WATER SUPPLY AND WASTEWATER SYSTEMS MASTER PLAN FOR THE BEKAA WATER ESTABLISHMENT

WASTEWATER ASSESSMENT REPORT

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THIS DOCUMENT IS PREPARED BY DAI/KREDO UNDER THE LEBANON WATER AND WASTEWATER SECTOR SUPPORT PROGRAM (LWWSS) FUNDED BY USAID

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BWE	BEKAA WATER ESTABLISHMENT
CDM	CAMP DRESSER & MCKEE
CDR	COUNCIL FOR DEVELOPMENT AND RECONSTRUCTION
DAI	DEVELOPMENT ALTERNATIVES, INC.
DAHNT	DAR AL HANDASAH NAZIH TALEB AND PARTNERS
GIS	GEOGRAPHIC INFORMATION SYSTEM
MEW	MINISTRY OF ENERGY AND WATER
O&M	OPERATION AND MAINTENANCE
USAID	UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT
YMCA	YOUNG MAN CHRISTIAN ASSOCIATION

1 INTRODUCTION

1.1 Background

On December 1st, 2012 KREDO has been commissioned by DAI to carry out the project entitled "Development of a Water Supply and Wastewater Systems Master Plan within the Service Area of the Bekaa Water Establishment" as part of the USAID – Lebanon Water Wastewater Sector Support Program (LWWSS). The scope of the current study is to establish water supply and wastewater master plans in order to support the Bekaa Water Establishment (BWE) decision-makers in the preparation of a rational infrastructure development and capital investment plan for water supply, water distribution, wastewater collection and wastewater treatment systems, as well as elements of an irrigation system. More specifically, the wastewater component encompasses the following activities:

- Collect existing studies concerning wastewater treatment plants, sewer networks, and planned discharge points as well as any existing master plans. Focus will be on recent and relevant studies.
- Collect information concerning wastewater treatment plants and sewer networks already executed.
- Determine current and future wastewater flow quantities based on population projections for the year 2035. The projected volumes of wastewater for every village and by region shall be calculated.
- Make recommendations for improvements to the sewage system and wastewater treatment plants according with the National Water Sector Strategy and the BWE 2012-2016 Business Plan, and present these recommendations in a schedule of CAPE and OPEX along with their timing.
- Evaluate funding mechanisms for all recommended actions.

This report presents the results of the data collection campaign regarding the existing and planned sewer networks as well as the existing and planned wastewater treatment plants in the Bekaa. It is divided in 8 chapters and an appendix. Chapter 1 gives a general overview of the activities undertaken in order to arrive at the description of the current status of the wastewater sector in the Bekaa. Chapters 2, 3, 4, 5, and 6 present in details the results of the data collection campaign regarding sewers and wastewater treatment plants for the cazas of Hermel, Baalbeck, Zahle, West Bekaa, and Rachaiya, respectively, Chapter 7 summarizes the findings of this campaign and gives general comments and recommendations concerning the existing situation and the future, and Chapter 8 presents the next activities to be undertaken.

1.2 Sewer Networks

The status of the sewer networks in the Bekaa proved extremely difficult to assess. The information is virtually non-existent at the BWE, the CDR, or any other relevant authority, except for the city of Baalbeck. For the other communities, a colossal effort was deployed to gather bits and pieces of information and transform them into a coherent picture. Some of the data was obtained in hardcopy format while some was obtained in AutoCAD format. Both had to be transformed into a GIS format which was a tedious and time-consuming task.

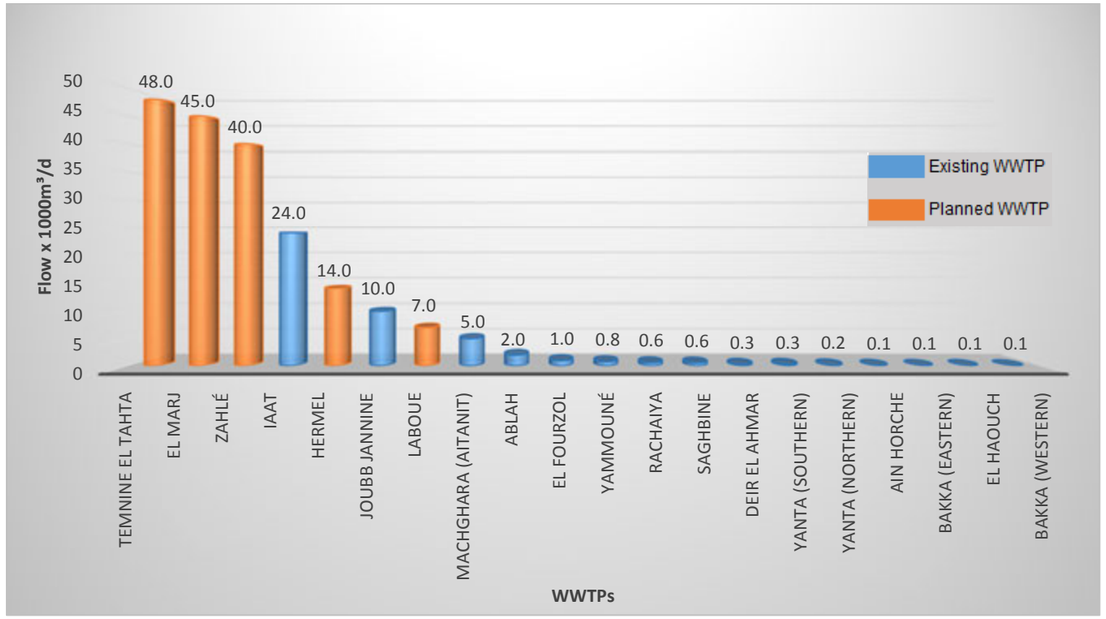
In view of the lack of information available, a data collection campaign was conducted with a large number of municipalities. This campaign comprised two components: a written questionnaire and a phone interview. Questions focused on the wastewater disposal method used by the village (septic tanks, sewer networks, wastewater treatment plant), as well as the status of the existing sewer network wherever it exists. Over the phone, the municipalities were also requested to provide a copy of their sewer network map, if available. The results of this data collection campaign in each caza are summarized in a table included in each of Chapters 2 to 6. It can be noticed from the entries in these tables that most municipalities were not cooperative, and virtually none (except for Hazerta in Baalbeck) provided any maps. Some municipalities gave as much information as available to them, others gave partial or sketchy information, while the rest did not answer the questions either on the phone or in the questionnaire.

Chapters 2 to 6 include plans that present the information gathered from municipalities, the CDR, the BWE, the MEW, as well as various contractors. This information consists in the following: layout of existing sewers (old or new); layout of planned sewers (studied by the CDR but not executed yet); status of each community (sewered or not); discharge location for each sewered community (treatment plant, or river/valley); and location of wastewater treatment plants (existing or planned).

1.3 Wastewater Treatment Plants

As mentioned in the Inception Report, the information regarding the wastewater treatment plants in the Bekaa is conflicting. Different official sources list different treatment plants. Even different documents from BWE do not give the same information. Moreover, the description of the plants status (construction date, under construction, operational, etc.) was inaccurate and diverging between different sources. Site visits were conducted at various plants by a KREDO wastewater specialist accompanied by the plant operator. These visits, along with an intensive data collection campaign allowed for a clearer image of the real situation prevailing in the Bekaa. Table 1-1 below lists all the existing and planned treatment plants along with their size, design capacity, and a description of their status. In Chapters 2 to 6, each one of these plants is described (design population and capacity, background, process description). For existing plants, an assessment of the plant's current status and recommendations for improvements are given. The detailed description of each plant process and operation are included in the appendix. Pictures taken during the site visits are also included.

Figure 1-1 is a bar chart depicting the existing and planned wastewater treatment plants and their design capacities, while Plan 1-1 shows the location of the existing and planned sewer networks (whenever available) for the Bekaa as a whole.

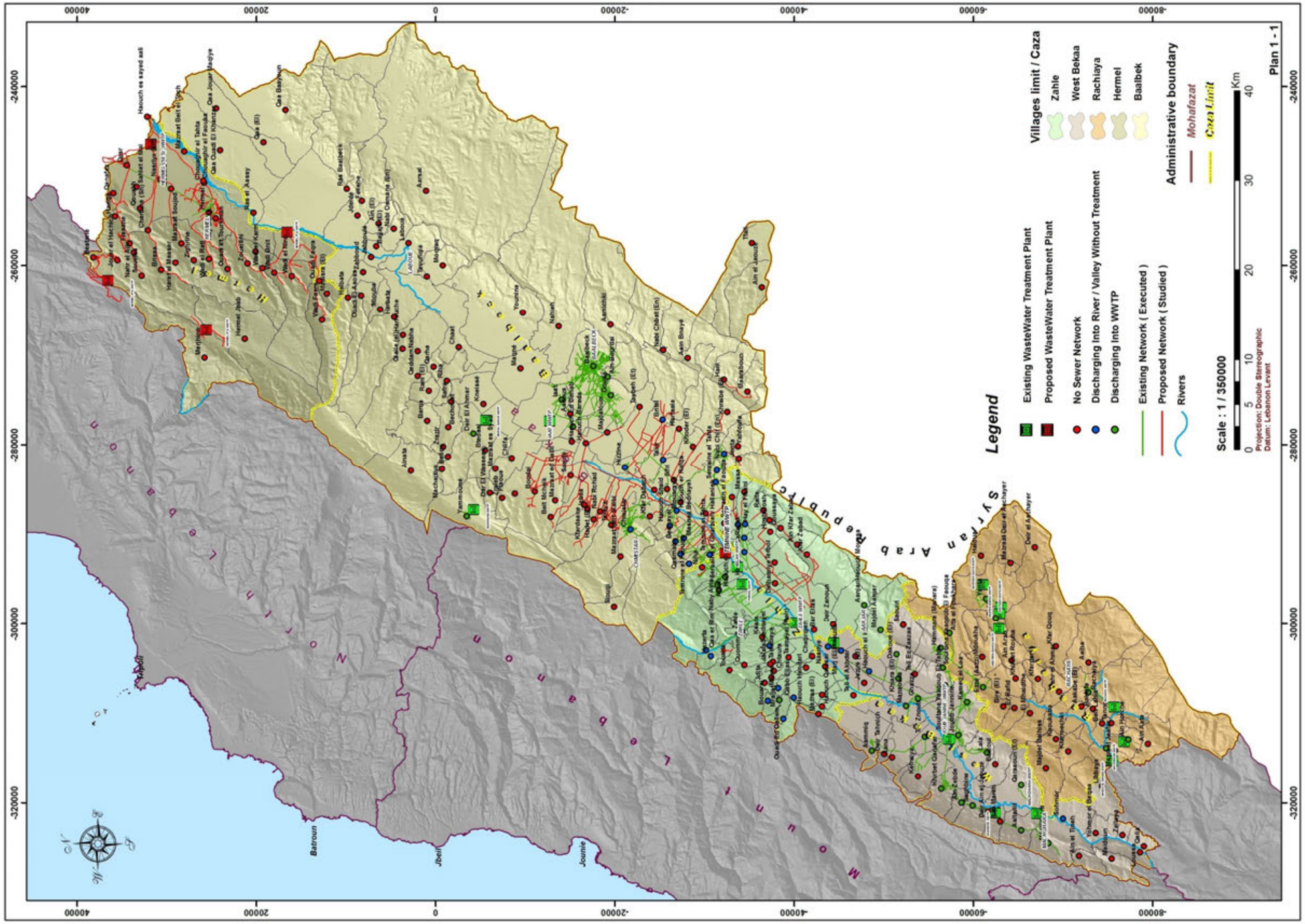


* A very small WWTP was built by USAID in Rachaiya. The CDR plans to build a larger WWTP which is still at the conceptual stage.

FIGURE 1-1: EXISTING AND PLANNING WWTPS DESIGN CAPACITY IN THE BEKAA

TABLE 1-1: WASTEWATER TREATMENT PLANTS IN THE BEKAA

Caza	Area	Size (Population Original Assigned)	Design capacity (m^3/day)	Status
Hermel	Hermel	96,200	14,000	Planning stage. 3 additional plants planned but only their locations are available.
Baalbeck	Deir el Ahmar	3000	300	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	Iaat	166,900	24,000	Construction completed in year 2007 and partial operation and maintenance (CDR).
	Laboué	53,000	7,000	Planning stage - No information available – According to CDR, might not be executed due to controversial sources of funding (Iran)
	Temnine El Tahta	297,585	48,240	Location selected (CDR) Treatment process not selected yet
	Yammoune	5836	788	Construction completed in year 2007 and outsourcing of operation and maintenance (CDR) until March 2011 then by MEW until now
Zahle	Ablah	14,630	2,000	Construction completed in year 2007 and handed over to Municipality (funding from USAID)
	El Fourzol	7,400	1,000	Construction completed in year 2007 and handed over to Municipality (funding from USAID) Outsourcing of operation and maintenance with funding by Ablah Municipality
	Majdel Anjar /El Marj	302,210	45,000	Planning stage.
	Zahle	274,000	40,000	Under construction
West Bekaa	Joubb Jannine	67,000	10,000	Construction completed in year 2010 and partial operation and maintenance (CDR).
	Machghara (Aitanit)	35,700	5,000	Construction completed in year 2007 and handed over to Municipality (funding from USAID)
	Saghbine	3,733	560	Construction completed in year 2010 and partial operation and maintenance (CDR)
Rachaiya	Ain Horche	1,000	120	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	Bakka (Eastern)	1000	100	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	Bakka (Western)	600	60	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	El Haouch	1000	100	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	Rachaiya	6,000	600	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	Yanta (Northern)	2000	200	Construction completed in year 2005 and handed over to Municipality (funding from USAID)
	Yanta (Southern)	3000	300	Construction completed in year 2005 and handed over to Municipality (funding from USAID)



PLAN 1-1: WASTEWATER SYSTEMS FOR THE BEKAA

2 HERMEL CAZA

2.1 Sewer Networks

The data collection campaign carried over the course of several months included various undertakings, among which the survey conducted with municipalities through the questionnaires and the phone interview. Table 2-1 summarizes the results of this survey.

There are no existing sewers in the caza of Hermel, except for an old and unused network in the city of Hermel. However, studies have been carried out by the CDR for sewer networks in most of the communities, and for a wastewater treatment plant to serve the city of Hermel and its surroundings. These are indicated as “Planned Design” in the “Network Maps Availability Status” column in Table 2-1

Figures 2-1 and 2-2 show respectively the percentages of population and of villages in the caza of Hermel served by existing or planned sewer networks. Form these pie charts it is noted that 12 % of the Hermel population, corresponding to 35 % of the caza villages is not served by any existing or planned networks.

Plans 2-1 and 2-2 show the layout of the existing and planned sewer networks (whenever available) for the caza of Hermel as a whole and the city of Hermel, respectively.

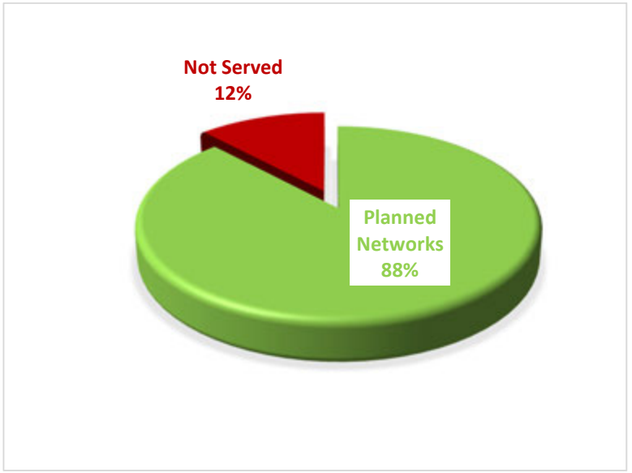


FIGURE 2-1: PERCENTAGE OF POPULATION SERVED BY SEWER NETWORKS IN HERMEL CAZA

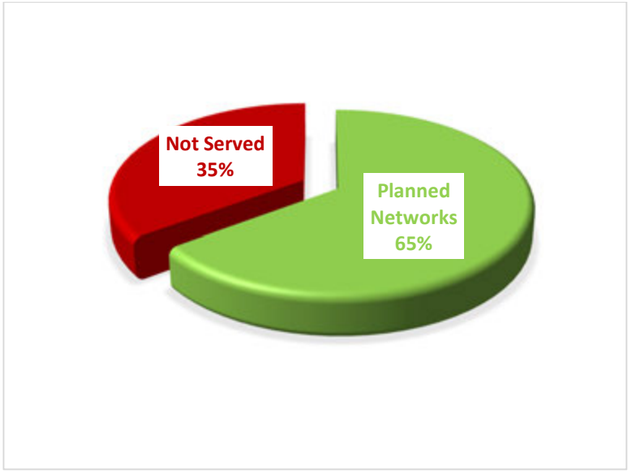
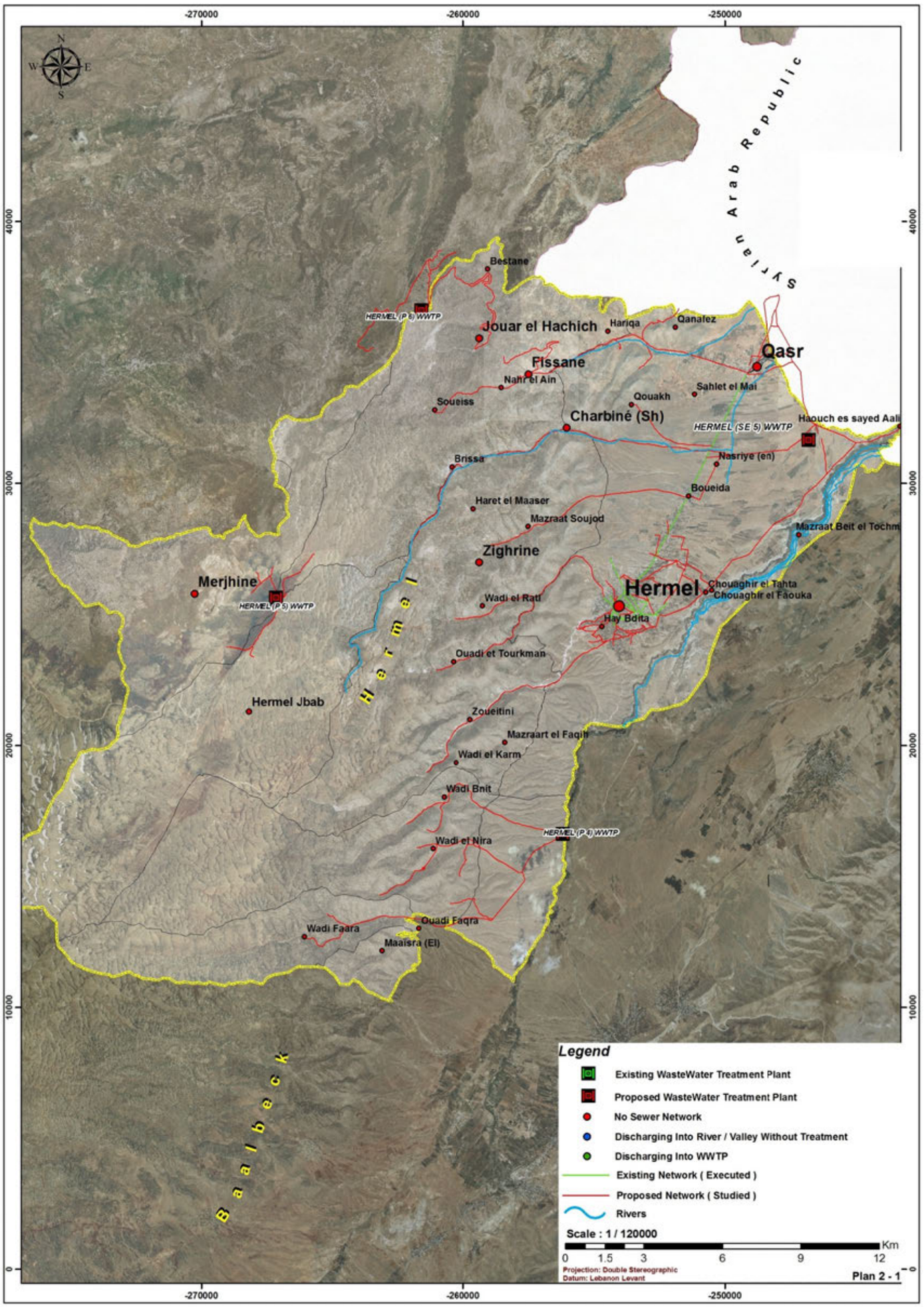


