Palestinian Authority
Palestinian Water Authority
Palestinian Energy and National Resources Authority
Coastal Municipalities Water Utility
Gaza Electricity Distribution Company

DATA COLLECTION SURVEY ON GAZA RECONSTRUCTION IN WATER AND ENERGY SECTOR IN PALESTINE

FINAL REPORT

Volume Ⅰ Water Sector

September 2017

Japan International Cooperation Agency (JICA)
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Volume I

Water Sector

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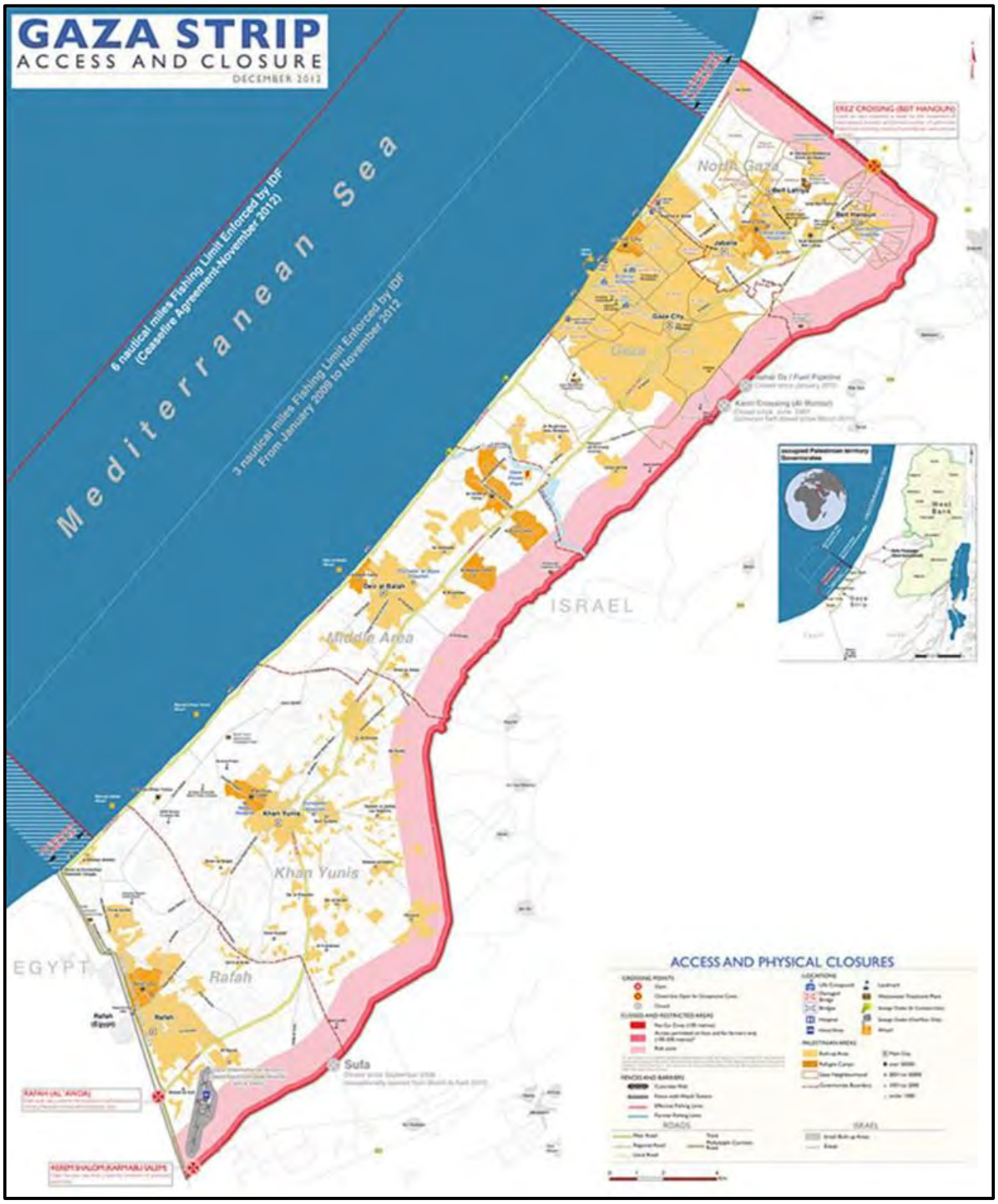
Abbreviations

ADC	Austrian Development Cooperation
BOQ	Bill OF Quantity
BWRO	Brackish Water Reverse Osmosis
CMWU	Coastal Municipalities Water Utility
CoGAT	Coordination of Government Activities in the Territories
DAC	Development Assistance Committee
DHS	Down-flow Hanging Sponge
DMA	District Metered Area
EMP	Environmental Management Plan
EQA	Environmental Quality Authority
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EIB	European Investment Bank
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GCC	Gulf Cooperation Council
GEDCO	Gaza Electricity Distribution Company
GIS	Geographic Information System
GNI	Gross National Income
GRM	Gaza Reconstruction Mechanism
ICRC	International Committee of the Red Cross
IsDB	Islamic Development Bank
Israeli MoF	Israeli Ministry of Finance
JSC	Joint Service Council
JICA	Japan International Cooperation Agency
JOD	Jordan Dinar
JPY	Japanese Yen
JST	JICA Survey Team
KFD	Kuwait Fund For Arab Economic Development
KfW	Kreditanstalt für Wiederaufbau
KPI	Key Performance Indicators
LIBOR	London Interbank Offered Rate
LMICs	Lower Middle Income Countries
MDTF	Multi-Donor Trust Fund
MMU	Materials Monitoring Unit
MoA	Ministry of Agriculture

MoCA	Ministry of Civil Affairs
MoF	Ministry of Finance
MoLG	Ministry of Local Government
MoPAD	Ministry of Planning and Administrative Development
NGEST	Northern Gaza Emergency Sewage Treatment
NIS	New Israel Shekel
NRW	Non-Revenue Water
OCHA	UN Office for the Coordination of Humanitarian Affairs
ODA	Official Development Assistance
PA	Palestinian Authority
PCU	Palestinian Contractors Union
PEC	Palestinian Electricity Company
PECDAR	Palestinian Economic Council for Development and Reconstruction
PIDMDTF	Partnership for Infrastructure Development Multi-Donor Trust Fund
PMU	Project Management Unit
PQ	Pre-Qualification
PV	Photovoltaic
PWA	Palestinian Water Authority
QRC	Qatar Red Crescent
SOP	Standard Operating Procedures
SWRO	Sea Water Reverse Osmosis
TFGWB	Trust Fund for Gaza and West Bank
UFM	Union for the Mediterranean
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UNMAS	United Nations Mine Action Service
UNOPS	United Nations Office for Project Services
UNRWA	United Nations Relief and Works Agency for Palestine Refugees in the Near East
UNSCO	Office of the United Nations Special Coordinator for the Middle East Peace Process
USAID	United States Agency for International Development
USD	United States Dollars
UXO	Unexploded Ordnance
WB	World Bank
WHO	World Health Organization
WSSSIP	Water Supply and Sewage Systems Improvement Project
WWTP	Wastewater Treatment Plant



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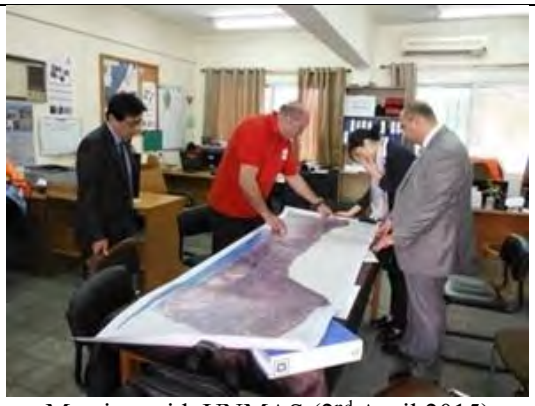
Explanation of IC/R for PWA (1st April 2015)

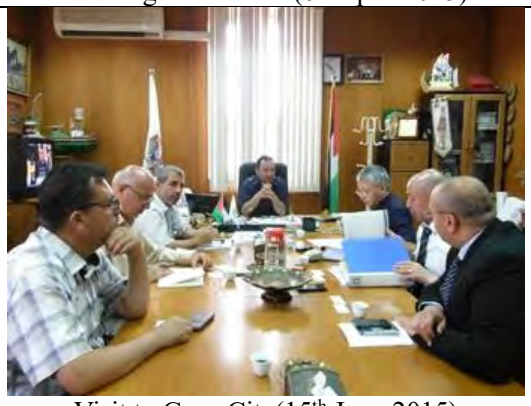
Explanation of IC/R for Beit Hanoun City (2nd April 2015)



Meeting with UNMAS (2nd April 2015)

Meeting with ICRC (6th April 2015)

Meeting with UNDP (6th April 2015)



Visit to Gaza City(15th June 2015)

Information Exchange with UNRWA (14th June 2015)

Photo-documentation: Conducting Project Related Meetings

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 Construction Supervision fot the Pilot Project in Absan Al Kabera (7th March 2017)	 Final Inspection for the Pilot Project in Rafah (9th May 2017)
 Signboard of the Pilot Project in Rafah (15th January 2017)	 Confirmation of water supply improved by the Pilot Project in Rafah (8th March 2017)

Photo documentation: Conducting Project Related Meetings

Sea Water Desalination Plant Supported by ADC (Capacity 600m^3/day)

Sea Water Desalination Plant Site Supported by UNICEF (Capacity 2,000m^3/day)

Water Reservoir Supported by IsDB (Capacity:3,000m^3)

Wastewater Pumping Station Supported by ICRC (Capacity 14,000m^3/day)

Wadi Gaza STP Supported by KfW (Capacity 14,000m^3/day)

Beit Lahia STP Supported by ICRC (Capacity 10,000m^3/day、Treated Wastewater 30,000m^3/day)

Anaerobic Lagoons in Rafah STP

Trickling Filters in Rafah STP

Photo-documentation: Completed or ongoing project site situation

Summary

Palestinians living in Gaza Strip, totaling 1.76 million people in the area of 359km^2 as of 2014, have long suffered from isolation due to blockade by Israel and Egypt. This political turmoil has been aggravated by dire economic conditions, plus the deterioration of living environment in the area.

Excessive pumping from the coastal aquifer attributable to the increase of domestic water demand has given rise to the pollution of the groundwater and sea water invasion into the aquifer. Deteriorated groundwater has caused not only reduction of crop yields but also water-borne health problems. The shortage of domestic water and food together with the frequent power failure (presently almost two thirds of the day), continue to bring untold pain to the people of Gaza.

Conflict with neighboring Israel is the main cause of such complaint. The latest large conflict in 2014 summer caused terrible human damage to the infrastructure damage. It was reported that the dead numbered 2,145 and that of the injured more than 11,200.

This JICA survey commenced in May 2015, when the damage of conflict was still fresh and recovery activities for social infrastructure were being preferentially conducted by the international agencies starting with UN and foreign donor agencies. Urgent assistance recovery work began soon after the cease-fire in August 2014. A number of NGOs stayed in Gaza during the conflict and gave assistance, while Japanese government supplied drugs and medicines and provided food. However, since the procurement of materials for recovery work other than basic construction material was difficult due to the nonfunctioning of the import mechanism outside of Gaza, social infrastructure rehabilitation was delayed.

The objectives of this survey are (1) to support the repair work of electricity distributing cable damaged by the conflict and installation of water distribution and sewer pipes and (2) to formulate a medium-term cooperation plan.

The termination of this survey was postponed from the original date of December 2015 to December 2017. The Japanese side obtained plenty of useful lessons through the implementation of the pilot project.

Some problems to be tackled in delivering carefully crafted Japanese assistance to Gaza area are;

1) Security of Japanese engineer is assured or not
2) Scheduled procurement of construction material and equipment is viable or not
3) Contract process and management/supervision method can be turned to internationally accepted way

First two items depend on external conditions, while third one has to be discussed more in detail among the implementing agency, consultants and contractor to be secured of high quality of constructed facility.

Above stated items are some of lessons from the pilot project and useful information to be shared by related agencies.

Medium-term cooperation project proposed in this report initially recommends the formulation of a reliable Master Plan; and secondly, to list priority project or pilot projects in line with Master Plan. These will promote the coherent development of water-related infrastructure with Japanese cooperation. In the Gaza Strip where water resource is very limited, energy and water saving measures, as well as wastewater recycling are of high significance. Through the development of water and sewerage works, the importance of valuable water resource needs to be emphasized.

Chapter 1

Background of the Survey

Chapter1 Background of the Survey

1-1 Introduction

The Gaza Strip of the Palestinian Authority (hereinafter referred to as "the Gaza Strip") had been subjected to attacks by the Israeli army from July to August 26, 2014 the time an agreement for a cease-fire was reached at the mediation of Egypt. During the conflict, a total of 2,145 persons were killed and over 11,200 persons wounded. Infrastructure and industry were also badly damaged.

Currently, there are several checkpoints at the borders between the Gaza Strip and Israel / Egypt to ensure the fragile ceasefire. These checkpoints have controlled and restricted flow of people and products since before the Israeli attack of July 2014 and have induced energy shortages, poor water environment and a stagnant economy in Gaza Strip. Conflict in 2014 summer aggravated this condition, damaging badly to the local infrastructure and industry.

Therefore, the Palestinian Authority expressed their needs for USD 4.5 billion in reconstruction support at the Gaza Reconstruction Conference held in Cairo on October 12, after the cease-fire. The donors responded with USD 4.9 billion pledge.

The Japan International Cooperation Agency (hereinafter referred to as "JICA") has implemented several follow-up projects in the Gaza Strip in the fields of energy, agriculture, health and local governance. It has also conducted follow-up cooperation projects for emergency relief support after the Israeli attacks intensified in the summer of 2014. To provide further fruitful assistance, it is requested for JICA to extend the original support plans. For this reason, survey team supported total five pilot-projects to get profound understanding of the area in this Data Collection Survey, and the lessons learnt from pilot project was utilized in fabricating medium-term support plan.

1-2 Objective of the Survey

The objective of this Survey is to formulate development plans for basic infrastructure, to render emergency relief support and carry out medium-term reconstruction projects for energy (especially electricity) transmission, the water supply and sewage sectors in order to stabilize the local infrastructure of the Gaza Strip.

This Survey has been implemented following two objectives, as shown below.

(1) Formulating medium-term reconstruction support plans and making concrete proposals

Medium-term (3 to 4 years) reconstruction support plans were formulated and concrete proposals for the following sectors of Gaza Strip were carried out.

(2) Pilot project implementation support

Support for the implementation of pilot projects in the sectors which have urgent needs was carried out. Knowledge and lessons acquired from the implementation support of the pilot projects shall be utilized for the reconstruction support planning process afterwards. In 2015, two pilot projects were carried out in Northern governorate, and in 2016 additional three projects were executed in Southern governorate, Khan Younis and Rafah utilizing the know-how obtained from previous projects.

1-3 Related Authorities

The main Palestinian authorities related to the survey implementation in water sector are listed below.

(1) General development plan

- Ministry of Planning and Administrative Development : MoPAD

(2) Water supply / sewage sector development plan

- Palestinian Water Authority : PWA
- Coastal Municipalities Water Utility : CMWU

1-4 Schedule of Survey

This survey was originally planned for 10 months from March 2015 to December 2015. However, the survey was extended, firstly, until March 2017 since additional pilot projects were formulated in water sector requested from CMWU, and procurement of equipment for electricity sector had been delayed several months; and, secondly, the extension was made. The reason for the second extensions was mainly due to the delay in the commencement of the second pilot projects. This final report was issued in August 2017 reflected the result of discussion on the draft final report in July 2017.

Chapter 2

Current Status of the Gaza Strip

Chapter2 Current Status of the Gaza Strip

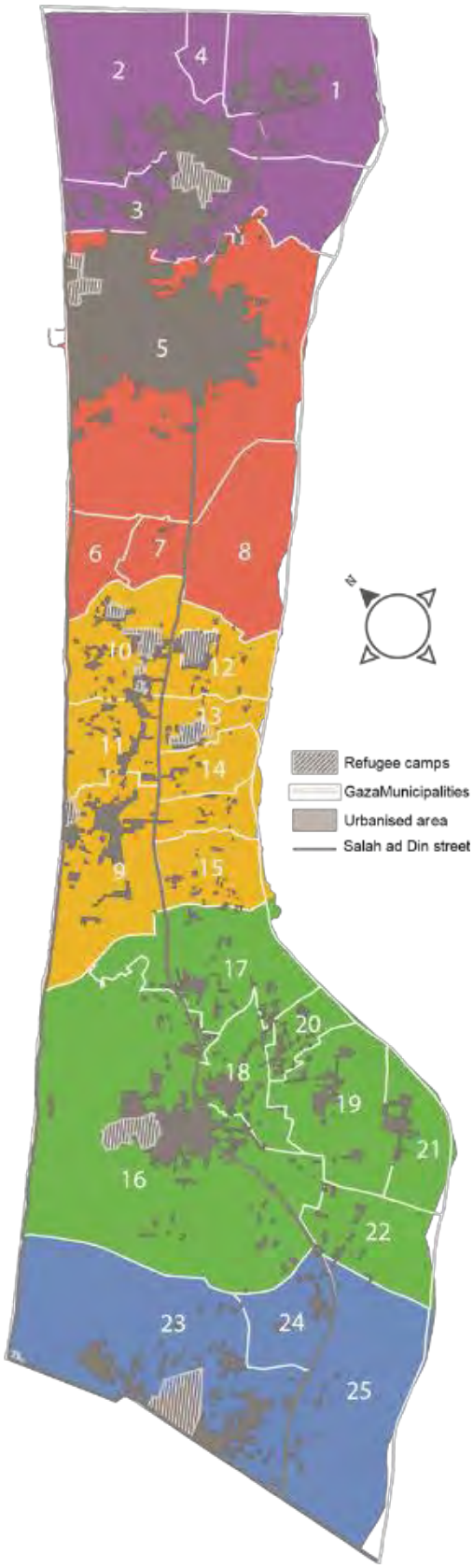
2-1 Location and Municipalities

The Gaza Strip is a narrow coastal strip along the Mediterranean Sea, situated away from the West Bank (**Figure 2-1**). The total area of the Gaza Strip is 359km^2, and it shares a 51km border with Israel and an 11km border with Egypt. There are five Governorates, under which is a total of 25 municipalities, in the Gaza Strip; namely: North Gaza with four municipalities, Gaza also with four, Deir Al Balah (Middle) with seven, Khan Younis also with seven and Rafah with three municipalities. The locations of the 25 municipalities are shown in **Figure 2-2**. The population of the Gaza Strip in 2016 was estimated at 1.88 million, and the annual population increase rate is 3.2 – 3.5% (**Table 2-1**). Population density in Gaza Strip is presented in **Figure 2-3**. Population density of Gaza City, Khan Younis and Rafah City in the south area, and Refugee Camp area is higher than other area.

Source: Arab Reporters for Investigative Journalism, 2009

Figure 2-1 Topography of the Gaza Strip

	No	Municipality	Area (km^2)
North	1	Beit Hanoun	18.10
	2	Beit Lahia	22.60
	3	Jabalia	18.10
		Jabalia Camp	*1.04*
	4	Om Al Nasser	3.00
		Total	**61.80**
Gaza	5	Gaza City	52.40
		Ash Shati' (Beach) Camp	*0.82*
	6	Al Moghraqa	4.40
	7	Al Zahra	3.30
	8	Wadi Gaza	14.20
		Total	**74.30**
Deir Al Balah (Middle)	9	Deir Al Balah	18.60
		Deir Al Balah Camp	*0.18*
	10	Al Nussirat	9.20
		Al Nussirat Camp	*0.96*
	11	Al Zawida	6.90
	12	Al Burij	6.20
		Al Burij Camp	*0.73*
	13	Al Maghazi	3.40
		Al Maghazi Camp	*0.55*
	14	Al Mosadar	4.40
	15	Wadi Al Salqa	6.40
		Total	**55.10**
Khan Younis	16	Khan Younis	53.50
		Khan Younis Camp	*1.00*
	17	Al Qarara	14.30
	18	Bani Suhila	6.80
	19	Abasan Al Kabira	12.60
	20	Abasan Al Jadida	3.30
	21	Khoza'a	6.70
	22	Al Foukhari	9.20
		Total	**106.40**
Rafah	23	Rafah	32.60
		Rafah Camp	*1.36*
	24	Al Nassir	6.60
	25	Al Shoka	22.60
		Total	**61.80**
Total Area			**359.40**



Source: Gaza Urban Profile, 2014

Figure 2-2 Municipalities of the Gaza Strip

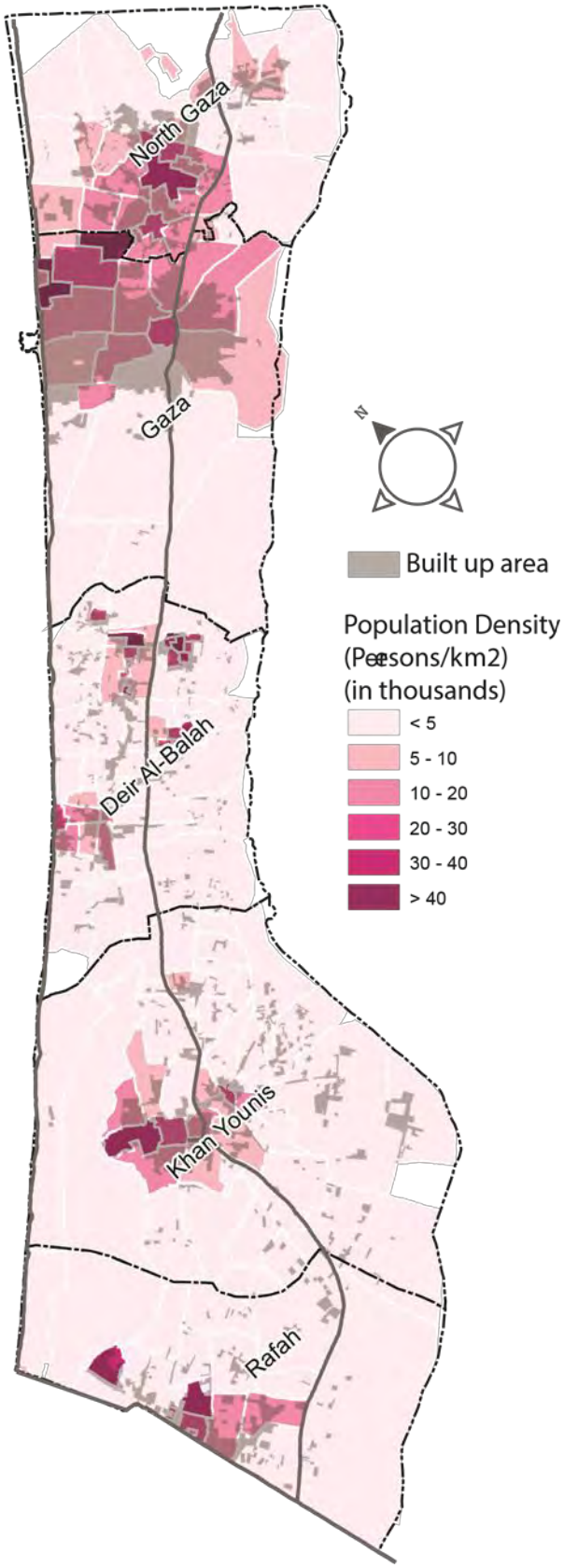
Table 2-1 Transition and Predictions of the Population of Gaza Municipalities

Governorate	No	Municipality	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
North	1	Beit Hanoun	37,392	38,813	40,300	41,851	43,564	45,351	47,199	49,107	51,073	53,094
	2	Beit Lahia	63,347	65,755	68,273	70,902	73,804	76,831	79,962	83,195	86,526	89,949
	3	Jabalia	162,092	168,251	174,696	181,423	188,848	196,592	204,605	212,877	221,400	230,159
		outside of camp	*120,881*	*125,474*	*130,280*	*135,297*	*140,834*	*146,609*	*152,585*	*158,754*	*165,110*	*171,642*
		in Jabalia Camp	*41,211*	*42,777*	*44,416*	*46,126*	*48,014*	*49,983*	*52,020*	*54,123*	*56,290*	*58,517*
	4	Om Al Nasser	2,763	2,868	2,977	3,092	3,219	3,351	3,487	3,628	3,773	3,923
		Total	**265,594**	**275,687**	**286,246**	**297,268**	**309,435**	**322,125**	**335,253**	**348,807**	**362,772**	**377,125**
Gaza	5	Gaza City	477,271	491,312	505,914	521,053	537,890	555,320	573,175	591,419	610,012	628,903
		outside of camp	*443,095*	*456,131*	*469,687*	*483,742*	*499,374*	*515,556*	*532,132*	*549,070*	*566,331*	*583,870*
		in Ash Shati' (Beach) Camp	*34,176*	*35,181*	*36,227*	*37,311*	*38,516*	*39,764*	*41,043*	*42,349*	*43,681*	*45,033*
	6	Al Moghraqa	6,448	6,638	6,835	7,039	7,267	7,502	7,744	7,990	8,241	8,496
	7	Al Zahra	3,043	3,132	3,226	3,322	3,429	3,541	3,654	3,771	3,889	4,010
	8	Wadi Gaza	2,880	2,965	3,053	3,144	3,246	3,351	3,459	3,569	3,681	3,795
		Total	**489,642**	**504,047**	**519,028**	**534,558**	**551,832**	**569,714**	**588,032**	**606,749**	**625,823**	**645,204**
Deir al Balah (Middle)	9	Deir Al Balah	59,976	61,907	63,920	66,010	68,327	70,732	73,203	75,736	78,329	80,972
		outside of camp	*53,633*	*55,360*	*57,160*	*59,029*	*61,101*	*63,252*	*65,461*	*67,727*	*70,045*	*72,409*
		in Deir Al Balah Camp	*6,343*	*6,547*	*6,760*	*6,981*	*7,226*	*7,480*	*7,742*	*8,009*	*8,284*	*8,563*
	10	Al Nussirat	63,800	65,856	67,996	70,220	72,684	75,242	77,871	80,566	83,323	86,135
		outside of camp	*36,123*	*37,287*	*38,499*	*39,758*	*41,153*	*42,601*	*44,090*	*45,616*	*47,177*	*48,769*
		in An Nussirat Camp	*27,677*	*28,569*	*29,497*	*30,462*	*31,531*	*32,641*	*33,781*	*34,950*	*36,146*	*37,366*
	11	Al Zawida	16,688	17,226	17,786	18,367	19,012	19,681	20,369	21,074	21,795	22,530
	12	Al Burij	33,354	34,428	35,547	36,709	37,998	39,335	40,710	42,119	43,560	45,031
		outside of camp	*9,702*	*10,015*	*10,340*	*10,678*	*11,053*	*11,442*	*11,842*	*12,252*	*12,671*	*13,099*
		in Al Burij Camp	*23,652*	*24,413*	*25,207*	*26,031*	*26,945*	*27,893*	*28,868*	*29,867*	*30,889*	*31,932*
	13	Al Maghazi	22,277	22,995	23,742	24,518	25,379	26,272	27,191	28,132	29,094	30,076
		outside of camp	*6,441*	*6,649*	*6,865*	*7,089*	*7,338*	*7,596*	*7,862*	*8,134*	*8,412*	*8,696*
		in Al Maghazi Camp	*15,836*	*16,346*	*16,877*	*17,429*	*18,041*	*18,676*	*19,329*	*19,998*	*20,682*	*21,380*
	14	Al Mosadar	1,845	1,905	1,967	2,031	2,102	2,176	2,252	2,330	2,410	2,491
	15	Wadi Al Salqa	4,552	4,698	4,851	5,010	5,185	5,368	5,555	5,748	5,944	6,145
		Total	**202,492**	**209,015**	**215,809**	**222,865**	**230,687**	**238,806**	**247,151**	**255,705**	**264,455**	**273,380**

Table 2-1 Transition and Predictions of the Population of Gaza Municipalities (Contd.)

Governorate	No	Municipality	Year									
			2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Khan Yunis	16	Khan Younis	177,889	183,107	188,532	194,157	200,413	206,889	213,522	220,299	227,204	234,219
		outside of camp	*140,697*	*144,824*	*149,115*	*153,564*	*158,512*	*163,634*	*168,880*	*174,240*	*179,701*	*185,250*
		in Khan Younis Camp	*37,192*	*38,283*	*39,417*	*40,593*	*41,901*	*43,255*	*44,642*	*46,059*	*47,503*	*48,969*
	17	Al Qarara	19,500	20,072	20,667	21,283	21,969	22,679	23,406	24,149	24,906	25,675
	18	Bani Suhila	31,272	32,189	33,143	34,132	35,231	36,370	37,536	38,727	39,941	41,174
	19	Abasan Al Kabira	18,163	18,695	19,249	19,824	20,462	21,123	21,801	22,493	23,198	23,914
	20	Abasan Al Jadida	5,984	6,159	6,341	6,531	6,741	6,959	7,182	7,410	7,642	7,878
	21	Khoza'a	9,023	9,287	9,562	9,848	10,165	10,493	10,830	11,174	11,524	11,880
	22	Al Foukhari	5,464	5,624	5,791	5,963	6,155	6,354	6,558	6,766	6,978	7,194
		Total	**267,295**	**275,133**	**283,285**	**291,738**	**301,136**	**310,867**	**320,835**	**331,018**	**341,393**	**351,934**
Rafah	23	Rafah	153,920	159,108	164,517	170,144	176,373	182,846	189,510	196,355	203,370	210,541
		outside of camp	*119,895*	*123,936*	*128,150*	*132,533*	*137,385*	*142,427*	*147,618*	*152,950*	*158,414*	*164,000*
		in Rafah Camp	*34,025*	*35,172*	*36,367*	*37,611*	*38,988*	*40,419*	*41,892*	*43,405*	*44,956*	*46,541*
	24	Al Nassir	6,211	6,420	6,638	6,865	7,117	7,378	7,647	7,923	8,206	8,495
	25	Al Shoka	10,566	10,923	11,294	11,680	12,108	12,552	13,010	13,480	13,961	14,453
		Total	**170,697**	**176,451**	**182,449**	**188,689**	**195,598**	**202,776**	**210,167**	**217,758**	**225,537**	**233,489**
Total Population			**1,395,720**	**1,440,333**	**1,486,817**	**1,535,118**	**1,588,688**	**1,644,288**	**1,701,438**	**1,760,037**	**1,819,980**	**1,881,132**

Source: Palestinian Central Bureau of Statistics



Source: Gaza Urban Profile, 2014

Figure 2-3 Population Density of the Gaza Strip

2-2 Social Conditions

According to the Ministry of Foreign Affairs of Japan (hereinafter referred to as "MoFA"), 92% of the population are Muslims, followed by the 7% Christians and the 1% other groups. The main ethnic race is Arab, and the official language is Arabic. The economic indicators are shown in **Table 2-2**.

Table 2-2 Economic Indicators of the Palestinian Authority

Indicator	Detail	Source
Industry ratio	Agriculture/fishery (3.8%), Industry (14.5%), Construction industry (7.2%), Retail/trade (17.3%), Financial/intermediary (3.7%), Public service/defense (13.0%), Service (20.6%), Transport/communication (1.6%) (Year 2014 GDP ratio)	(Palestinian Central Bureau of Statistics : PCBS, 2014)
Nominal GDP	USD 12.7 billion	(IMF, 2015)
GDP per capita	USD 2,708	(IMF, 2015)
Real GDP growth rate	3.5%	(IMF, 2015)
Price escalation rate	1.4%	(IMF, 2015)
Unemployment rate	26%	(IMF, 2015)
Total trade amount	✓ Export : USD 0.96 billion ✓ Import : USD 5.2 billion	(PCBS, 2015)
Trade items	✓ Export : Cement, limestone, olive ✓ Import : Petroleum/petroleum products, grain, non-metallic mineral products	
Trading partner	Israel (62%)	
Currency	No domestic currency (New Israeli Shekel : NIS) NIS1.00＝JPY 31.965 円	The exchange rate as of July 2017 based on JICA rate

Source; Japanese Foreign Ministry

2-3 Refugee Camps

There are eight refugee camps in the Gaza Strip (North Gaza, Gaza, Khan Younis and Rafah with one each, Deir al-Balah (Middle) with four), where 280,000 people reside. Most refugee camps are smaller than 1km^2 and have an average population density of a high 42,000 persons /km^2. Therefore, the living conditions in these camps are very poor. According to the United Nations Relief and Works Agency for Palestine Refugees in the Near East (hereinafter referred to as "UNRWA"), the common issues at the refugee camps are: high population density, power shortages, high unemployment rates, lack of construction materials, water pollution and poor access to water services.

Table 2-3 Refugee Camps in the Gaza Strip

No	Name of Camp	Municipality	Area (km^2)	Population in 2014	Population Density (capita/km^2)
3	Jabalia Camp	Jabalia	1.04	54,123	52,041
5	Ash Shati' (Beach) Camp	Gaza City	0.82	42,349	51,645
9	Deir Al Balah Camp	Deir Al Balah	0.18	8,009	44,494
10	Al Nussirat Camp	Al Nussirat	0.96	34,950	36,406
12	Al Burij Camp	Al Burij	0.73	29,867	40,914
13	Al Maghazi Camp	Al Maghazi	0.55	19,998	36,360
16	Khan Younis Camp	Khan Younis	1.00	46,059	46,059
23	Rafah Camp	Rafah	1.36	43,405	31,915
Total			6.64	278,760	41,982

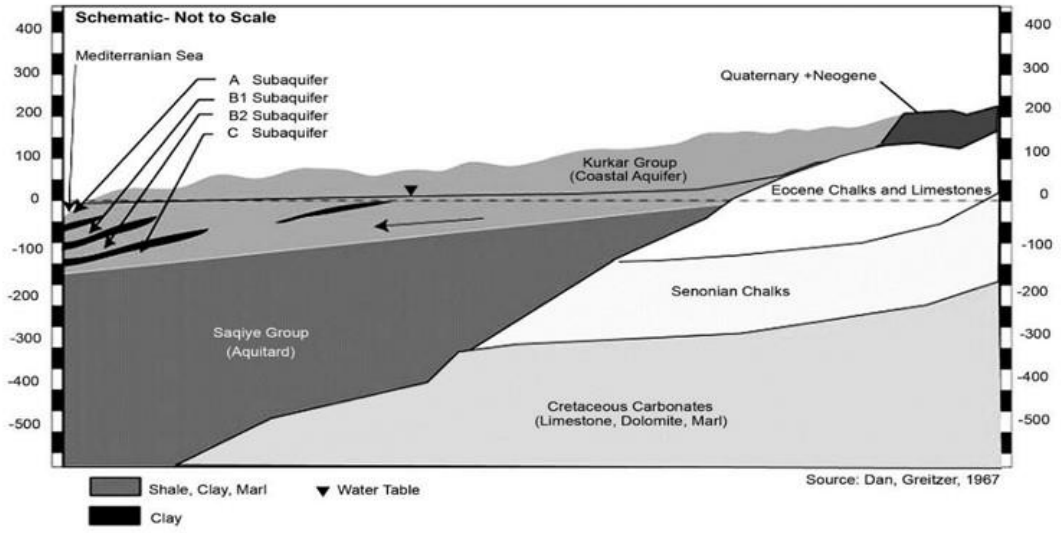
Source: Gaza Urban Profile, 2014

2-4 Topology and Geology

The Gaza Strip is located in the northern side of the Sinai Peninsula and southwest of Jerusalem along the Mediterranean Sea and also along the route which connects Egypt and Israel. It forms a part of the coastal foreshore plain with the Hebron Mountains in the northeast, the Northern Negev desert in the southeast and the Northern Sinai desert in the south. The Gaza Strip is also situated close to the Nile Delta and Northern Sinai, and a coastal curve starts from El Arish towards the north of Gaza.

The topography of the coastal plain is characterized by the exposure of Kurkar ridges, which are formed from sandstone dunes by Aeolian deposits, in both intermittent and continuous shapes. The age of these ridges turn out to be older on the eastern side rather than the coastal side. There are four ridges in northern Gaza; namely: the coastal ridge (20m AMSL), the Gaza ridge (up to 50 AMSL), the El Muntar ridge (80m AMSL) and the Beit Hanoun ridge (90m AMSL). Each ridge is separated by deep depressions (20-40m AMSL) formed by alluvial deposits. There is evidence for the existence of three to four newer Kurkar ridges on the continental shelf running parallel to the current coastal line, several kilometers offshore.

The typical soil layer of the coastal area of the Gaza Strip is sand dunes. There are also layers of sandy loess soils and loess soils that prevail in the eastern area of the Gaza Strip. **Figure 2-4** shows the cross sectional drawing of the typical layers.



Source: Gretzer, D. J. Dan. Report 1967

Figure 2-4 Section of Coastal Aquifer of the Gaza Strip

2-5 Climate

The Gaza Strip is located in the transitional zone between the arid desert climate of the Sinai Peninsula and the semi humid Mediterranean climate of the coastal regions. The main features are listed below.

- ✓ Temperature: The average temperature is 27.2°C in the summer and 13.1°C in the winter. The hottest month is August and the temperature averages between 25-28°C, while the coldest month is January with an average of 12-14°C.
- ✓ Humidity: The relative humidity is 60-80%.

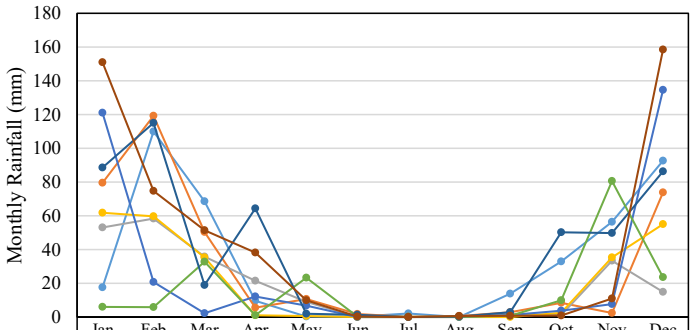
✓ Wind: In the summer, a sea breeze blows during the day and a land breeze blows during the night. This wind is at its strongest near noon and slackens during the night. During this season, strong northwestern winds, which average 3.9m/sec, blow regularly at certain hours. In the winter, southwestern winds, which average 4.2m/sec, blow; but storms which reach 18m/sec also are observed.

Table 2-4 Climate Data of the Gaza Strip (Year 2013)

Month	Temperature (C°)	Humidity (%)	Wind speed (km/d)	Sunshine (hrs./d)	Solar Radiation (MJ/m²/d)
January	13.1	64.2	282.6	4.7	9.8
February	13.4	66.4	277.2	6.1	13.3
March	17.8	68.1	263.4	7.5	17.8
April	19.3	67.1	251.6	8.2	20.9
May	24.1	72.3	232.8	9.7	24.4
June	25.4	77.5	238.1	10.4	24.8
July	26.5	74.7	235.2	10.9	25.6
August	27.2	72.2	240.4	10.5	24.5
September	25.6	68.1	250.3	9.4	21.3
October	21.3	67.3	257.2	8.3	16.7
November	19.6	65.1	260.1	5.9	11.6
December	13.5	62.6	262.5	4.3	8.5

Source: Adnan, Estimation of Water Balance Components in the Gaza Strip with GIS Based WetSpass Model, Civil and Environmental Research, Vol.6, No.11 (2014)

✓ Rainfall: Average monthly rainfall record during 2011 to 2016 is shown in **Figure 2-5**. Major rainy season in the Gaza Strip is in winter season, from October to March, dry season from June to August is being recorded very small rainfall. When it rains, heavy rainfall is recorded in a short time, not continuous gentle rainfall. Since drainage system is properly not developed in the Gaza Strip, road is often flooded at the time of heavy rain as shown in **Photo 2-1**. Although average annual rainfall in the Gaza Strip is 327mm, there exists area-wise difference between north and south area. In the north area, 500mm/year of rainfall is recorded while less than 250mm/year of rainfall is reported in south area closer to the Egyptian border. (**Figure 2-6** and **Figure 2-7**).



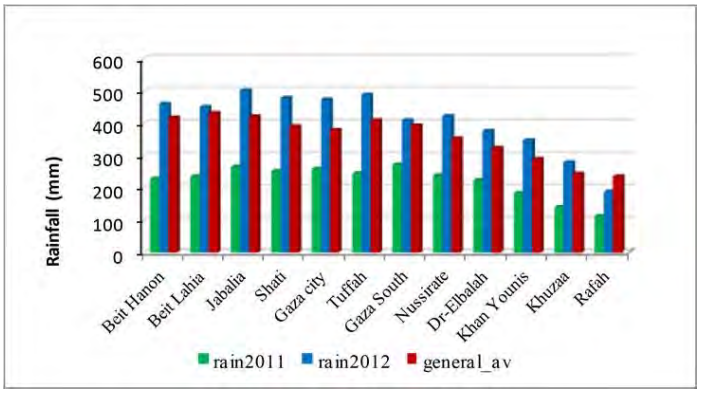
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	17.5	109.9	68.6	9.6	0.3	0.2	2.0	0.0	13.8	32.9	56.4	92.7
2010	79.6	119.3	50.4	5.5	10.6	1.8	0.1	0.6	2.8	8.3	2.4	73.8
2011	53.0	58.3	35.7	21.4	9.0	0.0	0.0	0.2	1.6	1.2	33.3	14.9
2012	61.8	59.7	35.3	1.0	0.6	0.0	0.0	0.0	0.0	2.5	35.3	55.0
2013	121.0	20.7	2.3	12.2	6.7	0.0	0.0	0.0	1.2	3.8	7.7	134.6
2014	6.0	5.8	32.7	1.0	23.3	0.2	0.1	0.1	0.7	9.9	80.6	23.6
2015	88.6	115.1	18.9	64.4	2.0	1.3	0.0	0.3	2.8	50.2	49.7	86.3
2016	151.0	74.8	51.4	38.2	9.9	0.3	0.0	0.6	0.7	0.9	11.0	158.6

Source: JST based on https://www.worldweatheronline.com/gaza-weather-averages/ps.aspx

Figure 2-5 Average Monthly Rainfall in the Gaza Strip

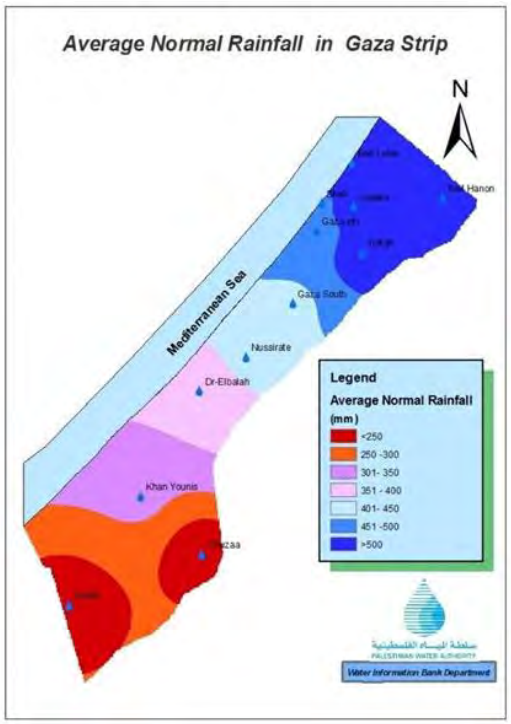
Source: Photo by JST taken on 27th October 2015

Photo 2-1 Flooded Road in Gaza City



Source: Status Report of Water Resources in the Occupied State of Palestine-2012, PWA (October, 2013)

Figure 2-6 Annual Rainfall in Principal Cities in the Gaza Strip



Source: PWA, Status Report of Water Resources in the Occupied State of Palestine-2012

Figure 2-7 Distribution Map of Average of Annual Rainfall in the Gaza Strip

2-6 Land Use

The general land use of Gaza Strip is divided into agriculture areas, built-up areas, governmental use areas, and empty private areas. **Table 2-5** shows the areas of each usage.

Table 2-5 Land Use in the Gaza Strip

Classification	Agriculture (Citrus, Permanent Crops, Vegetables)	Built-up areas and road	Empty Private areas	Governmental , sandy dunes / jungles	Others	Total
Total Area (km^2)	184	41	8	117	15	365
Percentage (%)	50.4	11.2	2.2	32.1	4.1	100

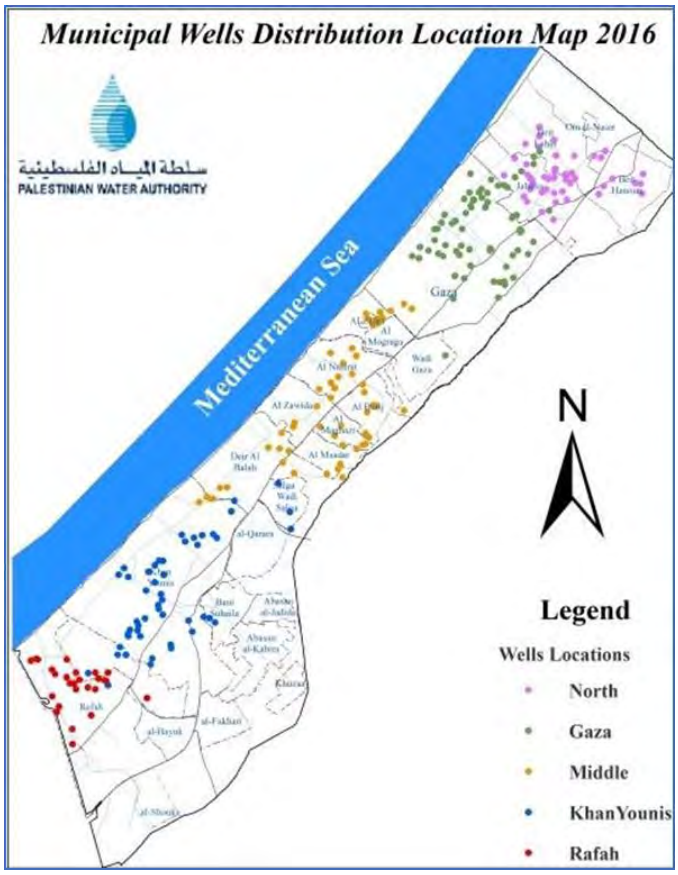
Source: Environmental and Social Impact Assessment & Environmental and Social Management Plan Final Report, EMCC 2014

2-7 Water Environment Conditions

2-7-1 Groundwater Intake and Supply

(1) Domestic water

Based on the information from PWA, in 2016, nearly 82 million m^3/year (actually, 223,509 m^3/day) of groundwater was pumped up from 273 municipal wells widely distributed in all-over the Gaza Strip as is shown in **Figure 2-8**. Besides it, 10 wells operated by UNRWA in Refugee Camps subtracted nearly 2.6 million m^3/year (actually, 7,198 m^3/day) of groundwater.



Source: 2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-8 Location of Municipal Wells

Other sources for domestic water are desalinated water and purchased water from Israeli Mekorot. Nearly 3.9 million m^3/year (actually, 10,734 m^3/day) of desalinated water is generated from 154 sea water and brackish water desalination plants and nearly 10 million m^3/year (actually, 27,309 m^3/day) of purchased water is supplied to the Gaza residents. Water supply volume from each water source is shown in **Table 2-6** by governorate. As a reference, groundwater subtraction volume by municipality in 2014 is presented in **Table 2-7**.

Table 2-6 Water Supply Conditions by Governorates

Governorate	Water Supplied (million m^3/year)				
	Municipal Water Wells	UNRWA Wells	Purchased from Israel	Desalination Plants	Total
North	21,909,688	2,187,060	0	632,910	24,729,658
Gaza	25,119,309	129,300	6,117,303	1,070,947	32,436,859
Middle	13,112,650	0	1,729,721	1,046,747	15,889,118
Khan Younis	12,474,096	170,100	2,120,766	450,957	15,215,919
Rafah	8,965,039	140,700	0	717,590	9,823,329
Total	81,580,782	2,627,160	9,967,790	3,919,151	98,094,883

Source: 2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

(2) Irrigation water

According to the PWA report, "*Annual Water Status Report 2011* and *Status Report of Water Resources in the Occupied State of Palestine 2012"*, groundwater subtraction volume for irrigation use was 86 million m^3/year in 2011 and 83 million m^3/year in 2012. However there are many illegal and non approved wells have been exsiting in the Gaza Strip. In fact, during implementation of the pilot projects by this survey, many pipelines for irrigation use which have not being approved were found (**Photo 2-2**). Hence such figures shall be recognized as rough indications.

