far from dwelling places. In those areas, water collection makes women feel terribly exhausted so that they sometimes can not be engaged in agricultural activity particularly during harvesting time. The attend rate of girls in elementary school is reported to be quite low due mainly to water collection. The provision of water supply facility brings the positive effect on productivity of agricultural works and attending condition of girls in elementary schools.

(3) Impacts on Local Community

Most significant social impact on local community to be induced by rural water supply will be the incentive to promote local participation. The operation of water supply in the form of stand-pipes would need a cooperative manner in the light of water collection schedule and collection of water charge.

3.8.6 Overall Evaluation

The results of financial evaluation identify that rural water supply project of Ain Defali proves to be relatively viable. Provided that the commune of Ain Defali is only responsible for direct construction costs, the resulting FIRRs (5.1% for Gravity and Pumping, 5.2% for Gravity only) would be financially sustainable for loan scheme consisting of external soft loan and the prevailing domestic fund from the FEC. This is mainly attributed to a large scale of water demand compared to the other communes. Though the FIRRs result in negative and marginal value in Teroual and El Bibane, project revenue is large enough to make up for operation and maintenance costs. If both schemes are financed by the government subsidy, operation and maintenance of water supply by the relevant communes would be sustainable.

The three model communes are the typical area having been suffering from scarce water resource. The provision of water supply facilities was reported to be the most desirable and actually placed as top priority as a result of socio-economic survey. Under such circumstance, rural water supply is worth of being implemented because it meets social need of local people. Socio-economic impacts might be considerable particularly in hilly and mountainous areas such as Teroual and El Bibane. The alleviation of physical burden from women and children will definitely improve the working condition of women in household and attend rate of children in elementary school.

Table 3.17 FIRR (Ain Defali, Gravity and Pumping, All Project Costs)

unt : DH

	Revenue	Capital Cost	O&M Cost	Total Cost	Net Revenue
1995					
96		2,839,828		2,839,828	-2,839,828
97	1,149,577	24,207,700	277,810	24,485,510	-23,335,933
98	2,507,711	22,020,384	588,957	22,609,341	-20,101,630
99	3,037,344	7,333,057	815,434	8,148,491	-5,111,147
2000	3,611,237	7,603,309	1,066,967	8,670,276	-5,059,039
01	3,755,268		1,066,967	1,066,967	2,688,301
02	3,899,299		1,066,967	1,066,967	2,832,332
03	4,043,331		1,066,967	1,066,967	2,976,364
04	4,187,362		1,066,967	1,066,967	3,120,395
05	4,331,393		1,066,967	1,066,967	3,264,426
06	4,486,160		1,066,967	1,066,967	3,419,193
07	4,640,928		1,066,967	1,066,967	3,573,961
08	4,795,695		1,066,967	1,066,967	3,728,728
09	4,950,462		1,066,967	1,066,967	3,883,495
10	5,105,229		1,066,967	1,066,967	4,038,262
11	5,259,997		1,066,967	1,066,967	4,193,030
12	5,414,764		1,066,967	1,066,967	4,347,797
13	5,569,531		1,066,967	1,066,967	4,502,564
14	5,274,299		1,066,967	1,066,967	4,207,332
15	5,879,066		1,066,967	1,066,967	4,812,099
16	6,033,833		1,066,967	1,066,967	4,966,866

FIRR=0.7%

Table 3.18 FIRR (Ain Defali, Gravity and Pumping, Direct Construction Cost Only)

unit : DH

	Revenue	Capital Cost	O&M Cost	Total Cost	Net Revenue
1995					
96					
97	1,149,577	16,199,745	277,810	16,477,555	-15,327,978
98	2,507,711	16,766,522	588,957	17,355,479	-14,847,768
99	3,037,344	4,871,303	815,434	5,686,737	-2,649,393
2000	3,611,237	5,036,393	1,066,967	6,103,360	-2,492,123
01	3,755,268		1,066,967	1,066,967	2,688,301
02	3,899,299		1,066,967	1,066,967	2,832,332
03	4,043,331		1,066,967	1,066,967	2,976,364
04	4,187,362		1,066,967	1,066,967	3,120,395
05	4,331,393		1,066,967	1,066,967	3,264,426
06	4,486,160		1,066,967	1,066,967	3,419,193
07	4,640,928		1,066,967	1,066,967	3,573,961
08	4,795,695		1,066,967	1,066,967	3,728,728
09	4,950,462		1,066,967	1,066,967	3,883,495
10	5,105,229		1,066,967	1,066,967	4,038,262
11	5,259,997		1,066,967	1,066,967	4,193,030
12	5,414,764		1,066,967	1,066,967	4,347,797
13	5,569,531		1,066,967	1,066,967	4,502,564
14	5,274,299		1,066,967	1,066,967	4,207,332
15	5,879,066		1,066,967	1,066,967	4,812,099
16	6,033,833		1,066,967	1,066,967	4,966,866

FIRR=5.1%

Table 3.20 Loan Repayability (Ain Defali, Gravity and Pumping, Direct Construction Cost Only)

unit : DH

	Revenue	O&M Cost	External Soft Loan			Domestic (FEC) Loan			Net Revenue	Acculation of Net Revenue
			85% of capital cost	Interest	Repayment	15% of capital cost	Interest	Repayment		
1995										
96										
97	1,149,577	277,810	13,769,783	413,093		2,429,962	242,996		215,678	215,678
98	2,507,711	588,957	14,251,544	840,640		2,514,978	494,494		583,620	799,298
99	3,037,344	815,434	4,140,608	964,858		730,695	567,564		689,488	1,488,786
2000	3,611,237	1,066,967	4,280,934	1,093,286		755,459		801,700	649,284	2,138,070
01	3,755,268	1,066,967		1,093,286				801,700	793,315	2,931,385
02	3,899,299	1,066,967			2,901,217			801,700	-870,585	2,060,800
03	4,043,331	1,066,967			2,901,217			801,700	-726,553	1,334,247
04	4,187,362	1,066,967			2,901,217			801,700	-582,522	751,725
05	4,331,393	1,066,967			2,901,217			801,700	-438,491	313,234
06	4,486,160	1,066,967			2,901,217			801,700	-283,724	29,510
07	4,640,928	1,066,967			2,901,217			801,700	-128,956	-99,446
08	4,795,695	1,066,967			2,901,217			801,700	25,811	-73,635
09	4,950,462	1,066,967			2,901,217			801,700	180,578	106,943
10	5,105,229	1,066,967			2,901,217			801,700	335,345	442,288
11	5,259,997	1,066,967			2,901,217			801,700	490,113	932,401
12	5,414,764	1,066,967			2,901,217			801,700	644,880	1,577,281
13	5,569,531	1,066,967			2,901,217			801,700	799,647	2,376,928
14	5,274,299	1,066,967			2,901,217			801,700	504,415	2,881,343
15	5,879,066	1,066,967			2,901,217			801,700	1,109,182	3,990,525
16	6,033,833	1,066,967			2,901,217			801,700	1,263,949	5,254,474

Table 3.23 Economic Cash Flow (Ain Defali, Gravity and Pumping)

unit : DH

	Benefit	Capital Cost	O&M Cost	Total Cost	Net Revenue
1995					
96		2,720,858		2,720,858	-2,720,858
97	1,125,403	21,826,095	222,525	22,048,620	-20,923,217
98	2,325,009	19,105,236	445,050	19,550,286	-17,225,277
99	2,399,211	6,207,812	581,310	6,789,122	-4,389,911
2000	2,972,086	6,207,812	717,570	6,925,382	-3,953,296
01	3,090,625		717,570	717,570	2,373,055
02	3,209,164		717,570	717,570	2,491,594
03	3,327,703		717,570	717,570	2,610,133
04	3,446,243		717,570	717,570	2,728,673
05	3,564,782		717,570	717,570	2,847,212
06	3,692,157		717,570	717,570	2,974,587
07	3,819,532		717,570	717,570	3,101,962
08	3,946,907		717,570	717,570	3,229,337
09	4,074,282		717,570	717,570	3,356,712
10	4,201,657		717,570	717,570	3,484,087
11	4,329,032		717,570	717,570	3,611,462
12	4,456,408		717,570	717,570	3,738,838
13	4,583,783		717,570	717,570	3,866,213
14	4,711,158		717,570	717,570	3,993,588
15	4,838,533		717,570	717,570	4,120,963
16	4,965,908		717,570	717,570	4,248,338

EIRR=0.6%

3.9 Water Quality and Environmental Impact Assessment (EIA)

3.9.1 Water Quality

(1) Existing Dugholes and Springs

Water sampling and testing was carried out for the existing dugholes and springs in July and August 1995 during the second field work stage. In all, thirty samples were collected for analysis. In the course of water sampling and testing, many of the dugholes were found to be dry or extremely poor in quantity due the prevailing hot climatic conditions at the time of sampling.

As seen in the result of water quality analysis, most of the parameters are seen to be within the maximum recommended values for drinking water.

It is seen that ammonia content is higher than the recommended value in 60 percent of the samples (18 out of 30 samples). This is uniformly true for all three model areas. Calcium and sulfide are other prominent parameters which exceed recommended values.

