Palestinian Hydrology Group

For Water and Environmental Resources Development

Master Plan for Water and Sanitation for Selected Communities in Tubas District and in Cooperation with PWA & ACAD

Final Report

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OUTLINE

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Study Working Staff:

The PHG assigned the following staff members:

Dr. Abdul-Rahman Al-Tamimi …………. Project manager

Eng. Sami Dawoud ……………………… Project Coordinator

Abdul-Latif …………………………………Senior water systems engineer

Mohammed Mar'i………………………… Senior wastewater systems engineer

Kanan Suwadi …………………………… Senior Socio-economic specialist

Solaif Dababseh ………………………… Senior civil engineer

Jihad Hijawi ……………………………… Project Secretary

Manar Kelfeh ……………………………. Financial Management specialist

List of Abbreviations

ACAD	Association des Consultants en Aménagement et Développement
ACPP	Asamblea de Cooperacion por la Paz
ECHO	European Community Humanitarian Office
ANERA	American Near East Relief Aid
BOD	Biological Oxygen Demand
EQA	Palestinian Environment Quality Authority
CF	Colony Forming Units
COD	Chemical Oxygen Demand
EC	Electrical Conductivity
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
g/hab./d	gram per habitant per day
Ha	Hectare

JSC	Joint Service Council
kg/c/day	Kilograms per capita per day
l/c/d	Liters per capita per day
MCM	Million Cubic Meters
MoA	Ministry of Agriculture
MoH	Ministry of Health
MoI	Ministry of Industry
MoLG	Ministry of Local Government
MoT	Ministry of Transport
MLSS	Mixed Liquor Suspended Solids
MoU	Memorandum of Understanding
MPN	Most Probable Number
NEB	North Eastern Basin
NGO	Non Governmental Organizations
NIS	New Israeli Shekel
PCBS	Palestinian Central Bureau of Statistics
PHG	Palestinian Hydrology Group
PNA	Palestinian National Authority
PWA	Palestinian Water Authority
SAR	Sodium Adsorption Ratio
SOUR	Specific Oxygen Uptake Rate
SS	Suspended Solids
TN	Total Nitrogen

TSS	Total Suspended Solids
UNDP	United Nation Developing Program
UNRWA	United Nations Relief and Working Agency
UPVC	Unplasticised Polyvinyl Chloride
VS	Volatile Solids
WBWD	West Bank Water Department
WHO	World Health Organization
WWTP	Wastewater Treatment Plant
µS/cm	micro Siemens per centimeter

Master Plan for Water and Sanitation for Selected Communities in Tubas District and in Cooperation with PWA & ACAD

CHAPTER 1: INTRODUCTION AND STUDY BACKGROUND

1.1 The study phases:

As to secure water supply of the villages located in Tubas-Tammoun and Al-Fari'a, in northern West Bank, the Palestinian Water Authority (PWA) requested the Agence Française de Développement (AFD) to finance consultancy services to carry out a feasibility study (FS1). That study was carried out by SOGREAH Consultants from September 2006 to January 2007.

Upon the positive results of that study, AFD, Agence de l'eau Adour Garonne and the French Association des Consultants en Aménagement et Développement (ACAD) financed some of recommended water facilities, including Water Supply Scheme of Maythaloun, Supply and installation of transmission pipeline between Tubas and Tammoun, booster station and reservoir for Tubas town. In addition, drilling of a new deep production well in Tubas was approved by the Joint Water Committee and many other ongoing activities in Maythaloun Area. ACAD and PWA are looking forward to further developments of water supply and sanitation in the area.

The Ministry of Planning and PWA requested a complementary feasibility study (FS2) to be carried out, in the view of additional financing from AFD. The complementary feasibility study was carried out by SOGREAH Consultants, from July 2008 to October 2008 and included the following items:

Water supply projects

- Updated status of water supply projects in the area,
- Phased investment program for Tubas Tammoun water supply scheme
- Updated social, environmental and risk analysis
- Updated economic & financial analysis

Sanitation projects

- Preliminary study on sanitation schemes
- Preliminary study on wastewater reuse opportunities

- Phased investment program for sanitation scheme
- Public information campaign

This Study:

To complete the work done in the previous two phases and include other communities in the master plan, PWA and ACAD contracted the Palestinian Hydrology Group to carry out this task. This study is classified as the third phase (FS3) of the general project area. It will combine all the previous works and evaluate of the existing socio-economic trends, demography, water and sanitation. Moreover; the study will resolve the technical solutions and development of future scenarios for water and sanitation within the study area. There will be focus on the institutional arrangement, capacity building, public awareness and financial analysis of proposed solutions.

1.2 Clustering

The study area is divided into two main clusters as follow: North cluster which includes the communities of Tubas, Tammoun, Aqqaba and Tayaseer. South Cluster includes Wadi Al-Fari'a, Ras Al-Fari'a, Al-Fari'a Refugee Camp, Talluza and Al-Bathan. The last two communities in south cluster are not administratively within the Tubas Governorate, however; they are included from technical point of view and future efficient management of water supply and sanitation projects.

1.3 The Working Theme

The Master Plan has been undertaken to consider future requirements in the selected area, overall drinking water sanitation treatment facilities and water distribution networks and to satisfy the current and projected drinking water demands including the provision of adequate flows and pressures. Moreover, to address the implementation of the preferred alternative(s) for upgrading the water supply and distribution water mains and infrastructure. In one hand such projects may include, internal water networks or expansion, trunk line, balancing or distribution reservoirs, groundwater water pumping stations, water booster pumping stations, wastewater collection systems, and wastewater treatment plants. On the other hand, the master will include a project to upgrade the technical and managerial capabilities for the water and wastewater bodies in the area. The master plan will propose actions at local levels to insure participation and acceptance by the communities.

The Master Plan will be developed progressively through the use of alternative technical solutions, institutional and legal arrangements, training assessment and needs, capacity building and public awareness programme and costs analyses and projects phasing. For that purpose we conducted the PWA, to review the compliance of the findings with the national criteria and figures and their comments throughout the development of the Master Plan

1.4 Methodology and Action Plan

At an early stage, it was necessary to clearly define the a methodology such that there was a clear understanding of the requirements to successfully complete the Master Plan and to allow to advertise the needs assessment and priority plan. The focus of the master plan was on the evaluation of existing water and sanitary services and responses to future needs. To achieve the objectives of this study, firstly research needs and objectives were defined. Characterization of the study area included geography, topography, climate, geology, land use, rainfall, roads, health, water resources and sanitation etc. Data collection was conducted depending on literature review and field visits for outlining and understanding the water supply and sanitation processes. The collected data were analyzed and processed using Excel and Auto-Cad/ GIS packages.

1.5 Data Assessment

- Desk study data collection and establishing baseline data;
- Conduct workshops and establish focus groups;
- Field visits to the municipalities and village councils;
- Verifications of raw data and cross check with the national plans and figures;
- Development of infrastructure alternatives and scenarios;
- Division the area into two main clusters
- Evaluating the alternatives
- Define areas of focus for institutional strengthening and training; and
- Phasing of the projects and costs/risks analyses.

1.6 Background Information on Tubas District

Tubas district is situated in the North Eastern part of the West Bank between E(180500-201000) and N(177000-200500). It is bordered by Jordan from the east, Jenin, Nablus Districts from the west, from the south Jericho and Nablus and from the North Bisan Area and Jenin District as shown in **Figure 1.**

1.7 Population Data

According to the results of Population, Housing and Establishment Census 2007 for Tubas Governorate, which carried out by the **Palestinian Central Bureau of Statistics** indicated that the total number of population in the Tubas Governorate is 50261 people, including 25533 males and 24728 females. Compared with the 1997 census, the number of people in Tubas Governorate was 35216 people, accordingly, the population increased at a percentage of 36.8. Population characteristics structure of age shows that the Palestinian residents in Tubas Governorate are young. In comparison with other districts in Palestine, the area

Study Area /Tubas District

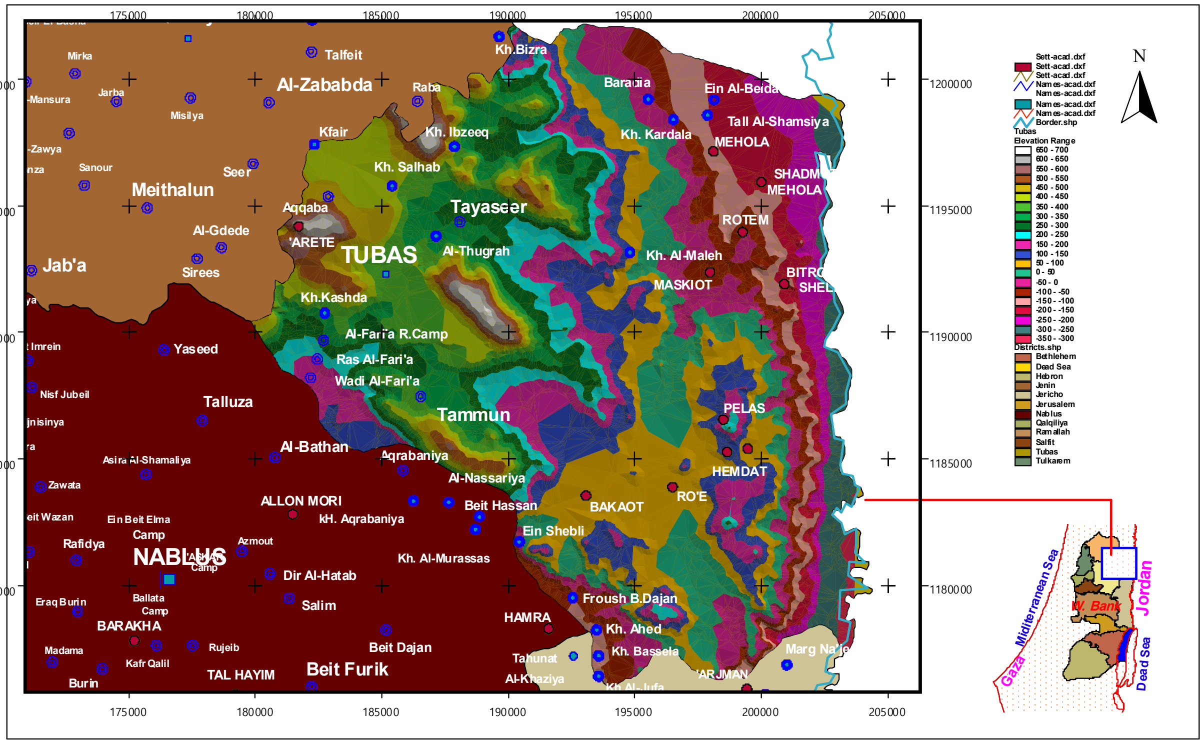

Figure 1.1: Study area and topography

is classified as the least in population density after Jericho District. The average area per person is around 8356 m^2 and this makes it 3.4 times more than the average area per person in the West Bank, and 33 times more than the available area per person in the Gaza Strip.

The number of people between the ages of 0-14 makes up to 40.5% (or 19505 people) of the total population in the governorate. Compared with the 1997 census, the total population between the ages of 0-14 years was 15648 people or makes up to 44.4% percent of the total population. Moreover, the census of 2007 shows that the number of families in Tubas Governorate was 8.628 families. The average family size in the governorate of Tubas had dropped from 6.1 members in 1997 to 5.6 people in 2007. The results for housing census indicated in **Table 1.1** shows that the numbers of buildings that have been reported during the census were 8628 buildings, while there were 5488 buildings in 1997.

1.8 Economic institutions

The 2007 census results indicate that the number of enterprises operating in the governorate of Tubas was 1670 enterprise belong mainly to the private sector and the number of workers employed in these enterprises is 3178 worker. Among them there are 2559 male and 619 female. The employment details are shown in **Tables 2, 3, 4 and 5**

1.9 Education and Illiteracy

The 2007 census results indicate that the number of people have bachelor's degree or higher was 2476 individuals. This figure applies for the people who are 10 years old or more. Accordingly, the percentage reached in census 2007 around 7.2% of this group age. Compared with the 1997 census, the population of those aged 10 years and older and those with bachelor's degree or higher qualifications make up the 764 individuals or 3.2% percent of this age group. And about the spread of illiteracy in the governorate of Tubas, the results indicated that the number of illiterates' people aged 10 years or more has reached 2570 members and make up 7.5% percent of the total population aged 10 years or more. Compared with the census in 1997 was the number of illiterates' people aged 10 years, has reached 3535 person and make up 14.9% of this age group.

1.10 Work and Unemployment

The 2007 census results indicate that the number of unemployed people in Tubas Governorate of age 10 years or over was 1275 individuals. Accordingly, the unemployment percentage reached in census 2007 around 10.6. In comparison with the results of 1997 there are 1356 people were unemployed or 14.8% of the total population in the governorate

Table (1.1): Housing Characteristics

Indicator	2007		1997	
	(%)	No.	(%)	No.*
Average Number of Persons per Room	**-**	**1.6**	**-**	**2.1**
Average Number of Room in Housing Unit	**-**	**3.5**	**-**	**3.1**
Occupied Housing Units by Type				
Villa	1.2	103	0.4	22
House	51.8	4,466	67.3	3,693
Apartment	41.7	3,599	26.3	1,445
Independent Room	0.3	27	2.6	144
Tent	2.3	196	2.7	150
Marginal	1.5	128	0.4	22
Others	0.0	2	0.0	2
Not Stated	1.2	107	0.2	10
Total*	**100.0**	**8,628**	**100.0**	**5,488**
Private Households by Tenure of Housing Unit				
Owned	83.1	7,165	79.4	4,601
Rented Unfurnished	5.6	480	4.5	258
Rented Furnished	0.4	38	0.4	26
Without Payment	8.6	741	14.4	834
For Work	0.6	52	0.5	28
Others	0.1	12	0.2	13
Not Stated	1.6	140	0.6	36
Total*	**100.0**	**8,628**	**100.0**	**5,796**

*According to the definition used in the 1997 census, the house may contain more than one household, while in 2007 census; the house contains only one household.

Table (1.2): Palestinians 10 Years and Over Employed and Unemployed Ever Worked by Economic Activity

Indicator	2007		1997	
	(%)	No.	(%)	No.*
Agriculture, Hunting	32.4	3,722	37.7	3,283
Mining and Quarrying	0.1	11	0.3	30
Manufacturing	6.4	739	6.0	524
Electricity, Gas and Water Supply	0.1	17	0.1	10
Construction	10.9	1,247	17.3	1,508
Whole sale and Retail Trade	11.7	1,344	10.2	893
Hotels and Restaurants	2.2	257	2.8	245
Transport, Storage and Communication	4.7	537	4.8	416
Financial Intermediation	0.6	72	0.5	45
Real-estate, Renting and Business Activities	1.3	153	0.7	59
Public Administration and Defense	12.0	1,378	8.6	752
Education	10.7	1,228	7.0	606
Health and Social Work	2.2	255	2.2	194
Other Community Social and Personal service Activities	2.0	231	1.1	96
Private Households with Employed Persons	0.0	1	0.0	1
Extraterritorial Organizations and Bodies	0.8	87	0.2	21
Not Stated	1.9	213	0.4	36
Total	**100.0**	**11,492**	**100.0**	**8,719**

Table (1.3): Number of Persons Engaged in the Private Sector, Non Governmental Organization Sector and Government Companies by Principal Economic Activity

Indicator	2007		1997	
	(%)	No.*	(%)	No.*
Agriculture, Farming of Cattle and other Animals	10.7	178	12.3	89
Mining & Quarrying	0.0	-	0.1	1

Manufacturing	10.8	180	11.2	81
Electricity And Water Supply	0.7	11	2.4	17
Construction	0.2	4	0.3	2
Wholesale, Retail Trade & Repairs	57.4	959	56.4	407
Hotels and Restaurants	4.1	68	3.5	25
Transport, Storage & Communications	0.8	14	0.3	2
Financial Intermediation	0.5	8	0.7	5
Real Estate, Renting & Business Activities	2.3	38	1.7	12
Education	1.9	31	2.4	17
Health & Social Work	2.5	42	3.4	25
Other Community, Social & Personal Service	8.2	137	5.4	39
Total	**100.0**	**1,670**	**100.0**	**722**

Table (1.4): Number of Persons Engaged in the Private Sector, Non Governmental Organization Sector and Government Companies

Indicator	2007		1997	
	(%)	No.*	(%)	No.*
Males	80.5	2,559	85.7	939
Females	19.5	619	14.3	157
Total	**100.0**	**3,178**	**100.0**	**1,096**

Table (1.5): Private Households by locality and Household size, 2007

Locality Name	Locality code	Total		Household size							
		Population	Households	+ 8	7	6	5	4	3	2	1
Bardalah	50420	1,569	259	70	37	33	32	37	25	20	5
'Ein el Beida	50450	1,114	189	50	26	24	28	28	20	11	2
Kardala	50455	294	47	10	10	10	6	4	2	5	0
Ibziq	50490	202	31	9	8	3	5	2	2	0	2
Salhab	50525	43	5	3	0	0	1	0	0	1	0
Aqqaba	50535	6,275	1,080	284	129	151	165	123	111	91	26
Tayaseer	50550	2,385	447	94	52	67	58	59	38	58	21
Al-Farisiya	50551	145	28	7	0	4	4	4	1	7	1
Al-Aaqaba	50560	100	22	4	2	1	3	1	6	3	2
Al-Thugrah	50575	523	96	20	13	15	13	12	10	11	2
Al-Malih	50580	355	55	44	4	7	6	3	6	6	1
Tubas	50610	15,480	2,811	601	369	414	404	344	302	282	95
Kashda	50650	68	8	6	0	1	0	1	0	0	0
Kh. Yarza	50656	37	8	1	0	0	1	4	1	1	0
Ras Al-Fari'a	50670	677	120	27	16	17	22	12	8	16	2
Al-Fari'a R.C	50700	5,474	1,004	228	107	149	140	111	117	105	47
Kh. R. Ahmar	50720	171	33	6	4	6	2	4	3	5	3
Wadi Al-Fari'a	50740	2,616	454	99	57	78	83	50	28	44	15
Tamoun	50755	10,345	1,883	417	261	252	243	206	188	224	92
Kh. Attouf	50790	164	27	6	3	6	1	8	0	3	0
Kh. Humsa	50871	127	21	7	1	1	1	4	4	3	0
Tubas Gov.		**48,164**	**8,628**	**1,993**	**1,099**	**1,239**	**1,218**	**1,017**	**872**	**896**	**316**

CHAPTER 2: HYDRO -METEOROLOGICAL DATA

2.1 Climate and general weather conditions

The climate of the study area could be classified as arid to semi-arid zones in the eastern parts and as semi-arid zones in the western parts. The study area has a Mediterranean climate characterized by two distinct seasons: a rainy season (winter) and a dry, hot season (summer). The climate is highly variable and is influenced by both elevation and the circulation of the air-stream as follows:

2.1.1 Precipitation Data

The rainy season extends from October to May with an average of 50 rainy days. The average annual rainfall in Tammoun area varies between around 500 millimeters (mm) on the western slopes, 100 to 400 mm on the eastern slopes. The upper and western parts of Wadi Al-Fara'a are affected by moist, west-oriented air streams coming from the Mediterranean Sea. This air stream is responsible for most of the rainfall in the wet season and increases the relative air moisture in the dry season. The annual average Precipitation ranges between 630 mm in Taluza to about 415 mm in Wadi Al-Fari'a and Tubas as shown in **Table 2.1** and F**igure 2.1**. Rainfall events predominantly occur October to April which comprises 95% of the total annual precipitation events.

2.1.2 Temperature

The Jordan Valley is characterized by high temperature variations over space and over time. Temperatures reduce with increasing elevation as in Taluza. The mean annual temperature changes from 18 ^{0}C in the western side of Nablus area to 24 ^{0}C in the eastern side of Al-Jeftlik area. **Table 2.2** presents the minimum maximum and average monthly temperatures in Nablus and Al-Jeftlik area.

2.1.3 Evaporation

The Mediterranean climate (hot and dry in the summer, mild and wet in the winter) has six to seven months of dryness in the year. Winter months where moisture is available from rain have low evapotranspiration rates. Summer months with high potential evapotranspiration rates have no rain and thus actual evapotranspiration is limited by the availability of moisture. Average monthly values of evaporation rates are measured from a US Class A pan at Nablus and Al-Jeftlik area presented in **Tables 2.2** for Nablus area. It shows that average annual evaporation in Nablus is about 1680 mm. Evapotranspiration is usually smaller than pan evaporation. Evaporation rates should be multiplied by a pan coefficient (less than 1) to estimate evapotranspiration rates.

2.1.4 Humidity

The mean annual relative humidity of Nablus area is 61%. The minimum value of relative humidity is 51% which occurs in May during the Khamaseen weather. Maximum relative humidity of 67% is usually registered in December, January and February. Relative humidity in general is low in the entire watershed especially in summer months because the watershed is located on the eastern side of the West Bank Mountains. The source of humidity in the region is the Mediterranean Sea and only western winds bring humidity to the area. Eastern winds coming from the desert are usually dry.

2.1.5 Wind

The direction and velocities of winds in the study area change according to the seasons of the year. The main wind direction is from west, southwest and northwest. Variation during winter is associated with the pattern of depressions passing from west to east over the Mediterranean. The prevailing winds in the area are the southwest and northwest winds with an annual average wind speed of 237 km per day in Nablus area and at a height of 10 meters from ground surface. During summer, wind moves with relatively cooler air from the Mediterranean towards the north, with an average wind speed of 288 km per day in June in Nablus at a height of 10 meters. At night the land areas become cooler, causing diurnal fluctuations in wind speed, due to the reduction of the pressure gradient. In winter, the wind moves from west to east over the Mediterranean, bringing westerly rain bearing winds of average wind speed 209 km per day in January (Nablus at a height of 10 meters). The Khamaseen, desert storm, may occur during the period from March to June. During the Khamaseen, the temperature increases, the humidity decreases and the atmosphere becomes hazy with dust of desert origin and eastern prevailing winds.

Wind velocities decrease with lowering elevation; wind velocities in Al-Fari'a are significantly lower than those in Nablus. Existing wind data showed that measurements of wind velocities were recorded at a height of 10 meters in Nablus and at a height of 2 meters in Al-Jeftlik. Due to the elevation of Al-Jeftlik which 198 meters below sea level and the existing mountains surrounding Al-Jeftlik, wind velocities are much lower than those at Nablus. Annual average wind velocity in Al-Jeftlik was estimated at 106 km/day at a height of 2 meters which is much less than the 174 Km/day estimated in Nablus at the same height from ground surface.

Table (2.1): Rainfall Data for the Stations in Al-Fara'a Area

Rainfall (mm)				**Rainfall (mm)**			
Years	**Tubas**	**Talluza**	**Tammoun**	**Years**	**Tubas**	**Talluza**	**Tammoun**
66-67	NA	926	483	88-89	426	507	314.9
67-68	274.	533	358	89-90	293	510	296.5
68-69	467.	770	267	90-91	257	500	130
69-70	321	575	279	91-92	899.5	1303.1	616.1
70-71	351	664	419	92-93	485.5	734.4	330.13
71-72	504	704	378.7	93-94	336.5	498.8	276.8
72-73	288	565	219	94-95	450.5	678.8	398.5
73-74	583	881	529	95-96	378.5	633.7	337.2
74-75	378	456	307	96-97	500	775.3	360.3
75-76	459	594	233	97-98	546.1	790.8	460
76-77	391	634	270	98-99	201.5	292.2	124.2
77-78	285	508	236	99-00	365.4	492.8	317.6
78-79	219	372	214	00-01	243.1	324.8	225.4
79-80	638	872	414	1-Feb	494	522.3	303.8
80-81	345	608	285	2-Mar	599	704.8	487.8
81-82	459	480	207	AVG	415.2	630.5	322.3
82-83	614	815	397	STD	143.9	196.0	106.4
83-84	460	561	295	MAX	899.5	1303.1	616.1
84-85	296	386	258	MIN	201.5	292.2	124.2
85-86	307	508	287				
86-87	309	707	218				

Rainfall (mm)				Rainfall (mm)			
Years	**Tubas**	**Talluza**	**Tammoun**	**Years**	**Tubas**	**Talluza**	**Tammoun**
87-88	522	1006	392.3				

Source: EQA

Table (2.2): Average Values for the Climatic Conditions Prevailing Nablus/ Al-Fara'a Area

	Nablus Area							**Al-Fari'a Area**				
Month	**Max. Temp (C°)**	**Min. Temp (C°)**	**Mean Temp. (C°)**	**Wind Speed at 10 m High (Km/day)**	**Sunshine (hrs/day)**	**Relative Humidity (%)**	**Pan Evaporation (mm)**	**Max. Temp (C°)**	**Min. Temp (C°)**	**Mean Temp (C°)**	**Wind Speed at 2m High in (Km/day)**	**Relative Humidity (%)**
January	13.08	6.2	9.6	209	4.7	67.2	49.6	19.5	9.3	14.4	4.6	73
February	14.4	6.7	10.5	226.8	4.75	67.3	67.2	20.2	9.2	14.7	6.5	73
March	17.21	8.8	13.0	240.4	6.4	62.2	99.2	24.3	12.1	18.2	10.8	63
April	22.15	12.0	17.1	244.0	8.2	53.0	149.1	29.1	14.4	21.7	9.7	63
May	25.73	14.9	20.3	257.2	8.9	50.7	202.7	34.6	19.0	26.8	6.5	52
June	27.88	17.4	22.6	288.1	8.4	55.0	225.9	37.1	21.1	29.1	5.1	51
July	29.07	19.3	24.2	298.7	9.6	60.6	237.9	39.4	22.7	31.1	5.1	51
August	29.4	19.5	24.4	281.5	10.9	64.8	218.2	38.5	24.2	31.4	5.4	52
September	28.4	18.5	23.4	247.0	10.2	64.4	177.6	36.6	22.9	29.8	5.1	43
October	25.8	16.24	21.0	183.8	9.8	57.4	131.1	33.5	20.2	26.9	5.8	54
November	20.2	12.1	16.1	186.2	7	57.3	74.4	27.9	16.8	22.4	5.8	55
December	14.6	7.8	11.2	183.8	4.76	67.3	48.6	21.5	11.9	16.7	7.9	67
Annual	**22.3**	**13.3**	**17.8**	**237**	**7.8**	**61**	**1681**	**30.2**	**17.0**	**23.6**	**6.5**	**58**

Source: EQA

2.2 Topography

The study area covers a wide range of different landscape and topographic features such as:

- The Fara'a Graben
- The Tubas Graben
- The Tayaseer Graben

The topography of these grabens is flat with gentle slopes filled with thick calcareous red-buff soils. The Fara'a, Tubas, and Tayaseer Grabens are incised with Wadi Fara'a, Wadi Abu Sidra, and Wadi Malih, which drain to the southeast. The mountains forming the highlands in the study area and consist mainly of carbonate sedimentary rocks. The mountains in Tammoun area stretch from the Fari'a Valley in the south to Wadi Malih in the north with an average elevation of approximately 600 meters above sea level. Meanwhile the mountains in Maythaloun Area are surrounding the Marj Sanur with approximate elevation of 755 meters above sea level near Heraish Mountains south of Maythaloun Town. The central and northern parts of the study area have a relatively flat to hilly topography that rises about from 300 to 500 meters above sea level. **Figure 1.1** shows the topography of the study area. The North area is confined by two ridges extending in the Northeast/Southwest from the city of Nablus to the Jordan River. Topographic relief of Al-Fara'a changes significantly throughout the area. It is notable that the topography of the region changes from about 550 m above mean sea level in the near Taluza to about 200 m in Wadi Al-Fari'a. This means that in about 5 kilometers of length there is a 350 m drop in elevation which indicates an average slope of more than 7%.

2.3 Geology

2.3.1 Regional Setting

Palestine is located on the north western part of the Arabian shield. During its geologic history, this shield separated from the great Afro-Arabian shield along the Red Sea line. Branch of this breakage extended along the line of Aqaba, Wadi Araba, the Dead Sea, and the Jordan Valley, and continued northwards to Lebanon, Syria, and Turkey. The West Bank occupies the western part of this branch, known as the Jordan Rift Valley.

The Arabian shield consists of a complex of crystalline plutonic and metamorphic rocks. The western and northern parts of the shield received large amounts of erosion products. These sediments known as the shelf deposits lay with unconformity over the basement rocks. Within the shield deposits, two sedimentary mantels dominated, one is Terrestrial and the other is Marine. The Terrestrial mantle is marked by inter-fingering of nitrite and lateral deposits. The Marine mantle is mainly composed of carbonates. The West Bank is dominated by this Marine mantle, particularly of carbonate deposits from the Mesozoic-Cenozoic age.

2.3.2 Stratigraphy and Lithology of the West Bank

Presently, the majority of the exposed rocks in the West Bank are Marine sediments particularly made of carbonate such as limestone, dolomite, chalk and chert. These rocks extend by age from lower Cretaceous to Quaternary. Jurassic rocks have limited exposures in the West Bank (Rofe and Raffety 1965). The geological column of the West Bank is presented in **Table 2.3** which gives a clear picture about its stratigraphy and lithology.

2.3.3 Stratigraphy and Lithology of the Study Area: Rock outcrops in the area range in age from Cretaceous to Quaternary. Partly due to cross faulting Jurassic limestone's and Kurnub sand stones (Ramali formation) the oldest rocks in the area are exposed in the core of Al-Fara'a anticline. Below are the main lithological units of the study area and arranged by age from oldest to youngest:

1. Cretaceous rocks: Which having the following exposures at Al-Fara'a watershed:
   - Ramali formation (kr): The outcrops of the Ramali formation in wadi Al-Fara'a composed mainly of sandstones and exposed to the north east of the middle zone of the watershed at the core of Al-Fara'a anticline.
   - Lower Beit Kahil formation (kclbk): The main outcrops of this formation are exposed in the north of the Al-Fara'a anticline axes. The lower part of the formation consists mainly of thick, massive iron-stained limestone. The formation passes up through sandy marls and shale's into thin-bedded pocellanous limestone.
   - Upper Beit Kahil formation (kcubk): This formation is considered to be equivalent to the upper part of the lower Cenomanian. This formation has a small outcrop area because of its steep dips. The

main outcrops of this formation are exposed on the deeply eroded flanks of the Al-Fara'a anticline. It consists of dolomitic and sometimes chalky and marly limestone.

- Yatta formation (kcy): It forms the lower part of the middle Cenomanian, consists mainly of marl, chalky limestone, clay and thin inter-bedded dolomitic limestone. This formation has outcrops at small different localities on the middle and upper wadi.
- Hebron Formation (kch): This formation is regarded as equivalent to the upper part of the middle Cenomanian. It consists mainly of blue-green limestone and dolomitic limestone. The lower part of its outcrop is massive while the upper part is well bedded. The Hebron formation rocks have karsts caves and joints; therefore it is an excellent aquifer. It is exposed at the western parts of the Al-Fara'a anticline.
- Bethlehem Formation (kcb): It is approximately equivalent to the upper Cenomanian and is exposed at different localities on the middle and upper basin, while it has wide exposures at the upper wadi it has limited exposures in the middle zone of the wadi. The upper part of the formation consists of Limestone, dolomite, and marly limestone (karastic) while the lower part consists of limestone, marly limestone, chalky limestone and dolomitic limestone.
- Jerusalem formation (ktj): this formation has wide exposures at the upper zone of the wadi and limited exposures at the middle zone of the wadi. It consists mainly of massive limestone, dolomite and sometimes chalk.

2- Rocks of the Cretaceous-Tertiary Transition Chalk with chert. The chalk formation (k/t-c) has wide exposures at the lower zone of the basin while the chert formation (ct) has limited intrusive.

3- Tertiary Rocks which consist of the following formations:

- Chalk with nummulitic limestone (Te-c/l): This is exposed at different localities on the lower zone of the wadi.
- Nummulitic limestone with chalk (Te-l/c): It is also exposed at different localities on the lower zone, but it has more exposures area than (Te-c/l) exposures.
- Nummulitic bedded limestone (Te-l): It has exposures at the lower zone of the wadi.

