Submitted to:

AFD

Zacharie MECHALI
Chef de Projet – Program Manager
Agriculture, Développement Rural, Biodiversité
+33 1 53 44 41 49
AGENCE FRANÇAISE DE DÉVELOPPEMENT
5, rue Roland Barthes 75598 PARIS
métro Gare de Lyon, sortie 9, Place Henry Fresnay
#MondeEnCommun | www.afd.fr

UPDATE THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) AND DEVELOP THE RESETTLEMENT ACTION PLAN OF THE PROPOSED RECOVERY AND REUSE SCHEME NAMELY THE RECOVERY SCHEME INFRASTRUCTURE, THE IRRIGATION NETWORK AND THE RELATED ENVIRONMENT

DRAFT SESIA UPDATE REPORT

22nd JUNE 2018

EcoConServ
ENVIRONMENTAL SOLUTIONS

UNIVERSAL GROUP
for Engineering & Consulting

EcoConServ Environmental Solutions
12 El-Saleh Ayoub St., Zamalek,
Cairo, Egypt 11211
Tel: + 20 2 2735907 / Fax: + 20227365397

E-mail: genena@ecoconserv.com

URL: http://www.ecoconserv.com

Universal Group for Engineering and Consulting - Maalem-Gaza
Said El Ass St. Nema Center, 2nd Floor, Flat 207,
Remal, Gaza, Palestine
Tel: +972.8.282.5557 | +972.8.282.0979

1 INTRODUCTION AND UPDATE ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT OBJECTIVES

1.1 Introduction

The Palestinian Water Authority (PWA) together with AfD have prepared the Terms of Reference (ToR) for updating the Supplementary Environmental and Social Impact Assessment (SESIA) carried out for the North Gaza Emergency Sewage Treatment Project (NGESTP) in 2013.

The SESIA update assignment will only cover the evaluation of the environmental and social risks and impacts of the Recovery and Reuse Scheme (part 'C2').

Part 'Cl' has been financed by World Bank and this part ,'C2' (refered to as **the Project** in this document) is anticipated to be financed by AfD and the Green Climate Fund. The update assignment was announced in a competitive bid and awarded to the joint venture of EcoConServ and UG Gaza.

This report is a fundamental deliverable for the SESIA update consultancy service which involves the update the SESIA, on the components covered by the Project, based on the updated project description, including the Photovoltaic system component (that was not part of the initial project) and with recent information regarding the baseline and institutional context.

1.2 Background

The Northern Gaza Emergency Sewage Treatment (NGEST) Project initiated in 2004 , was initially planned to be implemented in two phases. Part A of the treatment scheme was the construction of the terminal sewage pumping station at the Beit Lahia Wastewater Treatment Plant site, construction of a pressure pipeline to a new site about seven kilometers to the East of Jabalia, construction of nine infiltration ponds at the new site, and commissioning of the pipeline to allow a large and dangerous emergency partial effluent pond at Beit Lahia to be drained.

Part B of the treatment scheme included constructing a wastewater treatment plant at the new site that was envisaged to handle up to 70,000 cubic meters of sewage daily . Other parts of the overall project was the remediation of the land that was formerly covered by a large partial effluent at Beit Lahia and for a pilot program to recover treated and infiltrated effluent from the ponds.

Part 'A' had been in operation since April 2009, and was entirely completed in 2010, pumping partially treated sewage from the old BLWWTP site to the new infiltration basins site.

Part B was originally expected to be completed in 2013, but had not actually started its operations until the first quarter of 2018.

Part C, was proposed at a later stage, to expand the effluent recovery and reuse scheme to the full planned effluent flow from the plant and provide long-term protection for the underlying aquifer.

In addition to the core project components of C2, a additional new solar component was proposed to secure reliable source of power supply to the project, and reduce its operations dependency on the grid.

The joint venture between EcoConServ and Universal Group were hired by AfD and PWA to update the evaluation of the environmental and social risks and impacts of the Recovery and Reuse Scheme (part 'C2'). The Consultancy Term of Reference (ToR) identified the objective of the study in two parts: "Update the Environmental and Social Impact Assessment (ESIA) and Develop the Resettlement Action Plan of the proposed Recovery and Reuse Scheme, namely the recovery scheme infrastructure, the irrigation network and the related environment.

1.3 Project Rationale

The main goal the anticipated effects to the groundwater aquifer for both the interim phase (before the treatment plant is commissioned) and the consequent effects of the full operation of the system. The basic assumption used in those scenarios was that there would be a timelag (around two years) between the two phases when poor-quality effluent will be discharged to the basins. To mitigate those negative effects during this interim phase, the study recommended a recovery scheme where the groundwater “polluted” with the recharged effluent will be arrested through a chain of pumping wells (after its quality has improved) and used for agriculture.

The reality has changed since the EIA was prepared, and the timeframes envisaged for both phases have changed. Due to the closure of the Israeli borders with Gaza and lack of construction materials, phase A has taken more than four years to finish. Phase B was expected to be commissioned before the end of 2013 but has not been in operation until the first quarter of 2018. The effluent lake in Beit Lahia has been evacuated to the basins with sub-standard quality. Until then, inflow rate of partially-treated sewage to the basins was about 15,000 cubic meters daily and the remaining effluent was pumped daily to temporary ponds located near the north border with Israel (northwest Um Al-Nassr) and to the two basins adjacent to the existing BLWWTP.

The reuse/recovery scheme component aims at recovering and reusing the treated effluent after the new WWTP is completed. The system is composed of a group of 28 recovery wells surrounding the basins to capture the effluent after it passes through the effluent ponds, storage reservoirs to store the recovered water and a distribution network for agricultural reuse. The recovered effluent is expected to irrigate around 15,000 donums of adjacent agricultural land.

1.4 Project Component Site

The area of the project lies in the vicinity of NGWWTP and is designed to benefit from the recovered water in the agricultural activities. The existing situation of this area is illustrated hereafter according to a study (PWA, 2010) prepared during the NGWWTP effluent recovery system.

The proposed agricultural area for ruse activities is divided into two zones (A and B) according to its location from NGWWTP. Zone A is the part located north of NGWWTP with about 10,100 dunum whereas, Zone B is located south of NGWWTP with about 5,000 dunum.

The recent distribution of cultivated crops in both zones (A and B) is shown in Table 1. Most of the area (about 12,000 dunum) is considered as under rain-fed conditions.

Citrus is a crop grown in the project area with an area of 1198 dunum (fruitable and none-fruitable). Olives represent 614 dunum (fruitable and none-fruitable). Vegetables represent 280 dunum. The area of fruit trees is 120 dunum, whereas, the rain-fed area includes the grains and the demolished area occupying the most of the project area being 12,055 dunum as shown in Figure1 and Figure 2.

Figure 1:Proposed project area

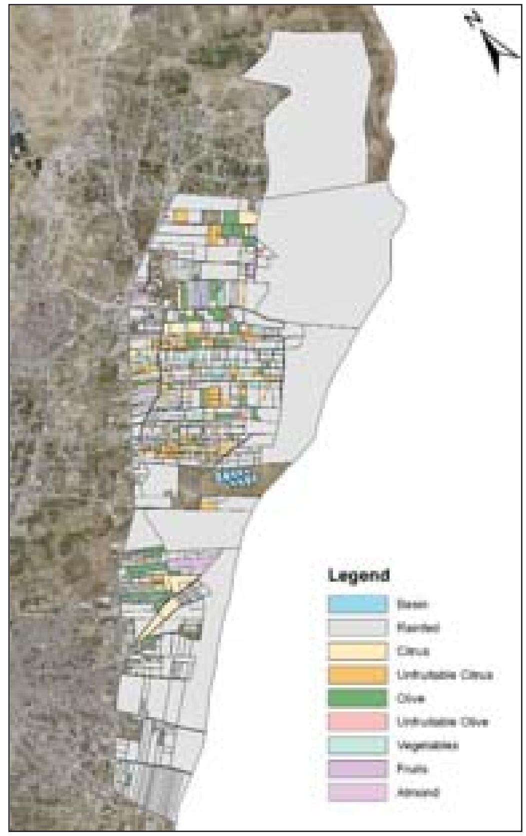


Figure 2:Existing crops in the project

Table 1: Distribution of cultivated crops in zone (A and B), Dec. 2009

Crops	Zone A1 (dunum)	Zone A2 (dunum)	Zone B (dunum)	Total
Rain-fed	3796.5	3796.5	4462	12055
Citrus	257.5	257.5	172	688
Olives	194	194	212	600
Vegetables	130	130	20	280
Fruit Trees	60	60	0	120
Almonds	26.5	26.5	64	117
Citrus (non-fruitable)	232	232	46	510
Olives (non-fruitable)	7	7	0	14
Total	4703.5	4703.5	4976	14,384

1.5 SESIA Update Objectives

The ESIA is an instrument that involves examining the project's technical, environmental, socio-cultural, institutional, historical and political context, and stakeholders' views and priorities. It aims to set a mitigation and monitoring plan to tackle the negative environmental and social impacts and defines the institutional responsibilities for implementing these measures. The RAP is regarded as a mitigation policy and action to minimize the negative impact of involuntary land acquisition that might be triggered as part of the project.

In order to fully comply with Palestinian environmental law and World Bank safeguard policies, as well as to support the sustainability of the expected project outputs and outcomes, the following are to be delivered in this consultancy:

i. Updated identification of the possible environmental and social impacts with focus on phase "C2" of the proposed effluent recovery and reuse scheme, taking into consideration all updates that have occurred since 2013.
ii. Updated identification of any potential temporary or permanent land acquisition requirements associated with civil works;
iii. if the Bank's Operations Policy 4.12 (see below) is determined to apply due to land acquisition requirements, preparation of draft terms of reference to formulate a Resettlement Action Plan (RAP) to manage, mitigate, and monitor the impacts of the acquisitions;
iv. An updated environmental and social impacts management plan (ESMP) based on the baseline relevant components of the ESMP in the SESIA update study to manage, mitigate, and monitor any possible negative impacts during the construction and operation phases of the project;
v. a capacity assessment of the implementing party to implement the ESMP and recommendations for any capacity-building needs.

1.6 ESIA Requirements

Initial screening for applicable World Bank social and environmental safeguard policies indicate these the project might be triggered by:

OP/BP 4.01- Environmental Assessment: According to World Bank screening, this project is classified as a category "A" project which requires an environmental assessment. The scope of assessment will include determination of any expected environmental and social impacts and preparation of an environmental management plan for managing, mitigating and monitoring risks and negative impacts.

OP/BP 4.12- Involuntary Resettlement: Project activities are expected to require minimal land acquisition for the construction of wells, pumping stations, effluent reuse pipelines and storage tanks. While the Bank's Operational Policy on Involuntary Land Acquisition and Resettlement (OP 4.12) does not apply in cases of public land acquisition or in circumstances of voluntary donation by private individuals, this supplementary ESIA will consider the totality of temporary and permanent land requirement for this project to ascertain if any lands will be involuntarily acquired through the principal of eminent domain. It will also clarify the nature of land ownership for each site (waqf, public, or private). These sets of assessments will determine the applicability of OP 4.12 and hence the requirements to prepare safeguards instruments, if any.

- BP 17.50- Disclosure of Operational Information: The proposed project is subject to the bank's access to information policy concerning the disclosure of project information including the environmental and social impact assessments.
- Natural Habitats (OP 4.04) (revised on April 2013) : The proposed project is subject to the the bank's natural habitats
- Cultural Property (OP 11.03)
- Project on International Waterways (OP 7.50)
- 2016 version of the World Bank Standards and applicable WB EHS Guidelines

This SESIA update follows the same structure as the original SEISA report, which was prepared in accordance with the National Environmental Impact Assessment (EIA) guidelines including the EIA brochure of the PNA. It also examined and recognized the international policies guidelines mentioned above.

In addition, the international guidelines from WHO and FAO are recognized this SESIA update study to account for concerning the health impact of using treated wastewater.

1.7 The Consultancy Term of Reference (ToRs)

The Consultancy Term of Reference (ToR) identifies the objective of the study in two parts: "Update the Environmental and Social Impact Assessment (ESIA) and Develop the Resettlement Action Plan of the proposed Recovery and Reuse Scheme, namely the recovery scheme infrastructure, the irrigation network and the related environment.

Seven tasks have been identified in the ToRs, in addition to a special task of RAP development, as follows:

Task 1. Updated Description of the Proposed Project:

Provide an updated full description of the project location; general layout; unit process description and diagram for new components; population served, present and projected; number and types of connected parcels/businesses; water supply characteristics, adjacent facilities and communities, natural, or cultural facilities close to project site; existing / new road or other supportive infrastructure (included associated infrastructure if any _ using the definition of World Bank).

Task 2. Updated Description ofthe Envirorunent - WHEN NEEDED: Assemble, evaluate and present relevant baseline data on the environmental characteristics of the study area. On items (a) and (b), only add strictly necessary data that would have evolved since the 2013 study

a. Physical environment. geology (general description for overall study area and details for land application sites); topography; soils (general description for overall study area and details for land application sites); monthly average temperatures, rainfall and runoff characteristics; description of waters bodies (identity of streams, springs, wadis, groundwater, water quality; existing discharges or withdrawals); with a focus on the groundwater characteristics, with notably an update on the groundwater level and quantity; new analysis of the groundwater quality, and integration of the results of the NGEST WWTP effluent analysis.
b. Biologzeal environment. identify and describe any terrestrial communities, rare or endangered species; sensitive habitats, including parks or reserves, significant natural habitats, in areas affected by construction, facility sitting, land application or disposal;
c. (c)Socio-economic and cultural environment (coordinating with the complementary feasibility stucy): present and projected population; present socio-economic activities; population, structure and description of the community(ies) present on the site (inc. gender analysis); land use / ownership; planned development activities; community structure; public health as it relates to water use; tourism; cultural properties and social fragile context.

Task 3. Legislative and Regulatory Considerations: This part will update and complete the review of the environmental and social Palestinian national, municipal, and local laws, regulations and standards; and will update the gap-analysis with the 2016 version of the World Bank Standards2 and applicable WB EHS Guidelines3 . The Consultant will ensure that the Project will be compliant with the 2016 version of the World Bank Standards, as a requirement of the GCF.

This will notably cover the environmental permit, environmental quality, pollutant discharges to surface waters and land, industrial discharges to public sewers, water reclamation and reuse, water users association, health and safety, land use control, etc.

The institutional context will identify the administration in charge of the environmental and social regulation implementation and verification.

Task 4. Update / Confirm the Analysis of project alternatives: Describe options explored during the implementation of the proposed project and indicate in particular the environmental and social reasons which governed the choice of this site, project (urban, social and technical design of the project). Compare these options in terms of their environmental and social impact, their investment and operating costs, compatibility with local conditions and in terms of institutional, training and monitoring needs. This task is to be performed only if additional analysis is needed with regard to the 2013 study.

Task 5. Determination of the updated Potential Impacts of the Proposed Project based on the current situation in the Recovery and Irrigation vicinity: In this analysis distinguish between significant positive and negative impacts, direct and indirect impacts, and immediate and long-term impacts. Identify impacts that are unavoidable or irreversible. Wherever possible, describe impacts quantitatively, in terms of environmental and/or social costs and benefits. The environmental and social impacts should be classified for both the construction and operational phases of the project. The cumulative impacts, impact of associated infrastructures if any, and impacts that could affect in a different manner men and women should be included.

Although not exhaustive, the main impacts to be investigated are:

i. Impacts on water supply and water quality, including groundwater resource contamination during infiltration, and from Reuse of Recovery Water in Irrigation;
ii. ii. Public Health related to Using Recovery Water for Irrigation; Impacts on the local agriculture industry;
iii. Impacts on vehicle, donkey, foot traffic, and conunerce ill the project areas during the construction period;
iv. Construction-related impacts (noise, dust, debris, waste generation, labor and working conditions, health & safety, increased accidents) during the construction phase;
v. Impacts related to construction of the effluent reuse pipeline, well field, and pumping of the effluent from beneath the infiltration ponds. Specific attention should be given to the possible impact on existing wells of groundwater level drawdown that may be caused by the effluent recovery wells;
vi. Hazardous waste generation and water use for the solar panel component; Public health benefits anticipated.

Task 6. Update and clarify the project social impacts including on issues related to involuntary resettlement:

i. Briefly describe who are the affected conununities: the Consultant should determine which populations are impacted by the project using a quantitative approach (number of people and villages affected) and qualitative approach (indicate various possible impacts by ethnic group / villages / populations / gender). If the project affects minority or disadvantaged ethnic groups, identify specific project impacts and risks for these populations;
ii. Summarize positive and adverse social impacts that will be accrued by community members;

iii. Clarify what the permanent and temporary land requirements of the project are in specific relation to land ownership, land use, access to properties, or livelihood as it relates to access to properties, most notably in and around the path of the construction including lands for access roads and reservoirs in the recovery well areas;

iv. Summarize both positive and adverse effects of various land taking scenarios including PWA rental of private lands, willing-buyer, willing-seller option, or voluntary land donations in exchange for specific project benefits (i.e, municipality employment);

v. For each project intervention (e.g. pipelines, recovery wells, monitoring wells, pumping stations, reservoirs, solar panels) clarify all direct economic and social impacts caused by the involuntary taking of land (if any) resulting in: relocation or loss of shelter; loss of assets or access to assets; loss of income sources or means of livelihoods (regardless of whether the affected persons must move to a new location)

vi. Negative impact on the livelihood status of those who operate wells;

vii. Impact for the farmers who does not own the land;Summarize Palestinian legislation on the acquisition of land through eminent domain principle and its relation with applicable international standards.

viii. Conduct a rapid assessment of community's willingness and ability to pay for services, with special attention to more vulnerable households (poorer families, widows, disabled persons) taking into account O&M costs and actual tariff collection rates in these communities. This would include detailing social impacts of the effluent reuse scheme, subsequent tariff collection, payment method and system efficiency; include the evaluation of the willingness to use recovered water

ix. Examine potential livelihood issues arising from a change in hydrology caused in the water regime. Including but not limited to whether farmers will be negatively impacted by the draw down resulting from the 14 wells, how the crop patterns shall be impacted related to the recovered water quality.

x. Methodology of follow-up of the physical-chemical quality of the treated effluent (after treatment and before reuse in the collection tanks of the recovery scheme including but not limited to water disinfection to allow for non-restricted water reuse);

xi. Emergency plan if a technical problem is faced on the WWTP (implying a low quality of the treated water, malfunction of the infrastructures, fail to recover and convey recovered water to farmers);

xii. Awareness campaign on sanitary issues for workers and population who will use the recovered water for irrigation and for livestock, consume the products grown on the 1,500 ha using the recovered water.

Task 7. Development of an Updated Environmental and Social Management Plan (ESMP) based on the baseline relevant components of the ESMP in the SESIA study

Prepare a detailed plan to monitor the implementation of each mitigating measurement that corresponds to a negative impact of the project during construction of the recovery scheme and irrigation network as well as operations.

Suggest and describe environmental and social mitigation measures (elimination, reduction or otherwise compensation) for the project's negative impacts: (i) briefly outlines the negative impacts of the project for both the works phase and operating phase; (ii) describes, with all necessary technical details, each mitigation measure, by indicating the type of impact or pollution it remedies, the period concerned, the organism or people responsible of its implementation and the conditions for which it is necessary (permanently or in unexpected cases for example), with, if necessary, detailed technical information (plans, material description, population census), and potential norms to observe; and (iii) assess the scope and costs of the measures as well as the institutional and training needs to implementing these measures.

Include in the plan an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to implement the plan. Review the authority and capability of institutions at local, provincial/regional, and national levels and recommend steps to strengthen or expand them so that the EMP may be effectively implemented. Assess compensation to affected parties for impacts that cannot be mitigated.

An outline of the contents of the ESMP to be included in the project's Operational Manual should be provided along with environmental/social protection clauses for contracts and specifications.

Task 8. Define the Stakeholder Engagement Plan and assist in conducting Stakeholder Consultations:

The aim of the SEP is to infonn and consult all stakeholders, to encourage their feedback and participation in the project and to inform the design of the project. The consultant should first identify all stakeholders (individuals or groups) who are likely to be affected by the project or may have an interest in the project. This may include beneficiaries/fanners; private well operators, people that should be relocated / loss access to land or resources, local communities; national and local authorities, neighbouring projects, and nongovernmental organizations. The SEP will describe at minimum the timing and methods of engagement adapted to each group throughout the life-cycle of the project, as well as the type of information to be sought from them. The SEP will pay specific attention the women, vulnerable people and will elaborate a consultation process in line with the Do Not Harm methodology (taking into account the local fragile context).

Following the identification o f key project stakeholders, the consulting firm will assist P W A in coordinating the updated ESIA-specific consultations with relevant stakeholders. The stakeholders should be consulted once a draft updated ESIA has been prepared and an executive summary of the updated ESIA will be publicized after these consultations. The draft ESIA should also be available in a public place accessible to affected groups and local NGOs.

Relevant materials will be provided to affected groups in a timely manner prior to consultation and in a form and language that is understandable and accessible to the groups being consulted. The consultant should maintain a record of the public consultation and the records should indicate: means other than consultations e.g. surveys used to seek the views of affected stakeholders; the date and location of the consultation meetings; a list of the attendees and their affiliation and contact address; and summary minutes.

At least two public hearing workshops shall be arranged; the first one shall be EA scoping before the inception report. The program should describe approach, frequency, and substantive issues to be discussed with concerned stakeholders. A public hearing should be held for presenting the findings and recommendations of the consultant at the end of the EA process. The SEP will also describe the Grievance mechanism in place for the initial project and suggest improvement if needed.

2 THE ENVIRONMENTAL AND SOCIAL IMPACTS ASSESSMENT OBJECTIVES AND METHODOLOGY

This chapter will highlight the different objectives of the ESIA study update.

2.1 Study objectives

While interventions of the Effluent Recovery, Irrigation Scheme and Remediation Works Project were previously identified during the preparation of the NGEST SESIA carried out in 2013, the project was included as a single component operating within the whole system. For this report however, all other system components are included only to the extent to which they are linked to the project. In other words, the scope is narrowed to include only the second stage of the Effluent Recovery, Irrigation Scheme and Remediation Works Project (C2). Based on the latter understanding, the update will aim at:

- Narrowing the scope down to include only the Recovery/Reuse scheme and agricultural components only rather than the whole system covered;
- Incorporating the operation of the new WWTP, accounting for the negative impacts of its five- year delay, (that implied an extention of the period of infilteration of partially treated sewage, consequently further pollution to the groundwater, beyond what was originally planned) in addition to the positive impacts expected after its recent operation ;
- Change in well locations design since last study in 2013;
- Incorporating new updated groundwater analysis;
- Incorporating the recent remediation of the infilteration basins carried out;
- Accounting for the new photovoltaic component of the project.

Using the new information on deviations/updates, the following will be carried out by the consultant:

Incorporating deviations/updates expected to affect environmental and social benefits/impacts previously addressed, the consultant will carry out a new analysis including:

- Identification of the possible environmental and social impacts of the proposed effluent recovery and reuse scheme.
- Identification of any potential temporary or permanent land acquisition requirements associated with civil works

- If Bank's Operations Policy 4.12 is determined to apply due to land acquisition requirements, preparation of draft terms of reference to formulate a Resettlement Action Plan (RAP) to manage, mitigate, and monitor the impacts of acquisitions
- An Environmental and Social Management Plan (ESMP) to manage, mitigate and monitor any possible negative impacts during the construction and operation phases of the project
- A capacity assessment of the implementing party to implement the ESMP and recommendations for any capacity-building needs

To achieve these specific objectives, the study team broke down the SESIA update into the same previously identified components, only adding the new component, these being:

a. Groundwater pumping
b. Reuse of water in irrigation
c. Solar operation of the wells

2.2 Environmental Methodology

2.2.1 Water Analysis

Recent water analysis conducted by third party consultants commissioned by PWA, were shared with UG and EcoConserv. All measurements were carried out using the standard method and similar equipment used in the 2013 SEISA, the original EA of NGESTP of 2006 and for the design project..

Analysis spots considered were at the effluent of NWWTP, before entering the infiltration basin, right after leaving the infilteration basin, at the recovery well locations and monitoring wells. Since the wells of the first phase are already operating, analysis made at those wells were used.

Table 2 shows the parameters that were analyzed. Standards against which compliance was measured provided in Annex 1 of this report.

Table 2: Proposed sampling parameters and locations

Parameter	Groundwater (MW2, MW3, Q52)	Influent to infiltration Basin	Recovery well location
pH	x		
TDS	x		
BOD	x	x	x

COD	x	x	x
NO3	x	x	x
T.N &P	x	x	x
Cl	x	x	x
Detergent	x	x	x
F.C	x	x	x

Table 3: Testing procedures and used instruments

Ser.	Parameter		Procedure	Name of instrument
Wastewater analysis				
1.	Temperature		Probe method	Digital TOC meter
2.	pH		Probe method	pH meter
3.	TDS		Probe method	TDS meter
4.	BOD		Oxitop method	Oxitop
5.	COD		Closed reflux method	Spectrophotometer & COD reactor
6.	TSS		2 hrImhofe cone	Imhofe cone
7.	Esi Coliform		Filtration technique	Incubator
8.	Fecal Coliform		Filtration technique	Incubator
9.	Heavy metal		Atomic method	Atomic
10.	Cations & anions	Cl	Argenometric method	Digital titration unit
11.		NO3	colorimetric method	Spectrophotometer
12.		Na	Flam photometry	Flam photometer
13.		Ca	Titration method	Digital titration unit
14.		K	Flam photometry	Flam photometer
15.		Mg	Titration method	Digital titration unit
17.		CO3	Titration method	Digital titration unit
18.	Detergent (mg/l)		Absorption (UV-249 nm)	Spectrophotometer
Soil analysis				
1.	ECe (S/cm)		Soil extraction method	EC meter
2.	SAR		By calculation method	Flam photometer
3.	Organic matter (%)		Ignition method	Furnaces
4.	CaCO3 (%)		Titration method	Digital titration unit
5.	PO--4		Ascorbic acid	Spectrophotometer

2.2.2 Field measurements

Field Measurements

The impact on ambient air quality and noise disturbance associated to this project will be determined during the construction of project components. including booster pumping stations, irrigation pipe distribution network, infilteration basins and recovery wells.

Ambient air quality and Noise sampling and their parameters and durations are as follows:

1. Close to the Cemetery area (nearby the storage tank and booster pumping station (for the reuse scheme) will be constructed)
   - Ambient air (SO_2, NO_x, CO and SPM (and PM10) will be measured to identify the current air quality)
   - Noise
2. Infiltration Pond site
   - Ambient air (SO_2, NO_x, awill be measured to identify the current air quality. SPM (and PM10) does not need to be measured as the construction phase is completed and the soil characteristic, in addition to; the surrounding infiltration ponds are covered with a pavement (service road) and vegetation, thus the dust associatedwith the operation phase can be eliminated.
   - Noise

   At the infiltration ponds area, noise is not expcted to be generated during the operation. Noise is only expected during the construction phase , which has already been completed, therefore, the noise measurement will not be necessarily conducted conducted in this site.

During the operation phase, the management and monitoring will be prepared in accordance to their sensitivity. In addition, the ambient air management and monitoring plan during construction and the operation phase of the project components will be determined in accordance to the specific nature of the site, i.e. the prevailing wind direction, during summer and winter season, day and night as well dry or humid conditions.

These measurements were not made at this phase but will be carried out to be included in the final report.

2.2.3 Groundwater Analyses Verification and Modeling

The impacts on groundwater has always been the most important issue associated with the project, as part of the project has been designed to prevent infiltration into the ground water by partially treated sewage. The EA of the NGEST Project estimated the water mound caused by infiltration of the partially treated sewage at the end of emergency phase will extend 700 m towards the sea, 300 m inland, 250 m north and south of the infiltration basin.

The EA had further assessed the impacts of chlorides, nitrates and pathogenic bacteria. The groundwater modeling prepared in the original EA of the project predicted that the groundwater quality will be improved after the operation of Part B as the new infiltrated plume will wash out the old plume of partially treated water. However, the EA has simulated a worst case scenario where the operation of Part B of the project is delayed and the EA recommended construction of remediation wells to pump out the effluent.

After the delay of Part B of the project, the design consultants have carried out another groundwater modeling for simulating the plume according to the recent conditions. According to this modeling practice the locations of the wells were identified along with their correspondent discharge rates and depths.

The team carefully reviewed the the latest project design and the 2013 update to verify the expected achievements and positive impacts on the groundwater and assess the impact on abstraction wells in the region.

The consultant prepared and run an independent groundwater modeling study taking into consideration the setup of groundwater model developed by the design consultants. This will be done to reach quantifiable assessment for groundwater quality impacts, and for groundwater movements. The assessment of the impacts on groundwater will take into consideration the abstraction rates of the recovery wells, the possible recharge in the agricultural lands and different scenarios for project implementation. In addition, the model will use the most recent available data provided by the Client.

For the current work, the existing groundwater modeling provided during the design project and EA of the original NGESTP study will be assessed and will be used as a reference. The design consultant used Visual Modflow (VMF) version 4.2 and its integrated modules which will be also used in the current study. Therefore, the conceptual model in the design report is considered valid; however, normally our approach consists of updating the conceptual model to schematize the most actual hydro geological context.

The developed numerical model consists of dividing the modeled domain in meshes (space elements) where hydro geological properties are constant, and in dividing the simulation period in time intervals if required, will be assessed. The most up-to-date data provided by the client will be used where the 2012 SEISA project model used the input data until 2012.

2.2.4 Secondary Data

Secondary activities involve collection of different national reports through reviewing available sources of secondary data and assess requirements for primary data collection.

A list of all reviewed data was prepared:

- Statistics of the Palestinian Central Bureau , Palestine Statistical Year Book, 2016
- Statistics of the Palestinian Central Bureau , Palestine Statistical Year Book, 2012
- Statistics of the Palestinian Central Bureau, Gaza Strip Governorates Statistical Year Book, 2015
- Websites i.e. Palestinian News and Info Agency
- Environmental Assessment, North Gaza Emergency Sewage Treatment Plant Project - November 2006
- Supplementary Environmental and Social Assessment of North Gaza Emergency Sewage Treatment Project, Effluent Recovery & Reuse System and Remediation Works, October 2012
- Supplementary Environmental and Social Impact Assessment , Effluent recovery and reuse system and remediation works – April 2013
- The Palestinian Environmental Protection Law No 7 of year 1999
- Land acquisition laws and decrees pertaining to the project
- Complementary prefeasibility study, included in Annex 6
- GCF concept note, included in Annex 7
- 2016 version of the World Bank Standards
- World Bank Safeguard policies
- World bank Report on Assessment of Restrictions on Palestinian Water Sector Development
- WORLD BANK Environmental and Social Framework Setting Environmental and Social Standards for Investment Project Financing
- General EHS Guidelines
- EHS Guidelines for annual crop production
- EHS Guidelines for perennial crop production
- Environmental, Health, and Safety Guidelines for Water and Sanitation
- WHO standards

2.3 Social Study Objectives &Methodology

2.3.1 Social Study Objectives

This ESIA aims at highlighting the following issues:

- Determine the the area of influence that will be affected, positively or negatively, by the project activities .

- Update the socioeconomic data provided in 2012 study.
- Review any updates on the legal framework, particulry, adding the IFC performance standards
- Conduct a detailed social assessment of the local area, by utilizing participatory surveying tools i.e. FGDs guidelines, in-depth interviews.
- Maintain proper engagement with identified key local stakeholders, and focus groups of relevant categories of local actor (including women and vulnerable groups), to discuss available options, listen to and consider proposals from the community, and determine which enjoy the broadest local support;
- Develop legal options for future use of the land;

2.3.2 Social Study Methodology

This study adopted a multidisciplinary approach that employ techniques reported in the Participatory Appraisal Approach. The study team developed various surveying tools that enabled the team to collect both qualitative and quantitative data from secondary and primary sources.

The data collection process was developed to collect similar data from various sources in order to verify the credibility of data collected. The figure below presents the sources of data and tools used

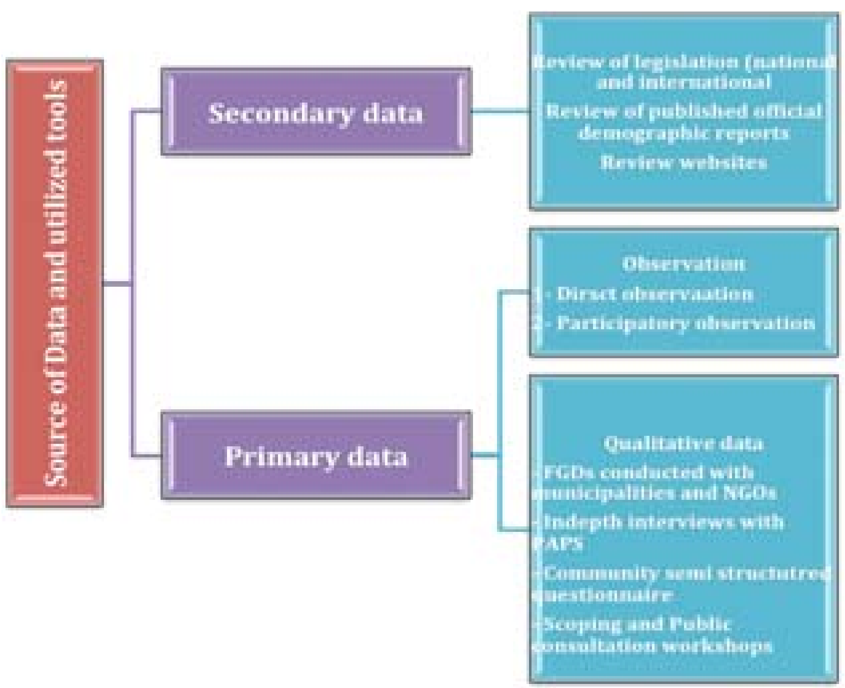


Figure 3:Summary of source of data and tools used

2.3.3 Secondary data

Secondary activities involved collection of different national reports through reviewing available sources of secondary data and conduct meetings to collect data from the municipalities. The review of secondary data was implemented on the level of data published on the internet and the reports developed by various Palestinian Authorities.

Additionally, the team managed to collect relatively updated data from the Palestinan Central Bureau of Statistics (2012).

2.3.4 Primary Data

Primary data collection was intensively implemented during the ESIA report developed in 2012. During this stage, primary data collection was limited to conducting meeting with the key stakehodlers and the project affected persons. As well as, visiting the project site and the area of influence. In order to fulfill the requirements of this project, it was crucial to collect detailed information. Therefore, a Participatory Rapid Appraisal (PRA) methodolgy was adopted in order to enable the study team to fulfill the requirements accordingly during the planned period. However, the verification of data should be assured according to the multi levels' tools that might be applied on different social groups and stakeholders:

1. Data collection

During this phase the study team has done the following activities in order to be able to collect the needed data based on a real situation with a clearer overview of the situation in different areas. Under this phase the following activities have been done:

- A kick off meeting about this assignment was conducted with PWA on the 8th of April 2018. The main objective of this meeting was to introduce the study objective and update the data required in the inception phase.
- Site visit and data collection were applied during April 2018. This date was considered to be the beginning of the Consultant team mobilization and preliminary data collection. EcoConServ and GU team accompanied by the Client representatives visited the project site and the lands that will be irrigated by used water.
- During April 2018, various meetings were conducted with the PAPs, the Endownment, municipalities and potential farmers

Figure 4: Meeting conducted with the PAP'S inside the treatment plant

Figure 5: Site visit to well location

- During April 2018, data was collected from the potential affected groups (well owners- well operators and land owners). The tool used was a semi-structured questionnaire that was modified to be used with each group

Figure 6: Well operator interview

Figure 7: Land owner interview

2. Data management and analysis

- Data was reviewed, edited and clustered based on the nature of stakeholders
- The quantitative data was coded and entered using Microsoft excel and analyused using SPSS 19.

Applying different analysis techniques enriched the results of the data collected which enabled study team to verify data collected. In case of having any discrepancy in data, the team tried to find the most reliable data from other sources either primary or secondary sources

2.3.5 Targeted Groups Identification and Sample Selection

Given the fact that this study is limited to updating the study developed in 2012, the surveyed sample was limited as the 2012 ESIA covered a wide range of potential beneficiaries and various stakeholders. The selected sample was as follow:

- Palestinan Water Authority
- The Ministry of Endownment
- Ministry of Agriculture
- The Municiplaities (Jabalia- Um El Nasr- Beit Lahia and Beit Hanoun
- Palestinian non- governmental Organization Network
- The project affected persons:
  - 11 well operators
  - 10 land owners
  - 11 well owners

2.4 Strengths and Weaknesses of the Adopted Methodology

The applied methodology involved a number of strengths that positively affected the quality of the gathered information and was highly informative for the ESIA process.

1. This methodology enabled the study team to fine tune project activities and enhanced the sense of ownership among various stakeholders
2. The process involved active participation from municipalities and Community Based Organizations. The FGDs have been facilitated and hosted by local CBOs. This secured convenient venues for the FGDs' participants and allowed the Consultants and survey team to engage the CBOs members and introduce the project to them.
3. The tools were carefully selected to suit the type of interviewed stakeholders and the issues that need to be investigated.
4. Bringing all stakeholders together in the workshops and Public Consultation provided the study with verified, multi-perception data which enriched the study,
5. Having about 700 customers interviewed using quantitative tool enabled the study team to have more reliable data
6. Based on the Consultant and research team previous experience and knowledge of the local settings, the survey and the FGDs samples were carefully selected to capture the various specificities of communities in GS.
7. Multiple data analysis techniques were used in order to present the findings informatively. A combination of computer software for the analysis of quantitative data as well as manual

compilation of transcripts and analysis of qualitative data were used. The presentation of the survey findings combined the various tools results.

One of the key challenges that faced the ESIA process is the limited time frame and permit acceptance of the international team to travel to GS due to the internal political situation in Egypt. In addition, due to Ramadan, the social surveys were delayed further.

Although this could not be regarded as a methodological problem, this challenge affected the progress of the stakeholders' consultations and the planned field investigations as part of the ESIA consultancy assignment for the long term actions.

3 POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

One of the tasks included in the SESIA study is reviewing the laws, regulations and institutional set up relevant to environmental and social management in the Gaza Strip in particular and Palestine in general. National and international guidelines for environmental assessment, treatment plants and technical design requirements, including health and safety were reviewed and key points are presented. Analysis of the gaps between Palestinian Laws and International Laws were presented in order to develop some mechanisms to fill in the gaps.

The following section is the summary of the Laws and Regulation reviewed and assessed during the preparation of the SESIA study. The detailed description of the Laws and Regulations is presented in detail in **Annex 1.** Detail Policy, Legal and Institutional Legal Framework.

3.1 Palestinian Laws and Regulations

Table 4: Summary of the reviewed Palestinian laws

Name of Law	Law Summary	Year
Environmental laws and regulations		
Law 7/1999	This basic enactment of the Palestinian Legislative creates a framework for the protection of the environment, public health and biodiversity in Palestine including marine areas. Its 82 sections are divided into 5 Titles: Definitions and general provisions (I); Environmental protection (II); Environmental impact assessment, licensing, inspection and administrative procedure (III); Penalties (IV); Final provisions (V). Article 1 contains an extensive list of definitions, including "natural reserv	1999
Law 3/2002	Palestinian Water Law	2002
	Regulations for Groundwater Pollution Control	
	Guidelines for Wastewater Reuse in the Gaza Strip, Palestine	2002
	Water Pollution Control System	
Decree Law No.14 of 2014	This Law, consisting of 68 articles divided in twelve Chapters, aims at a better water management and development of	

Name of Law	Law Summary	Year
relating to the Water Law	Palestinian water resources, through establishing for a new phase for the water and wastewater sector, its governance and management. It states that the Water Authority will be under the responsibility of the Cabinet, splitting policy from regulatory functions, which was previously carried out by Palestinian Water Authority (PWA) since its establishment	
Decree No. 90/1995	Regarding The establishment of Palestinian Water Authority (PWA)	1995
Decree No. 6/2002	The Environment Quality Authority was established by Presidential decree No 6/2002	2002
TS 34/2012	The Palestinian Treated Wastewater Standard (Technical Specification)	2012
Solid Waste regulations	Solid Waste Management Regulations	2004
Social laws and regulations		
Law 7/2000	Palestinian Labor Laws 7/2000	2000
	Health and safety	
Law 3/2011	Land Ownership	2011
Law 2/1953	Expropriation Law (Istmlak)	1953
Antiquities Law 1966	Palestinian Antiquities Law	1966
Basic laws	Basic Laws declaration for Palestinian Human Right	2003
Law 21	Consumer protection laws	2005
Other laws and regulations		
JSC Regulations	Joint Service Council (JSC) Regulations	2006
PRDP	Palestinian Reform and Development Plan (2008 -2010)	2008-2010
Law 1/1997	Local Council Law	1997

3.2 IFC Performance Standards on Environmental and Social Sustainability

This section will shed lights on international social legislations that might influence the project and which of them should triggered:

Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
Performance Standard 2: Labor and Working Conditions
Performance Standard 3: Resource Efficiency and Pollution Prevention
Performance Standard 4: Community Health, Safety, and Security
Performance Standard 5: Land Acquisition and Involuntary Resettlement
Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
Performance Standard 7: Indigenous Peoples
Performance Standard 8: Cultural Heritage

3.3 World Bank Safeguard Policies and Guidelines

The WB has ten environmental and social policies referred to as the Bank's "Safeguard Policies" that should be considered in its financed projects.

Based on the information to be collected of each project, the environmental initial assessment for each project is addressed through:

- Reviewing the safeguard policies and ensuring that the proposed project does not trigger a safeguard policy that makes it ineligible.
- Describing any safeguard issues and impacts associated with the construction of the project. Identifying and describe any potential large scale, significant and/or irreversible impacts.
- Describing any potential indirect and/or long term impacts due to anticipated future activities in the project area
- Describing measures taken to address safeguard policy issues. Provide an assessment of project proponent capacity to plan and implement the measures described.
- Identifying the key stakeholders and describing the mechanisms for consultation and disclosure of safeguard policies, with an emphasis on potentially affected people.

Among the ten safeguard policies of the WB, five are considered by the Consultant to be relevant to the NGESTP and have been taken into account during this ESIA study; these are listed and discussed below:

- Environmental Assessment (OP 4.01), that was previously discussed in section 3.4 of the current chapter.

- Involuntary Resettlement (OP 4.12)
- Disclosure (BP 17.50)
- Natural Habitats (OP 4.04)
- Cultural Property (OPN 11.03)

3.3.1 OP 4.12 - Involuntary Resettlement

The WB Operational Policy OP 4.12 on Involuntary Resettlement deals with involuntary resettlement in wider terms than the physical displacement of people due to development projects. It rather considers individuals who might be subjected to other sorts of adverse economic impacts on their livelihoods.

The overall objectives of the Bank's policy on involuntary resettlement are:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs;
- Where it cannot be feasibly avoided, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the displaced persons to share the project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs and compensation measures; and,
- Displaced persons should be assisted in improving their livelihoods and standards of living or at least in restoring them, in real terms, to pre-displacement levels or to levels prevailing prior to project implementation, whichever is higher.
- The policy cover the involuntary taking of land resulting in relocation or loss of shelter, loss of or access to productive assets, or loss of sources of income or means of livelihood, whether or not the affected persons must move to another location. It also covers the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

3.3.2 BP/OP 17.50 - Disclosure

WB policy OP 17.50 on Disclosure is also relevant to the project. This policy details the Bank's requirements for making operational information available to the public. The Bank reaffirms its recognition and endorsement of the fundamental importance of transparency and accountability to the development process. In addition, timely dissemination of information to local groups affected by the projects and programs supported by the Bank, including non-governmental organizations, is essential for the effective implementation and sustainability of projects.

3.3.3 OP 4.04 - Natural Habitats

The WB does not finance projects that degrade or convert critical habitats. Effects on non-critical habitats would be tolerated only if no alternatives are available and if acceptable mitigation measures are in place. It is essential to apply a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development.

3.3.4 OP 11.03 – Cultural Property

The core requirements for this Safeguard Policy include investigation and inventory of cultural resources that are potentially affected by the project and set appropriate mitigation measures when there are adverse impacts on physical cultural resources.

3.3.5 Israeli Palestinian Joint Water Committee

There is an agreement or understanding (Memorandum of Understanding) on guidelines and technical criteria for sewerage projects. The project component of reuse system has to follow this guideline. In particular, the guidelines concerning reuse scheme are as follows:

- Article 14 Effluent Reuse and Disposal; In general no discharge of effluent to wadis and / or to rivers and their tributes is permitted. Under exceptional circumstances, and only in the absence of any other disposal route, discharging to certain wadis and river may be permitted by the Joint Water Committee in accordance with the quality specification in schedule 1 and 2. All precautions shall be taken to prevent any possible environmental hazards. The reuse of treated effluent for irrigation shall be in accordance with the provisions detailed in schedule 1 and 2 .
- Article 15 Sludge Reuse and Disposal; Disposal of sludge shall take place at an agreed waste disposal site or reused in accordance with the provision detailed in schedule 3 .

3.4 Regional Legal Frameworks (Jordan, Israel and Egypt) concerning wastewater reuse and Sludge Management and Reuse

For comparisons and lessons learned, the regional legal frameworks in the region (Jordan, Israel and Egypt) as well as International standard (FAO and WHO) concerning wastewater reuse and sludge management and reuse were reviewed and compared during the ESIA process.

3.5 International Agreements involving PNA

The Oslo Accord I (1993) between the Palestinian and the Israelis stated that a joint committee should be established on Economic Cooperation to focus among other matters on environmental issues. The Oslo Accord II (1995), which has been ineffective since the Intifada in 2000, stated that the Israelis and the Palestinians agreed to cooperate in order to prevent damage to the environment.

Both parties also agreed to adopt and comply with internationally recognized environmental standards for air and liquid emissions and to take appropriate measures to prevent pollution of soil and water resources.

3.6 Relevant Ministries and Institutions

Figure below, = presents the relations between PWA and other organizations related to water, wastewater and sludge management. The coordination between the ministry and PWA related to this project is presented in the following chapter, Chapter 6 Environmental and Social Management Plan (ESMP).

4 ENVIRONMENTAL AND SOCIAL BASELINE CONDITIONS

4.1 Environmental Baseline Data

4.1.1 Introduction

Environmental baseline data represent the existing situation in the project component areas, which could be influenced by the project. This chapter will present updated baseline data, with focus on part C2 of the recovery and reuse scheme, covering infiltration ponds (adjacent of the NGWWTP), recovery well field locations and the targeted areas for irrigation sites. The existing environmental conditions in Gaza in general and project component sites in particulars were also studied. Environmental baseline data are presented in the following order:

- General view of the Gaza Strip
- Overview of the Project Components
- Physical Environment
- Biological Environment
- Water Resources;

4.1.2 Overview of the Gaza Strip

The Gaza Strip consists of five governorates, including a total of 33 villages and municipalities. It has a total surface area of 365 km2, a total length of 40 km and a variable width of 7-10 km. The main source of water in the Gaza Strip is the shallow aquifer that underlies the whole Strip. According to a 2016 estimate listed on The Palestinian Central Bureau of Statistics website, the population of the Gaza Strip is estimated to be 1,881,000, distributed between the five governorates including refugee camps. (Table 4.1 below). Population is expected to reach 5,672,829 towards the middle of the centuary, in 2050 (pcbs, 2017). This has been calculated based on an annual growth rate of 3.3% in 2016. This annual growth has been assumed to be constant for all governorates.

A road network already exist in the Gaza Strip with only one main road - Salah El Deen - linking the South to the North passing through the five governorates. UNRWA camps are scattered all over the strip and urban area are distributed over four main areas.

Table 5: Populations distribution in Gaza Strip (source: pbs, 2016)

Governorates	Populations
North Gaza	377,126
Gaza City	645,205
Middle Area	273,245
Khan Yunis	351,934
Rafah	233,490

4.1.3 Overview of the Project Components

Part 'C' is the recovery scheme of the project, divided into two identical stages. Each stage consists of, 14 Recovery Wells, booster pump station, 4,000 m3 storage tank and irrigation network. The first stage ‘C1’ of the project is completed. And includes: 14 Recovery Wells, 4,000 m3 storage tank, 5 booster pumps, 5 monitoring wells. Part 'C2' (the Project) is the project at hand. The location of the project within the Gaza context is depicted in Figure 4-1.

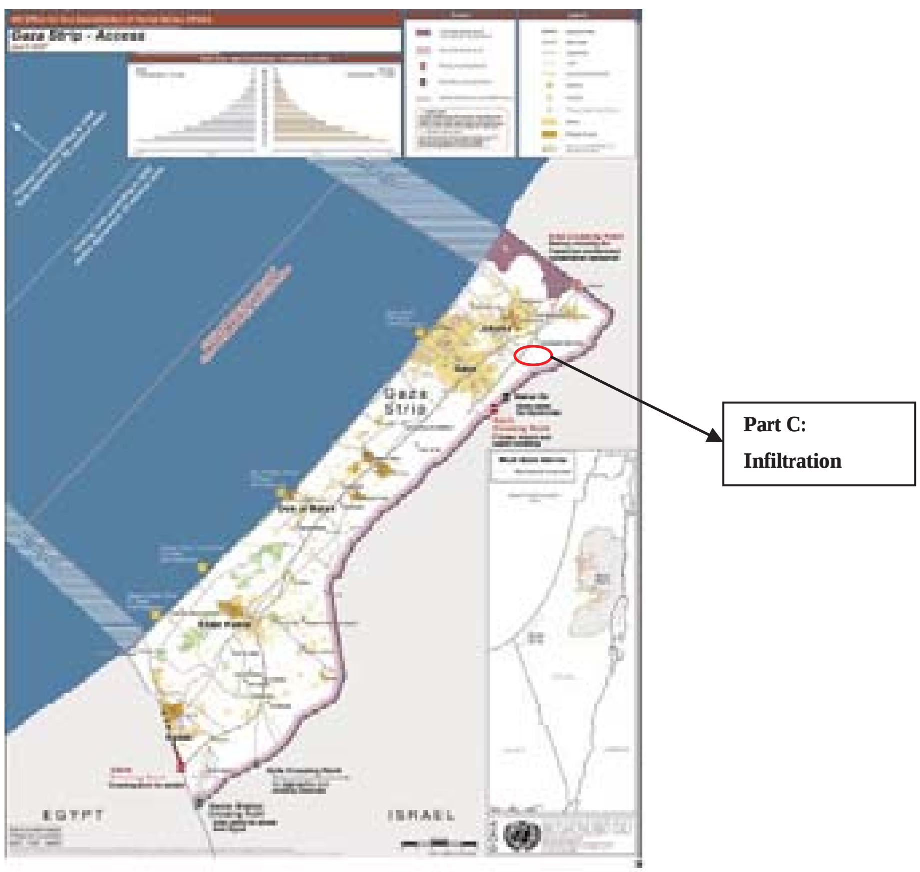


Figure 8: Locations of the project components within the Gaza Strip context

4.1.3.1 Recovery Wells

Locations of the 28 recovery wells are shown in the figure below. Stage 1 (C1) wells, RW1-RW13 and RW21 have been completed and are currently operating.

The rest of the recovery wells, RW14-RW20, RW22-RW29, form stage 2, (C2), the current focus of this project. Figure illustrates the modified locations of the recovered wells. Exact locations and coordinates of these wells are included in **Annex 2** of this report.

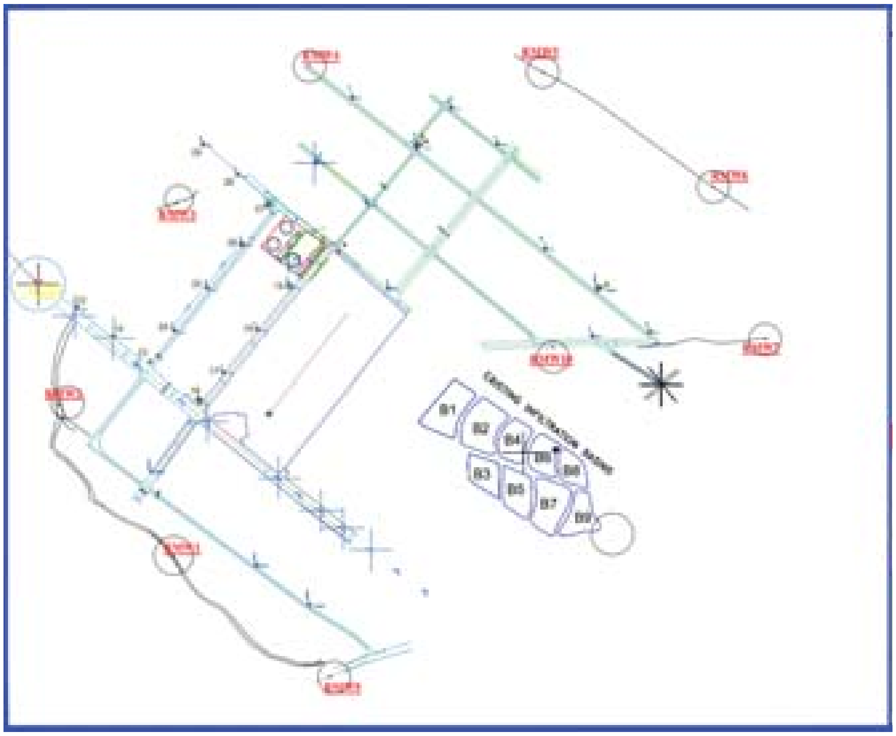


Figure 9: Locations of the Recovery Wells

4.1.3.2 PV Component

In addition, a solar system component was introduced, Figure 10 to provide continuous power supply to ensure the receipt of consistant signals for control systems and transmission of the data to the central control room. It is worth noting that the system is not intended to generate the power supply needed to operate the wells. This component was not included in the previous design report.

4.1.3.3 Booster pump station

The booster pumps are located in a pumping hall together with the suction and pressure manifolds and with all necessary pipe works. The pumping station will serve both irrigation networks; the south area with three irrigation zones and north area with six irrigation zones. There are all together 8 of duty pumps and 2 of stand-by units, all similar pumps, installed parallel and pumping from a common suction manifold into a common pressure manifold.

The pump size is selected based on the maximum system flow rate 6000 m3/hr with the total dynamic head (TDH) 101 m wc. The number of duty pumps for each pumping mode is selected based on the consultant analyses with pumping model software, and showing the pump discharge pressure for irrigation zones with different flows.

The booster pumping station buildings have all been completed, and are missing only the stage 2 pumps. Details of the system design are included in Annex 3.

Figure 10: PV unit on one of the first stage control rooms

4.1.3.4 Storage tank and Irrigation Network

Citrus is a crop grown in the project area with an area of 1198 dunum (fruitable and none-fruitable).Olives represent 614 dunum (fruitable and none-fruitable). Vegetables represent 280 dunum. The area of fruit trees is 120 dunum, whereas, the rain-fed area includes the grains and the demolished area occupying the most of the project area being 12,055 dunum as shown in Figure 11.

Figure 11: Location of the proposed irrigation land using recovery of water from NGEST

Data about the existing agricultural situation in the proposed project area was collected during site visits, interviews and through the first public consultation. The proposed area is actually cultivated with different crops: citrus, olives, fruits, grains and vegetables. The survey includes also the number and ownership of farms in each zone, crops type and their respective irrigation systems. The different types of irrigation systems and crops of proposed irrigation land for recovery water use are shown in Figure 12. Details have been included in Annex 3.

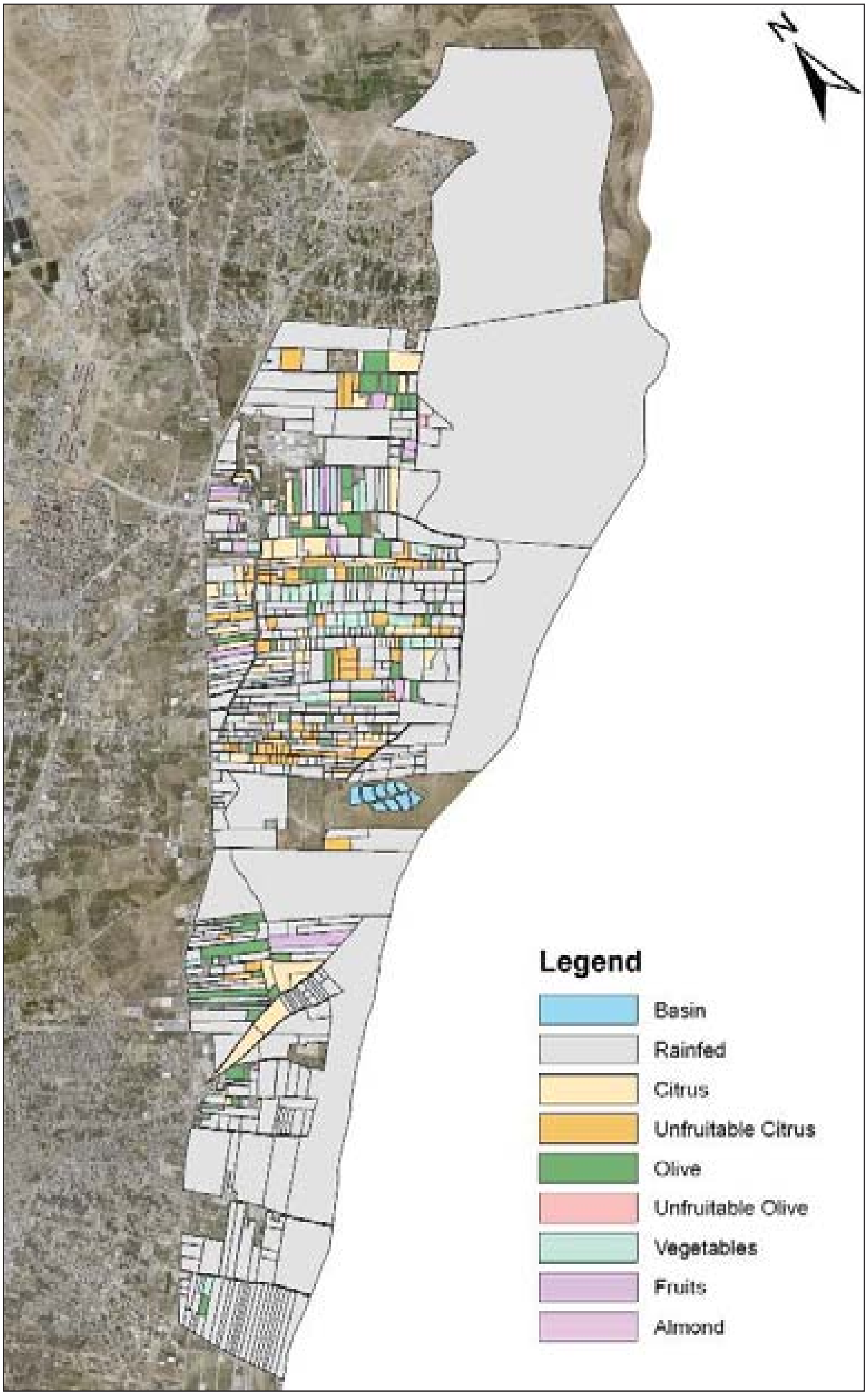


Figure 12: Different types of irrigation systems and crops of proposed irrigation land for recovery water use

Table 6: Distribution of cultivated crops in zone (A&B), December 2009.

Crops	Zone A (dunum)	Zone B (dunum)	Total
Rain-fed	7593	4462	12055
Citrus	515	172	688
Olives	388	212	600
Vegetables	260	20	280
Fruit Trees	120	0	120
Almonds	53	64	117
Citrus (non-fruitable)	464	46	510
Olives (non-fruitable)	14	0	14
Total	9407	4976	14,384

4.2 Physical Environment

4.2.1 Climate

The Gaza Strip is located in a transitional zone between the temperate Mediterranean climate to the West and North and the arid desert climate of the Negev and Sinai deserts to the East and South. There are two well defined seasons: the wet season (October to April), and the dry season (May to September).

As a result, the project sites; The infiltration basins adjacent to NGWWTP, the recovery site and the proposed irrigation land has a typical semi arid Mediterranean climate with long hot summer and dry summer cause by cast ward extension of the Azores high pressure and a mild wet resulted from penetration of mid latitude depressions accompanied by westerly wind moving eastward over the Mediterranean basin. The proximity of the Mediterranean Sea has a moderating effect on temperatures and promotes high humidity throughout the year.

The average daily temperature in Gaza Strip ranges from 25oC in Summer and 13oC in Winter, The maximum daily temperature can reach 29-30oC and the minimum temperature is around 9oC(UNDP/PAPP 2009; UNEP 2009).

Table 7 shows the monthly rainfall average recorded at Gaza station (mm) during period of 2000-2007 and Table 8 shows the monthly rainfall for project area to be irrigated using the recovery water.

Table 7: Monthly rainfall for the project area to be irrigated using recovery water

Season Rainfall	2000-2001	2001-2002	2002-2003	2004-2005	2005-2006	2006-2007
JAN	130.4	17.8	98.1	53.5	106.6	159.5
FEB	60.6	11.8	239.4	46.1	16.8	98.8
MAR	10.5	12.1	67.9	33.2	21.7	68.5
APR	3.2	6.6	9.2	0.2	42.5	1.7
MAY	0	0	0	0	0	0.8
JUNE	0	0	0	0	0	0
JULY	0	0	0	0	0	0
AUG	0	0	0	0	0	0
SEPT	1.2	75.6	0	0	0	2.2
OCT	132.3	23.7	38.8	0.1	19.7	40.8
NOV	17.6	198.3	6.7	104	56.4	27.8
DEC	132.5	202.4	163.2	52.1	51.4	84.9

Table 8: Climatic Data of Project Area in Average (1997-2006) (Meteorological Gaza Office, 2006)

Month	Rainfall(mm)	Min Temp (°C)	Max Temp (°C)	Relative Humidity	Wind (km/hr)	Sunshine (hours)
JAN	94.3	10.8	18.1	65	11.3	4.8
FEB	78.9	11	18.2	67	12.3	6.1
MAR	35.7	12.9	19.8	67	11.5	7.6
APR	10.6	16.3	22.9	67	11.0	8.4
MAY	0.1	19	24.6	72	10.2	9.7
JUN	0	21.7	27.2	74	9.8	9.8
JUL	0	23.8	29.6	74	9.7	10.7
AUG	011	24.5	30.2	72	10.1	10.6
SEP	13.2	23	29	68	10.5	9.7
OCT	42.6	20.3	26.7	67	10.5	8.3
NOV	68.5	16.3	23.5	62	10.6	6.2
DEC	114.4	12.6	19.6	64	10.9	4
Average	38.2	17.7	24.1	68	10.7	8

The prevailing wind direction is South West with an average speed of 4.2 m/s in winter and from North West during summer.

Evaporation rate data were collected during the year 1999 – 2005. The data were recorded at the Gaza station and presented based on average monthly bases, shown in Table 9.

Table 9: Daily average evaporation rate in Gaza station in mm/day (1999-2005)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVR
1999	1.9	2.7	4.7	5.0	6.0	6.3	6.7	6.0	5.3	4.0	3.2	2.6	4.5
2000	2.6	2.7	3.6	4.3	5.2	5.8	5.8	5.9	5.1	4.4	4.8	3.5	4.5
2001	3.7	3.8	4.7	5.1	5.8	8.4	6.4	6.8	6.1	5.0	3.8	3.1	5.2
2002	3.1	3.4	3.8	4.5	5.5	6.2	6.1	6.0	5.8	4.0	3.4	2.5	4.5
2003	2.5	3.2	3.4	4.7	5.4	5.8	6.0	6.0	5.7	4.0	3.1	2.2	4.3
2004	2.6	2.8	3.5	4.7	5.4	6.1	6.6	7.1	6.2	4.5	3.4	2.7	4.6
2005	2.8	2.7	3.4	4.0	5.0	5.7	5.8	5.8	5.4	4.5	3.3	2.1	4.2
AVR.	2.7	3.0	3.9	4.6	5.5	6.3	6.2	6.2	5.7	4.4	3.6	2.7	4.6

4.3 Climate Change

One of the major issues in the present century is global warming. Studies on global warming and its effect on climatic change are being pursued vigorously as a multi disciplinary problem. Global warming due to enhanced greenhouse effect is expected to cause major changes in various climatic variables such as absolute humidity, precipitation and net terrestrial and global solar radiation etc.

Atmospheric temperature is probably the most widely used indicator of climatic changes both on global and regional. Climate change will lead to an intersification of extremes of the global hydrological and could have major impacts on water resources, both ground and surface water, irrigation and in stream ecosystem. Changes in the total amount of precipitation and in its frequency and intensity directly affect the magnitude and timing of runoff and the intensity of floods and drought.

Climate change is also projected to have significant impacts on conditions affecting agriculture. While some aspects of climate change such as longer growing seasons and warmer temperatures may bring benefits (in cold region), there will be also adverse impacts including reduced water availability, greater water demand, and more frequent extreme weather.

The evaluation of potential impacts of climate change on crop and irrigation water requirement has been studied and analyzed during the preparation of Irrigation scheme of Effluent Recovery scheme of NGESTP. The main factor for water demand determination in the report based on the type and percentage of crops in the project area, climate in the project area (rainfall, temperature, relative humidity, etc) taking the climate changes in consideration, soil characteristic and irrigation method. The irrigation scheme was done with taking into account the climate change through the mentioned 10 years by increase the air temperature of 1.5oC / year.

4.4 Precipitation and Evaporation

Figure 13 shows the average rainfall for the hydrological years 2011/2012, as measured at the 12 meteorological stations distributed over GS. In addition, Table 10. present rainfall depth for the season 2010 -2011 in GS

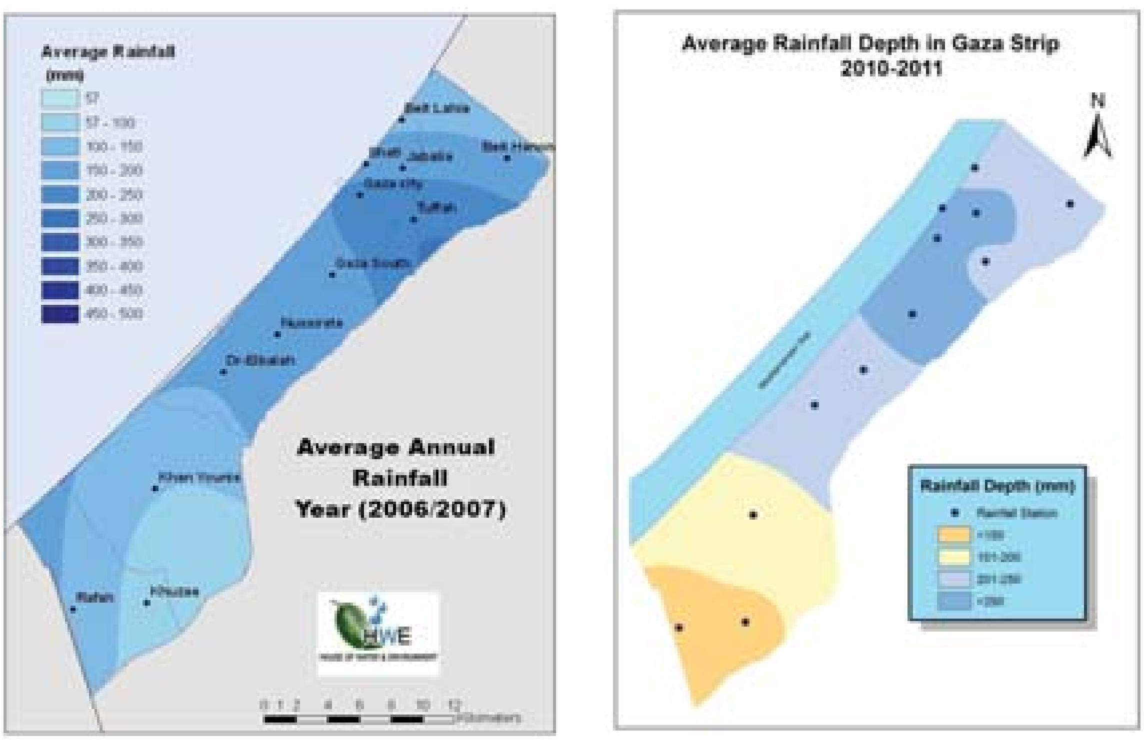


Figure 13: Average rainfall for the hydrological years 2011/2012 as compared to 2006/2007

Table 10: Rainfall depth for the season 2010-2011 in GS

	Rafah	Khuza'a	Khan Younis	Deir Elbalah	Gaza South	Gaza City	Jabalia	Beit Hanon	Beit Lahia
Accumulated Rainfall/ station (mm)	113	140.5	184.5	224	272	259.8	265.5	229.8	236.9
Normal Rainfall/ station (mm)	236	245	290	324	394	370	421	418	433

Source: different meteorological stations at GS

The average annual evaporation rate in the Gaza Strip is around 1900 mm/y (5.2 mm/day). The maximum evaporation rate increases during the summer and may reach over 6 mm/day between June and August(UNDP/PAPP 2009).

4.5 Ambient Air Quality

Ambient air quality (Concentrations of CO and CO2) nearby El Shuhada Cemetery where the booster pumps and storage tanks will be constructed as a part of the water distribution networks for irrigation are expected to be low since the areas have low population densities.

4.6 Noise

Noise levels at similar points as air ambient measurements are expected to be low since the area is of low population density.

4.7 Soil Characteristics

The soil in the Gaza Strip is mainly composed of three types; sand, clay and loess as shown in Figure 14. The sandy soil is found along the coastline extending from South to outside the northern border of the Strip, in the form of sand dunes. The thickness of sand fluctuates between 2 - 50 meters due to the hilly shape of the dunes

The dominate soil type in the area can be considered as heavy soil with a deep soil profile, which means that the hardpan of soil profile is far away from the soil surface. Thus, hardpan and/or parent material will not limit root penetration for deep rooted crops. Detailed soil characteristics (physical and chemical) investigations were provided by PWA.

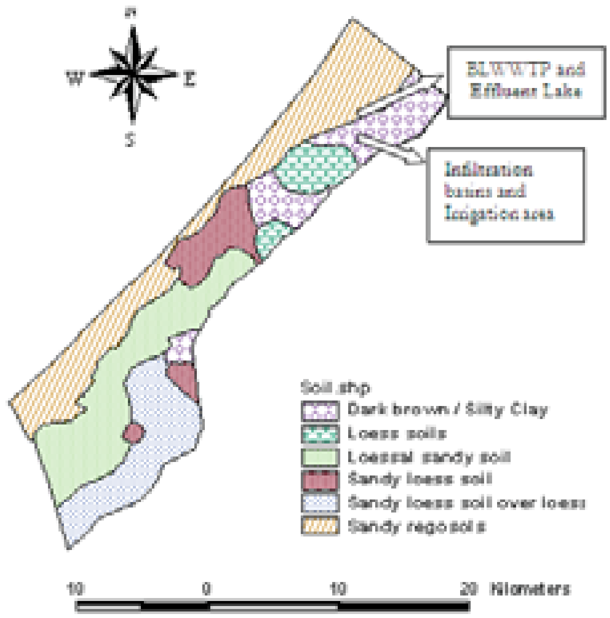


Figure 14: Soil Type of the Project Area for Effluent Recovery and Water Reuse

Zone A Loamy clay textured soils with dark brown to reddish brown color are dominated in the area (Figure 15). The calcium carbonate content ranges from 15 to 20%.

Zone B The north part of this area is loamy clay textured soil and the south part is loose textured soil and is yellow brown in color as shown in Figure 15.

The soil texture of the project area was first determined through soil investigation and reported in the soil report. The soil investigation showed that the texture of soils differs from loam to sandy loam (PWA, 2010).

Surface irrigation is common and predominant in the grooves. Most of the area (about 12,000 dunum) is considered as area under rain-fed conditions, which includes mainly the demolished area and area cultivated with grains. This area would benefit from available reclaimed water and turn from rain-fed farming to irrigated land.

The socio-economic survey will indicate the willingness to pay and the willingness to use the available recovery water and sludge.

Zone A of the project site is characterized with loamy clay textured soils with dark brown to reddish brown color are dominated in the area and the Zone B is characterized with loamy clay textured soil in the northern side and loess textured soil and is yellow brown color (see Figure 15).

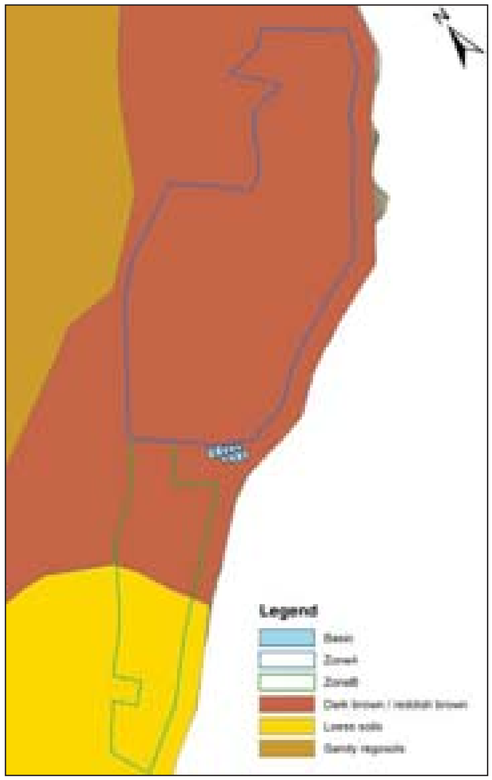


Figure 15: Gaza strip soil map and project area (MOA, 1994)

4.8 Topography and Physiography

The Gaza Strip topographical area is characterized by elongated ridges and depressions ,dry streambeds and shifting sand dunes. The ridges and depression generally extend in a North-North East (NNE) – South-South West (SSW) direction, parallel to the coastline. These are narrow and consist primarily of sandstone.

land surface of the strip attains its maximum elevation at the east of about 95m Above Mean Sea Level (AMSL). The general dipping of the surface is due west and northwest with different intensities. At project site, in the northern part, the maximum ground surface elevation ranges between 40-60 m (AMSL).

4.9 Geomorphology

Three small valleys (Wadi Bet Hanoon, Wadi Gaza and WadiSalqah) cross the Gaza Strip from East to West; they have little water in Winter and are dry in Summer. Wadi Gaza is the only river inside the area and is characterized by a stream regime, where it grows from the limestone hills of Neqab and its stream develops with SE-NW direction, for about 7 km inside the Gaza Strip, then dividing into two sectors. The Wadi cuts through thick loess sediments overlying a gravel horizon on partly hardened calcareous sand (locally known as "Kurkar").

Six sub-basins drain and discharge their water into Wadi Gaza through which it goes directly into the Mediterranean Sea. It was observed that the drainage patterns of the 6 sub-basins are at a considerable distance from the project sites. The coastal land with a width of 1.0 to 3.0 km along the sea is covered with sand dunes of 20-40m height AMSL.

4.10 Geology

Investigation of the Geology of the Gaza Strip was based on the following sources:

- Oil and gas exploitation logs – 2000 m depth - drilled by Israelis;
- Wells drilled during the Coastal Aquifer Management Project(Palestinian Water Authority and USAID 2000);
- Water wells drilled by PWA;
- Geophysical survey conducted in the Gaza Strip(Cooperative-International and Gaza 1997)

The geology of the Gaza Strip consists of a sequence of geological formations ranging from upper Cretaceous to Holocene. This sequence is gradually sloping westwardsincludes a tabular presentation of the geological history of the Gaza Strip. The formations of this sequence are:

Tertiary Formations

The Tertiary formations consist of Saqiya group (upper Eocene to Pliocene) with a thickness of 400 m to 1000 m underlined by Eocene Chalks and limestone.

Quaternary Formations

The Quaternary deposits throughout the Gaza Strip overlie the Saqiyagroup, while at the East they overlie the Eocene Chalks and limestones. The thickness of the Eocene deposits reaches to about 200 m. The coastal aquifer is composed of loose sand dunes (Holocene age) and Kurkar group (Pleistocene). The Kurkar group is composed of marine and aeolian calcareous sandstone (locally known as "kurkar"), reddish silty sandstone ("hamra"), silts, interlayers of clay deposited during the Last Glacial stage and during the Holocene, unconsolidated sand and conglomerates. Close to the present shoreline, the sequence of the Kurkar Group attains an average thickness of 200 m in the South and around 120 m in the North, wedging gradually out towards the foothills of the Judea and Samaria Mountains in the East. The Holocene deposits are found at the top of the Pleistocene formation with a thickness up to 25m.