(2) Exploratory Wells

The quality and quantity were subsequently identified to be suitable as a whole for drinking purposes. Caution must be exercised in assessing the water quality of Ain Berda Well No. JBD3, since ammonia and nitrate contents were assessed to be comparatively higher than maximum recommended values. Periodic monitoring is essential at this well once groundwater extraction commences. Samples from all the exploratory wells were brought back to Japan for testing of heavy hydrogen, heavy oxygen and tritium.

In accordance with the results of ^{3}H, the waters from ADF1, ADF2 and JBD2 consist of so called 'old water' which were charged into the ground approximately 50 to 70 years ago.

3.9.2 Environmental Impacts

(1) Social Environmental Impacts

1) Water Right Issues

As per Moroccan law, all water, irrespective of land ownership belongs to the government. Private individuals, groups, communes and douars have to get permission from the government for drilling wells for groundwater exploitation. For implementation of the rural water supply which aims at exploitation of water resources for equitable distribution and economic uplift of population residing in the model areas, water right issues need to be clarified and modified if necessary. In this regard, the AH could play a important role in resolving water right issues.

2) Wastewater Disposal and Pollution Control

The increase in water consumption from 20 l/c/d to 31 l/c/d with no change in existing wastewater disposal methods (natural infiltration into ground) may cause pollution of groundwater sources. Appropriate sanitary education concerning wastewater disposal methods and planning for very simple, but appropriate, wastewater sanitation system at a future date may be necessary. The sanitary system could be communal pour flush toilets with the toilet being flushed by hand with water poured from a bucket, and communal septic tank and infiltration pits.

3) Health, Sanitation and Water-bone Diseases

Precise data for the model areas concerning occurrence of water borne diseases is lacking. However, the socio-economic survey conducted indicated the problem to be present in some recent years, particularly in drought years. This probably may have been caused by shortage of water for sanitary purposes in drought years and consequent lack of hygiene. Thus, once a regular sustained water supply is assured in the model areas due to the water supply master plan, and if adequate sanitation is provided, along with adoption of appropriate hygiene practices by the population, the health related benefits should be significant.

(2) Natural Environmental Impacts

There are some surface water courses in the model areas which may be affected by the construction of water supply facilities. Appropriate disposal of wastewater generated by construction of the facilities such as cement slurry, oils, lubricants, and chlorine used for disinfection of supply pipe lines after installation. The contamination of water courses will affect the water for irrigation, water for animals and groundwater sources like dugholes or springs. Regular monitoring during construction is necessary to prevent these problems.

3.9.3 Environmental Management Plan

(1) Water Quality Monitoring

For water quality control and for early detection of pollution, testing of source water quality as well as water from the standpipes at the end of the distribution facilities needs to be carried out on a regular basis.

(2) Control and Monitoring of Extraction of Groundwater

For extraction of groundwater, the flow rate of groundwater and water levels in the wells should be constantly measured. Excessive extraction may bring about break between extraction and recharge as well as clogging of strainer.

(3) Environmental Protection of Well Site and Tanks

For environmental protection of well site, it is recommended that net fence be provided around the well as well as the pumping facilities, to prevent damage to the facilities. Drainage facilities from tanks should be provided considering environmental protection in the surrounding areas.

(4) Health, Sanitation and Education Plan

The implementation of an appropriately designed rural health, sanitation and hygiene education is necessary in addition to construction of water supply facilities.

(5) Institutional and Management Aspects

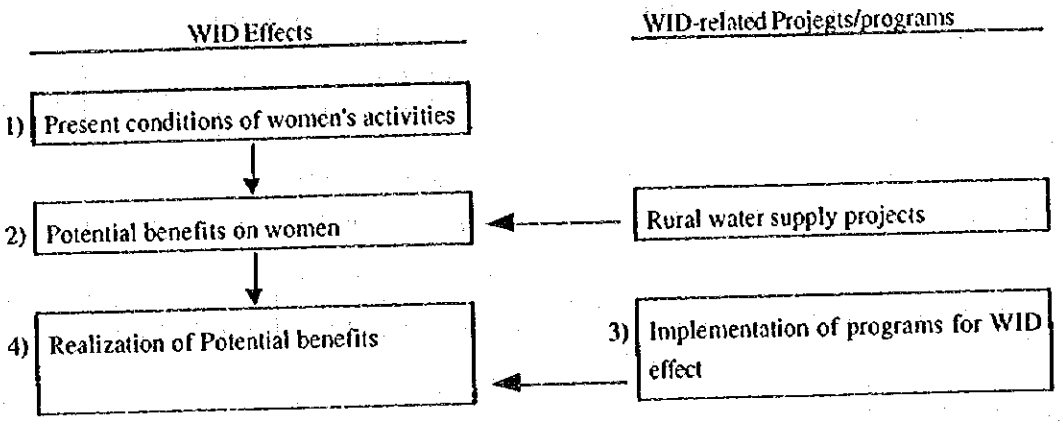
The main objective is to develop or create an adequate institutional structure at commune level. Communes are in a position to manage and protect their resources independently of other related agencies or institutions as is the care presently in the Study Area. The present institutional structure with roles and responsibilities for health and sanitation sectors concentrated in the Ministry of Public Health needs to be improved to increase participation as well as roles and responsibilities of communes.

3.10 Women in Development

3.10.1 Methodology to Evaluate Women in Development

The model areas for which WID is assessed are the three rural communes called Ain Defali, Teroual and El Bibane where water supply service is not currently provided. The methodology to evaluate WID in the model areas is contemplated to be as follows.

Figure 3.7 Evaluation of WID



3.10.2 Present Conditions of Women's Activities

(1) Ain Defali

Local women in Ain Defali are heavily involved in harvesting of vast plain fields. Most of women interviewed during socio-economic survey told that the harvesting activity was the most tiresome task. They are also involved in collection of tobacco leaves, sunflowers and olives to the lesser extent. The number of women heads of households was 310, comprising about 17 percent out of total number of households surveyed (1,880) at the time of socio-economic survey. The same ratios were about 22 percent in Teroual and 28 percent in El Bibane.

(2) Teroual

Located in hilly area, the holding size of farm land per household is small, resulting in a small scale of farming. Daily activities of local women cover a large number of tasks consisting of cereal harvesting, shaking down olive trees, fruit gathering and collection of olive oil. Local women left at farm home feel responsibility to sustain their livelihood for survival. The percentage of women involved in water collection including transportation is about 36 percent higher than the corresponding rates (16 percent in Ain Defali and 22 percent in El Bibane).

(3) El Bibane

Local women are seasonally involved in various activities such as cereal harvesting, collection of fruits and olive, and livestock grazing. Women being heads of household almost belong to the poor farm house. Local women whose husbands migrate elsewhere are normally employed

as labors by the near-by farm houses.

3.10.3 Potential Benefits on Women

The task of water collection done by women and children is regarded as the tiresome and time-consuming work in their daily activities. The introduction of rural water supply projects is certain to render them the direct effect such as alleviation of physical burden and saving of time required to undertake water collection. Such direct effect would lead to potential benefits on women and children. The following table presents the summary of potential benefits expected.

Table 3.24 Potential Benefits to be Expected

Nature	Beneficiary	Potential Benefits		Area
Economic	Women	(a)	Productive use of ground water for crops	All
		*(b)	Productive use of time to be saved	All
		*(c)	Loss of opportunity to work as labors	All
		(d)	Acceleration of poor women for job seeking elsewhere	El Bibane
	Children	(e)	Opportunity to improve technical skills and get the better jobs	All
Social	Women	(f)	Application of local women's collective action into management of water supply	Ain Defali
		(g)	Improvement of non-poor women's social status	All
		(h)	Reduction of women heads of households	Ain Defali Teroual
		(i)	Enhancement of women's awareness for hygienic conditions	All
	Children	(j)	Improvement of attending rates in primary and secondary schools	All
		(k)	Probability of poor families without parents	El Bibane

Note: * The benefit of (b) is expected at non-harvesting time.
The negative benefit of (c) is expected at harvesting time.

3.10.4 Programs to Realize Potential Benefits

Potential benefits discussed in the preceding sub-chapter (3.10.3) would not be realizable without specific programs. The importance should be attached to the following criteria in order to formulate such programs suitable for local people.

1) Maximum utilization of existing resources and systems (cost performance),
2) The participation of local people in projects or programs, and
3) Establishment of organizations.

The following table shows specific programs corresponding to the items of potential benefits. The same table also shows the criteria and constraints to take into account for implementation of them.