Quaternary Rocks which have the following exposures in the wadi: A small isolated localities of gravels and fans (Qhg). A wide spread of alluvial deposits (Qha) which are exposed along the basin are parallel to the stream from the both sides. They formed a local unconfined aquifer in the basin, thus they are considered as a main local aquifer **Figure 2.2** presents a geologic map which shows the geologic formations prevailing in the study area

Table (2.3): Geological Time Scale of the West Bank

Period	Age	Typical Lithology	Rofe & Raffety Terminology	Palestinian Terminology			Israeli Terminology	Jordanian Terminology	Aquifer Potentiality	Typical Thickness (m)
				Group	Formation	Symbol				
Quaternary	Holocene	Alluvium, gravels, fan deposits, and surface crust (Nari).	Alluvium		Alluvium	All	Alluvium	Alluvium	Fair	0-100
	Pleistocene	Thinly laminated marl with gypsum bands, and poorly sorted gravel and pebbles.	Lisan		Lisan	Lis	Lisan/ Kurkar Group	Lisan	Good	Unknown
Tertiary	Pliocene-Miocene	Conglomerate, marl, chalk, clay, and limestone.	Beida		Beida	Bei	Saqiya Group	Dana	Very Good	± 200
	Eocene	Numulitic limestone, reef limestone, bedded limestone, limestone with chalk, chalk with limestone (undifferentiated).	Jenin Subseries		Jenin	Jen	Avedat Group	Rijam & Shallala	Good	300-600
	Paleocene	Marl, clay, and chalk.	Khan Al Ahmar	Gerzim	Khan Al Ahmar	KhA	Taqiya		Poor	150

Cretaceous	Upper	Mastrichtian	Chalk, marl, metamorphic rocks.					Ghareb	Muwaqar		55
		Campanian	Phosphate, and chert	Amman & Zarqa		Al Qilt	Qil	Mishash	Amman & Hisa	Poor	50-75
		Coniacian-Campanian	White chalk, Chalky limestone, chert, and phosphate	Abu Dis		Abu Dis	Adi	Minuha	Ghudran	Poor	50-175
		Turonian	Karstified limestone, and dolomite.	Jerusalem	Ramallah	Jerusalem	Jer	Bina	Wadi Sir	Excellent	40-120
	Lower	Cenomanian	Limestone, dolomite, and marly limestone (karstic).	Bethlehem		Upper Bethlehem	Ube	Weradim	Wadi Shueib	Good	5-30
			Limestone, marly limestone, chalky limestone, and dolomitic limestone.			Lower Bethlehem	Lbe	Kefar Sha'ul		Fair	30-115
			Karstic limestone and dolomite.	Hebron		Hebron	Heb	Amminadav	Hummar	Excellent	105-260
			Marl, clay, and marly limestone.	Yatta		Upper Yatta	Uya	Moza	Fuhais	Poor	50-150
			Limestone, chalky limestone, and dolomitic limestone.			Lower Yatta	Lya	Beit Meir		Good	

		Albian	Reef limestone interbedded with marl.	Upper Beit Kahil		Upper Beit Kahil 1	UBK 1	Kesalon	Na’uor	Very Good	10-40
			Dolomite interbedded with marl.			Upper Beit Kahil 2	UBK 2	Beit Soreq			50-150
			Limestone and dolomitic limestone.	Lower Beit Kahil		Lower Beit Kahil 1	LBK 1	Giv’at Ye’arim		Good	10-50
			Limestone, dolomitic and marly limestone.			Lower Beit Kahil 2	LBK 2	Kefira			100-160
			Marl and clay.	Kobar		Qatana	Qat	Qatana		Poor	40-60
			Marl and marly limestone.			Ein Qinya	Eqi	Ein Qinya		Poor	70-100
		Aptian	Clay and marl.			Tammoun	Tam	Tammoun		Poor	50-90
		Neocomian	Multicolored sandstone.	Ramali		Ramali	Ram	Hathira Kurnub	Kurnub	Excellent	50-250
Jurassic		Callovian-Bajocian	Marl interbedded with chalky limestone.	Upper Malih		Upper Malih	Uma	Zohar, Sherif, Mahmal	Ramlah, Hamam, Mughaneieh	Fair	100-200
			Karstified and jointed dolomitic limestone.	Lower Malih		Lower Malih	LMa			Good	50-100

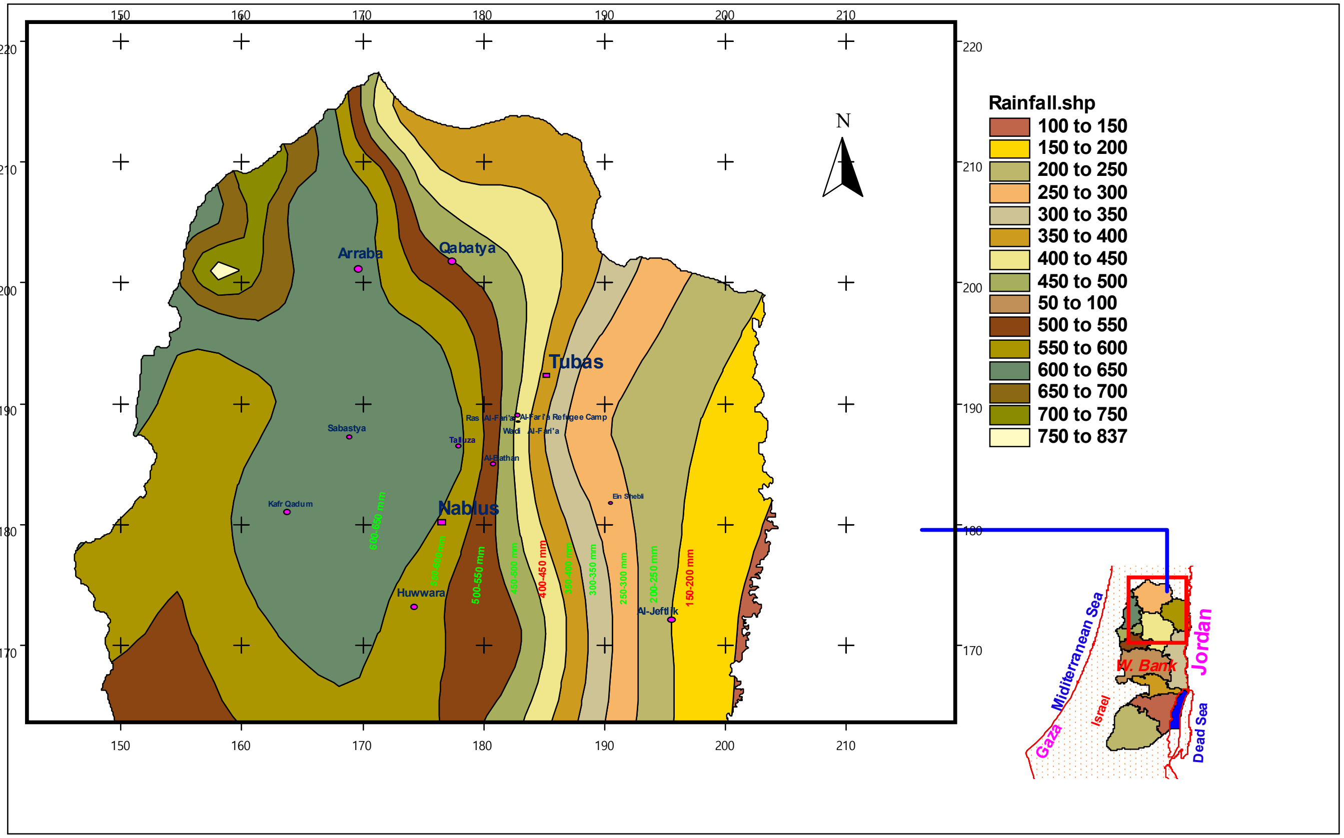

Figure 2.1: Rainfall map

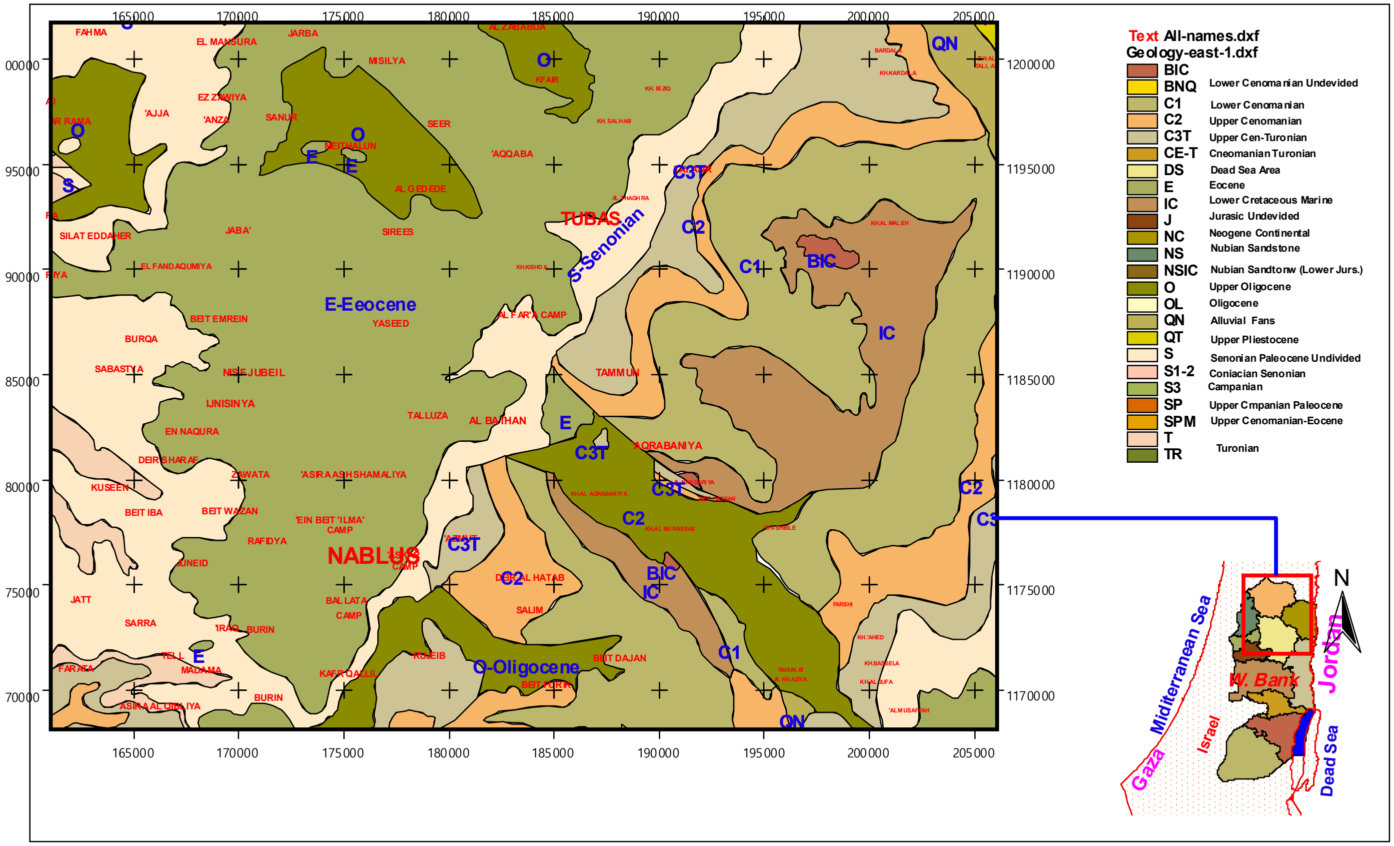

Figure 2.2: Geology of the study area

2.4 Water resources

The study area is located in the North-eastern Aquifer Basin (NEB), Northeastern Basin is one of the main three groundwater basins overlie on the West Bank and Israel, extends as a band along almost the whole northern part of the West Bank over an area of 1331km², of which 1132 km² inside West Bank and about 199 km² outside the West Bank, **Figure 2.3** This basin is characterized by three structural features: the Fari'a Anticline in the east; the Anabta Anticline in the west (together forming the Nablus-Beit Qad Syncline); and the Carmel-Gilbo'a Fault System in the north. Meanwhile, the groundwater system in Northeastern Basin consists of several carbonate-rock formations laterally and vertically interconnected, and forms the following renewable aquifers:

2.4.1 Shallow Aquifer System

The shallow aquifer system represents the Quaternary (Alluvial) Deposits in Tammoun Area and the Eocene Aquifer in Maythaloun Area and in the western parts of Tammoun Area. The existence and thickness of these formations varies from place to place. These aquifers outcrop at different locations within the Maythaloun and Tammoun area as shown in **Figure 2.4.** There are many wells tapping the shallow aquifer concentrated in the Marj Sanur, Ras Al-Fara'a, and Sahel Tammoun with depths between 60 and 200 meters. These wells are characterized by relatively low water quality and water quantity for domestic and irrigation.

The alluvial deposits in Tammoun area receive recharge mainly from direct rainfall and percolated water from base flow, returned water from irrigation, and floods within surface water catchments. Direct recharge from rainfall is believed to be negligible because of low precipitation and a high evaporation rate. Meanwhile, the Eocene Aquifer in Maythaloun Area receives direct recharge in a wide area (specifically Marj Sanur) where Jenin Subseries crops out and the annual rainfall is around 634 mm. In general, groundwater flows from southwest to northeast and northwest. However, the previous studies for the Northeastern Basin and for the Eocene Aquifer have estimated the recharge values for the shallow aquifer system of the Northeastern Basin.

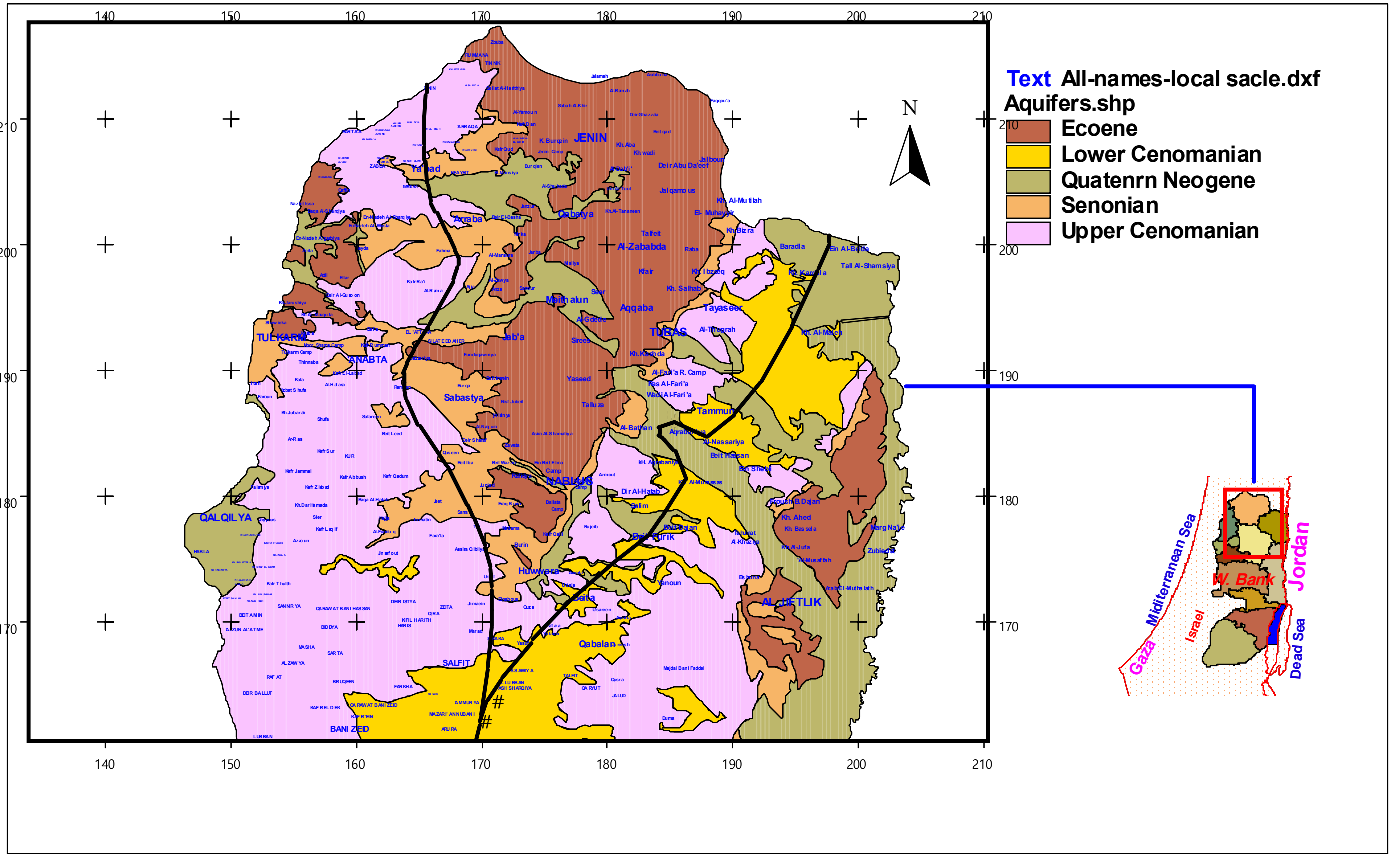

Figure 2.3: Groundwater basins in the study area

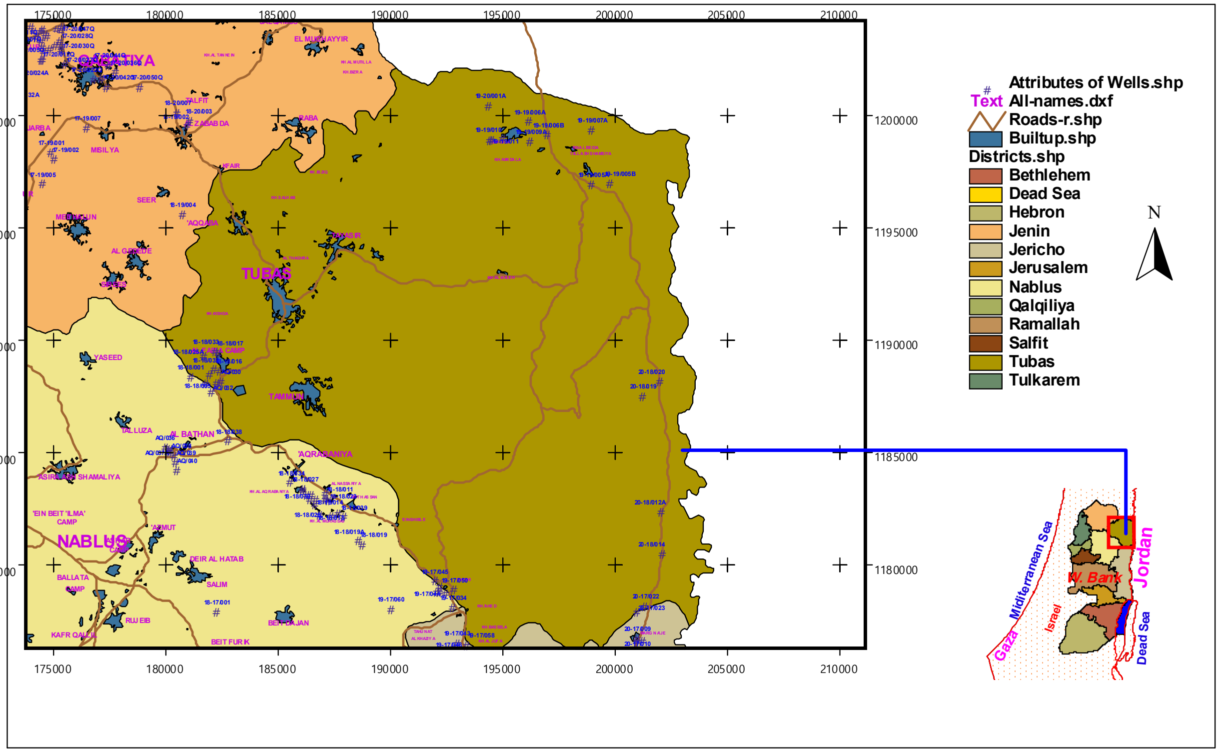

Figure 2.4: Water resources in the study area

The model shows that the average recharge (infiltration) rates over Maythaloun and Tammoun Area ranges from 0.0003 to 0.0007 m/day as shown. These values reflect approximate annual average recharge range from 32 to 54 Mcm/y over the Maythaloun and Tammoun Area entered to the shallow aquifer system from rainfall.

2.4.2 The Upper Aquifer

The Upper Aquifer is represented by the formations of the age of Turonian (Jerusalem formation) and Upper Cenomanian (Bethlehem and Hebron formations) and commonly classified as confined aquifer; and consists of the following aquifers:

2.4.2.1 Turonian Aquifer

The Turonian aquifer is part of the Upper Aquifer consists of the carbonate rocks of the Turonian age, locally identified as the Jerusalem Formation. The aquifer is considered a fairly good aquifer especially where the saturation thickness is in tens of meters. In this regards, the setting of this aquifer is playing significant role which is naturally varying from place to place depending on the structural features of the area. For example, in Maythaloun Area, this aquifer is situated at great depths range from 500 mbgl in south-east of Qabatya to more than 1150 mbgl (Maythaloun deep well), this mainly is due to the existence of Nablus-Beit Qad Syncline that cross the area from south to north. The aquifer in Maythaloun area is of good thickness (approximately 130-150 m thick) and has reliable coverage and extent in the area. In Tammoun Area, the data obtained from the drilling wells (Tammoun monitoring well and production well) shows that the Turonian aquifer is dry since it out cropping on the ground surface. Generally, the water quality of this aquifer is generally good.

2.4.2.2 Upper Cenomanian Aquifer

The formations of this aquifer are the Bethlehem and Hebron. The aquifer is an important regional source of water supply for domestic use in Tammoun Area since most of drilled wells and the wells that are under drilling are tapping this aquifer. The aquifer has intermediate depth in Tammoun area. The Upper Cenomanian section consists mainly of interbedded dolomites and chalky limestone. The formation’s thickness ranges from 150 meters to 400 meters. The quality of the water from this aquifer is generally good.

2.4.3 Recharge

Rainfall is considered as main source of recharge in the Upper Aquifer in Maythaloun and Tammoun area. According to the previous studies, recharge from rainfall for the whole Upper Aquifer in the Northeastern basin is taking place in the southern parts of the basin near Nablus City mountains and the eastern mountains where about 200 km^2 area of the formations of the Upper Aquifer are outcropping on the surface. Based on the previous studies, the total long-term average recharge from rainfall that enters the outcrops areas of the Upper Aquifer in Nablus Mountains (recharge areas for Maythaloun and Tammoun area) is expected to be approximately (18-32 MCM). However, more investigation is needed to assess and study the time period and the underground movement of the recharged water to reach the Maythaloun and Tammoun Area.

2.4.4 Karstification

Karst features develop with time according to rock solubility; the ideal environment for karst features and their development are soluble rocks such as limestone, dolomite, and evaporates. In these soluble rocks, fracture and fissure apertures and primary porosity are enlarged with time creating a network of conduits with a high hydraulic conductivity. In general, the Jerusalem and Hebron formations consist mainly of limestone and dolomite. The Karstification ability in these formations is higher than any other formation.

2.4.5 Groundwater Elevations

Groundwater flow gradients in the Maythaloun and Tammoun area are documented by a large data set of water level measurements taken in individual wells. Review of some hydrographs of water level measurements indicates several characteristic features of groundwater in the area:

- As might be expected, deeper wells show less seasonal variation in water levels (Examples: Maythaloun Deep Well).
- Seasonal variations of 1 to 6 m are common in shallow wells, typically with low water levels occurring in the winter, and high water levels occurring in the summer.
- Groundwater elevations of the shallow Aquifer in the Maythaloun and Tammoun area appear to follow a characteristic trend: declining from 1973 to 1978, rising from 1978 to 1986, rapid decline from 1986 to 1990, with rapid recovery of water levels in 1992.

Groundwater elevation is important to understand the aquifer system and to evaluate the long-term condition of the groundwater balance. In Maythaloun and Tammoun Area, water level in the Shallow Aquifer of the study area is rapidly affected by rainfall and ranged from 300 masl in the western parts to about 50 mbsl along the eastern parts. The water level of the upper Aquifer is much deeper than the shallow aquifer since it ranges from 0.0 to 175 mbsl in the area. The direction of ground water in the shallow aquifer is generally southwest northeast and in the upper aquifer is west-east north. In some cases the flow lines are affected by local hydraulic barriers.

2.4.6 Hydraulic Characteristics

The hydraulic properties of the aquifer systems include hydraulic conductivity or transmissivity, which can be estimated using available data from pump tests conducted in the Northeaster Basin. The available data shows that the shallow aquifer is characterized by relatively low to moderate values of transmissivity range from less than 1 to about 100 m^2/day, while the upper aquifer has moderate to high values of transmissivity range from 150 to 1000 m^2/day. The value of transmissivity is highly depending on the fractures system of the carbonate rocks of the aquifer. Table 6 lists available data on aquifer properties for the Shallow and Upper Aquifers in the Northeastern Basin.

2.4.7 North Cluster Water Budget

A water budget is the quantification of the recharge and discharge as it applies to groundwater body for any particular time period. In this case, it is an accounting of groundwater as it moves into and out of the study area.

2.4.7.1 Inflows:

The following are the major inflow components to the study area:

Recharge from rainfall on the area.

Rainfall recharge is a function of the precipitation intensity, storm duration, and topsoil saturation, slope, outcrop formations, and evapotranspiration. Based on the recharge models, it is estimated that the Shallow Aquifer receives approximately (32-54) mcm/yr from direct rainfall while the Upper Aquifer receive approximately (18-32) mcm/yr as indirect recharge.

Based on these results, the total long-term average recharge from rainfall is expected to be (50-86) mcm/yr. direct recharge from rainfall falling on the catchment area has significant effect especially in the southern heights where most of aquifers outcrops are there.

2.4.7.2 Outflows

The following are the major outflow components of the north cluster:

- Well Pumping – groundwater extraction
- Underflow - subsurface flow from inside the area to outside of the area
- Spring Discharge

The majority of data reviewed for the water budget analysis was obtained from PWA database, much of which was by automated data recording devices. Other sources include previous groundwater studies and previous investigations.

Outflows Wells Abstraction

Based on the available data for the area, the annual average abstraction rate from all wells (licensed and unlicensed) in the shallow aquifer and upper aquifer is estimated to be 10 and 2 Mcm/yr, respectively.

Springs Discharge

The annual average discharge of shallow aquifer springs is around 10.5 Mcm/yr as shown in **Table 2.4**. Lateral outflow component is the most critical one among the previous components and need careful attention in the assessment

Table (2.4): Summary of Water Balance (north cluster)

The following table lists the water balance component.			
Inflow/Outflow Components		**Shallow (mcm)**	**Upper (mcm)**
Recharge	**Inflow**	32-54	18-32
Well Abstraction	**Outflow**	10	2
Springs Discharge		10	0
Lateral Outflow		-	–
Balance		22-44	16-32
The net difference listed in the above table is a preliminary difference in area inflows and outflows and should be improved and refined again in details.			

2.4.8 South Cluster Water Budget

South cluster water resources are either surface or groundwater

1.4.8 Surface water: Most surface runoff in the area is usually lost in winter as there are no dam's or storage reservoirs to store that excess water. Studies showed that surface runoff in the eastern slopes of the West Bank is mostly intermittent and occurs when rainfall exceeds 50 mm in one day or 70 mm in two consecutive days. In general, the West Bank surface runoff constituted nearly 2.2% of total equivalent rainfall. It was estimated that the city of Nablus discharges about 2.0 MCM/year of untreated domestic and industrial wastewater effluent to Wadi Al-Fara'a. Storm water runoff within the Wadi was estimated at 4 MCM/year making a total runoff of about 6 MCM/year.

1.4.9 The groundwater aquifer system of Wadi Al-Fara'a comprises several rock formations from the Triassic (Lower Cretaceous) to recent age. These formations are composed mainly of Limestone, Dolomite and marl. Ground aquifers are usually utilized through springs and wells. Most of the springs of Wadi Al-Fara'a are located in the upper and middle parts of the Wadi. There are 8 fresh water main springs in the study area which can be divided into two groups: Al-Fara'a and Al-Bathan groups. Data available for these springs consist of monthly discharge rates for about 40 years. Spring discharge data for the springs show high spring discharge variability. **Table 2.6** shows the average annual discharge from these springs varies according to the elevation however all of them are located in the Eocene aquifer. According to the groundwater wells, the situation is much more complicated than the springs, because there are 9 licensed wells will fixed quota, but a new 28 groundwater unlicensed and pumping without any limit expect the technical capacity of these wells. In the past 8-years and during the Intifada, there was like a race between many farmers in drilling new groundwater wells. The main reasons for that are:

1- The Limited water available in the area and continuous increase in demand for all purposes.
2- The extreme difficulties to get a license from the Israeli, or even for the rehabilitation of the existing groundwater
3- The high percentage of un employment and low income and loss of jobs, pushed many people to work in agriculture and search for water to irrigate

these farms. This encouraged some local people to drill some wells and rent them or sell water to these new farmers.

4- Groundwater levels is relatively shallow and this make it easy to use local drilling machines (hand tool percussion)
5- The difficulties to make penalties against those people who violate the drilling rules.

2.4.8.3 Al-Faria' Water Balance

According to the figures of the PWA the annual recharge of the Ras Al-Fari'a catchment area ranges between 8 and 11 million cubic meter per year. This figure increase or decrease depends on the rainfall quantity and water storage in the upper recharge catchment (Marj Sanour). Historical annual recharge shows sustainable average inflow of 6.4 mcm from the springs, 2 mcm from licensed wells and 0.5 lateral surface outflows. The total perennial inflow is the sum of previous inputs or equal 9.1 mcm/year.

Because there is no lithological data available on the non licensed wells and according to the aquifer system and drilling techniques it is thought that all these wells are penetrating and pumping from the Eocene aquifer. Knowing that these wells capacity is about 1365 m^3/hr; it means they can pump up-to 11.8 million cubic meters per year. If only 8.5 mcm/year is considered to carry the water balance, it yields to the amount of estimated abstraction by these wells. In addition to that there are 2 millions cubic meters per year through the licensed wells. Then, the total annual discharge is 10.5 million cubic meters. If we assume zero lateral outflows nowadays, and no more illegal wells than those existing (many doubts on that!!) the system is over exploited and the springs discharge will be zero, or get dry for most of time except during rainy season and when wells cease operation for a period of time.

The optimistic scenario of water balance in the Ras Al-Fari'a aquifer is a s follows:

Inflow= 9.1 mcm

Outflow = 10.4

Budget= inflow-outflow= 9.1-10.5=1.4 mcm/year or over exploitation of the aquifer.

We think that the race of drilling new wells will not stop at this level; more wells will be drilled and the spring will be dry even during heavy rain season. Water levels will go down far below the exiting, however; they will share the same piece of cake what ever is the number of wells in the area.

Table (2.5): General hydro geological data for the spring in the study area

No	Spring ID	Name	Locality	Coordinates			Aquifer	Comments
				X	Y	Z		
3	AQ/030	Al-Fara'a	Ras Al-Fara'a	182.4	188.4	160	Eocene	Dry since summer 2006 until March 2009
4	AQ/032	Al-Duleib	Ras Al-Fara'a	182	187.95	155	Eocene	Dry since summer 2006
5	AQ/036	Sedrah	Wadi Al-Bathan	179.95	185.49	240	Eocene	Dries when rain is late or 30% below average
6	AQ/037A	Hamad & Beidah	Wadi Al-Bathan	180.12	185.32	215	Eocene	Gets dry some years when two drought consecutive years
7	AQ/037B	Qudairah	Wadi Al-Bathan	180.13	185.28	215	Eocene	Same as previous
8	AQ/038	Jisr	Wadi Al-Bathan	180.37	185.1	170	Eocene	Stable flow and effects with drought
9	AQ/039	Tabban	Wadi Al-Bathan	180.42	184.82	160	Eocene	More stable and minor effect with drought
10	AQ/040	As- Subyan	Wadi Al-Bathan	180.44	184.42	130	Eocene	Very stable and no effect with drought

Table (2.6): Discharge records for the springs in the study area ***1000**

year	Name of Spring							
	Fari'a	**Dulieb**	**Qudiera**	**H& Beida**	**Sedreh**	**Jiser**	**Tabban**	**Subyan**
70/71	4706.7	611	1243.878	849	625	142.3163	993	178
71/72	5048.3	1133	1243.878	1104	2239	142.3163	981	186
72/73	4428.1	596	1243.878	823	0	142.3163	1135	170
73/74	6181.0	2359	1401	946	3616	142.3163	1296	194
74/75	5227.0	817	1359	820	581	142.3163	1311	181
75/76	4801.3	450	946	874	194	161	1307	187
76/77	4325.6	353	1005	837	229	181	1313	176
77/78	3671.3	126	255	494	0	150	1282	163
78/79	1710.8	0	0	13	0	37	1196	137
79/80	5555.5	1132	1897	794	2426	184	1409	176
80/81	6267.7	1023	2087	883	1104	161	1414	184
81/82	4922.2	342	1146	539	0	124	1464	189
82/83	6354.5	2426	1792	815	3409	171	1508	234
83/84	6202.0	1043	1895	996	237	150	1692	215
84/85	4564.8	281	625	628	0	74	1579	215
85/86	2927.5	26	0	95	0	32	1587	197
86/87	4383.5	481	2473	941	670	81	1569	221
87/88	4625.2	1085	2445	849	2402	121	1436	218
88/89	5140.3	760	1869	952	187	132	1405	198
89/90	3973.5	399	1490	704	0	131	1254	202
90/91	2980.1	123	777	439	0	92	1450	192
91/92	9757.7	8604	2328	1750	8115	231	1629	221
92/93	10028.4	5385	1464	1267	5811	205	1493	221
93/94	6916.8	929	794	860	247	146	1390	201
94/95	6291.4	1017.7	986.53	1067	1724.5	147.7	1200.7	200.7
95/96	4747.4	571.7	839.9	908	285.5	143.1	1280.3	214
96/97	5787.3	1471.4	839.2	869.48	4074.3	155.39	1302.6	212.3
97/98	6584.9	1473.6	1192.2	1124.7	2008.1	240.1	1193.5	223.1
98/99	4350.9	457.836	435	657.8	48.1	165.3	1182.5	170.6
Average	14403.7	3351.6	3407.9	2257.8	3800.9	389.9	3708.3	536.3
Min=	4687.2	0.0	0.0	35.6	0.0	87.7	2687.7	375.3
Max	27475.2	23572.6	6775.3	4794.5	22232.9	657.8	4635.6	641.1
Average	**166.7**	**38.8**	**39.4**	**26.1**	**44.0**	**4.5**	**42.9**	**6.2**

Table (2.7): Summary of Basic Data for Wells in A-Fara'a Area

No	ID	X (km)	Y (km)	Z(m)	Name	Aquifer	Basin	Locality	Water use
1	18-18/001	181.050	188.620	220.00	Yunis Suwadi &	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
2	18-18/002	182.200	188.350	180.00	'Abed Al Ra'uf Faris	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
3	18-18/004	181.910	188.710	180.00	Ref'at Al Fares	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
4	18-18/016	182.370	188.890	175.00	Mustafa Abu	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
5	18-18/017	182.300	189.650	223.00	Tubas Water Project	Eocene	North Eastern	Ras Al-Fara'a	Domestic
6	18-18/025A	181.650	189.540	220.00	Muhammad 'Ali	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
7	18-18/032	182.120	188.950	197.28	Ahmad Shanti &	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
8	18-18/033	182.140	189.770	213.32	Sulayman Saleh	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
9	18-18/005	181.750	188.300	200.00	Ref'at Al Fares	Eocene	North Eastern	Ras Al-Fara'a	Agricultural
11	18-18/011A	187.040	183.400	-15.00	Marwan & Ameen	Neogene	North Eastern	Ras Al-Fara'a	Agricultural
27	18-18/037	180.150	185.400	210.86	Nablus Municipality	Upper	North Eastern	Wadi Al	Domestic
28	18-18/038	182.750	185.750	90.00	Nablus Municipality	Upper	North Eastern	Wadi Al	Domestic

Table (2.8): Water levels records for some of the wells of Al-Fara'a Area

Well ID	Aquifer	Min	Max	Abstraction License (m^3/year)	Abstraction 2006 (m^3/year)
18-18/001	Eocene	197.73	220.00	267 000	373156
18-18/002	Eocene	149.11	159.30	Unlimited	---
18-18/004	Eocene	161.95	180.00	183 000	366672
18-18/016	Eocene	141.88	161.57	224 000	318080
18-18/017	Eocene	160.84	206.91	Unlimited	442000
18-18/025A	Eocene	148.40	180.35	212 000	205597
18-18/032	Eocene	138.64	168.52	241 000	208838
18-18/033	Eocene	143.54	183.26	046 000	42812
18-18/037	Upper Cenomanian	-51.57	46.71	Unlimited	--
18-18/038	Upper Cenomanian	-10.23	0.82	Unlimited	----

CHAPTER 3: SOCIAL AND ECONOMIC SITUATION OF THE STUDY AREA

3.1 General Water Background

The water sector in the Tubas District has remained undeveloped since the occupation in 1967. Water resources have been controlled and managed by the Israeli Military Authority through a number of Military Orders. These orders have barred Palestinians from participating in the planning and management of water resources and prevented them from developing local water resources in relative with the growing water needs.

During this time, management of public resources was completely within Israeli domain; decisions were made without Palestinian participation, and with little regard for Palestinian need. As a result, the Palestinians have developed a distrustful, often antagonistic relationship with public authorities; this has adversely affected the overall performance of the water sector and resulted in creating a large gap between the services provided and the demanded ones. The very limited control over water resources hampered the access by many communities to potable freshwater resources. A community like Tamoun (10000 people) is without water network, and other communities like Tubas, Tayaseer and Aqqaba get their water once a week. The lack of investments in improving infrastructure (physical water losses reached 40% in some areas), the scattered nature of the water supply and management bodies with the absence of adequate rules and regulations and absence of stakeholder participation has resulted in the deterioration of the entire water system.