Sand Dunes

These dunes extend along the shoreline, and originate partly from Nile River sediments. The thickness of these dunes is about 15 m, and their width is small south of the Sofa site, increasing northward up to 3 km.

Sand, Loess and Gravel beds

This formation has a thickness of about 10 m and it is the main formation near the surface of Wadi Gaza.

Alluvial Deposits

These deposits spread in the area around Wadi Gaza and have a thickness of about 25m.

Beach Formation

This formation is composed of a relatively thin layer of sand with shell fragments. It is mainly unconsolidated, and in some places it is cemented due to the precipitation of calcium carbonate.

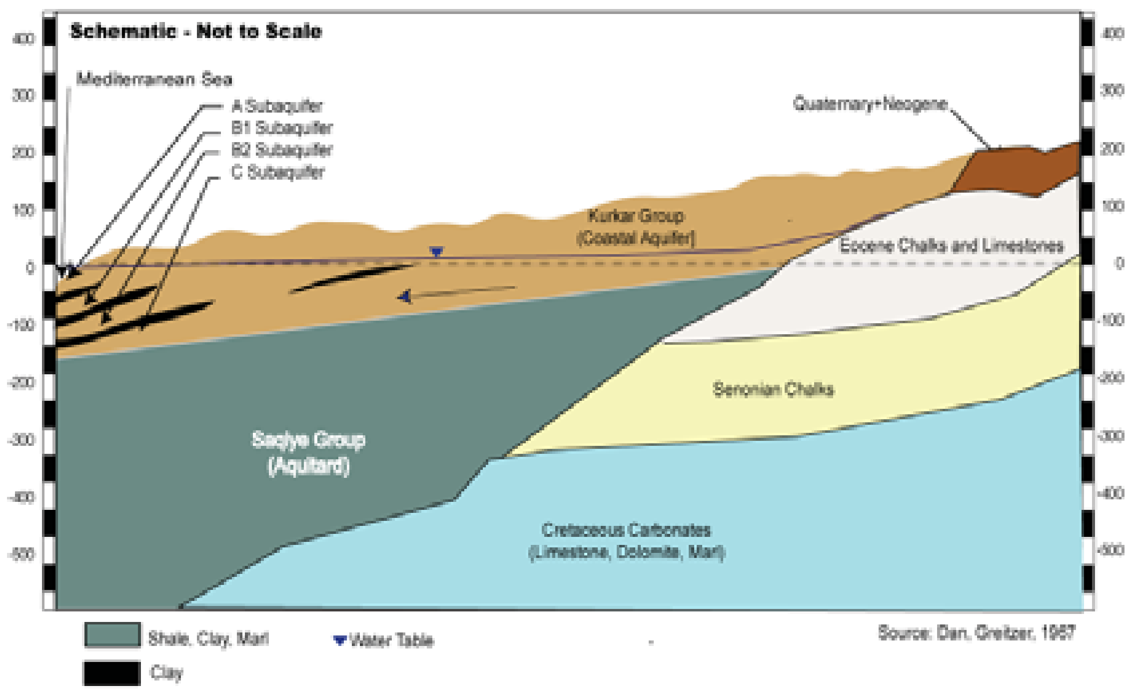


Figure 16:Typical hydrgeological cross section of the Gaza Strip(PWA/USAID 2000a)

4.11 Seismicity

Documented evidence of earthquake activity in Israel and adjacent areas is available over a period of 4000 years. The area is considered a medium seismicity region. Only a few large earthquakes with significant damages have occurred since the second century. The strongest earthquake being recorded in Palestine by modem seismographic equipment, took place in 1994 close to Jerusalem, this had a magnitude of 6 (Richter scale).

Figure 17 shows the variability of the peak ground acceleration (PGA) in Palestine, as developed by the Institute for Petroleum and Geophysical Research. The hazard is based on 10% probability of exceedance in 50 years (10/50), or a return period of circa 475 years. This hazard is mainly contributed by magnitude 6.0 - 6.5 earthquakes. Evidently, larger earthquakes (M>7) may occur in the region, once in 1000 to 6000 years on the average depending on the seismogenic zone, posing much higher hazard.

PGA (g)

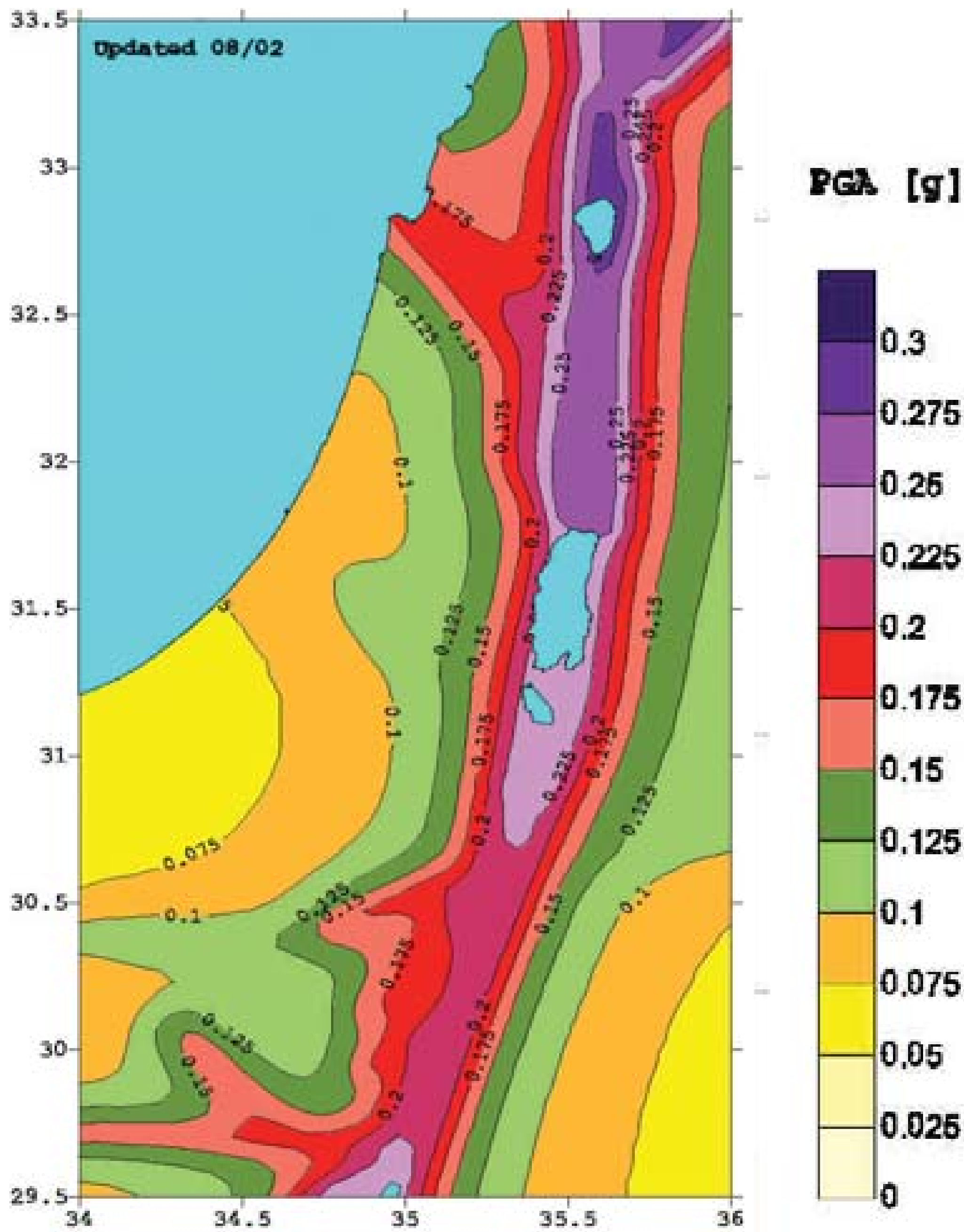


Figure 17: Seismicity map of Palestine

According to Figure 17, the maximum value of PGA is approximately 0.3 g, in the northern part of the Dead Sea fault. For structural design purposes in the Gaza strip, the PGA is taken as 0.075g which corresponds to an earthquake of magnitude 5 on Richter scale. According to the geological survey, no major fault type formations have been observed in Gaza Strip area.

4.12 Biological Environment

4.12.1 Flora

Despite its small size, Palestine is host to about 2,700 species of wild plants. What makes this floral diversity is the fact that Palestine is located where the Mediterranean, Irano-Turanian, Sudanian and Saharo-Arabian plant geographic zones intermingle in an area of varying climates and soil types. The Gaza Strip harbors a diversity of wild vascular plant species including Monocot and Dicot trees, shrubs and herbs. The following table indicates the most common floristic species prevailing in the vicinity of the project area.The plant cover of the area has many traditional uses, e.g. medicinal, nutritional and economical. The role of floristic species in providing vertebrate and invertebrate fauna with nesting, resting, feeding, roosting, sheltering and protection values is very considered.

Many aquatic birds including the Moorhen Gallinula chloropus and Coot Fulica atra in addition to many others usually use the Common Reed as nest material and site. Herons and egrets were found to use the Common Reed as roosting and foraging sites. Frogs are common inhabitants of reedy lagoons as they usually use the Common Reed for cover, rest, nest, breeding purposes and sunbasking. The plant has important ecological and environmental values as it benefits wildlife in different ways in addition to its role in wastewater treatment. The Acacia or Orange Wattle Acacia cyanophyllais a about 5-meter high shrub growing in the sand dune ecosystem characterizing the western belt of the Gaza Strip. The plant is often used as windbreaks, sand soil fixation and for grazing. The shrubs were considered as a vital resource to the Palestinian community in the last few decades due to its exploitation as a fuel material. The Sycamore Fig Ficus sycamorus is one of the old and historic plant species in the Palestine coastal valley. It may grow to 20 meter tall. The tree carries its fruits nearly year long and these fruits are usually eaten fresh by locals. The species is under actual threat due to over-cutting and agricultural and residential creep.

The table of common floristic species recorded in the sand dunes of the Gaza Strip are presented in the Table 11 and Figure 18.

Table 11: Common floristic species recorded in the sand dunes of the Gaza Strip

Scientific Name	Common Name
Cupressus sempervrens	Evergreen Cypress
Pancratium maritimum	Sea Daffodil
Phoenic dactylifera	Date Palm
Opuntia ficus-indica	Tuna Cactus
Salsola kali	Russian Thistle
Artemisia monosperma	Sagebrush
Silybum marianum	Blessed Milk-thistle
Ricinus communis	Castor Oil Plant
Acacia cyaophylla	Acacia
Acacia Arabica	Gum Arabic Tree
Alhagi maurorum	Camel-thorn
Ficus sycamoruz	Sycamore Fig
Eucalyptus camaldulensis	River Red-gum Tree
Ziziphus spina-christi	Christ's thorn
Nicotina glauca	Tree Tobacco
Tamarix nilotica	Nile Tamarisk

Figure 18: Common Floristic species found in the project sites

4.13 Agricultural Fields

Many Olive, Plum, Almond, Citrus agricultural fields or orchards have been encountered at agriculture land allocated for irrigation of water distribution network of water recovery and reuse. Olive trees are usually found arranged in regular rows. The harvest of olive fruits starts in September. Many wildlife species; particularly birds were found to inhabit these agro-ecosystems; Chukars, Stone Curlews, Olivaceous Warblers, Olive-tree Warblers, Yellow-vented Bulbuls, Crested Larks and Barn Swallows are some examples.

4.14 Water Resources

4.14.1 Surface Water

There are no permanent surface water bodies in Gaza Strip. The surface water system in the Gaza Strip consists mainly of valleys (locally named Wadis), which only flood during very short periods during winter. Wadi Gaza is the major wadi crossing the Gaza Strip in its central part. The geographical basin of the wadi has a large catchment area where extends far beyond Bear Esaba as shown in the figure below. Since several decades, it rarely flows due to numerous water diversion and storage projects created upstream in Israel. The second wadi is wadi Halib which drains the depression of Beit Hanon. The third valley is Wadi Silka near Khan Younes, now a dry wash only flowingafter torrential rains and no longer reaching the sea (Ubeid, 2010).

Figure 19:Wadi Gaza catchment area

4.14.2 Groundwater Aquifer

Gaza coastal aquifer has a considerable value for Palestinian people being the only fresh water source able to satisfy the daily consumption needs. The aquifer occupies the extreme western edge of the shallow coastal aquifer. The coastal aquifer is generally 10-15 km wide, and its thickness ranges from 0 - 200 m at the East and the coastline, respectively.

The coastal aquifer consists primarily of Kurkar Group deposits of Pleistocene age including calcareous and silty sandstones, silts, clays, unconsolidated sands, and conglomerates. Near the coast, coastal clays extend to around 2-5 km inland, and divide the aquifer sequence into three or four sub-aquifers, depending upon location (referred to as sub aquifers A, B1, B2, and C) as shown in the figure below. Towards the East, the clays pinch out and the aquifers are largely unconfined (phreatic). Within the Gaza Strip, the total thickness of the Kurkar Group is about 100 m at the shore in the South, and about 200 m near Gaza City. At the eastern Gaza border, the saturated thickness is about 60-70 m in the North, and only a few meters in the South near Rafah. Perched water conditions exist throughout Gaza Strip due to the presence of shallow clays. The base of the coastal aquifer is marked by the top of the Saqiya Group, a thick sequence of marls, clay stones and shales that slopes towards the sea. The Saqiya Group pinches out about 10-15 km from the shore and the coastal aquifer rests directly on Eocene age chalks and limestones.

The results of aquifer tests carried out at different places in the Gaza Strip, show that the transmissivity values range between 700 and 5000 square meters per day (m2/d). The corresponding values of hydraulic conductivity K are mostly within a range of 20-80 meters per day (m/d). Most of the tested wells are municipal wells screened across more than one sub-aquifer. Hence, little is known about any difference in hydraulic properties between sub-aquifers (PWA, 2000b). The estimated effective porosity is 25%, where is the Specific yield values are estimated to be about 15-30 percent and specific storativity is about 10 - 4 (PWA/USAID, 2000b) in Selmi, 2013.

The total water abstraction from the aquifer in 2009 was estimated between 160 and 165 x 106 m3 while the average of replenishment was estimated between 100 – 110 x 106 m3 (HWE report, 2010), this indicates a deficit in the aquifer balance ranging from 55 to 60 x 106 m3/yr.

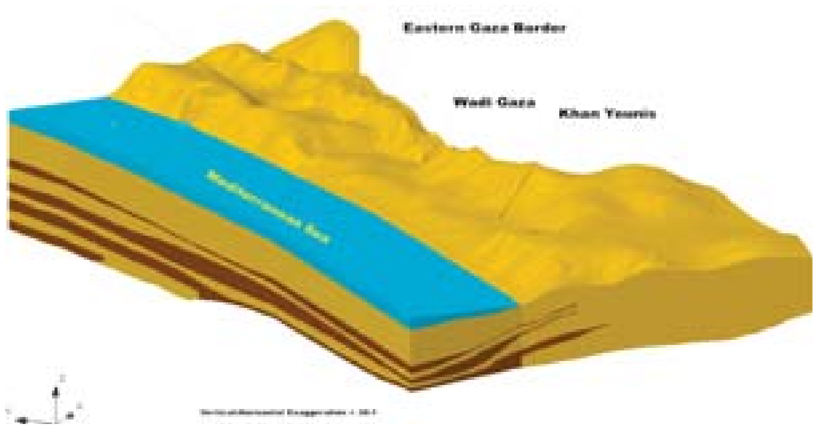


Figure 20: Geological presentation of the Gaza Strip

4.14.3 Northern Aquifer

The ambient water quality in this study focused on chloride and nitrate concentrations since these are the most important contamination indicators in the groundwater in the Northern Gaza aquifer, according to historical statistics. The reference level over which the water is to be considered a source and under which the water is to be considered a sink is set as follows based on the World Health Organization drinking water guidelines: 50 mg/l for NO3, and 250 mg/l for Chloride.

The highest chloride sources are expected in the areas affected by seawater intrusion and the deeper groundwater layer. Figure 4.15.2 2 shows the chloride concentration map for year 2011. The figure presents the average quality values for year 2011. Examining its data, it is apparent that the seawater intrusion zone covers the western part with 2 to 3 km inland the aquifer. Most of the municipal wells were concentrated in this zone and due the high pumping rate of these wells resulted in accelerating the seawater intrusion. Generally, the chloride concentrations in the abstracted water exceed 250 mg/l in most of the Gaza Coastal Aquifer.

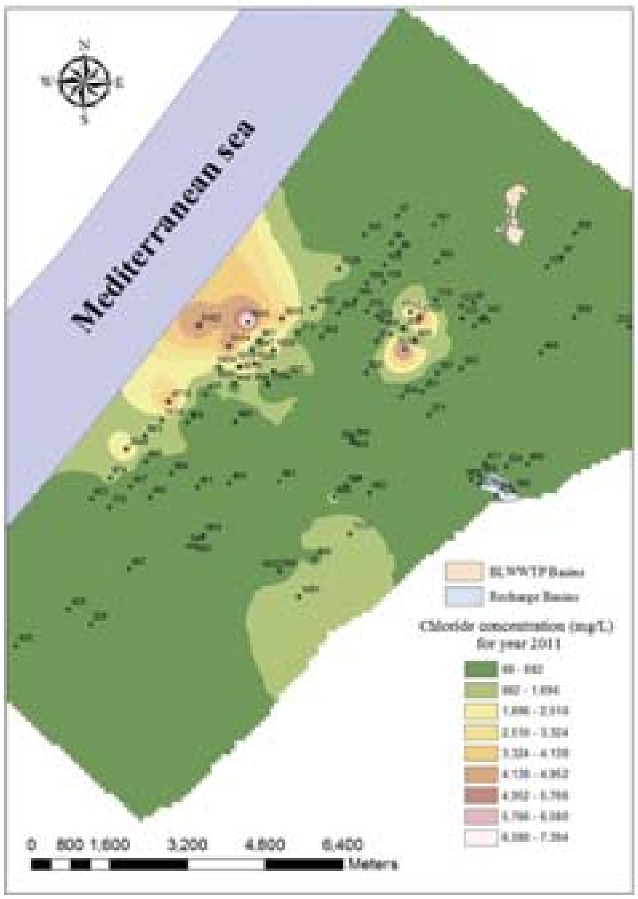


Figure 21:Chloride concentration contour maps for year 2011

Figure 21 shows the nitrate concentration contour maps for 2011. The figure presents the average quality values for 2011 collected from municipal and agricultural wells. Thefigure shows that NO3 concentration exceeds the WHO drinking water guidelines in most of the Northern Gaza aquifer.

In the area around the proposed infiltration site the average nitrate concentration ranged between 55 to 113 mg/l. In a 2006 EIA study, it was noticed that the maximum nitrate concentration in the groundwater was 30 mg/l in 2003 at the infiltration site. This indicates that the increase of the nitrate concentration is due to the operation of the infiltration basin using partially treated wastewater.

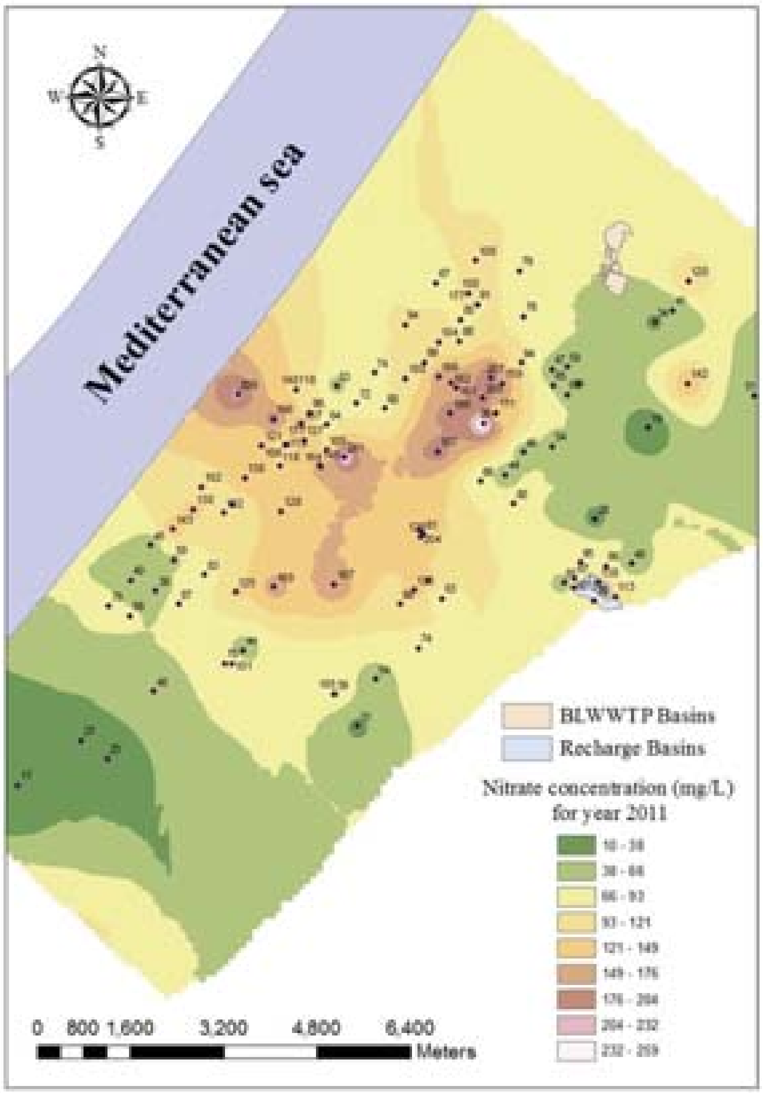


Figure 22:Nitrate concentration contour maps for year 2011

4.14.4 Infiltration Site

The assessment of the aquifer water quality in the infiltration site is based on:

- The aquifer water quality baseline survey carried out by PWA (Recovery Wells Geoinvestigations), included in Annex 4.

- The water sampling of the aquifer close to the basin carried out during design of the recovery scheme project through two circles as shown in Figure 23 and, the water analysis during the current project, .

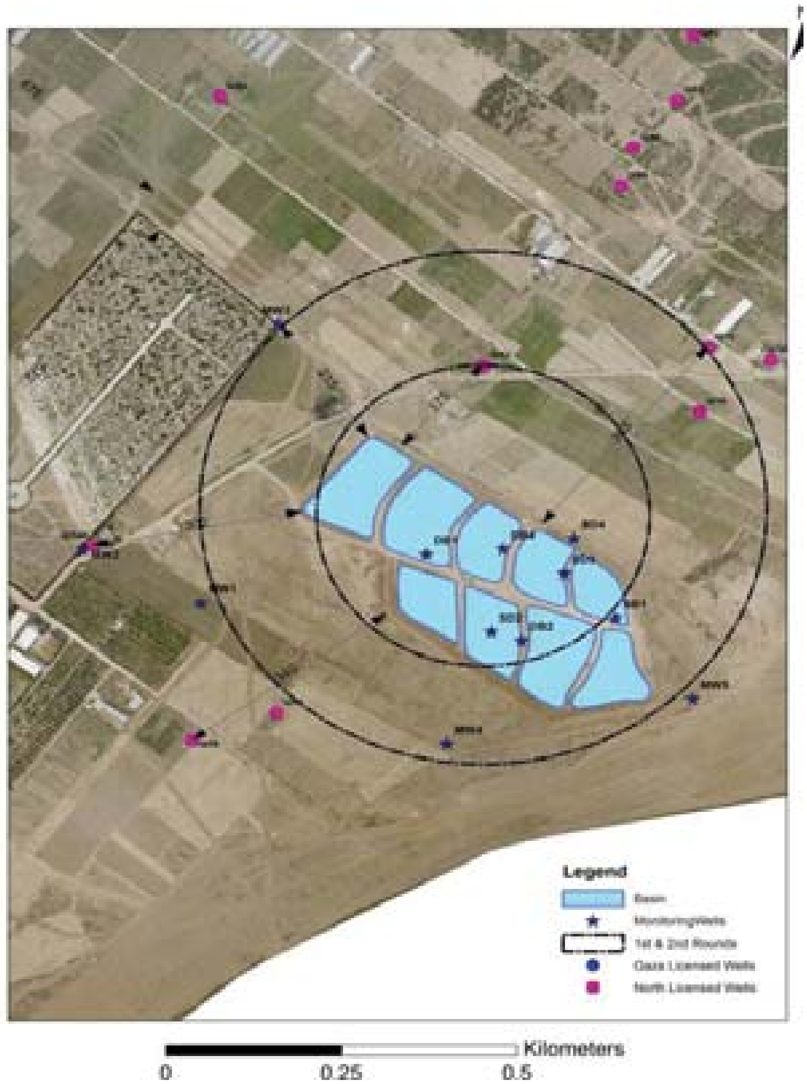


Figure 23:Location of Sampled Wells close to the infiltration basin

Figure 24 shows the results of Cl concentration in the wells close to the infiltration basin for the years 2007-2012. It can be seen that chloride concentrations were found to range between 350 to 650 mg/l, after which the trend continued to be steady since 2011. Well Q53 was an exception where a decrease in the Cl concentration was exhibited, dropping from 610 mg/l in 2009 (the start of operation of the infiltration basin) to 350 mg/l in mid-2012. The well is around 175 m from the basin which indicates that the infiltrated wastewater reached this well since the Cl concentration of this well is very close to the value of Cl concentration on the infiltration basin (around 330 mg/l).

Examining Figure 25, it can be seen that the steady trend continues, ranges being around 350-400 mg/l. Examining water sample analysis taken from the first stage recovery wells, it was found that chloride concentrations fell within the same range.

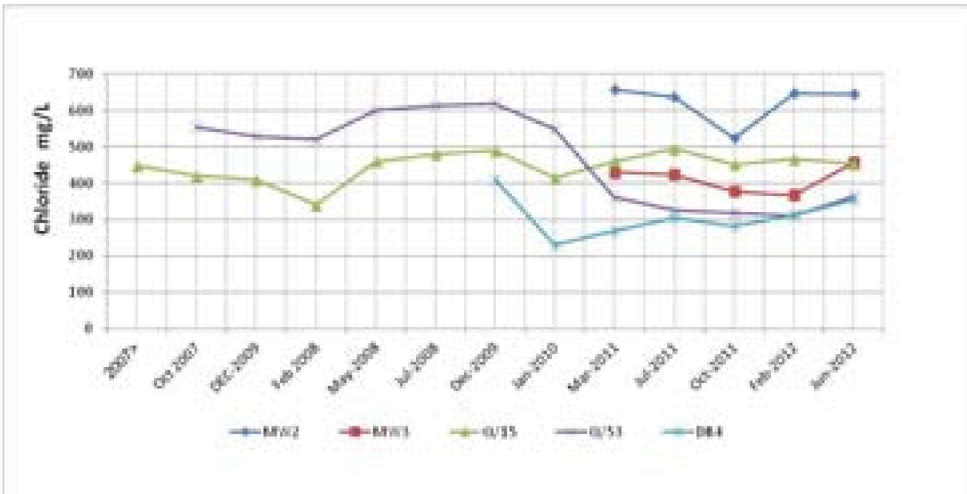


Figure 24:Cl Concentration in the Wells Close to the Infiltration Basins (2007-2012)

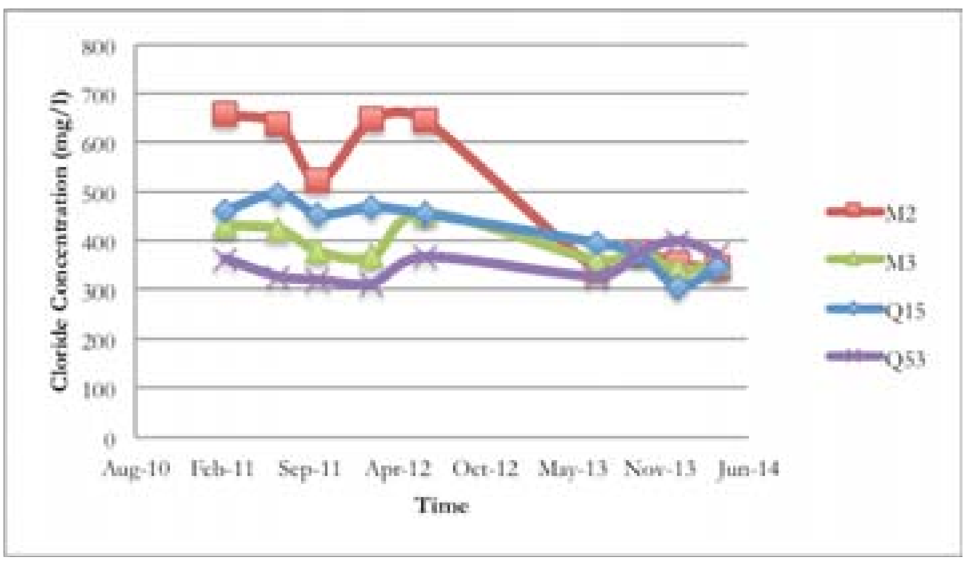


Figure 25:Cl Concentration in the Wells Close to the Infiltration Basins (2010-2014)

Looking at the nitrate results, it can be seen that concentrations range from 20mg/l to 150 mg/l in 2017, both in the monitoring wells and in the recovery wells, indicating some increase in nitrate concentrations since 2012. These numbers far exceed the WHO standards that indicate a maximum value of 55 mg/l for nitrate.

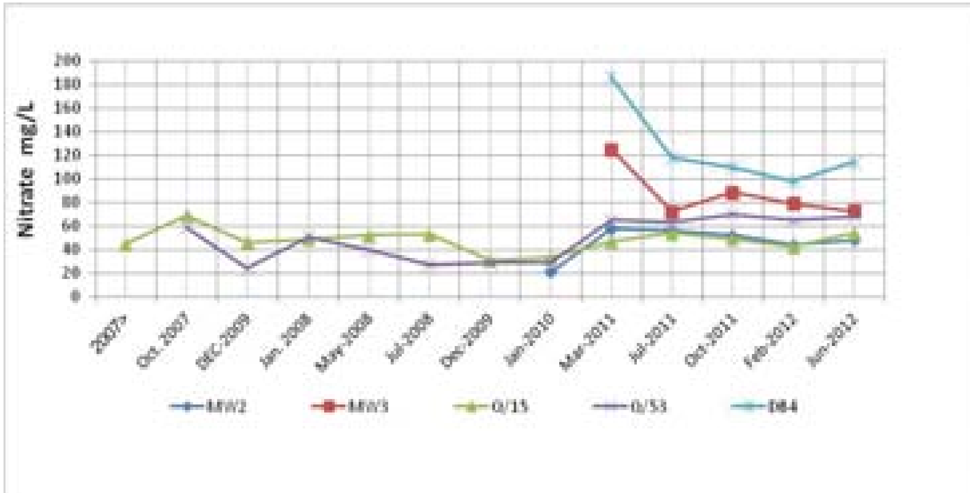


Figure 26: Nitrate concentration in the wells close to the infilteration (2007-2012)

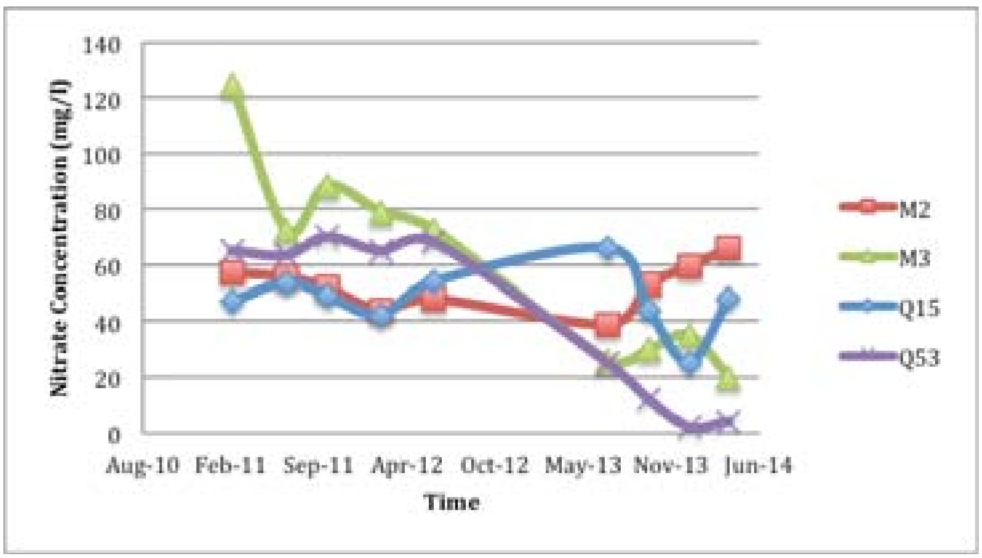


Figure 27: Nitrate concentration in the wells close to the infilteration (2010-2014)

Pathogenic bacteria is also expected in the groundwater in wells in close proximity to the infiltration basin, since partially treated sewage has been infiltrating the aquifer for 9 years. Table 12 presents the microbiological analyses of groundwater samples from the wells close to the infiltration basin. The table shows that the groundwater is free of Salmonella, Nematodes and Amoeba &Gardia. However, the total Bacteria ranges between 30 to 395 cfu/ml and the total coliform ranges between 6 to 650 cfu /100ml. This according to the standards discussed will only allow restricted use of the water for irrigation.

Table 13-24 shows the analysis of BOD and COD in the same wells. It can be seen that the BOD in the years 2014-2016 in most wells exceed 10mg/l.

Table 12: Microbiological analysis for groundwater samples from wells close to the infiltration basin

Well no.	2007-2012			2010-2014		
	Total Bacteria Count Stdcfu/1ml.	Total coliform cfu /100mL	Faecal coliform cfu /100mL	Total Bacteria Count Stdcfu/1ml. (2010)	Total coliform cfu /100mL	Faecal coliform cfu /100mL
Mw1	40-105	6	2	105	16-650	3
MW2	60-205	10	4	250	73-172	4-30
Mw3	40-350	14-25	9	350	11-150	5-46
Mw4	35-182	0	negative	182	39-106	2-10
Mw5	65	Over 300	7		50-6200	34-100
Site well	15-55	30	8	15	14-300	8
Q15	60-375	30-76	20	375	24-75	8-27
Q20	353-395	3-65	2	395	8-90	6-50
Q53	30-55	negative	negative	55	6-86	0-4
Q54B	33-85	40	25	33	65-74	26-33
Q64	90-310	50-1100	22	310	108-656	88-252
DB4	55-165	35-85	15-33	165	85-2000	6-33

Table 13: BOD5 Concentrations (O2/L) in wells close to the infiltration basin

	Mw1	MW2	Mw3	Mw4	Mw5	Site well	Q15	Q20	Q53	Q54B	Q64	DB4
	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Mar-11	1.8	0.8	1.5	0	0	1.9	1.9	2	1.9	< 2.00	2	11
Jul-11	5	2	4	1.9	1.8	4.9	4.9	5	1.9	< 2	5	11
Oct-11	5	5	6	5.1	5.1	5.1	5.1	5	5.1	< 5	5	12
Feb-12	5	5	6.5	4.9	4.9	4.9	4.9	5	4.9	-----	5	11.5
Jun-12	5	5	6.2	4.8	4.8	4.9	4.9	5	4.9	< 5	5	12
Jul-13	4.5	5	8.1	5	15	5	15	0	20	0	2	0
Oct-13	4	5	0	10	10	2	7	2	8	9	8	1
Jan-14	5	5	10	5	10	10	5	10	15	30	35	
Apr-14	7	10	15	15	20	65	45	60	45	45	55	
Jun-14	9.0	12.5	14.5	12.5	16							

Oct-15	11.0	15	14	10	12	15	7	6	10	5	7	10
Dec-15	7.7	11.7	13.3	15.7	9.7	3.0	8.0	4.0	12.0	4.0	8.0	11.0
Apr-16	20.0	22.0	10.0	25.0	22.0		20.0	5.0	20.0	22.0	15.0	20.0
Jul-16	25.0	25.0	17.0	27.0	25.0	30.0	25.0	15.0	25.0	22.0	25.0	20.0

Table 14: COD Concentrations (O2/L) in wells close to the infiltration basin

	Mw1	MW2	Mw3	Mw4	Mw5	Site well	Q15	Q20	Q53	Q54B	Q64	DB4
Mar-11	5	2	3	0	0	3	3	2.5	3.5	3	2	25
Jul-11	7.2	2.8	8.4	3.2	0.8	13.6	9.6	9.6	4.8	5.6	8	25
Oct-11	4.8	7.2	8.4	2.4	2.5	7.2	8.5	7.8	5.6	6.2	2.4	24
Feb-12	4.2	4.4	7.2	2.8	2.4	5.6	6.2	5.4	4.4	-----	3.6	24
Jun-12	4.5	4.8	8	3	3.5	6.6	6.7	5.8	4.9	6.5	3.8	26
Jul-13	2	10	2	16	50	20	40	20	50	5	7	2
Oct-13	17	20	3	30	25	6	14	17	95	20	20	5
Jan-14	38	25	12	35	32	23	20	27	31	89	41	
Apr-14	20	20	30	40	46	170	95	120	40	100	120	
Jun-14												
Oct-15	30	36	33	38	37	50	22		33			35

Heavy metals were analyzed in the same wells close to the infiltration by PWA in mid of year 2016. As shown in Table 15 the heavy metals concentrations in all analyzed wells were less than the Palestinian standard values for irrigation. However, there are some wells that have concentrations of Boron and Mercury higher than the standard values. The wells which have Boron concentration higher than the standard values are MW2, MW3, Q15, Q54B and Q64. The range of Boron concentration is between 0.4 to 1.39 mg/l. The mercury is also found in MW1, MW2, MW4, Q54B and Q64. The concentration of mercury in these wells ranges between 0.001 to 0.10 mg/l, which is higher than the standard value of 0.001 mg/l.

Table 15: Heavy metal concentrations in wells close to the infilteration basins

Parameter	Standard Value	MW1	MW2	MW3	MW4	Q15	Q54B	Q64
Silver, mg/l	1	0.005	0.005	0.005	0.01	0.01	0.01	0.01
Aluminum, mg/l	5	0.1	0.032	0.052	0.03	0.03	0.42	0.03
Boron, mg/l	0.7	**1.557**	**1.396**	**1.21**	0.4048	**1.166**	**1.527**	**1.19**

Cadmium, mg/l	0.01	0.0006	0.001	0.0006	0.001	0.001	0.001	0.001
Cobalt, mg/l	0.05	0.0032	0.002	0.0031	0.0069	0.001	0.0033	0.001
Chromium, mg/l	0.1	0.0173	0.01	0.0118	0.01	0.01	0.0303	0.01
Copper, mg/l	0.2	0.009	0.01	0.01	0.01	0.01	0.01	0.01
Iron, mg/l	5	2.7	0.66	0.67	0.67	0.26	0.17	0.27
Manganese, mg/l	0.2	0.21	0.005	0.005	0.0218	0.005	0.0883	0.005
Nickel, mg/l	0.2	0.004	0.001	0.0008	0.001	0.001	0.001	0.001
Lead, mg/l	1	0.095	0.088	0.093	0.099	0.092	0.09	0.089
Zinc, mg/l	2	0.05	0.014	0.012	0.027	0.008	0.0576	0.0257
Arsenic, mg/l								
Mercury, mg/l	0.001	0.001-0.0071	**0.01**	0.003	0.004	0.003	0.006	0.009
Phosphorus, mg/l	30	20	14-32	16-29	16-20	14-25	**2-55**	**3-40**

Table 16: Water analysis of major parameters in the stage 1 recovery wells

Parameter	RW24 (29/10/2017)		RW26 (12/10/2017)		RW27 (22/10/2017)		RW28 (21/10/2017)	RW29 (29/10/2017)	
	11:30AM 100m3/h	16:00 200m3/h	11:30AM 100m3/h	16:00 200m3/h	11:30AM 100m3/h	16:00 200m3/h	ND	11:30AM 100m3/h	16:00 200m3/h
Acidity (PH)	7.62	7.445	8.386	8.123	7.461	7.451	8.104	8.021	7.461
E.C.	2340	1405	2120	2130	2020	2000	2020	2140	2130
T.D.S	1405	1390	1272	1278	1212	1200	1212	1285	1278
T.A.	660	650	688	682	644	638	660	605	560
T.S.S.	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
B.O.D.	<10	<10	<10	<10	<10	<10	<10	<10	<10
NO3	37	35	25	20	62	63	150	92	90
NH3-N	Nil	Nil	1	1	Nil	Nil	Nil	Nil	Nil
NO2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Cl	444	440	444	386	444	425	367	386	452
PO4-P	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
SO4	60	60	42	43	50	50	48	64	60
Na	450	445	404	406	380	385	385	422	420
K	3	3	10	11	10	10	8	3	3

	Critical range in wells (boarderline to high)	Most stringent Limit	Complience criteria
BOD5	15-65	10	concentrations exceeding limits found
COD	50-170	Up to 50	Mostly within range
PH		6-9	All lie within range
NO3	53-79	55	concentrations exceeding limits found
Cl	262-891	250	Concentrations found exceeding limits
Heavy metals (in general)		Boron: 0.7 Murcury : 0.001	In just a few instances high concentrations of : ▪ Boron were exhibited in high concentrations, exceeding the allowable 0.7mg/l ▪ Murcury was found to be in concentrations higher than the allowable limits in some measurements wells **Generally, all metals found well below limits**
Phosphorus	30	2-55 &3-40	Found to exceed allowable limits in 2 of the wells.
Total Bacteria count	6000 in MW5	2000	Found to exceed allowable limits in MW5 of the wells.
Fecal coliform count	10 for unrestricted irrigation	8-52	

4.15 Water Status, Network and Utility in the Gaza Strip

The Gaza Strip is a semi-arid area where rainfalls in the winter season (from September to April), and ranges between 200mm/year in the south to about 400mm/year in the north, while the long term average rainfall rate in all ofthe Gaza Strip is about 317mm/year. Groundwater aquifers are the only water source for all kind of human usage in the Gaza Strip (domestic, agricultural and industrial) .

The Gaza aquifer, which is a classical coastal aquifer, represents the sole water source of the Gaza Strip covering an area of 360 (km2) with a total recharge of approximately 60 mcm/ yr. The Gaza aquifer is threatened by seawater and salt ground water intrusion due to over pumping, and by pollution especially nitrates from the overuse of fertilizers and infiltration of sewage (Murad, 2004).

Groundwater has faced deterioration in both quality and quantity for many reasons, among them low rainfall, increased in the urban areas leading to a decrease in the recharge quantity of the aquifer, and also increasing population whichdepletes the aquifer and leads to seawater intrusion in some areas as a result ofpressure differences between the groundwater elevation and sea water level. The groundwater aquifer beneath the Gaza Strip is limited in its area, while the natural boundary of this aquifer reaches Haifa in the North and goes to Sinai in Egypt in the south, and it's also bounded from Hebron in the East till the Meditation Sea in the west.

Fresh water production from the Gaza ground aquifer has become limited because the natural recharge from East and North is being trapped before reaching the political boundary of the Gaza Strip through drilling wells at the Eastern and Northern Gaza borders. This water added to that the dams which are being constructed along the upper stream of Wadi Gaza to stop the natural flow in the Wadi towards Gaza Strip, which makes the entire Wadi in the Gaza Strip dry.

The total length of water distribution networks in the Gaza strip is about 800 kilometers, with pipe diameters varying from 2 to 20 inches according to the purpose. The water network coverage in the Gaza Strip has reached 98%. The overall rate of water distribution in Gaza is between 70 to 85 liters per capita/day. The ratio of water distribution network efficiency is about 63%, including the illegal networks and leaks. The number of the water services subscribers is around 120 thousand, distributed over the Gaza governorates.

The size of the problem for Palestinians may be best illustrated by noting that the total available groundwater in Israel and the Palestinian Territory is 1,209 million cubic meters/year, out of which 1,046 mcm/year is currently being used by the Israelis, while the Palestinians are permitted to use only 259 mcm/year. The imbalance of current water use translates into an imbalance in water consumption. The Palestinian domestic per capita consumption of 35-80 l/day is far below the WHO standards, which assign a minimum of 100 l/capita/day. On the other end the Israeli per capita consumption exceeds 300 l/ day. Israel also uses about 800 mcm/ yr of the total quantities of the Jordan River water, which means that most of Israel's water comes from rivers that originate outside the border, or from disputed lands.

During the recent surveys on present water consumption in Palestine, the industrial consumption could not be separated from domestic water consumption; therefore it is included in the figures of domestic water consumption. In Gaza, Palestinians are using about 177.4 mcm/yr from groundwater, according to a 2010 estimate. With a safe yield of only 55 mcm/yr, there is an over pumping of about 87%, and it is for this reason that groundwater quality is deteriorating. The total water consumption in Palestine was estimated at 326.8 mcm/yr. A. Summary of Water Supply and Consumption in Palestine is presented on following table, Table 17.

Table 17: Summary of Water Supply and Consumption in Palestine

Water production in Palestine
All figures expressed in Mm3/year

196.1 PWA, 2012 | 26.1 other source | 80.0 TPAT estimation

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water made available (wells, springs + purchase from Mekorot)						**290.4**	**309.5**	**316.7**	**335.6**	**303.6**	**311.2**	**326.8**	
Palestine	wells					196.1	214.7	223.5	241.2	225.7	227.2	244.0	
	springs					52.7	53.6	51.7	44.8	25.2	30.6	26.8	
	Mekhorot					41.6	41.2	41.5	49.6	52.7	53.4	56.0	
West Bank	wells					50.6	70.2	70.5	77.7	69.7	68.2	71.5	
	springs					52.7	53.6	51.7	44.8	25.2	30.6	26.8	
	Mekhorot					37.6	37.2	37.5	45.0	47.9	48.7	51.1	
Gaza	wells					145.5	144.5	153.0	163.5	156.0	159.0	177.4	
	springs					0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Mekhorot					4.0	4.0	4.0	4.6	4.8	4.7	4.9	

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Water made available (wells, springs + purchase from Mekorot)						**278.2**	**278.1**	**284.7**	**293.8**	**277.8**	**276.1**	**304.4**	
Palestine	domestic					148.0	151.0	153.0	163.5	178.6	172.5	181.4	
	agriculture					130.2	127.1	131.7	130.3	99.2	103.6	123.0	
West Bank	domestic					80.0	80.0	80.0	85.5	96.6	86.5	85.0	
	agriculture					52.7	53.6	51.7	44.8	25.2	30.6	42.0	
Gaza	domestic	55.0	57.0	61.0	65.0	68.0	71.0	73.0	78.0	82.0	86.0	96.4	
	agriculture				79.5	77.5	73.5	80.0	85.5	74.0	73.0	81.0	
Gaza	water consumption	35.0	38.0	39.0	40.0	42.0	43.0	44.0	45.0	48.0	50.0	54.0	
	UFW	35%	33%	36%	38%	38%	39%	40%	42%	41%	42%	44%	

Source : National Water and Wastewater Strategy for Palestine, 2013

4.16 Current Status of Wastewater Treatment and Reuse

The term “wastewater” properly means any water that is no longer wanted, as no further benefits can be derived out of it. About 99 percent of wastewater is water, and only one percent is solid wastes. For the last three decades or so, the benefits of promoting wastewater reuse as a means of supplementing water resources and avoidance of environmental degradation have been recognized by national governments. The value of wastewater is becoming increasingly understood in arid and semi-arid countries and many countries are now looking forward to ways of improving and expanding wastewater reuse practices. Research scientists, aware of both benefits and hazards, are evaluating it as one of the options for future water demands.

Although wastewater reuse in agriculture has been practiced since a long time in several communities around the world, it is becoming significantly an important means for facing the future water challenges. Its role is vital in achieving a reliable and sustainable integrated water resources management in modern societies.

The main challenge for wastewater reuse in agriculture remains in finding cheap and appropriate wastewater treatment systems that can improve the quality of wastewater to be safely used in irrigation without imposing risks on health or the environment. Banning irrigation with insufficiently treated wastewater will unlikely be stop it. Effective wastewater treatment might not be available for many years within a number of developing countries where wastewater is being used for crop irrigation. Therefore, governments must adopt appropriate and practical policies that offer other solutions, when adequate wastewater treatment is beyond their reach.

In the MENA region, wastewater reuse in agriculture is common. In many countries, especially those where water shortage is severe, access to freshwater for irrigation is limited and instead farmers use wastewater. But this is done in a semi-planned or unplanned manner. The primary problems associated with reusing insufficiently treated wastewater are the inherent health risks from wastewater containing bacteria, viruses, and a wide range
of parasitic organisms, and the negative impacts of irrigation with wastewater on certain crops and the soil (World Bank 2001).

To overcome those implications and to utilize the full benefits of agricultural wastewater reuse, regulatory practices and the necessary institutional framework on both national and local levels and their adoption need to be reviewed and different stakeholders have to be recognized within a national policy context.

As discussed earlier, the oldest and largest reuse of wastewater is for irrigation of agricultural crops. Potential constraints in this type of application are:

- surface and groundwater pollution, if poorly planned and managed;
- marketability of crops and public acceptance;
- effect of water quality on soil, and crops;
- public health concerns related to pathogens.

The future of wastewater reuse seems to be promising in the Gaza Strip. The expected amount of wastewater to be used for irrigation will progressively increased on the coming twenty years saving more than half of groundwater needed for irrigation. To distribute the reclaimed wastewater to the agricultural areas and to the proposed infiltration basins, it is suggested to construct a main reclaimed wastewater carrier that will interconnect the three proposed regional WWTPs with the agricultural areas and the infiltration basins. The amount of well treated wastewater assumed to be used for irrigation by year 2005 will be around 19 Mm3/year and this will increase to about 53 Mm3/year by year 2020 (Tubail et. al., 2003).

Although the text of this task concentrates on using the treated wastewater in agricultural production, the treated wastewater will also feed the aquifer,andtherefore reduce the deficit in the aquifer water balance.

The accepted recharging system type is to leave substantial soil below the bottom of the infiltration basin. This system will improve the quality of the water by Soil Aquifer Treatment (SAT) before reaching the groundwater. Thus, this type can be used for unrestricted irrigation without any risk to farmers' health.

4.17 Public Health Concerns Related to Using Treated Wastewater for Irrigation

Public health concerns center around pathogenic organisms that are or could be present in wastewater in great variety. Survival of pathogens in wastewater and in environmental conditions other than their host organisms (mainly humans) is highly variable.

4.17.1 Parameters of Importance in Agricultural Use of Marginal Quality Water

Microbiological Parameters

Pathogenic organisms give rise to the greatest health concern in agricultural use of marginal quality water. The major source of water contamination with pathogens is the uncontrolled discharge of domestic wastewater. Lack of sewerage systems or effective on-site disposal has led to widespread contamination of drainage channels, particularly in those areas where piped water is available through house connections. The situation is especially critical in the area where high population densities, impervious soils and high ground water table make the application of low cost on-site sanitation options difficult.

The major pathways of pathogens are to groundwater, internal or external contamination of crops and translocation to grazing animals.

The risk of groundwater contamination by pathogens involves movement of bacteria or viruses to aquifers that are then used for drinking purposes without further treatment.

Concerns with respect to crop-contamination focus mainly on surface contamination and then persistence of pathogens until consumed by man or animals or the internal infection of the plant via the roots.

The survival of pathogenic organisms in soil or on crops is highly variable and depends on many factors such as moisture, shade, ambient temperature and the organic content of the immediate environment as summarized in Table 18.

Table 18: Survival of excreted pathogens (at 20-30°C)

Type of pathogen		Survival times in days			
		In faeces, night soil and sludge	In fresh water and sewage	In the soil	On crops
Viruses					
	Enteroviruses	<100 (<20)	<120 (<50)	<100 (<20)	<60 (<15)*
Bacteria					
	Faecal Coliforms	<90 (<50)	<60 (<30)	<70 (<20)	<30 (<15)
	Salmonella spp.	<60 (<30)	<60 (<30)	<70 (<20)	<30 (<15)
	Shigella spp.	<30 (<10)	<30 (<10)	-	<10 (<5)
	Vibrio cholerae	<30 (<5)	<30 (<10)	<20 (<10)	< 5 (<2)
Protozoa		<30 (<15)	<30 (<15)	<20 (<10)	<10 (< 2)
	Entamoebahistolytica cysts	<30 (<15)	<30 (<15)	<20 (<10)	<10 (< 2)
Helminths		Many	Many	Many	<60 (<30)
	Ascarislunbricoides eggs	Months	Months	Months	

* Figures in brackets show the usual survival time.

Source: Feachem et al. (1983)

Under favorable conditions, viruses may survive for several months in soil and perhaps 2 or 3 weeks on crops (WHO, 1989). Pathogenic protozoa are less persistent in the environment where survival beyond 2 weeks is unusual. These organisms are particularly sensitive to elevated temperatures (Feachem et al, 1938). Fecal bacteria generally have a limited survival expectancy in water but may persist in most organic rich soils for months. (WHO, 1981).

On crops, the limited availability of water and effects of the ultra violet component of sunlight rapidly reduces the number of viable bacteria. Helminth ova represent probably the most serious problem since their prolonged survival within the environment is well documented. The most persistent are Ascarisova which may survive for a year or more in moist organic environments (Feachem et al, 1978).

It is also known that many viruses and bacteria that are pathogenic to man are more infectious when inhaled than when ingested (WHO, 1989). This led to concern with regard to aerosol transfer of disease where sewage effluents were employed in spray irrigation. Research sponsored by the USEPA which measured the aerosol transfer of viruses and bacteria around an activated sludge wastewater treatment plant, found that the zone of influence is limited to 250 meters in that case. Other research has come up with a distance of 1.2 km (WHO 1973). Nevertheless it is now commonly accepted that spray irrigation with biologically contaminated water should be prohibited in order to minimize the threat of disease transmission by this route .In general, the health impact of pathogens in irrigation water has been ranked in the order of priority shown in Table 19. (Shuval et al. 1986).

Table 19: Relative Health Impact of Pathogenic Agents

High Risk (high incidence of excess infection)	Helminths(*Ancylostoma*, *Ascaris*, *Trichuris* and *Taenia*)
Medium Risk (low incidence of excess infection)	Enteric Bacteria *(Cholera vibrio, Salmonella typhosa, Shigella* and possibly others)
Low Risk (low incidence of excess infection)	Enteric viruses

The following microbiological parameters are particularly from the health point of view:

- Indicator Organisms
- Coliforms and Faecal Coliforms

The Coliform group of bacteria comprises mainly species of the genera Citrobacter, Enterobacter, Escherichia and Klebsiella and includes Faecal Coliforms, of which Escherichia coli is the predominant species. Several of the Coliforms are able to grow outside of the intestine, especially in hot climates, hence their enumeration is unsuitable as a parameter for monitoring wastewater reuse systems. The Faecal Coliform test may also include some non-faecal organisms which can grow at 44°C, so the E. coli count is the most satisfactory indicator parameter for marginal quality water use in agriculture.

Faecal Streptococci

This group of organisms includes species mainly associated with animals (Streptococcus bovis and S. equinus), other species with a wider distribution (e.g. S.faecalis and S. faecium, which occur both in man and in other animals) as well as two biotypes (S. faecalisvarliquefaciens and an a typical S. faecalis that hydrolyzes starch) which appear to be ubiquitous, occurring in both polluted and non-polluted environments. The enumeration of Faecal Streptococci in effluents is a simple routine procedure but has the following limitations: the possible presence of the non-faecal biotypes as part of the natural microflora on crops may detract from their utility in assessing the bacterial quality of wastewater irrigated crops; and the poorer survival of Faecal Streptococci at high than at low temperatures. Further studies are still warranted on the use of Faecal Streptococci as an indicator in tropical conditions and especially to compare survival with that of Salmonellae.

Clostridium perfringens

This bacterium is an exclusively faecal spore-forming anaerobe normally used to detect intermittent or previous pollution of water, due to the prolonged survival of its spores. Although this extended survival is usually considered to be a disadvantage for normal purposes, it may prove to be very useful in wastewater reuse studies, as Clostridium perfringens may be found to have survival characteristics similar to those of viruses or even helminth eggs.

Pathogens

The following pathogenic parameters can only be considered if suitable laboratory facilities and suitably trained staff are available

a) Salmonella spp. Several species of Salmonellae may be present in raw sewage from an urban community in a tropical developing country, including S.typhi (causative agent for typhoid) and many others. It is estimated (Doran et al. 1977) that a count of 7000 Salmonellae/litre is typical in a tropical urban sewage with similar numbers of Shigellae, and perhaps 1000 Vibrio cholera/litre.Both Shigellaspp and V. cholera are more rapidly killed in the environment, so if removal of Salmonellae can be achieved, then the majority of other bacterial pathogens will also have been removed.

b) Enteroviruses. May give rise to severe diseases, such as Poliomyelitis and Meningitis, or to a range of minor illnesses such as respiratory infections. Although there is no strong epidemiological evidence for the spread of these diseases via sewage irrigation systems, there is some risk and it is desirable to know to what extent viruses are removed by existing and new treatment processes, especially under tropical conditions. Virus counts can only be undertaken in a dedicated laboratory, as the cell culture techniques required are very susceptible to bacterial and fungal contamination.

c) Rotaviruses. These viruses are known to cause gastro-intestinal problems and, though usually present in lower numbers than enteroviruses in sewage, they are known to be more persistent, so it is necessary to establish their survival characteristics relative to enteroviruses and relative to the indicator organisms in wastewaters. It has been claimed that the removal of viruses in wastewater treatment occurs in parallel with the removal of suspended solids, as most virus particles are solids-associated. Hence, the measurement of suspended solids in treated effluents should be carried out as a matter of routine.

d) Intestinal Nematodes.It is known that nematode infections, in particular from the roundworm Ascarislumbricoides, can be spread by effluent reuse practices.

Chemical Pollutants

Until recently, concerns about the quality of water used for irrigation have focused largely on salinity (Environment Council of Alberta, 1982). In addition, concern over the potential impacts of specific variables such as selenium, boron, chloride, and a number of metals and other trace ions (which may originate in irrigation waters) on agricultural crops has resulted in the development of irrigation water guidelines for these elements by the Saskatchewan Water Corporation (1988). The potential health and environmental effects of pesticides, industrial pollutants, and other environmental contaminants in irrigation waters, have not been adequately addressed.
The potential impact of organic contaminants such as pesticides is of obvious immediate concern to the farmers (and the consumers) since the use and re-use of irrigation water containing pesticide residues may adversely affect sensitive crop species. For those contaminants that are persistent and do not degrade (e.g., heavy metals), concentrations causing adverse effects to crops may be reached due to accumulation in the soil environment. Since It is impractical to include chemicals of every body's choice and to establish maximum permissible levels for hundreds of organic chemicals that could sometimes be present in marginal quality water only in minute quantities, the WHO (1995) selected substances that appeared frequently in irrigation water (Table 4A.18). Many of these chemicals are of industrial origin. Since partially treated and untreated wastewater are frequently discharged into agricultural drains they have to be considered in the development of the guidelines.

Table 20: Chemical analysis commonly suggested by regulations

Inorganic Substance	Organic Compound	
As	Aldrin	Hexachloroethane
Ba	Benzene	Pyrenes
Be	Benzo(a) pytene	Lindane
Cd	Carbon Tetrachloride	Methoxychlor
Cr	Chlorodane	Pentachlorophenol
Cyanide	Chlorobenzene	PCBs
F	Chloroform (THMs)	Tetrachloroethane
Pb	Dichlorodethanes	Tetrachloroethylene
Hg	Dichlorophenols	Toluene

Ni Se Ag	2,4-D Dieldrin Heptachlor Hexachlorobenzene	Toxaphene 2,4,5-T Trichloroethane Trichlorophenol

Heavy Metals Fate and Transport

Understanding the distribution of toxic metals in aquatic ecosystems is important to the assessment of environmental and human health risks from irrigation water.

It is important to know whether the trace metals are (i) in solution or adsorbed on solids; (ii) in organo-metallic or hydroxide forms; or (iii) in the crystal structure of suspended materials. Without such precise distribution data, techniques for removing and development of guidelines for these harmful elements cannot be designed effectively.

Particulate matter has been recognized to be the major means of transport of metals through aquatic ecosystems and one of the major pathways of pollutants to biota. It has been indicated that the highest concentrations (mg/kg metal in solid) occur in the colloids and , the lowest in the dissolved solids. The metal content of coarse particles occupies an intermediate position, with the dissolved material having a lower concentration. Except for iron and manganese, the metals are about 2 to 10 time more enriched in the course particles relative to the dissolved solids. The capacity of minerals to hold dissolved metals is different for each type of clay mineral. For example the cation exchange capacity (determined by the number of negatively charged sites on clay mineral surfaces) ranges from a few milli equivalents per hundred grams (me/100g) of mineral for kaolinite clay to more than 100 me/100g for montmorillonite clay. Typical estuaries sediments, which are mixtures of clay, silt and sand minerals, have exchange capacities ranging from 15 to 60 me/100g (Krone, 1963).

The various chemical and biochemical transformations that metals may undergo in the aquatic environment deserve attention. Chemical changes may affect their biological availability or toxicity, which may be either enhanced or reduced. Knowledge of such processes is often essential for the understanding of health effects of these substances, whether physical, chemical or microbial transformations.

It is becoming increasingly apparent that microbial processes may be important and even dominating factors in the distribution of specific metals (Ford et al, 1992). Interactions between microorganisms and metals can be conveniently divided into three distinct processes, all of which may be important with respect to metal distribution in natural waters:a) intracellular interactions, (b) cell surface interactions, and (c) extracellular interactions (Ford et al, 1995).

Probably the most widely recognized microbial interaction with toxic metals in the aquatic environment is the microbial methylation of mercury. Although receiving less attention than mercury, methylation of other toxic metals, with subsequent volatilization, may also occur in the aquatic environment. Methylation has been shown for tin, arsenic, lead, selenium, tellurium, thallium, and antimony (Thayer et al, 1982).

A number of authors have shown that metal binding to cell surfaces is an important factor in the distribution of metals in natural waters (Sigg, 1987 and Xue, 1988). Algal surfaces contain functional groups (e.g. carboxylix, amino, thio, hydroxo, and hydroxy-carboxylix groups) that can interact with metal ions (Xue, et al. 1988).

Extracellular interactions with toxic metals range from the potential to leach metals from sediments by production of acidic metabolites to the formation of colloidal sized extracellular polysaccharide metal complexes implicated in mobilization and transport of toxic metals in soils (Black et al, 1986 and Chammgathus et al, 1988). Indirectly, toxic metals closely associated with iron oxide (Cd and Zn) have been shown to be solubilized by enzymatic reduction of the ferric iron (Francis et al, 1990).

Synergism is a phenomenon in which the combined effects of two agents is greater than that of each taken independently. Two metals mixed in water may have a lethal effect, while either alone would be relatively innocuous. Because of the variety in effluents discharged into receiving water bodies, the potential for synergistic effects is large.

Competition between essential and non-essential metals having similar chemical properties may take place. At low levels of the competing metals, the essential metal will win in the competition for binding sites. However, as levels of the nonessential metals rise, it will begin to interfere with the normal function of the essential metals. Thus, the essential metals have a capacity to protect the cells against low levels of metals contaminants, but at higher levels the protection fails. Interference with the normal function of the essential metal results in a toxic outcome.

Lead and calcium ions are sufficiently similar that some degree of competition occurs. Hexavalent chromium, in the form of the oxy-anion, gains entrance to the cell on the sulfate carrier. Once inside the cell, the chromate oxy-anion undergoes reduction, with the production of highly reactive toxic intermediates believed to be ultimately responsible for the carcinogenic action of hexavalent chromium (Wetterhahn, et al. 1993).

Uptake by Crops

a) Cadmium

Although Cadmium (Cd) is considered to be a nonessential element for plants, it is effectively absorbed by both root and leaf systems. In most cases a linear relationship between Cd in plant material and growth medium has been reported. Nevertheless several soil and plant factors affect the uptake of Cd.

In nearly all publications on the subject, soil pH is the major influence controlling both total and relative uptake of Cd. Kabata-Pendias (1984) reported results indicating that the relative uptakes of Cd by rice seedlings was the greatest within the pH range of 4.5 to 5.5. However, there are contradictory results which show that when Cd becomes more mobile in alkaline soil due to the formation of complexes or metal chelates, the plant uptake of Cd may beindependent of pH. The accumulation of cadmium in Maize is dependent on soil pH. The higher the soil pH, the less cadmium was taken up by the plants (Street et al. 1977). Addition of $CdCl_2$ to elevate soil concentrations to between 20 and 30 ppm resulted in decreased germination and yield of some plants (Kabata-Pendias et al. 1984).

The most important biochemical characteristic of Cd ions is their affinity for sulfhydryl groups of several compounds. In addition, Cd shows an affinity for other side chains of proteins and for phosphate groups.

Dabin et al. (1978) andBraude et al. (1980) have reported that cadmium will most likely be concentrated in the protein fractions of plants.

There are no known enzymes that require Cd for their normal activity. Cadmium has been shown to induce cysteine and methionine synthesis (Roucoux and Dabin 1977). Cadmium has been implicated in the inhibition of the formation of anthocyanin and chlorophyll in plants (Cunningham et al. 1975, and Baszynski et al., 1980). This in turn may lead to the interference with metabolism of micronutrients, inhibition of photosynthesis, disturbance of transpiration and CO_2 fixation, and alteration of the permeability of cell membranes.

In general, symptoms induced by elevated Cd content are growth retardation, root damage, chlorosis of leaves, and red-brown coloration of leaf margins or veins. The maximum permissible rate of cadmium addition to soil should depend strongly on the soil pH (Kabata-Pendias and Pendias 1984). USEPA (1979) guidelines regulating cadmium lifetime application rates state that a total of 20 kg of cadmium per hectare can safely be applied to soils with cation exchange capacity of 0.20 mol(+) kg^{-1} Crops grown on cadmium contaminated soils may accumulate cadmium in amounts sufficiently large to be of public health concern (Kabata-Pendias and Pendias, 1984). A soil to plant accumulation ratio of 0.15 for the fruit/seed of the crop and 0.55 in the vegetative plant parts has been reported by Baes et al. (1984).

b) Copper

The literature has reported that there is a relationship between the concentration of the metal measured in the growth medium and in the plant. The copper mobility in the plant tissues strongly depends on the level of copper supply. Copper when absorbed through root systems is transported into the xylem and phloem saps for distribution in the plant (Tiffin, 1972). There appears to be a correlation with concentrations of amino acids. A considerable portion of copper in green tissues appears to be bound to platocyanin and in some protein fractions.

The biochemical functions of copper indicate a potential role in disease resistance. Copper is generally complexed with organic compounds of low molecular weight and with proteins. Copper occurs in the compounds with no known functions as well as in enzymes having vital functions in plant metabolism. Copper plays an important role in photosynthesis, respiration, carbohydrate distribution, nitrogen reduction and fixation, protein metabolism, and cell wall metabolism. Copper influences water permeability of xylem vessels and thus controls water relationships. Copper controls the production of DNA and RNA, and its deficiency greatly inhibits the reproduction of plants. Finally Copper is involved in the mechanisms of disease resistance (Kabata-Pendias and Pendias, 1984).

Prediction of the copper content of soil that results in toxic effects on plants is difficult. Generally, before phytotoxic symptoms are evident the level of copper accumulation in the palnt will pose a human health risk. Baes et al. (1984) reported a soil to plant accumulation ratio in the fruit/seed of the plant of 0.25 and 0.40 in the vegetative plant parts.

c) Iron

Iron uptake by plants is metabolically controlled and can be absorbed as Fe^{3+}. Fe^{2+} or as iron chelates. At normal pH levels iron organic complexes apparently play an important role in plant nutrition. Generally roots adsorb Fe^{2+}cation (Kabata-Pendias and Pendias, 1984). In plant tissues iron has been identified as citrates and soluble ferro-dioxine. Iron uptake is generally dependent on soil pH, concentrations of calcium and phosphorus and the ratios of several heavy metals.

The metabolic function of iron is key to energy transformation needed for several cell processes, including: organic iron complexes are involved in the mechanism of photosynthetic electron transfer, non-heme proteins are involved in the reduction of nitrites and sulfates, chlorophyll formation seems to be influenced by iron concentrations, iron is implicated in nucleic acid metabolism, and catalytic and structural roles of iron are also known. Iron occurs in heme and nonheme chloroplasts. A soil to plant absorption factor of 0.001 has been reported for the fruit/seed of the plant and 0.004 for the plant parts by Baes et al. (1984).

High soil concentrations of iron can cause phytotoxic effects when soils are acidic, low in phosphorus, acid sulfate soils, and flooded soils. A 500 ppm soil concentration in a paddy soil solution has been reported to kill rice seedlings.

d) Lead

Airborne lead is readily taken up by plants through foliage. A number of studies have shown that lead deposited on the leaf surface is absorbed by these cells with a significant translocation into plant tissues (Kabata-Pendias and Pendias, 1984). Lead from soil is not easily translocated into edible portions of plants.

There is no evidence that lead is essential for the growth of any plant species. Some data suggest that some lead salts have a stimulation effect on plant growth while other reports have shown an inhibitory effect (Kabata-Pendiasand Pendias, 1984). Subcellular effects include the inhibition of respiration and photosynthesis due to the disturbance of the electron transfer reactions.

A relatively minor effect on lead concentrations in plants has been reported for the contamination of soil due to agricultural processes. Vegetables grown in areas of high lead concentrations such as urban and industrial areas may present a health risk to humans who consume them (Kabata-Pendias and Pendias, 1984). Baes et al. (1984) reported a soil to plant accumulation ratio in the fruit/seed of the plant of 0.009 and 0.045 in the vegetative plant parts.

e) Zinc

Soluble forms of zinc are readily available to plants with a linear uptake from both solution and soils. The presence of high calcium to zinc ratios in soil greatly reduces zinc uptake. Although Zn, Zn2+ and Zn-organic chelates are the primarily absorbed forms.Kabaa-Pendias and Pendias (1984) reported that only Zn2+ was absorbed by Maize roots. Zinc is generally bound to soluble low molecular weight proteins. Zinc bound to xylem fluids and other tissue extracts may indicate high mobility in the plant. However, some literature regards zinc as highly mobile while other data suggest intermediate mobility. Baese et al. (1984) reported a soil to plant accumulation ratio in the fruit/seed of the plant of 0.90 and 1.50 in the vegetative plant parts.

4.18 Parameters of Agricultural Significance

The quality of irrigation water is of particular importance in arid zones where extremes of temperature and low relative humidity result in high rates of evaporation, with consequent deposition of salt, which tends to accumulate in the soil profile. The physical and mechanical properties of the soil, such as dispersion of particles, stability of aggregates, soil structure and permeability, are very sensitive to the type of exchangeable ions present in irrigation water.

Traditionally, irrigation water is grouped into various quality classes in order to guide the user to the potential advantages as well as problems associated with its use and to achieve optimum crop production. The water quality classifications are only indicative guidelines and their application will have to be adjusted to conditions that prevail in the field. This is so because the conditions of water use in irrigation are very complex and difficult to predict.

The suitability of water for irrigation will greatly depend on the climatic conditions, physical and chemical properties of the soil, the salt tolerance of the crop grown and the management practices. Thus, classification of water for irrigation will always be general in nature and applicable under average use conditions.

Many schemes of classification for irrigation water have been proposed. Ayers and Westcot (FAO, 1985) classified irrigation water into three groups based on salinity, sodicity, toxicity and miscellaneous hazards. These general water quality classification guidelines help to identify potential crop production problems associated with the use of conventional water sources. The guidelines are equally applicable to evaluate Marginal quality water for irrigation purposes in terms of their chemical constituents, such as dissolved salts, relative sodium content and toxic ions. Several basic assumptions were used to define the range of values in the guidelines and more detailed information on this is reported by Ayers and Westcot (FAO 1985).

The effect of sodium ions in irrigation water in reducing infiltration rate and soil permeability is dependent on the sodium ion concentration relative to the concentration of calcium and magnesium ions (as indicated by SAR) and the total salt concentration, as shown in the guidelines. This emphasize the fact that soil permeability (including infiltration rate and surface crusting) hazards caused by sodium in irrigation water cannot be predicted independently of the dissolved salt content of the irrigation water or that of the surface layer of the soil.

Many of the ions which are harmless or even beneficial at relatively low concentrations may become toxic to plants at high concentration, either through direct interference with metabolic processes or through indirect effects on other nutrients, which might be rendered inaccessible. They are not normally included in routine analysis of regular irrigation water, but attention should be paid to them when using marginal quality water, particularly if contamination with industrial wastewater discharges is suspected. These include Aluminium (A1), Beryllium (Be), Cobalt (Co), Fluoride (F), Iron (Fe), Lithium (Li), Manganese (Mn), Molybdenum (Mo), Selenium (Se), Tin (Sn), Titanium (Ti), Tungsten (W) and Vanadium (V). Heavy metals are a special group of trace elements which have been shown to create definite health hazards when taken up by plants. Under this group are included, Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg) and Zinc (Zn).

Morishita (1985) has reported that irrigation with nitrogen-enriched polluted water can supply a considerable excess of nutrient nitrogen to growing rice plants and can result in a significant yield loss of rice through lodging, failure to ripen and increased susceptibility to pests and diseases as a result of over-luxuriant growth. He further reported that non-polluted soil, having around 0.4 and 0.5 ppm cadmium, may produce about 0.08 ppm Cd in brown rice, while only a little increase up to 0.82, 1.25 or 2.1 ppm of soil Cd has the potential to produce heavily polluted brown rice with 1.0 ppm Cd. Table 22 presents phytotoxic threshold levels of some selected trace elements.

Table 21: Guidelines for Interpretation of Water Quality for Irrigation

Potential irrigation problem		Units	Degree of restriction on use		
			None	Slight to moderate	Severe
Salinity					
Ec_w[1]		dS/m	< 0.7	0.7 - 3.0	> 3.0
or					
TDS		mg/l	< 450	450 - 2000	> 2000
Infiltration					
SAR[2] = 0 - 3 and EC_w			> 0.7	0.7 - 0.2	> 0.2
	3 -6		> 1.2	1.2 - 0.3	>0.3
	6-12		> 1.9	1.9 - 0.5	> 0.5
	12-20		> 2.9	2.9 - 1.3	> 1.3
	20-40		> 5.0	5.0 - 2.9	> 2.9
Specific ion toxicity					
Sodium (Na)					
	Surface irrigation	SAR	< 3	3 - 9	> 9
	Sprinkler irrigation	me/l	< 3	> 3	
Chloride (Cl)					
	Surface irrigation	me/l	< 4	4 - 10	> 10
	Sprinkler irrigation	me/l	< 3	> 3	
Boron (B)		mg/l	< 0.7	0.7 - 3.0	> 3.0
Trace Elements					
Miscellaneous effects					
Nitrogen (NO_3-N)[3]		mg/l	< 5	5 - 30	> 30
Bicarbonate (HCO_3)		me/l	< 1.5	1.5 - 8.5	> 8.5
pH		Normal range 6.5-8			

[1] *EC_w means electrical conductivity in deci-Siemens per metre at 25°C*

[2] *SAR means sodium adsorption ratio*

[3] *NO_3-N means nitrate nitrogen reported in terms of elemental nitrogen*

Source: FAO(1985).