Source: Photo by JST taken on 6th May 2017

Photo 2-2 Illegal Irrigation Pipes Installed in Rafah City

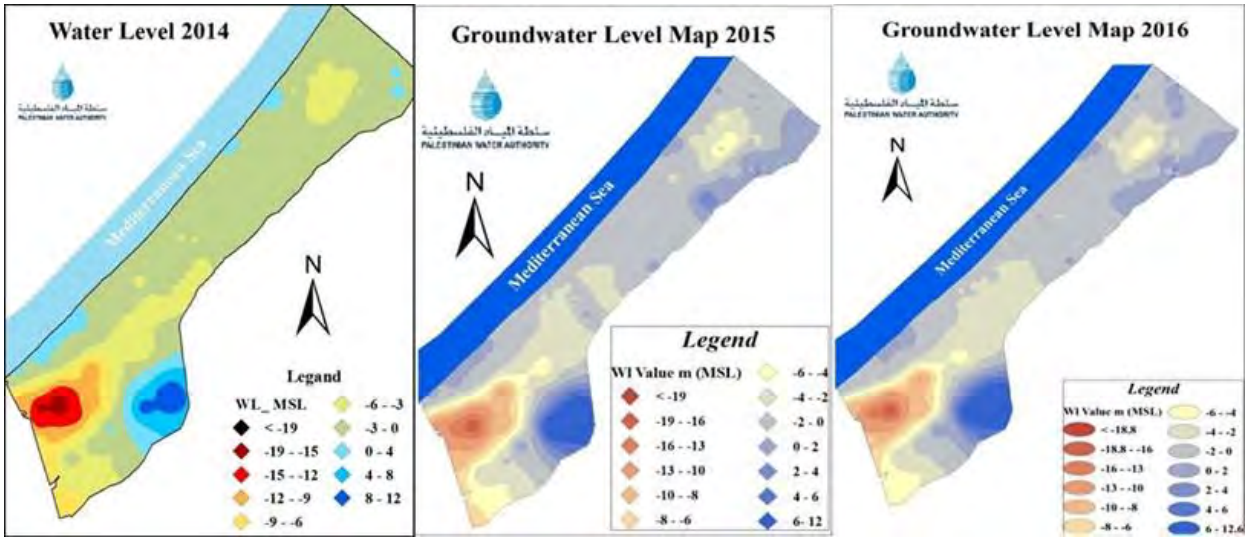
Table 2-7 Pumping Amount of Groundwater by Municipalities (Year 2014)

Governorate	Municipality	Monthly Water Wells Production (m^3) - Year 2014												Total Annual Production	Total Daily Production	Daily Production Rate
		January	February	March	April	May	June	July	August	September	October	November	December			
		m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	%
North Gaza	Beit Hanoun	289,600	271,750	323,220	338,630	367,730	373,660	274,980	47,920	377,420	374,570	351,734	263,650	3,654,864	10,013	4.3%
	Beit Lahia	527,606	415,857	425,406	506,685	1,126,514	362,869	398,326	362,420	436,887	388,785	487,108	393,488	5,831,951	15,977	6.9%
	Jabalia	944,574	865,089	997,042	1,053,322	1,150,888	1,065,880	952,477	952,477	874,575	936,584	876,242	911,027	11,580,176	31,726	13.7%
	Om Al Nasser	15,850	16,610	16,628	16,628	18,580	20,570	23,170	0	27,600	16,960	15,160	16,000	203,756	558	0.2%
sub-total		1,777,630	1,569,306	1,762,296	1,915,265	2,663,712	1,822,979	1,648,953	1,362,817	1,716,482	1,716,899	1,730,244	1,584,165	21,270,747	58,274	25.1%
Gaza	Gaza City	2,594,757	2,335,772	2,198,130	2,413,618	2,286,825	2,284,969	2,668,135	2,668,135	2,395,041	2,522,735	2,305,526	2,286,762	28,960,404	79,343	34.3%
	Al Moghraqa	41,710	47,800	44,940	62,560	71,700	70,600	53,870	53,870	52,420	45,690	48,910	51,890	645,960	1,769	0.8%
	Al Zahra	28,703	34,242	34,242	33,842	36,924	36,499	32,906	33,904	37,548	35,619	37,199	35,535	417,163	1,142	0.5%
	Wadi Gaza	7,600	7,630	9,140	9,930	10,750	11,510	2,800	5,240	4,400	5,340	6,410	7,750	88,500	242	0.1%
sub-total		2,672,770	2,425,444	2,286,452	2,519,950	2,406,199	2,403,578	2,757,711	2,761,149	2,489,409	2,609,384	2,398,045	2,381,937	30,112,027	82,496	35.7%
Deir Al Balah	Deir Al Balah	311,076	373,724	387,997	411,888	402,234	392,716	330,669	330,669	389,232	359,200	389,188	368,208	4,446,800	12,183	5.3%
	Al Nussirat	220,350	213,840	259,410	265,210	280,420	278,110	264,880	264,880	266,727	233,783	231,840	204,220	2,983,670	8,174	3.5%
	Al Zawida	73,396	68,741	96,335	86,360	95,493	98,173	88,954	79,762	90,358	82,947	72,157	76,075	1,008,751	2,763	1.2%
	Al Burij	74,570	89,940	90,790	93,625	117,170	135,320	120,502	139,624	131,318	135,371	105,380	130,652	1,364,262	3,737	1.6%
	Al Maghazi	78,117	64,210	81,311	88,700	79,467	90,484	103,856	103,856	98,632	100,710	73,927	72,182	1,035,452	2,836	1.2%
	Al Mosadar	8,100	9,520	9,870	12,780	16,760	17,664	13,169	13,169	13,169	13,320	9,090	10,230	146,840	402	0.2%
	Wadi Al Salqa	7,290	15,540	9,130	14,510	20,260	21,300	0	0	5,000	8,310	8,480	8,525	118,345	324	0.1%
sub-total		772,899	835,515	934,843	973,073	1,011,804	1,033,767	922,030	931,960	994,436	933,641	890,062	870,092	11,104,120	30,419	13.1%
Khan Younis	Khan Younis	656,788	669,560	769,133	766,587	801,182	837,345	736,260	736,260	721,771	742,054	701,073	609,215	8,747,227	23,965	10.4%
	Al Qarara	86,510	104,730	104,010	124,350	114,240	114,150	118,797	118,797	118,797	105,500	98,680	115,260	1,323,820	3,626	1.6%
	Bani Suhila	41,450	69,540	61,860	76,412	82,178	71,677	71,677	71,677	96,310	133,070	70,730	56,270	902,850	2,473	1.1%
	Abssan Al Kabira	56,210	56,120	88,940	69,130	100,260	99,817	99,817	99,817	131,090	154,560	84,250	101,120	1,141,130	3,126	1.4%
	Abssan Al jadida**															
	Khoza'a**															
	Al Foukhari	19,890	24,225	28,205	24,005	23,240	21,800	21,500	21,600	19,658	24,625	21,265	22,130	272,143	745	0.3%
sub-total		860,848	924,175	1,052,148	1,060,484	1,121,100	1,144,789	1,048,051	1,048,151	1,087,626	1,159,809	975,998	903,995	12,387,170	33,935	14.8%
Rafah	Rafah	626,555	626,829	704,102	734,912	774,608	756,066	725,801	690,177	780,968	802,015	702,326	665,428	8,589,787	23,533	10.2%
	Al Nassir	30,060	31,580	34,330	46,520	48,510	40,120	60,020	18,083	46,810	13,400	34,480	23,320	427,233	1,170	0.5%
	Al Shoka	40,760	42,650	42,650	35,850	46,060	44,560	27,743	26,821	63,340	56,606	46,701	44,518	518,259	1,419	0.6%
sub-total		697,375	701,059	781,082	817,282	869,178	840,746	813,564	735,081	891,118	872,021	783,507	733,266	9,535,279	26,122	11.3%
		6,781,522	**6,455,499**	**6,816,821**	**7,286,054**	**8,071,993**	**7,245,859**	**7,190,309**	**6,839,158**	**7,179,071**	**7,291,754**	**6,777,856**	**6,473,455**	**84,409,343**	**231,246**	**100.0%**

Source: CMWU

2-7-2 Groundwater Level

Groundwater level is annually being monitored by the PWA monitoring team at the wells located throughout the Gaza Strip. The team conducted the survey at 88 monitoring point in 2014, 85 points in 2015 and 75 points in 2016. Results of the survey are presented in **Figure 2-9**. According to the results, decline in Rafah area is distinctly large, recording minus 18.8m above mean sea level (AMSL). Highest groundwater level was recorded in south-east part of Khan Younis governorate with the AMSL of 12.5m, while groundwater level in Gaza City is minus 5.5m AMSL and that in Gaza central area varies from plus 2m to minus 3m AMSL. Although any remarkable changes are not found during 2014 - 2016 on groundwater level itself, both trends of rising and declining have being appeared in the Gaza Strip since 1969.



Source: 2014 Water Resources Status Summary Report/Gaza Strip, PWA (2015)
2015 Water Resources Status Summary Report/Gaza Strip, PWA (April, 2016)
2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-9 Changes in Groundwater Level in Gaza Strip from 2014 to 2016

(1) Fluctuation Trend

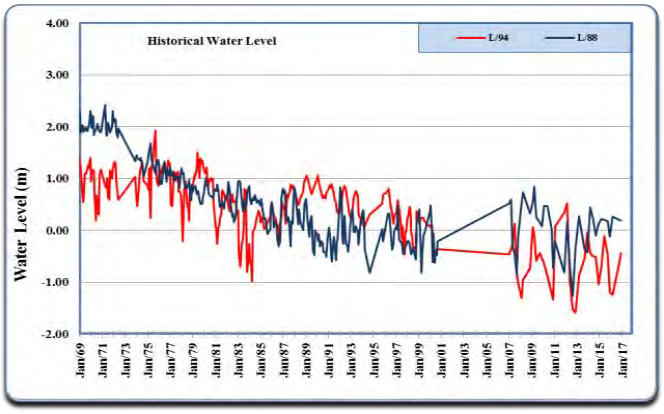
In the north Gaza area, east part of central Gaza area and far area away from the wells from which domestic water is heavily subtracted, fluctuation trends, in which both decline and rising trend are repeated, are observed. **Figure 2-10** shows this fluctuation trend.

(2) Decline Trend

Decline trend over time has been observed in north and south Gaza area where groundwater level is below sea level. Since 1997 this trend has been accelerated to critical conditions. **Figure 2-11** presents this decline trend.

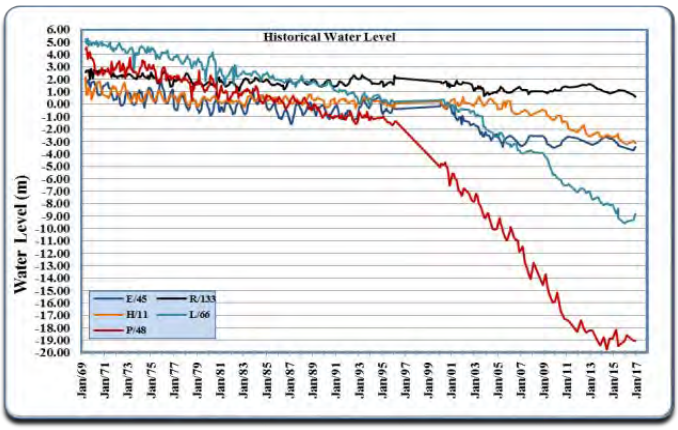
(3) Rising Trend

Rising trend of groundwater level is observed in only limited wells located in the south-east area of Khan Younis governorate. **Figure 2-12** shows this rising trend.



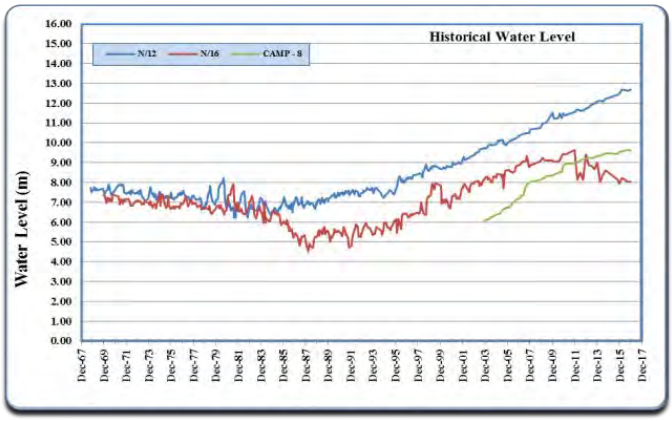
Source: 2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-10 Fluctuation Trend of Groundwater Level



Source: 2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-11 Decline Trend of Groundwater Level



Source: 2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-12 Rising Trend of Groundwater Level

2-7-3 Groundwater Quality

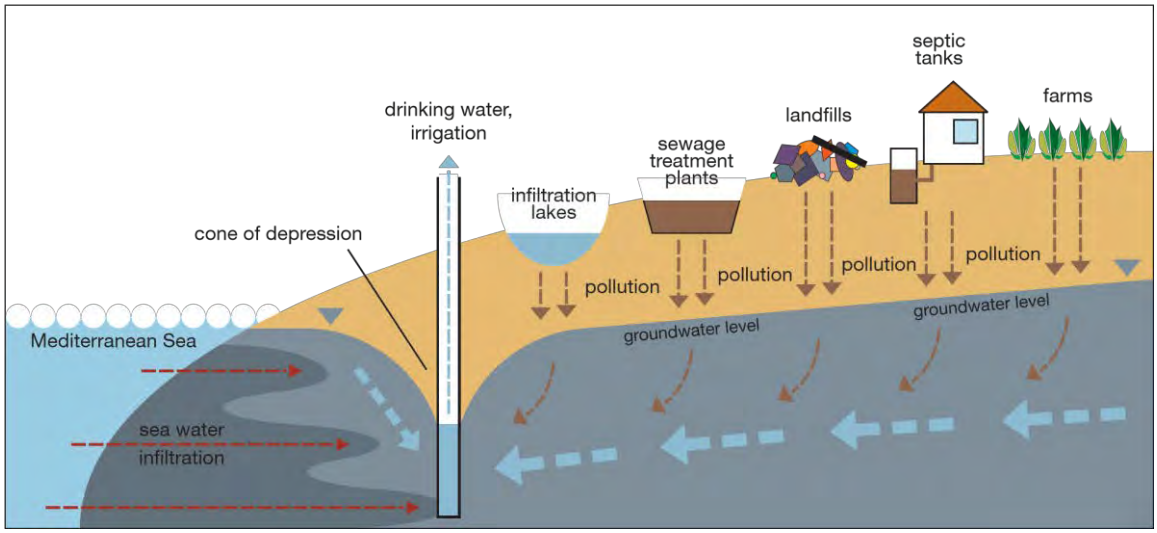
Analysis of water quality sampled from spring of 2010 to fall of 2012 from the well in the Gaza Strip is shown in **Table 2-8** together with comparison data of WHO drinking water guidelines and PWA drinking water guidelines. It explains that there are many samples which fail to clear the both guidelines in various parameters.

Table 2-8 Water Quality of Wells

		Nitrate as NO_3^- mg/l	Total Dissolved Solids(TDS) mg/l	Fluoride as F^+	Chloride as Cl^- mg/l	Conductivity mS/cm at 20°	Sulphate as SO_4^{-2} mg/l	Alkalinity mg/l $CaCO_3$	Hardness mg/l $CaCO_3$	Calcium as Ca^{+2}	Manganese mg/l Mg^{+2}	Potassium as K^+ mg/l	Sodium as mg/l Na^+	pH
		Values from wells in all the governorates												
Spring 2010	Median	106	1,531	1.0	518	2,470	148	251	496	90	67	4	318	7.8
	Max	524	18,414	2.3	11,476	29,700	1,163	571	9,610	2,160	1,022	320	4,440	8.9
	Min	11	241	0.0	53	389	4	52	103	17	15	1	25	6.1
Fall 2010	Median	129	1,519	1.0	524	2,450		275	467	84	60	4	320	7.7
	Max	417	18,476	2.0	8,281	29,800		600	7,446	1,307	1,014	92	4,725	8.5
	Min	14	231	0.1	50	372		23	102	13	10	1	21	6.7
Spring 2011	Median	121	1,559	1.0	558	2,515	152	278	458	84	62	4	360	7.5
	Max	528	16,616	1.9	9,116	26,800	1,447	797	4,419	764	683	105	5,000	8.8
	Min	12	257	0.3	49	415	15	69	83	18	7	1	34	6.7
Fall 2011	Median	87	1,612		526	2,600	156	243	435	78	63	5	400	7.5
	Max	335	13,578		7,605	21,900	1,080	521	3,159	725	442	100	3,940	8.4
	Min	8	311		64	502	4	108	113	19	15	1	27	6.8
Full Year 2012	Median	95	1,581		541	2,550	181	248	455	84	60	5	420	7.8
	Max	396	18,476		10,272	29800	1,521	571	4,351	650	662	140	5,600	8.6
	Min	14.7	295		72	476	9	99	94	16	13	1	27	6.8
WHO guidelines for drinking water		50	1,000-1,200 min 100 optimum level 250-500	1.5	250	400	500	200	200	min 30	min 10 optimum 20-30	12	200	6.5-9.5
PWA guidelines for drinking water		70	1,500	1.5	600	400	400	400		100-200	150	12	200	6.5-9.5

Source: A Systematic Literature Review and Recommendation on Water Usage in the Gaza Strip, September 2014, Norwegian Institute of Public Health & The Palestinian National Institute of Public Health

Groundwater is directly supplied to households after disinfection, while they are also used for agricultural irrigation, therefore groundwater pollution is probably the immediate cause for local health problems and growth-hindrance issues for crops. The groundwater pollution of Gaza Strip is represented by two parameters. The first, and most important indicator, is the nitrate concentration. Nitrate pollution is caused by untreated sewage and leachate water from waste dumping sites, which raise the nitrate concentration of groundwater and as a result, high nitrate concentration is detected in the supplied water. The second issue is the increasing salinity in groundwater caused by seawater invasion due to the overexploitation of groundwater. The intake of polluted groundwater is creating a health hazard to users and high salinity irrigation water is attributed to hinder growing of the crops. Groundwater pollution mechanism is shown in **Figure 2-13**.



Source: Environmental Assessment of the Gaza Strip, January, UNEP (2009)

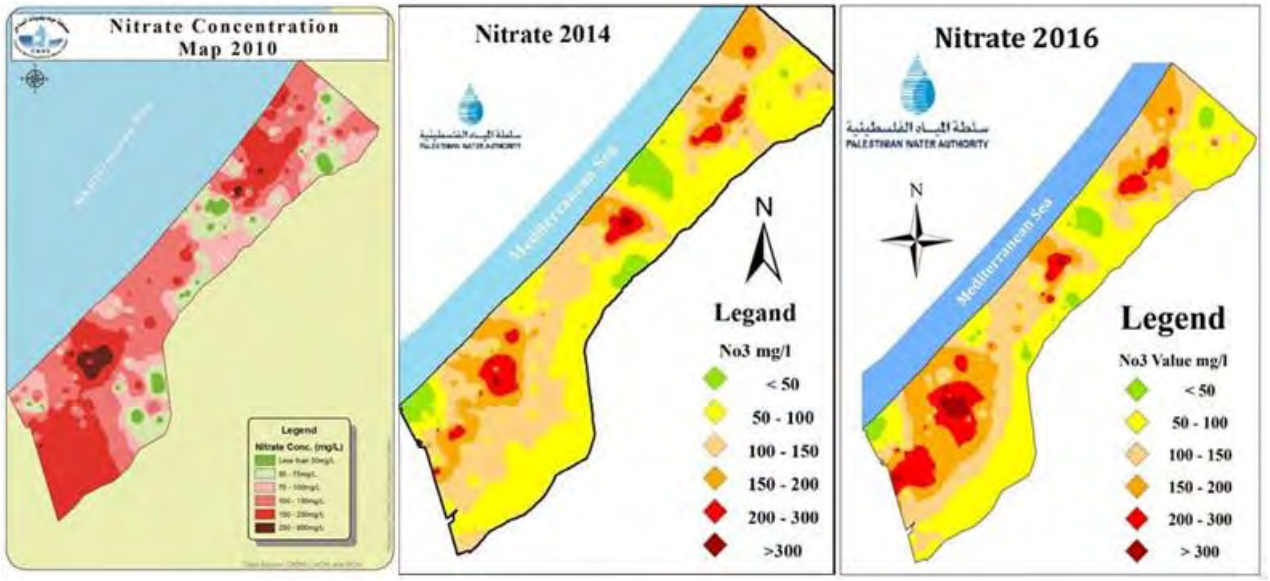
Figure 2-13 Groundwater Pollution Mechanism

(1) Nitrate

Distribution maps for nitrate concentration in the Gaza Strip from 2010 to 2016 is shown in **Figure 2-14**. Although area with wells of high nitrate concentration was limited only within a part of Gaza City in 2010, the area has spread to the Rafah City, central Gaza area and major part of Gaza City in 2016. In 2013, 13.3% of the wells surveyed cleared WHO nitrate concentration guideline criteria of 50mg/L, while its ratio was reduced to 11% in 2016.

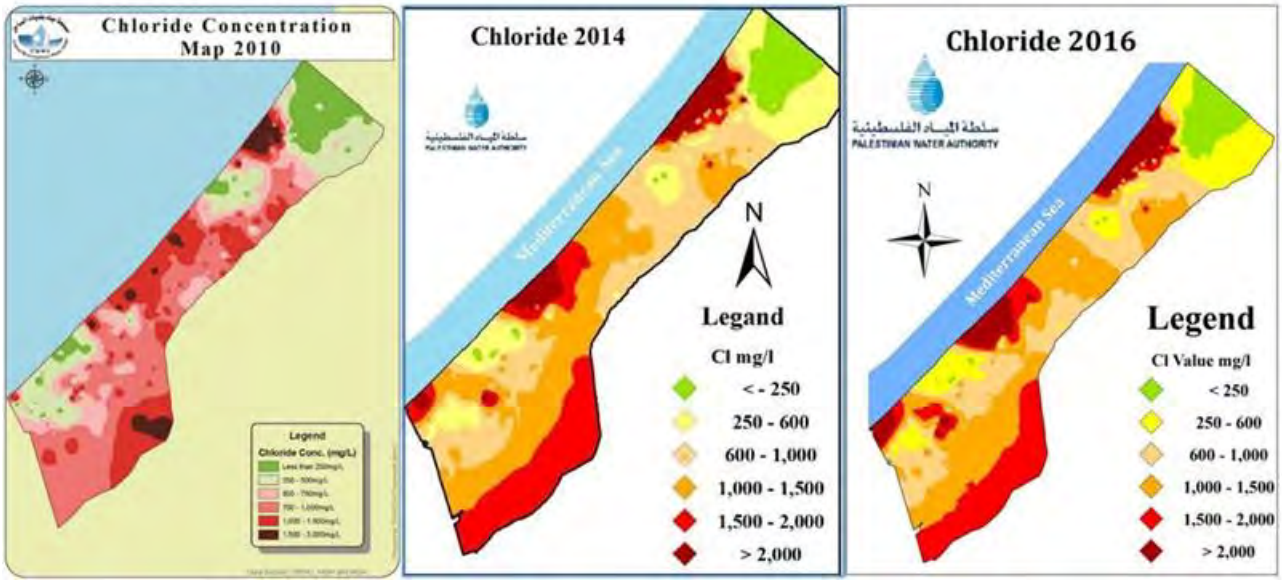
(2) Chloride

Distribution maps for chloride concentration in Gaza Strip from 2010 to 2016 is shown in **Figure 2-15**. Coastal area of Gaza City, coastal area between central Gaza area and Khan Younis governorate, and coastal area of Rafah City has recorded high concentration of chloride. In addition to the above stated area, chloride concentration has gone up in south area of Khan Younis and Rafah governorate, this area includes area where groundwater has been kept above sea level and where the ground water level has been kept rising trend. In the north part of the Gaza Strip where precipitation is comparatively large, chloride concentration has being kept less than 250mg/L.In 2013, 24.6% of the surveyed wells satisfied less than 250mg/L of chloride which is WHO guideline, while its ratio dropped to 18% in 2016.



Source: Summary about Water and Wastewater Situation in Gaza Strip (2011), CMWU
2014 Water Resources Status Summary Report/Gaza Strip, PWA (2015)
2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-14 Changes of Nitrate in Groundwater in the Gaza Strip from 2010 to 2016



Source: Summary about Water and Wastewater Situation in Gaza Strip (2011), CMWU
2014 Water Resources Status Summary Report/Gaza Strip, PWA (2015)
2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 2-15 Changes of Chloride in Groundwater in the Gaza Strip from 2010 to 2016

2-7-4 Health Damages Caused by Water Pollution

It is said that over 95% of the groundwater sources in the Gaza Strip are polluted severely by nitrate and/or chloride, causing negative impacts on the health of the local residents, especially children. The number of patients of water-related diseases, such as Hepatitis A and Diarrhea, which is the major diseases observed in the Gaza Strip, is rapidly increasing. According to the 2012 JICA Palestine office report on assistance needs analysis, 26% of the diseases in the area are water-related. Diseases included in this group are: acute diarrhea, parasitic

diseases, internal diseases related to kidney and liver, and methemoglobinemia (so-called "blue-baby syndrome") caused by elevated nitrate levels in drinking water.

The numbers of typical water-related diseases, Hepatitis A, Typhoid Fever and Bloody Diarrhea, reported by each governorate in the year 2012 are listed in **Table 2-9**.

Table 2-9 Number of Onset of Hepatis A, Typhoid Fevor and Bloody Diarrhea

	2012						2011	2010
	North Gaza	Gaza	Deir Al Balah	Khan Younis	Rafah	Total		
Hepatitis A	277	209	161	240	123	1,010	423	319
Typhoid Fever	22	7	0	136	0	166	169	249
Bloody Diarrhea	3,127	943	3,219	1,560	535	9,384	6,826	5,018

Source: Characterization of the Potential Water-borne Diseases in Wadi Gaza – Gaza Strip, March 2014, Islamic University of Gaza High Studies Deanship Faculty of Engineering Civil Engineering Department Water Resource Engineering, Khaled. J. Taleb

2-7-5 Pollution Caused by Sewage

Although sewer pipes coverage connected to each household is said to exceed 70% in 2014, sewage inflow amount to the WWTP is small and the treatment efficiency is low. Therefore sewage is a cause of pollution in groundwater and seawater. The analysis results of the sewage quality surveyed in the United Nations Environment Programme (hereinafter referred to as UNEP) in 2009, which collected samples from throughout the Gaza Strip are shown in **Table 2-10** (note: exact sampling locations are not clear).

Table 2-10 Treated Wastewater Quality

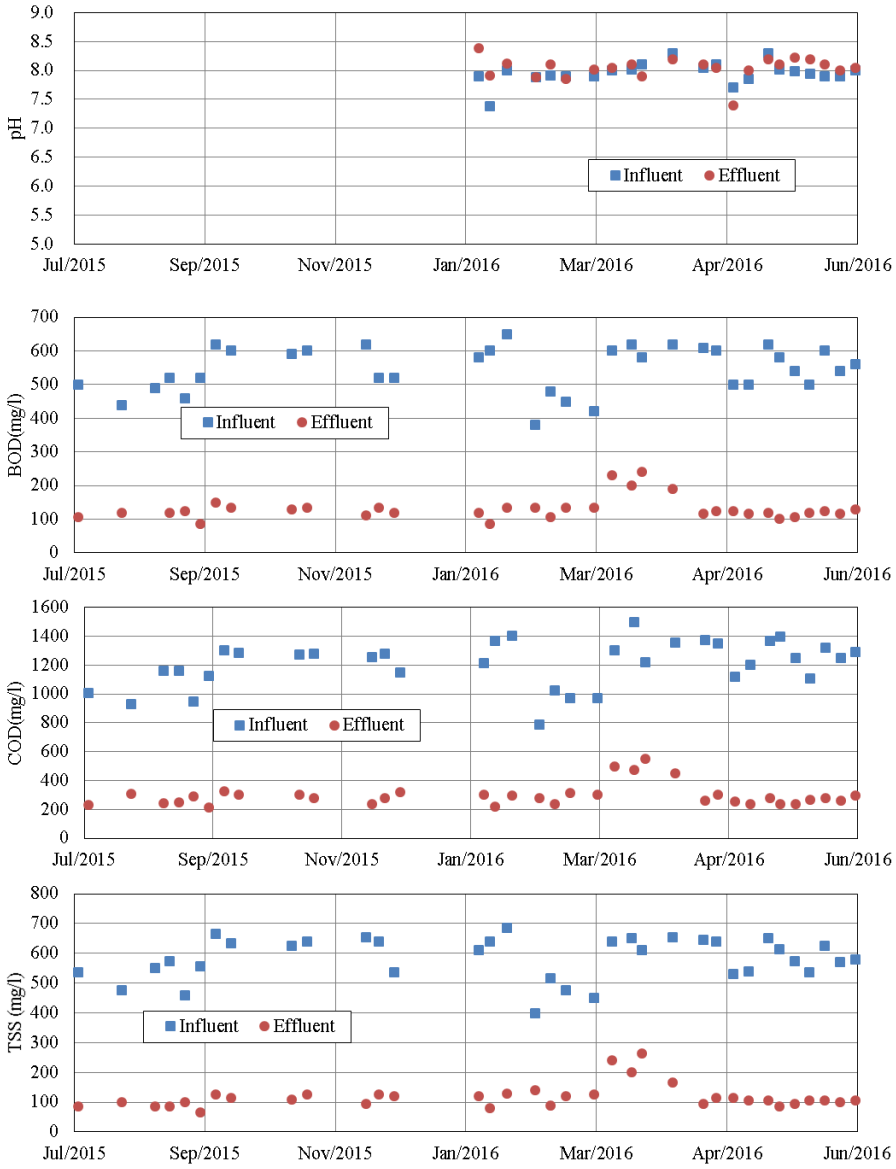
		Ammonia (mg/L)	COD (mg/L)	*E.coli* (cfu/100mL)
WHO guideline	Infiltration	5	150	1,000
	Marine Disposal	10	200	50,000
Sampling No.	1	92.4	416	＞10,000
	2	185	1,770	12,600
	3	135	3,440	＞10,000
	4	74.7	451	25,200
	5	76.4	1,470	＞10,000
	6	No Data	1	＜10
	7	65.2	761	＞10,000
	8	No Data	78	150
	9	135	280	14,000

Source: Environmental Assessment of the Gaza Strip, January 2009, UNEP

Regarding the existing treatment efficiency, survey result of influent and effluent of Rafah WWTP from July 2015 to June 2016 is shown in **Figure 2-16**. Average quality of treated wastewater is 132mg/L in BOD, 298mg/L in COD and 118mg/L in TSS. These values are not suitable for aquifer recharging or discharging into ocean.

Since unit water consumption in the Gaza Strip is less than 100L/day, the concentration in sewage becomes so high. For instance, BOD value usually reaches 600mg/L, much higher than typical value for urban areas of 250mg/L. This is one characteristic of this region.

The soil in the Gaza Strip, in general, is permeable. This means polluted water is easily separated from living space, which is sanitary in a sense, while infiltrated wastewater is easily accessible to the underground aquifer, which accelerates pollution.



Source: Based on CMWU data, JST fabricated

Figure 2-16 Influent and Effluent Quality of Rafah WWTP

2-7-6 Pollution Related to Solid Waste Dumping Sites

Poor solid waste management is also a commonly recognized environment issue in Gaza Strip. Although some improvements have been acknowledged, it still remains not enough. Major issues related to waste disposal are listed below.

- ✓ Dumping sites are in close proximity to residential areas.
- ✓ Leachate from the dumping sites easily seeps into the groundwater.
- ✓ There are no protective layers installed at the dumping sites.
- ✓ Waste collection vehicles, scavengers, animals, air pollution and odor measures are not managed.

Solid waste dumping sites in the Gaza Strip are shown in **Figure 2-17**. The quality of leachate is shown in **Table 2-11**. UNEP measured heavy metal contents in soil where the leachate infiltrated in 2009, the results of analysis were within the regulation.

Source: Environmental Assessment of the Gaza Strip, January 2009 United Nation Environment Programme

Figure 2-17 Location Map of Solid Waste Dumping Sites in the Gaza Strip

Table 2-11 Leachate Quality Generated from Dumping Site

Parameter (unit)	Acid phase, 0-2 years		Methanogenic phase >2 years
	Low	High	Average
pH (-)	5	6.5	7.5
COD (mg/L)	20,000	40,000	2,200
BOD_5 (mg/L)	10,000	30,000	400

Source: Environmental Assessment of the Gaza Strip, January 2009 United Nation Environment Programme

Chapter 3

Status of Water Sector in the Gaza Strip

Chapter3 Status of Water Sector in the Gaza Strip

3-1 Outline

Coastal Municipalities Water Utility (hereinafter referred to as "CMWU") was established to efficiently manage the water supply and sewerage work of all municipalities in the Gaza Strip in 2005. It is one of organization of the Joint Service Council（hereinafter referred to as "JSC"), which shall be managed as a financially self-supporting manner. CMWU was established by PWA and Ministry of Local Government (hereinafter referred to as "MoLG") through the financial and technical assistance by the World Bank (hereinafter referred to as "WB"). Fifteen municipalities had completed asset transfer procedures to CMWU.

CMWU started new project "The Water Supply and Sewage Systems Improvement Project (hereinafter referred to as "WSSSIP")" funded by WB in December 2012. The project consists of three components, namely: i) restoring and improving water supply and waste water facilities, ii) capacity building, operational support and CMWU recurrent cost, iii) project management, monitoring and evaluation. The total budget of the project is USD 17.54 million. The project includes a soft component, which is the improvement of the asset management system. The project implemented in In Khan Younis, Rafah and Deir Al Balah is to reduce of Non-Revenue Water ((hereinafter referred to as "NRW") and to improve the tariff collection system.

After the conflict in July 2014, the objective of WSSSIP was changed from "Improving water supply system" to "Improving water supply system and reconstruction of damaged facilities". The budget was also increased by the additional financial assistances i.e., Trust Fund for Gaza and West Bank (hereinafter referred to as "TFGWB"), Islamic Development Bank (hereinafter referred to as "IsDB") and Multi-Donor Trust Fund (hereinafter referred to as "MDTF").

3-1-1 Water Supply System

Table 3-1 shows a list of water supply service facilities before the conflict in the 2014. The distribution system in Gaza Strip has not been established District Metered Area (DMA).

Table 3-1 Water Service Facilities before the Conflict in Year 2014

Asset		Amount
Buildings/Plants	Filtration/Treatment Plants	21
	Distribution Centers	24
Conveyance and storage	Tube Wells	205
	Open Wells	0
	Hand Pumps	0
	Pumping stations	16
	Main lines	800km
	Pipelines	1,600 km
	Connections	140,000
	Storage Tanks	26
Administration	Buildings	6
	Stores	4
	Water and Wastewater Lab	2

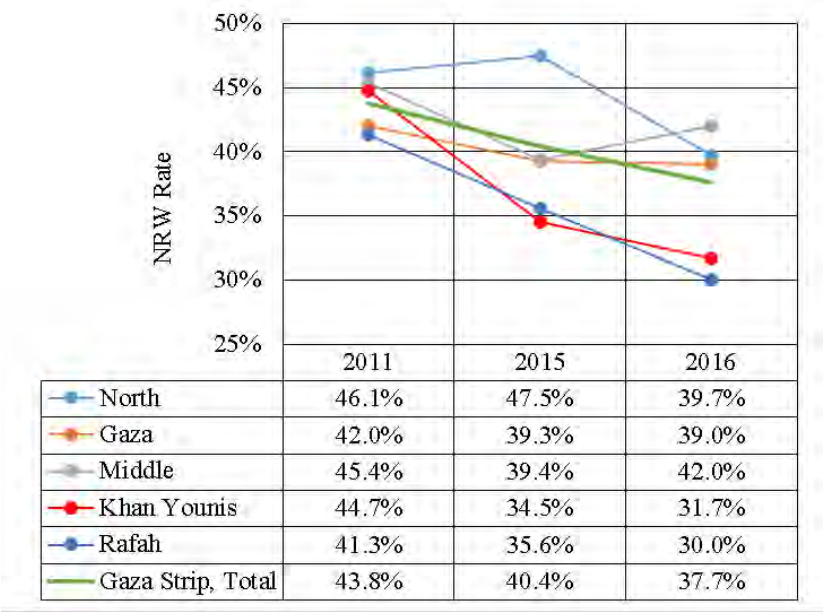
Source: Damages Assessment Report Water and Wastewater Infrastructure, CMWU (2014)

The water service coverage in the Gaza Strip had already exceeded 96% in 2011 (service population in 2011 was 1,526,200 against total population of 1,588,688) and as of now it records almost 100% although per capita volume is small. **Table 3-2** shows domestic water supply conditions, service population, supply volume, consumption volume and unit consumption volume in 2016. Annual supplied volume as domestic water is 94.18 million cubic meter including UNRWA supply volume and purchase volume from Israel, while consumed volume (billed volume) is 58.72 million cubic meter considering 37.7% of NRW ratio. Unit consumption volume varies by municipality from 55.6 lpcd to 194.6 lpcd, recording average 85.5 lpcd for allover Gaza Strip.

Water pressure in the network is generally low and service hour is limited due to the scheduled rationing. Although distribution facilities are often equipped with generators, it is seldom operational since diesel fuel is costly.

Since the existing network pipelines have been aged, high NRW ratio resulted from leakage is casting a bad influence on the water service entities. The WB report (No.72378-GZ, 2012) points out that 50% of the NRW is due to UfW, 20% is due to inaccuracies in metering, and 30% is due to illegal connections. That means physical loss occupies 50% of NRW, while another 50% is commercial loss (metering inaccuracies loss plus illegal connection loss).

Changes in NRW ratio from 2011 to 2016 by each governorate is shown in **Figure 3-1**. Although each governorate records more than 30% of NRW ratio and it needs more efforts to reduce it, it has a tendency toward improvement as a whole. Especially, in Khan Younis and Rafah Governorate, NRW ratio in 2011 which was 44.7% and 43.8% each, have dropped drastically to 31.7% and 30.0% respectively. That reduction seems thanks to the NRW reduction activities developed by World Bank in those areas. Lesson learnt givn through implementation of the activity is described in **6-7-2**, **Chapter6**.



	2011	2015	2016
North	46.1%	47.5%	39.7%
Gaza	42.0%	39.3%	39.0%
Middle	45.4%	39.4%	42.0%
Khan Younis	44.7%	34.5%	31.7%
Rafah	41.3%	35.6%	30.0%
Gaza Strip, Total	43.8%	40.4%	37.7%

Source：Summary about Water and Wastewater Situation in Gaza Strip(2011),CMWU
2015 Water Resources Status Summary Report/Gaza Strip, PWA (2016)
2016Water Resources Status Summary Report/Gaza Strip, PWA (April, 2017)

Figure 3-1 Changes in NRW Ratio by Governorates in the Gaza Strip from 2011 to 2016

Table 3-2 Domestic Water Supply, Consumption and Unit Consumption in the Gaza Strip in Year 2016

Governorate	Municipality	Gov. Population	Total Water Consumption (Mm^3/y)	Total Water Production (Mm^3/y)	Supplied by UNRWA (Mm^3/y)	Purchased from Israel (Mm^3/y)	Total Water Supplied (Mm^3/y)	System Efficiency	Unit Production (L/capita/day)	Unit Consumption (L/capita/day)	Private Desalination Plants (Mm^3/y)
North	Um Annaser	3,880	183,735	246,960			246,960	74.4%	174.4	129.7	632,910
	Beit Hanoun	52,635	1,911,140	3,533,617			3,533,617	54.1%	183.9	99.5	
	Beit Lahia	89,179	3,171,511	5,009,525			5,009,525	63.3%	153.9	97.4	
	Jabalia	228,204	9,259,754	13,119,586	2,187,060		15,306,646	60.5%	157.5	111.2	
Gaza	Gaza	631,314	19,133,206	25,119,309	129,300	6,117,303	31,365,912	61.0%	109.0	83.0	1,070,947
Middle	Wadi Gaza	3,799	77,033	131,495			131,495	58.6%	94.8	55.6	1,046,747
	Al Moghraqa	8,524	294,383	682,620			682,620	43.1%	219.4	94.6	
	Al Zahraa	4,022	285,712	434,037			434,037	65.8%	295.7	194.6	
	Al Nusairat	86,117	2,542,131	3,416,287		956,802	4,373,089	58.1%	108.7	80.9	
	Al Buraij	45,018	1,188,238	1,757,967		192,400	1,950,367	60.9%	107.0	72.3	
	Al Maghazi	30,067	860,841	903,563		580,519	1,484,082	58.0%	82.3	78.4	
	Al Zawaida	22,522	775,882	1,137,427			1,137,427	68.2%	138.4	94.4	
	Deir Al Balah	80,955	2,339,252	4,232,520			4,232,520	55.3%	143.2	79.2	
	Al Musadar	2,486	108,253	163,024			163,024	66.4%	179.7	119.3	
	Wadi Al Salqa	6,140	129,847	253,710			253,710	51.2%	113.2	57.9	
Khan Younis	Al Qararah	25,773	859,722	1,310,630			1,310,630	65.6%	139.3	91.4	450,957
	KhanYounis	235,155	6,072,070	8,961,016	170,100		9,131,116	66.5%	104.4	70.7	
	Bani Sohaila & Eastern Village	85,185	2,936,203	1,903,137		2,120,766	4,023,903	73.0%	61.2	94.4	
	Al Fakhari	7,220	214,221	299,313			299,313	71.6%	113.6	81.3	
Rafah	Al Naser	8,473	372,690	475,720			475,720	78.3%	153.8	120.5	717,590
	Al Shouka	14,418	357,360	470,370			470,370	76.0%	89.4	67.9	
	Rafah	210,051	5,644,551	8,018,949	140,700		8,159,649	69.2%	104.6	73.6	
Total		1,881,137	58,717,735	81,580,782	2,627,160	9,967,790	94,175,732	62.3%	118.8	85.5	3,919,151

Source：2016Water Resources Status Summary Report/Gaza Strip, PWA(April, 2017)

As shown in **Table 3-3**, each municipality sets its water tariff. It is said that the tariff collection at municipalities of Rafah, Khan Younis and Deir Al Balah is only 49% according to WB report (No.72378-GZ, 2012). Such lower collection rate of water tariff also makes financial problem. One of the reason is that a part of residents is impossible to pay due to poverty. However because stop of water supply is directly affected to people's life, water supply is being continued even though payment is not made.

Table 3-3 Water Tariff of each Governorate in the Gaza Strip

Governorate	Municipality	Housing	Industrial
North Gaza	Beit Hanoun	NIS 0.7 /m^3	
	Beit Lahia	NIS2.00/m^3	-
	Jabalia	Up to 40m^3: NIS30.00/month More than 40m^3: NIS 0.80/m^3	Up to 80m^3:NIS70.00/month More than 80m^3: NIS 0.80/m^3
	Om Al Nasser	NIS1/m^3	-
Gaza	Gaza City	1.0NIS/m^3	
	Al Moghraqa	Up to 10m^3: NIS10.00/month More than 10m^3: NIS1.00/m^3	
	Al Zahra	Up to 10m^3: NIS10.00/month More than 10m^3: NIS1.00/m^3	
	Wadi Gaza	NIS2.00/m^3	
Deir Al Balah (Middle Area)	Deir Al Balah	Up to 10m^3: NIS15.00/month More than 10m^3: NIS 1.80/m^3	Up to 50m^3: NIS75.00/month More than 50m^3: NIS1.80m^3
	Al Nussirat	Up to 10m^3: NIS1.60/m^3 Up to 20m^3: NIS1.80/m^3 Up to 30m^3: NIS1.90/m^3 More than 30m^3: NIS 2.00/m^3	
	Al Zawida	Up to 10m^3: NIS18.00/month More than 10m^3: NIS 1.80/m^3	Up to 10m^3: NIS20.00/month More than 10m^3: NIS 2.00/m^3
	Al Burij	Up to 10m^3: NIS1.70/m^3 Up to 20m^3: NIS1.80/m^3 Up to 30m^3: NIS1.90/m^3 More than 30m^3: NIS2.00/m^3	
	Al Maghazi	Up to 10m^3: NIS1.70/m^3 Up to 20m^3: NIS1.80/m^3 Up to 30m^3: NIS1.90/m^3 More than 30m^3: NIS2.00/m^3	
	Al Mosadar	Up to 10m^3:NIS10.00/month Up to 20m^3: NIS1.20/m^3 Up to 30m^3: NIS1.40/m^3 More than 30m^3: NIS1.50/m^3	
	Wadi Al Salqa	Up to 10m^3: NIS15.00/month More than 10m^3: NIS 1.50/m^3	Up to 10m^3: NIS25.00/month More than 10m^3 NIS2.50/m^3
Khan Younis	Khan Younis	Up to 26m^3: NIS25.00/month Up to 50m^3: NIS1.50/m^3 More than 50m^3: NIS 2.00/m^3	Up to 100m^3: NIS100.00/month More than 100m^3: NIS 2.00/m^3
	Al Qarara	Up to 20m^3: NIS25.00/month More than 20m^3: NIS 1.20/m^3	
	Bani Suhila	Up to 10m^3: NIS18.00/month Up to 30m^3: NIS2.00/m^3 More than 30m^3: NIS 2.20/m^3	Up to 50m^3: NIS100.00/month More than 50m^3: NIS 2.20/m^3
	Absan Al Kabira	Up to10m^3: NIS18.00/month More than 10m^3: NIS2.00/m^3	Up to 10m^3: NIS80.00/month More than 10m^3: NIS 2.50/m^3
	Absan Al Jadida	Up to 10m^3: NIS 20.00/month	

Governorate	Municipality	Housing	Industrial
		More than 10m^3: N IS2.50/m^3	
	Khoza'a	Up to 10m^3: NIS18.00/month Up to 20m^3: NIS1.90/m^3 Up to 30m^3: NIS2.00/m^3 More than 30m^3: NIS 2.2m^3	
	Al Foukhari	Up to 20m^3: NIS20.00/month Up to 30m^3: NIS1.50/m^3 More than 30m^3: NIS2.00/m^3	
Rafah	Rafah	Up to 20m^3: NIS26.00/month Up to 30m^3: NIS1.30/m^3 Up to 50m^3: NIS1.50/m^3 More than 50m^3: NIS 2.00/m^3	Up to 50m^3: NIS70.00/month More than 50m^3: NIS 2.00/m^3
	Al Nassir	Up to 60m^3: NIS1.50/m^3 More than 60m^3: NIS 2.00/m^3	
	Al Shoka	Up to 20m^3: NIS20.00/month Up to 30m^3: NIS1.50/m^3 More than 30m^3: NIS 2.50/m^3	

Source: CMWU, except Gaza City (interviews conducted)

3-1-2 Sewerage Service

Table 3-4 shows a list of sewerage facilities before the conflict in 2014.

Table 3-4 Sewerage Facilities before the Conflict in Year 2014

Asset		Amount
Buildings/Plants	Sewage Treatment Plants	5
	Disposal Systems	20
Conveyance and storage	Sewage Collection Lines	775 km
	Septic Tanks	30,000
	Pumping Stations	45

Source: Damages Assessment Report Water and Wastewater Infrastructure, CMWU (2014)

There are five WWTPs in the Gaza Strip currently, as of July 2017, including the Wadi Gaza Temporary WWTP, which has been started operation in July 2015. Operational conditions in 2015 is described in **Table 3-5** including Wadi Gaza WWTP. Water quality of effluent from WWTP is not so good due to the shortage of electricity supply. The wastewater amount to be treated is nearly 80 % of consumed water, assuming consumption volume is 58.72 million cubic meter from **Table 3-2**, while collection volume is 47.61 million cubic meter from **Table 3-5**. Regarding the newly proposed WWTPs in Gaza Strip, North Gaza WWTP for replacement of the existing Beit Lahia WWTP has newly being constructed and the phase 1 of facility has almost been completed. It is expected to start operation in the middle of year 2018. Although a South WWTP for the replacement of Khan Younis WWTP has also been started the construction work funded by UNDP, completion schedule is still not clear. A tender for selection of design for Central WWTP funded by KfW for replacement of the Wadi Gaza Temporary WWTP, was carried out in September 2015. However the contract has not been made because the land acquisition has still not completed. Hence the commencement date of construction has still not been fixed.

The sewage tariff of each municipality is shown in **Table 3-6**. According to the WB report, the sewage

connection rate of the Gaza Strip is 52.4%. Eleven (11) municipalities have sewage tariff regulations, but other fourteen (14) municipalities have no the regulation.

