No.

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DIRECTORATE GENERAL
OF AGRICULTURAL ENGINEERING
MINISTRY OF AGRICULTURE
REPUBLIC OF TUNISIA

THE DETAILED DESIGN STUDY
ON
THE RURAL WATER SUPPLY PROJECT
IN
THE REPUBLIC OF TUNISIA

FINAL REPORT

VOLUME I MAIN REPORT

MARCH 2001

NIPPON KOEI CO., LTD.
TAIYO CONSULTANTS CO., LTD.

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ESTIMATE OF PROJECT COST

Estimate of Base Cost：As of December 2000 Price Level

Currency Exchange rate：US$1.0 = 1.384TD = JP¥114.75

LIST OF VOLUMES

VOLUME I **MAIN REPORT**

VOLEME II **SUPPORTING REPORT**

VOLUME III **RAPPORT DE CONCEPTION DÉTAILLÉE**

ARIANA	**FAIDA EL AMRINE-SIDI GHRIB**
ARIANA	**HMAIEM ESSOUFLA**
ARIANA	**TYAYRA**
BEN AROUS	**OULED BEN MILED-OULED SAAD**
BEN AROUS	**SIDI FREDJ**
NABEUL	**SIDI HAMMED**
ZAGHOUAN	**JIMLA**
ZAGHOUAN	**ROUISSAT BOUGARMINE**
BIZERTE	**SMADAH**
BIZERTE	**TERGULECHE**
BEJA	**EL GARIA**
BEJA	**EL GARRAG**
BEJA	**FATNASSA**
JENDOUBA	**CHOUAOULA**
JENDOUBA	**COMPLEXE AEP BARBARA**
LE KEF	**CHAAMBA-O.EL ASSEL-HMAIDIA**
LE KEF	**M'HAFDHIA-GHRAISSIA**
KAIROUAN	**CHELALGA**
KAIROUAN	**GUDIFETT**
KAIROUAN	**HMIDET**
KAIROUAN	**ZGAINIA**
KASSERINE	**DAAYSIA**
KASSERINE	**HENCHIR TOUNSI**
KASSERINE	**OUED LAGSAB**
KASSERINE	**SIDI HARRATH-GOUASSEM**
SIDI BOUZID	**AMAIRIA**
SIDI BOUZID	**BLAHDIA**
SIDI BOUZID	**BOUCHIHA**
SIDI BOUZID	**MAHROUGA**
MAHDIA	**COMPLEXE BOUSSLIM**

MAHDIA	**COMPLEXE AITHA**
GAFSA	**HENCHIR EDHOUAHER**
GAFSA	**KHANGUET ZAMMOUR**
GAFSA	**THLEIJIA**
GABÉS	**BATEN TRAJMA**
GABÉS	**CHAABET EJJAYER**
GABÉS	**EZZAHRA**
MEDENINE	**BOUGUEDDIMA**
MEDENINE	**CHOUAMEKH-R.ENNAGUEB**
MEDENINE	**ECHGUIGUIA**
MEDENINE	**TARF ELLIL**

VOLUME IV ÉBAUCHE DES DOCUMENTS D'APPEL D'OFFRES

GOUVERNORAT ARIANA
GOUVERNORAT BEN AROUS
GOUVERNORAT NABEUL
GOUVERNORAT ZAGHOUAN
GOUVERNORAT BIZERTE
GOUVERNORAT BEJA
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GOUVERNORAT LE KEF
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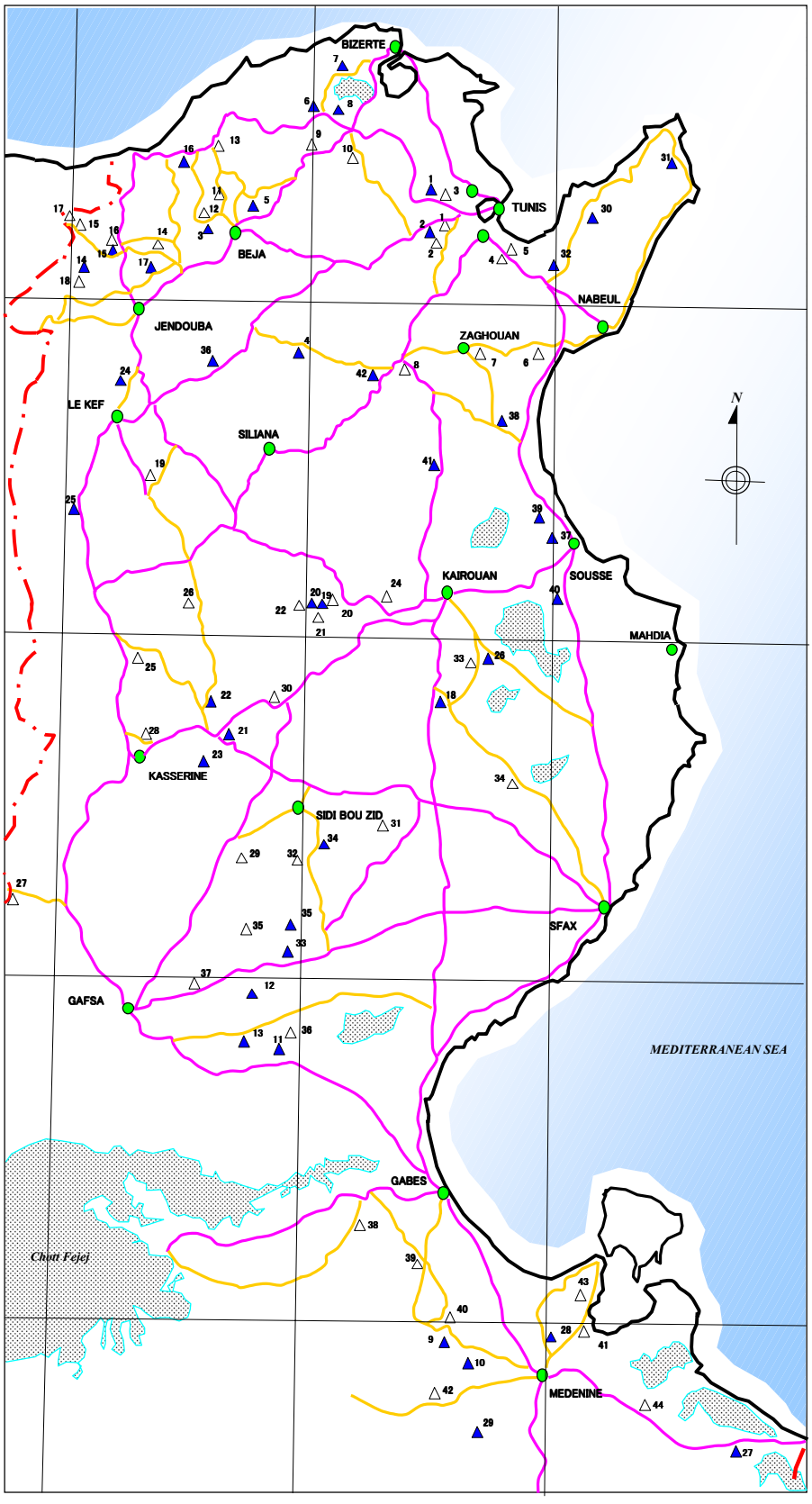
GOUVERNORAT KASSERINE
GOUVERNORAT SIDI BOUZID
GOUVERNORAT MAHDIA
GOUVERNORAT GAFSA
GOUVERNORAT GABÉS
GOUVERNORAT MEDENINE



Project 2001

1 FAIDH EL AMRINE-SIDI GHRIB
2 HMAIEM ESSOUFLA
3 TYAYRA
4 OULED BEN MILED and OULED SAAD
5 SIDI FREDJ
6 SIDI HAMED
7 JIMLA
8 ROUISSA/BOUGA
9 SMADAH
10 TERGULECH
11 EL GARIA
12 EL GARRAG
13 FATNASSA
14 CHOUAOULA
15 JOUAOUDA1/ BATTAHA
16 MAALIM
17 OULED DHIFALLAH
18 SIDI SALAH
19 CHAAMBA - O.EL ASSEL - HMAIDIA
20 M'HAFDHIA - GHRAISSIA
21 CHELALGA
22 GUDIFETT
23 HMIDET
24 ZGAINIA
25 DAAYSIA
26 HENCHIR TOUNSI
27 OUED LAGSAB
28 SIDI HARRATH - GOUASSEM
29 AMAIRIA
30 BLAHDIA
31 BOUCHIHA
32 MAHROUGA
33 COMPLEXE BOUSSLIM
34 COMPLEXE EL ALTHA
35 HENCHIER EDHOUAHER
36 KHANGUET ZAMMOUR
37 THLEIJIA
38 BATEN TRAJMA
39 CHAABET EJJAYER
40 EZZAHRA
41 BOUGUEDDIMA
42 CHOUAMEKH - R. ENNAGUE B
43 ECHGIUIGUIA
44 TARF ELLIL

Project 2000

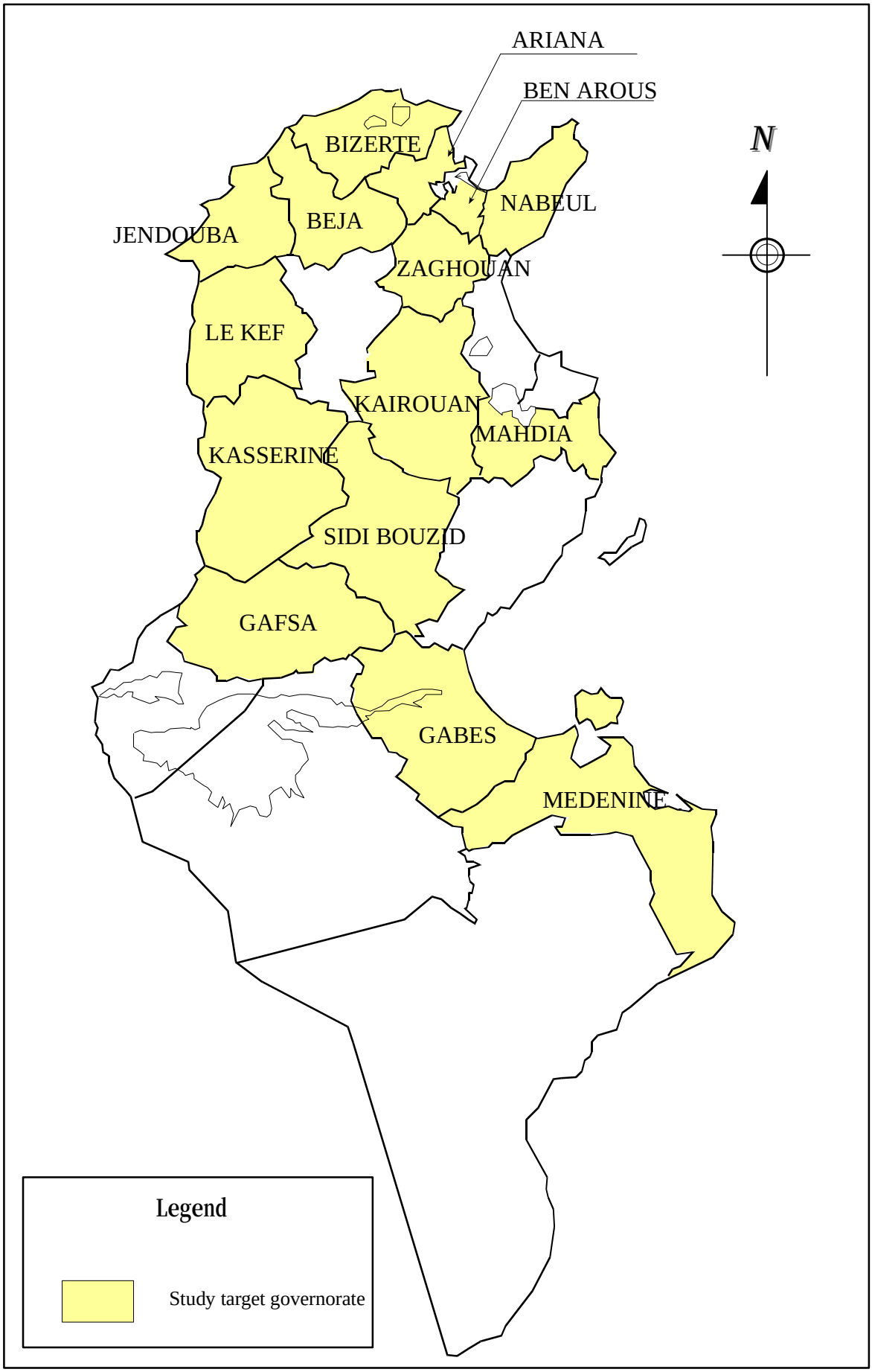
1 GUECHBA
2 BIR TOUIL OUEST
3 CHOUABIA
4 EL MATRIA et OULED MARAI
5 NOUAICHIA - SOUALA
6 BORDJ STILI
7 DOUIMIS
8 SIDI MANSOUR
9 LADBECHE
10 CHEGUIME
11 SHAILIA
12 TAFARTAST
13 SKAKRIA
14 EL BELDA
15 JAHFA
16 AIN TRARIB
17 BELDIA
18 GARAAT TEBAL
19 STALIA
20 ATTAYETT - OULED AMOR
21 BOUKHIL
22 KSAR TOUIL
23 O.KMIM/RAKHMET
24 AIN EL HENGHIR - TEL EL CHOZLA
25 AIN BABUCHE
26 BIR ESSID
27 BOULEK TIFET
28 BEDOUI
29 DIR HOUIA
30 EL GHAZALIA
31 HARET CHAARAA
32 EL BHIRA
33 BANAJDIA
34 GASSAIRIA
35 MALOUSSI/GALLEL
36 OUED ELLOUZ
37 SABBAGHINE
38 O.MHAMED
39 OUARRAD
40 OULED ALI
41 DHORBANIA
42 KEF LAZREG

LEGEND

Project 2000
Project 2001
City
Trunk road
Sub road

SCALE 0 10 20 30 40 50 km

Subprojects Location Map



Study Target Governorate Location Map

PREFACE

In response to a request from the Government of the Republic of Tunisia, the Government of Japan decided to conduct a study on the Detailed Design Study on the Rural Water Supply Project in the Republic of Tunisia and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA selected and dispatched a study team headed by Mr. Masato Fujinami of Nippon Koei Co., Ltd. to Tunisia between February and December 2000.

The team held discussions with the officials concerned of the Government of Tunisia, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Tunisia for their close cooperation extended to the Study.

March, 2001

Kunihiko Saito
President
Japan International Cooperation Agency

March, 2001

Mr. Kunio Saito
President
Japan International Cooperation Agency
Tokyo, Japan

LETTER OF TRANSMITTAL

Dear Sir,

We have the pleasure of submitting to you the Final Report of "The Detailed Design Study on the Rural Water Supply Project in the Republic of Tunisia", in accordance with the Scope of Work agreed upon between the Directorate General of Agricultural Engineering and Japan International Cooperation Agency (JICA).

The study was conducted by Nippon Koei Co., Ltd., and Taiyo Consultants Co., Ltd, under a contract to JICA, during the period from February 2000 to March 2001, aiming to prepare the detailed design and the tender documents of the Project 2001 while reviewing detailed design of Project 2000 in Rural Water Supply Project agreed on between the Japan Bank International Cooperation (JBIC) and the Government of the Republic of Tunisia.

In conducting the study, we have examined the project with due consideration to the present situation of Tunisia and formulated the appropriate detailed design for the project under Japan's project loan scheme. The study team sincerely hopes that the report would contribute to the implementation of the rural water supply project in Tunisia.

We wish to express our deep appreciation and gratitude to the personnel concerned of your Agency and Office in Tunisia, the Embassy of Japan in the Republic of Tunisia, as well as officials concerned of the Government of the Republic of Tunisia.

Sincerely yours,

Masato Fujinami
Team Leader
The Detailed Design Study on the Rural Water
Supply Project in the Republic of Tunisia

THE DETAILED DESIGN STUDY ON THE RURAL WATER SUPPLY PROJECT IN THE REPUBLIC OF TUNISIA

SUMMARY

1. Background of the Study

The Government of Tunisia (GOT) requested the Government of Japan (GOJ) to extend an ODA loan for water supply facilities at 119 subprojects in 19 governorates within 541 subprojects. In response to the official request from GOT, the Overseas Economic Cooperation Fund "OECF" (present Japan Bank for International Cooperation: "JBIC") dispatched a Special Assistance for Project Formation (SAPROF) Team in January 1999.

The SAPROF Study finally selected 86 subprojects to be subjected to JBIC loan and also proposed to GOJ to request a Detailed Design Study of 44 subprojects among 86 subprojects by Japan International Cooperation Agency (JICA) to GOJ.

Based on the proposal, GOT requested GOJ to conduct the Detailed Design Study on the Rural Water Supply Project (the Study) in August 1999 and GOJ decided to dispatch a JICA Preparatory Study Team to prepare the Scope of Works for the Study. The JICA Preparatory Study Team and GOT discussed the operation of the Study and signed the Scope of Work for the Study on November 4, 1999.

2. Objectives of the Study

The objectives of the Study are as follows:

(1) To prepare the detailed design and the tender documents for 44 subprojects called "Project 2001",

(2) To review the detailed design for 42 subprojects called "Project 2000, and

(3) To pursue technology transfer to the counterpart personnel in the course of the Study.

3. Study Area

The Study covers 86 sites in 17 governorates of Tunisia shown in Location Map. The population to be supplied water by the Project is 53,849 persons.

4. Contents of the Study

The Study covers:

(1) Review of the Studies for the Project 2000

(2) Basic Study (Subcontracting Work)
   1) Preliminary Study
   2) Data Collection and Water Demand Projection
   3) Water Quality Survey
   4) Topographic Survey
   5) Geotechnical Survey
   6) Formulation of Projected Water Supply System
   7) Sensitization Program
   8) Preliminary Design
   9) Financial Analysis
   10) Preparation of Draft Basic Study Report on Each Subproject (French Version)

(3) Environmental Study and Socio-economic Impact Study

(4) Preparation and Submission of Basic Study Main Report (English and French Version)

(5) Detailed Design (Subcontracting Work)
   1) Detailed Design
   2) Preparation of Detailed Design Report and Draft Tender Documents on Each Subproject (French Version)

(6) Preparation, Submission and Discussion of Draft Final Report (English and French Version)

(7) Preparation, Submission of Final Report

The basic study and detailed design were subletted to the local consultants and the JICA Study Team supervised the works and reviewed the outputs.

5. Organization of the Study

The Directorate General of Agricultural Engineering (DGGR) of the Ministry of Agriculture is responsible for the Study. The Department of Rural Potable Water (EPR) in DGGR and also District Agricultural Engineering Office (AGR) of every Regional Directorate General for Agricultural Development (CRDA) are actual counterpart organizations for the JICA Study Team.

6. Review Results of Project 2000

Each CRDA started the studies on the subprojects under the Project 2000 in 1999. Due to delay of the design works, the basic study of 25 subprojects, the detailed design of 24 subprojects, and the tender documents of 20 subprojects have been completed as of April 2000. Those documents were reviewed by the JICA Study Team in view of water demand projection, hydraulic calculation, financial analysis and unit prices. It was confirmed that no problems on the implementation of the subprojects of the Project 2000 were found.

7. Basic Study

Prior to the detailed design, the basic study consisting of water demand projection, water quality analysis, sensitization works, preliminary design, financial analysis, etc. was carried out in order to confirm feasibility of each subproject.

(1) Preliminary Study

The preliminary study was conducted to confirm the technical and economical soundness of each subproject. After the study, Sidi Sarah subproject in Jendouba was cancelled because the investment cost per beneficiary exceeded 550 DT. Marthoum Maja subproject in Kasserine was also cancelled because the beneficiaries have misunderstood the purpose of the project as irrigation water supply, and it was replaced by Henchir Tounsi subproject.

Further, three subprojects of Jouaouda1/Battaha, Maalim, and Ouled Dhifallah using the same water source of the Barbara dam were planned to be integrated into one project called Complexe AEP Barbara subproject.

As a result, 41 subprojects were subjected to the further study.

(2) Water Quality Survey

Among 44 original water sources, water quality analysis was carried out for 26 water sources which consist of one dam, two springs, 16 deep tube wells, 6 GR extensions and one untreated water source of SONEDE connection (refer to Table 4.2.3). Total Dissolved Solids (TDS) range between 199 mg/L and 1,845 mg/L, which are within allowable range of the guideline for drinking water of Tunisia. Water sources in the southern area were found to have rather high concentration of hardness, chloride and sulfate, while pH indicated from neutral to alkalinity property.

Twelve out of 26 water sources do not partly meet the national guideline values for drinking water. Though the final decision on the realization of each subproject shall be made by DGGR. It is not recommended to use water from such water sources, and especially the water sources containing Lead (Pb) exceeding the allowable limit shall not be used for drinking purpose.

(3) Topographic Survey

The topographic survey was conducted to prepare the pipeline route profiles and topographical maps of the facilities such as reservoirs, pump stations, and water purification plant.

The centerline survey for pipeline routes was carried out for 581km in total. The permanent benchmarks were placed at the beginning point, projected branching points, all service points and the center point of each installation, traverse points and end points. The topographic mapping is carried out for the area of 27,250m^2 in total. The pipeline route profiles were prepared with a horizontal scale of 1:2,000 and vertical scale of 1:100~200. The topographic maps were prepared with a scale of 1:100~200.

(4) Geotechnical Survey

Bore holes were drilled at six sites and test pits were dug at 201 sites for the Study.

According to the standard penetration test, the foundations of all subprojects sites have N-values of more than 50 within a depth of 5 m. No pile foundation is required for every site. Groundwater does not appear within 15m deep at the Complexe AEP Barbara 1 and 2 in Jendouba, Henchir Tounsi in Kasserine and Complexe Bouslim in Mahdia, while it was found at a depth of 7.0m at Thleijia in Gafsa and 6.0m at Tarf Ellil in Medenine.

According to the test pit logs, rock foundation appears around 10 to 20% of pipeline route. As pH values range between 6.9 and 7.6, the pipes will not be affected by corrosion. The electrical conductivities at Henchir Edhouaher, Thleijia, Baten Trajma, Bougueddima, and Tarf Ellil exceed 2,000 μS/m. In case of adopting ductile pipe for those areas, an appropriate protection method around the pipe may be required.

(5) Socio-economic Impact Survey

The socio-economic impact survey was carried out in order to grasp if the project has any socio-economic impacts on the governorate and the GIC, by comparing the socio-economic conditions before and after the project implementation. Nabeul was selected as a representative urban area and Sidi Bouzid as a representative rural area to analyze the macro aspects of the area based on the rural population share. As for the micro aspects, 4 GIC located in Bizerte, Sousse, Sidi Bouzid, and Medenine were selected taking into account the operation period of the GIC and the availability of data on the daily management and water usage. It was confirmed that the project has positive benefits for both macro and micro socio-economic aspects and is effective for the beneficiary.

(6) Water Demand Projection

The water demand was estimated based on the water supply population and population density for domestic water demand and numbers of heads of sheep/goat and cows/horses for cattle water demand. The total water demand of

41 subprojects in 2017 assuming the project life of 15 years are presented in Table 4.6.1. The total daily maximum water requirement of 41 subprojects comes to 4,308m^3. The maximum daily water requirement per capita is 70 liter including cattle water demand.

(7) Sensitization Work

The prospective users' opinions were considered into the project concept even before 1996, but the methodology was not systematic. Consequently, the implemented projects were less sustainable. A sensitization program was therefore introduced to improve situation. The sensitization work in the Study was executed three times based on the manual prepared by DGGR visiting the prospective beneficiaries' communities.

In the first visit, the concept and benefits of water supply system was introduced to the beneficiaries. One of the highlights of the first visit was that the beneficiaries participated could express the desire on location of service point at the project site.

In the second visit, the elaborated layout of water supply system was shown to the beneficiaries and they gave their opinions to the layout shown. The location of communal tap planed by the local consultant was changed through this meeting, when necessary.

In the third visit, the water charge and revolving fund required for the project were proposed to the prospective beneficiaries, and they were requested to to participate in the GIC which will be created during the construction period. The commitment rate of the beneficial families exceeded 80% of the total beneficial families for each subproject.

(8) Financial Analysis

The unit investment cost and unit water supply cost are factors to confirm the eligibility of each subproject. The allowable unit investment cost is 550DT/beneficiary. No subproject among 41 subprojects exceeds this ceiling (refer to Table 4.7.1).

A unit water supply cost was calculated assuming unaccounted-for water rate of 15%, the project life of 15 years and considering actual inflation rate. The estimated unit water supply cost varies between 0.2DT/m^3 and 0.9DT/m^3. On the other hand, the proposed water charge is generally 20% higher than the unit water supply cost. The unit water supply costs of 41 subprojects range between 0.25DT/m^3 and 1.00DT/m^3. The financial balances of 41 subprojects are also fine, so that sustainable project operation can be expected for all of them (refer to Table 4.7.2).

Consequently, the detailed design was executed for 41 subprojects.

8. Design Guidelines

In principle, the technical and financial guidelines prepared by DGGR are applied to the Study.

(1) Water demand projection guideline

1) The project lifetime is 15 years.
2) Water demand projection is made based on 25 lpcd with 2.5% annual increase rate for grouped population and 20 lpcd is fixed for scattered population.
3) Water demand is 5 liter/day for sheep and goats, and 30 liter/day for cows and horses.
4) Fifteen percent of the total demand is considered as loss and 1.25 (for North area) and 1.5 (for South area) are multiplied as the daily peak factor.

(2) Hydraulic calculation guideline

1) Velocity of pipe inner flow is recommended to be 0.4 m/s to 1.2 m/s.
2) Hazen-William formula is applied to the calculation.
3) Residual pressure at a service point shall be 1 bar (around 10m).
4) Designed discharge of service facilities is 0.5 liter/s except a *potence*, of which design discharge is 2 liter/s.
5) 50% of the average daily water supply of the final year of the project

period or 25% of the maximum daily water supply of the same year whichever bigger is adopted as the capacity of the distribution tank.

(3) Financial analysis guideline

1) The unit production cost of supplied water should be calculated assuming internal rate of return (IRR) as 5%, 8% and 10%.

9. Detailed Design of Facilities

The detailed design of 41 subprojects was made based on the basic study approved by CRDA. The detail design is composed of design memorandum, draft tender documents, drawings, form of bill of quantities and cost estimation. The draft tender documents, drawings and bill of quantities are prepared applying the standard form prepared by DGGR.

There are 41 water sources in the Project. These are composed of surface water by dam, spring, groundwater by deep tube well, GR Extension and SONEDE Connection. One subproject is supplied from the Barbara Dam. Two subprojects are supplied with the waters of the springs. Groundwater sources are developed by 16 tube wells in 8 governorates. Six GR Extensions in 4 governorates use the existing water sources. 16 SONEDE Connections in 8 governorates are connected to the network of SONEDE water supply system.

The general concept of water supply system is that water is transmitted by pump or residual pressure at the connecting point of SONEDE to existing pipeline to distribution tank, and then distributed by gravity through main and lateral distribution pipelines to the service points. Disinfection is made before transmission by injecting 12% hypochlorite solution called “javel water” into the transmission pipe by reciprocating pump. The capacities of almost all distribution tanks range from $20m^3$ to $50m^3$, while $250m^3$ is the biggest. A communal tap called *“potence”* supplying for big tank and individual connection to public facilities are service point in the system. The communal taps of 453 nos. including 23 existing taps and 28 *potences* were designed (refer to Table 6.2.1). One service point supplies about 125 users which is bigger than 100 users as a standard figure. The quantities of the major facilities designed are tabulated below:

Facilities	Quantities	Facilities	Quantities
1) Pipeline length	550 km	8) Potance	28 nos.
2) Reservoir	31 nos.	9) Individual connections	55 nos.
3) Pumping station	18 nos.	10) Water treatment plant	1 nos.
4) Relay pumping station	17 nos.	11) Disinfection equipment	2 nos.
5) Booster pumping station	8 nos.	12) Electrical equipment	28 nos.
6) Break pressure tank	28 nos.	13) GIC office	20 nos.
7) Public water tap	430 nos.		

10. Cost Estimate

The construction cost items in the detailed design are classified as follows in accordance with the B/Q of tender documents:

1) Procurement cost of pipes and special parts,
2) Installation and equipment costs of pipe networks,
3) Cost of civil works, and
4) Cost of hydro-mechanical and electrical works.

The project cost of the 41 subprojects was estimated based on the quantities and unit costs. They are summarized as below:

Items	Amount (1,000DT)	Equivalent to Japanese Yen (Million Yen)
1. Construction cost	15,712.7	1,302.8
2. Procurement cost	1,103.9	91.5
3. Engineering fee	4,493.5	372.6
4. Tax	2,828.3	1,234.5
Total	24,138.4	2,001.4

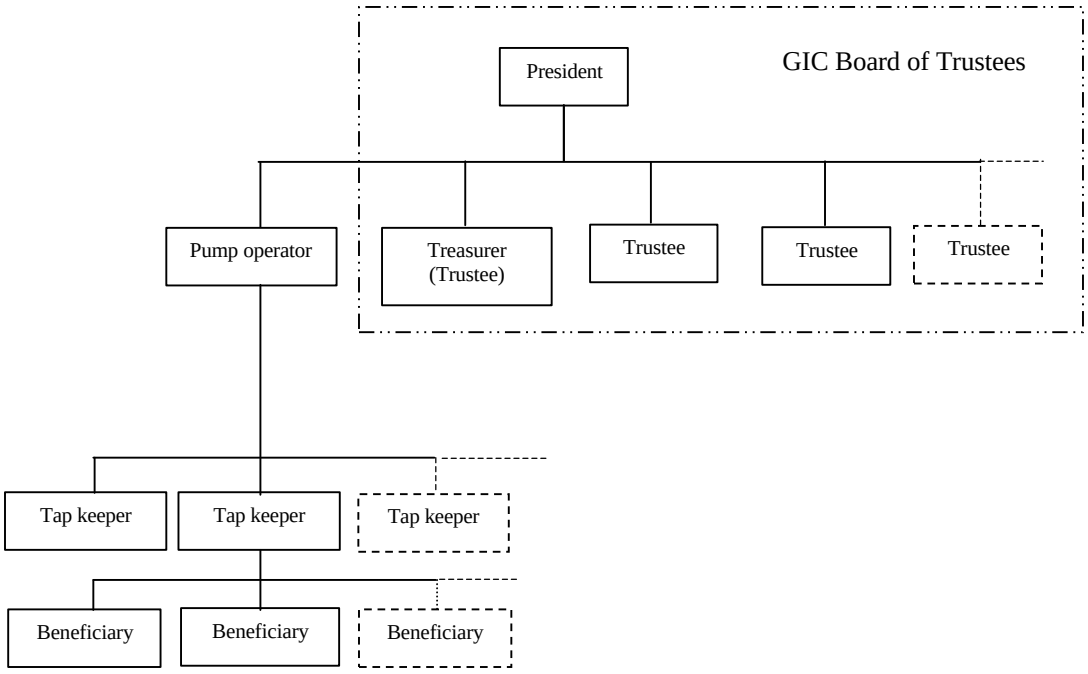
11. Operation Plan

The water supply systems constructed by the respective subprojects will be operated by the GICs which will be organized by the beneficiaries during the construction period.

In Tunisia, operation manual for GIC has been prepared by the Strategic Study in the Rural Potable Water Sector Project conducted by World Bank fund in 1998. According to the interview to the respective CRDA on the operation conditions of the GICs , no problem or inconvenience was reported. Therefore, the said operation manual is to be applied to the GICs under the Project 2001. In the

respective GICs, the operation manual will be modified according to the present conditions of the respective GICs.

The general organization chart of GIC is shown below.



General Organization of GIC

The tap keeper has to open a valve of communal tap or *potence* according to the daily operation program and then he should collect water charge whenever a beneficiary takes water from a service point. He also has the duty to do maintenance and minor repair works of the communal taps or the *potence* under the control of the pump operator. Operating hours of the service points of the water supply systems is decided by each GIC.

12. Project Implementation Plan

(1) Executing Agency

The Executing Agency of the Project 2000 and Project 2001 is Directorate General of Rural Engineering (DGGR), Ministry of Agriculture. DGGR is responsible for overall management of the Projects including loan management. DGGR functions as a technical and financial administrative organization for the

implementation of the subprojects. The Executing Agency of each subproject is Regional Office of Agricultural Development (CRDA) of each governorate. Division of Rural Engineering (AGR) and Direction of Hydraulics and Rural Equipment (DHER) are in charge of the implementation of the works under CRDA.

(2) Financial Source

The construction cost, equipment procurement cost and engineering service cost will be financed by JBIC loan. The taxes of construction costs, administration costs of each CRDA and employment cost of local consultants for construction supervision will be covered by Tunisian national budget.

(3) Contract Package

A contract of the subproject will be basically divided into the following three packages:

1) Procurement and installation of pipe networks and civil works
2) Hydro-mechanical and electrical works
3) Electrical works of outside line (by STEG)

(4) Implementation Schedule

The implementation of the Project 2001 is scheduled as follows:

1) Tender procedure : Mar.01, 2001~Sept.30, 2001
2) Commencement of Works : July.01, 2001
3) Completion of Works : Aug.31, 2003

The construction periods of the subprojects will range between 3 months and 12 months which depend on the scale of project and work conditions at each site such as weather, topography and geology. All the subprojects are scheduled to be completed within two years.

13. Environmental Impact Assessment

(1) Initial Environmental Examination (IEE)

The IEE was carried out following screening and scooping methods of JBIC's guideline.