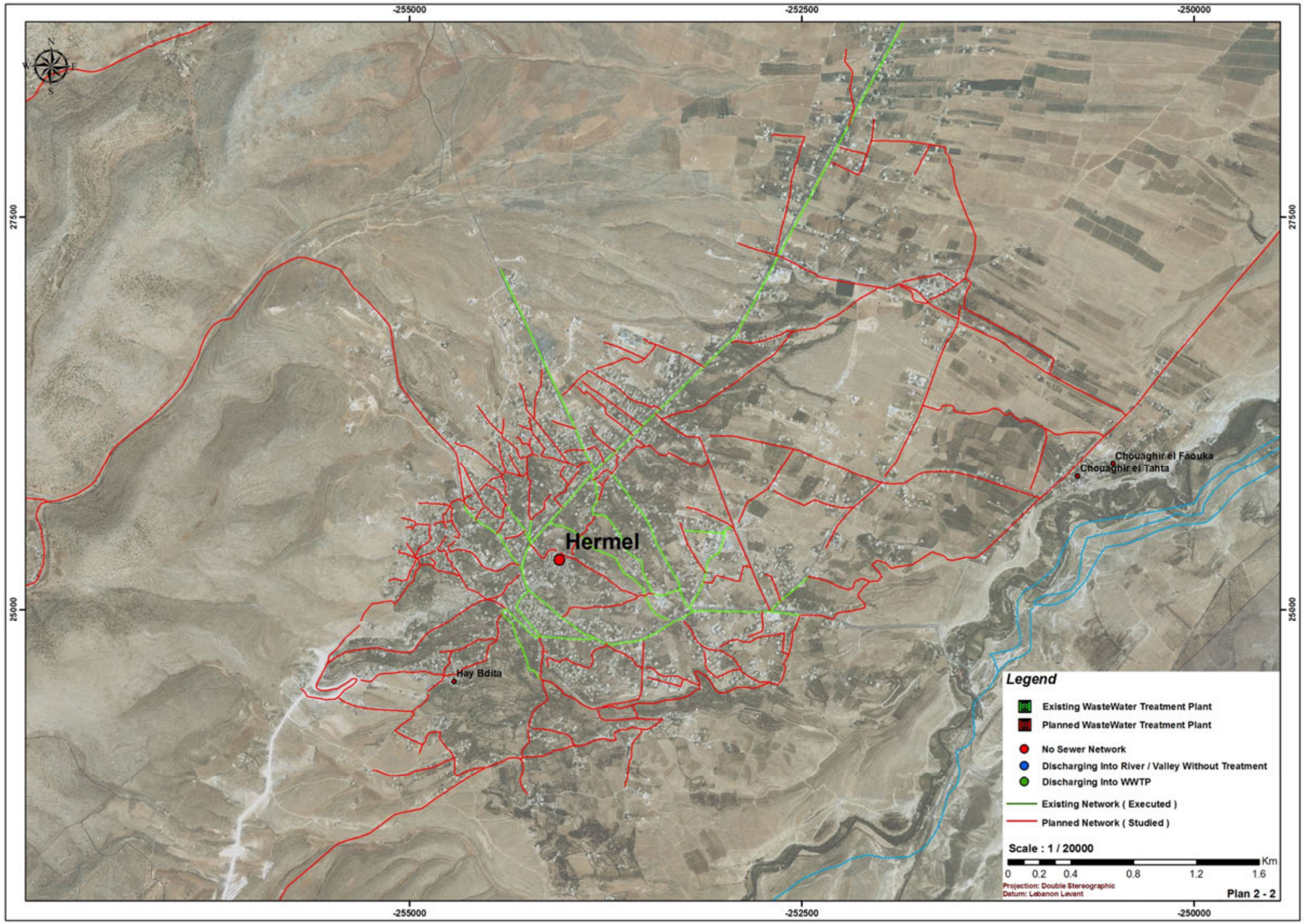
FIGURE 2-2: PERCENTAGE OF VILLAGES SERVED BY SEWER NETWORKS IN HERMEL CAZA

TABLE 2-1: WASTEWATER NETWORK STATUS IN CAZA OF HERMEL

Caza		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Hermel	1	Jouar el Hachich (El Haref - El Zakiyah - El Hawchariya - Sahlat El Maa - Qanafez)	No Answer	No	—	—	—	—	Obtained – Planned Design
	2	Chouaghir El Faouka - and El Tahta	No Answer	No	—	—	—	—	Obtained - Planned Design
	3	Hermel	No Answer	Yes	1980s	No Answer	* Network is unused (Bad condition)	Not Available at Municipality	Obtained - Planned Design & Main Existing Lines



PLAN 2-1: WASTEWATER SYSTEMS FOR CAZA OF HERMEL



PLAN 2-2: WASTEWATER SYSTEMS FOR CAZA OF HERMEL - HERMEL CITY

2.2 Hermel Wastewater Treatment Plants

There are four planned wastewater treatment plants for the caza of Hermel, However only the one serving the city of Hermel and its surroundings has been designed by the CDR (indicated as SE 5 in Plan 2-1). As for the other three, the available information is their locations and the villages they will be serving only. This information was obtained from the map of planned sewers provided by the CDR. These four wastewater treatment plans serve 80% of the Hermel population but only 24% of the Hermel villages as can be seen from the pie charts in Figures 2-3 and 2-4.

Plans 2-1 and 2-2 show the location of the existing and planned wastewater treatment plants for the caza of Hermel as a whole and the city of Hermel, respectively.

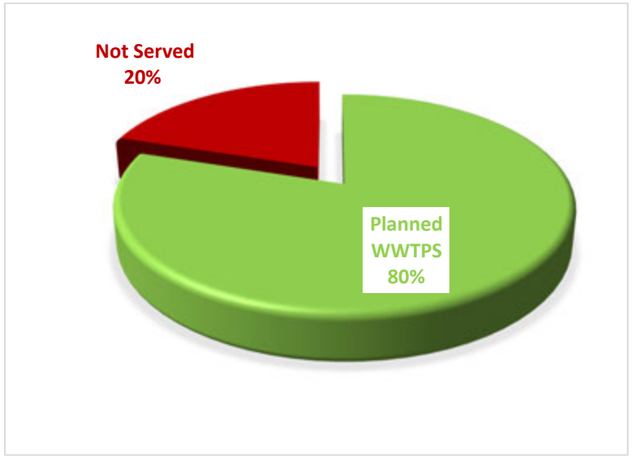


FIGURE 2-3: PERCENTAGE OF POPULATION SERVED BY WWTPS IN HERMEL CAZA

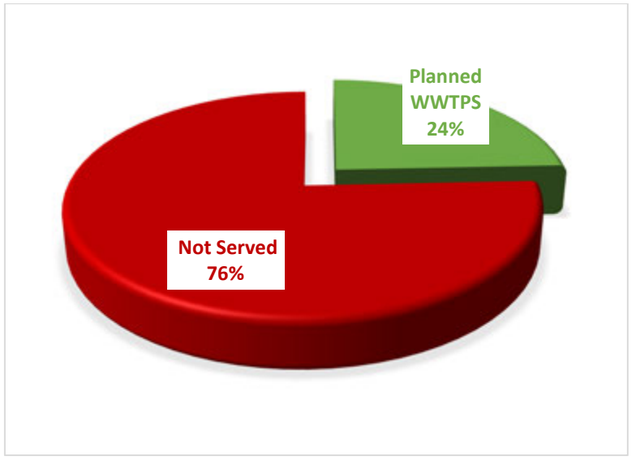


FIGURE 2-4: PERCENTAGE OF VILLAGES COVERED BY WWTPS IN HERMEL CAZA

2.3 Hermel Wastewater Treatment Plant (HWWTP)

2.3.1 Current Status

The Hermel Wastewater Treatment Plant (HWWTP, x = -246,337.46 , y = 31,822.00) is a tertiary treatment plant with a rated capacity of 14,000 m^3/d intended to serve ultimately 96,200 persons at a rate of 146 liters/person/day in the year 2025.This plant is not yet implemented yet but it is designed on the conventional activated sludge process. It will receive wastewater from the city of Hermel and its surroundings. This WWTP will be implemented by the CDR along with a sewer network for the serviced locations.

The plant components are as follows:

1. Coarse and fine inlet screens with a mechanical scraper, screenings washing and compaction plant;
2. Aerated grit removal chamber;
3. Grease and oil trap;
4. Primary clarifiers;
5. Aeration tanks;
6. Secondary clarifiers;
7. Chlorine contact tanks;
8. Raw sludge thickeners;
9. Aerobic sludge digesters;
10. Centrifuges.

A detailed description of the plant design and process is included in the Appendix.

2.3.2 Recommendations

As this plant is not constructed yet, the following recommendations concern its design.

1- Use the anaerobic sludge digestion technique with complete mixing as the aerobic sludge digesters consume a large quantity of electrical power to run the air blowers. This will reduce the power consumption and produce a combustible gas (methane) that should be used to raise the temperature of the sludge inside the anaerobic sludge digester.

2- Use sludge drying beds instead of the sludge dewatering unit. That alternative is more land demanding however it is more conservative in power consumption and the quantity of polymers needed. It is believed that land availability is not an issue in Hermel.

3 BAALBECK CAZA

3.1 Sewer Networks

As mentioned earlier, the data collection campaign carried over the course of several months included various undertakings, among which the survey conducted with municipalities through the questionnaires and the phone interview. Table 3-1 summarizes the results of this survey. As can be seen, a large number of municipalities answered, either in the questionnaire or over the phone, that they do not have a sewer network. For those, if no information could be found regarding any planned designs at the CDR or other relevant authority, then the notation "No Available Information" is listed in the "Network Maps Availability Status" column. For the majority of those cases, there are actually no planned studies. However, this notation was adopted in case any new information is discovered at a later stage. For the municipalities that answered that they do have a network but that it is very old, efforts were deployed to obtain the network maps. For some, these efforts were successful. However, for those villages were efforts were not successful, no further efforts will be spent in that regard as recommendations will be to disregard the old network and propose a new one. Of the 18 municipalities that answered affirmatively regarding the existence of a sewer network, the layout could be obtained for all but two, namely Deir el Ahmar and En Nabi Osmane where the networks are reportedly 12 and 20 years old, respectively. Of those two, only Deir el Ahmar is operational and so the existing En Nabi Osmane network will be disregarded. For the other 16 sewered municipalities, as-built drawings were obtained for most, while design maps were obtained for those where the sewers are relatively new such as Jenta and El Khoder.

Figures 3-1 and 3-2 show that 40% of the Baalbeck population, representing 71% of the caza villages, is not served by any sewers (existing or planned). It is noted that the existing sewers include both old and new sewers, as well as networks that are planned to be rehabilitated or expanded. However, networks that were declared by the municipalities to be non-operational are not included in this category.

Plans 3-1, 3-2, and 3-3 show the layout of the existing and planned sewer networks (whenever available) for the caza of Baalbeck as a whole, the city of Baalbeck, and the area of south Baalbeck, respectively.

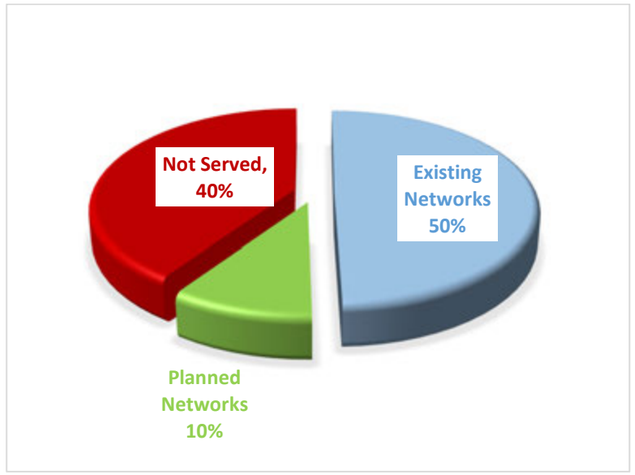


FIGURE 3-1: PERCENTAGE OF POPULATION SERVED BY SEWER NETWORKS IN BAALBECK CAZA

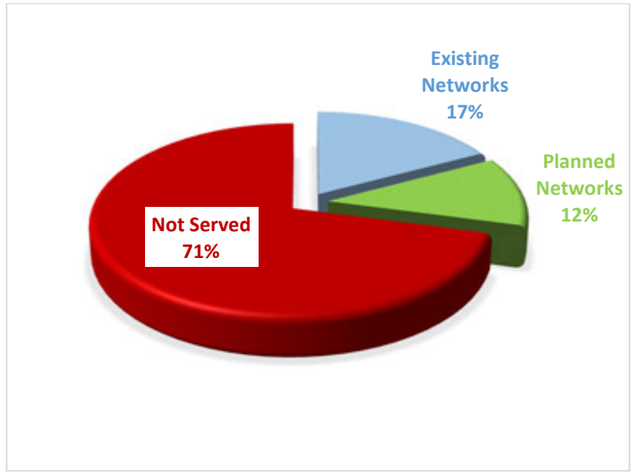


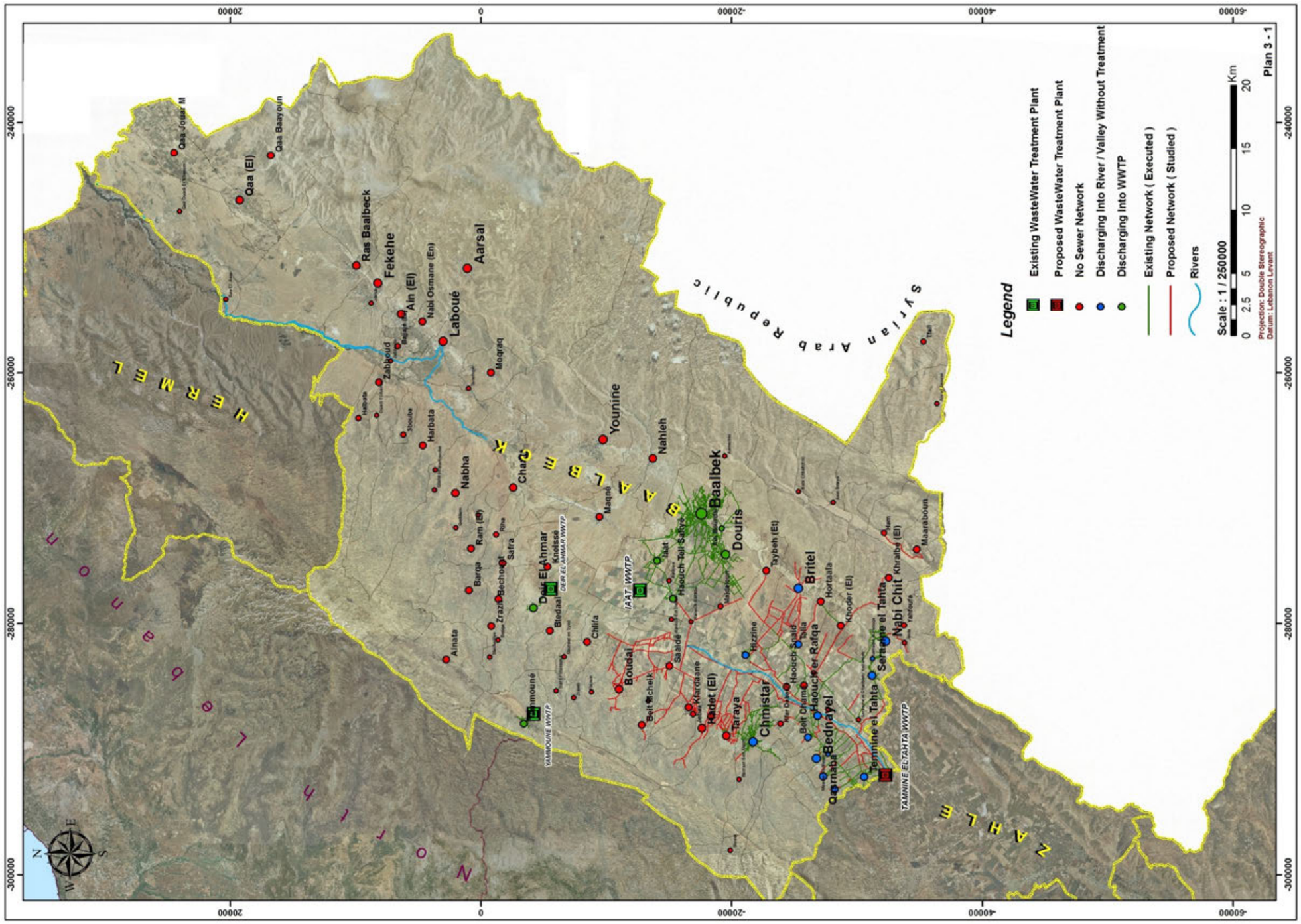
FIGURE 3-2: PERCENTAGE OF VILLAGES SERVED BY SEWER NETWORKS IN BAALBECK CAZA

TABLE 3-1: WASTEWATER NETWORK STATUS IN CAZA OF BAALBECK

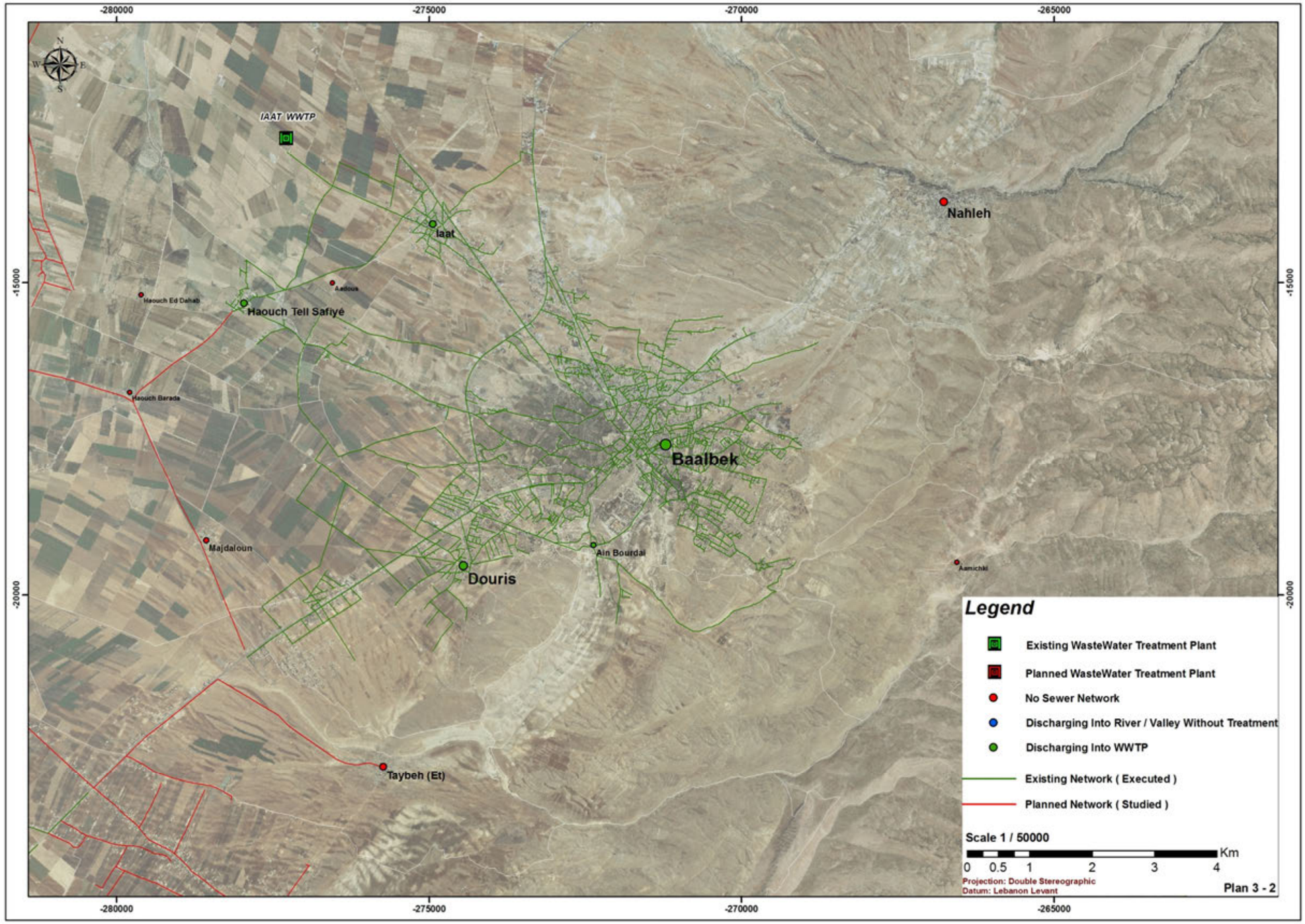
		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Baalbeck	1	**Aarsal**	Yes	No	__	__	__	__	No Available Information
	2	**Ain (El)**	No Answer	No	__	__	__	__	No Available Information
	3	**Ainata**	Yes	No	__	__	__	__	No Available Information
	4	**Baalbeck**	No Answer	Yes	Very old	WWTP in Iaat Village - Not Completed	No Answer	Did not call - Data available already	Obtained - Existing Network
	5	**Barqa**	No Answer	No	__	__	__	__	No Available Information
	6	**Bechouat**	Yes	No	__	__	__	__	No Available Information
	7	**Britel**	No Answer	Yes	2002	Litani River	No Answer	Not Cooperative	Obtained - Existing Network (main lines only) Obtained - Planned Design 2012
	8	**Btedaai**	No Answer	No	__	__	__	__	No Available Information
	9	**Chaat**	No Answer	No	__	__	__	__	No Available Information
	10	**Chlifa**	No Answer	No	__	__	__	__	No Available Information
	11	**Chmistar**	No Answer	Yes	12 years old	Litani River	No Answer	Not Cooperative	Obtained - Existing Network (main lines only)
	12	**Deir el Ahmar**	Yes	Yes	12 years old	Deir el Ahmar WWTP	* Sewer network is in medium condition. * Only 4 Km of 16 km were executed. * WWTP has a capacity for around 2000 people.	Promised to help but did not follow through	Not Obtained
	13	**Douris**	No	Yes	__	__	__	Not Cooperative	Obtained - Existing Network (discharging into WWTP)
	14	**Fekehe**	No Answer	No	__	__	__	__	No Information Available
	15	**Hadet (El)**	No Answer	No	__	__	__	__	No Information Available
	16	**Haouch Barada**	Yes	No	__	__	__	__	Obtained - Planned Network (main lines only)