Table 3-5 Existing WWTPs of the Gaza Strip (Operated as of July 2017)

Name of WWTP	Treatment Process	Average Annual Flow in 2016 (m^3/year)	Avg. Annual Influent			Avg. Annual Effluent			BOD&TSS Removal efficiency
			BOD (mg/l)	COD (mg/l)	TSS (mg/l)	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	
Beit Lahia	Aerated Lagoons	12,093,120 (=33,041m^3/d)	422	942	455	86	206	87	80.28%
Gaza	Bio Towers /Lagoons	21,313,860 (=58,235m^3/d)	436	910	447	96	299	94	78.54%
Khan Younis Temporary	Aerated Lagoons	4,933,020 (=13,478m^3/d)	499	1,117	532	131	291	118	75.78%
Rafah	Lagoons / Bio Towers	4,875,468 (=13,321m^3/d)	578	1,298	616	129	306	119	79.18%
Wadi Gaza Temporary	Aerated Lagoons	4,392,720 (=12,002m^3/d)	480	1,062	512	133	312	130	73.45%
Total & weighted average		47,608,188 (=130,077m^3/d)	458	994	481	104	276	100	78.23%

Source: Annual Progress Report 2016, CMWU January 2017

Table 3-6 Sewage Tariff of each Governorate in the Gaza Strip

Governorate	Municipality	Tariff (NIS)
North Gaza	Beit Hanoun	.25% from water bill price .30% from water for big factory or school
	Beit Lahia	.25% from water bill .NIS 15.00(no water Subscription) .NIS30.00 for big factory .NIS40.00 for school or establishment
	Jabalia	25% from water bill price 68% from water for big factory
	Om Al Nasser	.25% from water bill .NIS15.00(no water Subscription) .NIS30.00 for big factory .NIS40.00 for school or establishment
Gaza	Gaza City	15% from water bill
	Al Moghraqa	-
	Al Zahra	NIS7.00+15%(water bill)
	Wadi Gaza	-
Deir Al Balah (Middle Area)	Deir Al Balah	5+15% from water bill price
	Al Nussirat	15% from water bill price
	Al Zawida	15% from water bill price
	Al Burij	15% from water bill price
	Al Maghazi	15% from water bill price
	Al Mosadar	NIS25.00+15% (water bill) for big factory
	Wadi Al Salqa	-
Khan Younis	Khan Younis	6+15% water bill 10+15% water bill for big factory
	Al Qarara	-
	Bani Suhila	-
	Absan Al kabira	-

Governorate	Municipality	Tariff (NIS)
	Absan Al jadida	-
	Khoza'a	-
	Al Foukhari	-
Rafah	Rafah	.20 NIS .100 for big factory .60 for school
	Al Nassir	-
	Al Shoka	-

Source: CMWU, except Gaza City (from interviews conducted)

3-2 Water Supply and Sewerage Service Agency

CMWU is the implementation agency related to water supply and sewerage service in the Gaza Strip. CMWU is one of JSC and is responsible for smooth operation of the water supply and sewerage services in the region. Cooperation of CMWU with 25 municipalities in the Gaza Strip is shown in **Table 3-7**. "Joined Technically" in the Table means i) improvement of water facilities, ii) well function monitoring, iii) water disinfection monitoring, and iv) water production monitoring. "Water bill and issuance" in the Table means i) preparation of water bill, and ii) assistance for tariff collection. The latter services have being provided for 15 municipalities. The revenue from water sale to CMWU is, however, obtained only from Rafah Municipality.

Table 3-7 Relationship between CMWU and Gaza Governorates

Governorate	Municipality	Population in 2014	Situation	
			Joined Technically	Joined Financially (Water bill and Issuance)
North Gaza	Beit Hanoun	49,107	✓	-
	Beit Lahiya	83,195	✓	-
	Jabalia	212,877	✓	-
	Om Al Nasser	3,628	✓	-
Gaza	Gaza City	591,419	✓	-
	Al Moghraqa	7,990	✓	✓
	Al Zahra	3,771	✓	✓
	Wadi Gaza	3,569	✓	✓
Deir Al Balah (Middle Area)	Deir Al Balah	75,736	✓	✓
	Al Nussirat	80,566	✓	-
	Al Zawaida	21,074	✓	✓
	Al Burij	42,119	✓	-
	Al Maghazi	28,132	✓	✓
	Al Mosadar	2,330	✓	✓
	Wadi Al Salqa	5,748	✓	✓
Khan Younis	Khan Younis	220,299	✓	✓
	Al Qarara	24,149	✓	-
	Bani Suhila	38,727	✓	✓
	Absan Al Kabira	22,493	✓	-
	Absan Al Jadida	7,410	✓	✓
	Khoza'a	11,174	✓	✓
	Al Foukhari	6,766	✓	✓
Rafah	Rafah	196,355	✓	✓

Governorate	Municipality	Population in 2014	Situation	
			Joined Technically	Joined Financially (Water bill and Issuance)
	Al Nassir	7,923	✓	-
	Al Shoka	13,480	✓	✓
Total Population		1,760,037		

Source: CMWU

The coverage of water supply and sewerage services by CMWU is listed in **Table 3-8**. In the water supply field, despite the number of contracted households (connection rate) controlled by CMWU in the Gaza Strip is 62%; the ratio based on service population and distribution amounts is only 37%. On the other hand, the coverage of CMWU in the Gaza Strip is 42% in the field of sewage.

Table 3-8 Coverage of CMWU Services

		Total in Gaza	Served by CMWU	CMWU Coverage
Water	No of Connection (number of households)	128,125(1)	79,915(1)	62%
	Population Served with Water Services (persons)	1,526,200(1)	570,000(2)	37%
	People per connection (persons/connection)	11.91	10.33	-
	Water Production (m^3/year, million)	89(1)	32.6(2)	37%
	No of functioning meters (Active Water Connections)	No data	55,940(1)	-
	Rate of Functioning Metering	-	70% (=55,940/79,915)	-
Sewage	Population Served with Wastewater Services	800,000(1)	335,000(2)	42%
	Wastewater Coverage	52.4%	58.8%	-

Source: (1) Appraisal Report (No.72378-GZ), World Bank (2012)
(2) Performance Monitoring of Water Service Providers in Palestine, PWA (2012)

The key performance indicators (hereinafter referred to as "KPI") of CMWU are listed in **Table 3-9**. The unit water consumption is 86.4 lpcd, NRW ratio is 41.8%, and sewage collection rate is 58.8%. The water selling price is NIS 1.68/m^3 against the cost NIS 2.65/m^3, therefore the expenditure is approximately NIS 1 per 1m^3 of water supply. The electricity cost is the largest proportion of the cost, as it is NIS 1.08 per 1m^3 of water supply.

Table 3-9 KPI of CMWU

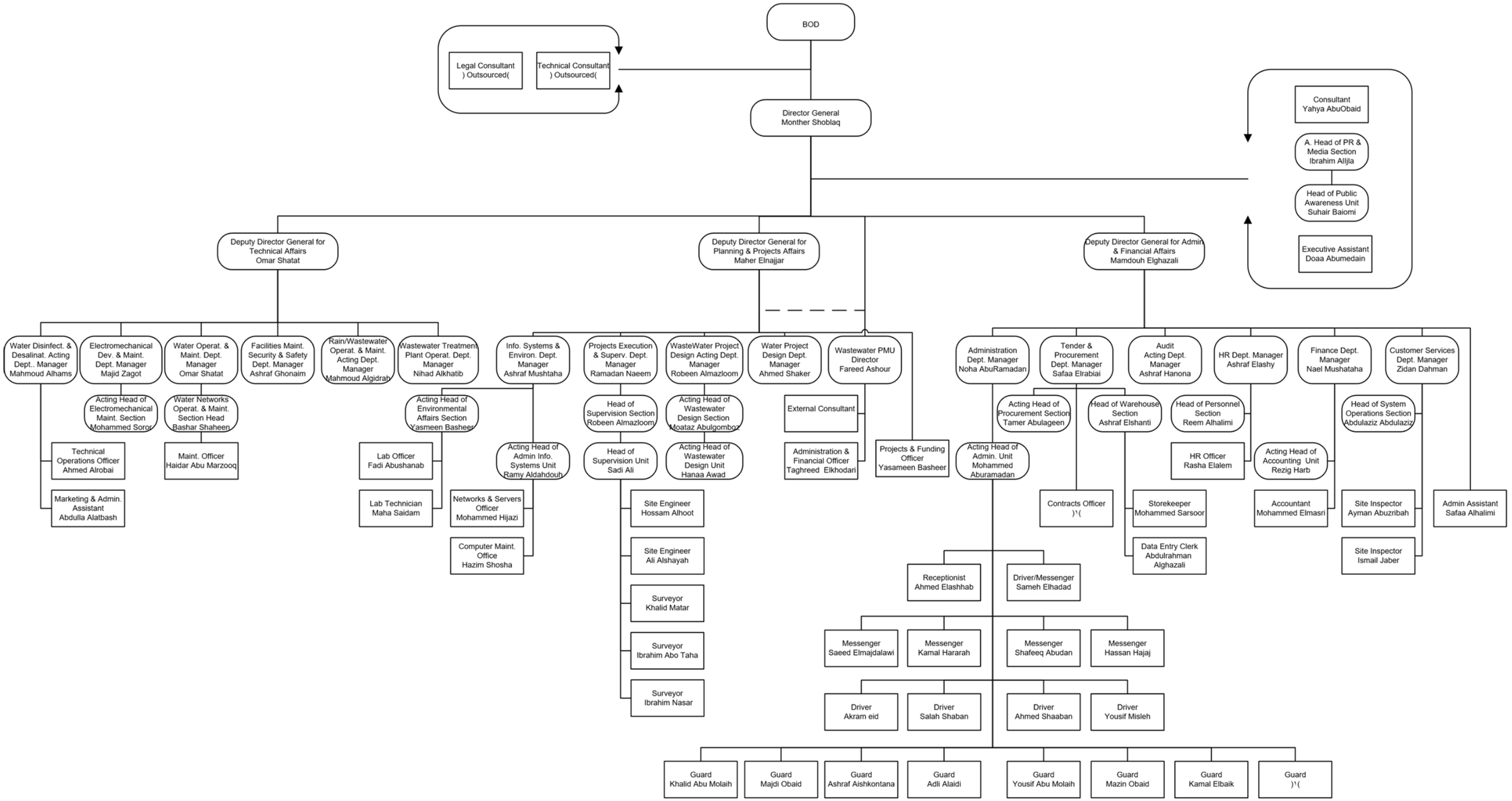
No	Key Performance Indicators (KPI)	Unit	Amount
Technical Indicators			
1	Average Daily Water Consumption per capita at domestic level	L/capita/day	86.4
2	Non-Revenue Water by volume	%	41.8
3	Non-Revenue water in m^3 per km in the network per year	m^3/year/km	5,372
4	Wastewater Coverage	%	58.8
Financial Indicators			
5	Average Selling Price per m^3 of Water	NIS	1.68
6	Operating Cost per m^3 of Water Sold *Personnel Costs* *Water Purchase Cost* *Energy Cost* *Other Operation Cost*	NIS	2.65 *0.65* *0.00* *1.08* *0.92*
7	Collection Efficiency	%	64
8	Working Ratio (Efficiency Ratio)-Water Service	No.	1.52
9	Average Cost per Employee per Month	NIS	2,374
10	Operation Cost per m^3 pf Wastewater	NIS	0.59

No	Key Performance Indicators (KPI)	Unit	Amount
Water Quality Indicators			
11	Water Samples (taken from network including mains) containing free chlorine residual (RC)	%	100
12	Water Samples (taken at source) free from total coliform contamination	%	100
13	Water Samples (taken at source) free from faecal coliform coliform contamination	%	100
14	Water Samples (taken from network including mains) free from total coliform contamination	%	100
15	Water Samples (taken from network including mains) free from fecal coliform contamination	%	100
16	Microbiological Tests Carried Out	%	104
17	Water Samples (taken at the source) free from Nitrate Contamination	%	33
Other			
18	Staff Productivity Index – Water Service	No.	7.91

Source: Performance Monitoring of Water Service Providers in Palestine, PWA (2012)

The organizational structure of CMWU is shown in **Figure 3-2**. Based on the PWA report "Performance Monitoring of Water Service Providers in Palestine (2012)", CMWU has 435 personnel as staff including part-time workers.

The financial status (Revenue) of CMWU as an agency in charge of water supply and sewage service over seven years (2010 to 2016) is shown in **Table 3-10**. A large portion, exceeding 80%, of the total revenue comes from financial assistance by donors, such as WB, KfW, QRC and ICRC. Since water sale accounts for only 12% of total revenue, it is difficult that CMWU operates itself under self-supporting accounting system.



Source: CMWU

Figure 3-2 CMWU Organizational Structure

Table 3-10 Financial Status of the CMWU (Revenue)

(unit: USD)

Year	2016	2015	2014	2013	2012	2011	2010	2010-2016 Total
Revenues								
From Donors	18,248,827	15,590,374	10,401,271	11,617,387	15,074,977	25,578,524	14,193,089	110,704,449
From Rafah Municipality	-	-	136,835	45,972	-	325,685	101,034	609,526
From MoF	-	-	-	-	-	46,907	-	46,907
Sales								
Sales of Tenders	6,078	24,040	19,524	6,501	37,262	20,526	28,005	141,936
Sales of Water -Rafah	2,535,806	2,258,308	2,636,809	2,805,338	2,221,549	1,934,718	2,164,513	16,557,041
Project Supervision Revenue	547,790	803,974	386,582	246,598	545,390	-	-	2,530,334
Municipalities' Contribution	336,434	250,266	-	-	-	-	-	586,700
Other Sales of Water, Ground Water Quality Analysis	200,902	169,231	314,702	296,883	116,663	150,631	110,747	1,359,759
Other Sales of used inventory	-	26,377	-	97,870	35,242	58,250	71,004	288,743
Sales Total	*3,627,010*	*3,532,196*	*3,357,617*	*3,453,190*	*2,956,106*	*2,164,125*	*2,374,269*	*21,464,513*
Interest Income	1,735	373	211	157	1,365	1,955	5,306	11,102
Currency Exchange	20,453	142,136	935	61,647	46	7,323	-	232,540
Others	4,252	-	-	-	4,000	7,046	12,882	28,180
Total Revenue	21,902,277	19,265,079	13,896,869	15,178,353	18,036,494	28,131,565	16,686,580	133,097,217

Source: Financial Statements, CMWU

3-3 Development Plan for the Water Sectors

3-3-1 The long term perspective for the water sector

The long term strategy in water sector was developed as the "National Water and Wastewater Strategy for Palestine" formulated by the PWA in July 2013. The summary is shown below. The plan is regarded as up-dated Integrated Coastal Aquifer Management Plan (CAMP). The target year of new plan is 2032.

1) Strategic Configuration

① Target Year

The long term strategic target year is 2032, 20 years after the base year of 2012. Short term strategic year is 2017, 5 years after base year. The intermediate target year has been fixed every five years from 2012.

Strategic target year	Short term strategic target year: 2017 Long term strategic target year: 2032 Intermediate target year is fixed every five years from 2012

② Projected population

✓ Administrative population

PWA applied most promising population projections based on MoPAD demographic projections for the period 2007-2050. The result is shown in **Table 3-11**. This demographic projection is deemed appropriate judging from the fact that Palestine keeps high population growth rate after 2012 in spite of the long lasting conflict with Israel.

Table 3-11 Results of the Calculation of Projected Population

	2012	2017	2022	2027	2032
West Bank	2,649,020	3,473,267	4,742,596	5,713,113	6,548,006
Gaza Strip	1,644,293	1,994,680	2,339,313	2,654,554	3,002,518
Total	4,293,313	5,467,948	7,081,910	8,358,667	9,550,523

Source: PWA, National Water and Wastewater Strategy for Palestine (2013)

✓ Service Population

The service population has been adopted as the same number as the administrative population because the water supply coverage is almost 100% in the current situation. It is said that the percentage of the sewered population is approximately 70% and will keep increasing. Then, the sewerage service population took into account the future increase rate of sewerage coverage.

③ Projected water demand

✓ Unit water consumption

Unit water consumption was an average of 96 liters per capita per day (lpcd) in the Gaza Strip, 72 lpcd in the West Bank and 82 lpcd as a whole in 2012. This rate is applied till 2017, and it will increase to 120 lpcd in 2032 (long term strategic target year). The WHO also recommends the unit value of the plan should be more than 100 lpcd, and this plan adopted 120 lpcd in 2032, even in water scarce Gaza Strip. This 120 lpcd is regarded as daily average figure and is used to calculate daily average supply volume. Another two figures, daily maximum and hourly maximum volume shall be considered to design, respectively, for treatment plant capacity and pipe network. Fluctuation of these three figures is

assumed as follows, which seems appropriate for the water scarce Middle East area.

Daily Average: Daily Maximum: Hourly Maximum = 1.0: 1.2: 1.8 (=1.2 x 1.5)

Domestic unit value of water supply amount	120 lpcd (Strategic target year: 2032)

✓ Projected water demand for industrial use

The water demand for industrial use is counted as certain percentage of domestic water demand. According to the track record in 2012, approximately 3% of the domestic water demand is used for industry; the rate will estimate likely increasing from 3% to 7% from 2017 to 2032.

Demand for industry	7% of domestic water demand (Strategic target year: 2032)

✓ Rate of Non-Revenue Water

Rate of Non-Revenue Water such as due to leakage has been estimated to be 42% as of 2016 in the Gaza Strip[1]. The strategic objective aims to reduce it up to 20% by 2032.

NRW Rate	20% (Strategic target year: 2032)

2) Estimation of Projected Water Demand

Based on the conditions mentioned above, the estimation of water demand in the Gaza Strip until the strategic target year and the corresponding growth of water production are calculated as shown in **Table 3-12**.

Table 3-12 Water Demand and Required Water Production

Item			2012	2017	2022	2027	2032
Domestic Water Demand	Designed population	capita	1,644,293	1,994,680	2,339,313	2,645,554	3,002,518
	Supply unit	lpcd	96	96	104	110	120
	Domestic water demand	m^3/d	157,850	191,490	243,290	291,010	360,300
		million m^3/year	58	70	89	106	132
Industrial Water Demand	Industrial water rate (as % of domestic)	%	3.0	3.0	4.3	5.7	7.0
	Industrial Water demand	m^3/d	4,740	5,740	10,460	16,590	25,220
		Million m^3/year	1.7	2.1	3.8	6.0	9.2
Total water demand		m^3/d	162,590	197,230	253,750	307,600	385,520
		Million m^3/year	59	72	93	112	141
Production Water Needs	Unaccounted for Water	%	42.0	36.5	31.0	25.5	20.0
	Production water demand	m^3/d	280,330	310,600	367,750	412,890	481,900
		Million m^3/year	102	113	134	151	176

Source: PWA, National Water and Wastewater Strategy for Palestine (2013)

3) Policy of Water Resources Development

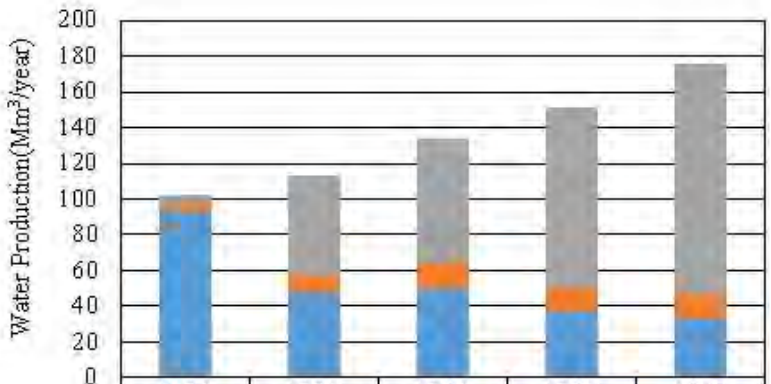
To ensure that required water amount estimated in **Table 3-12**, new water resources should be secured. The strategic policy for the development of water resources is shown below.

As of 2012, groundwater abstraction had reached 178.8 milion m^3/year. To prolong the life of the aquifer,

[1] **Table 3-2** shows39%(as of 2016), this number is based on "National Water and Wastewater Strategy for Palestine" issued by PWA in 2013.

the long term strategy aims to reduce total groundwater abstraction from the current rate to 70 million m^3/year in 2032. The short term strategy aims to reduce total ground water abstraction to 153million m^3/year in 2017 and to promote the construction of desalination plants in order to restore the aquifer capacity. Although intake for irrigation use needs to be extremely reduced, to utilize treated wastewater is one of solution in view of amount. One of Gaza Strip's required water amount comes from Mekorot which is Israel firm, the amount is 5 million m^3/year, the amount shall be increased 10 million m^3/year by 2017 and the amount is expected 14million m^3/year after 2022 to 2032.

Based on the policy as mentioned above, the water production requirements are presented in **Figure 3-3**.



	2012	2017	2022	2027	2032
Population(Capita)	1,644,293	1,994,680	2,339,313	2,645,554	3,002,518
Total Production(Mm3/year)	102	113	134	151	176
Desalination(Mm3/year)	4	55	70	100	129
Import(Mm3/year)	5	10	14	14	14
Groundwater(Mm3/year)	93	48	50	37	33

Source: PWA, National Water and Wastewater Strategy for Palestine (2013)

Figure 3-3 Production Water by Water Sources

4) Policy of Improvement of Water Supply Facilities

① Policy of expansion of pipe networks and house connections

Corresponding to the increasing population, additional house connections are scheduled. Number of house connection is calculated assuming the house connection number per 100 inhabitants. The network expansion volume, length, is also calculated assuming 8m installation of supply pipe per one house connection.

② Policy of Additional Storage Capacity

The strategic objective for 2032 is to secure a storage capacity of 10 hours of production volume. The current storage capacity is only nearly two hours. The results of calculation above are shown in **Table 3-13**.

Table 3-13 Water Storage Capacity

Item		Unit	2012	2017	2022	2027	2032
Designed Population		capita	1,644,293	1,994,680	2,339,313	2,645,554	3,002,518
Connection number and Network extensions	Connection rate	No./100inhab	14	14.8	15.9	17.6	20.0
	Connection number	No.	230,000	295,000	371,000	465,000	600,000
	Growth number of Connection	No.	-	65,000	76,000	94,000	135,000
	Network extensions	m	-	520,000	608,000	752,000	1,080,000
Total production water needs		m^3/d	280,330	310,600	367,750	412,890	481,900
Storage tank	Hours of storage	hour	2	2	4.7	7.3	10
	Storage capacity	m^3	23,000	26,000	72,000	126,000	201,000
	Additional storage	m^3	-	3,000	46,000	54,000	75,000

Source: PWA, National Water and Wastewater Strategy for Palestine (2013)

3-3-2 The long term perspective for the wastewater sector

1) Calculation of target wastewater flow

The conditions for the calculation of the wastewater volume in the Gaza Strip are as follows;

- ✓ The overall sewage connection rate is estimated at 72% in 2012, and the rate will increase up to 95% in 2032. Therefore, the target wastewater service population is set at 95% of the water service population in 2032.
- ✓ 80% of used water supplied becomes wastewater. Therefore, the wastewater amount is set at 80% of the water supply volume.
- ✓ Wastewater generated from industrial sector is assumed to be treated on-site at each industrial site, thus no wastewater is considered.
- ✓ The rate of the daily maximum flow and daily average flow is assumed at 1.2, and the hourly maximum flow and the daily maximum flow is assumed at 1.5. namely;
  Daily average : Daily maximum : Hourly maximum = 1.0 : 1.2 : 1.8

Table 3-14 Wastewater Collection Volume in the Gaza Strip

	Unit	Present situation	Short term 5-year plan	Medium-term plan	Long-term plan	
Year		2012	2017	2022	2027	2032
Target Population	capita	1,644,293	1,994,680	2,339,313	2,645,554	3,002,518
Households actually connected to sewer	%	72.0	78.0	84	89	95
Service population	capita	1,183,900	1,550,900	1,953,300	2,361,200	2,852,400
Water used per capita	lpcd	96	96	104	110	120
Wastewater conversion rate	%	80				
Water collected by sewers(average)	m^3/d	90,900	119,100	162,500	207,800	273,800
Variable rate	Daily average : Daily maximum : Hourly maximum = 1.0 : 1.2 : 1.8					
Daily maximum wastewater	m^3/d	109,100	142,900	195,000	249,400	328,600
Hourly maximum wastewater	m^3/d	163,600	214,400	292,500	374,000	492,800

Source: PWA, National Water and Wastewater Strategy for Palestine (2013)

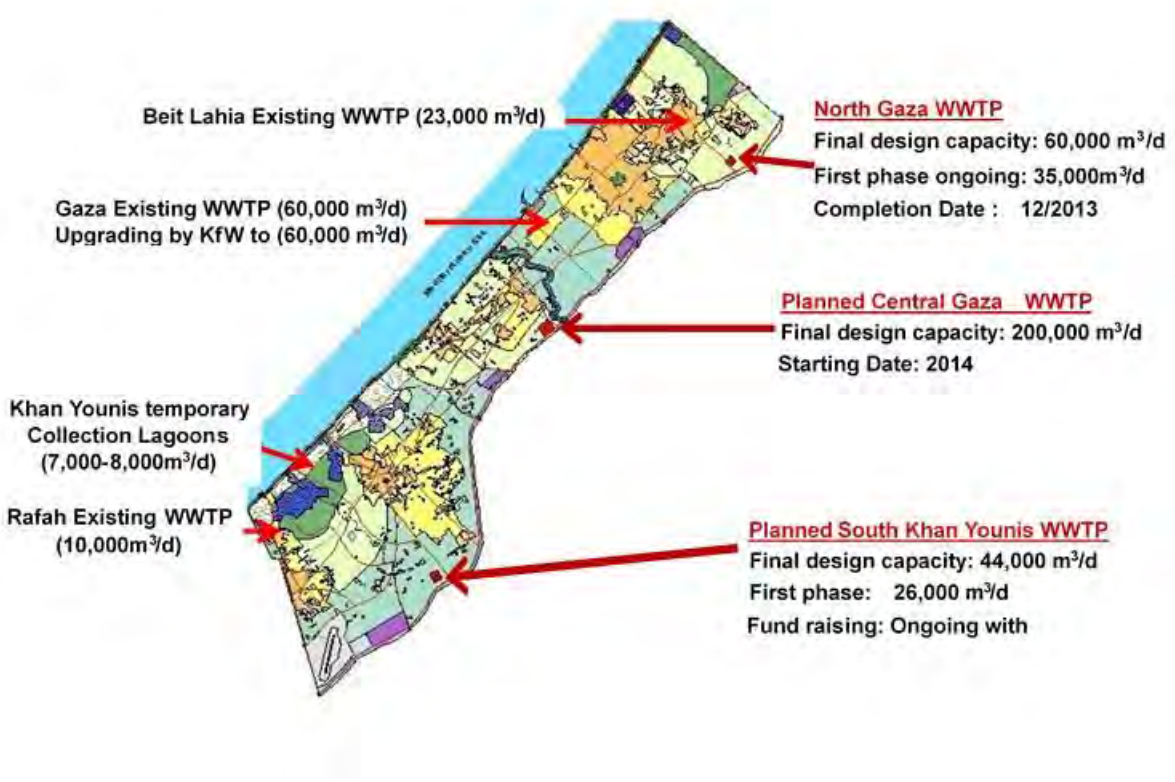
2) Policy of Improvement of Wastewater Facilities

① Policy of improvement of wastewater treatment plan

"National Water and Wastewater Strategy for Palestine 2014 ; PWA" issued in June 2013 indicates to build three WWTPs (**Figure 3-4**). The final capacity of the WWTPs plus Rafah's existing WWTP capacity will be 314,000m^3/day including the capacity of North Gaza WWTP of 60,00m^3/day, Central Gaza WWTP of 200,000m^3/day, South Khan Younis WWTP of 44,000m^3/day and Rafah's existing WWTP of 10,000m^3/day. Total capacity covers almost all the wastewater presented in **Table 3-14**. However the plan is not in good progress.

② Policy of booster pumping station and improvement of sewer pipeline

The strategy aims to extend the sewer networks to uncovered areas and to construct booster pumping stations together with construction of WWTPs. This contributes to raise the percentage of the covered population.



Source: National Water and Wastewater Strategy for Palestine, PWA (2013)

Figure 3-4 Location Map of Planned WWTPs

3-3-3 Policy of Development of Water Supply Facilities

Aiming for the provision of potable water from existing groundwater with high chloride concentrations in the Gaza Strip, United Nations Children's Fund (hereinafter referred to as "UNICEF") has installed 13 brackish water (mixed fresh and saltwater) desalination units which are presently in operation. There are also 154 desalination units have been established to produce 3.919million m^3 yaerly[2].

The provision of drinking water by Brackish Water Reverse Osmosis (hereinafter referred to as "BWRO") will go towards solving the water quality problem but does not have an appreciable effect on the preservation of the groundwater aquifers. Furthermore, it is afraid that brine water with high chloride concentration from BWRO

[2] 2016 Water Resources Status Summary Report / Gaza Strip, PWA (April, 2017)

is mixed with the groundwater worsening the chloride concentrations in groundwater. From this viewpoint, PWA has a policy to change the main water source from the abstraction of groundwater to providing water through Sea Water Reverse Osmosis (hereinafter referred to as "SWRO") for the environmental requirement. Groundwater subtraction invite invasion of sea water into the coastal aquifer. Based on this policy, the operation and design of the SWRO plants have been designed and operated. The list is shown in **Table 3-15**. Regarding the Gaza Central Desalination Plant, detailed information is described in **3-4** of this chapter.

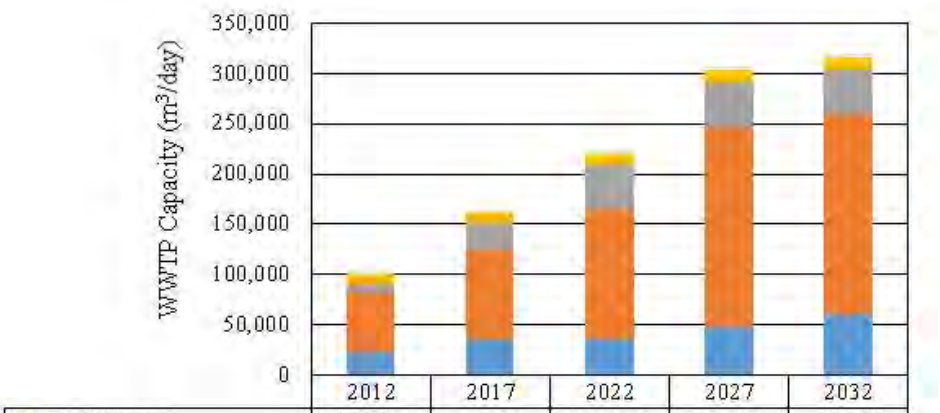
Table 3-15 List of Operating and Planned SWRO Plant

Desalination Plant	Capacity	Stage	Completion Year	Construction Cost	Donor
Deir Al Balah (Rehabilitation)	0.219 million m^3/y	Completed	Built in 2003 Improved in 2011	EUR 2.2M for Original EUR 0.2M for improvement	Austrian Development Cooperation
Deir Al Balah (Expansion)	0.73 million m^3/y	Tendering	-	USD 11.1M	WB and IsDB
Khan Younis STLV	2.19 million m^3/y	Completed	2017	EUR 10M for SWRO EUR 5M for distribution facility	EU and UNICEF
Gaza City	3.7 million m^3/y	Evaluation after Tendering	-	USD 15M	IsDB
North Gaza City STLV	6.84 millionm^3/y (current capacity after conflict, Original was 13 million m^3/y)	Partly completed (construction terminated due to conflict in 2014)	-	No data	AFD
Regional SWRO (Gaza Central Desalination Plant)	55 million m^3/y		Not fixed yet	USD 303M (SWRO Plant 207M Power Plant 96M)	Not fixed yet
Total	68.679 million m^3/y				

Source: JST made based on Shaddad Attili (PWA), 2015, UN Seminar on Assistance to the Palestinian People

3-3-4 Wastewater Facilities Development Plan

The strategy aims to extend the sewer networks to uncovered areas and to construct booster pumping stations together with construction of WWTPs. This contributes to raise the percentage of the covered population. The capacities of the proposed four WWTP's in the strategic target year are shown in **Figure 3-5**. At that time, the plan was that three WWTPs start operation in 2017, and Wadi Gaza Temporary WWTP was not planed. As of July 2017, construction of North Gaza WWTP has almost completed but it has not yet started operation.



	2012	2017	2022	2027	2032
Rafah WWTP	10,400	12,000	12,000	12,000	12,000
South Khan Younis WWTP	8,000	26,000	44,000	44,000	44,000
Central Gaza WWTP	60,000	90,000	130,000	200,000	200,000
North Gaza WWTP	23,000	35,000	35,000	47,500	60,000

① Capacity in 2012 represents that of existing one, while capacity after 2017 is that of proposed WWTP。
② Wadi Gaza (temporary) WWTP is not included.
Source: National Water and Wastewater Strategy for Palestine, PWA (2013)

Figure 3-5 Capacity of each WWTP up to Year 2032

South Khan Younis WWTP has already started construction work, however, construction has being delayed due to the shortage of construction material and completion year is not clearly declared. On the other hand, augmentation of Central Gaza WWTP is not yet scheduled due to the negotiation of land acquisition.

Reuse and recycle of treated wastewater is one of policies of PWA and regulated by the 1999 Environmental Law (Article 29).The policy of PWA is that reuse and recycle of treated wastewater is an essential element for construction project of new WWTP. To enforce these regulations, a draft of the Palestinian standards for the reuse of treated wastewater was proposed by Environmental Quality Authority (EQA) in 2000, then Standards for reuse and recycle of treated wastewater (PS/742/2003) was established in 2003. The standards principles mainly covers a) Sanitary, b) Environmental and c) Agro technical quality requirements, as shown in **Table 3-16**. The ongoing North Gaza WWTP construction project **(Photo 3-1**) funded by WB, AFD and KfW with the budget of USD 40 million has being designed satisfying WHO and FAO guidelines of reuse and recycle of treated wastewater presented in **Table 3-17**, **Table 3-18** and **Table 3-19**. The capacity of North Gaza WWTP has 35,000m^3/day for phase 1 and 60,000m^3/day for phase 2. Qulity of the treated wastewater will be satisfied BOD<10mg/L, TSS<15mg/L and T-N<10mg/L, according to "Assessment of Wastewater Treatment and Reuse Practices, PWA(2011)".

Table 3-16 Standards of Wastewater Reuse and Recycle

Item	Standard
a) Sanitary	Focused on pathogens and less than 1 intestinal nematode per liter and 200 to 1,000 fecal coliforms per 100mL are recommended
b) Environmental	Requires limitation of heavy metal concentration, like cadmium, copper and zinc, salt, nutrients (N&P) and malodors,
c) Agro technical	Requires total salt and several anions (Cl^-, SO_4^{2-}, HCO_3^-), cations (Ca^{2+} Mg^{2+}, Na^+) and boron depending on the application method and soil conditions.

Source: Palestinian Standard Institute

Source：Masoud & Ali Construction Company

Photo 3-1 North Gaza WWTP

Table 3-17 WHO Guideline of Microbiological Quality for Wastewater Reuse in Agriculture

Category	Reuse Condition	Exposed Group	Intestinal nematodes*2 (arithmetic mean number of eggs per liter)	Fecal coliforms (geometric mean number per 100 ml*3)
A	Irrigation of crops likely to be eaten uncooked, sports fields, public parks	Workers, consumers, public	≤ 1	≤ 1000*4
B	Irrigation of cereal crops, industrial crops, fodder crops, pasture and trees.*5	Workers	≤ 1	No standard recommended
C	Localized irrigation of crops in category B if exposure of workers and the public does not occur	None	Not applicable	Not applicable

Notes;1. In specific cases, local epidemiological, sociocultural and environmental factors should be taken into account, and the guidelines modified accordingly.
2. *Ascarid* and *Trichuriasis* species and hookworms.
3. During the irrigation period.
4. A more stringent guideline (≤ 200 fecal coliforms per 100 mL) is appropriate for public lawns, such as hotel lawns, with which the public may come into direct contact.
5. In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.
Source: WHO (1989) "A compendium of standards for wastewater reuse in the Eastern Mediterranean Region", WHO, 2006

Table 3-18 FAO Guideline of Water Quality for Irrigation

Potential Issue in Irrigation	Unit	Degree of Restriction on Use		
		None	Slight to Moderate	Severe
(1) Salinity				
EC_w[1]	dS/m	< 0.7	0.7 – 3.0	> 3.0
or				
TDS	mg/L	< 450.0	450.0 – 2,000.0	> 2,000.0
(2) Infiltration				
SAR[2] = 0-3 and EC_w =		> 0.7	0.7 – 0.2	< 0.2
SAR = 3 - 6 and EC_w =		> 1.2	1.2 – 0.3	< 0.3
SAR = 6 - 12 and EC_w =		> 1.9	1.9 – 0.5	< 0.5
SAR = 12 - 20 and EC_w =		> 2.9	2.9 – 1.3	< 1.3
SAR = 20 - 40 and EC_w =		> 5.0	5.0 – 2.9	< 2.9
(3) Specific Ion Toxicity				

Potential Issue in Irrigation	Unit	Degree of Restriction on Use		
		None	Slight to Moderate	Severe
Sodium				
Surface Irrigation	SAR	< 3.0	3.0 – 9.0	> 9.0
Sprinkler Irrigation	me/L	< 3.0	> 3.0	
Chloride (Cl)				
Surface Irrigation	me/L	< 4.0	4.0 – 10.0	> 10.0
Sprinkler Irrigation	m^3/L	< 3.0	> 3.0	
Boron (B)	mg/L	< 0.7	0.7 – 3.0	> 3.0
(4) Miscellaneous Effects				
Nitrogen (NO_3-N)[3]	mg/L	< 5.0	5.0 – 30.0	> 30.0
Bicarbonate (HCO_3)	me/L	< 1.5	1.5 – 8.5	> 8.5
pH		6.5 – 8.0		

Notes
1. ECw: means electrical conductivity in deci-Siemens per meter at 25℃
2. SAR means sodium adsorption ratio (= Na / $\sqrt{\{(Ca+Mg)/2\}}$)
3. NO_3-N means nitrate nitrogen reported in terms of elementary nitrogen

Source: WHO (1989) "A compendium of standards for wastewater reuse in the Eastern Mediterranean Region", WHO, 2006

Table 3-19 FAO Guidelines for Trace Metals in Irrigation Water

Element	Recommended maximum concentration (mg/L)*	Remarks
Al	5.0	Can cause non - productivity in acid soils (pH <5.5), but more alkaline soils at pH > 7.0 will precipitate the ion and eliminate any toxicity.
As	0.10	Toxicity to plants varies widely, ranging from 12 mg/L for Sudan grass to > 0.05 mg/L for rice.
Be	0.10	Toxicity to plants varies widely, ranging from 5 mg/L for kale to 0.5 mg/L for bush beans.
Cd	0.10	Toxic to beans, beets and turnips at concentrations as low as 0.1 mg/L in nutrient solutions. Conservative limits recommended due to its potential for accumulation in plants and soils to concentrations that may be harmful to humans.
Co	0.05	Toxic to tomato plants at 0.1 mg/L in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Cr	0.10	Not generally recognized as an essential growth element. Conservative limits recommended due to lack of knowledge on its toxicity to plants.
Cu	0.20	Toxic to a number of plants at 0.1 to 1.0 mg/L in nutrient solutions.
F	1.0	Inactivated by neutral and alkaline soils.
Fe	5.0	Not toxic to plants in aerated soils, but can contribute to soil acidification and loss of availability of essential phosphorus and molybdenum. Overhead sprinkling may result in unsightly deposits on plants, equipment and buildings.
Li	2.5	Tolerated by most crops up to 5 mg/L; mobile in soil. Toxic to citrus at low concentrations (< 0.075 mg/L). Acts similarly to boron.
Mn	0.20	Toxic to a number of crops at a few tenths to a few mg/L, but usually only in acid soils.
Mo	0.01	Not toxic to plants at normal concentrations in soil and water. Can be toxic to livestock if forage is grown in soils with high concentrations of available molybdenum.
Ni	0.20	Toxic to a number of plants at 0.5 mg/L to 1.0 mg/L; reduced toxicity at neutral or alkaline pH.
Pb	5.0	Can inhibit plant cell growth at very high concentrations.
Se	0.02	Toxic to plants at concentrations as low as 0.025 mg/L and toxic to livestock if forage is grown in soils with relatively high levels of added selenium. An essential element to animals but in very low concentrations.
Sn	-	Effectively excluded by plants; specific tolerance unknown.
Ti	-	Effectively excluded by plants; specific tolerance unknown.
W	-	Effectively excluded by plants; specific tolerance unknown.

Element	Recommended maximum concentration (mg/L)*	Remarks
V	0.10	Toxic to many plants at relatively low concentrations.
Zn	2.0	Toxic to many plants at widely varying concentrations; reduced toxicity at pH > 6.0 and in fine textured or organic soils

* The maximum concentration is based on a water application rate which is consistent with good irrigation practices (10,000 m^3/ha/year). If the water application rate greatly exceeds this, the maximum concentrations should be adjusted downward accordingly. No adjustment should be made for application rates less than 10,000 m^3/ha/year. The values given are for water used on a continuous basis at one site.

Source：“A compendium of standards for wastewater reuse in the Eastern Mediterranean Region”, WHO, 2006

3-4 Plan of Large scale seawater desalination plant

The Gaza Strip is not only afflicted with a chronical shortage of drinking water, but also is suffering from the deterioration of its water quality. In order to solve these problems, there is no choice but to construct a large scale seawater desalination plant as well as to restrict groundwater abstraction. Under such conditions, PWA has been planning to construct Gaza Central Desalination Plant (GCDP) with capacity of 55 million m^3/year based on the Coastal Aquifer Management Plan (CAMP) in 2000. **Table 3-20** shows water demand in 2020 and 2035 projected by PWA. This 55 million m^3/year of production volume will cover 40% of water demand in 2020. **Table 3-21** presents the outline of GCDP, together with the construction cost. Total construction cost including power supply facility is estimated at approximately USD 300 million. Including associated works such as construction of North-South carrier lines, local NRW reduction work, subsidy for operational cost for 5 years and consulting fee for construction supervision, total project will be USD 600 million. PWA has asked UFM (Union for the Mediterranean) to coordibnate the project and kept soliciting available fund to the promising donors in order to complete the construction of GCDP by 2020. Since IsDB has expressed that if other donors have committed 50% of overall project cost, they are willing to cover the rest 50%, UFM has been asking the European countries for funding. As of march 2017, EU has committed EUR 70 million, as well as EUR 10 million from France, EUR 5 million from Finland, and EUR 1.5 million from Algeria. PWA has been discussing with Government of Norway and Turky in parallel.

Land acquisition has already secured with 8 hectares (80 donums). Although Khan Younis STLV SWRO plant (land area is a half hectar) which capacity is 6,000m^3/day has constructed in a part of the land, the plan shows that the plant is possible to be constructed even if the capacity of GCDP becomes 110 million m^3/year in future. However the current plan is possible going to be revised to install solar power panels in a half of the acquired land for the operation of existing SWRO plant due to shortage of electricity. Thus it has to say that any expansion in future is difficult to be confirmed at present.

Table 3-20 Water Demand Projection and Water Source in Year 2020 and 2035

Year	Population	Water Demand at Source	Water Source (m^3/year, million)				Deliver to Customer		System Efficiency
			Ground water	Mekorat	Sea Water Desalination				
		m_3/year, million			STLV	Regional	m^3/year, million	lpcd	%
2020	2,570,198	140	60	12	13	55	113	120	80
2035	3,625,519	198	55	20	13	110	159	120	80

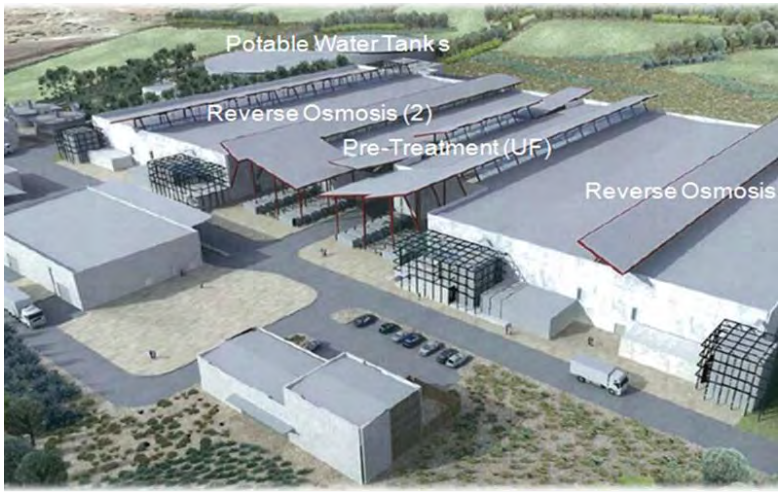
Source: PWA

Table 3-21 Outline of Gaza Central Desalination Plant(GCDP)

Location		South West Deir Al Balah
Area		8 ha
Capacity		55 million m^3/year (in future 110 million m^3/year)
Facility	SWRO Plant	(Components) – Total USD207million • Sea water intake structure • Primary treatment facilities • Reverse osmosis process facilities • Post treatment facilities and • Brine discharge facilities
	Power Supply	(On-site power supply) – Total USD52million • Reciprocating duel fuel engines (25MW) • Solar PV of 2 MW on roof of plant buildings (Off-site power supply) – Total USD37million • Solar PV of 22 MW on ground • Wind mills of 4 MW

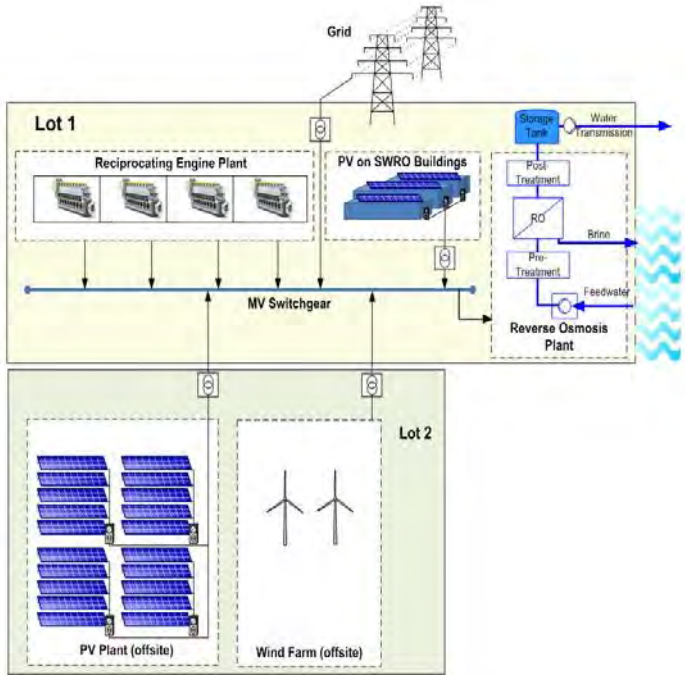
Source: PWA

Figure 3-6 shows the bird view of the proposed plant and **Figure 3-7** is anticipated power sources for the plant. Sequring power source for the plant is the most difficult. PWA is planning to procure electricity of 161 kV from Israel, and also have reciprocating duel fuel engines, solar PV and wind power generation system. This plan requires solar power generation system of 22MW which is installed in a land of 22 hectares. As describing in Chapetr 6 of this report, even SWRO plant which capacity is 6,000m3/day is hard to sufficiently operate due to shortage of electricity caused by lack of fuel, this plan takes much more time to be realized.



Source: European Investment Bank Group, Gaza Central Desalination Plant Project "The Impact on Water Security in Gaza" August 2016

Figure 3-6 Proposed Gaza Central Desalination Plant (GCDP)



Source: European Investment Bank Group, Gaza Central Desalination Plant Project "The Impact on Water Security in Gaza" August 2016

Figure 3-7 Power Sources for Gaza Central Desalination Plant (GCDP)

3-5 WWTP Effluent Recycling Project

This project which is realized through the activity of JICA Survey Team during the field work stage, consists of improvement of Rafah WWTP and construction of slow sand filters in order to meet water quality for irrigation use. The plan prepared by Ministry of Agriculture (MoA) was initially that effluent discharged from WWTP is treated by an advance technology to be suitable for agricultural use then distributed to agricultural land. The study result by JICA Survey Team showed that expected water quality is impossible to meet due to low treatment efficiency of Rafah WWTP even if the said slow sand filters are installed, hence JST proposed that the improvement of Rafah WWTP is included into the project scope.

The proposals regarding improvement of Rafah WWTP are;

- ✓ Improvement of the Grid Chamber to remove sand from raw wastewater
- ✓ Clean up of the Anaerobic Lagoons
- ✓ Installation of Baffle Plates at the Anaerobic Lagoons in order to avoid short cut
- ✓ Installation of the Photovoltaic (PV) system

JICA survey team proposed the planning of slow sand filters together with the improvement mentioned above. The project will be funded by a counterpart fund which is obtained through past project funded by Japanese government. Although the project will be owned by MoA, the Palestinian Economic Council for Development and Reconstruction (PECDAR) will mainly work under MoA. On the other hand, Japanese Non-Governmental Organization (NGO) has currently been working for installation of PV system at the Rafah WWTP. **Appendix-1** describes in detail.