Table 3.25 Programs to Realize Potential Benefits

Benefit Items	Criteria 1)	2)	3)	Number of programs	Programs	Constraints
(a)	X			(i)	• Utilization of Development Centers or Work Centers for transfer of farming practice to women • Agricultural credits for women	• Land ownership controlled by men
(b)	X	X	X	(ii)	• Training programs of crafting works • Establishment of cooperative for poultry and other activities	• Low rate of women's literacy • Social status of women being subordinate to men
(c)(d)	X			(iii)	• Subsidy system to be given to poor families in order to prevent negative effect of (c) and (d)	• Financial constraint • Difficulty in selecting poor families for allotment of subsidy
(e)				(iv)	• Introduction of vocational education into secondary school	• Low rate of girl's literacy
(f)		X		(v)	• Training programs of women to participate in administrative works of water supply management	• Low rate of women's literacy
(g)		X	X	(vi)	• Creation of women's club	• Social status of women
(h)	X				• The same programs as those in (iii)	• The same as those in (iii)
(i)				(vii)	• Proper guidance for public hygiene to women	• Low rate of women's literacy
(j)				(viii)	• Guidance for importance of education to parents	• Children as work force
(k)	X				• The same as those in (iii) to prevent negative effect of (k)	• The same as those in (a) and (b)

3.10.5 Implementation Programs for WID Effect

Enhancement of economic conditions is in general considered to be a prerequisite for WID. This viewpoint is based on the concept that the improvement of economic conditions gives women the opportunity of integrating them into economic and social activities. But the approach to implementation of programs might be different between poor and non-poor women. Although the term "threshold income" is not quantitatively defined, households in the model areas are classified into those more than the threshold income and less than it.

The Figure 3.8 shows the step-wise implementation of programs for WID effect.

Figure 3.8 Step-wise Implementation Programs for WID Effect

	Development Term	Implementation of Programs	
		Households more than threshold income	Households less than threshold income
(1)	Short-Term	Programs of (i) and (ii)	Programs of (iii)
		↓	↓
		Resultant Benefits (a) (b) (j)	Resultant Benefits (c) (d) (h) (k)
(2)	Middle-Term	Programs of (v) (vi) and (vii)	Programs of (i) (ii) and (viii)
		↓	↓
		Resultant Benefits (f) (g) (i)	Resultant Benefits (a) (b) (j)
(3)	Long-Term		Programs of (v) (vi) and (vii)
			↓
			Resultant Benefits (f) (g) (i)

CHAPTER IV ESTABLISHMENT OF MASTER PLAN FOR STUDY AREA

4.1 Water Demand Projection of the Study Area

The strategy for establishing unit water demand in this Master Plan Study is fundamentally set taking into account of the National Master Plan of Water Supply for Rural Population in parallel with referring the current actual water consumption records in the Study Area and socio-economic survey carried out in this Study.

Consequent to the consideration of above strategies, the unit water demand is set up as follows. It should be noted that the unit water demand given in Table 4.1 does not include unaccounted for water.

Table 4.1 Unit Water Demand

		1995	2000	2005	2010
Urban Area	Domestic (l/c/d)	30	35	43	52
	(Rate of Increase)	(3%)	(4%)	(4%)	
	Livestock (l/c/d)	20	20	20	20
	Unaccounted for Water	40%	35%	30%	26%
Rural Area	Domestic (l/c/d)	20	23	27	31
	(Rate of Increase)	(3%)	(3%)	(3%)	
	Livestock (l/c/d)	20	20	20	20
	Unaccounted for Water	40%	35%	30%	26%

Note: Unaccounted for water in the rural area shall be applied only to the areas currently being controlled by ONEP.

The water demand projection in the Study Area and supply capacities based on the existing water sources are given for respective commune. Consequent to the computation of water demand in parallel with supply capacity, the followings are resulted.

i) The Taounate province still has a surplus in water balance with an amount of 19,539 m^3/d. However, the potential is not well balanced to all the areas due to partial allocation of water sources.

ii) The Sidi Kacem and Taza provinces are in water-deficit condition in almost all the communes, therefore, new water sources required in these provinces.

4.2 Assessment of Future Water Resources

4.2.1 Surface Water

(1) General

In the SBO Master Plan, the water balance study on the sub-basin basis shows that the water demand in the Sebou river basin including the Study Area will be satisfied by the said dam construction until 2020. The succeeding development plan will be therefore discussed for water use at specific locations or areas with consideration to future availability of water resource.

(2) Middle Sebou

Available water resource of the Sebou river was estimated at 10.9 m^3/sec at the Mekansa intake and 7.5 m^3/sec at the Karia Ba Mohamed intake on the basis of the 95 percent dependable discharge under the present condition, while the planned supply capacity is 0.056 m^3/sec for Mekansa and 0.030 m^3/sec for Karia Ba Mohamed.

(3) Lebene River

The Sidi Abbou dam is planned on the Lebene river with a storage capacity of 60 million m^3. By this dam, the water resource will be developed at 58 million m^3/year which will mainly contribute to the irrigation water demand of 30 million m^3/year. The rest of water resource will be used for potable water demand in the area along the Lebene river and for the other downstream uses.

(4) Inaouen River Basin

Available water resource of the Inaouen river was estimated at 0.34 m^3/sec at the Ain Gdah intake on the basis of the 95 percent dependable discharge under the present condition, while the planned supply capacity is 0.064 m^3/sec. The firm discharge of the river is still larger than the planned supply capacity. However, it is anticipated that the water extraction might be forced to stop by severe drought as experienced in 1995. In order to avoid such case, it will be necessary to increase the firm discharge regulated by the Touahar reservoir or introduction of water from the Idriss No.1 reservoir.

(5) Lower Ouergha and Rdat Basin

Since possible surface water resource is not identified in these areas, surface water development for these areas will depend on introducing water from the Al Wahda reservoir or the Sebou river.

Even though use of surface water in the Lower Sebou river should be carefully studied for the various water demand, the surface water resource to be developed will be basically sufficient for satisfying the potable water demand within the Sebou river basin including the above-mentioned areas.

(6) Upper Ouergha Basin

1) Taounate Area

According to the Ouergha River Master Plan, the area along the Ouergha river near Taounate has the highest potential for agricultural development. The Ouergha River Master Plan proposed the agricultural development in this area as the priority project using water to be developed by construction of the Zrizer dam and the Oued Sra headwork on the Sra river and the El Mekabline dam on the Sahela river. Construction of the El Mekabline dam was completed in 1994. Other than these dam plans, construction of the Bouhouda dam located on the Sra river was commenced in 1995. Purposes of this project are the said agriculture and potable water supply.

Water use in this area was assessed by a preliminary water balance study considering the water requirement of agriculture development of 6,730 ha and the potable water demand for the communes around the objective area. The results shows that the surface water resource to be developed by the above-mentioned dam construction will meet with both potable water demand of 1.33 million m^3/year for the six communes and irrigation requirement of 73.4 million m^3/year.

2) Thar Souk and Beni Oulid Area

The Asfalou dam is proposed by the SBO Master Plan with the planned storage capacity of 97 million m^3. The site of Asfalou is most favorable for constructing a large scale dam for developing water resource of the basin. Main purpose of constructing the Asfalou dam is hydroelectric power generation. Meanwhile, the surface water resource will be developed at 75 million m^3/year.

(7) Small Scale Dam

Construction of small scale dams is an effective water resource development with consideration to the characteristics of the basin, project cost and construction period. The small scale dams are expected to supply water for use of domestic, livestock and irrigation for the scattered population in the mountainous areas.

Use of surface water for potable water supply requires a system including water purification plant, pipeline, pumping and storage facilities. Per capita investment cost of such system will be much higher than the existing water supply system using surface water because population covered by small scale dam ranges from 100 to 3,000 in number which is much smaller than those of the existing systems.

Meanwhile, a storage capacity of small scale dam is around 2 million m^3 in the maximum. Such capacity may be too small to regulate river discharge fluctuating by season for serving potable water constantly through a year.

Consequently, it is concluded that future potable water supply system by surface water will be planned to cover the urban area with a relatively large water demand and to be a component of a multi-purpose project based on construction of medium or large scale dam. On the other hand,

a role of small scale dam is still important for the above-mentioned purposes. It is also helpful as supplemental or alternative water source for a case of drought.

4.2.2 Groundwater

The geological and hydrogeological studies succeeded in identifying a number of promising groundwater supply sources distributed among the various geographical regions of the Study Area. The identified sources are shown in Figure 4.2.

(1) Sources of Fair to Good Water Potential

1) Taineste Flexure

The structure is of an allochton origin located to the southeast of Taineste. It consists of the outcropping Lias formations of the Jurassic period. The flexure covers an area of 3 km^2 and is marked with fissures and fault activities where water bearing formations can be located at about 125 m deep.

2) Jbel Khamise Monocline

The structure is an allochton flysch with the outcropping Lias formations of the Jurassic period and covers an area of 8.5 km^2. Water bearing formations located along fissures and faults of the monocline can be found at about 150 m deep.

3) Jbel Keil Monocline

The monocline is an allochton flysch with the outcropping Lias formations of the Jurassic period and extends over a total area of 40 km^2. Water bearing strata are located along fissures and fault lines of the structure at a depth of 150 m.

4) Thar Souk Syncline

The structure is an allochton of the Miocene epoch with massive formations of the Quaternary conglomerate overlaying impervious marl layers. The syncline has an area of about 12 km^2 and encloses water bearing formations at about 30 to 150 m below ground level.

5) Ourtzagh Syncline

Located in the valley of the Ouergha river, the structure encloses the Quaternary conglomerate deposits overlaying upper Tortonian Miocene formations marked with well developed fissures and faults. Water bearing formations can be located along the flanks of the valley at a depth of 300 m. The area of the structure is about 15 km^2.

