3.2.5 Life and Works of Women

This section is prepared for the purpose of presenting lives and daily/seasonal routine works of women in the three rural communes. A lot of women were interviewed and surveyed to comprehend actual women's conditions in the rural socioeconomic activities.

(1) Water Transportation

The task of water transportation is normally conducted by women and children. This task requires much of physical energy and sacrifices the valuable time because of long distance between water sources and homes. The water transportation in the terrain with sharp slopes puts a heavy burden on women. Under such circumstance, the task of water transportation is a nuisance to women. Women sometimes collect raw water from rivers and abandoned wells and use such contaminated water for household activities in order to avoid a nuisance work of water transportation.

In general, rural people make a strict schedule for water supply. Women try to get organized when collecting water in order to reduce waiting time at water sources. But this arrangement often remain uncontrolled. In dry season, particularly in the summer period, waiting time at the water source becomes considerably longer as a result of high demand and the limited volume of available water. Disputes over water rights are usually resolved by local authorities. The priority of water supply is normally given to a douar owning water sources.

(2) Wood Collection

The types of fuel used in the three communes are either butane gas or wood depending on the purposes of fuel usage. The consumption of butane gas depends on household income. Most of families utilize wood for bread baking. Traditional cooking by use of wood is highlighted at the time of harvesting and olive collection. Wood collection by women at harvesting time becomes frequent since additional food should be supplied to a number of labors mobilized for harvesting. The kinds of wood used as fuel are olive or vine trees.

(3) Agricultural Works

In general, the male tasks of farming practices are plowing, harvesting and cereal threshing only. However, women in rural areas are heavily involved in various kinds of farming practices including livestock breeding. In Morocco, farming begins with weeding and seeding in spring and comes to an end with harvesting in summer. The dry season from July to October corresponds to a fallow period. Plowing is practiced during winter season. Women are involved in farming activities through the year. According to the interview survey in Ain Defali, the longest working time per day is 14 hours in spring, 19 to 20 hours in summer and the early fall and 13 hours in winter. The interview survey concludes that harvesting is the most tiresome work for women and men.

(4) Crafting Activities

Among many douars surveyed, women in 14 douars engage themselves in various activities or participate in crafting works with their husbands. The majority of these cases were envisaged in Teroual and El Bibane. The major crafting activity is the production of traditional clothes made from wool, belts for women and table cloth. Farming tools, kitchen instruments and baskets are also manufactured in some douars.

3.2.6 Existing Conditions of Water Use

This section presents various socio-economic aspects of water use conditions of rural communes in the model areas based on the interview and questionnaire surveys. The results will be useful for analyses of socio-economic impact of water supply, economic analysis of the project and the issue of women in development.

(1) Involvement of Women and Children in Water Management

Water management means water collection, transportation and storage. The questionnaire survey was conducted to examine the proportions of men, women and children involved in water management. The male involvement in water management is relatively low, 35 percent in Ain Defali down to 17 percent in El Bibane. The role of children in this task is prominent, 61 percent in El Bibane down to 48 percent in Teroual. Because the survey was carried out in summer when children were out of school, the participation rates resulted in substantially high. In winter, water collection and transportation are mostly done by women and children. Table 3.2.5 shows the participation rate of men, women and children by commune.

Table 3.2.5 Participation Rates of Men, Wemen and Children in Water Management

(Unit : percent)

Commune	Men	Women	Children	Total
Ain Defali	35	17	48	100
Teroual	28	36	36	100
El Bibane	17	22	61	100

(2) Water Consumption

An average daily water consumption per person in the three communes is in the range from 15 to 17 litters in summer and 13 to 14 litters in winter. The surveyed data on water consumption is considerably lower than the statistical data (i.e. 35 to 40 l/c/d) projected by the DRPE. This difference can be explained as follows :

i) Water consumption is constrained due to scarce availability of water resources.
ii) The surveyed data show consumption from spring water and existing wells, but does not include the consumption from rainfall or another water sources such as rivers.

Table 3.2.6 shows the proportion of daily water consumption by different use per person in the three communes. Drinking is the biggest water use, followed by shower.

Table 3.2.6 Water Consumption by Different Use

(Unit : liter)

Commune	Cooking	Drinking	Dish washing	Vegetable washing	Shower	Religion	Cloths	Total
Ain Defali (percent)	1.1 (6.2)	7.0 (41.1)	2.6 (15.5)	0.8 (4.6)	4.4 (25.7)	0.2 (1.5)	0.9 (5.4)	17.0 (100.0)
Teroual (percent)	0.9 (5.8)	5.1 (34.3)	2.9 (19.2)	0.7 (4.9)	4.5 (29.8)	0.1 (0.6)	0.8 (5.4)	15.0 (100.0)
El Bibane (percent)	1.1 (6.4)	6.5 (38.3)	3.0 (17.9)	0.9 (5.3)	4.2 (24.8)	0.2 (0.9)	1.1 (6.4)	17.0 (100.0)

(3) Water Collection and Storage

The use of mules and donkeys for water transportation is prominent, followed by manpower by local people. Local people sometimes use vehicles like tractors for water transportation in Ain Defali. Containers used for transportation are made of plastic and rubber. There is no special storage for water transported. Local people directly take water from containers because water is consumed within a few days. Water for livestock breeding is normally stored in small ponds outside. Such a task as water storage is usually the responsibility of women.

(4) Impact of Water Collection to Education

It is difficult to evaluate how far the task of water collection negatively affects the attending rates of children in schools. Actually, a number of factors are interrelated and affect the level of education in rural areas. These factors are given below:

- i) Poverty
- ii) Absence of teachers
- iii) Distance to schools
- iv) Requirement of children as labor force for daily works
- v) Distance to water sources.

Long distance to water sources surely lowers the attending rate of children in classroom. The rate is worsened further in dry season since women and children are almost mobilized for water collection and transportation. In this respect, the provision of portable water supply facilities is certain to improve attending rate of children in school.

(5) Sanitary Conditions

None of the douars in the model areas has a public wastewater collection system. Out of 4,364 dwellings surveyed, only 1,414 or 32 percent have latrines. Table 3.2.7 shows the existing sanitary conditions of dwellings with respect to construction material and latrine having septic tank.

Table 3.2.7 Sanitary Conditions

Items	Ain Defal	Teroual	El Bibane	Total
(1) Nos of dwellings	1,980	1,134	1,250	4,364
(2) Nos of dwellings of concrete structure	313	46	104	463
(3) Nos of dwelling with septic tank	303	372	659	1,414
(4) Ratio of (2) / (1)	16 %	4 %	8 %	11 %
(5) Ratio of (3) / (1)	19 %	33 %	53 %	32 %

Source: National Master Plan

The ratio of houses with latrines is highest, 53 percent in El Bibane, followed by 33 percent in Teroual. The 32 percent of houses have latrines while concrete-made houses share 11 percent of total houses in the model areas. This indicates that houses with latrines are not always confined to concrete-made residences. People living in houses without latrines use an open air or construct a wooden privy with a dry pit. The sanitary conditions of schools and open market are even worse because of no latrines. Open air slaughter houses are common in the three communes. The hygienic conditions of slaughter houses are almost unacceptable since blood and viscera constitute a breeding ground for mosquitoes and insects.

People showed the awareness concerning the eventual pollution to springs and wells from septic tanks and ground holes. Springs are located on the slops where houses are constructed upstream of the water sources in some douars of Teroual and El Bibane. In Ain Defali there is no public waste disposal service even though people pay a certain tax for the collection. Some water sources are contaminated by animal excrete and feed.

It is quite difficult to assess the causes of water-borne diseases by means of only a field survey. People do not know the origin and the cause of their own diseases. Sixteen (16) people suffered from cholera recently in Teroual and El Bibane. Other diseases such as diarrhea, typhoid and scabies are very frequent in the model areas. It is likely that diseases such as diarrhea and cholera are related to water contaminated in Teroual and El Bibane. The existing water sources are mainly springs in those areas.

(6) Housing

Most of housing is clustered on flat ground or slopes. Out of total housing in each commune, the rate of clustered housing is 94 percent in Ain Defali, 60 percent in Teroual and 70 percent in El Bibane. There are also some houses located far from such clustered dwellings. The distance between them is estimated to be 1.7 km in Ain Defali, 2.5 km in Teroual and 3.0 km in El Bibane.

(7) Existing Water Supply Conditions

The model areas are endowed with a number of water sources such as springs, dug holes and wells, as shown in Table 3.2.8.

Table 3.2.8 Number of Existing Water Sources

Commune	Nos of Douars	Spring water		Dug holes	
		Available	Dried	Available	Dried
Ain Defali	60	25	23	73	195
Teroual	28	52	58	17	97
El Bibane	10	11	18	28	17
Total:	97	88	99	118	309

Source: AH

Some of water sources were dried up due to limited precipitation. The number of dried water sources were counted in the survey. The duration of water scarcity was reported to be 5 to 6 months during a drought year and 2 to 3 months in a normal year.

Table 3.2.9 summarizes the ratios of population distribution by the range of distance from housing to water sources.

Table 3.2.9 Ratios of Population Distribution by Distance

(Unit : percent)

Commune	0 km	0.1 - 1.0 km	1.0 - 4 km	< 4 km	Total
Ain Defali	3.1	38.9	33.5	24.5	100.0
Teroual	16.9	52.0	31.0	0	100.0
El Bibane	0	52.5	47.5	0	100.0

Source: AH

Ain Defali is marked with a large number of scattered water sources. Only 3.1 percent of population are served with house connection, whereas 38.9 percent collect water at a distance less than 1 km, 33.5 percent at a distance between 1 km and 4 km and 24.5

percent at a distance over 4 km. Water sources in the areas of Teroual and El Bibane are located relatively close to the douars where more than half of the population collect water at a distance less than 1 km. Almost all the existing dugholes in the three model areas are neither maintained nor equipped. Whereas more than 50 percent of the springs are refurbished either from public funds or by the commune itself. The legal status of water sources is different between spring water and wells. All springs are, in general, public and more than 90 percent of wells are privately owned.

Table 3.2.10 shows the ratios of population distribution by transportation time for water collection

Table 3.2.10 Ratios of Population Distribution by Transportation Time

(Unit : percent)

Commune	Season	0 - 0.5 hrs	0.5 - 1.0 hrs	1.0 - 2.0 hrs	<2.0 hrs	Total
Ain Defali	Summer	10.3	15.2	8.5	66.0	100.0
	Winter	35.0	48.5	9.3	7.2	100.0
Teroual	Summer	27.1	34.8	38.1	---	100.0
	Winter	63.2	36.8	---	---	100.0
El Bibane	Summer	23.8	13.1	63.1	---	100.0
	Winter	68.5	31.5	---	---	100.0

Source: AH

Time spent to collect water varies by season. In Ain Defali, about 66 percent of the population spend more than two hours for water collection in summer. In winter, however, the proportion of population spending more than two hours decreases to 7 percent. The trend is quite similar in the other two model areas. In general, rural people spend more time for water collection during summer in dry season than during winter in wet season.

(8) Cost of Water Collection and Willingness-to-pay

It is important to estimate the present cost of water collection and supply in the three model areas. This estimation could make rural people be aware of the actual cost incurred in water transportation. The actual costs differ according to a number of parameters such as the distance to the water sources, means of transport and the material used for water collection, etc. A number of cases were encountered during the socio-economic survey with the following items :

i) Breeding cost of animals is the range from DH240 to DH720 per month.
ii) Use of a tractor costs DH400 per month excluding rental charge.
iii) Guarding fees rang from DH10 to DH20 per month and household if water source is located within the douar.

Willingness-to-pay for water differs according to economic standard of living. Social classes of local residents in the model areas are divided into three categories, poor, average and rich. Table 3.2.11 shows the rough estimate of the expenditures which a household is willing to pay for water every three months.

Table 3.2.11 Willingness-to-pay of Household per Three Months

(Unit : DH)

Commune	Poor	Average	Rich
Ain Defali	60	183	340
Teroual	45	81	150
El Bibane	65	85	143

A household belonging to the average and rich classes in Ain Defali are able to pay more than the double of expenditures to be paid by the same classes in El Bibane and Teroual. The difference of willingness-to-pay between the poor and the rich is also substantial, more than five times in Ain Defali.

(9) Significance of Water Supply Facilities

The questionnaire survey was conducted to evaluate the priority order of social infrastructural facilities in the three model areas. The items of facilities were firstly classified and then ranked according to the frequency of priority expressed by local people surveyed. The list of facilities in the order of priority in the three communes is summarized in Table 3.2.12.

Table 3.2.12 Priority Order of Infrastructure Facilities

Items	Priority order by Male	Priority order by Female
Water	1	1
Road	2	2
Electricity	3	3
Clinic	4	4
School	5	5

Irrespective of sex, the need for water supply facilities appears to be the most urgent priority. Other infrastructural facilities are ranked as the second order of priority.

The survey was also conducted to inquire the type of water supply systems desired by local people. The questionnaires regarding the type of water supply systems are i) the supply mode and ii) the implementation body, which is shown in Table 3.2.13.

Table 3.2.13 Types of Water Supply Systems Desired by Local People

(Unit : percent)

	Ain Defali	Teroual	El Bibane
Supply Modes			
(1) Stand pipes	—	31	21
(2) House connections	83	57	57
(3) Common use (1)+(2)	17	12	22
(4) Total	100	100	100
Implementation Bodies			
(1) Local community	11	22	22
(2) Commune	—	22	33
(3) ONEP	78	22	45
(4) Public corporation	11	34	—
Total:	100	100	100

More than a half of the people surveyed opts for connection type of facilities. High percentages of house connection is ascribed to the people's desire to control and manage water use inside their dwellings. The people who selected the other type of facilities are, in general, located in poor douars.

The percentages of the ONEP as the implementing body is substantially high, 78 percent in Ain Defali and 45 percent in El Bibane. This may be explained by local people's information about the existing water supply services by the ONEP implemented in the near-by locations (i.e. Had Kourt near Ain Defali and Rhafsai adjacent to El Bibane). Local community implies local people's participation in operation and management of water supply services.

3.3 Hydrogeology and Groundwater Development

Groundwater development through exploratory well drilling in the three model areas was carried out in light of the findings of the geophysical prospecting, confirming the lithological character and water bearing potential of the three structures, coupled with the results of the detailed hydrogeological and socio-economic studies. The execution of the exploratory wells and the pumping test are presented in the following paragraphs.