3.2 Demography

The Study area is located about 10 km northeast of the city of Nablus, and extends a distance of 10 kilometers to the north where it includes the following communities: (Taluza, Al-Bathan, Wadi Al-Fari'a, Al-Fari'a Refugee Camp, Ras Al-Fari'a ,Tammoun, Tubas, Tayaseer, Aqqaba). They are bounded from west by the villages of, Yassed, Serees, Al-Jedaydeh, and from north by Raba Zababda and from south the City of Nablus and from the east is bounded by the village of Nassariya and the Middle Jordan Valley. The of Wadi Al-Fari'a, Ras Al-Fari'a, Fari'a Refugee Camp, Tubas, Aqqaba, Tammoun and Tayaseer are administratively within the governorate of Tubas. Al-Bathan and Taluza are administratively within the governorate of Nablus. However, these two communities were included in the study because of the problem of water and sanitation can not be separated from Tubas Governorate for the following reasons:

- Overlapping territories and Taluza /Al-Bathan with Wadi Al-Fari'a. Wadi Al-Fari'a residents and Al-Bathan are socially affiliated to Taluza. The majority of the people live in Al-Bathan and Al-Fari'a I own land in Talluza and the vice versa is true as well.
- Water source which provides Al-Bathan and Taluza is from a groundwater which well is located in Al-Fari'a and owned by the municipality of Nablus.
- Proposed treatment plant site is located in land belonging to the villages and Al-Bathan -Talluza.
- Geographical location and the inclination surface of the villages of Taluza and Al-Bathan commensurate with the other villages in the study area. There will be no feasible future solution for wastewater in these two communities without connection to the proposed treatment plant.

Tubas District (TD) has a population of 49994 people. The proportion of males and females respectively are 50.8% 49.2% .The number of refugees is 7700 person and the families is 8660 families, or the average family size 5.8 members.

Table (3.1): The number of population and housing in the targeted villages

Figure	Year	Site name	Population	Number of buildings
1	2007	Taluza	2375	422
2		Al-Bathan	2485	440
3		Wade Far'a	2730	454
4		Al-Fari'a R. Camp	5712	1004
5		Ras Far'a	706	120
6		Tubas	16154	3508
7		Aqqaba	6548	1207
8		Tammoun	10795	2235
9		Tayaseer	2489	496

A number of families is estimated about 280 families are living and registered in the Jordan Valley regions, but in summer, they come back and stay in Tubas area.

3.3 Land Classification and Distribution

Most of the land area in this study belongs to the people of the village of Taluza. Water and fertile soil are the main features of this region. The availability of many sources of water from springs and wells enabled the inhabitants of this region to cultivate the land and irrigated their farms. The farmers of this region are interested in irrigated agriculture, particularly the open fields. Usually the irrigated land is planted three times a year (winter, spring and summer season).

Table (3.2): The areas of each village and their uses:

Site	Irrigated land (dunum)	Rain-fed land (dunum)	Pasture areas and unused (dunum)	Housing areas (dunum)	Confiscated areas (dunum)	Total (dunum)
Wade Far'a	6500	2500	3000	800	0	12800
Taluza	0	4700	3600	700	0	9000
Al-Bathan	2000	3800	2500	700	0	9000
Al-Fari’a R. Camp	0	0	0	226	0	226
Ras Al-Fari'a	6500	600	800	100	0	8000
Tubas	0	30000	25000	7270	36157	98427
Tammoun	1000	22000	18000	5000	40000	86000
Aqqaba	30	4000	3000	1000	0	8030
Tayaseer	0	3000	3000	280	1000	7280
Total	16030	70600	58900	16076	77157	238763

Because of the availability of water resources in the area, some of the families originally live in Taluza were moved to Al- Fari'a area looking work and stability. It is therefore not strange to find many people who live and work in the area come from other places in Tubas District.

The availability of land, fertile soil and richness of water encouraged thousands of workers and traders to invest and make small enterprises. Many families from Jenin District and the surrounding areas such as Tammoun, Tubas, Series and other communities are working in agriculture at Al-Fari'a area

Table (3.3): The percentage of workers in the agricultural sector and other sectors

Site	The proportion of workers in agriculture	The proportion of workers working in governmental sector	The proportion of workers in the private sector	The proportion of workers in other sectors	Unemployment rate
Taluza	15%	15%	20%	30%	20%
Al-Bathan	25%	20%	25%	15%	15%
Wade Far'a	60%	7%	7%	11%	15%
Al-Fari'a R. Camp	20%	20%	5%	15%	45%
Ras Al-Fari'a	70%	4%	3%	8%	15%
Tubas	48%	20%	7%	10%	15%
Tammoun	43%	30%	5%	12%	10%
Aqqaba	32%	25%	15%	13%	15%
Tayaseer	35%	5%	5%	35%	20%

Table 3.3 shows that the main income for 40% of the population of this region is from agriculture; and 18% of the population of the region are unemployed or

sporadically in work agricultural during the harvesting season. Around 28% of the population has regular jobs and 14 % run have their own business and few percentages are still working in Israel settlements or inside the Green Line. These ratios gradually changed since 2000, and after the Al-Aqsa Intifada. Before that, the highest proportion of workers were working in Israel, but because of continuous Israel's closure large percentage of them moved to the work in the agricultural sector. This could be the reason behind the digging of tenths of boreholes, and the exploration on water resources in the region.

The landscape of the region and the mountainous features gave it a distinctive aesthetic and environmental concern over the entire of the northern part of the West Bank. In addition to that, the existence of the natural springs makes the first place of recreation and to attracting people from all the West Bank. Therefore, several parks were established in Al-Bathan and hundreds of thousands of people (particularly school students) visit the area during the spring. However, the economic returns according the village council in Al-Bathan is negligible, and on contrary during April and May, the community suffers from traffic congestions and the spread of solid waste in the community.

The topography and water is encouraging the people of the city of Nablus to purchase land in the region and to construct their homes in this area. Estimates show that around 1500 dunum of the land in Taluza and Al-Bathan were bought by people from outside the area for residential purposes in the future.

3.4 Institutional bodies in the locations

Each location has a village council which is responsible for the entire community services.. For example, Al-Bathan council was newly established as a successor from the Council Taluza in 2002, and the same for Council of Wadi Al-Fari'a which was established in 1998. For Ras Al-Fari'a, the existing council was established in 2003 as a successor to Tubas Municipality Council. In addition to that, The Al-Fari'a Refugee Camp Services Committee was established in 1990 through the Refugees Affairs Department. These councils lack sufficient expertise in administration and management of financial and technical fields. They have chronic problems in collection fees and pay the water electricity debits. Moreover, they lack the tools to carry by their own capabilities the daily maintenance of electric and water networks. They also lack knowledge of data inquiry, and archiving. Most of the financial and technical questions answers were not available or not calculated. Other communities (like Tubas, and Tammoun) councils have long experience in the management of municipal affairs. Because of the deteriorated economic situation, instability and the insecurity, Israeli control and projects or approval caused dramatic lack of the basic services as wastewater collection or treatment in these communities.

These village councils are either newly established or continued their functions from as before 1994. **Table 3.4** shows the basic services run by municipalities and village councils in the study area. The Israeli occupation left these authorities without the minimum capabilities to survive and deliver the services. Each of them must be rescued with two programs run in parallel: one to build the infrastructure of the basic services, however; it is still in the beginning even after 15 years since signing Oslo agreement. The other program is on capacity building and strengthening these authorities. The financial and administrative weakness and the absence of executive authorities to enforce the law, led them being bankrupted and crippled to do the maintenance issues. The fee collection for basic services as electricity and water can hardly reaches 50% in most of the communities. Consequently, high water loss percentages prevail in networks and accumulation of debts reaches up- to millions of shekels in most of these communities. A program of rehabilitation and institutionalization must include a strategic process for cost recover and development of services.

Table (3.4): The services run by municipal and village councils in the study area

Site	Water Services					Sanitation service		Elect %	Solid Waste %
	Public network %	Ground W. Wells %	Springs %	Cisterns %	W. Tanks %	Network	Cesspits %		
Taluza	95	0	0	5	0	0	100	100	100
Al-Bathan	95	0	5	3	2	0	100	100	100
Wade	20	25	0	20	35	0	100	100	100

Far'a									
Al-Fari'a R. Camp	95	0	0	0	5	100 gray water	100 black water	100	100
Ras Fari'a	35	40	0	0	25	0	100	100	100
Tubas	70	0	0	20	10	0	100	100	100
Tammoun	0	0	0	60	40	0	100	100	100
Aqqaba	70	0	0	20	10	0	100	100	100
Tayaseer	35	0	0	40	25	0	100	100	100

3.5 Future Proposals for the Rehabilitation of These Institutions

1- Capacity building of the board for these institutions. It is clear that the current Boards potential is not enough to manage the existing water and sanitation services at the sites. This means additional projects and services must be coupled with such program of capacity building to efficient operation and sustainability of the proposed projects.

2- For water service, it is proposed to remain under the management of village councils, but it is important to reinforce the technical with the tools and qualification for better management of water service in each village.

3- The sanitary sewage services at the moment are managed by people themselves. Cesspits system is used intensively in each house and disposed of through tanks pulled on trucks. The evacuation disposal process is not healthy neither to the people nor to the surrounding environment. This sector is not developed all over the rural areas and in general this is a national problem. Councils should start from zero, and qualify the technical staff for this type of services. It unlike drinking water in terms of health repercussions; it can be a health hazard instead of being a service. The idea is to build a joint water and sanitation council for this service. The entire communities share the same outlet downstream is responsible to manage the sanitation system.

Some services are efficiently administrated in the communities through local bodies such as electricity and solid waste local companies. Electricity is properly managed through a installing prepaid electric meters; where the company is responsible for technical operation and maintenance of the grid. The company acts as a wholesaler to the local village council and who are in turn responsible for the fees' collection. Similarly the solid waste services are done through a local company and the local council pays 95 Shekel/ton. In turn the councils collect fees as a lump sum amount and usually added to the monthly bills or calibrated in the electric prepaid meter.

It is clear that the councils' current potential is neither effective nor sufficient to manage water and sanitation services at the sites. Therefore, it is crucial to develop a structure or a framework and ensure of having a qualified of administrative and technical capacity to manage these services. In addition to that, provide with the necessary equipments for such services and to train staff on how to manage them. Training and capacity building program are necessary for the optimal use of these services and to ensure the sustainability of these services.

For example, the water service is individually operated by each local council. The Coordination and cooperation are absent at the levels of water resources and supply and distribution. The absence of trained technicians and specialized body for maintenance caused a fast deterioration of water networks and sharp increase in water losses. This has coupled with poor system of collecting the water fees. The result is early failure of the water supply projects after few years of construction or the accumulation of debts on and for council. In case of the un piped communities, each family is responsible to get their own and pay the costs to by and transport water.

3.5.1 Capacity Building

To adequately manage the water services it is proposed to establish a water body for each cluster and work side by side the existing councils. This new council will not cancel the role of the local authorities or abrogate their duties. However, it is going to improve the level of services and the feasibility of the water projects. Its technical mandate offers the local council a margin for monitoring the social and economical returns of the project. While the existing system can hardly being monitored or evaluated. The two water bodies will integrate their objective and share the responsibilities. The councils will be responsible to activate the fee collection and propose a socio-economic tariff.

On contrary to the existing water administration where people feel less committed to pay for this service.

According to the previous nomenclature, the north cluster will include Tubas City, Tammoun, Aqqaba, and Tayaseer. The south cluster includes, Wadi Al-Frai'a, Ras Al-Fari'a, Al-Fari'a Refugee Camp, Talluza and Al-Bathan. This water body has to be equipped with the suitable tools and machine to be able to carry the different activities. But before that, it needs a permanent place of operation and storehouse to manage the water services. The detail function and framework is indicated in **Figure 6.**

The sanitary services are individually managed, and each house has its own cesspit and a way to dispose sewage water. More details on this particular topic is discussed in chapter 4 (Existing Sanitary Situation). Once these communities are connected to a sanitary collection/disposal/treatment system, there must be a similar body to the water services. The new sanitary body could operate within the same framework mentioned above. The new council is called the Joint Committee for Water Supply and Sanitary Services (JWCS). This procedure aims to reduce the administrative and general costs.

The cost of establishing JWCS of the water and sanitation services:

Table (3.5): Proposed Salaries for the proposed JWCS

Job Title	**Salary / month (Euro)**	**No.**	**Total (Euro)**
Director	800	1	800
Administrative Manager	700	1	700
Technical Manager	700	1	700
Secretary	400	1	400
Civil Engineer	600	1	600
Sanitary Engineer	600	1	600
Health Monitor	600	1	600
Surveyor	600	1	600
Accountant	500	1	500
Office Keeper	400	1	400
Technicians	500	2	1000
JCB driver	600	1	600

4*4 Driver	500	1	500
Assistant Technician	400	4	1600
Total			9600

To make this committee active and continue the work, it is proposed to cover these costs for the coming three years. This means a total amount of 9600 * 36 = 345600 Euros is added to the overall proposed budget.

Table (3.6): Supplies and equipments for the proposed JWCS

Item	**Price (Euro)**	**No.**	**Total / Euro**
Council Building	100000	1	100000
JCP	79000	1	79000
Wastewater truck	59000	2	118000
Car to clean the drainage pipes	100000	1	100000
Welding machine	3000	1	3000
Asphalt Cutting Machine	2500	1	2500
4 wheel car	49000	2	98000
Computer	600	5	3000
Office supplies	500	7	3500
Water supply maintenance tools	2000	1	2000
Water supply fittings of different sizes and types	2000	1	2000
Sanitary maintenance tools	500	1	500
Sanitary fittings of different sizes and types	2000	1	2000
Total			**513500**

The above costs represents the costs needed for each cluster which equal to

Total = 345600 + 513500 = 895100 Euro

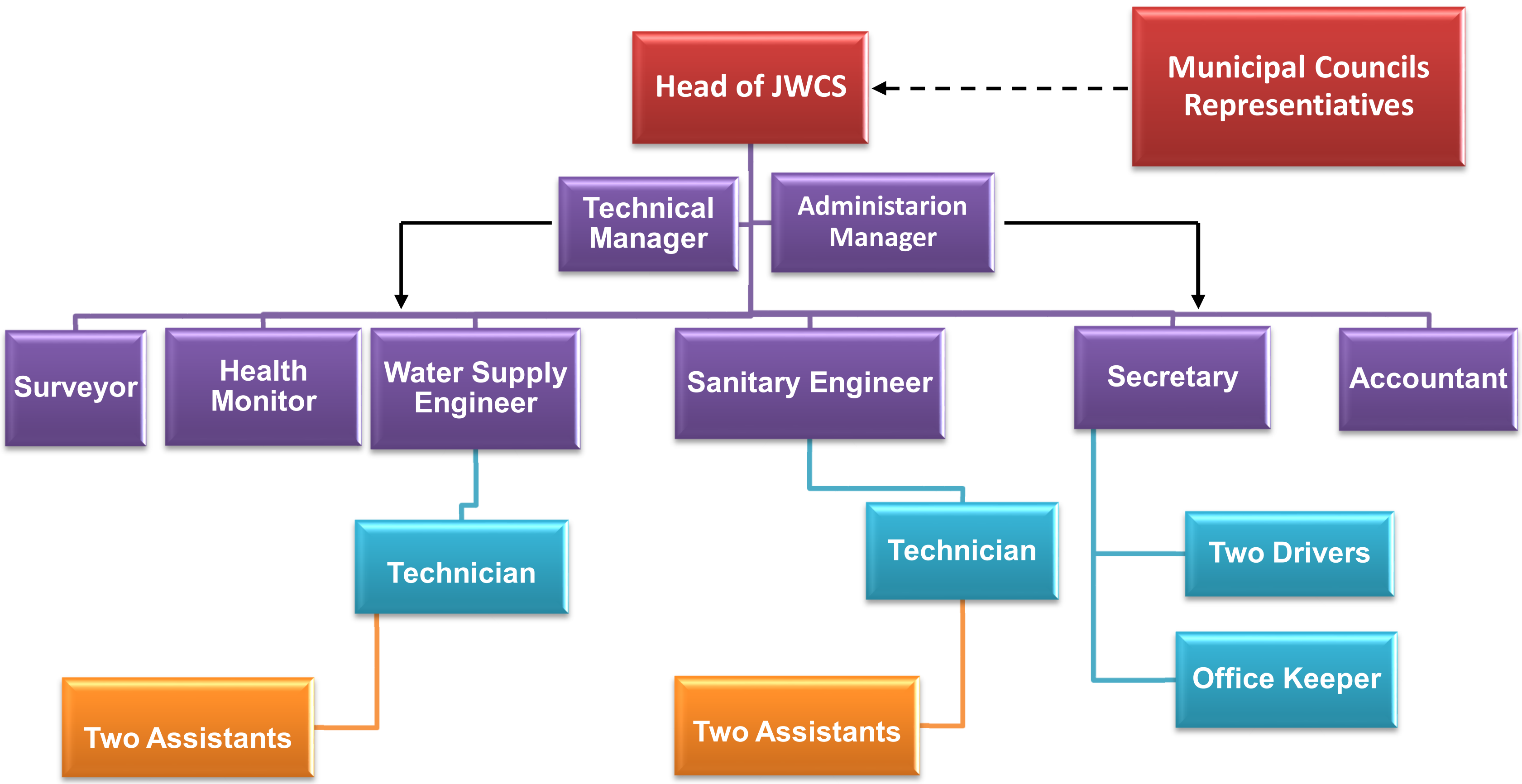

Figure 3.1: The anticipated JWCS framework

3.5.2 Awareness and training

Is important in the management of this project is to train technical staff to take over management and maintenance, both in the water or sanitation:

Table (3.7): Training on the management of water supply

Course Title	Hours	Target group	Cost / hour (Euro)	Total (Euro)
Maintenance of water systems	16	Technical staff in the Services Council	70	1120
Operation and maintenance of pumps	16	Technical staff in the Council	70	1120
Mechanism of water distribution	16	Technical staff in the Council + members of the Council	70	1120
Water supply management- collection and pricing	16	Council staff + members	70	1120
Water quality conservation and protection	32	Men + women	70	2240
Rationalization of water consumption	32	Women + school students	70	2240
Total	**128**			**8960**

Table (3.8): Public awareness materials for drinking water

Item	Number	Price (Euro)	Total (Euro)
Publications –leaflets and booklets	10000	1	10000
Posters and brochures	10000	1	10000
Training materials	500	4	2000
Total			**22000**

Table (3.9): Training on sanitation

Course Title	Hours	Target group	Cost /hr (Euro)	Total (Euro)
The importance of the Joint Services Council	16	Local councils	70	1120
Management of services and activation of collection of collection. Reducing costs of technical, administrative, operation and maintenance of the project.	16	Local councils	70	1120
Operating wastewater treatment plants	16	Technical Group in the councils	**70**	1120
The wise use of the sewerage system by customers.	36	People + school students	70	2520
Health criteria and prevention of pollution of surface water and groundwater and the surrounding environment	36	Citizens	70	2520
Wastewater reuse in agriculture: the possible achievements and constrains	8	Farmers	70	560
Total	**128**			**8960**

Table (3.10): Awareness materials for sanitation

Item	Number	Price (Euro)	Total (Euro)
Publications –leaflets and booklets	10000	1	10000
Posters and brochures	8000	1	8000
Training materials	500	4	2000
Total			**20000**

Table (3.11): Costs of external training and planning visits in sanitation

Address	**Target group**	**No.**	**Cost per person**	**Total**
The identification of modern sewage systems	Technical staff in the Services Council	10	2000	20000
Learn how to operate pumps, drinking water and maintenance				
The identification of new programs in the areas of water and sanitation				
Visit agricultural areas irrigated by water from the sewage treatment	Farmers	10	2000	20000
Total				40000

The total costs of establishing the JWSC in each cluster is **995020** Euro. The costs for the two clusters and for three years after establishments are **1990040** Euro. This number includes the costs of training and public awareness

CHAPTER 4: SANITATION ANALYSES OF EXISTING SITUATION AND ORIENTATIONS

4.1 Current situation:

Sanitation in the study area mainly consists of cesspits that are emptied by private tankers and trucks which are disposed nearby the wadies or near the sides of the roads. Cesspits are basically earth or concrete pools constructed with opening in the walls and no concrete bottoms to allow wastewater to infiltrate into the ground. The infiltration rate depends on the type of the soil. The cesspit needs evacuation when it fills with sewage. Most of cesspits are evacuated once or more each month. The number of evacuation depends on many factors like the volume of the cesspit itself, the quantity of the consumed water at the house and the nature of the soil of the cesspit.

Most of the existing cesspits are above fifteen years old and this means that the majority of these cesspits become less effective in infiltrating the sewage because they became blocked with the fine solids or the settled sludge. There were many cesspits that seep in the streets especially at the centre of villages where houses are dense. It causes social, health and environmental problems in these locations. Excavating a cesspit is difficult in these areas of dense houses, because of the limited area surrounding each house in these locations.

Most of the houses in the study area have their own cesspits and some of them share in the same cesspit. This happens especially to the big family like the father and his sons or whom their houses beside his house. These cesspits are located near the houses. The average size of the cesspits ranges between 10-50m^3. The total cost for construction a new cesspits is between 1000-2000 $US. The average cost for evacuating one tank 6m^3 volume from the cesspit and disposing is nearly about 20$ and it depends on the location of disposal.

In Al-Fari'a Camp the situation is different. The sewage system in the camp is divided as grey and black sewage. Each house has its own cesspit for the black sewage. In the past the grey sewage collected through open canals network in the camp until 1997. After that, a grey sewage collection network was constructed. It mainly consists of collection pipes, manholes and house connections. It has been aimed to collect grey water and storm water in winter. The project implemented in phases starting from 1997 and finished in 2007. The design criteria forbid discharging the black wastewater into the collection system, but there is a percentage of (nearly 5%!) of the houses in the camp discharge their black wastewater in the collection system in illegal way.

The existing collection system is not working adequately and many problems of clogging and flooding from the manholes happen in the camp. These problems came from that the system which was not designed for this purpose. As we mentioned above, part of the houses discharge their black wastewater in the system and in the winter a lot of rubbish in the streets goes to the system and causing clogging in the pipes and manholes.
The collection system collects the sewage from the camp and part of the adjacent houses in Ras Al-Fari'a (see **Figure 4.1**). The collection system discharges to an earth channel at a point near the camp to the south eastern part of it. The earth channel passes through Wadi Al-Fari'a and the farmers there use the sewage water for irrigating their citrus trees. The farmers begin to use sewage after the Al-Fari'a Spring dried in 2006.

In Al-Badan area, there is a problem of untreated wastewater from Nablus City as shown in **Figure 4.2**. Wastewater is flowing in the wadi of Al-Badan and crossing between the residential areas there and causing many problems of pollution. The fresh water from the Al-Bathan springs mixes with wastewater and ends with extensive environmental pollution. Adjacent to the wadi a lot of insects live coupled with bad odor and unpleasant seen. As reported by the village council that there are many health problems and diseases in the community. Pollutants like ameba, skin fungi are resulted from direct contact with the untreated sewage from Nablus City.

For the untreated wastewater from the east part of Nablus City and the wastewater from seven villages east of Nablus City flowing toward the proposed treatment plant. There was a suggestion from the PWA to transport these wastewater through a trunk main pipeline to the proposed southern treatment plant at Al-Malaki Bridge as shown in **Figure 4.3.**
East part of Nablus city has a collection system covering 95% of this part of the city. In the seven villages east of Nablus City there is no sewage collection system except in Salim village there is a sewage line covering 10% of the houses in the village. In the future the collected sewage from these villages will combine with the sewage of east part of Nablus City.

4.1.1 Transport and disposal of sewage

In most houses cesspits are emptied nearly one or more each month. The frequency of cesspits emptying depends on many factors such as the nature of the soil, the quantity of water consumption, methods of construction of the cesspits and if there is a separation of grey and black wastewater.

Figure 4.1: Grey wastewater from Al-Frai'a Refugee Camp in Wadi Al-Fari'a

Figure 4.2: Wastewater from Nablus City in Al-Bathan

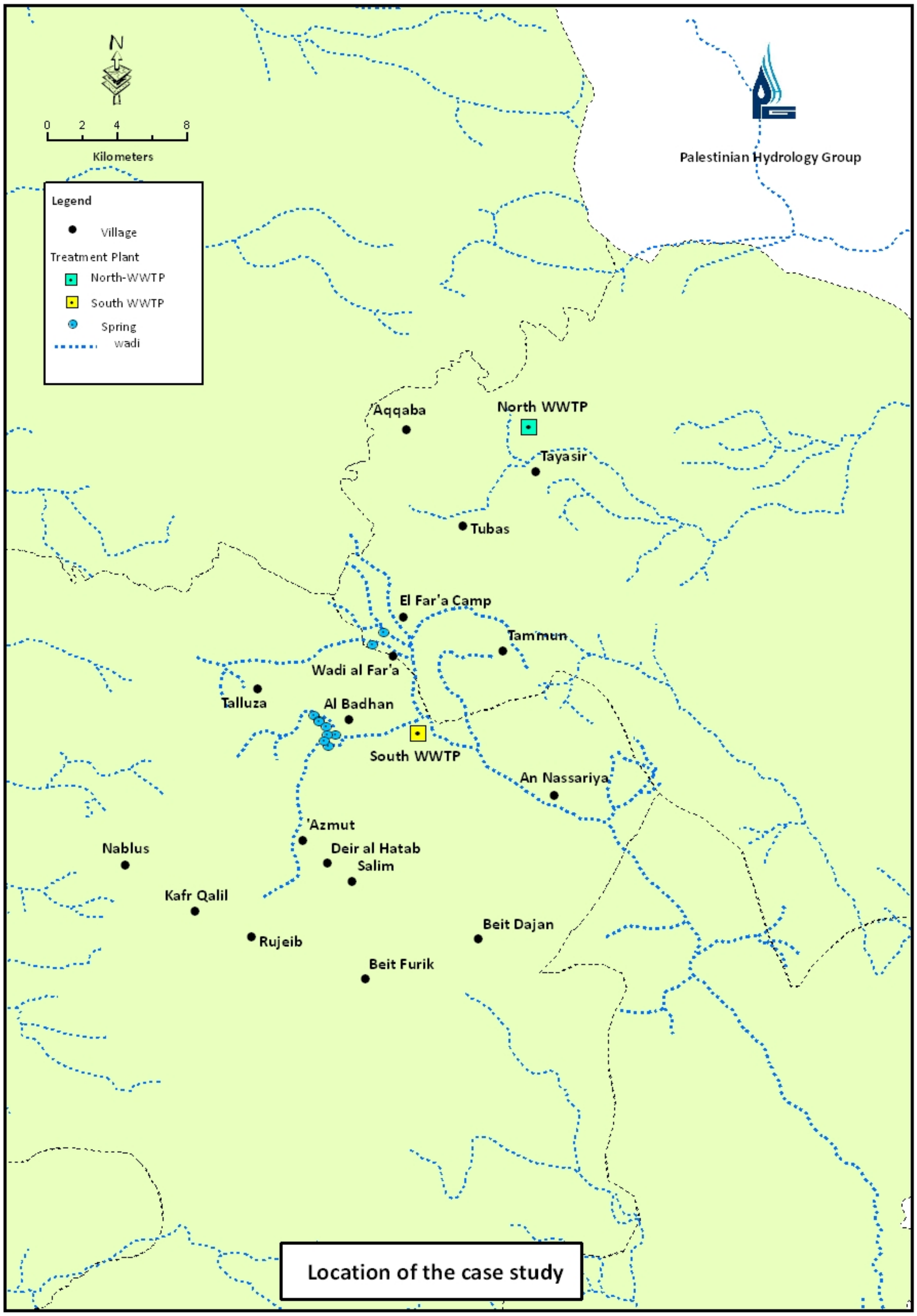

Figure 4.3: Proposed Locations of WWTPs in the North and South clusters

The emptying of the cesspits is performed by using vacuum truck tankers owned by private sector. The wastewater is usually disposed in the nearby wadies, agricultural lands and at road sides. Infiltration in soil causes underground water pollution, bad odor, soil salinization, environmental contamination, health problems and sometimes it ends with flooding in the streets and social problems between neighbors. Some houses empty their cesspits during the rainy days in the winter into the streets to avoid paying any money for that. The average cost of each truck service is nearly about 20$ per each $6m^3$ depending on the distance of the disposal

4.1.2 Perspective for Sanitation

From hydro geological point of view, the study area is classified as environmentally sensitive. In Al-Badan there are seven natural springs and in Wadi Al-Faria there are two springs and many groundwater wells. These wells and springs are used for drinking and agricultural purposes. The houses are located in the recharge area of these water resources; therefore the sanitation issue appears to be a major concern in the study area. The groundwater levels is shallow (few meters in many places particularly in the downstream of the study area), and the upper layer is composed alluvium deposit. This makes the pollution transport to the groundwater is a matter of few days if not less.

Population of the area and their representatives in the local councils are willing to cooperate and establish Joint Service Council (JSC) for the waste water collection and treatment. They would like to replicate the experience and achievements have been done with the JSC of solid waste project. The people in the study area are also willing to participate and pay their contribution in the construction of such projects of wastewater. They believe the required fees for collection and treatment of the proposed project will cost less the cost of evacuation their cesspits. There are negative effects from the existing situation of sanitation and there is a crucial need for suitable solutions to limit these adverse effects on the nature.

Table (4.1): The existing sanitation schemes and the type of problems encountered with the existing system.

Village	Pop.	Household (No)	Sanitation system				Disposal site	Distance of the disposal site(m)	Cost of evacuation of one tanker 6m^3($)	Main problems of the existing system
			Septic tank (%)	cess pit	Direct disposal to the wadies	Sewage network				
Taluza	2339	422	0	100%		0	Assira Solid waste dumping site	2000	20	- High cost of evacuation - Flooding of the cesspits in the roads
Al-Badan	2448	440	0	95	5	0	Wadi Sajor	200-500	17	- Springs pollution - Ameba, skin diseases(from Nablus sewage) - Bad odor (from Nablus sewage) - High cost of evacuation
Wadi Al-Fari'a	2616	454	5	95	0	0	Beside the road Al-Fari'a -Tubas	800	22	- Springs pollution - High cost of evacuation
Al-Fari'a R. Camp	5474	1004	0	100	0	100 (grey water)	Beside the road Al-Fari'a -Tubas For the Black water and through the Wadi Al-Fari'a for the grey water	500 (black) 100(grey)	18	- Clogging in the network - Drinking water pollution - 5% of the households discharge the black water into the grey water network - High cost of evacuation

Ras Al-Fari'a	677	120	0	100	0	20 (grey water	Beside the road Al-Fari'a -Tubas For the Black water and through the Wadi Al-Fari'a for the grey water	800 (black) 100(grey)	18	- Springs pollution - High cost of evacuation
Tammoun	10795	2235	0	100	0	0	East of the town	1000	18	1- High cost of evacuation 2- Flooding of the cesspits in the roads 3- Bad odor from the disposal site.
Tubas	16154	3508	0	100	0	0	Beside the road Wadi Al-Fari'a - Tubas and besides the near wadies	1000-1500	20	1- High cost of evacuation 2- Flooding of the cesspits in the roads 3- Bad odor from the disposal site.
Aqqaba	6548	1207	0	100	0	0	In all direction of the village not far away from the houses	500-1000	18	1- High cost of evacuation 2- Flooding of the cesspits in the roads 3- Bad odor from the disposal site. 4- Pollution of the water of the cisterns.
Tayaseer	2489	496	0	100	0	0	In the near wadies east and north	500-1000		1- High cost of evacuation 2- Flooding of the cesspits in the roads 3- Bad odor from the disposal site.

4.2 Wastewater Production Quantity and Quality Forecast

In estimating the quantity of the produced wastewater, we consider 80% of the consumed water for the household ends as wastewater (**see Table 4.2**). The water consumption is taken as 100L/C/D for the design period (2025) and 70 l/c/d in 2015. Considering 45g BOD/hab./d in 2015 and 55g BOD/hab./d in 2025 the expected results are shown in **Table 4.3 .**

Table (4.2): Expected wastewater collection quantities

South Cluster															
	2015							2025							
village	Population	Water Demand	Waste Water production	Collective sanitation	Individual sanitation	Waste water from collective	Waste water from individual	population	Water Demand	Waste Water production	Collective sanitation	Individual sanitation	Waste water from collective	Waste water from individual
	Hab.	m^3/h	m^3/h			m^3/h	m3/h	Hab.	m^3/h	m3/h			m3/h	m3/h
Taluza	3032	8.8	7.1	70	30	5.0	2.1	4187	17.4	14.0	80	20	12.6	1.4
Al-Badan	3172	9.3	7.4	70	30	5.2	2.2	4381	18.3	14.6	80	20	13.1	1.5
Wadi-Al-Fari'a	3485	10.2	8.1	70	30	5.7	2.4	4813	20.1	16.0	80	20	14.4	1.6
Ras-Al-Fari'a	901	2.6	2.1	10	90	1.5	0.6	1245	5.2	4.2	50	50	2.9	1.2
Al-Fari'a camp	7292	21.3	17.0	100	0	17.0	0.0	10070	42.0	33.6	100	0	33.6	0.0
Tammoun	13781	40.2	32.2	70	30	22.5	9.7	18139	75.6	60.5	80	20	48.4	12.1

South Tubas City	14436	42.1	33.7	70	30	23.6	8.6	19000	79.2	63.3	80	20	50.7	12.7
Nablus City-East	127586	425.2	340.1	95	5	323.2	17.0	176580	735.8	588.6	95	5	559.2	29.4
Nablus Villages- East														
Azmut	3383	9.9	7.9	60	40	4.7	3.2	4547	18.9	15.2	80	20	12.1	3.0
Deir Al-Hatab	2825	8.2	6.6	60	40	4.0	2.6	3797	15.8	12.7	80	20	10.1	2.5
Salim	6462	18.8	15.1	60	40	9.0	6.0	8685	36.2	28.9	80	20	23.2	5.8
Beit Dajan	4449	13.0	10.4	60	40	6.2	4.2	5979	24.9	19.9	80	20	15.9	4.0
Kafer Qalil	3129	9.1	7.3	60	40	4.4	2.9	4205	17.5	14.0	80	20	11.2	2.8
Beit Furik	13199	38.5	30.8	60	40	18.5	12.3	17739	73.9	59.1	80	20	47.3	11.8
Rujeib	5364	15.6	12.5	60	40	7.5	5.0	7209	30.0	24.0	80	20	21.6	2.4
Total	212499	672.9	538.4			456.7	81.7	290576	1210.7	968.6			871.0	97.6
North Cluster														
North-Tubas	6187	18.0	14.4	70	30	10.1	4.3	8143	33.9	27.1	80	20	21.7	5.4
Tayaseer	3178	9.3	7.4	0	100	0.0	7.4	4182	17.4	13.9	70	30	9.8	4.2
Aqqaba	8359	24.4	19.5	80	20	15.6	3.9	11003	45.8	36.7	80	20	29.3	7.3
Total(Tubas	17724													

Cluster		51.7	41.4			25.7	15.6	23328	97.2	77.8			60.8	16.9
Maythaloun Cluster	**28581**	**83.3**	**66.6**	70	**30**	**46.6**	**20**	**35480**	**147.8**	**118.3**	**80**	**20**	**94.6**	**23.7**
Total(North Cluster)	**46305**	**177.1**	**135**			**72.3**	**35.6**	**58808**	**245**	**196.1**			**155.4**	**40.6**

For the municipality of Tubas, the south and central part of Tubas City(around 70% of the households) should be connected with the southern Treatment plan by gravity and the northern part of the city (30% of the households) will be connected to the proposed northern treatment plant also by gravity.