Table 22: Threshold Levels of Trace Elements for Crop Production

	Element	Recommended maximum concentration (mg/l)	Remarks
Al	(aluminium)	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	(arsenic)	0.10	Toxicity to plants varies widely, ranging from 12 mg/l for Sudan grass to less than 0.05 mg/l for rice.
Be	(beryllium)	0.10	Toxicity to plants varies widely, ranging from 5 mg/l for kale to 0.5 mg/l for bush beans.
Cd	(cadmium)	0.01	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	(cobalt)	0.05	Toxic to tomato plants at 0.1 mg/l in nutrient solution. Tends to be inactivated by neutral and alkaline soils.
Cr	(chromium)	0.10	Not generally recognized as an essential growth element. Conservative limits recommended due to lack of knowledge on its toxicity to plants.
Cu	(copper)	0.20	Toxic to a number of plants at 0.1 to 1.0 mg/l in nutrient solutions.
F	(fluoride)	1.0	Inactivated by neutral and alkaline soils.
Fe	(iron)	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	(lithium)	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	(manganese)	0.20	Toxic to a number of crops at a few-tenths to a few mg/l, but usually only in acid soils.
Mo	(molybdenum)	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	(nickel)	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.
Pd	(lead)	5.0	Can inhibit plant cell growth at very high concentrations.
Se	(selenium)	0.02	-18- 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. As essential element to animals but in very low concentrations.
Sn	(tin)		
Ti	(titanium)	-	Effectively excluded by plants; specific tolerance unknown.
W	(tungsten)		
C	(vanadium)	0.10	Toxic to many plants at relatively low concentrations.

	Element	Recommended maximum concentration (mg/l)	Remarks
Zn	(zinc)	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 per hectare per 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 per hectare per year. The values given are for water used on a continuous basis at one site. (Source : Adopted from National Academy of Sciences (1972) and Pratt (1972))

4.19 SOCIAL BASELINE DATA

4.19.1 Socio-economic Environment

The potential impacts of any development project are affected by the different characteristics of the host community. Therefore, having a detailed description of the project area of influence (AoI) assists appropriate and accurate identification of the potential impacts. This section will discuss the socio-economic environment of the project areas (in terms of available data). The main sources of data are the following reports:

- Palestinian Human Development Report 2014
- Environmental Assessment for North Gaza Emergency Sewage Treatment Plant Project-2012
- Palestinian Statistical Year Book ,2012, Palestinian Central Bureau for Statistics
- PCBS Household Environmental Survey 2011
- Health conditions in the occupied Palestinian Territories, including east Jerusalem, and in the occupied Syrian Golan, WHO, Sixty- Fourth World Health Assembly A64/27-Provisional agenda item 15,2011

The project areas of influence is located in North Gaza Governorate. The project will mainly influence three settlement, namely, Jabalia, Beit Lahia and Beit Hanoun as well as Um El Nasr village. Figure 28 presents the project's areas of influence .

Figure 28: Project Area of Influence

Gaza Strip is a small closed coastal area of a total surface area of 365 Km2. The Gaza Strip is amongst the most densely populated areas in the world. The environment in the Gaza Strip has been suffering from a great deal of abuse and negligence. The limited land resources, large and rapidly growing social and economic sectors, long-term isolation, and negligence as a result of the political circumstances have led to the deterioration of the natural resources and resulted in the amplification of several environmental shortcomings. The surface area in Gaza is very limited, with an average land availability of 0.26 dunum per person in 2007.

The latest census conducted by the Palestinian Central Bureau of Statistics (PCBS) estimates the total population of the Palestinian Territories to be 3,825,512, of whom 2,385,180 live in the West Bank, and 1,440,332 live in the Gaza Strip.

With regards to the Area of Influence's settlements , Table 23 shows the area of each settlement.

Table 23: Total area of Influence

	Beit Hanoun	Beit Lahia	Um El Nasr	Jabalia
Total Surface area	12100 Dunum	38376 Dunum	800 Dunum	18.5 Km
Total agriculture surface area	4280 Dunum	2819 Dunum	260 Dunum	5694 Dunum
Total Inhabited area	3473 Dunum		153 Dunum	9328 Dunum
Total Area of other	900 Dunum		387 Dunum	52854 Dunum

Utilities				
Source	Source: Beit Hanoun 2017	Source: Palestinian Central Bureau of Statistics (2017)	Source: Palestinian Central Bureau of Statistics (2017)	Source: Directory of Population 2012- Jabalia municipality

Source: Beit Hanoun 2017

Source: Palestinian Central Bureau of Statistics (2017)

Source: Palestinian Central Bureau of Statistics (2017)

Source: Directory of Population 2012- Jabalia municipality

In terms of population, the last census conducted in 2007. As a matter of fact,the figures below are estiamtes based on the annual natural increase.

Jabalia village is considered of the biggest population (220,000 people). However, the smallest population was reported in Um El Nasr village (5,000 people). Female represent bout 49.0% of the total population.

Table 24: Distribution of population within the project areas

	Beit Hanoun	Beit Lahia	Um El Nasr	Jabalia
Total population	52800	164346	5000	220,000
Total number of males	26928	83613	2550	112,200
Total number of females	25872	80733	2450	107,800
Source	Source: Beit Hanoun 2017	Source: Palestinian Central Bureau of Statistics (2017)	Source: Palestinian Central Bureau of Statistics (2017)	Source: Directory of Population 2012- Jabalia municipality

The population growth rate is approximately 2.82% per year; although this represents significant growth in population, the birth rates from 1997 to 2008 have actually declined.

4.19.2 Demographic Characteristics

In 2007, approximately 1.4 million Palestinians resided in Gaza Strip, of whom almost one million were UN-registered refugees. The current population is estimated to be in excess of 1.5 million, distributed across five Governorates. Gaza City, which is the biggest governorate, has about 400,000 inhabitants. The two other main Governorates are Khan Younis (population 200,000) in central Gaza, and Rafah (population 150,000) in the South. The majority of people live in refugee camps .

4.19.2.1 Population distribution by sex in the AoI

The population of the North Gaza Governorate according to 2012 statistics is around 265,355 . As could be observed from the table below, the population growth in project area of influence is high and was observed to increase during the last five years. The population projection calculated by the Feasibility Study was based on the assumption that a gradual decline in the population growth rate will be seen starting in 2012. It is anticipated that population growth will reach 1.11% by 2040, after peaking at 3.5% in 2011.

Table 25: Population Distribution by Sex and settlement (thousand) 2012

Area	Total	Male	Female
North Gaza Governorate	265.355	134.987	130.368
Um Al-Naser	2.76	1.402	1.358
Beit lahia	63.213	32.16	31.053
Beit Hanoun	37.351	18.87	18.481
Jabalia	120.859	61.978	58.881

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

4.19.2.2 Age Structure

Age structure is a graphical illustration that shows the distribution of various age groups in a population (typically that of a country or region of the world), which forms the shape of a pyramid when the population is growing. It is also used in Ecology to determine the overall age distribution of a population; an indication of the reproductive capabilities and likelihood of the continuation of a species . Reviewing the age structure in the project area of influence , it can be concluded that the community has the potential for rapid, continuous growth. The majority of population in the four settlement are below 30 years old.

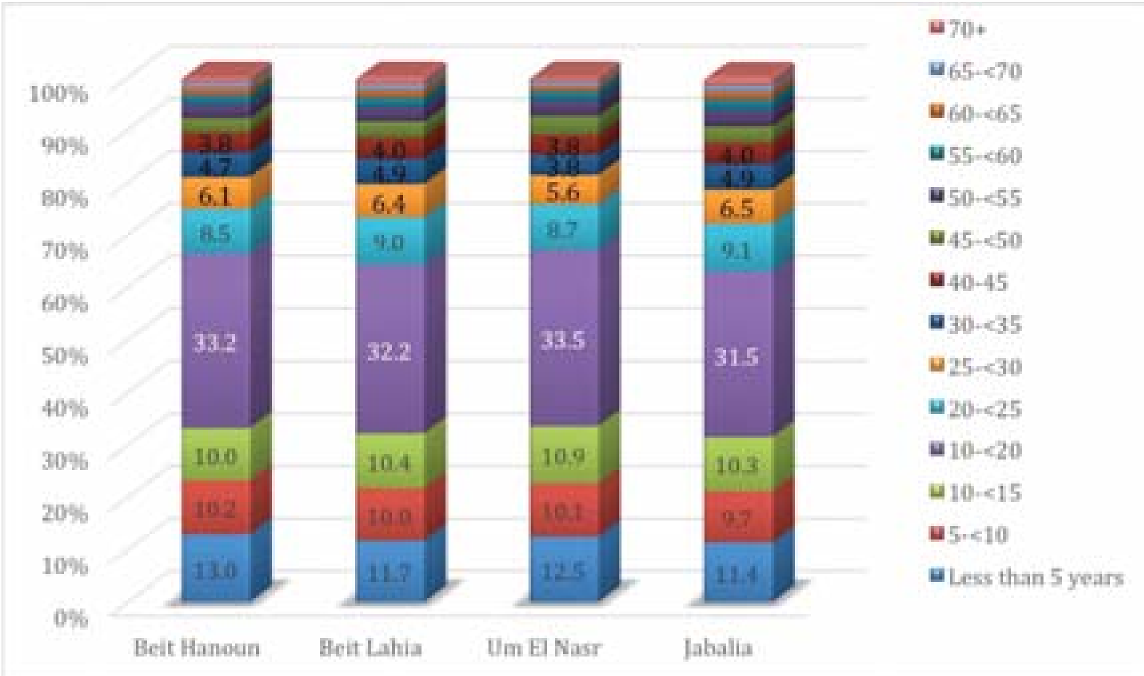


Figure 29: % distribution by the area of influence by age

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

The detailed distribution of the population by age category shows that the difference according to gender is to some extent limited, not exceeding 0.2% in total. The diversity according to gender is limited in all age categories. Taking into consideration that two thirds of the population is under 25 years old, there will be increasing demand for waste water recovery.

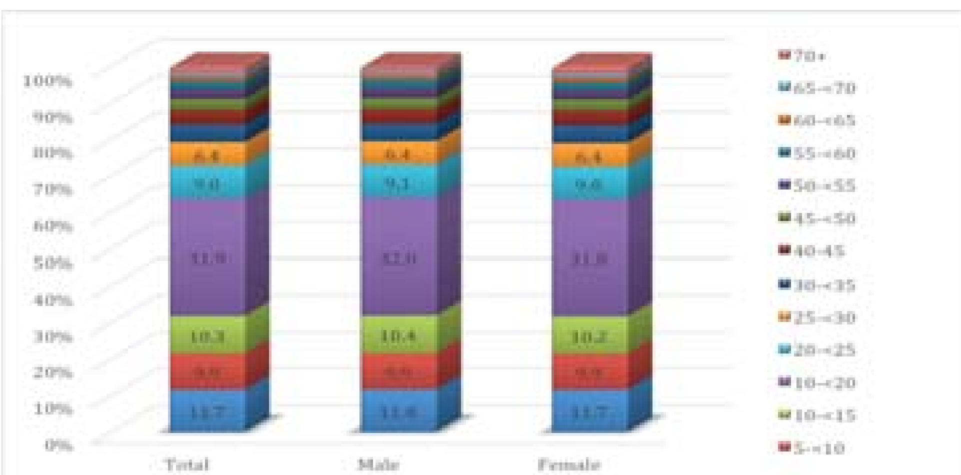


Figure 30:Percentage distribution for population in North Gaza Governorates by Age groups and sex

Source: Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

4.19.2.3 Birth Rate

The total fertility rate in the occupied Palestinian Territories was 4.6 in 2009 (4.1 in the West Bank and 5.3 in the Gaza Strip), which is comparatively high in the region. In terms of pregnant women, four out of 10 attend antenatal care while virtually all women deliver in health institutions.

4.19.2.4 Death Rate

The four leading causes of deaths in the occupied Palestinian Territories are non-communicable diseases such as heart diseases, cerebra-vascular diseases, cancer (led by trachea, colorectal and anal cancer) and inflammations of the respiratory system.

The infant mortality rate has shown little improvement in recent years (25.34 per 1000 live births: 22.9 per 1000 live births in the West Bank, 28.8 per 1000 live births in the Gaza Strip). The main causes of death among infants are pneumonia and other respiratory disorders (34.5%), congenital malformations (16.3%) followed by prematurity and low birth weight (13.4%).

There were 30 maternal deaths in 2008 and 2009 in the Gaza Strip, and 23 maternal deaths in 2009 in the West Bank, indicating a maternal mortality ratio of 29 per 100 000 live births in the Gaza Strip and 36.4 per 100 000 live births in the West Bank. Many pregnant women suffer from anemia (45% of pregnant women in the Gaza Strip and 20.6% in the West Bank). About a third of newly pregnant women are immunized against tetanus in the West Bank .

4.19.2.5 Rate of Natural Increase

The total fertility rate in the Palestinian Territories has declined with 4.6 births per thousand in 2007 compared to 6.0 births in 1997. Regional disaggregation indicates that the birth rate in the West Bank was 30.6 births compared to 35.6 births in the Gaza Strip in 2008. The majority of the population is under 25 years old. The natural increase in the Gaza Strip is higher than that in the West Bank. General notice was that Gaza is increasing steadily while the West Bank is decreasing with the same percentage. The proposed project may serve a population as much as 10% higher than current numbers.

Table 26: Estimated annual growth rates in the Palestinian Territories (Mid-year 2007-2009)

Year	Palestinian Territories		
	West Bank	Gaza Strip	Total
Year 2007	2.66	3.2	2.86
Year 2008	2.65	3.23	2.87
Year 2009	2.65	3.25	2.88

Source: Palestinian Statistical Year Book, Volume 10, 2009, Palestinian Central Bureau for Statistics

4.19.3 Household Size and Density

The average family size is one of the important indicators relevant to population growth. As could be observed from the table below, there is generally a high tendency for large family sizes that exceed eight persons. This observation supports the increase in the population growth rate during the last 5 years. This tendency is expected to affect the population growth rate during the coming years. Due to the absence of structured systems or interventions (e.g. family planning programmes) to tackle the large population growth, it is predicted that the preference for large family sizes will keep increasing the potential for high population growth. Overall, the average household size is 6.7 in the North Gaza Governorate. The biggest average household reported in Beit Hanoun 7.0 person/household. Whereas the least average household noticed in Jabalia 6.5 person/ household.

The Percent Distribution of Private Households in North Gaza Governorate by Locality and Household Size is illustrated in Table 27.

Table 27: Percentage Distribution of Private Households in North Gaza Governorate by Locality and Household Size

	North Gaza Governorate	Um Al-Naser	Beit Lahia	Beit Hanoun	Jabalia
Population	265355	2760	63213	37351	120859
Households	39604	413	9277	5328	18542
Average household size	6.7	6.7	6.8	7.0	6.5
	%	%	%	%	%
8+ persons	38.1	41.6	39.1	2.6	38.6
7 persons	12.5	10.4	12.8	7.4	13.4
6 persons	12.5	11.6	12.4	7.4	13.9
5 persons	10.9	9.7	11.1	67.7	12.0
4 persons	9.4	8.2	9.5	5.3	10.8
3 persons	7.5	4.1	7.3	4.5	0.9
2 persons	7.3	9.7	6.4	4.0	8.5
1 person	1.8	4.6	1.5	1.1	1.9

Source: Palestinian Statistical Year Book, 2012 Palestinian Central Bureau for Statistics

The analysis of the density by region showed that the Gaza Strip is of higher density than the West Bank, as about 45% of the Gazan population lives with more than 2 persons per room, while only 35.5% in the West bank are of the same category. Those who are less than 1 person per room represented 14.8% of the West Bank, while the same category represented 11.0% of the Gaza Strip.

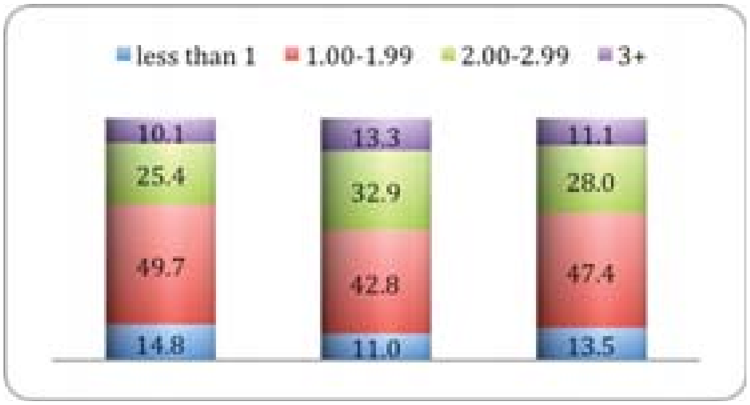


Figure 31: Percentage distribution of households by household density and region

Source: Palestinian Statistical Year Book, Volume 10, 2009, Palestinian Central Bureau for Statistics

Literature reviews and meetings with resource persons showed that the family structure in Gaza is witnessing a shift from the domination of the extended family to a higher level of prevalence for the nuclear families which constitutes now more than 80% of the family structure in the Gaze Strip (PCBS, 2010).

4.19.3.1 Type of Residence

One of the main indicators of living conditions and welfare of families is the type of dwelling. It is notified that the majority of the population (59.05%) in the North Gaza Governorate live in an apartment (that is a typical Palestinian type of residents), followed by 38.35% live in a house. In Um El Nasr village, 56.83% live in a house. This type of dwelling reflects the rural nature of the area

Figure 32:Percentage distribution of dwelling by type of building and locality

Source: Palestinian Statistical Year Book, 2012 Palestinian Central Bureau for Statistics

Figure 33: Dwelling type in Beit Hanoun

Figure 34: Residential area in Beit Lahia

The majority of people use their units exclusively for living purposes in North Gaza Governorate (78.3%). Few of residents use the dwelling for both habitation and work.

Table 28: Building utilization

Building Utilization	Locality				
	North Gaza Gov.	Um Al-Naser	Beit Lahia	Beit Hanoun	Jabalia
Habitation	20108	387	438	2832	8297
Habitation & Work	2714	15	626	275	1292
Work	1901	11	337	274	875
Vacant	437	1	102	65	191
Closed	428	18	76	98	149
Deserted	106	0	13	35	45
Not Stated	2	0	0	0	2
Total	25696	432	5534	3579	10851

Table 29: Completed Buildings in North Gaza Gov by Locality and Utilization

Building Utilization	Locality				
	North Gaza Gov.	Um Al-Naser	Beit Lahia	Beit Hanoun	Jabalia
Habitation	20108	387	438	2832	8297
Habitation & Work	2714	15	626	275	1292
Work	1901	11	337	274	875
Vacant	437	1	102	65	191
Closed	428	18	76	98	149

Deserted	106	0	13	35	45
Not Stated	2	0	0	0	2
Total	25696	432	5534	3579	10851

4.19.3.2 Ownership of Residence

The ownership of the house can be an important indicator of the socioeconomic characteristics of the household. In the Gaza Strip the vast majority of the population owns their houses (91.6%), while only 4.7% rent their dwelling. In this case, ownership does not necessarily reflect high socioeconomic status of the community, but may instead reflect a custom and tradition of the community which encourages private ownership.

Figure 35: Percentage distribution of households by tenure of housing unit in Gaza Strip

Source: Palestinian Statistical Year Book, Volume 10, 2009, Palestinian Central Bureau for Statistics

4.19.4 Access to Basic Services

Regarding access to basic services, the government of Palestine gives a large proportion of its attention to water supply. Connectivity to the public water system was around 98% in 2012 in all project settlements.

Table 30: Occupied Housing Units in North Gaza Gov. by Locality and Main Source of Water in the Housing Unit

Locality	Not Stated		Other		Water Tanks		Springs		Well (to gather rain water)		Public Network	
	(%)	(No)	(%)	(No)	(%)	(No)	(%)	(No)	(%)	(No)	(%)	(No)
North Gaza Gov.	0	19	1	378	0.1	47	0	12	0.2	60	98.6	39088

Locality	Not Stated		Other		Water Tanks		Springs		Well (to gather rain water)		Public Network	
Um Al-Naser	0	-	0	-	0	-	0	-	0.2	1	99.7	412
Beit Lahia	0	4	2.3	217	0.1	10	0	1	0.3	31	97.2	9014
Beit Hanoun	0	1	0.4	19	0.6	30	0	1	0.1	3	98.9	5274
Jabalia	0.1	13	0.8	142	0	7	0	8	0.1	25	98.9	18347

Electricity coverage is much higher, as almost all households are connected to the public electricity network. However, the continuity of electricity is affected by fuel supply problems. However, the continuity of electricity current remains one of the biggest problems facing developmental projects in Gaza Strip.

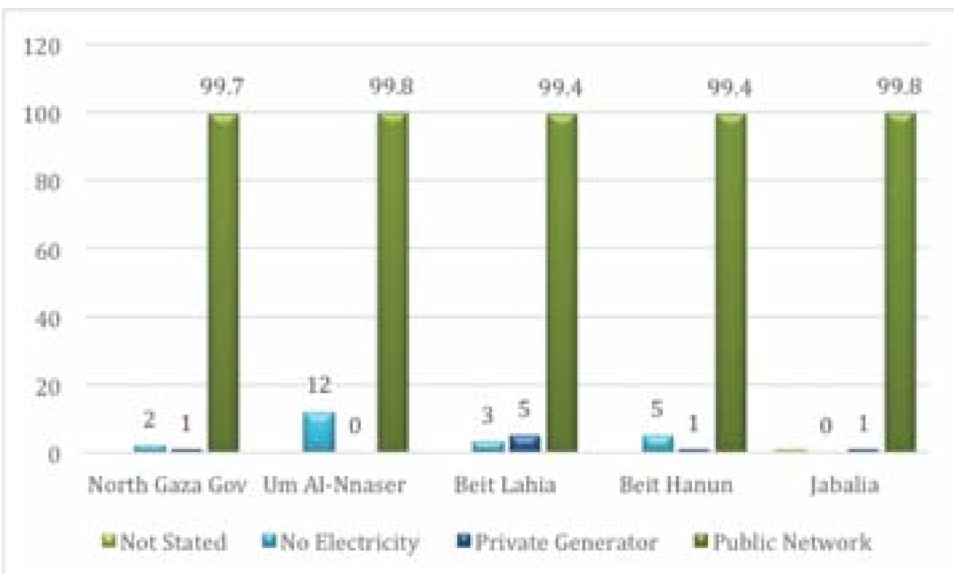


Figure 36: Percentage distribution for access to electricity in the AoI

Source: Palestinian Statistical Year Book 2012, Palestinian Central Bureau for Statistics

93.8% of households in North Gaza Governorate have access to the public sewage network. A detailed discussion of the type of sewage disposal used will be presented later.

The fourth basic service is the telephone lines, which serve 42.2% of the total households in the Palestinian Territories.

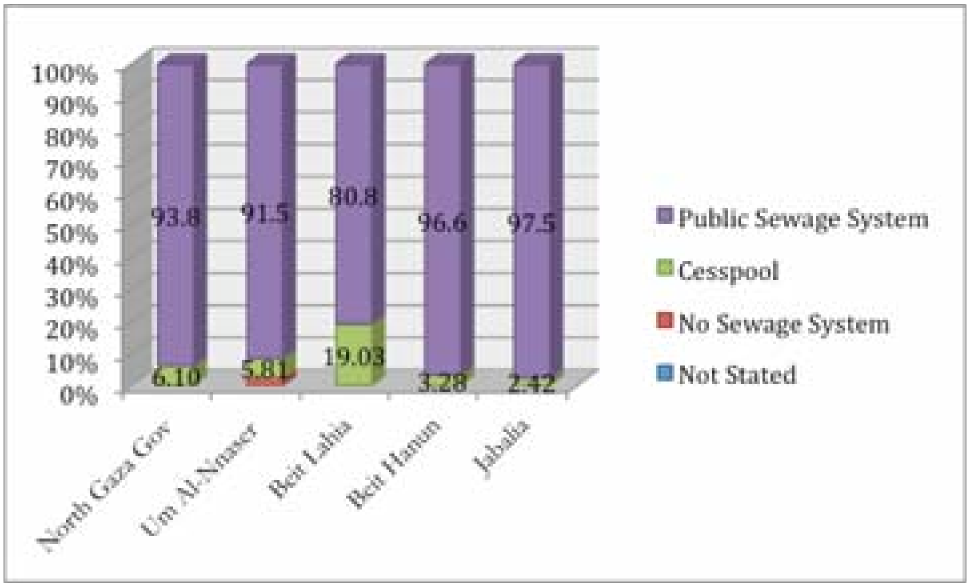


Figure 37:Percentage distribution of access to sanitary system in the AoI

Source: Palestinian Statistical Year Book 2012, Palestinian Central Bureau for Statistics

Water is one of the most challenging issues affecting environmental sustainability in the Palestinian Territories. The global Human Development Report 2006 noted that Palestinians, especially in Gaza, experience one of the highest levels of water scarcity per capita in the world, with physical availability and governance of shared water contributing to this shortage.

The unequal sharing of the aquifers below the West Bank between Israel and the Palestinian Territories is stark: average per capita water use by Israeli settlers in the West Bank is some nine times higher than by Palestinians. With only 13% of all wells in the West Bank, settlers account for 53 of groundwater extraction. The management of the western and coastal aquifers further demonstrates the problem. Part of the Jordan Basin, the western aquifer is the single most important source of renewable water for the Palestinian Territories. Nearly three quarters of the aquifer is recharged within the West Bank and flows to the coast of Israel. Much of the water is not accessible to Palestinians; this is a result partly, of the stringent regulation of the quantity and also depth of wells. Per capita access to water resources in the West Bank for Palestinians is a quarter of that for Israelis, and it is declining. There are similar problems with the waters from the Coastal Basin, which barely reach the Gaza Strip because of the high rates of extraction on the Israeli side.

It is estimated that the over-abstraction of the Coastal Basin–to approximately double the sustainable limit in 2000–is now reaching dangerous levels. Only 5% to 10% of the aquifer yields quality drinking water. The lowering of the water table coupled with increased salinization via sea water intrusion and pollution by raw sewage compromises both the quality and quantity of available water.

UNDP (2006) 'Beyond scarcity: Power, poverty and the global water crisis', Human Development Report.
The Water Crisis in the Occupied Territories and its Resolution in the Final-Status Agreement Position Paper'.

The main contaminants in the water resources in the Gaza Strip are nitrates, chlorides, salinity, and potentially, fecal coliforms and fecal streptococcus. The Palestinian Hydrology Group contends that the current pollutant rates are four times higher than the 2005 figures.

The main source of potable water in Palestinian Territories is the public water network. 91.8% of the total population has access; 89.4% in the West Bank and 96.3% in the Gaza Strip. Water tanks and wells made up 9.2% of the total sources in the West Bank, while it was only 1.7% in the Gaza Strip.

Table 4 8:

Table 31: Percentage distribution of households in the Palestinian Territories by the main mean of obtaining water and region 2011

Region	Public Water Network %	Water tanks %	Domestic well %	Other %	Total %
Palestinian Territories	**91.8**	**3.4**	**2.0**	**2.8**	**100**
West Bank	**89.4**	**4.7**	**4.5**	**1.4**	**100**
North of West Bank	87.5	6.1	5.4	1.0	100
Middle of West Bank	97.8	0.5	0.6	1.1	100
South of west Bank	83.1	8.4	8.0	0.5	100
Gaza Strip	**96.3**	**1.4**	**0.3**	**2.0**	**100**

Source: PCBS: Household Environmental Survey 2011

The quality of water supply reflects not only the living conditions of the households but also their health status. The Gaza Strip experiences low quality of water, as only 5.3% of households reported good water quality, compared to 70.9% of the West Bank.

Table 32: Percentage distribution of households in the Palestinian Territories by the Household evaluation of water quality and region, 2011

Region	Household evaluation of water quality			
	Good %	Fairly good %	Bad %	Total
Palestinian Territories	**47.2**	**37.9**	**14.9**	**100**

West Bank	**70.9**	**23.9**	**5.2**	**100**
North of West Bank	60.9	32.5	6.6	100
Middle of West Bank	81.2	13.6	5.2	100
South of west Bank	72.7	24.0	3.3	100
Gaza Strip	**5.3**	**62.8**	**31.9**	**100**

Source: PCBS: Household Environmental Survey 2011

4.19.5 Health Conditions and Handicapped

The discussion of health conditions in the project areas is somewhat difficult due to the scarcity of secondary non-aggregated data. The study team mainly relied upon the WHO report on health conditions in the occupied territories as source for generic information. More detailed information might be presented during the discussion of field results.

4.2.5.1.1 Health Status

Overall life expectancy is 70.5 years for males and 73.2 years for females. The population of the occupied Palestinian Territories grows at a rate of 2.9% (2.6% in the West Bank and 3.3% in the Gaza Strip). The crude birth rate declined over the last decade from 42.7 in 1997 to 29.6 in 2008. Many pregnant women suffer from anemia (45% in the Gaza Strip and 20.6% in the West Bank). About a third of newly pregnant women are immunized against tetanus in the West Bank.

The infant mortality rate has shown little improvement in recent years (25.34 per 1000 live births: 22.9 per 1000 live births in the West Bank, 28.8 per 1000 live births in the Gaza Strip). The main causes of death among infants are pneumonia and other respiratory disorders (34.5%), congenital malformations (16.3%) followed by prematurity and low birth weight (13.4%).

Despite the apparent difficulties that Palestinians faced over the reporting period, the WHO considers the general health status of the Palestinian Territories to be “commendably reasonable”.Malaria has been all but eradicated, incidences of HIV/AIDS are very low and the population is largely free of poliomyelitis, tuberculosis, and measles due to a series of successful immunization programmes. Palestinians are undergoing rapid epidemiological transition. Non-communicable diseases have overtaken communicable diseases as the main causes of morbidity and mortality.

The WHO, the Gaza Community Mental Health Project, and the Ministry of Health report that poor mental health is an increasing concern in the Palestinian Territories, particularly in the aftermath of Operation Cast Lead. A study from the Institute of Community and Public Health at Birzeit University noted that respondents demonstrated high levels of fear, threats to personal and family safety, loss of incomes, homes, and fear about their future and the future of their families.

Respondents also reported feeling hamm, meaning heaviness from worry, anxiety, grief, sorrow and distress, frustration, incapacitation and anger.

The UNDP's Social Development Assessment in Gaza highlights shortcomings in psychosocial support – for children, but also for adults – in the aftermath of Operation Cast Lead. It was found that while there has been some psychosocial support for children provided through the educational system and via child focused agencies, there has been a paucity of support for adults with no focus on older persons. Older people consistently expressed feelings of fear, insecurity and anxiety immediately following the hostilities which have not been alleviated in the present. Their lack of emotional wellbeing is largely focused on concerns about the future resurrection of conflicts.

With regards to disability in North Gaza Governorate, 3.7% of the total population are disabled. Seeing and moving disability are most common among both males and females. Relatively, females have higher disability ratio that reaches 3.3%

Table 4 10: isabilities/Difficulties of Palestinian Population in North Gaza Governorate by Type of Disability/Difficulty and Sex, 2007

	Percentage	Females	Percentage	Males	Percentage	Both Sexes
Seeing	1.8	2334	1.9	2592	1.9	4926
Hearing	0.8	1029	0.9	1181	0.8	221
Moving	1.4	1772	1.5	2024	1.4	3796
Cognition	0.6	744	0.7	976	0.6	172
Communication	0.6	734	0.7	972	06	1706
Total of Persons with Disability/Difficulty*	3.3	4348	0.4	5451	3.7	9799
Persons Without Disability/ Without Difficulty	96.6	125758	95.9	129448	96.3	255206
Not Stated	0	49	0	31	0	80
Total Population	100	130155	100	13493	100	265085

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

After significant progress from 1990 to 2000, the reduction of the under-five mortality rate was slow during the period 2000 to 2008: in 2006 and 2007 the rate of 27 deaths per 1,000 live births was the same as in 1990 In 2008 the WHO documented a rate of 28.2 deaths per 1,000 indicating a regression in child mortality figures The lack of progress during the reporting period, coupled with this deterioration, reflects declining health conditions The Gaza Strip has historically had a higher child mortality rate than the West Bank. The Palestinian Millennium Development Goals Progress Report noted that mortality rates in the Gaza Strip

4.2.5.1.2 Access to Health Services

The Ministry of Health, UNRWA, nongovernmental organizations and private, commercial organizations constitute the four main health providers of health services. The following health facilities are reported:

- Ministry of Health runs 59 primary health care centers in the Gaza Strip and 381 in the West Bank.
- UNRWA operates 18 primary health care centers in eight refugee camps in the Gaza Strip and 41 centers in the West Bank.
- The non-governmental organization sector manages 194 primary health care centers and general clinics (57 in the Gaza Strip, 137 in the West Bank).

There are 75 hospitals in the occupied Palestinian Territories (50 in the West Bank, 25 in the Gaza Strip), with a total of 5058 beds in government and nongovernment hospitals. Almost three quarters of them are general beds, 16.0% specialized beds, 3.8% beds for rehabilitation and 7.5% maternity beds. Overall, there are 12.9 beds per 10,000 population (12.7 beds in the West Bank and 13.5 beds in the Gaza Strip) .

The Ministry of Health, with the support of donors, has continued to develop the scope and range of public health services in the West Bank. The hospital sector in particular has benefited from significant investment in infrastructure and equipment with several hospitals being rehabilitated and services developed. The Ministry of Health has also sought to strengthen its institutional and governance capacity, not least by further efforts to improve the planning process. However, the Palestinian health-care system continues to face many challenges. These include restriction of movement and access to health services. Movement within the West Bank has become a little easier over the past year as a result of the removal of some of the checkpoints, but many checkpoints and closures still remain. There are particular difficulties of access to east Jerusalem, where the main tertiary health services are provided. Administrative restrictions also have an impact on the provision of health care in rural areas classified as “Area C” under the Oslo Accords.

In the Gaza Strip, the provision of adequate health services to the population continues to be severely affected both by the Israeli blockade and Palestinian internal political divisions between the West Bank and the Gaza Strip. While the hospitals and primary care clinics in the Gaza Strip continue to function, they face multiple challenges. For example, there have been growing shortages of essential drugs and consumables: 38% of essential drugs were out of stock at central store level at the beginning of January 2011. Recurrent power cuts and an unstable power supply have adversely affected medical care: sensitive medical equipment is damaged, supportive services have had to be suspended, treatments can be interrupted or need to be postponed. The functionality of medical equipment has also been deteriorating because of inadequate maintenance capacity and lack of spare parts (although a programme supported by the Government of Italy and WHO has been seeking to address this).

Figure 38: Beit Hanoun health center

Figure 39: Um El Nasr health center

Figure 40: Indonasian hospital in Beit lahia

Figure 41: : Governmentla hospital in Beit Hanoun

The project sites are served by different health facilities. The total number of hospitals is two, one in Beit Hanoun and one in Jabalia. There are many hospitals that are run by the private sector. There are relatively lack of health facilities in Um El Nasr and Beit lahia.

Table 33: Health facilite within project areas

	Beit Hanoun		Beit Lahia		Um El Nasr		Jabalia	
Service	Number	Most frequent destination	Number	Most frequent destination	Number	Most frequent destination	Number	Most frequent destination
General Hospital	1	Beit Hanoun hospital	0				1	
Private Hospital	1	Beit Hanoun hospital	1	Balsam Military Hospital			1	
Medical Center	2	Health Work Committee	0					
Outpatients' facility	1	Al shawa facility	2				1	Governmental
Health Bureau								
Health Unit	**1**	**Village's Unit**						
Childhood and maternity care							**1**	
Mobile Clinic (daily rate)							**1**	**Dental Care Clinic (Unrwa)**
Private Practice			**3**		**1**			
Pharmacy			**15**					

Source: The four municipalities 2018

Many qualified health staff are not working because of the factional divide. It is also difficult to maintain or upgrade the professional knowledge and clinical skills of health staff because the Israeli restrictions on the movement of people in and out of the Gaza Strip prevent access to appropriate health care and up-to-date education and training. The closure of the Gaza Strip is undermining the functioning of the health-care system, hampering the provision of medical supplies and the training of health staff and preventing patients with serious medical conditions from receiving timely specialized treatment outside the Gaza Strip .

A total of 8161 patients were referred to treatment outside the occupied Palestinian Territories in 2009: 3399 patients came from the West Bank and 4762 from the Gaza Strip.

4.19.5.1.1 Water Quality and Diseases

There is a high incidence of water related diseases. Water-borne disease is a major problem for Palestinians, creating substantial costs and losses. Epidemiological data is uneven, but there are many anecdotal stories of water related disease. In Nablus, for example, PWA explains: “We have a project to rehabilitate the waste water treatment plant. It is sorely needed. Yesterday 65 cases of diarrhea were treated in the hospital there.” At Burin near Nablus, there were recently 450 cases of Hepatitis A. Students in school were infected. The health impacts on smaller communities unconnected to the network, and for people living in Area C are particularly harsh.

The health impacts can be gauged by the high incidence of diarrhea amongst infants, and the health costs of poor water and sanitation services have been estimated at 0.4% of GDP.

The 2006 PAPFAM survey found that 12% of children under 5 had suffered from diarrhea in the two weeks preceding the survey. Diarrheal conditions are strongly associated with water quality, hygiene and sanitation. Some 54% of these cases had necessitated a medical consultation.

Extrapolating from the nature and cost of the medical treatments involved and without accounting for the losses of adult productivity, it has been estimated that the annual cost of the health impacts of poor water and sanitation on children 5-year old or less, is $20 million, equivalent to 0.37% of GDP

4.19.6 Human Development Profile

4.19.6.1 Literacy Rate

As could be observed from the table below, the literacy level is generally high in the Gaza Strip, reaching almost 95% of the population above 15 years of age in North Gaza Governorate. Gender discrepancy is not significant, except in the groups above 45 years of age. This could be attributed to an increased level of awareness of the importance of girls' education.

Table 34: Literacy Rates of AoI Population (15 Years and above) by Age Groups and Sex

Locality	Literacy	Literacy %

North Gaza Governorate	**Total**	**172436**	**94.84**
	Male	**89742**	**97.16**
	Female	**82694**	**92.44**
Um Al-Naser	**Total**	**1544**	**84.23**
	Male	**843**	**93.46**
	Female	**701**	**75.30**
Beit Lahia	**Total**	**40605**	**94.11**
	Male	**21172**	**96.51**
	Female	**344**	**16.22**
Beit Hanoun	**Total**	**23401**	**95.58**
	Male	**968**	**79.02**
	Female	**11408**	**93.25**
Jabalia	**Total**	**79807**	**95.35**
	Male	**41866**	**97.25**
	Female	**1356**	**33.36**

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

4.19.6.2 Educational Attainment

In North Gaza Governorate, the level of attained education is shown in the figure below. As could be observed, the largest portion of literate population attained preparatory education 31.76%, followed by the elementary education 24.04%. Here there is relatively high gender equity as well, with similar percentages of men and women attaining various educational degrees.

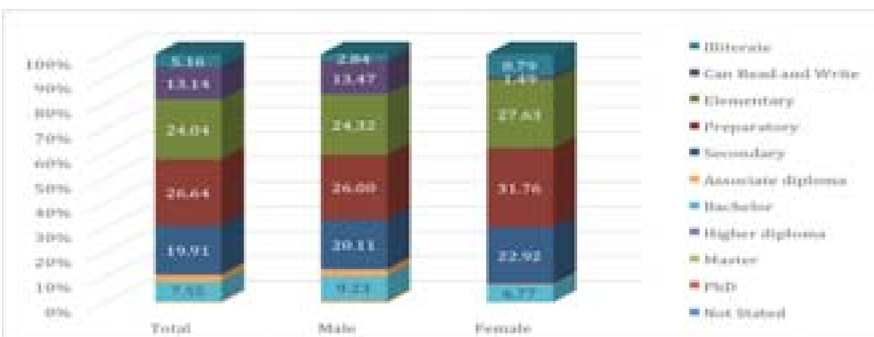


Figure 42: Percentage Distribution of Gaza Strip Population (15 years of age and above) by Educational Attainment and Sex, 2012 in Gaza Strip

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

4.19.6.3 Educational facilities

There are sufficient number of schools in the project areas. The following table represents the number of educational facilities.

Table 35: Educational facilities

Utility	Beit Hanoun	Beit Lahia	Um El Nasr	Jabalia
Adult Literacy class		1		
Basic school	7	12	1	1
Preparatory school	6	10	1	1
General Secondary school	3	13	1	1
Vocational, Agricultural, and Commercial Schools	1	2		
Azhar Institute		1		
High Institutes/ Universities		3		1

Source: Local municipalities 2018

Figure 43: Basic school inm Um El Nasr

Figure 44: Faculty of agriculture in Beit Hanoun

Figure 45: Palastine University in Beit Lahia

Figure 46: Religious institute in Beit lahia

4.19.7 Employment Status

The general unemployment rate in the Palestinian Territories is considered high, at 24.5% of the labor force. Unemployment in Gaza is double the rate observed in the West Bank (38.6% versus 17.8% in 2010). Within the Gaza Strip, Gaza City has the lowest unemployment rate at 31%. Unemployment is slightly higher for women than men in the Palestinian Territories (26.4% versus 24.1%). However, the gap is relatively high in the Gaza Strip as 37.3% of males are unemployed, whereas 45.8% of females are not working.

Regarding the main sector of work, the majority of employees work in services (63.3%), while people working in commerce, hotels and restaurants are only account for 18.3%. The diversity according to gender is relatively high as 86.6% of females work in the services sector, while 59.6% of males work in the same sector. However, 20.7% of males work in commerce versus null of the females in the same field.

With regards to project sites, there is no specific data there is no available data about employment on the level of project sites. However, the statistical updated data for the four areas reflected that the total number of employed among males is 59.9%, while it is limited to 34.1% among females (source PSB 2016).

The unemployment rate is high among females as it reaches about 64.8% of the female population within labor force. The unemployment among males is 37.8%. Unemployment ratio varies among different people in accordance to their level of education. Unemployment rate is 45.5% among those who have university education, however, it reaches only 16.9% among intermediate education graduates.

The total percentage of labor force is estimated at 67.3% among males and 18.8% among females.

Table 36: Percentage distribution of population (15 years and above) in the AoI by Sex and labor force status year 2012

Locality		Unemployed Never Worked	Unemployed Ever Worked	Employed	Economically Active	Employment Rate
North Gaza Governorate	Total	8686	11365	33638	53689	62.7
	Male	7586	11059	29586	48231	61.3
	Female	11	36	4052	5458	74.2
Um Al-Naser	Total	155	153	199	507	39.3
	Male	146	151	190	487	39.0
	Female	9	2	9	20	45.0
Beit Lahia	Total	2007	2355	8157	12519	65.2
	Male	1997	2315	7362	11456	64.3
	Female	228	40	795	1063	74.8
Beit Hanoun	Total	1144	1541	419	6875	6.1
	Male	1027	15	3662	6189	59.2
	Female	117	41	528	686	77.0
Jabalia	Total	4374	5442	15854	25670	61.8
	Male	3847	5309	13818	22974	60.1
	Female	527	133	2036	2696	75.5

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

4.19.8 Economic Wellbeing

PCBS has calculated the Real Gross Domestic Product (GDP) . It was $461 during the second quarter of 2014. Living standards in Gaza Strip deteriorated during the previous 4 years: GDP per capita in Gaza Strip is $274. For the period of the second quarter of 2013 until the second quarter of 2014, growth in real GDP for Palestine overall was 0.9%. The GDP in Gaza Strip fell by 10.2%. (these figures consider the circumstances before the latest Israeli attack on Gaza, July-August 2014, which undoubtedly severely impacted the economy of the Gaza Strip, in particular.) These figures are representative of already severely limited economic activity before Operation Cast Lead, as it resulted in the destruction of significant remaining economic assets, which means that further decline is inevitable.

The International Financial Institutions highlight that, even more troubling than the negative growth rates over the past few years, is the changing composition of the economy: as GDP is increasingly driven by government and private consumption of donor aid and remittances respectively, investments have fallen to dangerously low levels, leaving little productive base for a self-sustaining economy. The Palestinian economy is buttressed by enormous infusions of foreign aid: in 2008,budget support alone increased by nearly 80% from its 2007 level, and at close to USD 1.8 billion, was equivalent to about 30% of GDP. By comparison, in2007 the estimated recurrent and developmental budget support added up to 5% of GDP. This, impart, reflects the 'West Bank first' policy pursued by the international community in the aftermath of Hamas's takeover of the Gaza Strip. The cost of living in the Palestinian Territories rose significantly over the reporting period. The poverty rate according to the monthly consumptions of individuals in the Gaza Strip has decreased from around 50% in 2007 to 33% in 2009. However, the poverty rate using the same indictor of monthly consumption is much higher in the Gaza Strip than in the West Bank, recorded at 20% and 15% in 2007 and 2009 respectively. However, the Palestinian Human Development Report, using different poverty indicators, showed that about 34.5% are under the poverty line in Palestinian Territories. This percentage is reduced in the West bank to 23.6%, and increased to 55.7% in the Gaza Strip.

Table 37: Proportion of population below national poverty line

	Year			
Year	**2004**	**2005**	**2006**	**2007**
Total	**25.6**	**29.5**	**30.8**	**34.5**
Male	26.0	29.8	30.3	34.5
Female	21.0	25.0	35.6	34.5
Urban	24.4	24.9	29.3	33.1
Rural	24.6	32.5	29.5	30.3
Camps	31.6	39.9	38.6	47.7
Gaza Strip	37.2	43.7	50.7	55.7
West Bank	19.8	22.3	24	23.6

Source: Human Development Report 2009/10

It should be noted that poverty in Gaza is not limited to low levels of income. It is rather characterized by serious shortfalls in other dimensions. There is a serious level of insecurity of income, food, access to infrastructure and vulnerability resulting from the strong reliance on external assistance, with very limited ability to attain sustainability of livelihoods for a large portion of households. Many families are suffering from the consequences of war and blockade, and are generally overwhelmed by the economic and political situation .

The high level of poverty was clearly observed during the field work conducted as part of the ESIA. Some of the observations include the domination of short term employment modes and the high rate of unemployment among youth including university graduates, in addition to the various social implications on the household level. These observations are thought to be the key causes of poverty and insecurity issues. There are several other signs that demonstrate poverty amongst the households; one example is the irregularity of paying the charges of various types of services including electricity, water and SWM. This was observed during surveys and other field investigation activities. This is partially attributed to the families' inability to pay these charges.

4.19.9 Economic Activities

With a growing population and a shrinking economy, real Gross Domestic Product (GDP) per capita is close to 30% below the 1999 level. The overall economic picture is one of negative growth. PCBS estimates that the GDP in 2006 had a negative growth rate of 6.6 %. It estimates that real GDP growth in 2007 was a mere 0.5%, while results from the first quarter suggest that growth in 2008 is slightly negative. Similarly, the International Monetary Fund (IMF) recorded a drop in GDP of 0.5 % in 2007, and a modest growth of 0.8 % in 2008. This is probably due to a continued yet marginal drop in economic activity in Gaza, given its already low base, matched with a modest rise in economic activity (PCBS (2007) 'Economic forecasts for 2007'). Figures 42-43 are representative of already severely limited economic activity before Operation Cast Lead, as it resulted in the destruction of significant remaining economic assets, which means that further decline is inevitable.

Figure 47: Agriculture lands in Um El Nasr

Figure 48: City center in Beit Hanoun

With regards to human activities in the project sites, the estimations provided were based on the meetings conducted with the municipalities. This is just guiding information. Agriculture activities are the main employment activities in Beit Hanoun, Um El Nasr and Beit Lahia. However, the governmental posts are occupied by 62.4% of the labor force in Jabalia.

Regarding the main sector of work, the data showed that the majority of employees work in services (63.3%), while people working in commerce, hotels and restaurants are only 18.3%. The diversity according to gender is relatively high as 86.6% of the females work in services sector, while 59.6% of males work in the same sector. However, 20.7% of the males work in commerce versus null of the females in the same field.

Table 38: Number of Establishments in Operation and Persons Engaged in the Private Sector, Non Governmental Organization Sector and Governmental Companies in the AoI

Locality	No of Persons Engaged			No of Est
	Females	Males	Total	
North Gaza Gov	1704	10137	11841	4777
Um Al-Naser	11	9	20	8
Beit Lahia	311	287	2398	978
Beit Hanoun	198	681	879	426
Jabalia	829	5128	5957	2184

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

Table 39: Percentage Distribution of Employed Persons from Gaza Strip by Economic Activity and Sex

Economic Activities	Females	Males	Total	No of Est
North Gaza Gov	1704	10137	11841	4777
Agriculture, Farming of Cattle and other Animals	10	344	354	129
Mining & Quarrying	-	-	-	-
Manufacturing	47	1944	1991	513
Electricity And Water Supply	1	191	192	50
Construction	-	92	92	19
Wholesale, Retail Trade & Repairs	381	5153	5534	2929
Hotels and Restaurants	29	47	436	178
Transport, Storage & Communications	7	226	233	45
Financial Intermediation	16	79	95	37
Real Estate, Renting & Business Activities	38	284	322	172
Education	606	187	793	106
Health & Social Work	218	348	566	122
Other Community, Social & Personal Service	351	882	1233	477

Source: Palestine Annual Statistics Book (version 11), PCBS

4.19.10 Sewage Status in the Gaza Strip

4.19.10.1.1 Sewage Generation

The sewage is mainly generated from the households' consumption of water supply, which is about 17 million cubic meters. It is divided as follows: 11 million to the West Bank and 6 million to the Gaza Strip. Regarding the consumption ratio for water, it is 23m3 in the Palestinian Territories: 23.6 m3 in the West Bank and 24.3m3 in the Gaza Strip

Table 40: Amount of consumed water in the household sector in Palestinian Territories (1000m3) and household monthly average consumption of water (m3) by region, 2011

Region	Household monthly average consumptions	Amount of consumed water in the household sector (thousand cubic meter)
Palestinian Territories	23.8m^3	17.032.5 m^3
West Bank	23.6 m^3	11.063.0 m^3
North of West Bank	23.4 m^3	4.422.7 m^3
Middle of West Bank	29.7 m^3	4.247.1 m^3
South of west Bank	17.5 m^3	2.393.2 m^3
Gaza Strip	24.3 m^3	5.969.5 m^3

Source: PCBS Household Environmental Survey 2011

4.19.10.2 Wastewater networks and disposal

One of the main sources of wastewater is disposal from the public sewage network, which might reach 60.9% in the urban areas among which 47.0% live in the West Bank and 83.3% in urban areas in the Gaza Strip. However, the connectivity among those who live in rural areas is 10.3%. The highest connectivity rate reported was in the camps 90.9%. Yet, the Gaza Strip was of the highest connectivity ratio to the wastewater network which is 83.1% in total.

Table 41: Selected indicators of the household environment in the Palestinian Territories during years 2004, 2006,2008,2009,2011

Indicator	2004	2006	2008	2009	2011
Percentage distribution of households by:					
Availability of public network water	89.2	88.6	88.2	88.4	91.8
Quality of households water					
Good	63.0	50.6	45.6	48.1	47.2
Fairly Good	27.5	26.3	30.3	23.7	37.9
Bad	9.5	23.1	24.1	28.2	14.9
Wastewater disposal method					
Wastewater network	42.9	45.3	45.5	52.1	55.0
Tight or porous cesspit	56.1	54.0	53.7	47.2	44.3
Others	1.0	0.7	0.8	0.7	0.7
Exposure to smell					
Seldom or no smell	79.6	73.6	76.6	76.4	72.2
Sometimes	10.3	11.0	12.3	8.3	12.1
Very often	10.1	15.4	11.1	15.3	15.7

Source: PCBS: Household Environmental Survey 2011

Regarding exposure to smells it was notified that 15.7% of the total population reported facing a smell problem. These odor problems often occur at irregular times.

Table 42: Percentage distribution of households exposed to smell in the Palestinian Territories by time of exposure and region, 2011

Region	Time of exposure				
	6 AM- 12 PM %	12 PM-8 PM %	8 PM- 6 AM %	No specific time %	Total
Palestinian Territories	**7.4**	**6.0**	**21.1**	**65.5**	**100**
West Bank	**10.3**	**7.2**	**13.7**	**68.8**	**100**
North of West Bank	17.9	8.5	15.4	58.2	100
Middle of West Bank	7.2	9.7	22.0	61.1	100
South of west Bank	1.7	2.1	1.8	94.4	100
Gaza Strip	**3.9**	**4.7**	**29.7**	**61.7**	**100**

Source: PCBS: Household Environmental Survey 2011

The source of smell was mainly from treated water as 37.1% in Palestinian Territories reported, while 39.6% of the Gaza Strip reported waste water as the main source of smell.

Table 43: Percentage distribution of households exposed to smell in the Palestinian Territories by the most important source of smell and region, 2011

Region	Source of smell					
	Waste water %	Dumping site %	Agricultural waste %	Traffic %	Others %	Total
Palestinian Territories	**37.1**	**30.0**	**26.0**	**3.0**	**3.9**	**100**
West Bank	**35.0**	**24.4**	**31.4**	**4.8**	**4.4**	**100**
North of West Bank	32.0	20.9	37.7	6.8	2.6	100
Middle of West Bank	41.1	32.3	16.8	5.5	4.3	100
South of west Bank	33.0	21.4	37.4	1.0	7.2	100
Gaza Strip	**39.6**	**36.5**	**19.7**	**0.8**	**3.4**	**100**

Source: PCBS: Household Environmental Survey 2011

4.19.10.3 Cost

April 2009 Domestic tariffs for network supply are on the whole reasonable – but overall, water is a significant item in household expenditure. Generally, water supplied through the domestic network costs consumers around NIS 4/m3, and people find this fair. However, given the very low income levels, the PCBS 2003 survey found that average the expenditure on water from all sources was about 8% of household income – and much more for low income households. This level of water expenditure is double the standard of 3.5% of household expenditure recommended by Unicef/WHO.

High costs and poor service contribute to low payment rates, which may lead to increased dependence on Israel. This high cost of water in relation to income is one reason why the cost recovery rate for network supply averages 50% nationwide. The government ends up footing the bill – and even then the cost is deducted at source by the Israelis. The case of Bethlehem illustrates how this failure to pay is undermining the utilities and creating distorted incentives to use Mekorot water, which increases dependence on Israel.

It is the poor unconnected consumers who pay the highest costs – up to nearly half of their household budget – and run the biggest health risks. The poorest and most vulnerable communities are those in Area C. They are vulnerable to both access controls and to the high cost and poor quality of water. The summer months of June-October are when these communities are most vulnerable. The PCBS 2003 survey was used to compare average water expenditure share of income for each income group. The poor who are dependent on tankers may pay out almost half their income on water, five times more than the poor who are connected. Survey results regarding the percent of income spent by low income households on tanker water appear uncommonly high in 2003, and may be subject to confirmatory updates carried out by the Water, Sanitation and Health Monitoring Program (WaSH MP) 41: "Occupation checkpoints and curfews severely limit tanker access to communities. (The survey showed) that there are 36 fixed checkpoints across the West Bank, including the gates of the Separation Barrier, that seriously affect access of water tankers and maintenance teams to communities….Given the risks faced by drivers for their physical safety coupled with the longer routes, the price of water through tankers has increased exponentially…" WaSH MP has carried out research on the costs faced by communities before the M&A restrictions, and after. The survey found in 85 communities that water prices had increased by a minimum of 60%, and a maximum of 300%. Water prices that before the Intifada were generally in the range 5-10 NIS/m3 were now typically in the range 10-20 NIS/m3. In addition, communities had reduced their purchases of tanker water by at least 50%.

GDP using PCBS 2003 data, a preliminary study estimated that the additional cost at the national level of the use of tanker water over network water could be as high as 176.5 million NIS annually, equivalent to 0.93% of GDP.43 water ankers.

4.2.11 Agriculture sector in Gaza

Agricultural activities are one of the main sectors in the Gaza Strip. The total amount of land allocated for agricultural activities is 107.9 km2. The lands are distributed according to the type of crops (permanent or temporary) and the type of irrigation (irrigated or rain-fed). The majority of lands are permanently irrigated crops which cover about 75.6% of the total areas of lands, while rain-fed represented only 24.4%. That might reflect the necessity of having a permanent source of water.

Table 44: Agricultural Land Use in Gaza Strip

Agricultural Land Use in Gaza Strip		Cultivation Type							
Region/ Governorate	**Total Agricultural land (Km²)**	**Permanent Crops (Km²)**				**Temporary Crops (Km²)**			
		Irrigated		Rain-fed		Irrigated		Rain-fed	
		2007	2008	2007	2008	2007	2008	2007	2008
North Gaza	14.5	5.1	5.1	0.2	0.2	7.8	7.2	2.1	2.0
Gaza	16.7	22.0	13.4	0.6	3.1	1.3	1.1	1.4	1.1
Deir El Balah	21.8	12.6	12.6	1.6	1.6	6.5	5.0	2.7	2.6
Khan Yunis	37.5	14.5	14.5	2.5	2.5	12.3	10.5	12.4	10.0
Rafah	17.4	5.2	5.2	1.6	1.6	8.9	8.5	2.4	2.1
Total Strip	107.9	59.4	50.8	6.5	9.0	36.8	32.3	21.0	17.8

Source: Palestine Annual Statistics Book (version 11), PCBS

The main crops produced in the Gaza Strip are vegetables (215,251 tons), followed by crops (72,516 tons) and fruit trees (53,931 tons). This is very important as treated reused water is not recommended to be used with vegetables.

Table 45: Production of field crops, fruit, trees and vegetables by region 2007/2008

Region/Governorate	Field crops	Fruit trees	Vegetables
North Gaza	18,619	5,496	29,662
Gaza	863	22,606	9,400
Deir El Balah	3,506	12,750	38,074
Khan Yunis	26,572	8,066	64,827
Rafah	22,956	5,013	73,288
Total Strip	**72,516**	**53,931**	**215,251**
Production in Ton			

Source: Palestine Annual Statistics Book (version 11), PCBS

4.19.11 Archaeology

The known history of Gaza spans 4,000 years . Gaza was ruled, destroyed and repopulated by various dynasties, empires, and people originally a Canaanite settlement, it came under the control of the ancient Egyptians for roughly 350 years before being conquered by the Philistines, who made it one of the principal cities of their pent polis in the 12th-century BCE. Gaza fell to the Israelite King David in about 1000 BCE and with the fall of the Kingdom of Israel in about 730 BCE, it became part of the Assyrian empire, and subsequently, that of the Persian Achaemenid Empire. Alexander the Great besieged the city for five months before finally capturing it in 332 BCE. Most of the inhabitants were killed during the assault, and the city, which became a center for Hellenistic learning and philosophy, was resettled by nearby Bedouin Arabs. The area changed hands regularly between two Greek successor-kingdoms, the Seleucids of Syria and the Ptolemies of Egypt. The city was besieged and taken by the Hasmoneans in 96 BCE.

After the Roman Empire began its influence in the area in 63 BCE, Gaza was rebuilt under the command of Pompey Magnus, and granted to Herod the Great thirty years later. Throughout the Roman period, Gaza maintained its prosperity, receiving grants from several different emperors. A 500-member senate governed the city, and a diverse array of Greeks, Romans, Jews, Egyptians, Persians and Nabateans populated the city. On the breakup of the Roman Empire, Gaza became part of the Eastern Byzantine Empire. Conversion to Christianity in the city was spearheaded and completed under Saint Porphyrius, who destroyed its eight pagan temples between 396 and 420 CE. Gaza was the first city in Palestine to be conquered by the Arab Rashidun Caliphate in 635 CE. The arrival of the Muslim rulers brought drastic changes, as its churches were transformed into mosques, the population swiftly adopted Islam as their religion, and Arabic became the official language. Under the Arab Muslims, the city went through periods of prosperity and decline. The Crusaders wrested control of Gaza from the Fatimids in 1100, and ruled until 1187, when the city was conquered by Saladin and the Ayyubids. Gaza was in Mamluk hands by the late 13th-century, and became the capital of an administrative unit of Bilad ash-Sham that stretched from the Sinai Peninsula to Caesarea. By the time of its incorporation into the Ottoman Empire in the 16th-century, it was but a small village. The Ottomans charged the Ridwan family with governance over the city in the early 16th-century. From the early 19th-century, Gaza was culturally dominated by neighboring Egypt, with significant numbers of Egyptian Muslims moving in and Muhammad Ali of Egypt conquered it in 1832. His brief rule ended in 1840, after the Ottomans defeated his forces outside the city. In 1917, the forces of the Triple Entente captured the city after a third battle against the Ottoman forces there.

The 20th-century began in Gaza with two destructive earthquakes in 1903 and 1914. The city also expanded in the first half of the 20th-century under the British Mandate for Palestine. According to the 1947 United Nations Partition Plan, Gaza was assigned to the Arab state. The population of the city and the Gaza Strip swelled as a result of the 1948 Arab-Israeli War. After the war, it was held and militarily administered by Egypt until the 1967 Six-Day War, when it was occupied by Israel. Gaza was a center of political resistance in the First Intifada, and under the Oslo Accords of 1993, it was assigned to be under the direct control of the newly-established Palestinian National Authority. In 2007, Hamas emerged as the victor in Palestinian factional fighting with Fatah in the city and in the wider Gaza Strip and has since been the sole governing authority there. Israel has blockaded the Strip ever since and launched an assault in 2008–2009, which it characterized as a response to Qassam rocket attacks. The bombardment and ground assault reportedly left over 1,300 people dead in the territory, and destroyed over 4,000 buildings.

4.19.12 Archaeological Conditions of Project Sites

Field surveys in the area of the BLWWTP did not identify any archaeological sites. The nearest archaeological remains in the area is Tell al-Khirb, situated in the eastern part of Beit Lahia, 500 m south of the WWTP. In the area, archaeological remains such as mosaic fragments and pottery shards can be found over the whole of the mound. They are dated to be from the Roman Byzantine period. Beit Lahia has an ancient hill and nearby ruins of an abandoned village. A mihrab, or mosque alcove indicating the direction of salaah (prayer), is all that remains of an ancient mosque to the west of Beit Lahia, dating to the end of the Fatimid period and beginning of the Ayyubid Dynasty of Saladin. In addition, there are two other mosques dating to the Ottoman period within the area. There are many mosques and churches in the four project areas. Some of them dated 100 years ago and most of them are newly constructed

Figure 49: Awqaf mosque in Beit Lahia

Figure 50: Church in Jabalia

Figure 51: Mosa'b Ben Omair mosque in Beit lahia

Figure 52: El Omary El Sageir mosque in Jabalia

To ensure the non-existence of the archeological sites or artifacts, the Consultant sent the letter to the Antiquity authority. The reply confirmed the field surveys and interviews conducted by the Consultant and stated that no archeological objects or artifacts had been found and that the sites do not belong to the sensitive sites for archeological activities.

4.19.13 Security status

The project area of influence is located in the buffer zone from Israeli. Israel imposed a 50-meter buffer zone in Gaza. In 2000, it was expanded to 150 meters. Following the 2005 Israeli disengagement from Gaza, an undefined buffer zone was maintained.
In 2009/2010, Israel expanded the buffer zone to 300 meters. In 2010, the UN estimated that 30 percent of the arable land in Gaza had been lost to the buffer zone . On 25 February 2013, pursuant to a November 2012 ceasefire, Israel declared a buffer zone of 100 meters on land. In the following

month, the zone was changed to 300 meters and 3 nautical miles. Generally speaking, the buffer zone is titled to changes from the Israeli side.

In 2014, Israel invaded Gaza Strip and damaged most of crops in the project area of influence. Political situation in the project area of influence urged the residents to be keener to protect their lands and assets.

Total number of refugees 265,085 people 45.5% of the refugees reside in Jabalia, whereas about 23.8% of them reside in Beit Lahia.

Table 46: Refugee Status and Sex (thousand)

Locality	Total		Not Stated		Non-Refugee		Non-Registered Refugee		Registered Refugee	
	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
North Gaza Governorate	130.155	134.93	1	-	35.821	38.256	826	752	93.507	95.922
Um Al-Naser	1.358	1.402	-	-	51	63	10	12	1.297	1.327
Beit Lahia	31.001	32.159	-	-	13.162	14.01	217	148	17.622	18.001
Beit Hanoun	18.462	18.87	-	-	423	382	187	210	17.852	18.278
Jabalia Camp	20.571	20.574	1	-	73	41	80	61	20.417	20.472
Jabalia	58.763	61.925	-	-	22.112	23.76	332	321	36.319	37.844

Source: Palestinian Statistical Year Book, 2012, Palestinian Central Bureau for Statistics

5 ENVIRONMENTAL AND SOCIAL IMPACTS AND PROPOSED MITIGATION MEASURES

5.1 Environmental Impacts

5.1.1 Positive Impacts and Their Enhancement

The aim of the effluent recovery scheme of NGESTP is to achieve environmental and social improvements in the project areas through providing sustainable and safe reuse of recovery water to areas which were previously deprived of these services, especially for agricultural purposes.

The environmental and social benefits expected from the different components of the project are discussed in the following sections.

1. <u>Positive Impacts of Effluent Recovery Scheme (Water Effluent)</u>

The project will have many positive impacts on water resources, and ground water in a particular manner. The recovered effluent from the groundwater will be an important source of irrigation water, as water resources in the Gaza Strip are scarce. It is of ultimate importance however, that the water quality is suitable for the type of crops and exposure to the farmers and the public.

In the analysis carried out in 2012, it was concluded that the expected water quality from the recovery wells would be suitable for unrestricted use in irrigation. The conclusion at the time was developed through groundwater modelling, using the water analysis of samples taken from existing monitoring wells for calibration. Conclusions reached were mainly based on BOD, which was 5mg/l in the existing monitoring wells at the time.

Conducting a comparison using currently available data and analysis results of actually constructed recovery wells presented in the baseline chapter, the conclusion back in 2012 can be confirmed. While BOD levels are higher than 5mg/l, it is still lower than the permissible 30mg/l, the Palestinian limit for unrestricted groundwater use (10mg/l).

Results of the model also shows that, at the beginning of year 2018, the pollution plume extends to a distance of about 500 m (nitrate concentration contour line is 80 mg/l) in the North-West direction of the basin (See Figure 49); as wastewater with bad quality has been infiltrated in the basins since 2009 (15,000 – 20,000 m3/day).

The model results showed that even after the operation of the treatment plant for seven years (up to year 2025), polluted zones will still exist and some agricultural wells will be affected in the absence of the project (pollutant levels reaching 80mg/l at some areas).

After the operation of stage 1 wells, the situation will be highly improved and the nitrate levels will be brought down to almost half the concentration. After the operation of stage 2 wells, the project of concern, the area of influence will be constrained and the polluted zone in the North-west direction will become smaller, until it disappears completely in 2042.

However, although the unrestricted use is considered, it is advisable not to use the recovered water for unrestricted use.

1. Water Resource Contamination

The impact on groundwater is one of the most important issues that are being associated with the project, that is part of the project has been designed to prevent impacts on the groundwater from infiltrating partially treated sewage. The methodology used is detailed in **Annex 5.**

The most updated data provided by the client, up to year 2017, is used; i.e. the model was updated considering the followings:

- The actual infiltrated partially treated wastewater quantities and rates from 2012 to 2017,
- The updated locations and numbers of the recovery wells,
- The actual design of the first stage of the recovery wells (14 wells) that constructed by the end of year 2017.
- The updated time schedule for the operation of the treatment plant and the two stages of the recovery wells.

The assessment of the impacts on groundwater considered the abstraction rates of the recovery wells, the possible recharge in the agricultural lands and different scenarios for project implementation.

Two scenarios are considered in the current impact assessment:

1. Without the implementation of recovery scheme.
2. With the implementation of recovery scheme. 28 recovery wells will be implemented on two stages; 14 wells that already constructed and to be operated by the end of 2019 and 13 wells to be operated by the end of 2021.

Both scenarios take into account the operation of the WWTP by the beginning of 2018. Therefore, partially treated wastewater will continue to be infiltrated until the beginning of 2018, then, 35,600 m^3/day of treated wastewater will be infiltrated.

Modeling Results without Recovery Scheme

Results of the model shows that, at the beginning of year 2018, the pollution plume extends to a distance of about 500 m (nitrate concentration contour line is 80 mg/l) in the North-West direction of the basin (Figure 48); as wastewater with bad quality has been infiltrated in the basins since 2009 (15,000 – 20,000 m^3/day).

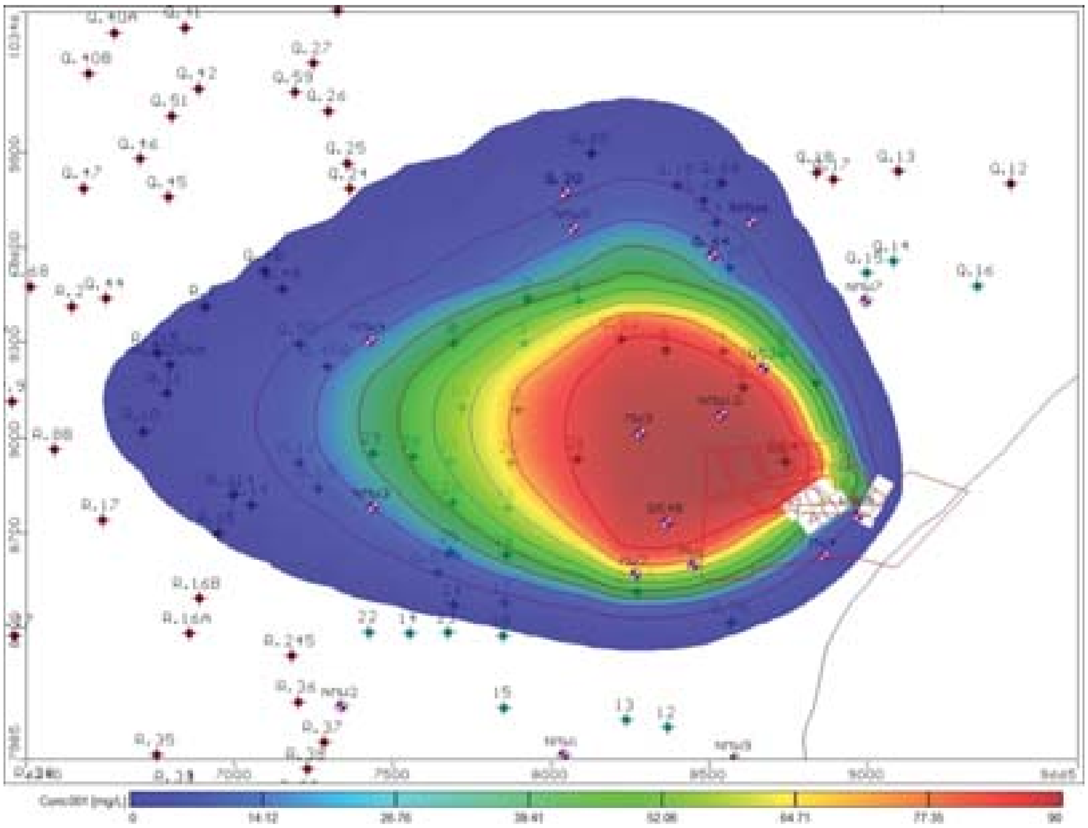


Figure 53:The pollution plume in year 2018 (before the infiltration of treated wastewater, no recovery)

Figure 49 shows the groundwater quality expectations in year 2019 after the operation of the treatment plant. Concentration of the infiltrated treated wastewater will be 10 mg/l. It can be noticed that there will still be polluted zones and some agricultural wells will be affected. Figure 50 shows the same scenario for year 2025 where the groundwater quality is highly improved. However, large polluted zone is still found in the North-west direction, where municipal and agricultural wells exist.

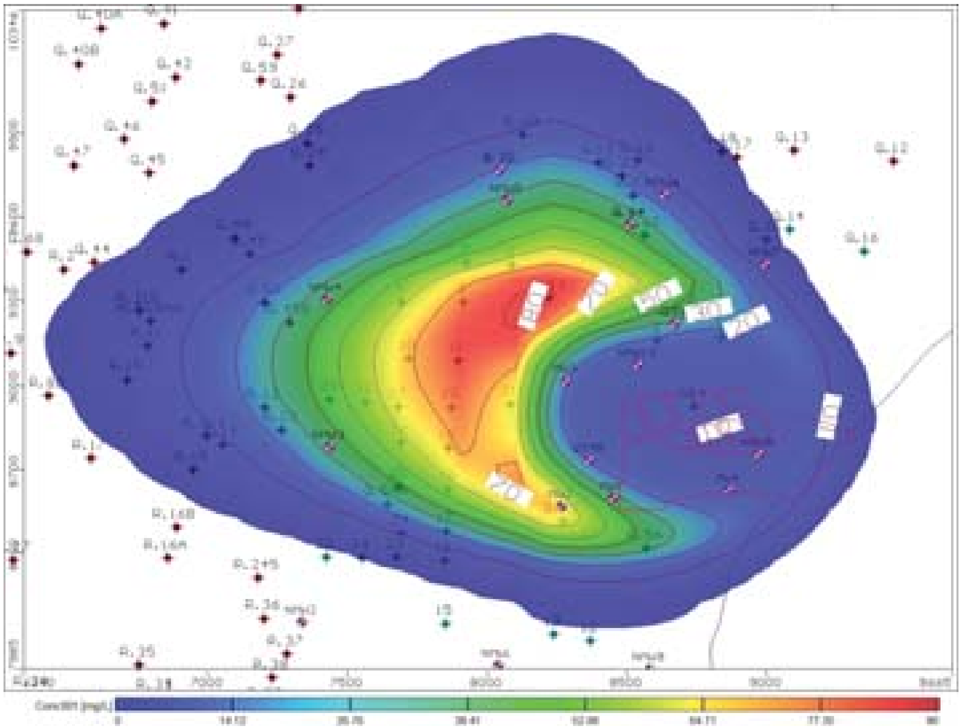


Figure 54: The pollution plume for year 2019 (35,600 m3 of treated wastewater is infiltrated starting from 2018)

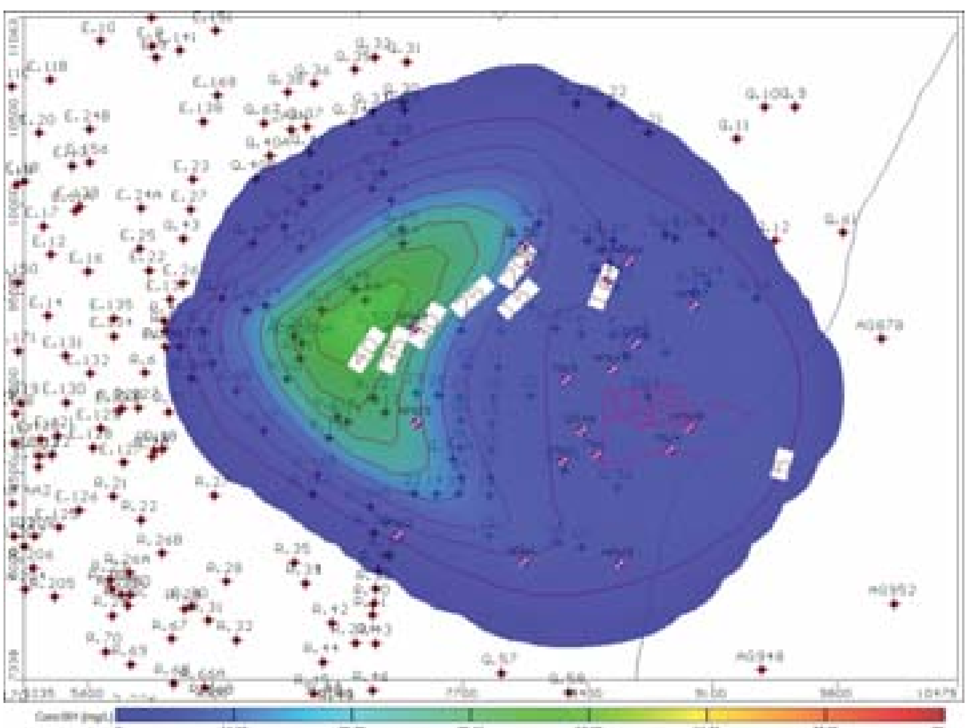


Figure 55: The pollution plume for year 2025 (35,600 m3 of treated wastewater is infiltrated starting from 2018)

Modeling Results with Recovery Scheme

A total of 28 recovery wells, designed to recover the infiltrated treated wastewater, will be implemented and operated on two stages:

- **Stage 1**: 14 wells, located in the North West direction of the basins, are designed to be operated by the end of 2019.
- **Stage 2**: 13 wells, located in the North and the South direction of the basins, are designed to be operated by the end of 2021.