3.3.1 Exploratory Well Drilling

The sites of the exploratory well drilling are located in the model areas of Ain Defali, Teroual and El Bibane thus complying with the categories considered in the three types of geographic configurations of flat plain, hilly and mountainous area respectively. The former two model areas are located in the province of Sidi Kacem, whereas the latter belongs to the province of Taounate. The locations of the drilling sites are shown in Figures 3.3.1 to 3.3.3.

(1) Execution of Exploratory Well Drilling

The exploratory well drilling started on June 12, 1995, immediately after the signing of the contract and the issuance of the order to commence to the local contractor, and were completed within the scheduled period of three months. The results of the drilling works, the pumping test as well as the outline of the technical details of the three structures are summarized in Table 3.3.1.

According to the scope of work, the drilling wells were originally planned to be executed at 8 locations. However, due to encountering the Triassic formation at well No. TRA1 in Teroual, it was decided to abandon the said well and substitute it with an additional well labelled TRA3.

In addition one of the exploratory wells, namely No. JBD1, at Jbel Berda had to be abandoned also as a result of encountering hydrocarbon gas that exploded while drilling at a depth of 67 m. In fact, groundwater started yielding at the depth of 63 m with a rate of 1.5 l/sec, unfortunately it was contaminated and the well was filled with cement mortar and capped.

The remaining seven wells were completed successfully up to the planned depth with sufficient groundwater yields of adequate quality good for potable water use. The total length of drilling added up to 1,298 m. The technical details of each of the exploratory wells are presented in Figure 4.4.4 of Supporting Report.

(2) Pumping Test

Pumping tests, carried out successfully at the seven exploratory wells, revealed that the yield capacity of the wells exceeded the theoretical quantities calculated earlier during the hydrogeological desk study. The largest yield was observed at Ain Defali with a total of 50 l/sec for the three exploratory wells combined. The syncline of Teroual produced a total flow of 30 l/sec for the two wells combined. Whereas the total yield of the wells of Jbel Berda, despite being relatively small when compared to that of the two structures, added up to 13.5 l/sec. The technical characteristics and details of the pumping tests are summarized in Tables 3.3.2 and 3.3.3, and Figure 4.4.5 of Supporting Report .

3.3.2 Inventory of Existing Groundwater Sources

The inventory survey of the groundwater sources in the three model areas was carried out during the two phases of the study in Morocco in order to determine their technical characteristics and to monitor the fluctuations of flow, water level and water quality and to record any modification in the operation of their exploitation.

The surveyed existing water sources in the syncline of Ain Defali comprised 18 dugholes, 2 springs and 3 exploratory wells. All dugholes are privately owned and vary between 3 and 30 m in depth with an average individual flow of 0.9 l/sec. The 2 springs owned by the commune are located in the douar of Beni Sennana. Their observed flow rates are 0.25 l/sec and 0.33 l/sec. The low yield of the existing water facilities can be explained by the fact that they draw water from the seasonal fluctuating superficial groundwater table. The three exploratory wells, ADF1, ADF2 and ADF3, penetrate deep into the conglomerate water bearing formation and yielded 15 l/sec, 5 l/sec and 12 l/sec respectively by constant rate pumping test.

The syncline structure of Teroual encloses 3 dugholes, 2 springs, 1 borehole and 3 exploratory wells. The survey of these facilities indicated that the depth of dugholes varies between 6 and 14 m with an average flow rate of only 1 m^3/d. The existing borehole was drilled by the AH to a depth of 82 m with casing extending 30 m only. It was equipped and exploited by the commune in September 1995 due to the drying up of the Teroual spring which is the major water source in the commune. At the time of the inventory, the yield of the existing spring started to deplete from the observed 60 m^3/d to a complete dry up in October 1995. The exploratory wells produced a total flow of 20 l/sec during the pumping test.

The existing water sources in the monocline of Jbel Berda add up to 10 dugholes, 4 springs and 3 exploratory wells. The average depth of dugholes varies between 10 and 18 m with an observed average individual flow of 250 l/d which was depleting at the time of the survey due to the exceptional drought period. The existing springs, that usually have surplus flows supplying the commune of Rhafsai, were not in a better condition, their yield dropped as a result of the exceptional drought and the measured flows ranged from 0.08 l/sec to 5.58 l/sec. Meanwhile, the two productive exploratory wells yielded at the time of pumping test a total flow of 13.5 l/sec.

The technical specifications of the surveyed existing groundwater sources and exploratory wells in each of the three model areas are summarized in Table 4.3.4 of Supporting Report.

The inventory survey also covered the monitoring of groundwater levels at the above mentioned existing water facilities, either by manual level reading or automatic measurement by water level recorders installed on six existing dugholes and seven exploratory wells. The recorded levels have been recapitulated in Table 4.3.5 of Supporting report.

3.3.3 Analysis of Hydrogeological Structures

(1) Ain Defali Structure

The three exploratory wells ADF1, ADF2 and ADF3, located along the EW axis of the structure, penetrate the syncline to a depth of 76m, 55m and 150m respectively thus allowing to detail the hydrogeological characteristics of the underlying formations with respect to water accumulation. The yields of these wells, at the time of the constant rate pumping test, were measured as 15 l/sec, 5 l/sec and 12 l/sec respectively with corresponding drawdowns of 14.35m, 31.82m and 23.41m. This indicates that the flow rate is function of the depth and the lithology of the penetrated formation.

Problems of caving in of pebbles and gravel from the loose conglomerate formation, encountered during the progress of the drilling work, necessitated the use of bentonite in circulation to remedy the problem. Polyphosphate solution was used to dissolve and remove the mud cake from the wells. The flow rates of the wells are expected to increase during exploitation as a result of removal of remaining traces of mud cake.

The water reserve of the syncline is approximated at 1.2×10^6 m^3 which is calculated in function of the area of the structure (12 km^2), the thickness of the productive water bearing formation (120 m) and an estimated storage coefficient of 0.8×10^{-3}.

(2) Teroual Structure

The analysis of the structure of Teroual showed that the syncline is marked with a rather peculiar hydrogeologic character revealed through the drilling of the three exploratory wells. The execution of the first well TRA1 disclosed the presence of a 130 m thick Triassic salt patch that, hydrogeologically, was unexpected due to the absence of such a formation in the catchment area of the syncline and consequently could not be detected by geophysical prospecting due to the high resistivity of the consolidated salt formation. As a result, the well was filled with cement mortar and abandoned. The second well TRA2 revealed the presence of two aquifers in the syncline. The first one, with good quality water, is located between 40 and 170 m below ground level and the second encountered between 215 and 300 m with high salt content and had to be isolated from the upper aquifer by cement plug. The third well TRA3 was deemed necessary in order to perform the hydrogeological analysis of the structure and led to successful results.

The two wells TRA1 and TRA2 produced a yield of 10 l/sec each after 72 hours constant rate pumping test with drawdowns of 21.6 m and 0.68 m respectively and corresponding transmissivities of 9.8×10^{-4} m^2/sec and 8.73×10^{-4} m^2/sec. The water reserve of the Oligocene water bearing formation of the syncline is approximated at 0.7×10^6 m^3 which correspond to an area of structure of 6.1 km^2 having a thickness of 40 m and a storage coefficient of 2.61×10^{-3}.

(3) Jbel Berda Structure

The three wells, JBD1, JBD2 and JBD3, were located close to the southern fault line of the monocline on the upper Cretaceous formation due to the inaccessibility to the summit of the structure. The distribution of the wells covered the eastern, middle and western parts of the monocline in order to determine its hydrogeological characteristics. The execution of the three wells confirmed the presence of water accumulation in the base formation of the structure and in the upper marlstone and schist close to the fault line.

Constant rate pumping tests at wells JBD2 and JBD3 produced yields of 2.5 l/sec and 11 l/sec and drawdowns of 48.19 m and 31.42 m respectively with corresponding transmissivity values of 9.8×10^{-5} m^2/sec and 4.88×10^{-4} m^2/sec. Whereas well JBD1 gave a yield of 1.5 l/sec at a depth of 63 m which was expected to increase as drilling progressed. Unfortunately, exploding hydrocarbon gas encountered at 67 m contaminated the groundwater and necessitated to backfill and abandon the well.

The presence of excessive fissures in the sub-strata of well JBD2 at depth of 120 and 140 m with additional water accumulation indicate the probable presence of another recharge layer in the upper Cretaceous formation. In this respect, additional geophysical prospecting is recommended in order to determine the actual recharge area of the aquifer.

The water reserve in the base formation of the monocline is approximated at about 0.75×10^6 m^3 which correspond to an area of structure of 6.3 km^2 and a water bearing layer of 60 m with an estimated storage coefficient of 2.5×10^{-3}.

The quantitative estimation of the hydraulic potentials of the syncline structure at the locations of the exploratory wells was determined in function of the various pumping tests and the observed piezometric water levels. The hydrogeologic parameters such as the transmissivity of the wells, the storage coefficient, specific drawdown and well loss coefficient were computed using Jacob's equations as shown in Tables 3.3.2 and 3.3.3, and Figure 4.4.6 of Supporting Report, respectively.

3.3.4 Water Balance Analysis

(1) Outline of Water Balance Analysis

The following presents an application of water balance analysis for estimation of groundwater recharge, using meteo-hydrological records. Water balance analysis is to clarify a balance of quantity of inflow and outflow in a hydrologic system within a certain period of time. Basically, this is formulated as the following equation.

(Inflow) - (Outflow) = (Change of Storage)

Groundwater flow system is a part of the hydrologic cycle illustrated in Figure 3.3.4. In general, it is difficult to know a quantity of groundwater recharge by measurement or observation. On the other hand, water entering into a hydrologic system is a sum of precipitation and runoff from a neighboring hydrologic system, and water going out is a total of runoff, evapotranspiration and water extraction from the system. Quantity of these items can be known based on measurement or observation data. Accordingly, groundwater recharge can be estimated based on these data.

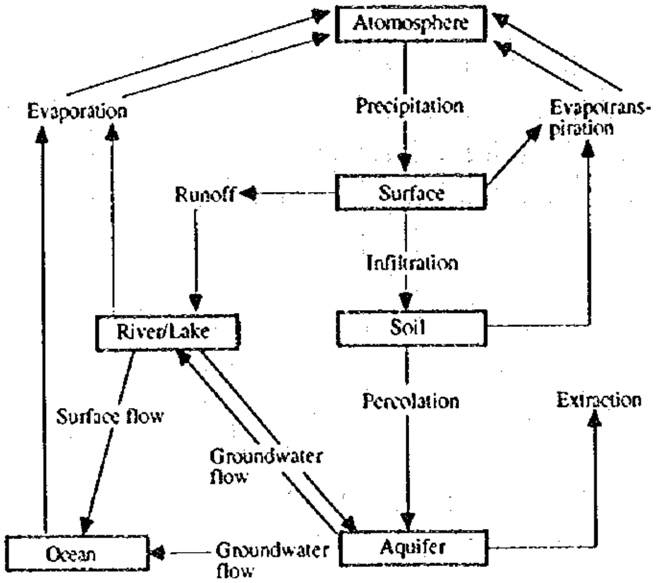


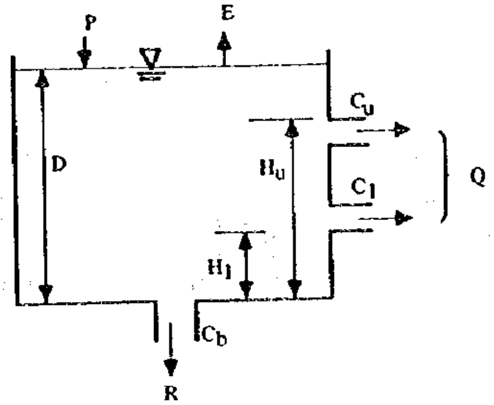
Figure 3.3.4 Schematic Diagram of Hydrologic Cycle

(2) Water Balance Model

A tank model method which is a serial storage typé model was applied for the water balance analysis. The tank model is composed of a number of containers which indicate the catchment basin (hereinafter the container is called a 'tank').

As shown in Figure 3.3.5, the tank has several holes on their sides and bottoms. Rain enters the top tank first then passes into the lower tank through holes on the bottom of the upper tank. Water also passes through holes on the sides of the respective tanks. Water moving through the bottom holes indicates infiltration, while runoff moving through the side holes of all the tanks indicates river discharge. When a model with serial three tanks is provided, each tank represents the runoff mechanism on the ground surface or layer, and is a component of the runoff hydrograph, which are generally considered as follows:

Top tank	Surface Runoff
2nd tank	Sub-surface / Groundwater Runoff
3rd tank	Groundwater Runoff (Baseflow)



$Q = (D - H_u) \times C_u + (D - H_l) \times C_l$ $(D > H_u)$

$Q = (D - H_l) \times C_l$ $(H_l < D < H_u)$

$Q = 0$ $(D < H_l)$

$R = D \times C_b$

Where,

P	:	Precipitation or infiltration from the upper tank
Q	:	Runoff
R	:	Infiltration to the lower tank
E	:	Evapotranspiration
C_u	:	Coefficient of the upper hole on the side
C_l	:	Coefficient of the lower hole on the side
C_b	:	Coefficient of the bottom hole
H_u	:	Height of the upper hole from the bottom
H_l	:	Height of the lower hole from the bottom
D	:	Depth of water (storage of tank)

Note: All variables are in mm.

Figure 3.3.5 Conceptual Diagram of Tank Model

Calculations are made for all tanks from the upper to the lower tanks. The sum of runoff from the side holes of all the tanks indicates river runoff. The remaining depth of each tank constitutes the initial depth for the next step, and the calculations are repeated using the same process.

To establish a tank model, precipitation and potential evapotranspiration are given as input for calculating runoff. Actual evapotranspiration is obtained as a result of calculation. The coefficients, such as H_u, C_u, H_l, C_l and C_b, are analyzed by comparing the computed runoff with the observed runoff. Model calibration is carried out by trial and error for adjusting the coefficients until the computed hydrograph fits in with that of the observed.

(3) Water Balance Analysis for Objective Area

1) Modeling for River Basin

The objective areas for water balance analysis and groundwater simulation cover the areas of the groundwater potential structures at Ain Defali, Teroual and J. Berda, respectively.

Applying the tank model, water balance analysis was carried out for estimating groundwater recharge of each objective area. The tank model was established for the gauged river basin which is closely located to the objective area. The objective river basins are the Rdat river basin for Ain Defali and the Amzaz river basin for J. Berda, respectively. For Teroual, since no runoff record is available on the neighboring tributary, the tank model established for the Rdat river basin was applied. The meteo-hydrological records used for water balance analysis are listed on Table 3.3.4.