Out of 43 subprojects, 17 subprojects were selected for IEE taking into consideration a scale of the project, socio-economic conditions, natural conditions, etc. The IEE was made through literature examination, field survey and discussion with DGGR. As a result, it was judged that the Project 2001 has generally positive effects to the environment.

The positive impact effects include supply of clean water, decrease of water related disease, health of people and increase of productivity and economic development.

On the other hand, negative effects will be influence to the environment caused by construction works and drainage of water disposed from the communal taps. Therefore, the Environmental Impact Assessment (EIA) is made for negative effects.

(2) Environmental Impact Assessment (EIA)

According to the environmental guideline of Tunisia, the Project 2000 and Project 2001 have no obligation to conduct the EIA due to rural water supply.

However, the EIA was conducted for the negative effects pointed out by the IEE as follows:

1) Influence by construction works

The scales of construction works carried out in the Project 2000 and Project 2001 are small. Therefore, the influence by the construction works will be small and also the influence can be reduced by informing the people affected of construction schedule and work schedule in advance.

2) Influence by drainage of water disposed from communal taps

The time to use the communal tap is limited to a few hours in the morning and afternoon and also the amount of water supplied is as small as several cubic meters per day. The communal tap is equipped with drainage facilities to infiltrate the disposed water into underground. However, no

salt damage may be caused as the drainage water amount is small and also no report of salt damage has been submitted on the existing communal taps. Further, no sanitary problem is concerned.

14. Conclusions

(1) In the Study, the design review of the Project 2000 designed by Tunisian government were executed, and the basic study and the detailed design were also carried out for the Project 2001. The design review of the Project 2000 were made for 42 subprojects of which design had been completed. No serious problem was found in the design. Therefore, each subproject proceeds to the implementation stage.

(2) Initially, the Project 2001 includes 44 subprojects. However, one subproject was cancelled due to high unit invetment cost of 550 DT/beneficiary which exceeds the allowable limit. Further, three subprojects in Jendouba were integrated as one subproject because these subprojects use the same water source. Therefore, the subsequent Study was conducted for 41 subprojects.

(3) For 41 subprojects, a sensitization work was carried out three times according to the sensitization program prepared by Tunisian government and consents to implement the subprojects were obtained from the beneficial families of more than 80% of total beneficial families. Based on the consents, the detailed design were carried out for 41 subprojects and tender documents were prepared.

(4) Though 12 water sources could not satisfy the national water quality guideline for drinking water according to the water quality analysis results, the project implementation was decided by the Tunisian government judgment. However, as the water source Blahdia in Sidi Bouzid contains Lead exceeding the allowable limit, the use of such water shall be reconsidered by the Tunisian government.

(5) According to the financial analysis, the water supply costs of 41 subprojects

range from 0.2 DT/m^3 to 0.9 DT/m^3. They are less than 1.0 DT/m^3 of the allowable limit to implement the project. Besides, all the subprojects are financially viable in 2017 (project final year). It was confirmed that sustainable operation is expected for all subprojects.

(6) The rural water supply project in Tunisia contributes to not only supplying water but also the realization of hygiene education, people's settlement in the rural area and realization of income opportunities, etc. The rural water supply project is beneficial for the people.

15. Recommendations

(1) It is prospected that groundwater resources will be continuously developed for irrigation and water supply purposes in the rural area. Meanwhile, there is concern that lowering of the groundwater level may occur in the long term. Because of this, the groundwater development is being managed by DGRE, Ministry of Agriculture. In order to secure the groundwater resource in the long term, DGGR should prepare the groundwater use plan following the recommendation of DGRE.

(2) Though the final decision on use of the water which could not satisfy the national water quality guideline for drinking water was entrusted to DGGR, DGGR should judge taking into consideration influence to the local people's health in case that such water is used for long time.

(3) Fortunately, national subsidy system by which the construction cost is born by the central government is available in Tunisia. It is recommended to supply safe water applying the subsidy system extensively even if the investment cost becomes higher.

(4) The present water quality analysis items of water source for drinking water are insufficient to properly judge suitability of water source. It is recommended to add analysis of toxic materials such as arsenic, lead, etc. to the present water quality analysis.

(5) It is important to train the sensitization experts in order to reflect the intention of beneficiaries in the future rural water supply project. The training should cover improvement of technique for discussion with the people, increase of capability on visual presentation, increase of capability to fully understand the opinions of the people, etc. Also, it is recommended from the viewpoint of gender to continue the effort to have more women participate in the sensitization meetings. Further, it is recommended to make an appeal to the women for participation in the rural water supply projects through the organizations such as literacy centers and medical offices which are related to enhancement of women's social status.

THE DETAILED DESIGN STUDY
ON
THE RURAL WATER SUPPLY PROJECT
IN
THE PUBLIC OF TUNISIA

FINAL REPORT
MAIN REPORT

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ABBREVIATIONS

AGR	District Agricultural Engineering Office, CRDA (Arrondissement du Génie Rural)
ANPE	National Agency for Environment Program (L'Agence Nationale de Protection de l'Environnement)
CEM	Defense Ministry Map (Carte d'Etat Major)
CRDA	Regional (provincial level) Directorate General for Agricultural Development (Commissariat Régional au Développement Agricole)
DT	Tunisian Dinar (Dinars Tunisien)
DGGR	Directorate General of Agricultural Engineering, Ministry of Agriculture (Direction Générale du Génie Rurale)
DGRE	Directorate General of Water Resources, Ministry of Agriculture (Direction Générale des Ressources en Eau)
DHER	Direction of Hydraulics and Rural Equipment (Direction Hydraulique de l'Equipment Rural)
EPR	Department of Rural Potable Water (Direction de l'Eau Potable Rural)
GIC	Group of Water Users (Groupement d'Intérêt Collectif)
GOT	Government Of Tunisia (Gouvernement Tunisien)
GR	Agricultural Engineering Office, AGR (Génie Rural)
INS	National Statistic Institution (Institut National de la Statistique)
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency (Agence Japonaise de Coopération Internationale)
KfW	Kreditanstalt für Wiederaufbau
LCAE	Central Laboratory for Analysis and Test, Ministry of Industry (Laboratoire Central d'Analyse et D'Essai, Ministère de L'industrie)
METAP	Mediterranean Technical Assistance Programme (Banque Mondiale et Programmes d'assistance technique méditerranéenne)
MOA	Ministry Of Agriculture (Ministère de l'Agriculture)
MOHE	Ministry Of Housing and Equipment (Ministère de l'Habitat et de l'Equipement)
MOI	Ministry Of Interior (Ministère de l'Intérieur)
OECF	Overseas Economic Cooperation Fund of Japan

	(Fonds de Coopération Economique du Japon)
ODA	Official Development Assistance
ONAS	National Office for Purification (L'Office National de l'Assainissement)
OTC	Topography and Cartography Office (Office de la Topographie et de la Cartographie)
PDARI	Integrated Rural Agricultural Development Project (Projet de Développement Agricole Rural Intégré)
PISA	Agricultural Sector Investment Loan Program (Pret d'Investissement au Secteur Agricole)
SAPROF	Special Assistance for Project Formation provided by JBIC (Assistance Spéciale pour les Projets en Formation)
SONEDE	National Corporation for Water Development and Supply (Société Nationale d'Exploitation et de Distribution des Eaux)
STEG	Tunisian Corporation for Gas and Electricity (Société Tunisienne de l'Electricité et de Gaz)
WHO	World Health Organization (L'Organisation Mondiale de la Santé)

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Government of the Republic of Tunisia (hereinafter referred to as "the Government of Tunisia" or "GOT") plans to increase the coverage of rural water supply up to 80% in 2001 from 67 % by the Ninth 5-Year National Development Plan (1997-2001), during the planned 5 years for the rural water supply for 541 subprojects that will be constructed for rural water supply and will benefit around 347,000 people.

The Government of Tunisia requested the Government of Japan (GOJ) to receive an ODA loan on water supply facilities at 119 subprojects in 19 governorates within the 541 subprojects. In response to the official request from the Government of Tunisia, the Overseas Economic Cooperation Fund "OECF" (present Japan Bank for International Cooperation: "JBIC") dispatched a Special Assistance for Project Formation (SAPROF) Team in January 1999.

Finally, 84 sites were selected as proposed subprojects on the basis of the review of 90 subprojects, which were selected by pre-screening of Tunisian side. Concerning 46 subprojects which are formulated as Project 2001, the possibility of implementation of Japan International Cooperation Agency (JICA) of the Detailed Design (D/D) was investigated in order to reduce the burden imposed of the Government of Tunisia.

Considering these conditions, the Government of Tunisia requested the Government of Japan to conduct the Study in August 1999. In response, the Government of Japan decided to conduct the Detailed Design Study on the Rural Water Supply Project and the Government of Japan dispatched a JICA Preparatory Study Team for preparation the Scope of Works for the Project. The JICA Preparatory Study Team and the Government of Tunisia discussed the operation of the Study and signed the Scope of Work for the Study on November 4, 1999.

Therefore, the total sites of Detailed Design Study decreased from 46 to 44,

because Government of Tunisia had already carried out two subprojects of D/D.

1.2 Objectives of the Study

The objectives of the Study are summarized in the following three items:

(1) To review detailed design of 42 subprojects of Project 2000 in the Rural Water Supply Project agreed on between the Japan Bank International Co-operation (JBIC) and the Government of Tunisia which will contribute to the development of rural water supply,
(2) To conduct the Basic Study and prepare the detailed deign and the tender documents of 44 subprojects of the Project 2001, and
(3) To pursue technology transfer to the counterpart personnel in the course of the Study.

1.3 Study Area

The Study covers 86 subprojects in 17 governorates of Tunisia. The Study Area is shown in the Location Map of Project Area. The inventory and location of Project 2000 and Project 2001 are shown on the Location Map of Project Area.

1.4 Activities of JICA Study Team

The work schedule is shown in Figure 1.4.1. The field work was initiated on February 17, 2000, by the JICA Study Team, headed by Mr. M. Fujinami. The JICA Study Team was dispatched by JICA in accordance with the agreed "Scope of the Work". The Inception Report for the Detailed Design Study was submitted to the Directorate General of Agricultural Engineering (DGGR) on February 19, 2000. The JICA Study Team and DGGR discussed the methodology, the work schedule and subproject sites for the Study. The Inception report was accepted by the DGGR. The JICA Study Team and DGGR signed the minutes of meeting on Inception Report on March 3, 2000. JICA Study Team guided and supervised the Detailed Design Study work for the Project 2001 that are subcontracted to local consulting firms by the JICA Study Team. Main activities during the field work from February to December 2000 included:

(1) Review of the Studies for the Project 2000
(2) Basic Study (Subcontracting Work)
    1) Preliminary Study
    2) Data Collection and Water Demand Projection
    3) Water Quality Survey
    4) Topographic Survey
    5) Geotechnical Survey
    6) Formulation of Projected Water Supply System
    7) Sensitization Program
    8) Preliminary Design
    9) Financial Analysis
    10) Preparation of Basic Study Report on Each Subproject
(3) Environmental Study and Socio-economic Impact Study
(4) Preparation, Submission and Discussion of Draft Basic Study Main Report
(5) Preparation and Submission of Basic Study Main Report
(6) Detailed Design Phase (Subcontracting Work)
    1) Detailed Design
    2) Preparation of Detailed Design Report and Draft Tender Documents on Each Subproject
(7) Preparation, Submission and Discussion of Draft Final Report
(8) Preparation and Submission of Final Report

The JICA Study team mainly carried out to supervise the subcontracted works for the local consultants, to review their outputs, and then prepared the Basic Study Main Report and the Detailed Design Main Report. The Study Procedure is shown in Figure 1.4.2.

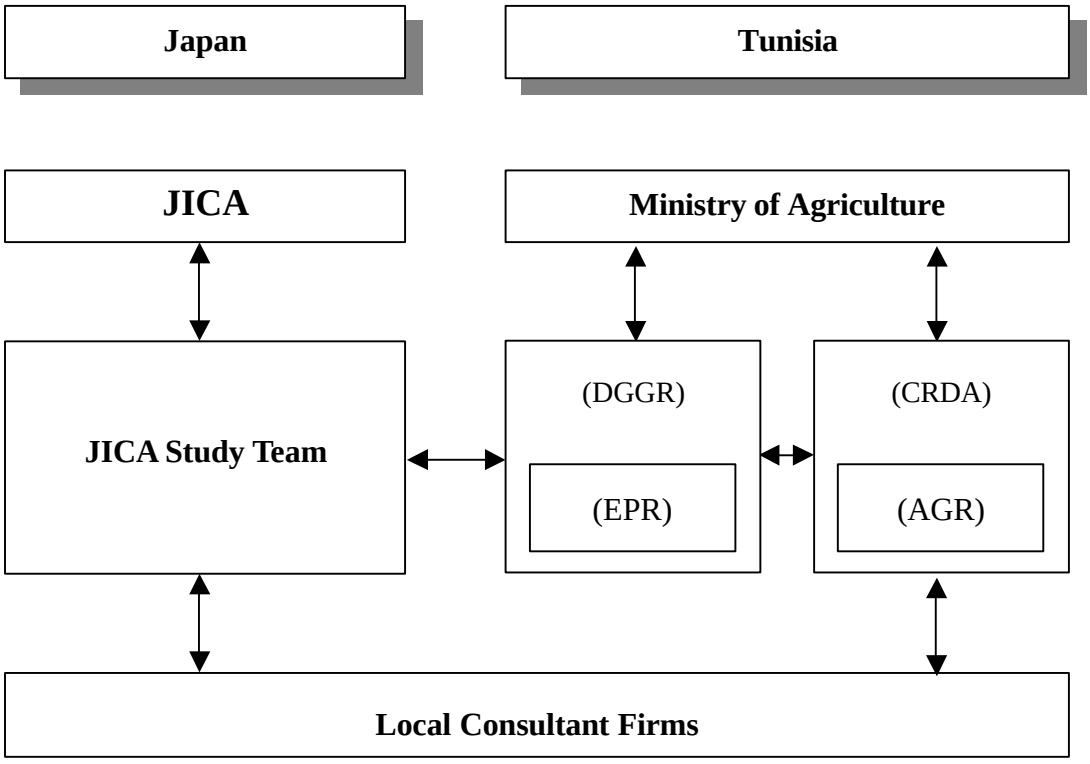
1.5 Organization of the Study and Staffing

It is of vital importance to set up an efficient organization for attaining smooth implementation of the Study and close co-ordination of various activities throughout the Study period.

Organization of the Study consists of the JICA Study Team, Directorate General of Agricultural Engineering (DGGR)/Department of Rural Potable Water (EPR) and Regional Directorate General for Agricultural Development (CRDA)/District Agricultural Engineering Office (AGR).

EPR in DGGR is the main executing agency for the Study. CRDA is the actual executing agency of each subproject. CRDA/AGR also supervised and directed the local consultant's study and design methods together with the Study team, because they grasp each subproject situation best.

The JICA Study Team subcontracted the Detailed Design Study work to local consultant firms. During the field work, DGGR/EPR provided necessary arrangement and co-ordination between CRDA/AGR and the JICA Study Team. Organization of the Study is illustrated as follows.



Organization for the Study

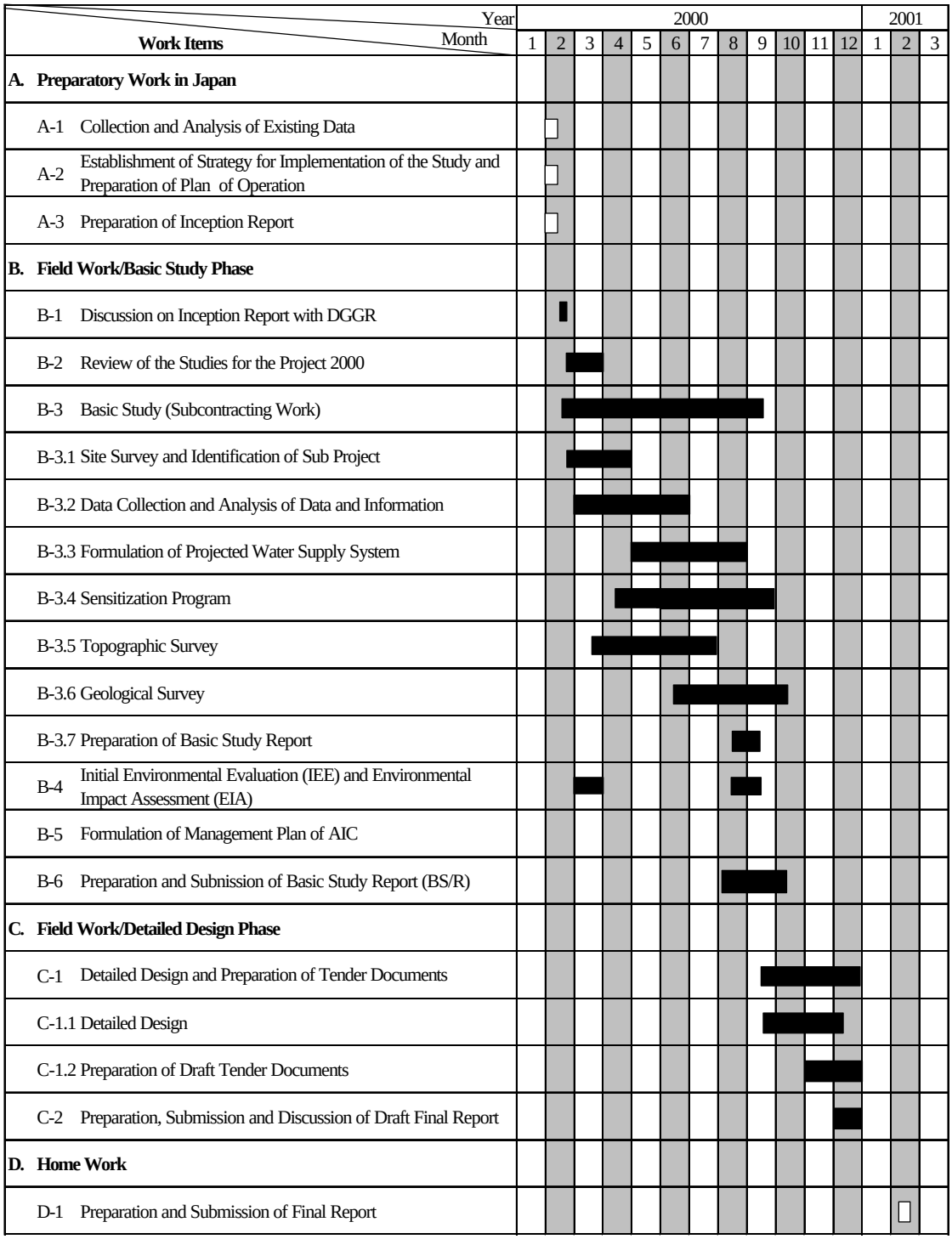
Engineers of the JICA Study Team have enjoyed excellent co-operation from the counterpart personnel of DGGR/EPR and CRDA/AGR. The members of the three teams are listed in Table 1.5.1.

Table 1.5.1 Participants in the Study

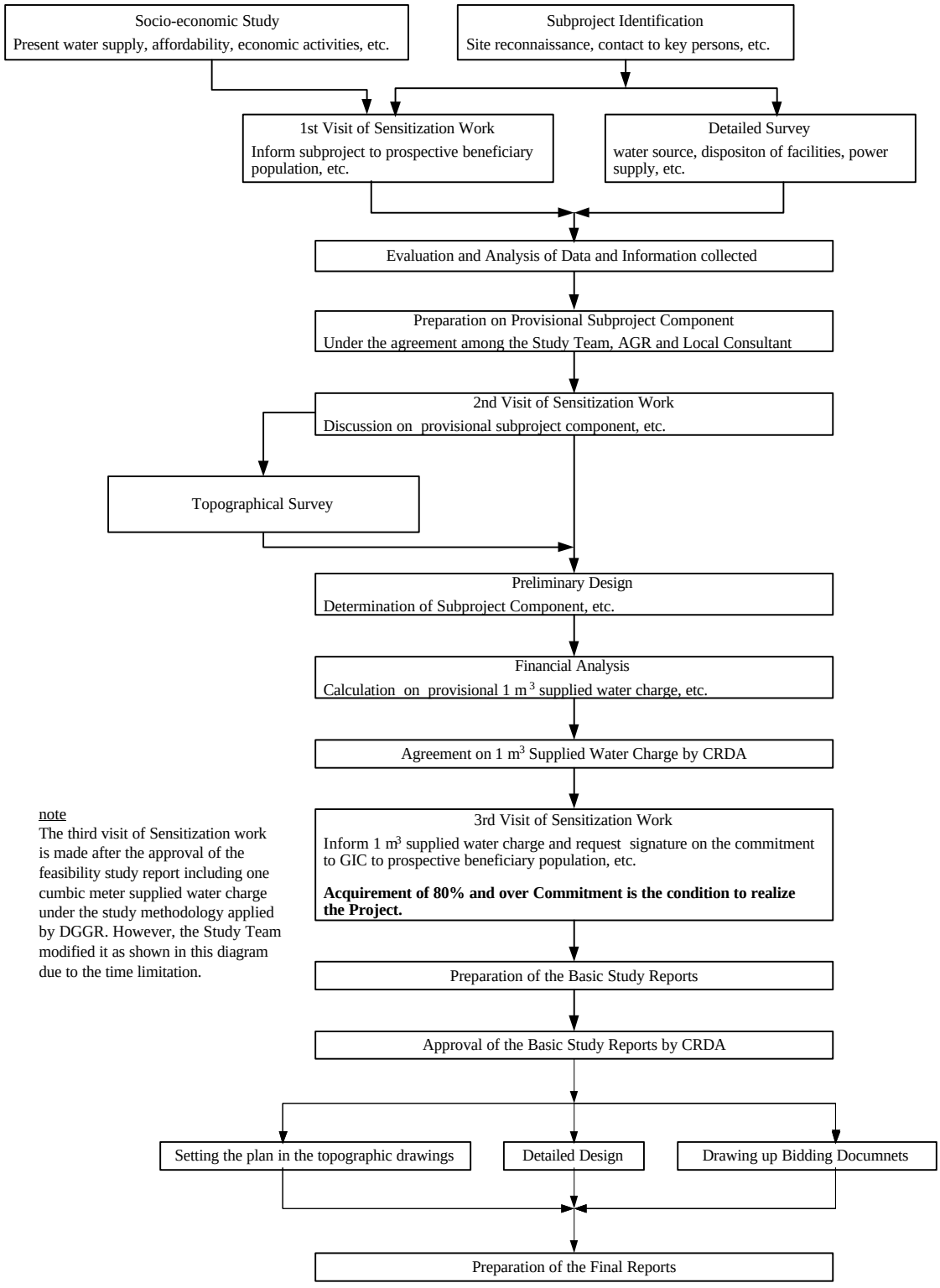
JICA Study Team	
Name	**Assignment**
Masato FUJINAMI	Team Leader
Toshihoro TSUCHIYA	Deputy Team Leader/Water Supply Engineer-1
Tijiani MERDASSI	Water Supply Engineer-2
Ken-ichi ISHII	Water Supply Engineer-3
Yasushi OSATO	Water Supply Engineer-4
Kouji MORIO	Water Supply Engineer-5
Yasuhiko MURAMATSU/ Takehiko NAKANE	Hydrochemist
Tsutomu MORI	Electric and Mechanical Engineer
Massamba GUEYE	Sensitization Expert-1
Maki HAMAOKA	Sensitization Expert-2
Daihachiro KAMIMURA	Socio-economist
Fumio TAMURA	Cost Estimator/Tender Document Expert
Mitsuharu NISHIMURA	Geodetic Expert
Mujahid IQBAL	Environmentalist
Makoto CHIBA/ Kenji NAKANO	Interpretor-1
Norihiko IGUCHI	Interpretor-2
Takuya YOSHIZAWA	Coodinator

Counterpart Personnel of DGGR/ EPR	
Name	**Assignment**
Jameleddine BRAHNI	Chief Counterpart
Mohamed FAKHFAKH	Design Engineer
Souad KADACHI	Sociologist
Taoufik BRAHEM	Water Supply Engineer

Counterpart Personnel of CRDA/ AGR		
Governorate	**Chief of AGR**	**Engineer in Charge**
Ariana	Bahaeddine JRADI	Mme BOUDOUR
Ben Arous	Mohamed ZIDI	Mounir AYED
Nabeul	Moncef Taieb	Abderrazek FEHRI
Zaghouan	Abdelmalek SELLAMI	Amor KHALOUI
Bizerte	Mustapha Mechani	Mme Monia GUISSOUMA
Beja	Noureddine FERCHICHI	Mohamed CHEBBI
Jendouba	Dhiab ABEDELLI	Abderrahmane OUASLI
Le Kef	Lazhari LIMAM	Jalel HASNAOUI
Kairouan	Abdejelil AFLI	Kamel HEDHLI
Kasserine	Arbi Haj NECIB	Tahar MBARKI
Sidi Bouzid	Tahar JABALLI	Mme Leila CHEOUR
Mahdia	Mohamed Klila	Youssef BARAKET
Gasfa	Mahfoudh CHAMKHI	Mme Fatma SAYAH
Gabes	Mounir Magrrech	Mme Souad DEKHIL
Medeine	Amor Jenni	Mohsen Ben AMMAR



The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisia	Figure 1.4.1 Work Schedule
Japan International Cooperation Agency	



The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisia	Figure 1.4.2
Japan International Cooperation Agency	Project Implementation Flow Diagram

CHAPTER 2 NATIONAL SOCIO-ECONOMIC BACKGROUND

2.1 General

Tunisia is located in the middle of the North African coast, neighboring Algeria to the west and Libya to the east. It has an area of about 164,000 km^2. Geological characteristics are mainly classified into three groups, Tell Atlas area in the north, steppe area in the central belt, and desert area in the south where it merges into the Sahara. Altitude of the north-west area is generally higher than the other areas.

Arabic is the official language and used for commerce and French is also commonly used for the whole country. Around 98% of the total population is Sunni Muslim and others are Christian and Jewish. Arab ethnic group occupies the most part in Tunisia. The Berber ethnic group inhabits the southern area, their population is around 60,000.

2.2 Rural Administration

The governorate is the organization in charge of rural administration, and Tunisia consists of 23 governorates in total. Administration is done by the governor who is appointed by the president.

There are two ministries involved in rural administration of rural water supply. The Ministry of Agriculture (MOA) is in charge of project implementation and the Ministry of Interior (MOI) plays a role of support through the governorate. AGR which is a section of CRDA plans, tenders for, and implements each rural water project. GIC is established when the project is implemented and it is placed under the governor's authority.

2.3 Economy

Table 2.3.1 summarizes recent economic indicators of Tunisia, which refer from the data of Central Bank of Tunisia, Ministry of Economic Development, and Ministry of Finance and Institution of National Statistics. During 1995 and 1999, nominal Gross Domestic Product (GDP) recorded an annual average growth rate

of almost 10%, while annual growth rate of actual GDP was as high as 5.92%. With such high rate of growth, GNP/capita quickly increased from 1,815DT in 1995 to 2,530DT in 1999 with average annual growth rate of 8.66%. And, during this period, more than 60,000 jobs were created annually, vitalizing the economic activities strongly. In the same period, both export and imports increased from 5,173MDT and 7,464MDT to 6,967MDT and 10,071MDT in 1999, showing annual average growth rate of 7.73% and 7.78%, respectively. As the annual growth rate of the latter is slightly larger than the former, trade balances (deficit) widened from 2,291MDT in 1995 to 3,104MDT in 1999.

As the tourist income and labor income are both increasing rapidly, almost covering the deficit in trade balance, the size of current deficit in the International Accounts is decreasing and its percentage to the GDP is also quickly diminishing, from 4.3% in 1995 to 2.1% in 1999. These favorable circumstances reflected the deduction of DSR (Debt Service Ratio) and Rate of External Indebtedness considerably.

GDP and GNP per capita of Tunisia

Item	Unit	1995	1996	1997	1998	1999
GDP	Million DT	17,052	19,066	20,901	22,701	24,948
GDP Deflator		130.4	136.1	141.5	146.5	151.5
GNP per capita	DT	1,815	1,987	2,160	2,327	2,530

2.4 Demography

(1) Population Trends

Tunisia's population in 1984 and 1994 census was 6,996,200 and 8,795,700, respectively. After the last census, however, the growth rate considerably decreased between 1994 and 2000 (refer to Table 2.4.1).

(2) Regional Distribution of the Population

By governorate level, average annual population growth rate (1984-1994) of greater Tunis suburbs, such as Ariana and Ben Arous are more than 4.0%, showing the highest figures among the governorates. The annual population growth projection from 1995 to 2000 of Ben Arous is more than 3.0%. Annual growth rate of each governorate is fairly close to the national average (1.0%), they project around 1% population growth. The figures of north-west area such as Beja,

Jendouba, Le Kef, Siliana are generally lower than the average, their growth rates are almost 0% (refer to Table 2.4.2).

Average Annual Population Growth Rate

Average annual population growth rate (1984-1994)			Average annual population growth projection (1994-2000)		
Urban	Rural	Total	Urban	Rural	Total
2.9%	1.4%	2.2%	1.7%	0.6%	1.3%

2.5 Development Plan

(1) Present Development Plan

Tunisia's on-going national development plan is the Ninth Development Plan covering 1997 – 2001. Its ultimate goal is to achieve the total integration of Tunisia's economy in the international environment and the preparation of the country to enter into the new century with the best chances for success.

Major economic target figures set by the 9th Development Plan compared with the former one (the 8th Development Plan) is shown in Table 2.5.1.

(2) Rural Drinking Water Supply in the 9th Plan

As a part of the Improvement Program of Living Conditions in Rural Areas in the 9th Plan, special attention has been paid to improve and develop the supply of electricity and drinking water in rural areas. It is projected to improve the supply ratios of rural electricity and access to drinking water in rural areas from 47.0% and 62.0% in 1994 to 87.4% and 78.1%, respectively, by the end of the 9th Plan.

2.6 National Finance

According to the "Annual Report 1998 & 1999 (Central Bank of Tunisia" actual Revenue of the Central Government in 1999 was 8,880MDT, an increase of 4.2% compared with the previous year (8,521MDT) mainly due to a fair increase in tax revenue. While the Actual Expenditure was 9,315MDT, which is a 7.2% increase compared to the previous year (8,686MDT), leaving a deficit of 875MDT (Deficit Exclusive of Debt Redemption).