6) Ain Saddine Syncline

The structure has the Quaternary formation and Miocene formations with conglomerate outcropping along the edge of the syncline. The area of the structure is about 10 km^2. Water accumulations can be found in the Quaternary and in the Miocene layers at depths of 30 and 150 m respectively.

7) Taounate Syncline

Located in the valley of the Sra river, the structure consists of the outcropping Quaternary formations overlaying middle Miocene formations of solidified conglomerate and fractured marlstone. Water accumulations are found in the upper and lower formations at depths of 30 and 250 m respectively. The area of the syncline is about 4 km^2.

8) Tissa Syncline

The structure is located in the valley of the Lebene river. It is marked with the outcropping Quaternary formations overlaying Oligocene formations of fractured marly limestone. Water accumulations can be found in the upper Quaternary and lower limestone layers at depths of 30 to 150 m respectively. The area of the syncline is about 5 km^2.

9) Jorf El Melha Syncline

Located in the flat plain of the Ouergha river, the syncline consists of the outcropping Quaternary formations with recent alluvium and conglomerate deposits followed by a lower layer of silt, marl and conglomerate of Miocene. Water accumulations can be found in these formations at depths of 30 and 150 m respectively. The area of the structure is about 10 km^2.

10) Had Kourt Basin

The structure is a depression of the Miocene epoch and is marked with the outcropping Quaternary formations followed by the Tortonian conglomerate with marl matrix. Water accumulations can be found in these formations at depths of 30 and 150 m respectively. The area of the structure is 6 km^2.

(2) Sources of Fair to Low Water Potential

The structures of this category of groundwater sources are widely spread around the Study area and cover the three types of the geographical configurations of mountainous, hilly and flat plain areas. The hydrogeological characteristics of these structures are summarized in Table 4.2.

(3) Sources of Low Water Potential

The majority or 70 percent of these groundwater sources belongs to flat plain and valleys of major river crossing the Study Area in the north west direction and the remaining 30 percent are located in the hilly areas. The hydrogeological details of these structures are presented in Table 4.3.

(4) Preliminary Evaluation of Possible Development Yield

The possible development yield of groundwater was evaluated by the water balance analysis and the groundwater simulation for the potential structures in the three model areas, respectively. With reference to the results for the model areas, the possible development yield was estimated approximately for the other ten potential structures. The estimated yield is tabulated on Table 4.4.

SOURCE : The Integrated Master Plan on Water Resource Development in the Sebou, Bou Regreg and Oum Er Rbia Basins, 1992, AH