Using the basic data above, the tank models were constructed for the respective river basins. The serial three tanks were provided for the model. Comparison of the observed and computed runoff are shown in Figure 3.3.6 on annual basis and in Figure 3.3.7 on flow duration curve, respectively. In general, the computed runoff almost corresponds with the observed runoff, the results are therefore regarded as acceptable.

2) Application for Objective Area

The tank model constructed for the river basin was used for estimating the groundwater recharge of the objective area. Application of the tank model and input data are shown in Table 3.3.5. From the results of the tank model simulation, the groundwater recharge for each objective area was obtained by the following equation:

$$Gr = P - Ro - E$$

Precipitation (P), surface outflow (Ro) and evapotranspiration (E) are components of surface runoff system expressed by the top tank. Value of (P – Ro – E) gives runoff from bottom hole of the top tank. The estimated groundwater recharge (Gr) is shown in Table 3.3.6

Table 3.3.6 Water Balance of Objective Area (1)

Unit: mm

Objective Area	Precipitation (P)	Surface Runoff (Ro)	Evapo-transpiration (E)	Recharge (Gr)
Ain Defali	587	65	468	54
Teroual	775	154	544	77
J. Berda	953	336	533	84

The value of recharge in the table indicates the average of the gauged river basin. On the other hand, the objective area with the relatively high groundwater potential is quite small in the river basin which is mostly covered with the area of low recharging rate. With consideration to this, the values of groundwater recharge estimated by the tank model are necessary to be reviewed in the groundwater simulation discussed in the succeeding section.

3.3.5 Groundwater Simulation

(1) Outline of Groundwater Simulation

For development of groundwater resources, the groundwater management should be provided covering evaluation of the resources, plan and implementation programs for development and subsequent preservation of the resources. Groundwater simulation is a component of the groundwater management and is utilized mainly for the evaluation of groundwater resources and the future prediction. It helps to decide the allowable yield of groundwater extraction newly developed. Generally, a numerical model is applied to simulate a behavior of groundwater flow system.

In this Study, the software MODFLOW, "A Modular Three-Dimensional Finite-Difference Groundwater Flow Model", was introduced to preparation of simulation model. The MODFLOW is developed by the US Geological Survey and is being used over the world with its wide applications covering two-dimensional, quasi-three dimensional and three-dimensional modeling of groundwater flow. For the objective areas of this Study, however, the several approximations and assumptions were required for preparing the groundwater simulation model, because the topographic conditions and the hydrogeological structures were complicated especially in the mountainous area. In addition, the necessary data were limited since the intensive hydrogeological investigations were firstly provided by this Study. Further revision of the simulation model will be required for the future groundwater management when additional data has been accumulated.

(2) Theoretical Approach

In principle, MODFLOW simulates groundwater flow in three dimensions. The three dimensional movement of groundwater through porous material may be described by the following equation:

$$\frac{\partial}{\partial x}\left(Kxx\frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(Kyy\frac{\partial h}{\partial y}\right)+\frac{\partial}{\partial z}\left(Kzz\frac{\partial h}{\partial z}\right)-W=Ss\frac{\partial h}{\partial t} \quad \text{------ (1)}$$

Where

Kxx, Kyy, Kzz	:	Values of hydraulic conductivity (Lt^{-1})
h	:	Potentiometric head (L)
W	:	A volumetric flux per unit volume and represents sources and/or sinks of water (t^{-1})
Ss	:	Specific storage of porous material (L^{-1})
t	:	Time (t)

This equation constitutes a mathematical representation of a groundwater flow system if flow and/or head conditions at the boundaries of an aquifer system and initial-head conditions are specified. Analytical solutions of the equation are rarely possible, so various numerical methods must be employed to obtain approximate solutions. Of them, MODFLOW employs the Finite Difference Method (FDM), wherein the continuous system described by equation above is replaced by a finite set of discrete points in space and time and the partial derivatives are replaced by terms calculated from the differences in head values at these points. This process leads to systems of simultaneous linear algebraic difference equations, and the solution yields values of head at specific points and times.

In order to formulate the finite difference equation, a spatial discretization of objective aquifer system is provided, using a mesh of blocks called cells with their locations described in terms of rows, columns and layers. In addition, since the head in the equation (1) above is a function of time as well as space, discretization of the continuous time domain is also required.

The continuity equation is applied for development of finite difference equation of groundwater. It expresses that a balance between inflow and outflow of a cell is equivalent to a rate of change in storage within the cell.

$$\sum Qi = Ss \frac{\Delta h}{\Delta t} \Delta v \qquad \text{------ (2)}$$

where

Qi	:	A flow rate into the cell (L^3t^{-1})
Ss	:	Specific storage equivalent to Ss in equation (1) (L^{-1})
V	:	Volume of the cell (L^3)
Δh	:	Change in head over a time interval of length (L)
Δt	:	Time interval (t)

Using the equation (2), the equation (1) for three dimensional groundwater flow can be expressed as a form of difference equation. The difference equations are established for the respective cells, which are composed of an objective aquifer, with unknown head. These equations can be solved simultaneously, then the heads of the respective cells can be obtained.

(3) Summary of Groundwater Flow Modeling

Based on the data obtained during the field investigation, the groundwater flow system in each objective area was estimated by modeling. For numerical model, the objective area was divided into mesh blocks. The data including topography, thickness and hydraulic constant of aquifer, etc. were given by mesh block.

1) Geometry of Aquifer System

Ground surface elevation was obtained from the available topographic maps with a scale of 1/50,000. Thickness of aquifer was estimated from the lithology of the exploratory well and the results of the geophysical prospecting, then the data of top and bottom elevations of aquifer were prepared.

2) Groundwater Level and Hydraulic Constant

With consideration to water balance in terms of inflow and outflow of the objective area, groundwater flow was reproduced on the model by adjusting groundwater level. This process was made by providing hydraulic conductivity of aquifer. Around the exploratory well, the hydraulic conductivity was given with reference to the results of pumping test, and the computed groundwater level was adjusted to the observed level as much as possible. For the other part of the objective area where the groundwater level data were insufficient, it was assumed that the groundwater surface might indicate a similar form to the ground surface.

3) Water Balance

Inflow to the objective area was initially set at the groundwater recharge estimated by the tank model. The sum of outflow from the objective area and spring yield was equivalent to the inflow. The present groundwater extraction was not considered because it may be very small compared with the water balance in the whole objective area and the most of extraction sources are non-equipped dug holes. In the process of modeling, the groundwater recharge estimated by the tank model was evaluated as acceptable for Ain Defali and Teroual. On the other hand, the recharge of J. Berda was evaluated much larger than that estimated by the tank model because of the yield of Tazrhadra spring which gives a relatively stable yield during dry season. As a result, water balance of each objective area was obtained as shown in Table 3.3.7 and Figure 3.3.8. The simulated groundwater flow indicated by the contour maps of groundwater level are shown in Figures 3.3.9 to 3.3.11.

Table 3.3.7 Water Balance of Objective Area (2)

Objective Area	Area (km^2)	Precipitation (10^6m^3/year)	Evapo-transpiration (10^6m^3/year)	Surface Runoff (10^6m^3/year)	Groundwater Runoff (10^6m^3/year)
Ain Defali	12.0	7.044	5.616	0.780	0.648
Teroual	6.1	4.728	3.424	0.943	0.381
J. Berda	6.3	6.016	3.198	2.121	0.697

(4) Conditions for Simulation

The groundwater flow model obtained in the previous section gives a steady state condition, which is an ideal condition, since the modeling was made based on the annual average recharge. In general, seasonal fluctuation of groundwater level is taken into account of the model by transient simulation based on the continuous observation data. However, since the groundwater level data of the exploratory well concerned were only available during a few month, the seasonal fluctuation could not considered into the simulation study. Accordingly, the simulated steady state condition was assumed as the groundwater flow condition in 1995 and the simulation study gives the prediction of groundwater level on annual basis.

The simulation study was carried out using the model for each objective area with the additional input of groundwater yield to be extracted. The initial condition of simulation was assumed as the steady state condition reproduced by modeling. The groundwater level was predicted for the time-dependent conditions on annual basis. The simulated groundwater level was compared with that of the initial condition, then the lowering of groundwater level from the initial condition was obtained.

(5) Results of Simulation

The allowable yield of groundwater extraction from the exploratory well was evaluated with the criteria of the lowering of groundwater level after 20 years pumping. The study was carried out for the alternative allowable limit of 10 m, 15 m and 20 m. In addition, the groundwater recharge was provided for two cases as follows:

i) Average recharge, and

ii) Estimated recharge year by year for the recent 20 years (1975/76 - 1994/95).

The results of simulation are listed on Table 3.3.8.

Table 3.3.8 Results of Groundwater Simulation

Ain Defali

Recharge	Allowable Limit GWL Lowering	Yield of Exploratory Well (m^3/day)			
		ADF1	ADF2	ADF3	Total
Average	10 m	241	60	155	456
	15 m	354	86	233	673
	20 m	475	120	311	906
Recent 20 Years	10 m	224	43	120	387
	15 m	336	77	120	533
	20 m	457	120	285	862

Terouat

Recharge	Allowable Limit GWL Lowering	Yield of Exploratory Well (m^3/day)		
		TRA2	TRA3	Total
Average	10 m	111	106	217
	15 m	166	157	323
	20 m	224	207	431
Recent 20 Years	10 m	108	103	211
	15 m	164	155	319
	20 m	220	207	427

J. Berda

Recharge	Allowable Limit GWL Lowering	Yield of Exploratory Well (m^3/day)		
		JBD2	JBD3	Total
Average	10 m	43	64	107
	15 m	64	99	163
	20 m	90	133	223
Recent 20 Years	10 m	34	47	81
	15 m	56	82	138
	20 m	82	116	198

As the results of the groundwater simulation, the possible amount of groundwater production is not large estimated from the future lowering of groundwater level, because the extent of the groundwater recharging area is small. Although the groundwater simulation still includes the several uncertain factors, the results suggest a limitation of the groundwater resources so that an excessive groundwater extraction is not recommended other than the potable water supply.

As a conclusion, the allowable yield of groundwater extraction should be kept at the yield meeting the potable water demand for each model area under the proper management of the groundwater resources. Further groundwater development will require the evaluation of groundwater resources not only by this Study but also by the long term monitoring under the groundwater management.

3.4 Water Demand Projection of Model Areas

Existing population of the three model areas as of 1995 was investigated by the socio-economic survey carried out in August 1995 during the stage of the second field work. The detail documents on the population were collected mainly from communal authorities. The population surveyed is a little different from the census survey carried out in 1994 due to increase of the number of douars within one year, and this data was conducted for the future population projection of the model areas by the target year of 2010.

In connection with water demand projection, basic approach for projecting, needless to say, should be same whichever in the model areas or in the Study Area. In this Master Plan Study, preliminary water demand projection for the Study Area was carried out during the stage of Phase I and Phase II taking into consideration of the existing condition, past trend of water use and existing projection presented in the National Master Plan under the AH as well as under the DRPE. Therefore, general aspects on water demand projection of the model areas other than the conditions peculiar to the model areas are described briefly in this section, and detail consideration for the entire Study Area is given in Chapter II.

3.4.1 Population Projection and Distribution

The socio-economic survey revealed the current population at the three model areas, namely, three communes as 25,234 at Ain Defali, 12,096 at Teroual, and 6,511 at El Bibane, respectively. On the basis of these, future population up to the target year was estimated applying the rate of annual increase of 0.7 percent as was established. The projected future population in each commune as the model areas is 28,000 in Ain Defali, 13,000 in Teroual, and 7,200 in El Bibane as given in Table 3.4.1 through Table 3.4.12 together with subsequent results of water demand projection of each commune.

The characteristics of the existing population in each model area are described hereinafter.

In the commune of Ain Defali which has the largest area among others, 60 douars having the population of 25,234 in total are registered as of August 1995. The average population in a douar comes to 420. The douar with the largest population is Oulad Ktir and the second is Slim having the population of 2,240 and 1,536, respectively. The rural center of Ain Defali, the third largest douar in the commune and where exploratory wells were drilled nearby, has the population of 1,048. Distribution of the douars extends and scattered all through the commune, and the size of the douar in this commune varies extensively.

The commune of Teroual consisting of 29 douars and having the population of 12,096 in total are registered. The average population of each douar comes to 417. The douar with the largest population in this commune is called Teroual located in the center of this commune and has the population of 2,050 people in total. Distribution of douars extends mainly in the southern part of the commune due to topographic configuration of the area.

The commune of El Bibane is the smallest among the three model areas and has 10 douars having the population of 6,511 in total with the average population of 651 in a douar. Out of 10 douars, 6 douars are gathered in the central part of the commune, where the test wells were exploited.

3.4.2 Existing Water Supply Conditions in the Model Area

(1) Ain Defali

The existing water supply facilities in the entire commune include 32 dugholes, 25 springs, 5 stand pipes and 18 equipped public water sources according to the survey carried out by the AH in 1994. In addition, the stream water at 16 locations in this commune also contributes for domestic and livestock use. The average distance from houses to the water sources varies from zero to 20 km.

The existing water supply conditions in the commune of Ain Defali surveyed in this Study is given in Table 3.4.13. The 14 out of 59 douars are selected as representatives of the entire commune, thus approximately 10 percent of the population is concerned for the survey.

In these douars, water is mainly obtained by means of mules from dugholes and springs in the vicinity. The average distance to the water source is approximately 4.8 km and two to three hours are spent to get water.

The domestic unit water consumption is estimated at 17.3 l/c/d and 14.5 l/c/d in summer and winter, respectively. The water for livestock is occasionally fed in houses during summer time and its rate is estimated to be about 15 percent. Whereas, water is fed in the nearest rivers and streams in winter, since comparatively abundant surface water is readily obtainable during winter.

The existing water supply system in the rural center of Ain Defali is currently managed by the communal organization itself. The water sources consist of a spring located at Bni Sennana and two dugholes located at Laamirat and Ain Defali, respectively. The water yield of the spring measured in this Study is estimated at approximately 0.4 l/s varying seasonally, and the water of 0.2 l/s is transported to an equipped water source in Bni

Sennana. The rest is transported by three inch pipe to the underground reservoir which was initially exploited as a dughole. The water from this underground reservoir is thereafter transported to an elevated tank located in the midst of the town of Ain Defali to supply water by distribution pipes and subsequent house connections.