As is summarized in Table 2.6.1, some 70% of the revenue is generated internally while remaining 30% is borrowed either internally (two-thirds of the total borrowing) or externally (one-thirds of the total borrowing). Out of Expenditure,

Debt Service is sharing more than one-third of the total, bringing out difficulty in getting the balance even. As can be seen in the table, the current revenue fairly covers the current expenditure and both the debt service ratio and the rate of indebtedness are decreasing, Tunisia's national financial status can be said to be fairly sound and improving

Summary of Central Government Budgetary Flows

Item		1997	1998	1999
Revenue -	Internal mean	5,194	6,090	6,129
	Borrowed resources	3,041	2,431	2,751
	Total	8,235	8,521	8,880
Expenditure	Operating capital goods & loans Granting expenditure	5,276	5,608	6,165
	Debt service	3,041	3,078	3,081
	Total	8,319	8,686	9,246
Balance		-887	-288	-875

Source : "Annual report 1998 &1999" (Central Bank of Tunisia)

Table 2.3.1 General Indicators of Tunisia's Economy

		unit	Actual Figures					Variations in %				Av. An. Growth
			1995	1996	1997	1998	1999	1996/'95	1997/'96	1998/'97	1999/'98	Rate '95-'99
National Accounts	GDP in current prices	MTD	17,052	19,066	20.901	22,701	24,948	11.8	9.6	8.6	9.9	9.98
	GDP deflator (1990=100)	-	130.4	136.1	141.5	146.5	151.5	4.4	4.0	3.5	3.4	3.82
	GDP in constant 1990 prices	MTD	13,074	14,009	14,768	15,500	16,458	7.2	5.4	5.0	6.2	5.92
	of which Agriculture & Fishing	MTD	1,573	2,037	2,098	2,077	2,305	29.5	3.0	-1.0	11.0	10.00
	Others	MTD	11,501	11,972	12,670	13,423	14,163	4.1	5.8	5.9	5.5	5.34
	GNP per caipta (TD/p.)	TD/p.	1,815	1,987	2,160	2,327	2,530	9.5	8.7	7.7	8.7	8.66
	Gross National Available Income (GNAI)	MTD	16,953	18,863	20,737	22,656	24,971	11.3	9.9	9.3	10.2	10.17
	Total National Consumption	MTD	13,505	14,586	15,841	17,195	18,722	8.0	8.6	8.5	8.9	8.51
	of which Public Consumption	MTD	2,777	2,976	3,274	3,585	3,901	7.2	10.0	9.5	8.8	8.87
	Private Consumption	MTD	10,726	11,610	12,567	13,610	14,821	8.2	8.2	8.3	8.9	8.42
	Average Propensity to Consume (Consumption/GNAI) in %	%	*79.7*	*77.3*	*76.4*	*75.9*	*75.0*	*-2.4*	*-0.9*	*-0.5*	*-0.9*	-
	Gross National Savings	MTD	3,448	4,277	4,896	5,461	6,249	24.0	14.5	11.5	14.4	16.03
	National Savings Rate (in % of GNP)	%	*24.2*	*23.7*	*24.6*	*25.1*	*26.2*	*-0.5*	*0.9*	*0.5*	*1.1*	-
	Gross Fixed Capital Formation (GFCF)	MTD	4,121	4,422	5,153	5,592	6,410	7.3	16.5	8.5	14.6	11.68
	of which Public Sectro	MTD	2,126	2,184	2,556	2,740	3,173	2.7	17.0	7.2	15.8	10.53
	Private Sector	MTD	1,995	2,238	2,597	2,852	3,237	12.2	16.0	9.8	13.5	12.86
	Investment Rate (in % of GDP)	%	*24.2*	*23.2*	*24.7*	*24.6*	*25.7*	*-1.0*	*1.5*	*-0.1*	*1.1*	-
	Consumer Price Index (1990=100)	-	132.4	137.4	142.4	146.8	150.8	3.8	3.6	3.1	2.7	3.31
	of which Food Staffs	-	132.0	137.0	142.8	146.7	150.0	3.8	4.2	2.7	2.2	3.25
	Jobs created (in '000 jobs)	000	61.0	55.3	58.0	61.0	63.0	-9.3	4.9	5.2	3.3	0.81
Ecternal Accounts	Exports	MTD	5,173	5,372	6,148	6,518	6,967	3.8	14.4	6.0	6.9	7.73
	Imports	MTD	7,464	7,499	8,794	9,489	10,071	0.5	17.3	7.9	6.1	7.78
	Balance of Trade	MTD	-2,291	-2,127	-2,646	-2,971	-3,104	-7.2	24.4	12.3	4.5	7.89
	Trade Coverage Rate (Exports/Imports in %)	%	*69.3*	*71.6*	*69.9*	*68.7*	*69.2*	*2.3*	*-1.7*	*-1.2*	*0.5*	-
	Tourism Income	MTD	1,323	1,413	1,565	1,713	1.954	6.8	10.8	9.5	14.1	10.24
	Labour Income	MTD	712	798	846	902	1,020	12.1	6.0	6.6	13.1	9.40
	Current Deficit	MTD	735	466	655	769	525	-36.6	40.6	17.4	-31.7	-8.07
	(in % of GDP)	%	*4.3*	*2.4*	*3.1*	*3.4*	*2.1*	*-1.9*	*0.7*	*0.3*	*-1.3*	-
	Net Inflow of Capital	MTD	839	882	1,054	558	1,338	5.1	19.5	-47.1	139.8	12.38
	Bottomline of the General Balance of Payments	MTD	+76	+386	+373	-213	+818	+310	-13	-586	+1031	-
	External Debt Service Ratio (in %)	%	*17.6*	*17.2*	*16.4*	*16.1*	*15.5*	*-0.4*	*-0.8*	*-0.3*	*-0.6*	-
	Rate of External Indebtedness (in % of GDP)	%	*53.6*	*51.0*	*52.2*	*47.3*	*47.6*	*-2.6*	*1.2*	*-4.9*	*0.3*	-
Public Finances	*Tax Ratio (in % of GDP)*	%	*20.5*	*19.9*	*20.2*	*21.0*	*20.9*	*-0.6*	*0.3*	*0.8*	*-0.1*	-
	Balance of Current Budget	MTD	431.8	442.6	337.7	611.6	697.8	2.5	-23.7	81.1	14.1	12.75
	Investment Expenditures	MTD	1290.7	1439.5	1515.1	1502.6	1775.1	11.5	5.3	-0.8	18.1	8.29
	Budget Deficit in % of GDP	%	*4.2*	*4.3*	*4.2*	*1.2*	*3.5*	*0.1*	*-0.1*	*-3.0*	*2.3*	-
	Total State Indebtedness (in % of GDP)	%	*58.5*	*56.8*	*58.6*	*55.8*	*56.4*	*-1.7*	*1.8*	*-2.8*	*0.6*	-
Money and its Counterparts	Money Supply (M4)	MTD	11,056	12,505	13,576	14,836	16,236	13.1	8.6	9.3	9.4	10.08
	Liquidity Rate of the Economy (M4/GDP) in %	%	*60.2*	*60.6*	*62.1*	*61.6*	*61.4*	0.4	1.5	-0.5	-0.2	-
	Net Foreign Assets	MTD	*854*	1,137	1,537	1,373	1,841	283	400	-164	468	-
	of which Net Asstets in Foreign Currency	MTD	1,525	1,892	2,227	2,032	2,747	367	335	-195	715	-
	in Day of Imports	Days	74	91	91	77	98	17	0	-14	21	-
	Net Claims on the State	MTD	3,163	3,527	3,702	4,112	4,170	364	175	410	58	-
	Finincing of the Economy	MTD	11,903	13,353	14,521	15,875	17,111	12.2	8.7	9.3	7.8	9.50

Source : Central Bank of Tunisia, Min. of Economic Development, Min. of Finance and Institute of National Statistics

Table 2.4.1 Population by Governorate (Census and year-end figures)

(unit : 1,000)

District	Governorate	Census Figures		Year-end Figures																				
		1984	1994	1994			1995			1996			1997			1998			1999 *			2000 **		
				Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	-	Total	Urban	Rural
Tunis	Tunis	774.4	890.1	897.6	*897.6*	-	905.5	*905.5*	-	913.7	*913.7*	-	921.5	*921.5*	-	928.0	*928.0*	-	934.3	*934.3*	-	939.9	*939.9*	-
	Ariana	374.2	568.8	579.3	*470.5*	*108.8*	595.9	*484.7*	*111.2*	612.5	*500.1*	*112.4*	629.3	*515.0*	*114.3*	645.4	*529.5*	*115.9*	661.1	*543.7*	*117.4*	676.5	*557.7*	*118.8*
	Ben Arous	246.2	371.7	379.8	*341.0*	*38.8*	393.0	*353.4*	*39.6*	406.2	*366.4*	*39.8*	419.6	*379.3*	*40.3*	432.4	*391.7*	*40.7*	445.0	*404.0*	*41.0*	457.3	*416.1*	*41.3*
	(sub-total)	**1394.7**	**1830.6**	**1856.7**	***1709.1***	***147.6***	**1894.4**	***1743.6***	***150.8***	**1932.5**	***1780.2***	***152.2***	**1970.3**	***1815.8***	***154.6***	**2005.7**	***1849.1***	***156.6***	**2040.3**	***1881.9***	***158.4***	**2073.8**	***1913.7***	***160.1***
North East	Nabeul	461.4	579.9	586.9	*379.6*	*207.3*	596.0	*386.2*	*209.8*	604.4	*393.3*	*211.1*	612.3	*399.6*	*212.7*	620.2	*406.0*	*214.2*	627.8	*412.3*	*215.6*	635.2	*418.3*	*216.8*
	Zaghouan	118.7	142.9	144.4	*49.1*	*95.3*	146.2	*49.9*	*96.3*	147.6	*50.8*	*96.7*	148.6	*51.5*	*97.1*	150.2	*52.3*	*97.8*	151.6	*53.1*	*98.5*	153.0	*53.9*	*99.1*
	Bizerte	394.7	484.3	489.2	*287.5*	*201.7*	495.5	*291.8*	*203.7*	501.4	*296.9*	*204.5*	506.7	*301.0*	*205.6*	511.9	*305.2*	*206.8*	517.0	*309.2*	*207.8*	521.7	*313.1*	*208.7*
	(sub-total)	**974.8**	**1207.1**	**1220.5**	***716.2***	***504.3***	**1237.7**	***727.9***	***509.8***	**1253.4**	***741.0***	***512.3***	**1267.6**	***752.1***	***515.4***	**1282.3**	***763.5***	***518.8***	**1296.4**	***774.6***	***521.8***	**1309.9**	***785.3***	***524.6***
North West	Beja	274.7	305.5	307.7	*117.5*	*190.2*	309.3	*118.6*	*190.7*	310.9	*120.0*	*190.9*	312.3	*121.1*	*191.2*	313.2	*122.0*	*191.2*	314.2	*122.8*	*191.4*	315.1	*123.6*	*191.5*
	Jendouba	359.4	403.8	407.3	*100.1*	*307.2*	411.3	*101.7*	*309.6*	414.8	*103.8*	*311.0*	417.8	*105.4*	*312.4*	420.3	*106.8*	*313.5*	422.6	*108.3*	*314.4*	424.8	*109.7*	*315.1*
	Le Kef	247.7	272.3	274.2	*128.9*	*145.2*	275.4	*129.8*	*145.6*	276.4	*130.9*	*145.6*	277.2	*131.6*	*145.6*	277.7	*132.1*	*145.6*	278.3	*132.6*	*145.7*	278.7	*133.0*	*145.8*
	Siliana	222.0	245.7	247.5	*79.6*	*167.9*	248.7	*80.3*	*168.4*	249.8	*81.4*	*168.4*	250.7	*82.0*	*168.6*	251.3	*82.6*	*168.6*	251.8	*83.1*	*168.7*	252.2	*83.5*	*168.7*
	(sub-total)	**1103.8**	**1227.2**	**1236.7**	***426.1***	***810.5***	**1244.7**	***430.4***	***814.3***	**1251.9**	***436.0***	***815.9***	**1257.9**	***440.1***	***817.8***	**1262.6**	***443.6***	***819.0***	**1266.9**	***446.8***	***820.1***	**1270.8**	***449.7***	***821.1***
Contral West	Kairouan	421.6	530.7	536.4	*157.0*	*379.4*	543.0	*159.7*	*383.3*	548.8	*163.2*	*385.6*	554.9	*166.1*	*388.8*	560.2	*168.9*	*391.4*	565.4	*171.5*	*393.9*	570.0	*174.1*	*396.0*
	Kasserine	298.0	387.2	392.3	*147.2*	*245.1*	398.4	*150.0*	*248.4*	404.2	*153.5*	*250.7*	409.4	*156.3*	*253.1*	414.2	*158.9*	*255.2*	418.7	*161.5*	*257.2*	422.9	*164.0*	*259.0*
	Sidi Bouzid	288.5	378.1	382.6	*82.3*	*300.3*	387.9	*84.0*	*303.9*	392.5	*86.3*	*306.2*	396.8	*88.0*	*308.8*	400.4	*89.6*	*310.8*	403.9	*91.2*	*312.7*	407.1	*92.7*	*314.3*
	(sub-total)	**1008.1**	**1296.0**	**1311.4**	***386.5***	***924.9***	**1329.3**	***393.7***	***935.6***	**1345.5**	***403.0***	***942.5***	**1361.1**	***410.4***	***950.7***	**1374.9**	***417.4***	***957.5***	**1387.9**	***424.2***	***963.7***	**1400.0**	***430.8***	***969.3***
Contral East	Sousse	322.5	435.1	441.4	*341.0*	*100.4*	450.3	*348.5*	*101.8*	459.1	*356.1*	*103.0*	468.1	*364.0*	*104.1*	476.5	*371.4*	*105.0*	484.6	*378.8*	*105.9*	492.4	*385.8*	*106.6*
	Monastir	278.5	363.4	368.5	*368.5*	-	376.1	*376.1*	-	383.9	*383.9*	-	391.3	*391.3*	-	398.5	*398.5*	-	405.5	*405.5*	-	412.2	*412.2*	-
	Mahdia	270.4	334.1	337.8	*147.1*	*190.7*	342.4	*149.6*	*192.8*	346.9	*152.4*	*194.5*	351.0	*154.9*	*196.2*	355.8	*157.7*	*198.2*	360.5	*160.5*	*200.0*	364.8	*163.1*	*201.7*
	Sfax	578.0	732.9	741.9	*459.8*	*282.1*	754.1	*468.4*	*285.7*	765.6	*477.8*	*287.8*	776.3	*486.0*	*290.3*	787.2	*494.4*	*292.8*	797.7	*502.6*	*295.1*	807.8	*510.5*	*297.3*
	(sub-total)	**1449.4**	**1865.5**	**1889.7**	***1316.5***	***573.2***	**1923.0**	***1342.6***	***580.4***	**1955.5**	***1370.2***	***585.3***	**1986.8**	***1396.2***	***590.5***	**2018.1**	***1422.1***	***596.0***	**2048.3**	***1447.3***	***601.0***	**2077.3**	***1471.8***	***605.6***
South West	Gafsa (1)	235.7	307.7	311.1	*224.1*	*87.0*	314.9	*227.3*	*87.6*	318.7	*230.7*	*88.0*	321.8	*233.6*	*88.2*	324.5	*236.2*	*88.4*	327.1	*238.7*	*88.4*	329.5	*241.1*	*88.4*
	Tozeur	67.9	89.0	90.2	*64.1*	*26.1*	91.7	*65.3*	*26.4*	93.0	*66.5*	*26.5*	94.3	*67.6*	*26.6*	95.5	*68.7*	*26.8*	96.8	*69.8*	*27.0*	98.0	*70.9*	*27.1*
	Kebili	95.4	131.6	133.3	*72.9*	*60.4*	135.5	*74.4*	*61.1*	137.7	*76.0*	*61.7*	139.6	*77.3*	*62.3*	141.2	*78.5*	*62.7*	142.8	*79.7*	*63.1*	144.3	*80.8*	*63.5*
	(sub-total)	**399.0**	**528.3**	**534.5**	***361.1***	***173.4***	**542.2**	***367.0***	***175.2***	**549.4**	***373.2***	***176.2***	**555.7**	***378.5***	***177.2***	**561.3**	***383.4***	***177.9***	**566.7**	***388.2***	***178.5***	**571.8**	***392.7***	***179.1***
South East	Gabes	240.0	310.3	313.7	*202.7*	*111.0*	318.0	*205.9*	*112.1*	322.0	*209.4*	*112.1*	325.5	*212.3*	*113.2*	328.5	*214.9*	*113.6*	331.4	*217.5*	*113.9*	334.1	*219.9*	*114.2*
	Medenine (2)	295.9	385.6	390.3	*240.5*	*149.9*	396.5	*245.3*	*151.2*	402.5	*259.7*	*142.8*	408.0	*264.0*	*144.0*	412.8	*268.0*	*144.8*	417.4	*271.8*	*145.6*	421.9	*275.5*	*146.4*
	Tatouine (1)	100.3	135.2	136.9	*79.0*	*57.9*	139.1	*80.5*	*58.6*	141.2	*82.2*	*59.0*	143.0	*83.6*	*59.4*	144.5	*84.7*	*59.8*	145.9	*85.8*	*60.0*	147.2	*86.9*	*60.3*
	(sub-total)	**636.2**	**831.1**	**840.9**	***522.2***	***318.8***	**853.6**	***531.7***	***322.0***	**865.7**	***551.3***	***314.4***	**876.4**	***559.9***	***316.6***	**885.8**	***567.6***	***318.2***	**894.7**	***575.1***	***319.6***	**903.2**	***582.3***	***320.8***
TOTAL TUNISIA		**6966.2**	**8785.7**	**8890.3**	**5437.7**	**3452.6**	**9024.8**	***5536.9***	***3487.9***	**9153.8**	***5655.1***	***3498.7***	**9275.8**	***5753.1***	***3522.8***	**9390.6**	***5846.7***	***3544.0***	**9501.3**	***5938.1***	***3563.2***	**9606.8**	***6026.3***	***3580.5***

(# between 1984 - 1994)

Source : "Rapport Annuel sur les Indicatoeurs d'Infrastructure 1999" (INS, Min. du Developpement Economique)

Note ; (1) extention of 1994 figures * probable figures

(2) extention of 1996 figures ** provisional figures

Table 2.4.2 Average Annual Population Growth Rate

Governorate	Average annual population Growth Rate (1984-1994)			Average annual population growth rate projection (1994-2000)		
	Urban	Rural	Total	Urban	Rural	Total
Tunis	1.3%	-	1.3%	0.8%	-	0.8%
Ariana	4.7%	2.3%	4.2%	2.9%	1.5%	2.6%
B.Arous	4.2%	3.2%	4.1%	3.4%	1.1%	3.1%
Nabeul	2.7%	1.4%	2.2%	1.6%	0.8%	1.3%
Zaghouan	4.1%	0.8%	1.8%	1.6%	0.7%	1.0%
Bizerte	2.5%	1.2%	1.9%	1.4%	0.6%	1.1%
Beja	2.4%	0.1%	0.9%	0.9%	0.1%	0.4%
Jendouba	2.9%	0.6%	1.1%	1.5%	0.4%	0.7%
Le Kef	2.0%	0.0%	0.8%	0.5%	0.1%	0.3%
Siliana	3.3%	-0.1%	0.9%	0.8%	0.1%	0.3%
Kairouan	3.7%	1.7%	2.3%	1.7%	0.7%	1.0%
Kasserine	4.0%	1.8%	2.5%	1.8%	0.9%	1.3%
Sidi Bouzid	6.2%	1.8%	2.6%	2.0%	0.8%	1.0%
Sousse	3.3%	1.6%	2.9%	2.1%	1.0%	1.8%
Monastir	2.6%	-	2.6%	1.9%	-	1.9%
Mahdia	2.1%	2.1%	2.1%	1.7%	0.9%	1.3%
Sfax	2.6%	1.9%	2.3%	1.8%	0.9%	1.4%
Gafsa	3.5%	0.8%	2.6%	1.2%	0.3%	1.0%
Tozeur	2.5%	3.1%	2.6%	1.7%	0.6%	1.4%
Kebili	3.7%	2.6%	3.2%	1.7%	0.8%	1.3%
Gabes	3.2%	1.4%	2.5%	1.4%	0.5%	1.1%
Medenine	2.8%	2.3%	2.6%	2.3%	-0.4%	1.3%
Tataouine	4.0%	1.8%	3.0%	1.6%	0.7%	1.2%
Total	2.9%	1.4%	2.2%	1.7%	0.6%	1.3%

Table 2.5.1 Major Economic Target Figures of the 9th Development Plan

Description	8th Plan	9th Plan
Major Indicators		
1) Global Factor of Productivity	1.3	2.4
2) Marginal Capital-Output Ratio	5.4	4.4
3) Consumer Price Increases	4.8	3.7
Global Results (Annual Average Growth Rates at Constant Prices of 1990)		
1) Gross Domestic Products (GDP)	4.6	6
2) Per Capita Income	2.9	4.3
3) Consumption	4.8	5.3
4) Investment	5.6	9.2
5) Investment Rate	26	26.4
6) Gross Savings	8.7	14.6
7) Gross Savings Rate	21.6	25.1
8) Imports	5.4	5.9
9) Exports	6.3	6
10) Job-Creation (in '000)	280	320
11) Rate of satisfying the job-demand (in %)	89.4	91.4
Main End-of-Period Figures		
1) Investment Rate	24.1	27.5
2) Savings Rate	22.3	26.9
3) Current Deficit/GDP	2.9	2.2
4) Budget Deficit/GDP	3.9	2
5) Debt Ratio	51.4	40.9
6) Debt Service Ratio (DSR)	17.7	16.2

Source : "Ninth Development Plan in Brief" 1997-2001

Table 2.6.1 Summary of Central Government Budgetary Flows

(unit : Million TD)

				1997	1998	1999	
				Actual	Actual	*F.L..**	Actual
REVENUE	**Internal Means**	Tax Revenue		4,228	4,763	*5,185*	5,207
		Non-Tax Revenue		966	1,327	*1,000*	922
		Sub-Total		**5,194**	**6,090**	***6,185***	**6,129**
	Borrowed Resources	Internal		1,874	1,806	*2,288*	1,656
		External		1,167	625	*1,117*	1,095
		Sub-Total		**3,041**	**2,431**	***3,405***	**2,751**
	TOTAL			**8,235**	**8,521**	***9,590***	**8,880**
EXPENDITURE	**Operating Capital Goods & Loans Granting Expenditure**	Operating Expenditure	Payroll & Salaries	n.a.	2,493	*2,707*	2,706
			Means of Public Service	n.a.	423	*427*	441
			Interventions	n.a.	983	*970*	955
			Sub-Total	3,634	3,899	*4,104*	4,102
		Capital Goods and Loan Granting		1,644	1,709	*1,939*	2,063
		Sub-Total		**5,278**	**5,608**	***6,043***	**6,165**
	Debt Service	Principal		2,262	2,308	*2,687*	2,311
		Interest		779	770	*860*	770
		Sub-Total		**3,041**	**3,078**	***3,547***	**3,150**
	TOTAL			**8,319**	**8,686**	***9,590***	**9,315**
BALANCE (Deficit Exclusive of Debt Redemption)				**-887**	**-288**	***-718***	**-875**
FINANCING OF THE DEFICIT	**Net Domestic Financing**	Internal Borrowing		1,874	1,806		1,656
		Debt Redemption		-1,638	-1,693		-1,566
		Financing from Treasury Resources		108	165		435
		Sub-Total		344	278		525
	Net Foreign Financing	External Borrowing		1,167	625		1,095
		Debt Redemption		-624	-615		-745
		Sub-Total		543	10		350

Source : "Annual Report 1998 & 1999" (Central Bank of Tunisia)

* F.L. : Financial Law

CHAPTER 3 PRESENT CONDITIONS OF THE RURAL WATER SUPPLY PROJECT

3.1 Background

3.1.1 Organization for Rural Water Supply

In the rural areas, two organizations are working for the sector of potable water supply, one is SONEDE who mainly supply water in densely populated rural areas, and the other is DGGR.

(1) SONEDE

In the course of the period from 1987 to 1998, SONEDE realized 1,475 projects for supplying drinking water to some 750,000 rural inhabitants under the Presidential program, National Solidarity Fund program, and National Development Plans.

(2) DGGR

As of December 1998, DGGR had realized 559 rural water supply projects as the national program for 808,371 inhabitants in 2,126 localities around the country and 79 projects for 95,218 inhabitants in 482 localities were being realized. Moreover, 456 projects under the Integrated Development Program, National Solidarity Fund Program and Presidential Program for 321,203 inhabitants in 1,017 localities were realized and 50 projects under said program were being implemented as of December 1998.

Table 3.1.1 shows the evolution of rural drinking water supply from 1984 to 1998 realized by SONEDE and DGGR and Table 3.1.2 shows the recapitulation of DGGR projects by governorate.

3.1.2 The Rural Water Supply Project Financed by JBIC

The Government of Tunisia set the agricultural sector development and the improvement of living standards in rural area as top priority policies in the Eighth National Development Plan (1992-1996) and it has implemented the Agricultural

Sector Investment Loan Program (PISA: *Prêt d'Investissement au Secteur Agricole*) which consists of the following four components:

(1) Small scale dam
(2) Groundwater exploration and development
(3) Irrigation
(4) Rural water supply

Regarding the rural water supply, Ministry of Agriculture had prepared the 5-Year Development Plan for Rural Water Supply in conformity with the Ninth National Development Plan (1997-2001). The following is the contents of the five-year rural water supply master plan:

(1) Investment amount under the master plan was estimated at 119 million DT during these five years, which is equivalent to 2.5% of the total investment amount of Ministry of Agriculture in the same period.
(2) The target number of projected water supply systems is 541.
(3) Estimated beneficiaries of said water supply systems are around 347,000.
(4) The target service rate of rural water supply in 2001 is 80% while the rate in 1996 was 67%.

This master plan necessitated international and/or bilateral economic cooperation to implement its projects. Following table shows number of yearly implemented projects and their investment amount sorted through fund sources:

unit :1,000DT

Fund Source	1997		1998		1999		2000		2001		Total	
	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
KfW	0	0	29	8,473	32	10,033	0	0	0	0	61	18,506
PDARI	10	2,061	2	230	2	300	3	270	3	393	20	3,254
PISA(OECF LOAN)	63	16,510	0	0	0	0	0	0	0	0	63	16,510
National Project[1)]	0	0	75	12,973	77	14,369	63	11,257	54	13,066	269	51,665
Regional Project[2)]	0	0	32	5,307	26	5,070	36	9,852	3	8,845	97	29,074
Total	73	18,571	138	26,983	137	29,772	102	21,379	60	22,304	510	119,009

Source: 5-Year Development Plan for Rural Water Supply, DGGR
1) The project being financed by MOA
2) The project being financed by Economic Development Fund (Ministry of Economic Development) which is managed by governorates

However, the content of this table had not been fixed in 1998 and GOT was

looking for fund source for the master plan. Under such situation, GOT requested a loan fund from the Government of Japan for the rural water supply project which consists of 119 water supply system construction subprojects scattered in 19 governorates.

Upon receipt of this request, JBIC dispatched a SAPROF study team to select 84 feasible subprojects from 90 candidate subprojects which are screened through a preliminary survey executed by GOT. These 84 subprojects are classified into the Project 2000 (38 subprojects) and the Project 2001 (46 subprojects) and they are suppose to be implemented in respective corresponding year.

Then some subprojects were exchanged between the framework of the Project 2000 and the Project 2001 by GOT. Moreover, some subprojects had been included in the Project by SAPROF and were executed in 1999 by corresponding governorates. Such subprojects were excluded from the framework of the Project and other new projects replaced them under the approval by JBIC Paris.

One of the reasons for these incidents is the decentralized policy of Tunisia. As shown in Figure 3.1.1, DGGR and CRDA are posted same level in the hierarchy of the Ministry of Agriculture so CRDA can therefore execute its regional project by itself. The classification of the nature of projects such as “National Project” and “Regional Project” depends on the fund source.

3.2 Project 2000 Current Situation

Each CRDA started the feasibility study and detailed design of subprojects in its administrative area since 1999. Due to delay of the design works, the basic study, the detailed design, and the tender documents were completed 25 subprojects, 24 subprojects, and 20 subprojects respectively as of April 2001. Those reports were reviewed by the JICA Study team in view of water demand projection, hydraulic calculation, financial analysis, and unit prices adequacy. The conclusion has no negative factor on the implementation of the subprojects and some lessons were drawn for the implementation of the Project 2001.

This review study has been interpreted as the review of the whole Project 2000.

As of August 2000, around 80% of the subprojects completed the necessary studies for their implementation and some of them had already started the bidding procedure to procure construction works.

Table 3.2.1 compares the subprojects of the Project 2000 in the framework of SAPROF with their present situation.

3.3 Project 2001 Current Situation

Table 3.3.1 shows the subprojects of the Project 2001 in the framework of SAPROF with their present situation.

Around 1,500 rural water supply systems had been constructed up to 2000, it is said that newly projected areas under the Rural Water Supply Project, consequently, have difficulties regarding socio-economic conditions, physical conditions, etc. such as dispersion of houses, scarcity of a good quality and enough quantity water source and so on. The subprojects under the Project 2001 seem to be under the similar conditions.

Project 2001 consists of 44 subprojects. Sidi Sarah subproject in Jendouba was suspended in course of the survey because the investment cost per person exceeded 550 DT. Marthoum Maja subproject in Kasserine was also suspended because the beneficiaries comprehended the subproject as irrigation water supply, and it was altered to Henchir Tounsi subproject.

Further, three subprojects consisting of Jouaouda1/Battaha, Maalim, and Ouled Dhifallah which took water from the Barbara dam respectively were unified so that one water intake facility distributed to the whole subproject area. Hence, three subprojects became one subproject called Complexe AEP Barbara subproject.

As a result of the above situations, 41 subprojects were studied finally.

3.4 Study Procedures

3.4.1 Applied Methodology

In order to make the Drinking Water Supply Projects uniform, DGGR put a methodology for the purpose of studying rural water supply systems of a simple and sustainable operation. The study includes the following two phases (Figure 1.4.2):

(1) Feasibility Study, and
(2) Detail Study and Tender document.

3.4.2 Project Identification

This stage is to identify a project area, collect information and has the following elements:

(1) Existing mode and conditions for water supply: water quality and quantity, access, hygienic conditions, waterborne diseases,
(2) Concerned localities (assignment, population, type of habitat, access...), and
(3) Projected water resources: location, quality (physico-chemical and microbiological analysis).

This stage is decisive for study engagement. Indeed, the project may be pending on the following cases:

(1) Water quantity at the projected distribution point not conform or insufficient,
(2) High project cost, involving an overrunning the threshold,
(3) Project of a SONEDE character, and
(4) Population refusal of the project.

3.4.3 Detailed Site Study, Data Evaluation and Analysis

The technical and socio-economic study aims at:

(1) Completing and verifying the identification data,

(2) Confirming and completing the data on water resources,
(3) Delimiting project area and localities to be served,
(4) Drawing up a sketch of the localities' existing conditions by tracing on the defense ministry map (CEM),
(5) Planning different supply alternatives,
(6) Informing future users of the project water supply system and evaluating their willingness to accept and undertake the project.
(7) Lists of beneficiary families,
(8) Characteristics of the distribution points,
(9) Physico-chemical and microbiological water analysis,
(10) Centerline on the CEM map with STEG and SONEDE networks, and
(11) Previous SONEDE agreement, etc.

3.4.4 Determination of Project Components

Collected data evaluation and analysis aim at determining the project components:

(1) Water resources (nature, characteristics, water quality),
(2) Possible treatment procedures,
(3) Energy to be used,
(4) Pumping station,
(5) Water storage tanks, and
(6) Distribution point division.

Component determining may be based on the necessary arguments concerning:

(1) Water needs of population and cattle,
(2) Nature and characteristic of the distribution point,
(3) Type of available energy,
(4) Preliminary characteristics of the pumping station (flow rate and TMH), and
(5) All other necessary information for severe project components determination.

This stage is to also identify the specific needs in sensitization and to undertake

the following actions:

(1) Preliminary sensitization (1st, 2nd and 3rd visits),
(2) Topographical works, and
(3) Hydraulic and financial design and calculation.

3.4.5 Consultation with Beneficiaries

Future water supply system components will be presented and discussed with the population. The results of this consultation will be taken in consideration for confirming and finalizing the traced project components. This stage will be realized before the topographical works not to deviate the discussions with the beneficiaries only on the distribution points and traced pipeline.

3.4.6 Execution of Topographical Works

Topographical works will be realized on the basis of CEM traced network. Site reconnaissance by land surveyor is performed in the presence of the Study Engineer. The topographical works aim at:

(1) Making up hydraulic calculations and pipe sizing,
(2) Positioning Hydraulic pipes and works, and
(3) Dressing up quantity surveying and estimating investment costs.

3.4.7 Project Design

In this stage the following will be carried out:

(1) Calculation of needs,
(2) Sizing of hydraulic network and works in conformity with the decided criteria,
(3) Water hammer phenomenon analysis and necessary protection of the facilities against it,
(4) System operation and control,
(5) Water treatment procedure selection, and

(6) Sharing the distribution points with their number and type.

It is noted that the project design may be orientated toward a simple operating water supply system insuring water with a minimal marginal cost (fixed charges + variable charges).

3.4.8 Information, Sensitization and Consultation with Beneficiaries (3rd visit)

After completing the hydraulic and financial designs and before compiling the study documents, population beneficiaries will be consulted for their information such as:

(1) Final network pipeline route retained,
(2) Layout and distribution of water points,
(3) Operation of the system,
(4) Marginal water cost (fixed plus variable charges),
(5) Cost recovery mode (Water sale or monthly subscription), and
(6) Recommended management system.

Commitment forms for running cost will be explained, distributed, and collected.

This methodology has been effective since 1994 and diffused to study engineers of CRDA as well as to local consultants. For the Project 2001, JICA Study Team takes several measures for a good use of this methodology and to bring the studies to a successful conclusion. They are:

(1) Presentation of the methodology in the terms of reference,
(2) Sending the letters to different CRDA for requiring its good coordination and applying the methodology, and
(3) JICA Study Team members participation in discussions on different subproject design with CRDA and local consultants.