Table (4.3) : Expected BOD load in the treatment plant.

Village	population	Unit pollutant load	Pollutant load	Collective sanitation	Individual sanitation	Pollutant load from collective	Pollutant load from individual
		Kg BOD/cap/d	Kg BOD/d			Kg BOD/d	Kg BOD/d
South Cluster 2015							
Taluza	3032	0.045	136.4	70	30	95.5	40.9
Al-Badan	3172	0.045	142.8	70	30	99.9	42.8
Wadi-Al-Fari'a	3485	0.045	156.8	70	30	109.8	47.1
Ras-Al-Fari'a	901	0.045	40.6	10	90	4.1	36.5
Al-Fari'a camp	7292	0.045	328.1	100	0	328.1	0.0
Tammoun	13781	0.045	620.2	70	30	434.1	186.0

South Tubas	14436	0.045	649.6	70	30	454.7	194.9
Nablus East	127586	0.045	5741.4	95	5	5454.3	287.1
Azmut	3383	0.045	152.2	60	40	91.3	60.9
Deir Al-Hatab	2825	0.045	127.1	60	40	76.3	50.9
Salim	6462	0.045	290.8	60	40	174.5	116.3
Beit Dajan	4449	0.045	200.2	60	40	120.1	80.1
Kafer Qalil	3129	0.045	140.8	60	40	84.5	56.3
Beit Furik	13199	0.045	594.0	60	40	356.4	237.6
Rujeib	5364	0.045	241.4	60	40	144.8	96.6
Total	**212499**		**9562.5**			**8028.5**	**1533.9**
North Cluster 2015							
North Tubas	8143	0.045	366.4	70	30	256.5	109.9
Tayaseer	3178	0.045	143.0	0	100	0.0	143.0
Aqqaba	8359	0.045	376.2	80	20	300.9	75.2
Total(Tubas Cluster)	**19680**		**885.6**			**557.4**	**328.2**
Maythaloun Cluster	**28581**	**0.045**	**1286.1**	**70**	**30**	**900.3**	**385.8**
Total(North Cluster)	**48261**		**2171.7**			**2408.2**	**714**

South Cluster-2025							
Village	Popu.	Unit pollutant load	Pollutant load	Collective sanitation	Individual sanitation	Pollutant load from collective	Pollutant load from individual
		Kg BOD/hab/d	Kg BOD/d			Kg BOD/d	Kg BOD/d
Taluza	4187	0.055	230.3	80	20	184.2	46.1

Al-Badan	4381	0.055	241.0	80	20	192.8	48.2
Wadi-Al-Fari'a	4813	0.055	264.7	80	20	211.8	52.9
Ras-Al-Fari'a	1245	0.055	68.5	50	50	34.2	34.2
Al-Fari'a camp	10070	0.055	553.9	100	0	553.9	0.0
Tammoun	18139	0.055	997.6	80	20	798.1	199.5
South Tubas	19000	0.055	1045.0	80	20	836.0	209.0
Nablus East	176580	0.055	9711.9	95	5	9226.3	485.6
Azmut	4547	0.055	250.1	80	20	200.1	50.0
Deir Al-Hatab	3797	0.055	208.8	80	20	167.1	41.8
Salim	8685	0.055	477.7	80	20	382.1	95.5
Beit Dajan	5979	0.055	328.9	80	20	263.1	65.8
Kafer Qalil	4205	0.055	231.3	80	20	185.0	46.3
Beit Furik	17739	0.055	975.6	80	20	780.5	195.1
Rujeib	7209	0.055	396.5	80	20	317.2	79.3
Total	**290576**		**15981.7**			**14332.3**	**1649.3**
North Cluster -2025							
Tubas	8143	0.055	447.9	80	20	358.3	89.6
Tayaseer	4182	0.055	230.0	70	30	161.0	69.0
Aqqaba	11003	0.055	605.2	80	20	484.1	121.0
Total(Tubas Cluster)	23328		1283.0			1003.4	279.6
Maythalun Cluster	35480	0.055	1951.4	80	20	1561.1	390.3
Total(North Cluster)	**58808**		**3234.4**			**2564.5**	**669.9**

4.3 Choice between collective sanitation and individual sanitation

As mentioned before, the study area is hydro –geologically classified as sensitive area, meanwhile; it is rich of water resources like springs and ground water wells. Because of that, it is a very important to cover all of the study area with a sanitation system to protect the water resources and the drinking water systems in the area through either of the following two systems.

4.3.1 Individual sanitation

It consists of a septic tank with two compartments that collects wastewater from one or several adjacent houses. The volume of the septic tank depends on the number of houses will be connected to it, but in general for one house a septic tank of a volume of $30m^3$ is a suitable volume. The septic tank is evacuated by tanker truck service and transport the sewage to the treatment plant or to any adjacent manhole in the wastewater network in the village- far away from houses. The proposed septic tanks in the study area will be located in the areas where the suggested sewage network will not serve these areas. The reason behind that is topography and cost. Few scattered or individual houses are located far away from the main network which will not be feasible to connect them in such conditions.

4.3.2 Collective sanitation

It consists of main collection network with individual house connections that collects wastewater and transfer it by main trunk line to the proposed wastewater treatment plant. It is mostly suitable for the high density areas. In our study we suggest to implement the collection system for eight locations from the nine locations in Tubas District, the seven villages in east of Nablus City and Maythaloun Cluster . The proposed networks will cover in a high percentage of the high density areas and part of the medium density areas and any houses in the way of the trunk line in each village.

The suggested feasible solution of the existing problem will be a mix of the two alternatives. A collection system and treatment plant must be initiated in the areas of dense houses. The condition to be connected or not should be topographically possible, and individual scattered houses don’t require long pipe distances.
Based on this suggestion, three zones have been identified.

1. C1: high density area urban center (only collective system).
2. C2: mid-density area, suburban (mixed between the two systems).
3. C3: low density area (individual system).

Table (4.4): Clustering of population and collection network zoning

South Cluster																	
	2015							2025									
village	Pop	C1		C2		C3		Pop	C1			C2			C3		
	Pop	Pop	%	Pop	%	Pop	%	Pop	.Ext	Pop	%	.Ext	Pop	%	.Ext	Pop	%
Taluza	3032	2395	79	334	11	303	10	4187	912	3308	79	336	670	16	94-	209	5
Al-Badan	3172	952	30	1586	50	634	20	4381	1239	2191	50	166	1752	40	196-	438	10
Wadi Al-Fara	3485	1046	30	1743	50	697	20	4813	1361	2407	50	183	1925	40	216-	481	10
Ras Al-Fara	901	0	0	451	50	451	50	1245	0	0	0	172	623	50	172	623	50
Al-Fara Camp	7292	7292	100	0	0	0	0	10070	2778	10070	100	0	0	0	0	0	0
Tammoun	13781	8269	60	2756	20	2756	20	18139	4429	12697	70	942-	1814	10	872	3628	20
Tubas South	14436	10105	70	2887	20	1444	10	19000	5095	15200	80	987-	1900	10	456	1900	10
East Nablus	127586	108448	85	12759	10	6379	5	176580	41645	150093	85	4899	17658	10	2450	8829	5
Azmut	3383	1692	50	1015	30	677	20	4547	1491	3183	70	106-	909	20	222-	455	10
Deir Al-Hatab	2825	1413	50	848	30	565	20	3797	1245	2658	70	88-	759	20	185-	380	10
Salim	6462	3231	50	1939	30	1292	20	8685	1980	5211	60	233	2171	25	10	1303	15
Beit Dajan	4449	2669	60	1112	25	667	15	5979	1516	4185	70	84	1196	20	69-	598	10
Kafer Qalil	3129	1565	50	939	30	626	20	4205	1379	2944	70	98-	841	20	205-	421	10
Beit Furik	13199	6600	50	3960	30	2640	20	17739	5817	12417	70	412-	3548	20	866-	1774	10
Rujeib	5364	3219	60	1341	25	805	15	7209	1828	5047	70	101	1442	20	84-	721	10
Total	**212497**	**158894**		**33668**		**19936**		**290576**	**72715**	**231609**		**3541**	**37208**		**1822**	**21758**	
North Cluster																	
Tubas-North	6187	4331	70	1237	20	619	15	8143	2184	6514	80	423-	814	10	196	814	10
Tayasir	3178	1589	50	795	25	795	25	4182	1338	2927	70	42	836	20	376-	418	10
Aqqaba	8359	5851	70	1672	20	836	10	11003	2951	8802	80	572-	1100	10	264	1100	10
Total	**17724**	**11771**		**3704**		**2249**		**23328**	**6473**	**18244**		**953-**	**2751**		**84**	**2333**	

4.4 Proposed options for the sanitation in the study area:

Because of the high cost of implementing of a sewage system, a partially collecting sewage system is suggested in all the villages. An exception of that is Ras Al-Faria'; it will not be covered during the interval from 2010 to 2025. The rest of houses not served by the network will be served by individual sanitation system (septic tanks with two compartments) as detailed in the table below. Due to the topography and high altitudes the sewage from eastern part of Nablus City and the villages around the city(Azmut, Deir Al-Hatab, Salim, Beit Dajan, Beit Furik, Kufur Qalil and Rujib) will proposed to combine in a trunk main pipeline near Azmout until reaching the proposed treatment plant. The sewage from Taluza is proposed to combine with Al-Badan sewage network. The sewage collected -from the two villages- will transported by a trunk main pipeline comes from east of Nablus area to Jiser Al-Malki in the downstream. For the same reason the sewage from wadi Al-Fari'a , Al-Fari'a camp, southern part of Tubas City and Tammoun will combined together in a trunk pipeline until it reaches Jiser Al-Malki where the proposed site for the treatment plant for the South Cluster.

For the North Cluster, the collected sewage will be transferred to the treatment plant site located to the north of Tayaseer village. The proposed treatment plant will serve the communities in the North Cluster (30% of Tubas City, Tayasir and Aqqaba in addition to Maythaloun cluster(Maythaloun, Misiliya, Serees, Seer, Al-Judeidha, Jarba and Kfair) as proposed by SOGREAH draft report.

4.4.1 Proposed materials for the network

There are many types of pipes could be used for sewage networks and collecting systems. The available type in the local market is the UPVC (Unplasticised Polyvinyl Chloride). It has light weight, high strength and low reactivity.

4.4.2 Proposed dimension of the sewage network

Taking into consideration the design diameters of the pipes must cover the productions quantities of sewage in the year of 2025.

The smallest diameter of the conveyance pipes will not be less than 200 mm. For the internal network and for the house connections, the diameter will not be less than 150 mm. The diameter of the main trunk pipelines from Nablus and the villages east of it will be around 1000mm and from southern part of Tubas city and Tammoun to Al-Fari'a Camp will be nearly 500 mm. The diameter of the trunk pipeline from wadi Al-Fari'a to the south treatment plant will be 600 mm. The pipes lengths are calculated by measuring the lengths of the roads from the aerial maps of the villages in zones C1 and C2.The house connections in the study area are not considered as part of the estimated cost of the project, but they are considered as community contribution in the project.

Table (4.5): The number of houses and percentages proposed for either of the two options

South Cluster																	
Commun.	population				households(5.6 person/household)				% of household to be connected to collection system			No. of households to be connected			No. of houses for individual sanitation		
	2007	2010	2015	2025	2007	2010	2015	2025	2010	2015	2025	2010	2015	2025	2010	2015	2025
Taluza	2375	2603	3032	4187	429	465	541	748	70	70	80	325	379	598	139	162	150
Al-Badan	2485	2723	3172	4381	447	486	567	782	60	70	80	292	397	626	195	170	156
Wadi Al-Fara	2730	2992	3485	4813	474	534	622	859	60	70	80	321	436	688	214	187	172
Ras Al-Fara	706	774	901	1245	125	138	161	222	10	10	50	14	16	111	124	145	111
Fara Camp	5712	6260	7292	10070	1048	1118	1302	1798	100	100	100	1118	1302	1798	0	0	0
Tammoun	10795	11830	13781	18139	1965	2113	2461	3239	60	70	80	1268	1723	2591	845	738	648
South Tubas City	11308	12392	14436	19000	2019	2213	2578	3393		70	80		1805	2714		773	679
Nablus City-East	83331	95722	127568	176580	14881	17093	22780	31532		95	95		21641	29956		1139	1577
Azmut	2650	2904	3383	4547	473	519	604	812		60	80		362	650		242	162
Deir Al-Hatab	2213	2425	2825	3797	395	433	504	678		60	80		303	542		202	136
Salim	5062	5548	6462	8685	904	991	1154	1551		60	80		692	1241		462	310
Beit Dajan	3485	3819	4449	5979	622	682	794	1068		60	80		477	854		318	214
Kafer Qalil	2451	2686	3129	4205	438	480	559	751		60	80		335	601		224	150
Beit Furik	10339	11331	13199	17739	1846	2023	2357	3168		60	80		1414	2534		943	634
Rujeib	4202	4605	5364	7209	750	822	958	1287		60	80		575	1030		383	257
Total	149844	168614	207115.6	283367	26817	30110	37943	51889				3337	31856	46534	26773	6087	5355
North Cluster																	
Tubas	4846	5311	6187	8143	880	948	1105	1454	70	70	80	664	773	1163	285	331	291
Tayaseer	2489	2728	3178	4182	467	487	568	747	50	50	70	244	284	523	244	284	224
Aqqaba	6548	7176	8359	11003	1127	1281	1493	1965	70	70	80	897	1045	1572	384	448	393
Total(Tubas)	13883	15215	17724	23328	2474	2717	3165	4166				1804	2102	3258	913	1063	908
Maythalun Cluster			28581	35480			5104	6336		70	80		3573	5069		1531	1267
Total (North Cluster)			46305	58808			8269	10502					5675	8327		2594	2175

4.5 Design criteria for the collection system

4.5.1 Collectors

For the southern, the pipes lengths are calculated by measuring the length of the roads from the aerial maps of the villages in zones C1 and C2 cluster.

For the northern cluster it based on:

- The percentage of asphalted roads per zone
- The total length of roads per hectare

After the site visits and with discussion with local councils, the assumptions made for the two clusters as follows:

1. 100% of the roads in C1 area in 2015 and in C2 in 2025 are considered to be asphalted.
2. The total length of roads per hectare is assumed to 350 m.

4.5.2 Manholes

Manholes are used as means of access for inspection and cleaning. They are placed at intervals of 40-50ms and at points where any these conditions are existing:

- There is a change in pipe's direction;
- A change in the pipe's size;
- A considerable change in grade and drop of levels.

4.6 Location of wastewater treatment plant:

The proposed location of the WWTP for the South Cluster will be at the site of the intersection of the two main trunk lines of the sewage from the study area. The nearest intersection site is at Al-Malaki Bridge area. **Table 4.6** The Justifications behind choosing the southern site of the treatment plant are:

1. Potential of reuse , the area are characterized as an agricultural area and also the area is suffering from the drought as shown in **Figure 4.2**.
2. Pollution risks of the upper aquifer is minimum compared with other places in the other places in the area.
3. Direction of the effluents will not intersect with the recharge areas with Al-Badan fresh water springs.
4. The areas are too far from the location of the treatment plant in case of odor pollution or failure of treatment plant.
5. The nearest cluster of groundwater wells in Nassaria are agricultural wells, while the effluents design criteria of the treatment plant is fit with the guidelines with the agricultural use.
6. The proposed location is favorable by Nablus Municipality than any other locations in the area. Moreover the wastewater from both governorates Tubas

and Nablus will join in this location and one treatment plant is enough for both instead of two plants in the same area.

7. The proposed area is publically owned and this avoid any social conflicts of the locations.
8. Access to treatment plant is easy for operation , maintenance and emergency.
9. Access to electricity power is easy
10. The location of the treatment plant don`t required further pumping to the natural stream, which passes adjacent to the plant.
11. The land is available for future expansion, for the coming 50 years.
12. Wastewater collection fees is garneted by the project, where all of the locations connected to treatment plant linked water and wastewater fees to electricity prepaid fees of electricity.

Table 4.6: Preliminary checklist matrix for the treatment sites

Environmental attributes	Related issues	Yes/no	clarification
Environmental criteria	Influence on ground water	No	Pollution risks of the upper aquifer is minimum compared with other places in the other places in the area. The nearest cluster of groundwater wells in Nassaria are agricultural wells, while the effluents design criteria of the treatment plant is fit with the guidelines with the agricultural use. Direction of the effluents will not intersect with the recharge areas with Al-Badan fresh water springs.
	Influence on Surface water	No	After constructing the system the sewage will not combined with the fresh water from the springs of Al-Fara and Al-Bathan.
Economic criteria	Minimum distance from the collective	yes	The distance between the treatment plant and the collective systems in the locations is minimum from any other sites for the treatment.

	Accessibility to the site	Yes	Access to treatment plant is easy for operation , maintenance and emergency. The proposed site is near the main road and it is easy to reach it.
	Large size of the plant	yes	The proposed treatment plant will be a centralized one and it will be with a large capacity which will reduce the fees for maintenance and operation
	Existence of electricity	yes	The high voltage electricity network passes near the proposed site of the treatment plant.
	Possibility of reuse	yes	Potential of reuse , the area are characterized as an agricultural area and also the area is suffering from the drought. More than 3500 dunum may be irrigated by treated sewage in the southern cluster in Al-Nassaryia and Al-Fara
	Availability of land	yes	There is a publically owned area for the proposed treatment plant. The land is available for future expansion, for the coming 50 years.
Public acceptance	Odor from the plant	No	The areas are too far from the location of the treatment plant in case of odor pollution or failure of treatment plant.
	Negative influence of the direction of the wind	No	The main wind direction is from west, southwest and northwest and the localities are located in west and northwest of the site which mean the localities are in the opposite direction of the wind.
	Ready for Paying fees	yes	Wastewater collection fees is garneted by the project, where all of the locations connected to treatment plant linked water and wastewater fees to electricity prepaid fees of electricity.
	Negative impacts on land use	No	The surrounding area is an agricultural area and also the site is publically owned.

The proposed location of the WWTP for the North Cluster will be located to the north of Tayaseer village. It is located on low vulnerable area and the area has a potential for reuse of treated wastewater

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4.7 Geology and Hydrogeology of the Proposed Site of the WWTP for the southern cluster

4.7.1 Litho stratigraphy:

Generally, the outcropping rocks of the area mainly belong on its age to Cretaceous – Tertiary period (see **Figure 4.4**). Rocks units with regard its litho logical composition, are divided into several geological formations. However, the following is a description of the encountered geological columnar section of the proposed site area from the youngest to the oldest.

- Alluvial deposits: These materials are mainly derived from the adjacent rock formations as a result of erosion processes. It has a red color and fine texture, mainly terra rossa.
- Abu Dies Formation (Coniacian-Campanian): Rocks of this formation are exposed in the south eastern part of the proposed site area. It is composed mainly of white and cream chalk, marly at base, with distinctive twin chert bands in the middle, and increasing amount of chert nodules and lenses above this, and chalk occasionally phosphatic.
- Jerusalem Formation (Turonian): Rocks of this formation are exposed in the Fari'a valley bed area. This formation is composed of dark grey –brown weathered massive limestone, locally cliff forming, finely grained lithographic pink and buff in the lower part, cream recrystallised dolomitic and occasionally silicified in the upper part. Thickness of Jerusalem formation is ranging between 50 and 75 meters.
- Bethlehem Formation (Upper Cenomanian): Rocks of this formation consists mainly of cream-grey bedded chalky limestone; frequently completely recrystallised to cream or pink porcellaneous limestone, with softer marly chalky limestone and marls. Thickness of Bethlehem formation ranges from 50 to 70 meters.

4.7.2 Structural Geology:

The dominant structural built in the area is the Fari'a anticline that has north-south trend. Due to the folding process, the area is marked intensively by fracturing. Wadi

Fari'a Graben forms the important result of this fracturing process. Also, there are some faults of local affect in the area, and do not affect the regional structure.

4.7.3 Hydrogeology:

In general, Water bearing formations (Aquifers) in study area mainly composed of limestone and dolomite. Outcropping rocks (recharge area) of the water bearing formations are mainly characterized by its prominent craggy outcrop, well jointed, honeycombed, and karstified pavements features. In particular, weathering a long bedding planes and major joints that seems to be resolves at depth into a series of relatively small interconnecting fissures have given rise to cavern systems that are likely continue underground. These features increase the secondary permeability of the rock formations that in turn increase the storage capacity and fast the groundwater travel time. Thus, outcropping areas of these water bearing formations, hydro geologically considers sensitive groundwater recharge areas. These common features of weathering process that seen in the outcrop of these formations contrast sharply with the soft chalk and marls of the other formations (Aquicludes). Regarding its ability to store and transmit water, hydro geologically, the geological formations classified to aquifers and aquicludes. In general, the main aquifer systems in the area are the Turonian-Upper Cenomanian. The main aquifers and aquicludes in the area are:

- Abu Dies Aquiclude: Regarding its lithological composition, Abu Dies formation acts as a strong aquiclude in the area, where it has low ability to store and transmit water. Hydrogeologically, outcropping areas of this formation consider low sensitive areas.
- The Turonian-Upper Cenomanian aquifer system: This aquifer system has a thickness of about 400 meters in some places, while it consists of three water-bearing formations of Jerusalem, Bethlehem, and Hebron. Outcropping areas of these water bearing formations are form the recharge area of the aquifer system. However, Turonian-Upper Cenomanian aquifer system fed several seasonal wells, and small to minor springs in the area. Thus, outcropping areas of this aquifer system consider sensitive groundwater recharge areas.

Table (4.7): Prevailing hydrogeology at Al-Malaki proposed treatment plant

System	Stage	Typical Lithology	Palestinian Terminology	Hydro-Stratigraphy		Typical Thickness (M)
	Senonian	Chalk, chert	Abu Deis	Aqitard		200-450
Cretaceous	**Turonian**	Limestone, dolomite, karstic	Jerusalem	Aquifer	Turonian-Upper Cenomanian	70-125
	Upper Cenomanian	Limestone, marly limestone, chalky limestone, and dolomitic limestone	Bethlehem	Aquifer		30-115
		Karstic limestone, dolomite	Hebron	Aquifer		105-260
	Lowe Cenomanian	Marl, marly limestone, clay, chalky limestone, dolomite	Yatta	Aquitard		50-150
		Limestone, dolomite, marl	Upper Beit Kahil	Aquifer	Lower Cenomanian	80-150
		Limestone, dolomitic, marly limestone	Lower Beit Kahil	Aquifer		130-170

4.7.4 Conclusions and Recommendations

The spreading of wide joints, fractures, fissures, cavern systems, and solution canals features that week the rock masses and increase the permeability in Jerusalem and Bethlehem formations shall be considered during the selection process of foundation type, and the transporting method of wastewater from the source to the proposed plant. These reservations should be carefully done to avoid the percolation of pollutants into the aquifer system.

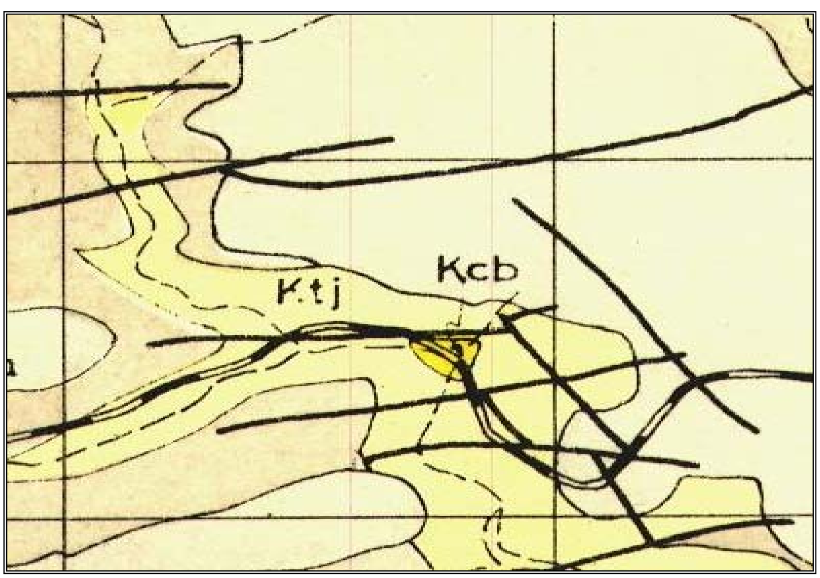

Figure 4.4: Geological Map of Southern WWTP

Legend: Qha: Alluvium. K/t-c: Senonian. Ktj: Jerusalem Formation Kcb: Bethlehem Formation.

4.8 Requirements for wastewater treatment system and for sludge treatment in West bank.

After defining the proposed location sites for the WWTPs, it is required to define the Parameters which will be used to choose the treatment system during the feasibility study.

- Guidelines and quality legal requirements
- Technical parameters
- Effluent quality requirements for reuse
- Operation and maintenance requirements
- Investment cost

4.8.1 Treatment requirements and treated wastewater quality

According to the Memorandum of Understanding (MoU) on Guidelines and Technical Criteria for Sewage projects, which was signed between the Israeli- Palestinian Joint Water Committee; following are specific requirements for the selection and design of the type of the treatment process:

- The main effluent disposal solution characteristics (for the West Bank wastewater treatment plants) must be suitable for reuse in irrigation of agricultural crops.
- All wastewater treatment plants shall be designed and operated in modular design, to allow for future adjustment and expansion. The first phase shall provide treatment to a minimum of a secondary level. In the second phase, wastewater treatment plants are to be upgraded to achieve tertiary level of treatment.
- Effluent quality should not exceed, in the first phase the following values:
    1. BOD_{max}=20 mg/L, TSS_{max}=30mg/L, TN_{max}=25mg/L, in the second phase, the effluent produced should not exceed the values listed in schedule 2.
    2. The quality of the effluent shall be in accordance with its end-use, as detailed in **Table 4.8 and 4.9**

Table (4.8): Effluent Disposal Options

End use	Quality	Treatment type	Suitable crops
Irrigation in areas of high hydrological sensitivity	1	Secondary treatment by activated sludge and tertiary treatment including nutrient treatment, additional filtration and disinfection.	Unrestricted crops including public parks, gardens and sports grounds.
Irrigation in areas of medium/low hydrological sensitivity	2	Secondary treatment by activated sludge and disinfection, or equivalent	Olives, peanuts, citrus, fruit, vegetables for cooking, fruit for canning and trees
Irrigation of inedible crops	3	Anaerobic ponds, oxidation ponds or aerated lagoons.	Cotton, sugar beets, cereals, green and dry fodder, seeds
Discharge into wadies/streams/rivers(incl. all their tributaries)	4	Secondary treatment by activated sludge and tertiary treatment including nutrient treatment, additional filtration and disinfection.	Unrestricted crops, including public parks, gardens and sports grounds

Table (4.9): Effluent Quality Criteria

	1, 4		2, 3	
Pollutant	**Average**	**Maximum**	**Average**	**Maximum**
BOD5(mg/L)	10	15	20	40
TSS(mg/L)	10	15	30	60
COD(mg/L)	70	100	100	150
EC(ds/m)	1.4(1)		1.4	
PH	6.5-8.5	7.0-8.5(4)	6.5- 8.5	
Chloride (CL)(mg/l)	250(1), 400(4)		250	
Boron (B) (mg/l)	0.4(1)		0.4	
Sodium (Na) mg/l	150(1), 200(4)		150	
SAR	5(1)		5	
Fecal Coliform (MPN/100ml)	10(1), 200(4)	10(1), 100(3)	10	
Total Nitrogen	10(4), 25(1)	15(4), 40(1)	25	40
Silver (Ag) mg/l	0.05		0.05	

Arsenic (As) mg/l	0.1		0.1	
Cadmium (Cd) mg/l	0.01(1), <0.005(4)		0.01	
Chromium (Cr) mg/l	0.1(1), 0.5(4)		0.1	
Cobalt (Co) mg/l	0.05(1)		0.05	

4.8.2 Requirements for Sludge Treatment

The MoU also sets minimum requirements concerning the sludge treatment, as follows:

The treated sludge should contain less than 2 million MPN(Most Probable Number) or CFU(Colony- Forming- Units) of bacteria per gram of total solids, as calculated by geometric mean of density of Fecal Coliform in the sludge samples (minimum of 7 individual grab samples). Sludge should be stabilized according to one of the following methods or by any equivalent method, according to advanced western standards, such as: composting thermophilic aerobic digestion, thermophilic anaerobic digestion, heat treatment and heat drying.

(1) **Anaerobic digestion**: if stabilized by anaerobic digestion (at temperature 33-38 degree), the mean cell residence time should not exceed 15 days and the mass of volatile solids in the sludge should be reduced to a minimum of 38%.

(2) **Aerobic digestion**, if stabilized by aerobic digestion, the mass of volatile solids in the sludge should be reduced to a minimum of 385 or alternatively, SOUR (Specific Oxygen Uptake Rate) for treated sludge should be less than 2mg O2/hour/gram VS (Volatile Solids) of sludge at 20 degree.

(3) **Stabilization** by alkali addition of sufficient alkali is required to raise PH to a minimum of 12 and maintain a PH>12 for 2 hours and a PH>11.5 for additional 22 hours."

4.9 Possible treatment processes

The proposed location site of the treatment plant is suggested to be at Al-Malaki Bridge for the South Cluster and at north of Tayaseer for the North Cluster. The hydrological area is sensitive and the requirements of the treatment process are very high, in particular for the second phase as mentioned before. But already for the first phase, the effluent standards are 20mg/l for BOD, 30mg/l for TSS and 25mg/l for total nitrogen. It is proposed to reuse the effluent for irrigation, since most of the surrounded area is used for agriculture. A reduction in fecal Coliform to < 200 fecal/100ml is required. The treatment process therefore needs to be relatively performing on a large range of parameters.

Hereafter are described a number of treatment processes that could be expected to meet the requirements set. The advantages and disadvantages of the possible processes are finally compared and discussed.

The range of possible secondary treatment processes that can produce the required high quality effluent is very wide. It extends from the large area, long detention, aerated ponds method, at one extreme to the compact, short detention, highly mechanized methods, such as the activated sludge family, at the other extremes.

4.9.1 Waste Stabilization ponds

Wastewater treatment ponds are a natural biological process which is non-mechanized. Ponds are relatively cheap and easy to construct but they required a large areas. Aerobic stabilization lagoons are large, earthen basins of wastewater where the treatment is provided by natural processes involving the use of both algae and bacteria. Natural aeration processes are used to supply some or all of the oxygen needed by the bacteria to metabolize organic matter and reduce the BOD. Stabilization lagoons have become very popular in small communities, because they are simple and economical to operate, requiring minimal operation and maintenance, namely one sludge removal of the primary lagoon once every two to three years and one sludge removal of the secondary lagoon once every five years. Aerobic lagoons are designed with a maximum depth of 1.5 m. A large surface area is then required to maximize the natural aeration capacity of the system. The rate of surface area may range from 6 to 10 m^2/inhabitants depending on the variation of water temperature. This area requirement includes only the lagoons themselves, with no allowance for access roads or other facilities. With a maximum depth of 1.5 m, the retention time is about 60 days, which is the minimum required to achieve a significant reduction in Coliform counts (reduction of about 104). The process would be expected to meet the discharge requirements regarding Coliform and, with addition of tertiary sand filters, the requirements for SS and BOD. The standards for nitrogen would probably not be met. However, the most significant disadvantage is the large size of the plants, and the availability of site therefore has to be carefully evaluated.

4.9.2 Aerated Lagoons Process

Aerated lagoons consist of earth or paved basins, into which air is introduced, mostly by mechanical surface aerators, to oxidize and stable the organic matter in the sewage. Aerated lagoons can be divided into two basic types fully aerobic and facultative_ differing in the level of aeration power applied and the degree of mixing produced and the biological process taking place. An aerobic pond is a high rate, completely mixed system, in which soluble BOD is converted into biomass which is partly assimilated in the aeration basin. In facultative pond, the turbulence levels are not sufficient to maintain all of the solids in suspension. Depending on the BOD loading and the SS present in the influent sewage, some of the solids are deposited on the bottom of the basin, where the undergo anaerobic decomposition. In aerated lagoons, the biological process is somewhat similar to that in activated sludge, but separation and return of sludge is not applied. Consequently, aeration process requires a considerably longer time. Effluent from an aerated lagoons, although almost completely oxidized and stabilized still contains a high concentration of solids in the form of biomass. To prevent depositions of sludge in the disposal facilities and receiving bodies, it is required to remove this biomass and dispose only of the clear effluent. The biomass can be easily separated in polishing or maturation ponds. Aerated lagoons can be designed in single or multiple stages or with various combinations with aerobic and anaerobic ponds, depending on the composition of raw sewage and the required effluent quality.

Advantages and disadvantages of aerated lagoons are as follows:

Advantages

1) Ease of operation and maintenance
2) Waste water equalization
3) Lower operational requirements relative to activated sludge process

Disadvantages

1) Large land area requirement
2) Difficult to modify process
3) High effluent suspended solids concentration
4) Sensitivity of process efficiency to variation in ambient air temperature.

4.9.3 Trickling filters

In this process filter media is place in a bed 2-3 ms deep. The settled sewage is distributed over the surface of the filter media by revolving distributors. A microbiological film grows on the filter media and oxidizes the organic matter.

The advantages and disadvantages of trickling filters

Advantages

1) Power requirements are small compared with activated sludge processes.
2) Little skill required for operation.

Disadvantages

1) High construction cost
2) Fly and odor nuisance
3) It is not much resistant against shock loads

The trickling filters are particularly adapted where the incoming wastewater is concentrated and where the discharge requirements are not to strict. But for our case, several additional steps of treatment would be required to treat nitrogen, to further reduce BOD and SS and to reduce the Coliform count. The trickling filter process it is therefore not recommended for the treatment plants in this project.

4.9.4 Activated Sludge

The activated-sludge process is one of the most common treatment processes and is currently in operation in the Gaza Strip. The process can be designed in many modified forms, including: selection of the reactor type, oxygen requirements and transfer, types of settling tanks, but fundamentally theoretical aspects of the process are similar:

- ✓ Wastewater is introduced into a reactor (aeration basin) where an aerobic bacterial culture is maintained in suspension. The reactor contents are referred to as the “mixed liquor”. In the reactor, the bacterial culture carries out the conversion of the organic matter into biological solids (biological cells).

- ✓ The aerobic environment in the reactor is achieved by the use of diffused or mechanical aeration, which also serves to maintain the mixed liquor in a completely mixed regime.

- ✓ After a specific period of time, the mixture of biological solids is passed into a settling tank, where some of the settled sludge is recycled to maintain the desired concentration of organisms in the reactor and the remainder is removed from the system.

- ✓ The level at which the biological mass in the reactor should be kept (mean cell - residence time) depends on the desired treatment efficiency and other considerations like: nature of the wastewater, local environmental conditions, etc.

Different parameters can be used for the design of the activated-sludge process:

- ✓ The food to micro-organism ratio or mass loading defined as the mass of BOD applied per day to the treatment system divided by the mass of mixed liquor suspended solids (MLSS) in the aeration tank.