In order to specify the optimal locations of these wells, several runs of the model were carried out, as part of the project design, on the base that these wells should be able to capture all pollution; these locations were modified to go in line with the delay in the operation of the treatment plant. Figure 51 shows the pollution plume after the implementation of the first stage of the recovery wells, it can be noticed that the plume is restricted to pass the 14 recovery wells. In addition, it reduces the dilution of the pollutants in the area after the recovery wells.

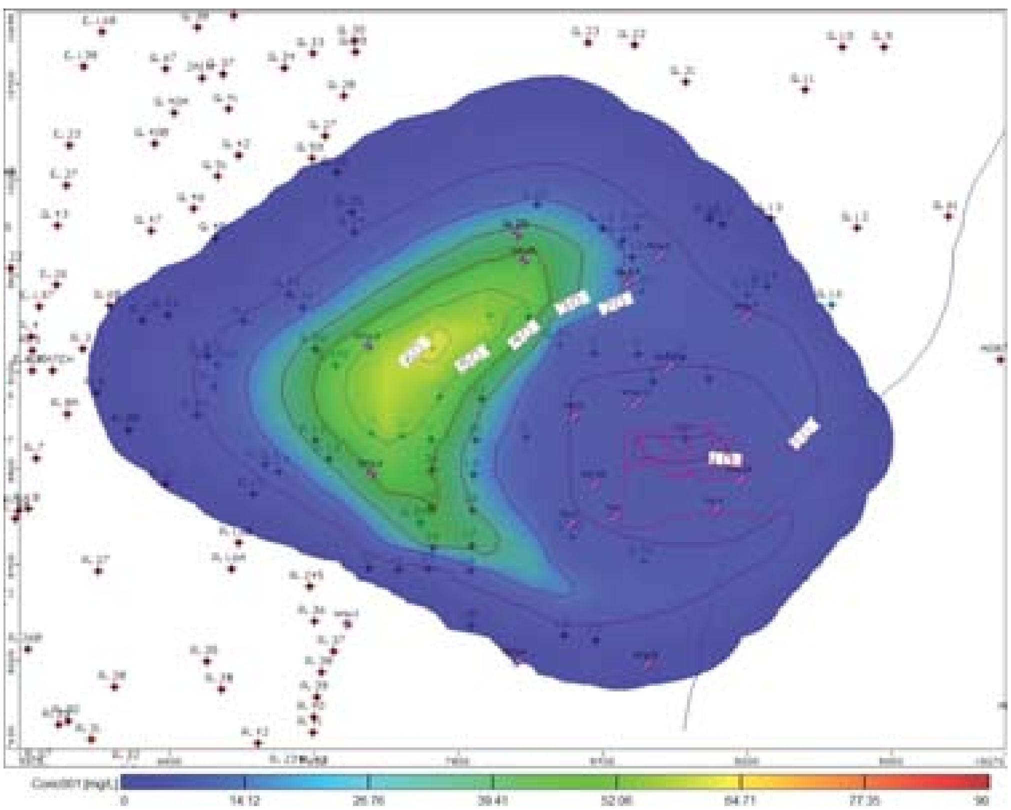
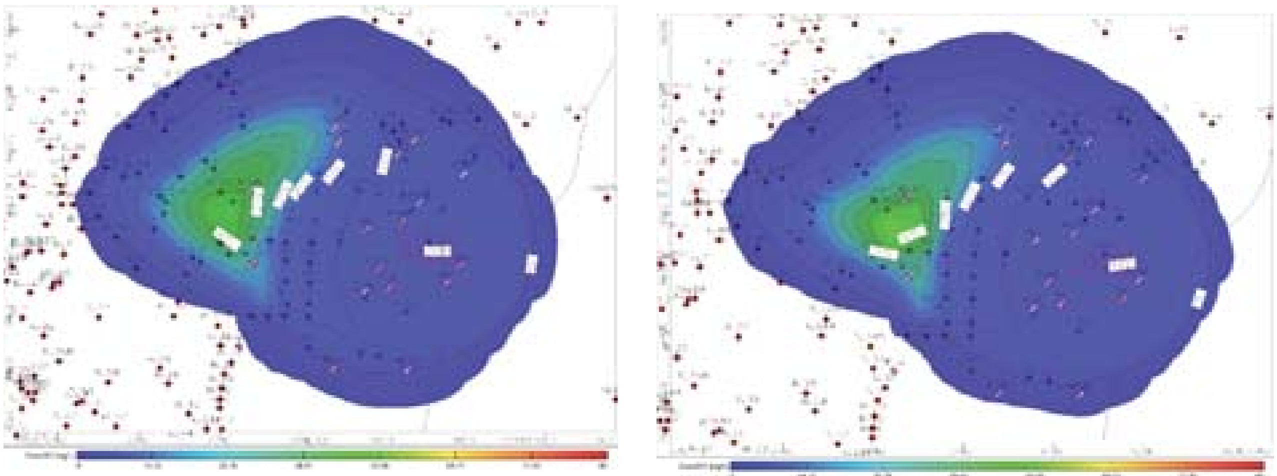


Figure 56: Pollution plume in 2021 (after the implementation of the first 14 wells in 2019)

The second stage of the recovery wells is intended to be implemented to restrict the expansion of the pollution plume; i.e. if only 14 wells continue to operate, the pollution will be extended and more wells will be at risk in year 2025 as shown in Figure 52 (a). In addition, polluted zone will be found in the North-west direction with concentration of pollution of 40 mg/l. While Figure 52 (b) shows that the pollution plume is restricted to pass the 28 recovery wells. In addition, the area of the polluted zone in the North-west direction will be smaller than that the area in the case of operating 14 wells. The presence of this pollution zone in the north-west direction is due to the delay of construction and operation of the 14 wells (stage 1) and 13 wells (stage 2). The pollution escapes the recovery wells and it is difficult be recaptured using the recovery wells since the remaining polluted area is in the downstream. This polluted area will disappear due the dilution with the existing groundwater which will take time. As shown in Figure 53 in year 2042 the pollution disappears.



(a) (b)

Figure 57:: Pollution plume in 2025: (a) without the implementation of Stage 2 of the recovery wells and (b) after the implementation of stage 2 of the recovery wells

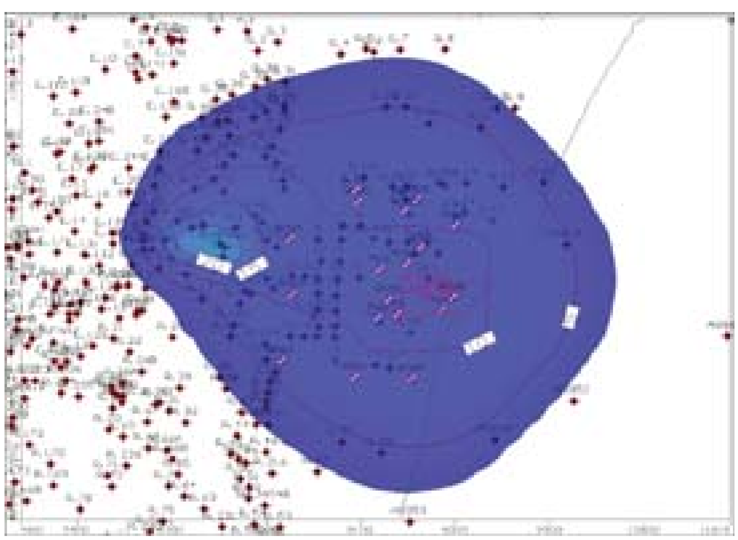


Figure 58: Pollution plume in 2042 after the implementation of stage 2 of the recovery wells

Based on the groundwater modeling and analysis, monitoring plan should be developed. The monitoring plan should include the mitigation measures which has to be considered during the operation of the effluent recovery scheme. The monitoring plan should include the provision of the monitoring wells location, monitoring indicators (parameters to be monitored) and monitoring frequency.

2. <u>Positive Impacts of the photovoltaic panels</u>

Securing the flow of unconventional water to the aquifer and its transfer to agricultural lands depends on the performance of the NGEST plant + Recovery Scheme (NGEST + RS) and, in particular, on the reliability of its power supply (mainly constrained by restrictions on access to electricity due to the geopolitical situation). By adding the photovoltaic (PV) system to NGEST, the annual supply from the grid in 2018 is reduced by 24% and the required annual energy from the emergency diesel is taken down by 27% allowing the NGEST facility to reduce its diesel consumption by 30%, leading to the saving of 1,3 million liters of diesel fuel. This will result in lower emissions amounting in 70 989 tCo2 eqover the 20 years lifespan of the project. Accordingly, the PV share in 2018 reaches 24% of the total annual power generation, the diesel share is 38,8 %, the grid share is 22,2 % and the biogas share is 16%.
The NGEST WWTP + RS power supply without PV and the current supply options lead to an overall Levelized Cost of Energy (LCOE) of 0,23 USD/kWh. NGEST with the PV option installed has an overall LCOE of 0,2 USD/kWh , making it 0,03 USD/kWh cheaper than the “no PV option”. This will generate a saving in present value of 15,5 MUSD.

5.1.2 Negative Environmental Impacts and their Mitigations

5.1.2.1 Construction Phase

1. <u>Air Quality and Noise Pollution</u>

- **<u>Dust Emissions</u>**

  The excavation of top soil in construction sites (for the water distribution networks) and the fugitive dust generated during construction will result from site clearing and earthworks including levelling, trenching, and other activities associated with the buildings housing the wells and well drilling.

  The major dust sources will be vehicle movement over un-paved areas and transportation of raw materials and equipment within the work site. The dust emissions result in temporary elevated levels of particulate matter in the ambient air near construction sites. Also there are other, relatively minor sources of air emissions, such as heavy equipments needed or construction trucks for transporting materials.

Palestinian Standard for ambient air, has specific standards to preserve the air quality; however there are no specific standards for dust emissions from diffuse sources. In controlling dust emissions from excavation, filling and installation of structures for water distribution networks activities, the Law has identified certain measures to be implemented during the construction activities including control of exhaust from fuel combustion machinery.

The occurrence and significance of fugitive dust generation will depend upon meteorological and ground conditions at the time and location of activities. However, under normal meteorological conditions, dust impacts will be limited to within several hundred meters of the construction area(s).

Dust can cause health risks and irritation or potential nuisance to the population in close vicinity to the construction site. In addition, dust can affect the ability of nearby vegetation to survive and maintain effective evapotranspiration, especially at areas of high vegetation cover (e.g. nearby existing farms).Considerable quantities of fugitive dust will be generated by construction activities such as earthmoving, levelling, grading and excavation.

The NGESTP project area is located in the down wind stream, i.e. all the emission will not directly affect the nearest populated area, so it is not anticipated that dust levels will impact greatly on existing settlements. The emissions of dust from construction activities will be localized and the dust is likely to settle in close proximity to the area where clearance activity or other earth work are being carried out.

In summary, fugitive dust impacts from the construction activities are expected to be minimal for the following reasons:

- Dust emissions from construction activities impacts will be limited in a small area in the vicinity of the project site and the dust is expected to settle in close proximity to the construction site(s).
- No residential areas have been developed in close proximity to the proposed project site (within 400 m or more).
- Construction is conducted in uncontaminated soils, therefore wind-blown dust is normally only considered a nuisance to these exposed.

Consequently, it was concluded that the air quality impacts associated with dust generation will be of “low” significance. However, whenever the dust emission is to become higher tha expected and disturbance is created for the workers and project activities, it is recommended to spray the lovation with water to reduce its impact.

- **Gaseous Emissions**

Emissions of CO2, CO, SO2, NOX and PM10 will result from the operation of the construction machinery and road vehicles during construction of the the different components of the effluent recovery service buildings and network (water distribution). These arise mainly during the construction of the booster pumping stations and the well drilling.
Impacts of gaseous emissions from the construction activities are not expected to be significant for the following reasons:

- Quantities of air pollutants emitted from construction machinery are generally small and non-stationary.
- The emissions are expected to be scattered over a large geographical area.
- The construction site is located in an open area where air pollutant dispersion is high.
- The emissions will be mostly limited to the construction phase and therefore are temporary.

Based on the above, the air emission impacts associated with the proposed project will be of “low” significance.

- **Noise**

The following activities are expected to be the most significant noise sources during the construction phase of the proposed project:

- Clearing and grading of the site area and axis roads inside the site.
- Trenching.
- Backfilling
- Well drilling
- Installing the solar panels

Noise will also be associated with construction activities associated with heavy machinery for piling and filling, heavy trucks and generators. The noises of this equipment vary from continuous sources, such as loader, vacuum trucks and construction trucks, to intermittent impacts, from piling and demolition.

The most effected people of noise impacts are the construction workers. Palestinian Outdoor Noise Standards has specified certain standards for noise intensity, number of impacts and exposure duration for the working environment, which should be respected during construction. The mitigation measures recommended in the Environmental and Social Management Plan (ESMP) and Monitoring Plan for control of noise and air emissions are based on compliance with the Law.

Noise can also have social impacts among the neighbouring areas, as it can cause, if it exceeds the standards, psychological effects among exposed persons. Traffic congestions, which could be caused by transportation of raw material, can also have secondary effects on noise levels in the area, which may increase ambient average noise intensity levels.
The activities during the construction phase would be similar to those associated with typical construction sites and it will have temporary impacts. The equipment to be used mainly consists of front loaders, trucks, vacuum tankers in addition to the concrete mixer, pumps and generators.
Construction activities are likely to be confined to daytime and noise will only affect the above-specified areas for a relatively short time, while the spread passes through. A relatively moderate number of heavy vehicles will be needed to transport raw materials to the work site.
The generation of noise is not expected to represent a significant issue to local residents for the following reasons:

- No major noise sensitive receptor is located in close proximity to the proposed project location.
- The main routing of construction vehicles will be along the main public roads.
- The construction noise is expected to be of a short duration and dispersion of the noise is likely to be about 100-150 meters from the construction area.
- Transportation and materials delivery will be limited to daylight hours.

Subsequently, the noise impact will be short-term only for the duration of construction activities, and therefore, the impact significance is considered "low".

The main impact on workers should be mitigated by providing noise protection equipment for the workers operation equipment that generates noise, especially the equipment that generates noise levels greater than 80 dBA. The protective earmuffs should be use especially for the workers who work continuously for 8 hours near heavy equipment.

2. <u>Vibration</u>

Construction activities would result in varying degrees of ground-borne vibration depending on the stage of construction, the equipment and construction methods employed, the distance from the construction locations to vibration-sensitive receptors and soil conditions.

The main source of vibration during the construction phase comes from the truck movements, construction of the storage tanks, pump installation, well drilling and other activities associated with concrete construction works.

The closest sensitive structures to the site is the El Shuhada cemetery (around 10 m away from where the water distribution network will be laid, especially the booster pumps). The management plan and monitoring plan has to be proposed in detailed at the closest sensitive receptor and proposed project location at the surrounding site of El Shuhada site. Consequently, medium vibration impacts could be anticipated to occur.

The mitigation measures proposed during the construction of water distribution network component, near the El Shuhada area are as follow:

1. The base camp and the place for storage of the equipment has to be on the future land dedicated for the booster pumps and the storage tanks.
2. The construction of the storage tank and the booster pumps room including the generators and the electrical rooms have to be separated and overlapped. The time management plan of separation works will reduce the numbers of the heavy equipment.
3. The ready mix concrete is preferred to be used instead of onsite concrete mix. Beside the reduction of the dust transmitted to the agricultural land due to chemical

content of the concrete materials and reduction of the hazardous waste and solid waste on site, the vibrational load will be reduced significantly. In addition, the ready mix concrete mix tanker with pump will be advantageous.

Many of the vibration causing construction equipment would be used on an intermittent basis (i.e. short-term and temporary in nature) during the construction period.

No significant adverse vibration impacts would be anticipated to occur and therefore, the impact is "low".

3. Construction Waste and Handling of Hazardous Waste

The waste that would be generated during construction could be categorized as follows:

- Human wastes generated by construction labor, including sewage and garbage collected from labor camps in water distribution networks locations. Disposal of sewage and garbage generated from construction labor, if not transported to adequate sites, will be a continuation of the existing sanitation situation and contribute, although to a relatively low extent, to environmental deterioration. In this project, the ESMP and Monitoring Plan has recommended measures for sound management of such waste.
- Normal construction wastes including scrap concrete, steel, bricks, wood, etc., which are chemically inert, therefore the associated environmental risks with improper disposal of such waste is limited to aesthetic effects at the disposal site. By following the construction waste management plan and monitoring plan, these limited aesthetic effects will be minimized.

Miscellaneous solid wastes, including packaging waste, used drums, wood, scrap metal, and building rubble will be generated during the construction phase of the project (mainly from the water distribution network site).

The stripped top soil will be backfilled carefully in position after the completion of construction activities. The top soil will be spread between the excavated space and the concrete. The excavated soil will be managed to cover the required volumes of backfilling soils.

Based on the above, impacts due to waste generation associated with the proposed NGESTP project activities will be of “low” significance. The following mitigation measures are proposed:

1. Onsite domestic sewage collection and disposal shall be provided by the contractor for construction workers needs.
2. Site waste management plan should be developed by the contractor prior to commencement of construction works. This should include the designation of areas to store different type of wastes, collection and removal schedule in addition to the provision of onsite conventional wastewater treatment. The disposal site and storage areas has to be discussed and approved by the Zone Management of the RLC and the supervision and monitoring of the solid waste management has to be developed, discussed and approved between the Contractor and the Zone Management.
3. The burning of any type of wastes should be avoided.
4. The reused clay or excavated sand should be stockpile and stored away from any waterway, drainage networks, existing wastewater networks and any other drainage patterns.
5. Nearby sanitary landfill should be notified to receive the unusable construction wastes or damaged construction materials.

4. Changes in Hydrology and Groundwater Quantity and Quality

During the construction of the recovery scheme there will be no impact on groundwater since groundwater is about 30 to 70 m blow the earth surface. Therefore, there will be no mitigation measures.

5. Health and Safety

During the construction phase, as the proposed project are at a large distance from the nearest population or residential area, the temporary impact due to exhaust gas emission, dust and noise that could affect the health of the population is not expected to be significant. These impacts are considered minimal. However, there is always risk of injury to the workers.

As a mitigation measure, safety measures should be put into consideration and addressed with the workers. The contractor and the PMU are mainly responsible for any safety procedures to be applied.

6. <u>Ecological Disturbance</u>

There is an opportunity that the water distribution network will be laid in agricultural land, and impose on the crops and animals around the site. Therefore, mitigation measures shall be developed to limit and to reduce the impacts.

Based on the ecological assessment, the project will have low to medium impacts.

Mitigation measures develop to avoid the crop and animal disturbances in the vicinity are as follow:

1. Fences have to be installed prior to the construction of the water networks and other components for recovery water distribution.
2. In case the destruction of the crops or plants at the farms near the construction of the recovery water distribution network, compensation has to be settled. The compensation measures shall be developed prior to construction. The compensation shall be developing based on the compensation framework of the Ministry of Agriculture.
3. Strictly standard procedure for health and safety of the workers, especially for the worker at the wetland site, should be observed.
4. Equipment to handle the vertebrates has to be prepared.
5. The fauna found to be dangerous must be isolated and handled with care.

5.1.2.2 Operation Phase

1. <u>Air Emissions and Noise Pollution</u>

Noise generating sources in the project are pump rooms and generators in the Booster Pumping Station. The main noise concerns are related to the Pumping Station staff, which may be exposed to intermittent pumping noise, caused by intermittent pump switching controlled by level control. This may be uncomfortable to PS staff. Measures for compliance with noise standards, especially for the working environment, have been recommended in the ESMP and Monitoring Plan.

However, the standard protection of the workers, including earmuffs, has to be practiced all the time, especially at the Pumping Station area.

2. Odour

The operation of the water distribution network system is not expected to have significant impacts from odour.

3. Vibration

Although the pumps and the generator will be installed in the room, but special attention has to be made to reduce the vibration impact at the pumping station and the generator to minimize the impact due to the close distance with the El Shuhada cemetery.

It is expected, at the installation area of pumps and generators for the water distribution network will have “medium” impact. The mitigation measures to be developed to minimize the vibration impacts of the machines are:

1. Tree plantation, heavy leaf trees to absorb the vibration and noise generated, is recommended to be planted at the cemetery area along the proposed main road at the other side of the pumping station.
2. Maintenance of the machines and equipment has to be maximize and if it is required less than the standard period required for maintenance and spare parts changes.

4. Impacts of Recovery Scheme on ground water table

The current water table elevation in the area around the basins is 2 m above mean sea level, as shown in Figure 54. After the operation of the first stage of recovery wells by the end of year 2019, about 20,000 m3/day of groundwater will be recovered (abstracted). This will affect the groundwater table as shown in Figure 55 ; which indicates the reduction in the water table elevation after two years of operation of the first stage of recovery wells.

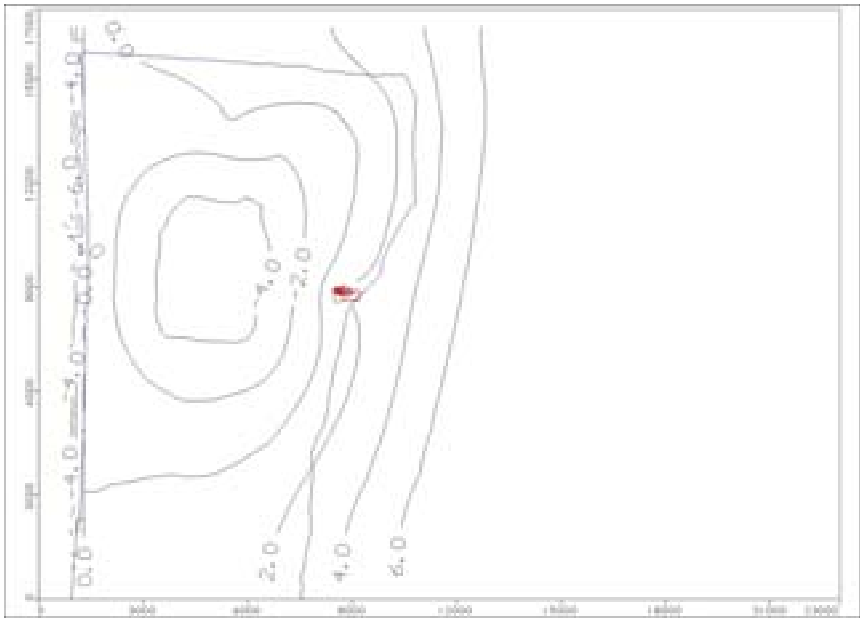


Figure 59: Groundwater Table before the implementation of the first stage of recovery wells in 2018

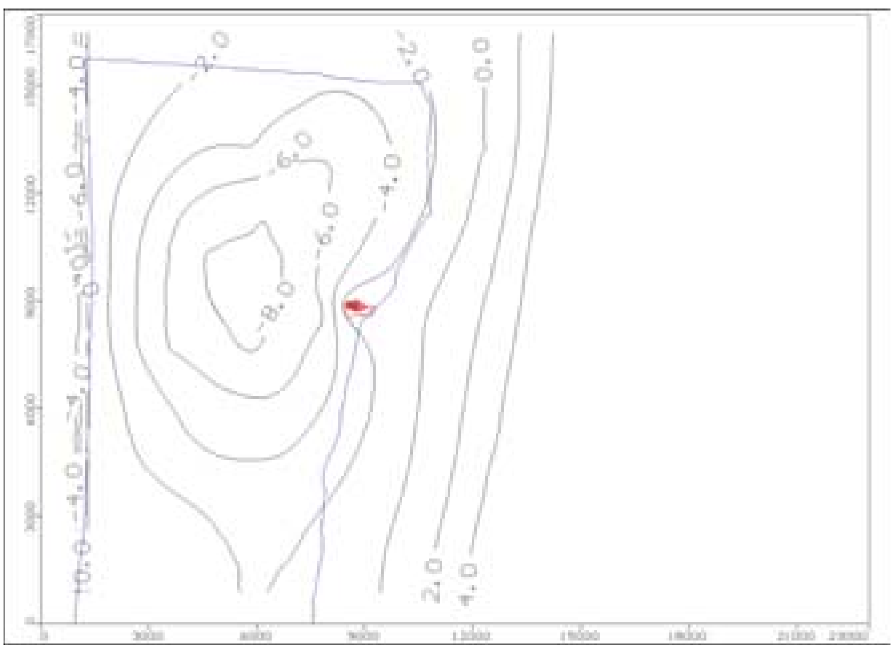
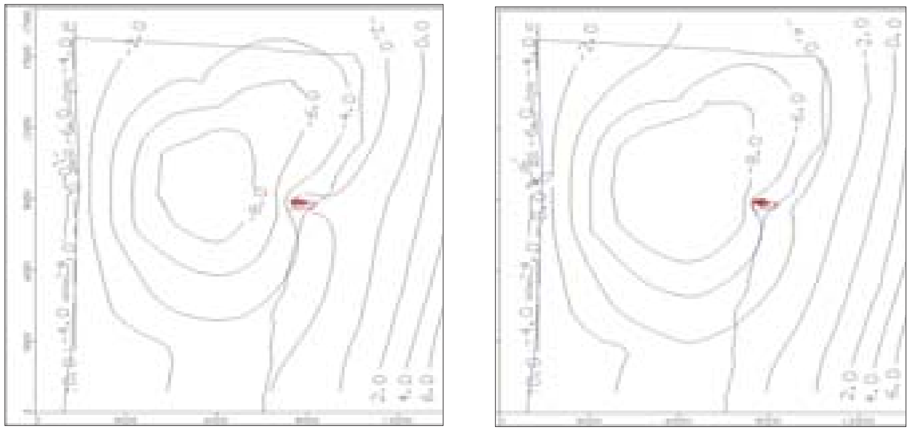


Figure 60: Groundwater Table before the implementation of the second stage of recovery wells in 2021

In 2030, the model estimated that the water table elevation, in the area around the basins, will be between 2 m and 4 m below mean sea level if the second stage of recovery wells is not implemented, as shown in Figure 61 (a). While, in the same area, the water table elevation will be between 4 m and 6 m below mean sea level if the second stage is implemented; as about 18,000 m3/day of groundwater will be abstracted through 14 recovery wells (See Figure 61 (b)).



(a) (b)

Figure 61: Ground water Table in 2030, (a): without the implementation of the second stage of the recovery wells, and (b): with the implementation of the second stage of the recovery wells

5. Impacts on Local Agriculture, Public Health and Water Resources

Based on the design project report three scenarios that considered the expected water quality were recommended as follows:

- Scenario I: In this Scenario it is more advisable to cultivate orchards on the available area to the west of the project along Al Karama Road, far away from the political boarder. The profiles of the soils on the area are deep enough to cultivate tree crops. Based on crops water requirements, the available reclaimed water (16,500 m3 daily) is just enough to irrigate 5375 dunum divided into citrus (1613 dunum), olives (1344 dunum), fruit trees (806 dunum), alfalfa (806 dunum) and grains (806 dunum). The expected quality of recovered water is suitable and has no impact on the crops selected under this scenario.
- Scenario II: In Scenario II the wastewater will be treated more effectively and consequently the effluent will be of better quality in general. The quantity of effluent diverted to the infiltration basin will increase to approximately 23,100 m3 daily. This reclaimed water will be used to irrigate additional land amounting to7525 dunum in total. The citrus area will increase to 2258 dunum, that for olives to 1881 dunum, fruits to 1129 dunum, alfalfa to 1129 dunum and grains to 1129 dunum.
- Scenario III: This Scenario assumes that the planned WWTP in East Jabalia will work with its full capacity by year 2025. The quality of reclaimed water (39,160m3/day which equals 35,600 plus 10% extra) is expected for unrestricted use as mentioned in following table, Table 47. The quantity of reclaimed water will be enough to irrigate about 12,577 dunum.

The citrus area will increase to 3773 dunum, area for olives to 3144 dunum, fruit trees to 1887 dunum, and alfalfa and grains each will increase to 1258 dunum. In this scenario vegetable crops will be introduced with an area of 1258 dunum, as it is difficult to convince the farmers to accept the recovered water for cultivation of vegetables at the beginning of the project.

Table 47: Criteria Recommended by PWA for Effluent Standards (PS742, 2003)

Criteria	Restricted Use1	Unrestricted Use2
BOD (Mg/l)	30	20
TSS (Mg/l)	50	30
Total-N (Mg/l)	10-15	10-15
F. coliforms	Less than 1000	Less than 200
Helminthes eggs	Less than 1	Less than 1
Intestinal nematode	Less than 1 ova per litre	Less than 0.1 ova per litre

Notes:

- Restricted crops: Cereal crops, industrial crops, fodder crops, crops normally eaten cooked and trees, etc.
- Unrestricted crops: Crops normally eaten uncooked (vegetables), Sport fields, and parks.

The expected water quality from the recovery wells through the groundwater modeling, as indicated in the previous task, and through reviewing of the water analysis of samples taken from existing monitoring wells is shown in Table 48. The parameters presented in the table are the maximum and the minimum values recorded by PWA in year 2012. Since BOD concentrations have increased significantly than the allowable 30 mg/l for unrestricted use, it is not recomended that it is used for irrigating any uncooked crops.

The recovered water will be prohibited for drinking water use since it could have negative impacts on public health and framers due to the Total-N being higher than the drinking water standard that recommends a minimum value of 50 mg/l. In addition, the recovered water might include some other contaminants which are not yet recorded and have negative impacts on public health and farmers.

Table 48: The expected recovery water quality close to the infiltration basin

Parameter	Values in the groundwater wells close to the infiltration basin
BOD (mg/l)	<5
TSS (mg/l)	No Recorded
Total-N (mg/l)	20-125
F.C	Present
Helminthes eggs	Negative

6. Contamination from Reuse of Recovery Water in Irrigation

This section pays attention to highlighting the potential contamination of reusing recovery water in irrigation. The discussion was based on scientific background information and the data collected from potential customers (consumers and traders) and the farmers. The reuse of recovered water might result the following impacts on health:

- The previous literature showed that the untreated water might have bad health effect on the farmers using such water. Potential diseases are nematodes, hookworm infection, Ascaris infection, Anaemia and Protozoa. The probability of infection is high among younger age.
- Those who do the maintenance for irrigation systems might get infected. Irrigation systems might play a role in the magnitude of impact of the recovery water (Sprinkle Irrigation Systems have worse repetition than Flood and Furrowing irrigation system). However, localized irrigation systems like bubbler and drip irrigation are of better impact due to the limitation of hazards on the workers health
- Potential impact on the consumers of the vegetative crops, especially, vegetables needed for salad i.e. lettuce, radishes, etc. That might infect consumers with nematode and Trichuris.

Table 49 and Table 50. present the summary of environmental and social significant of expected impacts during construction and operation of the project components, respectively.

Table 49: Assessed Significance of Expected Impacts during Construction Phase

Potential Impact	(+/-)	Likelihood and severity	Significance	Mitigation Measures Effects
Affecting air quality by dust emissions of construction works of water distribution networks	- temporary	Likely to raise PM in ambient air at the project sites.	Medium	Minimize the impacts to low
Noise impacts	- temporary	Impacts of construction is less likely at the cemetery area and water distribution network and part of the effluent lake that is far from the residential area	Medium at project sites except low at cemetery site	Minimize the impacts and maintain their control
Odour Impacts	+/-	Odour impact at the existing effluent lake does not have significant impact as there is almost no sludge present on the surface area. There is no impact as well for water distribution networks as the water is relatively clean. The positive impact at the BLWWTP as the pond, especially anaerobic ponds will be dried up.	Positive impact at BLWWTP and no impact or low impacts at the other project sites	No mitigation measures is required

Potential Impact	(+/-)	Likelihood and severity	Significance	Mitigation Measures Effects
Vibration due to the equipment movement	- Temporary	Vibration impacts to the water distribution networks especially the site of the pumps and storage area have significant impact. Low impact is predicted at the BLWWTP and Effluent lake as the closest residential area is between 300-400m	Medium impact especially nearby cemetery area (site for storage area and pumping station Low impacts at the BLWWTP and Effluent Lake	Minimize the impact at the storage and pumping station area that is nearby El Shuhada cemetery area and maintain control at the other sites of the project
Risks of hazardous wastes	-	Likely to have workers exposure to hazardous waste if no hazardous waste facility is established before the project preparation	Medium	Minimize the impacts
Risks on public health and hygiene	-	Likely to have populations of insects and rodents but not necessarily in conditions worse than the existing condition	Medium	Minimize the impacts
Change in the water hydrology a and groundwater (quantity and quality)		Due to the depth of the groundwater between 30-70 m, no significant impacts is expected	No significant impacts	Mitigation measures is not required.

Potential Impact	(+/-)	Likelihood and severity	Significance	Mitigation Measures Effects
Health and safety during construction	-	Likely to have significant impacts on the project site due to accident of the workers	Medium at water distribution networks.	Maintain control and standard protection at project sites to minimize the impacts.
Archaeological disturbance		Likely to have no significant impacts at the project areas	No significant impacts	Mitigation measures is not required.
Potential impact on the antiquities on the areas	-	Likely to have significant impacts at the archaeological sites is limited	Minor if any sites are discovered during the excavation	Work should be stopped in case of finding any antiquities Inform the Antiquities authority A guard should watch the site
Land use impacts and accessibility	-	Likely to have significant impact, especially for the water distribution networks This impacts also have significant impact on traffic disturbance	Medium impacts for water distribution network	Minimize the impacts

Table 50: Assessed significance of expected impacts during the operation phase

Impact	(+/-)	Likelihood and Severity	Significant	Mitigation Measures Effects
Ambient Air quality and Noise Pollution	+ / -	Positive likelihood for decommissioning of the BLWWTP and the effluent lake and likely to have negative impact on the water distribution network	Positive impact of high significance for remediation and the decommissioning and low significant impact at the storage and pumps area as a part of the water distribution network.	No mitigation measures required for the decommission and effluent lake site and standard protection of the workers of the storage tank and booster pumps and generators sites.
Odour	-	Medium likelihood for the pond # 7 site and no significant impact on the other component of the project.	Negative impact of medium significant for the remaining pond # 7 site	Minimize the impacts
Vibration	-	Medium likelihood for the booster	Negative impact of medium significant for the booster	Minimize the impacts

Impact	(+/-)	Likelihood and Severity	Significant	Mitigation Measures Effects
		pumps and storage area and no significant impact on the other component of the project.	pumps and storage area	
Water resource contamination	- / +	Medium likelihood for water distribution network and positive impacts on other project components	Combination of positive and negative impact of moderate significance	Reduce the severity of the impact
Impact on Local Agriculture, Public Health and irrigation	-	Medium to High likelihood for water distribution	Negative impact of moderate to high significance	Reduce the severity of the impact
Recovery water quantity and quality	- / +	Medium likelihood for water distribution due to the restriction of water purposes	Negative impact of medium significance	Reduce the impacts by awareness and monitoring campaign.

Impact	(+/-)	Likelihood and Severity	Significant	Mitigation Measures Effects
		and positive likelihood for better quality and quantity of the recovery water		
Put limitation to the plantation of certain crops in the beneficiaries who will use the recovered water	-	Minor likelihood	Negative impact of high significance on the farmers	Orientation sessions should be presented to raise farmers awareness regarding the type of crops that should be planted using recovered water
The construction of the pond near the *Shuhada* cemetery will cause some discomfort to the families of the deceased during the burial ceremonies.	-	Moderate likelihood	Negative impact of high significance on the people of *Shuhada*Cemetery	As the main disturbance will be resulted from the odour, all procedures should be taken (environmental procedures) to minimize the odour
Potential pollution of the raw eaten crops due to the usage of recovered water Children are often present on the farms and fallen fruit may be picked off the ground that was irrigated by recovered water	-	Moderate likelihood	Negative impact of high significance on the people who will purchase crops	Orientation sessions should be presented to raise people awareness regarding the type of crops that should be planted using recovered water

5.2 Socio-economic Impacts

The analysis of social impacts for any developmental project is the core process to address the factors which might work for the benefit or against the project. This discussion relied upon previous ESIA reports for BLWWTP and NGESTP. The combination of the previous studies and the current one enriched the data presented in this report. The various types of socio-economic impacts are discussed in the following sections.

5.2.1 National level Socioeconomic Impacts

- Contribute to solve the problem of water scarcity especially during summer time, as a source of water will be continuously available
- Partially solve the problem of the disposal of wastewater, as it will be treated and injected for agricultural use,
- The provision of good quality water will reduce the cost of water needed for irrigation in the area. The utilization of the recovered water of high quality and of less price might work for the benefit of the farmers, increasing their profits
- Sludge is one of the outputs of the project, and will increase the income for those who work in sludge trading
- Sludge reuse will work for reduction of chemical fertilizers that affect the health of people.
- Put limitation to importing sludge from abroad. Relying on the sludge might save money needed to import chemical fertilizers

5.2.2 Potential Socioeconomic Impacts

The project is expected to have the following main components:

1. Pumping out quantities of the infiltrated partially treated effluent from the groundwater to avoid potential long term irreversible impacts to the groundwater and surrounding areas;
2. Reuse the abstracted water from the groundwater in irrigation according to sound environmental and public health practices;

Socio-economic impacts can be categorized in various types, with many underlying issues. Potential social impacts may include the following issues:

- Workforce and job availability
- Occupational health and safety
- Impact pertaining to community health and health seeking behavior
- Traffic
- Land acquisiton
- Visual intrusion
- Impact of environmental aspects on the livelihood status of people
- Impact on land use

5.2.3 Area of Influence Descriptions

The discussion of impacts necessitates a brief description of the project area of influence , provided in the following sections.

Demographic characteristics: In 2007, approximately 1.4 million Palestinians resided in Gaza Strip, of whom almost one million were UN-registered refugees. The current population is estimated to be in excess of 1.5 million, distributed across five Governorates. Gaza City, which is the biggest governorate, has about 400,000 inhabitants. The two other main Governorates are Khan Younis (population 200,000) in central Gaza, and Rafah (population 150,000) in the South. The majority of people live in refugee camps[1]..

The population of the North Gaza Governorate according to 2012 statistics is around 265,355[2]. As could be observed, the population growth in project area of influence is high and was observed to increase during the last five years. The population projection calculated by the Feasibility Study was based on the assumption that a gradual decline in the population growth rate will be seen starting in 2012. It is anticipated that population growth will reach 1.11% by 2040, after peaking at 3.5% in 2011.

Economic Activities: With a growing population and a shrinking economy, real Gross Domestic Product (GDP) per capita is close to 30% below the 1999 level. The overall economic picture is one of negative growth. PCBS estimates that the GDP in 2006 had a negative growth rate of 6.6 %. It estimates that real GDP growth in 2007 was a mere 0.5%, while results from the first quarter suggest that growth in 2008 is slightly negative. Similarly, the International Monetary Fund (IMF) recorded a drop in GDP of 0.5 % in 2007, and a modest growth of 0.8 % in 2008. This is probably due to a continued yet marginal drop in economic activity in Gaza, given its already low base, matched with a modest rise in economic activity (PCBS (2007) 'Economic forecasts for 2007'). These figures are representative of already severely limited economic activity before Operation Cast Lead, as it resulted in the destruction of significant remaining economic assets, which means that further decline is inevitable.

Labor Force Conditions: With regards to human activities in the project sites, the estimations provided were based on the meetings conducted with the municipalities. This is just guiding information.

---

[1]Environmental Assessment of Gaza Strip, following the escalation of hostilities in December 2008 – January 2009 United Nations Environment Programme

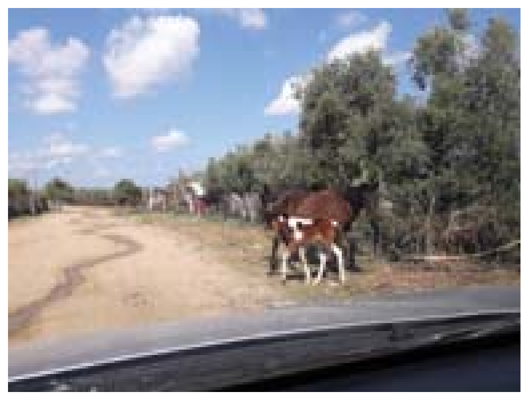
[2] PCBS, 2011

Agriculture activities are the main employment activities in Beit Hanoun, Um El Nasr and Beit Lahia. However, the governmental posts are occupied by 62.4% of the labor force in Jabalia. Regarding the main sector of work, the data showed that the majority of employees work in services (63.3%), while people working in commerce, hotels and restaurants are only 18.3%. The diversity according to gender is relatively high as 86.6% of the females work in services sector, while 59.6% of males work in the same sector. However, 20.7% of the males work in commerce versus null of the females in the same field.

5.2.3.1 NGESTP Site

The emergency project area is located east of Jabalia, neighbouring the Shuhada Cemetery. This is an area that has not been significantly used for any economic activities in the past. However, it is proximity to the cemetery might have some social consequences if used for wastewater treatment.

Figure 62: NGESTP Site



5.3 Socio-Economic Impact Assessment

The project will result in both positive and adverse impacts during the construction and operation phases.
As previously mentioned in the baseline chapter the project area of influence are as follow:

- Communities adjacent to the site and laydown area in Um El Nasr that is close to the project areas.
- Wheat warehouse and the graveyard that is located in Um El Nasr

These communities are locally acknowledged to have industrial features and culturally valuable. There is no foreseen any nomadic tribes residing the AOI .

5.3.1 Identification of impacts

The goal of the impact assessment is to focus on the aspects of utmost interest or concern to local communities, stakeholders, regulators, and decision makers. Considering the commitments of the Project to date. The following table identifies potential impacts together with relevant baseline information and excludes the potential impacts where (a) an adverse interaction is not expected, or (b) the embedded controls effectively avoid or mitigate the impact. Thus, only potentially significant impacts that have not been properly managed are carried forward for further assessment.

Table 51: Assessed Significance of Expected Impacts during Construction Phase

Potential socioeconomic impact (S)	**Type of impact**	**Duration of impact**	**Significance**	**Mitigation Measures Effects**	**Description of the impact**	IFC standard governing the impact
During Construction Phase						
1. Workforce	Positive	Temporary	Low to medium	Not applicable	The project will result a wide range of job opportunities for construction workers (150 person) • The unskilled and unemployed workers may need to receive trainings prior to the construction activities to be able to work in the project. On the job training activities should be functioning in order to train the community young people who expressed their willingness to work in the project. • Increase access to job readiness through the provision of education and training for both the personnel of the	Performance standard 2: labor and working conditions

					project and the community.	
	Negative	Temporary	Low	Minor	Demand for worker accommodation project AoI may stress the local housing resources and lead to displacement of low income or other vulnerable households.	2: labor and working conditions Performance standard 3: resource efficiency and pollution prevention Performance standard
	Negative	Temporary	Low	Minor	Influx of construction workers in Jabalia and project AoI may stress local health services (e.g. Hospitals, clinics).	2: labor and working conditions Performance standard 3: resource efficiency and pollution prevention Performance standard 4: community health, safety, and security
	Negative	Temporary	Low	Minor	Influx of construction workers in	Performance

					the project AoI may stress local utilities (e.g. Potable water, sanitation, electricity, waste management).	standard 3: resource efficiency and pollution prevention
	Negative	Temporary	Low	Minor	Influx of construction workers in the project AoI may lead to demographic imbalance and reduce social cohesion. The disrespect of norms and traditions might create problems with the local communities	Performance standard 4: community health, safety, and security
	Negative	Temporary	Low	Minor	Workers may be exposed to occupational health and safety risks. Occupational Health and Safety: Job-related accidents, illnesses, and other adverse impacts on worker safety, health and welfare of staff and contractor workers	Performance standard 2: labor and working conditions
	Negative	Temporary	Low	Minor	Inappropriate management of employment among the project areas: Not adhering to transparent employment might arouse community dissatisfaction due to	Performance standard 2: labor and working conditions

					the community inability to benefit from the employment prospects offered by the project. Raise the feeling of alienation among the community as a result of non-inclusive employment practices.	
	Negative	Permanent	Low	Minor	Access to electricity and potable water for site operation Use of public electricity and water networks could reduce availability for local residents.	Performance standard 3: resource efficiency and pollution prevention
2. Impact on community health conditions	Negative	Temporary	Low	Minor	As 150 workers will be working in the project area of influence, they might transfer diseases to the surrounding communities.	Performance standard 4: community health, safety, and security
3. Increased traffic on the roads	Negative	Permanent	Minor	Minimal	Construction activities and traffic/road use may increase dust and decrease air quality, and also generate noise. Disturbance due to dust and noise – changes in air quality,	Performance standard 3: resource efficiency and pollution prevention Performance standard 4:

					dust, and noise could affect health, livelihoods (e.g. Agriculture) and quality of life. Such impact was raised as a concern by project AoI residents . Water reuse projects tend to result in dust and emissions during the construction.	community health, safety, and security
4. Land acquisition	Negative	Permanent	Low	Minor	• Reduced livelihoods due to loss of land and/or resettlement. • The project will result in acquiring lands to install 14 wells on 1440 meter square • The project also will result in termination of 12 private wells • The project will result in affecting the livelihood of 10 well operators	Performance standard 5: land acquisition and involuntary
5. Visual intrusion	Negative	Permanent	Minor	Irrelevant	The surrounding agriculture lands might be affected by construction works	Performance standard 1: assessment and management of environmental

						and social risks and impact
6. Cultural Heritage	Negative	Permanent	Irrelevant		The pipeline and irrigation network as well as the construction of 14 wells might result in impacts pertaining to cultural heritage. It is not envisaged to find any objects of cultural value.	Performance Standard 8
During Operation Phase						
1. The potential change in source of income	Positive	Permanent	Low	Minor	The market of recovery water reuse and sludge is a big market, if it is appropriately managed. **Sludge reuse** In principle the sludge, which is very rich in nutrients (N, P, K) could be used as fertilizer and replace chemical fertilizer, which are currently imported from Israel. Indicating that relying on the sludge might save money needed to import the chemical fertilizers from Israel	Performance standard 2: labor and working conditions

					Water reuse The utilization of the recovered water of high quality and of less price might work for the benefit of the farmers, increasing their profits	
2. Workforce	Positive	Permanent	Low	Minor	The project will result job opportunities for operation workers (50 person)	Performance standard 2: labor and working conditions
	Negative	Permanent	Low	Minor	Occupational health and safety: Workers on the Project will be exposed to a range of OHS risks during construction and operation, such as working at height, manual handling, contact with hazardous material, noise and vibration, amongst others. In the absence of appropriate standards and preventative practices, the health and safety of workers would not be adequately protected. IFC PS 2 addresses occupational health and safety.	Performance standard 2: labor and working conditions

3. Impact on community health conditions	Positive	Permanent	**Medium**	**Not applicable**	**Sludge reuse** The sludge reuse will work for reduction of chemical fertilizers that affect the health of people, however people were concerned that the sludge might contain heavy metal **Water reuse** Using of treated water will reduce the sewage water that floods over, affecting people and their livelihood status. As well, the usage of untreated water due to the high cost of the municipality water might be reduced as the farmers will use the recovered water instead	Performance standard 4: community health, safety, and security
4. Access to electricity and potable water for site operation	Negative	Permanent	Low	Minor	Use of public electricity and water networks could reduce availability for local residents.	Performance standard 3: resource efficiency and pollution prevention

5.3.1.1 Impacts pertaining to workforce

An adverse impact could occur as a result of interactions between construction workers and existing residents of Project AOI and its villages , where worker accommodation will be located.

Description of Impact

The estimated construction workforce will peak at 150 workers. This might be changed in case of recruiting workers from surrounding villages and the Area of Influence . The contractors tend to have their teams assembled from their permanent workers. Skilled and semiskilled workers are primarily on project based workers who work with the subcontractors on the project. The unskilled laborers might be recruited from the vicinity areas.

Construction contractors provide accommodation for workers. Most of this accommodation is located in the camp and in the nearest village that might accommodate the 150 workers.

Due to the nature of work it is not anticipated to provide job opportunities to women, particularly, during the construction phase. Also, the subcontractors tend not to recruit women in construction activities. They are hired as administrative staff or engineers. Therefore, almost all workers during the construction phase will be primarily males. These workers might cause disturbance to the community, particularly, if they don’t abide to the norms and traditions.

Considering also the hygienic behaviors adopted by workers and their health seeking behaviors, it is anticipated that they might transfer diseases to the local communities. Reviewing similar projects of the same nature, there were no sexual intercourses between workers and community people in the project sites. Such attitude put limitation to Sexual Transmitted Infections that tend to be common in such projects. However, there is a percentage of homosexual males who might be seen in the site. These category will face health problems, especially, STIs. Therefore, workers will be need to receive health orientation sessions prior to the onset of construction work.

Embedded Controls

The project’s workforce accommodation will be carefully managed by the subcontractor companies. Accommodation will be availed in the site and monitored by security persons. The contractor and its subcontractors have committed to ensuring that workers’ accommodation meets the standards established by the IFC and other international authorities, and the Project management team will conduct inspections to ensure compliance in this regard.

Each worker should submit a health certificate that provides information about his health status, additionally, workers can be entitled to frequent health check and blood test must be applied each six month.

With regards to other diseases i.e. swine flu, tuberculosis and hepatitis B. Workers should have a health examination in order to avoid transmitting such diseases to the surrounding communities.

In addition, each company has a housing department and workers must inform this department if they play to spend a night outside their designated accommodation.

Impact Assessment

The impact is expected to be localized to the neighborhoods surrounding the workforce residences, and of short-term nature during construction period. However, due to the number of workers, there will be large degree of change from the baseline conditions, in terms of both relative population size and demographics.

Receptors are the existing residents of Jabalia, Beit Hanoun, Um El Nasr, Beit Lahia and surrounding areas , who may experience changes in the quality of life related to the presence and activities of the incoming workers. As there is capacity to absorb extra residents, and assuming that existing residents are working class (and may include other construction workers), receptor vulnerability is likely Low To Medium.

Mitigation Measures

- Conduct a health examination to workers prior to the onset of work
- Workers will be oriented and comply with a Code of Conduct governing behavior off-shift and interactions with local communities.
- Grievance mechanism to be provided to local residents with a proper communication channels that enabled the community to voice their concerns.
- Influx Management Strategy will be developed to coordinate worker accommodation between various construction companies, track the number of non-local workers, and manage issues related to accommodation. Development of the strategy will include further investigation of existing residents and their concerns and vulnerability to change.

- Engagement with local communities to understand changes or issues that have developed since the start of construction.

Residual Impact Significance (Post-Mitigation) Minor

After the implementation of the above mentioned mitigation measures, the significance of the residual impact is assessed as Minor.

Cumulative impacts

Given the nature of the project AOI where no industrial projects have been identified, the project will result in minor disturbance. However, applying the above mentioned mitigation measures will minimize the impact to Minor.

5.3.1.2 Potential implications for workers' Occupational health and safety

As 150 workers will be accommodated and work in the same place there will be different health risks. Following are the main risks related to health:

Description of Impact

- Potential infections by communal diseases i.e. respiratory diseases (tuberculosis, flue, swine flu) and skin diseases,
- As workers might share shaving tools and sometimes share tooth brush, there is a probability of being affected by blood transmission diseases,
- As they are all men, few of them might be homosexual. Thus, they might get affected by any of the sexual transmitted diseases,
- Workers also might get affected by accidents result from working on heights or traffic accidents ,
- In case of not adhering to hygienic behaviors, the workers might get lice and skin diseases. Additionally, the lack of ventilation might result in facing respiratory diseases,
- Not abiding to cleanliness in the kitchen might cause digestion and intestine infections. The cleanliness of pit latrine is essential to avoid any infections.

Embedded Controls

The project's workforce's health condition will be carefully managed by the subcontractor companies. Health facilities will be availed in the site and in the vicinity areas (Project AOI and Surrounding villages) and will be monitored by occupational health and safety persons.

The contractor and its subcontractors have committed to ensuring that workers' health meets the standards established by the IFC (Performance Standard 2: Labor and Working Conditions) and other international authorities, and the Project management team will conduct inspections to ensure compliance in this regard.

Each worker should submit a health certificate that provides information about his health status, additionally, workers can be entitled to frequent health check and blood test must be applied each six month.

With regards to other diseases i.e. swine flu, tuberculosis and hepatitis B. Workers should have a health examination in order to avoid transmitting such diseases to the surrounding communities.

For drivers working in the project they should have a first license certificate that enables them to drive all vehicles. They should be also entitled for drug test, particularly, the drugs that can be injected.

Impact Assessment

The impact is expected to be localized to the work place and roads to the project areas, and of short-term nature during construction period. However, due to the number of workers, there will be large degree of influence among the huge number of workers.

Receptors are the workers of the project who were recruited from Um El Nasr and Surrounding villages and other project areas , who may experience changes in their health conditions. As there is various preventive measures and precautions adopted by the, receptor vulnerability is likely Low.

Mitigation Measures

- Apply a health examination to workers prior to the onset of work
- Workers will be oriented and comply with a Code of Conduct governing behavior off-shift and interactions with local communities.
- Grievance mechanism to be available to workers with a proper communication channels that enabled the workers to voice their concerns.
- Occupational Health and Safety Strategy will be developed to coordinate worker health and safety measures between various construction companies, track the number of workers infected or died, and manage issues related to health conditions. Development of the

strategy will include further investigation of existing health and safety measures and workers concerns and vulnerability to change.

Residual Impact Significance (Post-Mitigation) Minor

After the implementation of the above mentioned mitigation measures, the significance of the residual impact is assessed as Minor.

Cumulative impacts

Such impact is limited to the work site and is not predicted to result in any cumulative impacts rather than facing with and epidemic disease.

5.3.1.3 Increased pressure on local services, related to construction workers' use of community services

An adverse impact may result from the Project's excessive utilization of local potable water which also service the local villages. Impacts on public sanitary system and landfill systems are not expected as there is no proper sanitary system or waste landfills. However, impacts related to public electricity grid tend to be of no relevance as the Water reuse plant will rely on generators during the construction phase. Otherwise, a small electricity plant should be constructed prior to the construction phase.

With regards to waste management, the Project is obliged to recruit a certified waste management contractor to collect, transport, and properly dispose of waste generated at the site. Additionally, hazardous wastes should be collected and transferred to the dumping station in Johr El Deik.

Construction water (non¬-potable) will be brought to site by water tanks, and will eventually be abstracted from the water station in Jabalia , Beit Hanoun and Beit Lahia; therefore, construction water will not affect local public water systems.

Description of Impact

The Project will use local water to supply the site with potable water during the construction phase. Baseline studies indicated that water quality is not acceptable. Water should be obtained from the water stations and brought to areas using vehicles equipped with water tanks. This will not affect water network but it might affect the quantity of water allocated to the AOI . There should be a contract signed with Water and Wastewater company that contains the exact quantity of water to be provided.

As the project will rely upon its own sources of potable water and electricity, the community networks will not be subject to pre-existing shortages. The Project's use of these utilities will not result in more frequent or severe disruptions of water and electricity supply. Contracts with utility providers are understood to be in place.

Embedded Controls

The Water and Wastewater Management Plan commits to monitoring the total volume of water obtained from the municipal water supply on a quarterly basis. This plan will predict a potential impact in terms of reduced availability for other water users, and also commits to regular measurement of water flows, and use of water reduction measures in construction activities (in line with Good International Industry Practice).

The Project also commits to regular engagement with stakeholders including regulatory authorities, community water users, and local businesses, with the purpose of collaboration and coordination to manage water resources.

Impact Assessment

The Project's impact on local potable water and electricity utilities, and the availability of these utilities to local households is expected to be limited as it will not affect the villages served by the Mining Company electricity network or the public water treatment and distribution system. As there will be limited changes during the construction phase, as once constructed, the Water reuse plant will generate electricity on site. Yet, water will be always fetched from the Water station. However, the scale of the effect is considered to be Minor.

Mitigation Measures

- The quantity of water supply should be calculated and negotiated with Water Company in order not to affect the local communities
- Wells can be dug in the site to work as alternative source of water. Potable water also might be obtained from bottled water companies
- Grievance mechanism to be availed to local residents with proper communication channels. This will provide the Project with any concerns or complaints, including potential issues related to utilities shortage.
- Ongoing engagement with stakeholders water treatment plant and villages to identify concerns or changes in water availability, and ensure water resources are managed properly.

- Engagement with local communities to understand changes or issues that have developed since the start of construction.

Residual impacts

As the project will rely on its sources of water and electricity, the impact and residual impacts tend to be minimal. In case if the water provided to the project affected the residents women will be particularly vulnerable to reductions in water and electricity provision due to their house chores and their role in maintaining the household. Impacts will be reversed when the Project becomes operational, as electricity and potable water will be generated on site from wells for Project use.

Cumulative impacts

The project impact on utilities might be escalated in case if villages and agriculture projects consumed more water. There is general shortage of water supply in the area. Any increase in water demand will influence other projects in the area.

5.3.1.4 Increased traffic on the Roads

Project-related traffic may adversely affect other users of the Project AOI , Surrounding villages . This could lead to congestion, delays, and traffic accidents.

Description of Impact

The roads in the vicinity areas are the main arterial road through the AOI , connecting all villages with the main cities. They are critical road for travel between various communities and used by local residents to travel to and from the villages to main cities to access their works markets and other services.

Existing traffic levels are reported to be minor to moderate throughout the year with a good level of service. Travelling to and from Project AOI is relatively acceptable but travelling to the villages is difficult due to the absence of vehicles. The main means of transportation reported was the carts, microbuses and private cars, pickups and shared taxi. There are few accidents on the road due to the absence of light column. There were no reports about robbery or theft on the roads.

The main road will be used by the Project to transport equipment, supplies, and workers to and from the site, as well as carrying wastes (including solid waste, hazardous waste, and sewage) to authorized disposal facilities. Add up about 10 trips for water tanks and 8 trips for waste and waste water disposal. In case of accommodating workers in Surrounding villages , there is a probability of 10 trip to transport workers to and from the site.

Embedded Controls

The Project is committed to establishing and maintaining a Traffic Management Plan. This plan will reflect good construction practices including scheduling of Project traffic to avoid peak travel times on local roads, construction shifts, and driver training and capacity building to promote safe driving.

The speed limit on the public road between the site and the laydown area should be 30-60 km/h maximum. Speed bumps, warning lights and signage are used to slow down all vehicles in this section.

Pedestrian movement between the site and the laydown area will be limited to a designated walkway independent from the access roads, and pedestrian crossings will be protected by speed barricade, traffic lights and warning signs.

Regular checks will be undertaken to ensure continued use of good practices, and daily visual inspections will be used to monitor increases in road congestion and/or travel times.

Performance of Project vehicles/drivers in accordance with the Traffic Management Plan will be enforced. All road traffic incidents involving project vehicles (including deliveries) must be reported to the contractor , who will keep records and cooperate with relevant authorities and Company.

Impact Assessment

Traffic impact is considered local and regional as it will extend along the surrounding villages road in the vicinity of the Project site. However, considering the traffic management plan and associated measures (including scheduling traffic to avoid off-peak hours, minimizing use of the road between the villages and the mother village and the site, and promoting safe driving practices through training and enforcement), the scale of impact is expected to be minor. Although there will be a substantial increase in vehicle numbers, including high goods vehicles, on the road, the identified management measures will minimize the escalation of traffic to avoid large-scale changes in congestion or accident rates. Traffic analysis conducted for the Project predicts that the Level of Service for the roads will remain good and therefore, traffic impacts remain Low .

Mitigation Measures

- Developing of Traffic Management Plan that contains all mitigation measures related to traffic impacts. This plan should explain the limitation and roles of traffic monitoring staff. Also, it should contain all indicators of monitoring that will put limitation to the unfavorable impacts
- Grievance Mechanism to provide road users with a means of contacting the Project with any concerns or complaints, including potential issues related to traffic and road safety. One of the important communication channel to be available in the GRM should be the cell phone of traffic inspector. Any violation of traffic issues will be treated very seriously and appropriate corrective action(s) to be taken as needed.
- Engagement with communities, road users, and the villages located around the site to identify concerns regarding road safety and traffic impacts. Signage and outreach activities to improve public awareness of traffic changes and potential hazards will also be targeted for high-risk sections of public roads, including near the site and laydown areas.
- Engagement with regulatory authorities regarding traffic management and condition of public roads.

Residual Impact Significance (Post-Mitigation)

The Project's Traffic Coordinator will be responsible for engaging the stakeholders and regulatory agencies to monitor conditions and address concerns. Monitoring will focus on roads and intersections in the immediate vicinity of the site, where traffic levels will be the highest and roadside services are increasingly dense, as well as other sections of the Road) where there is a high potential for interaction with the public. Additional mitigation measures may be identified in response to changing conditions and concerns. The residual impact significance is assessed as Minor.

Cumulative impacts

Given the limited industrial activities and project in the area, The project will not significantly add up to the traffic load on the project areas. Relying upon negotiations, collaboration and coordination will minimize cumulative traffic impacts to be Minor

5.3.1.5 Impacts related to land acquisition

Project-related land acquisition impacts may adversely affect the owners of lands, wells and the livelihood of well operators.

Description of Impact

The project will result on the adverse impacts pertaining to land acquisition and economic displacement:

- Reduced livelihoods due to loss of land and/or resettlement.
- The project will result in acquiring lands to install 14 wells on 1440 meter square
- The project also will result in termination of 12 private wells
- The project will result in affecting the livelihood of 10 well operators

Embedded Controls

The PWA will prepare a Resettlement Action Plan that identify project impacts pertaining to land acquisition and economic displacement. Mitigation measures and compensation strategy will be intensively presented. As well as, consultation strategy with the project affected persons.

Impact Assessment

Given the limited number of PAPs and the duration of impact,and acquisition and economic displacement impacts are classified as Low .

Mitigation Measures

• Developing of resetllement Action Plan that contains all mitigation measures related to traffic impacts. This plan should explain the limitation and roles of traffic monitoring staff. Also, it should contain all indicators of monitoring that will put limitation to the unfavorable impacts

• Grievance Mechanism to provide road users with a means of contacting the Project with any concerns or complaints, including potential issues related to traffic and road safety. One of the important communication channel to be available in the GRM should be the cell phone of traffic inspector. Any violation of traffic issues will be treated very seriously and appropriate corrective action(s) to be taken as needed.

- Engagement with communities, PAPs, and the villages located around the site to identify concerns regarding road safety and traffic impacts. Signage and outreach activities to improve public awareness of traffic changes and potential hazards will also be targeted for high-risk sections of public roads, including near the site and laydown areas.

Residual Impact Significance (Post-Mitigation)

The Project's land acquition will be responsible for engaging the stakeholders and regulatory agencies to monitor conditions and address concerns. Monitoring will focus census condusted to the PAPs and remedial actions adopted. The impact will be classified as Minor.

Cumulative impacts
There will be no cumulative impacts

5.3.1.6 Impacts related to visual intrusion and landscape

Construction activities can be seen in the project area of influence. Digging the land, construction of pipelines, and the moving of equipment will be noticed from the main road.
Description of Impact
Project component pertaining to installation activities would produce visible activity and dust in dry soils. Project construction may be progressive, persevering over a significant period of time. Ground disturbance (e.g., trenching and grading) would result in visual impacts that produce contrasts of color, form, texture, and line. Soil scars and exposed slope faces could result from excavation, leveling, and equipment movement. Impacts pertaining to visual intrusion and landscaping remain Low

Impact Assessment
Local residents of the surrounding areas in the villages are the receptor of this potential impact. The residents are less impacted by the visual intrusion impact as they don't reside in the vicinity of project sites .
Mitigation Measures

- The Project will implement a grievance mechanism to provide local residents with a means of contacting the Project with any concerns or complaints, including potential issues related to visual intrusion.

- Engagement with local communities to understand changes or issues that have developed since the start of construction.

Residual impacts

Visual intrusion impacts tend to be irreversible in touristic areas. No mitigation measures can minimize such impact. Thus, the impact remains of Irrelivant

Cumulative impacts

Given the nature of area of influence and the existence of no industrial activities, the project will not add to the unfavorable landscape of the area. Thus, the impact remains of Minor

5.3.1.7 Potential positive impacts during operation

Project operations will generate long-term economic benefits including opportunities for permanent employment and skills development, and economic growth through support for local businesses. As part of a larger effort to improve the capacity of Palestine sanitary infrastructure, the Project will also play an important role in improving access to, and reliability of water reuse throughout the region, with large numbers of direct and indirect beneficiaries as follows:

- Phase 1 about 3000 beneficiary who own up to 5 thousand dunums
- Phase 2 about Beneficiary who own up to 10 thousand dunums

5.3.1.8 Job creation and capacity building

A positive impact is expected as the Project will generate long term opportunities for employment and skills development. During operation, the Project is expected to employ 50 workers. Workers are expected to live in the AOI , particularly in Project AOI or in Surrounding villages and the Area of Influence. The Project has expressed a commitment to local hiring, which also supports the expectation of various stakeholders consulted in Um El Nasr and Project AOI . Workers will live in the local area as they are locally hired. The local hiring will be limited to males as women tend to be reluctant accepting such types of works. Project direct impacts would include the creation of new jobs for operation and maintenance workers and the associated income and taxes paid to the state.

Any job opportunities will generate tax to be paid to state. That will work for the benefit of all communities

Additional opportunities are predicted during the operation phase. They are related to increasing the possibilities for career development and advancement, as the stable and structured employment opportunity at the Water reuse plant will be play a major role in building skills and experience.

5.3.1.9 Potential negative impacts of the Water reuse plant during operation phase

The project construction is anticipated to result in various social impacts which can be summarized as follow:

- o Potential implications for worker health and safety;

5.3.1.10 Potential implications for workers' health and safety

As 300 workers will be accommodated and work in the same place there will be different health risks. Following are the main risks related to health:

Description of Impact

- Potential infections by communal diseases i.e. respiratory diseases (tuberculosis, flue, swine flu) and skin diseases,
- As workers might share shaving tools and sometimes share tooth brush, there is a probability of being affected by blood transmission diseases,
- As they are all men, few of them might be homosexual. Thus, they might get affected by any of the sexual transmitted diseases,
- Workers also might get affected by accidents result from working on heights or traffic accidents ,
- In case of not adhering to hygienic behaviors, the workers might get lice and skin diseases. Additionally, the lack of ventilation might result in facing respiratory diseases,
- Not abiding to cleanliness in the kitchen might cause digestion and intestine infections. The cleanliness of pit latrine is essential to avoid any infections.

Embedded Controls

The project's workforce's health condition will be carefully managed by the operator. Health facilities will be availed in the site and in the vicinity areas (Project AOI and Surrounding villages) and will be monitored by occupational health and safety persons.

The operator will be committed to ensuring that workers' health meets the standards established by the IFC (Performance Standard 2: Labor and Working Conditions) and other international authorities, and the Project management team will conduct inspections to ensure compliance in this regard.

Each worker should submit a health certificate that provides information about his health status, additionally, workers can be entitled to frequent health check and blood test must be applied each six month.

With regards to other diseases i.e. swine flu, tuberculosis and hepatitis B. Workers should have a health examination in order to avoid transmitting such diseases to the surrounding communities.

For drivers working in the project they should have a first license certificate that enables them to drive all vehicles. They should be also entitled for drug test, particularly, the drugs that can be injected.

Impact Assessment

The impact is expected to be localized to the work place and roads to the project areas, and of short-term nature during construction period. However, due to the number of workers, there will be large degree of influence among the workers.

Receptors are the workers of the project who were recruited from the AOI and surrounding villages and other project areas , who may experience changes in their health conditions. As there is various preventive measures and precautions adopted by the, receptor vulnerability is likely low.

Mitigation Measures

- Apply a health examination to workers prior to the onset of work
- Workers will be oriented and comply with a Code of Conduct governing behavior off-shift and interactions with local communities.
- Grievance mechanism to be available to workers with a proper communication channels that enabled the workers to voice their concerns.
- Occupational Health and Safety Strategy will be developed to coordinate worker health and safety measures by the operator , track the number of workers infected or died, and manage issues related to health conditions. Development of the strategy will include further investigation of existing health and safety measures and workers concerns and vulnerability to change.

Residual Impact Significance (Post-Mitigation) Minor

After the implementation of the above mentioned mitigation measures, the significance of the residual impact is assessed as Minor.

Cumulative impacts

Such impact is limited to the work site and is not predicted to result in any cumulative impacts rather than facing with and epidemic disease. The significance of cumulative impact is Minor

5.3.2 Vulnerable groups

The identification of the vulnerable groups, considering their interest and setting plans to mitigate for any negative impacts on them, lies within the core of social impact assessment. This mainly returns to the fact that vulnerable groups are more exposed to the implications of various impacts and are more likely threatened to get in more impoverishment. Identifying vulnerable groups and assessing the project impact is crucial in order to propose the appropriate procedures to be applied in order to reduce their agony.

By conventional definition, the vulnerable population are defined as those groups of people who are typically excluded, disadvantaged or marginalized based on their economic, environmental, social, or cultural characteristics. While various groups could fit within this description (e.g., women, youth, people with disabilities, refugees), a need for having a more specific and focused definition to identify the vulnerable groups relevant to the project raised as a necessity to the team. The SESIA analysis methodology for identifying the vulnerable groups and assessing project's impacts on them has been influenced by the Sustainable Livelihood Approach (SLA) which helped in setting the scene for describing the context, motivations and resources of the affected vulnerable households.

The Sustainable Livelihood Analysis to identify the vulnerable groups relied upon focusing on collecting information about the potential affected people, ranking them according to the severity of impact using different elements of the SLA which are:

1. Assets (social, physical, economical, human and natural assets)
2. Risks and vulnerability surrounding the targeted individuals
3. Polices and organizations that govern the implementation of mitigation measures

The level of vulnerability of certain group and the severity of the impact on these groups has been assessed by reviewing the individual's assets base using the sustainable livelihoods analysis (SLA) approach. The less assets base the affected groups have, the less alternatives and the less coping abilities they have and the more attention should be given in designing their compensation schemes and/or mitigation measures. The dimension of the asset base that affected population possesses has been considered and integrated in the various qualitative and quantitative tools designed by the Consultant.

The analysis of the vulnerability issues has been considered as a crosscutting issue in each of the mentioned impacts, including also the pure environmental impacts. It is believed that certain groups are more vulnerable to the environmental impacts than others due to higher level of exposure to these impacts or lack of alternatives or survival methods that allow for coping with these impacts. The presentation of the vulnerable groups, in that sense, has been integrated in each of the impacts (where applicable) and was addressed in deeper approach under the social impacts assessment.

According to the ranking for the most affected groups who has no alternative livelihood approach were ranked an recognized as follow:

1. The operators of wells who are uneducated, untrained might suffer due the termination of wells. They are maximum 10 people, therefore, the magnitude of their vulnerability might be mitigated
2. The owners of wells who might be terminated will be badly affected due to losing a valuable asset (the well) As well as, being in critical need for alternative source of water which will cost a lot. In addition, some of them used to gain his income through selling water which will not be available indicating that his income will be badly affected
3. The owners of small plots of lands who will be expropriated during the construction of the 14 wells. Some of them have small plot of lands that don't exceed one dunum. The wells will pass in the middle of such plots of lands. They will not be able to make use of their lands.

Mitigation measures for vulnerable groups

In order to reduce the impacts of the project vulnerable groups, it is recommended to apply the mitigation measures that can be summarized as follow:

The mitigation of impacts will be described in detail in the mitigation measures section. However the discussion of mitigation measures with the above mentioned affected groups based on the entitlement characteristics, any one that might be affected due to expropriation should be compensated. It is recommended to develop a Resettlement Policy Framework and Resettlement Action plan in order to identify the Project Affected Persons (PAPs), their entitlement, compensation valuation and mechanisms proposed for compensation.

Those who might be considered as project affected people can be summarized as follow:

1. The owners of wells: they should be provided with recovered water free of charge in addition in cooperation with the municipality they should be provided with fresh water of lower subsidized cost. The cost of digging their wells should be paid in a full market price.
2. The operators of wells should be provided with alternative job opportunity in the project itself or assessed by the agricultural entities to reduce their suffering.
3. The owners of small plots those groups should be completely avoided as they will be badly affected. Otherwise, they should be compensated in a full market price by the municipality

PWA does not provide any assistance to the affected people in terms of training or rehabilitation for the affected groups (which is not necessary for this project). As well, they are not the entity responsible for the compensation of any affected people especially those who will lose their lands. Therefore, they should apply the following strategy to minimize the unfavourable impacts:
Seeking for appropriate alternative for wells in order to reach the maximum limitation for the affected areas

- The wells in small plots of lands
- The wells that represent the sole source of income
- The wells should be compensated for the digging in a full market price

Cooperation with other entities to provide assistance or to mitigate affected persons appropriately

- Municipalities
- Ministry of Health
- Agricultural organizations
- Awqaf
- Other potential entities

Thinking about different strategies for compensation

- Provision of job opportunities.
- Supporting in the provision of appropriate compensation
- Supporting in the provision of alternative lands
- Provision of information to the affected people on strategies of compensation

5.4 Summary of Mitigation, Enhancement And Management Measures

Environmental and Social Management Plan (ESMP) aims at defining a mechanism for implementing mitigation measures for expected negative impacts and to monitor the efficiency of these mitigation measures based on relevant environmental indicators.

The ESMP identifies certain roles and responsibilities for different stakeholders for implementing, supervising and monitoring the environmental and social performance of the project.

The ESMP has distinguished between mitigation measures that should be implemented during the construction and operation phases of the project.

Roles and responsibilities for implementing the ESMP during the construction phase have been proposed based on the following set-up:

- The project owner company will develop detailed designs and tender documents, for construction of the Water reuse plant, which will include the environmental measures that should be undertaken by the construction contractor
- During tenders evaluation The project owner company assure that the approved offer must include the required environmental mitigation measures to be implemented during construction
- The project owner company will be responsible for the implementation and monitoring of the ESIA
    - During plant operation, the most critical responsibilities are the operation and maintenance of the equipment used to control and measure pollution discharges
    - Reports on the results of environmental monitoring and other activities may have to be prepared and submitted to the PWA and lending institutions.
    - Finally, compliance with all activities related to environmental compliance should be audited periodically throughout plant operation

The above mentioned tasks were defined by The project owner company Investments. The analysis of the following organic ram revealed that the social aspects were not entirely considered. In order to fill the gap noted, it is strongly recommended to hire a social development officer.

5.4.1 Worker Code of Conduct

Workers will be required to acknowledge and comply with a Workforce Code of Conduct that sets out the behavior expected from employees. The Code will provide guidelines for what is acceptable behavior, as well as examples of prohibited actions or behavior that will be regarded as misconduct. The Code will govern behavior both on- and off-shift and include interactions with local communities. Compliance with the laws and regulations of Palestine , as well as with all relevant

Project policies and procedures, will be required. Additionally, it will explain the consequences associated with violence, verbal abuse, harassment, and other anti-social behaviors.

The Company and contractor will ensure that the Code of Conduct is integrated into induction activities for all workers, including subcontractor employees, and all workers will be responsible for familiarizing themselves with the Code of Conduct and reporting any situation or activity that violates or appears to violate the Code.

The Project is committed to the principles of equal employment opportunities and anti-discrimination and strongly opposes and prohibits harassment of any kind, including sexual harassment and inappropriate sexual conduct, as well as all types of discrimination regardless of race, religion or belief, gender, disability, age, nationality, sexual orientation or ethnicity. The Project will not tolerate and prohibits any conduct which is contrary to applicable human rights legislation. Employees are responsible to report any violation of company policy or local and national laws, rules, or regulation. The proponent prohibits retaliation against any worker for filing a complaint or assisting in a complaint investigation.

5.4.2 Influx Management Strategy

The Project will develop and implement a comprehensive and coordinated strategy to track and manage the influx and accommodation of workers associated with the Project (including Company, contractor , and subcontractors).

For each company, the following information will be recorded and monitored monthly:

- Number of workers;
- Place of residence (permanent or prior to hiring);
- Accommodation while employed with the Project;
- Duration of contract;
- Job classification;
- Induction process; and
- Training received.

The Influx Management Strategy will also identify the program for standardized inspections of workers' accommodation, including applicable regulations and standards, schedule, documentation, and reporting. Provisions for mitigation or remedial actions will also be identified.

The capacity and performance of local infrastructure and utilities (in the areas around worker housing) will also be monitored to identify any unacceptable impacts to service provision associated with pressure from influx. Should monitoring indicate that infrastructure is being affected, actions will need to be put in place to reduce them. This may include the identification of alternative housing options and/or discussions with representatives of the village or municipality in order to manage the increased demand on local facilities.