3.4.9 Detailed Design

The objective of a detail design is not only to elaborate the least details necessary

for good understanding and execution of the project, but also to ensure a harmonization between different components of a drinking water supply system. In this way, a detail design shall contain the following elements:

(1) Revise of technical components of the system and their sizing
(2) Descriptive memorandum of the subproject including components
(3) Confidential estimation
(4) Drawings

Table 3.1.1 Evolution of Rural Water Supply from 1984 to 1998

Governorate	1984 Supply			1989 Supply			1994 Supply			1998 Supply					
	SONEDE	GENIE RURAL	TOTAL	SONEDE	GENIE RURAL	TOTAL	SONEDE	GENIE RURAL	TOTAL	SONEDE		GENIE RURAL		TOTAL	
										Popul.	**%**	**Popul.**	**%**	**Popul.**	**%**
District Tunis	53%		53%	56%	1%	57%	68%	8%	76%	118,203	75.50%	19,556	12.50%	137,759	87.90%
Ariana	56%		56%	57%	1%	58%	68%	8%	76%	87,766	75.70%	13,041	11.30%	100,807	87.00%
Ben Arous	41%		41%	53%	2%	55%	66%	10%	75%	30,437	71.90%	6,515	13.50%	36,952	90.70%
North East	21%	5%	26%	26%	14%	40%	35%	33%	67%	190,369	36.70%	202,035	39.00%	392,404	75.70%
Nabeul	23%	8%	31%	32%	19%	50%	41%	34%	75%	95,121	43.30%	77,003	42.70%	172,124	80.40%
Zaghouan	18%	5%	23%	24%	20%	44%	36%	38%	74%	36,661	37.60%	45,114	46.30%	81,775	83.90%
Bizerte	20%	2%	22%	22%	5%	27%	28%	28%	56%	58,587	28.40%	79,918	38.70%	138,505	67.00%
North West	13%	6%	19%	16%	10%	26%	23%	24%	47%	200,361	24.50%	323,186	39.40%	523,547	63.90%
Beja	15%	1%	16%	18%	4%	21%	27%	17%	44%	53,108	32.20%	63,186	27.30%	116,294	60.80%
Jendouba	13%	4%	17%	17%	8%	24%	22%	20%	42%	84,466	26.90%	105,968	33.80%	190,434	60.70%
Le Kef	10%	17%	27%	13%	24%	37%	19%	39%	58%	26,994	20.90%	78,672	51.80%	105,656	72.50%
Siliana	13%	4%	16%	16%	10%	26%	21%	27%	48%	35,793	23.00%	75,360	43.60%	111,153	65.90%
Cent West St	11%	13%	24%	15%	27%	42%	22%	46%	67%	228,699	23.90%	485,946	50.70%	714,645	74.60%
Kairouan	13%	7%	20%	17%	15%	32%	29%	30%	60%	133,566	34.10%	150,019	38.30%	283,585	72.40%
Kasserine	4%	23%	27%	7%	43%	50%	9%	69%	77%	23,712	9.30%	168,331	66.00%	192,043	75.20%
Sidi Bouzid	13%	13%	26%	19%	29%	48%	23%	47%	69%	71,421	26.60%	167,596	50.70%	239,017	76.90%
Centre East	19%	3%	22%	30%	8%	37%	42%	18%	60%	296,898	49.90%	165,771	27.90%	462,669	77.70%
Sousse	41%	6%	47%	58%	8%	65%	70%	21%	91%	75,508	71.90%	25,317	24.10%	100,825	96.00%
Mahdia	18%		18%	30%	1%	31%	38%	7%	45%	95,343	48.00%	40,080	18.70%	135,423	68.50%
Sfax	11%	5%	16%	19%	12%	31%	36%	24%	60%	126,047	43.10%	100,374	34.30%	226,421	77.40%
South West	20%	6%	26%	21%	15%	36%	54%	29%	83%	107,737	60.50%	52,221	29.30%	159,958	89.90%
Gafsa	5%	10%	15%	6%	23%	29%	24%	48%	72%	27,472	31.10%	44,714	50.60%	72,186	81.70%
Tozeur	71%	2%	72%	75%	8%	83%	87%	10%	97%	24,858	92.80%	1,929	7.20%	26,787	100.00%
Kebili	22%	2%	24%	28%	5%	32%	87%	8%	95%	55,407	88.20%	5,578	8.90%	60,985	97.10%
South East	22%	7%	29%	28%	9%	38%	45%	17%	62%	186,583	58.60%	79,205	24.90%	265,788	83.50%
Gabès	26%	7%	33%	37%	10%	47%	48%	16%	64%	69,952	61.60%	26,064	22.90%	96,016	84.50%
Médenine	28%	2%	29%	30%	3%	34%	43%	18%	61%	75,386	52.00%	39,169	27.00%	114,555	79.00%
Tatouine	5%	15%	20%	9%	21%	31%	45%	18%	63%	41,245	68.90%	13,972	23.40%	55,217	92.30%
TOTAL	**18%**	**7%**	**25%**	**22%**	**15%**	**37%**	**33%**	**29%**	**62%**	**1,328,850**	**37.50%**	**1,327,920**	**37.50%**	**2,656,770**	**75.00%**

source: Study of the Sector of Potable Water in Rural Areas, Ministry of Agriculture, Dec. 1999

Table 3.1.2 Recapitulation of DGGR Rural Water Supply Project by Governorate

GOVERNORATE	REALIZED PROJECTS AS OF 31st OF DECEMBER 1998			PROJECTS UNDER IMPLEMENTATION			NATIONAL PROGRAMS + REGIONAL PROGRAMS Average coefficient of price revision (June 1998) : 111,5 %						
	Number of projects	Number of villages	population	Number of projects	Number of villages	population	Number of projects	Number of villages	population	Amount (1,000TD) TD current	Amount (1,000TD) TD 1998	TD/habitan TD Current	TD/habitan TD 1998
District of Tunis	47	82	17,135	3	8	1,531	50	90	18,666	4,183	4,666	224	250
Ariana	28	41	10,256	1	4	890	29	45	11,146	2,342	2,612	210	234
Ben Arous	19	41	6,879	2	4	641	21	45	7,520	1,841	2,053	245	273
North East	177	452	169,727	17	118	20,684	194	570	190,411	31,717	35,377	167	186
Nabeul	67	205	63,308	10	78	10,870	77	283	74,178	10,895	12,152	147	164
Zaghouan	48	114	38,358	1	7	483	49	121	39,341	7,152	7,977	182	203
Bizerte	62	133	67,561	6	33	9,331	68	166	76,892	13,670	15,248	178	198
North West	251	1.000	256,841	31	163	28,563	282	1.163	285,404	60,311	67,271	211	236
Beja	71	290	55,180	10	33	9,515	81	323	64,695	14,309	15,960	221	247
Le Kef	52	174	45,336	4	38	5,324	56	212	50,660	12,351	13,776	244	272
Siliana	84	226	57,076	9	39	5,657	93	265	62,733	12,599	14,053	201	224
Jendouba	44	310	99,249	8	53	8,067	52	363	107,316	21,052	23,482	196	219
Central West	259	820	325,265	39	177	39,390	298	997	364,655	59,318	66,164	163	181
Kairouan	84	426	107,014	12	74	16,305	96	500	123,319	19,684	21,956	160	178
Kasserine	109	169	98,014	16	46	12,613	125	215	110,627	19,995	22,303	181	202
Sidi Bouzid	66	225	120,237	11	57	10,472	77	282	130,709	19,639	21,906	150	168
Central East	123	403	176,801	21	178	34,761	144	581	211,562	34,686	38,689	164	183
Sousse	15	31	15,787	2	10	1,549	17	41	17,336	3,022	3,371	174	194
Mahdia	53	147	59,783	14	141	24,931	67	288	84,714	15,655	17,462	185	206
Sfax	55	225	101,231	5	27	8,281	60	252	109,512	16,009	17,857	146	163
South West	67	182	48,210	8	30	2,871	69	212	51,081	13,010	14,511	255	284
Gafsa	51	173	43,702	7	29	2,151	58	202	45,853	11,721	13,074	256	285
Tozeur	7	6	2,608	1	1	720	8	1	3,328	1,079	1,204	324	362
Kebili	3	3	1,900				3	3	1,900	210	234	111	123
South East	97	204	135,595	10	40	7,032	107	244	142,627	23,353	26,048	164	183
Gabès	22	74	34,114	2	5	2,507	24	79	36,621	8,720	9,726	238	266
Médenine	41	80	53,015	5	32	3,716	46	112	56,731	8,925	9,955	157	175
Tatouine	34	50	48,466	3	3	809	37	53	49,275	5,708	6,367	116	129
TOTAL /Average	**1,015**	**3,143**	**1,129,574**	**129**	**714**	**134,832**	**1,144**	**3,857**	**1,264,406**	**226,578**	**252,727**	**179**	**200**

source: Study of the Sector of Potable Water in Rural Areas, Ministry of Agriculture, Dec. 1999

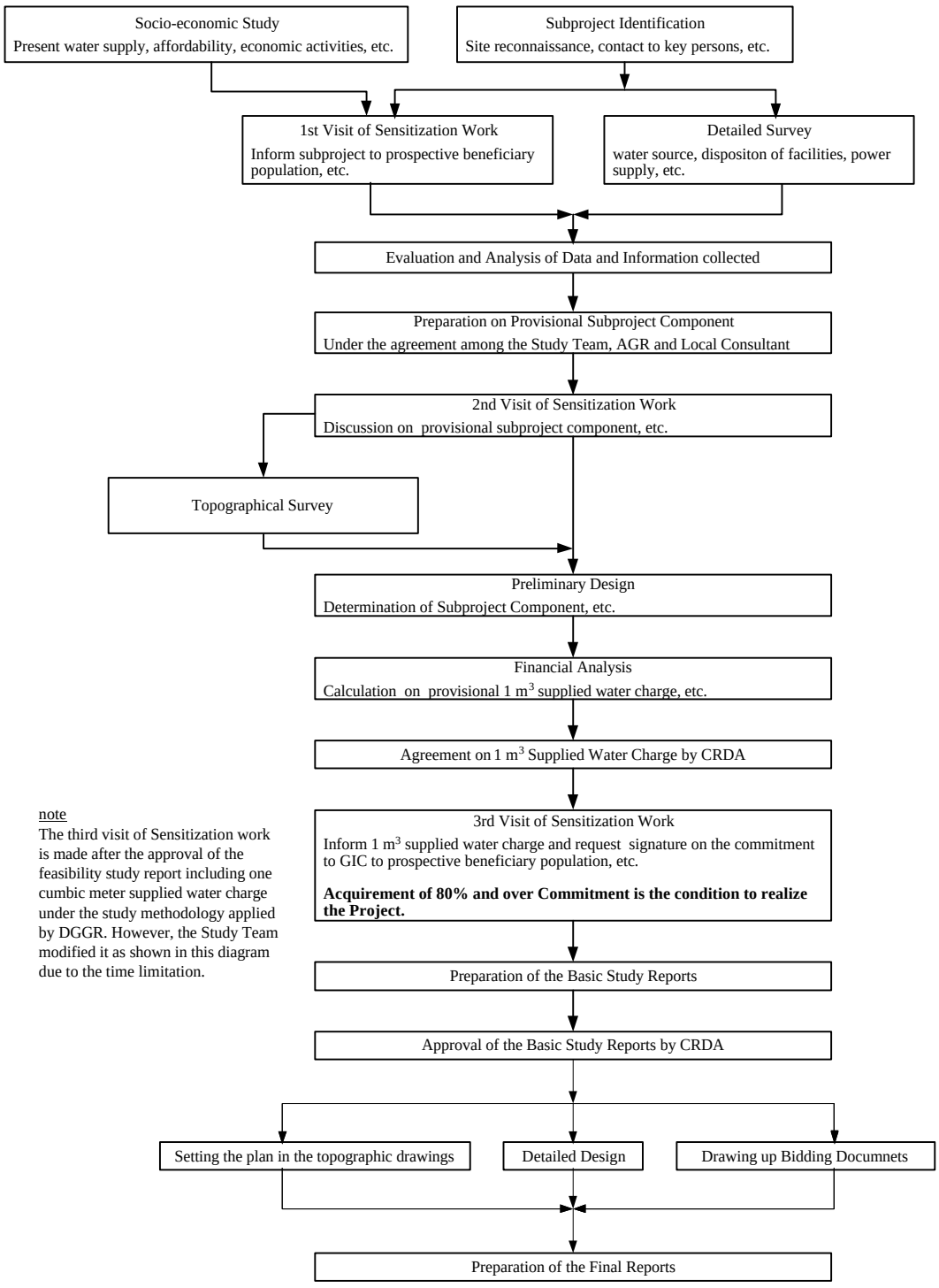
Table 3.2.1 Comparison Project 2000 between SAPROF Study and Latest Data

Governorate	Subproject		Population in 1998		Population in 2015		Water Source	Remark
	SAPROF	Modified in 2000	SAPROF	Updated in F/S	SAPROF	Updated in F/S		
ARIANA	BIR TOUIL OUEST	BIR TOUIL OUEST	180	435	248	599	SONEDE CONNECTION	
	GUECHBA	GUECHBA	450	415	620	571	SONEDE CONNECTION	
BEJA	EL GARIA		300		305		SPRING	Shift to Project 2001
	EL MATRIA et OULED MARAI	EL MATRIA et OULED MARAI	672	1403	684	1645	GR EXTENSION	
	NOUAICHIA - SOUALA	NOUAICHIA - SOUALA	700	336	712	394	TUBE WELL	
		CHOUABIA	900	509	915	597	SPRING	Shift from Project 2001
BIZERTE	BORDJ STILI	BORDJ STILI	1218	1160	1467	1421	TUBE WELL	
		DOUMIS	1152	762	1387	933	TUBE WELL	Shift from Project 2001
		SIDI MANSOR	978	1140	1178	1398	TUBE WELL	Shift from Project 2001
GABES	CHEGUIME	CHEGUIME	600		676		SONEDE CONNECTION	
	LADBECHE	LADBECHE	668		752		SONEDE CONNECTION	
GAFSA	SHAILIA	SHAILIA	740	1473	805	1603	GR EXTENSION	
	SKAKRIA	SKAKRIA	370		403		SONEDE CONNECTION	
	TAFARTAST	TAFARTAST	375	745	408	803	GR EXTENSION	
JENDOUBA	AIN TRARIB	AIN TRARIB	2775		2970		SPRING	
	CHOUAOULA		2261		2420		GR EXTENSION	Shift to Project 2001
	EL BELDA	EL BELDA	1339		1433		SPRING	
	JAHFA	JAHFA	4867		5209		TUBE WELL	
		BELDIA	2133		2283		DAM	Shift from Project 2001
KAIROUAN	ATTAYETT-OULED AMOR	ATTAYETT-OULED AMOR	840	891	978	1038	GR EXTENSION	
	GARAAT TEBAL	GARAAT TEBAL	1340		1560		SONEDE CONNECTION	
	STALIA	STALIA	1270	1273	1479	1483	GR EXTENSION	
KASSERINE	BOUKHIL	BOUKHIL	1245		1604		TUBE WELL	
	KSAR TOUIL	KSAR TOUIL	979		1261		TUBE WELL	
	O.KMIM / RAKHMET	O.KMIM / RAKHMET	2262		2914		TUBE WELL	
LE KEF	AIN EL HENGHIR - TEL EL CHOZLA	AIN EL HENGHIR - TEL EL CHOZLA	2720		2720		SONEDE CONNECTION	
	MAGRA - SIDI BOUMEFTAH		1100		1100		SONEDE CONNECTION	Excuted in 1999
		AIN BABUCHE	545		545		TUBE WELL	Replace MAGRA-SIDI BOUMEFTAH
MAHDIA	BIR ESSID	BIR ESSID	4052		4963		SONEDE CONNECTION	
MEDENINE	BEDOUI	BEDOUI	1050	823	1375	1061	SONEDE CONNECTION	
	BOULEKTIFET	BOULEKTIFET	444	501	582	646	SONEDE CONNECTION	
	DIR HOUIA	DIR HOUIA	732	688	959	887	SONEDE CONNECTION	
NABEUL	EL BHIRA	EL BHIRA	310		386		SONEDE CONNECTION	
	EL GHAZALIA	EL GHAZALIA	1275		1588		TUBE WELL	
	HARET CHAARAA	HARET CHAARAA	1095		1364		TUBE WELL	
SIDI BOUZID	BANAJDIA	BANAJDIA	3200	3723	4122	4336	TUBE WELL	
	GASSAIRIA	GASSAIRIA	1170	2229	1507	2596	TUBE WELL	
	MALOUSSI / GALLEL	MALOUSSI / GALLEL	1500	2127	1932	2478	TUBE WELL	
SILIANA	OUED ELLOUZ	OUED ELLOUZ	410		410		SONEDE CONNECTION	
SOUSSE	CHAALIL, AOUZJIA		316		407		SONEDE CONNECTION	Excuted in 1999
		O.MHAMED	524		674		SONEDE CONNECTION	Replace CHAALIL, AOUZJIA
	SABBAGHINE	SABBAGHINE	335	315	431	382	SONEDE CONNECTION	
ZAGHOUAN	DHORBANIA	DHORBANIA	700		775		TUBE WELL	
	KEF LAZREG	KEF LAZREG	683		756		TUBE WELL	
No. of Subproject	38	40						
Total Population			52,775		61,267			
Total Population on D/D executed subproject			17,906	20,948	21,789	24,871		

Source: Review Report for the Project 2000

Table 3.3.1 Comparison Project 2001 between SAPROF and Latest Data

Governorate	Subproject		Population in 1998		Population in 2017		Watere Source		Remarks
	SAPROF	Modified in 2000	SAPROF	Updated in F/S	SAPROF	Updated in F/S	SAPROF	Updated in F/S	
ARIANA	FAIDH EL AMRINE-SIDI GHRIB	FAIDH EL AMRINE-SIDI GHRIB	300	681	429	938	SONEDE CONNECTION	SONEDE CONNECTION	
	HMAIEM ESSOUFLA	HMAIEM ESSOUFLA	135	175	193	241	SONEDE CONNECTION	SONEDE CONNECTION	
	TYAYRA	TYAYRA	150	218	214	300	SONEDE CONNECTION	SONEDE CONNECTION	
BEJA	CHOUABIA		900		917		SPRING		Shift to Project 2000
	EL FTETNA - EL HAMRA		1344		1370		SPRING		Excuted in 1999
	LAHOUACHE		400		408		DEEP WELL		Cancelled (no water source)
		EL GARRAG	1200	1412	1221	1436		SONEDE CONNECTION	Replaced EL FTETNA-EL HAMRA
		EL GARIA	240	458	305	466	SPRING	SONEDE CONNECTION	Shift from Project 2000
		FATNASA	1320	1013	1343	1030		SPRING	Replaced LAHOUACHE
BEN AROUS	OULED BEN MILED and OULED SAAD	OULED BEN MILED and OULED SAAD	915	1002	1696	1740	SONEDE CONNECTION	SONEDE CONNECTION	
	SIDI FREDJ	SIDI FREDJ	618	507	1145	880	SONEDE CONNECTION	SONEDE CONNECTION	
BIZERTE	DOUIMIS		1152		1418		DEEP WELL		
	SIDI MANSOUR		978		1204		DEEP WELL		
		SMADAH	1278	1045	1539	1259		DEEP WELL	Supplement
		TERGULECH	1416	1151	1705	1386		DEEP WELL	Supplement
GABES	BATEN TRAJMA	BATEN TRAJMA	610	2747	696	3093	GR EXTENSION	DEEP WELL	
	CHAABET EJJAYER	CHAABET EJJAYER	400	284	457	320	SONEDE CONNECTION	SONEDE CONNECTION	
	EZZAHRA	EZZAHRA	250	198	285	223	GR EXTENSION	GR EXTENSION	
GAFSA	HENCHIR EDHOUAHER	HENCHIR EDHOUAHER	200	271	220	295	GR EXTENSION	GR EXTENSION	
	KHANGUET ZAMMOUR	KHANGUET ZAMMOUR	623	1636	685	1781	GR EXTENSION	DEEP WELL	
	THLEIJIA	THLEIJIA	860	1492	945	1624	GR EXTENSION	DEEP WELL	
JENDOUBA	BELDIA		2133		2301		DAM		Shift to Project 2000
		COMPLEX AEP BARBARA	(8759)	12492	(9449)	13369		DAM	JOUAOUDA 1 / BATTAHA, MAALIM and OULED SALAH were designed as one water system of which water source is BARBARA Dam.
	JOUAOUDA 1 / BATTAHA	(JOUAOUDA 1 / BATTAHA)	4818		5198		DAM	(GR EXTENSION)	
	MAALIM	(MAALIM)	2019		2178		DAM	(GR EXTENSION)	
	OULED DHIFALLAH	(OULED DHIFALLAH)	1922		2073		DAM	(DAM)	
	SIDI SALAH	SIDI SALAH	455		491		SONEDE CONNECTION		Cancelled (SONEDE will cover)
		CHOUAOULA	2261	2247	2420	2405	GR EXTENSION	GR EXTENSION	Shift from Project 2000
KAIROUAN	CHELALGA	CHELALGA	1452	1526	1721	1777	GR EXTENSION	GR EXTENSION	
	GUDIFETT	GUDIFETT	600	1210	711	1409	GR EXTENSION	GR EXTENSION	
	HMIDET	HMIDET	780	1609	925	1874	DEEP WELL	DEEP WELL	
	ZGAINIA	ZGAINIA	342	693	405	807	GR EXTENSION	GR EXTENSION	
KASSERINE	DAAYSIA	DAAYSIA	690	337	916	434	DEEP WELL	DEEP WELL	
	MARTHOUM - MAJA		570		756		DEEP WELL		Population refused
		HENCHIR TOUNSI	1000	1041	1288	1341		DEEP WELL	Replaced MARTHOUM-MAJA
	OUED LAGSAB	OUED LAGSAB	440	516	584	665	DEEP WELL	DEEP WELL	
	SIDI HARRATH - GOUASSEM	SIDI HARRATH - GOUASSEM	936	838	1242	1079	DEEP WELL	DEEP WELL	
LE KEF	CHAAMBA - O.EI ASSEL - HMAIDIA	CHAAMBA - O.EI ASSEL - HMAIDIA	675	661	675	661	DEEP WELL	DEEP WELL	
	M'HAFDHIA - GHRAISSIA	M'HAFDHIA - GHRAISSIA	700	474	700	474	SONEDE CONNECTION	SPRING	
MAHDIA	COMPLEXE BOUSSLIM	COMPLEXE BOUSSLIM	8608	5245	10798	6424	SONEDE CONNECTION	SONEDE CONNECTION	
	COMPLEXE EL AITHA	COMPLEXE EL AITHA	888	1214	1114	1487	SONEDE CONNECTION	SONEDE CONNECTION	
MEDENINE	BOUGUEDDIMA	BOUGUEDDIMA	264	319	357	418	SONEDE CONNECTION	SONEDE CONNECTION	
	CHOUAMEKH - R. ENNAGUEB	CHOUAMEKH - R. ENNAGUEB	1878	2147	2539	2812	SONEDE CONNECTION	SONEDE CONNECTION	
	ECHGIUIGUIA	ECHGIUIGUIA	480	478	649	626	SONEDE CONNECTION	SONEDE CONNECTION	
	TARF ELLIL	TARF ELLIL	445	476	602	623	SONEDE CONNECTION	SONEDE CONNECTION	
NABEUL	DAMOUSS		1365		1745		SONEDE CONNECTION		Excuted in 1999
		SIDI HAMED	600	1310	747	1632		SONEDE CONNECTION	Replaced DAMOUSS
SIDI BOUZID	AMAIRIA	AMAIRIA	500	364	663	469	DEEP WELL	DEEP WELL	
	BLAHDIA	BLAHDIA	1110	825	1473	1063	DEEP WELL	DEEP WELL	
	BOUCHIHA	BOUCHIHA	1500	1516	1990	1953	DEEP WELL	DEEP WELL	
	MAHROUGA	MAHROUGA	800	635	1062	818	DEEP WELL	DEEP WELL	
SOUSSE	OUARRAD	OUARRAD	2665		3443		SONEDE CONNECTION		D/D completed
	OUED EL KHARROUB		643		853		SONEDE CONNECTION		Excuted in 1999
		OULED ALI	335		431				Replaced OUED EL KHARROUB, D/D completed
ZAGHOUAN	CHEGAIGUIA et SOUAYSSIA		350		392		GR EXTENSION		Excuted in 1999
	JIMLA	JIMLA	300	239	336	265	DEEP WELL	SONEDE CONNECTION	
		ROUISSAT BOUGARMINE	1010	1147	1118	1270		DEEP WELL	Replaced CHEGAIGUIA et SOUAYSSIA
Total	46	46		53,849		63,167			



The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa Japan International Cooperation Agency	Figure 3.1.1 Project Implementation Flow Diagram

CHAPTER 4 BASIC STUDY

4.1 Survey Method

Basic study was carried out to confirm and study about socio-economical and technical possibilities on each subproject.

The local consultants commenced the site reconnaissance based on the information provided by each CRDA office, then they prepared the water supply outline map of 41 subprojects on the existing topographical maps (1/10,000 ~ 1/25,000). The following surveys were conducted using the water supply outline map:

(1) Water quality survey of the sourced water,
(2) Topographical survey for the pipeline routes and the structures,
(3) Geotechnical survey for the pipeline routes and the elevated tanks points,
(4) Socio-economic impact survey for rural water supply projects, and
(5) Sensitization activity.

After the site surveys, water demand projection and preliminary design of water supply structures were conducted, then financial analysis consisting of the investment cost per person and unit water price per cubic meter were analysed.

4.2 Water Quality Survey

4.2.1 Introduction

The JICA Study Team conducted the water quality assessment covering 41 water sources included in the Project 2001. Among 41 water sources, those categorized in dam, spring, deep tube well and GR extension totaling 25 were sampled and subjected to laboratory analysis for bacteriological and physico-chemical parameters. However, two subprojects in Jendouba were not analyzed because they are to be supplied from Barbara Dam water through Ouled Dhifallah subproject. The quality of the remaining 16 water sources, which is under jurisdiction of SONEDE, was in principle reviewed from standpoint of legal requirement imposed on water supplier with supporting monitoring data because

internal control is being carried out on regular basis by SONEDE.

However, the water source of the Sidi Hammed subproject in Nabeul, though it falls within SONEDE Connection, water samples were taken for analysis because the water supply system of the subproject was designed to take untreated water from the transmission pipe connecting a reservoir in Beja to the treatment facility in Tunis.

Type of Water Source and Assessment

	Type of Water Source	Number	Data source of assessment
1	Dam (Reservoir)	1	Laboratory analysis
2	Spring	2	Laboratory analysis
3	Deep Tube Well	16	Laboratory analysis
4	GR Extension	6	Laboratory analysis
5	SONEDE Connection Untreated Water	1	Laboratory analysis
Sub-total		26	-
6	SONEDE Connection Treated Water	15	Monitoring Data
Total		41	-

4.2.2 Methodology

(1) Sampling Procedure

Water samples were taken by pump or manual water sampler and stored in bottles made either with Polyethylene Terephthalate (PET) or glass having securely fitting stoppers or caps. EC, pH, and temperature were recorded on the spot. Samples were transported and delivered to the laboratories as immediately as possible, usually on the day or the following day within 24 hours. During the transportation, samples were kept under cool and dark ambient.

(2) Laboratory Analysis

The laboratory analyses were carried out at *Laboratoire central d'analyse et d'essai* (LCAE) in Tunis, and covered the following 33 parameters. These parameters are presented in accordance with the categories given in the national draft guideline for drinking water (*"PNT 09.14 (1983) QAULITE DES EAUX DE BOISSON"*).

1	Bacteriological quality		
	a. Total coliform b.Thermotolerant coliform	c. Escherichia coli d. Faecal streptococci*	
2	Toxic Chemical Substances (Provisoinal Values)		
	a. Arsenic b. Cadmium	c. Cyanide d. Mercury	e. Lead
3	Chemical substances that likely induce health problems		
	a. Fluoride	b. Nitrate	
4	Acceptability Aspects		
	a. Color b. Odor c. Turbidity d. pH e. Chloride	f. Copper g. Magnesium h. Manganese i. Iron j. Zinc	k. Hardness l. Sulfate m. Calcium
5	Other Supporting Data		
	a. Chromium (VI) b. Total Dissolved Solids c. Ammonium	d. Sulfide e. Sodium f. Potassium	g. Nitrite h. Bicarbonate(HCO3) i. Carbonate(CO3)

* Faecal streptococci are not included in the national draft guideline

Most of the analyses were undertaken following 'AFNOR', the French standard method. They are summarized in Table 4.2.1 with brief technical information concerning the analytical procedures and quantification limit.

(3) Basis of Assessment

DGGR refers the *"PNT 09.14 (1983) QAULITE DES EAUX DE BOISSON"* as a basis of assessment of water quality for rural water supply projects. The Ministry of Health has control of drinking water based on the draft guideline. However, this document is a draft guideline for drinking water and has not been acknowledged as the enforceable national drinking standard. Therefore, DGGR assesses the water quality by comparing of human health risk based on the draft guideline with benefits of water supply project. The digest of the draft guidelines is presented in the Table 4.2.2.

Accordingly in the Study, the water quality assessments for drinking purpose were carried out based on the *"PNT 09.14 (1983) QUALITE DES EAUX DE BOISSON" which* considered the above mentioned conditions. Guidelines for Drinking-Water Quality published by World Health Organization (Second Edition) were also referred when necessary.

4.2.3 Results and Assessment

The analysis results are given in Table 4.2.3.

(1) Overall Assessment

The total dissolved solid (TDS) for all samples range between 169 and 1,845 mg/l, which were below the maximum acceptable range of draft guideline for drinking water of Tunisia (2,000-2,500 mg/l).

Water sources in the northern area, levels of TDS are generally below 1,000 mg/l, on the other hand in the southern area, levels of TDS are generally over 1,000 mg/l which indicated the presence of high sulfate, chloride and cations such as calcium and sodium in the aquifer of southern area. However, the lowest TDS (169mg/L) is found at the very deep well (716m) of Blahdia in the southern area. In comparing surface water sources and groundwater sources, the former was proved to be more vulnerable to human activity as indicated in data of one water source in Le Kef categorized as spring which appeared to be contaminated by nitrate, while the quality of the latter was more susceptible to geological settings.

However, 12 water sources out of 26 water samples did not meet the draft guideline values. The parameters that did not meet the draft guideline values included lead (Pb), fluoride (F), nitrate (NO_3^-), pH, calcium (Ca), sulfate (SO_4^{2-}), chloride (Cl^-), turbidity, and iron (Fe). Quality of these water sources were judged inadequate for potable use based on the draft guideline.

The following part is devoted to describing the effects of these constituents on public health and consumers' acceptability.

(2) Bacteriological Quality

According to Table 4.2.3, all the water sources judged acceptable as drinking water sources from bacteriological aspects provided that the water is disinfected before distribution except for the sample of Baten Trajma subproject. The well

for the Baten Trajma subproject had not been completed when the sample was collected. These inadequate circumstances associated with sampling procedure may account for the high counts of E.coliform (<1,000) of the sample. It is suggested to take sample for bacteriological test after well completion.

Thermotolerant coliform was detected for some water samples analyzed in this study, faecal streptococci, generally regarded as supporting indicator of faecal pollution, was also detected for most of the water samples. In addition, such water sources as reservoir, spring and shallow groundwater are always at the risk of contamination by human and animal excreta. Therefore, effective disinfecting process is a precondition of water distribution.

(3) Toxic Chemical Substances

1) Lead

The high concentration of lead (0.361 mg/L) detected in the sample of the Blahdia deep well which is 716m in depth, where at levels exceeding the limit set (<0.05 mg/L) in the drinking water draft guideline value. Therefore, quality of this water source was judged inadequate for potable use based on the draft guideline. Though the high concentration of copper (0.291 mg/L) and zinc (2.51 mg/L) were also recognized in the same sample, those contents were still acceptable. There also was a high concentration of lead (0.329 mg/L) by reanalysis of spare sample to confirm the analysis results. Though the final decision on the realization of Blahdia subproject will be made by DGGR as the responsible executing agency, the Study Team can't recommend in principle making use of water from such water sources especially for drinking purpose.

2) Other Chemical Substances

Toxic Chemical Substances in excess of the draft guideline values were not detected in the remaining samples of water sources. However, considering effects of human health, it is suggested that the toxic chemical substance be included in the parameters of water quality to monitor.

(4) Chemical Substances that are Likely to Induce Health Problems

1) Fluoride

Fluoride result for tube wells and the other water sources range between 0.1 and 2.1 mg/l. Unfortunately, four water sources show rather high fluoride values ranging between 1.65 and 2.10 mg/l, which exceeds the draft guideline value. The highest fluoride (2.10 mg/l) was observed at Mahrouga subproject in the Governorate of Sidi Bouzid. Therefore, quality of these water sources was judged inadequate for potable use based on the draft guideline. In case using these water sources for a long term, it may affect population's tooth health.

2) Nitrate

The presence of nitrate (NO3) usually indicates the intrusion of human waste and is an important factor for detecting water sources contamination. Nitrate concentrations in the water sources of subprojects range between 1 and 75 mg/l. A high concentration of nitrate (46 and 75 mg/l) was found at the tube well of Daaysia subproject in Governorate Kasserine and spring of M'hafdhia – Ghraissia subproject in Le Kef Governorate, where levels exceed the limit set (45 mg/l) in the drinking water draft guideline value. Prospective beneficiaries should be warned of the risk of using the water for infant feeding. Preventive actions may provide realistic and effective means of control in the long run. It includes the control of fertilizer use, appropriate management of human and animal excreta in combination with the restriction of access to the water source and its catchment area. Therefore, quality of these water sources was judged inadequate for potable use based on the draft guideline.

(5) Acceptability Aspects and Other Considerations

1) Turbidity

Most of water samples were below 5 Nepherometric Turbidity Unit (NTU), however 6 samples exceeded the WHO's guideline value (5NTU). Samples of Amairia (29 NTU) , Baten Trajma (100 NTU) and Blahdia (270 NTU)

subprojects did not meet the draft guideline values for turbidity which was set at 25 NTU. It is necessary to lessen turbidity values up to guideline level because high turbidity prevents chlorine from functioning effectively. The tube well of Baten Trajma is under drilling, so turbidity was very high. The sample of Blahdia was taken from a long stagnant groundwater in the well by manual sampler, because of difficulty of pumping. Therefore, re-sampling by appropriate pump is required to confirm natural turbidity before construction work.

2) pH

The pH value of the Chouaoula subproject water source in Jendouba amounting to shown pH 8.60 did not meet the draft guideline set for pH values with a range between 6.5pH and 8.5pH. However, pH value at 8.6 does not instantly cause direct problematic event. For effective disinfecting with chlorine, the pH should preferably be less than 8.

3) Chloride

The chloride rate of subprojects water sources ranges between 16 and 728 mg/l. In general, high chloride is found in the southern area. The highest chloride (728mg/L) was observed at the tube well of Baten Trajma subproject in Gabes, which was the only one to exceed the draft guideline (600mg/L). Chloride at this level of concentration can give rise to detectable taste, though, it does not have any health effects. Sensory threshold for chloride varies among nations and regions as consumers can become accustomed to the taste.

4) Iron

Iron concentrations levels in most of water sources are below the drinking water draft guideline value (0.5mg/L). However, in the wells of Bouchiha subproject (1.61mg/L), Baten Trajma subproject (5.72mg/L), and Blahdia subproject (16.75mg/L), the iron concentrations exceeded the draft guideline value. Water from the wells of Baten Trajma and Blahdia are colored due to ongoing drilling and long stagnant conditions, so that re-sampling by pump is required after the well is completed and before the construction of

the work. Iron at this level of concentration does not have any health effects. The discoloration is possibly objectionable to consumers in combination with stains clothes during laundering and give metallic taste. In case that subproject uses the iron contained sourced water, it is expected to remove iron by the equipment.