It is recently reported by the ONEP Sidi Kacem office that the ratio of water consumption in the rural center to the estimated water demand resulted approximately in 40 percent or inversely 60 percent of water deficit to the demand. Due to difficulty of provision of financial arrangement despite of severe water deficit, the communal authority requested the ONEP Sidi Kacem to exploit new water sources and provide facilities as well as to help enhance the existing water supply system.

(2) Teroual

The existing water supply facilities in the commune consist of 7 dugholes, 1 well, 22 springs, 5 public stand pipes and 4 equipped public water sources. In addition, one distribution tank, distribution pipelines and house connection facilities are provided in the rural center of Teroual.

The existing water supply conditions in the commune of Teroual surveyed in this Study is given in Table 3.4.14. Nine out of twenty nine douars are selected as representatives of the entire commune, thus approximately 12 percent of the population are concerned for the survey. The means of transportation of water and persons in charge to carry water resemble to that of in Ain Defali. Due to hilly topographic configuration no vehicle is used to carry water as far as observed. The domestic unit water consumption in these areas are estimated at 15.2 l/c/d and 13.7 l/c/d in summer and in winter, respectively.

In the rural center of Teroual, the water supply system is provided with a distribution tank, distribution pipes and house connection facilities relying upon the spring water located on the slope of a mountain in the village. The water issued from the spring by 0.73 l/s is diverted to two directions to supply water to inhabitants. The spring water thereafter is conducted to the equipped water sources which are the so called 'Sheraton Spring' with 0.55 l/s and 'Caid Spring' with 0.18 l/s, respectively, according to the survey carried out in this Study in June 1995.

The spring water at the same time is also diverted to a reservoir located on top of a hill by pumping and distributed to the center of Teroual by gravity. The residents thereafter receive water by house connection facilities. The number of current house connection provided in the center as of July 1995 is counted as 360, which corresponds approximately to 50 percent of the requested number. The 50 percent of the population still await for the provision of house connection facilities. However, current total groundwater issue cannot meet the demand even for the residents already provided with house connection facilities.

(3) Ain Berda

The water supply facilities in the commune consists of only 2 dugholes and 10 springs with extremely less water issue contribute to domestic and livestock water use in the commune. The existing water supply conditions in this commune is given in Table 3.4.15. All of ten douars are selected for the survey so as to grasp the existing water supply conditions, and approximately 11 percent of the population as representatives is concerned for the survey.

Due to mountainous topographic conditions and concentration of residential areas in the vicinity of the rural center, the distance to carry water is rather short compared with other model areas varying from zero to 3 km. The domestic unit water consumption in this commune is estimated at 16.9 l/c/d and 13.3 l/c/d in summer and in winter, respectively.

In the rural center of this commune, two dugholes located in the midst of the housing area were exploited by the AH in 1983. They are currently dry and not in use any more. Whereas, two springs in the neighborhood currently yield water at only 0.02 to 0.09 l/s, or approximately 1.7 m^3/d to 7.8 m^3/d. As is obviously seen by this figure, the residents are severely suffered from water shortage.

While, the spring at Tazrhadra, a couple of hundred meters down from Ain Berda currently yields water about 10 l/s which corresponds to 864 m^3/d. This water is partially transported to the neighboring town of Rhafsai at the foot of the Jbel Berda and 3.6 km apart from Tazrhadra with the amount of 1 l/s in summer time and 5.5 l/s in winter time.

3.4.3 Parameters for Water Demand Projection

(1) Service Ratio of Water Supply

The existing water supply facilities provided in the model areas are insufficient in quality and quantity, and their water sources are very limited in number containing constraints of such as non physical and mechanical maintenance, poor sanitary cares in the vicinity of water sources and long distances to approach.

Many of the water sources are owned and controlled by the communal authorities, because their magnitude is, in general, quite small. The socio-economic survey revealed that more than 80 percent of the residents in the model areas are dependent on such public water sources even though the quality is not satisfactory, and the rest acquires water from private dug holes or wells. It is envisaged that such people who are able to acquire water from their own sources would continue the same way as it is in the future.

It was identified, according to the socio-economic survey, that land owners or owners of private water sources generally keep exploiting new dugholes or wells from time to time, to conserve potential of groundwater production for their own profits. In this regard, it is readily anticipated that the private owners would keep extracting groundwater at least fifteen years or so, namely until the target year. Thus, the water supply pervasion by public supply means will be at round 80 percent.

In a practical point of view existing water supply pervasion by public means or to be supplied by public supply system may be more or less 80 percent. However, due to lack of data, precise value of existing supply pervasion is a hard task to acquire. Therefore, the supply pervasion for both of 1996 and 2010 shall be 80 percent in convenience in this Study.

Meanwhile, the National Master Plan presented in the first edition in 1992, proposed the future water supply system in the rural areas in Morocco applying the ratio of 10 percent for house connection, 30 percent for refurbished water sources, and 40 percent for public stand pipes. The existing condition of water supply in the Pre-Rif region is, compared to other typical rural regions in Morocco, considered to be approachable to this target by the year of 2010.

The number of livestock in the future is also a significant parameter which exerts on water demand. The number of livestock may increase in the future in compliance with the development of socio-economy, but the rate of increase up to the target year is negligible when considered the past tendency as far as the model areas are concerned.

Whereas, actual unit water consumption by livestock may remain in the same level as it is because of the characteristics of animals. Therefore, the number of livestock together with the unit water demand shall remain in the same level as of 1995 in this projection unless otherwise remarkable irrigation schemes which may probably serve abundant grass to livestock would be carried out by the target year.

(2) Unit Water Demand

As was given in Chapter I, the DRPE proposed future water demand at around 30 l/c/d, although some imported water from neighboring commune is included. (See Table 2.5.5).

The National Master Plan on the other hand concluded that the unit water demand for 2010 in compliance with water supply facilities would reach the following values as given in Table 3.4.16.

Table 3.4.16 Unit Water Demand in compliance with Water Supply Facilities for 2010

Item	RWS	PSP	HC
Supplied Person per Unit	250	200	8
Domestic Unit Demand (l/c/d)	15	30	50
Livestock Unit Demand (l/large unit/d)	20	20	20

Note:
RWS: Refurbished Water Source
PSP: Public Stand Pipe
HC: House Connection
Source: National Master Plan

While, the existing ongoing projects under the ONEP North Regional Center for Ain Gdah and Karia Ba Mohamed systems which mainly supply water by stand pipes adopted the unit water demand of 15 l/c/d on average for both domestic and livestock use. These systems were originally established by adopting unit water demand at 30 l/c/d for domestic and livestock, respectively with the plan of house connections for the entire supply areas. However, because of actual suppressed water consumption in the system, the capacities of the treatment plants resulted in excess water production or oversized as of now, and currently being improved to expand the network system to fulfill the water production capacities.

Taking these conditions into consideration, the existing net water demand is established at 20 l/c/d. The unit water demand for domestic use was established to increase by 3 percent annually from 20 l/c/d for the year 1995 to 31 l/c/d for the year 2010.

Whereas, the unit water demand for livestock was set up at 20 l/head/d and to be constant up to the target year of 2010. However, the practical water demand of livestock was computed on the basis of the results of socio-economic survey applying 15 percent of 20 l/head/d on average through the year, since the water for livestock, in general, is fed by natural surface waters such as rivers and streams in the rural areas.

(3) Unaccounted for Water

Unaccounted for water shall be basically applied on urban areas and rural areas where water supply system is provided by the ONEP, since the system constitutes with pipe reticulation. The model areas, in the light of this, will be provided with adequate water supply facilities equivalent to the existing ONEP system, and consequently the parameter of unaccounted for water should be taken into consideration.

The unaccounted for water in the model areas shall include 1) water leakage from pipe reticulation, 2) water meter reading error by the staff of organization at the main supply facilities, 3) sensitivity or calibration errors of the meter, 4) non-payment by the residents, 5) water quantity recording error in the entire system, 6) water wastage during water intake, 7) water use by public purpose and 8) fire extinguish.

For establishment of practical figures, non of the data in relation with model areas exists. Therefore, existing data of water production and water charging record compiled in the system of Ain Gdah and Mekansa water supply system shall be referred and applied with 3 percent of annual decrease from 40 percent in 1995 to 26 percent in 2010.

3.4.4 Water Demand Projection

On the basis of the parameters of service ratio, unit water demand, and unaccounted for water, the water demand are computed as 990 m^3/d (11.5 l/s) at Ain Defali, 468 m^3/d (5.4 l/s) at Teroual, and 248 m^3/d (2.9 l/s) at El Bibane, respectively, in the year 2010. The results of computation for the demand from the years 1995 to 2010 are presented in Table 3.4.1 to 3.4.4 for Ain Defali, Table 3.4.5 to 3.4.8 for Teroual and Table 3.4.9 to 3.4.12 for El Bibane.

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) In the model areas selected, groundwater reserving geological structures other than the ones identified around the exploratory well sites are hard to find out in the rest of the area in the commune. For instance, the existing water yield from dugholes or springs is considerably small and not reliable through years due to seasonal fluctuation. Therefore, 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) A part of the existing water supply system in the rural center of Ain Defali and Teroual is favored by house connection system based on the existing springs. 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 proposed supply system in the model areas shall be divided into first and second prioritized groups; the first is based on gravity system and the second is on pumping system. The system as an urgent improvement program to be adopted this time shall be by gravity system and this system would be completed within three years.

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. Further, it is fully important to keep monitoring the exploratory wells to check quantitative and qualitative assurance for long time expansion.

v) The supply areas to be implemented this time shall be limited to the model areas where detail socio economic survey was performed. 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 such as pump facilities for the exploratory wells, transmission lines from the exploratory wells to the main tank, distribution lines to remote supply areas, distribution tanks and stand pipes. 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. There is indeed a difference in seasonal water consumption, especially, between summer and winter. The difference is generally brought from rainfall amount which affects the magnitude of water production in the case of surface water supply system, and so is the case of groundwater, although the effect on the latter case is smaller. 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, since inhabitants generally come to water sources in the day time any time by means of horses and donkeys and, thereafter, keep water in vases or jugs in their houses. Thus, average hourly supply amount would be acceptable to apply for designing supply pipe lines and appurtenant facilities.

(4) Capacity of Distribution Tanks

The capacity of distribution tanks is generally determined by applying 8 to 12 hours storage capacity based on the consumption of one third or one half of the maximum daily demand. 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. It should be noted that the locations of the douars to be supplied with water as well as the approach roads are considerably hard to identify on the maps, since the maps were indeed edited in the early 1950's. Therefore, the plans and profiles including allocation of tanks and stand pipes shall be a preliminary level in the accuracy. 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 Ain Berda are given in Figures 3.5.1 to 3.5.3. 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. Hydraulic profiles for the distribution lines with pumping system is, if detail information is needed, to be referred Drawings.

For hydraulic profile, minimum and maximum static pressures of 1 kg/cm^2 and 6 kg/cm^2, respectively, are basically adopted. Because of accuracy of the topographic map used, modification and adjustment of hydraulic pressure are inevitably necessary conducting, for example, pressure reducing valves, air valves and appurtenant facilities required to these.

(2) Exploratory Well Site Facilities

The schematic diagram of exploratory well site facilities are given in Figures 3.5.4 to 3.5.6. 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. In case of Ain Defali and Teroual, the water extracted by the submersible pumps are stored tentatively in the connection tank to protect water hammer and to unify the plural number of pipes. The technical details on the specification of pumps, pipes and connection tanks are given in section 5 in Supporting Report.

(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. The material and structure of these tanks are planned with reinforced concrete for the sake of water proof and durability and with rectangular semi-underground type.

(4) Distribution Pipes

Materials of distribution pipes adopted in Morocco, in general, are such as concrete, ductile iron, galvanized steel, asbestos cement and polyvinyl chloride (PVC). Amongst others, latter three materials are used often in the Study Area in view of economic aspects and ease of construction. 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. In this Study, galvanized steel pipe is adopted.

(5) Stand Pipes

A typical type of stand pipe is proposed in this Study to serve water to the douars. 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 major facilities to be improved are concentrated on dugholes and springs located in the model areas. Among them, the number of dugholes to be rehabilitated amounts to 7 for Ain Defali and 1 for Teroual. Whereas, number of springs to be rehabilitated is 19, 23, and 7 for Ain Defali, Teroual and Ain Berda, respectively.

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 dughole, 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.

The dugholes and springs to be rehabilitated for each douar in the model areas are summarized in Tables 5.5, 5.6 and 5.7 in Supporting Report.

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 ground water and water level in production well should be constantly measured. Excessive extraction may bring about break of balance between extraction and recharge, and slogging 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.

3.6 Preliminary Cost Estimate

3.6.1 Conditions of Cost Estimate

The project cost was estimated on the basis of the preliminary layouts and designs of water supply facilities in the model areas under the following conditions and assumptions.

(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.

US $ 1.0 = DH 8.6 = Yen 100.0
DH 1.0 = Yen 11.6

(4) Devaluation

Devaluation of Moroccan Dirhams to the US Dollar was reviewed and shown in Table 3.6.1. As Moroccan Dirhams are stable to the US Dollar in recent years, devaluation factor was not incorporated with the price escalation rate, accordingly.

Table 3.6.1 Devaluation of Dirhams to US$

	average	'95	'94	'93	'92	'91
DH / US$		8.495	8.960	9.651	9.049	8.150
Devaluation		-	-0.465	-0.691	0.602	0.899
Rate	1.35 %		-5.1%	-7.16%	6.65%	11.0%

(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:

VAT for sales activity	:	19.0 %
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

The project cost was estimated by the following approaches in terms of respective cost items.

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

Macro basis unit costs are presented with due comprehensive cost study on rural water supply in the Pre-Rif region in Table 6.1 of Supporting Report.

(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.

1) Unit Construction Costs to be Multiplied by Work Quantities

This method has been applied to almost all pay items of civil, mechanical and building works which constitute the majority of the project cost. The unit construction costs for these items are tabulated in Table 6.2 of Supporting Report, in compliance with a review and analysis of collected data of similar projects implemented recently in the north region of Morocco. Unit prices or charges were also scrutinized to make up for these unit costs. The unit prices consist of construction materials, labor charges and rental charges for construction equipment as shown in Tables 6.3, 6.4, and 6.5 of Supporting Report, respectively. The unit costs were also divided into foreign and local currency portions based on the country from which material, labor and equipment are obtainable.

2) Statistical Method Using Cost Data of Other Similar Projects

Costs of mobilization, preparatory and temporary works, and metal works has been estimated by this approach. Collected cost data of water supply projects in northern region of Morocco were valuable and referred. Same concept as above 1) was applied to divide into foreign and local currencies.