		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Baalbeck	17	**Haouch Er Rafqa**	No Answer	Yes	13 years old	Litani River	No Answer	Not Cooperative	Obtained - Existing Network
	18	**Haouch Snaid**	No Answer	No	__	__	__	__	No Information Available
	19	**Haouch Tell Safiyé (Aaddous)**	Yes	Yes	2007	Iaat WWTP	* The main pipe sizes are 16" and 8". * There are some problems with the network.	Not Cooperative	Obtained - Existing Network
	20	**Harbata**	No Answer	No	__	__	__	__	No Information Available
	21	**Hizzine**	No Answer	Yes	12 years old	Litani River	No Answer	Promised to help but did not follow through	Obtained - Existing Network
	22	**Iaat**	No Answer	Yes	4 year Old	Iaat WWTP	* Network is in bad condition	Told us to go to CDR	Obtained - Existing Network
	23	**Jabboulé**	No Answer	No	__	__	__	__	No Information Available
	24	**Jebaa**	No Answer	No	__	__	__	__	No Information Available
	25	**Jenta**	No Answer	Yes	1 year old	Into 3 reservoirs built by Municipality	No Answer	Not Cooperative	Obtained - 2012 Planned Design (main lines only)
	26	**Khoder (El)**	No Answer	Yes	1 year old	No Answer	No Answer	Told us to contact Nasma Company	Obtained - 2012 Planned Design (main lines only)
	27	**Khraibé (El)**	No Answer	No	__	__	__	__	No Information Available
	28	**Maaraboun**	No Answer	No	__	__	__	__	Obtained - Planned Design (main lines only)
	29	**Majdaloun**	No	No	__	__	__	__	Obtained - Planned Design (main lines only)
	30	**Maqné**	No Answer	No	__	__	__	__	No Information Available
	31	**Nabha**	No Answer	No	__	__	__	__	No Information Available
	32	**Nabi Chit (En)**	No Answer	Yes	1 year old	Litani River	No Answer	Told us to call Al Bunyan Contractors	Obtained - Existing Network
	33	**Nabi Osmane (En)**	No Answer	Yes	1993	No Answer	* Network is very old and not operational	Told us to call Nazih Braydi Company	Not obtained – Nazih Braydi said plans do not exist

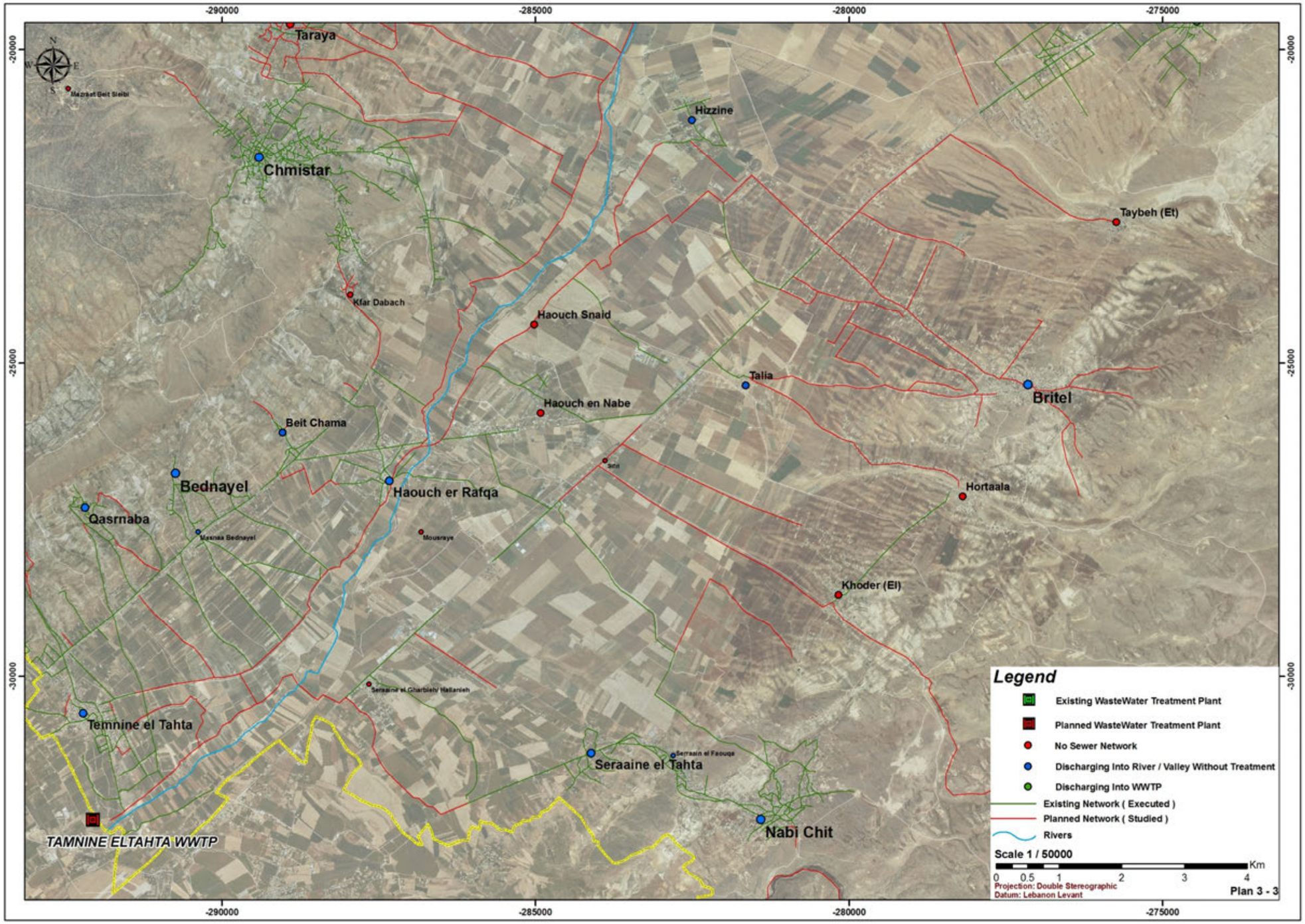
		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Baalbeck	34	**Nahlé**	Yes	No	__	__	* In winter pits are discharging into storm channels then to the river.	__	No Information Available
	35	**Qarha**	Yes	No	__	__	__	__	No Information Available
	36	**Qasrnaba**	No Answer	Yes	2004	Litani River	* Part of the network is in good condition * Some sewer lines are not executed	Told us to contact Dar Al Handasah	Obtained - Existing Network
	37	**Ram (El)**	Yes	No	__	__	__	__	No Information Available
	38	**Ras Baalbeck**	Yes	No	__	__	__	__	No Information Available
	39	**Saaidé**	No Answer	No	__	__	__	__	No Information Available
	40	**Seraain EL Tahta & El Faouka**	No Answer	Yes	10 years old	Litani River	No Answer	Promised to help but did not follow through	Obtained - Existing Network
	41	**Seraaine el Tahta (Serraain el Faouka)**	No	Yes	2010 - 2012	Litani River	* Sewer network is in good condition. * Its length is around 3.5 km and maximum pipe diameter is 8".	Not Cooperative	Obtained - Existing Network
	42	**Talia**	No Answer	Yes (main lines only)	No Answer	No Answer	No Answer	Told us to contact CDR & Nasma Contractors	Obtained - Planned Design (main lines only)
	43	**Taraya**	No Answer	No	__	__	__	__	No Information Available
	44	**Temnine El Faouqa**	No Answer	Yes (Partial)	20 years old	Litani River	* Just main line and some houses are connected to the network.	Not Cooperative	Obtained - Existing Network
	45	**Temnine El Tahta**	No Answer	Yes	1990	Litani River	No Answer	Told us to contact Ministry of Energy and Water	Obtained - Existing Network
	46	**Zabboud**	No Answer	No	__	__	__	__	No Information Available
	47	**Zrazir**	No	No	__	__	__	__	No Information Available



PLAN 3-1: WASTEWATER SYSTEMS FOR CAZA OF BAALBECK



PLAN 3-2: WASTEWATER SYSTEMS FOR CAZA OF BAALBECK - BAALBECK CITY



PLAN 3-3: WASTEWATER SYSTEMS FOR CAZA OF BAALBECK - SOUTH

3.2 Baalbeck Wastewater Treatment Plants

Some of the existing sewers in the caza of Baalbeck discharge into operational wastewater treatment plants, while others discharge into water courses or valleys. There are three existing treatment plants in the caza of Baalbeck, namely Deir el Ahmar, Iaat, and Yammoune. They vary greatly in size and are operational to different degrees. A technical report about each is included in sections 3.3 to 3.5 and a detailed description of the process and operational details of each plant is included in the Appendix. One additional treatment plant located in Temnine El Tahta has been approved by the CDR and is currently being studied by DAHNT. The location of the plant has been selected. It will be located partially in Temnine El Tahta and partially in En Nabi Ayla (caza of Zahle). The treatment process to be adopted has not been decided upon yet. This plant is intended to serve the localities of Temnine El Tahta, Temnine El Faouqa, En Nabi Chit, Serraine El Tahta, Serraine El Faouqa, Chmistar, Bednayel and some small nearby villages. Apparently, a treatment plant in Laboué had originally been planned for. However, no documents could be found for this plant, and according to the latest information obtained orally from the CDR, there is no plan to go ahead with this WWTP for the time being as there is some controversy about its intended funding source (Iran). Figures 3-3 and 3-4 show that 50% of the Ballbeck population, corresponding to 79% of the caza villages, is not served by any existing or planned wastewater treatment plant. It is important to note that the planned sewers are sometimes discharging into an existing wastewater treatment plant and hence the percentage of the population they serve does not correspond to that of the population served by planned wastewater treatment plants.

Plans 3-1, 3-2, and 3-3 show the location of the existing and planned wastewater treatment plants as well as the layout of the existing and planned sewer networks (whenever available) for the caza of Baalbeck as a whole, the city of Baalbeck, and the area of south Baalbeck, respectively.

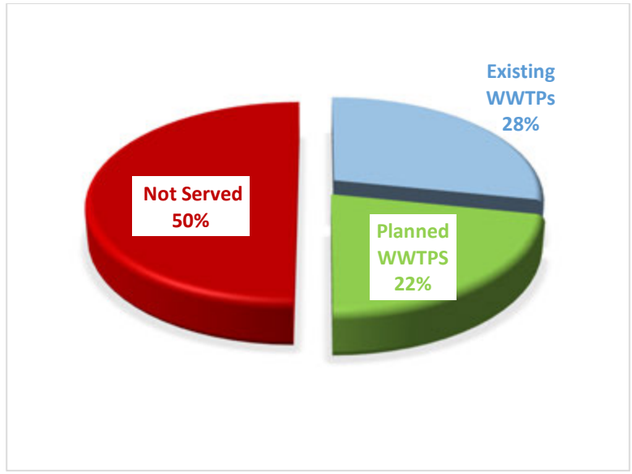


FIGURE 3-3: PERCENTAGE OF POPULATION SERVED BY WWTPS IN BAALBECK CAZA

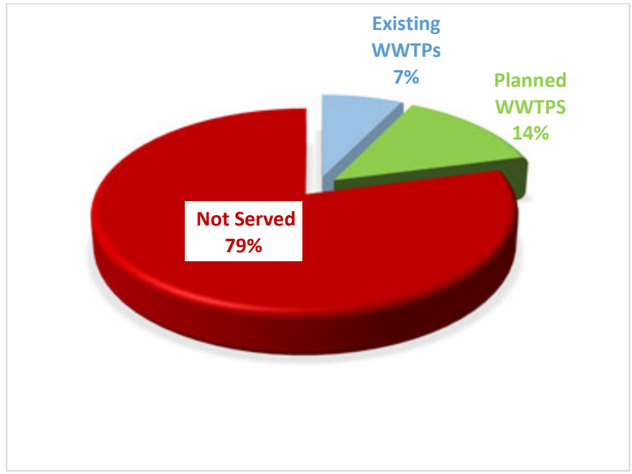


FIGURE 3-4: PERCENTAGE OF VILLAGES SERVED BY WWTPS IN BAALBECK CAZA

3.3 Deir El Ahmar Wastewater Treatment Plant (DAWWTP)

3.3.1 Current Status

Deir el Ahmar Wastewater Treatment Plant (DAWWTP, x = -277,178.12, y = -5,584.46) is a Secondary treatment plant with a rated capacity of 300 m^3/d to serve ultimately 3,000 persons at a rate of 100 liters/person/day in the year 2025. It serves the village of Deir el Ahmar (caza of Baalbeck) through a 15.5 km long network. The plant currently receives 180 m^3/d (which is 60% of its capacity). The facility was constructed in 1998 and designed as a Hans Bioshat Reactor treatment process. Creative Associates association and USAID were in charge of design and construction and the Deir el Ahmar municipality is in charge of operating and maintaining the plant.

The process of treatment is called the Hans-Reactor system. It is based on the extended aeration process principle. This proprietary method has not proven to be functional and is not adopted by the industry. This plant is not operating properly and works at 60% of its maximum capacity. The operation team is not able to operate the plant 24/24 hours as they do not have a backup generator. In principle, the municipality of Deir el Ahmar is in charge of directing this facility, however in fact no one is taking care of it and it is in a very poor condition. The effluent is discharging in an open channel.

Upon the site visit, the following was noted:

- A strong stench engulfs the vicinity of the plant.
- The treated wastewater is still black.
- There is no permanent staff at the plant.
- No sludge treatment unit is found inside the plant.
- Sludge has been accumulating since the plant started operating. Sludge has never been removed.

3.3.2 Proposed Improvements

In order for this plant to become operational, the following measures should be undertaken:

- The plant should be redesigned to achieve the standards of the secondary treatment.
- Sludge treatment unit should be implemented.
- Backup generator should be available on site as well as full-time operators.
- The steel reservoirs should be emptied and painted.

However, it is recommended that this plant be abandoned. A new wastewater treatment plant or a lifting station to pump the flow to the nearest wastewater treatment plant should be constructed.

3.4 Iaat Wastewater Treatment Plant (IWWTP)

3.4.1 Current Status

IAAT Wastewater Treatment Plant (IWWTP, x = -277,283.97, y = -12,692.58) is a tertiary treatment plant with a rated capacity of 24,000 m^3/d intended to serve ultimately 166,900 persons at a rate of 140 liters/person/day in year 2022. The wastewater flows by gravity from the following villages through sewer networks of various lengths: Baalbeck (18 km), Iaat (23 km), Douris (42.5 km), Ain Bourdai (9.2 km), Aadous and Haouch Tell Safiyé (7.2 km). The facility was constructed in 2007. It uses the activated sludge treatment process and is connected to the villages by a sewer network of around 99.9 km. The CDR was in charge of designing, building, and maintaining this facility.

The plant components are as follows:

1. Inlet screen with mechanical scraper, screenings washing and compaction plant.
2. Cross flow grit removal chamber (detritor) with rotating scraper, grit pumps and grit classifier.
3. Two oxidation ditches.
4. Two final settlement tanks.
5. Return activated sludge pumping station.
6. Surplus activated sludge pumping station.
7. Two gravity, picket fence sludge thickening tanks.
8. Two aerobic sludge treatment tanks with a floating surface aerator.
9. Sludge drying unit.

Engineer Yasser Omeyra (71-360201) is in charge of directing this facility on behalf of the contractor "Farhat Group". The operating team is one engineer, one lab operator, two foremen and four workers over two shifts. The effluent is discharging in an open channel.

The problems observed during the site visit can be summarized as follows:

1- The operation team is not able to operate the plant 24/24 hours due the failure of electrical current and the unavailability of fuel oil for the electrical generator.
2- The operation team does not have the experience required to compensate the failure of electricity by operating the generator the minimum time required to maintain the process working properly.
3- The dissolved oxygen meters are not operational.
4- The aeration ducts are installed under the sun light without any shield. This increases the temperature of the pressurized transferred air and leads to big losses in the oxygen pumped into the water as the concentration of oxygen decreases at higher temperatures.
5- The access road is in bad condition.
6- As the influent flow is less than 50% the operator is using only one treatment line out of two.

7- During the summer, local farmers divert the wastewater to the fields for irrigation purposes before reaching the plant. This decreases even more the influent flow.

3.4.2 Proposed Improvements

In order to improve the operation of the Iaat WWTP and protect the environment, it is recommended that the following measures and actions be undertaken:

1. Provide the plant with four dissolved oxygen meters to control the operation time of the blowers. This will allow the supply of the wastewater with the optimal quantity of oxygen.
2. Provide the plant with fuel oil to generate electricity 24 hours per day.
3. Install a cover above the air duct to avoid sun light and provide around 5 cm space to allow the air to flow between the shield and the pipe to reduce heating of the pipe to the minimum.
4. Pour 20 cm of reinforced concrete over the drying bed bottom to avoid any ground infiltration.
5. Minimize the concentration of sodium hypochlorite at the disinfection zone to reduce its residual amount, hence reducing any harm to the trees and the plants irrigated with the effluent.
6. Provide the access road over a length of 2000 m with a compacted base coarse layer 4.5 m in width 20 cm in thickness and an asphalt layer at least 3.5 m in width and 5 cm in thickness after compaction.
7. Paint the plant buildings.
8. Avoid adding $CaCO_3$ to the sludge in case of re-use it in agriculture.
9. Construct open ponds to stock the treated water during winter, Pump the treated water from the plant upstream either to the open ponds in the various villages or directly into irrigation channels.