5) Sulfate

The sulfate concentrations of the 5 subproject water sources in Governorates Sidi Bouzid and Gabes exceeded this draft guideline value of 600mg/L. No health-based guideline value has been derived in WHO's guidelines, this national standard value was adopted from health concern, including catharsis and gastrointestinal irritation.

As the high values may originate in geological sources of the area, most of the water sources in the subproject area was deemed affected by sulfate to various extents. Therefore, it was deemed difficult to exploit alternative water source free of sulfate. Considering the nature of the problems associated with consumption of drinking water with high concentrations, the concentrations determined in this study were supposed to have tolerable level.

6) Calcium

The draft guideline value of drinking water set calcium concentration at 300 mg/L from the viewpoint of scale formation. The samples of the Mahrouga subproject in Sidi Bouzid and Ezzahara subproject in Gabes did not meet the draft guideline values, however, it is normally used such a calcium contained water in southern areas. In this context, it was recommended that the water supply network for the subprojects be regularly maintained with particular attention to scale deposition.

4.2.4 Quality Assessment of SONEDE Water Supply System

The quality of the remaining 15 water sources, which is under jurisdiction of SONEDE, is being regularly monitored and controlled by SONEDE following the

national draft guideline for drinking water. Ministry of Health also has responsibility for inspection of the water quality. An interview was conducted with an officer at SONEDE planned to cover Jimla subproject in Zaghouan to confirm sampling frequency and parameters analyzed in the monitoring activity. The past monitoring data for the latest one year of physico-chemical parameters and for one month of bacteriological parameters were collected for review and assessment. Reviewing the past monitoring data of other SONEDE water supply systems, it was concluded that the water quality of SONEDE connection is generally well controlled and appropriate as drinking water source.

4.2.5 Recommendations

Since securing water quality is a principal element for successful water supply project, regular monitoring of water quality is of great importance to improve welfare of beneficiaries.

Quality of several water sources included in the project did not meet the national draft guideline for drinking water. Though the final decision on the realization of each subproject will be made by DGGR as the responsible executing agency, the Study Team advises DGGR to pay attention to health effects regarding lead (Pb), fluoride (F) and nitrate (NO3-) considering the particular conditions on the scarcity of water sources of each subproject area. However, the Study Team can not recommend in principle making use of water from such water sources especially regarding lead (Pb) as for drinking purpose.

Periodical monitoring of residual chlorine at service points is a prerequisite for all the subprojects to maintain the biological quality for drinking use.

4.3 Topographical Survey

4.3.1 General

The topographical survey is conducted to prepare the pipeline route profiles and topographical maps of the installations such as reservoirs, pump stations, and water purification plant. The survey was entrusted to local topographical firms

through the local consultants contracted with the JICA Study Team.

(1) Collected Data

The list of maps collected by the JICA Study Team is attached to Figure 4.3.1. 1:25,000 scale map covers only the north area and the central east area, and other areas have 1:50,000 scale ones. The *Office de la Topographie et de la Cartographie* (OTC) is the institution in charge of designing and issuing topographical maps. All of the site maps were collected from this institution. Information concerning collected maps are as follows:

1) Topographical map :1:25,000
   Data prepared : From 1980 ~ 1996
   No. of sheets : 103 sheets (original)
2) Topographical map : 1:50,000
   Data prepared : From 1923 ~ 1972
   No. of sheets : 41 sheets (original)

(2) Survey Datum

1) Horizontal Coordinate System

Tunisia has two different horizontal projection systems. One is the Universal Transverse Mercator (UTM) and the other one is the Lambert Authentic conic projection. Basic data is shown below:

a) Reference ellipsoid : Clarke 1880IGN

b) Universal Transverse Mercator

Projection : Zone No.32 (f=0°, L0=9°E)

Scale factor : K-0.999625

c) Lambert authentic conic projection North Tunisia

Lo = 40 GR = 36North,

Mo = 11 GR = 9.54’ East of Greenwich

2) Vertical System

Mean Sea Lesvel (MSL) based on the Bab Bhar Tunisia (7000mm)

3) Map Symbols and Legend

They are prepared based on the legend used in the Project 2000 drawings.

(3) Applied Regulations

1) Technical Specification

The DGGR issues the guidelines of the topographical works for rural water supply projects and applies them to the project basics such as the drawing scales, output style, and so on.

2) Benchmark

A provisional benchmark is prepared for each subproject site. It corresponds to a national triangulation point. In case there is no available points around the sites, a coordinate and elevation data can be acquired from mosque called MARABOUT, which is normally used to benchmark.

4.3.2 Centerline Survey

(1) Establishment of the Permanent Points

Centerline survey is carried out to set up the permanent points, and measure the direction and the distance between two points. The permanent centerline points are placed at the beginning point, projected branching points, all the service points and the center point of each installation, traverse points, and end points. They are made of a 50cm long and 16mm in diameter iron peg reinforced by concrete. A serial station number is allocated for each permanent point. Status of the permanent points are taken in a photo and kept in the file as “Survey Mark Description”.

(2) Measurement of the Horizontal Angle and Distance

The horizontal angle and distance is measured with an Electrical Distance Meter (EDM). Horizontal angle and distance between two permanent points are measured twice and four times, respectively.

4.3.3 Longitudinal Profile Survey

(1) Measurement of the Height

The points with slope changes are measured, and those are drawn in the

longitudinal profile. The height of each permanent point is measured twice. Track, structure, woods, river, etc., located along the pipeline route are surveyed and drawn on the flat plan.

(2) Drawing Scales

Scales to be applied to the longitudinal profile drawing refer to the specification applied by DGGR. In addition to grasp the general layout of each subproject, pipeline diagram is also prepared. As pipeline slopes are different between areas, vertical scale is adjusted by subproject. Each drawing scale is as follows:

1) Longitudinal profile horizontal scale 1:2,000,
2) Longitudinal profile vertical scale 1:100 ~ 1:200,
3) Flat plan 1:2,000,
4) Pipeline diagram 1:25,000.

(3) Output

Longitudinal profile length of each subproject is shown in Table 4.3.1 and total length becomes 581km.

4.3.4 Topographic Mapping

(1) Measurement of the Sitesa

The topographical mapping is carried out to follow the longitudinal profile survey, so measurement method of the survey also follows the one applied to the longitudinal profile survey. Each survey point is measured approximately at 4m intervals and heights are measured to 0.01m accuracy. Tracks, woods, and other existing structures are measured by the survey, and they are drawn on the plan.

(2) Drawing Scale

Scale and counter line intervals applied to the plan are as follows: Topographical conditions of surroundings are different mountainous area and plains, therefore, the map scale is adjusted to the site conditions.

1)	Scale	1:100 ~ 1:200
2)	Counter line intervals	0.5m by interpolation method.

(3) Output

Topographical mapping results of each subproject are summarized in Table 4.3.1 and total area becomes 27,250m^2.

4.4 Geotechnical Survey

4.4.1 General

The geotechnical survey consists of test pits with laboratory tests and boring surveys. Those are executed to clarify the sub-surface geological conditions and geotechnical characteristics under the important facilities such as elevated tanks and water purification plant.

4.4.2 Scope of Geotechnical Investigation

(1) Boring Survey

The Boring survey is conducted to investigate the geological condition under the installations. Core samples are taken to the geological logs, and N-value obtained from SPT is measured. Measured figures are used for the stability analysis of the installation substructure.

(2) Test Pits

Test pits are made to grasp the subsurface geological conditions along the pipeline route judging from the pit logs, and confirm the cost estimate conditions of the earthworks. A laboratory test is also conducted to measure pH and electrical conductivity of the soil. The laboratory test results are used to judge whether the soil affects pipe corrosion.

4.4.3 Survey Location and Number

(1) Boring survey

The boring survey are done at the six sites in the Study. Those are two borings in

Complexe AEP Barbara in Jendouba, and one each for Henchir Tounsi in Kasserine, Complexe Bouslim in Mahdia, Thleijia in Gafsa, and Tarf Ellil in Medenine. Each site location is shown in Figure 4.4.1.

(2) Test pits

Test pits were dug for each subproject site and total number of the pits are two hundred and one (201).

4.4.4 Survey Method

(1) Boring survey

Drilling machine used for the survey is a rotary type hydraulic boring machine. The drilling was made down to 15 m deep or the point where N-value exceeded 50. Standard Penetration Test (SPT) equipment and survey procedure are conducted following the Tunisian standard.

(2) Boring Survey

Test pits dimensions adopted for the survey were at least 1.2m square meter wide and 1.5m deep with manual dug. Soil sample is taken at 10cm or more above the pit bottom.

4.4.5 Boring Survey Results

(1) Drill log characteristics

Drill logs of each site are attached to Figure 4.4.2 to 4.4.7. Characteristics of each log are as follows:

1) Complexe AEP Barbara-1, Jendouba

The vegetation soil covers a 0.7m thick surface that is followed by reddish to greenish gravel mixed silty 2.6m thick clay, fracture and oxide sandstone of 1.9m and brown-greyish gypseuse marl that is 9.8m thick. Groundwater does not appear during the 15m deep boring survey.

2) Complexe AEP Barbara-2, Jendouba

The vegetation soil covers a 0.5m thick surface that is followed by a slightly gritty brownish sandy 1.5m thick clay, brownish gravel mixed marly 2.7m

thick clay and gravel mixed fine sand appears that is at least 5.3m thick. Groundwater does not appear during the 10m deep boring survey.

3) Henchir Tounsi, Kasserine

The soil section is mainly defined by the presence of a shelled brown clay 0.60m thick layer followed by a sallow beige silty clay 1.9m thick layer then a stiff sallow beige 8.5m thick layer and finally a stiff greenish beige clay layer that is at least 4.0m deep. Groundwater does not appear during the 15m deep boring survey.

4) Complexe Bouslim, Mahdia

The soil section is mainly defined by the presence of a calcareous crust 0.50m thick layer that is followed by a stiff white clayey 2.0m thick tuff then a stiff beige 2.0m thick clay, a stiff silty brown 4.5m thick clay, and a stiff light brown clay layer that is at least 6.0m thick. Groundwater does not appear during the 15m deep boring survey.

5) Thleijia, Gafsa

The surface soil is made of sandy 0.2m thick vegetation soil followed by a beige or yellow middle to fine 5.2m thick sand, and calcareous pebbles and stones at 1.6m thick. Groundwater appears at a depth of 7.0m.

6) Tarf Ellil, Medenine

The surface soil is a quaternary made of sandy vegetation soil that is 0.15m thick followed by a light clayey beige sand (2.4m thick) then a stiff light beige sandstone (1.0m thick), a stiff reddish clay (1.0m thick), very stiff whitish sandstone (1.0m thick) layer, and very hard calcareous pebbles (0.95m thick). Groundwater level is deeper than 6.0m under the surface.

(2) Standard Penetration Test results

According to the Standard Penetration Test results showing in the drill log, all the sites N-values indicate more than 50 within 5 m depth. So each site foundation is sound enough that no pile foundation is required for the design.

4.4.6 Test Pits Results

(1) Test pit log characteristics

All the test pit logs are attached to Figure 4.4.8. As a whole, north areas like

Jendouba and Bizerte, include largely clayey or marly soil, and going south, the areas include sandy or silty soil. Rock foundation is assumed around 10 to 20 % of pipeline route judging from the test pit logs.

(2) Laboratory test results

Laboratory tests results are also attached to Table 4.4.1. pH values range between 6.9 and 7.6, these values do not affect pipe corrosion. Several electrical conductivity test results in Henchir Edhouaher, Thleijia, Baten Trajma, Bougueddima, and Tarf Ellil exceed 2,000 μS/m. In case of adopting ductile pipe installation for those areas, appropriate protection method around the pipe may be required.

4.4.7 Bearing Strength Calculation for the Elevated Tanks

To estimate the allowable bearing capacity of the soil, bearing strength calculation was made in the study. There are several formula to evaluate the bearing strength, Terzaghi formula is applied for the calculation since it is widely used all over the world. Detailed calculations are attached as Table 4.4.2 and those results are tabulated below:

Calculation Results of Each Subproject

Subproject	Dimensions	Load (t/m2)	Bearing strength	Judgement
Barbara-1	V=100m^3	6.7t/m^2	12.8t/m^2	O.K
Barbara-2	V=100m^3&Package plant	6.7t/m^2	12.8t/m^2	O.K
Henchir Tounsi	H=15m, V=25m^3	8.5t/m^2	12.8t/m^2	O.K
Complexe Bousslim	H=25m, V=250 m^3	9.5t/m^2	12.8t/m^2	O.K
Thleijia	H=15m, V=50 m^3	11.6t/m^2	12.8t/m^2	O.K
Tarf Ellil	H=15m, V=50 m^3	11.6t/m^2	12.8t/m^2	O.K

As seen in the above, all the bearing strength exceeds installations weight. Also, N value shows more than 50 within 5m from the surface for all the sites. Therefore, the foundations are stable.

4.5 Socio-Economic Impact Study in The Project Implemented Area

4.5.1 Objective

A sample survey on the socio-economic impacts on the localities in which the water supply systems were already introduced and GICs were established has been carried out to know the variations/changes in the daily lives of beneficiaries

and their social-environments, to evaluate these variations/changes, and to facilitate the evaluation for a successful implementation of future similar projects. This survey analysed whether the rural water supply project influenced the governorate economy (macro economic level) and the rural economy (micro economic level).

4.5.2 Macro Economic Analysis Survey

(1) Selection of Study Area

Sidi Bouzid and Nabeul are selected for the Macro Aspects Study. Sidi Bouzid is mainly agricultural and rural. It develops slowly and tends to integrate the aspects of modern economy. On the other hand, Nabeul is rather urbanised in spite of the existence of very important agricultural and rural sector. The most important economic activities here are those to do with the services and the secondary sectors: tourism, industry, handicrafts workshops.

Economic Development Indicators

Items	Nabeul	Sidi Bouzid	National Average
Rate of rural population	29%	72%	37%
Work forces in industrial sector	22%	11%	20%
Work forces in service secor	24%	15%	-
Free workers rate	18%	32%	-

(2) Methodology

The following methodology is applied for the macro aspects study.

1) Two governorates, one from a relatively developed area and another from a developing area were selected.
2) Several socio-economic indicators were studied in both governorates and each data/information were compared.
3) Socio-economic impact by the rural water supply program to the selected governorates were analyzed and evaluated.

(3) Outcome of the Study

Enquiry to both governorates are attached to Table 4.5.1~4.5.2 respectively. As

the positive socio-economic impact of the rural water supply program to the beneficiaries of the area, almost the same positive impacts can be granted for both areas, but those of Nabeul are somewhat of a limited extent.

Macro Economic Indicators Changes before and after the Rural Water Supply Projects

Items	Sidi Bouzid		Nabeul	
	Before (1995)	After (1999)	Before (1995)	After (1999)
Population (1,000 person)	385.2	416.0	590.7	626.7
Average annual population increment ratio (%)	-	2.0	-	1.5
Annual household income (DT)	1,025	1,246	1,680	2,042
Typhoid fever (per) (National ave)	340	108	340	108

1) It is concluded that the rural water supply program brings out a considerable socio-economic change into governorate level of rural society, most of which is positive and/or favorable.
2) In terms of economic concern, production in agriculture and/or livestock breeding has considerably increased, although to what extent the program contributed to the growth is not yet measured.
3) From the viewpoint of financial aspects of GICs, the income usually covers most part or even all of the expenses for operation and maintenance, making it possible for them to be autonomous.
4) Availability of reliable water brings out much more hygienic and health concern into the community and water-related diseases tangibly decreased while human self-respect considerably improved.
5) Another social impact which is brought out by the establishment of GICs is a revitalization and reunifying of traditional community activities through joining and self-managing the GICs activities.

4.5.3 Micro Economic Analysis Survey

(1) Selection of Study Area

At a first stage, eight GICs were nominated to be studied taking into account the representative both at national and regional levels. Out of these eight nominated sites, the following four GICs are selected with regard to the duration of each GIC

(about 10 years or more) and the availability of data/information on its daily management and usage of water. Each GIC description before and after creation of water supply project is shown in Table 4.5.3~4.5.6.

(2) Methodology

1) Typical GICs representing major localities of Tunisia were selected such as, Northern Area, Central East Area, Central West Area and Southern Area. The selected locality was geographically, culturally, and economically representative to each area.
2) The changes in the socio-economic indicators before and after the introduction of the water supply system and the establishment of the GIC were studied.
3) By comparing and analyzing these indicators and results of the studies on the existing GICs, a primary evaluation of the impact on each GIC was conducted.

(3) Outcome of the Study

1) GIC “Beni Meslem”

The creation of the water system managed by the GIC of Beni Meslem has allowed the beneficiary population to have a better quality of water (a ground water instead of shallow well service). The system of drinkable water with other economic and social factors allowed the stabilization of the population and the reduction of migration towards coastal and neighboring cities.

2) GIC “Ouled Alouane”

The creation of the water system managed by the GIC of Ouled Alouan has allowed the beneficiaries a reduction in time spent to fetch water and a decrease in fatigue.

3) GIC “Ksar El Hammem”

The creation of the water system managed by the GIC of Ksar El Hammam

has allowed the beneficiaries to have a better quality of water (a ground water instead of shallow well service). The system of drinkable water with other economic and social factors allowed the reduction of migration towards coastal and neighboring cities

4) GIC "Modhar"

The creation of the water supply system managed by the GIC of El Modhar has allowed the beneficiaries to have a better water quality than that of collected rainwater and to benefit from a bigger quantity. The combination of drinkable water system with other socio-economic factors such as electricity, paved tracks linking the area of the project with the village of Beni Khdeche allowed to stabilize the population and to reduce the migration and exodus.

(4) Conclusions

1) As are described in every preliminary evaluation of every GICs studied here, socio-economic changes brought out by the introduction of the GIC are remarkably great and in favor of individual beneficiaries and their community.
2) In economic terms, it brings out increase of income supported by diversification of income sources such as the development of tree culture and increase in number of livestock.
3) In social terms, hygienic and health consideration is remarkably improved with much improved quality and increasing quantity of water supply at the same time bringing out improved kitchen and drainage facilities.
4) The solidarity of the community is supposed to be much strengthened through joining into daily operation/maintenance activities of the GIC.
5) All those positive and favorable impacts occurred in a rather short time proving the needs and function of the rural water supply program and the rural water supply system at the sites where it was implemented.

Micro Economic Indicators Changes before and after the Rural Water Supply Projects

Items	Bizerte		Souse		Sidi Bouzid		Medenine	
	1991	2000	1990	2000	1990	2000	1990	2000
Cultivated area (ha)	1,003	1,505	800	1,114	1,900	4,000	4	5.5
No. of livestock (nos.)	325	540	2,165	9,880	2,610	4,390	1,010	2,500
Average household income (DT)	1,500	2,000	1,600	2,800	1,500	3,000	1,500	2,000
Shower/toilet (%)	25	50	25	80	15	80	1	45
Population (1,000 person)	330	330	342	586	1010	1850	294	593
Population increment ratio (%)	-	0	-	5.6	-	6.2	-	7.3

4.6 Water Demand Projection

Water needs of the subprojects are defined on the basis of the needs of habitants and cattle, public installations are only taken in consideration for pipelines sizing.

4.6.1 Domestic Needs

For calculating domestic needs, the uniform consumption of 25 L/day/habitant is adopted for the projected service starting year (that is to say 2002 in case of this project), for grouped population with an annual growth rate of 2.5% in consideration of anticipated life level evolution. This growth will continue up to the project term of 15 years from the service starting year.

The Specific Consumption of Scattered Population Type

Specific consumption L/day/habitant	2002	2007	2012	2017
Grouped population	25	28	32	36
Scattered population	20	20	20	20

4.6.2 Cattle Needs

The specific consumption are adopted as follow:

1) Sheep or goats = 5 L/day/head
2) Cows and horses = 30 L/day/head

This consumption will be subjected to no future evolution.

Water demand projection was made according to the technical guidelines prepared by DGGR. Maximum daily water demand becomes 4,308 m3/day, and its demand per person including livestock purpose is 70 liter per day. Following

table shows the results of the projection.

Water Demand Projection

Governorate	Subproject	Population		Livestock		Ave. water demand		Max water demand	
		2000 (per)	2017 (per)	Sheep and Goats	Cows and Horses	2000 (m3/d)	2017 (m3/d)	2000 (m3/d)	2017 (m3/d)
ARIANA	FAIDH EL AMRINE	681	938	1,069	221	31	44	39	55
	HMAIEM ESSOUFLA	175	242	70	113	8	12	10	15
	TYAYRA	218	300	38	18	7	11	9	14
BEN AROUS	OULED BEN MILED	1,002	1,741	1,589	304	49	85	61	106
	SIDI FREDJ	507	879	316	303	27	43	33	54
NABEUL	SIDI HAMMED	1,310	1,632	1194	173	51	77	63	97
ZAGHOUAN	JIMLA	239	264	163	31	9	13	11	16
	ROUISSAT BOUGARMINE	1,147	1,270	2,825	268	51	66	63	83
BIZERTE	SMADAH	1,045	1,259	4,122	721	49	68	61	85
	TERGULECH	1,151	1,386	808	239	46	69	58	86
BEJA	EL GARIA	458	467	855	333	17	23	21	29
	EL GARRAG	1,412	1,435	353	358	57	84	71	105
	FATNASSA	1,013	1,030	1,453	488	72	105	89	131
JENDOUBA	CHOUAOULA	2,247	2,406	1,474	889	104	139	130	174
	COMPLEXE AEP BARBARA	12,492	13,370	13,996	2,811	482	571	603	714
LE KEF	CHAAMBA - O.EI ASSEL	661	661	3,379	319	28	34	35	42
	M'HAFDHIA - GHRAISSIA	474	474	3,043	258	20	26	26	32
KAIROUAN	CHELALGA	1,526	1,774	2,606	494	69	92	86	115
	GUDIFETT	1,210	1,409	2,608	351	54	72	68	90
	HMIDET	1,609	1,875	2,712	100	66	97	83	121
	ZGAINIA	693	807	1,661	160	33	46	42	58
KASSERINE	DAAYSIA	337	433	420	64	14	20	18	25
	HENCHIR TOUNSI	1,041	1,340	4,121	261	48	67	60	84
	OUED LAGSAB	516	665	1,895	149	23	31	29	39
	SIDI HARRATH	838	1,080	1,454	179	38	54	47	67
SIDI BOUZID	AMAIRIA	364	469	347	50	14	21	21	32
	BLAHDIA	825	1,064	2,025	220	38	53	57	80
	BOUCHIHA	1,516	1,952	4,053	434	69	96	104	144
	MAHROUGA	635	818	1,270	167	30	43	45	64
MAHDIA	COMPLEXE BOUSSLIM	5,245	6,426	11,959	1,384	261	375	392	562
	COMPLEXE EL AITHA	1,214	1,486	2,189	433	60	87	91	130
GAFSA	HENCHIR EDHOUAHER	271	295	490	34	12	16	18	24
	KHANGUET ZAMMOUR	1,636	1,781	2,007	226	67	94	100	140
	THLEIJIA	1,492	1,625	2,516	363	70	95	105	142
GABES	BATEN TRAJMA	2,747	3,092	17638	329	93	100	139	149
	CHAABET EJJAYER	284	320	810	17	14	19	20	28
	EZZAHRA	198	223	159	23	7	11	11	17
MEDENINE	BOUGUEDDIMA	319	418	1,512	71	16	24	25	37
	CHOUAMEKH	2,147	2,812	3,714	269	94	148	142	222
	ECHGIUIGUIA	478	627	502	30	18	30	27	45
	TARF ELLIL	476	623	2,239	147	25	36	37	54
Total		53,849	63,168	107,654	13,802	2,343	3,198	3,149	4,308

4.7 Financial Analysis

4.7.1 Investment Costs

The investment costs correspond to the expenses necessary to realize the project. The investment costs to be estimated for each subproject are shown in Table 4.7.1. In accordance with financial analysis, the investment costs for the water supply project in the basic study stage relate to the following items:

(1) Water sources facilities: Concerning the water sources facilities, the investments are not supported by the project aiming to create deep wells and dams. They are taken in charge by other finance funds.

The following works are included in the project.

1) Connection works on SONEDE and GR networks
2) Improvement and maintenance works of existing water source intake facilities, and
3) Filtering station for Jendouba subproject which water source is a dam.

Consequently, the finance for water source facilities is settled only a minor budget in comparison with the total investment. The investment costs related to pump facilities for deep well, filtering station and electrical works for water source facility are estimated in item (5) Hydro-mechanical and electrical works.

(2) Procurement of pipes and special parts: The procurement cost is expenditure for pipes, special parts and valves, and project site prices.

(3) Installation and equipment of pipe networks: This expenditure is the installation cost of pipes and special parts procured in item (2). The civil works of excavation, sand bed and back-filling, installation works of pipes and special parts, air valves, blow-off and construction of water supply facilities of public tap, etc., are included in this item.

(4) Civil works: The construction works and equipment that are necessary for the pumping station, water reservoir, overhead tank, relay pumping station and break pressure are included in this item.

(5) Procurement and installation of hydro-mechanical and electrical equipment: The pump facilities for deep well and pumping station, chlorination, filtering station, radio facilities and electrical works are included in this item. The deep well pump of the water source facility is included in this item.

4.7.2 Operation and Maintenance Costs

The operation costs of the drinking water supply subproject may be divided into two categories, fixed and variable costs

(1) Fixed Costs

The fixed costs are expenditures for the facilities of the subproject and are independent of produced water. These expenditures are essentially due to:

1) Maintenance of networks and equipment,
2) Salary for pump guardsman,
3) Subscription to STEG and SONEDE networks, and
4) Management cost of GIC.

1) Maintenance

Each project component is given a maintenance rate in %. The DGGR has a document, that determines the lifetime and maintenance rate of project components. Maintenance charges are determined by applying maintenance rates on each component cost during the observation period. Maintenance charges are necessary for a good production installation. They constitute a fixed term in running cost computation.

The maintenance charges are determined by:

$F.E = \Sigma Ci \cdot Ti$

Ci : Cost of component i

Ti : Maintenance rate of component i

2) Salary for pump guardsman

It is concluded that those which count a lot in fixed costs are the expenses for the maintenance and the pump guardsman, representing 80% to 90% of total expenses. It costs 100~150 DT/month per one pump guardsman.

In case of small networks, serving less than 100 households population by

means of pumping facilities, the pump guardsman costs may increase the water cost per m^3 up to or below 1DT, often more important than the solvency threshold of the population. This case is observed in Jimla subproject in Zaghouan, designed on SONEDE connection and operating with pumping system. The expenses for guardsman increase the cubic meter water cost up to 1.2DT. Because of this, the pump and storage tank capacities are increased in order to pump up every three days so that the pump guardsman might be a half-time employee. In this way, the water cost per m^3 is decreased to 0.8DT.

3) Subscription Charges

For other charges than those of electricity or water consumption of SONEDE, GIC pays a fixed amount for subscriptions to STEG or SONEDE. For SONEDE, these charges are intended especially to maintain the computer unit, being about 1.5DT/month. As for STEG network, these charges are also intended to maintain power cables being about 0.7DT/month.

4) Management cost of GIC

This cost should be spent by GIC and is essentially composed of:

a) Expenses due to office work,
b) Expenses for meeting,
c) Insurance fee, and
d) Unforeseen expenses

Management costs of GIC are estimated at 200DT per year.

(2) Variable Costs

The variable costs are the expenses proportional to water production. They may be composed of the following expenses:

1) Purchasing SONEDE water (0.15 DT/m^3~ 0.18DT/m^3),
2) Energy costs, and
3) Disinfection charges.

These expenses may be affected by energy price especially when gasoline is used. The water cost per m3 may also increase in case water is bought from SONEDE and then pumped up with a generator unit. The Project 2001 has no similar subproject. All subprojects designed on SONEDE connection and operating with a pumping system do not use generator.

4.7.3 Cost of Supplied Water per Cubic Meter

Raw water cost is set to cover operation and maintenance costs solely. Investment costs and large scaled repairing costs are paid by the government budget, raw water cost does not need to contain those costs. The water cost computation for the Project 2001 is set up for the observation period 2002-2017. The year 2001 is the starting year of the service and the year 2017 corresponds to the due year. The cost of supplied water per m^3 is set up in constant Tunisian Dinars.

The items involved in its determination are as follows:

(1) Annual evaluation of water production and consumption by taking into account the estimate losses of 15% of the consumption (Refer to Clause 5.3).
(2) Investments: this is the base for calculating maintenance costs, residual value, and renewal costs. In order that a financial analysis and a determination of supplied water cost per m^3 might be representative and brought closer to economic realities, it is necessary to value the establishing unit price. For this purpose, it is recommended to the local consultants to refer to the last contracts made up with companies of the Project area. The prices should be actualized to the execution year by taking into account the observed inflation.
(3) Fixed and variable running costs mentioned before.
(4) Increase of network water production set up according to the following hypothesis.

The cost of produced water per m^3 varies between 0.2DT and 0.9DT.

4.7.4 Financial Analysis

In the financial analysis, the investment and renewal costs are considered as a subsidy undertaken by the central government.

In case that GIC exists in a subproject area, the present conditions such as applied water charge, residual value of facilities and equipment, operation and maintenance cost of the existing GIC were studied. Whether GIC should newly be established for the subproject or prospected beneficiaries should participate in the existing GIC, it was analyzed and judged through the financial analysis based on such information. Even if GIC will be created, water charge applied to the existing GIC was referred by the Study Team to evaluate the proposed water charge for new GIC from the viewpoint of the project sustainability.

(1) Cash Flow on Fixed Household Water Charge

Any cash flow computation takes into account real cash flows in the project. In the subprojects of water supply by public tap and gallows, the fixed household cost is suitable for collection. On the assumption that the investment and renewal costs are supported by the subsidy of the central government in the cash flow computation, the water price is examined in order to operate the project.

1) Consumption Growth

GIC budget is computed by estimating the family subscription rate to GIC. From 2002, the installation service starting year, the water consumption reaches 60% of the potential demand. Then, this develops and reaches 70% of the potential demand in 2007, and continues increasing at the same rate until 90% at the year 2017.

2) GIC Revenue

GIC revenue is essentially composed of family fixed rate subscriptions.
Two cases are considered:

a) Case No.1

All subscribing families pay their fixed rate subscriptions. The first fixed rate is determined so that GIC budget might make a surplus. No financial provision is necessary. GIC cash box may accumulate certain surplus in 2017. Then, the second fixed rate is determined so that GIC cash flow, actualized (5%) during the observation period: 2002-2017, is just balanced. In this case and for several years after starting up operation, a financial provision in the form of subsidy or credit will be agreed to GIC for setting up the GIC budget.

b) Case No.2

It is assumed that 80% of the total participated families in GIC pay the flat rate. The conditions of the flat rate estimation are same as Case No. 1. In case that the output of the flat rate estimation had not been appropriate for GIC management, it was adjusted by taking necessary measures to improve affected negative conditions to the estimation so as to bring some surplus to GIC for unexpected expense. The flat rate got in this way was adopted in principle. However, it will necessitate some subsidy or debt for several years from starting the operation. The prospective beneficiaries are, consequently, to be requested to agree with this condition.

In the Rural Water Supply Project, the beneficiary families are requested to bear the cost for the revolving fund to compensate for the necessary expense just after starting the operation. The amount of the fund to be contributed by each beneficiary family is equal to the flat rate of four (4) months. It should be noted that in case of scaled rate system, the flat rate is estimated to determine the amount of the revolving fund.

(2) Cash Flow on Supplied Water per Cubic Meter

This computation concerns the supplied water per m^3 selling price to be applied so that the combined balance might be good at the end of the observation period. The computation takes into account inflation rate to be applied to running expenses and considered tariffs. The investment and renewal are considered as a subsidy

undertaken by the central government.

(3) Results of Financial Analysis

Before 2000, a lot of GIC applied the flat rate to the water supply systems established under the Rural Water Supply Projects in Tunisia. However, DGGR now recommends among beneficiaries, to reduce misuse and wastage of water, to conserve the resource, etc. In the Project 2001, no subproject was reported to apply the flat rate.

Following are, consequently, considered as the points in the financial analysis on condition that the construction and renewal cost of the water supply system are subsidy by the central government.

1) The estimation on water charge which can assure 5% of the internal rate of return
2) The cash flow analysis discussed above based on the estimated water charge

The supplied water cost, the project balance, and proposed water charge per 1 m3 of each subproject are shown in Table 4.7.2.