3) Quotations from Supplier, Distributors or Sole Agents

Electro-mechanical facilities such as, pipes and fittings, pumps and motors were estimated by this method on the basis of quotations. These facilities will have to be imported. The costs for this group excluding inland transportation and installation costs has been incorporated into the foreign currency portion.

(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 as indicated in Table 3.6.2. No devaluation factor between Dirhams and US$ was taken into account. Consequently, the following price escalation rates were incorporated into the cost estimate.

Foreign currency portion : 2.9 % p.a.
Local currency portion : 6.0 % p.a.

Table 3.6.2 Consumer Price Index of G-7 and Morocco

	average	1995 *	1994	1993	1992	1991	1990
Morocco		134.0	126.3	120.1	114.2	108.0	100
Rate (%)	6.0	6.1	5.2	5.2	5.7	8.0	-
G-7 (%)	2.9	2.0	2.1	2.6	3.1	4.6	-

* from January to July

(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 construction cost and incorporated into both foreign and local currency portions.

3.6.3 Construction Cost Data

Cost data were collected focusing unit construction costs in and around the Study Area during the field work in October 1995 to estimate the project cost as a preliminary level. They were investment cost data for water supply facilities published by the AH, unit construction costs for Karia-Tissa water supply project under the Ministry of Agriculture and water supply project in rural area by the AH, summary of average unit prices by the AH in Fes, ONEP's cost data for water supply project in Taza, quotations from local suppliers for water treatment plant, pipes and fittings, and others. These cost data were tabulated in Tables 6.1, 6.2, 6.3, 6.4, and 6.5 of Supporting Report.

The investment cost data for water supply projects prepared by the AH are also given in Tables 6.6, 6.7, and 6.8 and Figures 6.1, 6.2 and 6.3 of Supporting Report.

Major unit costs adopted for the construction cost estimate of water supply facilities in the model areas are given in Table 3.6.3.

3.6.4 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.

(1) Project Cost of Water Supply Facilities by Gravity Supply Area

The project cost for gravity supply area are summarized in Table 3.6.4. comprising the construction of water supply facilities and rehabilitation of existing rural water supply facilities in the model areas.

Table 3.6.4 Project Cost (Gravity System)

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

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 basic cost and price contingency

Of the project cost, total base cost excluding the price and physical contingencies amounts to DH 74.3 million (equivalent to Yen 864 million or US$ 8.6 million) in total. Direct construction cost and rehabilitation cost pertaining to foreign and local currency portions are given in Tables 3.6.5 and 3.6.6, excluding VAT of 14.0 percent.

Table 3.6.5 Direct Construction Cost of Water Supply Facilities (Gravity System)

Currency	Direct Construction Cost
Foreign currency portion	US$ 4,666 thousand
Local currency portion	DH 8,131 "
Total	DH 48,259 thousand

Table 3.6.6 Rehabilitation Cost of Existing Facilities

Currency	Rehabilitation Cost
Foreign currency portion	US$ 174 thousand
Local currency portion	DH 489 "
Total	DH 1,985 thousand

Priced bill of quantities of direct construction and rehabilitation works are given in Table 3.6.7. Annual disbursement schedule for the project cost is shown in Table 3.6.8 in compliance with the proposed implementation and construction schedule.

(2) Project Cost of Water Supply Facilities in Supply Area by Gravity and Pumps

The project cost for supply area by gravity plus pumping system are summarized in Table 3.6.9 comprising the construction of water supply facilities and rehabilitation of existing rural water supply facilities in the model areas .

Table 3.6.9 Project Cost (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 basic cost and price contingency

Priced bill of quantities of direct construction and rehabilitation works are given in Table 3.6.10. Annual disbursement schedule for the project cost is shown in Table 3.6.11 in compliance with the proposed implementation and construction schedule.

3.6.5 Operation and Maintenance Costs

Annual operation and maintenance costs were estimated divided into gravity supply system and gravity plus pumping system as summarized below. The details are given in Tables 3.6.12 and 3.6.13 for gravity system, and 3.6.14 and 3.6.15 for gravity plus pumping system for respective model area.

		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	DH1,303,000

		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

3.7.1 Construction of Facilities for Model Areas

(1) Scope of Works

On the basis of the extraction of groundwater equivalent to the water demand in the model areas and subsequent verification of affordability of the extraction in compliance with hydrogeological conditions, possibility of the groundwater extraction with the amount of 11.46 l/s at Ain Defali, 5.44 l/s at Teroual and 2.89 l/s at Ain Berda were confirmed. Preliminary design features of water supply facilities, taking into account of the above confirmation, are given in Table 3.7.1.

(2) Bill of Quantities

Major construction work items and the quantities are summarized as given in Table 3.7.2 for the proposed three model areas.

(3) Conditions for Construction Execution

1) Topography, Meteo-hydrology and Geology

Ain Defali is located in the province of Sidi Kacem approximately 120 km by road distance apart from Fes to the north-west, and relatively flat plain land with the altitude of approximately 200 m. Teroual is located in the province of Sidi Kacem at the north-north-west of Fes, 150 km apart by road distance, and hilly area with the altitude of approximately 400 m. Ain Berda is located in the province of Taounate at the north of Fes, 150 km apart by road distance and mountainous area with the altitude of approximately 1,000 m.

Regional distribution of average annual rainfall is 600 to 1,000 mm in the three model areas. Wet season continues for eight months from October to May and dry season continues for four months from June to September. Annual average temperature less varies depending on locations within a range of 18.3 °C to 20.5 °C, however, seasonal variation differs from 10.0 °C in January to 30.0 °C in July/August.

Marl is the main geological component with smooth and gentle topographic configuration. The land with greater relief and acute shape are often seen at the area where sand stone and lime stone are distributed. The following geological formation was confirmed during test drilling at the model areas.

Table 3.7.3 Geological Feature of Model Areas

Model area	Main Geological Component	Method of Drilling
Ain Defali	Gravel, pebbles and marl	Rotary Rig
Teroual	Sandy silty marl & sand and silt stone	Rotary Rig
Ain Berda	Marly limestone and schist	Rotary Rig

2) Infrastructure

For unloading and handling of imported cargoes, Tangier seaport will be used. The port situated in the northern peninsular of Morocco is equipped with a crane of 45 tons capacity to handle 20 and 40 ft containers. The distance between the port and Fes is 303 km via asphalt-paved national road, P28 and P38 which are well maintained by the Road Department of the Ministry of Public Works.

Nearest international airport to the model areas is in Rabat connecting major cities in Europe. The air port is 198 km apart from Fes by way of national road, P1 which is also well maintained. A domestic airport is available in the suburbs of Fes.

The existing access roads to the three model areas are well developed. The conditions of the roads are summarized in Table 3.7.4 below.

Table 3.7.4 Existing Access Road Conditions

Model Area	Route	Road Class	Road Condition	Condition of Maintenance
Ain Defali	P3	major	8.0 m wide, asphalt pavement	good
	P28	major	8.0 m wide, asphalt pavement	good
Teroual	P26	major	4.0 m wide, asphalt pavement	good
	2636	third	4.0 m wide, asphalt pavement	fair
Ain Berda	S302	secondary	4.0 m wide, asphalt pavement	good
	S304	secondary	4.0 m wide, asphalt pavement	good
	S305	secondary	4.0 m wide, asphalt pavement	fair
	Rural	(no class)	2.0 - 3.0 m wide, none pavement	very poor <1

Note <1 : Trafficability between Rhafsai and Ain Berda is poor.

Railway services are available between Fes and Taza, Tangier, Rabat and other major cities .

Existing public power lines of 22 kV/380 V run through the model areas. Telephone communication services are available both for international and domestic use at the model areas. At Ain Berda, only one set of public telephone is provided for common use.

3) Availability of Labor Force, Materials and Equipment

Skilled and semi-skilled labors can be mainly recruited in Fes, Meknes and Rabat. Common labors can be recruited in and around the model areas without seasonal variation.

Almost all of construction materials are locally available in the market of Morocco. Standard type of construction equipment such as cargo and dump trucks, excavator, loader, bulldozer, concrete mixer are also available by rental basis in Morocco. However, the following materials and equipment will be needed to import from abroad.

i) Submersible pump and motor
ii) Steel casing and screen
iii) Ductile iron pipe
iv) Mechanical valves
v) Distribution box and circuit breaker
vi) Electro-mechanical equipment

4) Local Contractor

Local contractors are in general conducting small to medium scale of construction projects having standard type earth moving equipment and transportation equipment. Local contractors have much experienced well development works, and some of them posses their own repair shop for equipment. However, those contractors occasionally come into trouble in operation due to shortage of equipment and spare parts.

(4) Construction and Procurement Plan

1) Mobilization and Preparatory Works

Mobilization and preparatory works will be required prior to commencement of works. These works are arrangement of equipment rental, labors, materials, access roads and others affecting the execution of construction works. Specially, an access road between Rhafsai and Ain Berda should be traficable conditions beforehand.

2) Main Construction Works

Major works required for each model area are broadly classified into 1) water extraction, 2) transmission pipe, 3) main distribution tank, 4) distribution pipe and tank, and 5) stand pipe. Submersible pumps and motors are installed for water extraction. Power will be conducted from the existing public power line carrier of 22 kV/ 380 V upon extension. A connecting tank and pump are equipped at well site in Ain Defali and Teroual due to topographic conditions. Galvanized steel pipes will be laid between the wells and main distribution tank. Main and distribution tanks are constructed of reinforced concrete. Galvanized steel pipes will also be used for the distribution pipes. Reinforced concrete made stand pipes are provided in the douars.

The construction works will be carried out by combination of mechanical equipment and labor force at three model areas concurrently. Transportation of materials, bulk excavation and concrete works will be carried out with small to light class equipment which are available by rental basis in Morocco. Pipe laying and appurtenant works will be carried out by labor force.

Major materials required for the construction works are concrete aggregates, cement, steel bars, fuel, lubricants, gravels, masonry stones and asphalt. These materials can be obtained in and around the site, Fes and Rabat.

3) Procurement of Pipes and Elect-mechanical Equipment

The following materials for the water supply facilities will be procured from offshore market. Import arrangement will have to be taken in an early stage after the contract agreement for smooth execution of construction works without idling times.

i) Submersible pumps, motors and appurtenant equipment
ii) Control panels and cables
iii) Galvanized steel pipes and fittings
iv) Water level sensors for main distribution tanks

(5) Construction Time Schedule

The construction works 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. It will be expected that the construction works will be commenced in the middle of 1997 after financial arrangement and execution of basic and detailed design on the model areas.

3.7.2 Rehabilitation of Existing Facilities

(1) Scope of Works

The following existing water supply facilities were planned to be rehabilitated together with the construction of planned water supply facilities in the model areas.

Ain Defali : 7 dug holes and 19 springs
Teroual : 1 dug hole and 23 springs
Ain Berda : 7 springs

Major items of rehabilitation works for dug holes are such as repair of walls of wells, roofing, covering, staging, installation of hand pumps, installation of drainage facilities, and appurtenant works. Rehabilitation works for springs are installation of concrete tanks, piping, roofing, concrete staging, installation of drainage facilities and other repair works.

(2) Rehabilitation Plan and Schedule

Rehabilitation works will be carried out by manual power in parallel with the construction of water supply facilities.

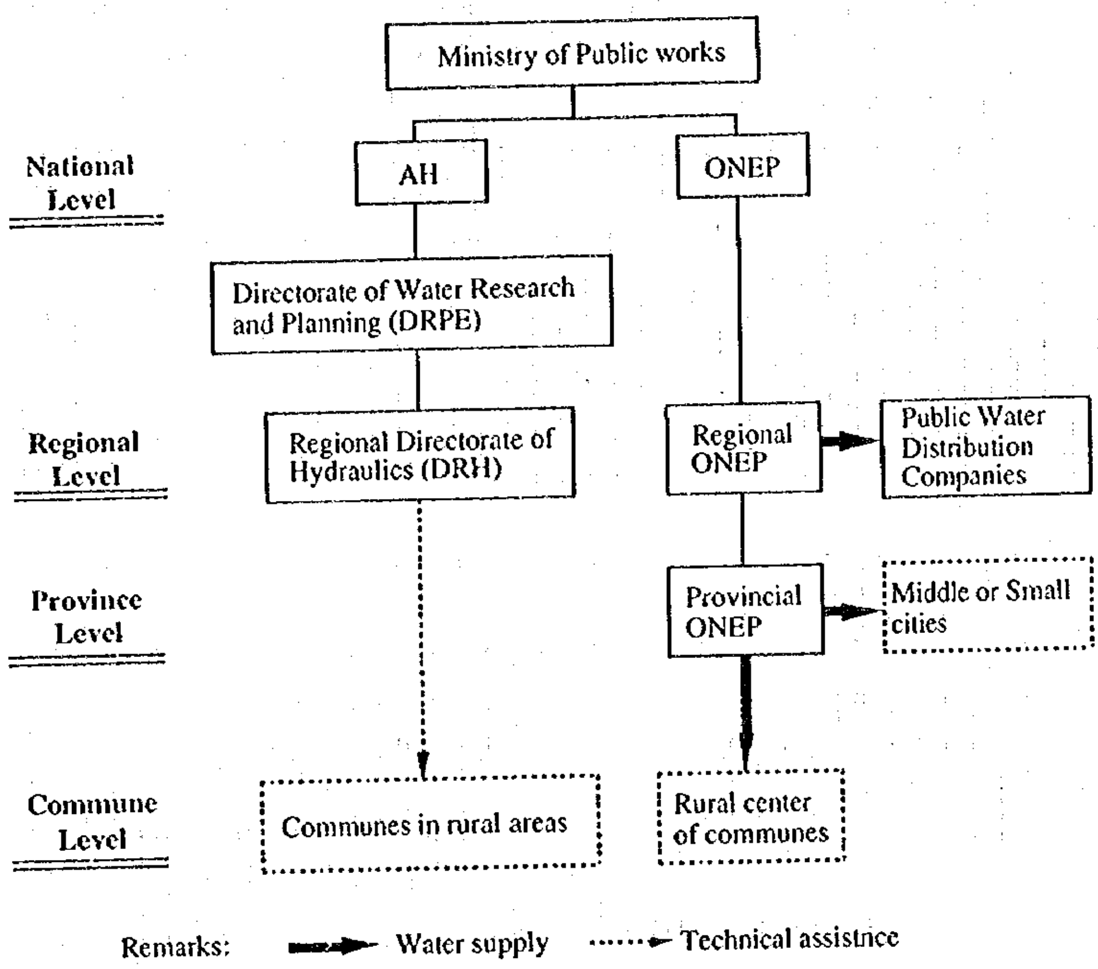
3.8 Project Evaluation

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 organizational structure of water supply systems in the country of Morocco is different by urban and rural areas. The following figure illustrates the framework of organizations concerning to water supply in urban and rural areas.