As other project, it has been carring out that wastewater reuse and recycle project in existing Khan Younis WWTP. Part of effluent will be filtered through slow sand filters which capacity os 3,000m3/day and distributed

to the agricultural land of 40 hectores.

This project cost is USD 700,000 funded by IsDB and the target period of completion is set at by the end of 2017.

3-6 Enhancement of CMWU Performance

World Bank carried out "Gaza Water and Sanitation Services Improvement Project (GWSSIP)" from 1996 to 2001, and at the end of the project, the municipalities of Gaza agreed to establish the CMWU. The Gaza Emergency Water Project (GEWP), launched in June 2005, was designed as a follow-on project building on the success of the GWSSIP with a grant of USD 20.0 million and was implemented by the recently established CMWU. To renew its commitment, the World Bank approved in April 2008 the additional financing of USD 5.0 million to GEWP to finance overrun costs associated with the provision of water and wastewater services' delivery in Gaza as well as strengthen the capacity of the newly established CMWU. In 2013, the World Bank launched the "Water Supply and Sanitation System Improvement Project (WSSSIP)", which was to be implemented in 2016. Hence the reconstruction work brought by armed conflict in 2014 was added to the project, setting back the project period to December, 2018.

CMWU has enhancement activities supported by the WB, as follows:

- ✓ CMWU Board of Directors decided that all municipalities that receive O&M services from the CMWU should pay 10% of the O&M cost to the CMWU account. This step will strengthen CMWU's future sustainability.
- ✓ Restructure the CMWU headquarters and regional offices for better performance.
- ✓ Expand the CMWU work activities to include all GAZA Strip municipalities.
- ✓ Enhance the interface management between CMWU and PWA by regular meeting and close coordination.
- ✓ Form a coordination committee with Municipality of Gaza in order to implement the Gaza Sewerage Emergency Project financed by KfW and other reconstruction project after the conflict.
- ✓ On-going negotiations between PWA, CMWU, Northern Municipalities and MoLG to hand over the NGEST operation to CMWU.
- ✓ The implementation of STLV (Phase I) funded by EU and negotiations among PWA, CMWU and IsDB to complete the Phase II of the STLV.
- ✓ The tender for supervision of the South Khan Younis WWTP.
- ✓ Ongoing negotiations with Gaza and Jabalia municipalities to join the CMWU framework for better services delivered to the customers.
- ✓ PWA and CMWU are working jointly with the WB and IsDB in order to fulfil the new project's targets and continue monitoring and seeking ways to improve the overall efficiency of the existing water and wastewater services.

3-7 Supporting by Donors

Amount of assistance to CMWU from each donor in 2010-2016 duration is presented in **Table 3-22**. Main donors listed are KfW, World Bank, ICRC and IsDB.

Table 3-22 Funding by Donors

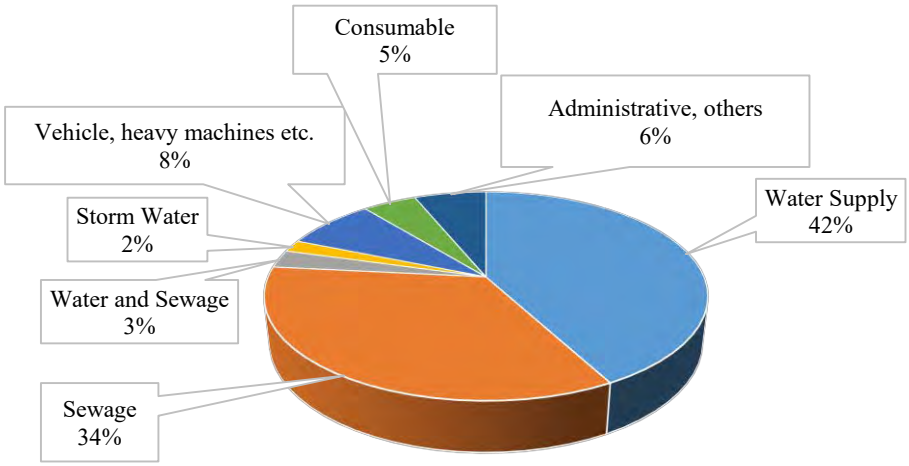
(Unit: USD)

Year	2016	2015	2014	2013	2012	2011	2010	2010-2016 Total	Remark
KfW	6,599,354	4,226,033	1,052,251	1,023,434	4,476,302	10,473,076	3,080,800	30,931,250	
World Bank	5,222,873	3,515,704	1,999,922	2,320,522	1,672,234	3,180,425	4,687,760	22,599,440	
ICRC	2,366,760	4,416,248	3,236,589	2,411,071	1,062,656	2,643,653	732,789	16,869,766	
IsDB	1,986,493	616,001	2,293,184	3,978,935	4,139,358	280,759	178,856	13,473,586	
QRC			210,902	116,107	1,252,451	2,077,713	1,270,795	4,927,968	
WATSAN					1,540,971	2,797,850		4,338,821	
UNICEF	556,548	998,974	533,113	669,823	230,717	145,590	808,924	3,943,689	
TRCS					314,659	1,038,278	1,244,134	2,597,071	
Oxfam	58,533			119,963	132,008	731,623	571,364	1,613,491	
PGF		253,914	652,861	290,322				1,197,097	
TIKA						1,019,220		1,019,220	
AECID	50,775	555,963	248,197	107,600				962,535	
Qatar Charity	521,366	173,059	33,000					727,425	
AFD						452,508	199,168	651,676	
Save the Children		161,969		17,935		87,282	306,875	574,061	
IR PAL				164,813		285,173	118,923	568,909	incl Islamic Relief
UNDP					103,622	103,622	310,864	518,108	
PAH				173,400		78,118	261,730	513,248	
Muslim Hands	38,007	212,808		81,285			53,024	385,124	
Interpal			108,280	136,733	120,146			365,159	
NRC	338,001						3,082	341,083	
PHO							199,522	199,522	
SIDA						56,166	111,602	167,768	
GVC						94,069	30,376	124,445	
ZakatGC					28,193	33,399		61,592	
Basna & Hirsik							22,501	22,501	
MEDRC					960			960	
PHS					700			700	
Others	510,117	459,701	32,972	5,444				1,008,234	
Total	18,248,827	15,590,374	10,401,271	11,617,387	15,074,977	25,578,524	14,193,089	110,704,449	

Source: Financial Statements, CMWU

Appendix-2 presents a list of projects funded by major donors. **Figure 3-8** shows breakdown by the project fields funded by 4 major donors 4 mojor donors namely KfW, WB, ICRC and IsDB, implemented from 2012 until 2016. KfW includes 2 projects which implemented since 2010 and continued until 2013 or 2015. IsDB includes funding by Gulf Cooperation Council (GCC), Kuwait Fund For Arab Economic Development (KDF) andQatar Red Crescent (QRC). These 4 major donors implemented 170 projects with cost of USD 71.3 million. The funding amount distributed to 42% (58 projects) for water supply and 34% (24 projects) for sewage, 3% (9 projects) for water and sewage, 2% (6 projects) for stormwater, 8% (29 projects) for supplying vehicles and heavy machines, 5% (8 projects) for supplying consumable items such as fuel and chemicals, and 6% (36 projects) for administrative matters such as CMWU warehouse, office supplies and softwares.

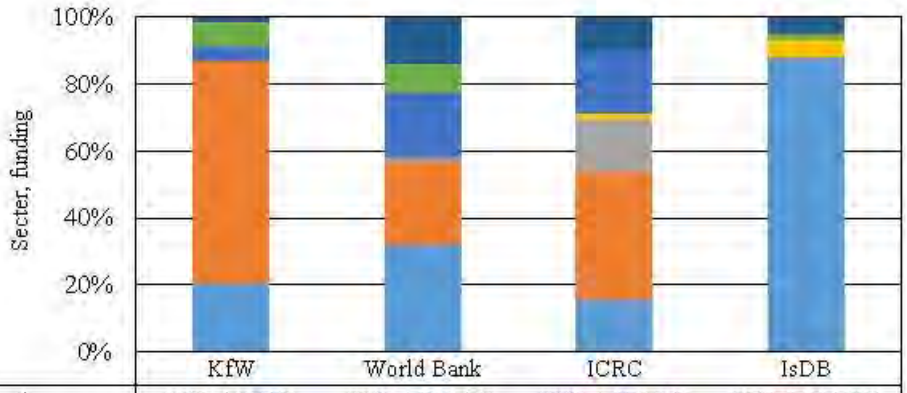
Since a part of the funds applies to wages for SMWU staff and administrative cost of CMWU, all funds given by each donor does not spend for their project cost. Also since there is a gap between the project implementation period and the period counted as revenue of CMWU, funding amounts given by each donor and project costs are not same.



Remark1) Currency exchange rates calculated at USD 1.00 ＝JPY 112.185, EUR 1.00 ＝JPY 127.430, and NIS 1.00 = JPY31.965.
Remark2) IsDB includes funding by GCC, KDF and QRC
Remark3) KfW includes 2 projects which implemented since 2010 and continued until 2013 or 2015.
Source: CMWU

Figure 3-8 Breakdown by the Project Fields Funded by 4 Major Donors

Figure 3-9 shows the rates of projects field by each donor. KfW focuses to support in sewage field and IsDB concentrates into field of water supply. The World Bank is covering to support to all fields of water sector. Although trend of ICRC is same as the WB, supporting for sewage seems slightly higher than others because of funding for Wadi Gaza Temporary WTP since 2012.



	KfW	World Bank	ICRC	IsDB
Administrative, others	USD 443,738	USD 1,786,181	USD 1,175,869	USD 1,046,336
Consumable	USD 1,864,126	USD 1,059,680	0	USD 418,700
Vehicle, heavy machines etc.	USD 1,045,599	USD 2,401,108	USD 2,171,994	0
Storm Water	0	0	USD 216,316	USD 1,098,807
Water and Sewage	0	USD 196,589	USD 1,770,187	0
Sewage	USD 17,140,249	USD 3,075,435	USD 4,396,254	0
Water Supply	USD 5,304,497	USD 4,020,683	USD 1,798,083	USD 18,909,106

Remark1) Currency exchange rates calculated at USD 1.00 ＝JPY 112.185, EUR 1.00 ＝JPY 127.430, and NIS 1.00 = JPY31.965.
Remark2) IsDB includes funding by GCC, KDF and QRC
Remark3) KfW includes 2 projects which implemented since 2010 and continued until 2013 or 2015.
Source: CMWU

Figure 3-9 Rates of Projects Field by Each Donor (Year 2012 - 2016)

3-8 Japan's Cooperation for Palestine in Water Sector

Appendix -3 shows Japan's cooperation for Palestine in water sector. The data was provided by JICA Palestine office. In water sector, Japan has contributed 21 projects in Palestine which are 13 projects in the West Bank, other 8 projects in the Gaza Strip. One of 8 projects (No.12 in the table of **Appendix-3**)in the Gaza Strip was WWTP effluent Recyclying project described in **3-5** of this chapter, other one (No.14 in the table of **Appendix-3**) is carried out by this Data Collection Survey as the Pilot Projects as described in **Chapter5**. Remaining 6 projects implemented or being impremented in the Gaza Strip are; Improved water and wastewater supply and wastewater system in Rafah and Middle area (Amount of the project: USD 1.5 million, implemented from 2016 to 2017); 2 projects of Construction of water network in Jabalia (Total amount ot the project USD 175,423, implemented in 2015); Constructing of Al-Shanti Water Well Desalination Plant in Jabalia (Amount the project USD140,000, implemented in 2012); Improvement of water networks in Al-Zawaida (Amout the project USD144,100, implemented in 2012); and Wastewater Treatment Khan Younis for construction of South Khan Younis WWTP through UNDP.

Also since 2006, 20 times of trainings for Palestinian in water sector have been conducted in third countries. Total number of participant is currently 204 people. Frequent country to be dispatched is Jordan for 16 times, next are Egypt and Singapore 2 times each.

Chapter 4

Conflict and Situation of Reconstruction

Chapter4 Conflict and Situation of Reconstruction

4-1 Projects for Damage Recovery after the Conflict in 2014

There are two reports that investigated the damage to the water supply and sewerage facilities caused by the conflict in 2014; "Damages Assessment Report" (7 July-14 August 2014, CMWU) and "Water Sector Damage Assessment Report" (August 2014, PWA). The PWA report is an official report that has added a medium to long term plan to the CMWU report. The CMWU report is more specific regarding reconstruction projects. The difference of the budget required for reconstruction is approximately 3% among the two reports, but it can be considered that both reports are based on the same investigation which CMWU was carried out.

The PWA report estimated the reconstruction cost for the water supply and sewage facilities which were damaged by the Israeli attacks in July and August 2014. Using this estimation, the report calculates the reconstruction cost for each facility in three stages, namely: emergency humanitarian support, early restoration support and long term support. The final stage corresponds to the long term projects such as the WB supported WSSSIP.

The emergency humanitarian support stage (first stage) includes the costs for the minimum repair/reconstruction and necessary fuel and chemicals to operate the water supply and sewerage facilities, and more importantly, the costs necessary to provide the minimum living requirements of the residents or water and sanitary facilities to the residents who were forced to evacuate.

The aim of the early restoration support stage (second stage) is to procure materials/equipment necessary for water service and sewerage facility recovery, while continuing to provide support to the refugees.

The plan for long term support stage (third or last stage) is the construction of a new seawater desalination plant to improve the water quality and supply a sufficient amount of safe water. This stage also includes plans to prevent the deterioration of the environment by expanding the sewerage service area and realize appropriate sewage treatment.

The cost of the damage caused by the attacks on each water supply/sewerage facility is shown in **Table 4-1**. These values were provided by surveys carried out by local CMWU staff and local agencies, and it covers a total of 250 facilities in the 25 governorates. The investment amount for each of the three stages is shown in **Table 4-2**. **Table 4-3** shows damaged amount by Governorate prepared by CMWU.

Table 4-1 Amount of Damages

Sub-Area	Type of Damage	Estimated Quantities	Estimated Cost (USD) of Repair/Reconstruction
Water Wells	Partially	15	419,000
	Completely	11	1,650,000
Water Network	Partially	17,500m	3,310,000
	Completely	29,300m	4,325,000
Water Tank	Partially	11	1,300,000
	Completely	5	4,400,000
Desalination Unit	Partially	4	205,000
	Completely	2	130,000
Wastewater Networks	Partially	10,310m	2,427,100
	Completely	7,238m	2,492,000
Wastewater Pump Station	Partially	12	1,447,000

Sub-Area	Type of Damage	Estimated Quantities	Estimated Cost (USD) of Repair/Reconstruction
	Completely	0	-
WWTP	Partially	4	1,224,000
	Completely	0	-
Water & Sanitation Vehicles & Equipment Damage		50	8,850,000
It and Stationary Damage		1	255,000
Unseen Damage		1	2,000,000
Total			34,434,100

Source: Water Sector Damage Assessment Report, PWA, August 2014

Table 4-2 Total Amount of Investment

Sub-Area	Immediate Humanitarian Intervention(USD)	Early Recovery Intervention (USD)	Long-Term Intervention (USD)
Water Supply (wells, networks, tank, etc.)	4,981,000	10,640,000	
Water Desalination (LT, ST)			500,000,000
Wastewater (network, pump stations, WWTP etc.)	4,790,100	2,800,000	55,000,000
Wastewater Reuse			65,000,000
Vehicle and Equipment	500,000	8,350,000	
IT and Stationary Damages	255,000		
Other & Unseen Damages	500,000	1,500,000	
Supply fuel for Water and Wastewater Facilities	6,000,000	6,000,000	
Provide Generators incl. Spare parts and other consumables	1,200,000	200,000	
Provide chlorine for water supply disinfection	300,000	300,000	
Supply mobile pumps, Spare parts and equipment	1,500,000	500,000	
Provide Potable Water trucking for displaced Population	1,200,000	600,000	
Provide water for domestic use trucking for displaced Population	3,600,000	1,800,000	
Bulk water storage, jerry cans for displaced population	3,000,000		
Sanitary installation for displaced population	3,000,000		
Total USD	30,826,100	32,690,000	620,000,000

Source: Water Sector Damage Assessment Report, PWA, August 2014

4-2 Progress of Reconstruction

(1) Emergency repairing work

According to "Gaza Water Supply and Sewerage Systems Improvement Program (Annual Progress Report 2014, January 2015, CMWU)", the number of repairing and reconstruction locations in water sector carried out by CMWU in 2014 was 714 in total. This is including scheduled maintenance and emergency repairing. The emergency repairing and reconstruction were concentrated in October and November 2014 to be performed and this was implemented in cooperation with the municipalities and regional offices' network repairing staff.

(2) Full-scale reconstruction work

Against the damages shown in **Table 4-3**, the recovery rate as of December 2016 is presented in **Table 4-4**. Almost all of the reconstruction work has been done, except distribution network in Al Mosadar whose project cost is expected at USD 135000. On the other hand, vehicle and heavy machineries, unseen damages are not yet fully recovered showing 54.6 % and 75.0 % of un-recovery rate respectively. Although CMWU has requested additional assistance for them, no donor has pledged assistance as of July 2017 since it is difficult to transport vehicles and heavy machineries from Israel.

Table 4-3 Detail of Damages per each Municipality

Governorate	Municipality	Groundwater wells	Desalination plants	Water reservoir	Water network	Wastewater treatment plants	Wastewater networks and pumping stations	Total Per Municipal Area	Total Per Governorate
North	Beit Hanoun	151,000			1,240,000	1,000,000	1,200,000	3,591,000	5,981,000
	Beit Lahia				480,000		505,000	985,000	
	Jabalia	38,000		650,000	180,000		132,000	1,000,000	
	Om Al Nasser				155,000		250,000	405,000	
	Sub-total	189,000		650,000	2,055,000	1,000,000	2,087,000	5,981,000	
Gaza	Gaza City	1,125,000		2,000,000	870,000	450,000	1,300,000	5,745,000	6,425,000
	Al Moghraqa			200,000	40,000		12,000	252,000	
	Al Zahra				100,000			100,000	
	Wadi Gaza	80,000	5,000	40,000	203,000			328,000	
	Sub-total	1,205,000	5,000	2,240,000	1,213,000	450,000	1,312,000	6,425,000	
Deir Al Balah (Middle Area)	Deir Al Balah	450,000	150,000	120,000	126,000		75,000	921,000	2,091,000
	Al Nussirat		30,000		196,000	24,000	50,000	300,000	
	Al Zawida				17,000		21,000	38,000	
	Al Burij				35,000		20,000	55,000	
	Al Maghazi	50,000			132,000			182,000	
	Al Mosadar	15,000		100,000	135,000			250,000	
	Wadi Al Salqa	120,000	50,000	40,000	135,000			345,000	
	Sub-total	635,000	230,000	260,000	776,000	24,000	166,000	2,091,000	
Khan Younis	KhanYounis				120,000		30,000	150,000	3,196,000
	Al Qarara				216,000			216,000	
	Bani Suhila			100,000	328,000		12,000	390,000	
	Abasan Al Jadida			700,000	25,000			525,000	
	Abasan Al Kabira			700,000	88,000			588,000	
	Khoza'a		60,000	1,000,000	176,000			1,236,000	
	Al Foukhari				91,000			91,000	
	Sub-total		60,000	2,500,000	1,044,000		42,000	3,196,000	

Governorate	Municipal Area	Groundwater wells	Desalination plants	Water reservoir	Water network	Wastewater treatment plants	Wastewater networks and pumping stations	Total Per Municipal Area	Total Per Governorate
Rafah	Rafah	5,000	20,000		80,000	100,000	125,000	330,000	432,000
	Al Nassir				42,000			42,000	
	Al Shoka	5,000			55,000			60,000	
	Sub-total	10,000	20,000		177,000	100,000	125,000	432,000	
All Gaza Strip	Total	2,039,000	315,000	5,650,000	5,265,000	1,574,000	3,732,000	18,125,000	
	Environmental Mitigation and Monitoring Measures							1,450,000	14,855,000
	Vehicles Damages (including Jitters, distribution, operation and maintenance)							9,150,000	
	IT and stationary Damages							255,000	
	Unseen Damages							4,000,000	
Total (USD)									33,380,000

Source: Damage Assessment Report Water and Wastewater Infrastructure CMWU August 2014

Table 4-4 Status of Reconstruction Work as of December 2016

Governorate	Municipality	Total Per Municipal Area (August 2015)	Done		Ongoing & Tendering		Pledged		No Available Fund	
			USD	%	USD	%	USD	%	USD	%
North	Beit Hanoun	2,591,000	2,391,000	92.3	200,000	7.7		0.0		0.0
	Beit Lahia	985,000	785,000	79.7	200,000	20.3		0.0		0.0
	Jabalia	2,000,000	2,000,000	100.0		0.0		0.0		0.0
	Om Al Nasser	405,000	405,000	100.0		0.0		0.0		0.0
	Sub-total	5,981,000	5,581,000	93.3	400,000	6.7	0	0.0	0	0.0
Gaza	Gaza City	6,485,000	6,485,000	100.0		0.0		0.0		0.0
	Al Moghraqa	252,000	252,000	100.0		0.0		0.0		0.0
	Al Zahra	100,000	100,000	100.0						
	Wadi Gaza	328,000	328,000	100.0		0.0		0.0		0.0
	Sub-total	7,165,000	7,165,000	100.0	0	0.0	0	0.0	0	0.0
Deir Al Balah (Middle Area)	Deir Al Balah	921,000	921,000	100.0		0.0		0.0		0.0
	Al Nussirat	300,000	300,000	100.0						
	Al Zawida	38,000	38,000	100.0		0.0		0.0		0.0
	Al Burij	55,000	55,000	100.0		0.0		0.0		0.0
	Al Maghazi	182,000	182,000	100.0		0.0		0.0		0.0
	Al Mosadar	250,000	115,000	46.0		0.0		0.0	135,000	54.0
	Wadi Al Salqa	345,000	345,000	100.0		0.0		0.0		0.0
	Sub-total	2,091,000	1,956,000	93.5	0	0.0	0	0.0	135,000	6.5
Khan Younis	Khan Younis	150,000	150,000	100.0		0.0		0.0		0.0
	Bani Suhila	440,000	440,000	100.0		0.0		0.0		0.0
	Al Foukhari	91,000	91,000	100.0		0.0		0.0		0.0
	Abasan Al Jadida	725,000	725,000	100.0		0.0		0.0		0.0
	Abasan Al Kabira	788,000	788,000	100.0		0.0		0.0		0.0
	Al Qarara	216,000	216,000	100.0		0.0		0.0		0.0
	Khoza'a	736,000	736,000	100.0		0.0		0.0		0.0
	Sub-total	3,146,000	3,146,000	100.0	0	0.0	0	0.0	0	0.0
Rafah	Rafah	320,000	320,000	100.0		0.0		0.0		0.0
	Al Shoka	60,000	60,000	100.0		0.0		0.0		0.0
	Al Nassir	42,000	42,000	100.0		0.0		0.0		0.0
	Sub-total	422,000	422,000	100.0	0	0.0	0	0.0	0	0.0
All Gaza Strip	Environmental mitigation	1,450,000	1,450,000	100.0		0.0		0.0		0.0
	Vehicle and heavy machineries	9,150,000	2,150,000	23.5	1,000,000	10.9	1,000,000	10.9	5,000,000	54.6
	IT and stationary damages	255,000	229,500	90.0		0.0		0.0	25,500	10.0
	Unseen Damages	4,000,000	1,000,000	25.0		0.0		0.0	3,000,000	75.0
	Sub-total	14,855,000	4,829,500	32.5	1,000,000	6.7	1,000,000	6.7	8,025,500	54.0
Total		33,660,000	23,099,500	68.6	1,400,000	4.2	1,000,000	3.0	8,160,500	24.2

Source: Documents submitted by CMWU as of December, 2016

Chapter 5

Pilot Projects

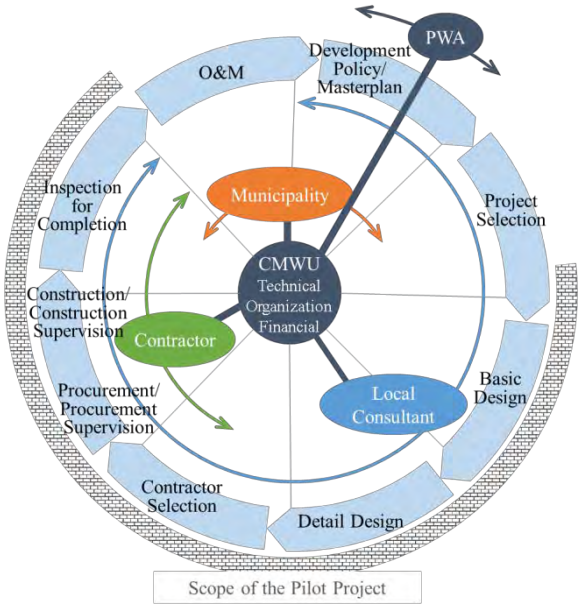
Chapter5 Pilot Projects

5-1 Purpose of the Pilot Projects

Reconstruction and development of transmission pipelines and distribution pipeline were carried out as pilot projects in water sector. In the sewage sector, the installation of main sewer line and branch lines was implemented. In the course of implementing the pilot projects, lessons learnt will be documented and made as a valuable input to the strategic medium-term assistance plan for the water sector.

Figure 5-1 shows project cycle in the water and sewage sector and the scope covered in the pilot projects. Firstly, the fundamental development policy and Master Plan are established. Based on these, the prioritized project is selected, and then the basic design, detailed design, contractor selection, supervision for procurement and construction, inspection for completion are carried out. After its completion, the facility is then handed over to the client. Afterwards, operation and maintenance of the facility commences and sustained. In the Gaza strip, the PWA is involved in planning fundamental policies, however, CMWU supervises and operates all of the business in water and sewage sector. Local consultants working in the water and sewage sector have been involved from basic design until inspection for completion, based on receiving the order from CMWU or directly from donors.

Implemented pilot projects were covered from project selection until inspection for completion, but excluded basic planning as well as operation and maintenance.



Source: JST

Figure 5-1 Project Cycle and Covered Scope of the Pilot Projects

5-2 Outlines of the Pilot Projects

Each pilot project was examined by making an analysis of damage assessment, a reconstruction needs assessment and studying related reports. Also, a candidate project list was provided by CMWU, which considered the possibility of material procurement, capacity of local contractor and budget. Then, a meeting with

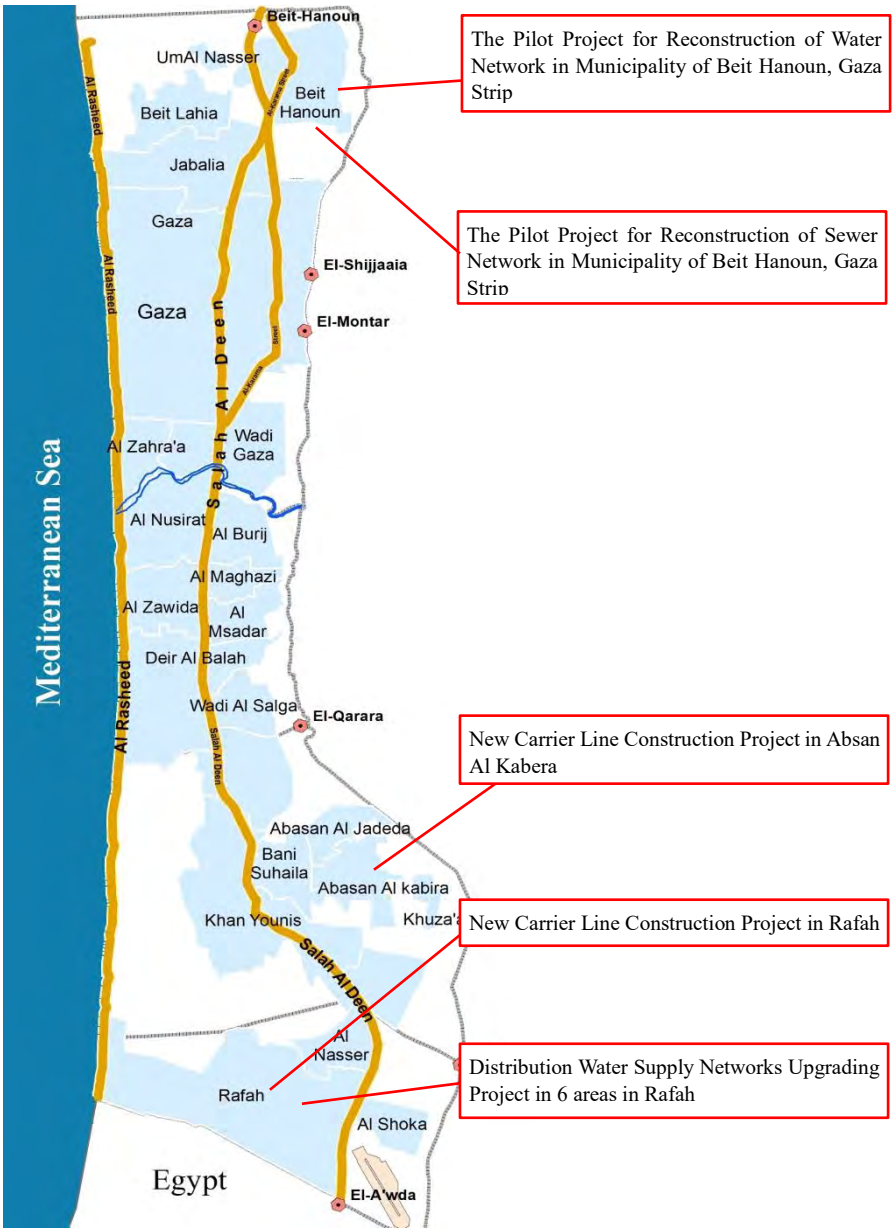
CMWU, JICA office in Palestine and JICA headquarters was held for project selection.

In FY 2015, two pilot projects – one for the water sector and the other for the sewage sector – were carried out. In order to utilize knowledge and lessons learnt obtained through the pilot projects in FY2015, additionally three pilot projects were also carried out. **Table 5-1** shows the five implemented pilot projects. Also the locations of the pilot projects are shown in **Figure 5-2**.

Table 5-1 Implemented Pilot Projects

No	Sector	Year	Area	Name of Project	Project Size	Period
1	Waters	FY2015	North Governorate, Municipality of Beit Hanoun	The Pilot Project for Reconstruction of Water Network in Municipality of Beit Hanoun, Gaza Strip	USD155,380.00	From 10th Jun. 2015 till 30th Oct. 2015
2	Sewage	FY2015	North Governorate, Municipality of Beit Hanoun	The Pilot Project for Reconstruction of Sewer Network in Municipality of Beit Hanoun, Gaza Strip	USD148,850.00	From 10th Jun. 2015 till 30th Oct. 2015
3	Water	FY2016	Rafah Governorate, Municipality of Al Shoka	New Carrier Line Construction Project in Rafah	NIS294,900.00	From 29th Nov 2016 till 15th May 2017 (After amended)
4	Water	FY2016	Khan Younis Governorate, Municipality of Absan Al Kabira	New Carrier Line Construction Project in Absan Al Kabera	NIS769,000.00	From 29th Nov 2016 till 15th May 2017 (After amended)
5	Water	FY2016	Rafah Governorate, Municipality of Rafah	Distribution Water Supply Networks Upgrading Project in six areas in Rafah	NIS682,559.70	From 29th Nov 2016 till 15th May 2017 (After amended)

Source: JST



Source: JST

Figure 5-2 Locations of the Pilot Projects

5-2-1 The Pilot Project for Reconstruction of Water Network in Municipality of Beit Hanoun, Gaza Strip

Four sites in Municipality of Bait Hanoun were selected as potential pilot project sites, namely, Al Qaraman, Gaza Street, Al Seka Area, and Khalil Al Wazeer. The networks installed by the Pilot Project consist of distribution branch pipes for house connections, main distribution pipes from pumping stations, leaking distribution networks and pipes connecting with existing pipelines, all of which require urgent reconstruction. The numbers of each material quantity required for the pilot projects are as follows;

(a) Supply and installation of approx. 3.0km of dia. 160mm of uPVC (PN10.0) pipeline with fittings

(b) Supply and installation of approx. 2.5km of dia. 110mm of uPVC (PN10.0) pipeline with fittings

(c) Supply and installation of gate valves (6 inches and 4 inches) with manholes

(d) Supply and installation of house connections for 100 households
(e) Removal and restoration of existing asphalt
(f) Removal and restoration of existing interlocking blocks etc.

5-2-2 The Pilot Project for Reconstruction of Sewer Network in Municipality of Beit Hanoun, Gaza Strip

Initially the plan was for the installation work of branch pipelines in three areas of the city. Through a meeting with Beit Haroun and CMWU, it was established that replacement of the main pipeline in the Sayel district was an urgent priority. Therefore, the components of the pilot project were reexamined. The Pilot Project consisted of reinstallation of the main pipeline under Baser Naim Street in the Sayel district, the installation of connected branch lines and house connections (public pits and connecting pipes).

The existing main pipeline required replacement because its 200mm of diameter was too small for the flow, the material of pipeline was asbestos and the pipe was too old.

The numbers of each material quantity required for the pilot projects are as follows;

(a) Supply and installation of main sewer line approx. 0.7km (dia400mm - 250mm of uPVC, PN 10.0) with fittings
(b) Supply and installation of branch lines approx. 1.2km (dia.200mm of uPVC, PN10.0) with fittings
(c) Supply and installation of 89 units of manholes (dia. 1.5m, 1.2m and 1.0m)
(d) Supply and installation of 112 house connections etc.

5-2-3 New Carrier Line Construction Project in Rafah

Groundwater produced from four wells (Al Jameia well, Al Matar well, Al Shoka 1 well and Al Fakhari well) had been supplied to Al Shoka area located east part of Rafah. Diameter of existing carrier line was small for required water flow. In addition, the length was long, approximately a distance of 7,200m with 225mm of diameter. This pipeline also supplied water to Al Shanora area in Rafah. Thus, sufficient water quantity could not be secured resulting into serious water shortage in the Al Shoka area.

On the other hand, there is an existing water tank with a capacity is 1,800m^3 in the Al Nassair area. Although a carrier line of 315mm has been installed close to the water wells to the water tank, the said line was not connected to the water wells. This pilot project was carried out to secure stable water supply to Al Shoa area, by installing a new 1.1 km carrier having a diameter of 280mm to connect the existing carrier line of 315mm and to the four water wells.

The numbers of each material quantity required for the pilot projects are as follows;

(a) Supply and installation of approx. 1.1km of dia. 280mm of uPVC (PN12.5) pipeline with fittings
(b) Supply and installation of gate valves (10 inches, 8 inches and 6 inches) with manholes / valve chamber
(c) Supply and installation of check valve at water well
(d) Supply and installation of an air valve (10inches) etc.

5-2-4 New Carrier Line Construction Project in Absan Al Kabera

The pilot project was implemented to install approximately 1.6km with dia. 280mm pipeline and to stop

the use of existing asbestos pipe lines. Although the diameter of existing asbestos pipelines was six inches, it is deemed too small for the demand. It will be replaced using uPVC with a diameter of 280mm, which made it possible to secure sufficient water supply.

The numbers of each material quantity required for the pilot projects are as follows;

(a) Supply and installation of approx. 1.6km of dia. 280mm of uPVC (PN10.0) pipeline with fittings
(b) Supply and installation of 10 inch gate valves with manholes
(c) Supply and installation of dia.110mm of uPVC and four inch gate valves with manholes for connection with existing distribution network
(d) Supply and installation of two air valves (10 inches)
(e) Removal and restoration of existing asphalt etc.

5-2-5 Distribution Water Supply Networks Upgrading Project in 6 areas in Rafah

The pilot project installed water distribution networks in order to contribute increasing of water supply population at 22 sites in 6 areas in Rafah (Al Salam, Tabit Zarea, Al Shabora, Al Mosabeh, Tal Al Sultan, and Al Saymat) where had no water distribution network established or had not appropriate network.

The numbers of each material quantity required for the pilot projects are as follows;

(a) Supply and installation of Dia. 63mm of HDPE and dia.110mm of uPVC pipelines to establish water distribution networks at 22 sites
(b) Supply and installation of 134 of house connections
(c) Supply and installation of gate valves
(d) Removal and restoration of existing asphalt
(e) Removal and restoration of existing interlocking blocks etc.

5-3 Manner of Implementation

Each pilot project was carried out as shown below:

5-3-1 Environmental and Social Considerations

The Water Supply and Sewage Systems Improvement Project (WSSSIP) was defined as falling under Category B of the World Bank Operational Policy 4.01 (Jan, 1998). This was also in accordance to the "Environmental and Social Impact Assessment (ESIA) and the Environmental and Social Management Plan (ESMP) for Gaza Water Supply and Sewage Systems Improvement Project (WSSSIP) Phase 1 and Additional Financing (AF) Final Report" (September, 2014). The project required the establishment and operation of an Environmental Management Plan (EMP). As the project will not have serious negative effects, additional Environmental and Social Impact Assessments (ESIA) will not be required.

Thus, at the implementation stage of the Pilot Projects, Environmental and Social Considerations were deemed to have been satisfied and confirmed based on the report mentioned above.

5-3-2 Design

CMWU is capable of designing water and sewage facilities with financial support from each donor. Two of

pilot projects implemented in FY2015 were designed by reviewing the drawings and specifications made by CMWU. The other three pilot projects, implemented in FY 2016, were designed by the JICA Survey team from discussions with CMWU, the concerned municipalities and JICA.

5-3-3 Cost Estimate

The results of the survey which have been carried reveal that estimate presented between CMWU and Japanese organizations have big differences. Through comparisons between estimate methods for public works in Japan and CMWU, appropriate estimate methodologies were examined.

CMWU calculates estimate cost through multiplying the length of installed pipelines and unit cost of materials and works, including almost all of pipe materials, fittings, excavation and backfilling work. This method is simple, easy to understand and possible to easily change the contract amount by any modification, but its accuracy is low. Although the CMWU has been developing asset management using GIS, existing information of actual condition and location of these facilities have not been properly reflected on the GIS. Actual excavation work is necessary in order to confirm the diameter of existing pipeline, material, installed depth of pipes, as well as location of existing pipe. Thus, CMWU accommodates flexibly for modification by preparing for contingencies. In other words, modification during the construction stage always happens, but work load on planning and designing are kept lower.

On the other hand, the cost estimate for JICA grant aid projects is to collect / accumulate all cost information of materials and works. Planning and designing work is given much time to minimize any modifications during the construction stage.

Table 5-2 shows the comparison between the estimates implemented by CMWU and the JICA grant aid projects. For the pilot projects implemented in FY2015, estimates are separately calculated as direct cost, administrative cost and profit, based on the CMWU method. Detailed cost information was not obtained because CMWU contractors and suppliers in the Gaza Strip are not familiar with the Japanese estimate system, and also due to the time limit for the work involved in estimation. On the other hand, considering additional costs brought about by any cause, the submission of Bill of Quantity (BOQ) should be requested from the Contractors, to make clear each unit cost. The pilot projects implemented in FY2016 adopted a method closer to how public works in Japan are estimated in order to improve accuracy.

Table 5-2 Enforcement Policy of Cost Estimate for the Pilot Projects

	Method of JICA Grant Aid	CMWU Method	Enforcement Policy of Tender for the Pilot Project	
			Implemented in FY2015	Implemented in FY2016
Quantity	Calculating the quantity from drawings based on the survey results	Calculating the quantity based on drawings. No land survey data available	Calculating quantities based on drawings provided by CMWU.	Calculating quantities based on information provided by CMWU.
	(Material) Not only lengths of pipelines but also amounts of all fittings are counted.	(Material) Length of pipelines is counted. Amounts of all fittings are estimated from length of pipelines (only branches counted).	(Material) Following CMWU method	(Material) Not only lengths of pipelines but also amounts of all fittings are counted.
	(Work) - Based on land survey results, amounts of excavation, backfilling and soil disposal are counted - Amounts of road work (asphalt, interlocking block etc.) are set based on land survey results.	(Work) - Based on length of each diameter of pipeline, amounts of excavation, backfilling and soil disposal are set. - Road work (asphalt, inter rocking block etc.) is set based on site reconnaissance but not implemented land survey	(Work) Following CMWU method	(Material) Same as on the left
Unit Cost	Quotations collected from several suppliers. The lowest quoted price is generally adopted. If number of collected quotation is not enough, discount rate may be applied.	- Average price calculated based on CMWU experiences (due to fluctuation widely depending on market condition, political reason) - Administrative cost and profit are also added on each unit price	-Through comparison between quotations issued by three suppliers and average price provided by CMWU, adopted unit costs are set. -Administrative cost and profit are not included in each unit price	- Quotations collected from several suppliers. The lowest quoted price is adopted. -Administrative cost and profit are not included in each unit pric
	(Material) All material are set from collected quotations or official data of construction cost	(Material) Unit cost of pipelines, valves, manholes are set. Unit costs of fittings are not set, fitting cost per 1m of pipeline is estimated.	(Material) Following CMWU method	(Material) All material are set from collected quotations or official data of construction cost
	(Work) Based on appropriate evidence, unit price of each work is set for each work (labor cost, machines)	(Work) Unit costs per 1m of pipelines are set based on the experiences. Unit costs of type of work are available but not classified between Labor costs and machines. Necessary expenses such as cost of soil disposal, procurement of pit sand etc. are included into other unit costs.	(Work) Following CMWU method	(Work) Based on appropriate evidence, unit price of each work is set for each work (labor cost, machines)
Common	Construction cost is calculated from	Unit cost includes all necessary expenses.	Construction cost is calculated from	Same as on the left

	Method of JICA Grant Aid	CMWU Method	Enforcement Policy of Tender for the Pilot Project	
			Implemented in FY2015	Implemented in FY2016
Expenses	direct cost and common expenses (administrative cost and temporary cost).	Administrative cost and profit are not appeared.	Direct cost and common expenses etc.	
Contingency	No contingency generally	10～15% of total cost adds on contract price as contingency	No contingency on contract price	Same as on the left
Correspondence in case of additional work	Amendment of contract (Contract including with contingency may be possible if necessary)	Contingency applies	Bill of Quantity (BOQ) is required in order to evaluate additional cost in case additional work occurs. (after contract)	Same as on the left
Remark	Submission of Bill of Quantity (BOQ) is required from contractor for confirmation of volume of work done for interim payment and for settlement in case of for early termination.			4% of the contract cost considererd as administrative cost for CMWU

Source: JST

5-3-4 Tenderer Selection

CMWU introduced / recommended contractors having construction experience in the water sector in the Gaza Strip. The JICA office in Gaza also recommended additional contractors that have had previous project contracts with the JICA from which a long list was made. Based on the list, tender announcement was sent. The companies interested in the tender were then requested to submit the prequalification (PQ) documents, after which tender documents were distributed to the company/ies which satisfied prequalification (PQ) conditions.

Table 5-3 shows the Criteria of prequalification.

Table 5-3 Prequalification Criteria for the Pilot Projects

Criteria	Description
Company Registration	To be a general civil contractor, duly organized and registered under the laws of Palestinian Authority, which is controlled by Palestinian physical persons. Any Joint Venture is not acceptable.
Financial condition	To be in sound financial condition in the last two fiscal years
License of Palestinian Contractors Union	To have a first, second or third class license in water sewage sector issued by Palestinian Contractors Union (PCU)
Work Experience	To have at least five completed projects in water and sewer network installation in Gaza Strip, Palestine.

Source: JST

Licenses issued by the Palestinian Contractors Union (PCU) are available ranging from first class to fifth class in each sector i.e., building, road, water and sewage, mechanical and electrical. The criteria for issuance of a license are shown in **Table 5-4**.

Contractors having a minimum of a 4th Class licence issued by PCU are eligible to participate in a tender which has the maximum amount of the contract of JOD 500,000 (approximately JPY79.29million, JOD1.00 = JPY158.585, as of July 2017). The contract amount of each Pilot Project in the water sector is estimated at JPY20 million, and so the participation of 4th class of contractor was examined. Past JICA projects had required that all tenderers should have at least a 3rd class license. Therefore, the minimum license class requirement was set for at least a 3rd class license, which is the same as that required in past JICA projects.

Table 5-4 Criteria of PCU Construction Licenses

Class	Qualification conditions				Maximum bidding amount
	Company Capital	Equipment Value	Office Area required	Experience: Value of Past performed project	
1st	Not Less than JOD 250,000	Not less than JOD 250,000	More than 140m^2	Not less than JOD 2,000,000	Up to JOD 4,000,000
2nd	Not less than JOD 150,000	Not less than JOD 150,000	More than 120m^2	Not less than JOD 1,000,000	Up to JOD 2,000,000
3rd	Not Less than JOD 75,000	Not less than JOD 75,000	More than 75m^2	Not less than JOD 500,000	Up to JOD1,000,000
4th	Not less than JOD 50,000	Not less than JOD 30,000	More than 50m^2	Not less than JOD 150,000	Up to JOD 500,000
5th	Not less than JOD 15,000	Not less than JOD 15,000	More than 30m^2	Not less than JOD 50,000	Up to JOD 100,000

JOD: Jordanian Dinar
Source: PCU

5-3-5 Tender and Contract

A two envelope tender was adopted. Construction schedules were requested to be submitted for technical evaluation, in order to confirm that the submitted schedule can be completed within the specified period. Tenders submitted from satisfactory tenderers were then opened, and the minimum ceiling price was confirmed. The tenderer who offered the lowest tender price below the ceiling price, had the first chance of negotiation, and contract negotiations were carried out.

All tenders for three pilot projects implemented in FY 2016 were deemed failed. After the tendering, the reasons for failure were investigated and re-tenders were carried out after design changes.

5-3-6 Procurement Supervision

Materials needed for construction works in the Gaza Strip can only be transported through Israel. The Government of Israel has regulated material transportation to the Gaza Strip by Defense Export Control Law (2007) and Defense Export Control Order (2008) in order to avoid any attack from the Gaza Strip. Applications for material transportation to the Gaza Strip must, therefore, be submitted to the office for Coordination of Government Activities in the Territories (CoGAT).

A Gaza Reconstruction Mechanism (GRM) has been established between Israel and the Palestinian Authority (PA) under cooperation with the United Nations on September 2014. GRM is a temporary agreement for Gaza reconstruction with stipulated rules for material procurement and control. GRM has basically the same as the framework as that of the Defense Export Law except that the window for the application is with the Ministry of Civil Affairs (MoCA) of Palestine instead of CoGAT. It has been established in order to facilitate short term procurement.

For all the pilot projects, procurements were carried out by applying GRM. Necessary applications were made by CMWU. JICA survey team worked to confirm specification of procured materials for the construction with hired local consultant.

5-3-7 Construction Supervision

JICA survey team hired local consultants and remotely supervised the construction works, due to difficulty to be stationed in the Gaza Strip. During the construction work, JICA survey team visited the construction sites to confirm the actual works of supervision, also implemented the final inspections at the completion of construction stage.

Based on "The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects (September 2014)" issued by JICA, safety management was thorough to the concerning parties.

The Gaza Strip suffered much damage from Israeli attacks in 2014 as well as previous attacks and the possibility of finding Unexploded Ordnance (UXO) at the project sites exists. In order to ensure safety, some meetings with United Nations Mine Action Service (UNMAS) were arranged prior to construction works. JICA Survey Team also requested field surveys at the project sites from UNOPS. UNOPS held trainings with the contractors, staff of CMWU and concerning municipalities offiicials to communicate safety considerations related to the site activities and corresponding actions in case of UXO discovery.

5-4 Lesson learnt through the Implementation of Pilot Projects

5-4-1 Cost Estimate

Adopted method of cost estimate for the pilot projects was combined CMWU's method with the method which is ordinarily adopted by JICA grant aid projects. But the three pilot projects implemented in FY2016 adopted a method similar to the one used by public works in Japan in order to improve accuracy. Although some bidders were not familiar with such Japanese estimate system at first, they understood the estimation method after some time. The adopted estimate system has been confirmed to work properly. The implemented pilot projects did not carry out land survey. Cost estimate was based on information provided by CMWU (such as that obtained from oral information). As a result, partially huge discrepancies were occurred between actual and estimated quantities. For improving accuracy of estimate, land survey and test excavation etc. should be made during the planning and designing stage, and accuracy of GIS data from CWMU should also to be improved.

5-4-2 Unstable Material Cost

All the tenders for the three pilot projects implemented in FY 2016 were failed. After the tendering, the reasons for failure were investigated and re-tenders were carried out after design changes. **Table 5-5** shows possible reasons of the tender failure.