Figure 4.2.1 Parameters and Methodology

No.	Parameters		Method adopted in the Study	Quantification limit (mg/L)*
Bacteriological quality				
1	Total coliform	-	NFT90-413 (General method by culture in liquid media, Most Probable Number)	3 MPN
2	Thermotolerant coliform	-	NFT90-413 (General method by culture in liquid media, Most Probable Number)	3 MPN
3	Escherichia coli	-	NFT90-413 (General method by culture in liquid media, Most Probable Number)	3 MPN
4	Faecal streptococci	-	NFT 90-411 (General method by culture in liquid media, Most Probable Number)	3 MPN
Toxic Chemical Substances				
5	arsenic	As	ICP/AES (Inductively Coupled Plasma Atomic Emission Spectrometry)	0.05
6	cadmium	Cd	FDT 90.112(Nov 96) [Extraction after formation of complex compound]	0.005
8	cyanide	CN	Potentiometric Method with specific electrode for cyanide	0.05
13	Mercury	Hg	NFT 90.113(Sept 86) [Cold vapor method]	0.001
11	lead	Pb	FDT 90.112(Nov 96) [Extraction after formation of complex compound]	0.05
Chemical substances that likely induce health problems				
9	fluoride	F^-	Potentiometric Method with specific electrode for fluoride	-
14	nitrate	NO_3^-	ISO 7890-3 1988(F) [Spectrophotometric]	0.18
Acceptability Aspects				
16	colour		Description of organoleptique	-
17	Odour		Description of organoleptique	-
18	turbidity		Turbidimeter LOVIBOND TM 720	-
24	pH	pH	NF T 90.008 Avril 1953 (Glass Electorode)	-
20	chloride	Cl^-	NF T 9.014 Fev 1952 [Volumetric]	-
7	copper	Cu	FDT 90.112(nov 96) [Direct dosage method]	0.1
30	magnesium	Mg^{2+}	NF T 90.005 Mars 1985 [Atomic Absorption]	-
12	manganese	Mn	FDT 90.112(nov 96) [Direct dosage method]	0.1
23	iron	Fe	FDT 90.112(nov 96) [Direct dosage method]	0.1
28	zinc	Zn	FDT 90.112(nov 96) [Direct dosage method]	0.02
21	total hardness		Summation of [Ca2+] and [Mg2+]	-
26	sulphate	SO_4^{2-}	NF T 90.040 Sept 1986 [Spectrophotometric]	-
29	calcium	Ca^{2+}	NF T 90.005 Mars 1985 [Atomic Absorption]	-
Other Supporting Data				
10	hexavalent chromium	Cr(VI)	NFT 90.043 Oct 1988 [Atomic Absorption]	0.05
27	total disolved solids	TDS	Direct measurement with electrode	
19	ammonium	NH_4^+	NFT 90.015 Aout 1975, 2 [Indophenol blue]	0.01
22	sulphide	H_2S	Dosage of sulfate and reducing agent	-
25	sodium	Na^+	NF T 90.019 Aout 1984 [Flame Photometer]	-
33	potassium	K^+	NF T 90.019 Aout 1984 [Flame Photometer]	-
15	nitrite	NO_2^-	NF EN 26777 Mai 97 [Spectrophotometric]	0.04
31	Bicarbonate	HCO_3^-	NFEN ISO 9963-1 Fev 96 [Volumetric]	-
32	Carbonate	CO_3	NFEN ISO 9963-1 Fev 96 [Volumetric]	-

* : Quantification limits are expressed in mg/L unless oterwise stated.

Table 4.2.2 Digest of the National Draft Guideline for Drinking Water

No.	Items in English	Unit	Standard of Tunisia for drinking water(PNT)		WHO's Guidelines	
			Maximum Desireble Level	Maximum Acceptable	Guideline values	Remarks
Bacteriological aspects						
1	Total coliform	MPN				
2	Thermotolerant coliform	MPN				
3	Escherichia coli	MPN				
4	Faecal streptococci	MPN				
Chemicals of health significance in drinking water						
5	arsenic	mg/L	-	0.05	0.01	(P)
6	cadmium	mg/L	-	0.005	0.003	
7	copper	mg/L	0.05	1	2	ATO
8	cyanide	mg/L	-	0.05	0.07	
9	fluoride			*	1.5	
10	chromium (VI)	mg/L	-	-	0.05	as T-Cr (P)
11	lead	mg/L	-	0.05	0.01	
12	manganese	mg/L	0.05	0.5	0.5	ATO (P)
13	Mercury(Hg)	mg/L	-	0.001	0.001	
14	nitrate	mg/L	-	**45	50	
15	nitrite		-	-	3	(P)
Substances and parameters that mat give rise to complaints from consumers						
16	colour	-	5 units	50 units	15TCU	True color unit
17	Odour	-	acceptable	acceptable	acceptable	
18	turbidity	NTU	5	25	5	
19	ammonium				1.5	
20	chloride	mg/L	200	600	250	
21	total hardness	$CaCO_3$mg/	100	1000	-	
22	sulphide				0.05	
23	iron	mg/L	0.1	0.5-1.0	0.3	
24	pH	-	7.0-8.0	6.5-8.5	-	
25	sodium		-	-	200	
26	sulphate	mg/L	200	600	250	
27	Total Disolved Solids	mg/L	500	2000-2500	1000	
28	zinc	mg/L	1	5	3	
29	calcium	mg/L	75	300		
30	magnesium	mg/L	***150	150		
Other substances						
31	Bicarbonate		-	-	-	
32	Carbonate		-	-	-	
33	potassium		-	-	-	

*: The value varies by water temperature as given below.

**: This standard value is applied to infant below 1 years of age.

Table 4.2.3 Water Quality Analysis Results

	Parameters	T.colif	Therm	E.Coli	Faec	As	Cd	CN	Hg	Pb	Cr(VI)	F	NO_3^-	Color	Odour	Turbidi	pH	Cl^-	Cu	Mg	Mn	Fe	Zn	Hardn	SO_4^{2-}	Ca	TDS	NH_4^-	H_2S	Na^+	K^+	NO_2^-	HCO_3^-	CO_3^{2-}
	Unit	orm *1	Col *2		al Str	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L			ty	*5	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ess *6	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Draft Guideline	Maximum Permissible Concentration					0.05	0.005	0.05	0.001	0.05	-	*3	45	50U	Acp	25	<8.5	600	1	150	0.5	0.5-1	5	1000	600	300	-	-	-	-	-		-	-
WHO	Chemicals of health significance					0.01	0.003	0.07	0.001	0.01	0.05	1.5	50	-	-	-	-	-	2	-	0.5	-	-	-	-	-	-	-	-	-	-	0.2	-	-
	Consumer complaints					-	-	-	-	-	-	-	-	15*4	Acp	5	<8	250	1	-	0.1	0.3	3	-	250	-	1000	1.5	0.05	200	-	-	-	-
	Quantification Limit	3	3	3		0.05	0.005	0.05	0.001	0.05	0.05	-	0.18	-	-	-	-	-	0.1	-	0.1	0.1	0.02	-	-	-	-	0.01	-	-	-	0.04	-	-
BEJA	FATNASSA	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.9	2	No	No	0.1	7.4	28	<0.1	12	<0.1	<0.1	0.028	134	30	87	253	<0.01	0	18	1	0.19	271	0
BIZERTE	SMADAH	4	<3	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.6	44	No	No	0.3	8.0	74	<0.1	6	<0.1	<0.1	<0.02	134	34	97	307	<0.01	0	37	10	<0.04	201	0
	TERGULECH	15	<3	-	9	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.2	36	No	No	0.2	7.5	143	<0.1	14	<0.1	<0.1	<0.02	169	43	113	390	0.0815	0	85	3	<0.04	214	0
JENDOUBA	CHOUAOULA	23	<3	-	23	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.2	3	No	No	6	**8.6**	82	<0.1	16	<0.1	<0.1	<0.02	125	117	75	325	<0.01	0	53	3	<0.04	0	143
	Barbara Dam (Lucastrine)	9	<3	-	9	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.2	5	No	No	6	8.4	45	<0.1	15	<0.1	<0.1	<0.02	122	131	73	290	<0.01	0	44	2	0.06	0	134
LE KEF	CHAAMBAO.EI ASSEL-HMAIDIA	200	<3	-	4	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.7	<0.18	No	No	2	7.7	119	<0.1	11	<0.1	0.36	<0.02	64	163	34	537	0.162	0	225	4	0.06	419	0
	M'HAFDHIA - GHRAISSIA	90	4	<3	4	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.4	**75**	No	No	0.2	7.7	51	<0.1	33	<0.1	<0.1	<0.02	198	200	104	413	<0.01	0	40	35	<0.04	198	0
NABEUL	SIDI HAMED	90	4	-	9	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.6	1	No	No	0.4	7.6	161	<0.1	65	<0.1	0.11	0.024	280	313	118	608	0.0745	0	133	7	<0.04	325	0
ZAGHOUAN	ROUISSAT BOUGARMINE	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.4	<0.18	No	No	1	8.0	400	<0.1	42	<0.1	0.15	0.438	151	137	52	823	<0.01	0	285	4	0.14	291	0
KAIROUAN	CHELALGA	4	<3	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.1	5	No	No	0.1	7.5	60	<0.1	15	<0.1	<0.1	<0.02	131	55	80	258	<0.01	0	27	2	<0.04	204	0
	HMIDET	15	4	<3	23	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.0	13	No	No	1	7.6	294	<0.1	89	<0.1	0.39	<0.02	286	310	83	869	<0.01	0	329	9	<0.04	296	0
	ZGAINIA	40	4	<3	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	**1.8**	19	No	No	0.1	7.6	16	<0.1	17	<0.1	<0.1	0.052	95	27	49	199	<0.01	0	27	3	<0.04	231	0
	GUDIFETT	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.0	23	No	No	0.2	7.7	101	<0.1	22	<0.1	<0.1	0.099	160	102	91	372	<0.01	0	63	3	<0.04	210	0
KASSERINE	DAAYSIA	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.2	**46**	No	No	1	7.4	32	<0.1	30	<0.1	<0.1	<0.02	175	42	91	287	<0.01	0	22	1	<0.04	364	0
	HENCHIR TOUNSI	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.9	28	No	No	0	7.2	445	<0.1	63	<0.1	<0.1	<0.02	411	365	226	1084	<0.01	0	318	4	<0.04	313	0
	OUED LAGSAB	9	<3	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.7	9	No	No	2	7.5	81	<0.1	41	<0.1	0.40	<0.02	208	178	100	415	<0.01	0	78	2	<0.04	233	0
	SIDI HARRATH - GOUASSEM	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.0	43	No	No	2	7.7	142	<0.1	41	<0.1	0.27	<0.02	219	278	108	491	0.0371	0	95	6	<0.04	176	0
SIDI BOUZID	BLAHDIA	7	4	<3	<3	<0.05	<0.005	<0.05	<0.001	0.361	<0.05	0.7	0.42	marron	No	**270**	7.3	30	0.291	5	0.26	**16.75**	2.51	25	8	12	169	1.066	0	48	4	0.11	0	121.2
	AMAIRIA	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.3	28	No	No	**29**	7.7	489	0.08	131	0.081	0.39	0.257	544	**1,013**	220	1376	0.048	0	330	8	0.13	232	0
	MAHROUGA	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	**2.1**	28	No	No	0.5	6.9	292	<0.1	144	<0.1	<0.1	1.18	739	**1,328**	**355**	1419	<0.01	0	265	7	<0.04	315	0
	BOUCHIHA	70	<3	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.2	<0.18	No	No	4.0	8.5	596	<0.1	85	0.067	**1.61**	<0.02	344	490	136	1122	1.22	0	279	15	<0.04	0	34.2
GABES	EZZAHRA	<3	-	-	<3	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.2	39	No	No	0.4	7.5	386	<0.1	118	<0.1	<0.1	0.072	695	**777**	**364**	1466	<0.01	0	258	9	<0.04	240	0
	BATEN TRAJMA	>1100	1100	>1100	23	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.4	28	yellow	No	**100**	7.5	**728**	<0.1	117	0.396	**5.72**	0.042	568	**1,296**	262	1845	0.496	0	577	21	0.050	63	0
GAFSA	HENCHIR EDHOUAHER	4	<3	-	90	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	0.9	15	No	No	0.4	7.7	182	<0.1	74	<0.1	<0.1	0.413	302	302	120	735	<0.01	0	149	6	<0.04	237	0
	THLEIJIA	40	<3	-	23	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	1.4	21	No	No	1	7.4	278	<0.1	95	<0.1	<0.1	0.030	478	546	228	1098	<0.01	0	233	6	<0.04	173	0
	KHANGUET ZAMMOUR	23	<3	-	90	<0.05	<0.005	<0.05	<0.001	<0.05	<0.05	**2.0**	36	Slight	No	8	7.7	208	<0.1	117	<0.1	0.80	0.256	492	**891**	201	1221	0.101	0	288	6	<0.04	165	0

*1: Total Coliform
*2: Thermotolerant Coliform
*3: The national drinking water standard for fluoride vaies by temperature.
*4: The unit is TCU
*5: In situ measurement is recorded when it is available.
*6: Unit: mg $CaCO_3$ per litre.

Table 4.3.1 Topographical Survey Results for Each Subproject

Governorate	Subproject	Longitudinal Profile Length	Topographical Mapping Area
Ariana	SIDI GHRIB	7 km	0 m2
	HMAIEM ESSOUFLA	2 km	0 m2
	TYAYRA	4 km	825 m2
Ben Arous	OULED BEN MILED	14 km	825 m2
	SIDI FREDJ	7 km	825 m2
Nabeul	SIDI HAMMED	19 km	825 m2
Zaghouan	ROUISSAT BOUGARMINE	13 km	825 m2
	JIMLA	5 km	825 m2
Bizerte	SMADAH	18 km	825 m2
	TERGULECH	24 km	825 m2
Beja	EL GARIA	5 km	400 m2
	EL GARRAG	11 km	800 m2
	FATNASSA	16 km	400 m2
Jendouba	CHOUAOULA	22 km	2,400 m2
	BATTAHA	27 km	400 m2
	MALLILM	20 km	1,600 m2
	OULED DHIFALLAH	22 km	1,600 m2
Le Kef	DAAYSIA	10 km	825 m2
	HENCHIR TOUNSI	12 km	825 m2
Kairouan	CHELALGA	27 km	810 m2
	GUDIFETT	11 km	810 m2
	HMIDET	6 km	810 m2
	ZGAINIA	6 km	810 m2
Kasserine	OUED LAGSAB	8 km	825 m2
	SIDI HARRATH-GOUASSEM	8 km	825 m2
	CHAAMBA	12 km	825 m2
	GHRAISSIA	9 km	825 m2
Sidi Bouzid	AMAIRIA	4 km	810 m2
	BLAHDIA	11 km	810 m2
	BOUCHIHA	20 km	810 m2
	MAHROUGA	13 km	810 m2
Mahdia	COMPLEXE BOUSSLIM	64 km	810 m2
	COMPLEXE AITHA	15 km	810 m2
Gafsa	HENCHIR EDHOUAHER	4 km	0 m2
	KHANGUET ZAMMOUR	16 km	0 m2
	THLEIJIA	18 km	0 m2
Gabes	BATEN TRAJMA	20 km	0 m2
	CHAABET EJJAYER	5 km	0 m2
	EZZAHRA	3 km	0 m2
Medenine	OUGUEDDIMA	6 km	0 m2
	CHOUAMEKH	18 km	0 m2
	ECHGUIGUIA	6 km	0 m2
	TARF ELLIL	13 km	0 m2
Total		581 km	27,250 m2

Table 4.4.1 Geotechinical Survey Laboratory Test Results

Subproject	Pit No.	pH	Coductivity (µS)
El Garia	1	-	320
	2	-	296
El Garrag	1	6.9	221
	2	7.2	339
	3	7.4	477
	4	7.0	312
Fatnassa	1	6.9	351
	2	6.9	331
	3	7.0	258
Chouaoula	1	7.1	546
	2	7.1	353
	3	7.3	273
	4	7.4	327
	5	7.0	231
	6	7.1	300
	7	7.3	432
Complexe Barbara	1	7.1	464
- Battaha	2	6.9	294
	3	7.3	264
	4	7.1	297
	5	7.3	515
	6	7.4	306
	7	7.2	681
	8	7.1	693
	9	7.6	395
	10	7.3	375
	11	7.3	375
	12	7.0	650
	13	7.0	370
	14	7.1	693
Complexe Barbara	1	7.6	295
-Ouled Dhiffalh	2	7.4	373
	3	7.5	545
	4	7.2	370
	5	6.9	335
	6	7.3	315
	7	7.2	515
Complexe Barbara	1	7.1	395
-Maalim	2	7.5	400
	3	7.5	510
	4	7.5	395
	5	7.3	625
	6	7.0	765
	7	6.9	300
Henchir Edhouaher	1	7.2	2,330
	2	7.3	90
Khanguet Zammour	1	7.2	300
	2	7.2	490
	3	7.2	160
	4	7.1	200
	5	7.2	1,020
	6	7.2	1,110
	7	7.2	1,850

Subproject	Pit No.	pH	Coductivity (µS)
Thleijia	1	7.1	2,180
	2	7.2	150
	3	7.2	400
	4	7.2	120
	5	7.2	720
Baten Trajima	1	7.2	2,650
	2	7.1	2,500
	3	7.2	2,870
	4	7.2	3,090
	5	7.1	2,300
	6	7.3	2,170
	7	7.2	250
	8	7.3	230
Chaabet Ejjayer	1	7.3	1,900
	2	7.4	130
	3	7.2	400
Ezzahra	1	7.3	90
	2	7.3	830
Bougueddima	1	7.2	2,140
	2	7.1	2,600
Chouamekh-R. Ennagu	1	7.1	80
	2	7.2	720
	3	7.2	130
	4	7.2	70
	5	7.2	80
	6	7.2	100
	7	7.3	100
Echgiuiguia	1	7.2	200
	2	7.2	150
Tarf Ellil	1	7.3	2,120
	2	7.4	1,780
	3	7.3	1,650
	4	7.4	1,970

Table 4.4.2 Bearing Strength Calculation Sheet

1. BEARING STRENGH OF THE SOIL

1.1 Applied formula

Terzaghi formula : $qd = CNc+1/2gBNr+gDfNq$

C :	Cohension (t/m2)	0.0
r :	Unit weight of soil (t/m3)	1.8
B :	Minimum width of foundation (m)	1.0
Df :	Penetration depth (m)	1.0
N_c :	Coefficient	20.9
N_r :	Coefficient	10.6
N_q :	Coefficient	16.1
ϕ :	Internal friction angle	>35.0

1.2 Long term bearing strength calculation

Applied safety factor 3.0

Modified formula : $qd = 1/3(1/2\gamma BN_r+\gamma D_f N_{q)}$

$= 1/3(1/2*1.8t/m^3*1.0m*10.6+1.8t/m^3*1.0m*16.1)$

$= 1/3(9.54t/m2 + 28.98t/m2)$

$= 12.84t/m2$

1.3 Short term bearing strength calculation

Modified formula : $qd = 2/3(1/2\gamma BN_r+1/2\gamma D_f N_q)$

$= 2/3(1/2*1.8t/m^3*1.0m*10.6+1/2*1.8t/m^3*1.0m*16.1)$

$= 2/3(9.54t/m^2 + 14.49t/m^2)$

$= 16.02t/m2$

1.4 Applied figure

Long term bearing strength is smaller than short tem one.

Therefore, long term bearing strength= 12.84ton/m2 is applied for the analysis. 12.8t/m2

2. LOADS

2.1 Water Tank

Complexe Barbara	H=0m, V=100m3 : Total weight =224ton	Unit Load	6.7ton/m2
Henchir Tounsi	H=15m, V=25m3 : Total weight=140ton	Unit Load	8.5ton/m2
Complexe Bouslim	H=25m, V=250m3 : Total weight=950ton	Unit Load	9.5ton/m2
Thleijia	H=15m, V=50m3 : Total weight=190ton	Unit Load	11.6ton/m2
Tarf Ellil	H=15m, V=50m3 : Total weight=190ton	Unit Load	11.6ton/m2

3. ANALYSIS RESULTS

3.1	Complexe Barbara	Bearing strength(12.8t./m2) > unit load (8.5t/m2)	OK
3.2	Henchir Tounsi	Bearing strength(12.8t./m2) > unit load (8.5t/m2)	OK
3.3	Complexe Bouslim	Bearing strength(12.8t./m2) > unit load (9.5t/m2)	OK
3.4	Thleijia	Bearing strength(12.8t./m2) > unit load (11.6t/m2)	OK
3.5	Tarf Ellil	Bearing strength(12.8t./m2) > unit load (11.6t/m2)	OK

Note: total weight of water tank is calculated based on the drawings.

Table 4.5.1 Enquiry to Sidi Bouzid Governorate

Governorate	**SIDI BOUZID**							
Localization	CENTRAL WEST							
Surface (ha)	698 400							
Date of beginning								
		1994	1995	1996	1997	1998	1999	2000
Data on the GIC of Governorate	Total number of GIC	-	-	94	102	100	93	-
	Nb. Subscribed family	-	-	12958	13247	14446	15914	-
	Nb.of users	-	-	71269	72856	79453	87527	-
	Nb. of BF & brackets	-	-	566	566	588	630	-
	Nb. Public Administration as users	-	-	188	190	207	216	-
	Nb. Linking up to lodging	-	-	362	390	390	400	-
	Water volume consummated per year (m^3)	-	-	1387997	1605755	1315926	1112463	-
	Yearly incomes of GIC (DT)	-	-	202404	278475	282447	274238	-
	Yearly expenses paid by GIC (DT)	-	-	183607	253876	271526	259658	-
Social economical factors during the period	Population (1000)							
	Male	190.4	194.5	198.3	202.2	206.1	210.1	214.1
	Female	186.7	190.7	194.5	198.3	202.1	205.9	209.8
	Total	377.1	385.2	392.8	400.5	408.2	416.0	423.9
	Rate of rural population (%)	78	77	76	75	74	73	72
	Average yearly incomes per inhabitant							
	DT/year	976	1025	1761	1130	1186	1246	1308
	DT/	-	-	-	-	-	-	-
	Impacts of diseases (Description)							
In all Tunisian territory	Typhoid fever	315	340	252	123	108	-	-
	Viral hepatitis	5990	6147	5850	4806	4286	-	-
Important changes in life style during the period	Livestock							
	Sheep		538285	566616	596438	627830	661222	694283
	Cows	41007	43050	45203	47462	59270	62234	65345
	Rate of drinkable water service rate (%)	68,4	73,5	73,5	74,6	77,3	80,1	-
	Rate of electricity service STEG (%)	51,3	58,3	63,5	69,3	77,2	82,3	-
	Girls schooling (2nd secondary level)	15534	16824	18653	19421	20198	21006	-
Final assessment of the impacts occurred by the implementation of rural water project	Other important questions appeared during the period (positive or negative)							

Table 4.5.2 Enquiry to Nabeul Governorate

Governorate	**NABEUL**							
Localization	NORTH EAST							
Surface (ha)	278 200							
Date of beginning								
		1994	1995	1996	1997	1998	1999	2000
Data on the GIC of Governorate	Total number of GIC	-	-	56	52	59	58	-
	Nb. Subscribed family	-	-	8890	8184	9062	9062	-
	Nb.of users	-	-	44450	40920	45310	45310	-
	Nb. of BF & brackets	-	-	389	369	422	424	-
	Nb. Public Administration as users	-	-	103	105	118	117	-
	Nb. Linking up to lodging	-	-	1590	3160	4443	641.9	-
	Water volume consummated per year (m^3)	-	-	647779	722039	898002	1005250	-
	Yearly incomes of GIC (DT)	-	-	259220	192696	227793	251998	-
	Yearly expenses paid by GIC (DT)	-	-	184062	194082	279352	282776	-
Social economical factors during the period	Population (1000)							
	Male	296.6	302.8	307.4	312.0	316.6	321.3	325.8
	Female	282.0	287.9	292.2	296.6	301.1	305.4	309.8
	Total	578.6	590.7	599.6	608.6	617.7	626.7	635.6
	Rate of rural population (%)	35	34	33	32	31	30	29
	Average yearly incomes per inhabitant							
	DT/year	1600	1680	1764	1852	1945	2042	2145
	DT/	-	-	-	-	-	-	-
	Impacts of diseases (Description)							
In all Tunisian territory	Typhoid fever	315	340	252	123	108	-	-
	Viral hepatitis	5990	6147	5850	4806	4286	-	-
Important changes in life style during the period	Livestock							
	Sheep	152310	159925	161310	169375	177844	181310	190375
	Cows	65500	68775	72214	75824	79616	82510	86636
	Rate of drinkable water service rate (%)	73.9	75.9	82.2	84.1	85.9	87.0	-
	Rate of electricity service STEG (%)	84.9	88.9	93.1	96.4	97.2	98.8	-
	Girls schooling (2nd secondary level)	18817	2002	21540	23493	25687	27912	-
Final assessment of the impacts occurred by the implementation of rural water project	Other important questions appeared during the period (positive or negative)							

Table 4.5.3 Beni Meslem GIC Description Form

Description	**Before SAEP creation**	**After SAEP creation**
Population	330	330
Number of family who benefit for water	66	66
Different type of source of water source	Natural source	Extension linking up from
Water quality	Rather bad	Good
Water sufficient quantity	Sufficient	Insufficient
People who are in charge of water transport	Mostly women	All the members of the
Distance to achieve to find water	2 Km	20 to 300 meters
Time spent for water transport	1 to 3 hours	5 to 10 minutes
The quality of the infrastructure in the area of the project		
Path	Not paved	Paved path
School	1	1
Mosque	1	1
Dispensary	1	1
Electricity	90%	100%
Sheep population		
Cattle local race	80	100
Cattle imported (milky cows)	15	70
Sheep / Caprinae	30	170
Horse and donkey	0	0
Poultry	200	200
Cultivated surface (ha)		
Cereal growing (ha)	300	300
Fruit trees (ha)	700	1200
Others : vegetable gardens (ha)	3	5
The average Income per year per family	**1500**	**2000**
Different sources of incomes		
· Cereal grown	40%	42%
· Tree culture	25%	30%
· Cattle breading	20%	25%
· Henhouses	10%	1%
· Others (exodus)	5%	2%
Effects of hydrias diseases		
Typhoid Fever		
Viral Hepatitis		
Intestinal infection by the children		
Little stones in kidney		
Others causes of parasites		
Changes in the activities calendar		
Different sorts of men activities :		
· Water transport	0%	0%
· Agriculture	50%	60%
· Cattle breading	40%	40%
· Business	0%	0%
· Towns Exodus	10%	0%
Different sorts of women activities :		
· Water transport	30%	5%
· Agriculture	25%	25%
· Cattle breading	25%	25%
· Handy crafts	0%	0%
· housekeeping	10%	25%
· Children bringing up	10%	20%
Other important changes in life conditions		
Average cost per m^3 of water (TD/m^3)	free	0.435
Average consumption of water per inhabitant per day	5	45
House stone built / The total number of the houses	60%	80%
Individual draining of used water /house	20%	45%
Sanitary bloc (Shower W/C)/house	25%	55%
Kitchen /house (%)	30%	70%
Small gardens /household	5%	20%
Improvement of the cattle breeding	10%	40%
Small handicrafts and scale activities	0	0
Girls Schooling (%)	45%	80%
Business development (grocers) (units)	1	2

Table 4.5.4 Ouled Alouan GIC Description Form

Description	**Before SAEP creation**	**After SAEP creation**
Population	342	586
Number of families who benefit from water	70	120
Different type of source of water source	Public brackets SONEDE	Linking up SONEDE
Water quality	Good	Good
Water quantity sufficient	Insufficient	Sufficient
People who are in charge of water transport	Chief family Water sellers	All the members of the
Distance to achieve to find water	3 to 4 Km	20 to 250 m
Time spent for water transport	1 to 3 hours	5 to 10 minutes
The quality of the infrastructure in the area of the project		
Path	Not suitable for vehicles	Paved path
School	1	1
Mosque	0	0
Dispensary	0	1
Club for teenagers	0	1
Electricity	90%	100%
Sheep population		
Cattle local race	0	0
Cattle imported race (milky cows)	0	15
Sheep / Caprinae	2080	3850
Horse and donkey	85	15
Poultry	0	6000
Cultivated surface (ha)	40	40
Cereal growing (ha)	300	300
Fruit trees (ha)	460	772
Others : vegetable gardens (ha)	0	2
The average Income per year per family	**1600**	**2800**
Different sources of incomes		
· Cereal grown	10%	10%
· Tree culture	35%	50%
· Cattle breading	5%	10%
· Henhouses	0%	10%
· Others (exodus)	50%	20%
Effects of hydrias illness		
Typhoid Fever		No case reported
Viral Hepatitis		
Intestinal infection by the children		
Little stones in kidney		
Others disease caused by parasites		
Changes in the daily calendar activities		
For men :		
Water transport	20%	0%
Agriculture	50%	60%
Cattle breading	20%	30%
Others	10%	10%
For women :		
Water transport	0%	5%
Agriculture	30%	20%
Cattle breading	20%	15%
housekeeping	20%	25%
Children care	20%	25%
Handy crafts	10%	10%
Other important changes in life conditions		
Average cost per m^3 of water (TD/m^3)	5	1
Average consumption of water per inhabitant per day	15 to 20	35 to 40
House stone built / The total number of the houses	80%	90%
Individual draining of used water system /house	30%	70%
Sanitary bloc (Shower W/C)/house	25%	80%
Kitchen /house (%)	20%	90%
Small gardens /household	5%	20%
Improvement of the cattle breeding /household	0%	10%
Small handicrafts and scale activities	0	0
Girls Schooling (%)	60%	70%
Business development (grocers) (unities)	0	1

Table 4.5.5 Ksar El Hammem GIC Description Form

Description	Before SAEP Creation	After SAEP creation
Population	1010	1850
Number of families who benefit of water	203	370
Different types of water sources	Over ground wells	Drilling
Water quality	Bad	Good
Sufficient water quantity	Insufficient	Sufficient
People who are in charge of water transport	Family chefWater sellers	All members of family
Distance to achieve to find water	10 Km	0 to1 Km
Time spent for water transport	6 to 8 hours	0 to 1 hour
The quality of the infrastructure in the area of the project		
Path	No good for driving	Paved paths to 70 %
School	1	4
Mosque	0	4
Dispensary	0	1
Electricity	None	100%
Sheep population		
Cattle local race	10	30
Cattle imported race (milky cows)	0	200
Sheep /Caprinae	2500	4000
Horse and donkey	100	150
Poultry	0	10
Cultivated surface (ha)		
Cereal (ha)	1000	1000
Tree culture (ha)	900	3000
Others : family vegetable gardens (ha)	0	5
The average income per year by family (DT)	**1500**	**3000**
Different sources of incomes :		
· Cereal grown	20%	10%
· Tree culture	20%	30%
· Cattle breeding	30%	35%
· Business	0%	15%
· Others (exodus)	30%	10%
Effects of hydrias diseases		
Typhoid fever		
Viral Hepatitis		
Intestinal infection among children		
Stones in kidney		
Other diseases caused by parasites		
Changes in the daily calendar activities		
Different types of men activities :		
· Water transport	10%	5%
· Agriculture	20%	30%
· Cattle breeding	30%	40%
· Business (agricultural business - handicrafts)	0%	25%
· Exodus to other cities	40%	0%
Different types of women activities		
· Water transport	0%	5%
· Agriculture	40%	20%
· Cattle breeding	30%	15%
· Handicrafts	10%	30%
· Ménage	10%	15%
· Children care	10%	15%
Other important changes in life style		
Average cost per m^3 of water (TD/m^3)	3 to 7	0.400 to 1
Average consumption of water /l (per inhabitant per/day)	5 to 10	60 to80
House built with stone (%)	30%	90%
Individual draining of uses water system/house	20%	90%
Sanitary bloc (Shower/WC)/house	15%	80%
Kitchen	25%	80%
Family Gardens (%)	0%	5%
Introduction of cattle breeding (%)	0%	60%
Small handicrafts and scale activities (units)	0	13 (poultries & handicrafts
Girls schooling (%)	10%	60%
Grocers (unit)	0	2

Table 4.5.6 El Modhar GIC Description Form

Description	Before SAEP Creation	After SAEP creation
Population	294	593
Number of beneficiary family	59	119
Type of water point	Individual Majels (rain	Over ground wells
Water quality	No treatment	Good and bleach
Water quantity	Irregular	Sufficient
Taking care of water transport	Household	Head of the family
Distance for getting water	To the home	0 to 100 meters
Time spent to carry water	None	0 to 30 minutes
The state of the infrastructure in the area of the project		
Path	Prepared paths	paved paths
School	1 modest school	1 big school
Mosque	1	1
Dispensary	0	1
Electricity	60%	100%
Sheep population		
local race cattle	0	0
Imported race cattle (milky cows)	0	0
Sheep cattle	1000	2500
Equide	10	0
Poultry	0	0
Cultivated surface (ha)	4	5.5
Cereal agriculture (ha)	0.5	0.5
Fruit trees (ha)	3.5	5
Others : (family vegetable gardens /ha)	0	0
Average annual income per family (TD)	**1500**	**2000**
Income structure		
· Cereal agriculture	10%	5%
· Tree culture	15%	20%
· Breeding	30%	40%
· Business	20%	25%
· Others (exodus & migration)	25%	10%
Effect of hydria disease		
Typhoid fever		
Hepatitis		
Children Intestinal infections		
Kidney stone & Other diseases		
Other disease such as parasites		
Change in the daily calendar of activities		
Type of men activities		
· Water transport	10%	5%
· Agriculture	30%	30%
· Cattle breeding	35%	40%
· Business	5%	15%
· Exodus & Migration	20%	10%
Different type of women activities :		
· Water transport	0%	5%
· Agriculture	10%	10%
· Cattle breeding	30%	25%
· Handicrafts	30%	30%
· Housekeeping	15%	15%
· Children care	15%	15%
Other important changes in life style		
Average cost per m^3 of water (TD/m^3)	Free 3 to 5	0.3
Average consumption of water (litters/day/inhabitant)	5 to 15	40 à 50
Building with stone (%)	30%	65%
Individual system of used water draining /house	10%	80%
Sanitary commodities (Shower-WC)/house	1%	45%
Kitchen	2%	45%
Settlement of small family gardens (%)	0%	3%
Introduction of cattle breeding (%)	0%	0%
Small scale handicrafts activities	0	0
Girls schooling (%)	55%	70%
Grocers/Café (small scale)	1	3