Figure 3.8.1 Organizational Structure of Water Supply



The urban water supply is operated by either public water distribution companies or provincial offices of the ONEP. Regional offices of the ONEP supply a bulk of water to distribution companies from which portable water is distributed to urban consumers. There are, at present, 16 public distribution companies operating in the major cities nationwide. Provincial offices of the ONEP are responsible for water supply in the middle or small size of cities located in capitals of provinces or circles.

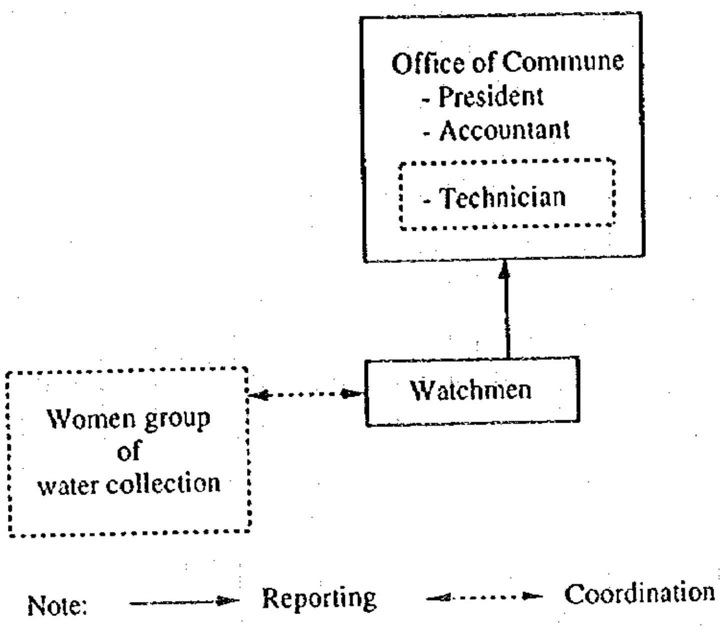
The rural water supply is operated by either independent systems controlled by provincial offices of the ONEP, or by communes themselves. Areas commanded by independent systems are primarily rural center of communes, whereas communes themselves operate water supply systems in isolated rural areas. The latter case needs technical assistance to communes (implementing bodies) in the fields of planning and design. The Regional Directorate of Hydraulics (DRH) is actually in charge of planning and design works of rural water supply projects. There are currently eight (8) regional offices of the DRH by basin nationwide under the Directorate of Water Research and Planning (DPRE). The Study area including the model areas is administered by the DRH located in Fes. The DRH of Fes commanding the entire Sebou river basin is responsible for identification of potential groundwater development sites and for design works of water supply facilities according to the request by communes. Communes are responsible for construction, and operation and maintenance.

(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. In general the offices of communes are engaged in various kinds of activities under the supervision of provincial government administered by the Ministry of Interior. Local staffs working for offices of communes are relatively trained and familiar to administrative tasks including accounting works. Accordingly the implementation of water supply project does not always need a special operation system in which staffs are to be recruited for the purpose of water supply business.

A simple system of site operation is desirable in order to sustain water supply management by communes in the model areas. The following figure shows the proposed structure of site operation in the model areas.

Figure 3.8.2 Organizational Structure of Site Operation



The above figure indicates that the office of commune performs an implementing body and local people participate in operation and maintenance. Both technician and women groups are the positions to be newly recruited. The roles of participants in water supply are considered to be as follows.

President	:	Overall management of site operation
Accountant	:	Budgeting / book keeping / water charge
Technician	:	O&M of water supply facilities
Watchmen	:	Monitoring of local people's water consumption
Women	:	Cooperative activities

As a stand-pipe was selected as the system of water supply in the model areas, both women and watchmen are mobilized from local people by water point of stand-pipe. The responsibilities of women to be involved in the cooperative works are as follows.

i) Establishment of time schedule for water collection, and
ii) Consultation with families having a handicap when collecting water.

Representatives of local women closely coordinate with watchmen whose daily work is monitoring of local people's water consumption. In particular, it is desirable to inform watchmen of time schedule for water collection. Accordingly it would not be difficult for watchmen to monitor water consumption of individual household.

Unlike house connection with a meter installed, a correct charge to local users according to portable water consumption is difficult to carry out in the system of a stand-pipe. Instead of a water-charge slip distributed to users, the office of commune is supposed to issue a user's member-card where installment on water consumption is periodically recorded. Users report the daily water consumption to the office of commune. Then the office requests each user to pay for the first installment calculated on the basis of daily consumption, given water tariff per m^3. The installment would be charged on the monthly or quarterly basis. Watchmen monitoring water collection of each user in the place of stand-pipe instruct users not to take water exceeding over their daily consumption reported. It is also the duty of watchmen to report technical and operational problem to the office of commune.

All the administrative tasks necessary for site operation will be done by the office of commune. An accountant is responsible for estimation of O & M costs, accounting of installment paid by users, and bookkeeping. Personnel expenses will be paid to both technician and watchmen.

3.8.2 Water Tariff

What level of water tariff will be charged to users is the key issue to sustain a sound operation and maintenance of water supply projects in the model areas. The criteria to determine water rate of an independent water supply system are 1) the existing water tariff charged by the ONEP, 2) cost recovery and 3) capacity-to-pay of local people.

(1) Existing tariff

The level of water tariff charged by the ONEP is substantially different by location and water consumption. The category of water tariff being similar to water supply in the model areas is the water charge to small demand centers in the range of quarterly water consumption from 0 to 24 m^3. The corresponding tariff per m^3 is about DH 2.1 as of October 1994. Due to cross-subsidy system water tariffs at small demand centers and in the Sahara provinces are virtually preferential. It is widely recognized that a small scale of water production can not exploit the economy of scale so as to reduce unit cost. Thus the water rate of small centers should have been set at higher level than the subsidized tariff (DH2.1 per m^3). The application of existing subsidized tariff to the model areas should be carefully made by taking into account the affordable payment of local people for portable water.

(2) Cost recovery

The methodology to estimate the water rate satisfying the principle of cost recovery is given below. The project costs are based on the water supply scheme consisting of gravity and pumping.

i) A planning time horizon is assumed to be 20 years considering economic life of water supply facilities.
ii) The cash flow of capital and O&M costs for 20 years is discounted by 12 percent to estimate the present worth of project costs.
iii) Water demand during the planning time (20 years) is also discounted by 12 percent to estimate the present worth of future consumption.
iv) The present worth of costs is divided by that of water demand in order to estimate water rates per m^3.

The water rates per m^3 based on cost recovery are tremendously high, DH 37.7 in Ain Defali, DH 41.6 in Teroual and DH 32.2 in El Bibane. The reasons for high water rates can be explained by low demand and high initial investment costs. Accordingly the application of cost recovery-based-tariff to an independent system in the model areas is virtually unrealistic.

(3) Capacity-to-pay

The following table shows the results of socio-economic survey with respect to the monthly household expenditures and capacity-to-pay for water in the model areas.

Table 3.8.1 Capacity-To-Pay for Water Consumption

Commune	Family Size (Person)	(1) Household expenditures (DH)			(2) Capacity-to-pay (DH)			(3) Ratio (%)			Average		
		R	M	P	R	M	P	R	M	P	(1) DH	(2) DH	(3) %
Ain Defali	6.0	1,896	1,770	1,026	113	61	20	6.0	3.4	1.9	1,524	61	4.0
Teroual	6.0	1,728	1,536	882	50	27	15	2.9	1.8	1.7	1,247	26	2.1
El Bibane	5.0	2,450	1,380	780	47	28	27	1.9	2.0	3.5	1,201	30	2.5

Legend: R -- Rich M -- Middle P -- Poor

Note: The term "Average" means the weighted average of respective expenditures by location in terms of distribution of social classes. The distribution of social classes in the model areas is as follows.

unit: %

Model area	Rich	Middle	Poor	Total
Ain Defali	29	33	38	100
Teroual	20	30	50	100
El Bibane	13	34	53	100

The weighted average of 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 as shown in Table 3.8.2. 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.

Table 3.8.2 Monthly Water Demand per Household

		Ain Defali				Teroual			
		95	2000	05	10	95	2000	05	10
1)	Domestic water								
	Consumption per capita and day (l)	20	23	27	31	20	23	27	31
	Family size (person)	6	6	6	6	6	6	6	6
	Monthly consumption (m^3)	3.6	4.1	4.9	5.6	3.6	4.1	4.9	5.6
2)	Livestock								
	Consumption per head and day (l)	3	3	3	3	3	3	3	3
	Nos of heads per family	8.5	8.5	8.5	8.5	5.1	5.1	5.1	5.1
	Monthly consumption (m^3)	0.8	0.8	0.8	0.8	0.5	0.5	0.5	0.5
3)	Monthly water demand (m^3)	4.4	4.9	5.7	6.4	4.1	4.6	5.4	6.1

		El Bibane			
		95	2000	05	10
1)	Domestic water				
	Consumption per capita and day (l)	20	23	27	31
	Family size (person)	5	5	5	5
	Monthly consumption (m^3)	3.0	3.5	4.1	4.7
2)	Livestock				
	Consumption per head and day (l)	3	3	3	3
	Nos of heads per family	2.8	2.8	2.8	2.8
	Monthly consumption (m^3)	0.3	0.3	0.3	0.3
3)	Monthly water demand (m^3)	3.3	3.8	4.4	5.0

Note: Water consumption of livestock per head and day was originally estimated to be 20 litters. About 15 percent (3 litters) is assumed to be taken from water supply facilities.

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. The results are not surprising because a small water demand pushes up the average water rate under the given conditions of capacity-to-pay. The sharp increase of water demand definitely pushes down water rate per m^3 on the contrary.

(4) Appropriate tariff

The characteristics of water tariff discussed in the preceding paragraphs are summarized as follows.

Criteria	Characteristics
Existing tariff	Application of the subsidized tariff (DH 2.1 per m^3) into independent systems would result in the far lower revenue than affordable expenditures for water. The low revenue makes it difficult to sustain a financial operation of independent systems in the model areas.
Cost recovery	Because of high initial capital costs, the water rate based on cost recovery is far beyond capacity-to-pay of local users. The introduction of recovery-based rate is unrealistic.
Capacity-to-pay	Water rates estimated seem to be high, but expenditure for water based on capacity-to-pay is in the range from 2 to 4 percents of household expenditures.

As a result, water rates based on capacity-to-pay are to be introduced into independent systems in the model areas.

3.8.3 Financial Evaluation

(1) Construction Period

The development plan of water supply in the model areas consists of two alternatives, 1) Gravity and Pumping systems, and 2) Gravity system. The construction period is assumed to be five (5) years from 1996 to 2000 for Gravity and Pumping, and three (3) years form 1996 to 1998 for Gravity only.

(2) Price escalation

Both project costs and water tariffs are estimated at 1995 price. Price escalation is considered for 5 year from 1996 to 2000. The escalation rates per annum are assumed to be as follows:

Local currency portion	:	6 % per annum
Foreign currency portion	:	2.9 % per annum

(3) Water Tariff

The water rate estimated on the basis of capacity-to-pay is tariff per m^3 valued at 1995 price. The tariff is estimated to be 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. The annual escalation rate (6 percent) is multiplied to the estimated tariffs at 1995 price in order to estimate the nominal value up to the year (2000). The results are as follows.

Table 3.8.3 Water Tariff per m^3

Unit: DH

Model Area	1995	1997	1998	1999	2000
Ain Defali	14.3	16.1	17.0	18.1	19.1
Teroual	6.5	7.3	7.7	8.2	8.7
El Bibane	9.2	10.3	11.0	11.6	12.3

(4) Financial Cash Flow

The financial cash flows on an annual basis are prepared for both revenue and project costs. The disbursement (portion) of project costs is assumed to be as follows.

	Gravity			Pumping	
	1996	1997	1998	1999	2000
Direct construction cost		50 %	50 %	50 %	50 %
Engineering services	30 %	50 %	20 %	50 %	50 %
Government administration	20 %	50 %	30 %	50 %	50 %

In the case of Gravity and Pumping, the construction plan consists of two stages. The first is the construction of water supply facilities by gravity system. The second is the construction of those by pumping system. In the case of Gravity system, the construction is confined to the first stage. The water supply development in El Bibane is Gravity system only.

Both price and physical contingencies are also taken into account as financial costs. Price contingency is 2.9 percent per annum for foreign currency and 6 percent per annum for local currency portions. Physical contingency is assumed to be 15 percent of total costs including price contingency. The operation and maintenance costs (O&M costs) are estimated as follows.

Unit: DH

Model Area	(1) Gravity system	(2) Pumping system	(3) Gravity + pumping
Ain Defali	494,500	302,800	797,300
Teroual	504,000	506,500	1,010,500
El Bibane	222,200	-	-

The disbursement (portion) of O&M costs is assumed to be as follows.

Water Supply Scheme	1997	1998	1999	2000
Gravity + Pumping	(1) x 50 %	(1)	(1) + (2) x 50%	(3)
Gravity only	(1) x 50 %	(1)		

Note : (1) --- O&M costs of Gravity system

(2) --- O&M costs of pumping system

(3) --- O&M costs of Gravity + pumping

Project revenue is estimated based on water tariffs (capacity-to-pay) and net water demand consisting domestic and livestock. The share of net water demand served is actually different by system. The share of net water demand by system is estimated on the basis of water supply area of two systems by model area. Those shares by model area are estimated as follows.

Model Area	(1) Gravity system	(2) Pumping system	(3) Gravity + pumping
Ain Defali	83 %	17 %	100 %
Teroual	50 %	50 %	50 %
El Bibane	100 %	-	-

The cash flow of project revenue is based on the above shares. The portion of project revenue is assumed to be as follows.

Water Supply Scheme	1997	1998	1999	2000
Gravity + Pumping	(1) x 50 %	(1)	(1) + (2) x 50 %	(3)
Gravity only	(1) x 50 %	(1)		

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 3.8.4 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 the 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 3.8.5 through 3.8.6.

(5) 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.