3.5 Yammoune Wastewater Treatment Plant (YWWTP)

3.5.1 Current Status

The Yammoune Wastewater Treatment Plant (YWWTP, x = -287,188.60, y = -4,227.55) has a rated capacity of 788 m^3/d. It is designed to serve ultimately 5836 persons at a rate of 135 liters/person/day in the year 2022. It serves the village of Yammoune through an 8 km long network and is located northeast of the village. The facility was constructed in 2005 and designed on the activated sludge treatment process principle. The CDR was in charge of design and construction and is currently responsible for maintaining this facility.

The plant is operational at less than one tenth of its maximum capacity: it currently treats around 50 cubic meters per day. This plant is not operated continuously as the lifting pump stations do not pump the wastewater permanently to the treatment plant. The effluent is discharging in the Yammoune Lake.

Problems observed during the plant visit can be summarized as follows:

- The operation team is left alone without any back up from the contractor.
- The lifting pump stations do not operate permanently.
- The failure of electricity is highly affecting the operation time. There is no fuel available to operate the electrical generator.
- The dissolved oxygen meters are not operational.

3.5.2 Proposed Improvements

In order to improve the operation of the Yammoune WWTP and protect the environment, it is recommended that the following measures and actions be undertaken:

1. Provide the plant with two dissolved oxygen meters to control the operation time of the blowers. This will allow the supply of the wastewater with the optimal quantity of oxygen.
2. Provide the plant with fuel oil to generate electricity 24 hours per day.
3. Minimize the concentration of sodium hypochlorite at the disinfection zone to reduce its residual amount, hence reducing any harm to the trees and the plants irrigated with the effluent.
4. Avoid adding $CaCO_3$ to the sludge in case of re-use in agriculture.
5. Repair the pumps in the pumping stations and adjust them so they can work automatically and continuously.
6. Make sure the lifting station is always operational to convey the flow to the YWWTP.

4 ZAHLE CAZA

4.1 Sewer Networks

Table 4-1 summarizes the results of the data collection campaign carried out through the questionnaires and over the phone. Twenty four municipalities were contacted. Of those, 16 answered affirmatively regarding the existence of a sewer network, 3 answered negatively, and 5 did not provide any answers. The sewer maps for only 7 of the municipalities that answered affirmatively were obtained (for the existing network or a newly studied one). For the 9 remaining ones, some information was collected in terms of description, condition, and network age. Based on this information, it is considered that the networks of the localities of Barr Elias, Jdita, and Majdel Anjar are old and unsalvageable. Of the 5 municipalities that provided no answer to any of our enquiries, maps for a planned design could be obtained for one only (Massa). In the city of Zahle whose municipality was completely uncooperative, information gathered orally from the CDR and other sources indicates that the city has a functional network which is currently being linked through a main collector to the Zahle wastewater treatment plant which is under construction. The layout of the main collector linking the sewers of the various localities served by the WWTP is available. As for the 3 remaining localities, namely Chtaura, Taalabaya- Jalala, and Taanayel, no information whatsoever is available at this point.

Figures 4-1 and 4-2 show that 43% of the Zahle population, representing 67% of the caza villages, is not served by any sewers (existing or planned). It is noted that the existing sewers include both old and new sewers, as well as networks that are planned to be rehabilitated or expanded. However, networks that were declared by the municipalities to be non-operational are not included in this category.

Plans 4-1 and 4-2 show the layout of the existing and planned sewer networks (whenever available) for the caza of Zahle as a whole, and the area of North Zahle, respectively.

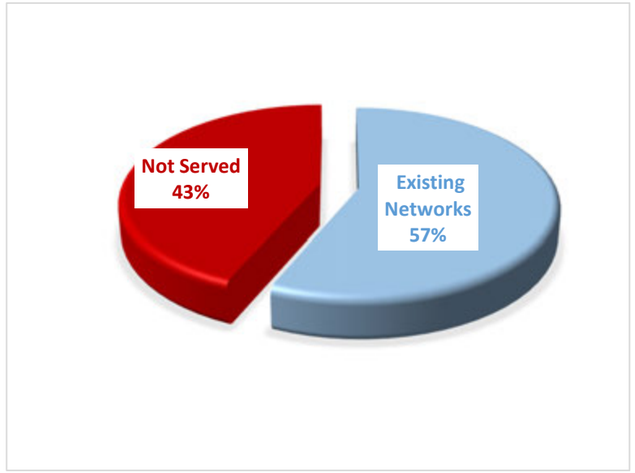


FIGURE 4-1: PERCENTAGE OF POPULATION SERVED BY SEWER NETWORKS IN ZAHLE CAZA

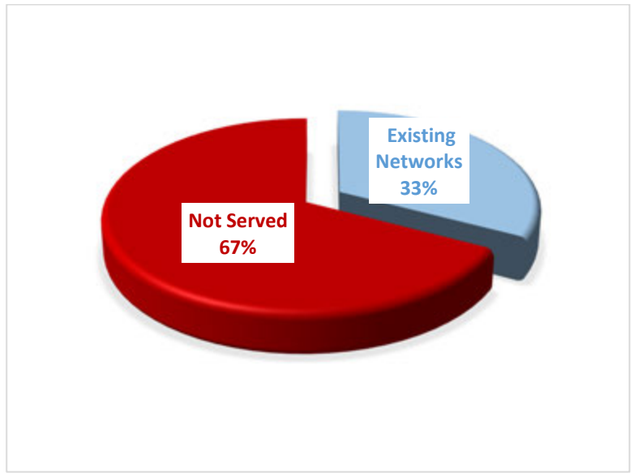
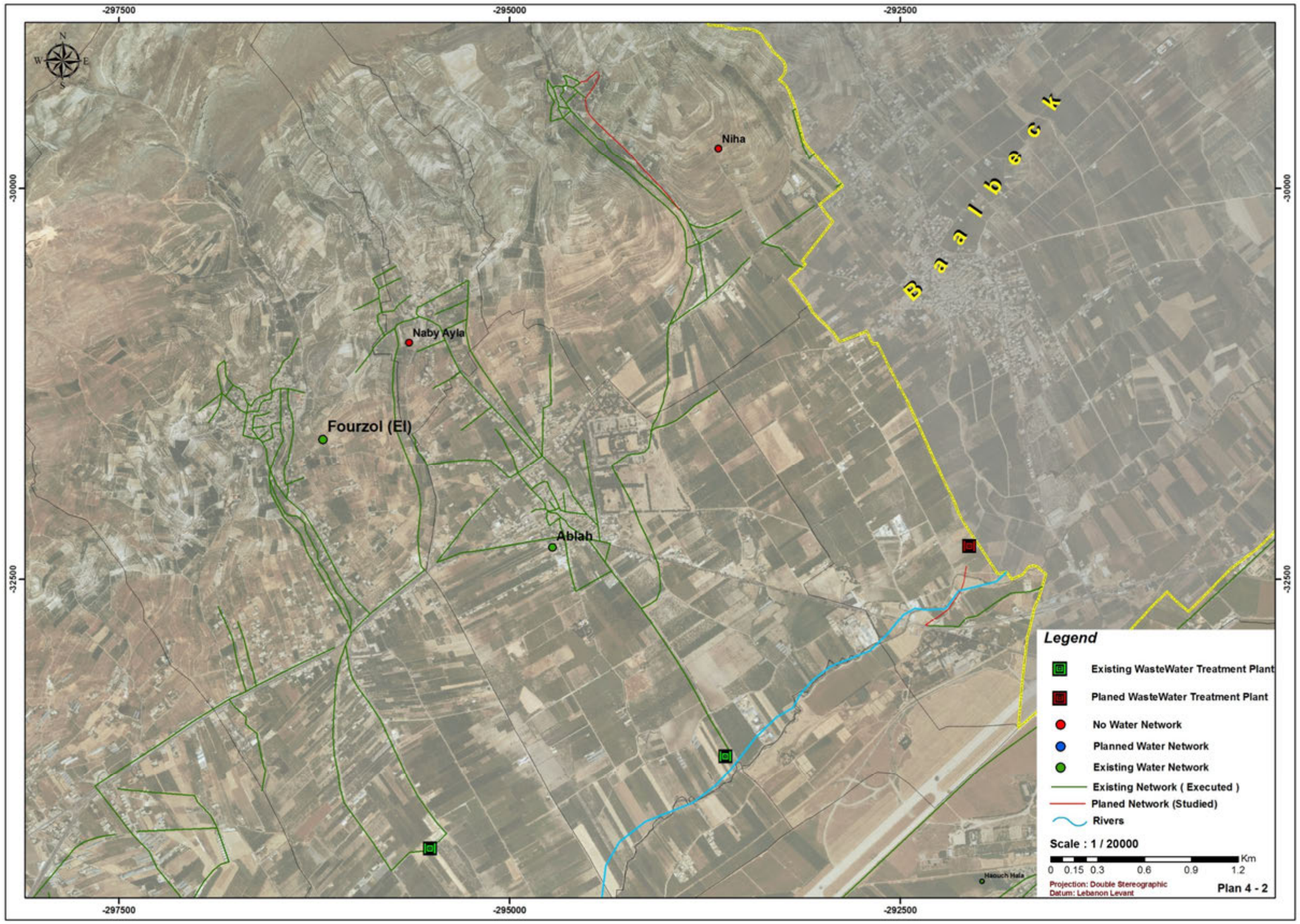


FIGURE 4-2: PERCENTAGE OF VILLAGES SERVED BY SEWER NETWORKS IN ZAHLE CAZA

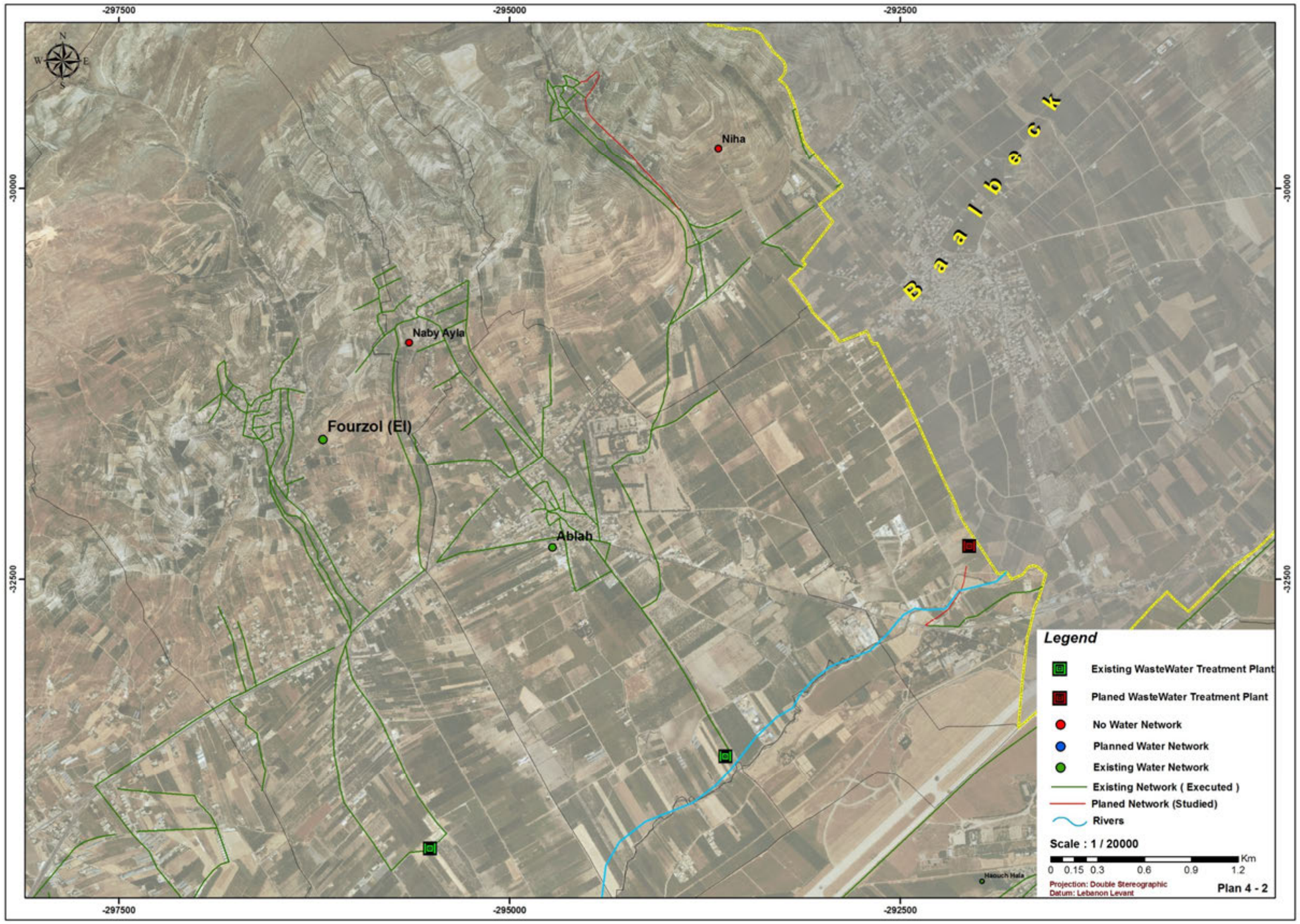
TABLE 4-1: WASTEWATER NETWORK STATUS IN CAZA OF ZAHLE

Caza		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Zahle	1	**Aanjar**	No Answer	Yes	1990 - 2000	Ghzayyel River	* Network doesn't cover new buildings or houses	Not Cooperative	Not Obtained
	2	**Ain Kfar Zabad**	No Answer	Yes (only 2 main lines)	Under Construction	No Answer	----	Engineer Ahmad Bou Zayya 03-362484 design and Execution.	Obtained - Planned Design
	3	**Barr Elias**	No Answer	Yes	Very old	No Answer	* Very old network * New pipes installed for new buildings	Not Cooperative	Not Obtained
	4	**Bouarej**	No Answer	Yes	1980 - Until now	Part to the agricultural land - Part to a river in Qabb Elias - Part to Jdita	* Network is old and the municipality is installing some new pipes	Not Cooperative	Not Obtained
	5	**Chtaura**	No Answer	No Answer	No Answer	No Answer	No Answer	Not Cooperative	No Information Available
	6	**Deir El Ghazal**	Yes	Yes (very old)	No Answer	No Answer	* Sewer network is in bad condition.	Not Cooperative	Obtained - Planned Design (main pipes only)
	7	**Fourzol (El)**	No Answer	Yes	No Answer	Fourzol WWTP	* There are two networks, one is very old and the second was installed 10 years ago. * The new one is damaged due to floods	Not Cooperative	Obtained - Existing Network
	8	**Hay El Fikani**	No Answer	Yes	1980s	Rayak network	* Network is in very bad condition	Not Available at Municipality	Obtained - Existing Network (main lines only)
	9	**Hazerta**	Yes	Yes	1996	Berdawni River	* Trying to discharge the sewer into Zahle WWTP * The municipality is trying to plan a new network.	Sent Map (hardcopy)	Planned Design Not Obtained Obtained - Existing Network
	10	**Jdita**	No	Yes	No Answer	No Answer	* Old sewer network is in bad condition. * Not covering all village. * Pipe diameters are too small. * The main pipe has a diameter of 25 cm.	Not Cooperative	Not Obtained
	11	**Maksé**	No	Yes	1998	Litani River	* Sewer network is in good condition	Not Available at Municipality	Not Obtained
	12	**Majdel Aanjar**	No Answer	Yes	1970s -1980s	Litani River	* Very old and worn network	Not Available at Municipality	Not Obtained
	13	**Massa**	No Answer	No Answer	No Answer	No Answer	No Answer	Couldn't get new phone number. Available one invalid.	Obtained - Planned Design (main lines only)
	14	**Mraijat (El)**	No Answer	Yes	1973 - 2008	Very old refinery in Mraijat then conveyed To Qabb Elias	* Network is in good condition * Municipality has changed the main and damaged pipes	Municipality promised to help but did not follow through	Not Obtained

Caza		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Zahle	15	**Niha**	No Answer	Yes	No Answer	No Answer	No Answer	Municipality promised to help but did not follow through	Obtained - Exiting Network
	16	**Qaa Er Rim**	No Answer	Yes	Very old	Berdawni River	* Very old network * Pipes were installed. * New network was installed by Butec	Not Cooperative (told us to contact Butec.)	Not Obtained
	17	**Qabb Elias / Ouadi Ed Dellem**	Yes	Yes	No Answer	Nearest River	* Sewer network exists in the town. * Pipes sizes range between 4" and 60". * Network length is around 65Km. * It doesn't cover all the town. * There is a plan for a new WWTP in Nasriye town under the Name of Qabb Elias and Majdel Anjar WWTP.	Not Cooperative	Not Obtained
	18	**Qoussaya**	Yes	No	—	—	—	—	Obtained - Planned Design (main lines only)
	19	**Raite**	Yes	No	—	—	—	—	Obtained - Planned Design (main lines only)
	20	**Saadnayel**	No Answer	Yes	From 1998 until now	Berdawni River	Old and new networks	Municipality promised to help but did not follow through	Obtained - Existing Network (main lines only)
	21	**Taalabaya - Jalala**	No Answer	No Answer	No Answer	No Answer	No Answer	Refused to answer any question	No Information Available
	22	**Taanayel (Deir)**	No Answer	No Answer	No Answer	No Answer	No Answer	Municipality claimed complete ignorance concerning the issue	No Information Available
	23	**Terbol**	No Answer	No	----	----	----	----	Obtained - Planned Design (main lines only but outside the village)
	24	**Zahle**	No Answer	No Answer	No Answer	No Answer	No Answer	Not Cooperative	No Information Available



PLAN 4-1: WASTEWATER SYSTEMS FOR CAZA OF ZAHLE



PLAN 4-2: WASTEWATER SYSTEMS FOR CAZA OF ZAHLE - NORTH

4.2 Zahle Wastewater Treatment Plants

There are currently two operational wastewater treatment plants in the caza of Zahle, the Ablah and Fourzol WWTPs. They are however rather small, serving their respective villages only. A large plant is planned by the CDR to serve the localities of Anjar and Majdel Anjar. This plant will be located in the village of El Marj in the caza of West Bekaa, but the exact coordinates of the location could not be obtained.

The construction of the Zahle wastewater treatment plant (serving the city of Zahle and surroundings) started a few years ago but has been stalled due to funding and other problems. However, according to the CDR, construction will start again soon and the plant is expected to be completed in two years.

A technical report for all 4 plants is included in sections 4.3 to 4.6 and a detailed description of the process and operational details of each plant is included in the Appendix. The Ablah and Fourzol WWTPs have been visited by a KREDO expert.

Figures 4-3 and 4-4 show that 17% of the Zahle population, corresponding to 38% of the caza villages, is not served by any existing or planned wastewater treatment plant. It is important to note that the Zahle and Majdel Anjar/El Marj WWTPs have large design capacities and are intended to serve 274,000 and 302,000 people respectively. However, according to the available documentation, the Zahle WWTP will serve the city of Zahle and surroundings only which was estimated in the present study to be about 74,600 currently, while the Majdel Anjar WWTP will serve the cities of Anjar and Majdel Anjar with an estimated current population of about 35,000 only. It is not understood why the Majdel Anjar WWTP has such a large design capacity, unless some additional localities will be connected to it in the future (however this is not mentioned in its report).

Plans 4-1 and 4-2 show the location of the existing and planned wastewater treatment plants for the caza of Zahle as a whole, and the area of North Zahle, respectively.