Table 4.6.1 Water Demand Projection

Governorate	Subproject	Population		Livestock		Ave. water demand		Max water demand	
		2000 (per)	2017 (per)	Sheep and Goats	Cows and Horses	2000 (m3/d)	2017 (m3/d)	2000 (m3/d)	2017 (m3/d)
ARIANA	FAIDH EL AMRINE	681	938	1,069	221	31	44	39	55
	HMAIEM ESSOUFLA	175	242	70	113	8	12	10	15
	TYAYRA	218	300	38	18	7	11	9	14
BEN AROUS	OULED BEN MILED	1,002	1,741	1,589	304	49	85	61	106
	SIDI FREDJ	507	879	316	303	27	43	33	54
NABEUL	SIDI HAMMED	1,310	1,632	1194	173	51	77	63	97
ZAGHOUAN	JIMLA	239	264	163	31	9	13	11	16
	ROUISSAT BOUGARMINE	1,147	1,270	2,825	268	51	66	63	83
BIZERTE	SMADAH	1,045	1,259	4,122	721	49	68	61	85
	TERGULECH	1,151	1,386	808	239	46	69	58	86
BEJA	EL GARIA	458	467	855	333	17	23	21	29
	EL GARRAG	1,412	1,435	353	358	57	84	71	105
	FATNASSA	1,013	1,030	1,453	488	72	105	89	131
JENDOUBA	CHOUAOULA	2,247	2,406	1,474	889	104	139	130	174
	COMPLEXE AEP BARBARA	12,492	13,370	13,996	2,811	482	571	603	714
LE KEF	CHAAMBA - O.EI ASSEL	661	661	3,379	319	28	34	35	42
	M'HAFDHIA - GHRAISSIA	474	474	3,043	258	20	26	26	32
KAIROUAN	CHELALGA	1,526	1,774	2,606	494	69	92	86	115
	GUDIFETT	1,210	1,409	2,608	351	54	72	68	90
	HMIDET	1,609	1,875	2,712	100	66	97	83	121
	ZGAINIA	693	807	1,661	160	33	46	42	58
KASSERINE	DAAYSIA	337	433	420	64	14	20	18	25
	HENCHIR TOUNSI	1,041	1,340	4,121	261	48	67	60	84
	OUED LAGSAB	516	665	1,895	149	23	31	29	39
	SIDI HARRATH	838	1,080	1,454	179	38	54	47	67
SIDI BOUZID	AMAIRIA	364	469	347	50	14	21	21	32
	BLAHDIA	825	1,064	2,025	220	38	53	57	80
	BOUCHIHA	1,516	1,952	4,053	434	69	96	104	144
	MAHROUGA	635	818	1,270	167	30	43	45	64
MAHDIA	COMPLEXE BOUSSLIM	5,245	6,426	11,959	1,384	261	375	392	562
	COMPLEXE EL AITHA	1,214	1,486	2,189	433	60	87	91	130
GAFSA	HENCHIR EDHOUAHER	271	295	490	34	12	16	18	24
	KHANGUET ZAMMOUR	1,636	1,781	2,007	226	67	94	100	140
	THLEIJIA	1,492	1,625	2,516	363	70	95	105	142
GABES	BATEN TRAJMA	2,747	3,092	17638	329	93	100	139	149
	CHAABET EJJAYER	284	320	810	17	14	19	20	28
	EZZAHRA	198	223	159	23	7	11	11	17
MEDENINE	BOUGUEDDIMA	319	418	1,512	71	16	24	25	37
	CHOUAMEKH	2,147	2,812	3,714	269	94	148	142	222
	ECHGIUIGUIA	478	627	502	30	18	30	27	45
	TARF ELLIL	476	623	2,239	147	25	36	37	54
Total		53,849	63,168	107,654	13,802	2,343	3,198	3,149	4,308

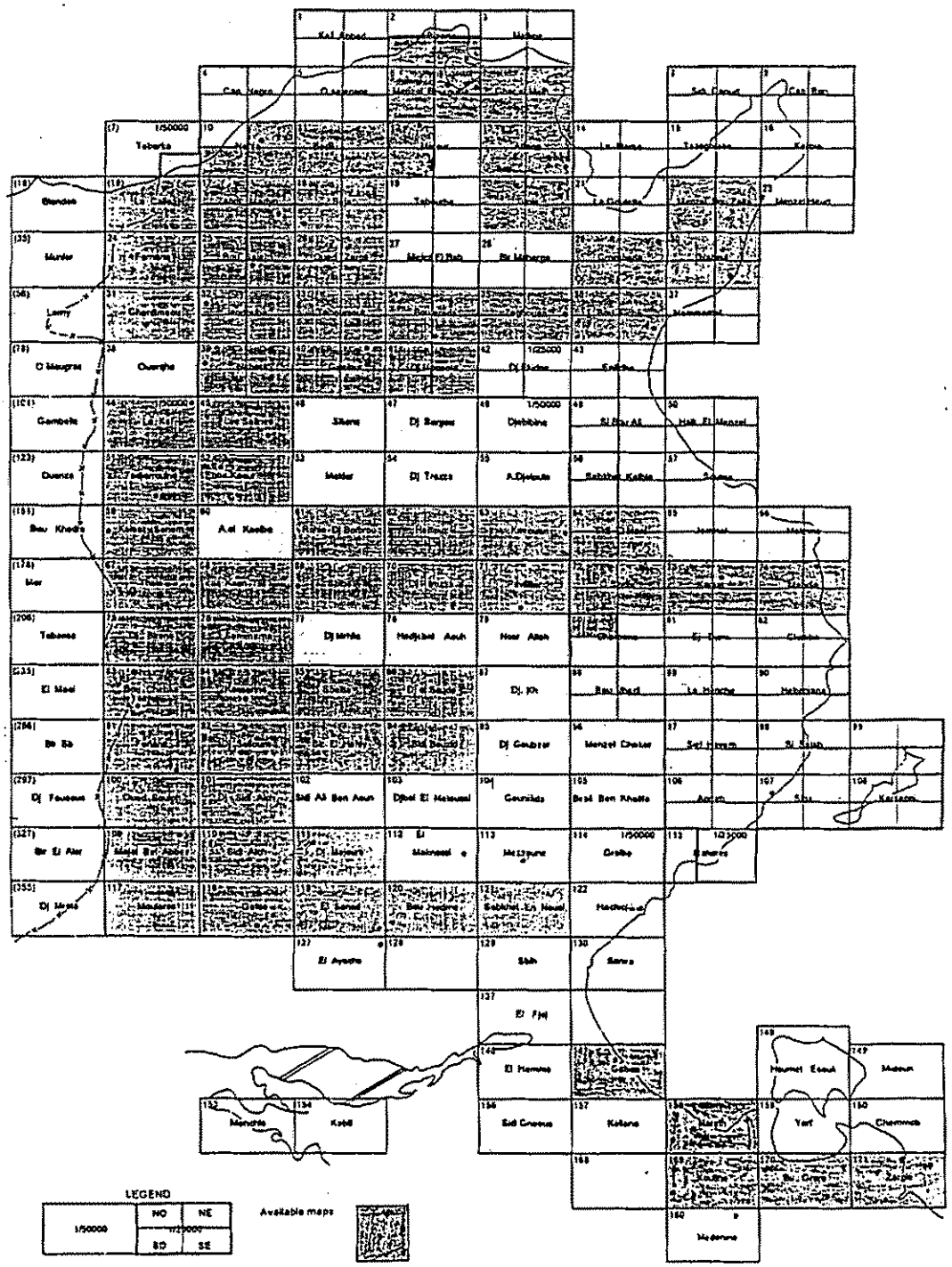
Table 4.7.1 Investment Cost Analysis

Governorate	Subproject	Population in 2017	Investment Cost	Per Capita Investment	Maximum Daily Water Demand in	Per 1m^3 Supplied Water Investment	Average Daily Water Demand in
			DT	DT	m^3/day	DT	m^3/day
ARIANA	FAIDH EL AMRINE-SIDI GHRIB	938	118,623	126	55	2175	43.6
	HMAIEM ESSOUFLA	241	32,921	137	15	2173	12.1
	TYAYRA	300	106,059	354	14	7702	11.0
BEN AROUS	OULED BEN MILED and OULED SAA	1,740	363,802	209	106	3432	84.8
	SIDI FREDJ	880	234,204	266	54	4325	43.3
NABEUL	SIDI HAMMED	1,632	550,525	337	97	5692	77.4
ZAGHOUAN	JIMLA	265	144,641	546	16	8896	13.0
	ROUISSAT BOUGARMINE	1,270	377,762	297	83	4559	66.3
BIZERTE	SMADAH	1,259	369,329	293	84	4375	67.5
	TERGULECH	1,386	704,403	508	86	8149	69.2
BEJA	EL GARIA	466	136,352	293	29	4744	23.0
	EL GARRAG	1,436	359,396	250	105	3437	83.7
	FATNASSA	1,803	492,527	273	131	3749	105.1
JENDOUBA	CHOUAOULA	2,405	990,557	412	174	5688	139.3
	COMPLEXE AEP BARBARA	13,369	4,014,288	300	714	5622	571.3
LE KEF	CHAAMBA - O.EI ASSEL - HMAIDIA	661	328,314	497	42	7740	33.9
	M'HAFDHIA - GHRAISSIA	474	258,533	545	32	8094	25.6
KAIROUAN	CHELALGA	1,777	736,174	414	115	6403	92.0
	GUDIFETT	1,409	282,956	201	90	3138	72.1
	HMIDET	1,874	312,841	167	121	2577	97.1
	ZGAINIA	807	119,333	148	58	2070	46.1
KASSERINE	DAAYSIA	434	238,364	549	25	9418	20.3
	HENCHIR TOUNSI	1,341	368,161	275	84	4388	67.1
	OUED LAGSAB	665	246,721	371	39	6270	31.5
	SIDI HARRATH - GOUASSEM	1,079	270,474	251	67	4012	53.9
SIDI BOUZID	AMAIRIA	469	198,772	424	32	6216	21.3
	BLAHDIA	1,063	427,327	402	80	5337	53.4
	BOUCHIHA	1,953	603,143	309	144	4184	96.1
	MAHROUGA	818	378,040	462	64	5891	42.8
MAHDIA	COMPLEXE BOUSSLIM	6,424	2,010,477	313	562	3578	374.6
	COMPLEXE EL AITHA	1,487	234,455	158	130	1805	86.6
GAFSA	HENCHIR EDHOUAHER	295	134,206	455	24	5498	16.3
	KHANGUET ZAMMOUR	1,781	447,545	251	140	3191	93.5
	THLEIJIA	1,624	472,005	291	142	3324	94.7
GABES	BATEN TRAJMA	3,093	528,490	272	149	3539	99.6
	CHAABET EJJAYER	320	87,849	275	28	3154	18.6
	EZZAHRA	223	70,241	315	17	4257	11.0
MEDENINE	BOUGUEDDIMA	418	122,325	293	37	3348	24.4
	CHOUAMEKH - R. ENNAGUEB	2,812	589,248	210	222	2659	147.7
	ECHGIUIGUIA	626	222,122	355	45	4932	30.0
	TARF ELLIL	623	287,443	461	54	5277	36.3
	Total and Average	63,940	18,970,950	297	4308	4404	3197

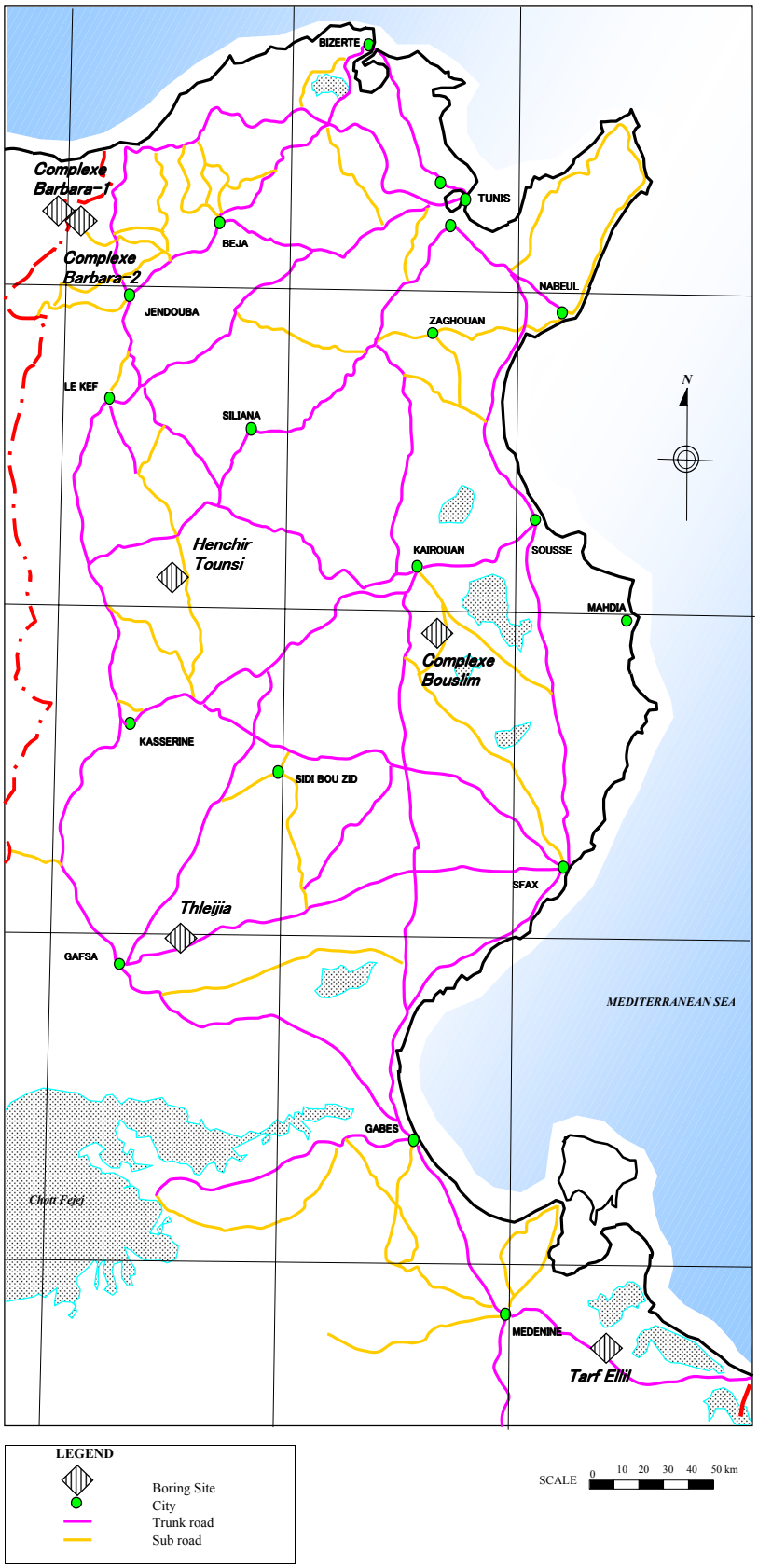
* The subprojects of OULED DHIFALLAH, MAALIM and JOUAOUDA 1 / BATTAHA in JENDOUBA Governorate are considered as one project named Complexe AEP BARBARA because the three subproject areas are projected to be covered by one water supply system of which water source is the BARBARA Dam.

Table 4.7.2 Financial Analysis Results

Governorate	Subproject	Cost of Supplied Water per m3			Project balance	Proposed water
		Total	Fixed cost	Valueable cost	in 2017	charge per m3
ARIANA	FAIDH EL AMRINE-SIDI GHRIB	0.281	0.096	0.185	35,445	1.000
	HMAIEM ESSOUFLA	0.336	0.151	0.185	7,685	1.000
	TYAYRA	0.742	0.512	0.230	23,422	1.000
BEN AROUS	OULED BEN MILED and OULED SAAD	0.513	0.263	0.250	78,850	0.700
	SIDI FREDJ	0.659	0.421	0.238	80,845	0.791
NABEUL	SIDI HAMMED	0.525	0.312	0.213	117,452	0.700
ZAGHOUAN	JIMLA	0.887	0.643	0.244	57	0.887
	ROUISSAT BOUGARMINE	0.315	0.254	0.061	212	0.390
BIZERTE	SMADAH	0.420	0.342	0.072	86,074	0.504
	TERGULECH	0.415	0.380	0.035	85,709	0.500
BEJA	EL GARIA	0.458	0.281	0.177	209	0.550
	EL GARRAG	0.542	0.333	0.209	2,529	0.650
	FATNASSA	0.436	0.361	0.075	9,503	0.523
JENDOUBA	CHOUAOULA	0.701	0.385	0.316	2,360	0.841
	COMPLEXE AEP BARBARA	0.527	0.321	0.206	45,894	0.632
LE KEF	CHAAMBA - O.EI ASSEL - HMAIDIA	0.613	0.528	0.085	0	0.750
	M'HAFDHIA - GHRAISSIA	0.570	0.534	0.036	1	0.700
KAIROUAN	CHELALGA	0.620	0.274	0.346	0	0.750
	GUDIFETT	0.493	0.147	0.346	0	0.600
	HMIDET	0.272	0.213	0.059	2	0.350
	ZGAINIA	0.199	0.151	0.048	10	0.250
KASSERINE	DAAYSIA	0.773	0.536	0.237	9	0.775
	HENCHIR TOUNSI	0.389	0.342	0.047	3	0.470
	OUED LAGSAB	0.829	0.631	0.198	4	0.850
	SIDI HARRATH - GOUASSEM	0.294	0.229	0.065	3	0.400
SIDI BOUZID	AMAIRIA	0.590	0.440	0.150	0	0.758
	BLAHDIA	0.429	0.353	0.076	1	0.520
	BOUCHIHA	0.295	0.220	0.075	0	0.400
	MAHROUGA	0.503	0.158	0.345	1	0.605
MAHDIA	COMPLEXE BOUSSLIM	0.313	0.092	0.221	17,330	0.500
	COMPLEXE EL AITHA	0.212	0.034	0.178	1,778	0.500
GAFSA	HENCHIR EDHOUAHER	0.684	0.394	0.290	36	0.800
	KHANGUET ZAMMOUR	0.303	0.257	0.046	16	0.400
	THLEIJIA	0.305	0.260	0.045	43	0.400
GABES	BATEN TRAJMA	0.528	0.397	0.131	25	0.650
	CHAABET EJJAYER	0.445	0.252	0.193	21	0.550
	EZZAHRA	0.408	0.260	0.148	114	0.600
MEDENINE	BOUGUEDDIMA	0.421	0.236	0.185	53	0.500
	CHOUAMEKH - R. ENNAGUEB	0.375	0.181	0.194	53	0.450
	ECHGIUIGUIA	0.390	0.205	0.185	2,886	0.500
	TARF ELLIL	0.521	0.334	0.187	181	0.650

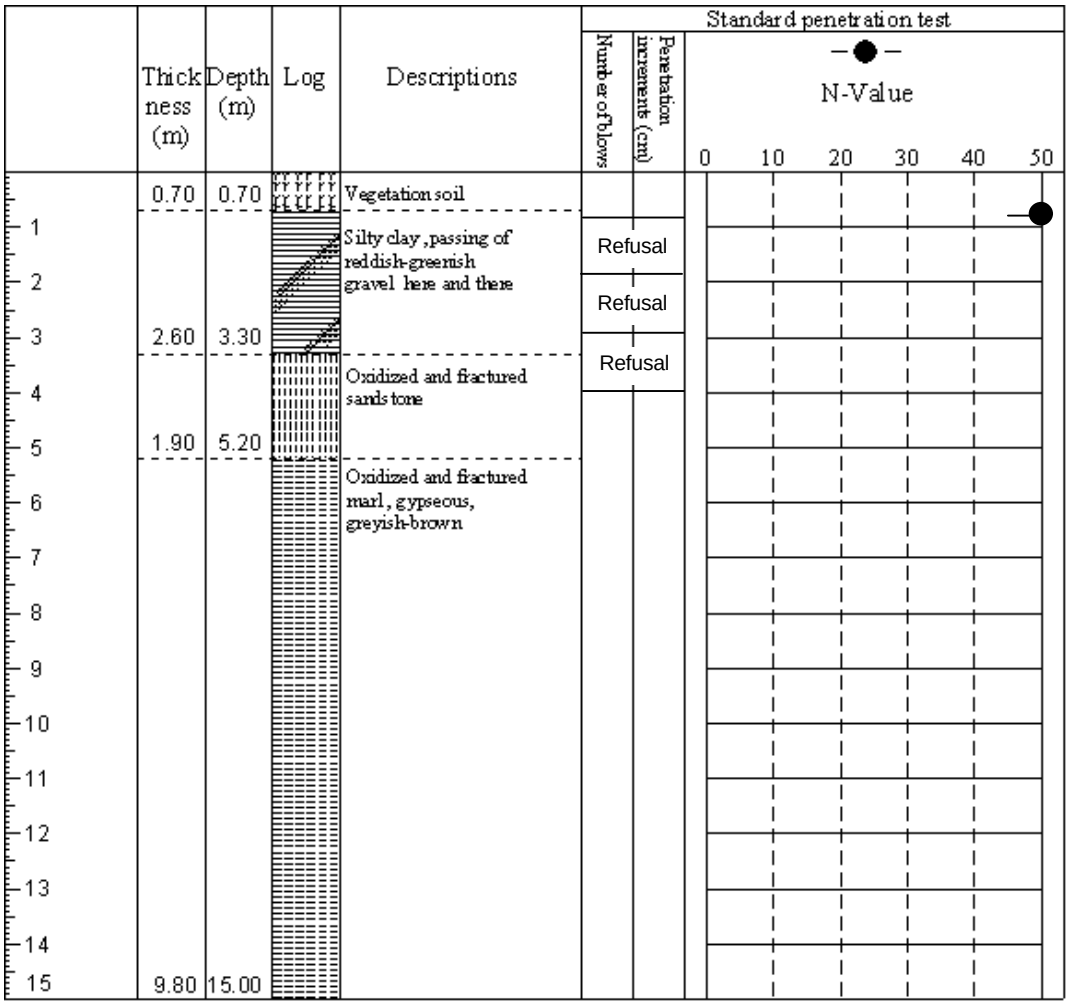


The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa	Figure 4.3.1 Collected Topographical Maps
Japan International Cooperation Agency	



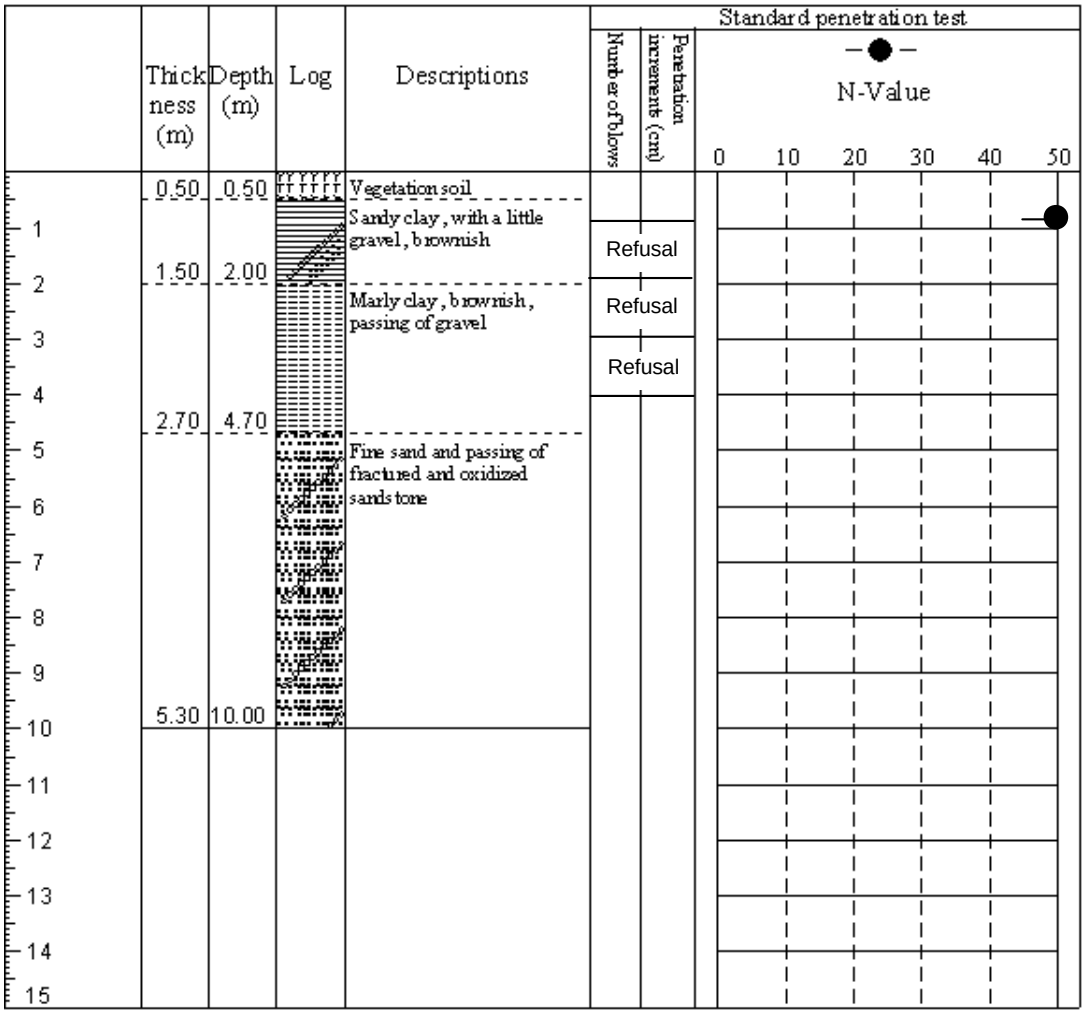
The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa	Figure 4.4.1 Boring Site Location
Japan International Cooperation Agency	

Project	Projet d'Adduction en Eau Potale 2001				Site	Ouled Dhiffallah	
Boring No.	SC1				Date	Nov. 2000	
Elevation		Angle		Direction		G.W.L.	
Depth	GL-15m						



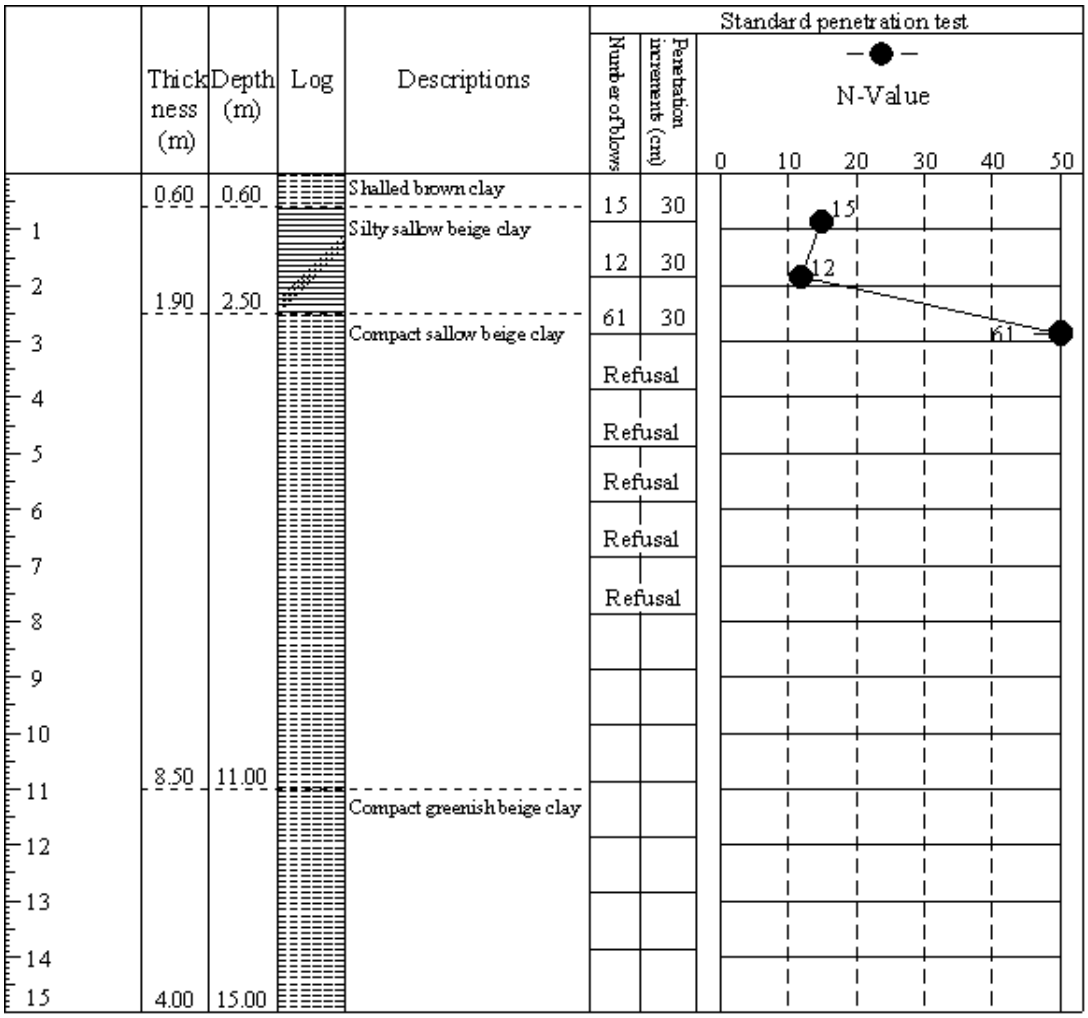
The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa	Figure 4.4.2 Complexe AEP Barbara Drill Log-1
Japan International Cooperation Agency	

Project	Projet d'Adduction en Eau Potale 2001				Site	Ouled Dhiffallah	
Boring No.	SC2				Date	Nov. 2000	
Elevation		Angle		Direction		G.W.L.	
Depth	GL-10m						



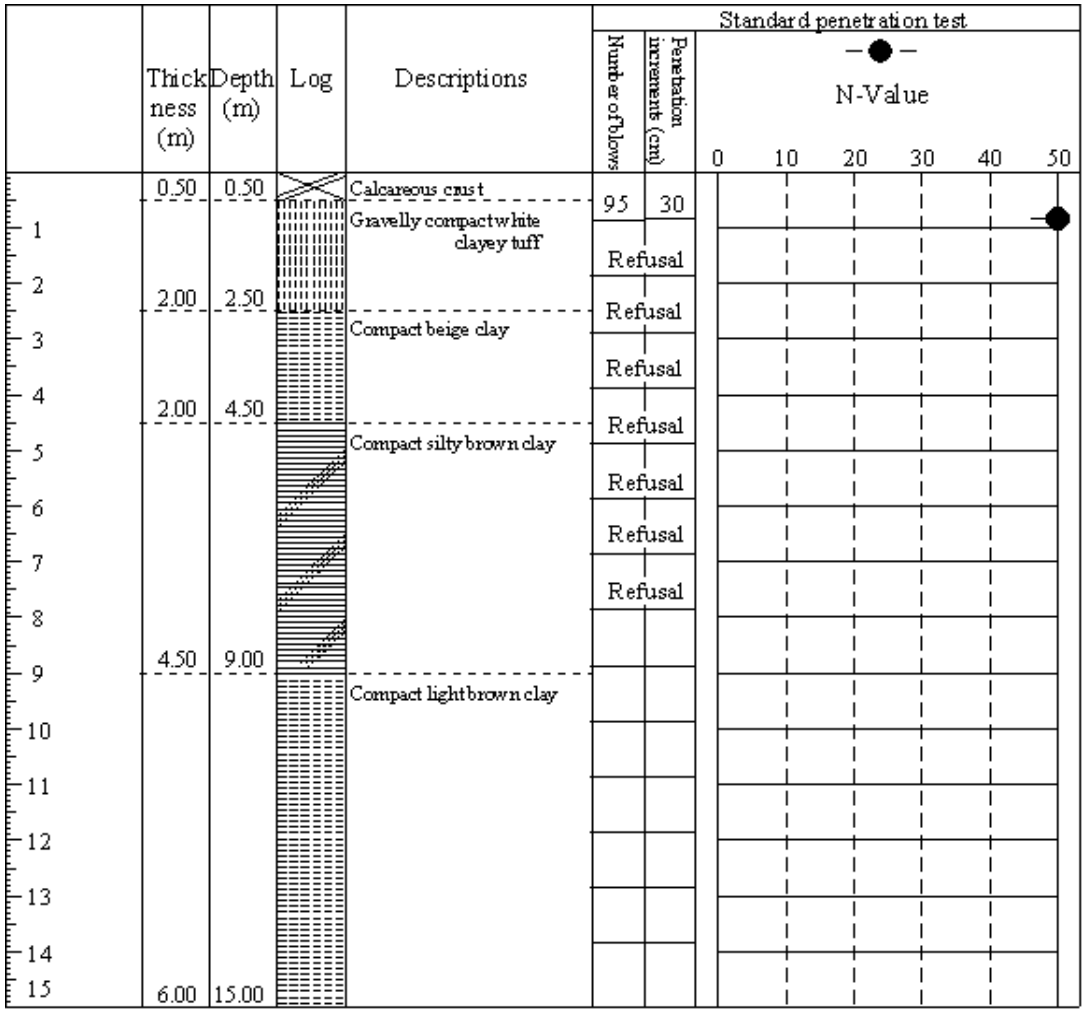
The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa	Figure 4.4.3 Complexe AEP Barbara Drill Log-2
Japan International Cooperation Agency	