Table 5-5 Possible Reasons of Tender Failure

Possible Reasons of Failure	Descriptions
Foreign Currency Exchange Rate	Ceiling price set at United States Dollars (USD). Increasing the bidding prices due to fluctuation of currency exchange rate.
Cost estimate considering price increases of pipes	Fluctuation of pipe prices due to limited pipe suppliers in Gaza Strip, and situation of supplying raw material (resin) of pipe. The bidders added risk of price fluctuation on their bidding prices.
Appropriation of contingency against JICA's project	Through two pilot projects implemented in FY 2015, there were rumors among tenderers that JICA did not accept any changes from the original design and the final inspections were also severe. Therefore, the tenderers added contingency on their bidding price.
Appropriation of opportunity cost	Increased business opportunities according to increasing of projects in Gaza Strip. Some tenderers mentioned not wanting any projects with small profitability.
Shortage of administrative cost (only for Distribution Water Supply Networks Upgrading Project in 6 areas in Rafah)	Rate of administrative cost set at 10% of the contract price. Since the project has 29 construction sites in wide area in the city, temporary cost and administrative cost is higher than other projects.

Source: JST

The setting of piping material price is a particular problem in the Gaza Strip. Lessons learnt from this problem will be utilized in future projects. There are three manufacturers of plastic pipes in the Gaza Strip, but two are small manufacturers. Thus, virtually one manufacturer monopolizes large-sized businesses such as those coming from the water sector. This manufacturer controls the domestic price of pipes and pipe prices are revised every month depending on resin price, electricity supply, the balance between demand and supply. With increasing of demand in the Gaza Strip, a shortage of resin, which is raw material of pipes, occurred, as a result of demand and supply. The contractor in the Gaza can procure from Israel side but trading must be made in cash. Most contractors in the Gaza Strip are financially weak find it difficult to procure from Israel.

Thus, the tenderers suffer from risks of pipe price fluctuations, and there is no other choice sometimes but to procure from the manufacturer mentioned who, by the way, also accepts credit sales. Price fluctuations are the reason why other bidders add contingency on their bidding price. Since the pilot projects implemented this time were small scale with short period of the construction, price escalation of materials was not considered. In the Gaza Strip, prices fluctuate at short intervals and this should be stated in the contract document for the next project. Another countermeasure is to consider supplying construction materials from the project orderer.

5-4-3 Material Procurement from outside the Gaza Strip and Period for Procurement

Procurement of construction materials in the Gaza Strip is basically carried out by the Gaza Reconstruction Mechanism (GRM). Before GRM was introduced, CMWU had been applying for GRM to transport materials, and the actual period for obtaining permission was six months or much longer than through direct application with CoGAT. To complicate matters, monitoring was impractical. At this time though, the GRM procedure improved and became smooth. The procurement requirements of five pilot projects were worked out through GRM.

In FY 2015, it took two months to apply for and get approval for GRM for the two pilot projects. With the three pilot projects implemented in FY 2016, GRM applications were made in parallel during the contractor selection stage to reduce the project period. The applications were made by CMWU, but it took more than two months to get approval for the pilot projects implemented in FY 2016. **Table 5-6** shows time required for GRM applications.

Table 5-6 Time Required for GRM Applications

No	Year	Name of Project	Waiting time for GRM approval
1	FY2015	The Pilot Project for Reconstruction of Water Network in Municipality of Beit Hanoun, Gaza Strip	Waiting Time for Submission: 14days Waiting Time for Approval: 68days Waiting Time for Construction Start: 0days
2	FY2015	The Pilot Project for Reconstruction of Sewer Network in Municipality of Beit Hanoun, Gaza Strip	Waiting Time for Submission: 2days Waiting Time for Approval: 57days Waiting Time for Construction Start: 2days
3	FY2016	New Carrier Line Construction Project in Rafah	Waiting Time for Submission: 0days Waiting Time for Approval: 62days Waiting Time for Construction Start:23days
4	FY2016	New Carrier Line Construction Project in Absan Al Kabera	Waiting Time for Submission: 0days Waiting Time for Approval:70days Waiting Time for Construction Start:69days
5	FY2016	Distribution Water Supply Networks Upgrading Project in 6 areas in Rafah	Waiting Time for Submission: 0days Waiting Time for Approval: 62days Waiting Time for Construction Start:72days

Source: UNOPS Website, (http://grm.report)

Also, for construction works in the Gaza Strip, interruption of construction work due to shortage of construction materials does happen. In the implemented pilot projects, the supply of pipe was interrupted due to lack of material, which resulted to a temporary stoppage of construction work. The Contractor procured from Israel side by an arrangement of CMWU, and procurement continued. Such eventualities should be taken into consideration in construction scheduling.

5-4-4 Administrative Cost in CMWU for the Implementation of Pilot Projects

At the time of the implementation of the FY 2015 pilot projects, CMWU requested JICA to carry the salaries of their staff involved in the pilot projects, as well as administrative expenses. JICA refused to pay citing JICA's policy. It was made clear that finances provided by other donors include salaries of staff, consulting fee, and their administrative expenses (application fee/licensing fee, coordination with concerning municipalities, inspection fee etc.). Because the budget is unitarily controlled by CMWU, budgetary allocation is made at the discretion of CMWU, in case of support to CMWU by other donors. In the FY 2015 pilot project only the construction cost was budgeted, so the salaries of CMWU staff plus administrative expenses were applied from other projects implemented by other funding sources.

In the FY 2016 pilot projects' implementation, administrative expenses of CMWU were calculated; namely, information / data collection for design work, site survey, coordination with concerned municipalities, attendance in meetings, design review, tender and site orientation, inspections and GRM application etc. The calculation showed that the administrative expenses of CMWU equal to around 4% of the contract price by and between JICA and the contractor. Because of this, comments on this finding were added in the contract document. But for JICA funded projects, JICA policy will prevail.

5-4-5 Information Sharing and Organizations for Construction Supervision

In the 2015 pilot project for reconstruction of sewer network in municipality of Beit Hanoun, Gaza Strip the local contractor carried out different work from the original plan without any notice to JICA, the project orderer following an instruction that originated from CMWU (**BOX 5-1**). This trouble is attributed to the lack of information sharing within the related agencies.

Box 5-1
Road pavement work in the project site was decided to be carried out by other project. For this reason, installation of sewer pipe under the road (main sewer line and part of branch lines where connected with main sewer line) needed to be completed prior to the pavement work. The contractor was requested from both of CMWU and municipality of Beit Hanoun to install all branch lines where are closer to the main sewer line and water supply pipeline under the road (both were out of scope of the project). Instead, CMWU and municipality of Beit Hanoun allowed the contractor to cancel a part of installation work for branch lines which was the project scope. The above was occurred by own judgment of CMWU and municipality of Beit Hanoun without any notice to anyone as well as JICA staff in Gaza who was the project manager.

The reason was that CMWU, the municipality of Beit Hanoun, the Contractor and the local consultant did not properly understand that difference between the project implemented by JICA and projects funded by other donors – which is, (i) for projects funded by other donors, CMWU is the orderer and any modification is ordered by CMWU, (ii) for projects funded by JICA, the orderer is JICA instead of CMWU. Information sharing among the concerning parties would be strengthened so that problems are minimized. For example, pavement work on the road in the project site, which was not planned commenced not only ahead of schedule, but also without notice.

Based on this, JICA and CMWU confirmed the problem in writing and tried to prevent a recurrence of similar problems. In the FY 2016 pilot projects, JICA policy and the function / scope of each party were disseminated to not only CMWU but also to the concerned municipalities, local consultants and contractors. The policy and implementation rule of JICA were explained several times at the tender orientation and kick off meeting. Also, the form of weekly report submitted by the local consultant in charge of construction supervision

was revised into describing not only construction result but also the latest situation at the construction site including issue, and modification requirement of the construction. The weekly report is signed by all concerned parties so that proper information on project implementation is shared and secured. However, despite this system, in the distribution water supply networks upgrading project in six areas in Rafah, a similar problem occurred as shown below. (**BOX 5-2**).

Box 5-2

（Problem-1）

This project was initially planned to establish distribution networks at 29 sites in 6area of Rafah city. Due to failure of tender, design change was carried out through consultation with CMWU, 22 sites were chosen with cancelation of 7 sites, and then second tender was conducted. Since the construction start was delay, unable enduring strong complaints of residents, one of selected site was constructed by CMWU. During working for design change, no information was obtained which CMWU has been working for the site. The second tender was conducted including work of the completed site into the scope. It was found clear after concluded the contract with the contractor that the work at the said site was completed. Moreover, CMWU instructed the contractor to divert some materials planned to use for the said site to other site.

（Problem-2）

At a site where is to be installed 2 distribution pipes, different work from the original plan was carried out. One was a site canceled by design change after tender failure, other was a site where had never been consulted. It was occurred by miscommunication according to CMWU, no one from CMWU, the local consultant and contractor recognized that actual situation was totally different from the drawing. It showed no management or supervision in each position worked properly.

This problem was caused by lack of internal information sharing in CMWU where the local consultant and contractor followed the instruction by CMWU without checking of the site drawings and the actual site. Those at the site did not recognize that work was for a different site compared to the site drawings and this issue was not included in the weekly report.

Moreover in new carrier line construction project in Rafah, coordination among the concerned municipalities, which should be done by CMWU, was not conducted, such that the existing and new carrier lines could not be connected (**BOX5-3**). Also, in the new carrier line construction project in Absan Al Kabera, since content of construction work implemented by a previous project was not shared between CMWU and the municipality, work on the project needed to be modified (**BOX5-4**).

Box 5-3

With regard to new carrier line to be connected with an existing pipeline, there are two municipalities (Al Naser and Al Fakharioyobi) concerned not only Al Shoka. It was found at the final stage of the construction that an official agreement was not made among the concerning municipalities. Although CMWU committed to conclude with the municipalities as soon as possible, the agreement could not be made until the construction period. Thus, JICA asked CMWU to promise making connection with existing pipeline with CMWU's expense, once obtaining the agreement with the municipalities. The carrier line installed through the project was closed using an end cap.

Box 5-4

A planned connection with existing pipeline was canceled since it has been done by other previous project. The content of the previous project was not shared between CMWU and the municipality.

In order to prevent the reoccurrence of these problems, development of information sharing system is necessary. Through support in future, JICA shall make steady efforts to develop the system between CMWU and concerned municipalities.

Since water supply pipes and sewer lines are located underground, the actual conditions of existing pipelines are difficult to confirm without excavation. In addition, the facilities have been damaged several times by conflicts, where emergency / temporary repairs were conducted each time. Thus, drawings and of the facilities

may have several discrepancies from the actual condition of existing facilities. Also, many farmers have installed own water wells and its carrier pipelines for irrigation use without license, making confirmation from drawings next to impossible. Due to such a situation, it is a common occurrence that work during construction stage had many changes, and there was not enough time devoted to the planning and design stages. Since modifications made during the construction were not properly managed, there were further discrepancies.

It is important to put emphasis on the planning and designing stage, and that as built drawings should be made to reflect all modifications made during the construction stage. This is one foundation to better manage the constructed facilities. In order to practice this series of improvements in the future, Japanese engineer(s) shall be on site for the construction supervision until this practice becomes common.

Chapter 6

Medium-Term Cooperation Plan

Chapter6 Medium-Term Cooperation Plan

6-1 Basic Development Policy of PWA

In the National Water and Wastewater Strategy for Palestine (2013), PWA there are seven policy items by PWA; (1) Sustainable development of water resources, (2) Integrated water resources management, (3) Water rights, (4) Access to water and wastewater services, (5) Financial sustainability of water utilities, (6) Governance and Management, and (7) Sustainable wastewater management. Details of each policy are shown below.

(1) Sustainable development of water resources

- ✓ Fresh water is a finite and vulnerable resource, essential for sustaining life, development and the environment
- ✓ Water is part of larger ecological systems. Realizing the importance and shortage of fresh water, it has to be treated as an essential element for sustaining all life forms.
- ✓ Water supply must be based on the sustainable development of all water resources (conventional and non-conventional, shared and endogenous).
- ✓ Water resources development must be based on data collection and evaluation of all water resources as well as balancing between water availability and water needs for all sectors.
- ✓ Water has an economic, social and environmental value.
- ✓ Environmental goals must be achieved through rationalization of water use and protection of all water sources from pollution.

(2) Integrated water resources management

- ✓ Water resources must be managed in an integrated manner, taking the needs and viewpoints of all existing and potential users and the long term sustainability of these resources into account.
- ✓ Just, equitable, and sustainable allocation to all legitimate users will be best ensured by the State.
- ✓ Agricultural, industrial, and other development and investments must be aligned to the water resource quantity and quality available or to be developed.

(3) Water rights

- ✓ The Palestinians will pursue their interests in connection with obtaining Palestinian water rights, including the fair right-of-access, right-of-control and right-of-use to water resources shared with other countries, in line with international law

(4) Access to water and wastewater services

- ✓ Water has a unique value for human survival and health. Each citizen has the right to sufficient and affordable water of the required quality for the purpose of use.
- ✓ Each citizen has the right to hygienic sanitation services.
- ✓ The needs and interests of all gender groups (marginalized, poor, restricted access, women, etc.) will be taken into account.
- ✓ The water integration concept will be applied Water supply and sewage treatment services.

(5) Financial sustainability of water utilities

- ✓ As water has an economic, social and environmental value in all its competing uses, water services are not free.

(6) Governance and Management

- ✓ All water resources are considered as a public property.
- ✓ Water resources development and management should be based on a participatory approach, involving all stakeholders (users, planners and policy-makers) at all levels.
- ✓ The responsibilities for water resources governance, being a regulatory function, and water services management, being an operational function, should be separated institutionally.

(7) Sustainable wastewater management

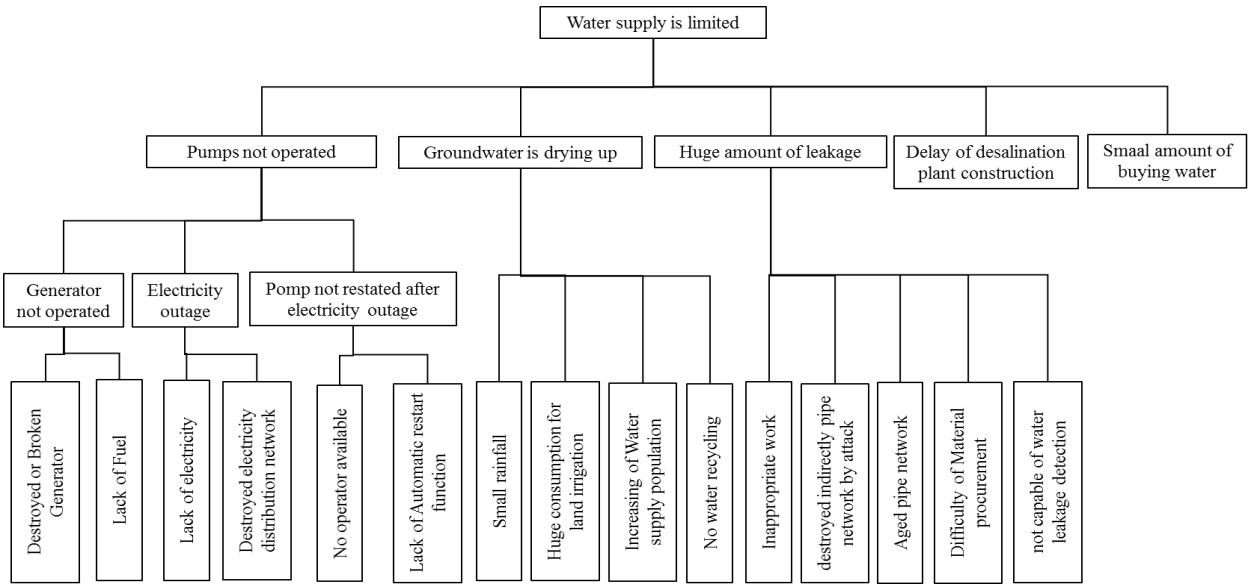
- ✓ Water polluters should stop their pollutions and be made to pay for the damage they have produced.
- ✓ Safe disposal of wastewater requires treatment to eliminate biological, chemical and physical hazards.
- ✓ Treated wastewater effluent is considered a water resource and is added to the water balance. This is deemed feasible in light of the semi-arid climate, the modest freshwater resources, the high demand for domestic water, and the marginal cost of such resource development.

6-2 Current Recognition of Water Sector in the Gaza Strip

Ensuring reliable water sources is recognized as the biggest issue in the Gaza Strip. This can be concluded not only from the prevailing situation but also from the "National Water and Wastewater Strategy for Palestine" a long term plan issued by PWA. While groundwater extraction seems to be the water source choice at this time, it should be emphasized that seawater desalination may hold better promise in the future. However, the construction cost of a seawater desalination plant is prohibitive and stable power at reasonable cost needs to be considered as well. But issues in over-pumping of groundwater results in increased groundwater salinity, therefore ensuring water resource stability and improvement of water quality must be planned for as early as now.

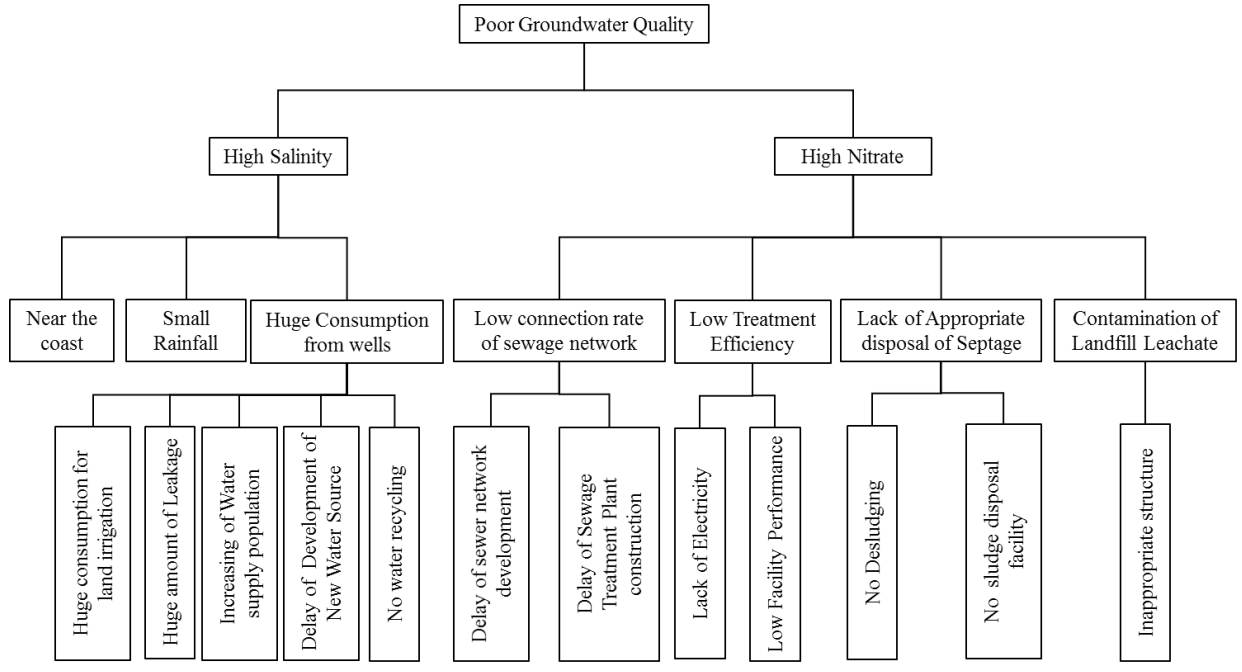
There are also a few current problems that need to be solved and one of them is to conserve the current water source until the completion of the new water source development. Vulnerability in the financial structure in the water and sewerage business is also a problem, along with the problem of water source conservation. At CMWU, expenses currently exceed revenues, and this business model cannot be operated without support from donors. The problem is recognized from the point of future stability and continuance of the business model.

Increased nitrates in the groundwater caused by contamination by untreated sewage etc. must also be examined together with the salinity problem. In order to consolidate such problems, problem analyses have been carried out for Limitation of Water Supply, Ground Water Quality and Weakness of Financial Structure. The results are shown in **Figure 6-1** to **Figure 6-3**.



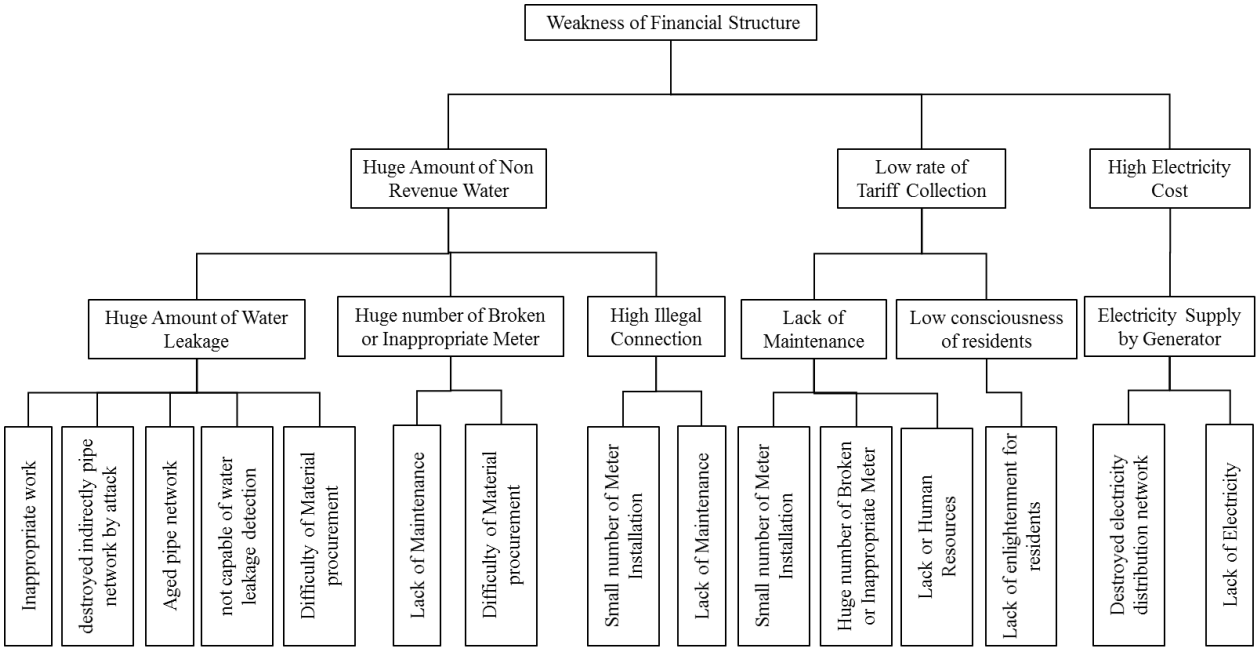
JST

Figure 6-1 Problem Analysis Result Regarding Limitation of Water Supply



JST

Figure 6-2 Problem Analysis Result Regarding Ground Water Quality



JST

Figure 6-3 Problem Analysis Result Regarding Weakness of Financial Structure

6-3 The needs of support for Water Sector

6-3-1 Necessity of JICA Assistance

Japan has been supporting the Gaza Strip through international executing agencies as Japanese ODA and JICA also has been contributing through implementation of small scale projects under the scheme of Follow-Up Cooperation. "The data book according to the country", published by Japan Ministry of Foreign Affairs describes ODA policy to the Palestinian Authority, as shown below.

“Priority Areas (1) Stability, improvement of the public welfare: In Palestinian Authority, various kinds of sacrifice has become routine, the Society is faced with unemployment and poverty, and basic infrastructure also become weak by longtime occupation and repeated /conflicts. C district, Gaza area and east Jerusalem are particularly in a more difficult situation because of relations with Israel. From the viewpoint of human security, Japan will assist the improvement of basic infrastructure i.e. water supply and sewage, health, education and assist the life of socially vulnerable which includes refugees, women and children to strengthen the peace.”

Infrastructure development in water sector in Gaza Strip is regarded as highly prioritized project under above mentioned Japanese support policy.

Japanese Government has kept emergency assistance for the Gaza Strips as follows since 2012：

- ✓ Gaza situation strain catches becoming it in 2012 and Japan carried out urgent grant aid of USD 3.5 million via UNRWA and UNICEF.
- ✓ Gaza situation strain catches becoming it in July, 2014 and Japan carried out urgent grant aid of USD 5.5 million via UNRWA and UNICEF. The grant aid included provision of relief supplies i.e. food, pharmaceutical products and water. It is JPY 220 million considerable supports such as food distribution in Gaza Strip, the distribution of daily commodities through Japanese NGOs. Through

JICA Alumni Association of Palestine, JICA carry out the support of pharmaceutical products, the food grant (JPY 80 million equivalency).

6-3-2 Directionality of JICA Assistance

In Japanese ODA, there are many water supply and sewerage projects carried all over the world. Japanese experts have since developed a strong background in the sector. Japan is one of the most efficient donors in this sector. Currently, the support for emergency rehabilitation is almost completed, and a project for regional development will follow.

6-4 Characteristics of Gaza Strips and Points of Concern for Support Activities

6-4-1 General

(1) Political Situation and Public Security

Israel had blocked the Gaza Strip after Hamas started to rule the area. Ever since the blockade, there were three attacks, such as invasions between 2008 and 2009, and an air strike in November 2012, and invasion in 2014. The Gaza Strip and its immediate vicinity are designated as the area of "Cancelation of travel is recommended" in the website of Safety Information by Ministry of Foreign Affair as of March 2017.

According to the same website, Gaza Strip is unstable situation because Hamas, which is designated as Terrorist group (Islamic extremist) by Israel, rules the area and other extremists are active as well.

After June 2014, there was fighting for 50 days between Israel and Hamas, but a cease-fire agreement was made on August 26, 2014, and indirect negotiation for homeostatic cease-fire had started on September 23, 2014. However, few rockets were documented to have been fired from the Gaza Strip to Israel after April 25, 2015, and 33 rocket fires were again documented by August 2016. Israel launched air strikes for each these rocket fires. The Gaza Strip is continually in critical condition because of Hamas's future action: Situation of the area will be exploded into something unexpected again.

(2) Economy

Most of economic activities in the Gaza Strip are controlled by Israel, and there is not enough equipment and fuel for infrastructure building. Carrying goods in Gaza Strip always requires the permission of Israel. Sometimes it takes few months depending on the type of goods. After the conflict in 2014, GRM (Gaza Reconstruction Mechanism) has been introduced, however material transfer from outside the Gaza Strip is still not flexible even the scheme is applied.Although GDP in West Bank shows an increasing trend, but economy in Gaza Strip is on the downside. GDP in Gaza Strip was 74% of the West Bank, and employment rate was 44% (Report on UNCTAD assistance to the Palestinian people: Developments in the economy of the Occupied Palestinian Territory, 2015). There is a serious lack of electricity and availability is a low eight hours a day.

(3) Relationship between Donor's Activities and Hamas

Activities in water sector by foreign donors are described in Chapter 3. Most of the economic activities in the Gaza Strip, water included, are supported by foreign donors. Generally, foreign donors hire local persons, and the local is in charge of managing the project. In 2016, a local employee of World Vision, an International NGO, was arrested by Israel because the employee provided funding to Hamas. In addition, a local employee in

UNDP was arrested the same year for the same reason. Israel carefully monitors activities which relate to support for Hamas, and donors behave carefully to gain permission to enter the Gaza Strip. Most of local authority chiefs are Hamas, and so local authorities in the Gaza Strip cannot be counterpart of aid projects. Meanwhile, CMWU is an independent organization comprised of municipalities in allover the Gaza Strip and it is administrated by PWA. CMWU can be a counterpart since PWA covers both West Bank and Gaza Strip and it belongs to Fatah Islam.

6-4-2 Situation of Candidate Organization as Project Counterpart

Candidate organization as a project counterpart is either CMWU or PWA. In case CMWU takes this position, following issues must be considered in implementing the project. It shall be noted that the item "(2) Training outside the Gaza Strip" describing below is applied to not only CMWU but also PWA staff.

(1) Ensure Salary for Employee

CMWU receives income from water supply activities in Rafah, such as sales of procurement document, surveillance, and water analysis. But the income is always under three million US dollars, and it shares only 16% on average. All other incomes are from foreign donors, and salary of employees in CMWU is paid with the support from donors. But, in pilot project, when CMWU asked JICA to cover the cost of salary for the pilot project, JICA could not accept this proposal according to JICA Policy. CMWU understood and accepted the JICA Policy since the pilot project was small scale and for a short duration. However, in case JICA carries a long-term project with CMWU as a counterpart, such as technical cooperation project, the situation may be different. CMWU will probably request that JICA to carry the cost of employees' salary. This may not materialize unless CWMU is able to pay salary of all employees from its water supply income, or from donor support.

(2) Trainings outside the Gaza Strip

Currently, the dispatch of Palestinians who live in the Gaza Strip to the area outside the Gaza Strip for trainings is difficult due to the surrounding conditions. Egypt border is opened only once a few months and it is not reliable. In case of outgoing from Israeli side, applications are usually rejected by Israel. Furthermore, approval from Jordan Government, through where flight passes, is required, which is in many case rejected. Therefore, trainings in Japan or other countries will not be made as a part of the project component.

(3) Human Resource in Counterpart Side

CMWU employs new human resources when a new project is started by each donor, such as World Bank and KfW. When the project ends, the employment of this human resource ends as well, and they leave CMWU until a new project commences. Since new employees stay only for short period in this system, continuous capacity development is difficult. Alternative employment system, where a person in charge of a project can be employed much longer should be studied.

(4) Capacity as an Organization

CMWU is one of JSC (Joint Service Council), and it plays a role in the effective operation and maintenance for water supply and sewerage in the Gaza Strip. Though CMWU provides technical support to 25 municipalities in the Gaza Strip, comprehensive service, including tariff collection, is limited as shown in **Table 3-7**. Only

Rafah Municipality is totally entrusted to CMWU. It explains vulnerable economic status of CMWU.

During the pilot project in this survey, all municipalities pointed out a problem of cooperation between CMWU and each municipality. Not only is cooperation needed; but more so information sharing is required between CMWU and each municipality so that construction work is smoother.

As a capacity development for organization, a program to develop better cooperation between CMWU and municipalities shall be formulated.

CMWU's financial situation must be improved. Currently, all economic issues depend on support from donors. Again, capacity development measures should be put in place where CMU can have measures to generate its own income and control its own expenditures.

6-4-3 Situation of Supplier, Contractor, and Local Consultant

(1) Suppliers

There are several suppliers for pipes, fittings, and valves in the Gaza Strip. Materials besides plastic pipes and fittings must be procured from Israel, but companies in Israel accept only cash sales. To transact business in Israel means that suppliers from the Gaza Strip must have good and steady cash flow.

There are three companies which produce plastic pipes and fittings in the Gaza Strip – two small companies, and another that can produce in large quantities, such as for public project. Price of products from the latter company is higher than from an Israeli company. However, most companies buy materials from the Gaza manufacturer rather than the Israeli companies because of cash flow constraints.

Manufacturers of pipes in the Gaza Strip import plastic from countries through Israel. However, there are times when pipe supplies are stopped when the prices change, or when demand is higher than supply. For example, construction work was forced to stop when the supply of pipes in the pilot project was likewise stopped because of lack of materials. In that case, the contractor arranged for pipes to be supplied from Israel with assistance of CMWU. To take care of this situation, the working schedule must be carefully planned. Procurement, contingency fund must also be set, and an escalation clause must be included in the contract. To be considered is the supplementation of materials or pipes from order placement side.

(2) Contractors

All foreign donor projects are carried out by local residents in the Gaza Strip. In these projects, surveillance and inspection are not satisfactorily carried out. It seems contractors accept low-priced orders and fail to pay attention to details. For example, a contractor said "Quality control of JICA project is very strict, compared to projects by other donors. Even the quality of a manhole will be checked during investigations. Because of this strict quality requirement, profit from the project is very little in case we make a bid in normal price. Therefore, we made a bid in high price, and then we did not succeed." Indeed, the quality of construction in the pilot project was could be much better.

Accepting low priced orders is one of the reasons why contractors do not make appropriate profit. Most of contractors, except some of large-scale companies, are not in a healthy financial condition. Payment of materials is made after the completion of construction works, worsening the already precarious cash flow condition of contractors. Most contractors in the Gaza Strip cannot purchase materials that are cheap but of good quality from Israel.

It seems that the contractors do not read contract stipulations, or they do not follow the said stipulation. Most contractors cannot communicate in English, and the national staff of JICA office in Gaza had to translate during the pilot projects. It may appropriate that tender documents and contract document are written both in English and Arabic, and a translator shall be employed for the field activities.

Because of unstable supply of materials and the lack of a secure environment in the Gaza Strip, construction works are usually delayed. In addition, the implementing organization frequently changes the construction plan. This situation contributes to the lack of motivation for contractors to keep deadline of construction works.

Quality of works is one of important issue in contractors in the Gaza Strip. To improve on this issue, the implementation organization and local consultants should properly manage the work schedule and aim to keep the deadline of works. Training for local consultants on project management is very important since currently local consultants in the Gaza Strip have not been able to ensure work quality.

(3) Local Consultants

Many of the works and projects in the Gaza Strip are generated by foreign donors' activities. Therefore, many local consultants are in charge of foreign donors' projects as well. Regarding water sector, there are less than five companies which meet the level of quality for foreign donors' requirement of works. The local consultants, who are employed by these companies have good educational qualifications and have shown competence in the job. But since employment opportunities of local consultants is short term and unstable, the local consultants also work on the foreign donor side, or on the contractor side.

Projects in the Gaza Strip are carried out by local residents, such as in the implementing organization, or in surveillance, and with the contractors. The work environment easily creates a structure of collusion. Although specifications are already described in the contract document, such stipulations are often ignored, and the project is carried out in their own way. This so-called practice has its own label – the "Gaza style". One of the reasons for such a practice is probably because new experiences are hard to come by as people cannot move in and out of Gaza easily.

Employment of local consultants is necessary for project implementation. At the beginning of Japanese ODA works, the Japan side must introduce the style of Japanese ODA. If contract stipulations in official documents are easily ignored in the Gaza Strip, and then the Japan side must be fully aware that this and they should learn how local consultants think and behave. It is impossible to control local consultants and their works remotely while Japanese teams are in Japan.

6-4-4 Activities of Japanese Experts in Gaza Strip

For activities in Gaza Strip, Japanese Experts must keep in mind following restrictions and concerns.

(1) Entry into Gaza Strip

The Gaza Strip faces to Israel and Egypt, but entrance from Egypt has been closed. There are five Crossing Points (entrance) from Israel side, but entrance to the Gaza Strip is possible only from Erez Crossing Point located in north part of the Gaza Strip so far.

For entrance to the Gaza Strip, it is necessary to acquire entrance permit beforehand from both Israel and Palestine. Since permit from Israel is not easy to acquire, Japanese experts are better to have official passport if possible. Since 2016 summer, Israel issues entrance permit only when the date of entry became close. Therefore,

Japanese expert must prepare a flexible visiting plan.

During Israeli holiday, Erez Crossing Point closes, or there are irregular opening hours in some cases. Therefore, the Japanese team must check opening schedule of Erez Crossing Point beforehand especially on Israeli holidays and Palestinian holidays as well. It is better to postpone field survey during long Israeli holidays, if possible. In addition, field survey is better to be postponed during Ramadan since efficiency of activities becomes lower.

Since Erez Crossing Point is located on north of the Gaza Strip, a project team must take into account the traveling time in case the project location is in south area, such as Khan Younis or Rafah. In addition, the team must keep in mind to acquire the latest information of security, and pay attention to sudden deterioration in the security situation.

(2) Overnight Stay in Gaza Strip

JICA restricts the hotels in the Gaza Strip which JICA project team can stay. Any members of JICA project team are not allowed to stay other hotel without JICA's permission. The hotels are located only in Gaza City, and so the JICA project team cannot stay in North or South part of the Gaza Strip. In case project site is far from Gaza City, JICA project team must keep in mind the traveling hours.

The hotel where JICA allows staying is the hotel where UNDP confirmed security and safety, thus many people from other organizations also stay. Therefore, it is better to reserve the hotel rooms earlier. In case security situation deteriorates in the Gaza Strip, JICA project team should not stay inside the Gaza Strip, and better to stay in Tel Aviv (Israel), or Ashkelon or Ashdot in the vicinity of the Gaza Strip, and then commute to Gaza Strip. In this case, activity hours inside Gaza Strip will be shorter because of opening hours in Eretz Terminal.

(3) Project Office

JICA Survey Team used a part of "JICA Office in Gaza" as a project office during this survey. The office can be used in case survey team consists of a few members, but it is better to rent an office in other place if the project team members increase. To rent an office space, the project team must talk to a counterpart to provide security for the location. In case project office will be inside counterpart's office, communication infrastructure, such as internet and telephone must be installed to allow contact outside the Gaza Strip. In addition, there are scheduled power interruptions, therefore preparation of Uninterruptible Power Supply (UPS) is necessary in the project office.

(4) Transportation

Traveling with ordinary vehicles was prohibited during this survey, and the team used a bulletproof car owned by JICA Palestinian Office. The driver was a national staff of JICA office in Gaza. There is only one bulletproof car in Gaza Strip, which other JICA employees and other Japanese consultants also use. Therefore, the use of the bulletproof car requires proper arrangement, and project activities may be limited by availability of the bulletproof car. In addition, national staff of JICA office in Gaza also have their own works, and timing of commuting/traveling have to be well arranged.

In case of a long-term project, and many Japanese experts will carry out field activities at the same time, it may be difficult to effectively and smoothly carry out field activities with only one bulletproof car.

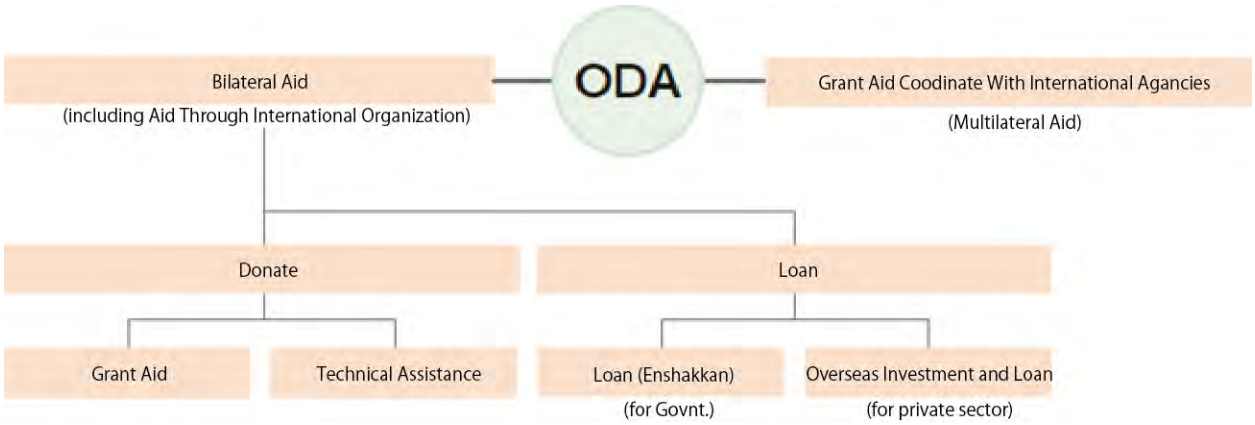
(5) Communication

There are two cellular phone carriers in Palestine, which are Jawwal and Wataniya, but only Jawwal provides service in the Gaza Strip. Condition of service is stable and there is no problem in normal situations. However, JICA has to consider the worst case, and better to borrow a satellite phone for use by the Japanese experts.

To further ensure security, the Japanese experts are requested to submit a daily schedule of activities the evening before and to send an SMS (short mail by cellular phone) to the JICA employee's mobile phone.

6-5 Japanese ODA

Japanese ODA activities for bilateral aid have three kinds of schemes, namely Technical Assistance, Loan Assistance, and Grant Aid. Multilateral aid is also available under UNDP and other international organizations. In addition, JICA has variety of other activities including dispatch of overseas volunteers and international emergency assistance.



Source: Ministry of Foreign Affair (http://www.mofa.go.jp/mofaj/gaiko/oda/about/oda/oda_keitai.html)

Figure 6-4 ODA Scheme by Government of Japan

6-5-1 Loan Assistance

Loan assistance by the Government of Japan is called "Yen Loan" and the assistance aims to provide a development fund to support developing countries with long-term and under soft conditions. Ownership of the aid project by the recipient countries is important for economic improvement and poverty reduction. Since loan assistance is a repayable fund, recipient countries have to consider the effective application and appropriate supervision of project. The advantage of loan assistance is the sustainability support method for Japan side since the fund is a debt to be repaid and financial burden is small in Japan.

Since GNI (Gross National Income) per Capita in Palestine is in the range of USD 1,046 to USD 4,125, then it is defined as LMICs (Lower Middle-Income Countries) in DAC List of ODA Recipients (White Paper on Development Cooperation / Japan's ODA White Paper, 2015). **Table 6-1** shows conditions of loan assistance to the Lower Middle-Income Countries. In case a project is addressed for environment/climate change, public health/medical issues, disaster prevention, and human resource development, category of "Priority" will be applied.

It should be noted that almost the entire annual revenue of Gaza Strip comes from donor support and this area may not be applicable for the scheme of loan assistance.

Table 6-1 Conditions of Loan Assistance to LMICs (Lower Middle-Income Countries)

Category	Applicable Interest	Basic/Option	Interest (%)	Redemption Period (Year)	Period of Deferment (Year)	Condition of Procurement
General	Fixed	Basic	1.20	30	10	Untied
		Option 1	1.00	25	7	
		Option 2	0.80	20	6	
		Option 3	0.60	15	5	
	Adjustable	Long Term Option	Yen LIBOR+105bp	40	12	
		Basic	Yen LIBOR+85bp	30	10	
		Option 1	Yen LIBOR+75bp	25	7	
		Option 2	Yen LIBOR+65bp	20	6	
		Option 3	Yen LIBOR+55bp	15	5	
Priority	Fixed	Basic	1.00	30	10	
		Option 1	0.80	25	7	
		Option 2	0.60	20	6	
		Option 3	0.40	15	5	
	Adjustable	Long Term Option	Yen LIBOR+85bp	40	12	
		Basic	Yen LIBOR+65bp	30	10	
		Option 1	Yen LIBOR+55bp	25	7	
		Option 2	Yen LIBOR+45bp	20	6	
		Option 3	Yen LIBOR+35bp	15	5	
STEP	Fixed	Basic	0.1	40	10	Tied

Source: JICA

Note: Conditions are applied for project which announced after April 1, 2017

6-5-2 Grant Aid

Grant aid is donation-type of funding which applicable for installment of infrastructure and procurement of necessary materials to recipient countries. Since there is no repayment obligation, grand aid is provided for recipient countries in low income level.

Grant aid is applicable for installment of basic infrastructure, such as construction of hospital, water supply facilities, construction of schools, installment of irrigation facilities, construction of road and bridges, facility installment in environmental conservation, and human resource development. In addition these issues, peace building in recipient countries, building better environment for business, disaster prevention, and climate change, are also taken into account as appropriate issue for grant aid. In terms of sustainability, Soft-Component (technical assistance for operation and maintenance) is carried out if it is necessary.

Table 6-2 shows schemes of Grant Aid. In the Gaza Strip, there are many grant aid projects carried out in collaboration with UNDP and/or other international agencies. However, the contribution of the Government of Japan and JICA are not clearly disseminated in the local level, therefore this scheme has no strong appeal to local residents when it comes to the contribution of Japan.

There are two types in grant aid: one is general grant aid through JICA, and the other is method of deputation procurement ordered directly by the Ministry of Foreign Affairs. Any contractor under the grant aid project must be Japanese firm. Many Japanese firms show their interest in bidding on grand aid projects in countries where

there do not suffer serious problem in security, or where many other Japanese firms have already settled. On the other hand, in Palestine, especially in the Gaza Strip, due to the security situation, participation of Japanese firms is hard to be expected. Therefore, general grant aid project may be difficult to be carried out in technical. Recently, a new scheme has been examined that the contractor is not limited to Japanese firm. If the scheme is applicable, it may be possible to be formulated as general grant aid project.

Meanwhile, grant aid by method of deputation procurement is when the Ministry of Foreign Affairs concludes Exchange of Notes with recipient government on Grant Aid and recipient government signs the agent agreement for procurement with reputable procurement organization selected by the Ministry of Foreign Affairs. Then, the designated organization takes care of procurement as a procurement agent or representative of the recipient government. In this scheme, foreign firms can apply for bidding. This may be a possible grant aid scheme for the Gaza Strip.

Table 6-2 Schemes of Grant Aid

Scheme of Grant Aid	Contents
Grant Aid in Project-Style	This is a type of grant aid that recipient government concludes a contract with consultants or contractors, and implements construction works and procurement of materials. This aid mainly focuses on facilities on basic human needs and social infrastructure.
Grant Aid in Program-Style	In this scheme, grant aid is provided for one project with several sub-projects underneath of it. This style is applicable for instauration from conflict and disaster as well.
Grant Aid under the collaboration with International Agencies	With Exchange of Notes or concluding a donation contract, a project is carried out with know-how of international organization and funding by grant aid.
Grant Aid through Financial Support	In this scheme, financial support is provided to developing countries especially on strategies to reduce poverty reduction under a comprehensive socio-economic development plan. There are three types of support: i) General financial support which does not specify items of expenditure, ii) Sector-limited financial support which specifies items of expenditure in the specific sector, iii) Common-fund type financial support which financially supports through special account set by counterpart government or aid agency.
Plan of Human Resource Development	In this scheme, Government of Japan invites young brilliant administrative officers, who are expected to be future leaders of their countries, as foreign student to universities in Japan. After these young officers go back to their home countries, they are expected to contribute to their societies the specialized knowledge learnt, as well as enhance and expand better relationship between Japan and their own countries.

Source: Prepared by JICA Study Team by reference with JICA Website

6-5-3 Technical Assistance

Technical Assistance is a scheme to support human resource development, research development, and institution-building for socio-economic development in recipient countries through a combination of various projects, such as dispatch of Japanese experts, equipment provision, trainings in Japan or in other country, and the comprehensive method support for the recipient country's ownership and ability of business solution. **Table 6-3** shows variety of Technical Assistance. In the Gaza Strip, it is impossible to send project counterpart outside the Gaza Strip for training, therefore overseas trainings (including in Japan) is not possible. Dispatch of Japanese Experts to the Gaza Strip, Technical Assistance Project, and Development Plan Survey may be applicable for the Gaza Strip under certain conditions.

Table 6-3 Scheme of Technical Assistance

Type	Contents
Receiving Trainee	To invite personnel who is in charge of development of each sector, and provide necessary technical knowledge through training in Japan or other country.
Dispatch of Japanese Expert	Japanese experts are dispatched to counterpart countries, and they teach techniques and knowledge which the countries need. Sometimes both parties (Japanese experts and counterpart countries) work together to looking for appropriate techniques applicable to the local environment, and they implement awareness activities together as well. Because of local situation, such as regional characteristics, historical background, and languages, experts are dispatched from the third country (neither Japan nor the counterpart country).
Technical Assistance Project	Technical Assistance Project is carried out with a combination of several components, such as dispatch of Japanese expert, receiving trainee, and equipment provision. Technical Assistance Project is a comprehensive assistance method through project planning, implementation, and evaluation.
Development Plan Survey	This is a technical transfer of survey and analysis and formulation method of planning by Japanese experts to the relevant experts in recipient countries. It is carried out with the support of government policy making and public works program in developing countries by Japanese side. Major contents of support are: ✓ Preparation of Master Plan and survey of policy support (financial reform, development of legal system, etc.,) which aim to government policy making and public works program ✓ Emergency Assistance Survey (Reconstruction and rehabilitation of basic infrastructure which was destroyed by natural disaster or conflicts) ✓ Feasibility study of creating business plan by government of developing countries or other donors ✓ Other survey (preparation of topographical map, groundwater survey, etc.)

Source: Prepared by JST by reference with JICA website

6-5-4 Dispatch Volunteers

Dispatch of JICA's volunteers contributes to solving problems in developing countries at the grass roots level. In this system, the Japanese who are interested in international cooperation are sent to developing countries as JICA volunteers, and they live in local communities, learn cultures and customs, and work to improve the local situation. There are four types of volunteers, which are youth overseas volunteers (known as JOCV), senior overseas volunteers, youth volunteers of Japanese immigrant society, and senior volunteer of Japanese immigrant society. Since there is no Japanese immigrant society in the Gaza Strip, only JOCV and senior overseas volunteers are applicable. However, dispatch of volunteers is not possible given the security situation in the Gaza Strip.

6-5-5 Other Scheme

(1) Follow-up Cooperation

Follow-up Cooperation is a supplementary support scheme to provide additional support to JICA's past projects. There are major two categories in Follow-up Cooperation, which provide solution for problems of facilities and materials, or expand effectiveness of the past project.