- ✓ The mean cell-residence time or sludge age that is the ratio of the mass of MSS in the aeration tank to the mass of sludge removed per day from the system.

- ✓ The volume loading defined as the mass of BOD applied per day to the treatment system divided by the aeration tank volume.

The activated sludge process was initially designed for removal of dissolved organic pollution (expressed as BOD, COD and SS), where removal rates up to 90%-95% can be expected depending on the design parameters. In the later years, the removal of nitrogen by biological nitrification and denitrification has been largely developed, requiring an increase of the sludge age in the tank and specific mixing, aeration and recycling arrangements. It has also been shown that biological phosphorus reduction can be achieved if an anaerobic tank is added at the inlet of the biological reactor and this development is now gaining more and more interest.

Aeration equipment for injecting oxygen into the MLSS can consist of mechanical aerators or diffused air systems that blow air into the MLSS.

Final settling tanks are used to separate the biological solids produced in activated sludge from the treated wastewater. Settling tanks are mainly designed on the basis of an overflow rate. Overflow rates may range from 0.5 to 0.7 m/h at peak flows.

It should be pointed out that an activated-sludge process does not provide any significant reduction in coliform counts (only a factor 10 to 100). Where coliform reduction is required, as the case is here, a tertiary treatment should be added to the treatment train, most often consisting in sand filtration and disinfection by chlorine or UV radiation.
Provided with tertiary disinfection, the activated sludge process would meet the set performance requirements in this specific case.

4.9.5 Membrane Bio Reactors

The membrane bioreactor technology combines a biological treatment of pollutants (BOD, N, P) with a membrane separation of the biomass and the treated water. The biological treatment used in an activated sludge process with high sludge concentration. The solid-liquid separation is carried out by microfiltration membranes, which most often are submerged directly in the aeration tank. The membranes may be flat sheet membranes, hollow fiber membranes or tubular membranes. The microfiltration membranes have a pore size in the range of 0.1 to o.4 microns, which retains suspended solids, bacteria and macro-viruses but not the micro-viruses.

Advantages

1) There is no need for sedimentation tanks
2) The biological reactor is smaller than the reactor in the activated sludge because of the higher MLVSS concentrations.
3) The process is well adapted for median sites (between 10000 and 80 000 habitants)
4) The quantity of the produced sludge is smaller by 40% than an activated sludge process.
5) Wastewater treated with membrane technology has very high quality and the process is therefore used where the requirements on the level of treatment are particularly high as in the case of irrigation reuse or aquifer recharge.
6) Land area requirement will be significantly lower as for the other process
7) The equipment (membranes, aerators, electric equipment..;) who represent 50 % of the cost of a WWTP should be gradually done according to the increase in the quantities of waste water.

Disadvantages

1) The capital cost of the membrane bioreactor plant is slightly higher than a conventional activated sludge plant but should be the same if we add a tertiary treatment.
2) Membranes must be replaced every 5-10 years of operation.

4.9.6 Comparison of Processes and Discussion

The advantages and disadvantages of the suitable treatment processes are listed **Table 4.10,** and allowing a comparison between them. A number of the described processes have been eliminated already at this stage since they cannot meet the requirements and only the remaining processes are compared.

Table (4.10): The advantages and disadvantages of the suitable treatment processes

Process	Advantages	Disadvantages
Membrane bioreactors	• Very high treatment performances, also on fecal Coliform. • No chlorination or UV disinfection required. • Low sludge production. • Compact process, easy to cover. • Modular construction and easy automation.	• Some uncertainty regarding the membrane life length and related replacement cost. • Investment costs are the same as the extended aeration process • Complex process operation.
Stabilization ponds	• Uncomplicated, reliable and stable process. • Good bacteria removal, no further disinfection required. • Low sludge production. • Low investment and operating costs.	• Large space required. • Cost of the land required • Risk of flies and mosquitoes. • Low removal rate of phosphorus and nitrogen • Risk of algae growth • Large loss of water (evaporation, infiltration..)
Activated sludge	• Proven and reliable process. • Stable performances at variations in hydraulic load. • Moderate cost for the base process. .	• Additional tertiary treatment required to meet treatment requirements. • High sludge production. • Relatively high land requirements. • Large basins, difficult to cover. • Long start-up of the biological process, cannot treat peak loads.

Only the membrane bioreactor and the activated sludge process with the complement of a disinfection process can provide the treatment level to the required discharge for wastewater reuse as mentioned in the MoU of the Israeli- Palestinian Joint Water Committee.

Stabilization pond could be used but only with the process with reed.

The feasibility study should define the system after a technical and economical study depending of the evolution of the cost of those different systems.

4.10 Sludge Treatment

Due to the low rate of industrial wastewater of the total, the produced sludge should be of such quality that it meets the requirements and can be reused in agriculture without problems. It is therefore anticipated for the purpose of this study that the sludge from the treatment plants of this project will be used as soil amendment in the agriculture. The process selection for the sludge treatment will be based on this assumption.

Three different steps in the sludge treatment can normally be distinguished: thickening, stabilisation and dewatering. Sometime, thickening and dewatering can be combined or stabilisation be omitted. An additional drying stage could also sometimes be required.

4.10.1 Sludge Thickening

The excess sludge which is withdrawn from the secondary clarifier has dry solids sludge, thus very liquid, "dirty water". The purpose of sludge thickening is to concentrate the solids to a solid’s content of around 30 g/l or 3%. After thickening the sludge remains as liquid, but with the volume reduced to around ¼ of the initial volume. Sludge thickening is generally carried out either by gravity thickeners, air flotation or drainage screens.

Gravity thickener is the most common type of sludge thickening device. It gives excellent results on primary sludge and acceptable results on digested secondary sludge. The principle and the operation are simple and robust. Gravity thickeners can not be used if biological phosphorus removal is used, since anaerobic conditions will appear in the thickener with subsequent phosphorus release as result.

Dissolved air flotation is used when the sludge is light and difficult to settle, typically for unstabilised activated sludge or sludge from biofilters. It is also a preferred option when biological phosphorus removal is used. The process is although more complicated to operate and more costly in operation and maintenance.

Drainage screens are mainly used in small treatment facilities and can be an interesting and space saving.

4.10.2 Sludge Stabilization

The purpose of the sludge stabilization is to reduce the content of organic matter in the sludge and thereby reduce the potential for further fermentation or putrefaction and, in the same time, eliminate offensive odors. The stabilization will also reduce pathogens in the sludge to some extent. The processes used are:

- Anaerobic digestion.

- Aerobic digestion.
- Lime stabilization.
- Thermal treatment.

Anaerobic digestion by methane fermentation is a powerful mean of removing substantial quantities of organic matter. The process most generally used is mesophilic digestion at 35°C. For normal wastewater treatment sludge, a reduction of 45 to 50% of the organic matter content can be expected. The digestion is producing biogas, mainly consisting in methane and carbon dioxide. A part of the produced biogas is used for the heating of the digester and the surplus can be used for heating other facilities or for producing electricity for the aerators of the plant.

Aerobic stabilization is usually employed in open-air units provided with air diffusers or surface aerators. The aerobic stabilization is rather energy consuming and is therefore rarely used as a specific unit. However, in an extended aeration activated sludge process, sludge is partly aerobically stabilized within the treatment process.

The fermenting capacity of sludge can be temporarily reduced by adding chemical agents in bacteriostatic dosages. **Lime** is the most widely used reagent because it is cheap, offers the right sludge. Lime can be added to the liquid sludge or to the dewatered sludge. The advantage of lime treatment is the absence of heavy investments in civil works and equipment, but this saving should be seen in the light of the relatively high operating

Thermal treatment is principally used for conditioning of the sludge by release of bound water in the cells and for deactivation of pathogenic agents. As a matter of fact, in many cases it is a combination of these processes that are used. In an extended aeration process, sludge is first partly stabilised in the aeration tank, thus aerobic digestion, before undergoing anaerobic digestion. The digested sludge is then often treated with lime in order to improve the physical properties and to ensure that the sludge could be stored for long time without any renewed fermentation. Sludge in stabilization ponds undergoes anaerobic stabilization in the ponds and will not need any further stabilization after having been removed.

4.10.3 Sludge Dewatering

The purpose of the dewatering process is to further reduce the moisture content in the sludge, thereby also reducing the volume. Typically, dewatered sludge has dry matter content between 20% and 40% depending on the process, which means a tenfold reduction of the volume. The degree of dewatering depends on the type of equipment being used and it should be selected depending on the final destination of the sludge. Where sludge should be transported over long distances, additional drying up to 60% or even 90% DS could be considered in order to reduce the transportation costs. Some kind of chemical conditioning is most often required to improve the dewatering characteristics of the sludge. Various types of chemicals are used: metal salts such as ferric chloride and aluminum sulphate, polymers (very commonly used) and lime. The most commonly used dewatering devices and their performances are given in the following **Table 4.11**

Dewatering of sludge on **drying beds** is a very inexpensive solution, but is limited by the large surface areas required. About 0.25 m² of land per person equivalent is required, which would double the required surface for an activated sludge plant. In the case of a stabilization pond plant, where the sludge quantities are smaller and the sludge contains less organic matter, the drying beds can be an interesting option.

Table (4.11): The most commonly used dewatering devices and their performances

Device	**Performance for stabilised biological sludge**	**Energy consumption**
Centrifuge	20% - 30%	55-70 kWh/ton dry matter
Belt filter	18% - 26%	40 kWh/ton dry matter
Plate filter press	30% - 40%	30-40 kWh/ton dry matter

4.11 Land Requirement

The outline design of sewage treatment plants undertaken at this stage is in particular for the purpose to verify that the surface areas required are available. Therefore, the following assumptions have been used for the assessment of the areas:

Process	**Land requirement**
Membrane bioreactor	0.15 m²/population equivalent
Stabilization ponds with reeds	6 m²/population equivalent
Stabilization pond	10 m2/population equivalent
Activated Sludge process	0.3 m²/population equivalent

Table (4.12): Required area per each type of treatment per each cluster

Type de traitement	North ckuster without Maythalun			North cluster with Maythalun			South Cluster		
	équivalent population (*)	(m2/p)	surface (ha)	équivalent population (*)	Taux de surface (m2/p)	surface (ha)	équivalent population (*)	(m2/p)	surface (ha)
Membrane bioreactor	23328	0,15	0,35	**58808**	0,15	0.9	290576	0,15	4.36
Stabilisation pond	23328	10	23.3	**58808**	10	58.8	290576	10	290.6
Stabilisation pond with Reed	23328	6	14	**58808**	6	35.3	290576	6	174.35
Activated Sludge	23328	0,3	0.7	**58808**	0,3	1.76	290576	0,3	8.72

4.11.1 Re-Use Opportunities

If properly treated, through WWTP, wastewater could be used as an additional water resource for specific applications such as irrigation purpose. If we consider the whole produced waste water is treated, the additional available resource could reach up to 968.6 m^3/h, which represent 8.48 Mm^3/year for the southern cluster and 196.1m^3/h, which represent 1.71 Mm^3/year for the northern cluster. Considering scarcity problems of water in the area, reuse opportunity is a key point to sanitation solution choice.

The proposed eastern treatment site next to Tayaseer for the northern cluster is close to large agricultural areas including Tayaseer plain (more than 2000 dunums and Al-Maleh with about 1000 dunums which are suitable for irrigation). The main crops in this area include open fields (about 2000 dunums) cultivated by winter field crops such as wheat and barley. No fresh water is available for irrigation in this area. Thus introducing treated wastewater there will have a positive impact on the agricultural development. In this area, it is recommended to use treated wastewater for irrigating fodder crops and trees. These crops consume large amounts of nitrogen, so they will be effective in significantly reducing nitrogen concentration in treated wastewater. Also, fodder crops are recommended to be introduced to open fields. In addition to the above, new crops could be introduced to the area. This area is suitable for vegetables and various types of fruit trees such as grapes, bananas, citrus and date palm.

For the southern cluster treatment plant site at Al-Malaki Bridge, its location is close to two large agricultural areas which are Al-Fari'a area (more than 1000 dunums) and in the downstream Al-Nassariya area (more than 2500 dunums). Treated wastewater could be used in the Fara'a Plain and along Wadi Al-Fari'a. This area has water available from springs; however, the variations of monthly flow rates from springs are large. Additional amount of treated wastewater will be mixed with the spring discharge and utilized in Wadi Al-Fari'a area. These amounts will be mixed with the existing water and conveyed in the existing system to provide more irrigation water along the wadi. However, wastewater should be treated to a level which will allow mixing it with fresh water and utilizing it for unrestricted use in agriculture.

4.11.2 Actual Agricultural Land Use

The study area covers an approximate area of 420 km², and as consequence of the ongoing Israeli occupation (Israeli declare the majority of the eastern parts of the study area as closed military areas), lands in the most areas of the eastern parts of the study area had not been developed since 1967.

Generally, the land use patterns within the study area have been shaped by topographical and climatic conditions, as well as by political factors see **Figure 4.4.** The diversity of the land use in the project area is related to the diversity of the climate, land and water resources, topography, and human activities. This section discusses the dominant land use categories, concentrating specifically on the agricultural application, which is considered the most important human as well as economic activities of the region. Rainfed annual crops like wheat and barley represent an important land use and dominate the undulating plains of Aqqaba, Tubas, Tammoun and Tayaseer. The surrounding hills are also mainly used for rainfed cultivation, especially wheat and barley. During the winter period, most of this rainfed area is used for the production of summer crops (Okra, cucumber and tomato) and after harvesting the winter ones.

The northern and central part of the study area is intensively cultivated with irrigated vegetables (main crops are tomatoes, eggplants, onions, and potatoes) as well as trees (mainly olives and almonds plantations). In addition to the different cropping patterns that are prevailing in this area, one can find nature reserves as well as forested areas especially in the hilly areas. Greenhouses are present mainly in the southern part of the project area. The aim of using this system is to increase the production of crops in year round. Greenhouses allow farmers to grow crops earlier in the year than in their regular season. By producing crops earlier, the farmers have a longer period of time in which to increase their profit margins. They have the advantage over other farmers because their crops are harvested sooner. In addition, the land can be harvested more than once a year and productivity exceeds the production in open land. During the winter months, the rain is collected on plastic on the roof of these greenhouses and is then transferred and stored in the storage facilities and then used for irrigation.

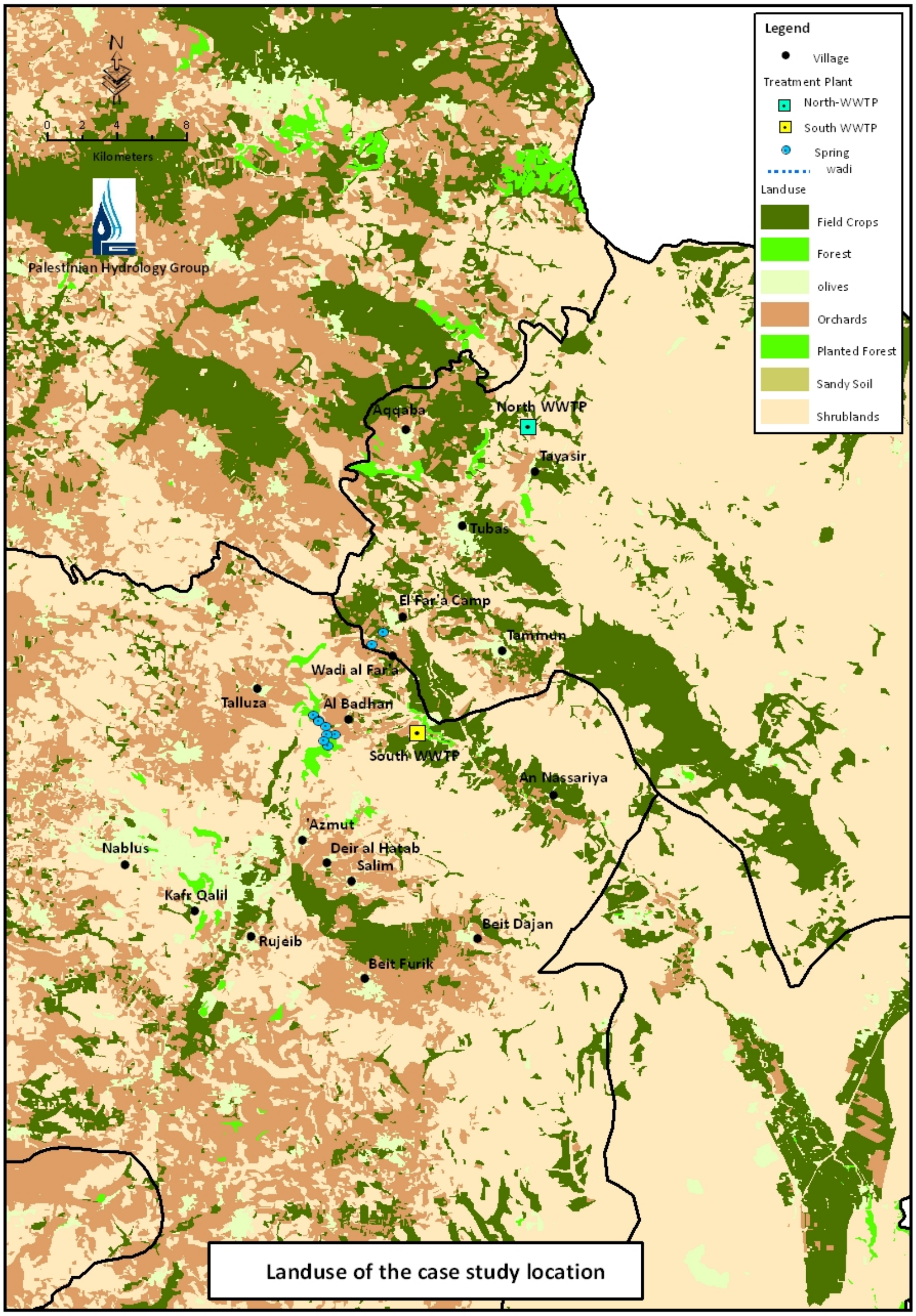

Figure 4.5: Land use and potential areas for wastewater reuse at both clusters

4.11.3 Sludge Reuse and Sludge Quality

Wastewater treatment processes produce a sludge which has to be disposed of conventional secondary sewage treatment plants. Typically they generate a primary sludge in the primary sedimentation stage of treatment and a secondary, biological, sludge in final sedimentation after the biological process. The characteristics of the secondary sludge vary with the type of biological process and, often, it is mixed with primary sludge before treatment and disposal. Approximately one half of the costs of operating secondary sewage treatment plants in Europe can be associated with sludge treatment and disposal. Land application of raw or treated sewage sludge can reduce significantly the sludge disposal cost component of sewage treatment as well as providing a large part of the nitrogen and phosphorus requirements of many crops. Thus sewage sludge will contain, in addition to organic waste material, traces of many pollutants used in modern society. Some of these substances can be phytotoxic and some of the are toxic to humans and/or animals. So it is necessary to control the concentrations in the soil of potentially toxic elements and their rate of application to the soil. In accordance with the Israeli-Palestinian Joint Water Committee guidelines, before sludge reuse it must be stabilized (by lime addition, anaerobic or aerobic digestion) and de-watered.

4.11.4 Sludge application

Based only on the design flow of 27950 m^3/d a rough estimate of the total solids production (projected wastewater production in the year 2025 from the two treatment plants), yields about 7014 ton/year. One m^3 effluent generates about 0.4 kg of dry sludge. Sewage sludge contains useful concentrations of nitrogen (3 to 9 %), phosphorus (4 to 6%) and organic matter (30 to 50 %). The availability of the phosphorus content in the year of application is about 50% and is independent of any prior sludge treatment. Nitrogen availability is more dependent on sludge treatment, untreated liquid sludge and dewatered treated sludge releasing nitrogen slowly with the benefits to crops being realized over a relatively long period. Liquid an aerobically-digested sludge has high ammonia-nitrogen content which is readily available to plants and can be of particular benefit to grassland. The organic matter in sludge can improve the water retaining capacity and structure of some soils, especially when applied in the form of dewatered sludge cake.

It is possible to apply 1 to 2 tons of dry sludge per dunum each 2 or 3 years. About 1000 dunums could be benefitted by sludge applications, i.e. 1 to 2 % of the cultivated area.

To minimize the potential risk to the health of humans, animals and plants it is necessary to coordinate sludge applications in time with planting, grazing or harvesting operations. Sludge must not be applied to growing soft fruit or vegetable crops nor used where crops are grown under permanent glass or plastic structures. Treated sludge can be applied to growing cereal crops without constraint, but should not be applied to growing fruit within 3 months of harvesting or to fruit trees within 10 months of harvesting. When treated sludge is applied before planting such crops as cereals, grass, fodder, sugar beet, fruit trees, etc., no constraints apply but in the case of soft fruit and vegetables, the treated sludge should not be applied within 10 months of crop harvesting.

4.12 Orientation for the sanitation scheme: Parameters

As with the previous analysis, sanitation scheme in the project area must fulfill the following conditions:

- Individual and collective systems must not be developed as complementary systems, so as to cover all areas, considering zone C1 cannot be covered by individual, nor can C3 be covered by collective system.
- Wastewater cannot be disposed without treatment, considering hydro geologic context and legal issue (MoU), and therefore must be treated.
- Wastewater reuse for irrigation is possible and recommended considering the wide range of possible reuse in this field and the scarcity of water in the area.
- Treatment process, in the quality standards imposed by the MoU, are achievable through various treatment processes. The choice of treatment process will therefore depend on technical and cost considerations.
- Individual sanitation as implemented to date must be improved, for cesspits proved inefficient, and tanker truck service out of public authority's control. The control of disposal site is a condition for truck service implementation.
- O&M must be reduced to the minimum, considering the low local experience on sanitation, the difficulties encountered on O&M to date (overflowing cesspits, no control on disposal sites, old tanker trucks).

In addition to those specific parameters, some general conditions must be taken into consideration:

- Investment cost and availability of funding,
- Available space for WWTP construction,
- Local social and political context (*which is in West Bank case of prime importance*)

Based on these considerations, and particularly on cost consideration, 3 scenarios are proposed for sanitation for the northern cluster(as SOGREAH suggested) and one scenario for the southern cluster(PHG suggestion), but none of them is allowing deliberate pollution, or increasing risks for environment and local population. It must be reminded however, that sanitation is to be considered as an independent item, even though water supply scheme will clearly increase waste water production, and then need for sanitation. The high cost of sanitation scheme justifies taking sanitation as a separate item in funding phase.

4.13 Proposed Scenarios for the collection network

North cluster scenarios

Proposed scenarios intend to offer several entering doors to implementation of a sanitation scheme in the project area as shown in **Figure 4.5.**

Scenario 1: Standard Sanitation Scheme

Wastewater is collected in each zone according to its typology (**Table 4.11**), and then transferred through transfer scheme to the WWTP for treatment and further reuse for irrigation purpose.

This scenario is divided to two alternatives , the first alternative(1.A) the north cluster of Tubas without Mithaloun cluster and the second alternative (1.B) the north cluster of Tubas with Mithaloun cluster.

Table (4.13): North cluster scenario 1, collection system per zones and up to year 2025

<table>
<tr><th>Collection mode</th><th>Zone C1</th><th>Zone C2</th><th>Zone C3</th></tr>
<tr><td>2015</td><td rowspan="2">Collective network, connected to the transfer network</td><td colspan="2">Individual collection, disposal by tanker truck service to the transfer network.</td></tr>
<tr><td>2025</td><td>Collective network, septic tank are connected to the transfer network through small bore pipes</td><td>Individual collection, disposal by tanker truck service to the transfer network</td></tr>
</table>

Scenario 2: Mixed Sanitation Scheme

Wastewater is collected in each zone according to its typology (**Table 4.12)**, and then transferred through transfer scheme to the WWTP for treatment and further reuse for irrigation purpose.

This scenario is divided to two alternatives, the first alternative (2.A) the north cluster of Tubas without Mithaloun cluster and the second alternative (2.B) the north cluster of Tubas with Mithaloun cluster.

Table (4.14): North cluster scenario 2 collection system per zones and up to year 2025

Collection mode	**Zone C1**	**Zone C2**	**Zone C3**
2015	Collective network, connected to the transfer network	Individual collection, disposal by tanker truck service to the transfer network.	
2025			

Scenario 3: Minimum Cost Sanitation Scheme

Waste water is collected by individual system whenever possible. Stabilization pond type is made of a single wastewater treatment plant, and collect effluent directly from trucks.

This scenario is not satisfactory however, considering it does not cover urban center and is not sustainable (trucks service shall be highly controlled to avoid wild disposal, and cost of truck collection may lead house owners to wild disposal in rainy season). If minimum funds are dedicated, this however is better than no system, and this minimum service scheme may be improved, with transfer scheme, then collection scheme, depending on later funding availability.

Southern Cluster Scenarios

Scenario 1: Standard Sanitation Scheme

The proposed networks will cover the high density areas and part of the medium density areas and any houses in the way of the trunk main line in each village until the year of 2025. The collected wastewater is transferred to a treatment plant and further reuse for irrigation purposes after treatment.

Table (4.15): South cluster scenario for collection system per zones and up to year 2025

Collection mode	**Zone C1**	**Zone C2**	***Zone C3***
2015	Collective network, connected to the	Part of this zone have a collective network and the remaining by individual collection	Individual collection, disposal by tanker truck service to the transfer network

2025	transfer network	Collective network, connected to the transfer network	Individual collection, disposal by tanker truck service to the transfer network

4.14 Cost Estimate of the collect network

The cost estimate for the network is established for scenarios 1 & 2, with their variations in the northern cluster and in the southern cluster.

4.14.1 Methodology Applied For Cost Estimates

Previous cost estimates for wastewater networks collection and treatment system from previous projects were analyzed and then compared to the **expected** tender prices.

The following general conditions are assumed:

- All cost estimates use 2009 prices
- All imported equipment are exempted from tax and duties
- Construction work will be carried out by selected local contractors through competitive bidding
- Cost of land acquisition is not included.
- All costs are in euro currency

4.14.2 Over Costs and Unexpected Costs - Contingencies

They cover variations on the unit prices which are known at the moment of cost estimates and related to the cost of the material, equipment, transport, energy, salaries, etc… both for local and imported goods. A ratio of 10% above the base costs is considered.

4.14.3 Detailed Engineering and Preparation of Tender Documents

As usual practices, a 10 % overhead ratio is usually applied on base costs and unexpected costs.

4.14.4 Tendering, Evaluation, Selection and Work Supervision

A 5 % overhead on base costs and unexpected costs is applied to cover costs under this item.

4.14.5 Project Management

The cost of this item varies widely with the option which will be finally considered; nevertheless the cost for the project management should not exceed a percentage of 5 % on base costs and unexpected costs.

4.14.6 Capital Costs

Individual Sanitation Component

Individual sanitation cost includes truck service, material and construction of septic tanks. Unit cost for ST is provided by local contractors, and truck services are estimated from trucks manufacturers.

Internal Collection Network

Internal collection network includes all cost of constructing the wastewater collection system to the waste water treatment plant for the two clusters. The cost includes also the trunk main pipe lines between the villages in each cluster.

Booster Pumping Stations & Collecting Chambers

An average unit cost of 100 000 € is applied for every booster station equipped with collecting chamber. There will be four pumping station in Maythaloun cluster, but in Tubas Cluster(south and north) and Nablus Cluster there will be no pumping station. The collection and flowing of the sewage will be by gravity.

4.14.7 Cost Estimates for the Project Facilities

Summary of Investment Costs

The following Tables summarize the investments cost (capital + over cost) for the project in the two clusters, considering phased investment (2010 and 2015). O&M are not considered at that stage, or the revenues from reused treated water. It could be anticipated that part of this revenue will be dedicated to O&M fund, to be studied and established as part of a proper study.

Table (4.16): Cost estimate and phasing for the network for scenario1.A in the Northern Cluster

Item	**Description**	**Unit**	**Quantity**		**Unit Cost (k€)**	**Total Cost (k€)**
			Phase I	Phase II		
1.1	Booster pumps	unit	0	0	100	0
2.1	14" Transfer pipes for free flow	M.L	330	0	0.17	56
3.1	6" Transfer pipes for pressurized flow	M.L	0	0	0.11	0
4.1	8" Transfer pipes for pressurized flow	M.L	0	0	0.17	0
5.1	Collection pipes	M.L	20000	15000	0.08	2800
Total investment						**2856**
Grand total						**3713**

Table (4.17): Cost estimate and phasing for the network for scenario1.B in the Northern Cluster

Item	Description	Unit	Quantity		Unit Cost (k€)	Total Cost (k€)
			Phase I	Phase II		
1.1	Booster pumps	unit	4	0	100	400
2.1	14" Transfer pipes for free flow	M.L	1830	0	0.17	311
3.1	6" Transfer pipes for pressurized flow	M.L	5900	0	0.11	649
4.1	8" Transfer pipes for pressurized flow	M.L	4600	0	0.17	782
5.1	Collection pipes	M.L	54399	40000	0.08	7552
Total investment						**9694**
Grand total						**12602**

Table (4.18): Cost estimate and phasing for the network for scenario2.A in the Northern Cluster

Item	Description	Unit	Quantity		Unit Cost (k€)	Total Cost (k€)
			Phase I	Phase II		
1.2	Booster pumps	unit	0	0	100	100
2.2	14" Transfer pipes for free flow	M.L	330	0	0.17	56
3.2	6" Transfer pipes for pressurized flow	M.L	0	0	0.11	0
4.2	8" Transfer pipes for pressurized flow	M.L	0	0	0.17	0
5.2	Collection pipes	M.L	20000	0	0.08	1600
Total investment						1756
Grand total						2283

Table (4.19): Cost estimate and phasing for the network for scenario2.B in the Northern Cluster

Item	Description	Unit	Quantity		Unit Cost (k€)	Total Cost (k€)
			Phase I	Phase II		
1.2	Booster pumps	unit	4	0	100	400
2.2	14" Transfer pipes for free flow	M.L	1830	0	0.17	311
3.2	6" Transfer pipes for pressurized flow	M.L	5900	0	0.11	649
4.2	8" Transfer pipes for pressurized flow	M.L	4600	0	0.17	782
5.2	Collection pipes	M.L	74399	0	0.08	5952
Total investment						8094
Grand total						10522

For the individual collection the cost will be:

Table (4.20): Cost estimate and phasing for the individual sanitation in the Northern Cluster without Maythaloun Cluster

Item	Description	Unit	Quantity		Unit Cost (k€)	Total Cost (k€)
			Phase I	Phase II		
1.2	Septic tanks	Unit	0	908	2,1	1907
2.2	Trucks	Unit	0	5	87,00	435
Total investment						2342
Grand total						3045

Table (4.21): Cost estimate and phasing for the individual sanitation in the Northern Cluster with Maythaloun Cluster

Item	Description	Unit	Quantity		Unit Cost (k€)	Total Cost (k€)
			Phase I	Phase II		
1.2	Septic tanks	Unit	0	2175	2.1	4568
2.2	Trucks	Unit		10	87,00	870
Total investment						5438
Grand total						7069

For the southern cluster the proposed scenario is a mix between individual and collective sanitation system. In phase one (2010-2015) the collection system in this cluster proposed to be the priority and in the second phase (2015-2025) the individual sanitation become the proposed project in that phase

Table (4.22): Proposed collection system and the cost estimate for the southern cluster

Item No.	project	unit	unit cost (€)	Tuluza	Badan	Wadi-Al-Fara	Ras Al-Fara	Fara Camp	Tammoun	south Tubas	Azmut	Deir Hatab	Salim	Beit Dajan	kufur Qalil	Beit Furik	Rujieb	Nablus-East	Total Quantity	Total Cost(€)
1	Sewage Collection system																			
1.1	supplying 8" UPVC pipes	M.L	14	5200	6560	7500	0	6000	8000	30000	4000	4000	4000	6000	4000	17000	8000	0	110260	1543640
1.2	supplying 12" UPVC pipes	M.L	30	0	1200	0	0	2000	8500	2000	2000	2000	2000	2000	1000	4000	2000	0	28700	861000
1.3	supplying 20" UPVC pipes	M.L	60	0	0	0	0	0	0	4000	0	0	0	0	0	4000	2000	0	10000	600000
1.4	supplying 24" reinforced concrete pipes	M.L	70	0	0	1600	0	0	0	0	0	0	0	0	0	0	0	0	1600	112000
1.5	supplying 40" reinforced concrete pipes	M.L	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7000	7000	700000
1.6	Supplying ready made Manholes	No.	600	173	259	303	0	320	550	1200	200	200	200	267	167	833	400	233	5305	3183200
1.7	Excavation trenchs for the pipes and manholes	M.L	20	5200	7760	9100	0	8000	16500	36000	6000	6000	6000	8000	5000	25000	12000	7000	157560	3151200
1.8	Backfilling trenches with sand and basecoarse	M.L	20	4160	4000	4000	0	5400	10000	30000	5000	5000	5000	6000	4500	22000	10000	0	115060	2301200
1.9	Backfilling trenches with sand and soil	M.L	12	1040	3760	5100	0	2600	6500	6000	1000	1000	1000	2000	500	3000	2000	7000	42500	510000
1.1	Installing the pipes and manholes	M.L	6	5200	7760	9100	0	8000	16500	36000	6000	6000	6000	8000	5000	25000	12000	7000	157560	945360
1.11	Asphalt Reinstatement	M.L	10	4160	4000	4000	0	5400	10000	30000	5000	5000	5000	6000	4500	22000	10000	0	115060	1150600
																		Total cost(phase 1) 2010-2015		**15058200**
																		Grand total (phase I)		**19575660**

Table (4.23): Proposed individual system and the cost estimate for the individual sanitation for the southern cluster

2	Septic Tanks																			
2.1	Excavation for the septic tank	No.	200	160	170	140	140	0	738	679	162	136	310	214	150	634	257	0	3890	778000
2.2	Supplying and casting reinforced concrete B-300	M3	100	1760	1870	1540	1540	0	8118	7469	1782	1496	3410	2354	1650	6974	2827	0	42790	4279000
2.3	Supplying reinforcing steel bars	Ton	800	160	170	180	140	0	738	679	162	136	310	214	150	634	257	0	3930	3144000
	Total cost (2025)																			**8201000**
	Grand total(phase II)																			**10661300**

4.14.8 Cost estimate for the WWTP

A t this stage of a master plan it is not possible to estimate very precisely the cost of the WWTP. It is the feasibility study which will precise this cost according to the following elements

- The process
- The capacity of the WWTP depending of the quantities of pollution and of water.
- The ability to treat the sewerage of individual sanitation
- The requirement of the quality of the treated water
- The cost of the land

We can nevertheless median estimation of the cost with suitable processes depending on the estimation of the proposed of Nablus west and Hebron treatment plants.