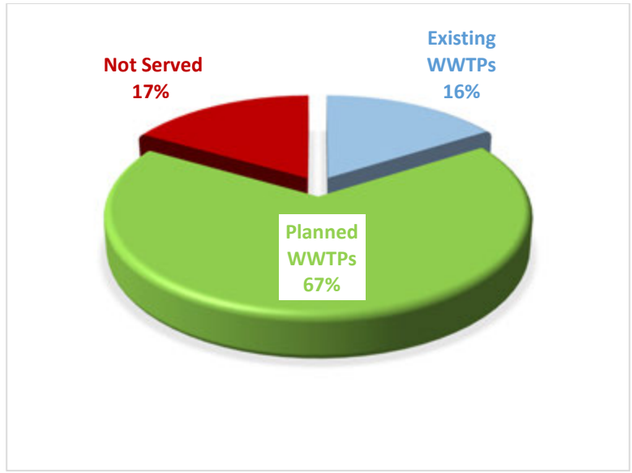


FIGURE 4-3: PERCENTAGE OF POPULATION SERVED BY WWTPS IN ZAHLE CAZA

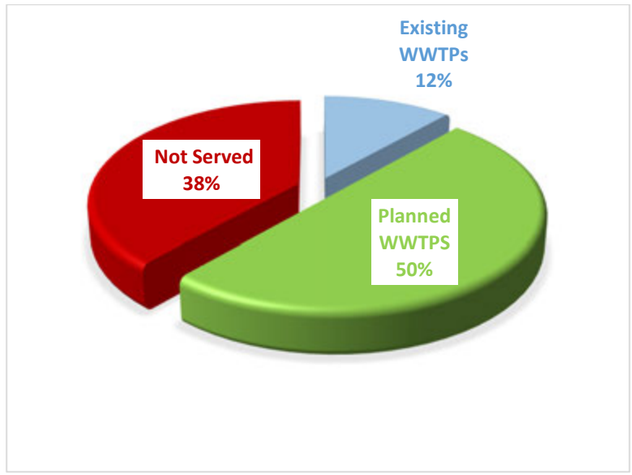


FIGURE 4-4: PERCENTAGE OF VILLAGES SERVED BY WWTPS IN ZAHLE CAZA

4.3 Ablah Wastewater Treatment Plant (AWWTP)

4.3.1 Current Status

The Ablah Wastewater Treatment Plant (AWWTP) located on the road to the Tell Amara (x = 293,616.33, y = -33,637.73)is designed to treat an average flow of 2000 cubic meters of domestic wastewater per day using primary and secondary treatment systems. It is designed to serve ultimately 14,630 persons at a rate of 137 liters/person/day in year 2022. It serves the village of Ablah (caza of Zahle) through a 13.07 Km long sewer system. The facility was constructed in 2007 and designed on the trickling filter treatment process principle. CDM and USAID were in charge of the design and construction supervision, while the Ablah Municipality is in charge of operating and maintaining the plant.

A sewer line serving the part of the town whose elevation is lower than the WWTP was installed in 2009 (after the WWTP was constructed) and discharges the wastewater directly into the Litani river instead of pumping it to Ablah treatment plant.

Currently the plant is operational at around 50% of its maximum capacity. It treats around 950 cubic meters per day (around 6000 beneficiaries). Engineer Mohamad Boudayyah (76-756101) is in charge of directing this facility on behalf of the Union of Municipalities. The operating team consists of one engineer and four workers over two shifts. The operation team is able to operate the plant 24/24 hours as they have a backup generator but the fuel cost presents a major economical constraint.

The plant is working properly, but two problems were identified:

- It lacks a disinfection unit for the treated water which is discharging in the Litani River.
- There is a lack of sufficient space for the sludge drying beds.

4.3.2 Proposed Improvements

In order to improve the operation of the Ablah WWTP and protect the environment, it is recommended that the following measures and actions be undertaken:

1. Construct a pumping station and a main pressurized sewer line to connect the new line that is dumping its wastewater into the Litani River to the WWTP.
2. Install a chlorination unit to treat the effluent before it is discharged into the river.
3. Install a sludge drying unit to dewater the produced sludge as the drying beds area is not sufficient.

4.4 Fourzol Wastewater Treatment Plant (FWWTP)

4.3.3 Current Status

Fourzol Wastewater Treatment Plant (FWWTP , x = -295,495.63 , y = -34,223.02) is a secondary treatment plant with a rated capacity of 1,000 m^3/day designed to serve ultimately 7,400 persons at a rate of 135 liters/person/day in the year 2022. It is located on the road to the old vegetable market and serves the village of Fourzol (caza of Zahle) through a 13.87 km long sewer network. The facility was constructed in 2007 and designed on the trickling filter treatment process principle. CDM and USAID were in charge of the design and construction supervision while the Fourzol Municipality is in charge of operating and maintenance.

A new sewer line has been recently installed and is planned to be connected to the FWWTP in the coming months. It is funded by the MEW.

The plant is operational at 50% of its maximum capacity. It currently treats around 500 cubic meters per day. Engineer Mohamad Boudayyah (76-756101) is in charge of directing this facility on behalf of the Union of Municipalities. The operating team is composed of 1 engineer and 4 workers over two shifts. The operation team is able to operate the plant 24/24 hours as they have a backup generator but the fuel cost represents a major economical constraint.

The plant is working properly. However, it does not have a disinfection unit for the treated effluent which is discharging in the Litani River.

4.3.4 Proposed Improvements

In order to improve the operation of the Ablah WWTP and protect the environment, it is recommended that the following measures and actions be undertaken:

1. Install an additional sewer network of 2000 m to connect all the Fourzol houses to the existing network.
2. Install a chlorination unit to treat the effluent before it is discharged into the river.

4.4 Majdel Anjar/ El Marj Wastewater Treatment Plant (MAWWTP)

4.4.1 Current Status

Majdel Anjar Wastewater Treatment Plant (MAWWTP) is a tertiary treatment plant with a rated capacity of 45,000 m^3/d intended to serve ultimately 302,210 persons at a rate of 146 liters/person/day in the year 2025. The wastewater will be located in the village of Al Marj and will receive wastewater from the localities of Aanjar/Haouch Moussa, Barr Elias, Bouarej, Chebrqieh, Chtaura, Haouch es Siyadi, Haouch Handari, Haouch Qaissar, Jdita, Kfar Zabad, Majdel Aanjar, Maksé, Mraijat (El), Qabb Elias, Taalabaya – Jalala, Taanayel (Deir), Zebdol, Nasriyet Rizk, El Marj, Souairi and Raouda-Istabl. This plant is not yet implemented but is designed on the activated sludge process principle with biological nitrogen removal and biological and chemical phosphorus removal. It will be implemented by the CDR along with a sewer network.

The plant components are as follows:

1- Coarse and fine inlet screens with a mechanical scraper, screenings washing and a compaction plant;
2- Aerated grit removal chamber;
3- Grease and oil trap;
4- Primary clarifiers;
5- Anaerobic tank;
6- Denitrification anoxic tank;
7- Aeration tank;
8- Secondary clarifiers;
9- Chlorine contact tanks;
10- Aerobic sludge digesters;
11- Digested sludge thickeners;
12- Belt filter presses.

4.4.2 Recommendations

As this plant is not constructed yet, the following recommendations concern its design.

1- Use the anaerobic sludge digestion technique with complete mixing as the aerobic sludge digesters consume a large quantity of electrical power to run the air blowers. This will reduce the power consumption and produce a combustible gas (methane) that can be used to raise the temperature of the sludge inside the anaerobic sludge digester.
2- Use sludge drying beds instead of the sludge dewatering unit. That alternative is more land demanding however it is more conservative in power consumption and the quantity of polymers needed. This recommendation assumes that land availability is not an issue. However as the location of the plant is not known yet, this condition might not be fulfilled.

4.5 Zahle Wastewater Treatment Plant (ZWWTP)

4.5.1 Current Status

The Zahle Wastewater Treatment Plant (ZWWTP, x = -299,805.00 , y = -40,143.00) is a tertiary treatment plant with a rated capacity of 40,000 m^3/d intended to serve ultimately 274,000 persons at a rate of 146 liters/person/day in the year 2015. This ZWWTP has been under construction for a number of years but is not yet completed. It is designed on the activated s

ludge process principle with biological nitrogen removal. It will be connected to the city of Zahle and the surrounding villages. The ZWWTP is funded by the Italian Government and implemented by the CDR. It is located in Haouch el Omara parcel number 508 and has an area of 10 ha.

The plant components are as follows:

The project is consisted of:

1- Coarse and fine inlet screens with a mechanical scraper, screenings washing and compaction plant;
2- Aerated grit removal chamber;
3- Grease and oil trap;
4- Primary clarifiers;
5- Anaerobic tank;
6- Denitrification anoxic tank;
7- Aeration tank;
8- Secondary clarifiers;
9- Chlorine contact tanks;
10- Aerobic sludge Digesters;
11- Digested sludge thickeners;
12- Belt filter presses.

4.5.2 Recommendations

As this plant is still under construction, the following recommendations concern its design.

1- Use the anaerobic sludge digestion technique with complete mixing as the aerobic sludge digesters consume a large quantity of electrical power to run the air blowers. This will reduce the power consumption and produce a combustible gas (methane) that should be used to raise the temperature of the sludge inside the anaerobic sludge digester.
2- Use sludge drying beds instead of the sludge dewatering unit. That alternative is more land demanding however it is more conservative in power consumption and the quantity of polymers needed. It is believed that land availability is not an issue in the Zahle plant.

5 WEST BEKAA CAZA

5.1 Sewer Networks

Table 5-1 summarizes the results of the data collection campaign carried out through the questionnaires and over the phone. Of the 22 municipalities surveyed, 20 affirmed having a sewer network. Layout maps could be obtained for 13 of those 20. For the 7 remaining ones, some information was collected in terms of description, condition, and network age. This information indicates that for all 7 localities, the sewer network could potentially be rehabilitated. The two localities for which no information whatsoever could be collected are Libbaya and Saouiri.

Figures 5-1 and 5-2 show that 69% of the West Bekaa population corresponding to 55% of the caza villages is served by existing networks. It is noted that the existing sewers include both old and new sewers, as well as networks that are planned to be rehabilitated or expanded. However, networks that were declared by the municipalities to be non-operational are not included in this category.

Plans 5-1, 5-2, and 5-3 show the layout of the existing and planned sewer networks (whenever available) for the caza of West Bekaa as a whole, the area of north West Bekaa, and the area of south West Bekaa, respectively.

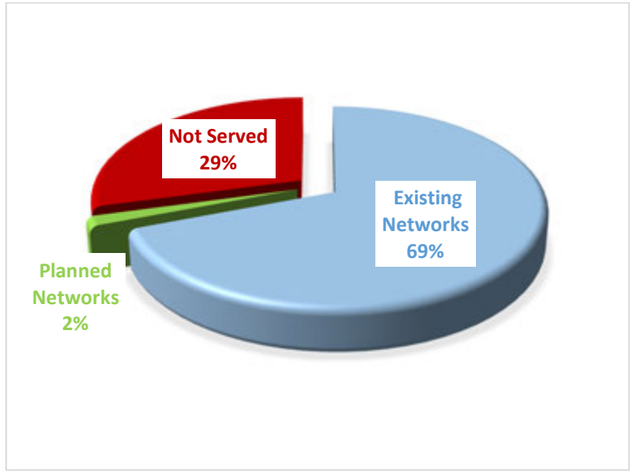


FIGURE 5-1: PERCENTAGE OF POPULATION SERVED BY SEWER NETWORKS IN WEST BEKAA CAZA

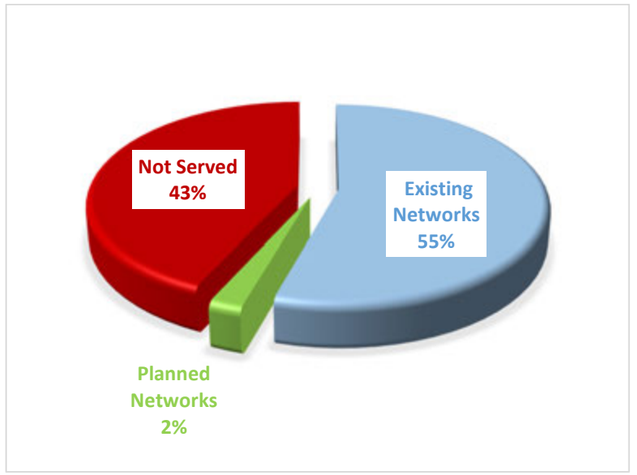
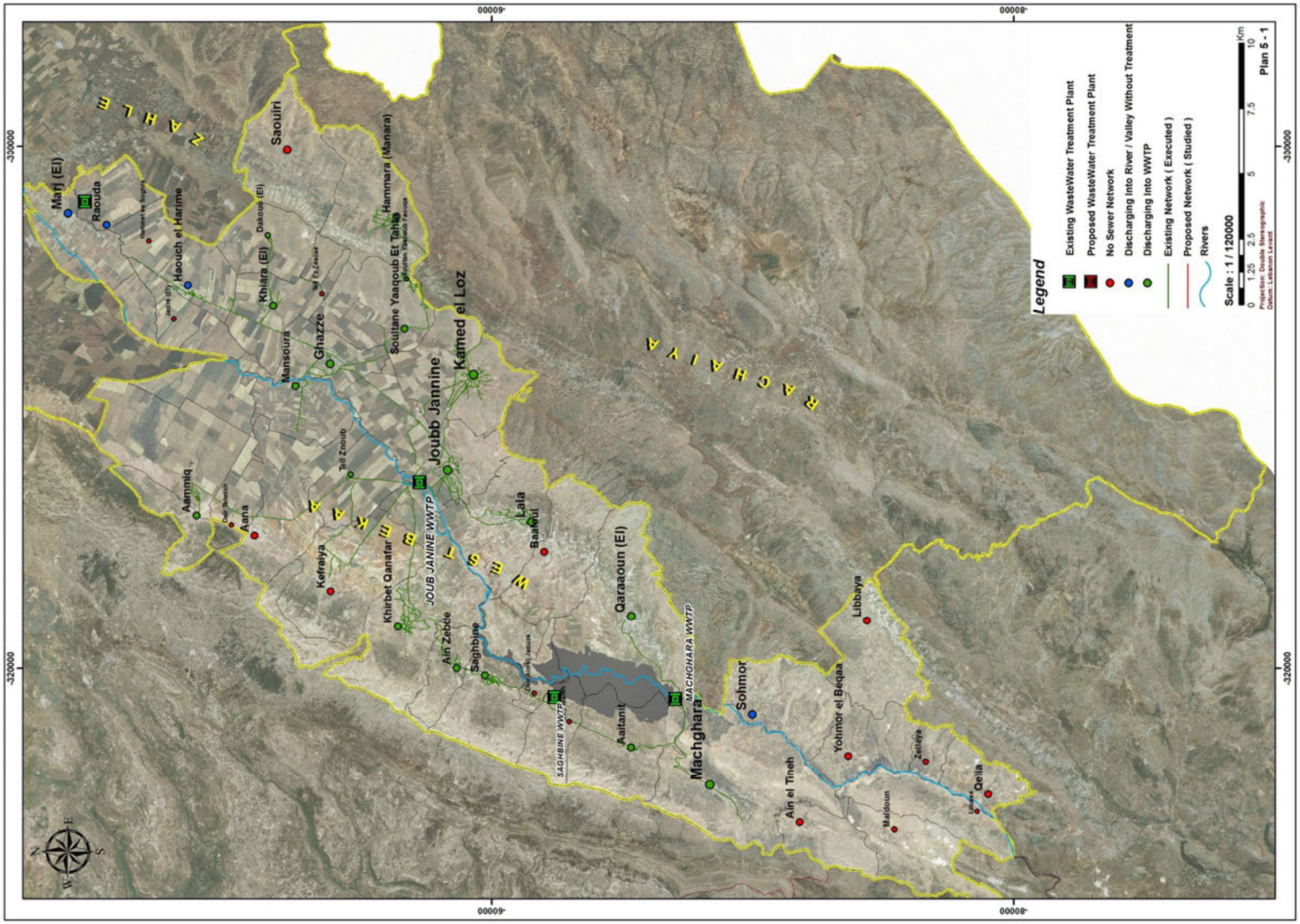


FIGURE 5-2: PERCENTAGE OF VILLAGES SERVED BY SEWER NETWORKS IN WEST BEKAA CAZA

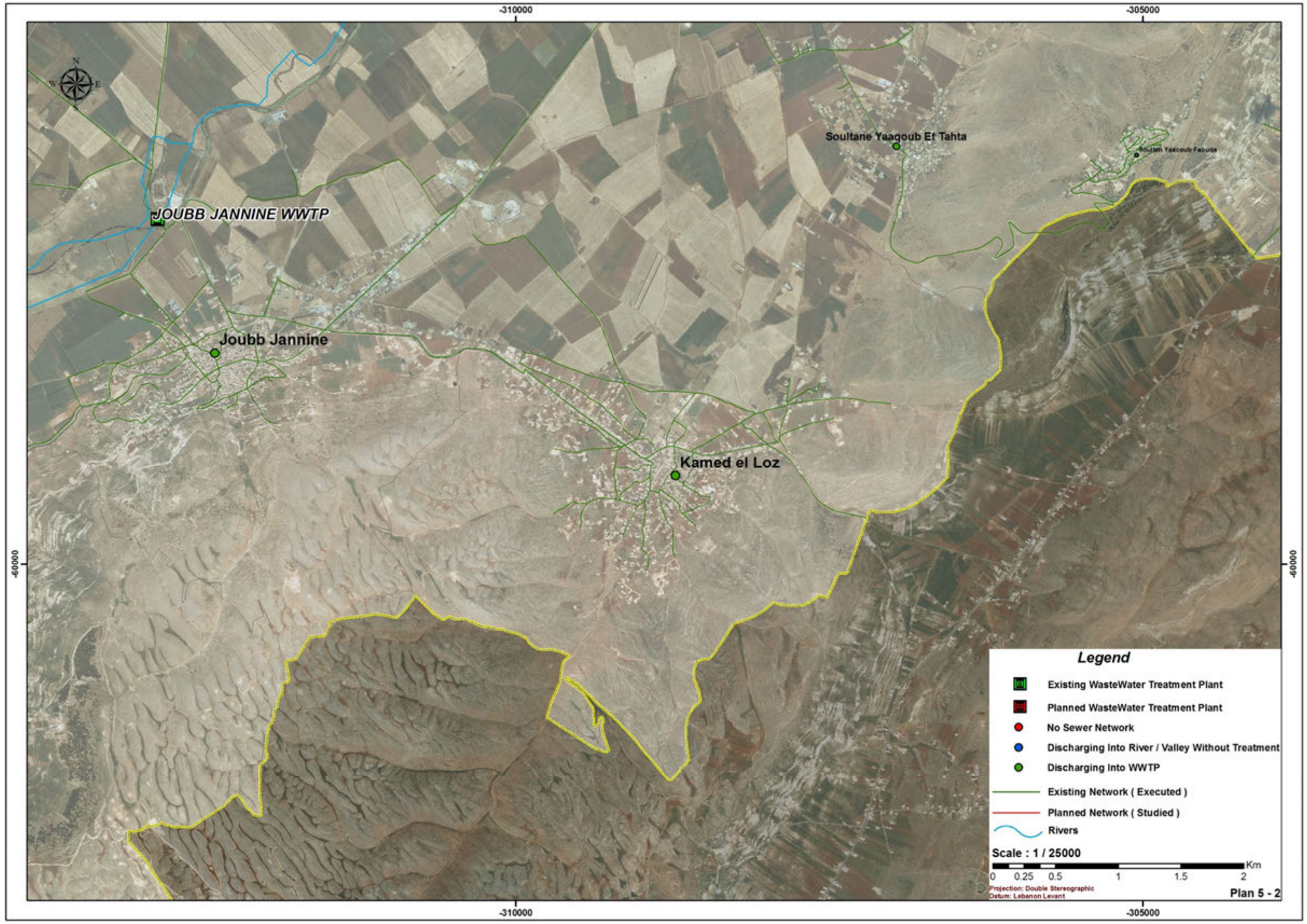
TABLE 5-1: WASTEWATER NETWORK STATUS IN CAZA OF WEST BEKAA

Caza		Village Name	Information From Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
West Bekaa	1	**Aaitanit**	No Answer	Yes	Under Construction	Aitanit WWTP - Beib Mareh WWTP	* 1/3 of the Network is constructed by CDR	Told us to go to CDR	Obtained - Existing Network
	2	**Aana**	Yes	Yes	Under Construction Since 2009	Not in use	Still under Construction	Not Cooperative	Not Obtained
	3	**Ain Zebdé**	No	Yesa	2007 used in 2011	Partial discharging into Litani River	No Answer	Told us to go to them	Obtained - Existing Network (connected to Saghbine and Khirbet Qanafar Network)
	4	**Haouch El Harime**	Yes	Yes	Old network in 1988 New network in 2006	Faregh River	* New network installed in 2006 (4 km length) but not connected to houses yet	Told us to call Nasma Company (Engineer Ahmad Hajar Tel : 03749049)	Obtained - Existing Network (not all lines)
	5	**Joubb Jannine**	No	Yes	1980	Joubb Jannine WWTP	* Sewer network is in good condition	Municipality promised to help but did not follow through	Obtained - Existing Network (not all lines)
	6	**Kamed el Loz**	No	Yes	2000	Joubb Jannine WWTP	* Sewer network is in good condition. * Pipe length is around 30 km.	Municipality promised to help but did not follow through	Obtained - Existing Network (not all lines)
	7	**Kefraiya**	Yes	Yes	10 years old	Joubb Jannine WWTP	* Network is not connected to houses yet. * Pipe diameters range between 20" and 30".	Not Cooperative	Not Obtained
	8	**Khiara (El)**	Yes	Yes	2010	Joubb Jannine WWTP	* Network still not Operational	Told us to go to CDR	Obtained - Existing Network (connected to El-Dakoueh network)
	9	**Khirbet Qanafar**	Yes	Yes	2010 - 2012	Joubb Jannine WWTP	* Network is in good condition. * Pipe diameter ranges between 400 mm and 110 mm.	Told us to contact Nazih Brayde Company	Obtained - Existing Network (connected to Ain Zebde network)
	10	**Lala**	Yes	Yes	2009	Joubb Jannine WWTP	* Network is in good condition. * Pipe diameter ranges between 20" and 40". * Network length is around 10 km. * 14 km additional network length is planned	Told us they don't know where maps can be obtained from	Obtained - Existing Network
	11	**Libbaya**	No Answer	No	----	----	----	----	No Available Information
	12	**Manara**	Yes	Yes	----	----	* A new network was designed but not installed in all the town yet	Promised to help but did not follow through	Obtained -Existing Network
	13	**Mansoura**	Yes	Yes	1998	Litani River	* Old network is not connected to all houses. * Network in bad condition. * Another network was installed in 2008 but still not operational	Told us to contact South Council	Obtained - Existing Network (main pipes only - connected to Ghazze village network)
	14	**Marj (El)**	No	Yes	1990	Litani River	* Part of this network was rehabilitated. * The majority of the pipes have a 20 cm diameter.	Not Available at Municipality	Not Obtained