The first type of follow-up program is implemented in case the facilities and equipment, installed by Japanese ODA, had been damaged by natural disaster, or inappropriate operation and maintenance, or if operation is no longer active due to the counterpart's financial difficulties. Meanwhile, the second type of follow-up program provides additional support after project implementation, or training to enhance the value and effectiveness of the project. Many of these follow-up programmes had already been implemented in the Gaza

Strip, so this scheme is applicable. However, the budget by this follow-up program is not so large and it is not possible to carry out a huge scale project.

(2) Grass Roots Project

Grass Roots Project is suitable scheme for NGO, University, local government body, and benevolent corporation in Japan which interested in international cooperation. Currently, 89 countries are target of Grass Roots Project (as of October 2015) and Palestine is included. However, application of Grass Roots Projects will not be accepted in case the project area is designated as "the area evacuation advised" and "the area cancel of travel advised". Currently, the Gaza Strip is designated as "the area of cancel of travel advised" therefore Grass Roots Project is not applicable for the Gaza Strip.

(3) Project by Counterpart Fund

Counterpart Fund is a type of fund that comprises profit of sale of products which was bought by Japanese ODA (loan assistance and grant aid) by developing countries (aid recipient countries). This fund is reserved for appropriate assistance activities for the recipient country in future. Some projects had been carried out applied this fund, and they are called "Project by Counterpart Fund". The project is controlled by Japanese diplomatic establishments, Japanese embassy or consulate in abroad, and not a project of JICA.

During this survey, a project in Rafah has being planned applied this fund. The project component is to utilize treated water for irrigation in Rafah, and it can be counted as a support scheme in the Gaza Strip. In case this project is carried out, it is better to dispatch Japanese expert in water sector for implementation of the project.

6-5-6 Applicable Schemes in the Gaza Strip

Table 6-4 shows applicable ODA schemes in Gaza Strip and characteristics.

Table 6-4 Applicable ODA Schemes in the Gaza Strip and Characteristics

Scheme		Characteristics of the Scheme
Grant Aid	General grant aid (not limited to Japanese firm)	✓ Under the condition which the Japanese consultant works for construction supervision, possible to be a contractor but not limited to Japanese firm. ✓ Possible to implement as JICA project
	Method of deputation procurement	✓ Ministry of Foreign Affair select organization for arrangement of procurement, and carried out a project. ✓ Foreign firms (not only Japanese firms) can participate in a project,
	Grant Aid collaboration with International Agencies	✓ A lot of support is already made through UNDP ✓ Weak appeal of support from Government of Japan ✓ Large-scale infrastructure construction is possible
Technical Assistance	Dispatch of Japanese Expert	✓ Strong appeal of support from Japan by presence of Japanese Expert ✓ Since Japanese experts stay in local environment, it is necessary to make sure local security and conditions and countermeasures must be considered.
	Technical Cooperation Project	✓ Strong appeal of support from Japan by presence of Japanese Expert ✓ It is possible to carry out larger scale project of infrastructure construction, compare to Follow-up project, as a pilot project in the project.
	Technical Cooperation for Development Planning	✓ Strong appeal of support from Japan by presence of Japanese Expert

Scheme		Characteristics of the Scheme
		✓ Since Japanese experts stay in local environment, it is necessary to make sure local security and conditions and countermeasures must be considered.
Other	Follow-up Cooperation	✓ A lot of support has already been made ✓ Since limitation of budget per project, large-scale project is not applicable
	Project by Counterpart Fund	✓ Scale of project depends on the reserve fund by the project implemented ✓ It is not a project of JICA ✓ It is better to dispatch Japanese expert in case in water sector

Source: JST

6-6 Selection of Candidate Medium-term Cooperation Projects

Since the 1990s, the Gaza Strip has continued to be supported by many donors, especially by the World Bank. Such supporting has widely covered from formulation of Master Plan, facility construction to the capacity development. Recently NRW reduction project has also being implemented. During the survey, CMWU proposed many improvement projects of facilities and pipeline networks.

Survey team evaluated these proposals, which are mainly construction projects, together with the technical cooperation project for development planning deemed necessary through field survey by the team, and listed up candidate medium-term cooperation projects in **Table 6-5**. Through discussion with CMWU and PWA, first priority was given to "Reuse and Recycling Master Planning of WWTP Effluent in the Gaza Strip" followed by "NRW Reduction Technical Cooperation Project". In case of Formulation of Master Plan, responsible organizationis is PWA, therefore, counterpart for the master planning stage will be PWA, while CMWU assumes the role in latter pilot project implementing stage.

Table 6-5 Outline of the Candidate Projects

Priority	Project	Sector (purpose)	Main components	Counter Part	Cost (estimated by CMWU)	Type of Cooperation applicable
1	Reuse and Recycling Master Planning of WWTP Effluent in the Gaza Strip	Wastewater (Master Planning of Reuse and Recycling Plan of WWTP Effluent)	Set-up of Reuse and Recycling Master Plan (including Pilot Project)	PWA/ CMWU (P/P stage)	USD 3-4 million (excluding P/P cost)	Note) 1
2	NRW Reduction Technical Cooperation Project	Water Supply (NRW Reduction)	・Soft Component ・Rehabilitation of Transmission and Distribution network	CMWU	Nearly USD 5.7 million is expected	
3	Wadi-Gaza Environment Improvement Project	Wastewater (Land Scape ,Network Improvement)	・Rehabilitation of trunk sewer line ・Installation of interceptor sewer line	CMWU	USD 1million	Note) 2
3	Photovoltaic Facility Installation Project for Khan Younis STLV SWRO Plant	Water Supply (Water Supply)	Installation of 2MW PV Facility (Battery is not included)	CMWU	USD 3.2million	
3	BWRO Facility Construction Project	Water Supply (Water Supply)	・Abstraction Well and Receiving Well	CMWU	USD 2 million	

Priority	Project	Sector (purpose)	Main components	Counter Part	Cost (estimated by CMWU)	Type of Cooperation applicable
	in Rafah Municipality		・BWRO Facility with 5,000m^3/day Capacity		(PV facility cost is not included)	
3	Sewer Network Development Project for Khan Younis Municipality	Wastewater (Sewer Network Development)	Installation of Sewer Pipe	CMWU	USD 0.15million	Note) 3

Note) Type of Cooperation
1. Technical Cooperation for Development Planning
2. General Grant Aid (Japanese Engineer is required to stay all through the project) or Grant Aid coordinated with International Agency or Designated Deputation Procurement Agency
3. Follow-up Cooperation

Prior to the discussion with PWA and CMWU, JICA Survey Team proposed revision of old Master Plan, the Integrated Coastal Aquifer Management Plan (CAMP) published in 2000 since Survey Team recognized that large scale central desalination plant with 55 million m^3/year capacity proposed in this plan has reached to the deadlock due to its huge construction cost and shortage of electricity, therefore, revised plan is in need. If JICA fabricate revised Master Plan, water related project derived from revised Master Plan can be easily applied as JICA-funded project since necessity and validity of selected project can be confirmed based on the newly formulated Master Plan. PWA and CMWU, however, have a strong policy to support and continue the existing Master Plan and they have no intention to ask for the revision of Water Supply Master Plan to JICA. That is why JICA Survey Team did not list up the revision of water supply Master Planning. **Appendix-3** shows outlines of Master Plan and related studies which have previously been made, as a reference.

6-7 Outline of Medium-term Cooperation Projects

The outline of each project proposed by PWA and CMWU is described in the order corresponding to priority set by JICA Survey Team.

6-7-1 Reuse and Recycling Master Planning of WWTP Effluent in Gaza Strip

Wastewater can be a new water source to relieve the water shortage conditions caused by rapidly growing domestic water volume in Gaza Strip together with the 1) production of potable water by sea water desalination and 2) reduction of wasted water volume, NRW.

Development policy on the sewerage sector, particularly on sewerage development and reuse of wastewater was taken up in 'The Integrated Coastal Aquifer Management Plan (CAMP) in 2000. According to the plan, sewage collection area is integrated into three areas, north, central and south, and appropriately treated water is transferred all over Gaza area through conveyance network, then, reused for irrigation use or recharged to the aquifer at the required points. Detailed method of reuse/recycling is not described in the Report. Only one WWTP in the north area is expected to be operational next year, 2018.

The existing WWTP receives nearly 130,000m^3/d of wastewater and that volume is projected to increase exceeding 300,000m^3/d in 2032. The existing WWTP inflow volume is equal to 80% of groundwater volume pumped-up for irrigation purpose on the agriculture side and if treated wastewater can cover and/or replace irrigation volume, then groundwater pumped-up for irrigation use can be reduced dramatically enabling

protection of the coastal aquifer. The WWTP proposed for and designed in CAMP has its own filtration basin for treated water to recharge the water into the aquifer.

The formulation of the reuse and recycling plan of WWTP effluent in the Gaza area shall consider the construction time schedule for the proposed WWTP. This is because one of proposed WWTPs – the central Buriej WWTP – has been suspended and a temporary Wadi-Gaza WWTP was constructed by way of compensation.

At present, the effluent of Rafah WWTP is proposed to be use as irrigation water for farm lands under the cooperation of MoA and CMWU. To promote this project more smoothly, WWTP effluent reuse plan for all over Gaza is requested by form of MoA.

Items to be considered in this Master Plan are;

- Counterpart of this Master Plan is both the PWA and CMWU
- Usage of treated wastewater shall be decided through discussion, but not limited to recharge and irrigation use. Water for use in landscaping, wadi maintenance and toilet flush are promising.
- Promotion of treated wastewater reuse by pilot project
- Technical transfer on reuse and recycling technology

(1) Reuse and Recycling of WWTP Effluent Project in Gaza Strip

Among the existing five WWTPs, Beit Lahia WWTP, Gaza WWTP, Wadi Gaza Temporary WWTP, Khan Younis (Temporary) WWTP and Rafah WWTP, Rafah WWTP is scheduled to be permanently operated while other four WWTPs are integrated into three proposed WWTPs, namely, North Gaza WWTP, Central Gaza WWTP and South Khan Younis WWTP. North Gaza WWTP is expected to complete construction in 2018. South Khan Younis WWTP, funded by Japanese government through UNDP, has already started construction work, but completion time is not clear due to the delay of procurement of construction materials and machineries. Construction of Central Gaza WWTP has been suspended since land acquisition problem has not yet resolved.

Proposed Master Plan shall be formulated in a phased manner considering the timing of the commencing operation of new WWTP and re-arrangement of sewer network as is imaged in **Figure 6-5**.

In case effluent of existing WWTP is utilized for irrigation for the time being, additional treatment is inevitable since existing effluent quality is too low to use as irrigation water. Besides the problems attributed to the design concept like lack of aerators, shortage of capacity, structure prone to short-cut of the flow and sand sedimentation arisen from the poor grit removal function, shortage of electricity has prevented normal operation of aerators or trickling filters. In the early stage of Master Planning, improvement of existing WWTP shall be arranged considering the actual and future effluent water quality and also local sewerage development policy. Discussion with KfW, who has long intervened sewerage development in Gaza Strip is an important key point.

Governorate	WWTP	Current Status of WWTP \ Year / Phase	2020	2025	2030	2035
			Phase I	Phase II		Phase III
North	Beit Lahia WWTP	Existing				
	North Gaza WWTP	Under Construction				
Gaza	Gaza WWTP	Existing				
Middle	Central Gaza WWTP	Under Planning				
	Wadi-Gaza (Temporary) WWTP	Existing				
Khan Younis	Khan Younis (Temporary) WWTP	Existing				
	South Khan Younis WWTP	Under Construction				
Rafah	Rafah WWTP	Existing				

Source: JST

Figure 6-5 Multi-phased Masterplan for Reuse and Recycle of Treated Wastewater

One project dedicated to the reuse of wastewater was conducted by PWA/PNA with funding from Austrian Development Cooperation. This "Technical Assistance on Reuse of Wastewater and Storm Water Harvesting in the Gaza Strip" provided following four reports and guidelines in 2011.

- ✓ Assessment of Wastewater Treatment and Reuse Practices, PWA(2011)
- ✓ Review of the National and International Institutional and Legal Frameworks for Treated Wastewater Reuse in Agriculture, PWA(2011)
- ✓ Safety Guidelines and Preventative Measures for Reuse of Treated Wastewater in Agriculture, PWA(2011)
- ✓ (Draft) Guidelines for Wastewater Reuse in Palestine, PWA

Outline of above-stated reports are described as follows. Proposed reuse and recycling Master Planning may start from detailed survey of this information.

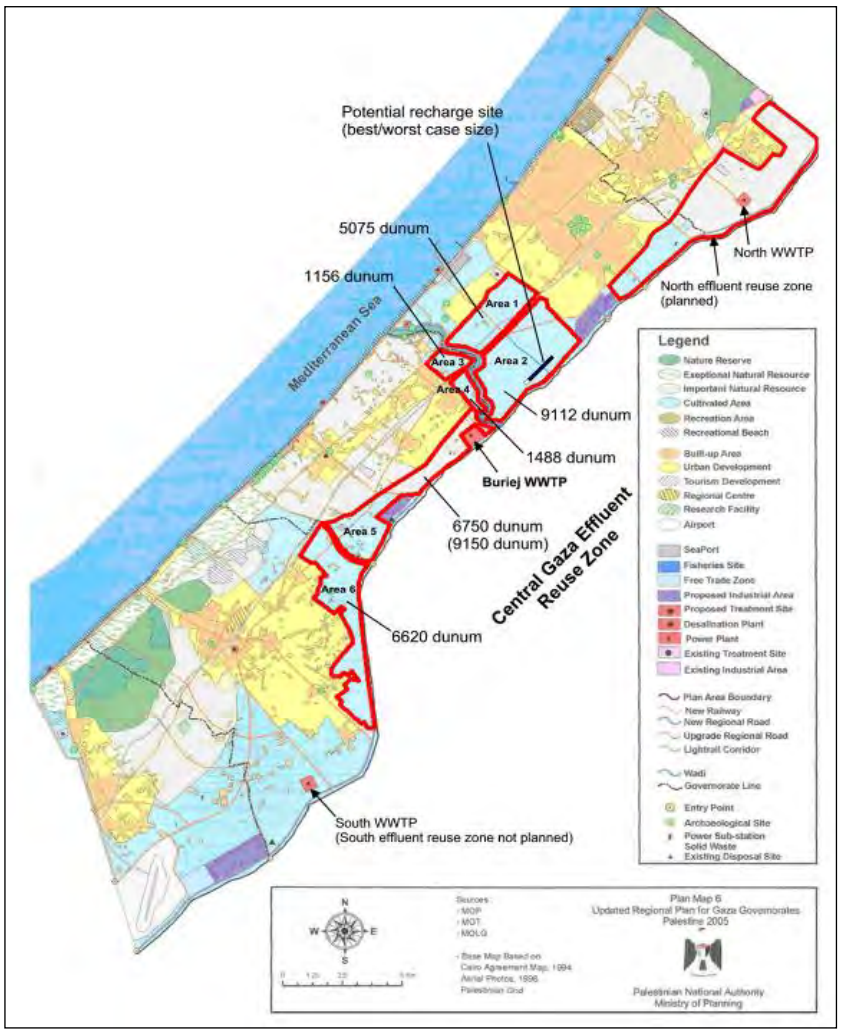
➢ <u>Assessment of Wastewater Treatment and Reuse Practices, PWA(2011)</u>

This report analyzed the present state of wastewater management and reuse in Palestine area and reviewed the previous experience of treated wastewater reuse in Palestine. Potential area irrigated with treated wastewater is also considered in this report. Two failed irrigation projects in Gaza City and Beit Lahia Municipality both assisted by UNDP is reported and the reason of failure are shown as follows;

- The farmers refused the idea out of fear that the Israeli Civil Administration would strengthen its control over the water resources.
- Lack of technical and operational trained staff in the municipalities to properly function the system.
- Lack of available funds.
- The acceptability of wastewater reuse by the farmers was immature.
- Private lands surrounded the miss-location of the treatment plants.
- The absence of follow and institutional set up system

Potential agricultural area for wastewater reuse in Gaza Strip presented in this report is shown in **Figure 6-6**. Treated wastewater from Gaza Central WWTP is reused in 6 areas and that from North Gaza WWTP is supplied to 1,370 ha of agriculture area. Excess treated wastewater not utilized for irrigation is recharged

to the aquifer since season irrigation water is usually required from May to September.



Source：Assessment of Wastewater Treatment and Reuse Practices, PWA(2011)

Figure 6-6 Potential Agricultural Land for Wastewater Reuse and Recycle

- Review of the National and International Institutional and Legal Frameworks for Treated Wastewater Reuse in Agriculture, PWA(2011)

Related agencies and their role in wastewater reuse are described in this report. The Palestinian standards for reuse (PS 742/2003) are presented together with standards of Jordan and Israel. Part of reuse standards are described in **Table 6-6**. Reuse standards is categorized into 4 classes, and Recharge category is also defined.

Table 6-6 Standards of Reuse and Recycle of Treated Wastewater (PS742/2003)

Parameter	Irrigation, Qualification of Effluent Quality				Recharge
	A	B	C	D	
Fecal coli(colony/100 ml)	200	1,000	1,000	1,000	
Helminth eggs (egg/L)					<1
TDS(mg/L)					1,500
TSS	30	30	50	90	
NO_3-N (mg-N/L)	20	20	30	40	15

Parameter	Irrigation, Qualification of Effluent Quality				Recharge
	A	B	C	D	
NH_4−N(mg-N/L)	5	5	10	15	10
pH					6-9
DO (mg/L)	1<	1<	1<	1<	>1
BOD_5 (mg/L)	20	20	40	60	
COD (mg/L)					150

For each class a number of additional barriers are required depending on the type of crop.
Furthermore limit values are given for an additional 35 parameters for 8 categories of reuse and disposal.
Source : Review of the National and International Institutional and Legal Frameworks for Treated Wastewater Reuse in Agriculture, PWA(2011)

- Safety Guidelines and Preventative Measures for Reuse of Treated Wastewater in Agriculture, PWA(2011)

Preventive measures and safety guidelines for treated wastewater reuse practice is introduced together with the plantable crops by level of wastewater and appropriate procedures for monitoring, inspection and corrective measures. **Table 6-7** shows summary of preventive measures and safe guidelines. And, **Table 6-8** is the classification table of plants suitable for each level of treated wastewater.

Table 6-7 Summary of Safety Guidelines of Reuse and Recycle of Treated Wastewater

Procedures	Description
Timing of irrigation	Irrigation with treated wastewater is prohibited of plants that produce crops are traded or packaged two weeks before the date of the harvest.
Regular Training	Ongoing training courses for workers to aware them of the dangers of handling contaminated crops
Guided Signs	Placed signboards in the places, appropriate attention must make clear to him and remembered by the workers during handling and the mobilization of crops.
Vaccination	Vaccination should be applied in accordance with the requirements of the Ministry of Health of workers in the networks and wastewater plants.
Protective materials	The provision of protective footwear and gloves should be in the place in required amount for the farm workers.
Supervision	Site supervisors and managers should verify the commitment of the workers using the means of protection and their commitment to implementing the instructions.
Periodical Examinations	Periodic required tests and examination of related groups should applied once every six months for detection of infectious diseases transmitted through wastewater
Records	Responsible authority should have and keep complete records of all actions that fall under any of the previous six procedures. They should keep record cases of illness discovered among workers.

Source : Safety Guidelines and Preventative Measures for Reuse of Treated Wastewater in Agriculture, PWA(2011)

Table 6-8 Crop Pattern and Plant Type Allowed by each Class of Treated Wastewater Quality

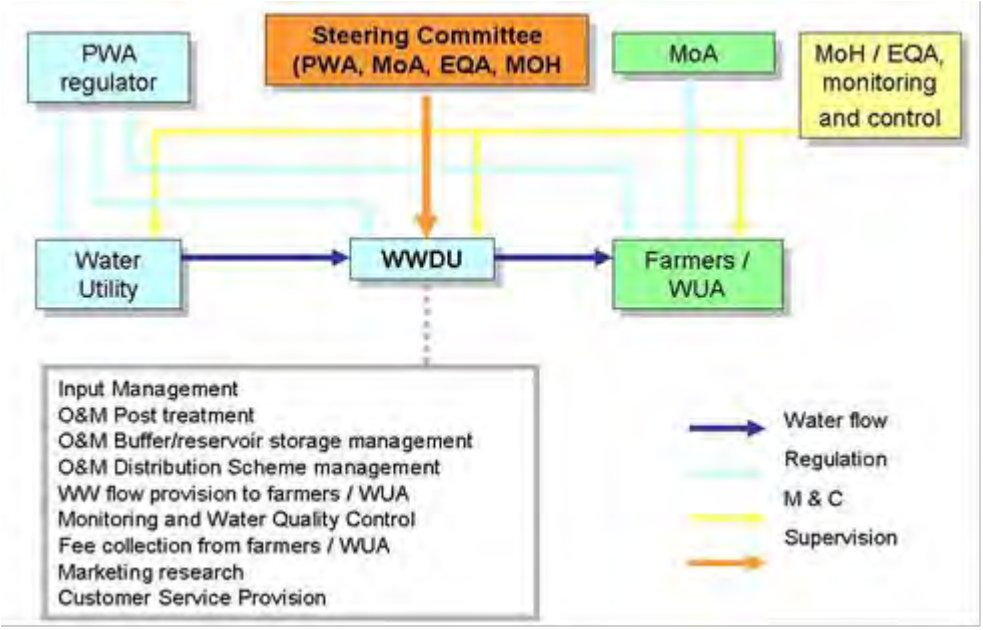
Class	Crop patterns	Plant type Description
A	A-1 Plants and trees that are planted and landscaped streets or hotels	Green grass, shrubs and trees, wooden fences and shade trees
	A-2 plants and trees that are planted landscaped inner-city	Grass
B	B-1 Fodder Crops	Sorghum- Alfalfa
	B-2 Peal- fruit trees	Fruits produced for canning or processing, such as lemon, mango, olive, palm or nuts such as almonds
	B-3 Trees suitable for planting highways and green belts around cities	Casuarinas, eucalyptus, tamarisk trees, Oleander, palm fruit and olives.
	B-4 Nurseries	Nursery seedlings of timber trees and

Class	Crop patterns	Plant type Description
		ornamental plants or fruit trees
C	C-1 Industrial Crops	Jojoba and castor
	C-2 Woody Trees	timber trees and eucalyptus

Source： Safety Guidelines and Preventative Measures for Reuse of Treated Wastewater in Agriculture, PWA(2011)

➢ (Draft) Guidelines for Wastewater Reuse in Palestine, PWA

Guidelines composed of 18 articles and 3 annex was proposed for the sustainable wastewater reuse in Palestine. One noteworthy issue is to request an institutional set-up of steering committee consisting of related agencies including PWA and Wastewater Distribution Utility (WWDU) who distribute treated wastewater to the users. **Figure 6-7** shows inter-institutional structure described in the guidelines. In the proposed reuse Master Plan, revised guidelines shall be published reflecting actual conditions in the Gaza Strip.



Source：(Draft) Guidelines for Wastewater Reuse in Palestine, PWA

Figure 6-7 Institutional Framework for Treated Wastewater Reuse and Recycle (Draft)

(2) Candidate Pilot Project

In the reuse and recycling Master Planning, emergent pilot project shall be formulated to enhance the reuse practice. At present, recycling project of Rafah WWTP effluent is planned while slow sand filtration facility to provide good quality of treated wastewater is under construction in existing Khan Younis temporary WWTP as described in **Chapter 3** of this report. North Gaza WWTP is expected to start operation during this proposed reuse project, while Gaza Central WWTP and South Khan Younis WWTP are not promising to start operation before the end of this project. Under such conditions, candidate pilot projects are selected in **Table 6-9**. Pilot project will be commenced in the second year of the project after the contents of the pilot project is confirmed in the first year.

Table 6-9 Proposed Pilot Projects

Candidate Pilot Project	Location	Contents
Monitoring and function improvement project for the advanced treated effluent of Rafah and Khan Younis WWTP	Rafah and Khan Younis temporary WWTP	Monitoring and analysis of slow sand filtration facility. Providing Material and reagent for the analysis work. Improving sand filtration facility and WWTP if necessary.
Improvement of Rafah WWTP effluent	Rafah WWTP	Improving one of two existing trickling filters which are called "Bio-Filters" (**Photo 6-1**), through changing into DHS[1)] method from conventional system.
Reuse of North Gaza WWTP effluent project	North Gaza WWTP (after completion of the plant)	Pilot plant to show the safety and validity of treated wastewater using actual farm land. Installing irrigation pipes to the agricultural land and transmission pump facility.
Improvement of Wadi Gaza temporary WWTP	Wadi Gaza temporary WWTP	Installation of PV facility for improvement of Wadi Gaza Temporary WWTP. Monitoring how to improve through contnuous operation of aerators
Sewer pipe installation work around Wadi Gaza	Vicinity of Wadi Gaza	There are some sewer pipe directly discharging to Wadi Gaza. The project is to connect between such pipes and the Wadi Gaza temporary WWTP to prevent deterioration of Wadi Gaza. This project consists of all or a part of project describing in 6-7-3 of this chapter.
Khan Younis sewerage development project	Khan Younis City	This is project describing in 6-7-6 of this chapter.

1) DHS: Down-flow Hanging Sponge
Source: JST

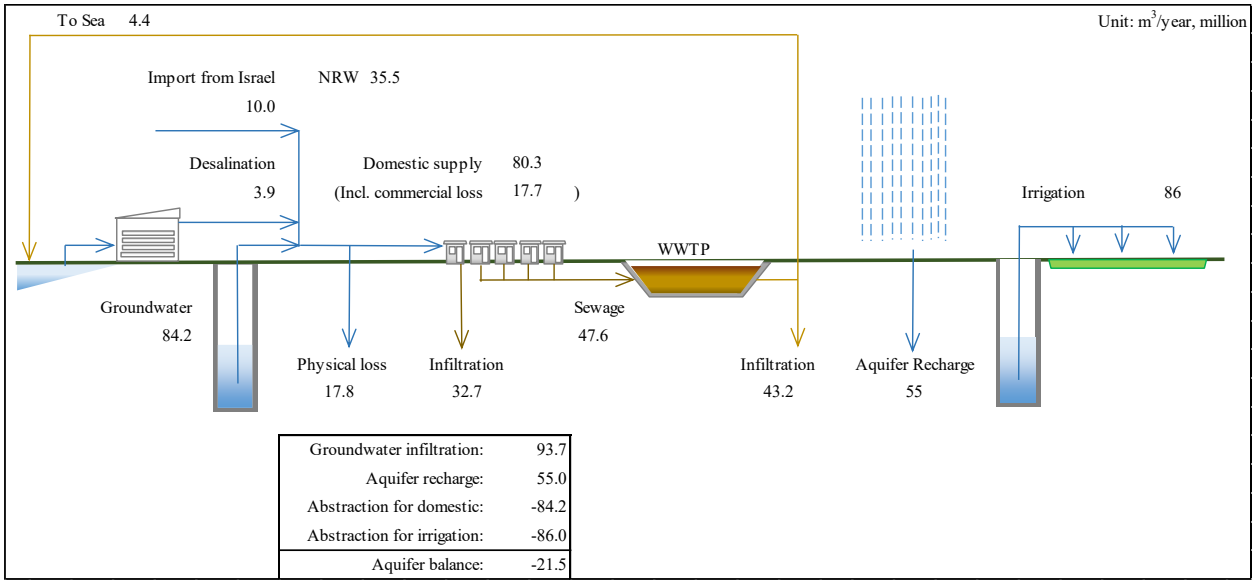
Source: JST photo taken on 27th September, 2016

Photo 6-1 Trickling Filters installed in Rafah WWTP and its Top Part

(3) Effect of the Project

Figure 6-8 shows the rough figures of water balance in the Gaza Strip in 2016. This is based on a report

made by PWA[3], actual data in 2016 has been reflected. Once groundwater consumption is assumed at 86 million m3/year, aquifer of groundwater has been reducing 21.5 million per year.

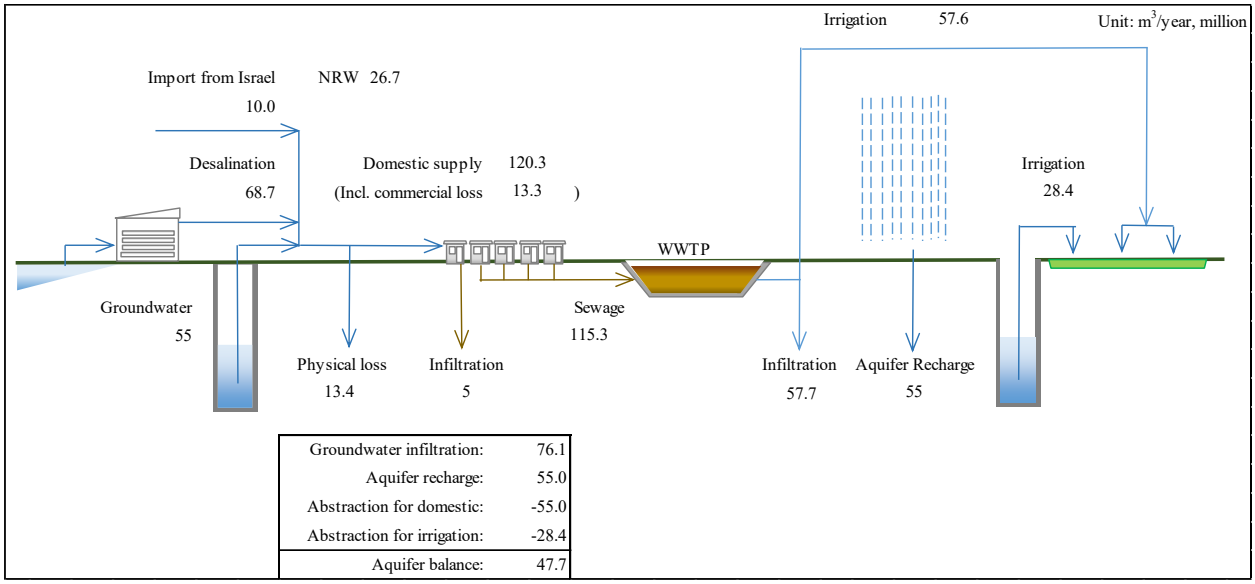


Source: Based on report by Shaddad Attili, Reflected actual data

Figure 6-8 Rough Figures of Water Balance in the Gaza Strip in Year 2016

Figure 6-9 presents the rough figures of water balance in 2035 in case treated wastewater is positively reused. In the same way, it is based on the above report, water amount produced by seawater desalination is set at 68.7 million m^3/year presented at **Table 3-15**, instead of 130 million m^3/year. This includes 55 million m^3/year which will be produced by the Gaza Central Desalination Plant (GCDP). The amount of purcasing water from Israel is set at same of 2016. Amount of wastewater to be treated is adopted the capacity of facilities in 2032 shown in **Figure 3-5**. This shows that the project will contribute to maintain groundwater in the Gaza Strip with increasing of 47.7 million m^3/year by reusing a half of treated watsewater for irrigation and remaining of it for infiltration to the ground.

[3] Shaddad Attili, Water Cricis in the Gaza Strip, UN Seminar on Assisstance to the Palestinian People, CPR/SEM/2015/8 (2015)



Source: Based on report by Shaddad Attili

Figure 6-9 Rough Figures of Water Balance in the Gaza Strip in Year 2035

(4) Public Awareness of Utilization of Treated Wastewater

Abdelmajid Nassar et al[4] implemented an interview survey in 2006 in terms of reuse and recycle of treated wastewater. The survey results shows that 68 percent of farmers in Bait Hanoun who were interviewd agreed to use treated wastewater for irrigation, and also 91% of farmers in south area of the Gaza Strip accepted the scheme of wastewater reuse.

On the other hand, some results of awareness survey related to reuse of treated wastewater is reported in detail on Appendix 9 of the Final Report on Supplementary Environmental and Social Impact Assessment for the construction of North Gaza WWTP[5]. The outline of report describes as follows but the project should include enlightenment activities for farmers and consumers, not only developing safe technology;

- Acceptance of Scheme of Treated Wastewater Reuse

  A half of interviewed Farmers accepted the scheme of Treated wastewater reuse. Including farmers who accepted with certain conditions, 82.4% of farmers accepted to reuse treated wastewater. In terms of ingestion of agricultural products irrigated by treated wastewater, 41.2% of interviewed farmers accepted, 76.5% accepted including with under certain conditions, and remaining 23.5% of farmers had negative opinions. The conditions for reuse of treated wastewater were as follows; securing safe; solving water problem; applicable for agricultural use; not to cause disease; and less cost etc. Negative opinions were concerning of health hazards, physiological barrier, and incomplete treatment etc.

- Consumer's Willingness to Purchase

  Consumer's willingness survey to purchase of agricultural products irrigated by treated wastewater was

[4] Abdelmajid Nassar et. al., Socio-Economic Aspects of Wastewater Reuse in the Gaza Strip, Journal of Environmental Science Technology 2(4), P.170-178(2009).

[5] PWA, Final Report on Supplementary Environmental and Social Impact Assessment (SESIA), Effluent Recovery and Reuse System and Remediation Works, North Gaza Emergency Sewager Treatement Project (NGESTP), April 2013.

conducted by classifying with 3 types of markets which are one day markets, small establishments (permanents), and supermarkets. **Table 6-10** presents the survey result. The different results showed depending on the type of market. For the one day markets, 82% of consumers purchasing showed willingness to purchase, and 63.3% of small establishments (permanents), however willingness to purchase was trended lower than others in case of supermarkents where having richer consumers. Negative opinings against purchasing were cause disease, no trust the people in charge, and phychological reasons.

Table 6-10 Consumer's Willingness to Purchase of Agricultural Products irrigated by Treated Wastewater

	One Day Market	Supermarket	Permanent
Willing to purchase	82.0%	43.0%	63.3%
Not care	0.0%	0.0%	0.5%
Not willing to purchase	18.0%	57.0%	36.2%

Source: PWA, Final Report on Supplementary Environmental and Social Impact Assessment (SESIA), Effluent Recovery and Reuse System and Remediation Works, North Gaza Emergency Sewager Treatement Project (NGESTP), April 2013.

- Affordability of Treated Watewater

Farmers who do not have own well, spent NIS 0.682/m^3 on average, annual purchasing cost of groundwater was NIS 583.82/donum of agricultural land on average. Affordability to purchase of treated wastewater was NIS 180.52/donum/year on average, on the other hand 20.6% of interview farmers showed willingness nothing to pay for treated water reuse.

(5) Overview of the Project

Priority project derived from JICA-led Master Plan is easy to confirm its validity and reliability of the project. Preparation of Master Plan on reuse and recycling of wastewater by JICA leads to the sustainable assistance. The overview of the Master Plan is described below;

Overview of the Project

1) Country

Palestinian Authority (PA)

2) Project

Reuse and Recycling Master Planning of WWTP Effluent in Gaza Strip、Palestine

3) Type of Cooperation

Technical Cooperation for Development Planning

4) Implementing Agency

C/P Agency:

・Palestinian Water Authority, Gaza Office (PWA-G), Gaza Project Coordination Unit (G-PCU)

5) Outline of the project

In the Gaza Strip, the enhancement of water and electricity supply capacity is the first priority to improve the living conditions of the people and for this purpose many donors all over the world have given their support. Under these circumstances, the systematic Master Planning on WWTP effluent reuse and recycling is required to maintain healthy water circulation system in Gaza. At present, although a limited volume of WWTP effluent is recharged to the aquifer to vitalize water circulation system, such systematic plan does not

exist.

・Final Objective

Conservation and sustainable use of coastal aquifer are promoted by recycling treated wastewater as irrigation water, increasing recharge volume and reducing the pump-up volume for irrigation purpose

・Target of the Project

After assessment of the existing wastewater treatment conditions, systematic reuse and recycling Master Plan shall be conducted. During the survey, priority project is listed and pilot project is implemented. Through the pilot project, technology transfer and capacity development of the C/P is promoted.

・Output

- ✧ Systematic Master Plan on WWTP effluent reuse and recycling shall be formulated.
- ✧ Management capacity of related staff is enhanced through capacity development by way of this project
- ✧ Urgent and effective pilot project is implemented to evaluate the validity of the project

6) Project Site

Gaza Strip

7) Activities

Main activity of the survey team are as follows

・Investigation of the existing conditions of WWTP and its effluent, on-going and future development plan of WWTP in Gaza Strip

・Formulation of Wastewater Reuse and Recycling Master Plan. Target year is 2030 and this Master Plan includes legal, institutional and financial aspects of the recycling project.

・Making of the list of priority projects

・Execution of pilot plan. Application of EIA/IEE shall be considered.

・Capacity building of the C/P is promoted through cooperative work during the project and also through technical seminar and training by Japanese experts regarding 「wastewater treatment」,「Water Quality」,、「O&M」,「Recycling」 as required.

8) Undertaking of C/P

PWA shall provide accommodation for the survey team, coordinate with the related agency, assist the team collect necessary data and information and be responsible for the security and emergency.

9) Survey team member (Draft)

Duration of this project is three years including completion of pilot project. Position and M/M of project member are; (Total 86M/M)

・PM/Sewerage Facility Planning (24 months)

・Reuse and Recycling Plan (12 months)

・Pipeline Plan/Design (8 months)

・Hydrology/Water Quality Management (6 months)

・Social/Environmental Consideration (3 months)

・Organization/Institution (3 months)

・Finance (3 months)

・Design/Procurement/O&M (24 months)

・Irrigation management (3 months)

Japanese experts on the seminar/training above stated will be dispatched upon request

10) Related Information

- ✓ Integrated Coastal Aquifer Management Plan (CAMP), PWA(2000)
- ✓ Water Facility Master Plan, PWA(2006)

- ✓ National Water and Wastewater Strategy for Palestine, PWA(2013)
- ✓ Gaza Sustainable Water Supply Program (on going) (March, 2015 – Dec.2017)
- ✓ Assessment of Wastewater Treatment and Reuse Practices, Technical Assistance on Reuse of Wastewater and Storm Water Harvesting in the Gaza Strip, PWA(2011)
- ✓ Review of the National and International Institutional and Legal Frameworks for Treated Wastewater Reuse in Agriculture, Technical Assistance on Reuse of Wastewater and Storm Water Harvesting in the Gaza Strip, PWA(2011)
- ✓ Safety Guidelines and Preventative Measures for Reuse of Treated Wastewater in Agriculture, Technical Assistance on Reuse of Wastewater and Storm Water Harvesting in the Gaza Strip, PWA(2011)

6-7-2 NRW Reduction Technical Cooperation Project

According to the information obtained from CMWU in March, 2017, there are two ongoing NRW Reduction projects. One project is conducted in Der Al Balah, Al Nussirat and Jabalia municipality funded by IsDB and another one is done in the 20 municipalities funded by WB. Outline of these two projects are described in **Table 6-11**. Lesson learnt obtained through implementation of these projects shall be reflected to the planning of next projet in order to improve. CMWU has recognized 5 lessons learnt, as well as necessary works carried out by the next project. **Table 6-12** shows the lessons learnt and necessary works.

Table 6-11 Outline of On-going NRW Reduction Projects

Donor	IsDB	World Bank
Target Municipality	Deir Al Balah, Al Nussirat, and Jabalia	20 municipalities in the Gaza Strip except 4 municipalities in North Governorate and Gaza City.
Project Duration	30/07/2015 to middle of 2017	2012 to 2017
Project Cost	USD 1.7 million	USD 2 million
Project Description	Rehabilitation and resizing water networks, supply and install water meters, supply leak detection equipment, public awareness and update the GIS system	Routine maintenance for water networks and facilities, supply spare parts, supply and install minimal no. of water meters to replace the malfunctioning meters, besides intervene in repairing and rehabilitating of the war damages in water networks (Work is not concentrated for certain areas)

Source: CMWU

Table 6-12 Lesson Learnt and Necessary Work for improvement of Next NRW Project

	No	内容
Lesson learnt	1	Reduction of NRW is an essencial to improve water services.
	2	Establishment of effective legal system with enforceability and its strict implementation are necessary.
	3	Illegal connections cause high rate of NRW and must be reduced through public awareness campaigns.
	4	Tariff is not decided based on the production cost of supplying water. It must be rectified, and approval system of revised tariff by a governmental institution shall be established.
	5	The leak detection equipment takes long time to be coordinated and reached to the Gaza Strip. It may be affected to the Project implementation.
Necessary Work for improvement	1	Establishment of District Metered Area and Installation of Flow Meters: The most highly NRW contribution zones in the water system will be selected for establishment of District Metered Area (DMA) and installed flow meters.
	2	Management and Repairing of Leakage: Setup and implement Standard Operating Procedures (SOP) for leakage control and repairing. Including

	No	内容
		supporting and raising the capacity of local team in each area. This task will include replacement of old and deteriorated pipes and house connections.
	3	Replacement and calibration of Customer Meters: This task will include replacement of blocked meters, regular calibration of meters, and installation of new meters for authorized unmetered customers.
	4	Campaigns for reduction of illegal connections: The campaigns will concentrate on customer survey, illegal connection disconnection, and enforcement of legal steps.
	5	Capacity building for the tariff collection sections: By training and raising the capacity of the local team on the assigned related tasks which will lead to significantly reduce the commercial losses.
	6	Campaigns of public awareness: To raise the public awareness of water situation in the targeted areas focusing on water saving, paying water bills, illegal connections, etc.

Source: CMWU

Besides those projects, KfW is planning to conduct NRW reduction project in Khan Younis City, Nusairat Municipality, Zawaida Municipality and Gaza City. CMWU requested NRW reduction project in these four cities and municipalities to KfW. This project will be extended with the anticipated budget of Euro 5 million. Outline of KfW NRW reduction project is shown in **Table 6-13**.

Table 6-13 Planned NRW Reduction Project implemented by KfW

Municipality	・Khan Younis City ・Nusairat & Zawaida Municipality in Middle Governorate ・Gaza City in Gaza Governorate
Duration	Two to Three years including construction work
Main Task	Task No.1 ; Assessment of the existing water supply and distribution system in the targeted areas Task No.2 ; Propose improvements on the existing water supply and distribution system Task No.3 ; leakage control and water network repair plan Task No.4 ; Bulk water supply and Customer meter replacement and calibration Task No.5 ; Conduct illegal connection campaigns Task No.6 ; Capacity building of the billing and collection sections and NRW operational team Task No.7 ; Tendering, Project Management and Coordination
Budget	EUR 5 million

Source: CMWU

On the other hand, CMWU has requested JICA to execute NRW reduction project in four municipalities in different governorates. Those four municipalities are Bani Suhila and Absan al Kabera municipalities in Khan Younis Governorate, Al Shoka municipality in Rafah Governorate and Beit Hanoon in Northern Governorate. Overview of NRW reduction project requested from CMWU is shown in **Table 6-14**.

Table 6-14 NRW Reduction Project Requested by CMWU

	・Bani Suhila & Absan al Kabera in Khan Younis Governorate ・Al Shoka in Rafah Governorate ・Beit Hanoon in Northern Governorate
Duration	2 to 3 years including pilot project starting from July 2018
Main Component	1. Rehabilitation of water mains and water distribution networks 2. Hydraulic Modeling which will include district metering 3. Supporting NRW operational team through providing the needed equipment, covering salaries for “meter readers, technicians, water engineers,” in order to enhance the NRW management plan

	4. Training and raising the capacity of the local team to implement the regular networks maintenance and metering management 5. Leak detection and disconnection of the illegal connections and making these legal, water meters' replacement for the blocked connections and installation for the non-metered.
Budget	Undecided. Nearly EUR 5 million (USD 5.7million) or equivalent is expected.

Source: CMWU

Project budget is supposed to be similar to the KfW budget of EUR 5 million. This project is expected to produce following advantageous effects; 1) Institutional set-up on NRW reduction activity and water tariff collection, 2) Improvement of executing capacity of Jenin City water works, 3) NRW reduction capacity is beefed-up through pilot project, 4) Water tariff Collection capacity is strengthened and 5) Output and lessons from this project are shared by another water works implementing agencies.

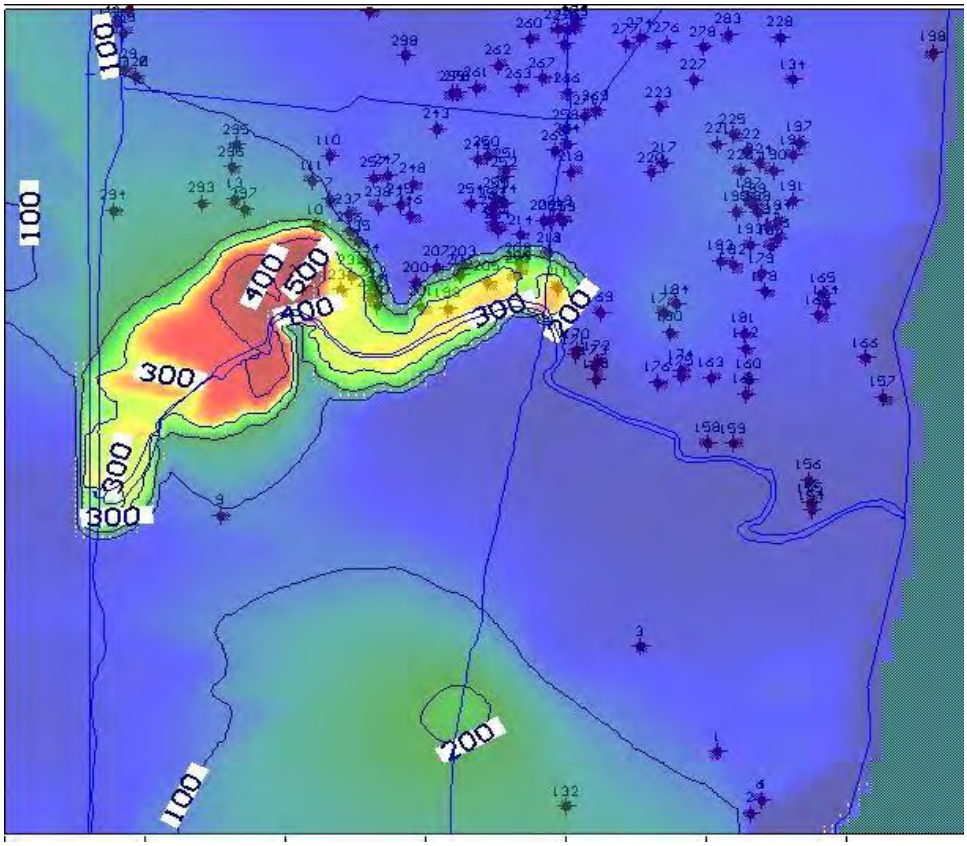
6-7-3 Wadi-Gaza Environment Improvement Project

According to the "National Water and Wastewater Strategy for Palestine" issued by PWA in 2013, wastewater generated from Wadi Gaza basin area is transferred to proposed Central Gaza WWTP. However, since construction of this WWTP has been long delayed, Wadi Gaza Temporary WWTP was planned to mitigate the pollution of Wadi Gaza. With the fund from ICRC, construction had started in 2012 and completed in 2015. From July 2015, operation of WWTP started receiving wastewater from UNRWA pumping station. Design criteria is based on the "Environmental Impact Assessment of the Temporary Wastewater Treatment Plant at Wadi Gaza - April 2012" surveyed by ICRC. **Photo 6-2** shows bird's-eye view of the Wadi Gaza Temporary WWTP. Wastewater introduced initially to Anaerobic Pond flows down to Aerated Pond, and finally to Polishing Pond before discharged to Mediterranean Sea. First anaerobic pond is covered by HDPE sheet to prevent diffusion of odor and to promote anaerobic fermentation. 6 aerators are installed to supply oxygen into the pond.

Source：Saqqa & Khoudary

Photo 6-2 Wadi Gaza Temporary WWTP

Based on the above stated EIA report, service population in 2017 was 288,182 person assuming 75% of sewerage connection rate and inflow volume was 17,290 m^3/d. Target cover area was such area that NO_3-N concentration of the area rise up to 200mg/L to 500mg/L in case of "without connection pipe to treatment plant" as shown in **Figure 6-10**. Water quality of effluent was decided considering the "Palestinian draft for treated wastewater quality for safe disposal to the sea" in **Table 6-15**.