Cost estimate of sewage treatment	TOTAL COST
South WWTP **250000**-300000 EH	30000 k€
North WWTP 50 000-60000 EH	12000 k€

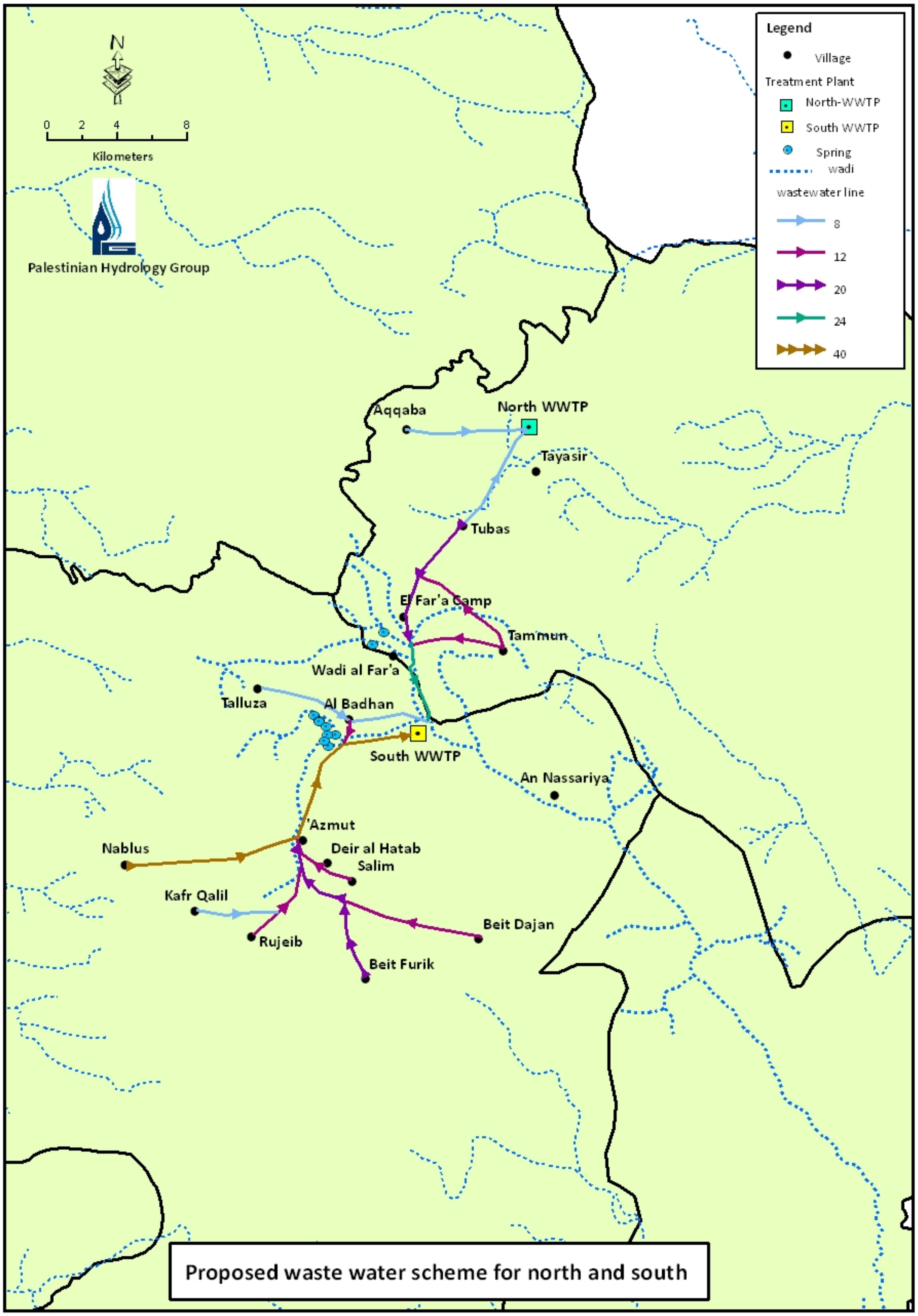

Figure 4.6: Proposed wastewater scheme for the north and south cluster

CHAPTER 5: ANALYSES OF EXISTING WATER SUPPLY CONDITIONS

5.1Connection to Water Supply Network

Domestic water supplies in the 9-communitiers are obtained from existing domestic and agricultural groundwater wells in the area. The status of supply for these communities could be divided into the following categories:

5.1.1 Piped communities

Three communities are connected to domestic water network and distribution system. The communities are:, Tubas, Talluza, Al-Bathan and AL-Fari'a Refugee Camp. These communities are supplied with water as shown in **Figures 5.1**

5.1.2 Partially Piped Communities

Four communities are partially connected to domestic water network and distribution system. The communities are: Aqqaba, Tayaseer Wadi Al-Fari'a, and Ras Al-Fari'a. These communities are supplied with water as shown in **Figures 5.1 and 5.2**

5.1.3 Unpiped Communities

Two communities are not connected with water supply network. The communities are: Tammoun and Ras Al-Fari'a. These communities are supplied with water as shown in **Figures 5.1 and 5.2**

5.2 Existing Water Supply System in North Cluster

Tubas scheme includes the Municipalities of Tubas, Tammoun and Tayaseer, with a total forecasted population of 49465 inhabitants by year 2025.

Tubas City

With 17000 inhabitants to date, and 27144 forecasted by year 2025, Tubas is the most populated municipality of the project area. The latest master plan anticipates an extent of urban area of 7500 dunum by 2025.

Water supply scheme was initiated by the construction, in year 1968, of a 900 m^3 reservoir (Tubas Old Reservoir) associated to 31, 90 km of distribution pipes. Based on first Master Plan previsions for urban developments, there will be 2500 dunums extension.

In 2007, a new reservoir (1000 m^3) was built, and a booster station (1 booster pump and 1 spare, Q = 80m^3/hr, H = 80m) flows water from Tubas Old to Tubas new reservoir. The overall distribution system distributes water to 2600 water meters connected =.

For some time, the scheme was supplied from Al-Fari'a water production well (90 m depth, transmission main 6" to Tubas old reservoir, well productivity of 70-78 m^3/h). Due to overexploitation of the water table by surrounding agricultural wells, production capacity of this well dropped down to 20 m^3/h before its activity was stopped. From then, 1400 m^3/day (19 to 20 h/day of pumping) ground water from Tammoun deep well (250 m^3/h overall production capacity, and 140 m^3/h existing pumping capacity) are flown through a transmission line to Tubas old reservoir. Among this volume, an average 600 $m^3/week$ is transferred to Tayaseer distribution network as shown in **Figure 5.1.** The water physical loss of the network was reduced from 40% in 2007 to 27.1% in 2008 as a result of rehabilitation projects and applying intermittent water supply system. The city is divided into 8-blocks; each block gets water once every 8-days. This helps to eliminate the losses in water meters, over estimate the air volume in the entire network and reduce the physical losses. In case of continuous supply the total water losses will exceed 35%. **Table (5.1)** shows the monthly water supply versus the consumption in year 2008.

Table (5.1): Water supply for Tubas City Year 2008

Month	Tubas Community	
	Purchased (m^3)	Collected (m^3)
January	31990	24028
February	27680	18930
March	41120	29785
April	42900	30048
May	37770	27583
June	67010	48301
July	54540	40014
August	54540	37780
September	55980	40599
October	51490	39853
November	44700	33007
December	46860	35909
Total (m^3/year)	556580	405837
Population	17000	17000
Avg. Per Capita consumption (litter/day)	90	65

Tammoun Municipality (Unpiped Community)

With 11000 inhabitants to date and 18139 by 2025, Tammoun is the only town in West Bank with population above 10,000 which is not equipped with water distribution network. Instead, each house is equipped with roof cisterns, filled by tanker trucks service, from Tammoun deep well. In fact, at Tammoun deep well, 70 m3/h is pumped 5 h/day (the remaining is pumped to Tubas) to the existing temporary water pool located at Tammoun deep production well where it provides approximately 140 private trucks or 1,400m^3 a day for Tammoun's private truck tanks and other truck tanks that provide the water to Tayaseer, Aqqaba, Aatouf, Alras Al Ahmar, Al Hudaideyyah and other villages. However, it must be recalled that water supplied by private trucks may be of low quality considering there is no control on cleaning and water resource used to fill the truck (mixing with private shallow well increase income for the private owner of the truck). Cost of water is also increased.

As a consequence, a detailed design for Tammoun water distribution network was recently prepared by WBWD and PWA, based on SOGREAH feasibility study (FS1), including water tanks (the first is located at medium level of the town of total capacity 1,000 cubic meter, while the second is located at the higher level area of the town with total capacity 200 cubic meter).

Finally, the Joint Water Committee gave the authorization for a new deep production well to be drilled for the town of Al Fara'a Camp (400 m deep); this production well may have negative effects on the productivity of Tammoun's well which may decrease its productivity; therefore the management of Tammoun municipality is requesting the PWA and WBWD to study the effect of drilling Al Fara'a Camp well on the productivity of Tammoun's well.

Tayaseer Town (Partially piped community)

With a population of 2600 inhabitants to date, and 4182 forecasted by 2025, Tayaseer is equipped with a distribution network since 1997, the network was empty of water until the beginning of 2008 and does not yet have storage tank or distribution reservoir. Among the 400 houses, 139 are connected to the water network; 100 houses are not piped and 161 houses lack water connections. The network is connected directly to Tubas distribution network through 4 inch steel pipe. From which it receives an average amount of 600m^3/week in one day; and the rest of days the network is empty of water as before 2008. This amount of water is less than 30% the actual domestic needs in Tayaseer; therefore, people buy water from Tammoun groundwater well through water trucks which costs double the water price through the network. Tayaseer was not included at first in FS1, however, several projects have been thought to install tank and extend the transmission line up to Tubas Old Tank. It was therefore agreed with PWA to include Tayaseer into the overall project.

Aqqaba Town (Partially piped community)

With population of 7000 inhabitants to date, and 11003 forecasted by 2025, Aqqaba is equipped with a distribution network since year 2000. The network does not cover all houses in the community. Among the 1050 houses, only 740 are connected to the water network; and the remaining 310 houses lack water supply services and connections. Water is supplied from Qabatya groundwater well through 6 inch steel pipe to an online pump station in Aqqaba. Then water is pumped against elevation to a ground reservoir of a capacity of 300 m^3. The network is connected to the ground reservoir; however, its elevation is not enough to cover more than 100 houses. Therefore, water is pumped again directly to the houses by another booster at the site of the reservoir.

Aqqaba receives an average amount of 35 m^3/hr in six days a week during the pumping time. The duration of pumping extends from 7:00 o'clock in the mooring until 7:00 o'clock in the evening except Friday there is no pumping. The municipality divided the community into 6-blooks and each block gets water one time a week. This amount of water is less than 25% the actual domestic needs in Aqqaba; therefore, people buy water from Tammoun groundwater well through water trucks which costs double the water price through the network

5.3 Existing Water Supply in the South Cluster

Ras Al-Fara'a:

It doesn't have a domestic water network, but some peoples' houses are connected to existing agricultural network. These houses are located adjacent to agricultural farms, and during the irrigation they pump water to their roof tanks each few days. Serious health problems were encountered as a result of using same lines for transporting fertilizers and pesticides. The rest of houses pull their water from surrounding agricultural well using the water tanks and store them in the roof tanks.

Wadi Al-Fara'a:

This village is also trying to construct a pipe network for domestic purposes. This village is supplied with water either from irrigation wells in the same area. Less than 25% of the houses are connected to domestic water network. The houses close to the wadi were suffering form wastewater pollution, therefore; the village council and in cooperation with ANERA had constructed 2" pipes and house connections for these houses. The existing water network needs upgrading and expansion to include all houses in the community. There is no storage or distribution reservoir; but, water is pumped directly to the houses each day.

Houses without pipe connections to the networks of these communities are either supplied with water either from a nearby irrigation well using direct pipe connections or by tanker vehicles which fill with water from the nearby irrigation wells.

Al-Bathan and Talluza: Nablus water supply system includes Talluza and Al-Bathan communities. Water is pumped from two deep wells in Al-Bathan and Al-Fari'a through a main trunk line running from Al-Bathan to Nablus as shown in **Figure 5.2**. The discharge capacity of the trunk line, the demands in the city of Nablus and the other available water resources in Nablus limits the amounts of water supplied to these areas. Among these resources are a number of springs in Nablus city. Since pumping costs from these springs are much less than pumping costs from Al-Bathan and Al-Fara'a wells, Nablus municipality tries to maximize pumping rates from the springs in Nablus. Therefore, the pumping rates from these wells are low during winter when spring discharge rates are high. In summer and due to the high demands for water in Nablus, the pumping rates from these wells reach their maximum capacity of about 270,000 m^3/month (210 m3/hr from well number 18-18/037 and 180 m3/hr from well number 18-18/038) Therefore, Al-Bathan village is currently supplies part of its domestic water directly from Ein Tabban to a ground distribution reservoir (200 m^3). The reservoir supplies water to one block in Al-Bathan around 60 houses. There is a need to build an elevated reservoir of a capacity of 500 m^3 so as to cover the whole community and maintain enough storage for emergency and water cut. Each three days, Nablus water system supplies water continuously for 12 hours.

The existence of number of springs in the community encourages large number of people visit the area during spring. According to the village council more than 700,000 person visits Al-Bathan each year.

Talluza and Assira Ash-Shamalayia are supplied by water from Nablus wells in Al-Bathan through 6” pipeline. There is an additional opening on the main supply line to Talluza which provides water to a group of houses in the way to the elevated reservoir. These houses belong to Talluza, and connected with a secondary water meter. The existing reservoir has a capacity of 200 cubic meters and used for water destruction in Talluza and as a balance reservoir for Assira Ash-Shamalayia. Each three days, Nablus water system supplies water continuously for 12 hours.

Table 5.2 shows the monthly amounts of water supply during 2007 and 2008 from Nablus water system and for both Talluza and Al-Bathan.

Table (5.2): Water supply for Talluza and Al-Bathan from Nablus Water System

Month	Year 2007		Year 2008	
	Community		Community	
	Talluza	Al-Bathan	Talluza	Al-Bathan
January	5727	6088	7700	778
February	5524	5754	4649	5138
March	4596	6155	7939	6461
April	7786	5919	8954	9265
May	9069	7233	8896	8910
June	9805	7223	5354	7430
July	12110	4820	15941	6610
August	10993	4849	13114	7584
September	8969	5133	2056	7697
October	10092	3186	10804	7888
November	8084	8108	8665	7343
December	6557	5204	6820	7042
Total (m^3/year)	99312	69672	100892	82146
Population	2375	2485	2463	2577
Avg. Per Capita consumption (litter/ day)	114.5	76.8	112.2	87.3

Al-Fara’a Refugee Camp network: Today, Al-Fari’a R.C network is supplied with water from nearby irrigation wells. Before 2006 the Camp was supplied from

Al-Fari'a Spring. Since the summer that year, the discharge was gradually reducing until it became completely dry over the year. As a result of heavy rains this year in March, the spring resumed flow. According to the field visits which carried out, we calculated the flow around 60 m3/hr. The Camp could not rely on this source, because it expected to get dry in the coming two months. Therefore, the Camp buys water from nearby irrigations wells. The pipe network in the camp and the pumping station are operated by the UNRWA in cooperation with the Camp Services Committee; however, there are no gages on pumping. Therefore, no data is available for the exact consumption rates of the camp. The percentage of coverage of the network is 100% of the population. The existing elevated reservoir needs maintenance and don't cover all houses within the Camp. Therefore, they need to build a new reservoir of larger capacity than the existing one and at higher elevation to cover the whole Camp and future expansion.

Table (5.3): Exiting Status of Domestic Water Supply System in the Project Area

Comm.	**Source of water**	**(Piped/ Unpiped)**	**Main parts Of the system**	**Water supply status**
Tubas	Al-Fari'a groundwater well, Tammoun groundwater well and other agricultural wells in the area	piped	Water network, distribution reservoir, and house connection	Not enough water, limited supply time, old network, more 100 houses are connected with plastic pipes, and more than 120 house are not connected
Tammoun	Tammoun groundwater well	Unpiped	No network. Water tanks and roof tanks	Water is pulled by trucks (5-10 m^3) expensive costs

Tayaseer	Tubas old reservoir and they buy water from Tammoun groundwater well using water trucks.	Partially piped	No storage or distribution tanks. Network is aging without water.	The community gets 600 m^3/week. 139 are connected to the water network; 100 houses are not piped and 161 houses lack water connections expensive costs
Aqqaba	Qabatya groundwater, and agricultural wells	Partially piped	Old pump, ground reservoir of a capacity of 300 m^3 Among the 1050 houses, only 740 are connected to the water network	Not enough water, limited supply time (Houses connected to network receive water once a week). expensive costs
Ras Al Fari'a	Connection to nearby irrigation wells & Water is purchased from tanker vehicles which fill irrigations wells	Unpiped	Agricultural wells and irrigation pipes, water tanks and roof tanks	Temporal agricultural connections, health risks, expensive costs
Wadi Al-Fara'a	Connection to nearby irrigation wells & Water is purchased from tanker vehicles which fill irrigations wells	Partially piped	Water network for 70 house connections, agricultural wells and pipes, water tanks roof tanks	Temporal connections, health risks, expensive costs

Al-Fara'a R.C	Nearby irrigation wells	Piped	Water network covers 100% of houses, elevated reservoir (200 cm), pump station at Attaban spring, roof tanks. Main water line from Nablus Mun	Limited time coverage twice a week, summer water cut and health risks.
Al-Bathan	Al-Bathan domestic well for Nablus municipality & Al-Tabban Spring (18-18/037, 18-18/038 & AQ/039)	Piped	Two pressure zones, Water network covers 100% of houses, elevated reservoir (200 cm), pump station at Attaban spring, roof tanks. Main water line from Nablus Mun	Limited time coverage twice a week, summer water cut and expensive costs
Talluza	Al-Bathan and Al-Fara'a wells Nablus municipality (18-18/037 & 18-18/038)	Piped	Water network covers 100% of houses, elevated reservoir (200 cm). Main water line from Nablus Mun	Limited time coverage twice a week, summer water cut expensive costs

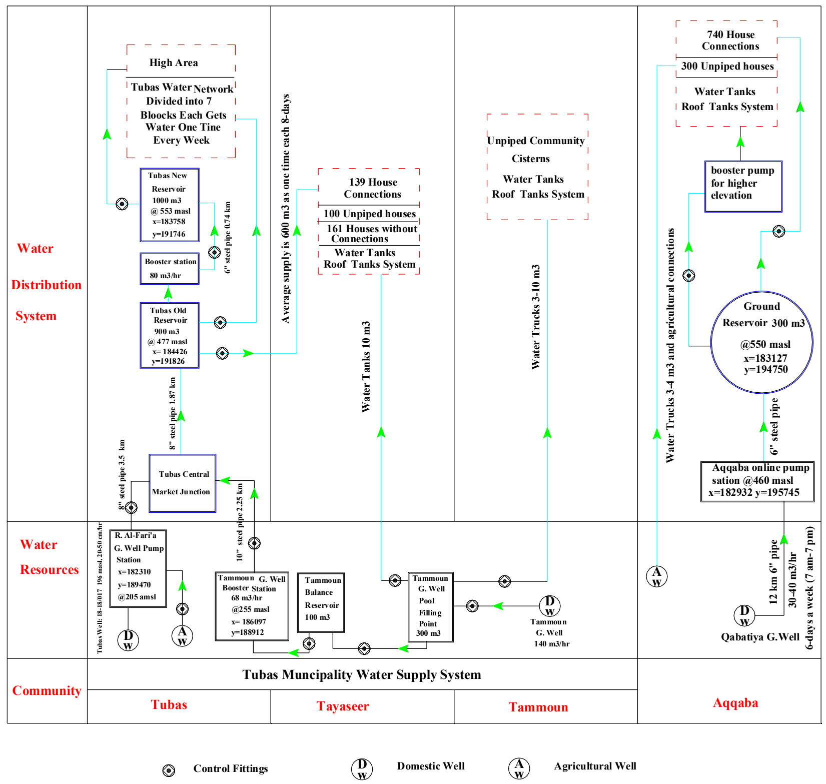

Figure 5.1: Existing water supply schemes in the North Cluster

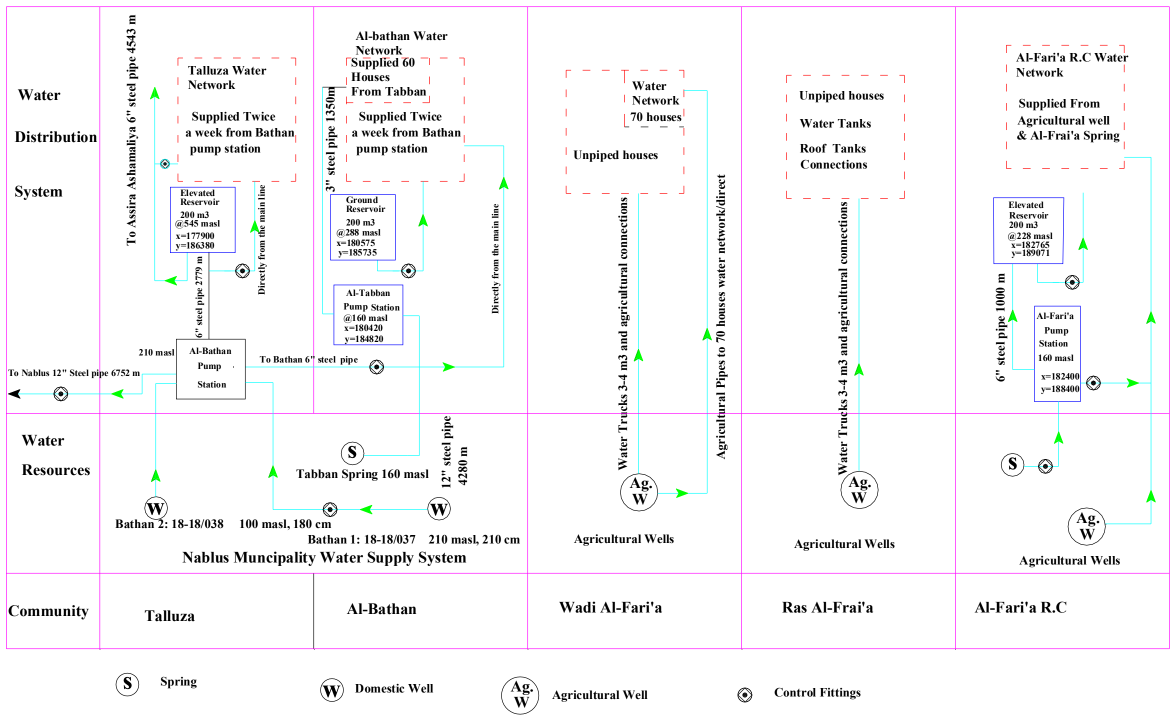

Figure 5. 2: Existing water supply schemes in the south cluster

5.4 Water Demand

The water demand analyses are divided in to three main items:

5.4.1 Domestic Demand

It accounts for the daily consumptions per capita per day as drinking. This figure is highly affected with several factors.

1- The water availability in the location. In general it increases with the continuous water supply and higher network pressure.
2- Water prices and tariff. This is a general rule, however; it does not apply to most of locations in the study area because customers don't pay the water bill and the collection percentage is less than 10%
3- The percentage of total losses (physical and administrative). Water auditing is such an important factor to determine the percentage of losses and the contribution of each factor.

The conclusion for a realistic figure which reflects the per capita consumption should include the previous conditions and the capacity to provide water. The study area is divided in two clusters of demand according to the water availability:

In north cluster domestic water is available from two deep groundwater wells in Tubas and Tammoun. These two main wells are intended to cover the existing and future demands without noticeable shortage. The system of water availability and demand reveals that a system of reservoirs will be required to match the maximum and peak demands as shown below. The per capita is assumed to be 80-liters/capaita/day up-to 2015 and 100 liters/capaita/day up-to 2025.

In the south cluster, domestic water is available by two sources (Nablus Municipality and the springs). This cluster doesn't show any social conflicts between users and water sectors. The perennial yield from springs is enough to supply larger number of population, thus; this water flow to the valley. There is no expected shortage or illegal drilling in these two locations. Accordingly the per capita is assumed to be 80-liters/capaita/day up-to 2015 and 100 liters/capaita/day up-to 2025. The other cluster (Wadi Al-Fari'a, Al-Fari'a Refugee Camp, and Ras Al-Fari'a) which is part a bigger zone, the water resources are under competition by many users and sectors as: Tammoun and Tubas municipality; in addition to the hundreds of farmers and water tankers. The previous figures of consumption will be used to this cluster as well.

5.4.2 Residential commercial institutional demand projections

- Part of the municipal water use will be defined as residential and commercial water use. Residential use includes single and multi-family residential household water use. Commercial use includes water used by business establishments, public offices, and institutions, but does not include industrial water use. Residential and commercial water uses are categorized together because they are similar types of uses, i.e., each category uses water primarily for drinking, cleaning, sanitation, cooling, and landscape watering. The census counts results for people and housing published by the Palestinian Central Bureau of Statistics (PCB) 1997, 2007 Census will be used for verifying historical long-term population growth rates and housing. Moreover, the results of field data collection particularly, the municipal data will be used as the baseline for existing conditions.
- Residential commercial demand constitutes for over than 90% of the total municipal consumption. This is not surprising because domestic water is relatively expensive, and water is hardly enough to meet basic human needs. Similar results can be found in most of the places in West Bank, with exception of some rural communities where the water is available and the costless. The design criteria are based on 80-liters/capaita/day up-to 2015 and 100 liters/capaita/day up-to 2025.

5.4.3 Industrial demand projections

- Industrial water use will be defined as water used in the production process of manufactured products, including water used by employees for drinking and sanitation purposes. Industrial users are responsible for less than 3% of the water consumption. It was assumed that nearly all non-residential water use would be accounted for in the projected municipal water demands. This figure could be presented as a factor added to the per capita water consumption. In this case it is assumed equal to 3 percent of the historical figures.

5.4.4 Agricultural and livestock demand projections

- The agricultural and livestock are minor users of the Municipal consumption for two reasons. One, because many other water sources are exist in the area which include the springs and groundwater wells. Secondly, municipal water are more expensive the agricultural sources. Only limited agricultural practices can be found within with the homes' yards and gardens. Raising animals is a minor agricultural activity in the area. According to the baseline data survey the average number sheep per capita is less than half. Chicken poultry and cows farms are few and don't contribute much to this sector. The total figure estimated for water consumption this sector is around 7% of the total municipal consumption.

5.5 Water Demand Calculation

For the sake of analyses and after evaluating the water availability and capacity to meet the future demand to comply with PWA recommendation, water consumption is projected according to the following terms:

- Short term demand 2010
- Mid term demand 2015
- Long term demand 2025

In an effort to satisfy the future water needs, the dataset design consists of water demand projections for 2010, 2015, and 2025, for each community in the study area. Water demand was represented through average and maximum daily demand, peak and hourly day demand for all sectors served by municipal water supply systems. Where data are insufficient to directly calculate the per capita demand factors, water supply demands were estimated based on data from municipal systems with similar characteristics and national figures. Municipal suppliers provide water to residential, commercial, institutional and industrial customers. The terms used in this study are defined as: **Average day demand** is the total water pumped in one year divided by the number of days in the year. **Maximum day demand** is the maximum volume pumped on a single day in a given year. This figure is assumed to equal 115% of the average daily value. The **Maximum or peak hourly demand** is the maximum volume of water should be pumped to avoid water cut. It equals a certain factor multiplied by year average hourly demand. In this it is assumed to equal 110% of the average daily value.

Municipal Water Demand Projections are based on the product of the revised population projections and the per capita usage projections including other sectors of demand. Therefore, the municipal water demand includes the following main sectors:

5.6 Losses Estimates

The municipal water supply from the resource to consumer is controlled by the total water losses in the system. Total water loss is defined as the difference between the amount of water produced and the amount which is billed or consumed. Two types of water losses encounter the calculation of total water losses as follows. 1- Physical or real losses such that, physical water loss occurs in all distribution systems. Leakage comprises the real physical losses from pipes, joints and fittings, and also overflows from reservoirs. These losses can be severe, and may go undetected for months or even years. The larger losses are usually from burst pipes, or from the sudden rupture of a joint, while smaller losses are from leaking joints, fittings, service pipes, and connections. The volume lost will depend largely on the characteristics of the pipe network and the leak detection and repair policy practiced by the company, such as:

- the pressure in the network;
- whether the soil type allows water to be visible at the surface;
- the "awareness" time (how quickly the loss is noticed);
- the repair time (how quickly the loss is corrected)

2- Non-physical (management or apparent losses). Several reasons stand behind this type of losses as follows:

- Over-estimation of production—caused by: Inadequate or no measurement facility and inadequate calibration programme for bulk meters.
- Under-estimation of consumption—caused by: under-registration of customers meters, inaccurate meters, stopped meters, inadequate meter maintenance /replacement policy, inadequate meter reading policy ,under-estimation of free supplies or operational use, and illegal connections;

The two losses types contribute to the calculations of total water loss. Water auditing and technical network evaluation must be done to determine which of the two types is more important and causes the high percentage of losses. Accordingly, such results decide which one has to be done first; a program of reparation maintenance and replacement or a new administrative water policy for better control of water meters and measurements. The problem of losses becomes more vigorous in the case of weak billing collection system. In that case, the total water loss is mixed between real and apparent losses and normally the municipalities draw their conclusion according to financial report item non-revenue water. However the real losses equal the amounts of non-revenue water minus the unbilled authorized consumption minus the apparent losses. The results can differs much of the original total percentage of losses.

Evaluation of the amounts of total losses shows that it reaches 35% in Al-Bathan, 30 % in Taluza and 32% in Al-Fari'a Refugee Camp. The previous figures are high to the age of existing water network. This could refer to two reasons. 1- The apparent losses are high 2- Absence of maintenance program or both of reasons.

For this study we assume better control of losses through institutional development program at both technical and administrative levels. The total losses by times will look as follows:

Table (5.4): losses forecast

Losses items	**2010**	**2015**	**2025**
Physical losses			
Main lines	2	3	5
Distribution lines, connections, fittings	6	9	15
Apparent losses			
Water meters	3	4	6
Illegal connections	1	1	1
Total	12	17	27

5.7 Population Volume and Growth

The population in the study area is distributed in 9-communities is estimated at **49994** people living in poor economic and environmental conditions. The average population growth rate is estimated to be about 3.1% annually (using the exponential average growth model in the area), which means that population doubles in nearly 23 years. Therefore, the population of the area is expected to reach 84007 people by the year 2025 as presented in **Table 5.5**

Table (5.5): Population census and Forecast for the study area*

Community	Pales. Code	1997*	2007**	2010	2015	2025
Aqqaba	50535	4443	6548	7176	8359	11003
Tayaseer	50550	1754	2489	2728	3178	4182
Tubas	50610	11771	16154	17703	20623	27144
Tamoun	50755	7640	10795	11830	13781	18139
Ras Al-Fara'a	50760	513	706	774	901	1186
Wadi Al-Fara'a	50740	1713	2730	2992	3485	4587
Al-Fara'a R. Camp	50700	4207	5712	6260	7292	9598
Taluza	150775	2003	2375	2603	3032	3991
Al-Badan	150805	1810	2485	2723	3172	4176
Total Population		35854	49994	54789	63824	84007

*Palestinian Central Bureau of Statistics (PCB) 1997

**Palestinian Central Bureau of Statistics (PCB) 2007

5.8 Proposed Water Supply Projects

Prior to any technical feasibility analysis, it is necessary to ensure available resources will cover water demand at the horizon of study. Though several shallow agriculture wells have been drilled and used for drinking purpose. In addition to that, 3 deep wells were drilled in Al-Fari'a Refugee Camp, Tammoun and Tubas as shown in **Tables 5.6 and 5.8**

5.8.1 North Cluster Proposed Projects The analyses of the proposed projects in each community as follows:

The deep well of Tubas

It was completed, by end of 2008. Following the pumping test and water quality tests show that the expected well capacity is around 150 m^3/hour. Water quality tests showed good results and this makes it suitable for drinking water supply. The municipality of Tubas is now preparing the technical specifications and heading to tendering phase. The AFD is expected to fund the wells' costs and operation in the coming few months.

The deep well of Tammoun

It produces 140 m^3/h of good quality water. However, the current production capacity is limited and expected to reach 250 m^3 /hour at full capacity. The existing pump in the well was installed as temporary pump for pumping tests. The Municipality of Tammoun and several villages were crucially in need of water at that time, therefore; they kept the pump to solve the urgent conditions were prevailing at that time until new pump is ready to install.

Table (5.6): Status of the two deep wells of the North Cluster

Well Name	Status	Depth (m)	Capacity (m^3/hour)	Water Quality
Tubas	Drilled	500	150	Good
Tammoun	Working	415	140	Good

The total resource available at the horizon of the study is therefore expected to reach 390 m^3/h. An amount of 150 m^3/hour will be available from Tubas well and 250 m^3/hour from Tammoun well. Table 5.7 below, shows production versus demand in this cluster. The figures in the table show almost balance between demand and supply and no expected harm deficit due to water shortage. This balance is only applicable if the capacity of Tammoun wells was upgraded to 250 m^3/hr; the water production is limited domestic use and no further water trucks that would supply other villages in Tubas District as shown before. If any of these conditions is not achieved, there will be increasingly water shortage.

Table (5.7): Water production and demand in the North cluster

Community	**Year 2010**		**Year 2025**	
	Production capacity (m^3/day)	**Demand**	**Production capacity (m^3/day)**	**Demand**
Tubas	---	1586	3600	1397
Tammoun	3350	1060	6000	531
Aqqaba	400	643	400	3447
Tayaseer	---	244	---	2304
Total	3750	3533	7283	7679

Tubas Water Distribution Network Proposed Projects

The water distribution network of Tubas was constructed in 1968 of total length 31.90 km; therefore most of the old pipes are badly need to be rehabilitated, moreover the management of Tubas municipality has been working to rehabilitate the old pipes through different fund organizations, the quantities, sizes and expected costs are shown in **Table 5.10** below. The main proposed projects include well's completion and construction of new 500 m^3 balance reservoir. In addition to that, the installation main transmission lines, expansion of existing water network and replacement of pipes and house connections.

Tammoun Water Distribution Network Proposed Projects

Tammoun municipality has no water distribution network so far; therefore the municipality priority concern is to construct a new water distribution network as soon as possible. However a detailed design for Tammoun water network and water tanks were recently prepared by WBWD and PWA, furthermore it was suggested to construct two ground distribution reservoirs as shown in **Figure 5.3.** The first reservoir is located at medium level of the town of total capacity 1,000 cubic meter, while the second is located at the higher level area of the town with total capacity 500 cubic meters.

Tayaseer Water Distribution Network Proposed Projects

Tayaseer has its own water distribution network which was constructed since 1996, Tubas is currently supplying the village with 600 m^3 of water weekly. The main proposed items includes expansion of Tayaseer water distribution network, construction of new elevated distribution reservoir of 500 m^3capacity. See Figure 5.3 which shows the proposed water schemes of Tayaseer water distribution network.

Aqqaba Water Distribution Network Proposed Projects

Aaqaba has its own water distribution network which was constructed since 2000. It gets its drinking water from Qabatya groundwater well 6 days a week. The main proposed items includes expansion of Aqqaba water distribution network and house connection for more than 300 houses, the construction of new elevated distribution reservoir of 500 m^3 capacity and pump station. See Figure 5.3 which shows the proposed water schemes of Aqqaba water distribution network.