The Company, contractor and subcontractors will form a workforce management committee with a mandate to oversee workforce housing and related issues (e.g. access to services, interactions with communities). Where possible, the parties will align accommodation plans, standards of living, and worker transportation with the goal of minimizing adverse impacts. This committee will also regularly review stakeholder engagement records and grievances so as to proactively manage relevant issues.

As a result of the Influx Management Strategy, the Company and CONTRACTOR Consortium should have access to updated and consolidated information about workforce accommodation at any given time, including numbers of workers (local and non-local), location of apartment/camp, responsible company, inspection results, and follow-up actions.

5.4.3 Stakeholder Engagement Plan (SEP)

A Stakeholder Engagement Plan (SEP) is being prepared for the Project and provides an overview of stakeholder engagement activities during both construction and operation. It has been designed to align with good international industry practice and meet all national regulatory requirements.

Stakeholder engagement is an ongoing process, and as such, the SEP is a working document that will be reviewed, and if necessary adjusted, as the Project progresses. It provides a framework to manage effective and meaningful engagement with stakeholders. Its purpose is to establish and maintain a constructive relationship with a variety of external stakeholders over the life of the Project; it is a fundamental management plan for the Project and an integral part of an effective and adaptive management system.

Many of the mitigation measures prescribed in this assessment, sit under the umbrella of the SEP and it will be important that it is implemented promptly, so that ongoing construction activities are appropriately managed. Additionally, the Project's proposed processes, such as the Grievance Mechanism need to be consulted on and amended, if necessary, to ensure their appropriateness and effectiveness.

The Social Development Officer (SDO) for the Project will be responsible for implementation of the SEP and actions therein, with support from others, as necessary. The SDO has not been hired to date, but EEHC intends to have hired and trained a team member by end of 2016.

5.4.4 Social Development Officer

The majority of socio-economic mitigation and management measures, as well as ongoing stakeholder engagement, will be the responsibility of the site's Social Development Officer (SDO).

As outlined in the ESMP, the SDO is responsible for community engagement and relationships management, and will have direct interaction with communities to facilitate information flow and build relationships throughout the life of the Project.

The specific roles and responsibilities of the SDO planned to be appointed under the PMU are presented in Box 1 Below.

Table 52: Key responsibilities of the Social Development Officer (SDO)

- Build a dialogue with project affected groups, including local communities in the project sites and ensure the project is implemented in socially sensitive manners that consider the interests of these groups.
- Monitor the project performance and report challenges and propose measures to improve project performance.
- Design and implement awareness raising campaigns in cooperation with NGOs
- Facilitate the formation of various community based mechanisms including community-based monitoring committee and social committee as part of implantation of the Involuntary Resettlement Plan (if needed).
- Ensure adapting participatory mechanisms in monitoring the project impacts and evaluating outcomes
- Prepare quarterly progress reports and raise it to the PMU and report to the project manager where applicable.

The SDO qualifications are as follow:

1. Has a degree in social science or social development practice.
2. Be familiar with work in projects with similar scope
3. Has very high communication and facilitation skills.
4. Local university graduates, particularly women, should be encouraged to apply.

In order to enable the SDO to efficiently fulfill his/her responsibilities, the capacity building and training modules presented in Box 2 are proposed. The SDO should receive these capacity building programs prior to the construction phase of the project.

Table 53: Proposed Capacity Building Programs for the SDO

- Information about Steam Water reuse Plant Techniques
- Promotion of Awareness Raising Activities
- Communication Skills
- Community Participation Tools
- Consensus Building Techniques
- Monitoring and Evaluation mechanisms (M&E)

- OP 4.12 with emphasis on involuntary actions and grievances
- Palestinian laws related to land acquisition (if needed)

5.5 Other Management Measures

In addition to the potential impacts described above (Sections 4.2 and 4.3), compliance with the IFC Performance Standards requires careful consideration of other key social risks related to Project construction and operation, including site security arrangements, working conditions, and occupational health and safety. Although these considerations are addressed in the Company's policies and procedures, they are discussed below in the context of potential socio-economic risks and impacts.

5.5.1 Site Security

Protests or aggressive activities at the site may require intervention by security personnel. In accordance with IFC PS4, the use of security personnel needs to be carefully managed. Security arrangements should be proportionate to the needs of the local area, and personnel should be properly trained, equipped and monitored.

The CONTRACTOR Consortium's Construction ESMP describes site security arrangement as follows:

"A layered security plan including vetting and qualification of security staff (via national security agency of Palestine) is in place for the Um El Nasr Site. This plan is coordinated with the local military and police organizations. Only Palestinian security forces will be allowed to carry firearms on the Site. This security plan is aligned to the Voluntary Principles on Security and Human Rights to which the Consortium commits; due to its nature this document is confidential."

The Security Plan has not been developed ; however, it should detail the Company's position and measures to address the use of force, training, equipping and monitoring security guards as well as investigating reports of unlawful behavior and preventing recurrence. Security shall be provided in a manner that does not jeopardize the community's safety and security, or the Project's relationship with the community. It will comply with national legislative requirements and with the requirements of IFC Performance Standard 4, which is consistent with good international industry practice. The commitment to align with the Voluntary Principles on Security and Human Rights is noted.

Any security personnel from private companies will be trained and will operate in accordance with the 'International Code of Conduct for Private Security Providers'. The Project will 'make reasonable enquiries to ensure that those providing security are not implicated in past abuses; will train them adequately in the use of force (and where applicable, firearms) and appropriate conduct toward workers and local communities; and require them to act within the applicable law'.

Appropriate information on the Project's security arrangements will be provided to local stakeholders and they will be engaged in discussions about these arrangements. The grievance mechanism for the Project will capture all grievances raised in relation to security and safety issues. These will be addressed promptly and appropriate actions will be taken in consultation with affected parties.

The Project should also recognize that security standards and expectations in Palestine may not align with the practices required by IFC PS4, and security personnel may be predisposed to use force; thus, the Security Plan should openly address inter-cultural issues that may affect the successful implementation of the plan. The Project should also ensure that local stakeholders and public are aware of security activities at the site, are informed of their rights and any restrictions on access/activities, and are aware of the Project's grievance mechanism.

5.5.2 Working Conditions

The Project will comply with Palestinian law Number 12 of year 2003, ILO conventions, and the international good practice of the IFC PS and related guidelines, in relation to labor and welfare standards, and freedom of association, with specific reference made to child and forced labor. Emphasis will also be placed on measures to ensure that workers are free of any discrimination, regardless of race, religion or belief, gender, disability, age, nationality, sexual orientation or ethnicity. The CONTRACTOR Consortium's Construction ESMP71 addresses issues related to employment, human resources, and working conditions. There is also an HR Policy72 for the Um El Nasr Project. The HR Policy (including occupational health and safety and other requirements) applies to all entities of the Project, including subcontractors and temporary workers. The Company has committed to align with the requirements of IFC PS2 and the Project's approach in relation to key elements is as follows:

HR Policy and Procedures

It is expected that the vast majority of workers will be Palestine ians, with any workers from the local communities filling positions for involving unskilled/low-skilled labor.

The Project commits to complying with Palestinian human resources and labor legislation including laws, executive regulations, Presidential and Ministerial decrees and laws related to labor, child labor and women's rights. Palestinian labor laws address key aspects of employment, including wages, overtime, sick-leave, communication, and non-discrimination, as applied to both permanent and temporary workers. As applicable to all such companies in Palestine , the Project (including construction contractors) must each have an HR policy that is aligned with Palestinian Labor Legislation.

The Project's HR policy and procedures will be clearly communicated to all Project workers and contractors. Copies of key documents will be posted in public places across the Project Site, including accommodation areas. The obligation to abide by the policy and procedures will be an integral, formal part of all contracts.

Working Conditions and Terms of Employment

The Project commits to ensuring competitive and fair remuneration, and will ensure that any migrant employees are engaged on equivalent terms as non-migrant workers. Terms of employment and working conditions will be clearly communicated to employees, including wages and benefits, hours of work, overtime and compensation, breaks, and provisions for leave.

Workers' Organizations

Under Palestinian law, certain labor unions are allowed and others unauthorized; currently there is no formal union for semi-skilled or unskilled workers. In any case, the Project will not limit or inhibit the rights of workers to join unions or otherwise associate or participate in collective bargaining.

Non-Discrimination and Equal Opportunity

The Project commits to ensuring that no discrimination by or of any employee (or in decisions on employment) is tolerated for reason of origin, nationality, religion, race, gender or age for any aspects of the employment relationship. This excludes where there are special measures of protection or assistance to remedy past discrimination in terms of national law. Discrimination, intolerance and any form of harassment (e.g. moral, sexual) shall be prohibited, actively tracked and eliminated. This principle shall be applied at all employment levels and in all circumstances.

Retrenchment

In the case of potential collective dismissals, the Project will take reasonable steps to reduce overall loss of employment by investigating suitable alternatives. Where these alternatives are not possible, reduction in the workforce shall be undertaken in accordance with a retrenchment plan developed by the Project through consultation with employees, and in line with national laws.

Grievance Mechanism

Worker grievances will be addressed through the Project's worker grievance mechanism, which was implemented in January 2016. This transparent mechanism is designed to receive and address grievances and objections for all direct employees. The Project will ensure that the grievance mechanism, or similar, is established for employees of contractors.

Child and Forced Labor

The Company states that they shall specifically monitor the health, working conditions and working hours and conditions of employees under the age of

18. Employment of minors is only permitted where such employment must ensure that it does not interfere in the child's education and or is not harmful to the minor's health, wellbeing or development, and where permitted by law. Employment of minors shall exclude any hazardous work and shall be in line with Palestinian regulations in terms of suitable work activities and additional specific conditions or requirements for young workers.

The CONTRACTOR Consortium commits that, in accordance with both Palestinian law and international good practice, no workers below the age of 18 will be hired. This will be monitored via the security controls and ID checks at the entrance gates.

The Project will actively ensure that there is no employment of forced labor (including indentured labor, bonded labor or similar contracting arrangements) or trafficked persons. The Project will not retain identification papers, work papers, or other important belongings to deny workers' rights to movement and resignation.

Contractors and Third Parties

The Project will take commercially reasonable measures to ensure that contractors are reputable enterprises, with management systems in place to ensure they operate in line with the Project's HR Policy (with the exception of retrenchment and supply chain policy statements). These requirements shall be included in contractual agreements and contractor compliance will be monitored on an ongoing basis. Recruitment agencies and other third parties will also be contractually obligated to align with this policy.

Supply Chain

The Project commits to reviewing the primary supply chain where there is a high risk of child and forced labor and significant safety issues, and identifying these risks. Where there is evidence of labor or safety incidents, the Project shall ensure appropriate steps are taken to remedy this. The implementation of these measures shall be monitored and where remedy is not possible, the Project shall shift the primary suppliers over time to those which can demonstrate alignment with the child and forced labor and safety statements contained within the Project's HR Policy.

Training

The Project will develop and provide adequate training programs in line with job descriptions of employees in order to enable employees to undertake their duties safely and with the expected technical competence.

Table 4-12 identifies specific considerations and recommendations related to labor and working conditions for the Project.

5.5.3 Occupational Health and Safety

Workers on the Project will be exposed to a range of OHS risks during construction and operation, such as working at height, manual handling, contact with hazardous material, noise and vibration, amongst others. In the absence of appropriate standards and preventative practices, the health and safety of workers would not be adequately protected. IFC PS 2 addresses occupational health and safety.

The Project has committed to implement an occupational health and safety management system in accordance with OHSAS 18001. This includes the development of an OHS management plans based on the identification and management of key hazards to which workers are exposed, and with the objective of ensuring that employees do not come to any harm. A quantitative risk assessment (QRA) has been conducted, including a hazard identification (HAZID) and evaluation of potential failure cases for the facility.

The Project is committed to complying with national labor, social security and occupational health and safety laws as well as the standards of IFC PS 2. The Project will have a robust OHS Plan in place for the duration of construction and operation

It will include measures to minimize the risk of accidents, illness and injury; document and report all incidents; and ensure appropriate emergency preparedness and response planning. A formal grievance procedure will be developed for workers and there will be occupational health and safety monitoring programs to verify the effectiveness of prevention and control strategies.

the EHS Manual for Project construction will encompass relevant policies, objectives, roles and responsibilities, and site protocols/regulations designed to manage risks associated with construction activities. The CONTRACTOR Consortium commits to a Zero Harm culture with objectives for zero incidents, accidents, occupational illnesses, or incidents affecting the environment or communities. Requirements for subcontractors are identified, as well as provisions for site access, environmental protection, health/hygiene, and protective equipment. Specific requirements are outlined for job activities such as working at height, excavations, and use of equipment.

The HR Policy also reinforces the Project's commitment to occupational health and safety, including worker accommodation. As defined in the HR Policy, the Project will provide safe and healthy conditions for working and accommodation for all employees, including subcontractor workers. The policy encompasses physical, chemical, biological and radiological hazards as well as specific threats to women. In regard to accommodation services, the Project commits to ensuring that they are of reasonable quality and include basic services including water, sanitation, ventilation, lighting, cooking facilities, and protection against the elements.

5.5.4 Awareness raising activities

- During different stages of the project, different awareness raising activities should be carried out with the public and the laborers in order to minimize the impact related to the misconceptions, and to inform the community about the different stages of the project as well as expected duration of its completion.
- Another benefit of raising awareness is to train the community especially the women and children on the safety measures that should be applied in the areas of constructions.
- These awareness raising activities can be implemented through workshops, public meetings in public gathering places, printing pamphlets, and through the different social interaction websites.
- Awareness raising activities is a proactive approach that minimize conflicting with project stakeholders. Additionally, it is an active feedback channels that might predict the perception of community and working crew towards project activities.

Training plan for socio-economic issues as well as awareness raising activities is presented in the table below.

Table 54: Recommended Training courses

Training course	Type of training	Receptors	Proposed Scheduling	Cost Estimate *In US $*
• **Information about clean steam Water reuse plants**	Workshop + on the job training	Social Development Officers	Prior to the project	**1000 $**
• **Promotion of Awareness Raising Activities**	Workshop + on the job training	- Social Development Officers	Once before the project implementation Refreshment course during the implementation of the project	**2000 $**

Training course	Type of training	Receptors	Proposed Scheduling	Cost Estimate *In US $*
• **Communication Skills**	Two days Workshop + on the job training	Social Development Officers	- One workshop during the beginning of the project implementation	**1000 $**
• **Grievance and redress mechanism**	One day Workshop + on the job training	Social Development Officers	- One workshop during the beginning of the project implementation	**1000 $**
• **Palestinian laws related to social aspects**	One day Workshop + on the job training	Social Development Officers	- One workshop during the beginning of the project implementation	**1000 $**
• **Community Participation Tools**	One day Workshop + on the job training	Social Development Officers	- One workshop during the beginning of the project implementation	**1000 $**
• **Monitoring and Evaluation mechanisms (M&E)**	**Two days Workshop + on the job training**	**Social Development Officers Project management unit**	**- One workshop during the beginning of the project implementation**	**2000 $**

5.5.5 Analysis of Alternatives

The analysis of alternatives is meant to investigate the feasibility of different design alternatives, which have been presented in the final impact assessment in terms of environmental and social impacts. The analysis of alternatives has considered the environmental and social advantages and disadvantages of the available project alternatives. In the previous Chapter some project alternatives were assessed against specific impacts and this assessment was presented under the correspondent impact analysis, this assessment is also presented in this chapter but with wider scope through comparing the degree of relevant environmental and social impacts for each alternative and hence reach a conclusion about the environmental and social preferred alternative.

5.5.5.1 No Project Alternative

The objectives of the Effluent Recovery of recovery water for irrigation and sludge reuse for fertilizer and soil condition, in addition of decommissioning of BLLWTP and remediation works of Effluent Lake adjacent to BLWWTP basically to improve the environmental, socio economic and public health conditions in Gaza strip, especially at the project areas, accordingly it is expected, by definition, that the environmental and social benefits will overweigh the impacts.

The main benefits that are expected by the projects include:

- Better water effluent reuse for unrestricted use for irrigation. The project will have many positive impacts on water resources by definition. The recovered effluent from the groundwater will be an important source of irrigation water as the water resources in Gaza Strip are scarce.
- Better and more efficient use of scarce water resources. The expected recovery water quantity and quality will have additional recovered water for irrigation purposes.
- The recovery will limit the horizontal dispersion and the vertical building up of the water table which without recovery will have negative impact on current land use. Horizontal dispersion of the contamination will be captured by the recovery schemes. Without recovery scheme, vertical building up of infiltrated water will reach the water table and in some extend, at the certain area, depending on the topographical and contour, the surface water will appear in a very near future and will negatively impact the land use that is limited already at the Gaza Strip.
- Socio economic aspects for recovery effluent and reuse:
- The potential change in source of income due to the provision of good quality water will reduce the cost of water needed for irrigation in the area. Sludge is one of the output of the project that will increase the income for those who work in sludge trading
- Job availability especially during the construction period, skilled and unskilled labor.
- Better access for the community surrounding due to the construction of NGESTP and Infiltration basins.

The negative environmental and social impacts of the project were discussed in the previous chapter. All these impacts are mainly site-specific and could be managed/minimized through implementing the proposed mitigation measures as described earlier in this ESIA. Comparing the benefits to the impacts in a strategic level, it could concluded that the “no project alternative” is not supported from the environmental and social perspective, given that the project impacts will be controlled as recommended in this ESIA.

6 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP) AND MONITORING PLAN

6.1 Introduction

This chapter presents Environmental and Social Management Plan (ESMP) developed for NGESTP Effluent recovery scheme. This chapter consists of the following sections:

- Objectives of ESMP
- ESMP
- Guidance on Emergency Response Plans
- Roles and responsibilities in the implementation of the ESMP
- Cost Estimation

6.2 Objectives of ESMP and Monitoring Plan

The Environmental and Social Management Plan (ESMP) consists of a set of mitigation, management and monitoring measures to be taken during implementation of the project to avoid, reduce, mitigate, or compensate or offset any adverse social and environmental impacts. In addition, the ESMP defines procedures to ensure that the management of environmental and social issues during the different project phases are undertaken in accordance with national legislation and best practice procedures.

The successful implementation of the ESMP will depend on a range of different elements. To ensure a management plan that incorporates and successfully integrates with interface documents, the following elements must be considered and acted upon:

- The environmental and Social Management unit should be adequately staffed to ensure the proper implementation and monitoring of the ESMP. The organizational structure of the environmental and social PMU should also reflect the range of complete competencies to perform the tasks.
- The development and management of registers for the proper documentation and tracking of environmental and social training, environmental and social incidents and environmental and social related complaints.

6.3 Environmental Management Plan (ESMP) and Monitoring Plan

The Environmental and Social Management Plan (ESMP) presented in this chapter reflects the implementation procedures and mechanisms for the mitigation measures and monitoring activities of the expected impacts previously discussed. The ESMP assigns certain tasks for different stakeholders according to their roles and responsibilities in the project.

Based on the Institutional Capacity Assessment for effluent recovery, the proposed institutional set up for project management is comprised of the following main features:

6.4 ESMP Institutional Set Up

The PMU, during construction of the project components, shall include an Environmental Manager (PMU-EM) who will have the overall responsibility for implementing the ESMP and shall report directly to the PMU Director. The PMU-EM will have a supervisory role over different stakeholders and will be responsible to include the proposed mitigation measures and monitoring activities in the tender documents and equipment supply contracts.

During the construction phase (before starting) the contract of the Engineering Consultant (EC), who will supervise construction work, should include supervision component on the relevant mitigation measures that will be implemented by the construction contractor. The EC representative in each construction site should report directly to the PMU-EM about the performance of the contractor in implementing ESMP measures during his work, the approval of the contractor's invoices should include the signature of the PMU-EM based on the reports he receives about the contractor performance in implementing the ESMP measures.

The PMU-EM should not totally depend on the reports he receives from the EC, but he should also make site visits on regular basis to confirm the reports he receives about the implementation of the ESMP measures by the construction contractor.

Efficient implementation for the social management plan should involve tailored efforts for maximizing the positive social impacts and ensuring that they are reaching the local communities and minimizing the negative impacts that may hit the poor and vulnerable groups. The potentially-affected groups (particularly farmers and villagers and communities surrounding the project component and land owners) should be consulted along the process in order to ensure that their views are considered and that suitable measures are in place to eliminate the severity of negative impacts. Efficient consultations with stakeholders and high level of participation are seen as a prerequisite for a successful ESMP. It is strongly recommended to appoint a Social Development Officer (SDO) within the PMU. The SDO should be leading the various participatory activities.

During operation, different authority responsible for the operation and maintenance of the project components shall appoint the manager who will generally be responsible for implementing mitigation measures and monitoring activities during operation phase. The managers will supervise the ESMP measures at the different project sites, in addition to corresponding and cooperating with different authorities for monitoring the operation of the site, and will be the staff in charge of implementing the social mitigation measures.

Please note as indicated above, the responsibility during operation and maintenance of the reuse system is still under development. In addition, negotiations are being held to indicate the coverage cost and strategy to cope with the operational and maintenance cost of the reuse system.

6.5 Roles and Responsibilities for Implementation and Supervision

The mitigation measures and monitoring activities that were recommended in Chapter 5 of the report shall be implemented according to the above-mentioned institutional set-up. The following 2 tables present the responsibilities of different stakeholders for mitigation measures and monitoring activities during construction/operation, remediation works and decommissioning phases.

The reporting of ESMP measures should be done on a monthly basis by the EC during the correspondent phase of the project. The monthly reports will be presented to the PMU-EM or CMWU-EM (or WWDU – EM) who shall make sure that the ESMP measures are implemented in due course according to the progress report. The PMU-EM should report for the PMU Manager on an annual basis. In case a corrective action is needed the PMU-EM should ask the PMU Manager for the resources to take corrective action and should adequately report the corrective action taken. These reports should include the following components:

- Monthly reports prepared by EC and submitted to PMU-EM:
- Annual report prepared by the PMU-EM and submitted to the PMU Manager or CMWU Manager depending on their project components.

The specific roles and responsibilities of the SDO planned to be appointed under the PMU are presented in Table 55 below.

The SDO should have a degree in social science or social development practice. He/she should be familiar with work in projects with similar scope and has very high communication and facilitation skills. Local university graduates, particularly women, should be encouraged to apply. To enable the

SDO to efficiently fulfill his/her responsibilities, the capacity building and training modules presented in Box 6.2 are proposed. The SDO should receive these capacity building programs before start of the construction phase of the project.

Regarding the public health issues related to different orientation sessions and awareness raising activities, the social officer should prepare, implement and document the awareness raising activities provided to community people and project stakeholders. The main topics that will be covered by the SDO are:

1- Water problems in Gaza Strip and mechanisms to solve them
2- Sludge and recovered water benefits
3- Health preventive methods to be applied during usage of sludge/ recovered water
4- How to combat insects in an environmentally safe way

Some of the proposed awareness sessions will require the SDO both in coordination with the Ministry of Health and Ministry of Agriculture

Regarding the monitoring issues during the operation and maintenance for the reuse system (recovered water reuse and the sludge reuse), the coordination between the PMU, MoA and MoH will be established. The monitoring procedures will be discussed in detailed on the following subsection, the monitoring plan

Table 55: Key responsibilities of the Social Development Officer (SDO)

- Establish dialogue with project affected groups, including local communities in the project sites, landowners and farmers and ensure the project is implemented in socially sensitive manners that consider the interests of these groups.
- Monitor the project performance and report challenges and propose measures to improve project performance.
- Design and implement awareness raising campaigns in cooperation with NGOs
- Facilitate the formation of various community based mechanisms including community-based monitoring committee and social committee as part of implantation of the Involuntary Resettlement Plan.
- Close facilitation for the execution of the Ressettlemetn Action Plan and ensuring that compensations are reaching the PAPs.
- Maintain databases and efficient records for the PAPs as part of the ARAP
- Maintain database and efficient records of the farmers for distribution of recovery water and sludge reuse and work to integrate them in the various programmes and interventions to minimize the potential negative impact on them.
- Assist in developing strategies for the implementing the long term measures (e.g. raising the z wastewater reuse and sludge management and reuse, develop and enforce financial sustainability instruments)
- Ensure adapting participatory mechanisms in monitoring the project impacts and evaluating outcomes

- Prepare quarterly progress reports and raise it to the PMU and report to the World Bank where applicable.

Coordinate with other successful models (e.g. the model of …. Project for wastewater reuse and sludge management and recycling) to benefit from the experience and lesson learnt

The SDO should have a degree in social science or social development practice. He/she should be familiar with work in projects with similar scope and has very high communication and facilitation skills. Local university graduates, particularly women, should be encouraged to apply. To enable the SDO to efficiently fulfil his/her responsibilities, the capacity building and training modules presented in Box 8.2 are proposed. The SDO should receive these capacity building programmes before start of the construction phase of the project.

Table 56: Proposed Capacity Building Programmes for the SDO

- OP 4.12 and Palestinian laws related to land ownership
- Communication Skills
- Community Participation Tools
- Consensus Building Techniques
- Participatory Monitoring and Evaluation (PM&E)
- Promotion of Awareness Raising Activities

Regarding the public health issues related to different orientation sessions and awareness raising activities, the social officer should prepare, implement and document the awareness raising activities provided to community people and project stakeholder. The main topics that will be covered by the SOD are:

1. Water problem in Gaza Strip and mechanism to solve
2. Sludge and recovered water benefits
3. Health preventive methods to be applied during usage of sludge/ recovered water
4. How to combat insects in environmentally wise approach

Some of the proposed awareness sessions will require SOD facilitation with Ministry of Health and Ministry of Agriculture

Table 57: Environmental Management Plan

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
During Pre-Construction / Preparation					
Site clearance prior to water distribution network	Health and safety of the workers	standard procedure for health and safety of the workers	PWA (through tendering activity)	50.000	
		Fences have to be installed prior to the construction	PWA (PMU-EM) through tendering activity	50.000	
		In case the crop or plan destruction, the compensation has to be settle	PWA (PMU-EM) in coordination with MoA	150.000	Compensation framework has to be developed accordingly
Base camp preparation for the workers	Ambient air, noise and community disturbance	Base camp and storage of the equipment has to be defined to avoid the disturbances	Contractor	As a part of their financial budget during the bidding activities	
During Construction					
Ambient Air Quality by dust emission of construction works	Health impact associated with fugitive dust generated due to the vehicles	Localized the vehicle movements	Contractor As a part of their financial budget during the bidding activities		Low impact and temporary

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
	movements				
	Potential nuisance to the population in the vicinity to the construction site	Pavement of access road prior to usage in construction of the project component			
	Vegetation survival, especially on the agricultural land	Keep the site nearby the agriculture land and plantation wet, especially during the hot and dry season	Contractor As a part of their financial budget during the bidding activities		
Noise impacts	Construction activities associated with heavy machineries and generators	Noisy equipment, especially those that will be used in the constructon works including generators should be supplied with adequate silencers	Supplier	None, as a part of the supplier offers	Short term duration
		Standard noise protection equipment for the construction workers			

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
	Psychological impacts among the neighbouring area	Optimize the use of noisy machines	Contractor	None	Low impact as there is no major noise sensitive receptor is located in close proximity of the project
		Use acoustic barriers as necessary if complaints from neighbors were received	Contractor	None	Secondary impacts. It is apply when the mitigation measure is not properly managed.
Vibration at the location nearby El Shuhada cemetery area	Vehicles movement Construction work (concrete work) of facility of water distribution network.	Base camp and the storage of the equipment has to be on placed further from the cemetery area (on the future land dedicated for the future location for booster pumps and storage tank.	Contractor	None, as a part of the contractor's offers	
		Time management plan to reduce the overlapped heavy	Contractor	None	

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
		equipment			
		Ready mix concrete is preferred instead of on site concrete mix with mixer.	Contractor	None	
Impact on construction waste and handling of hazardous waste	Human wastes including wastewater and solid waste	Provision of onsite sewage collection and disposal	Contractor	None	Coordination with the landfill management for receiving the unusable construction waste.
	Construction waste	Site waste management including storing, collection and removal			
		Maximize the reuse and recycle of construction materials			
		Notify the sanitary landfil of receiving the unusable construction wastes or damaged construction materials.			

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
Changes in hydrology and groundwater quantity and quality	Potential leaks or spill chemical / fuel	Proper waste management	Contractor	None	
	Potential leaks from temporary sewage storage tank	Spill prevention measures			
	Impact associated with waste generation	Waste management plan			
Health and safety	Risk of injury or accident to the construction workers	Safety measures and standard safety protection of the workers	Contractor	As a part of the contractor's financial offer	
Ecological disturbance	Impose the crops	Fences installation prior to the	Contractor	As a part of the	

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
	and animal, especially at the water distribution network site	construction of the recovery water distribution networks		contractor's financial offer	
		Compensation preparation for destructed crops or plant	Contractor in coordination with MoA	This section will be define prior to the construction phase.	
	vertebrate or pets and fauna findings that dangerous for the workers	Strictly standard ptocedure especially at the wetland site	Contractor in coordination with the PWA (PMU)	Contractor in coordination with the PWA (PMU)	On the preparation stage, the tendering has been done to purchase the standard procuder for site clearance. However, the contractor shall put into consideration on their budget proposal
		Equipment to handle the vertebrates			
		Dangerous fauna must be isolated and handle with care			
During Operation / Maintenance					
Air emission and noise pollution impacts	Impact on noise especially for the PS staff at the water distribution network PS	Standard protection for the workers including the ear muffs.	CMWU as the authority for collection and storing the recovery water	10,000 for initial purchase of equipment and 10,000 for monitoring programme annually	

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
Vibrations	Vibration impacts especially nearby the el shuhada cemetery of the installation of pumping station and generators	Heavy leafy tree plantation at the tree to absorb the vibration and noise associated with the PS and generators	CMWU in coordination with MoA	10,000	MoA provide the suitable plantation can be sufficient for vibration and noise absorption
		Maintenance of the machines and equipment has to be maximized.	CMWU		Cost estimation is depending on the average annual budget for pumping, generators and pipelines connections
Water resource contamination	Completely Captured contaminant by 14 recovery water well installed as designed	The maintenance of the recovery well to meet the design criteria to captured the contaminant	PWA		Cost estimation is depending on the local materials availability

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
Lowering of ground water table		Monitoring of pumping using pumping tests.	PWA i		
Impact on local agriculture, public health and water resource	Use of recovery water for agriculture purpose of unrestricted crops	Prohibition of using recovery water for drinking purposes (higher total N and possible other contaminations which are not recorded)	PWA in coordination with MoA and MoH through private communities, NGOs and farmer's associations	40,000	
		Farmer's awareness for crop restriction and assistance in development of a balanced mix of crops	MoH in coordination with MoA through private sectors or NGOs	20,000	
	Human exposure control for agriculture workers and families, crop handlers, consumers of crops, inhabitant nearby the irrigated	Provision of protection clothing, the maintenance of high levels of hygiene and immunization against selected infections	MoH in coordination with MoA through private sectors or NGOs	20,000	

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
	area				
		Cooking the agriculture product before consumption and high standard of foodhygiene	MoH in coordination with MoA through private sectors or NGOs		As a part of public awareness
		Health education associated with irrigation scheme			
		Special care for assurance of not using the irrigation water for drinking water or domestic purposes by accident or by lack of an alternative	MoH in coordination with MoA through private sectors or NGOs		As a part of public awareness
		Health and safety protection shall be introduced to the farmers and the transporters			
Climate change	Flood or drought	Crops selections, irrigation method, water distribution management	MoA		Cost estimate is base on every two year study for climate change impact on

Project Activities	Potential Impacts	Proposed Mitigation Measures	Institutional Responsibilities (enforcement and coordination)	Cost Estimates ($)*	Comments
					irrigation

Table 58: Environmental Monitoring Plan

Proposed Mitigation Measures	Parameters to be monitored	Locations	Measurements (methods and equipments)	Frequency of measurements	Responsibilities
During Pre Construction / Preparation					
Site clearance prior to water distribution network	Worker's injure	Construction site location	Preparation of recording form of workers injure during the construction	Monthly	contractor
Base camp preparation for the workers	Neighbors complaint	Project construction sites	Recording of complaint and type of complaint	Once during the preparation and prior to start the construction phase	contractor
During Construction					

Proposed Mitigation Measures	Parameters to be monitored	Locations	Measurements (methods and equipments)	Frequency of measurements	Responsibilities
Ambient Air Quality by dust emission of construction works	Ambient PM, dust complaint	Ambient PM closest farm at location of location of pumping station, water distribution network and nearby community	Sampling collection and laboratory analysis Recording and documentation of complaints	Once during the most activities at each location	contractor
Noise Impacts	Ambient noise, noise complaint from the neighboring communities	Project locations	Portable noise measurement to take representative of average noise, recording and documentation of complaints	Annual during operation and once during the construction activity	Contractor
Odour Impacts	Odor complaints from neighbors	Site location	Recording and documentation of complaints	Monthly	PMU-EM
Vibration at the location nearby El Shuhada cemetery	Vibration level	Site location close to el shuhada	Portable vibration measurement	Annual during operation and once during	Contractor during construction and

Proposed Mitigation Measures	Parameters to be monitored	Locations	Measurements (methods and equipments)	Frequency of measurements	Responsibilities
area		cemetery		construction	CMWU during operation
Impact on construction waste and handling of hazardous waste	Amount of hazardous and non hazardous waste generated	Project site locations	Estimation of the hazardous waste and non hazardous waste in relation to the handling and transporting to the landfill	Weekly or monthly depending on the volume of waste	Contractor
Remediation works at the effluent lake	Clean up the site, edible tree plantation,	Project sites	Recording and documentation during the preparation of remediation and during the plantation period	monthly	contractor
Health and safety	Health records about occupational injuries and infectious diseases among workers	Clinic / hospital contracted by the project	Medical reporting on received cases	Quarterly / on received case	Occupational health clinic / hospital
Ecological disturbance	Record about biodiversity found, removed, handling over to relevant authority, damaged or replanted	Project sites	Recording and documenting and reporting to the relevant authority	monthly	contractor
During Operation / Maintenance					
Groundwater	Presented below at separate subsection				PWA

Proposed Mitigation Measures	Parameters to be monitored	Locations	Measurements (methods and equipments)	Frequency of measurements	Responsibilities
monitoring plan					
Impact on local agriculture, public health and water resource	Recording and documentation of Agriculture production, endemic or health related disseases due to recovery water usage on agriculture	Nearby community and farms connected with recovery water distributions	Sampling collection or survey, recording and documentations	Annualy	MoA in coordination with MoH

6.6 Monitoring Plan

6.6.1 Groundwater Monitoring Plan

A comprehensive groundwater monitoring plan is prepared to maximize the expected positive impacts on the groundwater and monitor these impacts with adequate frequency. The plan is prepared to safeguard against unexpected delays during construction of the wastewater treatment plant and the recovery scheme. EIA, 2006 study proposed a groundwater monitoring plan consisting of 5 monitoring wells surrounding the infiltration basin (later .

After the operation of the infiltration basin using partially treated wastewater, an extension of the monitoring plan is required to be compatible with location of the recovery wells. The design report of the recovery scheme included a proposed monitoring plan. In the current section, this monitoring plan was assessed according to the updated groundwater modeling presented in previous sections. The types of data needed are usually defined by regulation; for other types of monitoring programs, the types of data needed are typically based on site-specific considerations.

6.6.1.1 Monitoring Wells Locations

Locating the appropriate monitoring point locations is essential in designing a monitoring network capable of providing data of adequate quality to achieve the program objectives. At times, monitoring well locations may be prescribed by the regulations under which the groundwater monitoring program is being developed. For example, some regulations require monitoring locationsto be placed at a designated "point of compliance," which is often at the property boundary or a groundwater discharge location. For other groundwater monitoring programs, the groundwater professional should select monitoring locations that provide the most reliable data needed to detect or assess a groundwater contaminant plume. To verify that the monitoring network can accomplish this goal, target monitoring zones must be selected based on the site hydrogeologic conditions and anticipated contaminant pathways. Figure 8.1 shows the recommended locations of the monitoring wells which wereset up based on the location of the recovery wells.

The overall strategy of the groundwater monitoring program in this project is to evaluate the status of the groundwater quality after infiltration of partially treated and treated wastewater. The monitoring wells are distributed in two rows: the first around 400 to 500 m from the infiltration basin, and the second will be 1100 to 1200 m from the basin.

The first monitoring well row should be located before the first row of recovery wells in the direction infiltration basin, and the second row of the monitoring wells should be located after the second row of the recovery wells, to check the quality of groundwater outside the recovery wells areas. The monitoring network will also use the existing 5 monitoring wells constructed recently by PWA and used to monitor the infiltration basin. In addition, the recovery wells will be part of the monitoring network as shown in Figure 58. Notice that the monitoring network proposed in the design of recovery scheme project was found appropriate.

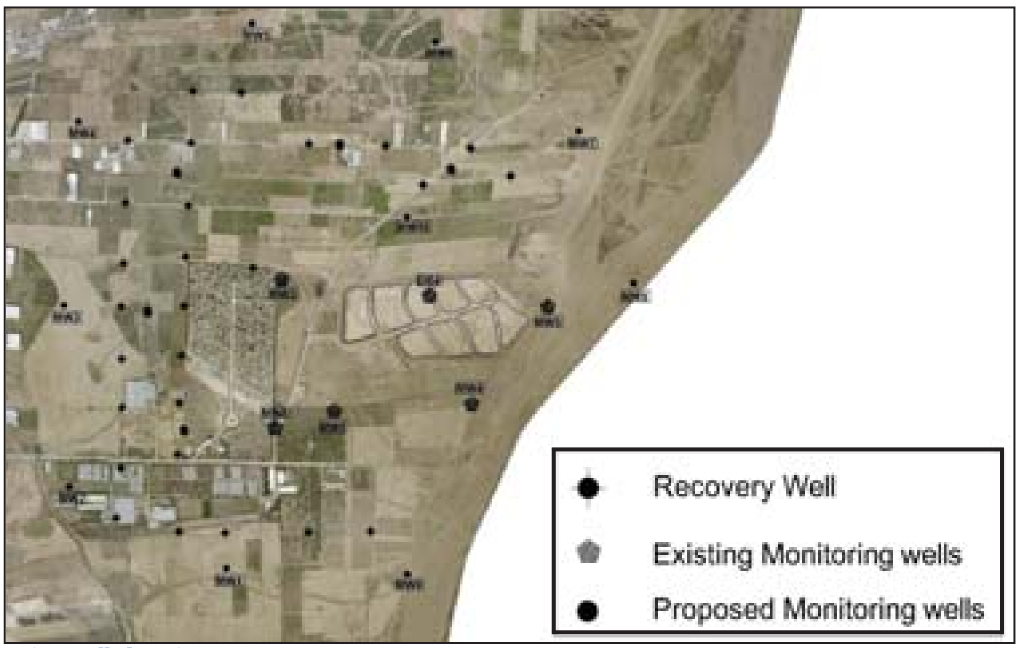


Figure 63: Monitoring wells locations

6.6.1.2 Parameters to be Monitored

After determining the number and location of observation wells, the parameters to be monitored should be specified. The main objective of monitoring is to check the groundwater quality after infiltration and check the operation of the Soil Aquifer Treatment process. The consultant made extensive reviews of similar projects such as the Gosh Dan Project where several parameters are monitored. Among these parameters, the consultant proposed in Table 57 some parameters which could reflect the status of groundwater after infiltration of partially treated wastewater and could be analyzed in Gaza Strip laboratories.

Table 59: Monitored Parameters and Frequency of Monitoring

Parameters	Frequency of Monitoring
Water Level	Monthly
pH	Four Times a year
TDS	Four Times a year
BOD	Four Times a year
COD	Four Times a year
DOC	Four Times a year
TC	Four Times a year
Ammonia as N	Four Times a year
NO3	Four Times a year
T.N	Four Times a year
Cl	Four Times a year
Detergent	Four Times a year
F.C	Four Times a year
Phosphrous	Four Times a year
Heavy Metals	Four Times a year
Mg	Four Times a year

6.6.2 Public Health Related Monitoring Plan for Using Recovery Water (treated wastewater)

6.6.2.1 Objectives

Water quality monitoring plays an important role in water management to protect the environment and human health.

The main objectives of the monitoring program are:

- to assess the quality of water entering the pilot area.
- to quantify the variation in irrigation and drainage water at the pilot area
- to assess the impact of the use of drainage water on crop production (quality & quantity).
- to assess the impact of the use of drainage water on the soil quality

- to provide the decision makers with the information required to propose and implement mitigation measures
- to develop public information and awareness programs on water quality

6.6.2.2 Parameters to be measured

a. Irrigation Water.

All parameters presented in Table 58 should be measured twice a year, during the minimum and maximum river flows in February & August respectively (from the eaisting sampling sites in the pilot area).

Table 60: Proposed Guidelines for Irrigation Water

Parameter	Unit	Proposed Guidelines
Inorganic Elements		
Aluminium	mg/l	5
Arsenic	mg/l	0.1
Cadmium	mg/l	0.01[a]
Cobalt	mg/l	0.05
Chromium *Trivalent chromium (Cr(III))* *Hexavalent chromium (Cr(VI))*	mg/l	 0.05 0.08
Copper	mg/l	0.2 [b] - 1.0[c]
Iron	mg/l	5
Manganese	mg/l	0.2
Nickel	mg/l	0.2
Lead	mg/l	5
Selenium	mg/l	0.02
Zinc	mg/l	1.0 [d] – 5.0[e]
Molybdenum	mg/l	0.01
Conventional Parameters		
Boron	mg/l	3[f]
Fluoride (F)	mg/l	1
Nitrate (NO3)	mg/l	30
Sulphate (SO_4)	mg/l	1000

Chloride	mg/l	100-700[g]
pH	--	6.0-9.0
TDS [h]	mg/l	2000
C.O.D [h]	mgO_2/l	80
B.O.D [h]	mgO_2/l	4 0
Fecal Coliform	(CFU/100ml)	1000
Oil & grease	mg/l	5
Benzene	mg/l	2.5
Organic Compounds		
Benzene	mg/l	2.5
Trichloroacetaldehyde	mg/l	0.5
Propionaldehyde	mg/l	0.5
Phenol	mg/l	2
Atrazine	mg/l	0.01
Dimethoate	mg/l	0.003
Chlorpyrifos	mg/l	0.024

Table 61: Social Management and Monitoring Plan

Impact	**Mitigation measures**	**Responsibility of mitigation**	**Responsibility of direct supervision**	**Means of supervision**	**Estimated Cost of supervision**
During the construction					
Impacts pertaining to workforce	• Conduct a health examination to workers prior to the onset of work • Workers will be oriented and comply with a Code of Conduct governing behavior off-shift and interactions with local communities. • Grievance mechanism to be provided to local residents with a proper communication channels that enabled the community to voice their concerns. • Influx Management Strategy will be developed to coordinate worker accommodation between various construction companies, track the number of non-local workers, and manage issues related to accommodation. Development of the strategy will include further investigation of existing residents and their concerns and vulnerability to change. • Engagement with local communities to understand changes or issues that have developed since the start of construction.	PWA In cooperation with the contractor, Ministry of Health and Ministry of Labor	The PMU in the PWA should work closely with the MoH and MoL	Documentation for all mitigation and relocation	No cost as all activities are part of PWA activities
Workers' Occupational Health and Safety	• Apply a health examination to workers prior to the onset of work	PWA In cooperation with	The PMU in the PWA should work closely with	Documentation for all mitigation and	No cost as all activities are

Impact	Mitigation measures	Responsibility of mitigation	Responsibility of direct supervision	Means of supervision	Estimated Cost of supervision
	• Workers will be oriented and comply with a Code of Conduct governing behavior off-shift and interactions with local communities. • Grievance mechanism to be available to workers with a proper communication channels that enabled the workers to voice their concerns. • Occupational Health and Safety Strategy will be developed to coordinate worker health and safety measures between various construction companies, track the number of workers infected or died, and manage issues related to health conditions. Development of the strategy will include further investigation of existing health and safety measures and workers concerns and vulnerability to change.	the contractor, Ministry of Health and Ministry of Labor	the MoH and MoL	relocation	part of PWA activities
Increased pressure on local services, related to construction workers' use of community services	• The quantity of water supply should be calculated and negotiated with Water Company in order not to affect the local communities • Wells can be dug in the site to work as alternative source of water. Potable water also might be obtained from bottled water companies • Grievance mechanism to be availed	PWA In cooperation with the contractor	The PMU in the PWA should work closely with the contractor	Documentation for all mitigation and relocation	No cost as all activities are part of PWA activities

Impact	Mitigation measures	Responsibility of mitigation	Responsibility of direct supervision	Means of supervision	Estimated Cost of supervision
	to local residents with proper communication channels. This will provide the Project with any concerns or complaints, including potential issues related to utilities shortage. • Ongoing engagement with stakeholders water treatment plant and villages to identify concerns or changes in water availability, and ensure water resources are managed properly. • Engagement with local communities to understand changes or issues that have developed since the start of construction.				
Increase traffic on roads	• Developing of Traffic Management Plan that contains all mitigation measures related to traffic impacts. This plan should explain the limitation and roles of traffic monitoring staff. Also, it should contain all indicators of monitoring that will put limitation to the	PWA In cooperation with the contractor and Traffic Department	The PMU in the PWA should work closely with the contractor	Documentation for all mitigation and relocation	No cost as all activities are part of PWA activities

Impact	Mitigation measures	Responsibility of mitigation	Responsibility of direct supervision	Means of supervision	Estimated Cost of supervision
	unfavorable impacts • Grievance Mechanism to provide road users with a means of contacting the Project with any concerns or complaints, including potential issues related to traffic and road safety. One of the important communication channel to be available in the GRM should be the cell phone of traffic inspector. Any violation of traffic issues will be treated very seriously and appropriate corrective action(s) to be taken as needed. • Engagement with communities, road users, and the villages located around the site to identify concerns regarding road safety and traffic impacts. Signage and outreach activities to improve public awareness of traffic changes and potential hazards will also be targeted for high-risk sections of public roads, including near the site				

Impact	Mitigation measures	Responsibility of mitigation	Responsibility of direct supervision	Means of supervision	Estimated Cost of supervision
	and laydown areas. • Engagement with regulatory authorities regarding traffic management and condition of public roads. •				
Impacts related to land acquisition	• Apply restrict avoidance mechanism in order to reduce resettlement activities to the most necessary ones and avoid small plots of lands • Develop Resettlement Action Plan to be the foundation set for a Resettlement Action Plan • Provide appropriate compensation strategy through the resettlement action plan RAP • Develop and enforce efficient consultation strategy with the community people in order to reach the appropriate compensation that will be based on Laws and the desire of people • Providing compensation to the land owners, tenants, house owners, tenants, Or provision of alternative lands	PWA In cooperation with the municipalities, Awqaf and Land Authority	The PMU in the PWA should work closely with the municipalities, Awqaf and Land Authority to be assured that all PAPs have relocated and mitigated fairly	Documentation for all mitigation and relocation	No cost as all activities are part of PWA activities
During operation					
Workers' Occupational Health and Safety	• Apply a health examination to workers prior to the onset of work • Workers will be oriented and comply with a Code of Conduct governing behavior off-shift	PWA In cooperation with the Ministry of	The PMU in the PWA should work closely with the MoH and MoL	Documentation for all mitigation and relocation	No cost as all activities are part of PWA

Impact	Mitigation measures	Responsibility of mitigation	Responsibility of direct supervision	Means of supervision	Estimated Cost of supervision
	and interactions with local communities. • Grievance mechanism to be available to workers with a proper communication channels that enabled the workers to voice their concerns. • Occupational Health and Safety Strategy will be developed to coordinate worker health and safety measures between various construction companies, track the number of workers infected or died, and manage issues related to health conditions. Development of the strategy will include further investigation of existing health and safety measures and workers concerns and vulnerability to change.	Health and Ministry of Labor			activities

6.7 Social Monitoring Guidelines

It was notable that the main activities that should be monitored are those related to expropriation of lands and valuation of units and lands. Moreover, the grievances should be also highlighted and reported.

This monitoring process necessitates some forms in order to be able to process the management and monitoring system appropriately:

The results of the monitoring and management system should be reported quarterly to the Headquarter of PWA. The monitoring and management will be implemented by the Project Management Unit.

In order to achieve this monitoring system the following personnel are needed. Regarding the compensation committee that is responsible for the valuation of the compensation

The Compensation Committee should be assessed by the governorates during the process of compensation.
In addition to that, a social officer should be hired in order to do the following tasks as part of the monitoring system:

6.8 Required Human Resources and Training

PMU-EM and SDO will be recruited on full time basis for the project. It is recommended to nominate staff from PWA from the existing training staff members from Environmental sector with background of monitoring and laboratory experience, while the SDO is trained with the socio economic with strong background from the involuntary and public awareness campaign.

Other staff needed is the site supervision. For back to back activities, it is recommended to have 2 staff under the supervision. In addition, the site supervision will help in documentation and recording during the project phases.

After completion of construction phase, another staff will needed for follow up operation and maintenance including recording and documentation for effluent recovery system. For the operation of the effluent lake, after completion to remove residual contaminant from the soil, the land will be return back to El Awqaf for future use, and the remaining pond will be similar as the existing set up. Table 62 below summarized rhe training needed for human resource of the effluent recovery system.

Table 62: Institutional Strengthening and Training for Implementation

Institutional Strengthening	Contents	Scheduling	Participants	Cost Estimation ($)	Comments
Tailored training on Environmental Management Plan and Monitoring Plan	Project features, legal aspects, environmental impacts and mitigations, monitoring and evaluation and reporting and documenting (including template and forms)	Before starting the implementation	PMU staff, MCWU staff	20,000 per session	Classroom, field visits and excercises
Environmental Aspects of recovery water distributions and networks	Types and treatment process, international environmental standards, national and regional standards, water quality and quantity objectives, sludge management and distributions	Once before starting the implementation	PWA, CMWU, NGWWTP management, MENA, MoA	25,000 per session	Classroom with field visits and excercises
Environmental Auditing and Inspections	Environmental auditing technique, auditing checklist and environmental reporting	Once before starting the implementation and every two years	PWA (PMU), CMWU, farmer's association (Union for Agriculture and PARC), MENA, MoA and MoH	25,000 per sessions	Classroom
Social	Communication skills, mass communications,	Once before	PWA (PMU),	25,000 per	Classroom with field

assessment, community communications and community survey and inspections	social survey, sampling, analysis and reporting	implementation and once every two years	CMWU, Private organizations, NGO and farmer's associations (Union for Agriculture and PARC)	sessions	visits and exercises.

6.9 ESMP Budget

The ESMP matrices and Monitoring matrices presented include many items that need to be allocated in the final budget of the project. Because the project is basically an environmental project the distinction between the budget for engineering works and environmental safeguard measures is difficult because ultimately the whole project will have clear environmental and social benefits. For distinguishing the ESMP budget from other cost items needed to implement the project, it has been assumed that all the measures included in Tables 55,56, 59 are included in the project budget.

7 STAKEHOLDER ENGAGEMENT ACTIVITIES

Stakeholder engagement chapter aims at highlighting the key consultation and community engagement activities and their outcomes, in addition to outlining the validity and reliability of the collected data.

7.1 Regulatory Context

7.1.1 World Bank requirements for stakeholder engagement and public consultation

The polices pertaining to stakeholder engagement activities according to the World Bank are:

- World Bank Procedure (BP 17.50)
- World Bank Operational Policy (OP 4.01)

7.1.2 IFI requirements for stakeholder engagement and public consultation

PWA has committed to developing the Project in line with international good practice standards and in particular the IFC PS 2012. The specific standard of reference is:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts
- PS1 requires a systematic approach to stakeholder engagement, which considers the views, interests and concerns of stakeholders, particularly those within the AOI . Such an approach is designed to help build and maintain a constructive relationship with Project stakeholders. PS1 also requires the development of a Grievance Mechanism (GM) for the Project, which needs to be disclosed to affected communities and project workers, as appropriate, to ensure there is good understanding of the process.
- PS1 also states that in addition to meeting the requirements of the Performance Standards, 'clients must comply with applicable national law, including those laws implementing host country obligations under international law'.

7.2 Stakeholder Engagement Objectives

The objective of the Stakeholder Engagement is to ensure safe and successful Project delivery by:

- Informing stakeholders, including persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively;

- Listening to their comments, ideas and concerns and recording the same for follow up;
- Communicating and implementing a viable community grievance mechanism.
- Avoiding conflict by addressing impacts and issues raised by stakeholders promptly; particularly with the communities that will not be served by the project
- Ensuring that fears and anxieties about the nature, scale and impact of the operation have been properly considered in the development and management of the Project;
- Accessing and making good use of existing local knowledge of the area;
- Avoiding any misconceptions about the project and properly manage expectations;

Thereafter the results will provide proper documentation of stakeholder feedback and enhance the ESIA accordingly.

7.2.1 Consultation Methodology and Activities

The research team for this study has adopted multi-dimensional consultation activities that enable the marginalized, voiceless, youth and women to gain information about the project. As well, gaining information about their concerns and worries regarding the project during various implementation phases. Due to time constrains a team was mobilized to consult with community people and stakeholders in parallel.

Following are the main consultation activities to date that will be supplemented by additional engagement activities:

- The study team visited the project area in order to define various stakeholders during April 2018
- Meetings were conducted during April 2018 in order to develop an engagement plan that is locally tailored for the residential communities with the study team members
- Based on the identification of stakeholders, various questionnaires and guidelines were prepared in order to engage: i) the residents in the project areas, ii) Governmental municipalities , iii) the CBOs, iv) health facility, v) Ministry of Endowment and Ministry of Agriculture ,vi)the EQA
- The study team divided various engagement activities of the project to:
    a) Screening
    b) Scoping phase and data collection phase and,

c) Public consultation phase.

d) Final report disclosure

Figure 64: Stakeholder engagement process and objectives

- All activities conducted were documented with photos and lists of participants in order to warrantee appropriate level of transparency.

7.3 Strengths and Limitation of consultation

7.3.1 Strengths of the consultation

1) Local mobilizers were recruited from Gaza Strip in order to facilitate conducting consultation meetings and collecting primary data
2) The local mobilizes proposed the main stakeholders that will play role or have interest in the project based on a list of potential stakeholders provided by the consultant
3) They managed to facilitate various meetings conducted with the governmental and non-governmental entities in their premises

4) Prior to each consultation event, the local mobilizers exert remarkable effort to invite the community people. Through the distribution of flyers, posters and meeting with the local authorities
5) The CBO recruited managed to facilitate any permissions required to meet with any of stakeholders

7.3.2 Limitation of the consultation

1) Consultation activities did not manage to meet with All PAPs who will lose their wells, lands…etc
2) Concerns raised about the cost of water and the detailed of project implementation were not responded to due to the absence of information

7.4 Project Stakeholders

The objectives of stakeholder identification include: a) establishing which organisations and individuals may be directly or indirectly affected (positively and negatively), or have an interest in the Project; and b) understanding their needs and expectations for engagement.
Stakeholder analysis enables engagement to be tailored appropriately to the needs and interests of different stakeholder groups to ensure their views and concerns are addressed in a suitable manner.
A systematic approach has been adopted to identify Project stakeholder which has included:

- defining the Project's AOI which basically covers Jabalia, Um El Nasr, Beit Hanoun and Beit Lahia;
- scoping and identifying stakeholder group that could be affected (directly or indirectly) by the Project, or have an interest in it;
- identifying vulnerable groups; and
- review AOI , stakeholders and vulnerable groups during each SEP update and, if necessary, revise based on current Project context.

In order to ensure that the engagement process is inclusive, individuals and groups who may find it more difficult to participate and those who may be 'directly and differentially or disproportionately affected by the Project, or disadvantaged in sharing development benefits and opportunities, because of their vulnerable status' were identified. It will be important for the Project to ensure specific steps are taken to access these groups and afford them the opportunity to engage in discussion about the Project and their interactions with it.

Table 49 Vulnerable Groups

Vulnerable Group	Description and Relationship to the Project
Women and Female-headed households, and low-income women	Women and female-headed households, widows and divorcees tend not to have the same access to income generation. They have often not received as much education as their male counterparts and it is not customary for women to work outside the home, therefore will not have the same opportunities for employment by the Project. Female-headed households and women with limited access to income generation. They have often not received as much education as their male counterparts and it is not customary for women to work outside the home; therefore will not have the same opportunities for employment by the Project. Additionally, they are likely to have reduced opportunities for participation in public engagement (or other public activities) and potentially less access to information.
People with	People with disabilities or chronic diseases often have a lower ability to gain employment and

disabilities or chronic diseases	generate income. The physically disabled are likely to be particularly vulnerable members of the community as they tend to need more support and often rely on family care.
Elderly (men and women)	Elderly (men and women) are likely to have a more limited ability to work; there may be challenges for them to gain employment with the Project.

The following table summarizes various stakeholders who have interest/influence of the project or might be affected by project activities.

Table 50: Description of Project Stakeholders

Stakeholder Category	Stakeholder Group	Potential Implications for Stakeholder Groups
Communities in the Area of Influence (AOI	Residents of rural communities within the AoI including, but not limited to: • Jabalia residents • Beit Lahia residents • Um El Nasr • Beit Hanoun	Residents of these communities are more likely to be adversely affected by environmental and social impacts; for example noise and traffic during construction and other impacts relating to health, safety and security. Residents of local communities will also potentially benefit from job opportunities or other positive economic outcomes. They will have interest and will be impacted by project activities
	Vulnerable groups within the local communities	Vulnerable groups may be likely to be adversely affected by environmental and social impacts, while also being least likely to benefit from the Project. They will have interest and will be impacted by project activities
	Village family heads and influential, trusted leaders	As residents of the local communities, family heads are likely to be impacted by any social and environmental risks and impacts (positive and negative). Family heads are leaders in the community, representing the local families and often taking a key role in dispute resolution. They will have interest and will be impacted by project activities
	Small business owners	Local businesses have the potential to benefit economically from the Project. However, as local residents this group also have the potential to be impacted by any social and environmental risks and

		impacts (positive and/or negative). They will have interest and will be positively impacted by project activities
Businesses /Industry	All businesses/industries	Other industries/businesses (e.g., food stalls) will have the potential to benefit economically (directly or indirectly) from the Project, particularly during construction. They will have interest and will be positively impacted by project activities
Project Workforce (both direct and through subcontractors)	Project workers	The workforce is integral to the Project and a sound worker-management relationship is key for the sustainability of a company. Failure to establish and foster a sound worker-management relationship can undermine worker commitment and retention, and can jeopardize a project. They will have interest and will be positively impacted by project activities
Property owners of workforce accommodation	Property owners	The Project workforce is being accommodated in distinct properties, many of which are located in New Beni Suef. The Project will establish and maintain a database of property owners and, as needed, can engage with these stakeholders to understand any potential impacts posed by the Project workforce. They will have interest and will be positively impacted by project activities
Health care providers	Local health care providers	The Project will need to establish procedures to minimize the risk of exacerbation of community exposure to health issues, as a result of worker influx. They will have interest and will be positively impacted by project activities and they might be concerned about the project
NGOs and civil society	Community Development Associations in Jabalia, Beit Lahia and Om El Nasr	The Community Development Association in Jabalia, Beit Lahia and Um El Nasr is active in the AOI and a good partner and source of local knowledge. They will have interest and will be positively impacted by project activities
National government	Environmental Quality Agency (EQA)	The EQA has overall responsibility for permitting and the EA process.

stakeholders		They have interest in the project
	Palestinian Water Authority	They are the project owner
	Coastal Municipality Water Utility (CMWU)	They are responsible for providing the Gaza Strip' residents with integrated, distinct, and environmentally safe water and sanitation services through the optimal utilization of available resources and creative solutions. They will cooperate with the PWA in managing and operating the project
	Ministry of Agriculture / Agricultural Directorate	This Ministry is involved in crop valuation and irrigation scheme cost They have interest in the project
	Traffic department http://www.garblt.gov.eg/	Responsible for permitting related to any road work for the Project (e.g., road cutting). They have interest in the project
Local/provincial government stakeholders	Municipalities in Gaza, Jabalia, Beit Lahia	They will be responsible for provision of lands and other facilities to the project. They will participate in the operation phase They will have interest and will be positively impacted by project activities
Civil society organization	Palestinian non-governmental NGOs' network	They will be responsible for raising farmers awareness about irrigation water They will have interest and will be positively impacted by project activities
	Water Users Association	They will be the direct beneficiary of the project and will participate actively in project implementation procedures

7.5 Summary of Key consultation activities conducted to date (May 2018)

The key consultation activities during the course of the project could be divided into the following:

Table 51: Summary of consultation activities conducted to date

No	Stakeholder	Date	Meeting objectives	Meeting outcome
1.	PWA	8th of April 2018	• A preliminary meeting to introduce the study objective and update the data required in the inception phase	• PWA shared information about issues related to: a. Updating project information b. Challenges c. Land required d. Mitigation of unfavorable impacts

2.	the Ministry of Endowment representative	10th of April 2018	• To inform the participant about the project • To define any land needed by the project	• The ministryof endownment did not show any interest in this phase as they will not be affected.
3.	Jabalia municipality	10th of April 2018	• Sharing information about the project rehabilitation activities • Collect information about their perception of the project • Awareness strategies and community participation • Capacity building of the municipality to monitor project activities	• The project positive impacts pertaining to environmental aspects • Potential measures required to put limitation of the adverse impacts
4.	Beit Hanoun municipality	11th of April 2018	• Sharing information about the project rehabilitation activities • Collect information about their perception of the project • Awareness strategies and community participation • Capacity building of the municipality to monitor project activities	• The project positive impacts pertaining to environmental aspects • Potential measures required to put limitation of the adverse impacts
5.	Gaza municipality	11th of April 2018	• Sharing information about the project rehabilitation activities • Collect information about their perception of the project	• The project positive impacts pertaining to environmental aspects • Potential measures required to put limitation of the adverse impacts
6.	Ministry of Agriculture	11th of April 2018	• Land acquisition related to the project • The price of generated water • Farmers' perception of the reused water • Awareness raising requirement	• Limited reluctance from the farmers was reported • Awareness raising activities are essential • The exact water tariff to be shared with the farmers
7.	Palestinian Land Authority	15th of April 2018	• Land acquisition related to the project procedures and responsibility • Price of lands • Responsibility for compensating wells operators and crops	• Land acquisition procedures to be adopted by the PLA
8.	Ministry of Local Government	16th of April 2018	• Defining the role of MLG • Identify the proposed compensation and responsibility of compensation	• MLG role is limited to expropriation of lands • They review the urban development plans and assure no transections with the project

9.	PWA, the consultant with the PAPs This meeting with sublemented with site visits and additional meetings	22nd of April 2018	• Provide information about the project • Respond to farmers and PAPs concern	• PWA provided the available information to date • PWA and the consultant documented various concerns raised: a. Land required to construct the wells b. Remedial actions c. The need not to terminate the private well until the project is fully and properly functioning d. Reduce water cost
10.	Palestinian non-governmental organizations network	24th of April 2018	• Provide information about the project • Define further engagement with the community • Define the required data to be shared with farmers • Propose awareness raising role in full cooperation with the NGOs	• The required data needed was mainly: a. Information about pricing system b. Required lands c. Compensation for lands

Figure 65: Meeting with El Awqaf

Figure 66: Meeting with Jabalia municipality

Figure 67: Meeting with Beit Hanoun municipality

Figure 68: Meeting with Gaza municipality

Figure 69: Ministry of Agriculture

Figure 70: Palestinian Land Authority

Figure 71: Meeting with the PAPs on the 22nd of April

Figure 72: **Meeting with one of the PAPs**

The above mentioned activities supplemented the activities conducted in 2012. Additionally, a scoping session was prepared and implemented .

7.6 The Scoping consultation event

The scoping meeting was held on the 23rd of April 2018 and was attended by a wide range of stakeholders including various municipalities, academics, NGOs, Palestinian Water Authority, Ministries and consultation firms.

The workshop was organized as per TOR requirements. The workshop took place from 9.30 to 12.40. There were 32 participants 5 of them were females and 4 speakers. The first session was opened by briefing the project components and followed by the environmental and social presentations, the second session was an open discussion.

The speakers were the following:

- E.Rebhi Al-Sheikh, Vice chairman of PWA
- E.Yaser Qishawi, PMU-PWA
- Dr.Tareq Genena, EcoConServ
- Dr.Zeinab Hafez, EcoConServ

Figure 73: The panel

Figure 74: Beit Lahia municipality representative

Figure 75: Ministry of health

Figure 76: Participants

Following is a summary of the main issues raised during the scoping session

7.7.1 Summary of discussion

Issue raised	Comment raised	Response	How it was responded to in the study
Health concerns	Some previous ground water tests show a high level of health related pollutants (ammonia as example), this should be considered. What are the tools that will be used to predict the project impact on ground water, and how to quantify this impact? The pilot project of Gaza municipality of waste water reuse in Sheikh Ajleen area, this can be revised as a case study.	PWA have an integrated sampling program for the plant, the infiltration ponds and groundwater reservoir. Which has been recently updated. The private wells will not be closed, we hope the project will provide the farmers a competitive service to use the recovered water. Certainly, the monitoring plan shall be developed. It may be extended to the crops irrigated by the recovered water. The Land Authority allocated the land of 14 wells from private lands. The compensation issue will be covered by this study.	To be added in the mitigation section
Institutional set-up	The project should focus on the importance of the institutional framework as it is the basis for the operation and success of this project. He explained that the	One of the outputs of the study is the environmental management plan, which assign who will do what. I suggest to	To be added in the institutional section

Issue raised	Comment raised	Response	How it was responded to in the study
	Palestinian legislation classifies this water as groundwater because it mixes with groundwater after its infiltration.	form an institutional body from all the stakeholders to manage, organize, monitor, and operate the project components. This study should result a realistic and applicable procedures	
Monitoring requirements	There is a lack of monitoring in all project stages. It's recommended to engage the relevant authorities in this progress. He mentioned the Ministry of Health, Agriculture, Environment, and the municipalities.	PWA will develop a detailed monitoring scheme for all project activities including E&S performance	To be added in the monitoring sections
Land acquisition and role of municipality	Municipalities should be involved in the process of land acquisition and compensation to contribute in resolving disputes, if any. The Ministry of Agriculture and other Agricultural Institutions should be involved in the development of the project operation plan. He focus on Developing a clear vision of water pricing and whether there is a cost recovery.	In full compliance with the Palestinian land acquisition regulations, the municipalities will be engaged and consulted in the process of compensation	To be added in the mitigation sections and in the RAP study
Required updated data	There are many updates regarding 2013 data, such as	The study team reviewed the current	Updated data will be presented in the

Issue raised	Comment raised	Response	How it was responded to in the study
	statistics, economic conditions in Gaza, water quality and suitability for agricultural use, farmers' crop pattern. He focused on the use of the nitrate existing in the waste water as soil fertilizer. Which also reduce its treatment cost.	data disclosed on PCBS and obtained updated data from the PWA including the new layout	project description and baseline
Water tariff	How can the social impact be measured without a clear water tariff? Emphasized on the importance of water pricing considering the operational capacity of the project. Modern agriculture should be supported through good pricing and product marketing. Solar energy is a very good proposition because it lowers water prices on farmers. Government support should be provided for this project. All possible emergency cases shall be considered and the study.	The tariff is still being discussed	To be added in stakeholder engagement requirements and concerns
Need to recover all water	The need to recover all the infiltrated water to minimize the negative impact on the groundwater quality.	PWA will exert effort to reuse all water, particularly due to the rigid need for water supply	To be added in stakeholder engagement requirements and concerns
Participation	The absence of community	During scoping phase,	Community people

Issue raised	Comment raised	Response	How it was responded to in the study
of community in the scoping session	institutions from all project activities! We recommend to engage the farmers in the consultative process of the project.	we managed to meet with various community members in their premises. However, the scoping session is allocated for experts who might provide guidance to enrich the ESIA. This is in full compliance with EQA and IFC standards	should be invited in the final consultation section
Termination of private wells	The Private wells within the area of the recovery wells, Will it be closed or merged with system	Few number of private wells will be terminated	To be added in the RAP
Pollutants	Is there any examination of the microbes (ex: hepatocellular virus) pollute the groundwater through infiltration?	PWA developed and will continue measuring various pollutants	To be added to mitigation plan
Management of private wells	How to manage the private wells exist within the project area?	PWA will cooperate with the farmers	To be added in the Stakeholder Engagement Plan
Probability of Israeli incursion	Concern of Israeli incursions into the destruction of irrigation networks.	All projects in Gaza have the same concern	To be added as a risk to the project
Well operators mitigation measures	How well operators will be mitigated?	Well operators have been interviewed and mititgation measures will be proposed in the RAP study	To be added in the RAP and mitigation measures
Points to be added to the	There are clay layers in the saturated zone that have not	To be studied by the environmental expert	

Issue raised	Comment raised	Response	How it was responded to in the study
study	been studied in 2013 and may affect the infiltration process.		
Water usage in case of not used by farmers	Where will this water discharge if it is not used by farmers? I suggest a conveyor line to Wadi Gaza.	There is an emergency plan that proposes the measured to be taken in such case. However, given the shortage of water supply in Gaza Strip, water will be used	To be added in the emergency plan
Time plan	When the remaining components of the project are expected to be completed?	There is no time plan as the fund has not been secured to date	No action
Marketing for produced water	The importance of this water being marketed in a way that attracts the farmer to use it. He emphasized Developing a vision for the project regulatory body	This proposal will be discussed and handled by the PWA	To be added in the SEP

By the end of this session the PWA and ESIA consultant (UG/ ECOCONSERV) made it clear that all comments raised will be fully and proberly addressed

7.7 Stakeholder Engagement Program

The section of the SEP provides details of the engagement to be undertaken during planning, construction and operation of the Project

7.7.1 Communication Methods

Community members indicated that they are comfortable receiving information about the Project via local leaders (family heads), teachers, religious leaders, representatives of civil society organisations, as well as elected members of parliament. They also suggested that a "SDO" should be put in place by the Project. Since this suggestion was received, the Project has hired and put in place the Social team to liaise with the community on a regular basis.

Stakeholder engagement activities are being / planned to be conducted through the following engagement methods:

- Public hearing
- letters and phone calls;
- notice boards;
- distribution of Project Information Documents (PIDs);
- key informant interviews (KIIs);
- focus group discussions (FGDs) with key stakeholders (including vulnerable);
- Comment forms as part of the grievance mechanism

7.7.2 Proposed stakeholder engagement and disclosure activities

Following is a preliminary stakeholder engagement program that will be fine-tuned on quarterly basis during the construction and operation phases:

Table 63: Stakeholders Engagement & Disclosure Activities

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Preparation Phase					
Environmenal and Social Impact Assessment results	o Non technical summary o ESIA final report, RAP and Stakeholder Engagement Plan	Upon completion of the ESIA	PWA	o All stakeholders	o Hard copies to be shared with various stakehokIders, o Upload studies and reports on PWA website
Land required and termination of private wells	o Brief summary about the lands required and potential impacts o Lists of project affected persons (well owners- land owners – well operators) o	Three months prior to any land acquisition	PWA	o PAPs o Municipalities o Ministy of Agriculture o Palestinina Land Authority o Awqaf o Ministry of Local Government	o Face to face meetings o Group meetings o Posters to be disclosed on the billboard
Timeframe	o Time line of project activities	One month prior to construction activities	PWA and the contractor	o Municipalities and local community people	o Provide a time plan to the municipalities
Job opportunities	o List of available opportunities including duration and application details o Monitoring reports; o Health and safety instructions; o Labour rights	1 month prior to beginning of construction	Social Development Officer in PWA and the contractors	o Young people o Workers unions	o List of available opportunities at SDO office o Posters in the municipalities and PWA premises o Advertisement

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Construction of infrastructure	o Construction program and timing o Project progress report upon finalization of construction activities, including environmental and social impacts, health and safety performance, and implementation of the external GRM	Two weeks prior to construction)	SDO On-site engineer Relevant municiplaities	o Area of influence municipalities o Other interested bodies i.e. Ministry of Agriculture	Sharing brief updates on unified project's social media Face-to-face meetings, which could involve the whole community or smaller focus groups. Written updates posted at frequented locations like the local school and mosques;
Training and Capacity Building activities	Sharing capacity building opportunities and necessary requirements with community Monthly update	Once per month	SDO and training centers	o Area of influence municipalities o Other interested bodies i.e. Ministry of Agriculture	List of available capacity building opportunities at SDO office Posters in the municipalities Summary to be shared with target groups (hard copies)

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Health and safety	Safety instructions and warning signs should be placed in a clear and understandable (visual preferred) manner on all relevant locations on site	Prior to construction activities. Ongoing.	On site engineer SDO	o Area of influence municipalities o Other interested bodies i.e. Ministry of Agriculture o Project workers	Safety signs, instructions and emergency plan
Construction Phase					
Job opportunities	o List of available opportunities including duration and application details	3 weeks-1 month prior to beginning of operation	Social Development Officer in PWA and the contractors	o Young people o Workers unions	o List of available opportunities at SDO office o Posters in the municipalities and PWA premises o Advertisement
Traffic	o Schedule of transportation including expected traffic peaks & routs and numbers for grievances o Traffic Management Plan	1 week – 10 days prior to mobilization	Social Development Officer in PWA and the contractors	o Muncipalities o Traffic department and Ministry of Transportation	Schedule on site and at SDO office Schedule at municipalities

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Site construction activities	o Construction program and timing o Annual project progress reports, including environmental and social impacts, health and safety performance, and implementation of the external GRM o Induction training to all workers. o Prior to work a daily briefing to be given to the workers o Regular bulletin disclosed on site; tool box talks; induction information for new workers	Two weeks prior to beginning of construction From beginning of project activities	SDO On-site engineer Relevant Developer	o Area of influence municipalities o Other interested bodies i.e. Ministry of Agriculture, Ministry of Local Government, and Farmers NGOs	Sharing brief updates on unified project's social media Face-to-face meetings, which could involve the whole community or smaller focus groups. Written updates posted at frequented locations like the local school and mosques;
Health and safety	o Safety instructions and warning signs should be placed in a clear and understandable (visual preferred) manner on all relevant locations on site	Prior to beginning of construction activities on site. Ongoing.	On site engineer SDO	Workers	Safety signs, instructions and emergency plan
Operation Phase					

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Operation activities	Update on operational performance, and ongoing communication on key issues, Annual reports Monitoring Plans; Progress of ESMP	Once per month	SDO, on-site engineer, Health and Safety specialist, relevant developer	o Area of influence municipalities o Other interested bodies i.e. Ministry of Agriculture, Ministry of Local Government, and Farmers NGOs	Monthly meeting with community leaders and municipalities
Emergency Plan	Sharing unified emergency procedures/plan including evacuation routes, rally points, emergency signals Contact information for emergency response facilities such as firefighting or first aid equipment	Prior to operation Weekly reminders and monthly drills	SDO, on-site engineer, Health and Safety specialist, relevant developer	o Area of influence municipalities o Other interested bodies i.e. Ministry of Agriculture, Ministry of Local Government, and Farmers NGOs	Emergency plan document shared will all site managers/engineers, health and safety officer

7.7.3 Proposed Grievance and Redress Mechanism

7.8 Proposed Grievance and Redress Mechanism

Grievances are a problematic issue for the majority of developmental projects. Thus, this section should be handled carefully in order to settle any potential disputes that might rise with the hosting communities. This section will cover the following issues:

1) Responsible entity for implementing the grievances' mechanism
2) Grievances tiers that encourage inclusion of marginalized group (women, poor, illiterate and handicapped groups)
3) Grievances channels that are locally tailored
4) Response to grievances procedures
5) The role of locally based organizations
6) Dissemination of the results of the submitted grievances to the community
7) Monitoring of grievances activities

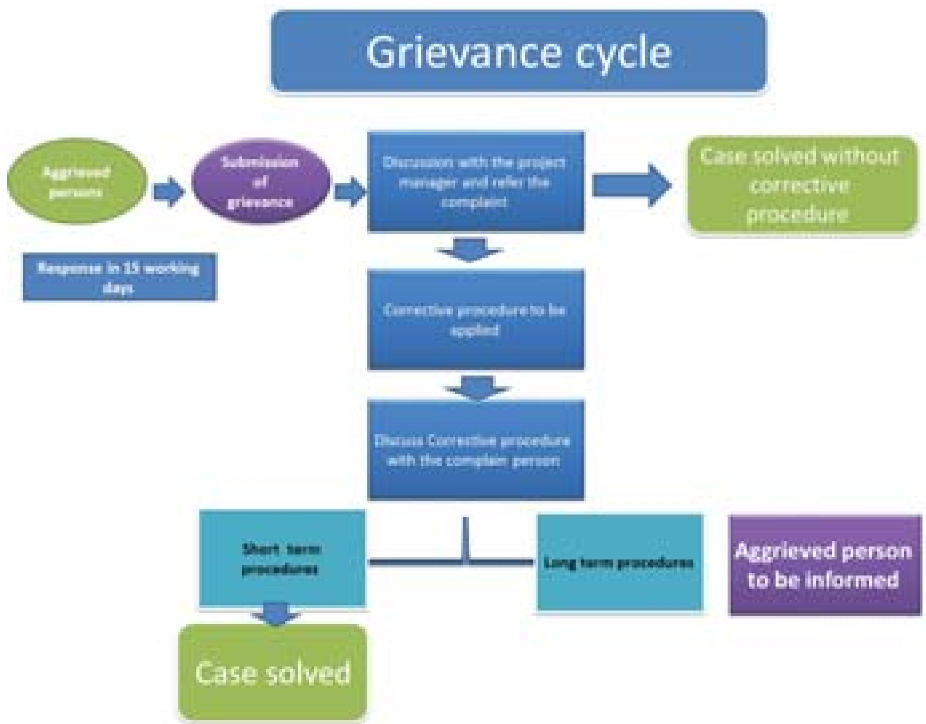


Figure 77: Grievance and Redress Mechanism Cycle

Generally speaking, all grievances received verbally or in written shall be documented in a grievance register, handled by the PMU in PWA. It is of importance to react as quickly as possible to the grievance of the citizens.