Source：Environmental Impact Assessment of the Temporary Wastewater Treatment Plant at Wadi Gaza, ICRC (April 2012)

Figure 6-10 Nitrate Distribution in Year 2015 in case Wadi Gaza Temporary WWTP is not built

Table 6-15 Design Criteria of Effluent of Wadi Gaza Temporary WWTP

Parameters	Palestinian draft for treated WW quality for safe disposal to the sea	Adapted effluent quality in the design of the Wadi Gaza temporary WWTP
BOD_5	60mg/L	60mg/L
COD	200mg/L	150mg/L
TSS	60mg/L	60mg/L
Fecal Coliforms	50,000/100ml	2,000/100ml

Source：Environmental Impact Assessment of the Temporary Wastewater Treatment Plant at Wadi Gaza, ICRC (April 2012)

At present, a significant part of the sewered area in middle Gaza governorate is connected to the UNRWA pumping station. The collected wastewater is pumped-up to Wadi-Gaza temporary WWTP to treat the wastewater before discharging to the Mediterranean Sea. However, some sewer pipes directly discharge wastewater to Wadi Gaza, and poor on-site treatment facility, like the pit latrine still remains in the area, causing environmental pollution and groundwater degradation. Unpleasant odor, forming caused by discharged surface acting agent and discolored shore line represents the environmental degradation of Wadi Gaza area. (**Photo 6-3**)

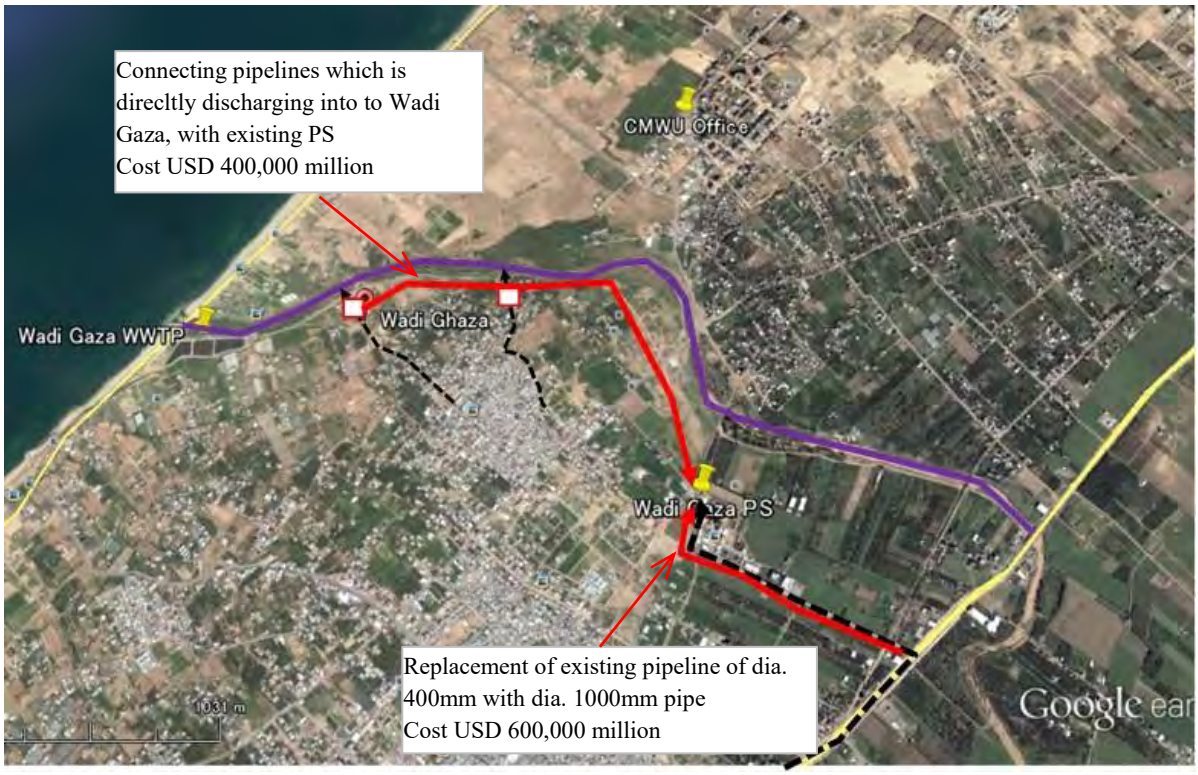
Source： JST

Photo 6-3 Pollution in Wadi Gaza

CMWU is building a Wadi-Gaza Environment Improvement Project through the rehabilitation and expansion of the sewer network, which also functions as an improvement of Wadi-Gaza temporary WWTP. This is a high priority project requested to JICA. The main components of the project and estimated cost of each component are as follows.

- Rehabilitation of trunk main gravity sewer from Salah Al Deen Road to UNRWA PS
  (Estimated cost is USD 0.6 million)
- Interceptor sewer from the direct discharging sewer pipe to Wadi-Gaza
  (Estimated cost is USD0.4 million)

Location map of this project is shown in **Figure 6-11**.



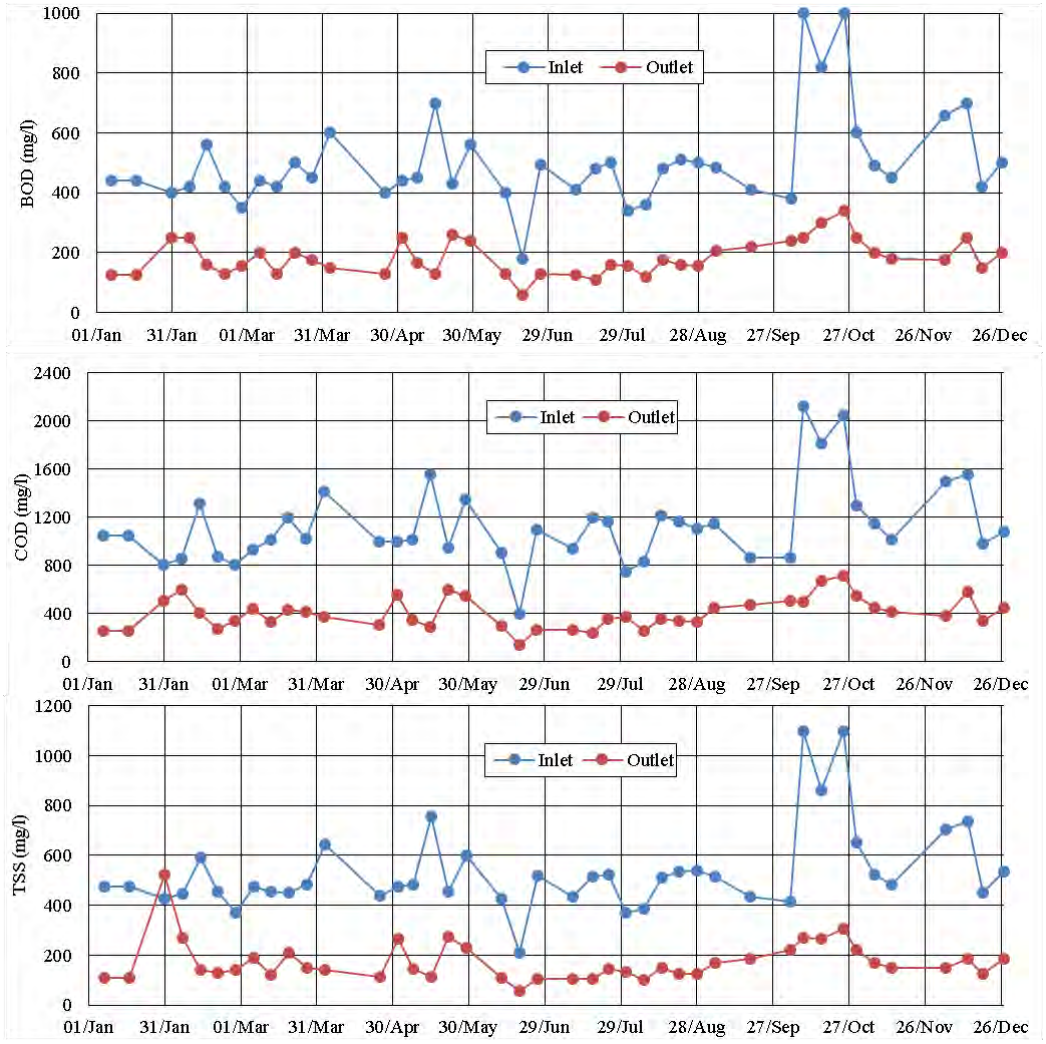
Source: JST

Figure 6-11 Wadi-Gaza Environment Improvement Project Plan

Effluent quality is not so good, as shown in **Figure 6-12**, mainly due to the electricity shortage for aerators. Then, CMWU is planning to expand the outfall capacity for future capacity increase and install a photovoltaic

(PV) facility to supply electricity to the aerator in the second aeration pond aimed at upgrading the Wadi-Gaza temporary WWTP. Installation cost, however, is not calculated.

This plant is temporary and, in the future, wastewater from UNRWA PS shall be transmitted to the proposed Central Gaza WWTP, named Buriej WWTP, which had been committed by KfW and is expected to be in operation in 2020. Efficiently treated water is to be reused for irrigation use or for aquifer recharge purpose. At present construction project of Central Gaza WWTP is suspended due to the land acquisition problem and timing of completion of the WWTP is unpredictable. Under such conditions, this Wadi Gaza Improvement project has high priority since improvement of odor nuisance and landscape makes a good appeal to the local residents.



Source: JST made based on data provided by CMWU

Figure 6-12 Inlet and Outlet of Water Quality of Wadi-Gaza Temporary WWTP (Year 2016)

6-7-4 Photovoltaic Facility Installation Project for Khan Younis STLV SWRO Plant

The project is to install nearly 2,000kWh capacity of photovoltaic (PV) facility for the Khan Younis STLV (Short Term Low Volume) SWRO Plant.

The outline of the plant is described in **Table 6-16**. Main facility comprises three sets of RO unit, each

capacity is 2,000m^3/d, and 24 hour full operation can produce 6,000m^3 of desalinated water per day. Total electricity demand in case of full operation is 1,280kWh including demand for intake and transmission facility. Although, under the plan, electricity demand is mainly supplied by GEDCO through existing grid and stand-by diesel engine driven generator functions as a back-up electricity source, recent degraded electricity conditions has not allow electricity supply from existing grid and even the generator cannot work as expected due to the shortage of fossil fuel. PV facility with the 120kW capacity installed on the roof of building is functional as shown in **Photo 6-4**, however, it covers only small part of electricity required in the plant.

Table 6-16 Outline of Khan Younis STLV SWRO Plant

	Khan Younis STLV SWRO
Capacity of the plant	6,000m^3/day (2,000m^3/day/unit x 3 units)
Contract Cost -Water Intake Facility -SWRO Plant -Transmission Facility -Others	Around EUR10.000.000 for all facilities.
O&M Staff	CMWU Staff
Electricity consumption	1,280kWh
Membrane life time	5 years
O&M Cost - Personnel Cost - Electricity - Fuel - Chemical - Membrane/Filters - Other Maintenance Cost	 Monthly coast for personal :USD20,000 Electricity: USD150,000 Fuel : USD311,040 Chemical : USD10,000 Membrane and filters and maintenance : USD7,000
Production cost (Bill Cost)	USD0.7 for 1 m^3

Source: CMWU and UNICEF

Source: UNICEF

Photo 6-4 PV Facility on the Roof of Khan Younis STLV SWRO Plant

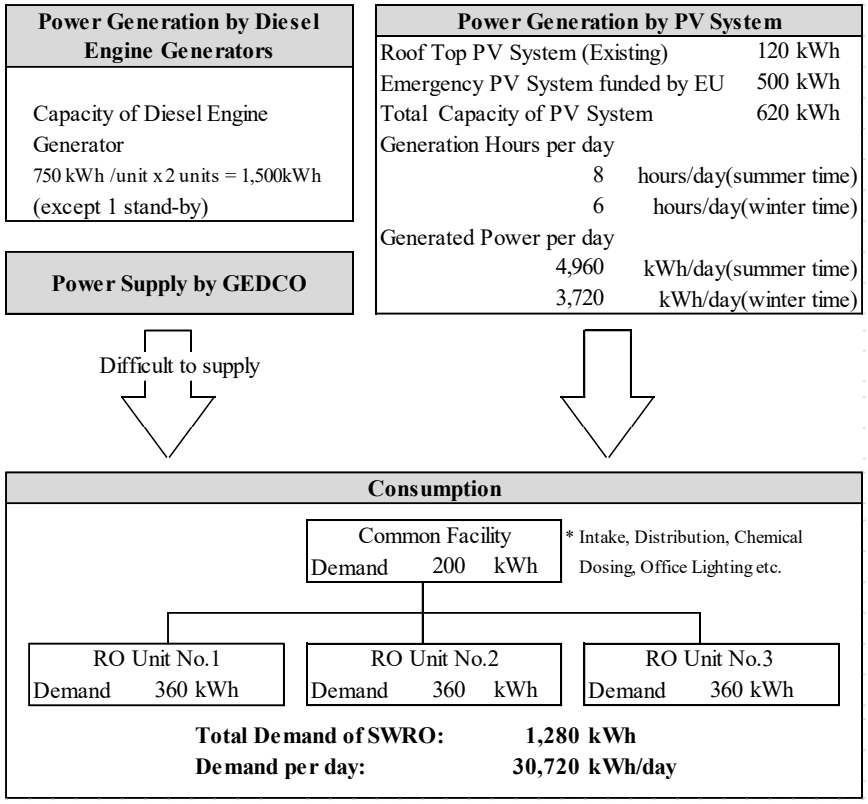
EU pledged, under such situation, additional fund of EUR 700,000 for 500kW capacity of emergency PV facility. The fund comes by allocating from the electrical part of construction budget for SWRO of 14,000m3/day which is additionally planned. The installation work of the PV facility will be finished by December 2017. This additional electricity source makes it possible to operate the one unit of RO facility for limited hours in daytime, 8 hours in summer season and 6 hours in winter season, although this is, of course, not enough for full time operation.

Demand and supply balance of the electricity after installation of additional EU funded PV facility is shown in **Figure 6-13**. Based on this balance figure, confirmed supply capacity of 620kWh can care for only

one unit of RO facility and common facility. And also since any battery is not equipped in this plant, operation during night time is impossible. Generally, capacity of PV facility is desirably double of demand electricity since a certain volume of electricity is lost during long time operation due to the degradation of equipment efficiencies. How fast degraded depends on various conditions, like actual consumed electricity volume, load power factor, operation time, radiation amount, inverter efficiency, environmental conditions, degradation characteristics, etc.

Base on the electricity balance, additional 4,500kWh of supply is required at minimum to operate the facility minimum 6 hours in winter season from following calculation.

{(30,720 kWh/day (demand per day for full operation)-3,720 kWh/d (supply amount during 6 hours operation in winter)} / 6 hours = 4,500 kWh/d



Source: UNICEF JST based on the hearing from UNICEF

Figure 6-13 Balance of Electricity Demand and Supply of Khan Younis STLV SWRO Plant

Project cost to install 4,500kWh of PV facility including battery for night time operation is estimated JPY 10 billion due to expensive cost of the battery. 24-hour operation using battery requires high repair and maintenance cost of battery and, unless this budget is secured, sustainability of the project is very hard to confirm.

On the other hand, nearly 2,000kWh of PV facility meets the demand if operation is limited to only daytime based on the following calculation. In this case, no battery is required.

1,280 kWh x 2 - 620 kWh = 1,940 kWh ≃2,000 kWh

In this case, 6,000 m^3/day x 8/24 =2,000m^3/day of desalinated water is obtainable.

By instalaing additional PV facility of 2,000kW class, the SWRO plant can produce 2,000m^3 for 8hour per

day in summer and 1,500m^3 for 6 hours per day in winter. **Table 6-17** shows contribution of the additional PV facility. Even though EU installs the PV facility of 500kW, the generated electricity is still not enough for operation of 1 unit of RO membrane. Additional 500kWh is necessary to be generated by the emergency diesel generator, in order to produce water is 667m^3/day in summer and 500m^3/day in winter. On the other hand, by installing additional PV facility of 2,000kW class, operation of emergency generator is not necessary to operate during day time, amount of water production increases 3 times.

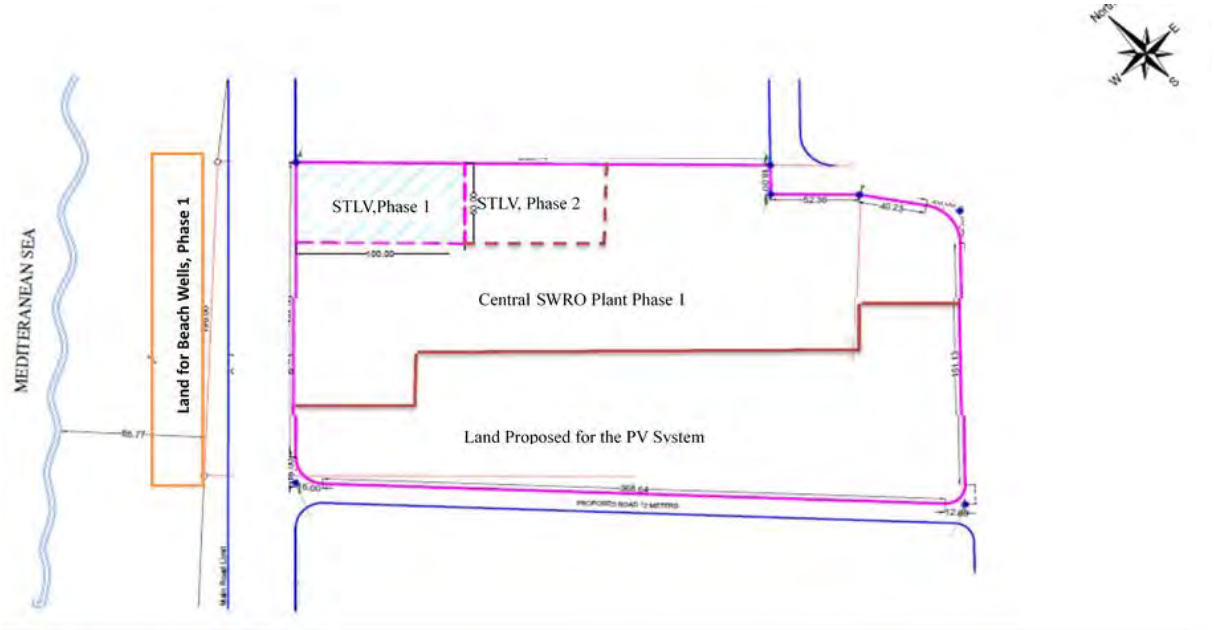
Table 6-17 Contribution of 2,000kW Class PV Facility

	Before Installation of Additional PV	After Installation of Additional PV
Capacity of PV System	620kWh	2,620kWh
Necessity of Diesel Engine Generator	500kWh x 8hours in summer 500kWh x 6hours in winter	Not necessary
Possible number of RO units to be operated	1unit	3units
Expected Water Production	667m^3/8hours in summer 500m^3/6hours in winter	2,000m^3/8hours in summer 1,500m^3/6hours in winter

Source: JST

Project cost is estimated EUR 2.8 million (= EUR 1,400/kW x 2,000 kW, equal to USD 3.2 million).

2,000kW capacity of PV facility requires nearly 2.0 hectars (20 donums) of land assuming 1,000kW facility needs 1.0 hectar from the similar past project. This PV facility of 2,000 kW capacity will be installed within the land owned by PWA for the future Gaza Central Desalination Plant (GCDP). Total area is 8.0 hectars (80 donum) as is shown in **Figure 6-14**.



Source: UNICEF

Figure 6-14 Candidate Area for Installation of PV Facility

6-7-5 BWRO Facility Construction Project in Rafah Municipality

Even after Rafah governorate and eastern part of Khan Younis governorate receive 6,000 m^3/d of treated water from UNICEF-supported STLV (Short Term Low Volume) SWRO plant, water shortage problem in those areas is not completely resolved. In the Rafah area, construction of new BWRO plant is exceptionally allowed

since this area is suffering from serious water source shortage although PWA basically prohibits construction of new BWRO plant in the Gaza Strip to restrict the rise in saline concentration of coastal aquifer.

A new BWRO plant with the production capacity of 5,000m^3/d (=200 m^3/hr) is planned to provide good quality of domestic water to the densely populated two districts, Al Junienah and Al Shaboora district, in east part of Rafah governorate. Service population of these two districts is 60,000 persons. At present, these two districts are covered by two existing wells, each has 50 m^3/hr of lift-up capacity. However, they are severely suffering from the shortage of water volume and high salinity water. Water source of proposed BWRO plant is two existing wells and additional new two wells with 70m^3/hr of capacity. Existing wells are scheduled to be upgraded from existing 50 m^3/hr to 70m^3/hr so that the total water sources for new BWRO plant can provide the required volume. Each of the four wells is equipped with 70 m^3/hr capacity pump, thus securing a total of 280 m^3/hr (= 4 x 70m^3/hr). Considering 70% of Recovery rate, 200 m^3/hr of desalinated water is produced.

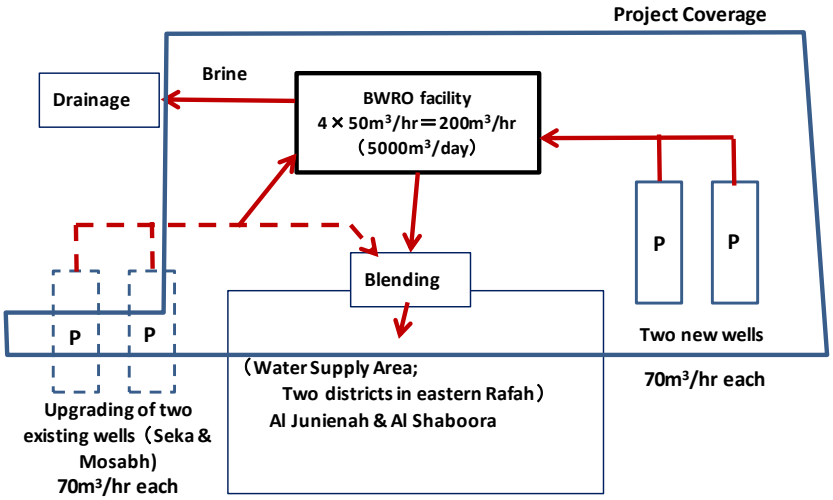
Electricity consumption per produced water volume for general SWRO plant is 4.0 kW per m^3; while that of BWRO plant can be reduced to 1.3 kW per m^3 since salinity concentration in groundwater is much lower than sea water. The outline of the BWRO plant construction project is summarized in **Table 6-18**.

Table 6-18 Outline of Rafah BWRO Project

Item	Content
Project Name	Construction and equipping of 200 m^3/hr (5000m^3/day), Modular Skid Mounted RO Brackish water desalination plant –Rafah eastern region.
Location of Project:	Gaza Strip , Palestine
Implementing Agency	CMWU
Local Partner:	Undecided
Objectives	The main objective of prospective project is to construct modular packaged type skid mounted four modules each of 50 m^3/hour Brackish RO water desalination plant (total 200m^3/hr) to serve eastern parts of Rafah. The establishment of such plant shall provide great improvement with regard to the water quality (TDS level <400ppm) supplied to the whole area through appropriate blending system and assist the neighboring people to get drinking water through appropriate blending water schemes.
Project Component	• Supply, install and test four modular skid mounted brackish water desalination units each of 50m^3/hr. production capacity complete with all associated electromechanical and process requirement systems (pretreatment, chemical dosing systems, High pressure pumps with VFD, RO membrane and vessels, post treatment and limestone filters, chemicals post treatment, CIP, flushing system and electric control panel). • Construct and install brackish water raw water 500m^3 tank with raw water feed pump to receive the water from existing brackish water wells. • Mechanical and electrical upgrading installations and works of two existing deep well pump turbine to cope with RO inflow hydraulic requirements. • Modify and upgrade electro-mechanical installations to match with existing water supply facilities and the new plant arrangements. • Construction of brine rejection line • Construction of truss roofed building of 600 m^2 with all associated electrical and mechanical services. • Drilling and equipping two water wells each of 70m^3/hr. with all associated electromechanical installations. • Construction and equipping of 500m^3 capacity concrete product water tank with booster station with all associated electromechanical installations. • Construct and equipping administrative buildings and boundary wall, land-scaping.etc. • Supply and install two standby generators each of 400KVA with synchronization system including installation of electric grid lines 0.4/22KV with all associated systems as recommended by Gedco
No. of Beneficiaries	60,000 inhabitants
Project Cost	USD2,000,000
Project Start Date	One month after approval
Project Duration	18months

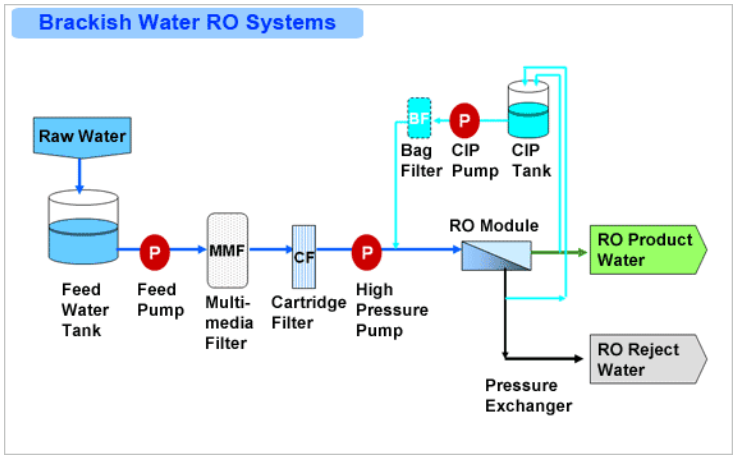
Source: Project Proposal, February 2017

Water flow around the BWRO plant and project components are indicated in **Figure 6-15**. Flow sheet in the BWRO plant is shown in **Figure 6-16**.



Source: JST

Figure 6-15 Rafah BWRO Project Flow



Source: Project Proposal, February. 2017

Figure 6-16 Rafah BWRO Plant Flow Chart

Table 6-19 presents estimated Operation and Maintenance Cost of Rafah BWRO Plant. The result shows that monthly cost of operation and maintenance requires USD 160,000, unit cost of water production is calculated at USD 1.07/m^3 (=USD160,000/month / (5,000m^3/day×30days/month)).Water tariff in municipality of Rafah is, as shown in **Table 3-3**, set at NIS 26 up to water consumption of 20m^3, unit tariff is NIS 1.3m^3 (≃USD 0.37/m^3). Even loewer cost for operation of BWRO compared to SWRO, cost of water production by BWRO is 2.9 times higher than water tariff in municipality of Rafah. Reason to be expensive cost of operation and maintenance is due to electricity cost, and fuel cost which is necessary during no supplying electricity. To be realistic project, study of set up of PV facility is necessary. However since during this survey, any candidate site for the construction of BWRO plant was not clearly proposed by CMWU, possible land to install the PV system has not been confirmed. Also connection with existing network is not clear, additional study is necessary to be realized the project.

Table 6-19 Estimated Operation and Maintenance Cost of Rafah BWRO Plant

Item	Monthly operational cost
personal	USD 20,000/month
Electricity	USD 42,000/month
Fuel	USD 90,000/month
Chemical	USD 4,000/month
Membrane and filters and maintenance	USD 4,000/month
Total	USD 160,000/month

Source: Estimated by JST based on data provided by CMWU

6-7-6 Sewer Network Development Project for Khan Younis Municipality

According to the information obtained from CMWU in March, 2017, there are two existing sewer network development projects in Khan Younis Governorate. One project is the sewer network and pump station development plan which is in parallel with the Khan Younis WWTP. This project, funded by UNDP and partially by the Japanese government, has just started. The other one is the development of the within the existing catchment area of the existing temporary Khan Younis WWTP.

The former project aims to complete the network for the four eastern municipalities in the Khan Younis governorate based on the 2005 design. It covers the construction of uPVC gravity lines with house connections, pressure line and the pumping station. The construction cost is estimated at USD 5,000,000.

The latter one is the replacement of wastewater networks at Al Amal Neighborhood. Detailed components are the replacement of the existing gravity UPVC pipes with manholes and associated fittings, as shown below.

- diameter 8" with length 7,250m and 300 manholes
- diameter 6" with length 5,500m and 550 manholes

The construction cost is estimated to be at USD 600,000.

However, after the hearing from CMWU on site, it was later confirmed that emergent project component is the replacement/installation of 200mm diameter UPVC pipes. The total length of the project is nearly 4.0 km and consists of five lines, not 7,250m of diameter 8” (200mm) pipe. Residents along the proposed sewer pipe suffer from the environmental degradation caused by the overflow from the existing pit latrine placed under public road and badly maintained, as shown in **Photo 6-5**. Proposed project resolves such environmental problem. The proposed project is summarized in **Table 6-20**.

Source: JST

Photo 6-5 Pit Latrine under the Public Road

Table 6-20 Sewer Network Development Project in Khan Younis Municipality

Item	Contents
Sewer Network Installation Work and Construction Cost	5 lines Total 4,000m UPVC diameter 200mm, Nos. of manhole is 80 units assuming 50m spacing (4,000m/50m = 80units) Including house connection from surrounding household Construction cost is estimated from unit construction cost from pilot project in 2016 Unit cost per 1 meter of 200mm UPVC pipe is USD25 Unit cost of manhole is USD 600 Construction cost is 4,000×25＋80×600＝USD 148,000

Source: JST

6-8 Suggestion on Medium-term Cooperation Project

6-8-1 Problems and Lessons Obtained from This Survey

With respect to water shortage, aquifer pollution and electricity failure, the residents in the Gaza Strip still experience great difficulty in spite of the assistance from international donor agencies. Japanese assistance is expected to improve this situation. The development of a JICA-supported project in the Gaza Strip, however, confronts many problems both on the social and technical aspects. Some of these are the unstable political situation, the dire economic condition, the double standard of authority in Palestine Authority and, technically, the lack of project management capability of counterpart, local consultant and local contractor and so on.

On the other hand, there also exist limitations on cooperation scheme from the Japanese side and also limitation on the activity of Japanese engineers in the Gaza Strip preventing Japanese a more comprehensive form of assistance provided in other developing countries. Under such conditions, the following items are being evaluated to select the most efficient cooperation project in the Gaza Strip.

1） CMWU can be a counterpart of the project, while each municipality cannot due to the political realities in the Gaza Strip. Regarding the continuous capacity building, it is difficult for CMWU staff to receive training since they are usually employed on project basis.

2） In case of JICA-funded project supervision, it is required that Japanese engineers are stationed on site to guarantee the quality of the project since local consultants seem to lack project management capability judging from observation and experiences in the follow-up project.

3） Emergency damage recovery project from the conflict in the summer 2014 is almost completed and project assistance is moving to the infrastructure improvement stage which requires the formulation of acceptable JICA-aided project justification of the project components based on the officially established plan.

4） In case proposed projects are based on the established plan, an independent of justification on the benefit to the residents can be made. This can result in a JICA-assisted project on condition that Japanese consultant is involved in the design and supervision work.

6-8-2 Suggestions on Medium-term Cooperation Projects

Considering the above-stated lessons and all the projects including construction projects proposed from CMWU and Technical Cooperation for development planning project suggested by JICA Survey Team have been evaluated and prioritized as Medium-term cooperation project.

First priority is given to the ‘Reuse and Recycling Master Planning of WWTP Effluent in Gaza Strip’ project since wastewater recycling is indispensable for the water-scarce Gaza Strip, but systematic Master Planning of

wastewater reuse has not been surveyed yet. Japanese experience in this field is effectively utilized. This project is categorized as Technical Cooperation for Development Planning project. In addition, the projects derived from this Master Plan can be given validity or justification worthy of a Japanese cooperation project.

'Wadi-Gaza Environment Improvement Project', 'Sewer Network Development Project for Khan Younis Municipality' and 'Rafah WWTP Effluent Recycling Project for Irrigation Use' can be positioned as priority project/pilot project of above stated wastewater recycling Master Plan.

'Photovoltaic Facility Installation Project for Khan Younis SWRO Plant' can be independently applied as JICA-funded project following the appropriate project frame. Although to realize 'BWRO Facility Construction Project in Rafah Municipality' is required studies of installation PV facility and effective network system, sufficient information has not been obtained at present.

Although the study area of requested 'NRW Reduction project' limited to four municipalities, Japanese NRW detection and prevention technology can be successfully transferred to local staff, then this project is given second priority as Medium-term technical cooperation project.

Evaluation is summarized in **Table 6-21**.

Table 6-21 Evaluation Summary of the Proposed Projects

No.	Project	Sector	Evaluation	Priority	Remarks
1	Reuse and Recycling Master Planning of WWTP Effluent in Gaza Strip	Wastewater	Very important project for water scarce Gaza area. Priority projects/Pilot project has valid background data based on this Master Plan	High	First priority project as a Medium-term Technical Cooperation Project
2	NRW Reduction Technical Cooperation Project	Water Supply	Even the limited area, Japanese NRW reduction tetechnology can be transferred	Moderate	TOR of the project shall be discussed with CMWU
3	Wadi-Gaza Environment Improvement Project	Wastewater	Justification of the project is possible to be made clear by the proposed project No.1	Moderate	Pilot/Priority project under Proposed project No.1
4	Photovoltaic Facility Installation Project for Khan Younis STLV-SWRO Plant	Water Supply	No need justification from existing Master Plan	High	Applicable as an JICA project independently
5	BWRO Facility Construction Project in Rafah Municipality	Water Supply	Uncleared network. PV facility is necessary for the project, but uncleared construction site.	Low	No decision made for implementation. Additional study is necessary.
6	Sewer Network Development Project for Khan Younis Municipality	Wastewater	Justification of the project is made clear by No.1 MP	Moderate	Pilot/Priority project under No.1 MP or follow-up project

Source: JST

Chapter 7

Conclusion

Chapter7 Conclusion

Palestinians living in Gaza Strip, totaling 1.76 million people in the area of 359km^2 as of 2014, have long suffered from isolation due to blockade by Israel and Egypt. This political turmoil has been aggravated by dire economic conditions, plus the deterioration of living environment in the area.

Excessive pumping from the coastal aquifer attributable to the increase of domestic water demand has given rise to the pollution of the groundwater and sea water invasion into the aquifer. Deteriorated groundwater has caused not only reduction of crop yields but also water-borne health problems. The shortage of domestic water and food together with the frequent power failure (presently almost two thirds of the day), continue to bring untold pain to the people of Gaza.

Conflict with neighboring Israel is the main cause of such complaint. The latest large conflict in 2014 summer caused terrible human damage to the infrastructure damage. It was reported that the dead numbered 2,145 and that of the injured more than 11,200.

This JICA survey commenced in May 2015, when the damage of conflict was still fresh and recovery activities for social infrastructure were being preferentially conducted by the international agencies starting with UN and foreign donor agencies. Urgent assistance recovery work began soon after the cease-fire in August 2014. A number of NGOs stayed in Gaza during the conflict and gave assistance, while Japanese government supplied drugs and medicines and provided food. However, since the procurement of materials for recovery work other than basic construction material was difficult due to the nonfunctioning of the import mechanism outside of Gaza, social infrastructure rehabilitation was delayed.

The objectives of this survey are (1) to support the repair work of electricity distributing cable damaged by the conflict and installation of water distribution and sewer pipes and (2) to formulate a medium-term cooperation plan.

The termination of this survey was postponed from the original date of December 2015 to December 2017 since the procurement of pilot project materials took much longer than expected. Also, three new pilot projects were introduced in addition to the two original projects in the water sector. In the implementing process of pilot project in the water sector, some discrepancies came up since the local bidding and supervision processes do not meet JICA's requirement. Although many donors including UN have accepted CMWU's local method of bidding and supervision, there is area for revisions. The Japanese side obtained plenty of useful lessons through the implementation of the pilot project.

Some problems to be tackled in delivering carefully crafted Japanese assistance to Gaza area are;

4) Security of Japanese engineer is assured or not
5) Scheduled procurement of construction material and equipment is viable or not
6) Contract process and management/supervision method can be turned to internationally accepted way

First two items depend on external conditions, while third one has to be discussed more in detail among the implementing agency, consultants and contractor to be secured of high quality of constructed facility.

Above stated items are some of lessons from the pilot project and useful information to be shared by related agencies.

Medium-term cooperation project proposed in this report initially recommends the formulation of a reliable

Master Plan; and secondly, to list priority project or pilot projects in line with Master Plan. These will promote the coherent development of water-related infrastructure with Japanese cooperation. In the Gaza Strip where water resource is very limited, energy and water saving measures, as well as wastewater recycling are of high significance. Through the development of water and sewerage works, the importance of valuable water resource needs to be emphasized.

Appendices

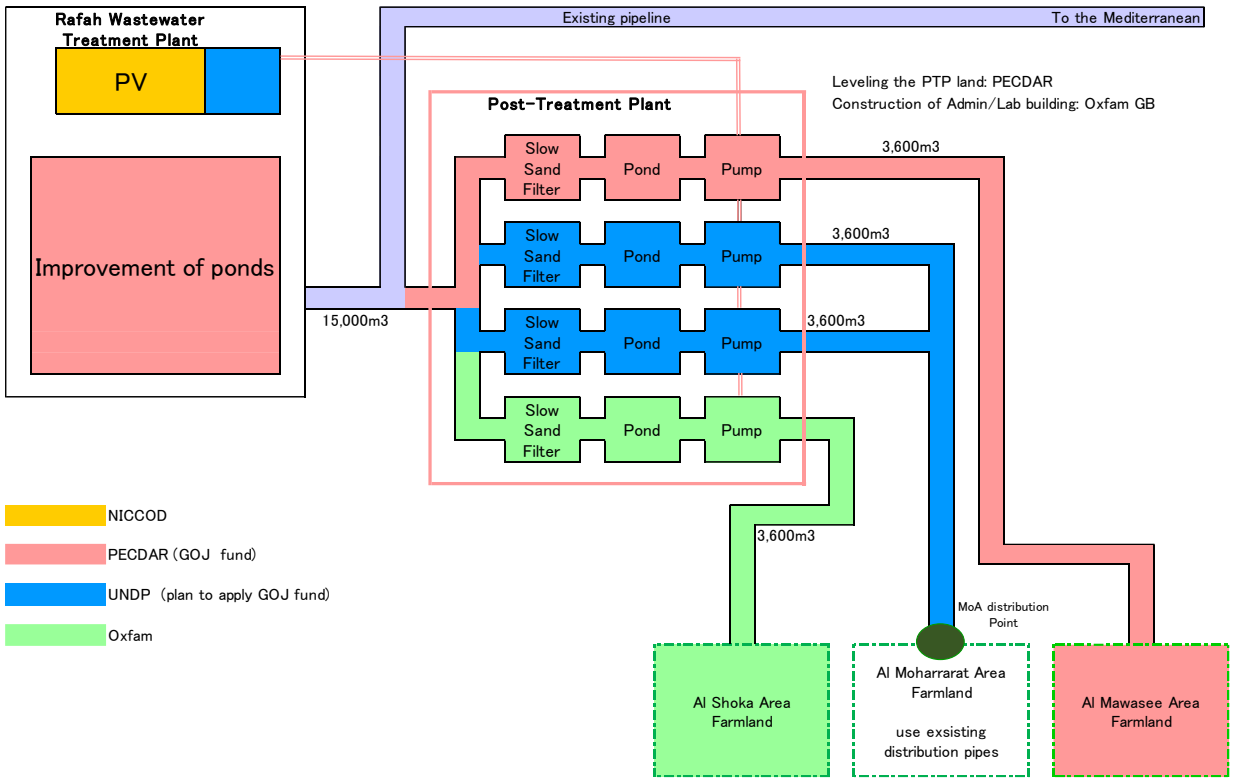
Appendix-1 Rafah WWTP Effluent Recycling Project

- Outline：
  - Recycling of wastewater for Irrigation use of 3 to 4 farm lands. Supply volume is 15,000m^3 in winter season and 13,000m^3 in summer season.
  - Related agency is CMWU, MoA, GEDCO, PECDAR, JICA, ROJ, NICCOD (Japanese NGO),Oxfam GB
- Purpose：
  - Within Gaza Strip, aquifer of Rafah area is severely polluted and damaged. Irrigation use of Rafah WWTP effluent reduces abstraction volume of groundwater for irrigation use and lessens the degradation of aquifer.
  - Improvement of environmental conditions of Rafah coastal area, where pollution is proceeding due to the effluent not-sufficiently treated
- Project Formation（Fig. 1）：

  This project is financed by partly C/P fund by ROJ and partly by MoA through Japanese NGO NICCOD after the arrangement by JICA. Afterwards, Oxfam GB also decided to join the project. JICA is planning to finance as FU Corporation.
- TOR of the Project：
  - **Rehabilitation of Existing WWTP**（Fig. 2）
    ① Installation of PV (Photovoltaic) facility to support 24 hour operation (NICCOD and UNDP).
    ② Improvement of Anaerobic Pond（C/P fund)。
  - **Construction of advanced treatment facility**（Fig 3）

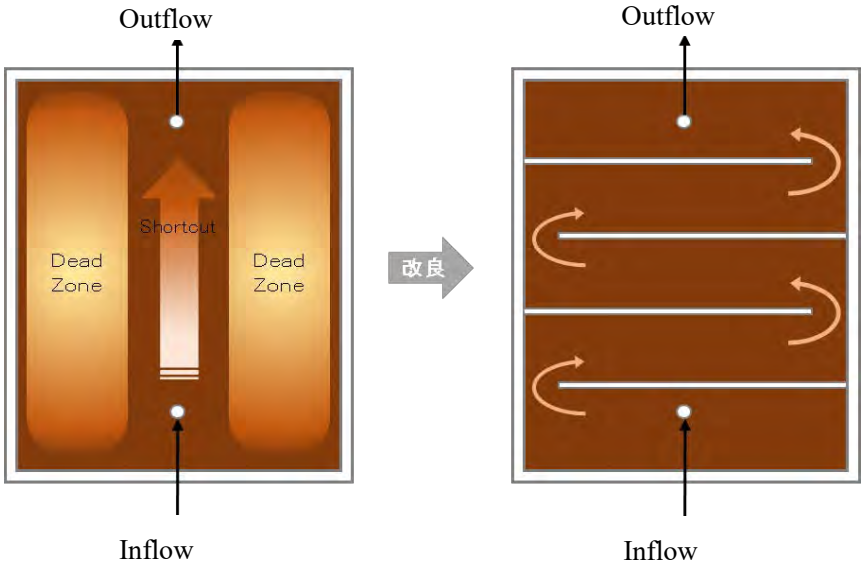
    4 units of Slow Sand Filtration、Storage Tank and Transmission pump facility shall be installed to clear the irrigation standard of Palestine
    ① Leveling and foundation of Electricity facility and 2 unit of recycling facility shall be constructed by PECDAR through C/P fund
    ② Administration/Laboratory facility and 1 unit of recycling facility is constructed by Oxfam GB
    ③ Regarding 2 unis by UNDP
  - **Construction of Transmission pipe and Distribution pipe for farm land** （Fig. 4）
    ① Transmission and distribution line to Al Mawasee area by C/P fund
    ② Transmission line to Al Moharrarat area by UNDP *distribution line is existing
    ③ Transmission and distribution line to Al Shoka area by Oxfam GB
  - **Others**
    ① Institutional Set-up for Operation& Maintenance work（Oxfam GB）
    ② PV-related negotiation is on-going among CMWU, GEDCO, NICCOD and JICA）
    ③ Campaign for farmers by Oxfam, NICCOD and JICA

【Fig1】 Assignment of related agency

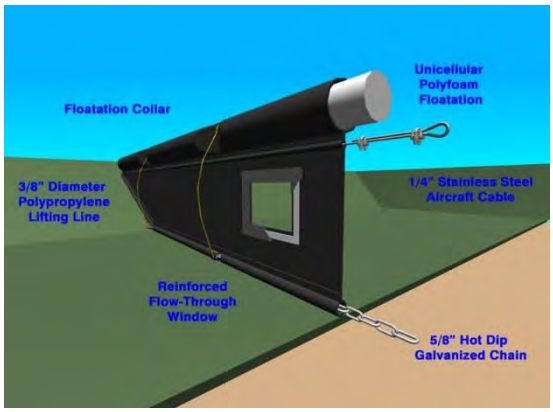


【Fig2】 Improvement of Anaerobic Pond

Baffle plate installation in Anaerobic Pond

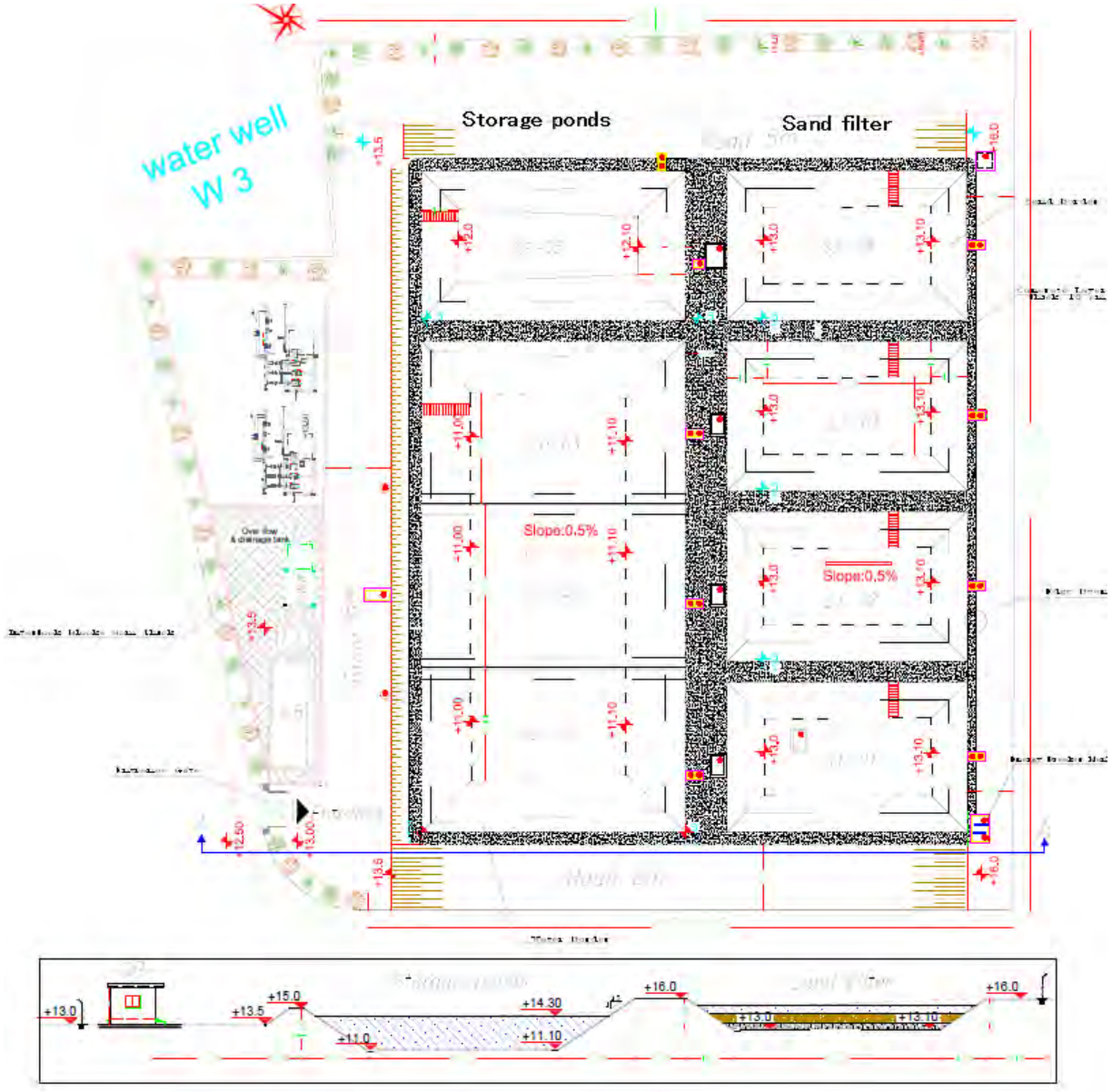


Baffle system image and application sample pond



Source: http://www.environeticsinc.com,

【Fig3】Additional Treatment facility



【Fig4】Candidate farm land

Appendix-2 Water and wastewater projects implemented since 2012 (Since 2010 in case of KfW)