Caza		Village Name	Information From Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
West Bekaa	15	**Qaraaoun (El)**	Yes	Yes	1987 Continued in 2004 Rehabilitated in 2010	No Answer	* Network length around 5 Km * Another 5 km are still needed to cover all the town. * Some corroded pipes need to be rehabilitated. * Downstream part of the new network under main road needs to be linked to old network.	Promised to help but did not follow through	Not Obtained
	16	**Raouda**	No	Yes	2008	Ghzayyel River	* New sewer network installed	Not Cooperative	Not Obtained
	17	**Saghbine**	Yes	Yes	2010-2011	WWTP near Beib Mareh	No Answer	Promised to help but did not follow through	Obtained - Existing Network
	18	**Saouiri**	No Answer	No	—	—	—	—	No Available Information
	19	**Sltan Yaqoub el Fouqa (Sltan Yaqoub el Tahta)**	Yes	Yes	1998 in Sltan Yaqoub el Tahta New in Sltan Yaqoub el Fouqa	Connected to Ghazze Network - Discharging into Litani River	* Length around 3.5 km and maximum pipe diameter 8".	Told us to contact Ministry of Energy and Water	Obtained - Exiting Network of Sltan Yaqoub el Fouqa Not Obtained - Exiting Network of Sltan Yaqoub el Tahta
	20	**Sohmor**	No Answer	Yes	2004	River near Qaraaoun Lake	* Network is not completed * It is in good condition	Not Cooperative	Not Obtained
	21	**Tell Znoub (New & Old)**	Yes	Yes	2007-2008	Joubb Jannine WWTP	* New sewer network was installed but no house connections yet.	Promised to help but did not follow through	Obtained - Existing Network
	22	**Yohmor el Beqaa**	Yes	Yes	2005	Litani River	* Sewer network is not connected due to some problems concering the discharging point.	Promised to help but did not follow through	Not Obtained



PLAN 5-1: WASTEWATER SYSTEMS FOR CAZA OF WEST BEKAA



PLAN 5-2: WASTEWATER SYSTEMS FOR CAZA OF WEST BEKAA - NORTH

PLAN 5-3: WASTEWATER SYSTEMS FOR CAZA OF WEST BEKAA - SOUTH

5.2 West Bekaa Wastewater Treatment Plants

There are 3 existing wastewater treatment plants in the caza of West Bekaa. They are located in Joubb Jannine, Machghara, and Saghbine and they serve a large number of villages as described in their technical reports included in sections 5.3 to 5.5. These plants have been visited by a KREDO expert and are operational to various degrees. A detailed description of the process and operational details of each plant is included in the Appendix.

Figures 5-3 and 5-4 show that 61% of the West Bekaa population, corresponding to 41% of the caza villages, is served by an existing wastewater treatment plant.

Plans 5-1, 5-2, and 5-3 show the location of the existing and planned wastewater treatment plants for the caza of West Bekaa as a whole, the area of North West Bekaa, and the area of south West Bekaa, respectively.

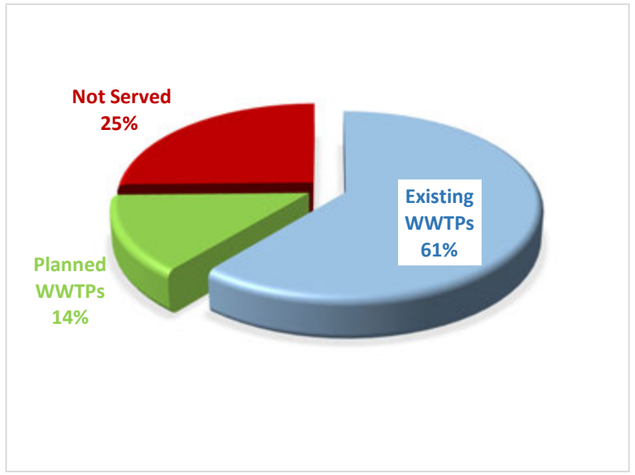


FIGURE 5-3: PERCENTAGE OF POPULATION SERVED BY WWTPS IN WEST BEKAA CAZA

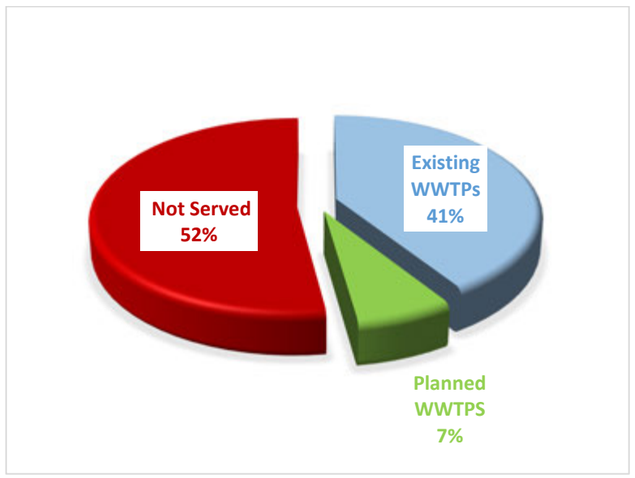


FIGURE 5-4: PERCENTAGE OF VILLAGES SERVED BY WWTPS IN WEST BEKAA CAZA

5.3 Joubb Jannine Wastewater Treatment Plant (JJWWTP)

5.3.1 Current Status

The Joubb Jannine Wastewater Treatment Plant (JJWWTP, x = -312,853.73, y = -57,251.89) is a tertiary treatment plant with a rated capacity of 10,000 m3/d intended to serve ultimately 67000 persons at a rate of 150liters/person/day in year 2022. The wastewater flows by gravity from the following villages through sewer networks of various lengths: Kamed el Loz (12.86 km), Joubb Jannine (10.24 km), Lala (11.27 km), El Khirbeh (19.83 km) and Kefraiya (9.5 km).

In addition the JJWWTP serves the following villages : Ghazze (8.1 km) through 3 pumping stations, El Haouch (5.76 km) through 2 pumping stations, Al Manara (11.7 km) through one pumping station, Deir Tahnich (2.65 km) through one pumping station and Al Mansoura (3.66 km) through one pumping station. The facility was constructed in 2010 and designed based on the activated sludge treatment process with an anoxic zone. It was connected to the villages by a sewer network of around 63.7 km by gravity and around 32 km by pressurized pipes. The construction of this plant has been implemented by the Council for Development and Reconstruction and funded by the Islamic Development Bank under the project of Wastewater Treatment in West Bekaa. The overall project capital cost was US$53 Million.

The WWTP includes the following components:

1- Inlet screen with mechanical scraper, screenings washing and compaction plant.
2- Cross flow grit removal chamber (detritor) with rotating scraper, grit pumps, grit classifier and balance, aeration and anoxic tank.
3- Two oxidation ditches.
4- Two final settlement tanks.
5- Return activated sludge pumping station.
6- Surplus activated sludge pumping station.
7- Two gravity, picket fence sludge thickening tanks.
8- Two aerobic sludge treatment tanks with underwater air diffusers.
9- Sludge drying unit.

The plant is operational at 15% of its maximum capacity. It presently treats around 1500 cubic meters per day while the max capacity is 10000 cubic meters per day. Engineer Abd el Kareem Saleh (76-385248) is in charge of operating this facility on behalf of the contractor "Soubal Company". The operating team consists of one engineer, one lab operator, two foremen and four workers over two shifts. The operation team is able to operate the plant 24/24 hours as they have a backup generator.

The aeration ducts are installed under the sun light without any shield, which increases the temperature of the pressurized transferred air and leads to big losses in the oxygen pumped into the water as the concentration of oxygen decreases at higher temperatures.

Only one line of the wastewater treatment plant is currently operational as the flow is less than 50% of the design capacity.

The lift pumping stations in the served villages are not yet operational although all their generators are stored in Joubb Jannine WWTP and all their equipment are installed and ready to operate.

The disinfection unit is in good condition but not operational. The treated effluent discharges directly in the Litani River without disinfection.

5.3.2 Proposed Improvements

In order to improve the operation of the JJWWTP, it is recommended that the following measures be applied:

1. Install a cover above the air duct to avoid sun light and provide around 5 cm space to allow the air to flow between the shield and the pipe to reduce heating of the pipe to the minimum.
2. All eight lift pumping stations must be made operational as soon as possible.
3. Add the required sodium hypochlorite in the disinfection zone to kill any remaining fecal coliforms as the treated effluent is discharging directly into the Litani River.
4. Avoid adding $CaCO_3$ to the sludge in case of re-use in agriculture.

5.4 Machghara Wastewater Treatment Plant (MWWTP)

5.4.1 Current Status

Machghara Wastewater Treatment Plant (MWWTP , x = -321,161.95 , y = -67,051.11) is a secondary treatment plant with a rated capacity of 5,000 m^3/d to serve ultimately 35,700 persons at a rate of 140 liters/person/day in the year 2022. It is located on the road to the old vegetable market and it serves the villages of Aaitanit, Baaloul, Qaraaoun, and Machghara. The facility was constructed in 2007 and designed on the trickling filter treatment process and connected to the villages by a sewer network of around 18 km. CDM and USAID were in charge of the design and construction supervision while the Union of Municipalities of the Lake are in charge of operating and maintaining this plant.

The plant is operational at 20% of its maximum capacity, as it currently treats around 1000 cubic meters per day whereas the maximum capacity is 5000 cubic meters. The Union of Lake Municipalities is in charge of directing this facility. The operating team consists of one engineer and four workers over two shifts. The operation team is able to operate the plant 24/24 hours as they have a backup generator but the fuel cost constitutes a major economical constraint.

The operators are using one trickling filter out of two as the influent is very low. The effluent is discharging in the Litani River without any disinfection as the plant does not have a disinfection unit.

5.4.2 Proposed Improvement

Install a chlorination unit to treat the effluent before it is discharged into the river.

5.5 Saghbine Wastewater Treatment Plant (SWWTP)

5.5.1 Current Status

Saghbine Wastewater Treatment Plant (SWWTP), is a treatment plant with a rated capacity of 560 m^3/d intended to serve 3733 persons at a rate of 150 liters/person/day in year 2022. The wastewater flows by gravity from the following villages through sewer networks: Saghbine (8.1 km), Ain Zebde (4.5 km), Bab Mareh (2.79 km), Deir Ain El Jaouze (1 km) and the northern part of Aaitanit (1 km). The total length of the sewer network is 16.4 Km. The facility, located next to the Qaraaoun lake between the villages of Deir Ain ej Jaouzé and Bab Mareh (x=-321,088.79, y=-62,418.22) was constructed in 2010 and designed based on the activated sludge treatment process with anoxic zone. This plant has been implemented by the CDR and funded by the Islamic Development Bank under the project of Wastewater Treatment in West Bekaa. The overall project capital cost was US$53 Million.

The WWTP includes the following components:

1. Inlet screen with mechanical scraper, screenings washing and compaction plant.
2. Cross flow grit removal chamber and anoxic tank.
3. Two aeration tanks.
4. Two final settling tanks.
5. Return activated sludge pumping station.
6. Surplus activated sludge pumping station.
7. Two gravity, picket fence sludge thickening tanks.
8. Sludge drying unit.
9. Chlorination unit.

The building structures are constructed of concrete blocks with a flat roof. The building is in a good condition and no maintenance works are needed.

The plant is operational at 15% of its maximum capacity. It presently treats around 100 cubic meters per day while the max capacity is 560 cubic meters per day. Engineer Abd el Kareem Saleh (76-385248) is in charge of operating this facility on behalf of the contractor "Soubal Company", the team is using only one line of the treatment process. The operating team consists of 1 engineer and 2 foremen over two shifts. The operation team is able to operate the plant 24/24 hours as they have a backup generator. The dried sludge quantity observed on site is very low compared to what would be produced by a 100 m^3/day wastewater flow.

It was noted that the chlorination unit is still brand new which means that the team has not operated it yet and the treated wastewater is discharging in the Quaraoun Lake.

5.5.2 Proposed Improvements

Operate the chlorination unit and add the required sodium hypochlorite in the disinfection zone to kill any remaining fecal coliforms as the treated effluent is discharging directly into the Qaraaoun Lake.

6 RACHAIYA CAZA

6.1 Sewer networks

Table 6-1 summarizes the results of the data collection campaign carried out through the questionnaire and the phone survey. Only 7 of the 26 municipalities surveyed answered affirmatively concerning the existence of a sewer network, and layout maps could be obtained for all of these localities. Eighteen municipalities said they do not have a sewer network, while one municipality (El Aakabe) refused to cooperate and provided no information. While the "Network Maps Availability Status" column in Table 6-1 lists the statement "No Information Available" for most of these localities, it is believed that a sewer network does not actually exist, nor is one planned (except for Majdel Balhiss where the municipality informed us that a new sewer is being planned by the ministry of Public Works). However, this notation was adopted in case any new information is discovered at a later stage.

Figures 6-1 and 6-2 show that 70% of the population corresponding to 74% of the caza villages is not served by any existing networks, and that there are no sewer networks currently planned for this caza.

Plans 6-1, and 6-2 show the layout of the existing sewer networks (whenever available) for the caza of Rachaiya as a whole, and the area of north Rachaiya, respectively.

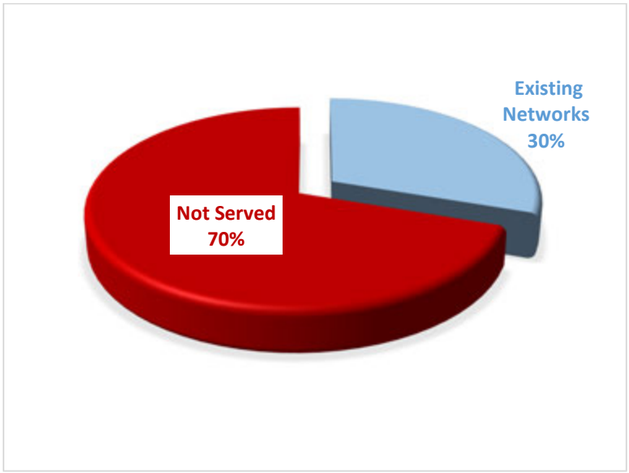


FIGURE 6-1: PERCENTAGE OF POPULATION SERVED BY SEWER NETWORKS IN RACHAIYA CAZA

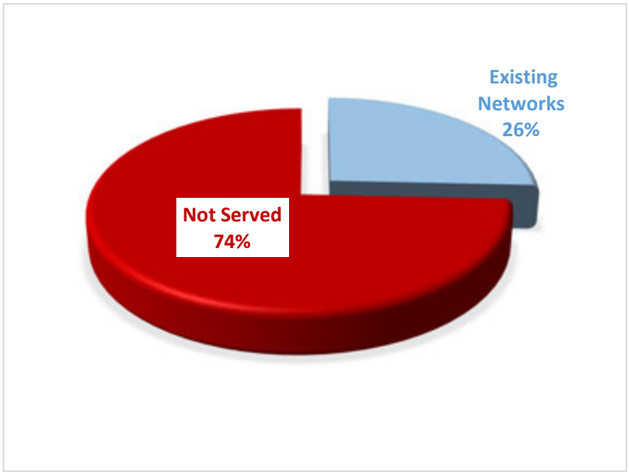
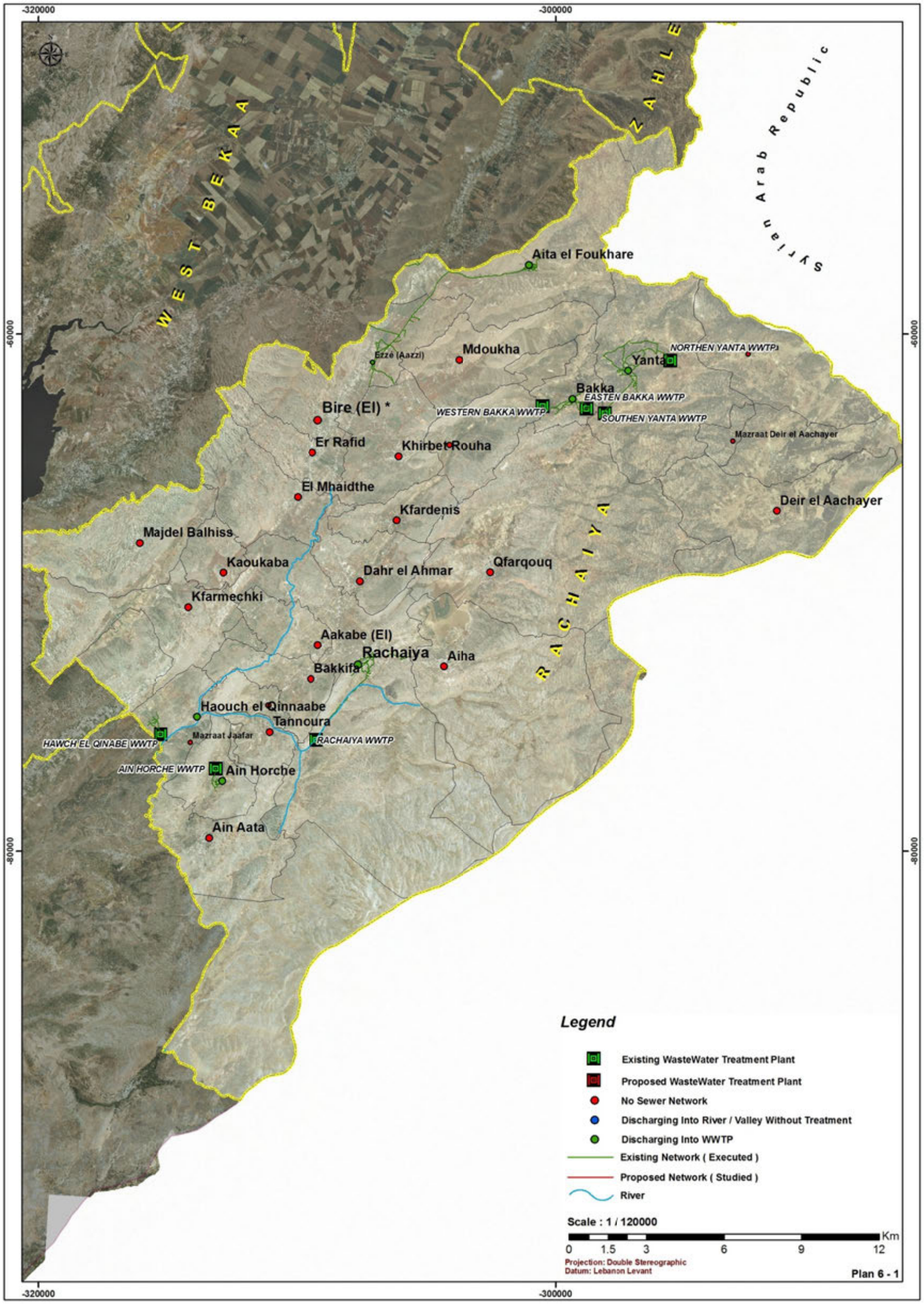