A best practice standard is to acknowledge all complaints within 10 days. Due to the different character of the complaints, some of them cannot be resolved immediately. In this case medium or long-term corrective actions are required, which need a formal procedure recommended to be implemented within 30 days:

8) The petitioner has to be informed of the proposed corrective measure.
9) In case if a corrective action is not required, the petitioner has also to be informed accordingly.
10) Implementation of the corrective measure and its follow up has to be communicated to the complainant and recorded in the grievance register

In order to enable the PWA to implement the grievances mechanism appropriately, a Social Development Officer should be hired and integrated in the PMU

7.8.1.1 Institutional Responsibility for the Grievances

Regarding the responsible entity that will handle the grievances, it will be mainly the PMU within the implementing agency (PWA). The Social Development Officer (SDO) working within the PWA in cooperation with the municipalities will address all grievances raised by community people, particularly the ones related to resettlement activities. The main tasks of the SDO are:

1) Raise people awareness about the exact grievances mechanisms
2) Collect the grievances received through different communication channel
3) Document grievances received
4) Direct the grievance to the responsible entities to solve the problem
5) Follow up how the problem was addressed and solved
6) Document, report and disseminate the grievances results
7) Monitoring of grievances activities

- Raising community awareness about the grievance mechanism should be handled as follows: brochures should be developed and sent to the main stakeholders, PAPs, CBOs, municipalities, mosques and churches.
- Documentation of the activities should be handled carefully and thoroughly. A monthly report should be prepared about received grievances, how they were solved and the level of satisfaction of the affected person towards the solution. This report should be published on the website.

7.8.1.2 Grievances tiers

The World Bank's OP 4.12 advances a "first tier grievance management mechanism", which will be a function of the Project, to provide aggrieved people with an avenue for amicable settlement without necessarily pursuing a court case.

The absence of a first tier grievance mechanism in Palestinian law means there are difficulties addressing minor issues that otherwise should be resolved within a short period of time. The absence of such mechanism denies project affected groups the direct channel for grievance and delays resolution of disputes in an appropriate time prior to resettlement. In order to avoid delay in dispute resolution, it is essential for the government to consider adopting the first tier grievance redress mechanism advanced by the Bank OP 4.12. If need arises, aggrieved people would however remain free to open a Court case without having registered their grievance with this first-tier mechanism.

A grievance is an important process that should be tackled carefully. The PWA receives grievances from the petitioners, and any other channels. Based on the site visits, the Project affected persons don't know the appropriate channels through which they can submit their grievances. Thus the following procedures will be applied in order to have a clear grievance's mechanisms:

First tier of grievances:

1) The PWA will assign a Social Development Officer (might be more than one) who will be responsible of receiving all grievances from all different stakeholders.
2) The SDO will inform the community about grievances mechanism, whom to address to solve the complaints, solution for the problems and document all grievances received. Moreover, he will follow up the problem until it is solved. The turnaround time for the response /resolution should be 15 days.

Second tier of grievances:

In case of having unsolved complain, the affected person might follow the second level of grievances:

1) A Grievance Mediation Committee should be formed among the municipalities and other entities. It will be responsible for the discussion of the unsolved complains, propose solutions, as well as, take decision and play a mediation role with the affected persons.
2) A regular meeting should be assigned by the Compensation Committee. The complainants can attend these meetings

7.8.1.3 Grievances channels

Due to the diversity of the socioeconomic characteristics of the PAPs the communication channels to receive grievances were locally tailored to address all affected groups. The following are the main channels through which grievances will be received:

1) Hotline (a mobile number for the SDO to be informed to project affected areas).
2) The second channel is through religious institutes in the area (mosque or church)
3) CBOs will be appropriate channel among rural areas

4) Regular meetings with community people to be conducted and applied by the influence stakeholders
5) Website for educated people who have access to the internet
6) Influence people and Mediation Committee

7.8.1.4 Response to grievances

Response to grievance will be through the following channels

1) The response of the grievance will be through the same channel used to submit the problem. For example, those who sent their grievances in writing should receive their response in written form, those who used the website should receive an email, those who phoned should receive a telephone call from the SDO telling the solution of their problems
2) The second channel is through religious institutes in the area (mosque or church)
3) Response to grievances should be handled in appropriate timing limits in order to give the community people the feeling that their worries are responded to quickly and efficiently, that might put limitation to the problems

7.8.1.5 Monitoring of grievances

All grievances activities should be monitored in order to verify the process. Monitoring will be for the following indicators:

1) Number of received grievances monthly (Channel, gender, age, basic economic status of the complainants should be mentioned)
4) Type of grievance received (according to the topic of the complaint)
5) Number of grievances solved
6) Dissemination activities done
7) Satisfaction with solutions
8) Documentation efficiency
9) Efficiency of response to grievance provided

7.8.1.6 Disclosure of grievances

All grievances activities should be disclosed in the municipalities, CBOs and PWA website. A monthly report should be prepared for the most frequent grievances faced and how they were solved. This report will be disclosed through the PWA website, CBOs, municipalities.

7.8.1.7 Responsibilities for Monitoring and Reporting

Monitoring and documenting activities to be undertaken by the Social Development Officer in the environmental and social unit are described below:

- reviewing and revising, as needed, the list of stakeholders to ensure that the register is accurate and complete;
- monitoring consultation activities conducted with government representatives and local communities;
- monitoring the effectiveness of the engagement process in managing impacts by tracking feedback received during engagement activities;
- reviewing/auditing the implementation of SEP;
- monitoring and responding to grievances received; and
- Reviewing and revising, as needed, the engagement activities programme to determine if additional activities are required.

All engagement activities are being documented by the E&S Team in order to review records and track performance.

The E&S will measure the performance of the SEP by documenting and tracking the indicators outlined in Table 64 below.

Table 64: Proposed Stakeholder Engagement Performance Indicators

Annual review of publically-available Project documents such as PIDs, flyers, website documents and other documents	• Assess whether publically-available Project documents are up-to-date • Assess cultural appropriateness of publically-available Project documents • Assess level distribution documents to ensure they are available to communities in the area of impact	• Date of publically-available Project documents; frequency of distribution • Level of understanding of documents by stakeholders • Level and location of distribution
Quarterly review of consultation activities	• Assess level of engagement with stakeholders through formal and informal means (e.g., meetings with government agencies, FGDs, public meetings; other community engagement) • Track issues raised by stakeholders • Ensure that issues are responded to in a timely manner • Ensure consultation activities include awareness raising about GM	• Number of engagement activities, (including place, time and number of participants involved) • Number and types of comments/feedback received by stakeholders • Number and timing of responses to comments received • Qualitative assessment of awareness of community stakeholders of GM through stakeholder engagement process
Quarterly review of community grievances	• Assess whether grievances are correctly classified • Identify trends in grievances • Ensure grievances are being addressed	• Number grievances by level and type • Number and percentage (%) of grievances closed according to level and type • Timeframes for resolution (and closure) by grievance level and type • Number of repeat grievance from the same stakeholder • Qualitative assessment of awareness of community stakeholders of GM through stakeholder engagement process
Annual review of grievance mechanism	• Assess compliance with the grievance management process • Evaluate progress in achieving GM objectives • Identify improvements and update GM	• Level of compliance with process • Completeness of grievance log • Number of grievances by level and type • Timeframes for resolution (and closure) by grievance level and type • Number and % of grievances closed according to level and type • Number of satisfied responses from complainants by grievance level and type • Number of repeat of a grievance from the same community stakeholder • Qualitative assessment of awareness of community stakeholders of GM through stakeholder engagement process • Qualitative assessment of trust in grievance management process through stakeholder engagement.

7.8.2 Internal Reporting

The SDO will produce quarterly reports for the Unit Manager that summarise the stakeholder engagement activities undertaken during the quarter. The report will include a summary of issues raised by stakeholders and responses from the Project, including any corrective actions or mitigation measure undertaken to address issues.

7.8.3 Public Reporting

The Project will report annually to stakeholders on the outcomes of engagement and grievance management. The public report will be prepared in a manner that is culturally appropriate with supporting documents, as necessary.

The report will include information relating to:

- project activities and timelines;
- summary of engagement activities;
- any changes to the SEP (with rationale);
- summary of grievances.

The public report will be available via the MoT website and copies will be shared with the Ministries and the municipalities.

References

1. Antiquities Law 1966
2. Ayers, R. S., and Westcot, D.W., 1985, Water Quality for Agriculture. Rome, Food and Agriculture Organization of the United Nations (Irrigation and Drainage Paper No. 29, Rev. 1).
3. Baes, C. F. Sharp, R. D., Sjoreen, A.L., Shor. R.W., 1984, A Review and Analysis of Parameter for Assessing Transport of Environmentally Released Radionuclides Though Agriculture. ORNL-5786.
4. Basic Information about Beit Lahia- Wikipedia
5. Basic laws
6. Basic Laws declaration for Palestinian Human Right
7. Baszynski, T., Wajda, L., Krol, M., Wollnska, D., Krupa, Z., and Tukendorf, A., 1980, Photosynthetic Activities of Cadmium treated tomato plants, physiol. Plant., 4:365.
8. Black, J.P., Ford T.E., Mitchell R., 1986, The role of bacterial polymers in metal release into water. In: International Symposium on Biofouled Aquifers: Prevention and Restoration. (Cullimore, R. ed) Bethesda, MD: AWRA, 37-42.
9. Brauch, H.J. 1993, Occurrence and Fate of pesticides in River Rhine, a survey for the period 1986-1991. Wat. Supply. 11, 31.
10. Braude, G., Nash, A., Wolf, W., Carr, R., and Chaney, R., 1980, Cadmium and Lead Content of Soybean Products.J. Food Science, 45: 1187.
11. Buras N., Duek L. and Niv S. (1988). Reactions of Fish to Microorganisms in Wastewater. Appl. Environ. Microbiol. 5o: 989-995.
12. Buras N., Duek L., Niv S., Hepher B. and Sandbank E. (1987). Microbiological Aspects of Fish Grown in Treated Wastewater, Water Research 21 : 1-10.
13. Buras, N. et. al. Reactions of fish to microorganisms in wastewater. Applied and environmental microbiology, 50: 989-995 (1985).
14. Chanmugathas, P- and Bollag: J.M. (1988). A column study of the biological mobilization and speciation of cadmium in soil. Arch. Environ. Contam. Toxicol. 17: 229 – 237
15. Coastal Municipalities Of Water Utility Vision And Objectives, Booklet
16. Coastal Municipalities of Water Utilities Annual Report on Water Status in the Gaza Strip 2010
17. Collet M., 1988, Evaluation des tranferts existant ou potentials de produits phytosanitairies utilize en agriculture vers le milieu marin. Rapport IFREMER, DERO-88-04-EL.
18. Cultural Heritage in Palestine, RIWAQ New Experience and Approach, Nazmi Ju'beh

19. Cunninham, L., Collins, F., and Hutchinson, T., 1975, Physiological and Biochemical Aspects of Cadmium Toxicity in Soybean. Paper presented at Int. Conference on Heavy Metals in the Environment, Toronto.
20. Dabin, P., Marafante, E., Mousny, J., and Myttenaere, C., 1978 Adsorption, Distribution and Binding of Cadmium and Zinc in Irrigated Rice Plants. Plant Soil, 50-329.
21. Department for standards and Metrology (1996). Standards for the use and treatment of sludge in Jordan (JISM 1145/1996).
22. Doran, J.W.; Ellis J.R. and Mc Calla, T.M. (1977). Microbial concerns when wastes are applied to land. Laud as a Waste Management Alternative. R.C. Loehr (ed) Ann Arbor Science, Michigan.
23. Drainage Water Irrigation Project (1997) Environmental Component. Report No. 11 Drainage Research Institute, National Water Research Centre. Ministry of Public Works and Water Resources, Egypt.
24. Edwards P. (1990). Reuse of Human Excreta in Aquaculture: A State-of-the-art review. Draft Report. World Bank, Washington Dc.
25. Environmental Assessment North Gaza Emergency Sewage Treatment Plant Project
26. Environmental Assessment of Gaza Strip, following the escalation of hostilities in December 2008 – January 2009 United Nations Environment Programme
27. EPA 1992. Control of Pathogens and Vector attraction in sewage sludge.
28. European Union, (1999) , Draft proposal for sewage sludge management, XI. E. 3/LM. IAWQ (1996), “A Global Atlas of Wastewater Sludge and Bio-solids Use and Disposal”, Scientific and Technical Report, No. 4.
29. Expropriation Law (Istmlak)
30. FAO. 1985. Water quality for agriculture. R.S. Ayers and D.W. Westcot. FAO Irrigation and Drainage Paper 29, Rev. 1. FAO, Rome. 174 p.
31. Feachem, R.G., Bradley, D.J., Garelick, H, and Mara, D.D., 1983, Sanitation and disease: Health aspects of excreta and wastewater management. Chichester, John Wiley.
32. Federal Remediation Technologies Roundtable, 2007 (www.frtr.gov/matrix2/top_page.html)
33. Ford, T. E., Maki, J.S., Mitchell, R. 1995, Metal-microbe interactions. In; Bioextraction and Biodeterioration of Metals (Gaylarde, C., Videla, H., eds). Cambridge, UK, press.
34. Ford, T. E., Mitchell R., 1992, Microbial transport of toxic metals. In: Environmental Microbiology (Mitchell R., ed). New York: John wiley-Liss; 83-101.
35. Francis A. J., Dodge, C.J., 1990, Anaerobic microbial remobilization of toxic metals co-precipitated with iron oxide. Environ Sci. Technol 24:373-378.
36. George Tchobanoglous, Franklin L. Burton, Wastewater Engineering, Treatment, Disposal and Reuse, Third Edition, McGraw-Hill, Inc.

37. Getzin, L.W., and Rosefield I.C., 1996, Persistence of diazinon and Zinophos in soils J. Econ. Entomal., 59, 512.
38. Goa, health at the front line, Real Health News • the magazine of real action and research • No. 9 • May 2008
39. Haraguchi, K., Kitamura, E., Yamashita, T., and Kodo, A., 1995, Simutaneous determination of trace pesticides in urban precipitation Atmospheric Environ., 29, 247.
40. Health and safety Law 3/2011
41. Health conditions in the occupied Palestinian Territories, including east Jerusalem, and in the occupied Syrian Golan, WHO, SIXTY-FOURTH WORLD HEALTH ASSEMBLY A64/27-Provisional agenda item 15,2011
42. Health conditions in the occupied Palestinian territory, including east Jerusalem, and in the occupied Syrian Golan
43. http://en.wikipedia.org/wiki/History_of_Gaza
44. http://en.wikipedia.org/wiki/Population_pyramid
45. http://en.wikipedia.org/wiki/Water_tariff
46. Human Development Report 2009/10 Investing in Human Security for a Future State-occupied Palestinian territory
47. Institutional And Legal Framework For Wastewater Reuse Of Palestine , Technical Assistance on Wastewater Reuse and Storm water Harvesting, Palestinian Water Authority, Austrian Development Agency, July 2011, Draft
48. Institutional water sector review in Palestine, final report, HYDROSULT INC, (member of Snc-Lavalin Group), Palestinian water authority, phase iii, August 2011
49. Integrated Water Resource Management ii, Feasibility of Wastewater reuse, Report no. 14 June 2010 , Russell Misheloff, IRG Principal, Iwrm ii Project Manager, senior economist
50. Joint Service Council (JSC) Regulations
51. JSC Regulations
52. Kabata-Pendias, A., and H. Pendias, H., 1984, Trace Elements in Soils and Plants. CRC Press.
53. KFW 2005. Sludge and Effluent reuse study for Gaza Central Area, Concept Report Volume I, Dorsch Consult, Gaza.
54. Krone, R.B., 1963, A study of rheologic properties of estuaries sediments. (Hydraulic Engineering Laboratory and Sanitary Engineering Research Laboratory, University of Callifornia, Berkeley).
55. Land Ownership Law 2/1953
56. Law 21Consumer protection laws
57. Living Conditions in Gaza Strip, during and after Israel's military campaign in the winter of 2008/2009

1) Evidence from interviews with 2,000 households, UNFPA, 2009

58. Local Council Law 1/1997
59. Ministry of Environmental protection of Israel 2004. Water Regulations (Usage of Sludge) 5764-2004, (http://old.sviva.gov.il- Accessed August 2012)
60. Morishita T. (1988) . Environmental hazards of sewage and industrial effluents on irrigated farmlands in Japan. Ch. 6, Treatment and use of Sewage Effluent for Irrigation. M.B. Pescod and A. Arar (eds). Butterworths, Severoaks. Kent.
61. National Water Quality and Availability Management (NAWQAM) 1999- Inception Report. Vol. 4. Drainage Water Reuse and Pilot Schemes. Report No. DR-In- 9904-004-FN.
62. National Water Quality and Availability Management (NAWQAM) 2004- Operational Drainage Water Reuse Guidelines. Drainage Water Reuse and Pilot Schemes. Report No. DR-TE-0103-006-DR.
63. North Gaza Emergency Sewage Treatment Plant Project Chapter ThreeEnvironmental Assessment Study – Final Report Assessment of Environmental Impacts and Benefits
64. Northern Gaza Wastewater Treatment Plant report no 3:1, final, detailed evaluation, April 2002
65. Palestine Water Authority, organization and tasks, PWA website
66. Palestinian Environmental Assessment Policy
67. Palestinian Environmental Law .7, 1999
68. Palestinian Human Development Report 2009/10
69. Palestinian Labor Laws 7/2000
70. Palestinian Ministry of Health, Health Annual Report Palestine. Palestinian Health Information Centre, 2010
71. Palestinian Reform and Development Plan PRDP (2008 -2010)
72. Perjac, R.M., 1972 Distribution of Cd, Co, Cu, Fe, Mn, Ni, Pb and Zn in dissolved and particulate solids from two streams in Tennessee Journal of Hydrology 15, 177-186.
73. Pescod, M.B. (1992). Wastewater Treatment and Use in Agriculture. FAO, Rome
74. Pionke, H. B., and Glotfelty, D.E., 1989, Nature and extent of groundwater contamination by pesticides in agricultural watershed. Wat. Res., 23, 1031.
75. PWA 2010. Special report concerning irrigation scheme using the recovery water under the NGEST project, FCG and CEP consultants, Gaza.
76. Roucoux, P., and Dabin, P., 1977, The Effect of Cadmium on the Nitrogen Fixation. Paper presented at Seminar on Carbohydrate and Protein Synthesis, Giessen.
77. Schottler, S.P., Eisenreich, S.J., and Capel, P.D., 1994, Atrazine, alachlor and cyanazine in a large agricultural system. Environ. Sci. Tech., 28, 1079.
78. Sherma, J., 1993, Pesticides Anal. Chem., 65, 40 R-54R.

79. Shuval, H.J., Adin, A., Fattal, B., Rawitz, E., and Yekutiel, P., 1986. Wastewater Irrigation in Developing Countries, World Bank Technical Paper No. 51, Washington, D.C.
80. Sigg L., 1987. Surface Chemical Aspects of the Distribution and Fate of Metal Ions in Lakes. Aquatic Surface chemistry Chemical Processes at the Particle-Water Interface. (Stumm W.) New York, Wiley; 319-349.
81. Socio-economic Assessment of Using Treated Wastewater in Irrigated Agriculture – The Case of Northern Gaza, Dr. Ahmed A. Abu Shaban
82. Socioeconomic Report, January 2011, UNSCO
83. Stamatiadis S, Werner M, Buchanan M (1999). Field assessment of soil quality as affected by compost and fertilizer application in a broccoli field (San Benito County, Califirnia). Appl Soil Ecol. 12:217-225.
84. Standards for the re- use of treated wastewater for irrigation, www.arriyadhenv.com
85. Strauss M. (1985). Pathogen Survival, Part II., Health Aspects of Night soil and Sludge Use in Agriculture and Aquaculture. IRCWD Report No. 04/85. International Reference Centre for Waste Disposal, Dubendorf, Switzerland.
86. Strauss M. and Blumenthal U.J. (1989). Human Waste Use in Agriculture and Aquaculture: Utilization Practices and Health Perspectives. IRCWD Report No. 08/89. International Reference Centre for Waste Disposal, Dubendorf, Switzerland.
87. Strauss, M. Health aspects of night soil and sludge use in agriculture and aquaculture. Part II-pathogen survival. Dubendorf, International Reference Centre for waste Disposal, 1985 (Report No. 04/85).
88. Street, J., Lindsay, W., and Sabey B., 1977, Solubility and Plant Uptake of Cadmium in Soils Amended with Cadmium Sewage Sludge. J. Environ. Qual., 6:72.
89. Technical and Institutional Options for Wastewater Reuse in Palestine, Al MADINA-Consultants, April 2011
90. Technical proposal for the Supplementary Environmental and Social Assessment North Gaza Emergency Treatment Project
91. Technical Report No. 34 (2000). Agricultural Policy Reform Program (APRP)- Water Policy Activity- Contract PCE- I-00-06-00002-00 Task Order 807. Policies and Procedures for Improved Urban Wastewater Discharge and Reuse.
92. Technical Report No. 56 vol. I & II (2000). Monitoring and Analysis of Drainage Water Quality Project-Drain Pollution Sources Study for the Delta & Fayoum. Drainage Research Institute.
93. Technical Report No. 56, Vol. II (2000) DRI. Monitoring and Analysis of Drainage Water Quality Project.
94. Thayer, J. S., Brinckman, F.E., 1982, The biological methylation of metals and metalloids, And Organometallic Chem 20:313-356.

95. The Palestinian Central Bureau of Statistics, (http://www.pcbs.org/populati/est_n1.aspx)
96. Tiffin, L., 1972, Translocation of Micronutrients in Plants. In: Micronutrients in Agriculture. J. Moortvedt, P. Giodano, and W. Lindsay, Eds. Soil Science of America, Madison, Wisconsin.
97. Tisseau, M.A., Fauchon, N., Cavard J., and Vandevelde, T., 1996, Pesticide contamination of water resources : A case study- The rivers in the Paris Region Wat. Sci. Techn., 34, 147.
98. Treated Water Reuse in Agriculture and the Potential Health Impact, A.Gad Allah Aboud, Damascus University. published paper in the Forth Environmental Conference ,Tazz University in Yemen, 14-16 May 2007
99. U.S. Environmental Protection Agency (USEPA), 11989a, 7,1989.
100. Ursula J. Blumenthal, Anne Peasey, Guillermo Ruiz-Palacios & Duncan D. Mara (2000), Guidelines for wastewater reuse in agriculture and aquaculture: recommended revisions based on new research evidence. London School of Hygiene & Tropical Medicine, UKWEDC, Loughborough University, UK
101. Wallach, R., Jury W. A., and Spencer, W.F. (1988), transfer of chemicals from soil solution to surface runoff: A Diffusion-based Soil model Soil Sci. Soc. Amer., 52, 612.
102. Wasim Aktar and Dwaipayan Sengupta ,2008. Sewage Sludge Disposal – Land Application - Environmental Problems – An Overview.
103. West Bank and Gaza Assessment of restrictions on Palestinian Water Sector Development, sector note, World Bank April 2009
104. Wetterhahn K.E., and Hamilton, J.W., 1993, Molecular basis of the hexavalent chromium carcinogenicity: effect on gene expression. Sci Total Environ. 86 : 113-129.
105. Wild SR, Jones KC (1999). Organic contamination in wastewater and sewage sludge: Transfer to the environment following disposal. In: Jones KC(ed), Organic contaminants in the Environment. Elsevier, London.
106. World Bank OP.4. 12 concerning Involuntary Resettlement
107. World Health Organization, 1977, Environmental Health Criteria for Cadmium :Summary, EHE/EHC/77.1 (Geneva, WHO).
108. World Health Organization, 1995, Health Effects relating to Direct and Indirect Reuse of Wastewater for Human Consumption. Report of an International Working Meeting held at Amsterdam. The Netherlands, January 13-16, 1975, WHO Technical Paper No. 7 164 pp.
109. World Health Organization, Technical Report Series No. 516, 1973,-Reuse of Effluents: methods of wastewater treatment and health safeguards. Report of a WHO Meeting of Experts.
110. World Health Organization, Technical Report Series No. 778m 1989. Health guidelines for the use of Wastewater in Agriculture and Aquaculture.

111.World Health Organization,(1981),The risk to Health of Microbes in Sewage Sludge Applied to Land. EURO Reports and Studies No.54. Regional Office for Europe, WHO, Copenhagen.
112.Xue H-B, Stumm W, Sigg L., 1988, The Binding of Heavy Metals to Algal Surfaces. Wat. Res. 22:917-926.
113.Zagore-Koncan, J., 1996, Effect of Atrazine and Alachlor on Self-purification Processes in Receiving Streams. Wat. Sci., Tech. 33, 181-187.

Web sites
http://en.wikipedia.org/wiki/History_of_Gaza
http://en.wikipedia.org/wiki/Population_pyramid
http://en.wikipedia.org/wiki/Water_tariff
The North Gaza Emergency Sewage Treatment project, World Bank website

Annex 1: Comparisons of quality standards for the Reuse of Water in Irrigation in Jordan, Israel, Palestine and FAO

Policy, Legal and Institutional Framework

This annex includes a summary of the laws, regulations and institutional setup relevant to environmental and social management in the Gaza Strip, with particular focus on water reuse and social rights. National and international guidelines for environmental assessment, treatment plants and technical design requirements were reviewed and key points are presented. . A review of the most pertinent regulations and standards governing health and safety has been included. In addition, analysis for the gaps between Palestinian Laws and International Laws were presented in order to develop some mechanisms to fill in the gaps. The section also includes a review of environmental quality standards for ambient air, drinking water, and limited values for liquid and gaseous emissions.

1. Palestinian Legal Framework

Palestinian Legal Framework includes the laws, regulations and guidelines related to thepreparation of the project (EIA), the standard for ambient air, water quality forgroundwater and drinking water as well as the sludge reuse (is not yet endorsed). TheConsultant reviewed the available laws, regulations and guidelines ensure that theprocedure for the implementation process is done according to the relevant laws appliedin Gaza Strip. In addition, the Consultant, based on the task assigned for each authorityrelated to the water, sludge and water collection and distribution identified the relevantauthority to implement the project components, both during construction and operationphase.

Concerning the land acquisition, the Consultant reviewed the relevant laws related to theland ownership, compensation and the involuntary resettlement applied in Gaza Strip.

Based on the available laws, the Consultant compared it with the International guidelines (in this regard the WB Operational Procedure concerning the involuntary resettlement asthe project is financed by the WB).

As to the Palestinian Environmental Assessment Policy (PEAP), the EIA is a perquisitefor the approval of any project in Palestine. The EIA is the project document informingthe relevant permitting authorities and the Environmental Quality Authority (EQA) thata project is being considered. It is the document used by the EQA to screen the projectfor its disposition under the EA Policy, and to consider permitting conditions. The EIAshould list what environmental and other permits must be obtained and complied, itindicates how the expected conditions of these permits will be fulfilled, and it includes asigned statement by the proponent that these conditions will be fulfilled. Each project is subject to a screening process in which the level of requiredEnvironmental Assessment (EA) is determined. The list of the projects that require a fulldetailed EA includes WWTP and its processes. In this study, as the recovery waterresulted from partially treated wastewater, decommissioning of WWTP and remediationof effluent lake is a part of WWTP management, therefore the project "NGESTP,

Effluent Recovery and Reuse System and Remediation works" will require an EIA. In order to determine what environmental and social issues should be covered by anEIA, a scoping process is done in which the stakeholders and impacted entities and localsare invited. The scoping sessions are then to address the project and get feedback on theconcerns and subjects to be addressed. The EQA issues the Terms of References (ToR) based on the scoping and the experiences gained. Nevertheless, scoping is essential as itwill inform about the project and enhance the acceptance and the understanding of theenvironmental and social impacts. The Palestinian Ministerial Council approves the Palestinian Environmental AssessmentPolicy, through resolution No: 27-23/4/2000.

This Policy shall be interpreted andimplemented to support the sustainable economic and social development of thePalestinian people through assisting in meeting the following goals:

- Ensuring an adequate standard of life in all its aspects, and not negatively affecting the basic needs, and the social, cultural and historical values of people as a result of development activities.
- Preserving the capacity of the natural environment to self-clean and sustain.
- Conserving biodiversity, landscapes and the sustainable use of natural resources.
- Avoiding irreversible environmental damage, and minimizing reversible environmental damage, from development activities.

There are three types of EA documents that represent sequential stages in the project lifecycle and the EA review process. These are Application for Environmental Approval, Initial Environmental Evaluation (IEE), and Environmental Impact Assessment (EIA). The EQA shall provide guidance on the content and preparation of the EA reports. TheInitial Environmental Evaluation (IEE) is for projects where significant environmentalimpacts are uncertain, or where compliance with environmental regulations must beensured; whereas An Environmental Impact Assessment (EIA) is required for projects, which are likely to have significant environmental impacts. An EIA may be carried out asa result of an IEE.

A determination of whether or not IEE or EIA must be conducted is based on ascreening criterion. The screening process will be based on requirements of relevant landuse plans, and on whether the project is likely to:

- Use a natural resource in a way that pre-empts other uses of that resource,
- Displace people or communities,
- Be located in or near environmentally sensitive areas such as natural reserves, wetlands, or registered archeological and cultural sites,
- Generate unacceptable levels of environmental impact,
- Create a state of public concern, or
- Require further, related development activities that may cause significantenvironmental impacts.

Based on the Application for Environmental Approval, screening criteria are used todetermine whether an Initial Environmental Evaluation or an Environmental ImpactAssessment is required for a project. An EIA shall be conducted for the different typesof major development projects. Among which are Wastewater treatment plants includingmain sewers. Without limiting its content, an Environmental Approval may specify:

- Required measures to mitigate adverse environmental impacts or capture potential environmental benefits, including a compliance schedule,
- Measures that the proponent must implement in order to comply with relevant standards and requirements; and
- Monitoring and reporting duties of the proponent.

The following is a summary of the laws and regulations reviewed by the Consultant inthe course of conducting the ESIA:

Table 1 Summary of the reviewed Palestinian Laws

Name of Law	Law Summary	Year
Environmental laws and regulations		

Name of Law	Law Summary	Year
Law 7/1999	This basic enactment of the Palestinian Legislative creates a framework for the protection of the environment, public health and biodiversity in Palestine including marine areas. Its 82 sections are divided into 5 Titles: Definitions and general provisions (I); Environmental protection (II); Environmental impact assessment, licensing, inspection and administrative procedure (III); Penalties (IV); Final provisions (V). Article 1 contains an extensive list of definitions, including "natural reserves	1999
Law 3/2002	Palestinian Water Law	2002
	Regulations for Groundwater Pollution Control	
	Guidelines for Wastewater Reuse in the Gaza Strip, Palestine	2002
	Water Pollution Control System	
Decree Law No.14 of 2014 relating to the Water Law	This Law, consisting of 68 articles divided in twelve Chapters, aims at a better water management and development of Palestinian water resources, through establishing for a new phase for the water and wastewater sector, its governance and management. It states that the Water Authority will be under the responsibility of the Cabinet, splitting policy from regulatory functions, which was previously carried out by Palestinian Water Authority (PWA) since its establishment	
Decree No. 90/1995	Regarding The establishment of Palestinian Water Authority (PWA)	1995
Decree No. 6/2002	The Environment Quality Authority was established by Presidential decree No 6/2002	2002
TS 34/2012	The Palestinian Treated Wastewater Standard (Technical Specification)	2012
Solid Waste regulations	Solid Waste Management Regulations	2004
Social laws and regulations		
Law 7/2000	Palestinian Labor Laws 7/2000	2000
	Health and safety	
Law 3/2011	Land Ownership	2011
Law 2/1953	Expropriation Law (Istmlak)	1953
Antiquities Law 1966	Palestinian Antiquities Law	1966
Basic laws	Basic Laws declaration for Palestinian Human Right	2003
Law 21	Consumer protection laws	2005
Other laws and regulations		
JSC Regulations	Joint Service Council (JSC) Regulations	2006
PRDP	Palestinian Reform and Development Plan (2008 -2010)	2008-2010

Name of Law	Law Summary	Year
Law 1/1997	Local Council Law	1997

1.1 Palestinian Environmental law 7, 1999

The Environmental Law of Palestine (PEL) includes a framework for environmentalprotection including reused treated water and sets roles and responsibilities for the EQAas follows:

- Chapter 1 (Article 4): To promote environmental awareness in schools, universities and clubs and encourages volunteer work aiming to protect the environment
- Chapter 1 (Article 5): To ensure the right of every individual to live in a sound and clean environment and stress on resource conservation and sustainable development including the protection of water resources, soil quality, flora and fauna
- Chapter 1 (Article 6)The different entities should cooperate with the EQA regarding the policy of land use in order to protect the natural resources that have particular nature and preserve environment and ensures the protection of natural resources and areas with special habitats
- Chapter 1(Articles 11 to 13) To ensure a safe disposal of hazardous wastes and to prohibit the import of such waste to Palestine
- Chapter 1 (Article 14): the EQA is responsible, with other entities, for addressing the environmental conditions for manufacturing, distributing, and storage of the pesticides, chemical fertilizers that might be hazardous to the environment
- Chapter 2 (Article 20): The owner of the project is responsible for health and safety of all workers against any type of pollutants inside the working environment
- Chapter 3 (Articles 28): The EQA addresses with other ministries the quality of accepted potable water.
- Chapter 3 (Articles 29): It is the responsibility of EQA to address the standards of water collection, treatment and disposing in environmentally sound way that preserve the environment
- Chapter 3 (Article 30): To prohibit the discharge of any solid or liquid or other substance unless conforming to the regulations.
- Chapter 3 Environmental Impact Assessment (Articles from 45-57): that includes some subsections regarding EIA requirements, licenses and inspections (monitoring). Part IV of the law gives the authority to EQA to periodically inspect and to acquire all needed information and collect all necessary samples. EQA has the authority to apply penalties on projects not complying with the laws/regulations.

1.2 Palestinian Water Law 3/2002

The Water Law No. 3 of 2002 has to be considered as the basic legislation for anyactivities related to water sector. This law comprises of all regulations that governwater in the Palestinian territory and Gaza Strip. The following are some of theimportant articles that will regulate the project:

- Chapter 2 (Article 6) According to this law an organization should be established under the auspices of the Palestinian Authority in order to be responsible for water sector and should be named as Water Authority.
- Chapter 2 (Article 7) discusses the responsibility of water authority which is asfollow: 1)assume full responsibility for the management of water resources andsanitation in Palestine.2) the preparation of water policy and public action toimplement them in cooperation and coordination with the concerned authoritiesand submit periodic reports on the water situation for the Council.30 survey ofwater sources and propose various aspects of water allocation and priorities fortheir use.4) the establishment of protection zones of the risk of contaminationand to exercise control and supervision and approval of the transfer of waterbetween geographical areas.5) permit the usage of water resources including theestablishment of public and private wells, organizing and drilling water wells andthe drilling of exploratory and experimental, productivity, and any matters oractivities related to water and sanitation in cooperation and coordination with theconcerned authorities.6) study of water projects, sanitation or supplementing it,and the development of design standards, quality control, technical specificationsand to monitor their application.7) the rehabilitation and development of waterservices to provide water all over the country as a national water facilities anddetermine the responsibilities and functions under the regulation issued by theCabinet for this purpose.8) coordination and cooperation with relevant agenciesto develop plans and programs for regulating water use and prevent waste andrationalizing consumption and awareness-raising campaigns in this area.9)supervision of the profession of well drilling and rehabilitation contractors in thestablishment of water facilities in accordance with procedures prescribed by law.10) developing plans and programs for the training of technical personnel working in the field of water for the development of water resources management and supervision of the implementation and development.11) work towards equitable distribution and optimum utilization of water resources to ensure the sustainability of groundwater and surface and in cooperation and coordination with the relevant authorities and to find solutions and appropriate alternatives in case of emergency.12) regulation and supervision of research and studies related to water and sanitation and follow-up with the specialized and relevant.13) rehabilitation centers, research, studies and training working in the field of water in accordance with procedures specified by the regulation .14) participate in the development of the approved specifications of the quality of water to various aspects of their use with the competent authorities and mainstream application.15) work on the development and coordination of technical cooperation programs of international, regional and bilateral cooperation in the field of water resources and the holding of conferences, seminars and representation of Palestine in the regional and international meetings in this area.16) the preparation of draft laws, regulations and instructions relating to water resources, implementation and provision oftechnical opinion in disputes concerning the sources of water.17) Any other tasks entrusted to them under the provisions of laws and regulations in force.
- Chapter 5 (Article 18-20) discussed the licenses and tariff mechanisms
- Chapter 7 (Articles 25-27) that discusses the water utilities roles and responsibilities, which can be summarized as follow: A25) a regional water facilities shall be established at the behest of local authorities and water users associations to provide water services, sanitation and define its functions and powers, composition and management, and resolution of financial resources and all matters relating to its work under a regulation issued for this purpose. A26) Facilities and regional associations of water users determine the price

of water for different queries according to the tariff system headquarters.A27) Authority may contract with regional facilities for the operation of alternative water systems. A 28) the power of supervision and control of regional facilities and water users associations in cooperation and coordination with the relevant authorities and to take all necessary actions right inconsistent with the provisions of this Act or the regulations or instructions issued there. the Council, upon the recommendation, of the relevant authorities decides that the decision to stop or cause the dissolution of the management services of any of the facilities or regional associations of water users and this decision be appealed to the competent court

- Chapter 8 (Articles 29-32) environmental protection for the water sources. However, the most crucial item is article 30 that indicated: The Authority is able to issue a decision to stop production or supply of water if they determine that pollution source, the supply system and has a closed source system, or if the pollution and shall notify the competent authorities that, and get rid of pollutants.
- Chapter 9 (Article 33-35) related to inspection and monitoring for water quality

1.3 Regulations for Groundwater Pollution Control

The Water Law No. 3 of 2002 has to be considered as the basic legislation for these Regulations. In addition, the Environmental Law No. 7 of 1999 prescribes development of relevant regulations and standards, contributes to clarification of the division of roles and responsibilities between different relevant authorities within this field, and constitutes also a part of the legal basis for these Regulations.

PWA has in its mandate set out in Article 7.4 of the Water Law No. 3 of 2002 the task to create reservation areas for protection from the danger of pollution, exercising oversight and supervision over such areas, and approval of transfer of water between the different geographic areas. Article 31 of the Water Law No. 3 of 2002 states that any area contains groundwater is considered a protected area if the quality or quantity is in danger.

These Regulations aim to regulate groundwater pollution control to prevent contamination of groundwater, or restore polluted groundwater, to obtain an acceptable water quality in accordance with prevailing standards. In addition, these Regulations aim to contribute to a sustainable integrated water resources management in the Palestinian Territories to the best for the society as a whole.

Following are the main regulations:

- Chapter Two: Prevention of pollution of groundwater discusses in four articles (5-8) the regulations related to prevention of pollution

  Article 5 declared that “The Authority shall, to as large extent reasonable in relation to its capacity and need for prioritising, determine a well head protection area applying to the entire surface and subsurface area surrounding a well or a well field, supplying a public or private water system, through which contaminants are likely to reach such a well or well field after a period varying from at least 50 days to up most 10 years.”

  Article 6 (Zoning) “The Authority shall divide a well head protection area into three different zones, taking into consideration the ToT and associated need for protection against pollution. The zoning shall be related to the following criteria:

  a. Zone I: 50 days ToT or 50 meters radius, whichever indicates the largest area;
  b. Zone II: 2 years ToT; and
  c. Zone III: 10 years ToT.

The criteria described under subsection (1) are indicative. Based on all relevant factors and the extent of available information, the Authority shall make an individual decision seeking an optimal solution for zoning of each well head protection area.
Article 7 (Restriction of activities): (1) In order to prevent or reduce the risk of pollution of groundwater, EQA shall develop one or more lists of activities which may be restricted within the different zones of a well head protection area. The reason to restrict activities is the connection between those activities and regulated substances. This list, or those lists, shall be incorporated as an annex to these Regulations. (2) The Authority may decide that some activities specified in the annex shall be prohibited within one or more of the zones as described under Article 5. Other specified activities may only provide guidance to the Authorities' decisions to be made in conjunction with licensing. The Authority may differ between existing activities and establishment of new activities of the same type. Article 8 (Regulated substances): EQA shall develop one or more lists of substances applicable in relation to the Authority's considerations of restriction or licensing of activities, discharge, disposal or storage. The involvement of listed substances may make it mandatory for the Authority to reject applications, or the list or those lists, may only give guidance for the Authority's considerations and decisions. Such list, or lists, shall be incorporated as an annex to these Regulations.

- Chapter Three – Licensing and licenses :
  Article 9 License requirements)
  The most important items mentioned under this article are as follow:
  1. No person may execute any activity involving discharge, disposal or storage of substances listed in an annex to these Regulations, or to construct, alternate, own or operate a disposal system, within any zones of a well head protection area, without a licence granted by the Authority. This licence requirement applies to both existing and intended activities.
  2. Subsection (1) does not apply to:
  a) drilling fluids and additives associated with drilling of new wells; and
  b) Application of fertilisers, pesticides or other agriculture chemicals approved for that purpose by EQA or any other empowered authority, and in compliance with prevailing standards regulating such activities in particular.
  3. The Authority may exempt activities regulated under subsection (1) from licensing if the quantity or adverse impacts of the discharge or disposal is considered to be insignificant.
  4. A person who executes an activity regulated under subsection (1) prior to these Regulations becoming effective, shall submit an application for a licence to the Authority within a timeframe from the effective date, to be determined
  by the Authority by a decision applying to groups of prospective licensees, or to individual prospective licensees. The Authority is responsible for notifyin all prospective licensees in a way ensuring them attainment of knowledge about the licensing requirement.
- Chapter Four – Well head protection plans. Article 22 (Well head protection plans)
  1. Each existing or prospective owner of a well with an abstraction capacity larger than [determine volume] or of a well-intended for public water supply, shall fence zone I surrounding their well and all activities shall be prohibited within this zone.
  2. The Authority, in cooperation with EQA and other relevant stakeholders, may prepare well head protection plans for protected areas outside zone I of any well regulated under subsection (1).
- Chapter Five – Reporting, records and inspections Article 23 (Reporting) A licensee shall report to the Authority on its findings of state of activity facilities and volume and contents

of its discharge and disposal obtained by own inspection and monitoring in accordance with Article 14, and specified in its licence conditions. The samples of discharge and disposal shall be analysed only by laboratories approved by the Environment Quality Authority.

- Chapter Seven – Disputes, offences, penalties and appeals Article 26 (An offence) A licensee violating these Regulations, conditions imposed by licences granted under these Regulations, or the Authority's individual decisions made according to those legal instruments, commits an offence and shall be liable to a fine imposed by the Authority.
  Article 28 (Appeals)
  1. All decisions made by the Authority directly affecting rights or duties of nongovernmental parties may be appealed to the Authority within 20 days after the directly affected parties are informed about the decision.
  2. Other parties than the appellant also directly affected by the decision, shall receive a copy of the appeal and from the Authority and be requested to lodge their representations within 20 days of receipt of the appeal.
  3. Based on all available information, the grounds set out in the appeal and received representations; the Authority shall make a final decision.
  4. The Authority's final decision may be appealed to the Court.

1.4 Guidelines for Wastewater Reuse in the Gaza Strip, Palestine

This guideline is for reuse of treated wastewater from housing, municipality, industry and commercial enterprises in the Gaza Strip and to provide information for collection, additional treatment, and storage of treated effluent in such manner that the use of groundwater can be replaced, the aquifer can be enriched and the inflow of saline water into coastal aquifer can be reduced. (Article 1 and 2)

- Chapter I Article 6: Principles of the Water Reuse
  1. Economic and financial principles
     Water is not a usual commercial product but a scarce natural resource which must be protected, defended and treated correspondingly and must be provided as a basic need by supplying safe water to all consumers. One of the important components for wastewater reuse is wastewater tariff charge and the incentives must be given to promote the widespread reuse. In addition, demand and supply management for treated wastewater has to be considered.
  2. Environmental Principles
     Activities related to the reuse of wastewater need to be planned and implemented with due regard for all their environmental implications, including the protection of aquifer from pollution and over exploitation. In addition, the short- and long-term effects of the reuse of wastewater should be monitored so that the improvements can be encouraged and detrimental impacts minimized.
  3. Institutional and management principles
     The role of the responsible authorities and all official bodies at all levels should be clearly defined and the areas of responsibility officially established. The structure and system of the wastewater reuse management should be designed in such a way as to facilitate the involvement by the responsible authorities at different levels with encouragement of private sector involvement. In addition, capacity building for all institutions for treated wastewater reuse has to be envisaged and intermediary bodies such as association, NGP and local councils has to be enhanced.

- Chapter II: Article 7: Technical Principles

1. General Technical Principles
   All wastewater shall be collected, treated and used according to these guidelines to minimize the deficit in the water balance. The treated wastewater reuse should comply with the standards and has to be transported in accordance to the guidelines (closed pipes). Dilution of the wastewater to reach the compliance standard and direct injection to the aquifer without treatment is forbidden. In addition, wastewater treatment operator shall provide information and test results of quality of wastewater or any other information as requested.
2. Technical Principles for Irrigation and Recharge
   Industrial and commercial wastewater is allowed to be used for irrigation and groundwater enrichment, only if the compliance with the standards is durably guaranteed during operation. The use of wastewater for irrigation and ground water enrichment is forbidden in drinking water protection zones. The ground water enrichment by wastewater is only allowed in facilities that are operated with a license from the competent authorities.
   The reuse of wastewater for irrigation is only allowed if it follows the regulations and standards according to the relevant type of cultivation and irrigation technique. The use of sprinklers is not allowed for irrigation.
   All kinds of vegetables are not allowed to be irrigated by treated wastewater. Irrigation with treated wastewater has to be stopped two weeks before harvest. Fruits on the ground from trees that have been irrigated with treated wastewater are forbidden to eat, to process or to sell.

- Chapter III: Competent Authorities and Responsible Areas
  This chapter includes responsibilities of National water council (NWC), Palestinian Water Authority (PWA), The Ministry of Environmental Affairs (MEnA), Ministry of Health (MoH), Ministry of Agriculture (MoA), Coastal Municipal Eater Utility (CMWU) and formation of Committee for the reuse of wastewater (that consisting of representative from NWC, PWA, MEnA, MoH, MoA, Palestine Institute for Standardization and Measurement (PSI), Gaza Municipality, Rafah Municipality, Khanyounis Municipality, Islamic University of Gaza, El Azhar University, and Birzeit University.
  Application and approval for wastewater reuse process is following EA administrative procedure (that describes in the Palestinian Environmental Assessment Policy (See Chapter 2). Licenses and permission is prepared by PWA with coordination with MoA. (Article 9)
  Regarding wastewater reuse, PWA is responsible for technical, financial and operational issues, including compliances (chemical, microbial, samples, groundwater measures, and wells). MEnA is responsible for environmental issues supervision. MoH is responsible for the public health supervision in regards to the consumption of food products that are irrigated by wastewater reuse and employees working on the reuse system. (Article 10)
  Monitoring of groundwater, wastewater quality, soil quality of product and human health is required to ensure proper treatment, avoiding environmental degradation, minimizing adverse health impacts and increasing the agriculture production in a sustainable manner. The monitoring of facilities and operation includes self-monitoring, compliance with regulations of facilities and operations and required control facilities and documentations. In addition, sampling analysis and conservation shall follow Annex 1 of

this guideline (Article 11, 12 and 13)

- Article 8: Competent Authorities and Responsibility Areas

1. National Water Council (NWC)
   NWC is responsible for:
   a) Setting the policy for reuse of wastewater for Palestine and submitting it to the Council of the Palestinian National Authority for approval.
   b) Reinforcing regional and international co-operation in reuse of treated wastewater.

c) Determining the budget required for investment in reuse of wastewater.

2. Palestinian Water Authority (PWA)
   PWA is responsible for:
   The strategic planning for the reuse of treated wastewater, e.g., for setting up the water management plan
   a. Issuing licenses related to the operation of facilities for the groundwater recharge
   b. Giving permission for the use of ground water and irrigation with treated wastewater.
   c. Monitoring the quality and quantity of treated wastewater.
      For the reuse of treated wastewater PWA is working in close cooperation with other stakeholders mainly the Ministry of Environmental Affairs, the Ministry of Health and the Ministry of Agriculture.
   d. Instruct the Coastal Municipal Water Utility with special design tasks.

1.5 Technical Specification (TS) 34 / 2012

This Technical specification divide the quality of treated wastewater into 4 categories, high quality (A), Good quality (B), Moderate quality (C) and Poor quality (D). In addition, this specification regulate that the effluent quality of the treated wastewater for irrigation has to be approved by the Ministry of Irrigation and Ministry of Agriculture to use of the treated wastewater for irrigation in accordance to their standards and specification.

1.6 Solid Waste Management Regulations 2004

Solid Waste Management Regulations (2004)

The Solid Waste Management Regulations, issued by the EQA in 2004, are the first trial to develop regulations that aims to complement the Environmental Law. These include the following key guidelines related to waste collection:

- MSW collection is the responsibility of municipalities and village councils, as well as ensuring that this the process does not have health and/or environmental implications.
- It is prohibited to dispose of waste outside the street containers designated for this purpose. These containers should be closed and manufactured out of a metallic or similar material. The number of these containers should be sufficient and waste has to be collected at least three times per week in urban areas.
- It is the responsibility of industrial, commercial and agricultural waste generators

Key guidelines for landfills included in the regulations

In general, the construction of a waste landfill is subjected to an environmental approval according to the conditions and instructions of Environmental Impact Assessment Policy. The co-mixing of hazardous and non-hazardous wastes is prohibited. And the different cells of the landfill should be classified according to one of the following types:

- Inert landfills;
- Non-hazardous landfills;
- Hazardous landfills.

The landfill operator shall be responsible for the landfill for a period of 20 years following its closure. Additional technical considerations related to the site selection and landfill design include the following:

- The site should be fenced, and located at a considerable distance from residential or commercial areas – no distance has been indicated.
- The landfill site should be lined with a protective insulation layer in order to protect groundwater.
- A leachate collection system should be constructed.
- The site should have sufficient quantity of soil which will be needed for daily covering the waste.
- Regular inspection of the monitoring wells.
- The landfill operator should prepare a waste register.

1.7 National Strategy for Solid Waste Management in the Palestinian Territory, 2010

The National Strategy for Solid Management in the Palestinian Territory was endorsed by the Cabinet in May 2010 and represents the first cross-sectoral strategy for solid waste in Palestine. The strategy aims at establishing the framework to all decisions, programs, activities, and mid-term investment plans to develop the solid waste sector in Palestine. At institutional level, the strategy confirmed the urgent need to address major issues like:

- Ineffective legislative framework
- Lack of standards for various stages of SWM
- No division of tasks and responsibilities among various stakeholders
- Lack of resources (human, financial, organizational capacity) in the instates involving in SWM
- No unified system to manage data related to SWM
- Limited participation of the private sector
- Insufficient public awareness in SWM issues and weakness of participation.

Among the strategy's policies are the following:

Policy (1) Strategic Objective 1: Development and update of the legislative framework supporting integrated SWM

Policy (2) Strategic Objective 1: Strengthen the organizational framework of national institutions and supporting their complementary roles in SWM.

Policy (3) Strategic Objective 2: Establishing an integrated, coordinated, and sustainable institutional approach to support institutional capacity building in the SWM sector.

Policy (4) Strategic Objective 3: Developing the current management systems for SW collection and transport, in order to improve the quality and effectiveness of services and its availability to all citizens
Policy (5) Strategic Objective 3: Safe and efficient disposal of SW in regional sanitary landfills servicing all communities
Policy (6) is concerned with diverting waste from landfills through waste minimization, reuse and recycling. The MoLG shall play a vital role as the key executing party for achieving most of the strategic objectives. This shall be considered in any new institutional set-up for SWM in GS. The municipalities in GS are the main parties responsible for the SWM at all stages including primary collection, secondary collection, and landfill management.
Policy (7) – Strategic Objective 3: Prohibiting the use of random dump sites and closing or rehabilitating the existing sites to limit their environmental and health risks.
Monitoring the implementation of the solid waste management strategy has been assigned to the national team for solid waste management by a Ministerial Council Cabinet Decision in 16 May 2010. This is the steering committee which develops the solid waste management strategy and is chaired by the Minister of Local Government. Policy (14) of the strategy promotes private sector participation in SWM projects

1.8 Palestinian Labor Law 7/2000 and supplementary bylaws

This law governs the whole labor activities and arranges the relation between laborers and employers.

- Chapter 2 Article 34 indicates the importance of applying health and safety procedures
- Chapter 4: health and safety. Article 90 indicates the importance of using protective clothes to rescue the workers from any danger. Health and safety inside work place. Needed medical supplies inside work. Periodical examine for all of the workers.
- Chapter 4 Article 91 discussed the regulations according to which the organization can set its own health and safety procedures and penalties that should be indorsed by the Ministry and disclosed in a visible place
- Chapter 4 Article 92 indicated that the worker should not pay for health and safety arrangement
- Chapter 4 Article 93 banned any employment for the children less than 15 years old.

1.9 Land Ownership Law 3, 2011

Law 3 Year 2011 concerns with land ownership, acquisition and compensations. This law comes to amend Law 2 Year 1953. The law stipulates all the regulations and procedures related to the acquisition of private land for the purpose of public interest projects. It defines the meaning of public interest projects and presents the entitlement requirements including land registries and ownership documents needed to prove the affected person entitlement to compensation. It also regulates the cases where disputes over ownership may occur.

1.10 Land Expropriation Law2/1953

Land expropriation is one of the key issues of relevance to the project. The most important articles related to this law are as follow:

- Article 3: Initiation of the expropriation
  1. the beneficiary should publish an advertisement in the Official Gazette for a period of fifteen days after declaring his intention to precede to the Cabinet a request for expropriation of the land described for Public Benefit
  2. The transactions related to Secretion1 (Ifrath) that takes place after publication of the notice mentioned in paragraph (1) above, shall not affect the right of the government or the municipal council or the local council to expropriate 25% of an area of land before secretion without compensation, which is similar to the provisions of Article (21) of this law.
- Article 4 presents the types of expropriation including: 1) permanent 2) temporarily 3) Not allowing full use of land 4) forcing certain use of land
- Article 5 is related to the disclosure of expropriation activities and inventory for the affected groups
- Article 6 is about the informing of land owners
- Article 8; after the declaration of land expropriation. The land registration officer should ban any action or activities to be applied through putting a reference number. The Ref. No of the land should be attained from Land Authority to stop any action on this land if it is registered
- Article 9 is about the negotiations with the affected persons
- The articles from 10-21 discuss the entitlement of compensation and strategies to pay it. As well, the different cases that enable the affected people to stop the expropriation actions and retain their lands
- Article 22 discussed the taxes needed due to any change of the value of land due to the implementation of the project

1.11 Antiquities Law of 1966

Since the establishment of the Palestinian Ministry of Tourism and Antiquities in 1994, the Ministry, in cooperation with governmental and non-governmental institutions, academics and intellectuals, has drafted its own version of a National Antiquities Law. However, this draft has never been enacted as law, and therefore the Jordanian Antiquities Law of 1966 is still applicable in the Palestinian Territories today.
There is no unified legal regime in the Palestinian Territories. In fact, there are different laws that are applicable in these territories. This is because Palestine was subject to different rulers since the end of nineteenth century. The British Mandate, Jordan, Egypt, and the Israeli Occupation issued large amounts of legislation, some of which is still applicable in the West Bank and the Gaza Strip.[2]
The Palestinian Legislative Council (PLC) that was inaugurated in March 1996 also issued legislation on different fields of life in the Palestinian Territories. However, the different scopes of sovereignty of the Palestinian Authority in the West Bank and the Gaza Strip (areas A, B, and C), the continuing application of the Israeli military orders in area C, the continuation of the Israeli occupation to East Jerusalem and application of the Israeli law

there, and the reoccupation by Israeli troops of the PA areas (since 2002) put serious constraints on the legislative role of the PLC, the role of the judiciary, and the executive role of the PA to enforce this legislation.
The existing legal regime concerning cultural and natural heritage in the Palestinian Territories are the British Mandate Law of Antiquities of 1929 (applicable in Gaza Strip only), the Jordanian Law of Antiquities of1966 (applicable in the West Bank) and the Israeli laws of 1978 in East Jerusalem.
The Palestinian Basic Law of 2003 contained a paragraph of relevance to heritage protection. Under this paragraph, the President swears, "…to be faithful to the homeland and holy places, to the people and its national heritage…" This is currently the only reference to "heritage", and it is limited, in the draft constitution.
Since there is not yet an approved Palestinian constitution, the protection of cultural and natural heritage remains, until today, without a solid constitutional basis. As it stands today the Constitution is in its fourth reading. The major Deficit of the 1966 Law of antiquities is the Definition, which reads:
"Antiquities are any movable or immovable remains or any part of it that was constructed, or formulated, or decorated, or inscribed or built in any form or any addition by a human being before 1700
AD. Antiquities also include human or animal remains prior to the year 600 AD. It also includes any structure built after 1700 AD, which is declared by the Director of the Department of Antiquities to be
ancient antiquities".
The definition clearly excludes any archaeological sites (including historic buildings) and artifacts (movable objects), which postdate 1700 AD. The definition also excludes religious buildings, as well as natural heritage sites. Neither architecture (groups of buildings, monuments) nor movable objects are defined or included as separate categories in these two laws.

1.12 Basic Laws

Within the framework of the provisional period, resulting in the Declaration of Principles Agreement, the establishment of the Palestinian National Authority with its three pillars – the legislative, executive and judicial branches – became among the most urgent of national missions. The establishment of the Palestinian Legislative Council, through free and direct general elections, made the adoption of a Basic Law suitable for the interim period a necessary foundation upon which to organize the mutual relationship between the government and the people.
Title Two – Public Rights and Liberties

- Article 9: Palestinians shall be equal before the law and the judiciary, without distinction based upon race, sex, color, religion, political views or disability.
- Article 10: Basic human rights and liberties shall be protected and respected. The Palestinian National Authority shall work without delay to become a party to regional and international declarations and covenants that protect human
- Article 31: An independent commission for human rights shall be established pursuant to a law that will specify its formation, duties and jurisdiction. The commission shall submit its reports to the President of the National Authority and to the Palestinian Legislative Council.

1.13 Consumer protection law 21/2005

This law discusses intensely the consumer rights which might be trigged during the implementation of the project. The most relevant articles related to the project are as follow:

- Chapter Two: Consumer rights Article (3) The consumer has the following rights: 1 - Maintain his health and safety when using any type of good or service in terms of quality
- Chapter three. Article (4): Formation of the Palestinian Council for consumer protection and consumer protection associations. "Established under the provisions of this law advisory board called "the Palestinian Council for Consumer Protection" and consists of the following entities: - Member of the Ministry of National Economy - Member of the Ministry of Finance. - Member of the Ministry of Health - Member of the Ministry of Agriculture - Member for Environment Authority - Member of the Institution for Standards and Metrology Palestinian - Member of the Chamber of Commerce - Member of the industry associations - Member of the Federation of Contractors - Member of the Business Association - five members of associations of consumer protection
- Chapter three .Article (5): The Council aims at protecting consumer rights and ensures that he is not exposed to any risks or damages resulting from using any types of goods and services provided through the following: 1 - Participation in the formulation of the relationship and coordination between all relevant agencies to protect the consumer. 2 - Support and strengthen the role of consumers in the national economy.
- Chapter four. Product safety Article (9) "Each product that might result any dangerous must be signed by the warning showing the type of risk.
- Chapter four. Article (11). If the provider observed that the good or service that is purchased has a defect or more would be detrimental to the safety of consumer or health or that they may pose a threat to it, for the supplier to take and immediately the following procedures: 1 - to inform the competent authorities and inform the public by the media about these defects and warned of the risks that may result from them. 2 - Item withdrawn from the market. 3 - To recover the goods that were sold or leased and re-paid the price. 4 - Replace the goods at provider's expense and re-paid the price in case they could not fix it. 5 - Get rid of them, in ways that are correct and not harmful to the environment, and at his expense.
- Chapter V. Integrity of the economic transactions, Article (15)
  The promotion should apply advertising of products that takes into account the consensus is to be announced and the reality of the advertised product specifications, and must not imply that declaration to deceive or mislead the consumer

1.14 Joint Service Council (JSC) Regulations, 2006

The JSC regulations were issued by the MoLG in 2006; they set the managerial system and authorities for the JSCs. The work of the JSC shall be organized by the Minister of Local Government in coordination with the councils of concern.

1.15 Palestinian Reform and Development Plan (2008-2010)
The Palestinian Reform and Development Plan 2008 - 2010 (PRDP) is a national plan which sets out Palestinian Authority medium term agenda for Palestinian reform and development. Among the primary objectives set out in the PRDP is "strengthen public institutions" which is of support to "good governance" as one of PA national goals. This is to increase the capacity of the public sector organizations in delivering basic health services which will have a direct positive effect on the daily life of the citizens as has been stated by PRDP. This is also in line with "strengthening the local government" policy and objective set out in PRDP. That is work with local government unit to empower and increase the accountability and effectiveness through intensive capacity building.
The Palestinian National Policy Agenda (PNPA) has conservation and recycling of natural resources including SW as one of its objectives. This is under the "development of physical capital" objective and is stated as "Equitable, efficient and environmentally friendly management of solid waste". The other PNPA objective of developing affordable and regional SWM is listed in the development budget resources. The main two objectives and targets in this regard stated in PRDP are complete construction of a new sanitary landfill in the West Bank and increase number of SW tons disposed of in regional sanitary landfills.

1.16 Local Council Law, 1/ 1997

The local council law issued in 1997 has replaced the old law and is currently the prevailing council law. After perusal of the Municipalities Law No. 29 of 1955 in force in the provinces of the West Bank, and the Municipalities Law No. 1 of 1934 in force in the Gaza Strip, and the Law on Management of villages No. 5 of 1954 applicable in the provinces of the West Bank, and the Law on Management of villages No. 23 of 1944, in force in the Gaza Strip, and the draft law submitted by the Council of Ministers, the Legislative Council after the adoption of the bill, we have issued the following law.
According to the new law, water collection and disposal are the responsibility of local councils, which was clearly stated as follows:

- Provision of potable water and other types of water. Addressing specification of water equipments i.e. pipes and water meter. Arrange for the distribution of water, the tariff and prevention of pollution to the wells, basins and springs
- Planning the town and roads including, road development planning and closing of roads, modification, set the length and width, paving, construction and resurfaced, cleaning, lighting, maintenance, naming or numbering and numbering its buildings, beautification, plantation and monitoring of street conditions.
- Protection measures for safe public health shall also be taken by the council; this includes the implementation of an efficient waste collection system.
  The law provides for municipalities the possibility to form JSCs through which they can join forces and collaborate onto the delivery of municipal services including water tariff. Regulations to give effect to this law were adopted the following year.

1.17 Project Approval Requirements

- Article 45 of the PEL; "The Ministry (EQA), in coordination with the competent agencies, shall set standards to determine which projects and fields shall be subject to the environmental impact assessment studies. It shall also prepare lists of these projects and set the rules and procedures of the environmental impact assessment".

- Article 47 of the PEL states that; "The Ministry (EQA), in coordination with the competent agencies, shall determine the activities and projects that have to obtain an environmental approval before being licensed. This includes the projects that are allowed to be established in the restricted areas".
  According to the PEL and the Palestinian Environmental Assessment Policy (PEAP), was approved through resolution No: 27-23/4/2000, the project proponent must first obtain an initial approval from the appropriate ministry or local planning committee. The proponent then submits an application for environmental approval to the EQA. The EQA notifies the appropriate permitting authorities that an application for environmental approval has been received. The application should also list what environmental and other permits must be obtained and complied with, indicate how the expected conditions of these permits will be fulfilled, and include a signed statement by the proponent that these conditions will be fulfilled.
  An Environmental Approval may specify:
- Required measures to mitigate adverse environmental impacts or capture potential environmental benefits, including a compliance schedule. This may include land compensation measures issued by the Higher Planning Council after reviewing the project. The procedures involve the Ministry of Finance, the MoLG and municipalities of concern.
- Measures that the proponent must implement in order to comply with relevant standards and requirements.
- Monitoring and reporting duties of the proponent.
  The project proponent shall express the commitment to the standards and requirements for the protection of the environment and to apply all the required mitigation measures addressed in the EIA. The proponent shall express the legal commitment towards the EIA.

2. World Bank Safeguard Policies and Guidelines

The WB has ten environmental and social policies referred to as the Bank's "Safeguard Policies" that should be considered in its financed projects.
Based on the information to be collected of each project, the environmental initial assessment for each project is addressed through:

- Reviewing the safeguard policies and ensuring that the proposed project does not trigger a safeguard policy that makes it ineligible.
- Describing any safeguard issues and impacts associated with the construction of the project. Identifying and describe any potential large scale, significant and/or irreversible impacts.
- Describing any potential indirect and/or long term impacts due to anticipated future activities in the project area
- Describing measures taken to address safeguard policy issues. Provide an assessment of project proponent capacity to plan and implement the measures described.

- Identifying the key stakeholders and describing the mechanisms for consultation and disclosure of safeguard policies, with an emphasis on potentially affected people.

Among the ten safeguard policies of the WB, five are considered by the Consultant to be relevant to the NGESTP and have been taken into account during this ESIA study; these are listed and discussed below:

- Environmental Assessment (OP 4.01), that was previously discussed in section

3.4 of the current chapter.

- Involuntary Resettlement (OP 4.12)
- Disclosure (OP 17.50)
- Natural Habitats (OP 4.04)
- Cultural Property (OPN 11.03)
- Project on International Waterways (OP 7.50)

2.1. OP 4.12 - Involuntary Resettlement

The WB Operational Policy OP 4.12 on Involuntary Resettlement deals with involuntary resettlement in wider terms than the physical displacement of people due to development projects. It rather considers individuals who might be subjected to other sorts of adverse economic impacts on their livelihoods.

The overall objectives of the Bank's policy on involuntary resettlement are:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs;
- Where it cannot be feasibly avoided, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the displaced persons to share the project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs and compensation measures; and,
- Displaced persons should be assisted in improving their livelihoods and standards of living or at least in restoring them, in real terms, to predisplacement levels or to levels prevailing prior to project implementation, whichever is higher.

  The policy cover the involuntary taking of land resulting in relocation or loss of shelter, loss of or access to productive assets, or loss of sources of income or means of livelihood, whether or not the affected persons must move to another location. It also covers the involuntary restriction of access to legally designated parks and protected areas resulting in adverse impacts on the livelihoods of the displaced persons.

  Based on the survey conducted by the Consultant, the OP. 4.12 related to the involuntary resettlement is trigger. Therefore, the ToR of RPF and RAP were prepared and presented as an Annex in the SESIA study to be reviewed by the donors. Afterward, the donor will approve the ToR and the Client will prepared the tender for performing RAP.

2.2. OP 17.50 - Disclosure

WB policy OP 17.50 on Disclosure is also relevant to the project. This policy details the Bank's requirements for making operational information available to the public. The Bank reaffirms its recognition and endorsement of the fundamental importance of transparency and accountability to the development process. In addition, timely dissemination of information to local groups affected by the projects and programs supported by the Bank, including non-governmental organizations, is essential for the effective implementation and sustainability of projects.
The Consultant conducted the disclosure procedures in accordance to the WB procedures. The activities were done as early as possible to ensure the disclosure processes takes place in a manner that the project affected people as well as the stakeholders were fully informed and involved during report preparation. The detailed processes conducted by the Consultant regarding the disclosure processes are presented at different chapters and Annexes of the SESIA report.

2.3. OP 4.04 - Natural Habitats

The WB does not finance projects that degrade or convert critical habitats. Effects on non-critical habitats would be tolerated only if no alternatives are available and if acceptable mitigation measures are in place. It is essential to apply a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development.
Concerning the remediation works and the decommissioning of the BLWWTP, the OP 4.04 is triggered. Therefore, the degree of the impacts and the mitigation measures has to be presented to reduce the impacts. However, the habitats expected to be disturbed during the project implementation are not consider endanger. In addition, after the activities (rehabilitation and the decommissioning), the health and the disturbance of the neighboring community due to the outbreak (as a result of the operation of BLWWTP and Effluent Lake) will be eliminated.

2.4. OP 11.03 – Cultural Property

The core requirements for this Safeguard Policy include investigation and inventory of cultural resources that are potentially affected by the project and set appropriate mitigation measures when there are adverse impacts on physical cultural resources.
The Consultant conducted the review of the cultural resources within the project component. In addition, the clarification and confirmation from the Antiquities Authority was obtained to ensure the project components do not trigger the cultural property.

2.5. OP 7.50 - Project on International Waterways

The core requirement for this Safeguard Policy include investigation of the Project that might affect the International or shared waterways or water bodies. Impact on the international shared waterways or water bodies could be tolerate only if no alternatives are available and if acceptable mitigation measures are in place.
The project component of reuse system is nearby the Israeli border. The Consultant

reviewed the groundwater characteristics at the surrounding site. In addition, based on the groundwater modeling, the expected impact is presented. The detailed explanation of the impacts on the groundwater might affect the neighboring country (Israel) due to the reuse system is presented in detailed at Chapter 5. In addition, as the storage tanks is located nearby the Israeli border, due to security, the emergency plan in case the storage tanks is damage or not functioned is presented as well on the SESIA report, Chapter 6.

3. Israeli Palestinian Joint Water Committee

There is an agreement or understanding (Memorandum of Understanding) on guidelines and technical criteria for sewerage projects. The project component of reuse system has to follow this guideline. In particular, the guidelines concerning reuse scheme are as follows:

- Article 14 Effluent Reuse and Disposal; In general no discharge of effluent to wadis and / or to rivers and their tributes is permitted. Under exceptional circumstances, and only in the absence of any other disposal route, discharging to certain wadis and river may be permitted by the Joint Water Committee in accordance with the quality specification in schedule 1 and 2. All precautions shall be taken to prevent any possible environmental hazards. The reuse of treated effluent for irrigation shall be in accordance with the provisions detailed in schedule 1 and 2.
- Article 15 Sludge Reuse and Disposal; Disposal of sludge shall take place at an agreed waste disposal site or reused in accordance with the provision detailed in schedule 3.

The Consultant reviewed the design of the reuse system and ensures that the articles mentioned above are followed. In addition, the standard of the effluent reuse and sludge reuse is following the available limit by Israeli laws and standard. Please note, according to the design criteria, the sludge limit guideline is following the EPA standard (according to the design criteria) and the effluent reuse, beside the Israeli guidelines, the guideline according to the Egyptian standard was compared.

4. Regional Legal Frameworks (Jordon, Israel and Egypt) Concerning Wastewater Reuse

Palestine by law has a standard and guideline for recovered water (groundwater) quality standard to be used for irrigation. However, the regional legal framework as well as the standard guidelines from the region (especially Jordan, Israel and Egypt) and the International standard for wastewater reuse were reviewed and compared. The Consultant reviewed the available frameworks and guidelines to ensure that the recovered water proposed within this project is according to the framework and guidelines applied in the region and according to the acceptable international guidelines. In addition, as the guidelines for sludge management and reuse in Palestine is not yet endorsed the frameworks, including guidelines, and practices from countries within the region and international guideline for sludge reuse were reviewed by the Consultant. The Consultant ensures that the guideline provided by the Palestine is in accordance to the practice and in comparison with the regional and international standards.

4.1. Wastewater Reuse Policy in Jordan, Israel in comparison with the FAO standards for irrigation

Authority of Jordan has established the standard of wastewater reuse for irrigation purposes in 2006. These standards are currently applied to all municipal wastewater treatment systems. The standards establish a variable standard for wastewater quality for 7 categories of discharge or direct reuse. The direct use of treated wastewater for the irrigation of crops normally consumed raw was explicitly forbidden by the Standard.
The 1995 Standard # 893 includes the following categories of wastewater reuse standards depending on the fate of domestic wastewater after it is released from the wastewater treatment facility:

- Recycling of water for irrigation of vegetables that are normally cooked,
- Recycling of water used for tree crops, forestry and industrial processes,
- Discharges to receiving water such as wadis and catchment areas,
- Use in artificial recharge to aquifers,
- Discharge to water bodies containing fish,
- Discharge to public parks or recreational areas,
- Use in irrigation of animal fodder.

The 1995 standard enabled design engineers and concerned health officials to adjust the level of treatment and, hence, the cost of treatment to the actual conditions of treated effluent reuse. Standards for BOD were limited to 150 mg/l for most forms of agricultural reuse and a more stringent standard was created for amenity irrigation in areas that can be accessed by the public.
Similarly, Israeli has similar policy of reusing treated wastewater for irrigation with different quality standard. Table 1 and 2 below present the comparisons of quality standards of Jordan, Israel, Palestine and the standard comparison with FAO.

4.2. Wastewater Reuse Policy in Egypt

Law 48/1982 concerning protection of the river Nile from pollution that restrict the discharge of the wastewater on different water bodies (groundwater and surface water) and Ministry of Water Resource and Irrigation (MWRI) whereas, the Ministry of Health and Population (MoHP) are responsible for monitoring effluent. In addition, only discharge of treated municipal wastewater can only discharge to brackish water bodies. Moreover, the reuse of drainage water is also regulated.
Law 12/1982 is the legal basis for irrigation and drainage is set out in Law 12/1982 and its supplementary Law 213/1994, which define the use and management of public and private sector irrigation and drainage systems including main canals, feeders, and drains. Law 12/1982 defines inter alia public properties related to irrigation and drainage: the River Nile, the main canals, public feeders, and public drains and their embankments. The law regulates the use of groundwater and drainage water (construction of wells or the use of drainage water and water pumps). It provides regulations for the development of new land and the price that has to be paid for the irrigation and drainage of land.
Law 93/1962—Wastewater disposal and reuse; Decree No. 649/1962 of the Minister of Housing issued the executive regulations for Law 93/1962. It specifies regulatory standards for wastewater disposal. It was updated in 1989 by Decree No. 9/1989, in

which a distinction was made between wastewater disposal on sandy soils and clay silt soils.

In 1995, an amendment was made by both the Ministry of Irrigation and the Ministry of Agriculture and approved by the Ministry of Health. In 2005, new standards for the reuse of wastewater were set in the Egyptian Code for the Use of Treated Wastewater in Agriculture.