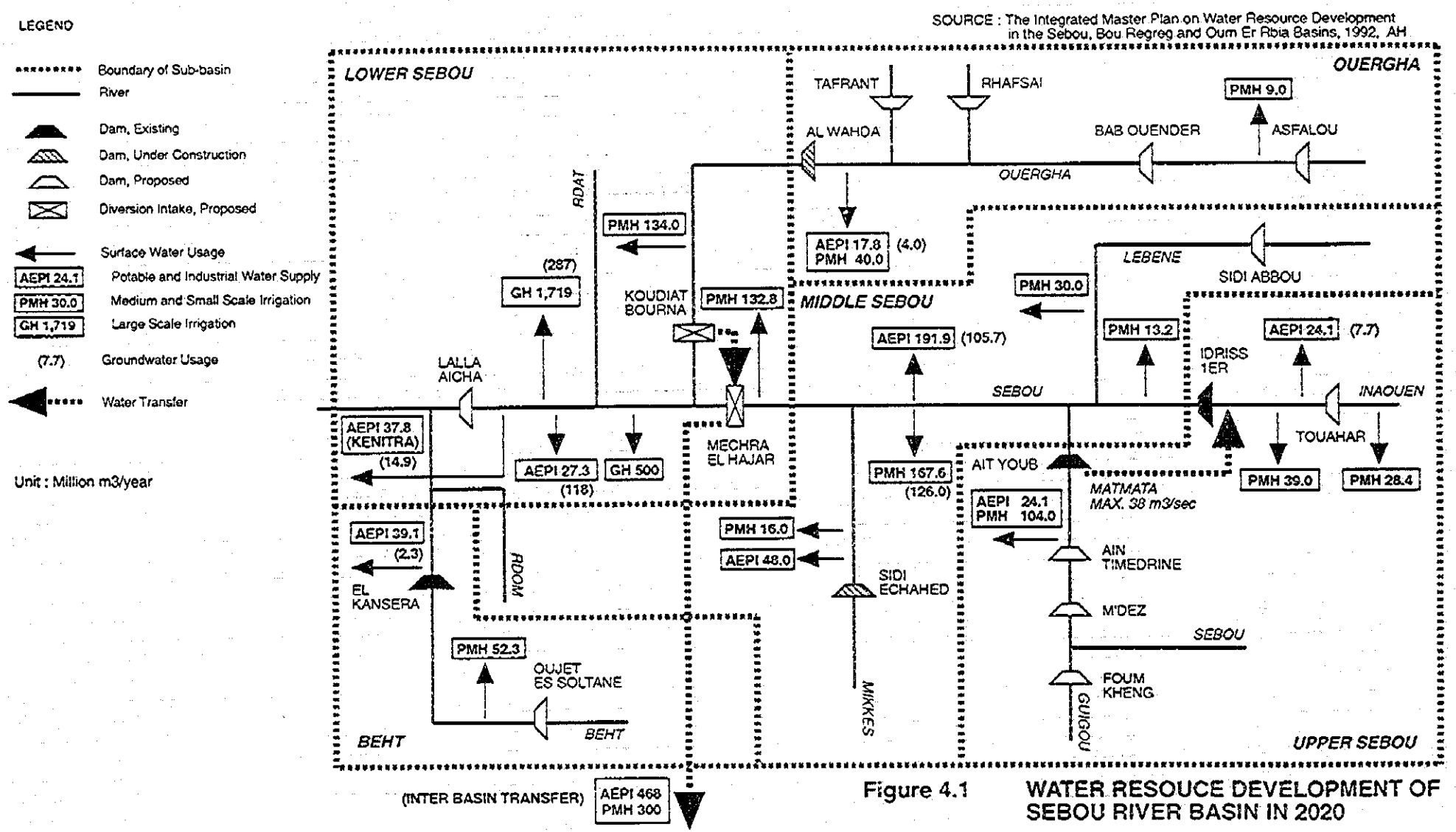


Figure 4.1 WATER RESOUCE DEVELOPMENT OF SEBOU RIVER BASIN IN 2020

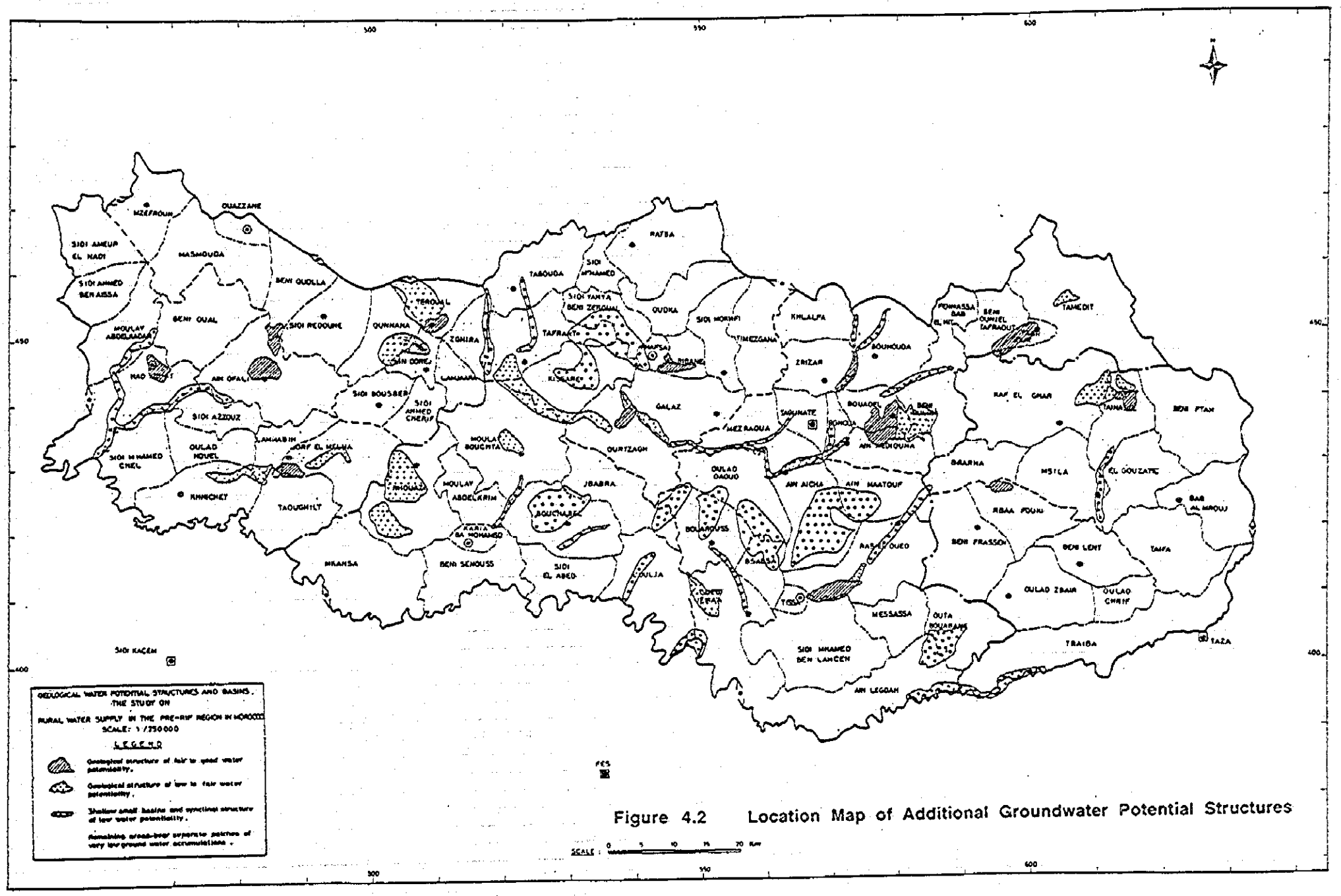


Figure 4.2 Location Map of Additional Groundwater Potential Structures

Table 4.2 Hydrogeological Details of Fair to Low Groundwater Sources

Location of Structure	Appox. Coordinates (1000)		Elevation (m)	Outcropping Formations	Water Potential	
	X	Y	Z		Flow	Depth
Mountainous structures						
- Between Oued Azghar and Taïneste	610	440	1300	Jurassic/Cretaceous	2-5 l/s	125 m
- Region of Sebbaba W of Taïneste	610	440	1400	Ditto	2-5 l/s	125 m
- Between Oued Ouergha and Afress	605	455	800	Jurassic/Upper Cretaceous	1-3 l/s	150 m
- S. of Oued Ouergha & E. of Bouadel	585	430	1000	Ditto	1-5 l/s	150 m
Hilly structures						
- Jbel Seddine east of Oued Guejawa	552	407	550	Miocene/Tortonian	1-3 l/s	125 m
- NW of My. Bouchta & E. of J. Khil	525	433	350	Up/Tortonian	1-3 l/s	125 m
- Between O. Ouergha & Dr. Zeroual	508	428	350	Cretaceous/Oligocene	1-2.5 l/s	150 m
- Between Dr. Zeroual & Dr. Skhaskha	505	420	350	Ditto	1-2.5 l/s	150 m
- Jbel Ouannane area NW of Aïn Dorij	505	445	200	Oligocene	1-3 l/s	150 m
- Jbel Hafa Radi north of Teroual	510	455	610	Oligocene	1-3 l/s	150 m
Flat plain Structures						
- O. Ouergha (A. Aïcha to A. Mediouna)	577-565	430-435	250	Quaternary/Alluvium	1-3 l/s	75 m
- O. Ouergha East of Ourtzagh	540-550	437-440	150	Ditto	1-3 l/s	75 m
- O. Ouergha South of Kissane	436-442	523-536	140	Ditto	1-3 l/s	75 m
- O. Ouergha South of Jorf El Melha	495	431	70	Ditto	1-2 l/s	60 m
- O. Ouergha NW of Khnichet	480	428	40	Ditto	1-2 l/s	50 m

Table 4.3 Hydrogeological Details of Low Potential Groundwater Sources

Location of Structure	Approx. Coordinates (1000)		Elevation (m)	Outcropping Formations	Water Potential	
	X	Y	Z		Flow	Depth
Hilly Structures						
- Between O. Inaouen & Outa Boubane	593	402	450	Cretaceous/Oligocene	1-2.5 l/s	125 m
- Between RS 301 and RS 318	570-580	415-427	500	Oligocene	1-2 l/s	150 m
- Jbel Miyaiha East of Bouarouss	560	420	400	Eocene/Oligocene	1-2 l/s	125 m
- North of Bouarouss include. O. Jemaa	555	420	400	Cretaceous/Oligocene	1-2 l/s	125 m
- North West of Bouarouss	550	425	500	Oligocene	1-2 l/s	125 m
- Bled S. Bou Jemaa West of Bouchabel	534	425	300	Cretaceous/Oligocene	1-2 l/s	125 m
- W of J. Bibane & J. Haikiya, E of Kissane	530	442	500	L/M Miocene	1-2 l/s	125 m
- Between Tafrant, Haddarine & Ghafsaï	530-542	450	550	L/M Miocene	1-2 l/s	125 m
Flat Plain Structures						
- O. Marticha (El Ghouzate - Had Msila)	615	420-430	600	Quaternary/Alluvium	1-2 l/s	75 m
- O. Ouergha South of Bouhouda	580-590	440	370	Quaternary	1-1.5 l/s	50 m
- O. Bouaroussa North of Bouhouda	578	450	400	Quaternary/Alluvium	1-2 l/s	50 m
- O. Sra West of Bouhouda	575	450	400	Ditto	Ditto	Ditto
- O. Lebene NE and SW of Ras El Oued	579-584	415-425	250	Ditto	Ditto	Ditto
- O. Inaouen (Oued Amlil - Chebbabat)	590-600	392-399	250	Ditto	Ditto	Ditto
- O. Sra East of Taounate	572	435	400	Ditto	Ditto	Ditto
- O. Sahela West of Taounate	565	435	250	Ditto	Ditto	Ditto
- O. Ouergha (A. Aicha - East of Ghafsai)	550-570	432	200	Ditto	Ditto	Ditto
- O. Jemaa (Bouarouss - O. Jemaa)	570	407-420	200	Ditto	Ditto	Ditto
- O. Sebou South of Oulja	545	405	150	Ditto	1-1.5 l/s	Ditto
- O. Izar North of Oulja	543	410-417	200	Ditto	Ditto	Ditto
- O. Bouchabel South east of Bouchabel	525-538	415-420	130	Ditto	Ditto	Ditto
- O. Habbalat (Karia - My. Bouchta)	525	420-430	130	Ditto	Ditto	Ditto
- O. Aoudour (Tafrant - Tabouda)	526	448-458	120	Ditto	Ditto	Ditto
- O. Aoudiyar (RP 26 and Haddarine)	520	444-455	200	Ditto	Ditto	Ditto
- O. Rdat (Ain Defali - O. Sebou	455-480	440	60	Ditto	Ditto	Ditto
- O. Et Tine (Had Kourt - O. Sebou)	460	430-450	60	Ditto	Ditto	Ditto

Table 4.4 Preliminary Evaluation of Groundwater Development Yield

Average Year

Structure	Area (sq. km)	Annual Rainfall (mm/yr)	Recharge Rate (%)	Recharge (mm/yr)	Groundwater Resource (Million m3/yr)	Groundwater Resource (m3/day)
Tainaste	3	769	12	92	0.277	758
J. Khamise	8	724	12	87	0.695	1903
J. Keil	40	796	12	96	3.821	10468
J. Berda	6.3	953	12	114	0.720	1974
Thar Souk	12	724	12	87	1.042	2855
Teroual	6.1	775	9	70	0.425	1166
Ourtzagh	15	729	9	66	0.984	2696
Ain Saddine	10	649	9	58	0.584	1600
Taounate	4	823	9	74	0.296	812
Tissa	5	524	9	47	0.236	646
Jorf El Melha	10	499	9	45	0.449	1231
Ain Defali	12.0	587	9	53	0.634	1737
Had Kourt	6	519	9	47	0.280	768

10-Year Drought

Structure	Area (sq. km)	Annual Rainfall (mm/yr)	Recharge Rate (%)	Recharge (mm/yr)	Groundwater Resource (Million m3/yr)	Groundwater Resource (m3/day)
Tainaste	3	473	8	38	0.114	311
J. Khamise	8	445	8	36	0.285	781
J. Keil	40	490	8	39	1.568	4296
J. Berda	6.3	622	8	50	0.313	859
Thar Souk	12	445	8	36	0.428	1172
Teroual	6.1	480	6	29	0.176	481
Ourtzagh	15	526	6	32	0.473	1297
Ain Saddine	10	624	6	37	0.374	1025
Taounate	4	454	6	27	0.109	298
Tissa	5	337	6	20	0.101	277
Jorf El Melha	10	480	6	29	0.288	789
Ain Defali	12.0	587	6	35	0.423	1158
Had Kourt	6	499	6	30	0.180	492

4.3 Establishment of Future Water Supply System

4.3.1 Groundwater Supply System

For the establishment of groundwater supply system, the following implementation program is proposed.

i) In compliance with drilling of test wells, pumping tests and subsequent analysis, reliability of groundwater yield for potable water use in the model areas is confirmed. Due to urgent necessity of increasing of production capacity and provision of water distribution facilities, the groundwater development program is recommended as an urgent scheme.

ii) The water supply system recommended in the model areas is classified into two groups; the one is supply by gravity and the other is by pumping. The gravity supply system is to be laid on the first priority and the pumping supply system is on the second in the implementation program.

iii) Establishment of water supply system including both of gravity and pumping system in the model area as well as rehabilitation programs for the existing facilities shall be completed within five years.

iv) Development of ten high potential areas comprising planning, physical inspecting, test drilling, detail designing and construction works is proposed to be completed within ten years in parallel with the development of three model areas.

v) Medium and low potential areas shall be developed thereafter in compliance with the progress and/or results of the development of 10 potential areas. At the same time, development condition of surface water supply system should also be taken into consideration.

vi) Extremely low potential areas for groundwater development, such as north-west, north of El Bibane commune and far east regions, and where surface water potential is also poor shall be developed based on the transmission of water from other provinces.