Financial source	Interest (%)	Crace (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 percent 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 3.8.7, net revenue turns out to be negative 2002 through 2007. But accumulation of net revenue during repayment period will 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, which are discussed in the sub-chapter of 3.10. The quantifiable effect is expected to be cost saving of water collection. The reduction of water collection cost depends on location of stand-pipes to be planned. Local people do without donkey or mule required for water collection in douars where stand-pipes are to be installed. Most of local people use animals for water collection on the rental basis. Accordingly rental costs would be saved in those douars. The number of population to be favored with free of rental costs is estimated in the following way.

Commune	Gravity + Pumping			Gravity only			Whole
	Affect population	Population served	Ratio (%)	Affect population	Population served	Ratio (%)	Population served
Ain Defali	9,945	20,188	49	8,210	16,760	41	20,188
Teroual	4,450	9,680	46	2,230	4,840	23	9,680
El Bibane	-	-	-	5,210	5,210	100	5,210

Note: Ratios mean the rate of affected population to the whole population served. The figures of population are those in 1975.

Gravity + Pumping

About 50 percent of the whole population served enjoys the benefit of transportation cost saving in Ain Defali and Teroual.

Gravity only

The population served is smaller in gravity system than in Gravity and Pumping system in Ain Defali and Teroual. Accordingly the ratios of affected population (beneficiaries) to the whole population served becomes lower, 41 percent in Ain Defali and 23 percent in Teroual. In El Bibane the whole population served enjoys the some benefit.

The costs of water collection per m^3 are estimated in the following way.

i) Seasonal times spent for water collection per day in summer and non-summer seasons are averagely estimated to be:

Unit: minutes

	Summer (3 months)	Non-summer (9 months)
Ain Defali	153	50
Teroual	54	25
El Bibane	66	20

ii) The seasonal average is weighted by seasonal period in order to estimate the yearly average, resulting in 75 minutes in Ain Defali, 33 minutes in Teroual and 31 minutes in El Bibane.

iii) Rental cost to use a donkey or a mule is conservatively estimated to be DH 300 per month.

iv) Assuming local people use such animals for 4 hours a day, the yearly average time per day spent for water collection corresponds to 31 percent (Ain Defali), 14 percent (Teroual) and 13 percent (El Bibane) of 4 hours respectively.

v) The ratios are multiplied by DH 300 in order to estimate the equivalent rental costs of animals for water collection, resulting in DH 93 in Ain Defali, DH 42 in Teroual and DH 39 in El Bibane.

vi) Rental costs of animals for water collection is divided by the monthly household water demand in Table 3.8.2 in order to estimate water transportation cost per m^3, resulting in DH 21.1 in Ain Defali, DH 10.2 in Teroual and DH 11.8 in El Bibane.

The following assumptions are made in order to estimate the reduction of water transportation costs due to implementation of water supply projects.

i) A full reduction of costs would be expected at douars where installment of stand-pipes is planned. A full reduction of cost would be realized for affected population to be favored with free rental costs. The ratios of affected population to the whole population served for both schemes of Gravity and Pumping, and Gravity only are estimated to be as follows.

Unit : %

Commune	Gravity + Pumping	Gravity only
Ain Defali	49	41
Teroual	46	23
El Bibane	-	100

ii) Local people would still need time for water collection at douars where stand-pipes are not to be installed. A 50 percent of cost reduction is assumed to be expected at those douars. The 50 percent of cost reduction would be realized for the population to be not favored with free rental costs. The ratios of such population to the whole population served for both schemes of Gravity and Pumping, and Gravity only are estimated to be as follows.

Unit : %

Commune	Gravity + Pumping	Gravity only
Ain Defali	51	42
Teroual	54	27
El Bibane	-	0

The water transportation cost per m^3 is multiplied by net water demand adjusted by the above ratios in order to estimate economic benefits. The annual full benefits (1995) are estimated given below.

Table 3.8.8 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

(3) Economic Cash Flow

The economic cash flows on annual basis are prepared for both benefit and economic costs. The following adjustments are made in order to estimate economic costs.

i) Value Added Tax (VAT) is deducted from financial costs.
ii) Price contingency is not taken into account since economic costs are valued at 1995 price.

iii) A conversion factor of 0.9 is applied to the local currency portion of direct construction costs and O&M cost.

Economic benefits are estimated based on net water demand and unit benefit (the reduction of water transportation cost per m^3).

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

Table 3.8.9 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 percent) but results in the marginal value. The other cases almost show no positive rate of return. The low EIRRs are partially attributed to the less number of affected population that would receive the full benefit, or partially caused by high economic cost. The economic cash flow of Ain Defali in the case of Gravity and Pumping is shown in Table 3.8.10.

3.8.5 Socio-Economic Impacts

Rural water supply has long been considered a tool for national socio-economic development and particularly as one of the significant policy instruments for rural development in many developing countries.

Rural water supply is expected to exert certain socio-economic impacts or potential impacts on households and local community as a whole. The magnitude of these impacts are heavily dependent on some preconditions in the model communes as follows:

i) Level of income and communes' budget
ii) Level of social infrastructure such as school, community meeting place, clinic,
iii) Level of education particularly with regard to local women, and
iv) Degree of agricultural production, small scale industrial (craft works) and commercial activities.

Impacts of rural water supply may be limited, unless these preconditions meet. As proved in many past instances in developing countries, rural water supply alone is unlikely to induce development and can be ineffective and costly. Thus rural water supply is not the sole factor to automatically trigger socio-economic development, thereby considered as one of the necessary conditions but not always sufficient condition.

With this in consideration, the socio-economic impacts which will be possibly induced by rural water supply are introduced below.

(1) Economic Impacts

Most profound impact brought about by rural water supply will be possibly the increase in agricultural production. Although water demand is estimated for domestic and livestock only, the abundant availability of groundwater would be used for agricultural production. The construction of small scale canals would revive the abandoned crops due to water shortage. Tobacco and com in Ain Defali, tobacco and vegetable in Teroual and vegetables in El Bibane are the candidate crops.

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. The majority of craft works are observed in Teroual and El Bibane. Those products are traditional clothes, table cloth, farming tools and kitchen instrument made of wood, and basket and tray making. They are desirable because of indigenous resource-oriented industries.

(2) Impacts on Household

Rural water supply unquestionably improves the working condition of local women and children who are engaged in the task of water collection. 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.

Rural water supply also improves the living condition of local people. According to socio-economic survey, water supply was placed as top priority in the model areas. It is clear that the living condition without water supply makes people inconvenience. The installment of stand-pipes makes it possible for people to take water several times a day whenever they want. Water collection near local residence undoubtedly enhance degree of convenience.

(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. This is particularly the case with Ain Defali where cooperative work of local women is envisaged during harvesting time. 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. The nature of cooperative work observed in Ain Defali could be effective for operation of rural water supply.

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 percent for Gravity and Pumping, 5.2 percent for Gravity only) would be financially sustainable for loan scheme consisting of external soft loan and the prevailing domestic fund from 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 results of economic evaluation reveal that all projects in the model areas are not economically viable. The undersirable outcome of EIRR can be explained as follows:

i) Economic benefit is confined to reduction of water transportation cost.

ii) Some douars are not able to receive the full economic benefit due to location of stand-pipes to be planned. Local people in those douars still require animals as mean of water transportation.

The extension of water distribution facilities would enhance economic benefit, but the additional costs would level off the resulting EIRR. Unit benefit (water transportation cost per m^3) more or less reflect the willingness-to-pay for water. But such benefit is estimated based on transportation cost without any consideration of condition for water collection. Perhaps the willingness-to-pay varies by location and season. At any rate, the resulting EIRRs are not the sole indicators to evaluate the projects.

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.

The justification of rural water supply projects is difficult both financially and economically unless the projects satisfy a certain scale of economy. Nevertheless, with mobilization of fund the projects in the model areas are proved to be operationable as operation and maintenance costs can be financial by project revenue. The most significant criteria to evaluate rural water supply project is the aspect of basic human needs. As long as water supply is demanded as top priority by local people the implementation of the projects is justifiable as it meets basic humand needs.

3.9 Water Quality and Environmental Impact Assessment (EIA)

The EIA of the water supply master plan components was carried out to determine impacts during and after construction and/or rehabilitation of water supply facilities. The EIA facilitates in identifying areas of action which are outside the scope of the master plan, and need to be addressed by other projects or programs. The EIA is restricted to the three model areas selected.

3.9.1 Water Quality of Existing Water Sources

(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. These included fifteen in Ain Defali, Four in Teroual and eleven in Ain Berda. 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. This phenomenon is common in the Pre-Rif region and is noted to be especially remarkable from the middle 1980s, causing severe depletion of surface and groundwater sources.

Table 3.9.1 gives the locations of the sampling sites. Table 3.9.2 presents the results of the water quality analysis. As seen in table , most of the parameters are seen to be within the maximum recommended values for drinking water. It must be noted that in case of some parameters which exceeded the recommended values, the level of water in the sampled dughole(s) was barely 10 to 30 cm. The inhabitants in the vicinity of such sampling sites in general do not use such water for drinking themselves, but for feeding domestic animals. They in turn travel long distances to collect clean 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. Possible causes for these could be human and animal fecal contamination of the shallow aquifer from nearby houses. Other possible causes include the open nature of all dugholes with no provision of covers exposing them to contaminants, and the buckets used for getting water from the dugholes themselves being the source of contamination. Only one sample as found in Ain Defali No. 8 was found to have very high salt content (483 mg/l).

(2) Exploratory Wells

The exploratory wells were drilled during the second field work stage. Out of 9 exploratory wells, 7 wells were successful in yielding groundwater. The quality and quantity were subsequently identified to be suitable as a whole for drinking purposes. Three samples in Ain Defali, two samples in Teroual and two samples in Ain Berda were obtained and tested for thirteen water quality parameters. The samples were collected from the exploratory wells at the time of the constant rate pumping test. Results are given in Table 3.9.3. 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. Results are presented in Table 3.9.4.

Table 3.9.4 Water Quality Test of Hydrogen, Heavy Oxygen and Tritium

Sample	δD (%)	$\delta^{18}O$ (%)	^3H (TR)
ADF1	-28.3	-5.7	<0.54
ADF2	-25.9	-5.6	<0.53
ADF3	-25.3	-5.3	2.0 ± 0.2
JBD2	-33.4	-6.8	<0.55
JBD3	-30.4	-6.0	7.8 ± 0.2
TRA2	-27.9	-5.7	6.3 ± 0.2
TRA3	-28.6	-5.4	7.0 ± 0.2

In accordance with the results of ^3H, 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. Whereas, the waters from ADF3, JBD3, TRA2 and TRA3 revealed that they were charged newly or they had ever contacted with tritium suspended in atmosphere due to some incidents.

While, the value of δD and $\delta^{18}O$ revealed that the water samples must have been obtained from groundwater without intervene and they might not have contacted with magma or certain type of rock which may change the characteristics.

3.9.2 Environmental Impacts

Environmental impacts during construction of water supply facilities (during construction) as well as environmental impacts (residual negative impacts and benefits) after construction (post construction impacts) are determined and elaborated upon collectively below.

(1) Social Environmental Impacts

1) Relocation and Resettlement Problem

The exploratory wells are located in the rural centers of Ain Defali, Teroual and El Bibane communes. Due to low population density around the well locations, no relocation or resettlement problems exist in compliance with the construction of well site facilities. Again, no relocation problems are expected for construction of transmission and distribution facilities, since distribution tanks and pumping facilities are mainly laid along the road and scattered housing areas.

2) Traffic

During the construction period, traffic volume may increase on the national roads and small access roads. However, the increase in traffic volume will neither bring about any traffic jam or other problems. Small access roads are mainly non-paved soil roads and frequent movement of vehicles may cause some nuisance to nearby residents. The increased movement of vehicles and people could be beneficial in stimulating residential activities, such as intensive movement of daily necessities and establishment of open markets.

3) 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 very important role in resolving water right issues.

4) Wastewater Disposal and Pollution Control

Domestic wastewater quantities can be expected to increase with the development of water supply systems and increased water consumption. Due to scarcity of water in the Study Area and kind of water supply facilities presently available in the Study Area (communal dugholes and springs), water consumption is quite low. Moreover, the existing wastewater disposal systems are very rudimentary, when they exist (dry latrines). The master plan envisages provision of standpipes in the concerned douars. The water supply master plan does not plan for provision of water carried waste disposal systems at the same time as providing water supply systems. 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.

There are no large scale industries in the model areas. There are some small scale olive oil factories. However their scale of production is very small and no significant pollution related problem is reported. Increase in domestic water consumption will have no effect in the wastewater generated by these factories.

5) Health, Sanitation and Water-bone Diseases

The existing condition of occurrence of water borne diseases such as cholera, diarrhea and typhoid for the entire Study Area is reported in the IEE in section 2.6. These were largely related to lack of hygiene and sanitation facilities, and inadequacy of disinfection of water sources. Precise data for the model areas concerning occurrence of water borne diseases are 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. Occurrence of water borne diseases should decrease if not disappear altogether. The implementation of an appropriate sanitation and health education plan as well as increased and regular disinfection of water sources is necessary, in addition to provision of water supply facilities.

(2) Natural Environmental Impacts

1) Water Courses and Water Pollution

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.

2) Landscape

No deterioration in landscape is expected to occur by the construction of water supply facilities, as the project scale is very small and is being carried out in rural areas.

3) Noise and Vibration

During the construction of the water supply facilities, some noise and vibration will occur. However, this is not expected to cause any nuisance to nearby population as the scale of construction is small and is to take place in rural areas.

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, preferably at least once every week if financial and manpower resources for monitoring and testing are limited. The deterioration of water quality is not only due to pollution of source water, but is also brought about by the occurrence of negative pressure in the pipes resulting in the suction of contaminated water from the surrounding soils.

(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. Elements of such a plan are presented in Section 4.4.4.

(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 own water resources independently of other agencies or institutions as is the case 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. An organizational structure proposed in this report is recommended for implementation. This organizational structure involves the office of commune (president, accountant, technician), watchmen in the douars and women involved in water collection.