FIGURE 6-2: PERCENTAGE OF VILLAGES SERVED BY SEWER NETWORKS IN RACHAIYA CAZA

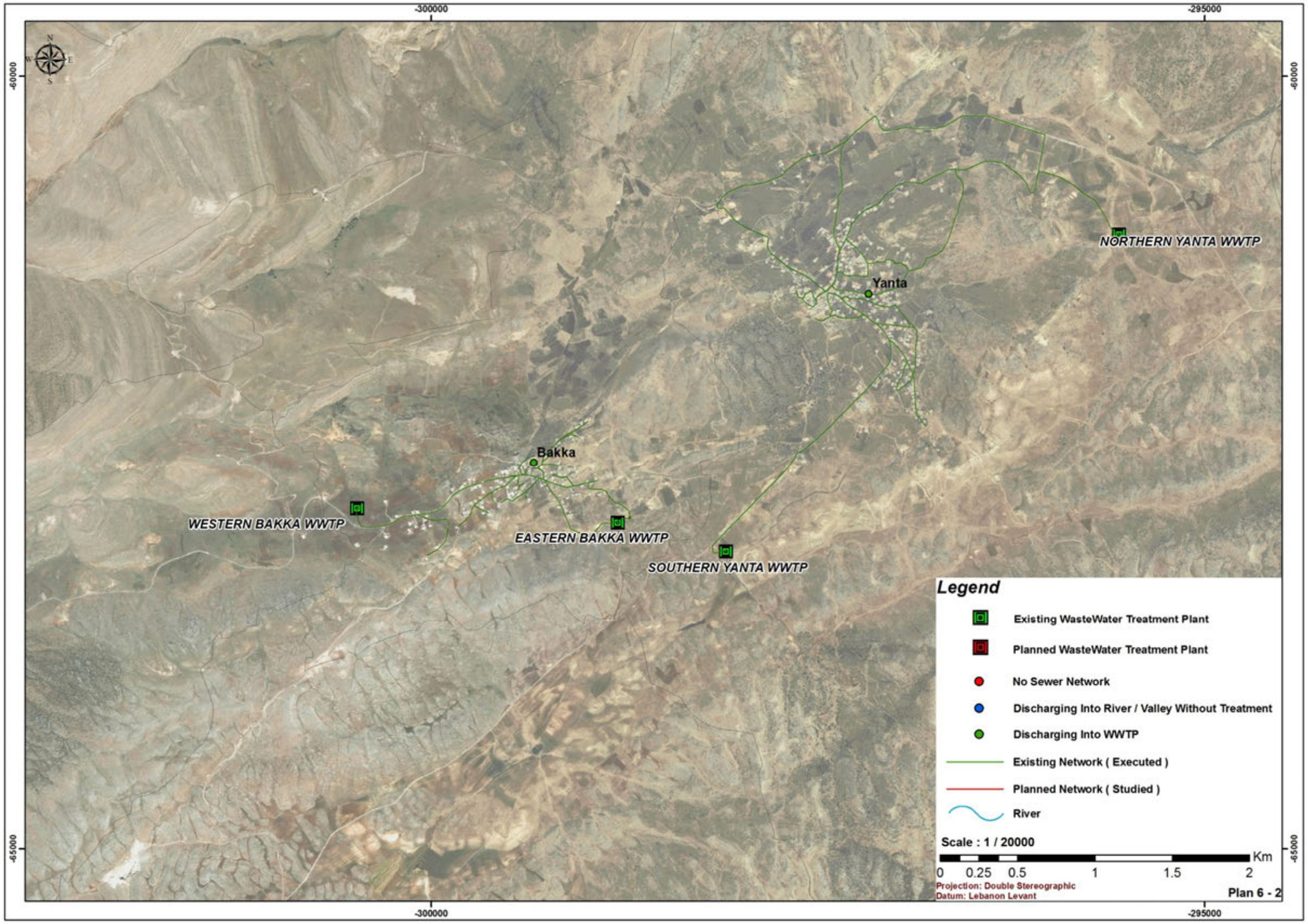
TABLE 6-1: WASTEWATER NETWORK STATUS IN CAZA OF RACHAIYA

Caza		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Rachaiya	1	**Aaiha**	No Answer	No	__	__	__	__	No Information Available
	2	**Aain Arab**	Yes	No	__	__	__	__	No Information Available
	3	**Aakabe (El)**	No Answer	No Answer	No Answer	No Answer	No Answer	Told us they have no time to answer	No Information Available
	4	**Ain Aata**	No Answer	No	__	__	__	__	No Information Available
	5	**Ain Horche**	No	Yes	1996 used in 2002	Reservoir then to WWTP	* Pipe diameters range between 8" and 10"	Not Cooperative	Obtained - Existing Network
	6	**Aita El Foukhar**	Yes	Yes	2008	Joubb Jannine WWTP	No Answer	Not Available at Municipality	Obtained - Existing Network
	7	**Bakka**	No	Yes	2005	2 WWTP in village	* New sewer network is in good condition. * Pipe diameter ranges between 8"and 10"	Told us to contact CDR	Obtained - Existing Network
	8	**Bakkifa**	No Answer	No	__	__	__	__	No Information Available
	9	**Beit Lahia**	Yes	No	__	__	* Some septic tanks are spread randomly. * Pits are dangerous due to leakage which may seep into the domestic water pipes.	__	No Information Available
	10	**Bire (El)**	Yes	Yes	2007	Litani River	* Most houses have their own septic tanks. * In Mazraat el Aazza, there is a 12 km long sewer network that is still unoperational * No house connections. * Main pipe is 12" in diameter and secondary pipes are 8" in diameters.	Did not Call - Information already existing	Obtained - Existing Network
	11	**Dahr El Ahmar**	Yes	No	__	__	__	__	No Information Available
	12	**Deir El Aachayer**	No Answer	No	__	__	__	__	No Information Available
	13	**Haloua**	Yes	No	__	__	__	__	No Information Available
	14	**Haouch El Qinnaabe**	No	Yes	2006	WWTP in the village	* Sewer network is in good condition	Promised to help but did not follow through	Obtained - Existing Network

Caza		Village Name	Information from Questionnaire/Phone Interview					Response of Municipality to Phone Request for Sewer Maps	Network Maps Availability Status
			Septic Tanks	Sewer Network	Network Construction Date (Year)	Discharge Location	Status of Sewer According to Municipality		
Rachaiya	15	**Kaoukaba**	No Answer	No	__	__	__	__	No Information Available
	16	**Kfar Qouq**	Yes	No	__	__	__	__	No Information Available
	17	**Kfardenis**	Yes	No	__	__	__	__	No Information Available
	18	**Kfarmechki**	Yes	No	__	__	__	__	No Information Available
	19	**Khirbet Rouha**	No Answer	No	__	__	__	__	No Information Available
	20	**Majdel Balhiss**	Yes	No	__	__	* There is a new sewer network planned by the Ministry of Public Works, but it is not executed yet.	__	Not Obtained
	21	**Mdoukha**	No Answer	No	__	__	__	__	No Information Available
	22	**Mhaidthé (El)**	Yes	No	__	__	__	__	No Information Available
	23	**Rachaiya El Wadi**	No Answer	Yes	2007	Part in WWTP in the village and other part in septic tanks	No Answer	Told us to call South Council	Obtained - Existing Network
	24	**Rafid (Er)**	Yes	No	__	__	__	__	No Information Available
	25	**Tannoura**	No Answer	No	__	__	__	__	No Information Available
	26	**Yanta**	No	Yes	2002	Into 2 WWTPs in the village	No Answer	Municipality promised to help but did not follow through	Obtained - Existing Network



PLAN 6-1: WASTEWATER SYSTEMS FOR CAZA OF RACHAIYA



PLAN 6-2: WASTEWATER SYSTEMS FOR CAZA OF RACHAIYA - NORTH

6.2 Rachaiya Wastewater Treatment Plants

A number of small wastewater treatment plants exist in Rachaiya. However they mostly serve a village or even a part of a village. Some of these are not properly operational and need either major rehabilitation or should be disregarded. Their technical reports are included in sections 6.3 to 6.9. All 7 plants were visited by a KREDO expert.

Figures 6-3 and 6-4 show that 78% of the population, corresponding to 86% of the caza villages is not served by any existing wastewater treatment plant, and that no treatment plants are currently planned for this caza.

Plans 6-1, and 6-2 show the location of the existing and planned wastewater treatment plants for the caza of Rachaiya as a whole, and the area of north Rachaiya, respectively.

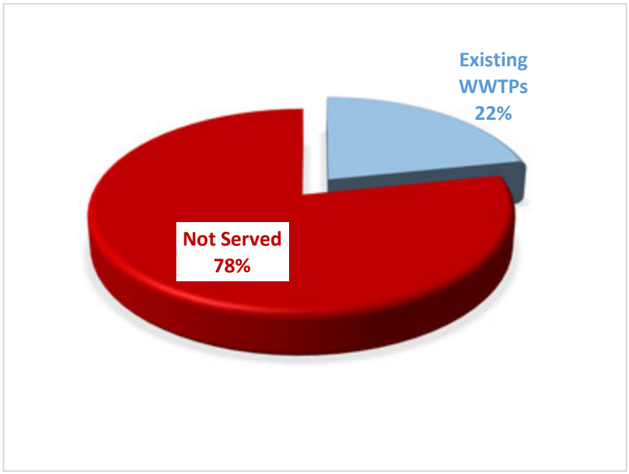


FIGURE 6-3: PERCENTAGE OF POPULATION SERVED BY WWTPS IN RACHAIYA CAZA

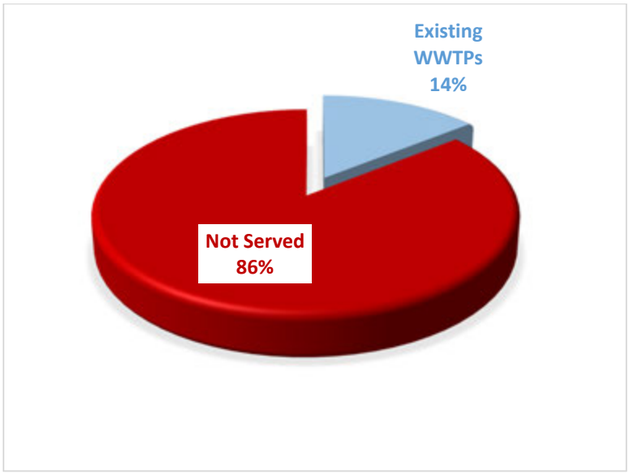


FIGURE 6-4: PERCENTAGE OF VILLAGES SERVED BY WWTPS IN RACHAIYA CAZA

6.3 Ain Horche Wastewater Treatment Plant (AHWWTP)

6.3.1 Current Status

Ain Horche Wastewater Treatment Plant (AHWWTP , x = -313,130.84 , y = -76,816.24) is a secondary treatment plant with a rated capacity of 120 m^3/d designed to serve ultimately 1,000 persons at the rate of 120 liters/person/day in year 2025. It serves the village of Ain Horche through a sewer network approximately 5.34 km long. The facility was constructed in 1999 and designed on the oxidation ponds treatment process principle. YMCA (Young Men Christian Association) and USAID were in charge of the design and construction supervision while the Ain Horche Municipality is in charge of operating and maintaining this plant.

The plant is operational at 50 percent of its maximum capacity, as it currently treats around 50 cubic meters of wastewater per day whereas the maximum capacity is 100 cubic meters daily. This plant is continuously operational as it does not require any power consumption. The treated effluent discharges in a nearby river bed. The plant operator does not have any back up from any environmental advisor.

Although the plant does not require the presence of a full time operator, some major works need to be carried out annually such as ponds cleaning, sludge removal and paint works.

6.3.2 Proposed Improvements

1- Paint the exterior walls of the plant.

2- Once per year, remove the sludge accumulated at the bottom of the anaerobic digester and place it in the sludge drying bed. A diesel sludge pump should be used for this process.

3- Empty the pond once per year and clean it.

4- Provide the plant with an environmental advisor or expert once per trimester to improve the operator's skills.

6.4 Eastern Bakka Wastewater Treatment Plant (EBWWTP)

6.4.1 Current Status

Eastern Bakka Wastewater Treatment Plant (EBWWTP , x = -298,793.24 , y = -62,890.82) is a primary treatment plant with a rated capacity of 100 m^3/d designed to serve ultimately 1,000 persons at a rate of 100 liters/person/day in year 2025. It serves the eastern part of the village of Bakka through an approximately 6.24 km long sewer network. The facility was constructed in 2004 and designed on the oxidation ponds principle treatment process. YMCA and USAID were in charge of the design and construction supervision while the Bakka Municipality is in charge of operating and maintaining this plant.

The plant is operational at 60 percent of its maximum capacity, as it currently treats around 60 cubic meters of wastewater per day whereas the maximum capacity is 100 cubic meters daily. This plant is continuously operational as it does not require any power consumption. The treated effluent discharges in a small open channel. The plant operator does not have any back up from any environmental advisor.

Although the plant does not require the presence of a full time operator, some major works need to be carried out annually such as ponds cleaning, sludge removal and paint works. There are no drying beds in the plant.

6.4.2 Proposed Improvements

1- Construct two drying beds to dry the sludge.

2- Paint the exterior walls of the plant.

3- Once per year remove the sludge accumulated at the bottom of the anaerobic digester and place it in the sludge drying bed. A diesel sludge pump should be used during this process.

4- Empty the ponds once per year and clean them.

5- Provide the plant with an environmental advisor or expert once per trimester to improve the operator's skills.

6.5 Westerm Bakka Wastewater Treatment Plant (WBWWTP)

6.5.1 Current Status

Western Bakka Wastewater Treatment Plant (WBWWTP, x = -300,478.33 , y = -62,797.19) is a primary treatment plant with a rated capacity of 60 m^3/d to serve ultimately 600 persons at a rate of 100 liters/person/day in the year 2025. It serves the western part of the village of Bakka through a 6.24 km long network. The facility was constructed in 2004 and designed on the oxidation ponds treatment process. The YMCA and USAID were in charge of the design and construction while the Bakka Municipality is in charge of operating and maintaining this plant.

The plant is operational at 40 percent of its maximum capacity, as it currently treats around 24 cubic meters of wastewater per day whereas the maximum capacity is 60 cubic meters daily. This plant is continuously operational as it does not require any power consumption. The treated effluent is discharging in a small open river. The plant operator does not have any back up from any environmental advisor. The access road is in a very bad condition and is not accessible during wintertime.

Although the plant does not require the presence of a full time operator, some major works need to be carried out annually such as ponds cleaning, sludge removal and paint works. There are no drying beds in the plant.

6.5.2 Proposed Improvements

1- Construct two drying beds to dry the sludge.
2- Paint the exterior walls of the plant.
3- Once per year remove the sludge accumulated at the bottom of the anaerobic digester and place it in the drying bed. A diesel sludge pump should be used during this process.
4- Empty the ponds once per year and clean them.
5- Install a compacted 5 m-thick asphalt layer over the existing base course of the 1100 m-long access road.
6- Provide the plant with an environmental advisor or expert once per trimester to improve the operator's skills.

6.6 El Haouch Wastewater Treatment Plant (EHWWTP)

6.6.1 Current Status

El Haouch Wastewater Treatment Plant (EHWWTP, x = -315,268.27 , y = -75,486.61) is a secondary treatment plant with a rated capacity of 100 m^3/d designed to serve ultimately 1,000 persons at a rate of 100 liters/person/day in the year 2025. It serves the village of Haouch El Qinnaabe (caza of Rachaiya) through a 1.42 km long sewer network. The facility was constructed in 2004 and designed on the oxidation ponds treatment process principle. YMCA and USAID were in charge of the design and construction supervision while the El Haouch Municipality is in charge of operating and maintaining this plant.

This plant is located in Haouch EL Qinnaabe and it serves all the citizens of the village. The plant is operational at 30 percent of its maximum capacity, as it currently treats around 30 cubic meters of wastewater per day whereas the maximum capacity is 100 cubic meters daily. This plant is continuously operational as it does not require any power consumption. The treated effluent discharges in a small nearby river. The plant operator does not have any back up from any environmental advisor. The access road is in a very bad condition and is not accessible during wintertime.

Although the plant does not require the presence of a full time operator, some major works need to be carried out annually such as ponds cleaning, sludge removal and paint works. There are no drying beds in the plant.

6.6.2 Proposed Improvements

1- Construct two drying beds to dry the sludge.
2- Paint the exterior walls of the plant.
3- Once per year remove the sludge accumulated at the bottom of the anaerobic digester and place it in the drying bed. A diesel sludge pump should be used during this process.
4- Empty the ponds once per year and clean them.
5- Install a compacted 5 m thick asphalt layer and a 20 cm thick base course over the 1500 m long access road.
6- Provide the plant with an environmental advisor or expert once per trimester to improve the operator's skills.

6.7 Rachaiya Wastewater Treatment Plant (RWWTP)

6.7.1 Current Status

The Rachaiya Wastewater Treatment Plant (RWWTP) is a secondary treatment plant with a rated capacity of 600 m^3/d designed to serve ultimately 6,000 persons at a rate of 100 liters/person/day in the year 2025. It is located in a mountainous site at 1150 m above mean sea level. It sits on the right hand side of the road leading to Fakaa farm in the southeastern region of Rachaiya (x=-309,246.00, y =-75,710.06). The plant serves the eastern part of the village of Rachaiya through an 8.7 km long network. The facility was constructed in 2005 and designed on the trickling filter treatment process principle. YMCA and USAID were in charge of the design and construction supervision while the Rachaiya municipality is in charge of operating and maintaining this plant.

The technology used in RWWTP is the two stage trickling filter. The plant is operational at 60 percent of its maximum capacity as it treats around 360 cubic meters per day whereas its maximum capacity is 600 cubic meters. This plant is operational continuously without any power consumption. It was noticed during the site visit that the operator has no back up from any environmental consultant. The treated wastewater discharges in the valley.

6.7.2 Proposed Improvements

1- Paint the exterior walls of the plant.
2- Every three months remove the sludge accumulated at the bottom of the first clarifier and place it in the drying bed. A diesel sludge pump should be used during this process.
3- Empty the ponds once per year and clean them.
4- Install a compacted 5 m thick asphalt layer and a 20 cm thick base course over the 100 m long access road.
5- Provide the plant with an environmental advisor or expert once per trimester to improve the operator's skills.

6.8 Northern Yanta Wastewater Treatment Plant (NYWWTP)

6.8.1 Current Status

Northern Yanta Wastewater Treatment Plant (NYWWTP, x = -295,551.77 , y = -61,028.07) is a secondary treatment plant with a rated capacity of 200 m^3/d designed to serve ultimately 2,000 persons at a rate of 100 liters/person/day in the year 2025. It serves the northern part of the village of Yanta through a 15.5 km long network. The facility was constructed in 1998 and designed as a Hans Bioshat Reactor treatment process. YMCA and USAID were in charge of design and construction and the Yanta municipality is in charge of operating and maintaining this plant.