4.3.2 Surface Water Supply System

For the establishment of surface water supply system, the following implementation program is proposed:

i) According to urgent needs for exploitation of surface water sources and subsequent development of water supply facilities, the first stage implementation will be dependent upon the ongoing program being carried out by the ONEP. According to enlargement of treatment plant capacities to a double size or more, the supply area could be extended to several communes along the Sebou river.

ii) As for future water resources to meet requirement by the target year, the Al Wahda reservoir which is supposed to be completed within 1996 will be realized, however, there is no plan for water supply to the Pre-Rif region. Substantial planning for utilization of the Al Wahda reservoir shall be commenced around the year, 2000.

iii) By the time of commencement of planning for water supply based on the Al Wahda reservoir, review work of groundwater development programs and their progress as addressed previously shall be carried out in parallel with the programs currently being carried out by the ONEP.

iv) The surface water supply system based on the Al Wahda reservoir may be first of all applied to the flat plain areas in the Sidi Kacem province where easily supplied by gravity system.

v) Southern part of the Taza province, will be developed by the water from the proposed Touahar reservoir in the future.

4.3.3 Covering Area by Supply System

Figure 4.3 shows the covering area by supply system. The southern part of the Study Area will be covered by the surface water supply systems by Ain Gdah, Karia Ba Mohamed and Mekansa including enlargement of the existing treatment plants. By enlargement of these treatment plant, population of these area shown will be covered by these systems.

The rest of the majority will be covered by the groundwater based on the existing ONEP supply system, three model areas, ten high potential areas and medium and low potential areas. At the west end of the Study Area around Ouazzane, water is to be transmitted from the groundwater source from Bouaguba located out of the boundary and which is the source of the city of Ouazzane.

If the Al Wahda reservoir is found to be applicable for potable water supply in the surrounding areas after an appropriate study will be completed and the government commission will be obtained, the proposed area will be supplied from the reservoir as given in the figure. It should be noted that demarcation of supply area based on the Sebou river, the high potential groundwater and the Al Wahda reservoir shall be re-arranged in the future.

In the areas located in the north central and the east of the Study Area, it is pointed out that water resources suitable for potable water supply are not available. The alternative solutions such as water transmission from the neighboring areas or construction of medium and small scale dams will be necessary for these areas.

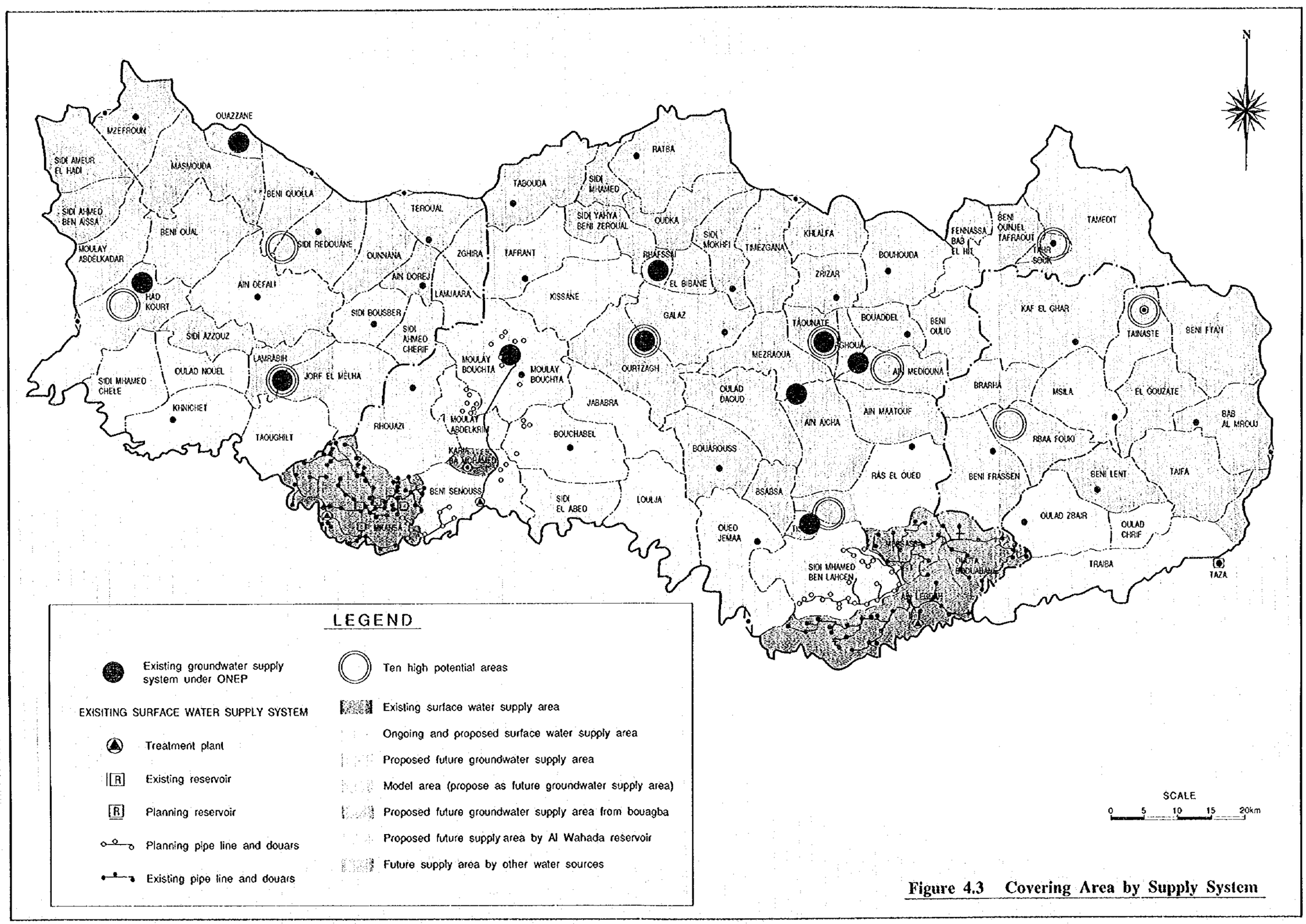
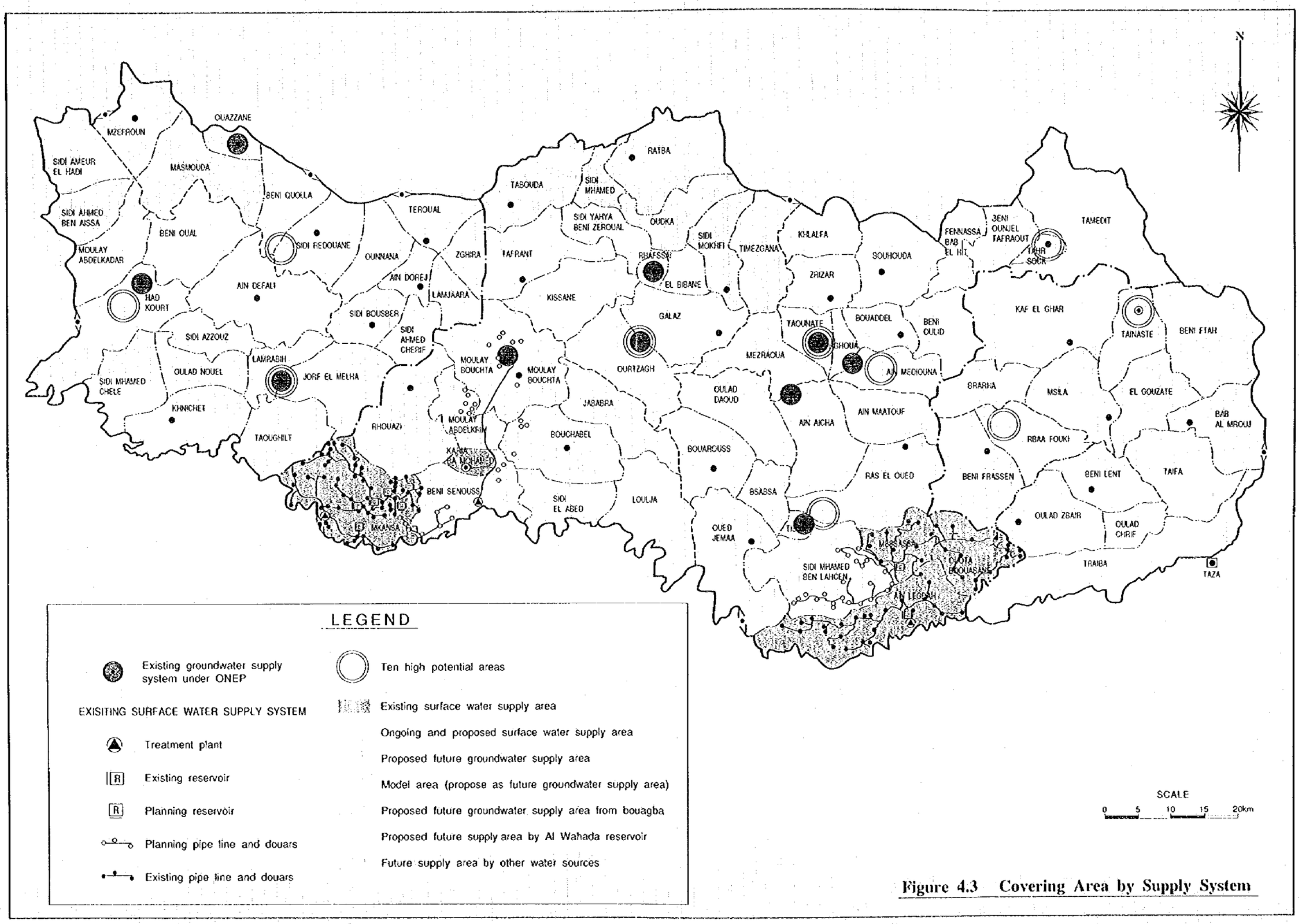