Project	Construction of a tank in Henchir Tounsi EL AYOUNE --- Geotechnical survey				Site	Henchir Tounsi	
Boring No.					Date	Sept. 2000	
Elevation		Angle		Direction		G.W.L.	
Depth	GL-15m						



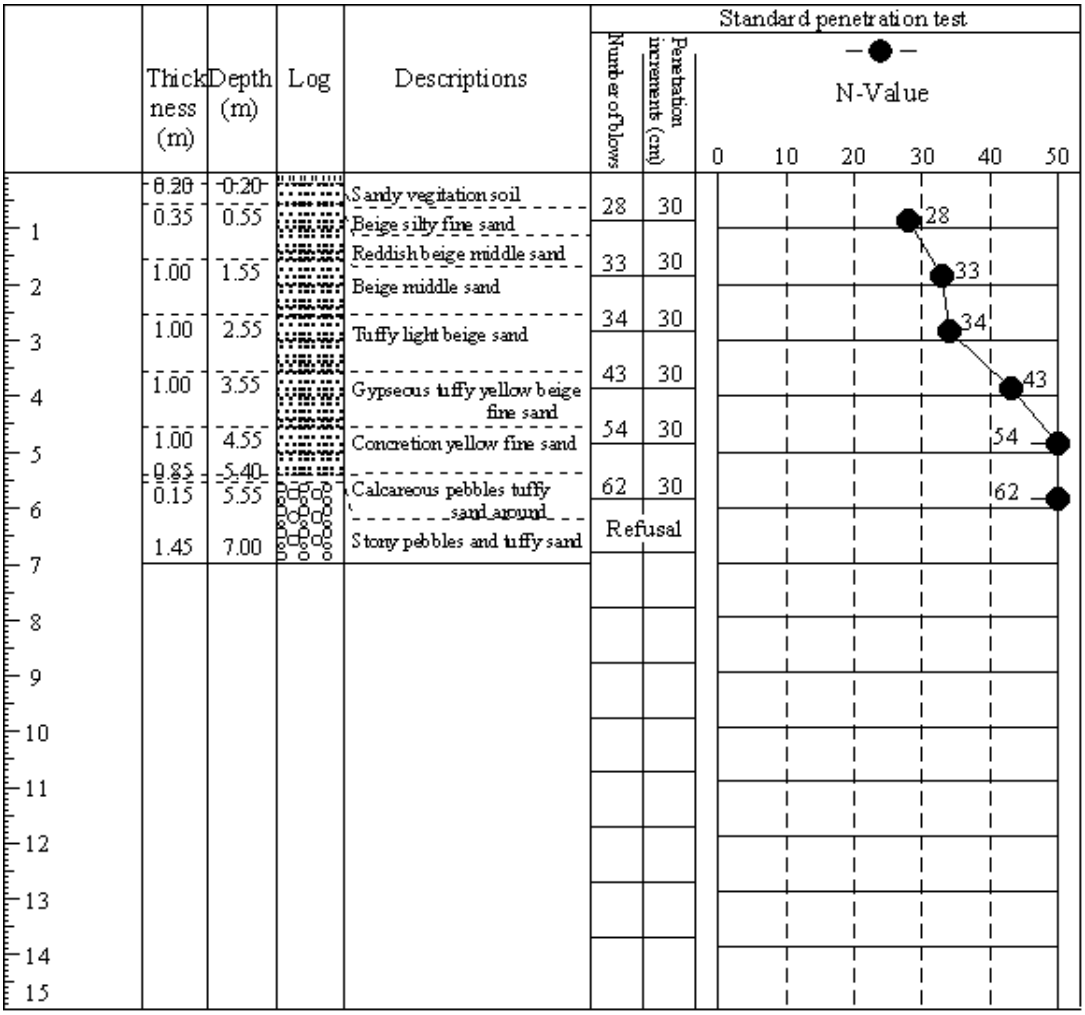
The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa Japan International Cooperation Agency	Figure 4.4.4 Henchir Tounsi Drill Log

Project	Construction of a tank in Bouslim Ouled Chamekh --- Geotechnical survey				Site	Bouslim Ouled Chamekh	
Boring No.					Date	Sept. 2000	
Elevation		Angle		Direction		G.W.L.	
Depth	GL-15m						



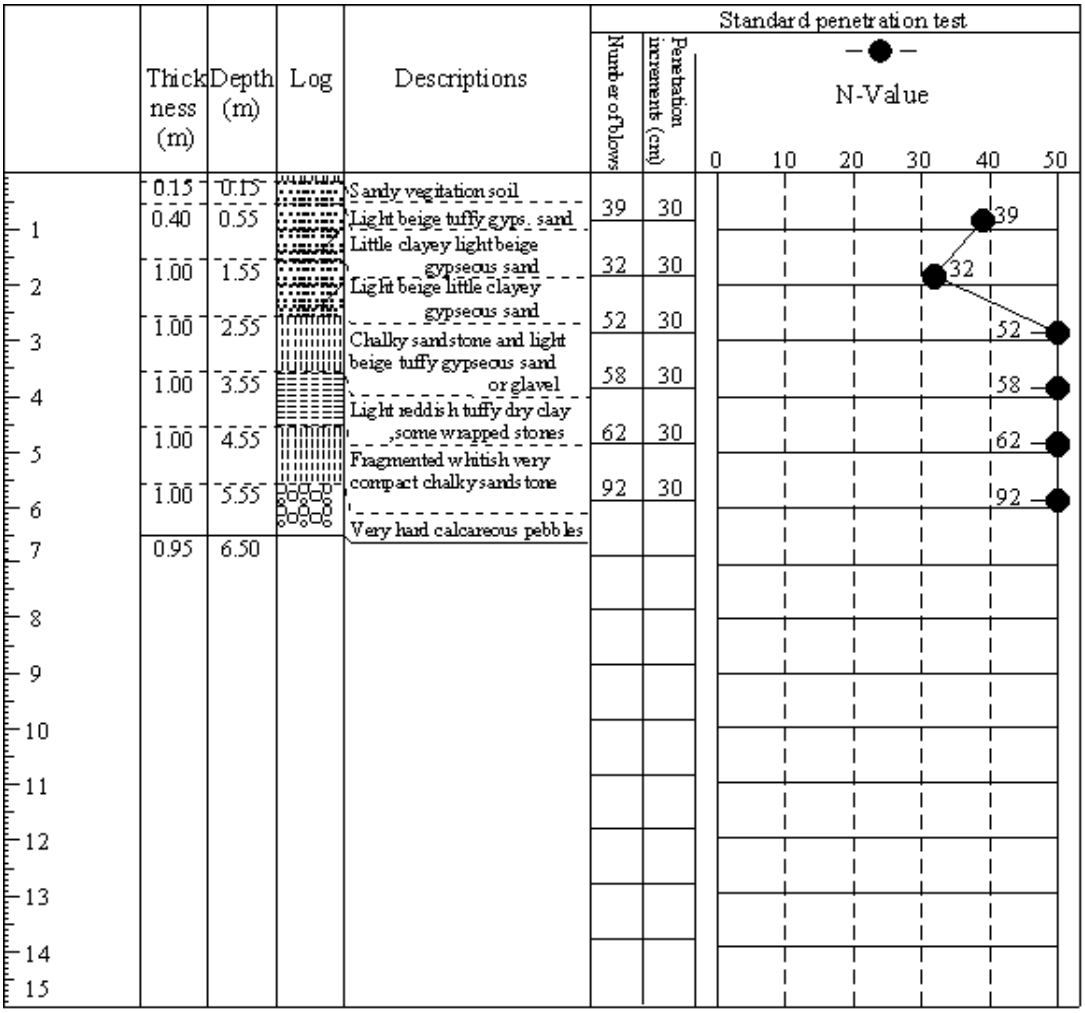
The Detailed Design Study on The Rural Water Supply Project in the Repubilc of Tunisa	Figure 4.4.5 Complexe Bouslim Drill Log
Japan International Cooperation Agency	

Project	Geotechnical study of the 50m^3 water tower				Site	Thleijia	
Boring No					Date	Oct. 2000	
Elevation		Angle		Direction		G.W.L.	
Depth	GL-7.0m						

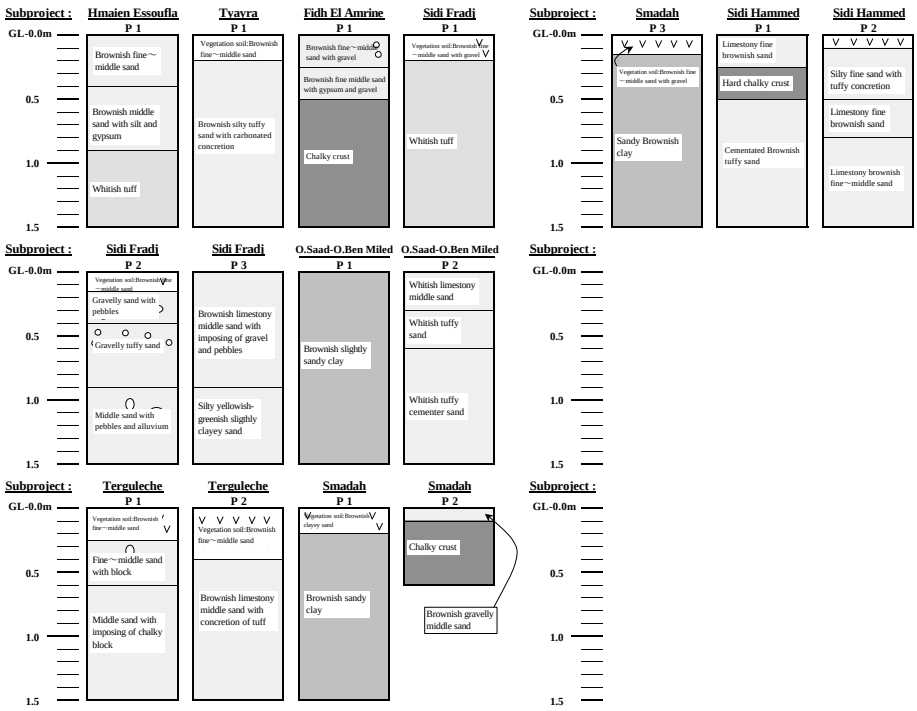


The Detailed Design Study on The Rural Water Supply Project in the Repubilc of Tunisa	Figure 4.4.6 Thleijia Drill Log
Japan International Cooperation Agency	

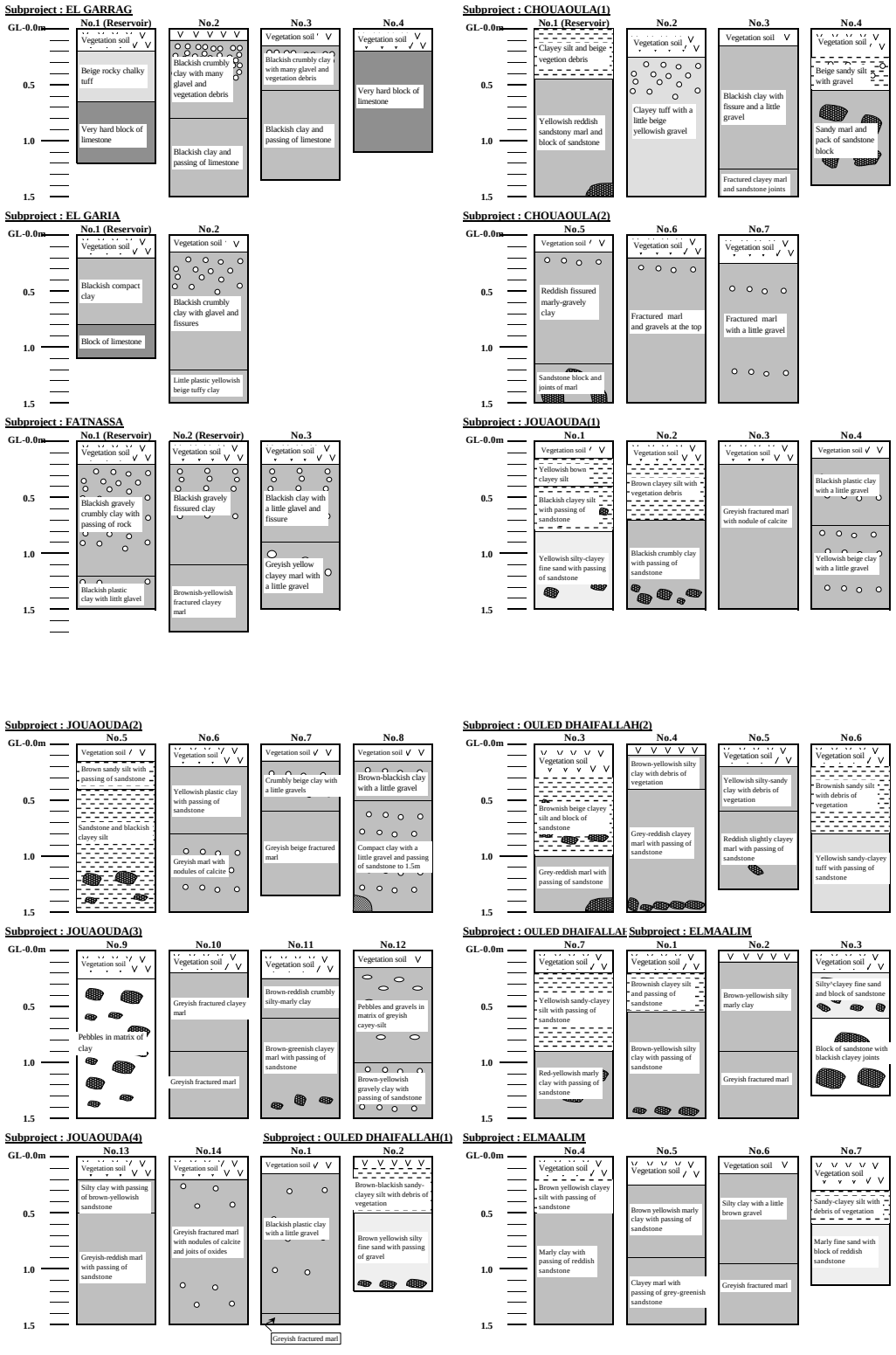
Project	Geotechnical study of the 50m^3 water tower				Site	Tarf Ellil	
Boring No					Date	Oct. 2000	
Elevation		Angle		Direction		G.W.L.	
Depth	GL-7.0m						



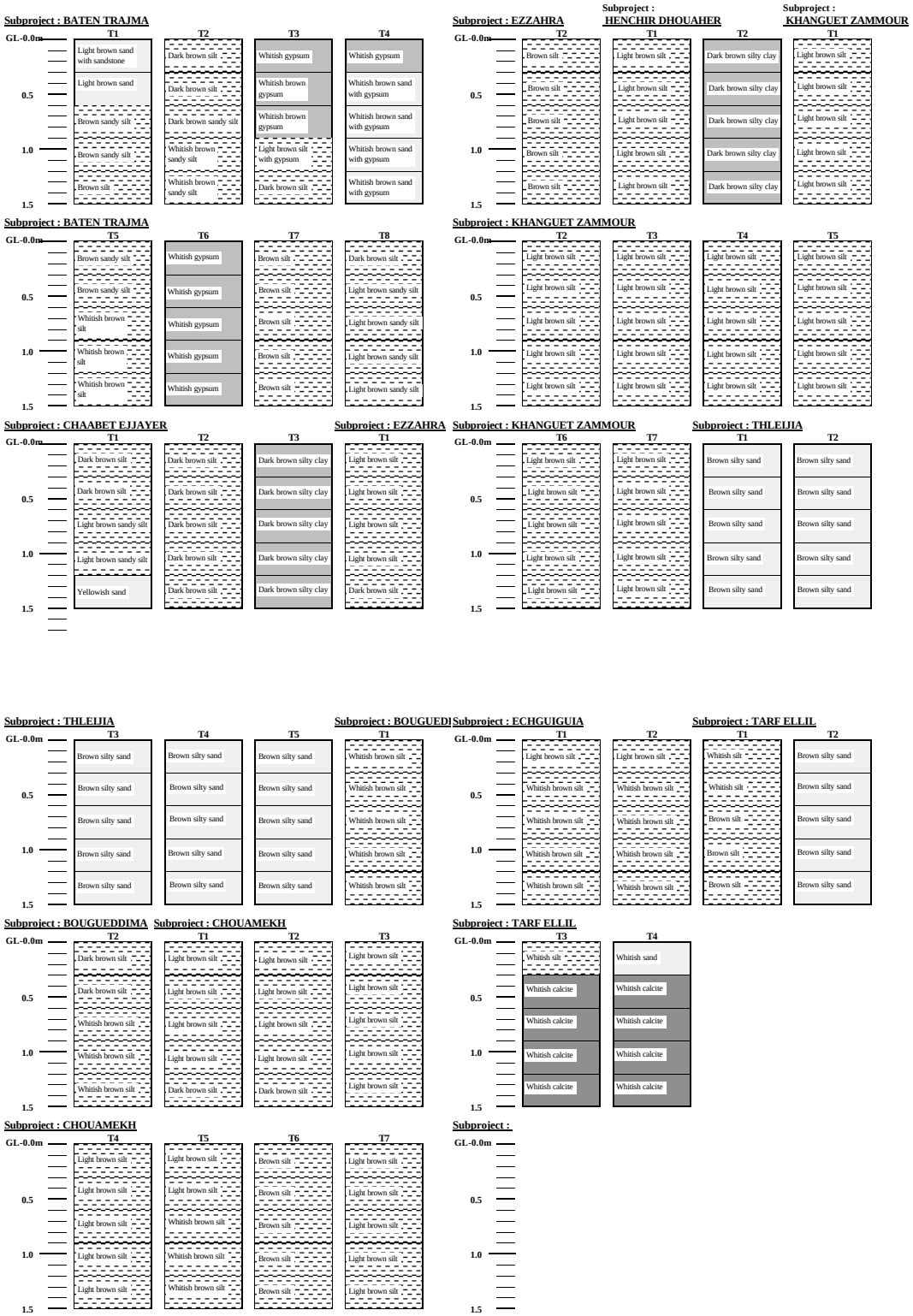
The Detailed Design Study on The Rural Water Supply Project in the Repubilc of Tunisa	Figure 4.4.7 Tarf Ellil Drill Log
Japan International Cooperation Agency	



The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa Japan International Cooperation Agency	Figure 4.4.8 Test Pit Logs (1/3)



The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa	Figure 4.4.8
Japan International Cooperation Agency	Test Pit Logs (2/3)



The Detailed Design Study on The Rural Water Supply Project in the Republic of Tunisa	Figure 4.4.8 Test Pit Logs (3/3)
Japan International Cooperation Agency	

CHAPTER 5 DESIGN CONCEPTS

5.1 Definition

This chapter explains the guideline applied by DGGR to the Rural Water Supply Project.

(1) Urban areas

The overall communities designated by the decree of the Ministry of Interior and administrated by the municipal law of the local council.

(2) Rural areas

The areas located outside the community areas

(3) Grouped Population

The population who lives outside the community areas forms a locality which consists of at least 10 housings. Among the housings, the maximum distance between one to others is 200m.

(4) Scattered Population

The population who lives outside the community areas but who is not classified as grouped population is considered as scattered population.

5.2 Project Lifetime

The Project Lifetime, which defines the period to recover the investment cost, etc., shall be 15 years from the commencement of the operation of the projected water supply system.

5.3 Water Demand Projection

The following is the basis of the water demand projection applying the design of the water supply system.

(1) Grouped Population

25lpcd at the commencement of the water supply system operation and annual increase rate of 2.5% shall be applied to future water demand estimation.

(2) Scattered Population

To be fixed with 20 lpcd. It is considered that the living conditions of scattered population will not be able to be improved in a near future, so the estimated consumption of these people therefore is not expected to increase.

(3) Domestic Animals

Water demand of 5 lpcd for sheep and goats and 30 lpcd for cows and horses. The water demand for domestic animals is limited at 40% of the above-mentioned populations' total consumption at the final year of the project in case that no alternative source exists for animal watering.

Though 5 lpcd is applied to the water consumption of a pupil in a school, it is used for the sizing of service facilities only.

The volume of loss is considered as 15% of the water demand. The loss mainly includes:

(1) Leakage from the system
(2) Water drained at service point
(3) Error of water meter
(4) Water used in the system

Daily peak factor which indicates the ratio of the maximum daily water demand (it comes in general in summer) to the average daily water demand (it is estimated based on per capita per day demand) shall be 1.25 for the governorates in the North area and 1.5 for those in the South area. Classification of which governorate is in the North area or in the South area is shown in below.

Daily Peak Factor Applied to Governorates

	Governorate	Area	Daily Peak Factor
1	Ariana	North	1.25
2	Beja	North	1.25
3	Ben Arous	North	1.25
4	Bizerte	North	1.25
5	Jendouba	North	1.25
6	Kairouan	North	1.25
7	Kasserine	North	1.25
8	Le Kef	North	1.25
9	Nabeul	North	1.25
10	Zaghouan	North	1.25
11	Gabes	South	1.50
12	Gafsa	South	1.50
13	Mahdia	South	1.50
14	Medenine	South	1.50
15	Sidi Bouzid	South	1.50

Hourly peak factor which shows the ratio of the maximum hourly water demand to the average hourly water demand shall be 1.8. The maximum hourly water demand is the water demand at the peak time in a day, it exists in the morning in many cases, and the average hourly water demand is one twenty-fourth (1/24) of average daily water demand.

Since the designed discharge of each service facility is far bigger than the estimated hourly peak demand in this Project, the hourly peak demand is seldom used for the design of the water supply system under the Project.

Therefore the maximum daily water demand with loss can be calculated as follows:

Wp=(Wg+Ws+Wd)x1.15x1.25(North) or 1.5(South)

$Wg = Pg \times 25 \text{ (liter)} \times (1+0.025)^{(15+2)}$

Prospective beneficiary population is surveyed in the feasibility study which is generally executed two years before starting the operation of the projected water supply system.

Ws= Ps x 20

In case Wd > 0.4 x (Ws + Wg), Wd = 0.4 x (Ws + Wg)

where:

Wp (liter/day) : The maximum daily water demand with loss
Wg (liter/day) : Water demand by grouped population at the final year of the project life
Ws (liter/day) : Water demand by scattered population
Wd (liter/day) : Water demand by domestic animals
Pg : No. of grouped population
Ps : No. of scattered population

5.4 Guideline for Hydraulic Calculation

(1) Velocity of Pipe inner flow shall be 0.4m/s to 1.2m/s

Considering small scale water supply, pipe discharge is quite small but adopting small size pipe for keeping recommended pipe inner flow velocity makes high friction head loss. It cannot, therefore, help accepting less velocity than the recommended one.

(2) Residual Pressure at a service point shall be 1 bar (around 10m)

The gravitational flow distribution is adopted to almost all projected water supply systems to lower the operation cost. In this sense, keeping this pressure head for all service points in a system is sometimes difficult without higher investment cost. The residual pressure at a service point should be determined by considering the appropriateness of the investment cost

(3) Friction head loss of pipe inner flow shall be estimated Hazen William or Colebrook formula.

The application of Hazen William formula is recommended. C value (hydraulic factor related to pipe surface roughness) used in the Hazen William formula should be applied 120 for the consideration of long-term use of pipe.

(4) Designed discharge of each service facility is as follows:

Communal tap, domestic animal watering space and individual connection are 0.5l/s and *potence* is 2.0l/s.

(5) Capacity of Distribution Tank

The capacity of the distribution tank shall be determined as follows:

1) 50% of the average daily water supply of the final year of the project lifetime or
2) 25% of the maximum daily water supply of the same above, whichever is bigger.

5.5 Financial Guidelines

(1) The lifetime and rates of maintenance cost for each equipment, device, etc., to be applied are given in Table 5.5.1.

(2) An annual rate of 5% is applied to update maintenance cost.

(3) An annual rate of 5% is applied to update flat rate of supplied water.

(4) Actual receipts whichever flat rate or metered charge of supplied water should be equivalent to 80% of the theoretical revenue of GIC.

(5) GIC membership ratio to all the beneficiary families is equal to 60% at the beginning of operation with a yearly uniform increment of 2%. The rate is equal to 90% at the final year of the project lifetime.

(6) The number of persons per household is that from the CENSUS in 1994 of INS (National Statistic Institute) related to the non-communal population of the governorate.

(7) The production cost of $1m^3$ of supplied water should be calculated assuming internal rate of return (IRR) as 5%, 8%, and 10%, respectively. The cost should be divided into the following three components:

1) The investment cost
2) The fixed expenses
3) The variable expenses

Table 5.5.1 Lifespan and Maintenance Rate of Equipment and Devices (1/4)

Base: 1994

ITEMS	UNIT	UNIT PRICE (DT)	LIFESPAN	MAINTENANCE RATE %
1. Service Point				
1) Shallow well construction D= 3,00 m : depth: 30m	ml		20	1.0
2) Shallow well facilitation	set		20	1.0
3) Digging	ml		20	0.1
4) Intake of spring	set		20	1.0
2. Equipment				
1) Tube well or source	set		7	2.5
2) Booster pumping station	set		7	2.5
3) Equipment against water-hammer, Operating pressure 10 bar				
capacity 200 l	set		7	2.5
capacity 250 l	set		7	2.5
capacity 500 l	set		7	2.5
capacity 1000 l	set		7	2.5
capacity 2000 l	set		7	2.5
4) Equipment against water-hammer, Operating pressure 16 bar				
capacity 200 l	set		7	2.5
capacity 500 l	set		7	2.5
capacity 1000 l	set		7	2.5
capacity 2000 l	set		7	2.5
5) Disinfection (chlorination)	set		7	2.5
6) Chlorinating station (volumetric pump)				
pump capacity: 20 m3/h	set		7	2.5
hydraulic pump	set		7	2.5
3. Power Supply from STEG				
1) Connection LV single or three-phase 1 to 60 m	set		2.5	0
2) Extra cost between 60 and 200 m	set		2.5	0
3) Connection MV single-phase, extension line MV	km		2.5	0
4) Transformer station MV/LV single-phase P = 10 kVA	set		2.5	0
5) Connection MV three-phase, line MV three-phase	km		2.5	0
6) Transformer station MV/LV single-phase, three-phase				
P = 10 kVA	set		2.5	0
P = 25 kVA	set		2.5	0
P = 40 kVA	set		2.5	0
P = 50 kVA	set		2.5	0
7) Switchgear and operating cubicle (10 kVA)	set		1.5	2.5
8) Switchgear and operating cubicle (25 kVA)	set		1.5	2.5
4. Independent power supply				
1) Generator				
P = 7.5 kVA	set		7	4
P = 10 kVA	set		7	4
P = 15 kVA	set		7	4
P = 18 kVA	set		7	4
P = 25 kVA	set		7	4
P = 36 kVA	set		7	4
5. Material and devices for piping work				
1) PE piping PN6				
OD 32 (outside diameter)	ml		3.0	0.5
OD 40	ml		3.0	0.5
OD 50	ml		3.0	0.5

Table 5.5.1 Lifespan and Maintenance Rate of Equipment and Devices (2/4)

Base: 1994

ITEMS	UNIT	UNIT PRICE (DT)	LIFESPAN	MAINTENANCE RATE %
OD 63	ml		3.0	0.5
OD 75	ml		3.0	0.5
OD 90	ml		3.0	0.5
OD 110	ml		3.0	0.5
OD 125	ml		30	0.5
OD 160	ml		30	0.5
OD 200	ml		30	0.5
2) PE piping PN 10				
OD 32	ml		30	0.5
OD 40	ml		30	0.5
OD 50	ml		30	0.5
OD 63	ml		30	0.5
OD 75	ml		3.0	0.5
OD 90	ml		3.0	0.5
OD 110	ml		3.0	0.5
OD 125	ml		3.0	0.5
OD 160	ml		3.0	0.5
OD 200	ml		3.0	0.5
3) PE piping PN16				
OD 32	ml		3.0	0.5
OD 40	ml		3.0	0.5
OD 50	ml		3.0	0.5
OD 63	ml		3.0	0.5
OD 75	ml		3.0	0.5
OD 90	ml		3.0	0.5
OD 110	ml		3.0	0.5
OD 125	ml		3.0	0.5
OD 160	ml		3.0	0.5
OD 200	ml		3.0	0.5
4) Ductile cast iron piping PN 25				
ND 100 (Nominal diameter)	ml		30	0.5
ND 150	ml		30	0.5
5) Water Meter				
ND 150	set		15	2.5
ND 50	set		15	2.5
6) Pressure switch	set		15	2.5
6. Structures				
1) RC ELEVATED TANK H= 9 m				
Capacity 15 m^3	set		40	1
Capacity 25 m^3	set		40	1
Capacity 50 m^3	set		40	1
Capacity 100 m^3	set		40	1
Capacity 150 m^3	set		40	1
2) RC ELEVATED TANK H= 15 m				
Capacity 15 m^3	set		40	1
Capacity 25 m^3	set		40	1
Capacity 50 m^3	set		40	1
Capacity 100 m^3	set		40	1
Capacity 150 m^3	set		40	1
3) RC SEMI-BURIED TANK				
Capacity 15 m^3	set		40	1
Capacity 25 m^3	set		40	1
Capacity 40 m^3	set		40	1

Table 5.5.1 Lifespan and Maintenance Rate of Equipment and Devices (3/4)

Base: 1994

ITEMS	UNIT	UNIT PRICE (DT)	LIFESPAN	MAINTENANCE RATE %
Capacity 50 m^3	set		40	1
Capacity 75 m^3	set		40	1
Capacity 100 m^3	set		40	1
Capacity 150 m^3	set		40	1
4) BOOSTER PUMP				
Capacity 5 m^3	set		40	1
Capacity 10 m^3	set		40	1
Capacity 15 m^3	set		40	1
Capacity 20 m^3	set		40	1
Capacity 40 m^3	set		40	1
5) PUMPING STATION	m^2		40	1
6) GENERATOR CAGE	m^2		40	1
7) EQUIPMENT INSTALLATION FOR ELEVATED TANK				
15 and 25 m3	set		15	2.5
40 m3	set		15	2.5
50 m3 and 100 m3	set		15	2.5
150 m3	set		15	2.5
8) Equipment Installation for Semi Buried Tank				
25 m^3 and less	set		15	2.5
between 40 and 100 m^3	set		15	2.5
9) Manhole	set		40	1
10) BOOSTER PUMPING STATION WITH 8m3 TANK	set		40	1
11) EQUIPMENT INSTALLATION FOR BOOSTER PUMPING	set		15	2.5
12) DISTRIBUTION WORKS				
public tap	set		15	2.5
cattle drinking place	set		15	2.5
gallows	set		15	2.5
individual connection	set		15	2.5
7. Others				
1) Extra cost for rocky grounds	m^3		30	0
2) Connection to tank	set		20	0
3) GALVANIZED STEEL piping				
OD 80	ml		30	0.5
OD 100	ml		30	0.5
OD 125	ml		30	0.5
OD 150	ml		30	0.5
OD 200	ml		30	0.5
4) AC piping				
OD 80	ml		30	0.5
OD 100	ml		30	0.5
OD 150	ml		30	0.5
OD 200	ml		30	0.5
Class 15 d OD 80	ml		30	0.5
OD 100	ml		30	0.5
OD 150	ml		30	0.5
OD 200	ml		30	0.5
8. JOINT PARTS SUPPLY				
1) Joints for PE piping				
OD 125 / OD 200	set	40% of the pipe price	30	0.5
OD 90 / OD 110	set	25% of the pipe price	30	0.5

Table 5.5.1 Lifespan and Maintenance Rate of Equipment and Devices (4/4)

Base: 1994

ITEMS	UNIT	UNIT PRICE (DT)	LIFESPAN	MAINTENANCE RATE %
OD 32 / OD 75	set	15% of the pipe price	30	0.5
2) Joints for Steel piping	set	not legible of the pipe	20	0.5
3) Joint for AC piping	set	20% of the pipe price	20	0.5
9. Pipe fittings				
1) PE piping				
OD 32	ml		30	0.5
OD 40	ml		30	0.5
OD 50	ml		30	0.5
OD 63	ml		30	0.5
OD 75	ml		30	0.5
OD 90	ml		30	0.5
OD 110	ml		30	0.5
OD 125	ml		30	0.5
OD 160	ml		30	0.5
OD 200	ml		30	0.5
2) GALVANIZED STEEL piping				
OD 80	ml		30	0.5
OD 100	ml		30	0.5
OD 125	ml		30	0.5
OD 150	ml		30	0.5
OD 200	ml		30	0.5
OD 250	ml		30	0.5
3) AC piping				
OD 80	ml		30	0.5
OD 100	ml		30	0.5
OD 150	ml		30	0.5
OD 200	ml		30	0.5
10. Pipe Transportation				
Add on piping price in %				
1) Tunis, Ben Arous, Ariana, Bizerte, Zaghouan, Nabeul				5
2) Beja, Jendouba, Le Kef, Siliana				10
3) Sousse, Monastir, Mahdia, Kairouan, Sfax, Kasserine				15
4) Gafsa, Tozeur, Kebili, Gabes, Medenine, Tataouine				20
11. Piping Equipement Supply and Fitting				
1) Cast iron taps, valves, flanges				
OD 40	unit		20	1
OD 50	unit		20	1
OD 65	unit		20	1
OD 80	unit		20	1
OD 100	unit		20	1
OD 125	unit		20	1
OD 150	unit		20	1
OD 200	unit		20	1
2) DRAIN	set		20	1
3) AIR VALVE	set		20	1