5.8.2 South Cluster Proposed Projects

The analyses of the proposed projects in each community as follows:

The deep well of Al-Fari'a Refugee Camp

Its drilling was completed in 2008 and expected to get a completion fund through the Ministry of Finance. Following the pumping test and water quality tests show that the expected well capacity is around 100 m^3/hour. Water quality tests showed good results and this makes it suitable for drinking water supply. Based on the analyses of the municipal water demands (see **Table 5.8),** each community needs new water projects to meet these demands.

Table (5.8): Water production and demand in the south cluster

Community	Year 2010		Year 2025	
	Production capacity (m^3/day)	**Demand**	**Production capacity (m^3/day)**	**Demand**
Ras Al-Fara'a	--	70	--	158
Wadi Al-Fara'a	--	269	--	611
Al-Fara'a R. Camp	2300	563	2300	1279
Talluza	250*	234	500	532
Al-Bathan	300**	245	600	556
Total	2850	1381	3400	3136

*): From Nablus Municipality groundwater wells in Al-Bathan

**): From Nablus Municipality and Al-Tabban Spring

Al-Fari'a R.C Proposed Projects

There is a need to build a new reservoir of Capacity 500 m^3 at higher elevation. The existing 240 m^3 doesn't cover all houses in the camp and leaks water. The existing source of water in the camp will be replaced by a newly drilled ground well in 2008-2009. This well capacity is around 100 m^3 at stable water table 277 m below surface. This well is enough to supply the Camp with domestic water beyond 2025. The extra water available could be used to supply neighboring communities like Tubas, Tammoun, Ras Al-Fari'a and Wadi Al-Fari'a. This well drilled in the Turonian –Upper Cenomanian Aquifer and this makes it out of the existing race or competition on water in the area. There is a need to complete the well with the mechanical electrical equipments, and civil work to build a pump station and balance reservoir. The new proposed projects will be completed once the new system is interconnected with existing system through 6” pipelines between the new well and the proposed reservoir and Al-Frai’a Pump station.

Wadi Al-Frai’a Proposed Projects

It is suggested to expand the existing water network, and build a new elevated water reservoir of capacity 200 m^3. According to the data we got from the local council, they propose to build two reservoirs according to the source of water. However, we see that as extra development costs and will add additional future costs to operation and maintenance of the network system.

Ras Al-Fari’a Proposed Projects

It is suggested to construct a new water network and to build new elevated reservoir. The location of the source of water and the reservoir are not determined exactly by the local council. The proposed location will be not far from the new elevated reservoir in the camp, but a little higher than it. Therefore, the proposed reservoir in the could be used for Ras Al-Frai’a as well. The source of water will remain from the existing agricultural wells, or could be from the new well for the camp and Tubas old well in the area. These proposal need to be discussed with the communities and to reach a binding agreement. This option is more economical and technically more feasible than continue buying water from the agricultural well.

Al-Bathan Proposed Projects

There is a need to rehabilitate the existing pump station and to connect it with electric power instead of running on diesel power. Besides that, the existing ground reservoir needs to replace it with an elevated one with higher capacity (500 m^3) at the same location of the existing ground reservoir. It is also feasible to increase the amount pumping from Al-Tabban spring in future, because it will be more economical than buying water from Nablus Municipality. However, the community still doesn’t think in this option because they don’t pay any money for water consumption to Nablus Municipality. There is also a need to expand the existing network and to reach with main distribution lines to recreational and development area in the community. Since the construction of the network, tenths of house connections were added to the network, and there is a need to connect these houses correctly.

Talluza Proposed Projects

They don't have other alternatives for water supply except the one from Nablus Municipality. According to Nablus Municipality, they expect no shortage or reduction in the quantity supplied to Talluza in the coming years. Nablus Municipality is seeking to secure their customers of water enough including Talluza. They have new groundwater well in Sabastya which will add about 200 m^3/hr to Nablus water system. Another groundwater well in Rujeeb ill adds about 125 m3/hr to Nablus water system. At the same time they have a project to lower the total water losses by 10-15% which will save hundreds of cubic meters a year. Moreover, Nablus Municipality did a hydro geological and groundwater exploration study over the entire area surrounding Nablus for future strategic demands. Therefore, there is ne fear that Talluza will be thirsty in the domain of this study. The basic needs in Talluza in terms of water supply is to replace the existing reservoir and build a new elevated reservoir particularly Assira Shamalayia and to change the frequency of water supply instead of two times a week to three or four times. Addition needs include the replacement of old fitting and expansion of the internal water network. The above mentioned proposed projects are explained in the schematic diagram as show in **Figure 5.4**

Table (5.9): Estimated water demands in the study area

Community	2010				2015				2025			
	Pop.*	**A.D.D (m^3)**	**M.D.D (m^3)**	**P.H.D (m^3)**	**Pop.**	**A.D.D (m^3)**	**M.D.D (m^3)**	**P.H.D (m^3)**	**Pop.**	**A.D.D (m^3)**	**M.D.D (m^3)**	**P.H.D (m^3)**
Aqqaba	7176	643	739	33.89	8359	782	900	41.24	11003	1397	1607	73.65
Tayaseer	2728	244	281	12.88	3178	297	342	15.68	4182	531	611	27.99
Tubas	17703	1586	1824	83.61	20623	1930	2220	101.74	27144	3447	3964	181.70
Tamoun	11830	1060	1219	55.87	13781	1290	1483	67.99	18139	2304	2649	121.42
Ras Al-Fara’a	776	70	80	3.66	908	85	98	4.48	1245	158	182	8.33
Wadi Al-Fara'a	3001	269	309	14.17	3512	329	378	17.33	4813	611	703	32.22
Al-Fara'a R. Camp	6278	563	647	29.65	7349	688	791	36.26	10070	1279	1471	67.41
Talluza	2610	234	269	12.33	3056	286	329	15.08	4187	532	612	28.03
Al-Bathan	2731	245	281	12.90	3197	299	344	15.77	4381	556	640	29.33
Total	54833	4913	5650	258.96	63963	5987	6885	315.56	85164	10816	12438	570.08

*Population forecasts are based on the results of PCB census in 1997 and 2007

A.D.D: Average Daily Demand M.D.D: Maximum Daily Demand P.H.D: Peak Hourly Demand

Table (5.10): Summary of proposed projects costs in North Cluster

Item	Description	Unit	Quantity	Unit Cost (€)	Total Cost (€)*1000
1. Production - Well Equipment and Installation					
1.1	**Tammoun Deep Well**				
1.2	Vertical shaft pump including features (250 m3/h at 300 m)	Unit	1	380,00	380
1.3	Balancing tank (1000 m3)	Unit	1	180,00	180
1.4	Horizontal pump to Tammoun 1 (50 m3/h at 220 m)	Unit	4	25,00	100
1.5	Horizontal pump from Tammoun 1 to Tamm 2 (20 m3/h at 100 m)	Unit	2	18,00	36
1.6	Horizontal pump to Tubas exist. (70 m3 /h at 220 m)	Unit	3	40,00	120
1.7	Connection to transformer and electrical	Lump .S	1	50,00	50
1.8	Building, features	Lump .S	1	25,00	25
	Chlorination system	Lump .S	1	20,00	20
1.9	Stand by generator	Unit	1	900,00	900
Sub Total 1:					**1811**
2 Tubas Deep Well					
2.1	Vertical shaft pump including features (150 m3/h at 300 m)	Unit	1	280,00	280
2.2	Balancing tank (750 m3)	Unit	1	160,00	160
2.3	Horizontal pump to Main junction (80 m3/h at 160 m)	Unit	3	30,00	90
2.4	Horizontal pump from Tubas Old to Tubas New	Unit	2	20,00	40

	Reservoir (80 m3/h at 80 m)				
2.5	Connection to transformer and electrical	Lump sum	1	50,00	50
2.6	Building, features	*Lump sum*	1	25,00	25
2.7	Chlorination system	Lump sum	1	20,00	20
2.8	Stand by generator	Unit	0	900,00	0
Sub Total 2:					**665**
3- Ground and Elevated Reservoirs					
Tubas scheme					
3.1	Tubas tank (900 m3)	Unit	1	0,00	0
3.2	Tubas new Tank (1000 m3)	Unit	1	0,00	0
3.3	Tammoun tank 1 at level 435 (1000 m3)	Unit	1	200,00	200
3.4	Tammoun tank 2 at level 545 (200 m3)	Unit	1	80,00	80
3.5	Jarba tank at level 430m (100 m3)	Unit	1	50,00	50
3.6	Tayaseer tank (500 m3)	Unit	1	130,00	130
Sub Total 3:					**460**
4- Main Transmission Pipelines					
Tubas scheme					
4.1	DN 250	km	0	110	0
4.2	DN 200	km	0,3	78,1	24
4.3	DN 150	km	3,6	61,13	220

4.4	DN 100	km	1,406	42,62	60
4.5	DN 75	km	0,6	38,62	23
Sub Total 4:					**327**
Interconnection 5					
5.1	DN 250	km	2,71	110	298
5.2	Fittings & accessories, concrete & asphalt work	%	30	14.8	14.8
Sub Total 5:					**313**
6 Distribution Networks					
6.1	Tubas rehab.	km	8,461	43,41	367
6.2	Tubas new	km	24,227	37,94	919
6.3	Tammoun	km	34,116	40,48	1381
6.4	Tayaseer	km	3,000	35,37	106
6.5	Fittings & accessories, concrete & asphalt work	%	30,000	833	833
Sub Total 5:					**3606**
Total Investment					**7 182**
7	**Contingency**	*Lump S*	%	10	735
8	**Detailed Design and Supervision**	*Lump S*	%	10	735
9	**Assistance to JWSC**	*Lump S*	1	995	995
10	**Project management and supervision**	*Lump S*	%	5	368
Sub total additional costs					**2833**
Grand Total Excluding Escalation of Prices					**10015**
Escalation of Prices & Inflation % 15		*Lump S*	**1**	**1409**	**11424**
GRAND TOTAL (1000* €) Excluding Maintenance and Operational Costs					

Table (5.11): Proposed Project fro Water Supply and Distribution in South Cluster

Proposed Project		Unit	Unit Price (€)	Community need Quantity					Total Price (€)
				Talluza	Al-Bathan	Wadi AL-Fari'a	Ras Al-Fari'a	Al-Frai'a R.C	
1.0	**Elevated Water Reservoir (200 m^3)**								
1.1	Earth Works: Excavation, backfilling;	m^3	7.5	0.0	0.0	200.0	200.0	0.0	3000
1.2	Concrete materials and works B200, B-300	m^3	115.0	0.0	0.0	190.0	190.0	0.0	43700
1.3	Steel material and works	ton	916.0	0.0	0.0	18.0	18.0	0.0	32976
1.4	Pipes and fittings (4", 6") including fixing	L.S	9160.0	0.0	0.0	1.0	1.0	0.0	18320
1.5	Staircase	L.S	6100.0	0.0	0.0	1.0	1.0	0.0	12200
1.6	Plaster, sealing, panting and finish	m^2	11.5	0.0	0.0	200.0	200.0	0.0	4600
1.7	Level indicator, ladder, ventilation, steel covers, balustrade	L.S	3820.0	0.0	0.0	1.0	1.0	0.0	7640
1.8	Mesh fence, concrete foundation, and gate	M.L	46.0	0.0	0.0	80.0	80.0	0.0	7360
1.9	Base course and asphalt yard finish	m^2	9.0	0.0	0.0	500.0	500.0	0.0	9000
	Sub Total								138796
2.0	**Elevated Water Reservoir (500 m^3)**								

2.1	Earth Works: Excavation, backfilling;	m^3	7.5	350.0	350.0	0.0	0.0	350.0	7875
2.2	Concrete materials and works B200, B-300	m^3	115	400.0	400.0	0.0	0.0	400.0	138000
2.3	Steel material and works	ton	916	45.0	45.0	0.0	0.0	45.0	123660
2.4	Pipes and fittings (4", 6") including fixing	L.S	9160	1.0	1.0	0.0	0.0	1.0	27480
2.5	Staircase	L.S	6100	1.0	1.0	0.0	0.0	1.0	18300
2.6	Plaster, sealing, panting and finish	m^2	11.5	500.0	500.0	0.0	0.0	500.0	17250
2.7	Level indicator, ladder, ventilation, steel covers, balustrade	L.S	3810	1.0	1.0	0.0	0.0	1.0	11430
2.8	Mesh fence, concrete foundation, and gate	M.L	46	80.0	80.0	0.0	0.0	80.0	11040
2.9	Base course and asphalt yard finish	m^2	9	500.0	500.0	0.0	0.0	500.0	13500
	Sub Total								368535
3.0	**Construction Rehabilitation of Pump Stations**								
3.1	Pumping Room: excavation, concrete, steel, plaster, painting, windows, doors, sealing..etc	L.S	10700	0.0	0.5	1.0	1.0	1.0	37450
3.2	Base course and asphalt yard finish	m^2	9	0.0	500.0	500.0	500.0	500.0	18000

3.2	Chlorination Room: excavation, concrete, steel, plaster, painting, windows, doors, sealing, chlorinator unit	L.S	6880	0.0	1.0	1.0	1.0	1.0	27520
3.3	Mechanical works and accessories (booster pump 50 m^3/120 m)	Numbe r	9160	0.0	1.0	1.0	1.0	1.0	36640
3.4	Electrical works: control panel, electric motor, earthing, lighting, control sensors, ETC	L.S	13000	0.0	1.0	1.0	1.0	1.0	52000
3.5	Pipes and fittings: Valves, control flow, water meter, elbows, 4", 6" pipes, pressure barrel, relieve valves, strainers	L.S	8400	0.0	1.0	1.0	1.0	1.0	33600
3.6	Steel pipes 6" for domestic water supply line from source to distribution reservoir	M.L	34.5	0.0	1400.0	1100. 0	1000. 0	1200. 0	162150
	Sub Total								367360
4.0	**Construction Expansion of Drinking Internal Water Network**								
4.1	Supply and install steel pipes 6" for domestic water	M.L	34.5	0.0	1100.0	800.0	600.0	400.0	100050
4.2	Supply and install steel pipe 4" for domestic water	M.L	29	400.0	500.0	2500. 0	1200. 0	300.0	142100

4.3	Supply and install steel pipe 3" for domestic water	M.L	23	300.0	400.0	2500.0	1500.0	200.0	112700
4.4	Supply and install steel pipe 2" for domestic water	M.L	17	800.0	500.0	6500.0	3500.0	500.0	200600
4.5	Supply and install steel pipe 1" for domestic water	M.L	11.5	1200.0	1000.0	3500.0	2500.0	1000.0	105800
4.6	Supply and install steel pipe 3/4" for domestic water	M.L	9	800.0	500.0	2500.0	1500.0	1000.0	56700
4.7	Pipes and fittings: Valves, control flow, water meter, elbows, 4", 6" pipes, pressure barrel, relieve valves, strainers	L.S	53400	0.1	0.3	1.0	0.8	0.2	128160
4.8	Concrete and steel work (Manholes)	L.S	45800	0.1	0.3	1.0	0.8	0.2	109920
4.9	Water meters and house connection	Number	99	70.0	50.0	400.0	125.0	60.0	69795
	Sub Total								1025825
5.0	**Circular, Balance Water Tank 300 m^3**								
5.1	Earth Works	m^3	7.5	0.0	0.0	0.0	0.0	300.0	2250
5.2	Concrete materials and works B200, B-300	m^3	115					210.0	24150
5.3	Steel material and works	ton	916	0.0	0.0	0.0	0.0	13.0	11908

5.4	Pipes and fittings (4", 6") including fixing	L.S	11450	0.0	0.0	0.0	0.0	1.0	11450
5.5	Plaster, sealing, panting and finish	m^2	458	0.0	0.0	0.0	0.0	10.0	4580
5.6	Level indicator, ladder, ventilation, steel covers, balustrade	L.S	3820	0.0	0.0	0.0	0.0	1.0	3820
5.7	Mesh fence, concrete foundation, and gate	M.L	46	0.0	0.0	0.0	0.0	80.0	3680
5.8	Base course and asphalt yard finish	m^2	9	0.0	0.0	0.0	0.0	500.0	4500
	Sub Total								66338
6.0	**Rehabilitation Of Groundwater Well**								
6.1	Mechanical works and accessories for vertical pump 100 m^3/300m	Number	22900	0.0	0.0	0.0	0.0	1.0	22900
6.2	Pumping pipes 6" sch40	M.L	69	0.0	0.0	0.0	0.0	300.0	20700
6.3	Stainless steel shafts grade 316/ 48 mm	M.L	76	0.0	0.0	0.0	0.0	300.0	22800
6.4	Restrainers and Rubber joints	Number	61	0.0	0.0	0.0	0.0	100.0	6100
6.5	Vertical Hollow shaft motor 200 hp	Number	15300	0.0	0.0	0.0	0.0	1.0	15300
6.6	Electrical works: control panel, electric motor, earthing, lighting, control sensors, ETC	Number	9160	0.0	0.0	0.0	0.0	1.0	9160

6.7	Pipes and fittings: Valves, control flow, water meter, elbows, 4", 6" pipes, pressure barrel, relieve valves, strainers	L.S	76400	0.0	0.0	0.0	0.0	1.0	76400
	Sub Total								173360

Summary of proposed projects costs in south cluster

Proposed Project	Talluza	Al-Bathan	Wadi AL-Fari'a	Ras Al-Fari'a	Al-Frai'a R.C	Total
Elevated Water Reservoir (200 m3)	0	0	69398	69398	0	138796
Elevated Water Reservoir (500 m3)	122845	122845	0	0	122845	368535
Construction Rehabilitation of Pump Stations	0	95590	90590	87140	94040	367360
Construction Expansion of Drinking Internal Water Network	69950	120860	469650	283485	81880	1025825
Circular, Balance Water Tank 300 m3	0	0	0	0	66338	66338
Rehabilitation Of Groundwater Well	0	0	0	0	173360	173360
Total Investment Cost	192795	339295	629638	440023	538463	2140214
Additional Costs						
Item	Unit			Unit Cost	Quantity	Total Cost
Contingency	*Lump sum % of Total Investment Cost*			2140214	10.0%	214021

Detailed Design and Supervision	*Lump sum % of Total Investment Cost*	2140214	10.0%	214021
Assistance to JWSC	*Lump sum*	995000	1	995000
Project management and supervision	*Lump sum % of Total Investment Cost*	2140214	5.0%	107011
Escalation of Prices & Inflation	*Lump sum % of Total Investment Cost*	2140214	15.0%	321032
Sub total additional costs				**1851085**
Total Costs for cluster 2 including investment and additional costs				**3991299**

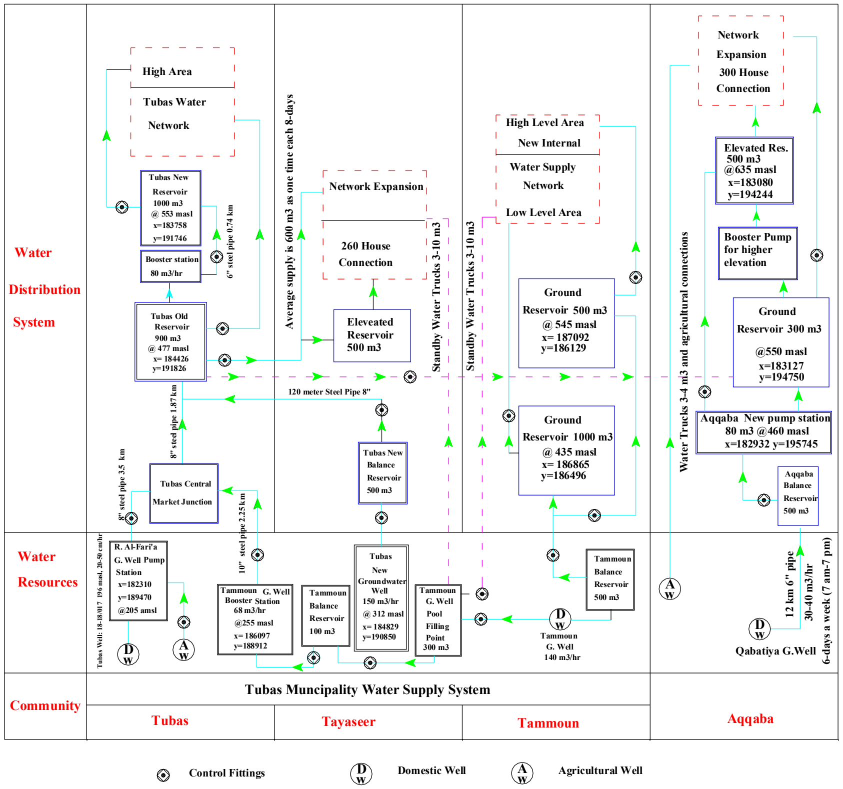

Figure 5.3: Proposed water supply schemes in the North Cluster

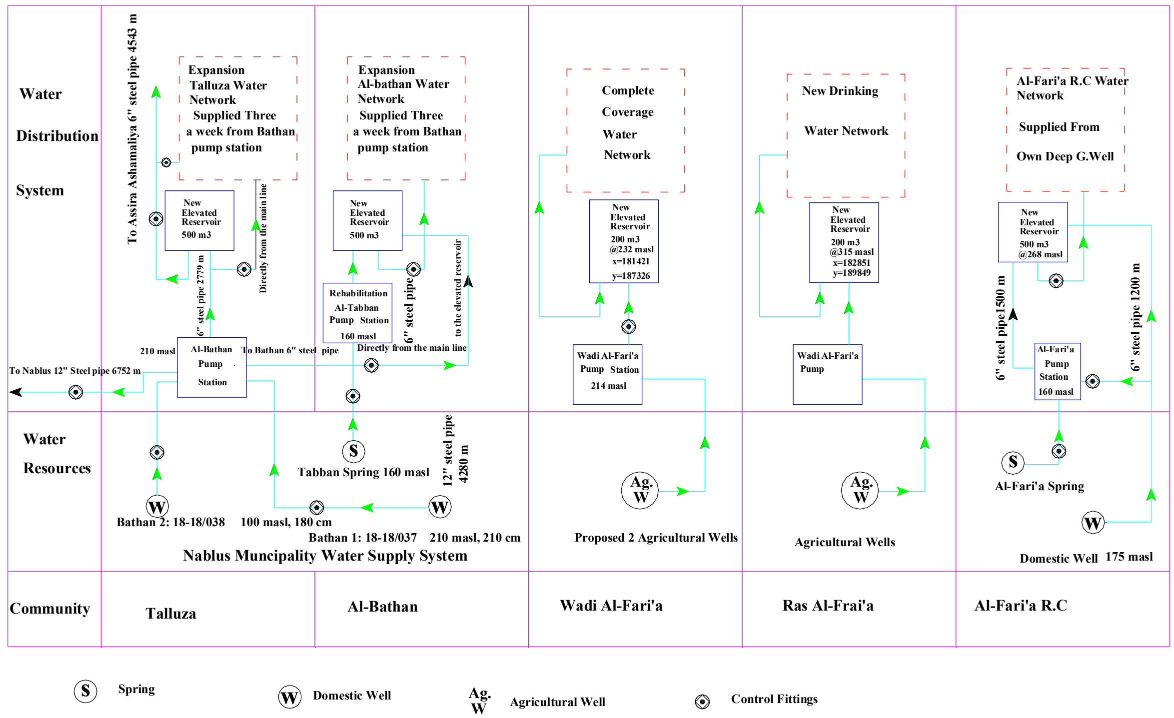

Figure 5.4: Proposed water supply schemes in the South Cluster

CHAPTER 6: WATER PRICING AND TARIFF

6.1 Evaluation of water prices

In recent years, water pricing has gained widespread acceptance as a valuable and versatile tool for municipalities and utilities to promote a number of goals. The most common goals associated with a sound water pricing are identified as: economic efficiency, revenue stability, equity, income redistribution, and resource conservation. Much of the debate concerning the issue of water pricing has been done to determine the role local municipalities in the process of policy formulation and implementation. It is now the task of local authorities to provide their citizens with potable water at a price that people can afford, and at a price that will create revenue stability for the authority in charge of supply and distribution. What this demands is a pricing scheme that needs to be tailored to the social, economic, and environmental situation of each community.

The existing pricing schemes are merely the best estimates of people affordability. They reflects mainly accounting costs of supply and allocation at each locality, while neglecting many of the economic, social and environmental costs aimed at generating a higher level of efficiency in the sector. As a result, public satisfaction with the current pricing policies hasn't been met in most of the areas in the West Bank. Even in the areas where the water tariffs is low, and water consumption is high people willingness to pay is

This study will focus on the logical analyses of water pricing and cost recovery more than water pricing and policy formulation. The existing water supply management is highly scattered and organized. There are many actors charged with the task of supplying and distributing water for the communities. The lack of cooperation between those actors has been one of the major factors contributing to the inefficient methods of pricing. The result of this is that we find areas where a low- income household is spending more than 15% or of their yearly income on household water use alone.

Water pricing depends mainly on the source of water, way of transport and distribution. For areas with piped water systems, pricing is done by the municipality or the village council. For the partially piped or un piped communities the water prices depend on costs of pulling water through water trucks. Table presents current prices of domestic water in the communities in the study area

Table (6.1): Water Pricing for Domestic Supplies

<table>
<tr><th rowspan="3">Community</th><th colspan="2">Average buying water price (NIS/m^3)</th><th rowspan="3">Avg. selling water price (NIS/m^3)</th><th colspan="4">Water Tariff if Existing</th><th rowspan="3">Avg. Collect %</th></tr>
<tr><th rowspan="2">Tanks</th><th rowspan="2">Network</th><th colspan="4">Block Consumption Range</th></tr>
<tr><th colspan="4">Price/m^3</th></tr>
<tr><td>Aqqaba</td><td>15</td><td>2.6</td><td>5</td><td></td><td></td><td></td><td></td><td>60</td></tr>
<tr><td rowspan="2">Tayaseer</td><td rowspan="2">15</td><td rowspan="2">3.7</td><td rowspan="2">4</td><td>0-5</td><td>6-20</td><td>21-30</td><td>>=31</td><td rowspan="2">45</td></tr>
<tr><td>4+5maint</td><td>4.5</td><td>5</td><td>6</td></tr>
<tr><td rowspan="4">Tubas</td><td rowspan="4">15</td><td rowspan="4">2.1 - 2.49</td><td rowspan="4">2.5</td><td>0-5</td><td>6-20</td><td>21-30</td><td>31-40</td><td rowspan="4">65</td></tr>
<tr><td>20</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td colspan="2">41-60</td><td colspan="2">>=61</td></tr>
<tr><td colspan="2">7</td><td colspan="2">8</td></tr>
<tr><td>Tamoun</td><td>15</td><td>--</td><td>--</td><td></td><td></td><td></td><td></td><td>---</td></tr>
<tr><td>Ras Al-Fara’a</td><td>12</td><td>2</td><td>3</td><td></td><td></td><td></td><td></td><td>3</td></tr>
<tr><td>Wadi Al-Fara'a</td><td>12</td><td>1.75</td><td>3</td><td></td><td></td><td></td><td></td><td>4</td></tr>
<tr><td>Al-Fara'a R. Camp</td><td>12</td><td>1.5</td><td>3</td><td></td><td></td><td></td><td></td><td>3</td></tr>
<tr><td>Talluza</td><td>15</td><td>3.25</td><td>4</td><td></td><td></td><td></td><td></td><td>5</td></tr>
<tr><td>Al-Bathan</td><td>12</td><td>3.25</td><td>4</td><td></td><td></td><td></td><td></td><td>10</td></tr>
</table>

Prices of water in Al-Fara'a R. Camp are the lowest in the area because water services are provided to the camp by less than the economic costs. In general, neither the population nor the village councils pay for the water and the price paid by residents is only utilized for irregular maintenance of the pipeline and the pumping stations. Communities obtaining their water from Tank vehicles have to pay from 5 to 20 NIS/m^3 for water to the tank vehicle, another 0.5 NIS/m^3 is usually needed to pump this water to tanks on the roofs of the houses. The costs of cisterns required to store that water are not included.

6.2 Costs Recovery Analyses:

Two questions have to be answered before the evaluation of above prices. Firstly, what types of costs are included in the water prices? Secondly, what is the relation between the existing water prices and the percentage of collection? To give concrete answers, more investigation will be performed to obtain and analyze information regarding actual costs of water as compared to water prices.

Improving cost recovery clearly involves more than just charging higher fees or spending more on fee collection. However, which water costs are to be recovered and what mechanisms can be used to recover them have to be specified. The full costs of providing domestic water can be divided into three categories: direct project costs, environmental costs, and marginal user costs.

Direct project costs are the easiest of the three to measure, and most projects take only direct costs into account in determining full cost recovery. Direct costs refer to costs stemming from the process of capturing and delivering domestic water, which can be broken into fixed costs and variable costs. Fixed costs include all investments in water infrastructures such as, water supply and distribution networks, building reservoirs and pump stations and installing house connections, plus depreciation and interest payment on the investment. Higher level administrative costs and some operational and maintenance costs not involved with actual water delivery are also considered fixed costs because they do not vary with the amount of water delivered. Variable costs consist of the operational and maintenance costs of water delivery, lower level administrative costs (usually temporary labor costs during the time of water delivery), and costs of supplying water, which include, material costs, conveyance costs, groundwater extraction costs, and costs due to water loss. These costs vary with location, water supply method, technology, and seasonal changes in power tariff.

Environmental costs could substantially raise the total costs of projects. These costs include any damage to the surrounding ecosystem during and after the construction of water project. However, rarely water projects in practice include environmental costs as part of their full cost to be recovered. Therefore they will be ignored in the analyses of pricing and costs recovery.

Marginal user cost is defined as the present value of future sacrifices implied by current resource use. It involves the higher costs of obtaining future water supplies because more accessible and less expensive water resources are used up first. In an extreme case, water resources are completely used up in the current period. This cost is especially relevant for groundwater resources with little or no recharge. Excluding marginal user costs in the price of groundwater often results in overuse of the resource and depletion of the aquifers. However marginal costs are important, will not be included in the analyses of pricing and costs recovery. Because, this value in a nation debate and more related on future alternative scenarios of water supply and opportunity costs which is out of the scope of this study. Therefore the only costs to be included in this study are the direct costs.

After determining which of these costs to include, the next concern is what percentage of total costs should be allocated to citizens. In many cases, who should bear the full costs of providing water is not clear. Whether the customers should pay the full costs or the local authorities should pay part of these costs. Because water supply is not a secondary service and higher costs could have negative implications on the low-income families and hygiene living. Among the direct costs, it is very important to decide if depreciation of investment has to be included or not. Theoretically yes, it must be included because who will pay for another investment after will cease? Practically not clear, because this item alone will escalate the costs beyond the citizens' affordability and willing to pay. Taking into consideration the previous and existing socio-economic conditions in Palestine, building water tariff with depreciation is impossible. Therefore, depreciation should not be canceled in cost recovery analyses, but paused and related to national tariff policy in future.
To clarify the above discussion, a detail sample of the cost analysis was carried out. The example of Wadi Al-Frai'a and analyses procedure applies for the other communities in the study area. To make the analyses easier, the data entry was programmed on excel and all we need to do is to change the input data for each community. According to this ability of quick results, it is possible to carry further sensitivity analyses as shown in the tables below.

Table (6.2): Basic data on recovery costs for domestic water in Wadi Al-Fari'a.