Figure 4.3 Covering Area by Supply System



LEGEND

- Existing groundwater supply system under ONEP
- Ten high potential areas

EXISITING SURFACE WATER SUPPLY SYSTEM

- Treatment plant
- Existing reservoir
- Planning reservoir
- Planning pipe line and douars
- Existing pipe line and douars

- Existing surface water supply area
- Ongoing and proposed surface water supply area
- Proposed future groundwater supply area
- Model area (propose as future groundwater supply area)
- Proposed future groundwater supply area from bouagba
- Proposed future supply area by Al Wahada reservoir
- Future supply area by other water sources

Figure 4.3 Covering Area by Supply System

4.4 Establishment of Guidelines

4.4.1 Guideline for Operation and Maintenance for Rural Water Supply System

(1) Standard and Monitoring of O&M

The rural water supply projects will be operated and maintained by either ONEP or communes themselves. In the latter case, an importance would be attached to work quality and sustainability of operation and maintenance. In order to sustain the acceptable works of operation and maintenance should be established and executed respectively.

(2) Operation Management

The operation of rural water supply would not require implementing bodies (communes) to get the high standard of technical knowledge unlike maintenance works. The only exception may be operation of motorized facilities driven by electricity, diesel and petrol. The management will be necessary for power supply and procurement of fuel, and technical control and maintenance of such facilities. In this respect, communes are to be responsible for training staffs to manage technical matters.

(3) Maintenance Policies

The AH is the government agency which is liable for formulation of maintenance policies. The scope of works for which the AH is responsible should be spelled out in respect of maintenance works, organization, staffs and budget appropriation.

(4) Operation and Maintenance Costs

As made clear in financial analysis of rural water supply projects in the model areas, operation and maintenance costs would be financed by project revenues. Nevertheless, low rate of revenue collection and cost increase associated with price escalation would make it difficult for communes to manage operation and maintenance costs out of project revenues. If necessary, the budget support will be given to communes.

4.4.2 Guideline for Environmental Aspects

(1) Environmental Consideration Necessary for the Study Area

Based on the IEE and the EIA for planning the water supply system in the model areas, environmental considerations for potable water supply in the Study Area are summarized as follows.

1) Natural Environment

Since a scale of water supply facility is not so large in the case of rural water supply, impacts on natural environment by constructing the facility are not to be significant. Consideration should be provided for construction of dam planned as a source of water supply system.

For groundwater resources, it is necessary to forecast impacts on existing groundwater sources, groundwater potential and quality after groundwater extraction is newly implemented. An intensive hydrogeological study should be carried out for this purpose.

The Sebou river is a perennial river in the Study Area. The baseflow of the river is abundant and has not been affected seriously by water extraction in the current condition. When water demand increases in the future, a water management plan will be required for control of water extraction and maintain the baseflow for environmental purposes.

2) Social Environment

As described before, implementation of rural water supply project will bring to rural people the positive effects including reduction of hard works for water collection and improvement of sanitary conditions as well as other indirect socio-economic effects.

Attention should be paid for development of water resources concerning with water rights. Under the Moroccan law, all the water is owned by the government. While some traditional springs in rural area have been actually managed by local people. Proper coordination is required for water resource development and water supply plan in such areas, especially for the case that water supply plan includes water transfer to the neighborinng areas. It is reported that the AH has experienced the difficulties of such coordination in the Study Area.

3) Water Quality and Sanitation

It is reported that water pollution in the Sebou and Inaouen river is caused by industrial and domestic wastewater from urban areas. These rivers are important water resources in the Pre-Rif region and should be preserved in order to sustain the existing water supply systems as well as the future extension. It is necessary to implement a plan of wastewater disposal as soon as possible for Fes and other urban areas.

Wastewater disposal in rural area will be provided in view of water quality preservation of water sources as well as improvement of health and sanitation. It is expected that appropriate measures for wastewater disposal will be provided and spread over rural communities in line with the sanitary education to be implemented by the government.

(2) Implementation of Environmental Considerations

In general, plan and implementation of environmental considerations area is carried out corresponding with project preparation as shown below.

Stage of Project	Environmental Considerations
Master Plan	Initial Environmental Examination (IEE)
Feasibility Study	Environmental Impact Assessment (EIA)
Detailed Design	Preparation of Environmental Preservation Measures
Construction	Implementation of Environmental Preservation Measures
Operation	Environmental Monitoring

In parallel with establishing a plan of water supply system in the Study Area, the environmental preservation plan shall be prepared based on EIA for the above-mentioned environmental aspects and others particular for the objective water supply system. The environmental preservation plan shall be established with the definitive plan of the objective project. Implementation of the environmental preservation measures shall be commenced at construction stage. After commencement of project operation, the monitoring shall be carried out for evaluating actual impacts by the projects and effects of the preservation measures.

The AH and ONEP will be in charge of the environmental considerations for water supply projects. In addition, cooperative works with the Ministry of Public Health and other related agencies will also be required for improvement of health and sanitary conditions in rural areas.

4.4.3 Guideline for Women in Development (WID)

The implementation of programs for WID effects requires the inter-governmental organization. The concerned agencies are:

i) Ministry of Agriculture and Agricultural Development,
ii) Ministry of Interior,
iii) Ministry of Public Works,
iv) Ministry of Public Health,
v) Ministry of Education,
vi) Ministry of Industry,
vii) Ministry of Finance, and
viii) Local Government.

Representative staffs from the respective agency should be selected to organize the inter-agency working committee whose purpose is specifically oriented to WID. The role of the working committee would be as follows:

i) Establishment of strategies for WID,
ii) Preparation of programs for WID effects,
iii) Determination of the role of respective agency for implementation of programs,
iv) Budget estimation for implementation of programs,
v) Monitoring works of programs, and
vi) Evaluation of programs.

4.4.4 Guideline for Sanitary Education

The government of Morocco has prepared the sanitary education program for rural area. By implementation of the program with the potable water supply project, it is expected that rural people will be aware of health and sanitation and water borne diseases will decrease as a result of improvement of sanitary conditions in rural areas.

1) Objectives

i) To induce the population to get water from disinfected water points
ii) To make the population participate in the disinfection of private water points

2) Target population

i) Family heads (mother / father)
ii) Authorities
iii) Elected representatives
iv) Teachers
v) Fkihs (wise, religious men)

3) Methodology

i) Interpersonal communication
- Interviews
- Discussions
- Round table conversations

ii) Mass Media
- Advertisements
- Megaphone
- Public address system

4) Main topics

i) Seriousness of water-related diseases
ii) Importance of water points disinfection
iii) Personal (and hand) hygiene

5) Human means

i) Elected representatives
ii) Chiokhs and Makadems
iii) Teachers
iv) B.M.H. and B.C.H. personnel

6) Communication means

i) Advertisements
ii) View masters
iii) Folders (Brochures)
iv) Stickers
v) Cassettes

4.5 Implementation Program of Project

4.5.1 Project Screening for Urgency

On the basis of establishment of future water supply system addressed in the Section 4.3, implementation schedule has been scrutinized by the category of 1) urgency of project (short term, medium term, and long term), 2) economic effect , and 3) ease of implementation and establishment of organization, 4) coordination and cooperation with the ongoing and already planned programs, and 5) regional contribution in socio-economic aspects in rural areas.