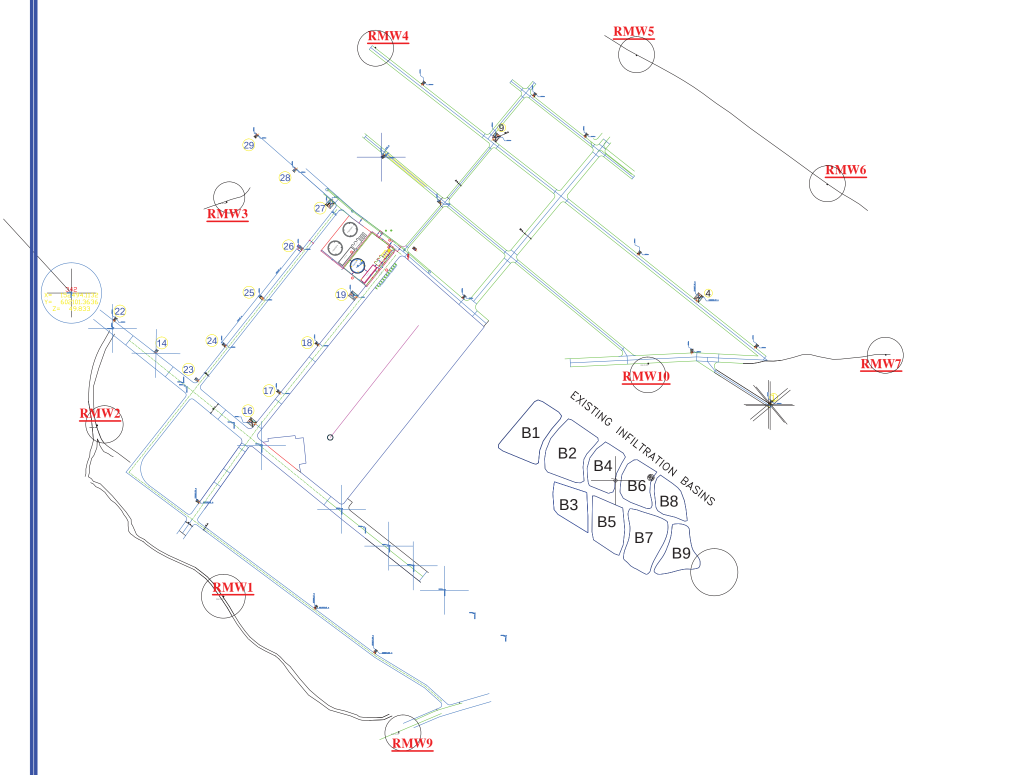
		Jordan JS 893/2006				Palestine TS 34-2012				Israel[1]	FAO[2]		
Parameter	UM	A	B	C	D	A	B	C	D		Degree of restriction on use		
		Cooked vegetables Parks Playgrounds Roadsides	Fruit trees Landscaped roadsides of highways	Industrial crops Forest trees	Collecting flowers	High quality	Good quality	Medium quality	Low quality	unrestricted irrigation	none	slight to moderate	severe
Physico-chemical characteristics													
BOD_5	mg/l	30	200	300	15	20	20	40	60	10			
TSS	mg/l	50	200	300	15	30	30	50	90	10			
COD	mg/l	100	500	500	50	50	50	100	150	100			
pH		6-9				6-9				6.5-8.5	6.5 - 8		
Turbidity	NTU	10			5								
EC	dS/m									1.4			
- salt sensitive		(EC: ~ 2.34)									< 0.7	0.7 - 3.0	> 3.0
- medium salt tolerant													
- salt tolerant													
- higly salt tolerant													
TDS	mg/l	1500				1200	1500	1500	1500		< 450	450 - 2000	> 2000
Ammonium as NH_4-N	mg/l					5	5	10	15	10			
Nitrate as NO_3 / NO_3-N	mg/l	30 / 6.8	45 / 10.4	70 / 16.1	45 / 10.4	- / 20	- / 20	- / 30	- / 40		< 5	5 - 30 / 1.2 - 6.8	> 30 / > 6.8
Total Kjeldahl N	mg/l	45	< 70	100	70	30	30	45	60	25			
PO_4-P	mg/l	30				30							
Chloride	mg/l	400				400				250	~ < 400	~ 400 - 1000	~ > 1000
residual Chlorine	mg/l									1			
Bi-carbonate (HCO_3)	mg/l	400			400						< 1.5 (me/l)	1.5 - 8.5 (me/l)	> 8.5 (me/l)
Microbiological characteristics													
Escherichia coli	MPN/100 ml	100	1000		< 1.1	100	1000	1000	1000	12			
Feacal coli	MPN/100 ml					200	1000	1000	1000	10	1000 F. coli (irrigation of crops likely to be eaten uncooked; otherwise no standard recommended)		
Intestinal Nematodes	viable eggs/l					< 1	< 1	< 1	< 1				
Intestinal Helminthes	viable eggs/l	< 1	< 1	< 1	< 1						1 (irrigation of crops likely to be eaten uncooked)		

		Jordan JS 893/2006	Palestine TS 34-2012	Israel[1]	FAO[2]		
Parameter	UM	A - D	A - D		Degree of restriction on use		
					none	slight to moderate	severe
Heavy metals / trace elements							
Arsenic	mg/l	0.1		0.1	0.1		
Cadmium		0.01	0.01	0.01	0.01		
Chromium		0.1	0.1	0.1	0.1		
Copper		0.2	0.2	0.2	0.2		
Lead		0.2	0.2	0.1	5.0		
Mercury		0.002	0.001	0.002			
Nichel		0.2	0.2	0.2	0.2		
Zinc		5.0	2.0	2.0	2.0		
Aluminium		5.0	5.0	5.0	5.0		
Boron		1.0	0.7	0.4	< 0.7	0.7 - 3.0	> 3.0
Lithium		2.0 (0.075 for citrus)		2.5	2.5 (0.075 for citrus)		
Iron		5.0	5.0	2.0	5.0		

Annex 2: Recovery Wells Locations and Roads Layout

Recovery wells locations

WELL	X	Y
RW1	154204.93	601833.89
RW2	154011.86	601959.49
RW3	154169.59	601971.47
RW4	154027.91	602090.19
RW5	153883.17	602199.40
RW6	153752.77	602487.09
RW7	153626.90	602586.26
RW8	153355.02	602614.46
RW9	153532.04	602482.42
RW10	153256.77	602435.47
RW11	153395.28	602323.52
RW12	153184.78	601236.23
RW13	153092.17	601333.12
RW14	152701.68	601958.79
RW15	152803.59	601592.06
RW16	152936.44	601778.53
RW17	153001.33	601859.62
RW18	153095.30	601977.09
RW19	153183.66	602095.00
RW20	153278.24	602206.17
RW21	153454.25	602091.57
RW22	152600.91	602037.06
RW23	152801.04	601889.46
RW24	152868.12	601947.24
RW25	152959.37	602089.57
RW26	153055.71	602211.35
RW27	153127.40	602319.68
RW28	153040.70	602402.11
RW29	152946.08	602485.40



NOTES :-

FOR TENDER ONLY

CLIENT:
PALESTINIAN NATIONAL AUTHORITY
PALESTINIAN WATER AUTHORITY

BENEFICIARY:
MUNICIPALITIES OF GAZA, JABALIA & BEIT HANOUN

PROJECT TITLE:
EFFLUENT RECOVERY AND IRRIGATION SCHEME FOR NGEST (FIRST STAGE /PACKAGE 1)
CONTRACT NO. : NGEST/AF-QCBS01-08/DD

CONSULTANT:
center for engineering and planning

DRAWING TITLE:
Recovery Wells Locations
And Road Layout

DRAWING NO.

DATE: NOV./2014 | SCALE: NTS

Annex 3: Design Report

Annex 3: Design Report

Annex 4: Recovery Wells Geoinvestigations

4A – Water Analysis

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/29	رقم العينة
Sample Description	Water Sample from Well No. 24 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 100m^3/h	#2: 200m^3/h
1	PH	Acidity	*	7.62	7.445
2	E.C.	Electric Conductivity	µS/cm	2340	2320
3	T.D.S.	Dissolved Solids	mg/l	1405	1390
4	T.A.	Total Alkalinity	mg/l	660	650
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	37	35
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	440
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	60	60
13	Na	Sodium	mg/l	450	445
14	K	Potassium	mg/l	3	3

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:

1- The above results represent the testet samples only

2- No any reproduction of this report is allowed unless agreed in written permit

For/Laboratory Manager

Moh. Ghanem

Remaining Days to finish the project	47 Days

Date: 14-11-2017

Ref No: SAK-EFF-145/461

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Water Analysis Report for Recovery Wells no.24, 27, 28 & 29

Dear Sir

With reference to the above mentioned subject, please see the attached reports for the samples which taken during the pump test.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/29	رقم العينة
Sample Description	Water Sample from Well No. 24 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 100m^3/h	#2: 200m^3/h
1	PH	Acidity	-	7.62	7.445
2	E.C.	Electric Conductivity	µS/cm	2340	2320
3	T.D.S	Dissolved Solids	mg/l	1405	1390
4	T.A.	Total Alkalinity	mg/l	660	650
5	T.S.S	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	37	35
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	440
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	60	60
13	Na	Sodium	mg/l	450	445
14	K	Potassium	mg/l	3	3

* The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed by written permit

المركز الاستشاري للجودة والمعايرة
CCQC

For/Laboratory Manager
Moh. Ghsoom

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 2886362-08، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
Email: ccqcmtl@gmail.com
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 2130081- 08

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171022/5	رقم العينة
Sample Description	Water Sample from Well No. 27 (Pumping Stage)	وصف العينة
Receiving Date	22/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	22/10/2017 to 31/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1	#2
1	PH	Acidity	-	7.461	7.451
2	E.C.	Electric Conductivity	µS/cm	2020	2000
3	T.D.S.	Dissolved Solids	mg/l	1212	1200
4	T.A.	Total Alkalinity	mg/l	644	638
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	62	63
8	NH_4-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	425
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	50	50
13	Na	Sodium	mg/l	380	385
14	K	Potassium	mg/l	10	10

* The Samples was tested by **Bir Zeit Testing Laboratory** - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171021/44	رقم العينة
Sample Description	Water Sample from Well No. 28 (Pumping Stage)	وصف العينة
Receiving Date	21/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	21/10/2017 to 29/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Sample
1	PH	Acidity	*	8.104
2	E.C.	Electric Conductivity	µS/cm	2020
3	T.D.S.	Dissolved Solids	mg/l	1212
4	T.A.	Total Alkalinity	mg/l	560
5	T.S.S.	Total Suspended Solids	mg/l	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10
7	NO3	Nitrate	mg/l	150
8	NH_3-N	Ammonia-N	mg/l	Nil
9	NO_2	Nitrite	mg/l	Nil
10	Cl	Chloride	mg/l	367
11	PO_4-P	Phosphate	mg/l	Nil
12	SO4	Sulfate	mg/l	48
13	Na	Sodium	mg/l	385
14	K	Potassium	mg/l	8

* **The Samples was tested by Bir Zeit Testing Laboratory for Environmental Testing - Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

M.A.S

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

CCQC

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/30	رقم العينة
Sample Description	Water Sample from Well No. 29 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 11.30 A.M $100m^3/h$	#2: 16.00 P.M $200m^3/h$
1	PH	Acidity	-	8.021	7.461
2	E.C	Electric Conductivity	µS/cm	2140	2130
3	T.D.S	Dissolved Solids	mg/l	1285	1278
4	T.A	Total Alkalinity	mg/l	605	560
5	T.S.S	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	92	90
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	386	452
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	54	60
13	Na	Sodium	mg/l	422	420
14	K	Potassium	mg/l	3	3

* The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written pre..d

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة الرجبي بجوار برج أبو رمضان - تليفاكس 2886362-08 جوال 0599-991191 ،0598-880379 ،0598-995595 ،0599-890879

Email: ccqcmtl@gmail.com

فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 2130081- 08

Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171012/38	رقم العينة
Sample Description	Water Sample from Well No. 26 (Pumping Stage)	وصف العينة
Receiving Date	12/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	12/10/2017 to 19/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: after 1hour 100m³/h	#2: at 6.30 p.m. 200m³/h
1	PH	Acidity	*	8.386	8.123
2	E.C.	Electric Conductivity	µS/cm	2120	2130
3	T.D.S.	Dissolved Solids	mg/l	1272	1278
4	T.A.	Total Alkalinity	mg/l	688	682
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	25	20
8	NH_3-N	Ammonia-N	mg/l	1	1
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	386
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	42	43
13	Na	Sodium	mg/l	404	406
14	K	Potassium	mg/l	10	11

* The Samples was tested by Bir Zeit Testing Laboratory - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة ... - جوال 08-2886362 ، 0598-991191 ، 0598-880379 ، 0598-995595 ، 0599-890879
Email: ccqcmtl@gmail.com
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 08-2130081

Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171022/5	رقم العينة
Sample Description	Water Sample from Well No. 27 (Pumping Stage)	وصف العينة
Receiving Date	22/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	22/10/2017 to 31/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1	#2
1	PH	Acidity	*	7.461	7.451
2	E.C.	Electric Conductivity	µS/cm	2020	2000
3	T.D.S.	Dissolved Solids	mg/l	1212	1200
4	T.A.	Total Alkalinity	mg/l	644	638
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	62	63
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	425
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	50	50
13	Na	Sodium	mg/l	380	385
14	K	Potassium	mg/l	10	10

* The Samples was tested by Bir Zeit Testing Laboratory - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق قرية العدس - جوال 059 2283740 هاتف 2130081 -08
Email: ccqcmtl@gmail.com

Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171021/44	رقم العينة
Sample Description	Water Sample from Well No. 28 (Pumping Stage)	وصف العينة
Receiving Date	21/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	21/10/2017 to 29/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Sample
1	PH	Acidity	-	8.104
2	E.C.	Electric Conductivity	µS/cm	2020
3	T.D.S.	Dissolved Solids	mg/l	1212
4	T.A.	Total Alkalinity	mg/l	660
5	T.S.S.	Total Suspended Solids	mg/l	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10
7	NO3	Nitrate	mg/l	150
8	NH_3-N	Ammonia-N	mg/l	Nil
9	NO_2	Nitrite	mg/l	Nil
10	Cl	Chloride	mg/l	367
11	PO_4-P	Phosphate	mg/l	Nil
12	SO4	Sulfate	mg/l	48
13	Na	Sodium	mg/l	385
14	K	Potassium	mg/l	8

* The Samples was tested by Bir Zeit Testing Laboratory for Environmental Testing - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 2886362-08، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
Email: ccqcmtl@gmail.com
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق حرية العنس - جوال 059 2283740 هاتف 2130081- 08

فحص عينات مياه

Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/30	رقم العينة
Sample Description	Water Sample from Well No. 29 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 11.30 A.M 100m^3/h	#2: 16.00 P.M 200m^3/h
1	PH	Acidity	*	8.021	7.461
2	E.C.	Electric Conductivity	µS/cm	2140	2130
3	T.D.S.	Dissolved Solids	mg/l	1285	1278
4	T.A.	Total Alkalinity	mg/l	605	560
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	92	90
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	386	452
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	64	60
13	Na	Sodium	mg/l	422	420
14	K	Potassium	mg/l	3	3

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:

1- The above results represent the testet samples only

2- No any reproduction of this report is allowed unless agreed in written permit

For/Laboratory Manager

Moh. Ghanem

Remaining Days to finish the project	18 Days

Date: 13-12-2017

Ref No: SAK-EFF-145/496

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Water Analysis Report for Recovery Wells no.14 & 23

Dear Sir

With reference to the above mentioned subject, please see the attached reports for the samples which taken during the pump test.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171205/15	رقم العينة
Sample Description	Water Sample from Well No. 14 (Pumping Stage)	وصف العينة
Receiving Date	05/12/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	05/12/2017 to 11/12/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 11.30 A.M $100m^3/h$	#2: 16.00 P.M $200m^3/h$
1	PH	Acidity	*	7.517	7.01
2	E.C.	Electric Conductivity	µS/cm	2570	2560
3	T.D.S.	Dissolved Solids	mg/l	1593	1587
4	T.A.	Total Alkalinity	mg/l	396	400
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	33	33
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	512	520
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	112	113
13	Na	Sodium	mg/l	460	460
14	K	Potassium	mg/l	0.5	0.5

* **The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171205/16	رقم العينة
Sample Description	Water Sample from Well No. 23 (Pumping Stage)	وصف العينة
Receiving Date	05/12/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	05/12/2017 to 11/12/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 100m^3/h	#2: 200m^3/h
1	PH	Acidity	*	7.392	7.448
2	E.C.	Electric Conductivity	µS/cm	2310	2320
3	T.D.S.	Dissolved Solids	mg/l	1432	1438
4	T.A.	Total Alkalinity	mg/l	525	530
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	47	42
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	385	385
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	70	70
13	Na	Sodium	mg/l	440	440
14	K	Potassium	mg/l	1.5	1.5

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For/Laboratory Manager
Moh. Ghanem

مركز الهندسة والتخطيط
center for engineering and planning

FCG

Date: Dec. 06, 2017
PWA-S1-P1-59

Project: Effluent Recovery & Irrigation Scheme (First Stage- Lot 1 and Lot 2)

Dear Eng. Mohammed Nazik Rewhan.

<u>Subject: Water quality report about the results of Recovery Wells (29, 28, 27,24 and 26)</u>

- pH is range from 7.4 – 8.3 , all samples within the range of WHO and PWA standard
- EC is range from 2000 -2400 , all samples exceed the range of the standard (2000)
- TDS is range from 1200 – 1400, all samples within the range of PWA standard (1500 mg/l)
- BOD results should be a value not acceptable in range as 10<.
- TC should be measured for each well, not possible to use old data as indicator.
- Nitrate is range from 20 – 150. Samples of Wells 26, 24 and 27 are in range with PWA standard. The wells 28 and 29 are exceed the PWA standard 70 mg/l
- - Chloride is range from 376 – 452, all samples within the range of PWA standard (600 mg/l)
- Sulfate is range from 42 – 60 , All samples less than PWA standard (250 mg/l)
- Sodium is range from 380 – 445, All samples exceed the range of the PWA standard (200 mg/l)
- Potassium is range 3 – 11, All samples exceed the range of the PWA standard (12 mg/l)

In general water quality results indicate that recovery water will be acceptable for agricultural use. Also, we advise that during operating the pumps of wells, should take water quality samples from all recovery wells.

Best Regards

06-12-2017

Eng. Adel Al-Gazzaz
Site Project Manager

Gaza: Office # 48, 4th Floor, Burge Al Jowharah, El Wehda St. Tel: +972- (0)8 -2827173 Fax: +972- (0) 8-2846445 Email: cepgaza@gmail.com

فحص عينات مياه

Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/29	رقم العينة
Sample Description	Water Sample from Well No. 24 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	**Test**		**Unit**	**Test Result of Samples**	
				#1: 100m^3/h	**#2: 200m^3/h**
1	PH	Acidity	*	7.62	7.445
2	E.C.	Electric Conductivity	µS/cm	2340	2320
3	T.D.S.	Dissolved Solids	mg/l	1405	1390
4	T.A.	Total Alkalinity	mg/l	660	650
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	37	35
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	440
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	60	60
13	Na	Sodium	mg/l	450	445
14	K	Potassium	mg/l	3	3

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:

1- The above results represent the testet samples only

2- No any reproduction of this report is allowed unless agreed in written permit

For/Laboratory Manager
Moh. Ghanem

Remaining Days to finish the project	47 Days

Date: 14-11-2017

Ref No: SAK-EFF-145/461

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Water Analysis Report for Recovery Wells no.24, 27, 28 & 29

Dear Sir

With reference to the above mentioned subject, please see the attached reports for the samples which taken during the pump test.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

فحص عينات مياه

Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/29	رقم العينة
Sample Description	Water Sample from Well No. 24 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 100m^3/h	#2: 200m^3/h
1	PH	Acidity	-	7.62	7.445
2	E.C.	Electric Conductivity	µS/cm	2340	2320
3	T.D.S	Dissolved Solids	mg/l	1405	1390
4	T.A	Total Alkalinity	mg/l	660	650
5	T.S.S	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	37	35
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	440
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	60	60
13	Na	Sodium	mg/l	450	445
14	K	Potassium	mg/l	3	3

* The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza

Notes:

1- The above results represent the testet samples only

2- No any reproduction of this report is allowed unless agreed by written permit

For/Laboratory Manager

Moh. Ghsenni

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171022/5	رقم العينة
Sample Description	Water Sample from Well No. 27 (Pumping Stage)	وصف العينة
Receiving Date	22/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	22/10/2017 to 31/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1	#2
1	PH	Acidity	-	7.461	7.451
2	E.C.	Electric Conductivity	µS/cm	2020	2000
3	T.D.S.	Dissolved Solids	mg/l	1212	1200
4	T.A.	Total Alkalinity	mg/l	644	638
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	62	63
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	425
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	50	50
13	Na	Sodium	mg/l	380	385
14	K	Potassium	mg/l	10	10

* The Samples was tested by **Bir Zeit Testing Laboratory** - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171021/44	رقم العينة
Sample Description	Water Sample from Well No. 28 (Pumping Stage)	وصف العينة
Receiving Date	21/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جاهز العينة
Testing Date	21/10/2017 to 29/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Sample
1	PH	Acidity	*	8.104
2	E.C.	Electric Conductivity	µS/cm	2020
3	T.D.S.	Dissolved Solids	mg/l	1212
4	T.A.	Total Alkalinity	mg/l	560
5	T.S.S.	Total Suspended Solids	mg/l	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10
7	NO3	Nitrate	mg/l	150
8	NH_3-N	Ammonia-N	mg/l	Nil
9	NO_2	Nitrite	mg/l	Nil
10	Cl	Chloride	mg/l	367
11	PO_4-P	Phosphate	mg/l	Nil
12	SO4	Sulfate	mg/l	48
13	Na	Sodium	mg/l	385
14	K	Potassium	mg/l	8

* **The Samples was tested by Bir Zeit Testing Laboratory for Environmental Testing - Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

M.A.S

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 2886362-08، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 2130081- 08
Email: ccqcmtl@gmail.com

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/30	رقم العينة
Sample Description	Water Sample from Well No. 29 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 11.30 A.M 100m³/h	#2: 16.00 P.M 200m³/h
1	PH	Acidity	-	8.021	7.461
2	E.C	Electric Conductivity	µS/cm	2140	2130
3	T.D.S	Dissolved Solids	mg/l	1285	1278
4	T.A	Total Alkalinity	mg/l	605	560
5	T.S.S	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	92	90
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	386	452
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	54	60
13	Na	Sodium	mg/l	422	420
14	K	Potassium	mg/l	3	3

* The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written paper

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة الرحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362 جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
Email: ccqcmtl@gmail.com
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 08-2130081

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171012/38	رقم العينة
Sample Description	Water Sample from Well No. 26 (Pumping Stage)	وصف العينة
Receiving Date	12/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	12/10/2017 to 19/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: after 1hour 100m³/h	#2: at 6.30 p.m. 200m³/h
1	PH	Acidity	*	8.386	8.123
2	E.C.	Electric Conductivity	µS/cm	2120	2130
3	T.D.S.	Dissolved Solids	mg/l	1272	1278
4	T.A.	Total Alkalinity	mg/l	688	682
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	25	20
8	NH_3-N	Ammonia-N	mg/l	1	1
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	386
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	42	43
13	Na	Sodium	mg/l	404	406
14	K	Potassium	mg/l	10	11

* The Samples was tested by Bir Zeit Testing Laboratory - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171022/5	رقم العينة
Sample Description	Water Sample from Well No. 27 (Pumping Stage)	وصف العينة
Receiving Date	22/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	22/10/2017 to 31/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1	#2
1	PH	Acidity	*	7.461	7.451
2	E.C.	Electric Conductivity	µS/cm	2020	2000
3	T.D.S.	Dissolved Solids	mg/l	1212	1200
4	T.A.	Total Alkalinity	mg/l	644	638
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	62	63
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	444	425
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	50	50
13	Na	Sodium	mg/l	380	385
14	K	Potassium	mg/l	10	10

* The Samples was tested by Bir Zeit Testing Laboratory - Gaza

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
Email: ccqcmtl@gmail.com
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق قرية العدس - جوال 059 2283740 هاتف 2130081 -08

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171021/44	رقم العينة
Sample Description	Water Sample from Well No. 28 (Pumping Stage)	وصف العينة
Receiving Date	21/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	21/10/2017 to 29/10/2017	تاريخ الفحص

No	Test		Unit	Test Result of Sample
1	PH	Acidity	*	8.104
2	E.C.	Electric Conductivity	µS/cm	2020
3	T.D.S.	Dissolved Solids	mg/l	1212
4	T.A.	Total Alkalinity	mg/l	860
5	T.S.S.	Total Suspended Solids	mg/l	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10
7	NO3	Nitrate	mg/l	150
8	NH_3-N	Ammonia-N	mg/l	Nil
9	NO_2	Nitrite	mg/l	Nil
10	Cl	Chloride	mg/l	367
11	PO_4-P	Phosphate	mg/l	Nil
12	SO4	Sulfate	mg/l	48
13	Na	Sodium	mg/l	385
14	K	Potassium	mg/l	8

*** The Samples was tested by Bir Zeit Testing Laboratory for Environmental Testing - Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

M.A.S

فحص عينات مياه

Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171029/30	رقم العينة
Sample Description	Water Sample from Well No. 29 (Pumping Stage)	وصف العينة
Receiving Date	29/10/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	29/10/2017 to 06/11/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 11.30 A.M $100m^3/h$	#2: 16.00 P.M $200m^3/h$
1	PH	Acidity	*	8.021	7.461
2	E.C.	Electric Conductivity	µS/cm	2140	2130
3	T.D.S.	Dissolved Solids	mg/l	1285	1278
4	T.A.	Total Alkalinity	mg/l	605	560
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	92	90
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	386	452
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	64	60
13	Na	Sodium	mg/l	422	420
14	K	Potassium	mg/l	3	3

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:

1- The above results represent the testet samples only

2- No any reproduction of this report is allowed unless agreed in written permit

For/Laboratory Manager

Moh. Ghanem

Remaining Days to finish the project	18 Days

Date: 13-12-2017 Ref No: SAK-EFF-145/496

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Water Analysis Report for Recovery Wells no.14 & 23

Dear Sir

With reference to the above mentioned subject, please see the attached reports for the samples which taken during the pump test.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171205/15	رقم العينة
Sample Description	Water Sample from Well No. 14 (Pumping Stage)	وصف العينة
Receiving Date	05/12/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	05/12/2017 to 11/12/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: 11.30 A.M $100m^3/h$	#2: 16.00 P.M $200m^3/h$
1	PH	Acidity	*	7.517	7.01
2	E.C.	Electric Conductivity	µS/cm	2570	2560
3	T.D.S.	Dissolved Solids	mg/l	1593	1587
4	T.A.	Total Alkalinity	mg/l	396	400
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	33	33
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	512	520
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	112	113
13	Na	Sodium	mg/l	460	460
14	K	Potassium	mg/l	0.5	0.5

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة ... - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
Email: ccqcmtl@gmail.com
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 08 -2130081

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

فحص عينات مياه
Water Analysis Report

Contractor :	Saqqa & Khouday Contracting Company -SAK-	المقاول
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01-NGEST /2015 (First Stage) Lot (1 + 2)	المشروع
Owner	PWA	المالك
Consultant:	Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD	الاستشاري
Lab No	171205/16	رقم العينة
Sample Description	Water Sample from Well No. 23 (Pumping Stage)	وصف العينة
Receiving Date	05/12/2017	تاريخ الاستلام
Sampled By	Contractor in presence of Consultant	جهز العينة
Testing Date	05/12/2017 to 11/12/2017	تاريخ الفحص

No	Test		Unit	Test Result of Samples	
				#1: $100 m^3/h$	#2: $200 m^3/h$
1	PH	Acidity	*	7.392	7.448
2	E.C.	Electric Conductivity	µS/cm	2310	2320
3	T.D.S.	Dissolved Solids	mg/l	1432	1438
4	T.A.	Total Alkalinity	mg/l	525	530
5	T.S.S.	Total Suspended Solids	mg/l	Nil	Nil
6	B.O.D.	Biochemical oxygen demand	mg/l	<10	<10
7	NO3	Nitrate	mg/l	47	42
8	NH_3-N	Ammonia-N	mg/l	Nil	Nil
9	NO_2	Nitrite	mg/l	Nil	Nil
10	Cl	Chloride	mg/l	385	385
11	PO_4-P	Phosphate	mg/l	Nil	Nil
12	SO4	Sulfate	mg/l	70	70
13	Na	Sodium	mg/l	440	440
14	K	Potassium	mg/l	1.5	1.5

*** The Samples was tested by Bir Zeit Laboratory for Environmental Testing- Gaza**

Notes:
1- The above results represent the testet samples only
2- No any reproduction of this report is allowed unless agreed in written permit

For/Laboratory Manager
Moh. Ghanem

المقر الرئيسي: غزة - شارع الوحدة - عمارة ... - الفاكس 2886362-08- جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879

Email: ccqcmtl@gmail.com

فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق خربة العدس - جوال 059 2283740 هاتف 2130081- 08

Sample Summary Report

Sample ID	well26s1	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2120	uS/cm
Sum of Anions	23.04788	meq/L
Sum of Cations	25.22595	meq/L
Balance	4.511903	%
Total dissolved solids	1612.474	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	404	17.57303	17.57303
K	10	0.2557656	0.2557656
Ca	84.09091	2.098181	4.196363
Mg	38.22314	1.572645	3.14529
Cl	444	12.52373	12.52373
SO4	42	0.4375	0.875
NO3	25	0.4032258	0.4032258
HCO3	564.16	9.245926	9.245926

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334173	0.319	0.194
Ca/SO4	2.002165	4.795844	0.152	0.364
Na/Cl	0.9099099	1.403179	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well 26s2	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2130	uS/cm
Sum of Anions	21.27145	meq/L
Sum of Cations	25.17978	meq/L
Balance	8.413824	%
Total dissolved solids	1545.909	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	406	17.66003	17.66003
K	11	0.2813421	0.2813421
Ca	82.27273	2.052815	4.105631
Mg	37.39669	1.538642	3.077284
Cl	386	10.88775	10.88775
SO4	43	0.4479167	0.8958334
NO3	20	0.3225806	0.3225806
HCO3	559.24	9.165293	9.165293

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334174	0.319	0.194
Ca/SO4	1.913319	4.58303	0.152	0.364
Na/Cl	1.051813	1.62201	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well24s1	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2340	uS/cm
Sum of Anions	23.24014	meq/L
Sum of Cations	26.15893	meq/L
Balance	5.908587	%
Total dissolved solids	1643.63	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	450	19.57392	19.57392
K	3	7.672968E-02	7.672968E-02
Ca	74.54546	1.86001	3.720019
Mg	33.8843	1.394129	2.788258
Cl	444	12.52373	12.52373
SO4	60	0.625	1.25
NO3	37	0.5967742	0.5967742
HCO3	541.2	8.869638	8.869638

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334173	0.319	0.194
Ca/SO4	1.242424	2.976016	0.152	0.364
Na/Cl	1.013514	1.562947	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well 24s2	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2320	uS/cm

Sum of Anions	22.96067	meq/L
Sum of Cations	25.70333	meq/L
Balance	5.635921	%

Total dissolved solids	1620.463	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	445	19.35644	19.35644
K	3	7.672968E-02	7.672968E-02
Ca	71.81818	1.79196	3.58392
Mg	32.64463	1.343124	2.686248
Cl	440	12.4109	12.4109
SO4	60	0.625	1.25
NO3	35	0.5645161	0.5645161
HCO3	533	8.73525	8.73525

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334173	0.319	0.194
Ca/SO4	1.19697	2.867136	0.152	0.364
Na/Cl	1.011364	1.559632	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well27s1	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2020	uS/cm

Sum of Anions	23.22001	meq/L
Sum of Cations	22.81692	meq/L
Balance	-0.8755828	%

Total dissolved solids	1574.576	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	380	16.52909	16.52909
K	10	0.2557656	0.2557656
Ca	69.09091	1.723911	3.447823
Mg	31.40496	1.292119	2.584239
Cl	444	12.52373	12.52373
SO4	50	0.5208334	1.041667
NO3	62	1	1
HCO3	528.08	8.654617	8.654617

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334173	0.319	0.194
Ca/SO4	1.381818	3.309909	0.152	0.364
Na/Cl	0.8558559	1.319822	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well 27s2	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2000	uS/cm
Sum of Anions	22.61958	meq/L
Sum of Cations	22.91535	meq/L
Balance	0.6495425	%
Total dissolved solids	1554.672	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	385	16.74658	16.74658
K	10	0.2557656	0.2557656
Ca	67.72727	1.689887	3.379773
Mg	30.78512	1.266617	2.533233
Cl	425	11.9878	11.9878
SO4	50	0.5208334	1.041667
NO3	63	1.016129	1.016129
HCO3	523.16	8.573983	8.573983

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334174	0.319	0.194
Ca/SO4	1.354545	3.244582	0.152	0.364
Na/Cl	0.9058824	1.396968	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well29s1	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2140	uS/cm
Sum of Anions	21.83545	meq/L
Sum of Cations	23.82983	meq/L
Balance	4.367369	%
Total dissolved solids	1553.017	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	422	18.35599	18.35599
K	3	7.672968E-02	7.672968E-02
Ca	61.81818	1.542447	3.084894
Mg	28.09917	1.156107	2.312213
Cl	386	10.88775	10.88775
SO4	64	0.6666667	1.333333
NO3	92	1.483871	1.483871
HCO3	496.1	8.130503	8.130503

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334174	0.319	0.194
Ca/SO4	0.9659091	2.31367	0.152	0.364
Na/Cl	1.093264	1.685931	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well 29s2	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2130	uS/cm
Sum of Anions	22.97675	meq/L
Sum of Cations	23.58409	meq/L
Balance	1.304413	%
Total dissolved solids	1571.473	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	420	18.269	18.269
K	3	7.672968E-02	7.672968E-02
Ca	60	1.497081	2.994162
Mg	27.27273	1.122104	2.244207
Cl	452	12.74938	12.74938
SO4	60	0.625	1.25
NO3	90	1.451613	1.451613
HCO3	459.2	7.525754	7.525754

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334173	0.319	0.194
Ca/SO4	1	2.395329	0.152	0.364
Na/Cl	0.9292035	1.432932	0.556	0.858
Cl/Br			287	648

Sample Summary Report

Sample ID	well28s1	
Sample Date		
Station	R1	
Location	Recovery	
Geology		
Watertype	Na-Cl-HCO3	
Temperature (°C)		
pH		
Conductivity	2020	uS/cm
Sum of Anions	22.64081	meq/L
Sum of Cations	23.3801	meq/L
Balance	1.606406	%
Total dissolved solids	1606.307	mg/L
Total hardness		mg/l CaCO3
Alkalinity	0	mg/l CaCO3

Major ion composition	mg/l	mmol/l	meq/l
Na	385	16.74658	16.74658
K	8	0.2046125	0.2046125
Ca	73.63636	1.837326	3.674653
Mg	33.47107	1.377127	2.754254
Cl	367	10.35182	10.35182
SO4	48	0.5	1
NO3	150	2.419355	2.419355
HCO3	541.2	8.869638	8.869638

Ratios	Sample		Standard Seawater	
	mg/l	mmol/l	mg/l	mmol/l
Ca/Mg	2.2	1.334174	0.319	0.194
Ca/SO4	1.534091	3.674653	0.152	0.364
Na/Cl	1.049046	1.617742	0.556	0.858
Cl/Br			287	648

Physicochemical water quality Standards WHO and PWA

Parameters	WHO	PWA
PH	6.5-8.5	6.5-8.5
TDS (mg/l)	1000	1500
Mg^{2+} (mg/l)	60	150
Ca^{2+} (mg/l)	100	100
Na^{+} (mg/l)	200	200
K^{+} (mg/l)	5	12
HCO^{-}_{3} (mg/l)	200	200
Cl^{-} (mg/l)	250	600
NO^{-}_{3} (mg/l)	45	70
SO^{2-}_{4} (mg/l)	250	250

Annex 4: Recovery Wells Geoinvestigations

4B – Pumping Tests

Remaining Days to finish the project	29 Days

Date: 02-12-2017

Ref No: SAK-EFF-145/482

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.14

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 14 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 29/11/2017* at well 14 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST).*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.
These parameters are useful to determine:
- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also, to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 14. The pump was started on November, 29, 2017 at 10:05 a.m. and was stopped on November, 29, 2017 at 17.05 p.m. The duration of the pumping was a total of 7 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	55.00	60
2	102.00	60
3	148.00	60
4	201.00	240

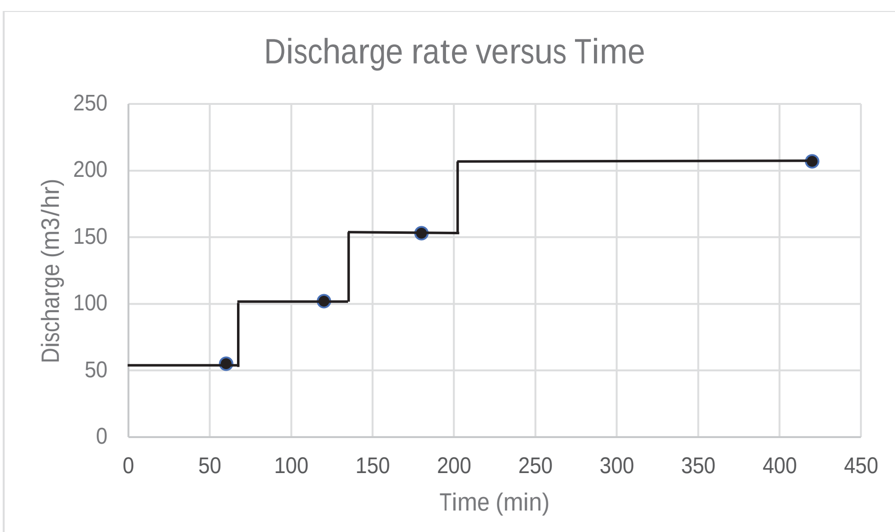


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well no. 14 and the monitoring well no. 23 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3.

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-240	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 14 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

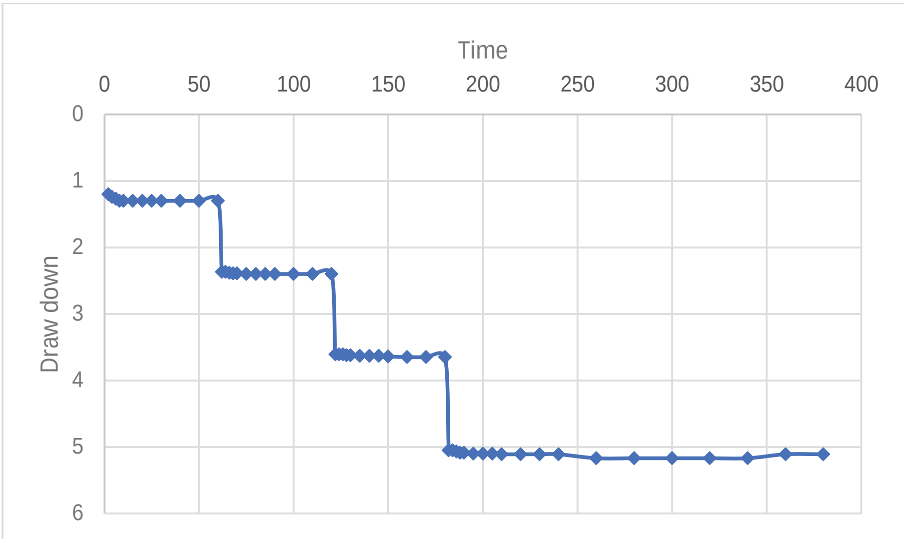
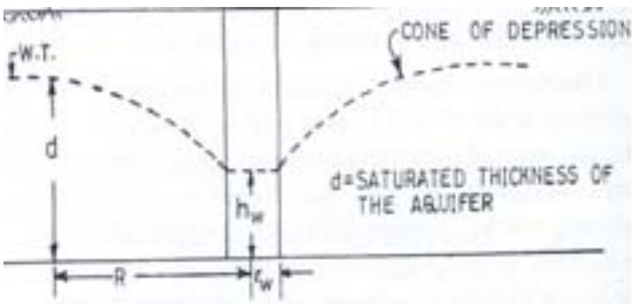


Figure 2: Drawdown curve for step-draw down test in well 14

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K \left(d^2 - h_w^{\ 2}\right)}{2.3 \log_{10}\left(\dfrac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	5.11	m
Q	201*24 =4824	m^3/d
R	150	m
d	25	m
r_w	0.15	m
h_w	19.89	m

Then the hydraulic conductivity is computed as K = 46.21 m/d

Transmissivity = 1155.30 m^2/d

Maximum draw down of well 14 is 5.11 m and maximum drawdown of the observation well 23 is 15 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: Specific capacity

Q	Well sp. Capacity (m3/d)
55.00	1065
102.00	1020
148.00	973
201.00	944

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

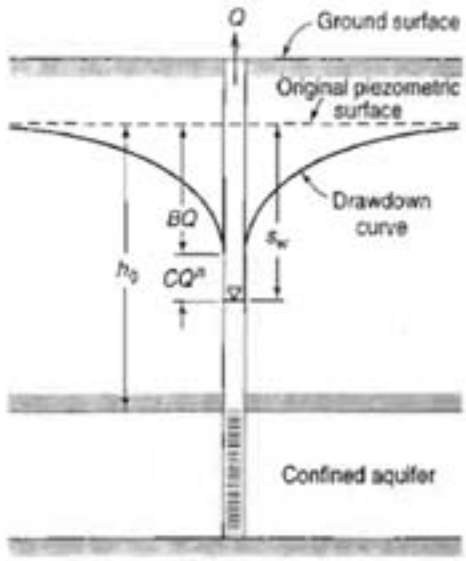


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows:

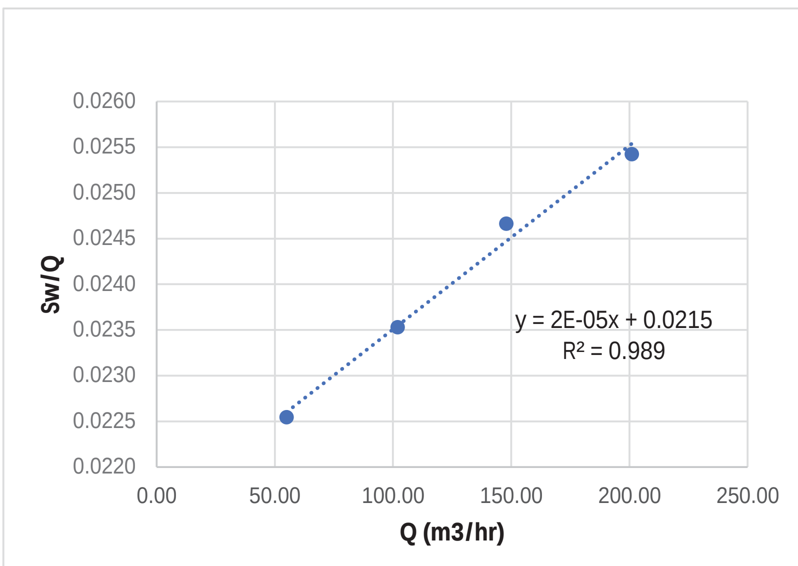


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0215
C = 0.00002
letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
55.00	0.061	1.18	1.24
102.00	0.21	2.19	2.40
148.00	0.44	3.18	3.62
201.00	0.81	4.32	5.13

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100\,\frac{Q/s_w}{Q/BQ} = 100\,\frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well Efficiency
55.00	95.13
102.00	91.33
148.00	87.90
201.00	84.25

6.1.5 Recovery Test Results

At the end of pumping test which continued for 420 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=420 min)

t'	t	t/t'	S'
2	422	211.00	0.110
4	424	106.00	0.110
6	426	71.00	0.110
8	428	53.50	0.100
10	430	43.00	0.100
15	435	29.00	0.090
20	440	22.00	0.090
25	445	17.80	0.090
30	450	15.00	0.080
40	460	11.50	0.080
50	470	9.40	0.080
60	480	8.00	0.080
80	500	6.25	0.070
100	520	5.20	0.070
120	540	4.50	0.070

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q = 201 m^3/hr and s' is 0.03 then **T will be equal to 1226.91 m^2/day**. It was noticed from the recovery data as shown in Table 7 that 98 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

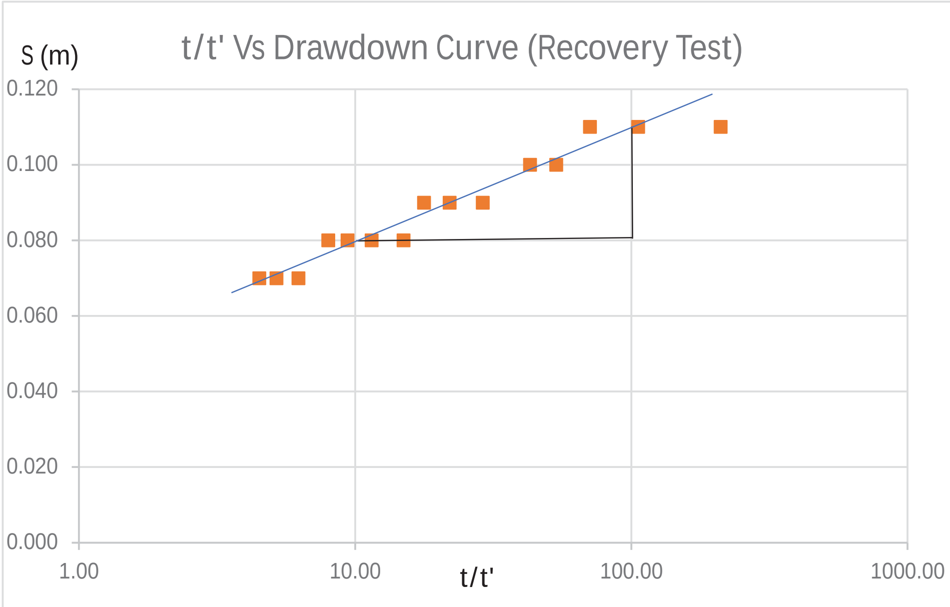


Figure 5: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 5.11 m for 201 m^3/hr. Since the operation of the recovery well 14 will be 180 m^3/hr and the expected draw down will be around 4.6 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 14 the pump should be located 12 m below the static groundwater level and 62.65 m from finishing level. (Finishing level is +48.48 and Groundwater is at a depth of 50.65 m from finishing level).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 14
Annex 2: Pumping test data sheet readings of well 23
Annex 3: Recovery test data sheet readings of well 14
Annex 4: Recovery test data sheet readings of well 23

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 14	observation well no.: 23
Distance from observation well: m	
Well depth :	well diameter :12"
Date of test: 29/11/2017	start time 10.05 AM finish time: 17.05 pm
Depth of pump: 62.3 m	water table depth : 51.59 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	55	2	52.79	1.2
4	55	2	52.83	1.24
6	55	2	52.86	1.27
8	55	2	52.89	1.3
10	55	2	52.89	1.3
15	55	5	52.89	1.3
20	55	5	52.89	1.3
25	55	5	52.89	1.3
30	55	5	52.89	1.3
40	55	10	52.89	1.3
50	55	10	52.89	1.3
60	55	10	52.89	1.3
62	102	2	53.96	2.37
64	102	2	53.96	2.37
66	102	2	53.97	2.38
68	102	2	53.98	2.39
70	102	2	53.98	2.39
75	102	5	53.99	2.4
80	102	5	53.99	2.4
85	102	5	53.99	2.4
90	102	5	53.99	2.4
100	102	10	53.99	2.4
110	102	10	53.99	2.4
120	102	10	53.99	2.4
122	148	2	55.2	3.61
124	148	2	55.2	3.61
126	148	2	55.2	3.61
128	148	2	55.21	3.62
130	148	2	55.21	3.62
135	148	5	55.22	3.63
140	148	5	55.22	3.63
145	148	5	55.22	3.63
150	148	5	55.23	3.64
160	148	10	55.24	3.65
170	148	10	55.24	3.65
180	148	10	55.24	3.65

182	199	2	56.64	5.05
184	199	2	56.64	5.05
186	201	2	56.66	5.07
188	201	2	56.68	5.09
190	201	2	56.68	5.09
195	201	5	56.69	5.1
200	201	5	56.69	5.1
205	201	5	56.69	5.1
210	201	5	56.7	5.11
220	201	10	56.7	5.11
230	201	10	56.7	5.11
240	201	10	56.7	5.11
260	209	20	56.76	5.17
280	209	20	56.76	5.17
300	209	20	56.76	5.17
320	209	20	56.76	5.17
340	209	20	56.76	5.17
360	201	20	56.7	5.11
380	201	20	56.7	5.11
400	201	20	56.7	5.11
420	201	20	56.7	5.11

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet well 23	
Pumping well no.: 14	observation well no.: 23
Distance from observation well 20:	
Well depth :	well diameter :12"
Date of test: 29/11/2017	start time 10:05 AM finish time:17:05 pm
Depth of pump:	water table depth : 50.89 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	55	2	50.89	0
4	55	2	50.89	0
6	55	2	50.89	0
8	55	2	50.89	0
10	55	2	50.9	0.01
15	55	5	50.91	0.02
20	55	5	50.91	0.02
25	55	5	50.91	0.02
30	55	5	50.91	0.02
40	55	10	50.91	0.02
50	55	10	50.91	0.02
60	55	10	50.92	0.03
62	102	2	50.92	0.03
64	102	2	50.93	0.04
66	102	2	50.94	0.05
68	102	2	50.94	0.05
70	102	2	50.95	0.06
75	102	5	50.95	0.06
80	102	5	50.95	0.06
85	102	5	50.95	0.06
90	102	5	50.96	0.07
100	102	10	50.96	0.07
110	102	10	50.96	0.07
120	102	10	50.96	0.07
122	148	2	50.96	0.07
124	148	2	50.96	0.07
126	148	2	50.97	0.08
128	148	2	50.97	0.08
130	148	2	50.97	0.08
135	148	5	50.98	0.09
140	148	5	50.98	0.09
145	148	5	50.98	0.09
150	148	5	50.98	0.09
160	148	10	50.98	0.09
170	148	10	50.98	0.09
180	148	10	50.98	0.09

182	199	2	50.99	0.1
184	199	2	50.99	0.1
186	201	2	50.99	0.1
188	201	2	51	0.11
190	201	2	51	0.11
195	201	5	51.01	0.12
200	201	5	51.01	0.12
205	201	5	51.02	0.13
210	201	5	51.02	0.13
220	201	10	51.02	0.13
230	201	10	51.02	0.13
240	201	10	51.02	0.13
260	209	20	51.02	0.13
280	209	20	51.02	0.13
300	209	20	51.02	0.13
320	209	20	51.02	0.13
340	209	20	51.03	0.14
360	201	20	51.04	0.15

Recovery test readings well 14	
Time intervals after stoping pumping (min)	water table readings
2	51.7
2	51.7
2	51.7
2	51.69
2	51.69
5	51.68
5	51.68
5	51.68
5	51.67
10	51.67
10	51.67
10	51.67
20	51.66
20	51.66
20	51.66

Recovery test for Obs. Well 23	
time intervals after stoping pumping (min)	water table readings
2	51.4
2	50.96
2	50.93
2	50.91
2	50.9
5	50.89
5	50.89
5	50.89

Remaining Days to finish the project	19 Days

Date: 12-12-2017

Ref No: SAK-EFF-145/493

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.16

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 16 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 07/12/2017* at well 16 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST).*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.
These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also, to evaluate the loss, efficiency and the productivity of the well.

4.1. Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 16. The pump was started on December, 07, 2017 at 10:00 a.m. and was stopped on December, 07, 2017 at 16:00 p.m. The duration of the pumping was a total of 6 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	53.50	60
2	101.00	60
3	150.00	60
4	199.00	180

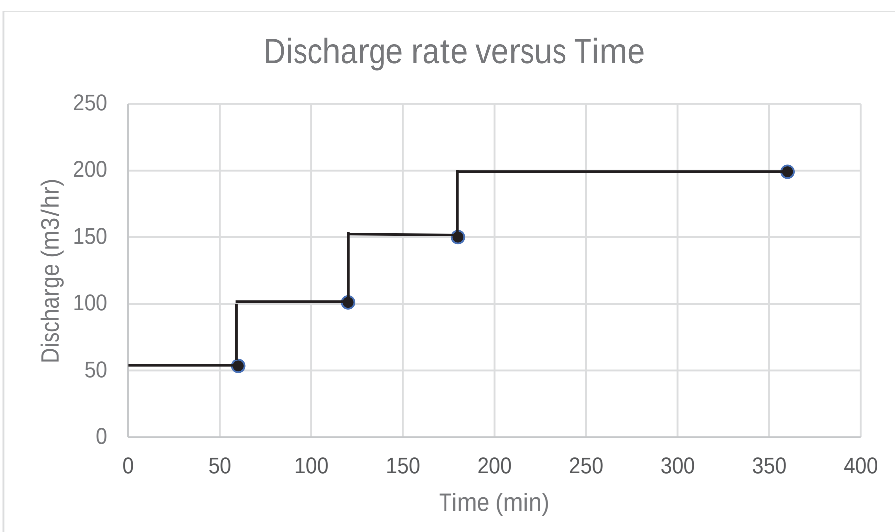


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well no. 16 and the monitoring well no. 17 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3.

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-180	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 16 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

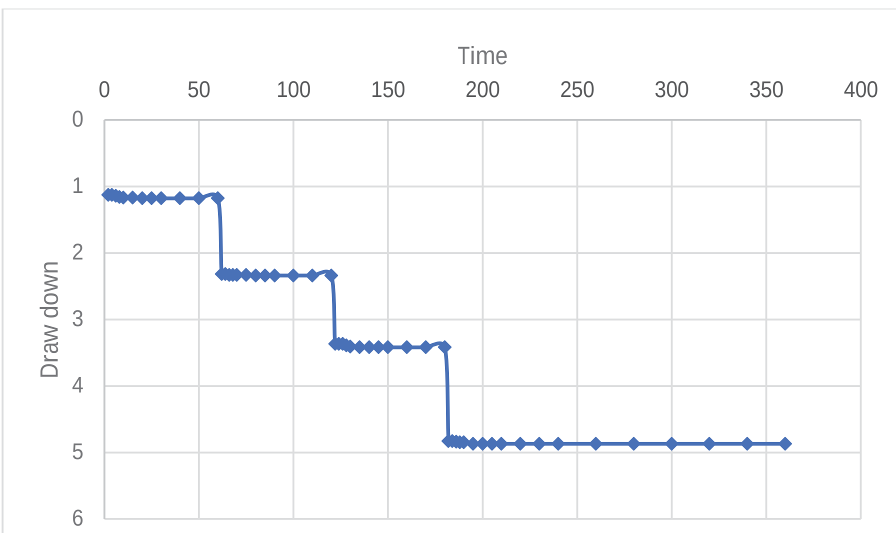
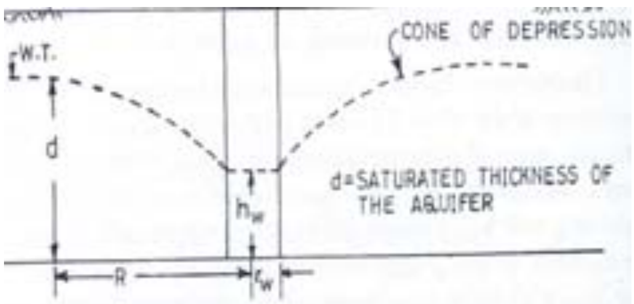


Figure 2: Drawdown curve for step-draw down test in well 16

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K \left(d^2 - h_w^{\,2}\right)}{2.3 \log_{10}\left(\dfrac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	4.87	m
Q	199*24 = 4776	m^3/d
R	150	m
d	24	m
r_w	0.15	m
h_w	19.13	m

Then the hydraulic conductivity is computed as K = 49.97 m/d

Transmissivity = 1199.19 m^2/d

Maximum draw down of well 16 is 4.87 m and maximum drawdown of the observation well 17 is 19 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: Specific capacity

Q	Well sp. Capacity (m3/d)
53.50	1136
101.00	1045
150.00	1053
199.00	981

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

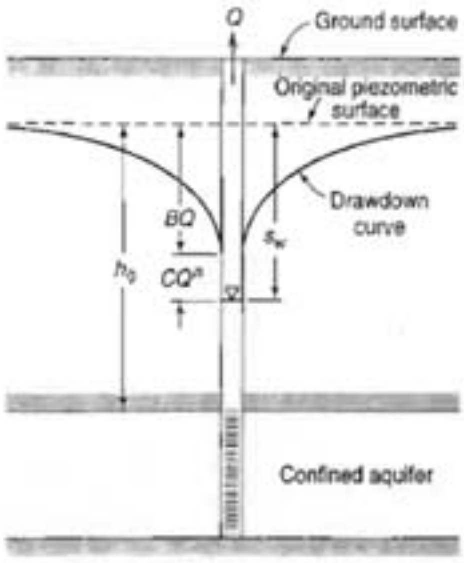


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows:

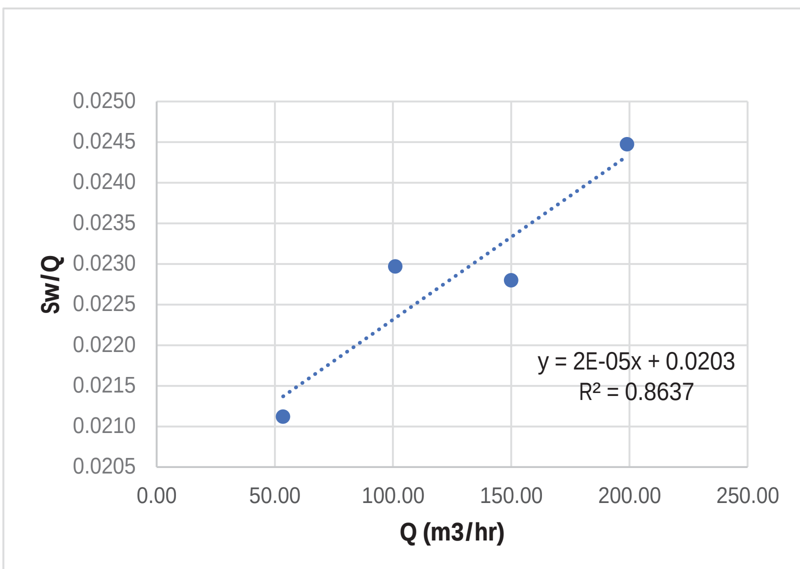


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0456
C = 0.00006
letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
53.50	0.057	1.09	1.14
101.00	0.204	2.05	2.25
150.00	0.450	3.05	3.50
199.00	0.792	4.04	4.83

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well Efficiency
53.50	94.99
101.00	90.95
150.00	87.12
199.00	83.61

6.1.5 Recovery Test Results

At the end of pumping test which continued for 360 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to pumping) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=360 min)

t'	t	t/t'	S'
2	362	181.00	0.120
4	364	91.00	0.120
6	366	61.00	0.110
8	368	46.00	0.110
10	370	37.00	0.100
15	375	25.00	0.090
20	380	19.00	0.090
25	385	15.40	0.080
30	390	13.00	0.080
40	400	10.00	0.080
50	410	8.20	0.070
60	420	7.00	0.070
80	440	5.50	0.070
100	460	4.60	0.060
120	480	4.00	0.060

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q = 199 m^3/hr and s' is 0.042 then **T will be equal to 867.6 m^2/day**. It was noticed from the recovery data as shown in Table 7 that 98 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

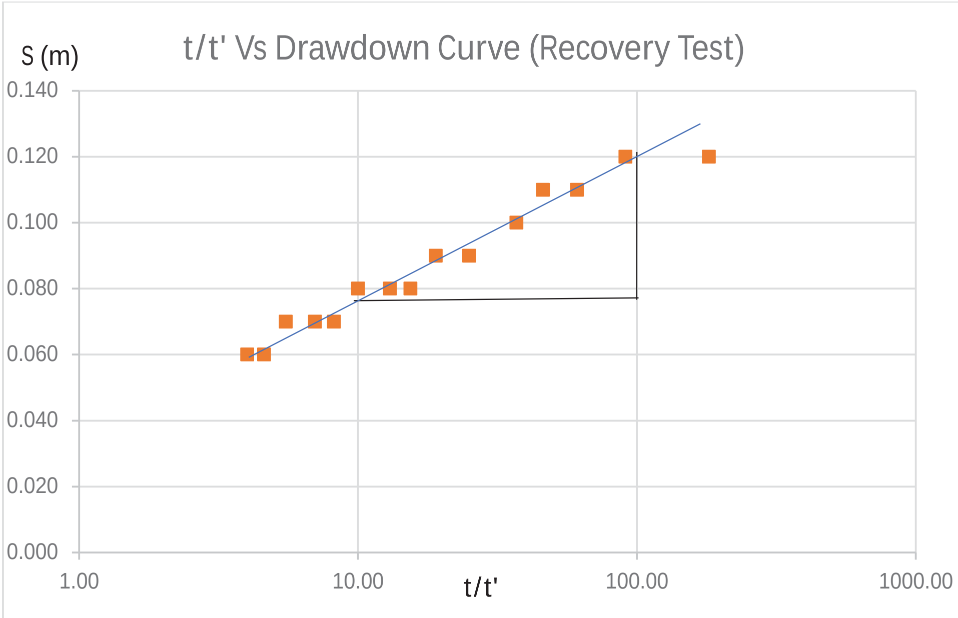


Figure 5: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 4.87 m for 199 m^3/hr. Since the operation of the recovery well 16 will be 180 m^3/hr and the expected draw down will be around 4.5 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 16 the pump should be located 11.5 m below the static groundwater level and 62.55 m from finishing level. (Finishing level is +49.36 and Groundwater is at a depth of 51.05 m from finishing level).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 16
Annex 2: Pumping test data sheet readings of well 17
Annex 3: Recovery test data sheet readings of well 16

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 16	observation well no.: 17
Distance from observation well: m	
Well depth :	well diameter :12"
Date of test: 7/12/2017	start time 10:00 AM finish time: 16:00 pm
Depth of pump: 63.3 m	water table depth : 52.13 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	53.5	2	53.26	1.13
4	53.5	2	53.26	1.13
6	53.5	2	53.27	1.14
8	53.5	2	53.29	1.16
10	53.5	2	53.3	1.17
15	53.5	5	53.3	1.17
20	53.5	5	53.31	1.18
25	53.5	5	53.31	1.18
30	53.5	5	53.31	1.18
40	53.5	10	53.31	1.18
50	53.5	10	53.31	1.18
60	53.5	10	53.31	1.18
62	101	2	54.45	2.32
64	101	2	54.45	2.32
66	101	2	54.46	2.33
68	101	2	54.46	2.33
70	101	2	54.46	2.33
75	101	5	54.46	2.33
80	101	5	54.47	2.34
85	101	5	54.47	2.34
90	101	5	54.47	2.34
100	101	10	54.47	2.34
110	101	10	54.47	2.34
120	101	10	54.47	2.34
122	150	2	55.5	3.37
124	150	2	55.5	3.37
126	150	2	55.5	3.37
128	150	2	55.52	3.39
130	150	2	55.54	3.41
135	150	5	55.55	3.42
140	150	5	55.55	3.42
145	150	5	55.55	3.42
150	150	5	55.55	3.42
160	150	10	55.55	3.42
170	150	10	55.55	3.42
180	150	10	55.55	3.42

182	197	2	56.96	4.83
184	199	2	56.96	4.83
186	199	2	56.97	4.84
188	199	2	56.98	4.85
190	199	2	56.98	4.85
195	199	5	57	4.87
200	199	5	57	4.87
205	199	5	57	4.87
210	199	5	57	4.87
220	199	10	57	4.87
230	199	10	57	4.87
240	199	10	57	4.87
260	199	20	57	4.87
280	199	20	57	4.87
300	199	20	57	4.87
320	199	20	57	4.87
340	199	20	57	4.87
360	199	20	57	4.87

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet well 17	
Pumping well no.: 16	observation well no.: 17
Distance from observation well 20:	
Well depth :	well diameter :12"
Date of test: 07/12/2017	start time 10:00 AM finish time:16:00 pm
Depth of pump:	water table depth : 50.39 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	53.5	2	50.39	0
4	53.5	2	50.39	0
6	53.5	2	50.39	0
8	53.5	2	50.39	0
10	53.5	2	50.39	0
15	53.5	5	50.41	0.02
20	53.5	5	50.42	0.03
25	53.5	5	50.42	0.03
30	53.5	5	50.42	0.03
40	53.5	10	50.42	0.03
50	53.5	10	50.42	0.03
60	53.5	10	50.42	0.03
62	101	2	50.43	0.04
64	101	2	50.44	0.05
66	101	2	50.45	0.06
68	101	2	50.45	0.06
70	101	2	50.45	0.06
75	101	5	50.45	0.06
80	101	5	50.45	0.06
85	101	5	50.45	0.06
90	101	5	50.45	0.06
100	101	10	50.45	0.06
110	101	10	50.45	0.06
120	101	10	50.45	0.06
122	150	2	50.45	0.06
124	150	2	50.46	0.07
126	150	2	50.47	0.08
128	150	2	50.47	0.08
130	150	2	50.48	0.09
135	150	5	50.49	0.1
140	150	5	50.49	0.1
145	150	5	50.51	0.12
150	150	5	50.52	0.13
160	150	10	50.52	0.13
170	150	10	50.52	0.13
180	150	10	50.52	0.13

182	197	2	50.52	0.13
184	199	2	50.52	0.13
186	199	2	50.53	0.14
188	199	2	50.53	0.14
190	199	2	50.54	0.15
195	199	5	50.54	0.15
200	199	5	50.55	0.16
205	199	5	50.55	0.16
210	199	5	50.55	0.16
220	199	10	50.55	0.16
230	199	10	50.56	0.17
240	199	10	50.57	0.18
260	199	20	50.57	0.18
280	199	20	50.57	0.18
300	199	20	50.58	0.19
320	199	20	50.58	0.19
340	199	20	50.58	0.19
360	199	20	50.58	0.19

Recovery test readings well 16	
Time intervals after stoping pumping (min)	water table readings
2	52.25
2	52.25
2	52.24
2	52.24
2	52.23
5	52.22
5	52.22
5	52.21
5	52.21
10	52.21
10	52.2
10	52.2
20	52.2
20	52.19
20	52.19

Remaining Days to finish the project	38 Days

Date: 23-11-2017

Ref No: SAK-EFF-145/469

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.17

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 17 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 21/11/2017* at well 17 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.
These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also, to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 17 in two stages due to the motor failure and winter conditions.

The duration of the pumping was a total of 4 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	51	60
2	102	60
3	150	60
4	210	60

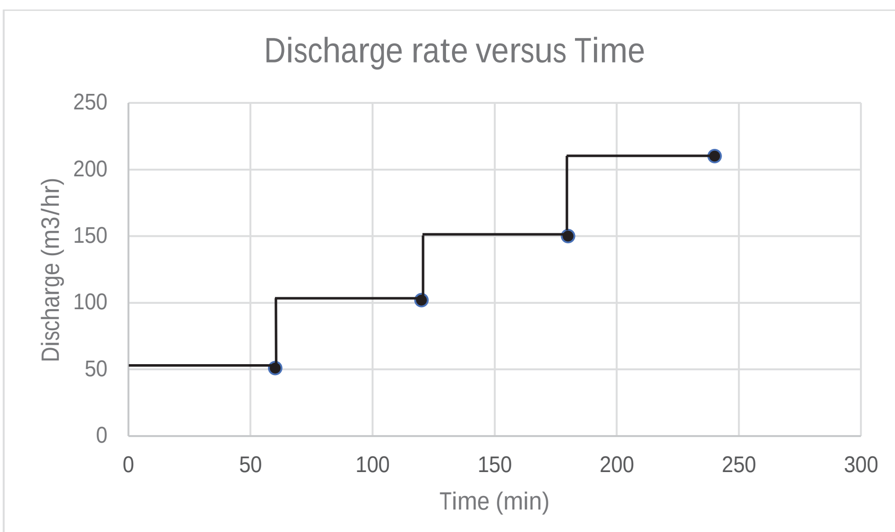


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-80	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 17 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping. First pumping test was stopped due to sudden failure of the motor after 120 minutes from the starting of the test. The rest of measurements was taken from second pumping test made for well 17 in the second day for another 120 minutes.

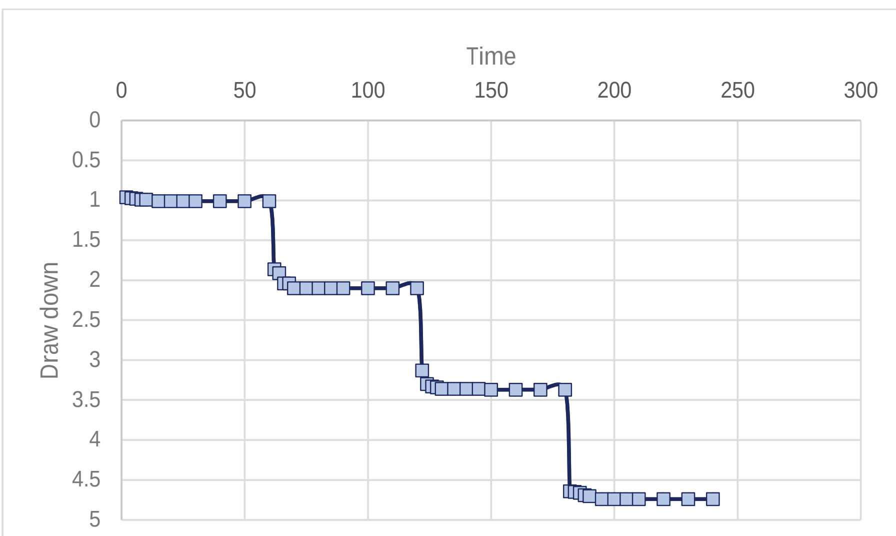
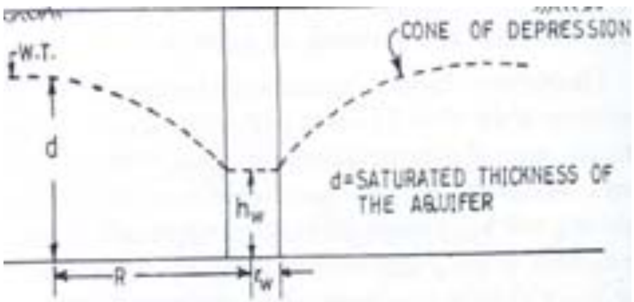


Figure 2: Drawdown curve for step-draw down test in well 17

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^2)}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	4.74	m
Q	210*24 = 5040	m^3/d
R	150	m
d	31	m
r_w	0.15	m
h_w	26.26	m

Maximum draw down of well 17 is 4.74 m.

Then the hydraulic conductivity is computed as = 40.81 m/d
Transmissivity = 1264.98 m^2/d

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: Specific capacity

Q	Well sp. Capacity (m3/d/m)
51.00	1212
102.00	1166
150.00	1068
210.00	1063

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 4 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

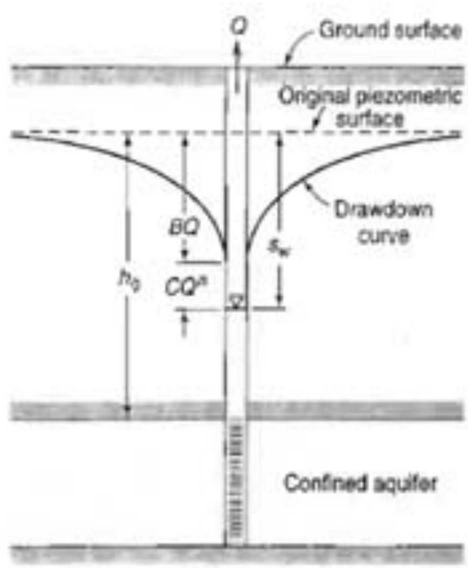


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows:

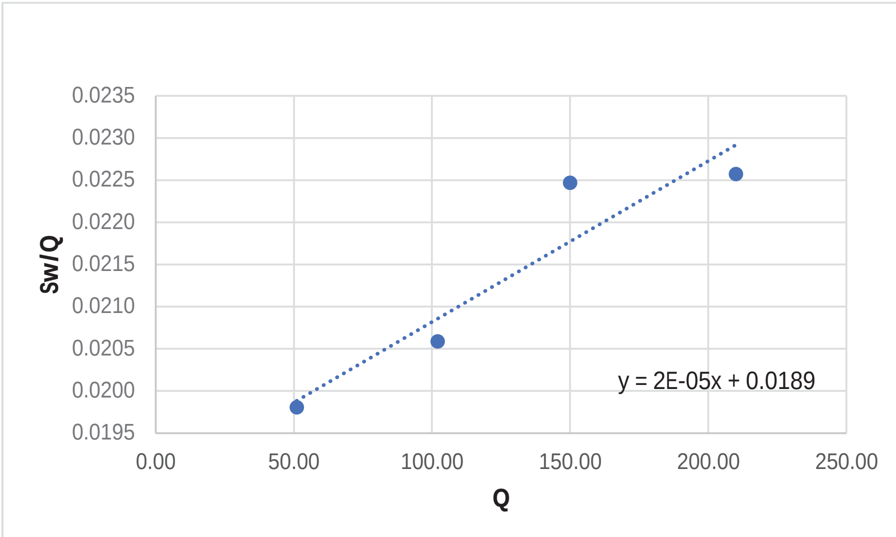


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0189
C = 0.00002
letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
51.00	0.052	0.96	1.02
102.00	0.21	1.93	2.14
150.00	0.45	2.84	3.29
210.00	0.88	3.97	4.85

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100 \frac{Q/s_w}{Q/BQ} = 100 \frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well Efficiency %
51.00	94.88
102.00	90.26
150.00	86.30
210.00	81.82

6.1.5 Recovery Test Results

At the end of pumping test which continued for 240 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T \simeq \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=240 min)

t'	t	t/t'	S'
2	242	121	0.180
4	244	61	0.170
6	246	41	0.160
8	248	31	0.150
10	250	25	0.140
15	255	17	0.130
20	260	13	0.130
25	265	10.6	0.120
30	270	9	0.110
40	280	7	0.100
50	290	5.8	0.080
60	300	5	0.070
80	320	4	0.050

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q = 210 m^3/hr and s' is 0.06 then **T will be equal to 640.9 m^2/day**. It was noticed from the recovery data as shown in Table7 that 97 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

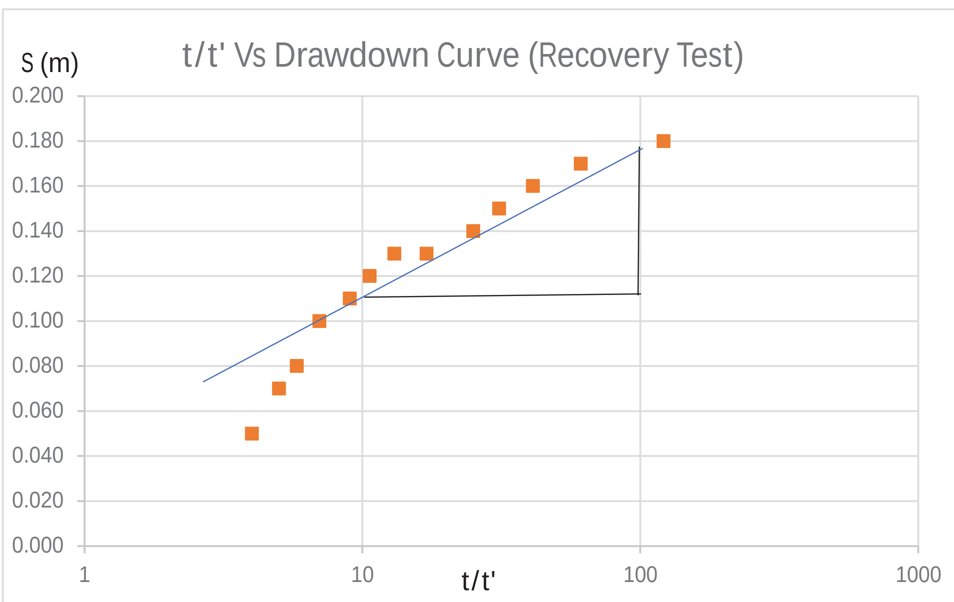


Figure 6: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 4.74 m for 210 m^3/hr. Since the operation of the recovery well 17 will be 180 m^3/hr and the expected draw down will be around 4.00 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 17 the pump should be located 14.00 m below the static groundwater level and 63.99 m from finishing level. (Finishing level is +48.49 and Groundwater is at a depth of 49.99 m from finishing level)

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 17
Annex 2: Recovery test data sheet readings of well 17

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 17	observation well no.: -
Distance from observation well: m	
Well depth :	well diameter :12"
Date of test: 21/11/2017	start time AM finish time: pm
Depth of pump: 62.3 m	water table depth : 51.00 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	51	2	51.96	0.96
4	51	2	51.97	0.97
6	51	2	51.98	0.98
8	51	2	51.99	0.99
10	51	2	51.99	0.99
15	51	5	52.01	1.01
20	51	5	52.01	1.01
25	51	5	52.01	1.01
30	51	5	52.01	1.01
40	51	10	52.01	1.01
50	51	10	52.01	1.01
60	51	10	52.01	1.01
62	90	2	52.86	1.86
64	93	2	52.91	1.91
66	100	2	53.04	2.04
68	104	2	53.04	2.04
70	104	2	53.1	2.1
75	104	5	53.1	2.1
80	102	5	53.1	2.1
85	102	5	53.1	2.1
90	102	5	53.1	2.1
100	102	10	53.1	2.1
110	102	10	53.1	2.1
120	102	10	53.1	2.1
122	150	2	54.13	3.13
124	150	2	54.3	3.3
126	150	2	54.33	3.33
128	150	2	54.34	3.34
130	150	2	54.36	3.36
135	150	5	54.36	3.36
140	150	5	54.36	3.36
145	150	5	54.36	3.36
150	150	5	54.37	3.37
160	150	10	54.37	3.37
170	150	10	54.37	3.37
180	150	10	54.37	3.37

182	210	2	55.64	4.64
184	210	2	55.65	4.65
186	210	2	55.66	4.66
188	210	2	55.69	4.69
190	210	2	55.7	4.7
195	210	5	55.74	4.74
200	210	5	55.74	4.74
205	210	5	55.74	4.74
210	210	5	55.74	4.74
220	210	10	55.74	4.74
230	210	10	55.74	4.74
240	210	10	55.74	4.74

Recovery test readings well 17	
Time intervals after stoping pumping (min)	water table readings
2	51.18
2	51.17
2	51.16
2	51.15
2	51.14
5	51.13
5	51.13
5	51.12
5	51.11
10	51.1
10	51.08
10	51.07
20	51.05

Remaining Days to finish the project	52 Days

Date: 09-11-2017

Ref No: SAK-EFF-145/451

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.18

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 18 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 08/11/2017* at well 18 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.