Basics for Tariff and Cost Recovery Calculations	Projects	Cost (Euro)
Cost Recovery Analyses: Sample Analyses for Wadi Al-Fari'a Water Supply Network Technical study of the water supply system includes analysis of the key elements of the water system. Brief description of the Project : Drinking Water is purchased from different sources of agricultural groundwater wells, The project includes installation of transmission lines, distribution lines, and all manholes, house connections and construction of elevated reservoir 200 m^3 and pump station	Elevated Water Reservoir (200 m3)	**69398**
	Elevated Water Reservoir (500 m3)	**0**
	Construction Rehabilitation of Pump Stations	**90590**
	Construction Expansion of Drinking Internal Water Network	**469650**
	Circular, Balance Water Tank 300 m3	**0**
	Rehabilitation Of Groundwater Well	**0**
	Total Investment Cost	**629638**

Table (6.3): Base Scenario

Basic Data	Cost	Unit
Euro/NIS	5.4	
Population	3000	person
Per capita consumption per day	100	litter
Percentage of losses	0.120	
Total Investment Cost	**629638**	Euro
Water price purchased (NIS)	1.75	NIS
Water price purchased (Euro)	0.324	Euro
Cycle of revenues collection	2.000	month(s)
Percentage of Collection	100.00%	assume
Project Life	20-50	Year
Depreciation on projects included or not (Y/N)	Y	
Water demand	122640	m^3/year
Total cost of bought raw materials (water)	**39744**	Euro/year

Table (6.4): Analyses of Costs

1- Network Establishment Costs	469650	Euro		
2- Machines, equipment and other appliances	90590	Euro		
3- Buildings and construction	69398	Euro		
One Euro=	5.4	NIS		
Project Life and the proportion of depreciation	20-50	Year		
Depreciation on projects included or not (Y/N)	Y			
4- Raw materials price/m^3				
Population number	3000	person		
Per capita consumption per day	100	litter		
Percentage of losses	0.12	%		
Water demand	122640	m^3/year		
Water price purchased (NIS)	2	NIS		
Water price purchased (Euro)	0.324	Euro		
Total cost of bought raw materials (water)	**39744**	**Euro/year**		
5- Employee salaries (Administrative & Technical)				

Network management requires number of skilled and un-skilled workers. The salaries of the staff are either fixed or variable as follows:	**Num.**	**Monthly Salary (Euro)**	**Annual Salary (Euro)**	
5.1 Total Fixed Costs				
Director (fixed cost)	0.30	600.00	2160	
Accountant (fixed cost)	0.40	400.00	1920	
			4080	
5.2 Total Variable Costs				
Engineer, surveyor (variable cost)	0.30	500.00	1800	
Field workers meters' reader, etc (variable cost)	0.50	300.00	1800	
			3600	
Total Employee costs			**7680**	
6- Annual maintenance costs				
Maintenance costs are usually computed as a percentage of the economic value of the asset as follows: For the purposes of financial analysis these costs are classified within the variable expenses.				
Item	Investment cost	The proportion of maintenance	The cost of maintenance	
machines, equipment and other appliances	90590	1.50%	1358.9	

Buildings and construction	69398	0.50%	347.0	
Network Establishment Costs	469650	1.00%	4696.5	
Total annual maintenance costs			**6402.3**	
7- Insurance Costs:				
As for the above paragraph in the calculation of the cost of insurance is a percentage of the asset and expenses are summarized as follows:				
For the purposes of financial analysis they are classified within the fixed expenses	Investment cost	The proportion of insurance	The cost of insurance	
machines, equipment and other appliances	90590	%0.75	679.4	
Buildings and construction	69398	%0.50	347.0	
Employee	7680	%0.50	38.4	
Total Insurance Costs:			**1064.8**	
8- Industrial Indirect Costs:				
Electricity, water, etc.	200	Euro/year		
Oil, lubrication, etc.	150	Euro/year		
Tinker tools	300	Euro/year		
Transportation	250	Euro/year		
un seen other costs	200	Euro/year		

Total Industrial Indirect Costs:	**1100**	**Euro/year**		
9- General administrative expenses				
Offices maintenances	150	Euro/y		
Telephone	100	Euro/y		
Local Transport	150	Euro/y		
Auditing	200	Euro/y		
Technical assistance	150	Euro/y		
Publications and printing	200	Euro/y		
workshops and public meetings	200	Euro/y		
Other	200	Euro/y		
Total general administrative expenses	**1350**	Euro/y		
Summary of Direct Costs				
1- Establishing Costs	469650	Euro/year		
2- Machines, equipment and other appliances	90590	Euro/year		
3- Buildings and construction	69398	Euro/year		
4- Raw materials	39744	Euro/year		
5- Employee	7680	Euro/year		

6-Maintanances (Variable)	6402	Euro/year		
7- Insurance (Fixed)	1065	Euro/year		
8- Total Industrial Indirect Costs:	1100	Euro/year		
9- General administrative expenses	1350	Euro/year		
Total costs	**686,980 €**	**Euro/year**		
Capital Costs				
Invested capital: It is the money that will be invested in the project to purchase the materials, equipments and services as well as the financing of the production costs. It is divided into types of capital investments.				
A- Fixed capital which equals				
1- Establishing Costs	469650	Euro		
2- Machines, equipment and other appliances	90590	Euro		
3- Buildings and construction	69398	Euro		
Total fixed capital cost	**629638.0**	**Euro**		
B- Working capital which equals the funds are needed by the project to cover the cost of production during the production and marketing phases. For the purposes of economic and financial analysis of capital; is calculated on the basis of the cost of raw materials and salaries and other expenses during a cycle of produce, as follows:				
	Cycle (months)	Cycle (%)	Cost/cycle (Euro)	

4- Raw materials	2	0.167	6624.07	Euro/year
5- Employee	2	0.167	1280.00	Euro/year
6-Maintanances (Variable)	2	0.167	1067.06	Euro/year
7- Insurance (Fixed)	2	0.167	177.47	Euro/year
8- Total Industrial Indirect Costs:	2	0.167	183.33	Euro/year
9- General administrative expenses	2	0.167	225.00	Euro/year
Total working Capital cost			**9556.93**	**Euro/year**
Total Invested cost	**639195**	**Euro/year**		
Depreciation Costs				
Depreciation costs were calculated according to the item life and initial cost				
Item	Expected life	Initial Cost (Euro)	Yearly Depreciation (Euro)	
Network	40	469650	11741.3	
Machines	20	90590	4529.5	
Building	50	69398	1388.0	
Total Depreciation Cost			**17658.7**	
Annual operation costs				

Annual operation costs are in order to determine the feasibility and profitability of the project. For the purposes of analysis, annual operation costs were divided into fixed and the second variable costs as follows:				
Annual Fixed Operation Costs	Yearly Cost (Euro)			
General administrative expenses	1350			
Employee (fixed part only)	4080			
Insurance	1065			
Network Depreciation	11741			
Machines and appliances depreciation	4530			
Building Depreciation	1388			
Theoretical Total Annual Fixed Operation Costs	24154			
Total Annual Fixed Operation Costs	**24154**			
If we exclude depreciation from the cost analyses and assume project donation recover after the project period expire then the formula of the Total Annual operation costs will look equal to the above value minus the depreciation costs				
Annual Variable Operation Costs	Yearly Cost (Euro)			
Raw materials (water)	39744			

Employee (variable costs only)	3600			
Maintenance	6402			
Industrial Indirect Costs:	1100			
Total Annual Variable Operation Costs	**50847**			
Total Annual Operation Costs	**75000.3**			
Output Results: Estimated Annual Income selling/collection water quantity to consumers				
Total Municipal Water Supply Quantity (m^3/year)	% of losses (physical and apparent)	Actual water consumption (m^3/year)	% of collection	
122640	**12.0%**	**109500**	**100.0%**	
Maximum Annual Income (Euro)	**97500.40**			
Estimated initial price (Euro)= Total annual operation costs/(Actual water consumption *% of collection)	**0.685**			
Price factor=	**1.3**			
New Estimated initial price/m3 (Euro)	**0.890**			
Annual Returns:				
Annual revenues =Annual income - Annual operating costs	**22500.1**			

Net profit before tax = annual returns - the benefits of the loans (if any)	Euro/year			
In this case value of loans =	0			
Tax %	0			
Net Profit before tax=	**22500**			
Net profit after tax = net profit -loans - tax				
Tax income rate=	0.05			
Net profit after taxes	**21375**			
The return on investment (before tax) = net profit before tax ÷ capital investment	3.520%			
It means that investing 100 Euro will have an annual return of	**3.52**	**Euro/year**		
Investment Recovery Period				
Payback period = Invested capital ÷ net profit after tax	**30**	**Year**		
Break point				
Break-through point = Annual fixed operating costs ÷ (Annual revenues - annual variable operating costs	**0.52**			

6.3 Prices Sensitivity Analyses

The above analyses are considered as the base scenario for further assumptions and water prices comparison. To measure the impact and importance of the input values for each cost, a sensitivity analyses were carried out as shown in the **Table 6.5.** These results are summed as shown in **Figure 6.1**. It shows that the percentage of collection and depreciation are the most effective parameters in determining the water prices. The percentage of losses and the per capita consumption are less important in comparison with the previous parameters. The worst scenario would happen in case more than two or three parameters exist in the same location. For example, in Tubas City, the percentage of collection is 65% and the percentage of losses is around 34%. Tubas City has the highest % of collection in the study area, however; it is still very low. Such figures are becoming phenomena in the area; the highest percentage of water collection in the south cluster was found in Al-Bathan, however; it does not exceed 10%. Accordingly, whatever the planning recovery system and water pricing will not solve such problems. During the data collection we found that several communities were indebted with millions of Shekels, and they have no plan to payback the debt or even the future costs. There should be two recovery programs, and must work in parallel to solve this chronic problem. One aims at community level education and public awareness. The other enhances law enforcement and policing. Otherwise, the above discussion and cost recovery analyses are meaningless.

Table (6.5): Water pricing sensitivity analyses

Sensitive Factors	Base Scenario	Population	Per capita consumption	% of losses	% Collection	Depreciation (Y/N)
Population	3000	**3900**	3000	3000	3000	3000
Per capita consumption per day (litter)	100	100	**80/120**	100	100	100
Percentage of losses	0.120	0.12	0.12	**0.25**	0.12	0.12
Water price purchased (Euro)	0.324	0.324	0.324	0.324	0.324	0.324
Percentage of Collection	100%	100%	100%	100%	**70%**	100%
Depreciation on projects included or not (Y/N)	Y	Y	Y	Y	y	**N**
Outputs						
Total Municipal Water Supply Quantity (m3/year)	122640	159432	98112/147168	136875	122640	122640
Actual water consumption (m3/year)	109500	142350	87600/131400	109500	109500	109500
Annual operation costs (Euro)	75000	86924	67051/82949	79614	75000	57342
Annual income (Euro)	97500	113001	87166/107834	103498	97500	74544
Annual revenues (Euro)	22500	26077	20115/24885	23884	22500	17202
Indicators						
Estimated initial price/m3 (Euro)	**0.685**	**0.611**	**0.765/0.631**	**0.73**	**0.98**	**0.52**
New Estimated initial price/m3 (Euro)	0.890	0.794	0.995/0.821	0.95	1.27	0.68
Net Profit before tax	22500	26077	20115/24885	23884	22500	17202
Net profit after taxes	21375	24773	19109/23641	22690	21375	16342
The return on investment	3.52	4.06	3.15/3.89	3.73	3.5	2.69
Payback period	29.90	26	33.37/27.09	28.20	29.9	39.11
Break-through point	0.52	0.48	0.55/0.49	0.49	0.5	0.52

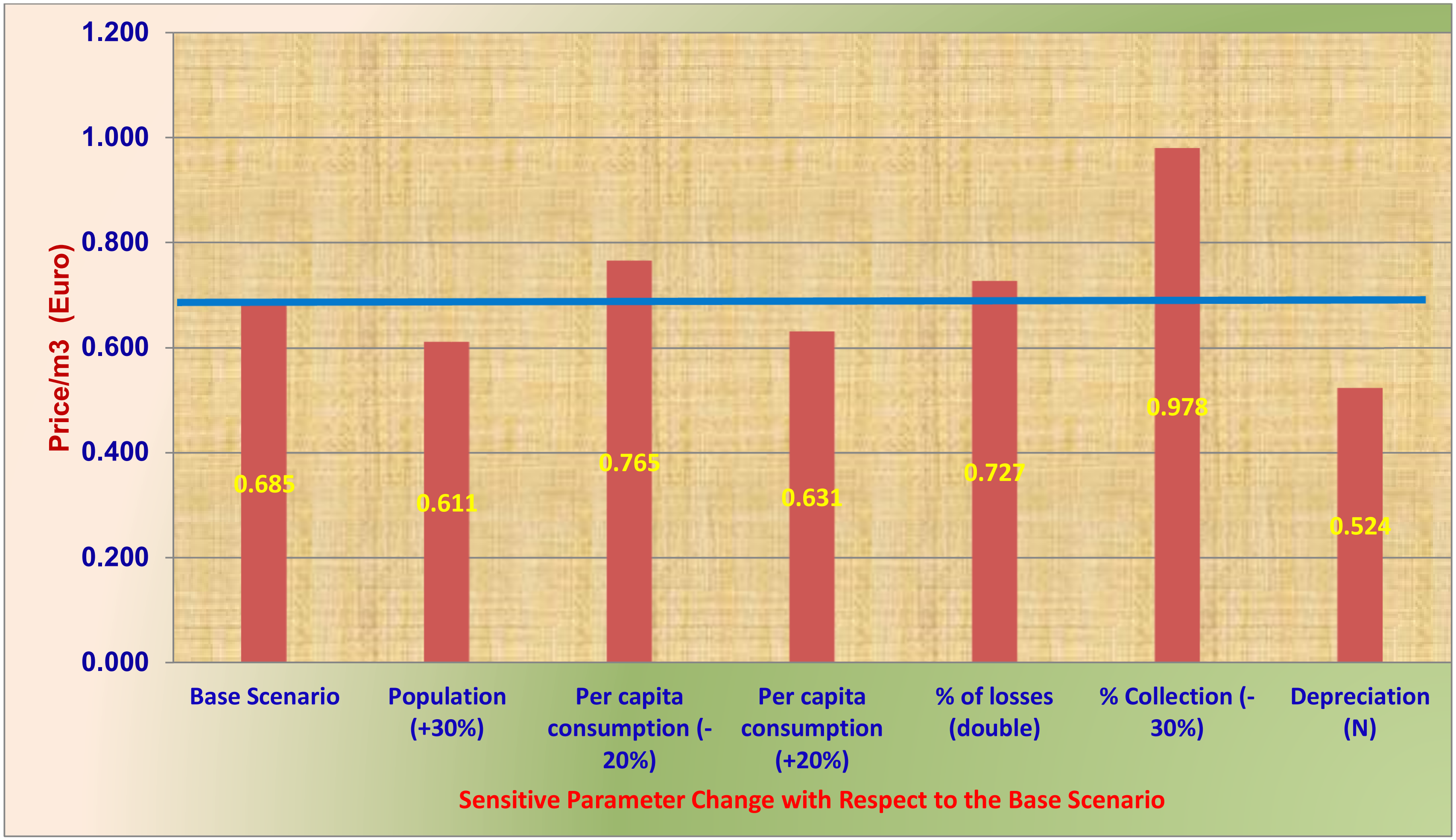

Figure 6.1: Water Prices Sensitivity Analyses

CHAPTER 7: ANTICIPATED PROJECT IMPACTS

7.1 Socio-Environmental assumptions

The areas targeted by this project are suffering from seasonal water shortage and deteriorated water quality. With this project, better quality and sufficient potable water will be supplied to meet projected future demands of domestic consumers in the 9 targeted cities and villages, in addition to equal distribution of water among inhabitants, extended service areas and better consumer services. The anticipated positive impacts of the Project can be split into human impact and environmental impact.

7.2 Impacts on Human Living Condition

The following can be considered as positive impacts of the project on human living conditions:

As a result, public health will be improved through reduced risk of waterborne and water-related diseases, and health costs associated with waterborne and water related diseases will be reduced. After the project is implemented, it is expected that the use and the degradation and pollution of the present water facilities (springs, drainage) in the areas will be reduced and therefore the living conditions of the population will significantly improved, through:

- Improved sanitation and hygiene for residents near such water sources.
- Improved recreation and environmental aesthetics for the communities of the project area.
- Increased property value for lands alongside surface water.
- Increased quality of life and standard of living for residents living downstream from the project area
- The adverse effects of irrigation with untreated wastewater will be reduced following project implementation;
- Increased employment opportunities for local labor from men and women
- Increased income from sale of agriculture products by construction camps (Poverty alleviation);
- Adopting water tariff system that is considered as effective demand management tool, helps to ensure sustainable service, and should provide better service
- Constructing of main transmission pipelines would serve as permanent electrification for inhabitants as well as construction sites

- Reduced work load on women through the implementation of private house connection.
- Provide additional water quantities for agriculture through wastewater treatment reuse.
- Helps to solve social problems between neighbors and which results from cesspits flooding.
- Saving the money spent on emptying the houses' cesspits.

7.2 Impact on the Environment

The condition of the environment in the study area will also be improved. This is achieved through:

- Improved biodiversity and ecosystems.
- Increased public satisfaction with the surrounding environment.
- The quality of the groundwater, which could remain one of the important domestic and agricultural water supply sources in the targeted areas, is also expected to improve (considering the expectations of the sanitation component of the project).
- Stop dumping wastewater to the nearby wadies or in the agricultural areas close to the houses.
- Stop the environmental pollution and disease caused by randomly dumping of the wastewater. Moreover, wastewater treatments help to minimize the increase and the spread of flies, mosquitoes and gnawing animals which live in such conditions.
- Increase of green areas and parks

  No major negative impacts are envisioned since the project will mainly rehabilitate existing facilities and provide improved and systematic operational and maintenance water supply systems. Potential negative impacts that are localized and limited in nature will be avoided by providing instructions in the contract document which specifically address environmental issues as well as following good management practices during construction.

The different impacts and the foreseen environmental mitigation and monitoring actions are presented in a simple matrix format. This includes identifying the issues and the needed mitigation measures. Table (7.1) presented these issues during the implementation phase, while Table (7.2) presented these issues for the operational phase in details

Table (7.1) Anticipated negative impacts and proposed mitigation measures during the implementation phase.

Impacts	Type Anticipated Negative Impact(s)	Mitigation measure(s)
Physical	Airborne dust caused by excavation, demolition, vehicle movement, construction materials and materials handling particularly downwind from the construction sites. Dust will have short-term adverse effect on the surrounding environment such as farmlands, canals, and residential areas.	Construction sites, transportation routes and materials handling sites should be water-sprayed on dry and windy days up to three times a day, especially if these sites are near sensitive receptors, such as residential areas. Materials should be stored in appropriate places and covered or sprayed. Minimizing the on-site storage time is preferred. Materials should be covered during transportation to avoid spillage or leakage especially along the major highways. Controlling the speed of the transporting vehicles, selecting transportation routes to minimize dust impact on sensitive receivers, and washing trucks tires before leaving the construction site Construction of containing walls to control muddy runoff
	Air pollution caused by emissions from vehicles and construction machinery such as exhaust, gas , dust, etc.	Vehicles and construction machinery should be required to be properly maintained and to comply with relevant emission standards
	Occurrence of noise, vibration due to heavy construction machinery and vehicular movement, potentially affecting residents of nearby households, schools	Construction activities should be scheduled carefully to minimize the impact of noise from construction machinery. Night-time construction near residential

	and others. Generally, construction noise exceeding a noise level of 70 decibels (dB) has significant impacts on surrounding sensitive receptors within 50 meters of the construction sites.	areas using heavy machinery such as pile drivers and concrete vibrators, should be prohibited from 22:00 to 6:00 No discretionary use of noisy machinery within 50 meters of residential areas. Good maintenance and prop operation of construction machinery to minimize noise generation Installation of temporary sound barriers if necessary. Selection of transport routes for large vehicles to avoid residential areas.
	Traffic congestion caused by pipeline construction and by increased construction traffic in the areas, altering public safety. Roads may be fully or partially closed during construction, causing temporary inconvenience to residents, commercial operations and institutions	Traffic plans should be prepared before construction in conjunction with relevant authority Regulating traffic at the road crossings and improve existing roads to accommodate increased heavy traffic Build interim roads; select transport routes to reduce disturbance to regular traffic. Divert traffic at peak traffic hours Reinstate the roads as soon as possible.
	Waste discharge: discharge of wastewater from construction camps could create new pollution sources. The camps could also be sources of solid waste, debris, and waste oil from machinery maintenance. Road construction spoils and rocky materials will be generated	Sewage and other wastewater from construction camps should be collected and treated using septic tanks before being discharged to avoid contamination of the surrounding areas. Refuse generated by construction spoil material and solid waste should be timely cleaned up and stored in closed containers Disposed materials should be properly compacted and stabilized. Road construction spoils and rocky materials could be used by local people on a' take for free' basis.

	Excavated materials generated by pipeline construction and demolition might exceed the amount needed for refill.	Construction waste should be promptly removed from the construction sites. Burning of construction waste should be prohibited.
	Explosives (If used in construction) might injure or kill people s	24-hour security should be provided to the storage bunker Cradle to grave accounting for all explosives.
	Potential accidental break of other utility lines	Survey of existing facilities during the design; monitor the excavation, an immediate repair if happened.
	Soil erosion	Provision of setting pond Minimal activities in erosion prone areas
	Interruption or temporary suspension of municipal services as construction of project facilities may require relocation of underground municipal utilities such as sewers, gas, water supplies, communication cables, and power poles.	Avoidance of other utilities should be carefully considered in project design and construction. Emergency measures should be in place to minimize adverse impacts.
	Problems related to public safety due to the trench excavation along roads and streets	Contractors should be required to take safety measures at the construction sites to protect the public, and warning signs should be provided to alert the public of potential safety hazards at and around the construction sites. Contractors and construction supervisors should be introduced to environmental protection measures and are recommended to participate in an environmental training program before construction begins. Environmental protection measures in connection with construction operations are required as integral parts of the engineering contracts
	Construction of access roads involving	Balanced cut and fill design, replanting,

	erosion hazards due to vegetation and unprotected soil (if developed on hill slope), vegetation clearance and resettlement	resettlement's compensations
	The treatment plant must be far enough from the living areas, and should be clean enough even to use pesticides when necessary.	Spread of odor and the accumulation of flies and mosquitoes in the area
	Compensating the farmers who will be affected by opening the new roads. This compensation action must go in parallel with public awareness program	Open new roads beside the main conveyance pipelines to enable easy access for maintenance and expansion in future
	Damaging of heritage and archaeological sites if exist within the construction area	Construction should be immediately suspended if any archaeological or other cultural properties are found. The relevant cultural authority and the project management office should be notified promptly and only after a thorough investigation will construction resume.
Biological	Significant adverse impacts might be imposed on the local ecological environment such as : - Cutting of the national protected trees and economic trees identified within the project areas. - Affecting agricultural crops including major crops(such as rice, soybean, maize), cash crops (such as vegetables and herbal medicine) and fruits - Affecting rare or endangered species living within the construction areas. - Adverse impact on flora and fauna at the project site	Plans should be prepared by the alternatives to minimize the removal of the trees by relocation whenever possible, and to find land to grow more of these trees to compensate for the loss. Owners of economic trees should be compensated. Farmers should be compensated for their livelihood loss Plans should be prepared by specialists or project design institutes to minimize the adverse impact on the local ecological environment

	- Affecting designated natural reserves or scenic spots, and sites of significant geo- conservation values within the construction area.	
	Lab tests to decide which cultivation is suitable for the type of treated wastewater.	There is a possibility that the water effluent is not suitable for agricultural produce
Socioeconomic	Workforce might be from outside the immediate neighborhood and thus living in temporary quarters. Such conditions provide a favorable environment for the propagation of disease, exacerbated by the impacts of noise and dust.	Efficient sanitation must be maintained and monitored, with provision of health services.
	Small amounts of wastewater flow will be generated by the Construction workers	Interim pipelines should be placed to convey the wastewater to nearby sewers, or interim holding tanks should be constructed with the effluent discharged to the existing drainage or wastewater sewers. Timely cleanup of workers` refuse
	Construction workers might be exposed to or injured by different occupational hazards	Occupational health and safety measures should be taken a construction sites Workers should use personal protective equipment (PPE) Safety officer.
	Wastewater tariff that includes all costs of collection and treatment. The fees must be collected on monthly bases and linked with water and electricity services to insure good commitment by the citizens.	The operation costs could be high such that the village councils could not pay for wastewater services.
	Farmers' training through field visits and creation of model farms on wastewater reuse.	Teaching farmers on safe use of treated wastewater.

Table (7.2): Anticipated Negative Impacts and Proposed Mitigation Measures During the Operational Phase

No respect of protection perimeter (no control of raw water quality, inadequate use of chemicals, inadequate control and cleaning of reservoirs)	**Safe** operational procedures should be followed properly Water quality standards should be followed strictly Equipment should be installed for automated control of chlorine treatment. **Training** on operation safety and emergency procedures should be provided for in charge human resources before the operation. **Regular** training and practical sessions should be provided after operation **Develop** contingency plans for power failure, overflows, equipment malfunctioning and other conditions which may affect the proper functioning of the network, resulting in water contamination and water leakage. **Hold** regular consultations with residents in nearby communities and respond promptly to their concerns with regard to the network operations, pumping stations, and landscape project sites include trees, lawns and community parks.
Major impacts from operation and maintenance of water pipelines are associated with repair and replacement activities when there are leaks or breaks on pipelines.	A program should be established to detect leaks and replace old pipelines to minimize the risk of water supply interruption, noise, odors and impacts on traffic and other utilities.
Noise generated from well pumps and booster stations usually contained within the plant.	Selecting low noise machinery Putting high noise equipment indoors Installing noise enclosures or buffers Partial setting of pump stations underground.
Contamination of network by sewage, dead ends, and pollution of household cisterns due to the insufficient public health education.	Conduct health education and awareness programs for communities in targeted areas

Storing and handling of hazardous chemicals (Chlorine) which could result in accidental pollution or working accidents	Handling and final disposal of chemicals should be in a safe, proper, and environmentally responsible manner
Increased water consumption in the service area resulting in higher sewage production and increased wastewater generation rate (70 percent of water supplied is collected as wastewater). This could affect public health if sanitation facilitates are not developed in accordance with requirement or are inadequate to cope with the extra wastewater	Information of population concerning sanitation issues is to be performed Sanitation facilitates should be developed in accordance with requirements. Development of long-term plans, funding, and implementation of the rehabilitation schemes are needed to reduce unacceptable situation relating to the wastewater collection and treatment, and its effects on the ecology of the targeted areas. Through improvements of sewers to collect wastewater, open ditches should be improved or covered.
In case of water cutoff, villagers will resort to other water sources that are not rehabilitated or monitored, resulting in public health problems (waterborne diseases)	Develop contingency plans for conditions that may affect the proper functioning of the network such as power failure, overflows, equipment malfunctioning and others
Increased water tariffs or increased water cost (for instance in some areas such as Tubas where the assumed tariff proposed by the new JWSC is higher than the present one) resulting in questioning consumers` willingness to pay and affordability	**Conduct** WTP surveys **Conduct** public relations and public awareness program **Special** studies should be undertaken to see how very poor people can be given access to water supplies under such system **Adopt** equitable tariff structure

7.3 Implementation of Mitigation Measures

Construction Phase

The mitigation measures described above will be implemented mainly by the constructor(s) in charge of the construction of the facilities. It is to be noted that there will not be specific impact on the costs of the works because the mitigation measures and the care to environment are part of the general regulations on construction in Palestine. The respect of these measures will be addressed and secured on one hand by a detailed assessment based on the detailed engineering and on other hand by the translation of those in the tender documents for the enterprises. Those will be achieved under the provision of technical support unparallel. The specific cost of this service should not exceed 0,3 or 0,7 % of the total cost of the project.

Operational Phase

The respect of environment constraints and the implementation of mitigation measures will be under the direct responsibility of the JWSC.

Monitoring Of Project Impact

It is proposed to monitor the impact of the project using the following indicators:

- Quality of the water extracted from the wells,
- Quality of water extracted from shallow wells,
- Total water production from the wells,
- Potable water consumption
- Total population
- Served population
- Number of shops, businesses and small scale industries
- Market price of housing: sales and rental cost
- Public health ratios
- Number of tankers supplying water to the population in the area.
- The impact on groundwater water quality and pollution
- The money used for emptying of the cesspits.
- Types of agriculture products
- The areas have been cultivated
- Wastewater effluent characteristics.

The following Table gives a more detailed definition of the parameters that should be monitored and recommends corresponding monitoring procedures.

Table (7.3): Monitoring parameters and procedure

Indicator	**Parameter to be monitored**	**Monitoring procedure**
Water quality	Bacteriological quality Physical and chemicals Parameters	Analysis by independent laboratory or JWSC laboratory
Water quality of shallow Wells	Bacteriological quality	Analysis by independent laboratory or JWSC laboratory
Water Quantity	Monthly volume	Monitoring by JWSC
Potable water consumption	Annual volume, for each category of consumers: residential use, shops and small businesses, gardens and field (if any?)	Monitoring by JWSC
Total population	Total population of each Village	Monitoring by municipalities or JWSC
Served population	Number of connections per category of consumers, Estimated population Coverage rate	Monitoring by JWSC
Number of shop, businesses and small scale industries	Total number	Annual survey to be carried out by the Municipalities or Ministry of Local Government, using local consultants
Housing market price	Average market price of sales, per sq. meter Average monthly rental cost, per sq. meter	Annual survey to be carried out by the Municipalities or Ministry of Local Government, using local consultants
Public health	Total number of Number of water borne Diseases	Annual survey to be carried out by the Municipalities or Ministry of Local Government, using local

		consultants
Ministry of Environmental Quality	Monitoring the environmental changes in the area	Environmental impact assessment
Study done by the Ministry of Agriculture	Total irrigated areas	Total area
JWSC	Chemical and biological tests	Wastewater characteristics
Ministry of Agriculture	Trees and vegetables	Types of cultivation and irrigated crops
Number of tankers	Total number of private and public (if any) tankers operating in the district	Annual survey to be carried out by the Municipalities or Ministry of Local Government, using local consultants

7.4 Internal Risks and External Assumptions

Like other projects, the present project is a complex ensemble of components including stakeholders, executors and deciders, as well as of beneficiary populations. The project risks have to be carefully identified and analyzed at earliest stage as possible, in order to address preventive measures and make appropriate recommendations.

The risks are understood to be internal to the project, i.e. to deal with the project components and their implementation; the analysis of the risks has to be completed by the analysis of the assumptions, which are the external factors susceptible to jeopardize the success of the project.

Most of the project tasks and activities are linked in a logical flow stream (which is presented in the action plan) resulting in a strict scheduling which has to be respected in order for the project to be achieved on due time. Mismanagement of the overall project and its planning as well as of the generation of delays in the execution of unit tasks or taking of decisions will affect the overall achievement of the project; nevertheless those will not be considered as risks in this section.

Objectives

Following discussion aims at:

- Identifying and describe all potential risks of the project as of technical or financial aspects;
- Find the origin of the identified risk;
- Evaluate the impact on the project;
- Propose the corrective measures to be envisage and make recommendations accordingly.

Risks Summary

Table (7.4): Lists the most important risks identified at this stage of the study.

Risk or assumption	Origin	Actions and recommendations
The average groundwater wells capacity is not enough	The tests to be performed are not satisfactory	Project (and design) based on the mobilization of well has to be reshaped while other sources have to be looked for
No sufficient power to operate the wells	The Electricity company / authorities fail to provide enough energy for the Well and pumping stations and wastewater treatment.	Coordination, information and lobbying towards other project / donors (Belgium cooperation ?) Provision of stand by generators at early stages of programming
The organizational structures (JWSC) are not approved	An agreement between Municipalities, PWA and Ministry of Local Government is not been reached in the choice of options	Coordination meetings and support as proposed in the report (section 3) has to be implemented to reach agreement and implementation
The terrains needed for	Lack of funds or	It is assumed that the expected

construction of new reservoirs and wastewater treatment cannot be made available	willing or political capacity of the Municipality	benefits of the project for the Municipality will make it easy to dispose of the lands ; if not the case, the Ministry of Local Government should be in position to implement adequate measures to enforce the availability of the required terrains.
The budget for construction is exceeded after tendering process	Evolution in the overall economic and political context	The project has to be reshaped or other donors identified
The population does not apply for connections	Limited financial resources	Careful and continuous information has to provided in the context of the project assistance and Management
The population cannot afford the expected volumes consumed	Change in the socio economic conditions assessed	Conditions for access to the system should not exceed the current levels
Main authorities involved in the project do not agree on main issues	Project institutional arrangement are complex	Intense and permanent coordination is needed
The project implementation is to be interrupted due to the political situation		Flexibility and easiness is to be sought in the procedures and the project management
Not using treated wastewater in agriculture		Training the farmers and the people that treated wastewater can be used in agriculture
Lack of qualified staff and mismanagement of the project. The village couldn't pay the running cots.		Capacity building program and modifying the tariff.

7.4.1 Technical Risk

The Production Capacity

To date, as mentioned above, the capacity of the 2 wells foreseen for the project is not yet confirmed and additional tests have to be performed especially on water quality. There is a risk that after these additional tests one or both of the wells cannot provide the design flow rate of 200 m^3/h.

Actions and Recommendations

In this case, additional resources have to be sought and analyzed for potential mobilization ; in the specific case in study area, the utilization of the Al Farah well has to be seriously considered, not only from a complementary and« marginal » point of view (implying addressing the issue of water quality). This requires:

- Additional studies and hydraulic simulations with the rectified well capacity flow rates;
- Reshaping of the project and re-evaluation of costs._- Drilling new groundwater wells and insure enough water reaches the communities
- Building big storage reservoirs and insure water availability during emergency cases and water cuts.

7.4.2 Land Availability Risk

Availability of land is an issue for the construction of new reservoirs and wastewater treatment; it is not an issue for the laying of pipes which is proposed to be done under public roads and ways. The availability of terrains is not secured in some of the project villages.

Actions and Recommendations

Often, both political / local background and financial problems cause difficulties in the resolution of the issue. In the absence of external funding for land purchase, the Municipality and its parent Ministry of Local government will have to solve the issue and make available land satisfactory of the project needs.

7.4.3 External Assumption: The Energy Availability

It has been assumed in the project calculations that the energy requirements will be quickly unmet in the study area , it is understood that apart from the energy needed for the well and its pumping equipments and wastewater treatment , the other energy needs of the population are far to be met).

Actions and Recommendations

Permits and extension of power capacities are expected both from the Electrical Company of from the implementation of other projects. Project information and donor coordination is needed. Alternatively, the mobilization and implementation of generators could be considered for additional funding (from AFD or other donors).

7.4.4 Financial Risk and Funding Of Investment Costs

The budget for construction is exceeded after tendering process for main reasons (economical context, increase in the materials and goods,…).

Actions Recommended

At early stages of the project (from now on and during the detailed studies), close coordination and exchange of information should be implemented with other donors working and financing projects in the region / in the sector ; full description of those projects / donors have been made in a previous section ; in particular :

- Within the UNDP program, works are currently under executing to connect the Tammoun well to Tubas city ; extension should be looked for;
- NGO Care International has expressed interest for participation in the same project dealing with supply of study area;
- UNRWA is also interested to solve the wastewater problem in the area.

7.4.5 Affordability of Future Beneficiaries

Two aspects have to be considered:

- The access of population to the water supply through private connection;
- The affordability of population to pay the water bills.

These aspects have been assessed and proposals made in the course of the study:

- For access to individual connection, the willing / capacity has been surveyed as around 100 Euros (representing around the half, and therefore it is recommended for the project to finance the rest;
- For the rates, results of the survey are indicating that the population agrees to pay some 3 NIS/m^3, which is the figure in Tubas; nevertheless, it is expected from the financial analysis that this figure will be higher and closer from the figures of the present JWSC in West Jenin.

Actions and Recommendations

We are assuming that the figures of tariffs as per ongoing figures in Jenin (36NIS every 2 month) as a fixed rate giving 6 m3 and from 4,5 to 7 for the additional should not be exceed. Careful information and communication have to be implemented.

7.4.6 Political Risk

We include here the project local political / institutional issues and the general political situation.

7.4.7 Project Institutional Organization and Arrangements

The project is including authorities and stakeholders which are different and will have different places and shares in the project; they have to cooperate and join efforts to reach success of the project for the benefit of the villages and their population.

- PWA is producing the water and conveying it to the villages, until the meter at the entrance of the reservoir) ; PWA sells the water at around 3 NIS / cum, which is hardly sufficient to cover the energy costs in the project;
- The JWSC will distribute the water and charge the users according to tariffs decided by its board including the representatives of the Municipalities.
- The whole project is handled and managed by PWA. Although PWA has the overall management of the project, insufficient coordination with the other stakeholders could lead to difficulties in the project implementation.

Actions and Recommendations

As soon as of next steps such as detailed design, the beneficiaries Municipalities and future JWSC should be deeply included in the project for the components they will be in charge of, namely: reservoirs and distribution systems.

General Political Situation

The general situation in West Bank by mid of year 2009 as well as the uncertainties for the short and mid term future has just to be mentioned as an overall background for the project

7.5 Economic Justification of the Project

The economic justification of the project has to demonstrate if the subsidy requested is justified by the economic benefit generated by the project for the direct beneficiaries and, more widely, for society as a whole.

Economic Benefit of the Project and Beneficiaries

Those benefiting directly from the project are the households in the towns and villages in the 9 towns in the study area, indirectly, the local suppliers of the future structure that will operate. The results of the project are established by the difference between the economic flows with and without the project.

Amount of Water Supplied

The amount of water supplied without the project comes from the operation of:

- the existing well in Tammoun (140 m^3/h) and the near well in Tubas (150 m^3/h) for connected households (2 005 connections in 2008, up to 2 410 in 2015)
- and, for not connected households, half from the water purchased from tankers and half from rainfall. Water from tankers and rainfall is stored in cisterns of capacities in the range of 15 to 30 cum. The estimated consumption ratio for connected household is 30 lcd, and for not connected household 15 lcd (same figures as in the previous analysis)

The amount of water delivered with the project increase slightly up with to the population connection (100% connected to the network in 2015), and the consumption ratio, that grows from 67 l/c/d in 2010 to 90 lcd in 2025.

Price

The direct economic benefits are expressed:

- at market price, that is to say, by including the VAT if any (there is still no VAT in the water sector):
- at JSWC tariff for the households supplied by connections,
- at tankers' tariff for the households supplying by tankers, that is ILS/cum 10
- in 2006,
- at "shadow prices" for the rainfall, valued at the same tariff than the JSWC tariff (ILS/cum 5.0), because the first 15 liters per capita are essential needs.

Direct Economic Benefit of the Project

The economic benefits for the households are evaluated by multiplying the incremental amount consumed by the incremental price. The discount rate generally depends on the opportunity cost of the capital or the interest rate applicable to governmental bonds. This cost is difficult to assess in Palestine because no financial market exists and external funding (grants) are directly linked to specific investment (education, health, water, etc.). Thus, Norberto fix the discount rate applicable to the water sector, we have considered the value used generally for such project, i.e. 5% per year