Out of the schemes proposed to be implemented by the target year of 2010, the following programs have been screened:

(1) Establishment of water supply system in model areas
- i) Development by gravity system
- ii) Development by pumping system

(2) Exploitation of groundwater resources
- i) High potential structures (10 structures)
- ii) Medium potential structures

(3) Rehabilitation of existing facilities of groundwater sources
- i) Model areas
- ii) Others in the Study Area

(4) Development of surface water supply system
- i) Rehabilitation and improvement of ONEP facilities
- ii) New water supply system based on Al Wahda reservoir

4.5.2 Scope of Programs

In compliance with the schemes screened, the following programs in three terms have been proposed. The implementation plan for these programs are shown in Figure 4.4.

(1) Short Term Program (1996 - 1998)

1) Construction of Water Supply Facilities in the Model Areas (by Gravity System)

Ain Defali

- Submersible Pump	Model	BS - MF Type
	Diameter	80 mm
	Stage	5 No. of impeller
	Frequency	50 Hz
	Power	11 kW
	Discharge	0.69 m^3/min
	No. of pump	3 units
	Head	48 m
- Pipe line installation	D=200 mm	L= 600 m
	D=150 mm	L= 1,500 m
	D=125 mm	L= 4,700 m
	D=100 mm	L= 13,600 m
	D= 89 mm	L= 11,750 m
	D= 75 mm	L= 12,530 m
	Total	L= 44,880 m
- Distribution tank (RC)	V= 600 m^3 x 1	
	V= 400 m^3 x 1	
	V= 100 m^3 x 6	
- Stand pipes	25 units	
- Appurtenant facilities	LS	

Teroual

- Submersible Pump.	Model	BS - MF Type
	Diameter	65 mm
	Stage	10 No. of impeller
	Frequency	50 Hz
	Power	5.5 kW
	Discharge	0.33 m^3/min
	No. of pump	2 units
	Head	46 m
- Pipe line installation	D=125 mm	L= 500 m
	D=100 mm	L= 250 m
	D= 89 mm	L= 11,300 m
	Total	L= 12,050 m
- Distribution tank (RC)	V= 280 m^3 x 1	
	V= 140 m^3 x 2	
- Stand pipes	9 units	
- Appurtenant facilities	LS	

Ain Berda

- Submersible Pumpa.	Model	BS - MF Type
	Diameter	50 mm
	Stage	10 No. of impeller
	Frequency	50 Hz
	Power	5.5 kW
	Discharge	0.18 m^3/min
	No. of pump	2 units
	Head	65 m
- Pipe line installation	D= 75 mm	L= 900 m
	D= 64 mm	L= 1,300 m
	D= 50 mm	L= 4,800 m
	D= 25 mm	L= 4,100 m
	Total	L= 11,100 m
- Distribution tank (RC)	V= 120 m^3 x 1	
	V= 30 m^3 x 1	
	V= 10 m^3 x 1	
- Stand pipes	4 units	
- Appurtenant facilities	LS	

2) Rehabilitation of Existing Water Supply Facilities

Dugholes

i) repair of wall
ii) provision of roof on dughole
iii) provision of cover on dughole
iv) provision of hand pump
v) provision of concrete stage for sanitary purpose
vi) provision of drain

Springs

i) provision of water tank
ii) provision of conduction pipe from spring to tank
iii) provision of roof
iv) provision of concrete stage for sanitary purpose
v) provision of drain

Ain Defali	Dughole	7 location
	Spring	19 location
Teroual	Dughole	1 location
	Spring	23 location
Ain Berda	Dughole	0 location
	Spring	7 location

3) Exploitation of High Potential Groundwater Sources

Mountainous Area		No. of Well	Depth
i)	Taineste	1	125 m
		1	100 m
		1	75 m
ii)	Khamise	1	150 m
		1	125 m
iii)	Lakdar (Keil)	1	150 m
		1	150 m
		1	100 m
iv)	Thar Souk	2	150 m each
		3	30 m each

Hilly Area		No. of Well	Depth
v)	Ourizarh	2	300 m
vi)	Ain Saddine	3	30 m each
		1	100 m
		1	150 m
vii)	Taounate	3	30 m each
		1	250 m
viii)	Tissa	3	30 m each
		1	75 m
		1	100 m

Plain Area		No. of Well	Depth
ix)	Jofl El Melha	3	30 m each
		1	125 m
x)	Had Kourt	3	30 m each
		1	125 m

4) **Rehabilitation and Improvement of ONEP Facilities**

(2) Medium Term Program (1999 - 2005)

1) **Construction of Water Supply Facilities in the Mode Areas (by Pumping System)**

Ain Defali

- Pipe line installation
  - D=125 mm L= 800 m
  - D=100 mm L= 7,800 m
  - D= 89 mm L= 6,300 m
  - Total L= 14,900 m
- Pumping Facilities
  - 18.5 kW h=100 m 4 unit
  - 1.5 kW h= 13 m 2 unit
- Distribution tank (R.C)
  - V= 100 m^3 x 2
- Stand pipes
  - 5 units
- Appurtenant facilities
  - LS

Teroual

- Pipe line installation
  - D= 89 mm L= 8,700 m
- Pumping Facilities
  - 30 kW h=130 m 4 unit
  - 7.5 kW h= 70 m 2 unit
  - 7.5 kW h= 60 m 2 unit
- Distribution tank (RC)
  - V= 140 m^3 x 2
- Stand pipes
  - 6 units
- Appurtenant facilities
  - LS

Ain Berda

No facilities to be installed

2) **Rehabilitation of Existing Water Supply Facilities**

3) **Exploitation of High Potential Groundwater Sources**

4) **Rehabilitation and Improvement of ONEP Facilities**

5) **Development of Surface Water Supply System (Al Wahda dam)**

(3) Long Term Program (2006 - 2010)

1) **Development of medium and low potential groundwater resources**

2) **Continuation of establishment of water supply system by Al Wahda dam**

4.5.3 Financial Plan

(1) Financial Strategy

1) Model areas

Irrespective of water supply schemes, the application of loan to communes is financially possible for the case in which the commune of Ain Defali is liable for direct construction cost only. Accordingly the government is responsible for appropriation of budget to finance engineering services and administration expenses for Ain Defali, and all project costs for both Teroual and El Bibane. The sources of fund would be 1) the government revenue from various taxes or issuance of bonds, 2) domestic funds and 3) international loans. Except for internal revenue, the government is basically responsible for borrow and repayment of such loans.

2) Study area

Unlike the model areas, projects are not physically formed for the other components. The exploration cost of the ten (10) high potential structures for groundwater was only estimated.

The exploration cost is estimated to be about DH14.9 million. The financial plan of groundwater development in the Study area is contemplated to be as follows.

i) The rehabilitation cost of existing groundwater source would be costless, which is within payable capacity of local people. For example, the per capita cost of rehabilitation in the model areas are estimated to be less than DH100. Accordingly the rehabilitation of existing groundwater sources should be implemented by communes themselves.

ii) There are some areas where the proposed potential structure and the existing ONEP's groundwater supply system co-exists. It is desirable that the ONEP should be the implementation body of groundwater development in those areas. Accordingly the ONEP will be in a position of financing exploration and distribution costs.

iii) For areas where new water supply system is confined to the proposed structure only, it is recommended that the AH should prepare for the budget for exploration and a part of distribution cost. Projects would be operated by communes themselves. The government finance is certain to contribute to improvement of financial viability.

iv) The AH is recommended to prepare for the budget for execution of Pre-F/S or F/S for groundwater development projects in the study area.

(2) Financial Plan

1) Grant

Grant is specially designed to relieve the communes such as Teroual and El Bibane who are considered difficult to implement water supply project with even subsidiary or soft loan. The fund will be provided from either the Official Development Assistance (ODA) or the government budget. In case the government commits itself to borrow loan funds from ODA, the government is responsible for repayment of such loans in place of communes.

2) Subsidiary loan

This financial support intends to extend soft loans to assist the commune like Ain Defali whose financial viability (FIRR) is marginally viable.

3) Financial Support

i) Tax reduction
This arrangement is intended to relieve or exempt income tax, import tax and value added tax (VAT) imposed on implementing bodies. The Ministry of Finance is responsible for issuance of special decree to enforce exemption of income tax and VAT to be executed for rural water supply projects. The AH is responsible for rendering necessary arrangements with agencies concerned including custom office on behalf of the commune offices.

ii) Foreign exchange risk
In the case of loan procurement from foreing countries, foreign exchange risk arises. Such a risk should be basically borne by the government and not to be imposed on implementing bodies.

ii) Establishment of financial intermediary
Financial channeling system is necessary for supply of funds to implementing bodies. It is preferable that intermediary banks do not act as executing bank but as channel ones. Accordingly the premium would not be imposed on implementing bodies.

Figure 4.4 Implementation Plan for Water Supply System

No.	Implementation Item	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
(1)	Establishment of Water Supply System in Model Areas															
	1) Development by Gravity System															
	2) Development by Pumping System															
(2)	Exploitation of Groundwater Resources															
	1) High potential structures (10 structures)															
	2) Medium potential structures															
(3)	Rehabilitation of Existing Facilities of Groundwater Sources															
	1) Model Areas															
	2) Others in the Study Area															
(4)	Development of Surface Water Supply System															
	1) Rehabilitation and Improvement of ONEP Facilities															
	2) New Water Supply System based on Al Wahda Reservoir															

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