The treatment process is called the Hans-Reactor system and based on the extended aeration process principle. This proprietary method has not proven to be functional and is not adopted by the industry. This plant is not operating properly and works at 50% of its maximum capacity. The operation team is not able to operate the plant 24/24 hours as they do not have a backup generator. In principle, the municipality of Yanta is in charge of directing this facility, however in fact no one is taking care of it and it is in a very poor condition. The wastewater is spilling out from the tanks and the Hans reactor (made of steel) is rusted. All the air blowers and the suction lifting pipes are not operational. The effluent discharges in an open channel.

Upon the site visit, the following was noted:

- A strong stench engulfs the vicinity of the plant.
- The treated wastewater is still black.
- There is no permanent staff at the plant.
- No sludge treatment unit is found inside the plant.
- Sludge has been accumulating since the plant started operating. Sludge has never been removed.

6.8.2 Proposed Improvements

In order for this plant to become operational, the following measures should be undertaken:

- The plant should be redesigned to achieve the standards of the secondary treatment.
- Sludge treatment unit should be implemented.
- Backup generator should be available on site as well as full-time operators.
- The steel reservoirs should be emptied and painted.

However, it is recommended that this plant be abandoned. A new wastewater treatment plant or a lifting station to pump the flow to the nearest wastewater treatment plant should be constructed.

6.9 Southern Yanta Wastewater Treatment Plant (SYWWTP)

6.9.1 Current Status

Southern Yanta Wastewater Treatment Plant (SYWWTP , x = -298,094.78 , y = -63,077.55) is a Secondary treatment plant with a rated capacity of 300 m^3/d to serve ultimately 3,000 persons at a rate of 100 liters/person/day in the year 2025. It serves the southern part of the village of Yanta (caza of Rachaiya) through a 15.5 km long network. The plant is currently receiving 50% of its capacity. The facility was constructed in 1998 and designed as a Hans Bioshat Reactor treatment process. YMCA and USAID were in charge of design and construction and the Yanta municipality is in charge of operating and maintaining this plant.

The process of treatment is called the Hans-Reactor system and based on the extended aeration process principle. This proprietary method has not proven to be functional and is not adopted by the industry. This plant is not operating properly and works at 50% of its maximum capacity. The operation team is not able to operate the plant 24/24 hours as they do not have a backup generator. In principle, the municipality of Yanta is in charge of directing this facility, however in fact no one is taking care of it and it is in a very poor condition. The wastewater is spilling out from the tanks and the Hans reactor (made of steel) is rusted. All the air blowers and the suction lifting pipes are not working. The effluent is discharging in an open channel.

Upon the site visit, the following was noted:

- A strong stench engulfs the vicinity of the plant.
- The treated wastewater is still black.
- There is no permanent staff at the plant.
- No sludge treatment unit is found inside the plant.
- Sludge has been accumulating since the plant started operating. Sludge has never been removed.

6.9.2 Proposed Improvements

In order for this plant to become operational, the following measures should be undertaken:

- The plant should be redesigned to achieve the standards of the secondary treatment.
- Sludge treatment unit should be implemented.
- Backup generator should be available on site as well as full-time operators.
- The steel reservoirs should be emptied and painted.

However, it is recommended that this plant be abandoned. A new wastewater treatment plant or a lifting station to pump the flow to the nearest wastewater treatment plant should be constructed.

7 GENERAL COMMENTS AND RECOMMENDATIONS

During the past several months, a data collection campaign was carried out to gather all existing studies and reports that have been prepared regarding sewage collection and wastewater treatment in the Bekaa. This campaign encompassed various activities including but not limited to: extensive meetings with the CDR, MEW, BWE and other authorities; written questionnaires sent to 146 municipalities which included questions about the wastewater disposal methods and the existence of a sewer network and its status; a phone campaign to municipalities to obtain information not answered in the questionnaires and request a copy of the existing sewer map wherever present; and a physical and operational assessment of wastewater treatment plants and related installations through an extensive site visits program. Based on this campaign, the following is noted:

1- The data regarding the wastewater disposal situation is scattered and greatly deficient.
2- Most municipalities were not cooperative in providing information and none but one provided a map of the existing sewer system.
3- Few cities and villages (25% corresponding to 49% of the population as shown in Figures 7-1 and 7-2) actually do have a sewer network, and only for a handful of those is the network in good condition. Some are operational but in bad condition while others are not functional.
4- The CDR is planning or executing a sewer network for some areas in the Bekaa (14% of the villages corresponding to 11% of the population). However these remain limited. The best served area until now is the city of Baalbeck which has an extensive network linked to the Iaat wastewater treatment plant. As for the city of Zahle, it has a functional network which is currently being linked through a main collector to the wastewater treatment plant, also under construction.
5- Large areas of the Bekaa remain without any sewer system, either existing or planned (61% of the villages corresponding to 40% of the population). These localities still rely on septic tanks which are often old, seeping, or overflowing which causes a major pollution threat to the groundwater.
6- Only a handful of sewer systems are currently linked to wastewater treatment plants. The rest are discharging raw sewage into water bodies or valleys, while some are diverted to agricultural land so that the wastewater can be used for irrigation. This catastrophic situation is causing a major pollution threat to the environment and a health threat to the Bekaa population.
7- A few wastewater treatment plants currently exist in the Bekaa. The combined population served by the operational wastewater treatment plants is a small fraction of the Bekaa population as a whole (25% corresponding to 13% of the villages as shown in Figures 7-3 and 7-4). Except for the Iaat WWTP serving the city of Baalbeck and its surroundings, these are small facilities serving one or more small villages. Some of these WWTP are operational (mostly at below capacity as shown in Figure 7-5) but need improvements to various degrees. Others are dysfunctional and need to be replaced.
8- The CDR is currently planning or executing a few large wastewater treatment plants. These cover 40% of the Bekaa population or 19% of the Bekaa villages. The remaining 68% of the Bekaa villages (35% of the Bekaa population) are not served by any existing or planned wastewater treatment plant.

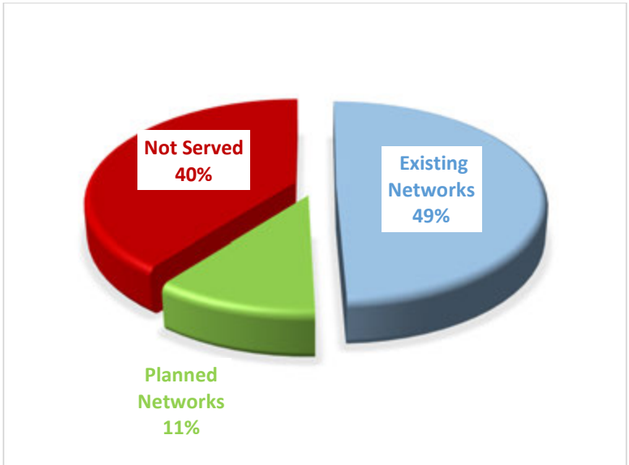


FIGURE 7-1: PERCENTAGE OF POPULATION SERVED BY SEWER NETWORKS IN THE BEKAA

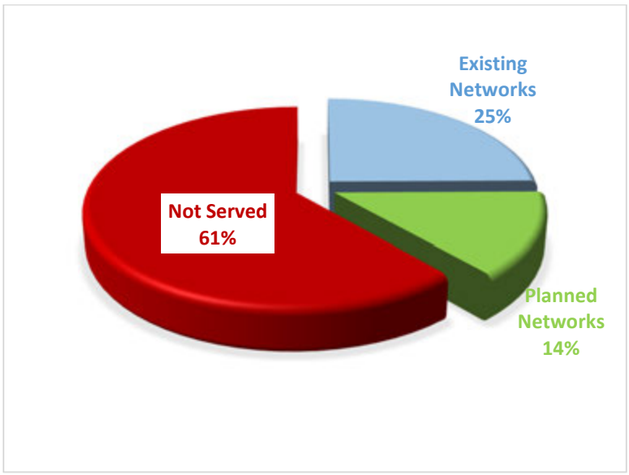


FIGURE 7-2: PERCENTAGE OF VILLAGES SERVED BY SEWER NETWORKS IN THE BEKAA

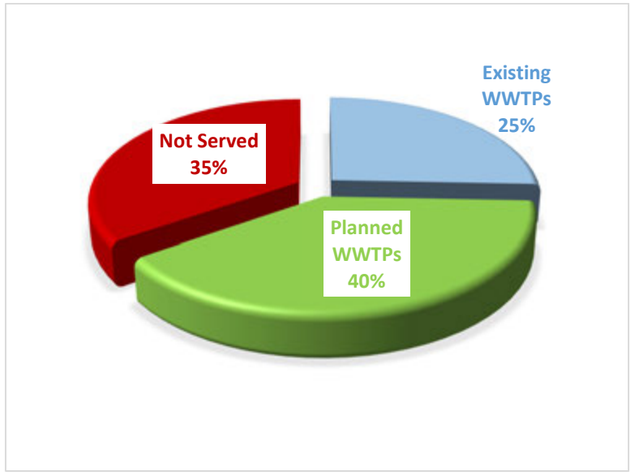


FIGURE 7-3: PERCENTAGE OF POPULATION SERVED BY WWTPS IN THE BEKAA

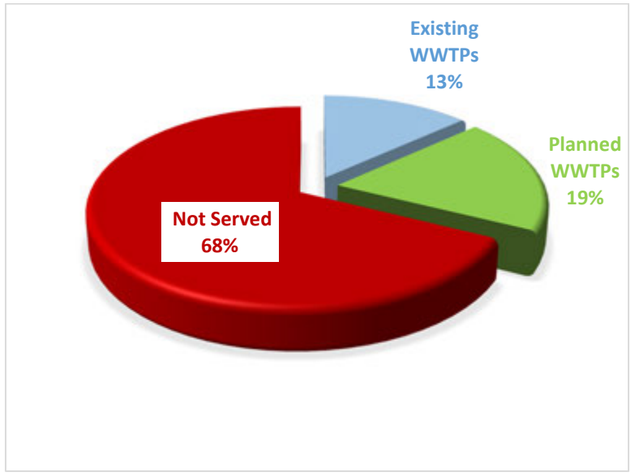


FIGURE 7-4: PERCENTAGE OF VILLAGES SERVED BY WWTPS IN THE BEKAA

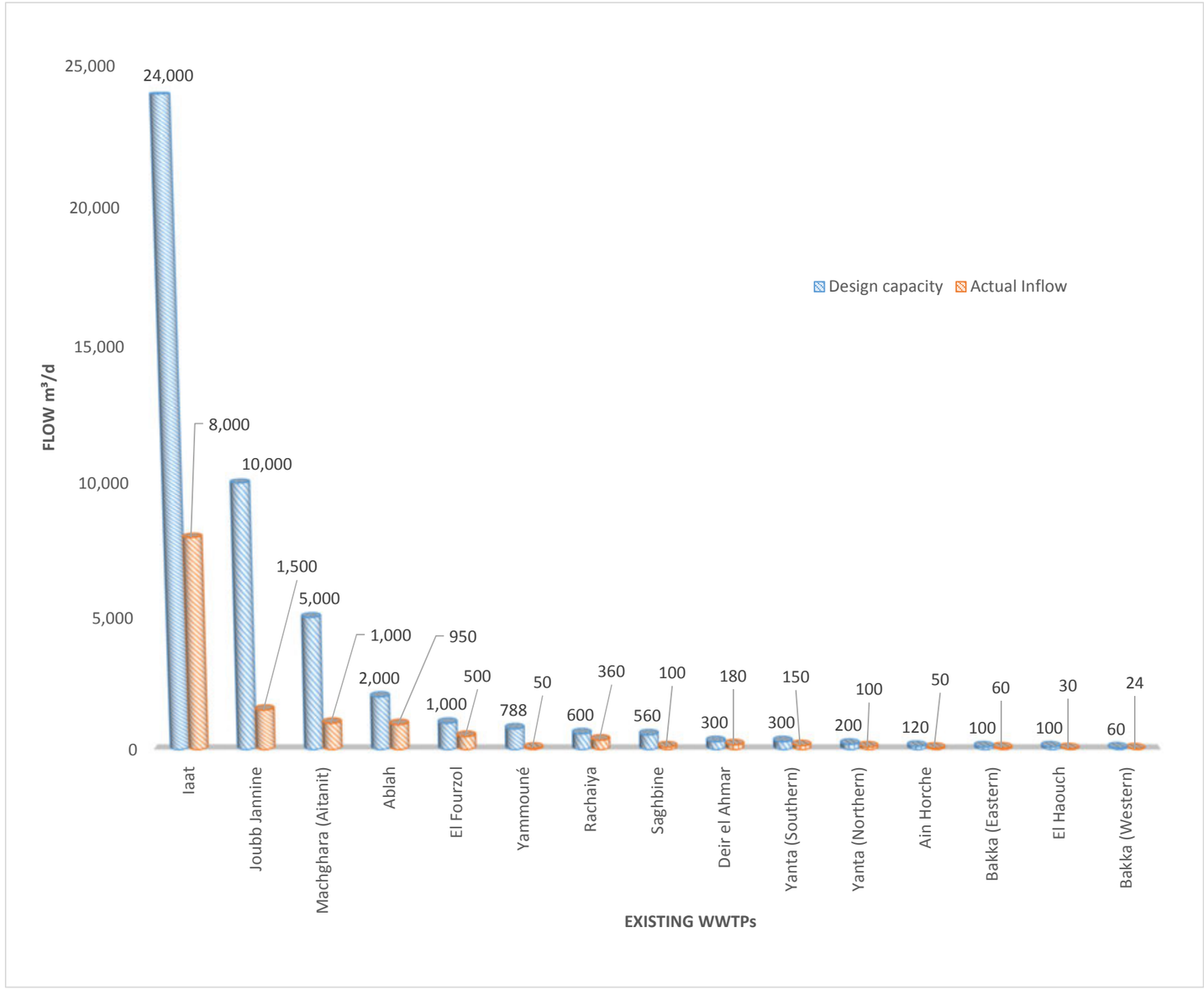


FIGURE 7-5: EXISTING WWTPS DESIGN CAPACITY AND ACTUAL INFLOW IN THE BEKAA

In order to improve the current situation of the wastewater treatment plants in the Bekaa, the following general measures are recommended:

1- Try to operate all the existing plants at their design capacity to increase their efficiency.
2- Plant a tree belt zone around the perimeter of the facilities to protect the surrounding area from bad odors. Preferably two belt zones would be planted for landscape purposes.
3- Provide the plants that are under the municipalities with an environmental advisor or expert once per trimester to improve the operator's skills.
4- Make all lifting stations operational before their equipment becomes unusable and obsolete.
5- Air blowers should be installed in a well-aerated room with no direct sun access as a reduced intake air temperature will increase their performance.
6- The BWE should take over all the wastewater treatment plants and allocate a budget for their operation.
7- Set a system whereby each plant operator submits to the BWE a quarterly report which includes a description of encountered problems as well as results of effluent quality and sludge quality laboratory tests.
8- Training courses should be given to a specialized team of BWE employees to educate them about treatment processes and the supervision of the operator's performance.
9- BWE should hire one wastewater expert to review the quarterly reports submitted by the plant operators, assess the plant efficiencies, and recommend changes or improvements wherever needed.
10- Carry out a detailed economical study of the wastewater treatment cost in order to infer the tariff that should be collected from the beneficiaries to cover the management, operation, maintenance, and power consumption cost of the plants.

The National Strategy for the Wastewater Sector issued by the Ministry of Energy and Water under Resolution No. 35, date 17/10/2012 states that the sector targets 2011-2020 are the following:

- Increase the present wastewater collection (60%) and treatment (8%) to 80% collection and treatment by 2015, and 95% collection and treatment by 2020.
- Pre-treatment of all industrial wastewater by 2020.
- Increase reuse of treated effluent from zero percent in 2010 to 20% of treated wastewater by 2015, and 50% by 2020.
- Secondary treatment and reuse of all inland wastewater by 2020, and secondary treatment by 2020 of coastal wastewater where reuse is economically justified.
- Full recovery of all O&M costs by 2020 following the 'polluter pays' principle and full recovery for BOT projects.

The Strategy specifies that national guidelines and criteria for wastewater treatment and reuse will be reviewed and issued jointly by an inter-ministerial committee, and that specific studies of plants will be undertaken to assess the technical and economical reuse potential for each. Hence as of now, there is no specification as to what is considered reuse, and no knowledge about whether effluent reuse will be economical for all the Bekaa treatment plants. Consequently, this report will give general recommendations geared towards a potential reuse of the effluent. These recommendations will be detailed some more in the future report entitled "Capital Investment Recommendations with Options for all Wastewater Facilities", as specific measures will be recommended for each plant.

A notable absence in the Strategy is any mention of the reuse of the biosolids issued from the wastewater treatment plants. However a European Bank funded study entitled: "Etude du plan directeur pour la valorisation ou l'élimination des boues d'épuration" managed by the CDR was conducted in 2001-2003 by the Joint Venture TECSULT/KREDO. It aimed at recommending a disposal method for all the sludge to be produced by the wastewater treatment plants included in the 1982 Wastewater Master Plan, with a priority given for reuse in agriculture.

Based on the above, the following general measures are recommended regarding the reuse of the wastewater and biosolids produced by the Bekaa wastewater treatment plants:

1- Try to reuse the effluent in the following domains:
   - Irrigation purposes.
   - Industrial cooling systems.
   - Firefighting water reservoirs.
   - Car washing units.
   - Street cleaning.
   - Water catchment ponds or lakes.

   The appropriate use(s) have to be studied by the BWE for each plant as they each require an infrastructure which could prove to be economically feasible or unfeasible.

2- Where reuse is deemed to be unfeasible, groundwater recharge should be considered.
3- The BWE should update the 2003 biosolids master plan to take into account the existing and currently planned wastewater treatment plants and update the land use information which is crucial to the evaluation of the potential for reuse in agriculture.
4- Based on the updated master plan, the MEW should issue a directive to regulate the reuse of biosolids in agriculture. This regulation should set limits on the amount of metals and pathogens that can be present in biosolids to be used in agriculture. It will also have requirements to reduce the possibility that the biosolids will attract flies or other pests that might spread disease. The law should require that specific conditions be met before biosolids can be applied to the

land, and will specify on which types of crops it can be used. Buffer zones should also be set (minimum distance away from water bodies or ecologically sensitive areas for example) as well as checks and controls to avoid over application of nutrients, as these will eventually find their way to the groundwater.

5- The dried sludge from the plants should be tested for heavy metals contents before distribution to the farmers in order to be able to estimate the adequate quantities of sludge that can be applied per hectare and determine the number of years during which application is possible. As heavy metals tend to accumulate in soils, it is important to keep the total amount of heavy metals below the acceptable limits.

6- After the biosolids directive is issued, the BWE should devise an extensive information campaign to educate farmers about the use of sludge as fertilizers, and teach them about how to comply with the directive.

8 FUTURE TASKS

The next phase of the project will concentrate on making recommendations for improvements to the sewage system and wastewater treatment plants. More specifically, the following tasks will be performed:

1- Estimate the current and future wastewater flow quantities based on the population projections for the year 2035 that have been carried out at an earlier stage. The volumes of wastewater for every village and by region will be calculated.
2- Attempt to obtain more information regarding the missing network plans. However as this has turned out to be a prohibitively time-consuming endeavor, it will be limited to the few networks that will be deemed essential to the fulfillment of the project objective. As an example, networks that were described as old and not functional by the municipalities will be considered non-existent, and municipalities who declared not having a sewer network and for which no studies were found for any planned network will be considered to be unsewered.
3- Formulate a set of priorities according to which the areas of interest will be identified. These priorities should be set after discussions with the BWE administration so that they take into account the BWE strategic plan. Obtain DAI/USAID approval on these priorities.
4- Based on the set priorities, assess the needs of the identified areas and make recommendations as to the improvements needed. These recommendations will encompass both upgrading of existing sewer networks wherever applicable and proposing new networks when none exist.
5- Formulate a set of criteria according to which the size and locations of the wastewater treatment plants should be decided. These criteria should be set after discussions with the BWE administration so that they take into account the BWE strategic plan. Obtain DAI/USAID approval on these criteria.
6- Make recommendations concerning the location and size (population served) of the wastewater treatment plants.
7- Present all recommendations in a schedule of CAPEX and OPEX along with their timing.
8- Evaluate funding mechanisms for recommended actions.