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
1	Supply materials and spare parts for Elshieck Ejleen Treatment Plant	KfW	Jun-10	Jan-13	EUR 8,556,016	Sewage
2	Civil works and equipment installation of Elshieck Ejleen Treatment Plant	KfW	Oct-10	Jan-15	EUR 5,498,800	Sewage
3	Supply and Distribute Fuel (Diesel) within Gaza City I	KfW	Oct-14	May-15	EUR 292,538	Sewage
4	Immediate Repair PS1 & Sheikh Ejleen WWTP	KfW	Oct-14	Aug-15	EUR 98,114	Sewage
5	Montar Reservoir Rubble Removal	KfW	Nov-14	Jan-15	EUR 24,000	Water
6	Material Supply to CMWU Stores I	KfW	Dec-14	Oct-16	EUR 490,871	Vehicle, Heavy Machine etc
7	Service Contract	KfW	Jan-15	May-16	EUR 520,000	Administrative, Others
8	Reconstruction of Montar Water Well	KfW	Jan-15	Jul-15	EUR 93,100	Water
9	Construction of Saraya Water Well	KfW	Jan-15	Aug-15	EUR 95,518	Water
10	Chlorine & other Consumable Operations Chemicals	KfW	May-15	Jan-15	EUR 341,931	Comsumable
11	Supply and Distribute Fuel (Diesel) within Gaza City II	KfW	Jun-15	Dec-15	EUR 227,259	Comsumable
12	Lot 4 - Wheel Loader	KfW	Jun-15	Aug-16	EUR 162,700	Vehicle, Heavy Machine etc
13	Supply IT Equipment to CMWU Stores	KfW	Jun-15	Dec-16	EUR 103,674	Administrative, Others
14	Reconstruction of Water Networks	KfW	Jun-15	Dec-16	EUR 659,280	Water
15	Lots 3 - CMWU Cars	KfW	Jun-15	Jun-16	USD 45,000	Vehicle, Heavy Machine etc
16	Lot 2 - CMWU Cars	KfW	Jun-15	Jun-16	USD 35,000	Vehicle, Heavy Machine etc
17	Supply to CMWU Warehouse Materials, Equipment and Spare Parts II (Partial benefit to MOG	KfW	Jun-15	Oct-16	EUR 412,015	Vehicle, Heavy Machine etc
18	Water Wells Reconstruction Contract	KfW	Jun-15		EUR 468,700	Water
19	Sheikh Ejleen Measures	KfW	Jun-15		EUR 929,000	Water
20	Reconfiguration of Internal Water Networks	KfW	Jul-15	Dec-16	EUR 397,000	Water
21	Rehabilitation of PS3 & PS2	KfW	Aug-15		EUR 872,275	Water
22	Reconstruction of Montar Reservoir	KfW	Aug-15	Aug-15	EUR 757,525	Water
23	Reconstruction of Wastewater Mains	KfW	Aug-15	Dec-16	EUR 727,727	Sewage
24	Construction of Civil Defense Reservoir	KfW	Mar-16		EUR 913,386	Water
25	Supply of Electromechanical spare parts, equipment and materials for Sewage lifting stations, fittings, fixtures and pipes for WW distribution networks and 2000	World Bank	Jan-12	Mar-12	USD 162,105	Vehicle, Heavy Machine etc
26	Consultancy service for preparation of CMWU strategic plan	World Bank	Jan-12	Jun-12	USD 24,000	Administrative, Others
27	Consultancy Services for Design of major water supply projects	World Bank	Jan-12	Apr-12	USD 30,800	Water
28	Environmental & Social +Impact Assessment	World Bank	Jan-12	Mar-12	USD 26,000	Administrative, Others
29	Electrical Service Contract for CMWU Water & Wastewater Facilities	World Bank	Mar-12	Nov-12	USD 18,500	Water and Sewage

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
30	Electromechanical rehabilitation and upgrading of water wells including pumps replacement	World Bank	May-12	Aug-12	USD 34,810	Water
31	Electrical Upgrading of Water Wells Systems	World Bank	May-13	Mar-14	USD 39,876	Water
32	Supply Fuel for Water and Wastewater Facilities	World Bank	May-13	Feb-14	USD 178,089	Water and Sewage
33	Supply of electrical and mechanical equipment and spare parts for water wells and pumping facilities and Supply of electrical and mechanical equipment and spare parts for wastewater pumping and treatment facilities	World Bank	Jul-13	Nov-15	USD 294,359	Vehicle, Heavy Machine etc
34	Electromechanical Rehabilitation and Upgrading of water Wells Including Pumps Replacement & Electro and Mechanical Repairs and Refurbishment of Electrical Power Supply generators for Water Facilities - Phase I	World Bank	Jul-13	Jan-15	USD 239,527	Water
35	Supply GIS Hardware & Software	World Bank	Aug-13	Nov-13	USD 45,085	Administrative, Others
36	Electromechanical Maintenance for Sewage Lifting Stations and its associates & Upgrading of Wastewater Networks to Cope with the Pump Stations Upgrading	World Bank	Oct-13	Oct-14	USD 254,692	Sewage
37	Upgrading of Wastewater Pumping Stations in Gaza Strip & Electro and Mechanical Repairs and Refurbishment of Electrical Power Supply Generators for Wastewater Facilities	World Bank	Nov-13	Sep-15	USD 385,263	Sewage
38	Relocate Wadi Al Salga and Al Nussirat Water Wells, Drilling New Wells with all Associated Facilities.	World Bank	Dec-13	Dec-14	USD 194,286	Water
39	Calibration and Modeling for Water Networks in Rafah and Deir Al Balah	World Bank	Feb-14	Oct-14	USD 43,200	Water
40	Supply CMWU Customer Service Offices with new PCs and mass printers	World Bank	Feb-14	Mar-14	USD 46,663	Administrative, Others
41	Construction Service Building and Installation of Electromechanical Equipment at Bani Suhaila Reservoir	World Bank	May-14	Nov-14	USD 369,000	Administrative, Others
42	Assessment of CMWU Information Communication Technology capacity and readiness to cope with ICT	World Bank	May-14	Nov-14	USD 10,500	Administrative, Others
43	Construction of Carrier Lines and Connections for Al Moghraqa Reservoir	World Bank	Jun-14	Dec-14	USD 132,967	Water
44	Electromechanical Rehabilitation and Upgrading of water Wells Including Pumps Replacement & Electro and Mechanical Repairs and Refurbishment of Electrical Power Supply generators for Water Facilities - Phase II	World Bank	Aug-14	Aug-16	USD 168,718	Water

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
45	Repair and Replacement of Water Meters	World Bank	Sep-14	Mar-15	USD 169,970	Water
46	Replacement, Rehabilitation and Upgrading of Water Distribution Networks	World Bank	Nov-14	Apr-15	USD 199,000	Water
47	Drilling, Construction and Equipping of Two new wells replace completely damaged Abu Hamam and Abu Marwan wells in Deir Al Balah Area	World Bank	Jan-15	Sep-15	USD 239,510	Water
48	Electromechanical Repair and Rehabilitation of Al Salam Brackish Water Desalination Plant of 50m3/hour production capacity in Rafah Area and rehabilitation of partially damaged wells	World Bank	Jan-15	Jan-16	USD 144,844	Water
49	Electromechanical rehabilitation , repairs and upgrading of 15 wastewater pumping stations including the replacement of damaged electrical switchboards, generators, pressure manifolds and its associates, pumps ,..etc.	World Bank	Feb-15	Jan-17	USD 1,179,850	Sewage
50	Repair & Rehabilitation of Water Tanks and Booster Stations in Middle and Southern Area.	World Bank	Feb-15	Jul-15	USD 324,000	Water
51	Construction and Equipping of Khoza'a Ground Water Reservoirs of 1800 m^3 capacity in Khan Younis Governorate.	World Bank	Feb-15	Oct-15	USD 599,606	Water
52	Supply To CMWU Central Warehouse Equipment and Tools	World Bank	Apr-15	Jun-15	USD 37,300	Administrative, Others
53	Rehabilitate the Administration and Operation Buildings of the CMWU beside CMWU warehouse	World Bank	May-15	Nov-15	USD 456,097	Administrative, Others
54	Electromechanical rehabilitation of mechanical surface aerators located in both Khan Younis and North WWTP.	World Bank	May-15	Nov-15	USD 144,595	Sewage
55	Rehabilitation of Water Mains, Networks and House Connections.	World Bank	Jun-15	Dec-15	USD 267,714	Water
56	Cleaning & Desludging of 6 anaerobic wastewater lagoons located at 3 treatment plants in North, Rafah and Khan Younis Area	World Bank	Jun-15	Jun-16	USD 287,781	Sewage
57	Consultancy Service for Environmental Mitigation Measures and Monitoring	World Bank	Aug-15	Apr-16	USD 142,880	Administrative, Others
58	Construction and Equipping of Absan Al Kabera Ground Water Reservoirs of 1800 m^3 capacity in Khan Younis Governorate.	World Bank	Nov-15	Jul-16	USD 684,855	Water
59	Replacement and upgrading of various wastewater gravity pipelines of different sizes with all associated manholes requirements	World Bank	Nov-15	Apr-16	USD 274,420	Sewage
60	Supply To CMWU Central Warehouse Equipment and Tools - 2	World Bank	Nov-15	Dec-15	USD 45,600	Administrative, Others
61	Construction of Warehouse in Khan Younis	World Bank	Nov-15	Nov-16	USD 113,749	Administrative, Others

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
62	Consultancy Service for CMWU Documented Management System	World Bank	Dec-15	Jun-16	USD 21,000	Administrative, Others
63	Supply Fuel for Water and Wastewater Facilities	World Bank	Dec-15	Jun-16	USD 368,000	Comsumable
64	Supply Chlorine and Chemicals - package 1	World Bank	Dec-15	May-16	USD 326,300	Comsumable
65	Supply to CMWU Wooden Furniture	World Bank	Feb-16	Jun-16	USD 149,500	Administrative, Others
66	Supply of Wheel loaders, Excavator and Backhoe Loader	World Bank	Mar-16	Dec-16	USD 878,352	Vehicle, Heavy Machine etc
67	Procurement of well equipped two leakage detection vehicles	World Bank	May-16	Dec-16	USD 141,400	Vehicle, Heavy Machine etc
68	Procurement of Pipes for water networks	World Bank	May-16	May-17	USD 924,892	Vehicle, Heavy Machine etc
69	Repair & Rehabilitation of Water Tanks and Booster Stations in Middle and Southern Area - package 2	World Bank	May-16	Dec-17	USD 435,020	Water
70	Procurement of 15 PC units, 5 printers, 5 photocopy machines, 5 scanners, and other IT equipment	World Bank	May-16	Aug-16	USD 169,572	Administrative, Others
71	Electromechanical Rehabilitation and Upgrading of Water Facilities in Gaza Strip	World Bank	Jul-16	Jul-17	USD 71,980	Water
72	Procurement of Laboratory Equipment and Kits	World Bank	Oct-16	Feb-17	USD 129,236	Administrative, Others
73	Supply Chlorine and Chemicals - Package 2	World Bank	Oct-16	Apr-17	USD 365,380	Comsumable
74	Rehabilitation of Wastewater Treatment Plants in all Gaza Strip	World Bank	Oct-16	Mar-17	USD 99,444	Sewage
75	Electromechanical rehabilitation, repair and upgrading of 30 wastewater pumping station including replacement of damaged electrical switchboards, generators, pressure manifolds and its associates, pumps, ….etc.	World Bank	Nov-16	Nov-17	USD 449,390	Sewage
76	Design and Construction of Wadi Gaza Interim Wastewater Treatment Plant	ICRC	Dec-12		USD 1,304,000	Sewage
77	Construction of pressure line from UNRWA pump station to the Wadi Gaza WWTP	ICRC	Dec-12		USD 633,900	Sewage
78	Pipes and Fittings for water Networks & Spare Parts for Generators LOT (1)	ICRC	Feb-13	Apr-13	USD 99,043	Vehicle, Heavy Machine etc
79	Pipes and Fittings for water Networks & Spare Parts for Generators LOT (2)	ICRC	Feb-13	Apr-13	USD 28,200	Vehicle, Heavy Machine etc
80	Rehabilitation of Nusirate Sewage Pumping Station	ICRC	Nov-13		USD 543,786	Sewage
81	Supply Equipment, Spare Parts and Fittings for Upgrading of Sewage Pumping Station 7b and 5a in Gaza City	ICRC	Nov-13	Apr-14	USD 456,893	Vehicle, Heavy Machine etc
82	Upgrading of water networks in different areas in Gaza strip	ICRC	Apr-14	Oct-14	USD 172,445	Water
83	Mechanical and Electrical Refurbishment and Upgrading Installations of CMWU Water and Wastewater Facilities in Gaza Strip	ICRC	May-14	Jan-15	USD 783,582	Water and Sewage

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
84	Covering the Anaerobic Pond at Wadi Gaza Interim Wastewater Treatment Plant	ICRC	Jun-14	Sep-14	USD 161,260	Sewage
85	Supply Wastewater Testing Devices	ICRC	Aug-14	Mar-15	USD 30,280	Administrative, Others
86	Supply of Electrical Material and Spare Parts	ICRC	Aug-14	Jan-15	USD 48,320	Vehicle, Heavy Machine etc
87	Supply of Water and Wastewater Networks Material and Equipment	ICRC	Aug-14	Jan-15	USD 129,945	Vehicle, Heavy Machine etc
88	Supply Utility Vehicles for Mobile Workshop and Leakage Detection Services.	ICRC	Sep-14	May-15	USD 77,800	Vehicle, Heavy Machine etc
89	Repairing damages for water and wastewater infrastructures in Beit Hanoun as a result of the " Protective edge" operation in Gaza	ICRC	Sep-14		USD 55,000	Water and Sewage
90	Water and wastewater infrastructures repairs in a result of the " Protective edge" operation in Gaza	ICRC	Sep-14		USD 240,000	Water and Sewage
91	Repairing damages at different area in the Gaza Strip	ICRC	Sep-14	Sep-14	USD 9,562	Water
92	Supply of Material, Equipment, and Spare Parts for Water Pumping and Production Facilities	ICRC	Sep-14	Feb-15	USD 107,885	Water
93	Water infrastructure repairs in Beit Hanoun as a result of the protective Edge operation on Gaza	ICRC	Sep-14		USD 11,800	Water
94	Supply and Install of Electrical Generators	ICRC	Sep-14	Nov-14	USD 606,651	Vehicle, Heavy Machine etc
95	Supply and Install of Electrical Generators – Phase 2	ICRC	Sep-14	Oct-14	USD 127,980	Vehicle, Heavy Machine etc
96	Repairing damages at the Sewage pressure line in Beit Lahia area	ICRC	Sep-14		USD 31,200	Sewage
97	Supply to CMWU New PCs, Mass Printers and Accessories for Customer Services Regional Offices	ICRC	Sep-14	Oct-14	USD 83,668	Administrative, Others
98	Supply and Install Wi-Max Towers	ICRC	Sep-14	Nov-14	USD 103,720	Administrative, Others
99	Emergency Rehabilitation and Refurbishment of Water Production Wells and Pumping Facilities in Gaza Strip	ICRC	Oct-14	Jun-00	USD 473,798	Water
100	Repairing Damages of Water and Wastewater Infrastructures at Bait Hanoun Governorate	ICRC	Oct-14	Dec-14	USD 292,606	Water and Sewage
101	Emergency Fast Track for Repairing Wastewater Pumping Stations at Beit Hanoun	ICRC	Oct-14	Nov-14	USD 418,686	Sewage
102	Emergency Response: Electromechanical Refurbishment for Water and Wastewater Facilities Throughout Gaza Strip as a result of the operation on Gaza	ICRC	Oct-14	Dec-14	USD 75,000	Water and Sewage
103	Repair the damages at the CMWU Offices	ICRC	Oct-14	Nov-14	USD 46,235	Administrative, Others

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
104	Repair damages for sewerage infrastructure in various places in the Gaza Strip	ICRC	Oct-14	Oct-14	USD 27,740	Sewage
105	Supply of IT Products for the CMWU	ICRC	Nov-14	Dec-14	USD 12,005	Administrative, Others
106	Supply total stations for CMWU	ICRC	Nov-14		USD 35,000	Administrative, Others
107	Rehabilitation of Bait Lahia Waste Water Treatment Plant	ICRC	Nov-14	May-15	USD 428,000	Sewage
108	Bani Suhaila Water Reservoir Piping & Mechanical Works	ICRC	Nov-14	Apr-15	USD 380,840	Water
109	Supply and Install of Electrical Generators – Phase 3	ICRC	Nov-14	Jan-15	USD 124,700	Vehicle, Heavy Machine etc
110	Repairing Damages for the infrastructure in Various places in the Gaza Strip	ICRC	Nov-14		USD 11,700	Water
111	Emergency response to flood of Al sheikh Radwan storm Water pond	ICRC	Dec-14	Dec-14	USD 216,316	Storm Water
112	Repair damages for sewerage infrastructure in various places in the Gaza Strip	ICRC	Dec-14	Feb-14	USD 20,940	Sewage
113	Emergency cleaning works and winterization service contract	ICRC	Dec-14	Mar-15	USD 141,200	Administrative, Others
114	Supply Materials, critical Spare Parts and Equipment to CMWU Warehouse	ICRC	Apr-15		USD 253,436	Administrative, Others
115	Electromechanical Refurbishment & Upgrading of Absan Al Kabera Water Booster Station	ICRC	Sep-15	Mar-16	USD 218,552	Water
116	Electromechanical Upgrading and Rehabilitation installations of Water Facilities in Gaza Strip.	ICRC	Sep-15	Mar-16	USD 240,010	Water
117	Emergency Stock Stores for Water and Wastewater Infrastructures	ICRC	Sep-15	Nov-15	USD 130,124	Administrative, Others
118	Supply Safety & Security Tools and Spare Parts	ICRC	Oct-15	Apr-16	USD 136,960	Administrative, Others
119	Supply and Install of Water Meter Test Bench	ICRC	Oct-15	Jun-16	USD 99,999	Water
120	Construction of West Al-Nusirat Pumping Station, Wastewater Networks & Household Connections.	ICRC	Oct-15	Jun-16	USD 749,995	Sewage
121	Fleet Visibility Emergency Preparedness Plan	ICRC	Dec-15	Feb-16	USD 59,250	Administrative, Others
122	Maintenance of Emergency Municipal Vans Lot No.1	ICRC	Jan-16	Apr-16	USD 20,718	Vehicle, Heavy Machine etc
123	Maintenance of Emergency Municipal Vans Lot No.2	ICRC	Jan-16	Apr-16	USD 19,270	Vehicle, Heavy Machine etc
124	Maintenance of Emergency Municipal Vans Lot No.3	ICRC	Jan-16	Apr-16	USD 20,150	Vehicle, Heavy Machine etc
125	Maintenance of Emergency Municipal Vans Lot No.4	ICRC	Jan-16	Apr-16	USD 32,911	Vehicle, Heavy Machine etc
126	Maintenance of Emergency Municipal Vans Lot No.5	ICRC	Jan-16	Apr-16	USD 30,831	Vehicle, Heavy Machine etc
127	GIS ESRE Software Maintenance Renewal Agreement	ICRC	Mar-16		USD 36,980	Administrative, Others

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
128	Purchase of Servers for GIS Enterprise System	ICRC	Apr-16		USD 19,966	Administrative, Others
129	CMWU / Emergency Preparedness, Constructing a Second Power Line to Essential Water & Waste Water Facilities	ICRC	Jul-16	Jan-17	USD 264,000	Water and Sewage
130	Mechanical Rehabilitation and Maintenance of water Facilities	ICRC	Aug-16	Dec-16	USD 71,492	Water
131	Upgrading and rehabilitation of electrical equipment for W&WW facilities	ICRC	Aug-16	Dec-16	USD 59,999	Water and Sewage
132	Supply and Delivery to CMWU Warehouse Spare Parts for Water and Wastewater Facilities	ICRC	Aug-16		USD 87,045	Administrative, Others
133	Maintenance of Emergency Municipal Heavy Machines-Rafah	ICRC	Sep-16		USD 40,790	Vehicle, Heavy Machine etc
134	Maintenance of Emergency Municipal Heavy Machines-Gaza	ICRC	Sep-16		USD 50,190	Vehicle, Heavy Machine etc
135	Maintenance of Emergency Municipal Heavy Machines-North	ICRC	Sep-16		USD 103,568	Vehicle, Heavy Machine etc
136	Maintenance of Emergency Municipal Heavy Machines-Middle	ICRC	Sep-16		USD 69,775	Vehicle, Heavy Machine etc
137	Maintenance of Emergency Municipal Heavy Machines-Khan Younis	ICRC	Sep-16		USD 84,260	Vehicle, Heavy Machine etc
138	Mechanical Rehabilitation and Maintenance of wastewater Facilities	ICRC	Oct-16	Jan-17	USD 76,747	Sewage
139	Construction of Water and Wastewater Central Lab	IsDB/GCC	Feb-12	Oct-12	USD 298,988	Administrative, Others
140	Supply & Delivery of Diesel Fuel & Lubricant Oil for CMWU electrical Generators in Gaza Strip-Phase 2	IsDB/GCC	Feb-12	Mar-12	USD 100,250	Comsumable
141	Electromechanical Refurbishment & Upgrading and rehabilitation installations-Water Production Wells	IsDB/GCC	Feb-12	Aug-12	USD 244,374	Water
142	Rehabilitation and upgrading of Malezian Water well -Al Shoka	IsDB/GCC	Feb-12	May-12	USD 82,066	Water
143	Supply & Delivery of Diesel Fuel & Lubricant Oil for CMWU electrical Generators in Gaza Strip-Phase 3	IsDB/GCC	Mar-12	Apr-12	USD 132,450	Comsumable
144	Rehabilitation of water networks in Middle area	IsDB/GCC	Apr-12	Aug-12	USD 114,437	Water
145	Supply of water meters and house connections fittings	IsDB/GCC	Apr-12	Jul-12	USD 406,670	Water
146	Supply & Delivery of Diesel Fuel & Lubricant Oil for CMWU electrical Generators in Gaza Strip-Phase 4	IsDB/GCC	May-12	Jul-12	USD 186,000	Comsumable
147	Rehabilitation of water networks in Rafah and Khan Younis Gov.	IsDB/GCC	May-12	Nov-12	USD 231,863	Water
148	Rehabilitation of water networks in Beit Hanon	IsDB/GCC	May-12	Oct-12	USD 205,000	Water
149	Rehabilitation maintenance and refurbishment installation of Water wells	IsDB/GCC	Jun-12	Feb-13	USD 495,853	Water
150	Construction of water carrier lines and distribution networks	IsDB/GCC	Jul-12	Nov-12	USD 227,508	Water

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
151	Rehabilitation of networks at Rafah Gov.	IsDB/GCC	Aug-12	Nov-12	USD 82,604	Water
152	Construction of CMWU Central warehouse and workshop	IsDB/GCC	Sep-12		USD 496,984	Administrative, Others
153	Rehabilitation and development of Sea water RO desalination plant in Deir Al Balah	IsDB/GCC	Sep-12		USD 2,155,090	Water
154	Construction of water tank and pumping station in Al Moghragh area	IsDB/GCC	Sep-12		USD 836,649	Water
155	Supply and install of domestic water meters	IsDB/GCC	Nov-12		USD 175,675	Water
156	Finishing building of Water and Wastewater CMWU Central Lab	IsDB/GCC	Nov-12		USD 128,306	Administrative, Others
157	Construction of Bani Suhaila Water tank and booster pump	IsDB/GCC	Jan-13	Sep-13	USD 783,001	Water
158	Construction of Deir Al Balah Water tank and PS	IsDB/GCC	Jan-13	Jan-14	USD 999,975	Water
159	Monitoring and Safety System for the Central CMWU Warehouse	IsDB/GCC	Jun-14	Sep-14	USD 25,488	Administrative, Others
160	Construction of Gravity Carrier Line for Abeda Storm Water Collection Pond at Rafah	IsDB/GCC	Feb-15	Jun-15	USD 237,749	Storm Water
161	Construction of Gravity Carrier Line for Abeda Storm Water Collection Pond at Rafah	IsDB/GCC	Feb-15	Jun-15	USD 237,749	Storm Water
162	Construction of Al Amal Pumping Station & Carrier Line at Khan Younis	IsDB/GCC	Jul-15	Jan-16	USD 576,975	Water
163	Construction of Storm Water Collection Pond at Rafah.	IsDB/GCC	Dec-15	Feb-16	USD 77,000	Storm Water
164	Procurement of 4000 Water Meters and House Connections.	IsDB/GCC	Jan-16	Jul-16	USD 210,672	Water
165	Construction of Al Qarara Infiltration Basin	IsDB/GCC	Mar-16		USD 419,147	Storm Water
166	Geographic Information System Development	IsDB/GCC	Apr-16	Sep-16	USD 96,570	Administrative, Others
167	Construction of Gravity Storm Water Carrier line to Al Amal Pond	IsDB/GCC	Oct-16		USD 127,163	Storm Water
168	Construction of Carrier Line from the Desalination Plant to Sheikh Radwan Water Tank	IsDB & KDF	Jan-15	Jun-15	USD 1,057,300	Water
169	Construction of Sheikh Radwan Blending Tank 500 m3	IsDB & KDF	May-15	Mar-16	USD 1,258,396	Water
170	Seawater Reverse Osmosis Desalination Process Plant with Associated Civil, Mechanical & Electrical Works	IsDB & KDF	May-16		USD 8,765,000	Water
171	Service Contract for Rehabilitation GIS System and IT Equipment	UNICEF	Jun-14	Jul-14	NIS 54,075	Administrative, Others
172	Emergency Repair for Damages in Water & Wastewater Networks in all Gaza Strip	UNICEF	Jul-14		NIS 107,075	Water and Sewage
173	Repair of Damages in Water & Wastewater Networks, Water Well and RWWTP	UNICEF	Aug-14		NIS 183,000	Water and Sewage
174	Supply consumables for Generators	UNICEF	Sep-14	Apr-15	NIS 296,477	Comsumable
175	Rehabilitation of Water & Wastewater Networks at the Southern Governorate Package (1).	UNICEF	Dec-14	Apr-15	NIS 840,065	Water and Sewage

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
176	Rehabilitation of Water & Wastewater Networks at the Middle Governorate Package (2)	UNICEF	Dec-14	Apr-15	NIS 706,004	Water and Sewage
177	Emergency Winterization Intervention during the Storms Phase I	UNICEF	Jan-15	Feb-15	NIS 75,849	Storm Water
178	Rehabilitation of Water Networks at Baghdad Neighborhood - Rafah	UNICEF	Jan-15	Feb-15	NIS 309,100	Water
179	Emergency Winterization Intervention during the Storms Phase II	UNICEF	Feb-15	Mar-15	NIS 75,000	Storm Water
180	Electromechanical Repair Rehabilitation and Refurbishment of Water Production Wells - Al Nussirate - Middle Area	UNICEF	Feb-15	Mar-15	NIS 64,000	Water
181	Emergency Repair and Upgrading Water & Wastewater Infrastructures Amendment	UNICEF	Jun-15		USD 10,200	Water and Sewage
182	Emergency Winterization Intervention during the Storms- Phase I	UNICEF	Nov-15	Feb-16	NIS 147,400	Storm Water
183	Repair of Wastewater Networks at Bani Amer Area in Rafah	UNICEF	Nov-15	Feb-16	NIS 601,126	Sewage
184	Emergency Winterization Intervention during the Storms- Phase II	UNICEF	Feb-16	May-16	NIS 98,610	Storm Water
185	Install Two RO Desalination Plants for Al Shoka & Al Fukhary	UNICEF	May-16	Jul-16	NIS 55,500	Water
186	Repair water and wastewater pipelines in Jabalia	Save the Children	Dec-12	Sep-12	NIS 26,400	Water and Sewage
187	Maintenance work for WW pumps in Al Buraij	Save the Children	Nov-13	Nov-13	USD 3,988	Sewage
188	Emergency Works in Beit Lahia	Save the Children	Aug-14	Sep-14	USD 9,790	Water
189	Rehabilitation of Two Water Wells and Repair Water and Sewer Pipelines in Beit Hanoun and Jabalia	Save the Children	Nov-14	Mar-15	USD 134,630	Water and Sewage
190	Conducting Laboratory Heavy Metals Sampling, Testing and Analyzing Program	UNDP	Jan-12	Mar-12	USD 30,900	Administrative, Others
191	Conducting Laboratory Heavy Metals Sampling, Testing and Analyzing Program	UNDP	Oct-12	Oct-12	USD 55,953	Administrative, Others
192	RAD7 for Samples Collection for Heavy Metal Analysis by International Lab	UNDP	Dec-12	Dec-12	USD 15,890	Administrative, Others
193	Pumps for Samples Collection for Heavy Metal Analysis by International Lab	UNDP	Dec-12	Dec-12	USD 12,960	Administrative, Others
194	Construction of Sewage Pumping Station, Waste Water Networks and Household Connections at Batin Al Sameen Neighborhood- Khan Younis	AECID	Jun-14	Jan-15	EUR 546,450	Sewage
195	Construction of Sewage Pipeline, Household Connections and Sewage lifting Pump at Khan Younis	AECID	May-15		USD 9,310	Sewage
196	Supply and install IP surveillance and Access control system for CMWU HQ	AECID	Jul-16		EUR 22,097	Administrative, Others
197	Supply and install modular skid mounted well head 600 m3/day brackish water RO desalination plant - Taj Al Waqar in Nusirate	Interpal	Jul-12	Sep-12	USD 174,381	Water

No	Project Description	Donor	Project Period		Amount	Sector
			Start	End		
198	Supply and Install Modular Skid Mounted Well Head 600m3/day Brackish Water RO Desalination Plant-Bani Suhaila Ground Water Reservoir – Well M2B	Interpal	Jul-13	Oct-13	USD 168,683	Water
199	Construction of Water Well at Wadi Al Salga Municipal Area	Islamic Help	Dec-14	May-15	USD 126,350	Water
200	Supply and Install Modular Skid Mounted Well Head 500m3/day Sea Water RO Desalination Plant-Al Sheifa Hospital in Gaza City.	Islamic Help	Jan-16	Jul-16	USD 387,587	Water
201	Emergency Winterization Preparedness Response for North and Middle Area Governorates -Phase I	NRC	Dec-15	Mar-16	USD 88,786	Storm Water
202	Emergency Winterization Preparedness Response -Phase II	NRC	Feb-16	Mar-16	USD 206,208	Storm Water
203	Construction Sewage Pumping Station, Wastewater Network and Household Connections at Bani Suhila Area	Oxfam	May-12	Sep-12	NIS 704,350	Sewage
204	Rehabilitation and Construction of Storm Water Flooding Prevention Infrastructure Facilities	Oxfam	Apr-16	Jun-16	USD 49,270	Storm Water
205	Emergency Dewatering and Cleaning of Wastewater Lagoons at Rafah Wastewater Treatment Plant	PAH	Feb-13	Jun-13	USD 88,000	Sewage
206	Emergency Dewatering and Cleaning of Wastewater Lagoons at Beit Lahia Wastewater Treatment Plant	PAH	Feb-13	Jun-13	USD 71,500	Sewage
207	Construction of Storm Water Network, Storm Water Pond at Rafah Municipal Area - Phase II"	Paltel	Sep-13	Jun-14	USD 1,271,160	Storm Water
208	Construction of Water Well in Al Qarara	AFESD	Mar-14	Aug-14	USD 134,756	Water
209	Construction of Wastewater Networks at Baghdad Neighborhood Rafah	IAC	Feb-16	Apr-16	USD 99,998	Sewage

Appendix-3 Japan's Cooperation for Palestine in Water Sector

1. Grant Aid, Techinical Assistance, Follow Up ett

No	Name of Project	Location	Type of Project	Year		Budget
				From	Till	
1	Improvement of Water Distribution Facilities In The Northern Districts of the West Bank (Phase One) construction of 14 water networks & 4 water tanks	West Bank	GA	Unknown	2000	Unknown
2	Supply of NRW equipments	Bethlehem, West Bank	FU	2009	2010	Unknown
3	Supply of NRW equipments	Salfit, West Bank	FU	2009	2010	Unknown
4	Supply of NRW equipments	Ramallah, JWU, West Bank	FU	2009	2010	Unknown
5	Supply of NRW equipments	Ramallah, JWU, West Bank	FU	2009	2010	Unknown
6	Drilling Auja production well, Project for Support for the Public Activities of the Communities in Jordan Valley, Under the Japan's Grant Aid in 2009	Jericho, the West Bank	GA	2011	2014	USD528,000
7	Construction Works of Al-Auja Well - Jericho Governorate, Project for Support for the Public Activities of the Communities in Jordan Valley, Under the Japan's Grant Aid in 2009	Jericho, the West Bank	GA	2016	2017	USD820,300
8	Improved water and wastewater supply and wastewater system in Rafah and Middle area	Rafah, theGaza Strip	Supplementary Fund	2016	2017	USD1.5million
9	Construction of water network in Jabalia (additonal)	Jabalia, the Gaza Strip	FU	2015	2015	USD 34,983
10	Construction of water network in Jabalia	Jabalia, the Gaza Strip	FU	2015	2015	USD 140,440
11	Construction of sewerage network (which will be connected to Jericho municipality network)	AqbadJabar Camp, Jericho, the West Bank	GOJ	2016	2018	USD 5million
12	Capacity enhancement of the Rafah Wastewater Treatment Plant and Construction of Wastewater Post Treatment Plant for irrigation[*2]	Rafah, the Gaza Strip	GOJ	2017	2018	USD1.2million
13	Wastewater Treatment Khan Younis	Khan Younes, the Gaza Strip	GOJ	2017		unknown
14	Construction/ rehabilitation of 4 water pipelines & 1 wastewater pipe (BeitHanum, Khan-Yunis& Rafah)[*1]	BeitHanum, Khan Yunis& Rafah, the Gaza Strip	FU	2016	2017	USD1.8million
15	Rehabilitating water tank in Haris Village	Salfit, the West Bank	GA-FU	2014	2015	USD 63,000
16	Providing Pre-Paid water meter and Test Bench, Follow up Cooperation for water Resources Management in Nablus	Nablus, the West Bank	FU	2015	2015	USD 98,105

No	Name of Project	Location	Type of Project	Year		Budget
				From	Till	
17	Construction of Jericho Wastewater Collection, Treatment System and Reuse Project	Jericho, the West Bank	GA	2011	2014	USD32million
18	Technical Assistance and Capacity Building Project for the Jericho Sanitation Project	Jericho, the West Bank	TA	May 2012	2018	USD5.2million
19	Project for Strengthening the Capacity of Water Service Management in Jenin Municipality	Jenin, the West Bank	TA	Sep 2017	2020	USD4.7million
20	Constructing of Al-Shanti Water Well Desalination Plant in Jabalia (Northern of Gaza)	Jabalia, the Gaza Strip	FU	2012	2012	USD 140,000
21	Improvement of water networks in Al-Zawaida (Central Gaza)	Zawaida, the Gaza Strip	FU	2012	2012	USD 144,100

注) GA: Grant Aid
FU: Follow Up
TA: Technical Assistance
GOJ: Government of Japan

*1 No.12 ”Capacity enhancement of the Rafah Wastewater Treatment Plant and Construction of Wastewater Post Treatment Plant for irrigation” is realized by this Data Collection Survey.

*2 No.14 ”Construction/ rehabilitation of 4 water pipelines & 1 wastewater pipe (BeitHanum, Khan-Yunis& Rafah)” implemented as pilot projects in this Data Collection Survey.

2. Training in Third Countries

No	Year	Country	Topic	No of Participats
1	2015	Egypt	Ground Water and Artificial Recharge	4
2	2014	Egypt	Ground Water and Artificial Discharge	3
3	2011	Singapore	Integrated Water Resources and Environment Management Policy Scarce Regions In Singapore	1
4	2011	Jordan	Capacity Building in Water Resources Mangement in Jordan	1
5	2011	Jordan	Water Quality Phase (I)	10
6	2011	Jordan	Waste Water Treatment Phase (II)	9
7	2011	Jordan	Waste Water Quality Phase (III)	10
8	2010	Jordan	Water Resources Management (3 courses)	1
9	2010	Jordan	1. Operation and Preventive Maintenance of Waste water Treatment Plants	9
10	2010	Jordan	2. Sampling and Testing Of waste water at Treatment plant laboratories	9
11	2009	Jordan	Capacity Building in Water Resource Management (Non-Revenue Water Management) in Jordan	10
12	2009	Jordan	Capacity Building in Water Resource Management (GIS Application in Water Resources Management) in Jordan	8
13	2009	Jordan	Capacity Building in Water Resource Management (Water Meter Maintenance) in Jordan	12
14	2008	Singapore	Non-Conventional water resources and environmental management in water scarce countries	2
15	2008	Jordan	Capacity Building in Water Resource Management for Palestinians (Water Meter Maintenance)	11
16	2008	Jordan	Capacity Building in Water Resource Management for Palestinians (GIS)	8
17	2008	Jordan	Capacity Building in Water Resource Management for Palestinians (Non-Revenue Water II)	10
18	2008	Jordan	Capacity Building in Water Resource Management for Palestinians (Water Quality Monitoring)	8
19	2007	Jordan	Capacity Building in Water Resource Management for Palestinians	26
20	2006	Jordan	Capacity Building in Water Resource Management for Palestinians	52

Appendix-4 Outlines of major Master Plans made for Water Sector

1, Overview of the Integrated Coastal Aquifer Management Plan (CAMP) in 2000

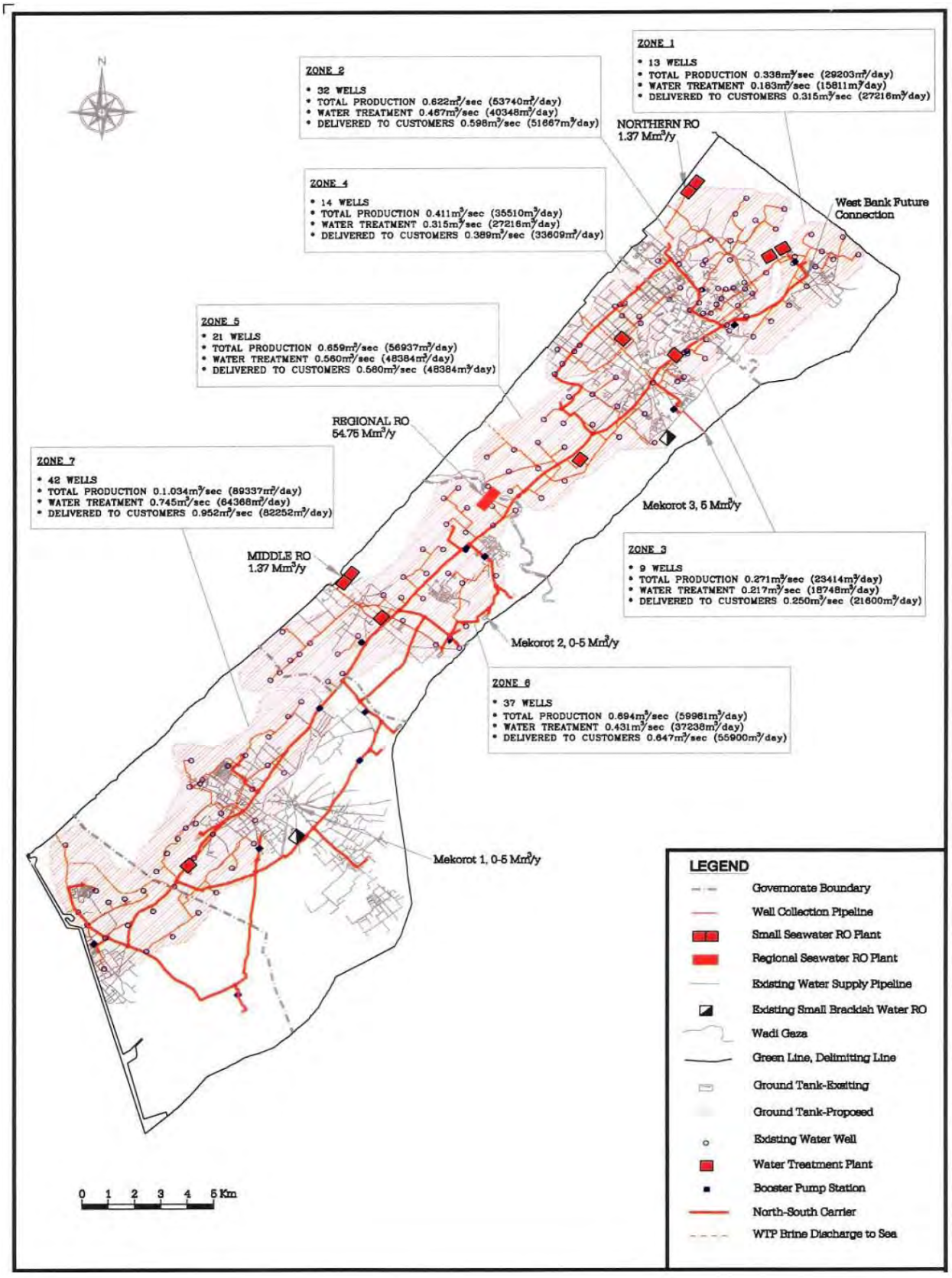
In 1994, the Gaza-Jericho agreement placed water resources under the control of the newly established Palestinian Authority (PA) and, in 1955, the Palestinian Water Authority (PWA) was formed. It was given the mandate to manage water in the Palestinian Territories. At this time, it was widely recognized that there were serious environmental problems with the Gaza Aquifer, with the expert predicting that if nothing was done, the entire aquifer would become unusable by the year 2000. In addition, the water infrastructure was in a very poor state, with 50% of water being lost through leaking pipes.

Therefore, the PWA, with the help of international donors (principally the United States Agency for International Development or USAID), set out to develop a management strategy for the Gaza Aquifer and engaged the engineering firm Metcalf & Eddy to carry out an environmental survey and draw up a management plan. The Integrated Coastal Aquifer Management Plan (CAMP) was drawn up in 2000, with an implementation period of 20 years.

The main components of the CAMP included reducing the amount of water pumped from the aquifer for agricultural irrigation, while simultaneously improving water supply to the population by providing additional water from sources other than the aquifer. These included the importation of water from Israel, the construction of seawater desalination plants and the improvement of wastewater treatment to allow the treated water to be used for irrigation and aquifer recharge.

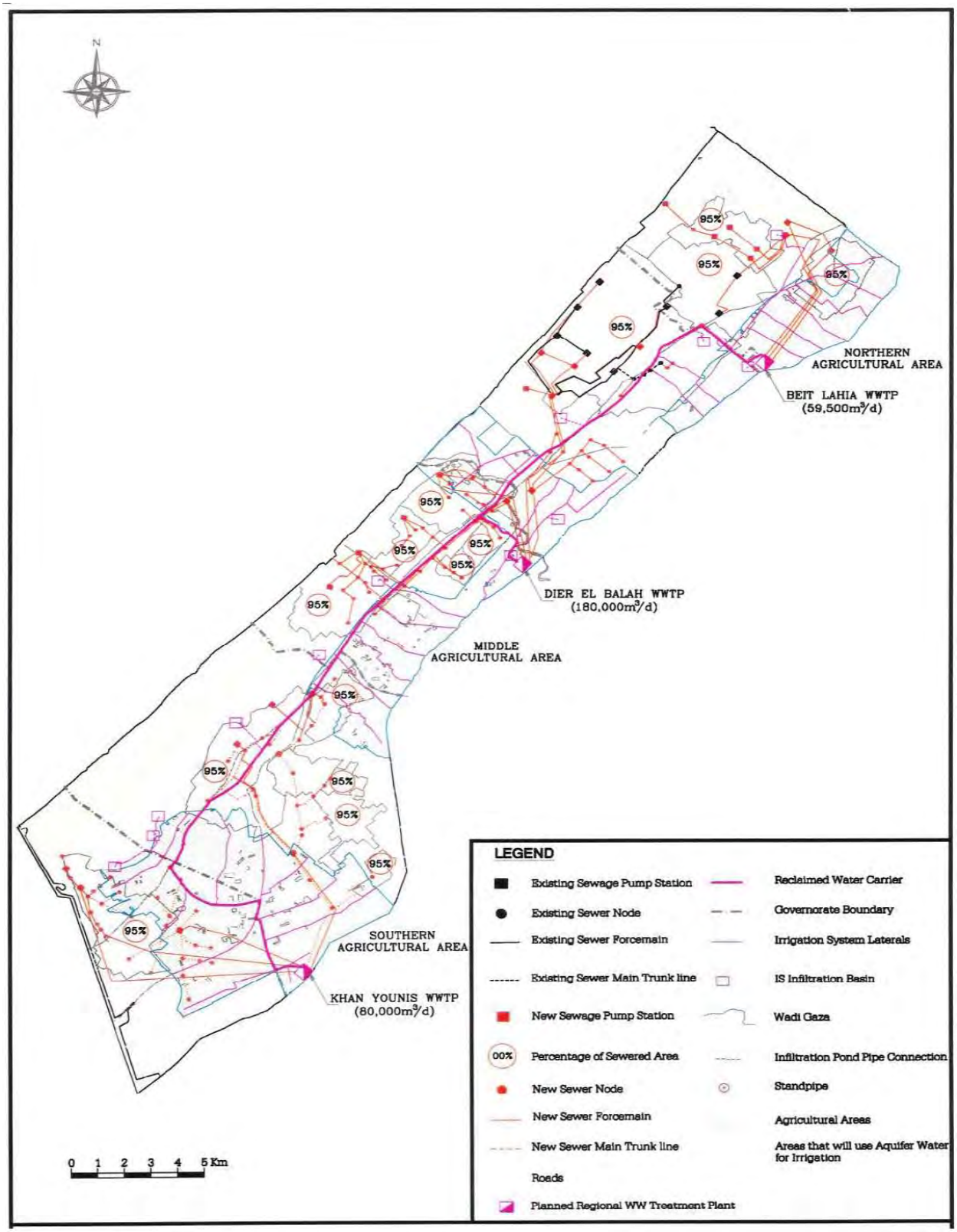
It was envisaged that, in the longer term, following a political settlement with Israel, and resolution of the Palestinian's water rights in the West Bank, a pipeline could be constructed between the West Bank and Gaza to ensure adequate supplies for the growing population. If implemented on schedule, it was expected that the CAMP would bring the Gaza Aquifer back into a positive water balance by 2007, whereas failure to implement the CAMP in accordance with the schedule will result in the continuing decline in the quantity and quality of the aquifer water.

In the CAMP water supply plan, blockage of water distribution area (Zoning) is considered together with desalination plant and water from outside, West Bank and Israel. On the other hand, three new large wastewater treatment plants (WWTPs) were proposed covering north, central and south Gaza, respectively. Locations were placed upper area of the Strip to utilize treated water for irrigation and recharge purpose. Regarding the WWTP, construction is proceeding in accordance with this plan.



Source: Integrated Coastal Aquifer Management Plan

Figure 1 Water Supply Master Planning in CAMP



Source: Integrated Coastal Aquifer Management Plan

Figure 2 Sewerage Master Planning in CAMP

2. Water Facility Master Planning in 5 Governorates

Water facility Master Plan for five Governorates was formulated and submitted to PWA by the local consultants who are familiar with local water supply conditions in 2005 and 2006. They were funded by the Government of Finland. Independent network systems are integrated into fewer network systems in each governorate while waiting for future inter-governorate water carrier whose source is the proposed large SWRO facility.

Table 1 Water Facility Master Plan for Five Governorates

Governorate	Title of Master Plan	Submittal	Consultant	Implementing Agency/Donor
North Gaza	(Draft Final Report) Water Facility Master Planning in North Governorate	Jan.2006	CEP-EMCC	PWA/Finland
Gaza	(Draft Final Report) Gaza Governorate Water Facilities Master Planning	Aug.2006	UG	PWA/Finland
Middle Gaza	(Draft Final Report) Water Facility Master Planning in Deir El Balah	Feb.2006	CEP-EMCC	PWA/Finland
Khan Younis	(Final Report) Water Facility Master Planning in Khan Younis Governorate	Sep.2006	TECC	PWA/Finland
Rafah	(Revised Final Report) Gaza Governorate Water Facilities Master Planning	Oct.2005	UG	PWA/Finland

Source：CMWU

3. National Water and Wastewater Strategy for Palestine, 2013 and NRW Reduction Project

The National Water and Wastewater Strategy for Palestine was finalized in 2013 by PWA, which sets up the long term plan up to 2032. The intermediate target year is set at 2017, 2022 and 2027 considering a five-year span from the base year of 2012. In 2032, the population in Gaza Strip is projected to exceed three million and unit consumption rate will go up to 120 lpcd. The projected water demand is nearly 386,000m3/d assuming 7% of domestic demand volume is added as industrial demand and NRW ratio is reduced to 20% from the existing 40%. The SWRO facility is deemed essential as the additional water source.

As for the NRW Reduction activity is concerned, the IsDB project is on-going in Der Al Balah, Al Nussirat and Jabalia municipality while the WB project is being developed in 20 municipalities allover Gaza Strip. KfW is also planning to start another NRW reduction project in 2017.

4. Associated Works for Gaza Desalination Project, March 2015

The water carrier line which conveys treated water from the central large SWRO facility to north and south area of the Gaza Strip is being planned and designed under the WB funding. The establishment of the integrated water supply system using this water carrier and local receiving/storage facility enables efficient NRW management. Study and design aimed to reduce NRW in Gaza City and Northern municipality are on-going through a joint venture of Italian and local consultants. The final report will be completed at the end of this year.