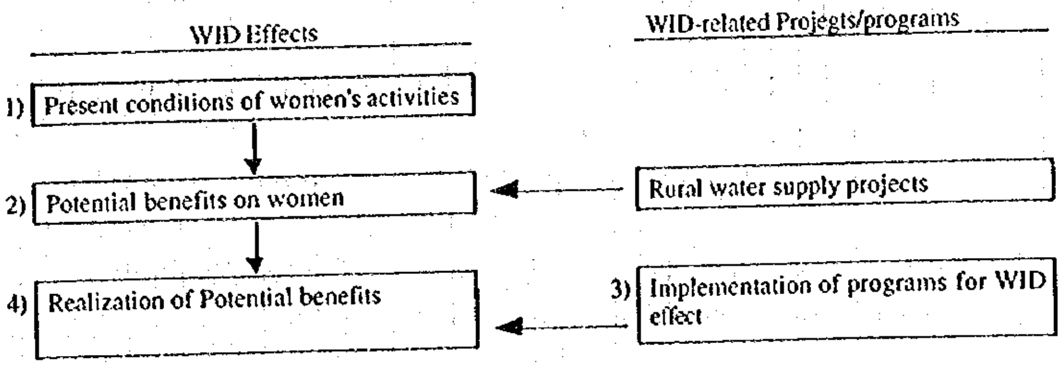
3.10 Women in Development

3.10.1 Methodology to Evaluate Women in Development

Women in Development (WID) is in general defined as a positive integration of women into social and economic development. To what extent a development project has a favorable effect on WID depends on social and cultural backgrounds, economic activities of women where a project is implemented. If WID is the primal objective the analysis of women's roles in social and economic activities would define the types of projects or programs to fulfill the purpose of WID. A development project is assessed to be efficient only if it is designed for needs of women.

The country of Morocco is characterized by the diversified socio-cultural aspects as well as traditional customs. Despite diversified features of douars by location, douars can be grouped into two categories. One is a douar not provided with basic infrastructure and necessary facilities. The other is a douar being already equipped with those facilities. In the former case, women spend a substantial part of their time for collection of portable water and fire wood. The high priority is placed on the basic human need such as water supply in a douar without such a social service. The provision of rural water supply facilities would greatly alleviate physical burden and time required to undertake the task of water collection done by women and children. Education and literacy are not considered essential until the family reaches a certain threshold of economic welfare. In the latter case, since women enjoy basic social services such as water and electricity supply, some WID-related projects carefully designed on the basis of their priorities would enhance social and economic status of them.

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.



The above figure illustrates how WID effects will be realized by showing the relation between WID effects and WID-related projects/programs. First of all, life and work of women is discussed to analyze present condition of their activities without water supply service. Second all conceivable potential benefits on women due to implementation of rural water supply projects are to be presented. The provision of basic human needs (water supply) would lead local women to potential WID-effects, but those effects would not be realized without specific programs. Thus thirdly some programs are taken into account on the basis of local women's priorities. Finally, implementation of programs for WID effect (realization of potential benefits) is discussed.

3.10.2 Present Conditions of Women's Activities

(1) Ain Defali

The agricultural works including livestock breeding constitute the major profession in the surveyed three model areas. Ain Defali is featured by vast plain fields where cereals such as wheat and barley are mainly produced. The farming practice for cereal production begins with weeding and plowing in winter season, seeding in spring, and harvesting and threshing in summer. 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 scarcity of water sources forces women to work much harder in daily activity. The distance to the near-by water sources ranges from one to four km on an average, depending on location. Some douars are located more than five km far from water sources. Time required for water collection is averagely in the range from one to two hours and correlates with the distance to water sources. In general, water collection including transportation is done by women and children in douars where the distance to water sources ranges from one to four km. Men are, on the contrary, the principal work force for water collection in douars from which the near-by water source is far away. The recent drought occurred in 1994 forced local people to be engaged in inter-douar movement for water collection. In particular poor women became a victim of such a drought as they had to walk for a long distance by carrying small plastic containers. However, thanks to flat topographic condition, physical burden on women by water collection is considered to be less severe than in mountainous areas.

Local women are particularly busy at the time of harvesting. Most of farm households employs agricultural labors and even women resident in urban areas at the time of labor shortage because of harvesting in vast areas. Women were reported to work more than ten hours a day, so that water collection really puts them on hearty burden. Under such circumstance local women are relatively trained to take an organized actions such as a collective baking bread and even water collection.

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. The lower ratio in Ain Defali is assumed to be caused by the fairly constant agricultural income. Thus the migration of men for job seeking elsewhere is relatively lower than in El Bibane locating in mountainous area. Responsibilities are, in general, much heavier for women heads of households than women living with husbands. The daily activities of women tends to be taken for their survival in the case of women heads of households. In this respect, local women in Ain Defali are relatively placed in the more favored condition than in other model areas.

(2) Teroual

Located in hilly area, the holding size of farm land per household is small, resulting in a small scale of farming. Hilly lands are mostly utilized for olive tree growing. The other crops such as cereals and legumes are produced to the lesser extent. 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. Because of plant disease or water shortage, some crops were already abandoned. Agricultural income is not so sustainable that men tend to migrate elsewhere for job seeking. Local women left at farm home feel responsibility to sustain their livelihood for survival. Thus they do not perform collective actions envisaged at the time of harvesting in Ain Defali, rather their activities are independent. The crafting work such as traditional cloths and coversheets made by local women are marginally observed in some douars.

Water points in Teroual are located relatively close to the douars where more than a half of the population collect water at a distance less than one km. 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). Time spent for water collection is almost less than one hour. Despite the short distance to water points the rugged nature of terrain makes it difficult for women to collect portable water. Accidents frequently occur because of slippery soil condition. In order to overcome this problem, local women collect raw water for house activities. Women's desire to escape from the heavy task of water collection sometimes precedes over their sanitary sense to use clean water.

(3) El Bibane

Agriculture in El Bibane located in mountainous area is featured by sloping farm. The production of major crops such as cereals, legumes, fruits and olive is substantially small compared to the other model areas. In order to earn the sustainable level of agricultural income local farms have to cultivate variety of crops. Local women are seasonally involved in various activities such as cereal harvesting, collection of fruits and olive, and livestock grazing. The marked feature of social condition in El Bibane is represented by high percentage of women heads of household. The rate is about 28 percent higher than in the other model areas. 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. Nevertheless, because of few chance to be hired as labors some women heads of households also go to urban areas for job seeking. In general, the poor families resident in mountainous area tend to migrate to urban areas because to make a livelihood in living area is extremely difficult. In this respect, life and activities of poor women are not rooted in indigenous area.

About a half of population collect water at a distance less than one km, whereas the rest at a distance ranging from one to four km. Time spent for water collection extends to two hours in summer, but less than one hour in winter. Steep slopes to water points make it really tiresome for women to transport portable water. In fact, children especially girls are the major work force for water collection. In general water collection and transportation is carried out by women and children together, but children of the poor families do those tasks by themselves. The involvement of children in entire task of water collection is often observed in El Bibane. In this sense, the poor women are virtually helped by children regarding to water collection.

3.10.3 Potential Benefits on Women

Owing to the scarcity of water resource in the model areas, water use by local people relies on spring, dugholes and the near-by surface water. 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. However a careful analysis is needed to estimate such potential benefits on them. Firstly potential benefits expected might be different by nature. The benefits by nature are largely classified into economic and social categories. Secondly those benefits are to be different by beneficiaries (i.e. women or children) and season. The estimation of benefits should be carefully made on the basis of present conditions of women's activities in the model areas.

The following table presents the summary of potential benefits expected.

Table 3.10.1 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.

The potential benefits including negative items shown in Table 3.10.1 is regarded as indirect effect to be expected due to implementation of water supply projects. The positive economic benefits are assumed to be derived from availability of water or saving of time for water collection. Productive use of saving time for non-agricultural activities may be only expected at non-harvesting time. Because it is difficult for women to make the effective use of saving time for another activity during the busy time of harvesting. Some local women would lose the opportunity to work as labors at harvesting time since time to be saved does without them in order to harvest cereals. Poor women without any opportunity to work as labours in indigenous area (i.e. El Bibane) would seek jobs outside because it is no necessary for children to do the task of water collection in place of women.

The nature of social benefits is more or less attributed to the characteristics of the model areas. The possibility of women to be involved in management of water supply will be only expected in Ain Defali as women have already been trained to take a collective action at the harvesting time. Women heads of households might be a little reduced in Ain Defali or Teroual as the scale of agricultural production indicated by the holding size of farm land would guarantee poor women additional agricultural income. The enhancement from subordinate position to the more positive involvement in social activities can be expected in the case of non-poor women because their daily activities are not constrained by economic condition such as the survival level of income. The provision of water supply facilities would equally bring women the sense of improving hygienic conditions in the model areas.

Children will be also beneficiaries due to the availability of water supply services. The improvement of attending rates in schools is directly derived from saving of time spared for water collection. But children of poor families might be forced to send their life without parents in El Bibane where agricultural income is not the sustainable level.

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.

A disregard for the above criteria would probably fait to implement projects or programs formulated, resulting in no expectation of benefits. 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 3.10.2 Programs to Realize Potential Benefits

Benefit Items	Criteria 1)	Criteria 2)	Criteria 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)

The program (i) to realize the benefit item (a) have already been implemented. The Ministry of Agriculture and Agricultural Development so far established 170 Development Centers and 120 Work Centers nationwide. There are in total about 3,000 technicians being engaged in agricultural extension services. These institutions are located in Had Kourt of the province Sidi Kacem and Rhafsai of Taounate. However, the lesson from such an existing program recently identified that a real obstacle to women's involvement in agricultural production is proprietary rights of farm land controlled by men. Accordingly the National Bank of Agricultural Credit created a special credit facility to be utilized for women who wish to cultivate a variety of crops. Such a credit system was actually reported to be successful in the region of Khemisset.

It normally takes time to realize the program (ii), productive use of time for non-agricultural activities. The most realistic way to promote this item is the development of crafting products already manufactured by local women in Teroual and El Bibane. Training of crafting works will be necessary for women who do not get skill of such works. The more dynamic way to facilitate women's role in economic activities is the establishment of agricultural cooperatives for poultry or livestock breeding. So far more than 20 agricultural cooperatives have been established nationwide. But both low rate of women's literacy and a subordinate status of them would be a real constraint to such activities.

Financial assistance to poor families, the program (iii) is supposed to be the most practical tool to prevent negative benefits of (c) and (d). At present the use of local budget in the form of subsidy is only confined to financial assistance to local people suffering from disasters. If such a subsidy system is extended to the reduce inequality of income distribution, poor women corresponding to the items of (c) and (d) would be greatly helped. The difficulty is the budget constraint of local government under control of the Ministry of Interior.

The benefit item of (f) is one of social benefits which can be expected most. Perhaps local women's participation in operation of rural water supply in Ain Defali would not be so difficult as they have been trained to take a collective action at the harvesting time. The key issue will be what kind of role women are able to play in water supply management. The responsibilities of women are not the fields requiring a substantial level of education, but those needing cooperative manner. The examples of the latter responsibilities are:

i) Establishment of time schedule for water collection,
ii) Consultation with families having a handicap when collecting water,
iii) Formation of information network to report technical and operational problems to a management body, and
iv) Collection of water charge provided that water tariff is charged to users.

In order to do so, some representatives of women should be grouped into an association where they will be required to discuss the above responsibilities.

The objective of the programe (vi) is the improvement of social status of women. Whether or not the creation of a women club will be successfully implemented is attributed to a cooperative movement of women discussed in the preceding paragraph. Women should begin with recognition of the subordinate position in society. The establishment of a women organization is certain to empower them to make men comprehend their rights.

The reduction of women heads of households would depend on the successful execution of the programs (iii). Provided that poor families get chances of receiving financial subsidy, the migration of men elsewhere for job seeking would be reduced. Accordingly women are able to concentrate on their household duties and economic activities. To alleviate the responsibility of women being heads of households would also contribute to improvement of their social status, the benefit item of (g). But women head of households would not decrease in the case of poor women whose agricultural income is on the threshold of survival level, observed in El Bibane.

A program to realize social benefit of (i) normally takes the form of the proper guidance for public hygiene to women. The Ministry of Public Health is the appropriate agency to guide women in improvement of hygienic condition. The dissemination program for public hygiene is desirable to be as easy as possible to women whose rate of literacy is substantially low at present. The use of picture in programs would be powerful to make women understand how water-borne diseases break out. Perhaps women sense of public hygiene will improve step by step.

To make parents understand how important education is for children is not an easy task because children are regarded as a part of work force. Thanks to the government decree issued in 1991, education in primary school become the compulsory service. Parents take the responsibility for accomplishing the compulsory service of children. It is not clear whether the guidance for importance of education to parents would directly improve children's attending rate of school or not, though a continuous program in the from of dissemination is desirable to change parent's attitude toward education.

3.10.5 Implementation Programs for WID Effect

Each program shown in Table 3.10.2 presents criteria and constraints to be taken into account in order to implement it. Some programs correspond to none of the three criteria established. The effect of them on WID would not be sustainable as the implementation of them does not entail a mobilization of indigenous resources including local people. Beneficiaries consisting of women and children can not help being passive. The other programs satisfying the criteria have the possibilities of the favorable effect on WID. The nature of constraints is characterized by either a customary practice or the prevailing conditions surrounding local women. These constraints should be considered to be the given conditions. Otherwise the formulation of programs disregarding the prevailing constraints would fail to have the positive effect on WID.

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 3.10.1 shows the step-wise implementation of programs for WID effect.

Figure 3.10.1 Step-wise Implementation Programs for WID Effect

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

(1) Households more than threshold income

Local women of households more than threshold income generally can afford the time for training programs of new economic activities. Time frame of programs' implementation is divided into the short and middle terms. In the short-term, the programs of (i) and (ii) to realize potential benefits of (a) and (b) would simultaneously contribute to the benefit of (j). This is because children will be no longer regarded as the work force due to enhancement of household income. In the middle-term, the programs of (v), (vi) and (vii) will be implemented to realize potential benefits of (f), (g) and (i). At this stage, an integration of women into society can be attained to some extent.

(2) Households less than threshold income

Local women of households less than threshold income can not afford to participate in training programs. Time frame of programs' implementation is divided into three stages, the short, middle and long terms. In the short-term, the program of (iii) will be implemented to compensate for household income of poor families. The living conditions of them would improve to some extent as to the benefit items of (c), (d), (h) and (d). In the middle-term, the programs of (i), (ii) and (viii) will be implemented to realize potential benefits of (a), (b) and (j). The programs of (viii) would be necessary to change parent's attitude toward importance of education. In the long-term, the programs of (v), (vi) and (vii) will be implemented to realize potential benefits of (f), (g) and (i).

As shown in Figure 3.10.1, it takes time to fulfill an integrated effect of WID. In order to make the successful implementation of programs, the followings are to be made clear.

i) Quantitative definition of threshold income,
ii) Analysis of preceding WID-related programs, and
iii) Financial capacity of local government for allotment of subsidy.