2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.

2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.

2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.

2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.

These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 18. The pump was started on November, 08, 2017 at 09:50 a.m. and was stopped on November, 08, 2017 at 16.40 p.m. The duration of the pumping was a total of 6.6 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	50	60
2	100	60
3	150	60
4	200	220

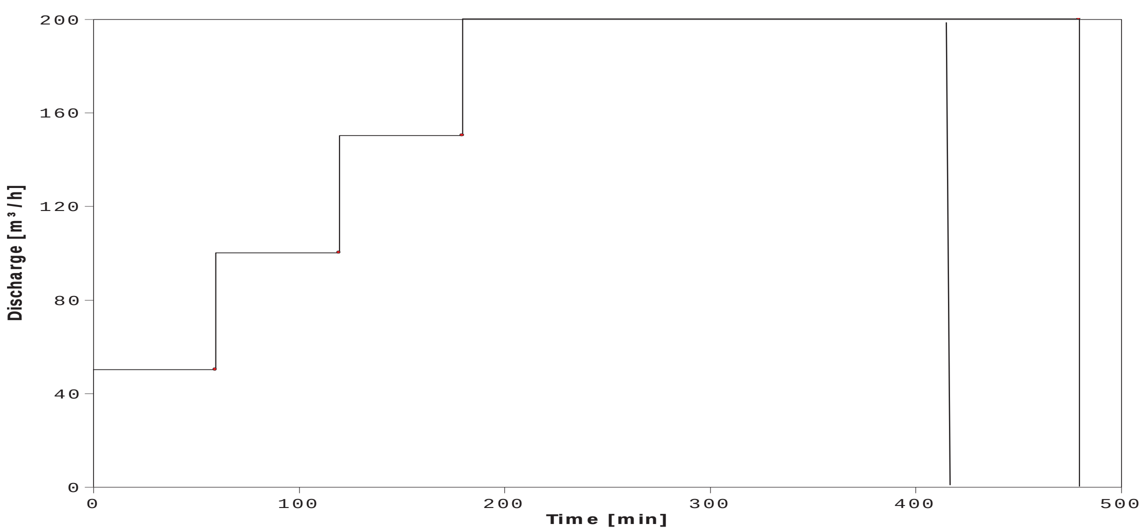


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well and in the observation well No. 17 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-220	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 18 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

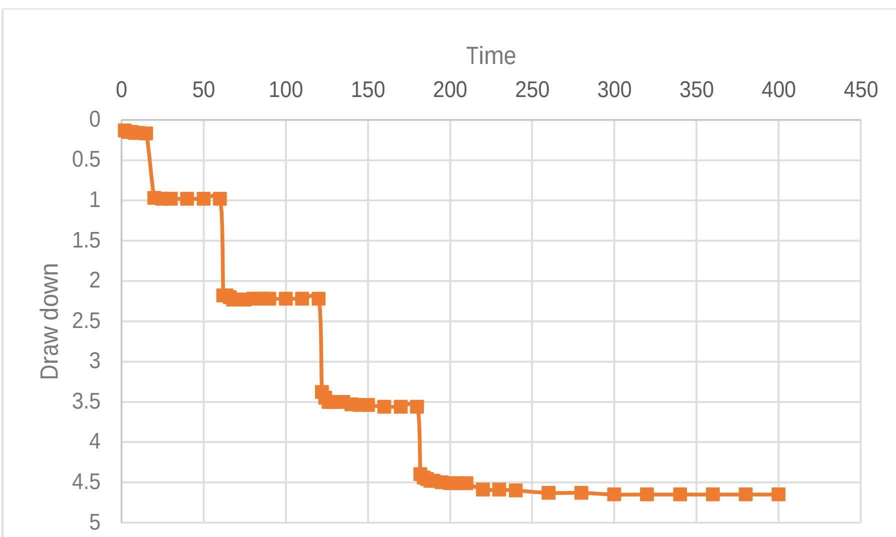
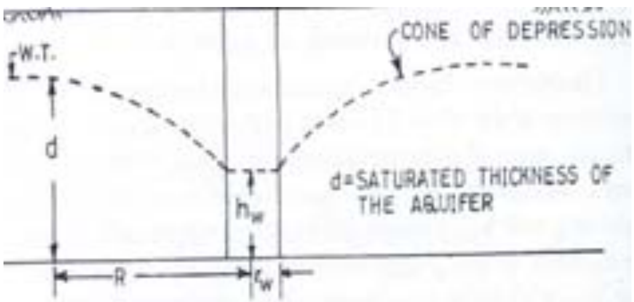


Figure 2: Drawdown curve for step-draw down test in well 18

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^2)}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	4.65	m
Q	= 198*24 = 4752	m^3/d
R	150	m
d	30	m
r_w	0.15	m
h_w	25.35	m

Then the hydraulic conductivity is computed as =40.57 m/d

Transmissivity = 811.44 m^2/d

Maximum draw down of well 18 is 4.65 m and maximum drawdown of the observation well no. 17 which is 115 m away from well 18 is 8 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: specific capacity

Q	well sp. Capacity (m3/d)
47	1151
97	1049
155	1045
198	1022

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 4 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

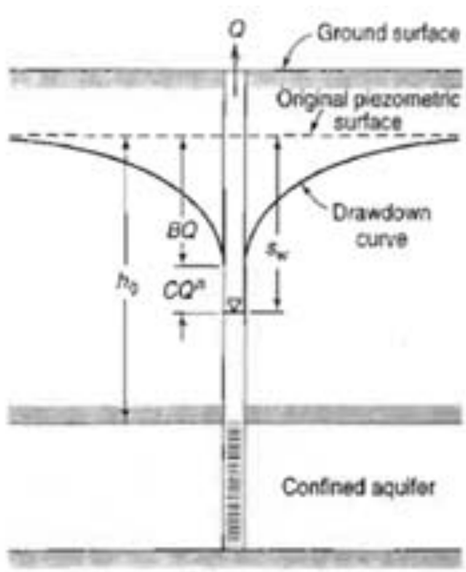


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows :

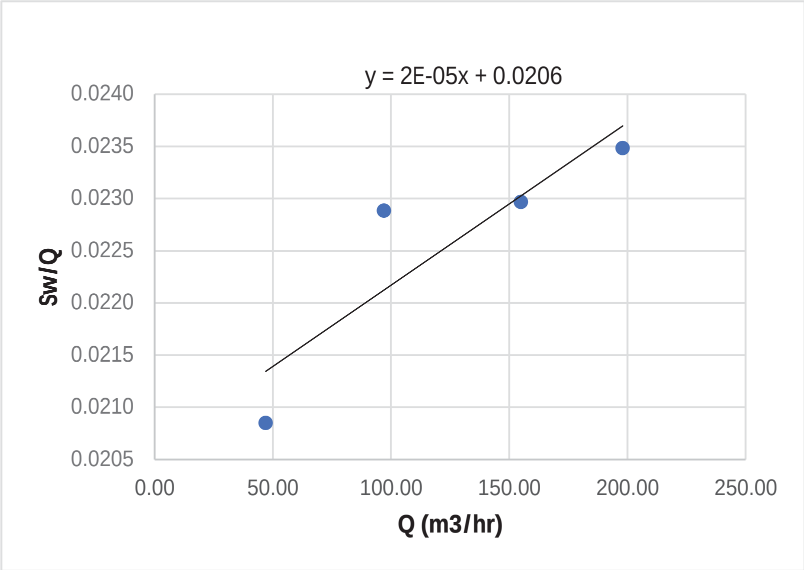


Figure 3: Specific draw down Vs Discharge

Therefore, from figure 5, B and C were adjusted and these values are as follows

B = 0.0206
C = 0.00002

letting n=2

By using these values and the equation above Table 6 presents the estimated well losses and aquifer losses.

Table 6: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
47	0.04	0.9682	1.01
97	0.19	1.9982	2.19
155	0.48	3.193	3.67
198	0.78	4.0788	4.86

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well efficiency
47	95.64
97	91.39
155	86.92
198	83.88

6.1.5 Recovery Test Results

At the end of pumping test which continued for 400 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 7 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T \simeq \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=400 min)

t'	t	t/t'	S'
2	402	201	0.300
4	404	101	0.220
6	406	67.67	0.180
8	408	51	0.180
10	410	41	0.160
15	415	27.67	0.150
20	420	21	0.150
25	425	17	0.150
30	430	14.33	0.140
40	440	11	0.130
50	450	9	0.120
60	460	7.67	0.100
80	480	6	0.080
100	500	5	0.070
120	520	4.33	0.060

It was noticed from the recovery data as shown in Table 7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

7. Location of Pump:

As noticed in the pumping test the draw down was 4.65 m for 198 m^3/hr. Since the operation of the recovery well 18 will be 180 m^3/hr and the expected draw down will be around 4.2 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 18 the pump should be located 12.6 m below the static groundwater level and 62.06 m from the finishing level (the total depth from finishing level is 80 m). so, there is 2 m free before we reach the screen.

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 18
Annex 2: Pumping test data sheet readings of well 17
Annex 3: Recovery test data sheet readings of well 18

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 18	observation well no.: 17
Distance from observation well 28: m	
Well depth :	well diameter :12"
Date of test: 08/11/2017	start time 09:50 AM finish time: 16.40pm
Depth of pump: 62.3 m	water table depth : 50.60 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	45	2	50.73	0.13
4	45	2	50.75	0.15
6	45	2	50.75	0.15
8	48	2	50.76	0.16
10	48	2	50.76	0.16
15	48	5	50.77	0.17
20	47	5	51.57	0.97
25	47	5	51.58	0.98
30	47	5	51.58	0.98
40	47	10	51.58	0.98
50	47	10	51.58	0.98
60	47	10	51.58	0.98
62	96	2	52.78	2.18
64	96	2	52.78	2.18
66	96	2	52.8	2.2
68	99	2	52.83	2.23
70	99	2	52.83	2.23
75	99	5	52.83	2.23
80	97	5	52.82	2.22
85	97	5	52.82	2.22
90	97	5	52.82	2.22
100	97	10	52.82	2.22
110	97	10	52.82	2.22
120	97	10	52.82	2.22
122	153	2	53.98	3.38
124	153	2	54.05	3.45
126	153	2	54.1	3.5
128	153	2	54.1	3.5
130	153	2	54.1	3.5
135	153	5	54.1	3.5
140	155	5	54.13	3.53
145	155	5	54.14	3.54
150	155	5	54.14	3.54
160	155	10	54.16	3.56
170	155	10	54.16	3.56
180	155	10	54.16	3.56

182	195	2	55	4.4
184	195	2	55.04	4.44
186	195	2	55.06	4.46
188	195	2	55.08	4.48
190	195	2	55.08	4.48
195	195	5	55.1	4.5
200	195	5	55.11	4.51
205	195	5	55.11	4.51
210	195	5	55.11	4.51
220	196	10	55.19	4.59
230	196	10	55.19	4.59
240	196	10	55.2	4.6
260	198	20	55.23	4.63
280	198	20	55.23	4.63
300	198	20	55.25	4.65
320	198	20	55.25	4.65
340	198	20	55.25	4.65
360	198	20	55.25	4.65
380	198	20	55.25	4.65
400	198	20	55.25	4.65

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 18	observation well no.: 17
Distance from observation well 28: 115 m	
Well depth :	well diameter :12"
Date of test: 08/11/2017	start time 09:50 AM finish time:16:40 pm
Depth of pump: 62.3	water table depth : 50.20 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	45	2	50.2	0
4	45	2	50.2	0
6	45	2	50.2	0
8	48	2	50.2	0
10	48	2	50.2	0
15	48	5	50.2	0
20	47	5	50.2	0
25	47	5	50.2	0
30	47	5	50.2	0
40	47	10	50.2	0
50	47	10	50.2	0
60	47	10	50.2	0
62	96	2	50.2	0
64	96	2	50.2	0
66	96	2	50.2	0
68	99	2	50.2	0
70	99	2	50.21	0.01
75	99	5	50.21	0.01
80	97	5	50.21	0.01
85	97	5	50.21	0.01
90	97	5	50.21	0.01
100	97	10	50.22	0.02
110	97	10	50.22	0.02
120	97	10	50.23	0.03
122	153	2	50.23	0.03
124	153	2	50.23	0.03
126	153	2	50.23	0.03
128	153	2	50.23	0.03
130	153	2	50.23	0.03
135	153	5	50.23	0.03
140	155	5	50.23	0.03
145	155	5	50.23	0.03
150	155	5	50.23	0.03
160	155	10	50.23	0.03
170	155	10	50.23	0.03
180	155	10	50.23	0.03
182	195	2	50.23	0.03
184	195	2	50.23	0.03
186	195	2	50.23	0.03
188	195	2	50.23	0.03
190	195	2	50.23	0.03
195	195	5	50.24	0.04
200	195	5	50.24	0.04
205	195	5	50.24	0.04
210	195	5	50.24	0.04
220	196	10	50.25	0.05
230	196	10	50.25	0.05
240	196	10	50.25	0.05
260	198	20	50.27	0.07
280	198	20	50.27	0.07
300	198	20	50.27	0.07
320	198	20	50.27	0.07
340	198	20	50.28	0.08
360	198	20	50.28	0.08
380	198	20	50.28	0.08

Recovery test	
time intervals after stoping pumping (min)	water table readings
2	50.9
2	50.82
2	50.78
2	50.78
2	50.76
5	50.75
5	50.75
5	50.75
5	50.74
10	50.73
10	50.72
10	50.7
20	50.68
20	50.67
20	50.66

Remaining Days to finish the project	34 Days

Date: 27-11-2017

Ref No: SAK-EFF-145/475

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.19

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 19 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 25/11/2017* at well 19 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.

2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.

2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.

2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.

2.5 Hydraulic Conductivity (Permeability): Symbolically represented as K, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.

These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also, to evaluate the loss, efficiency and the productivity of the well.

4.1. Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 19. The pump was started on November, 25, 2017 at 10:10 a.m. and was stopped on November, 25, 2017 at 16.30 p.m. The duration of the pumping was a total of 6 hours and 20 minutes. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	56	60
2	100	60
3	153	60
4	202	200

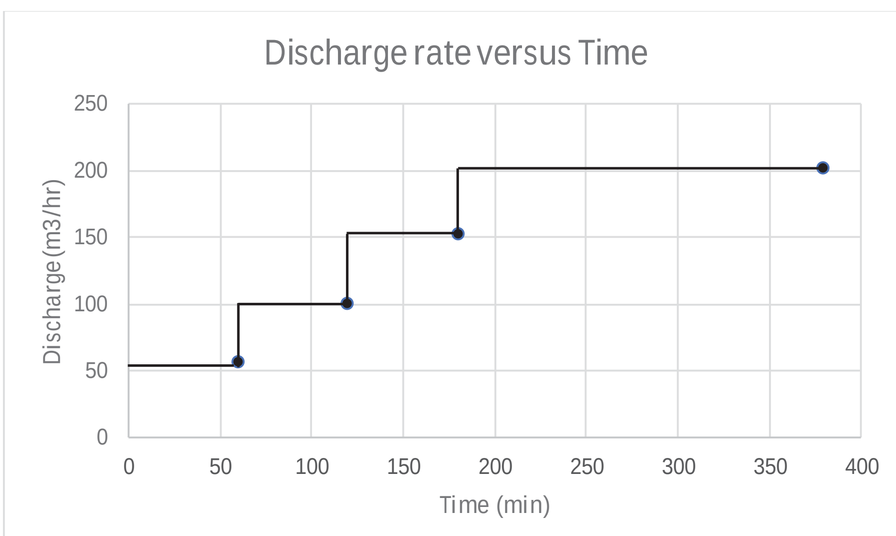


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well no. 19 and the monitoring well no. 20 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-200	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 19 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

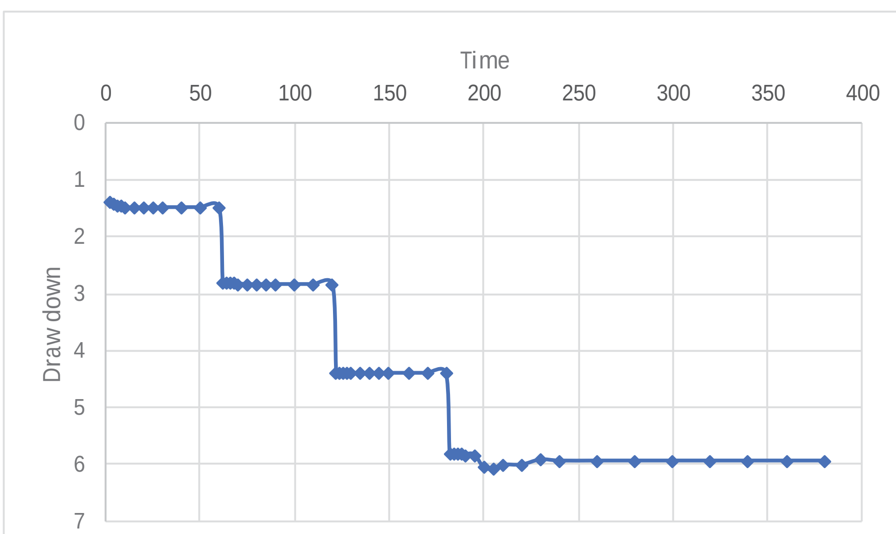
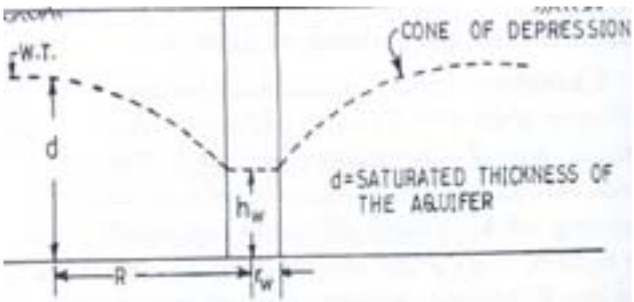


Figure 2: Drawdown curve for step-draw down test in well 19

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^2)}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	6	m
Q	202*24 = 4848	m^3/d
R	150	m
d	33.4	m
r_w	0.15	m
h_w	27.4	m

Then the hydraulic conductivity is computed as = 29.20m/d
Transmissivity = 975.38 m^2/d

Maximum draw down of well 19 is 6 m and maximum drawdown of the observation well 20 is 12 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: Specific capacity

Q	Well sp. Capacity (m3/d)
56.00	908
100.00	848
153.00	836
202.00	808

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

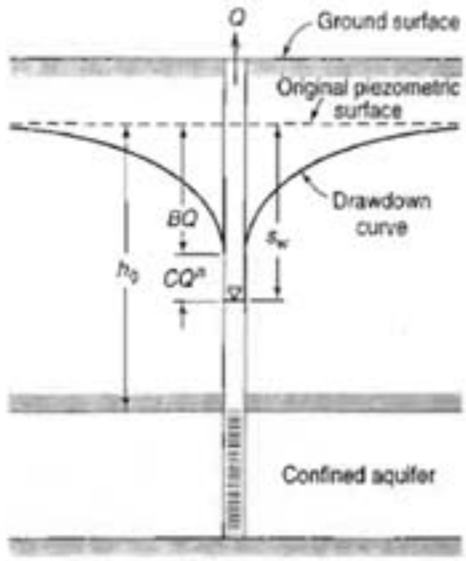


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows:

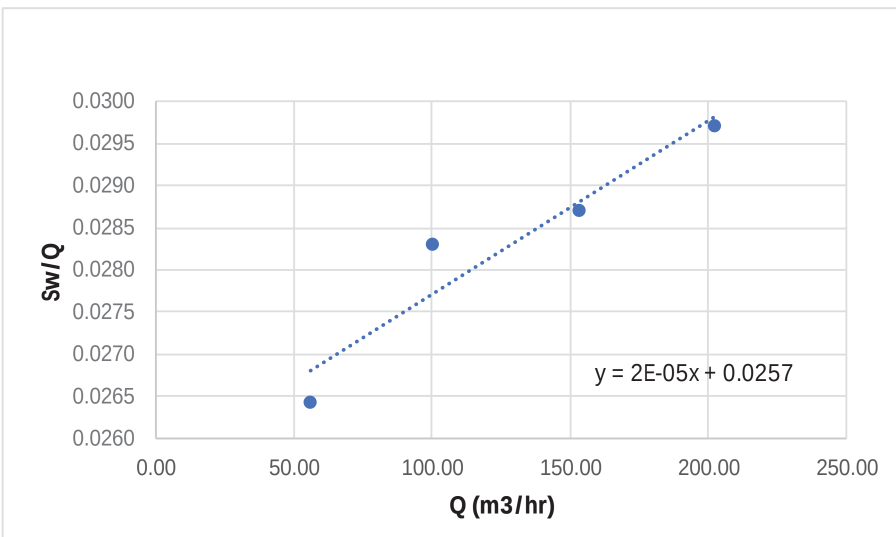


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0257
C = 0.00002
letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
56.00	0.063	1.44	1.50
100.00	0.20	2.57	2.77
153.00	0.47	3.93	4.40
202.00	0.82	5.19	6.01

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100 \frac{Q/s_w}{Q/BQ} = 100 \frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well efficiency
56.00	**95.82**
100.00	**92.78**
153.00	**89.36**
202.00	**86.42**

6.1.5 Recovery Test Results

At the end of pumping test which continued for 380 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=380 min)

t'	t	t/t'	S'
2	382	191.00	0.080
4	384	96.00	0.070
6	386	64.33	0.070
8	388	48.50	0.070
10	390	39.00	0.060
15	395	26.33	0.060
20	400	20.00	0.050
25	405	16.20	0.050
30	410	13.67	0.050
40	420	10.50	0.040
50	430	8.60	0.040
60	440	7.33	0.040
80	460	5.75	0.040
100	480	4.80	0.040
120	500	4.17	0.040

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q = 202 m^3/hr and s' is 0.032 then **T will be equal to 1155.951 m^2/day**. It was noticed from the recovery data as shown in Table7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

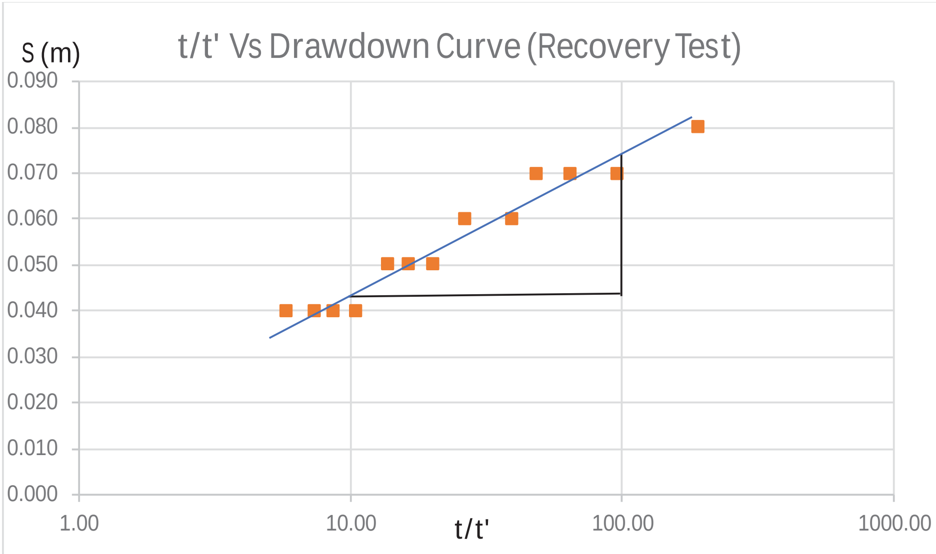


Figure 5: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 6 m for 202 m^3/hr. Since the operation of the recovery well 19 will be 180 m^3/hr and the expected draw down will be around 5.5 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 19 the pump should be located 16 m below the static groundwater level and 64.4 m from finishing level. (Finishing level is +47.00 and Groundwater is at a depth of 48.4 m from finishing level)

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 19
Annex 2: Pumping test data sheet readings of well 20
Annex 3: Recovery test data sheet readings of well 19
Annex 4: Recovery test data sheet readings of well 20

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 19	observation well no.: 20
Distance from observation well: m	
Well depth :	well diameter :12"
Date of test: 25/11/2017	start time 10.10 AM finish time: 16.30 pm
Depth of pump: 62.3 m	water table depth : 49.81 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	56	2	51.19	1.38
4	56	2	51.22	1.41
6	56	2	51.26	1.45
8	56	2	51.27	1.46
10	56	2	51.29	1.48
15	56	5	51.29	1.48
20	56	5	51.29	1.48
25	56	5	51.29	1.48
30	56	5	51.29	1.48
40	56	10	51.29	1.48
50	56	10	51.29	1.48
60	56	10	51.29	1.48
62	100	2	52.6	2.79
64	100	2	52.6	2.79
66	100	2	52.61	2.8
68	100	2	52.62	2.81
70	100	2	52.63	2.82
75	100	5	52.64	2.83
80	100	5	52.64	2.83
85	100	5	52.64	2.83
90	100	5	52.64	2.83
100	100	10	52.64	2.83
110	100	10	52.64	2.83
120	100	10	52.64	2.83
122	153	2	54.19	4.38
124	153	2	54.2	4.39
126	153	2	54.2	4.39
128	153	2	54.2	4.39
130	153	2	54.2	4.39
135	153	5	54.2	4.39
140	153	5	54.2	4.39
145	153	5	54.2	4.39
150	153	5	54.2	4.39
160	153	10	54.2	4.39
170	153	10	54.2	4.39
180	153	10	54.2	4.39

182	198	2	55.6	5.79
184	198	2	55.61	5.8
186	198	2	55.61	5.8
188	198	2	55.62	5.81
190	198	2	55.63	5.82
195	198	5	55.63	5.82
200	204	5	55.86	6.05
205	204	5	55.88	6.07
210	202	5	55.81	6
220	202	10	55.81	6
230	199	10	55.72	5.91
240	199	10	55.74	5.93
260	199	20	55.74	5.93
280	199	20	55.74	5.93
300	199	20	55.74	5.93
320	199	20	55.74	5.93
340	199	20	55.74	5.93
360	199	20	55.74	5.93
380	199	20	55.74	5.93

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 19	observation well no.: 20
Distance from observation well 20:	
Well depth :	well diameter :12"
Date of test: 25/11/2017	start time 10:10AM finish time:16:30 pm
Depth of pump:	water table depth : 48.30 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	56	2	48.31	0.01
4	56	2	48.31	0.01
6	56	2	48.31	0.01
8	56	2	48.31	0.01
10	56	2	48.31	0.01
15	56	5	48.31	0.01
20	56	5	48.31	0.01
25	56	5	48.31	0.01
30	56	5	48.31	0.01
40	56	10	48.31	0.01
50	56	10	48.31	0.01
60	56	10	48.31	0.01
62	100	2	48.32	0.02
64	100	2	48.32	0.02
66	100	2	48.32	0.02
68	100	2	48.32	0.02
70	100	2	48.32	0.02
75	100	5	48.32	0.02
80	100	5	48.32	0.02
85	100	5	48.32	0.02
90	100	5	48.32	0.02
100	100	10	48.32	0.02
110	100	10	48.32	0.02
120	100	10	48.32	0.02
122	153	2	48.33	0.03
124	153	2	48.33	0.03
126	153	2	48.33	0.03
128	153	2	48.33	0.03
130	153	2	48.33	0.03
135	153	5	48.33	0.03
140	153	5	48.33	0.03
145	153	5	48.33	0.03
150	153	5	48.33	0.03
160	153	10	48.33	0.03
170	153	10	48.33	0.03
180	153	10	48.33	0.03

182	198	2	48.34	0.04
184	198	2	48.34	0.04
186	198	2	48.34	0.04
188	198	2	48.34	0.04
190	198	2	48.34	0.04
195	198	5	48.35	0.05
200	204	5	48.36	0.06
205	204	5	48.37	0.07
210	202	5	48.37	0.07
220	202	10	48.38	0.08
230	199	10	48.38	0.08
240	199	10	48.38	0.08
260	199	20	48.39	0.09
280	199	20	48.4	0.1
300	199	20	48.4	0.1
320	199	20	48.4	0.1
340	199	20	48.41	0.11
360	199	20	48.42	0.12
380	199	20	48.42	0.12

Recovery test readings well 19	
Time intervals after stoping pumping (min)	water table readings
2	49.89
2	49.88
2	49.88
2	49.88
2	49.87
5	49.87
5	49.86
5	49.86
5	49.86
10	49.85
10	49.85
10	49.85
20	49.85
20	49.85
20	49.85

Recovery test for Obs. Well 20	
time intervals after stoping pumping (min)	water table readings
2	48.42
2	48.42
2	48.42
2	48.39
2	48.38
5	48.36
5	48.33
5	48.31

Saqqa & Khoudary Co. Ltd
General Contracting
SAK
Saqqa & Khoudary Co.Ltd.
شركة سقا وخضري م. م.
مقاولات عامة

Remaining Days to finish the project	55 Days

Date: 06-11-2017

Ref No: SAK-EFF-145/441

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.20

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 20 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 02/11/2017* at well 20 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.
These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 20. The pump was started on November, 02, 2017 at 10.50 a.m. and was stopped on November, 02, 2017 at 16.50 p.m. The duration of the pumping was a total of 4 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	48	6
2	46	54
3	103	4
4	104.2	56
5	147	8
6	150	2
7	147	50
8	206	10
9	204	5
10	201	10
11	198	15
12	192	10
13	177	10
14	207	20
15	210	20
16	208	20

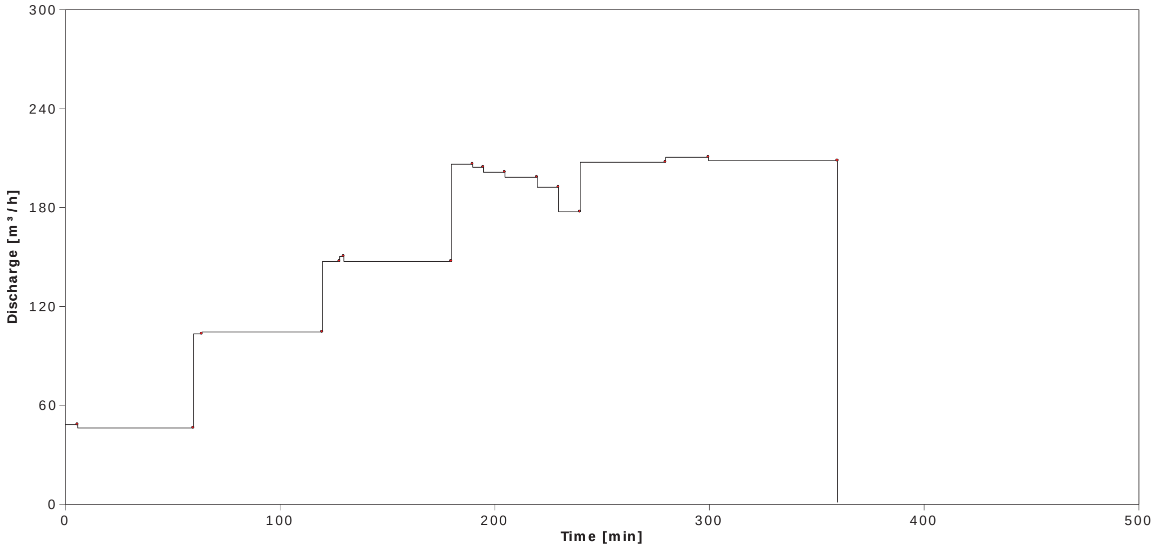


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well. Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well and in the observation well No. 27 during the pumping test. Water levels were collected for each flow rate as follows in table 2.

Table 2: Time interval between measurements.

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-70	2
70-90	5
90-120	10

120-130	2
130-150	5
150-180	10
180-190	2
190-210	5
210-240	10
240-360	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 3: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 20 was drawn by Aquifer Test software. Figure 2 shows the recorded draw down against time.

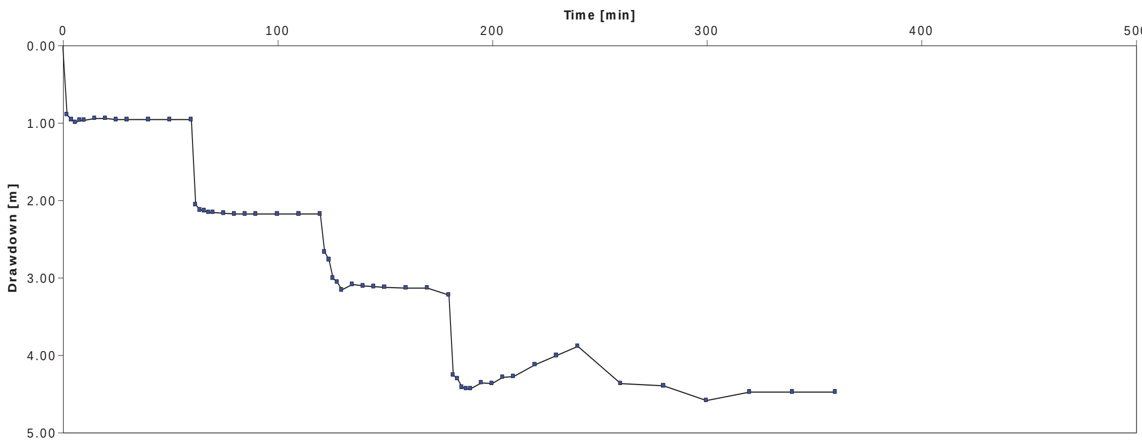
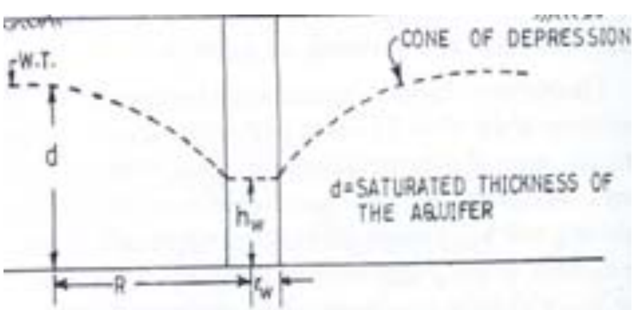


Figure 2: Drawdown curve for step-draw down test in well 20

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^{\ 2})}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	4.48	m
Q	= 208*24 = 4992	m^3/d
R	150	m
d	30.7	m
r_w	0.15	m
h_w	26.22	m

Then the hydraulic conductivity is computed as = 43.018 m/d

Transmissivity = 903.380 m^2/d

Maximum draw down of well 20 is 4.48 m and maximum drawdown of the observation well 27 is 7 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected that draw down will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Table 4 shows the specific capacity of the well at various discharges.

Table 4: Drawdown and specific capacity of well 20

Q (m3/hr)	Sw(m)	Q/sw (m2/d)
48.00	1.00	1152
103.00	2.13	1161
150.00	3.16	1139
210	4.59	1098

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 4 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

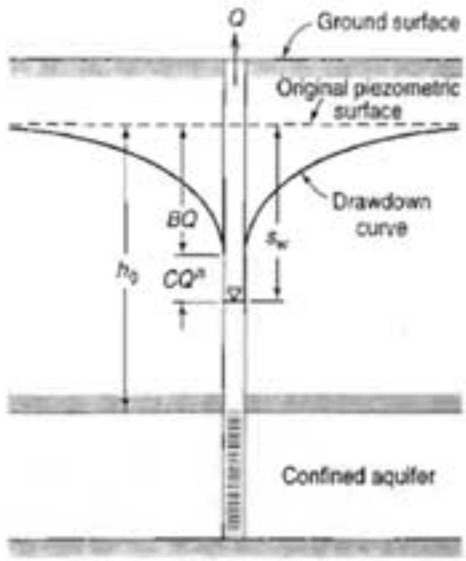


Figure 4: Aquifer losses and well losses

By calculating well losses B and C values can be calculated from figure 5 as follows:

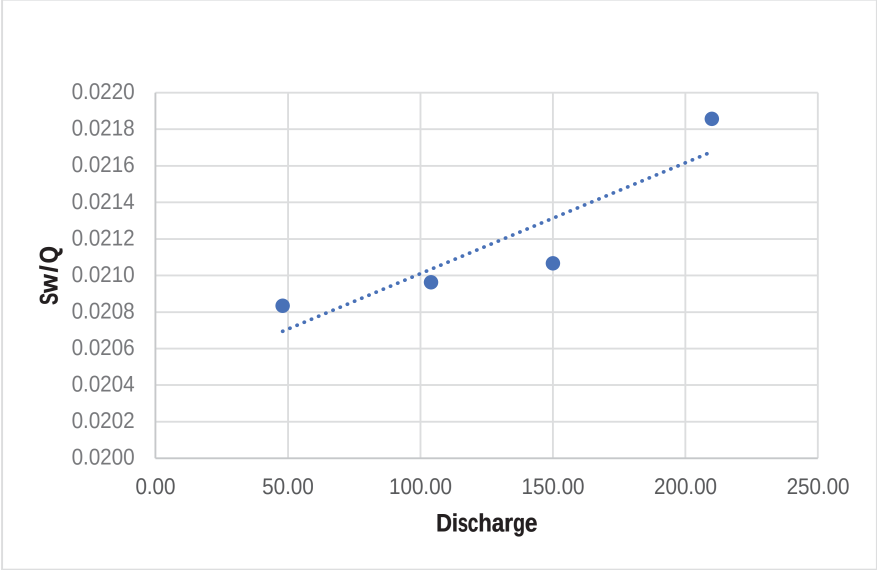


Figure 3: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0204

C = 0.00006

letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losess
48	0.14	0.9792	1.12
103	0.64	2.1012	2.74
150	1.35	3.06	4.41
210	2.65	4.284	6.93

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100 \frac{Q/s_w}{Q/BQ} = 100 \frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well efficiency
48	87.63
103	76.75
150	69.39
210	61.82

6.1.5 Recovery Test Results

At the end of pumping test which continued for 360 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 7 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=360 min)

t'	**t**	**t/t'**	**S'**
2	**362**	**181**	**0.290**
4	**364**	**91**	**0.290**
6	**366**	**61**	**0.260**
8	**368**	**46**	**0.240**

10	**370**	**37**	**0.220**
15	**375**	**25**	**0.180**
20	**380**	**19**	**0.150**
25	**385**	**15.4**	**0.150**
30	**390**	**13**	**0.150**
40	**400**	**10**	**0.140**
50	**410**	**8.2**	**0.140**
60	**420**	**7**	**0.140**
80	**440**	**5.5**	**0.140**
100	**460**	**4.6**	**0.140**
120	**480**	**4**	**0.140**
1560	**1920**	**1.23**	**-0.010**

It was noticed from the recovery data as shown in Table 7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

7. Location of Pump:

As noticed in the pumping test the draw down was 4.59 m for 210 m^3/hr. Since the operation of the recovery well 20 will be 180 m^3/hr and the expected draw down will be around 4 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 20 the pump should be located 12 m below the static groundwater level which is -1.53, and at 60.15 m from the top ground level (the groundwater level is 46.62 m) and 60.26 m from finishing level. (the finishing level is 46.73).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 20
Annex 2: Recovery test data sheet readings of well 20
Annex 3: Pumping test data sheet readings of well 27

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 20	observation well no.: 27
Distance from observation well 27: m	
Well depth :	well diameter :12"
Date of test: 2/11/2017	start time 09:25 AM finish time: 13:00 pm
Depth of pump: 62.3 m	water table depth : 48.96 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	48	2	49.86	0.9
4	48	2	49.92	0.96
6	48	2	49.96	1
8	46	2	49.93	0.97
10	46	2	49.93	0.97
15	46	5	49.91	0.95
20	46	5	49.91	0.95
25	46	5	49.92	0.96
30	46	5	49.92	0.96
40	46	10	49.92	0.96
50	46	10	49.92	0.96
60	46	10	49.92	0.96
62	103	2	51.02	2.06
64	103	2	51.09	2.13
66	104.2	2	51.1	2.14
68	104.2	2	51.12	2.16
70	104.2	2	51.12	2.16
75	104.2	5	51.13	2.17
80	104.2	5	51.14	2.18
85	104.2	5	51.14	2.18
90	104.2	5	51.14	2.18
100	104.2	10	51.14	2.18
110	104.2	10	51.14	2.18
120	104.2	10	51.14	2.18
122	147	2	51.63	2.67
124	147	2	51.73	2.77
126	147	2	51.97	3.01
128	147	2	52.02	3.06
130	150	2	52.12	3.16
135	147	5	52.05	3.09
140	147	5	52.07	3.11
145	147	5	52.08	3.12
150	147	5	52.09	3.13
160	147	10	52.1	3.14
170	147	10	52.1	3.14
180	147	10	52.19	3.23

182	206	2	53.22	4.26
184	206	2	53.27	4.31
186	206	2	53.38	4.42
188	206	2	53.4	4.44
190	206	2	53.4	4.44
195	204	5	53.32	4.36
200	201	5	53.33	4.37
205	201	5	53.25	4.29
210	198	5	53.24	4.28
220	198	10	53.09	4.13
230	192	10	52.97	4.01
240	177	10	52.85	3.89
260	207	20	53.33	4.37
280	207	20	53.4	4.44
300	210	20	53.55	4.59
320	208	20	53.44	4.48
340	208	20	53.44	4.48
360	208	20	53.44	4.48

Recovery test well 20	
time intervals after stoping pumping (min)	water table readings
2	49.25
2	49.25
2	49.22
2	49.2
2	49.18
5	49.14
5	49.11
5	49.11
5	49.11
10	49.1
10	49.1
10	49.1
20	49.1
20	49.1
20	49.1
1440	48.95

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 20	observation well no.: 27
Distance from observation well 27: m	
Well depth :	well diameter :12"
Date of test: 2/11/2017	start time 09:25 AM finish time: 13:00 pm
Depth of pump: 62.3 m	water table depth : 48.75 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	48	2	48.75	0
4	48	2	48.75	0
6	48	2	48.75	0
8	46	2	48.75	0
10	46	2	48.75	0
15	46	5	48.75	0
20	46	5	48.75	0
25	46	5	48.75	0
30	46	5	48.75	0
40	46	10	48.76	0.01
50	46	10	48.76	0.01
60	46	10	48.76	0.01
62	103	2	48.77	0.02
64	103	2	48.77	0.02
66	104.2	2	48.77	0.02
68	104.2	2	48.77	0.02
70	104.2	2	48.77	0.02
75	104.2	5	48.77	0.02
80	104.2	5	48.77	0.02
85	104.2	5	48.77	0.02
90	104.2	5	48.77	0.02
100	104.2	10	48.78	0.03
110	104.2	10	48.78	0.03
120	104.2	10	48.78	0.03
122	147	2	48.78	0.03
124	147	2	48.78	0.03
126	147	2	48.79	0.04
128	147	2	48.8	0.05
130	150	2	48.8	0.05
135	147	5	48.8	0.05
140	147	5	48.8	0.05
145	147	5	48.8	0.05
150	147	5	48.8	0.05
160	147	10	48.8	0.05
170	147	10	48.8	0.05
180	147	10	48.8	0.05

182	206	2	48.81	0.06
184	206	2	48.81	0.06
186	206	2	48.81	0.06
188	206	2	48.81	0.06
190	206	2	48.81	0.06
195	204	5	48.81	0.06
200	201	5	48.81	0.06
205	201	5	48.81	0.06
210	198	5	48.81	0.06
220	198	10	48.81	0.06
230	192	10	48.81	0.06
240	177	10	48.81	0.06
260	207	20	48.81	0.06
280	207	20	48.81	0.06
300	210	20	48.82	0.07
320	208	20	48.82	0.07
340	208	20	48.82	0.07
360	208	20	48.82	0.07

Remaining Days to finish the project	31 Days

Date: 30-11-2017

Ref No: SAK-EFF-145/481

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.22

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 22 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 27/11/2017* at well 22 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST).*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as K, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.
These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also, to evaluate the loss, efficiency and the productivity of the well.

4.1. Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 19. The pump was started on November, 27, 2017 at 10:36 a.m. and was stopped on November, 27, 2017 at 16.36 p.m. The duration of the pumping was a total of 6 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	51	60
2	100	60
3	153	60
4	207	180

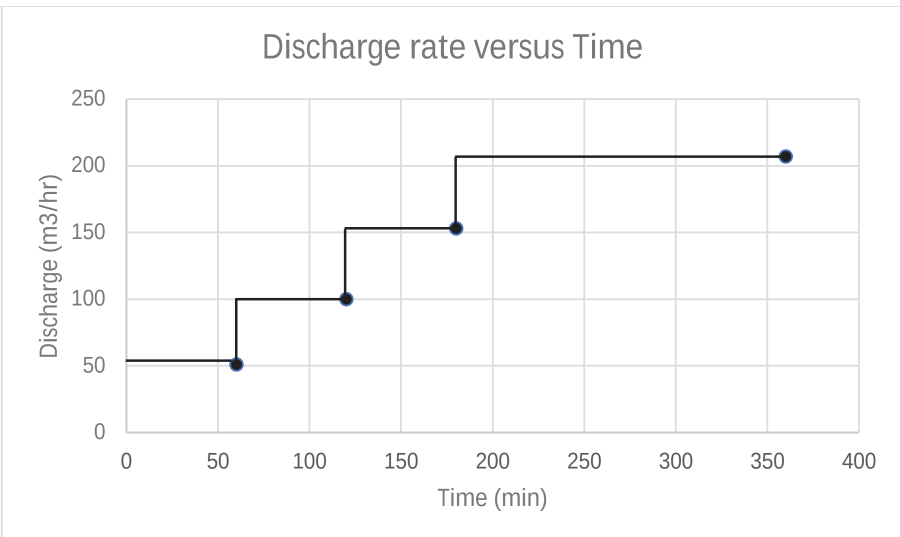


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well no. 22 and the monitoring well no. 14 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3.

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-180	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 22 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

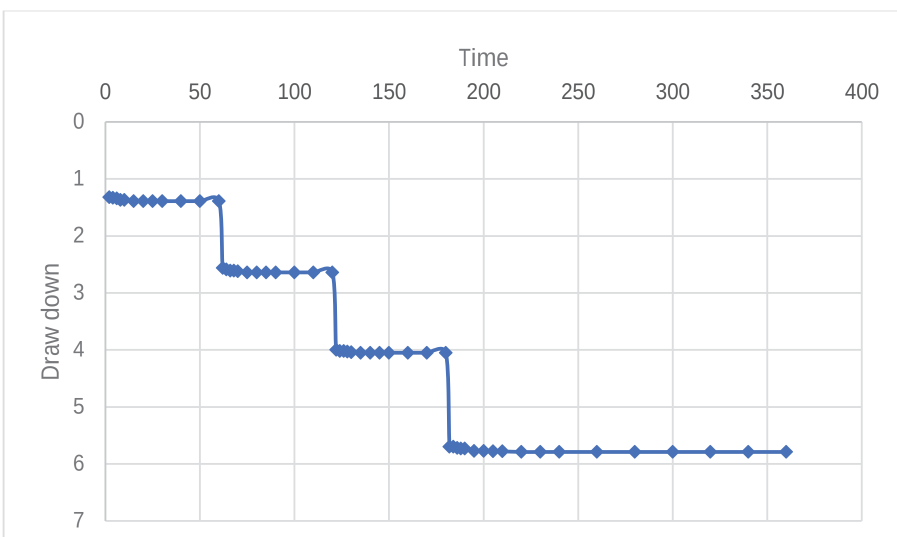
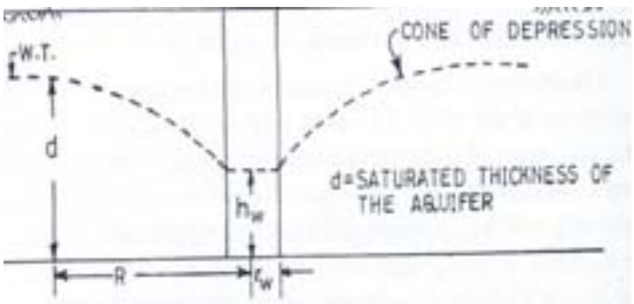


Figure 2: Drawdown curve for step-draw down test in well 22

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^2)}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	5.79	m
Q	207*24 = 4968	m^3/d
R	150	m
d	20	m
r_w	0.15	m
h_w	14.21	m

Then the hydraulic conductivity is computed as K = 55.11 m/d

Transmissivity = 1102.30 m^2/d

Maximum draw down of well 22 is 5.79 m and maximum drawdown of the observation well 14 is 23 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: Specific capacity

Q	Well Specific Capacity (m3/d)
51.00	1020
100.00	923
153.00	907
207.00	858

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

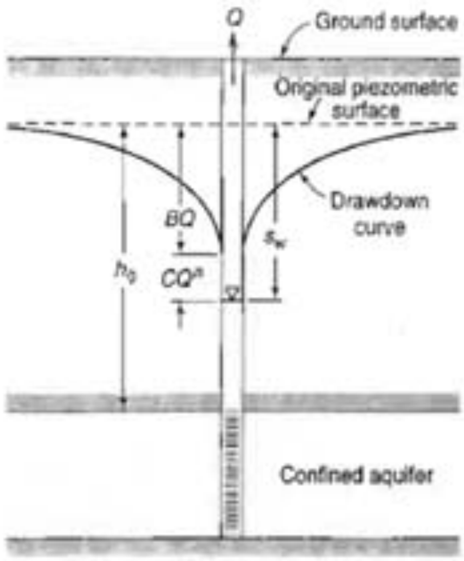


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows:

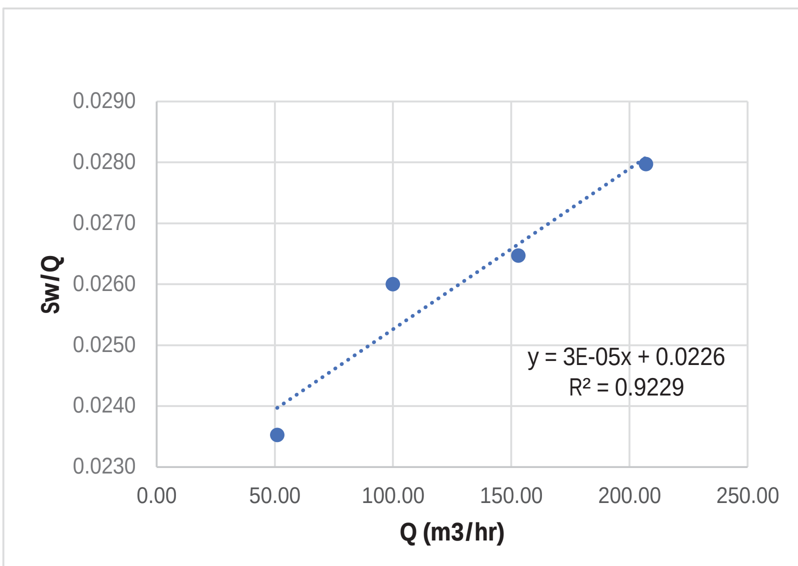


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0226
C = 0.00003
letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
51.00	0.078	1.15	1.23
100.00	0.30	2.26	2.56
153.00	0.70	3.46	4.16
207.00	1.29	4.68	5.96

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well Efficiency
51.00	**93.66**
100.00	**88.28**
153.00	**83.12**
207.00	**78.44**

6.1.5 Recovery Test Results

At the end of pumping test which continued for 360 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=360 min)

t'	t	t/t'	S'
2	362	181.00	0.110
4	364	91.00	0.100
6	366	61.00	0.100
8	368	46.00	0.100
10	370	37.00	0.090
15	375	25.00	0.090
20	380	19.00	0.070
25	385	15.40	0.070
30	390	13.00	0.070
40	400	10.00	0.060
50	410	8.20	0.060
60	420	7.00	0.050
80	440	5.50	0.040
100	460	4.60	0.040
120	480	4.00	0.040

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q = 207 m^3/hr and s' is 0.038 then **T will be equal to 997.5 m^2/day**. It was noticed from the recovery data as shown in Table7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

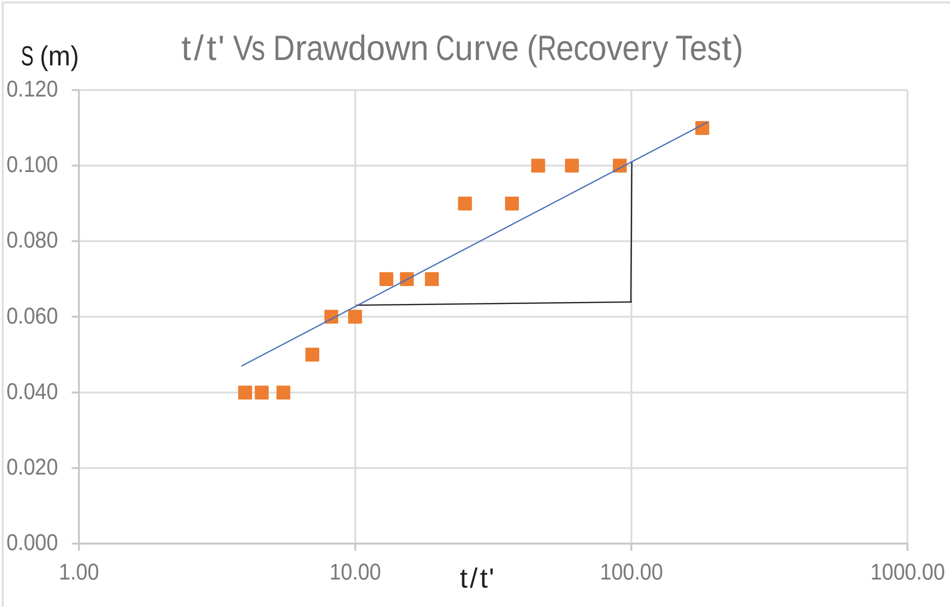


Figure 5: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 5.79 m for 207 m^3/hr. Since the operation of the recovery well 22 will be 180 m^3/hr and the expected draw down will be around 5 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 22 the pump should be located 12 m below the static groundwater level and 62.68 m from finishing level. (Finishing level is +48.13 and Groundwater is at a depth of 50.68 m from finishing level).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 22
Annex 2: Pumping test data sheet readings of well 14
Annex 3: Recovery test data sheet readings of well 22
Annex 4: Recovery test data sheet readings of well 14

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 22	observation well no.: 14
Distance from observation well: m	
Well depth :	well diameter :12"
Date of test: 27/11/2017	start time 10.36 AM finish time: 16.36 pm
Depth of pump: 62.3 m	water table depth : 51.70 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	51	2	53.02	1.32
4	51	2	53.03	1.33
6	51	2	53.04	1.34
8	51	2	53.07	1.37
10	51	2	53.07	1.37
15	51	5	53.09	1.39
20	51	5	53.09	1.39
25	51	5	53.09	1.39
30	51	5	53.09	1.39
40	51	10	53.09	1.39
50	51	10	53.09	1.39
60	51	10	53.09	1.39
62	100	2	54.26	2.56
64	100	2	54.29	2.59
66	100	2	54.31	2.61
68	100	2	54.31	2.61
70	100	2	54.32	2.62
75	100	5	54.34	2.64
80	100	5	54.34	2.64
85	100	5	54.34	2.64
90	100	5	54.34	2.64
100	100	10	54.34	2.64
110	100	10	54.34	2.64
120	100	10	54.34	2.64
122	153	2	55.7	4
124	153	2	55.72	4.02
126	153	2	55.72	4.02
128	153	2	55.73	4.03
130	153	2	55.74	4.04
135	153	5	55.75	4.05
140	153	5	55.75	4.05
145	153	5	55.75	4.05
150	153	5	55.75	4.05
160	153	10	55.75	4.05
170	153	10	55.75	4.05
180	153	10	55.75	4.05

182	203	2	57.4	5.7
184	203	2	57.4	5.7
186	203	2	57.42	5.72
188	203	2	57.43	5.73
190	203	2	57.43	5.73
195	207	5	57.47	5.77
200	207	5	57.47	5.77
205	207	5	57.48	5.78
210	207	5	57.48	5.78
220	207	10	57.49	5.79
230	207	10	57.49	5.79
240	207	10	57.49	5.79
260	207	20	57.49	5.79
280	207	20	57.49	5.79
300	207	20	57.49	5.79
320	207	20	57.49	5.79
340	207	20	57.49	5.79
360	207	20	57.49	5.79

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet well 14	
Pumping well no.: 22	observation well no.: 14
Distance from observation well 20:	
Well depth :	well diameter :12"
Date of test: 28/11/2017	start time 10:36 AM finish time:16:36 pm
Depth of pump:	water table depth : 50.74 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	51	2	50.74	0
4	51	2	50.76	0.02
6	51	2	50.78	0.04
8	51	2	50.79	0.05
10	51	2	50.79	0.05
15	51	5	50.79	0.05
20	51	5	50.79	0.05
25	51	5	50.79	0.05
30	51	5	50.79	0.05
40	51	10	50.79	0.05
50	51	10	50.79	0.05
60	51	10	50.79	0.05
62	100	2	50.8	0.06
64	100	2	50.81	0.07
66	100	2	50.82	0.08
68	100	2	50.82	0.08
70	100	2	50.83	0.09
75	100	5	50.83	0.09
80	100	5	50.83	0.09
85	100	5	50.83	0.09
90	100	5	50.83	0.09
100	100	10	50.83	0.09
110	100	10	50.83	0.09
120	100	10	50.84	0.1
122	153	2	50.85	0.11
124	153	2	50.86	0.12
126	153	2	50.87	0.13
128	153	2	50.88	0.14
130	153	2	50.89	0.15
135	153	5	50.89	0.15
140	153	5	50.89	0.15
145	153	5	50.89	0.15
150	153	5	50.89	0.15
160	153	10	50.89	0.15
170	153	10	50.89	0.15
180	153	10	50.89	0.15

182	203	2	50.9	0.16
184	203	2	50.91	0.17
186	203	2	50.92	0.18
188	203	2	50.93	0.19
190	203	2	50.93	0.19
195	207	5	50.93	0.19
200	207	5	50.93	0.19
205	207	5	50.93	0.19
210	207	5	50.93	0.19
220	207	10	50.93	0.19
230	207	10	50.93	0.19
240	207	10	50.93	0.19
260	207	20	50.95	0.21
280	207	20	50.96	0.22
300	207	20	50.96	0.22
320	207	20	50.97	0.23
340	207	20	50.97	0.23

Recovery test readings well 22	
Time intervals after stoping pumping (min)	water table readings
2	51.81
2	51.8
2	51.8
2	51.8
2	51.79
5	51.79
5	51.77
5	51.77
5	51.77
10	51.76
10	51.76
10	51.75
20	51.74
20	51.74
20	51.74

Recovery test for Obs. Well 14	
time intervals after stoping pumping (min)	water table readings
2	50.96
2	50.91
2	50.87
2	50.82
2	50.8
5	50.78
5	50.74

Remaining Days to finish the project	19 Days

Date: 12-12-2017

Ref No: SAK-EFF-145/492

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.23

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Sohail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 23 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 04/12/2017* at well 23 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST).*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.
These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also, to evaluate the loss, efficiency and the productivity of the well.

4.1. Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 14. The pump was started on November, 29, 2017 at 10:05 a.m. and was stopped on November, 29, 2017 at 17.05 p.m. The duration of the pumping was a total of 7 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	57.50	60
2	105.00	60
3	153.00	60
4	192.00	180

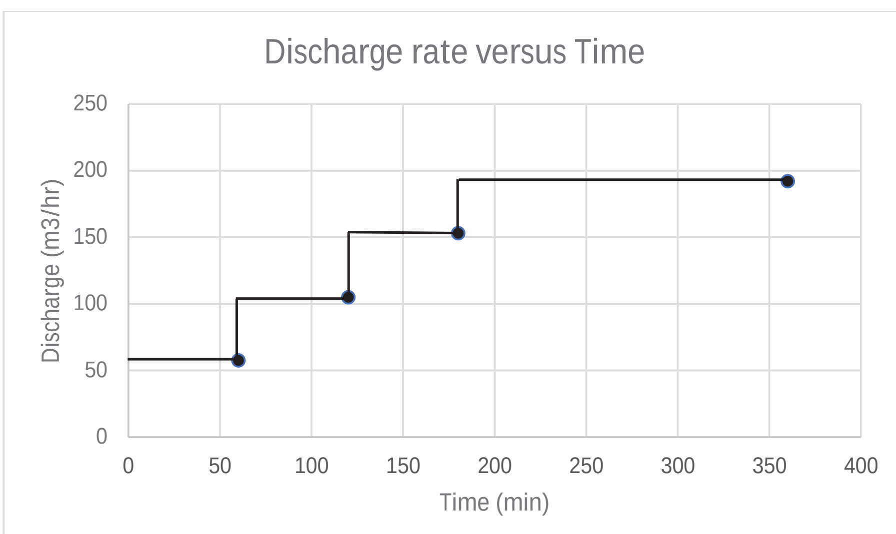


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well no. 23 and the monitoring well no. 14 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3.

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-180	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-140	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 23 was checked and analyzed using Excel software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

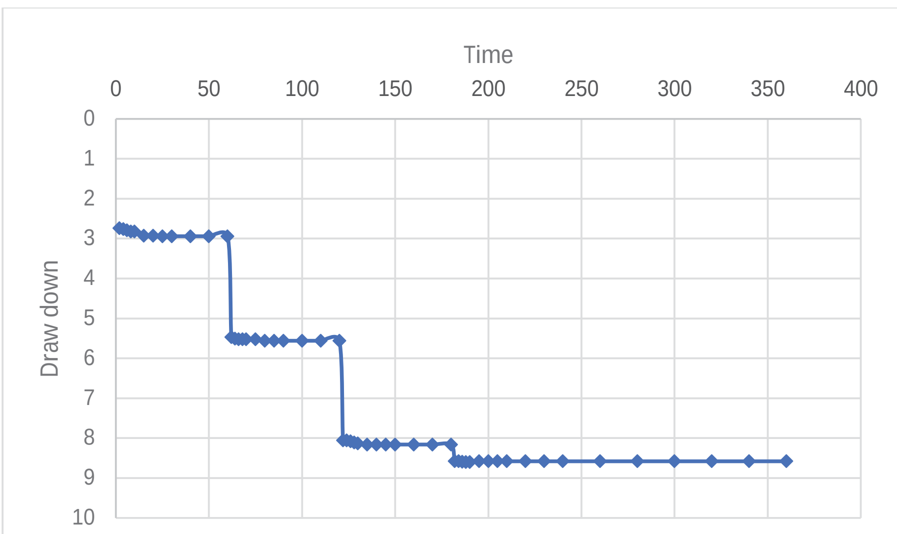
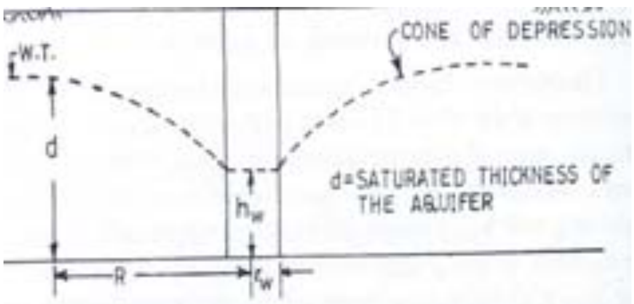


Figure 2: Drawdown curve for step-draw down test in well 23

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^2)}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	8.58	m
Q	192*24 = 4608	m^3/d
R	150	m
d	27.6	m
r_w	0.15	m
h_w	19.02	m

Then the hydraulic conductivity is computed as K = 25.31 m/d

Transmissivity = 698.69 m^2/d

Maximum draw down of well 23 is 8.58 m and maximum drawdown of the observation well 14 is 13 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Specific capacity for each flow rate as follows in table 5.

Table 5: Specific capacity

Q	Well sp. Capacity (m3/d)
57.50	500
105.00	453
153.00	450
192.00	537

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

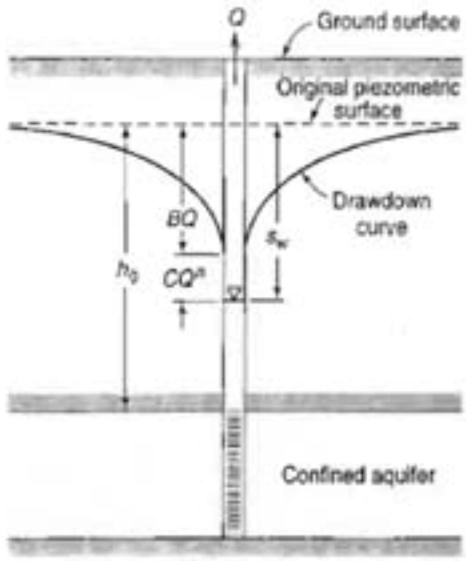


Figure 4: Aquifer losses and well losses

By calculating well losses by Aquifer test, B and C values can be calculated from figure 5 as follows:

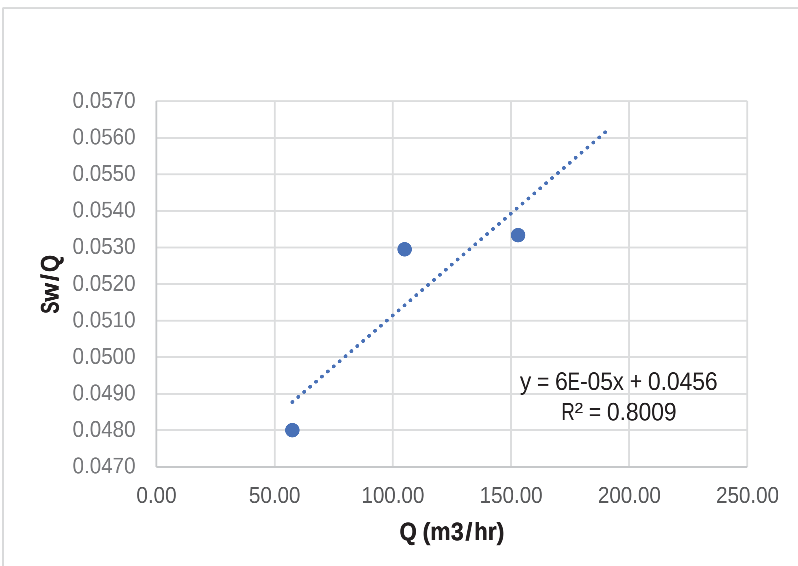


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0456
C = 0.00006
letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
57.50	**0.198**	**2.62**	**2.82**
105.00	**0.66**	**4.79**	**5.45**
153.00	**1.40**	**6.98**	**8.38**
192.00	**2.21**	**8.76**	**10.97**

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100\,\frac{Q/s_w}{Q/BQ} = 100\,\frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well Efficiency
57.50	92.97
105.00	87.86
153.00	83.24
192.00	79.83

6.1.5 Recovery Test Results

At the end of pumping test which continued for 360 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to pumping) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=360 min)

t'	t	t/t'	S'
2	362	181.00	0.070
4	364	91.00	0.060
6	366	61.00	0.060
8	368	46.00	0.050
10	370	37.00	0.050
15	375	25.00	0.040
20	380	19.00	0.040
25	385	15.40	0.040
30	390	13.00	0.040
40	400	10.00	0.040
50	410	8.20	0.040
60	420	7.00	0.040
80	440	5.50	0.040
100	460	4.60	0.040
120	480	4.00	0.040
140	500	3.57	0.040

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q = 192 m^3/hr and s' is 0.03 then **T will be equal to 1171.9 m^2/day**. It was noticed from the recovery data as shown in Table 7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

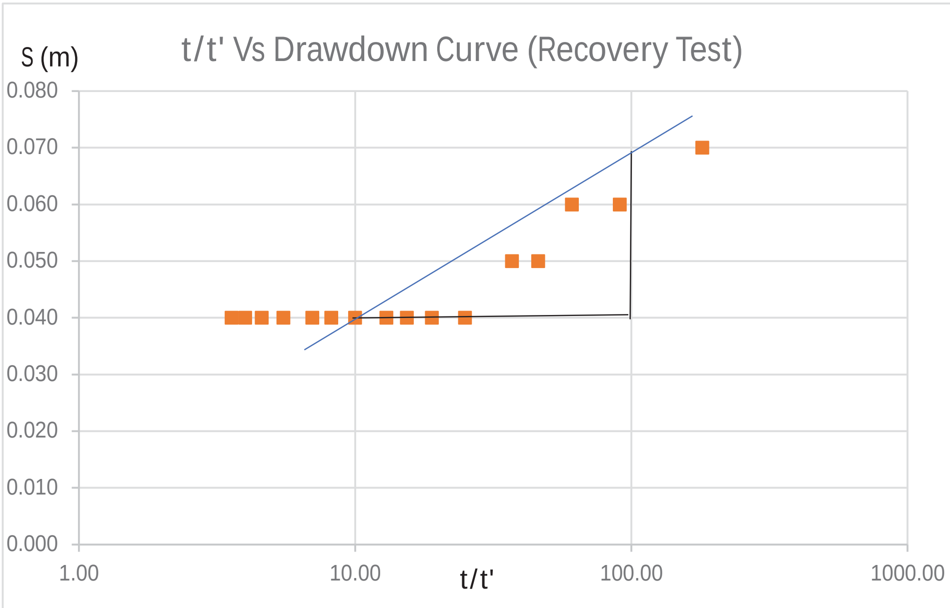


Figure 5: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 8.58 m for 192 m^3/hr. Since the operation of the recovery well 23 will be 180 m^3/hr and the expected draw down will be around 8.4 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 23 the pump should be located 16.8 m below the static groundwater level and 67.6 m from finishing level. (Finishing level is +48.83 and Groundwater is at a depth of 50.8 m from finishing level).
Thus, the Pump should be installed inside the screen at least 5 m.

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 23
Annex 2: Pumping test data sheet readings of well 14
Annex 3: Recovery test data sheet readings of well 23
Annex 4: Recovery test data sheet readings of well 14

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 23	observation well no.: 14
Distance from observation well: m	
Well depth :	well diameter :12"
Date of test: 04/12/2017	start time 08:50 AM finish time: 02:50 pm
Depth of pump: 62.3 m	water table depth : 51:74 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	57.5	2	54.48	2.74
4	57.5	2	54.5	2.76
6	57.5	2	54.53	2.79
8	57.5	2	54.56	2.82
10	57.5	2	54.56	2.82
15	57.5	5	54.67	2.93
20	57.5	5	54.67	2.93
25	57.5	5	54.68	2.94
30	57.5	5	54.68	2.94
40	57.5	10	54.68	2.94
50	57.5	10	54.68	2.94
60	57.5	10	54.68	2.94
62	104	2	57.21	5.47
64	104	2	57.25	5.51
66	104	2	57.26	5.52
68	104	2	57.26	5.52
70	104	2	57.26	5.52
75	105	5	57.26	5.52
80	105	5	57.3	5.56
85	105	5	57.3	5.56
90	105	5	57.3	5.56
100	105	10	57.3	5.56
110	105	10	57.3	5.56
120	105	10	57.3	5.56
122	150	2	59.8	8.06
124	150	2	59.8	8.06
126	150	2	59.82	8.08
128	153	2	59.85	8.11
130	153	2	59.87	8.13
135	153	5	59.9	8.16
140	153	5	59.9	8.16
145	153	5	59.9	8.16
150	153	5	59.9	8.16
160	153	10	59.9	8.16
170	153	10	59.9	8.16
180	153	10	59.9	8.16

182	192	2	60.32	8.58
184	192	2	60.32	8.58
186	192	2	60.33	8.59
188	192	2	60.34	8.6
190	192	2	60.34	8.6
195	192	5	60.32	8.58
200	192	5	60.32	8.58
205	192	5	60.32	8.58
210	192	5	60.32	8.58
220	192	10	60.32	8.58
230	192	10	60.32	8.58
240	192	10	60.32	8.58
260	192	20	60.32	8.58
280	192	20	60.32	8.58
300	192	20	60.32	8.58
320	192	20	60.32	8.58
340	192	20	60.32	8.58
360	192	20	60.32	8.58

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet well 14	
Pumping well no.: 23	observation well no.: 14
Distance from observation well 20:	
Well depth :	well diameter :12"
Date of test: 04/12/2017	start time 08:50 AM finish time:02:50 pm
Depth of pump:	water table depth : 50.84 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	55	2	50.84	0
4	55	2	50.84	0
6	55	2	50.85	0.01
8	55	2	50.85	0.01
10	55	2	50.86	0.02
15	55	5	50.86	0.02
20	55	5	50.86	0.02
25	55	5	50.86	0.02
30	55	5	50.86	0.02
40	55	10	50.86	0.02
50	55	10	50.86	0.02
60	55	10	50.86	0.02
62	102	2	50.87	0.03
64	102	2	50.87	0.03
66	102	2	50.88	0.04
68	102	2	50.88	0.04
70	102	2	50.89	0.05
75	102	5	50.89	0.05
80	102	5	50.89	0.05
85	102	5	50.89	0.05
90	102	5	50.89	0.05
100	102	10	50.89	0.05
110	102	10	50.89	0.05
120	102	10	50.89	0.05
122	148	2	50.89	0.05
124	148	2	50.9	0.06
126	148	2	50.9	0.06
128	148	2	50.91	0.07
130	148	2	50.91	0.07
135	148	5	50.92	0.08
140	148	5	50.92	0.08
145	148	5	50.92	0.08
150	148	5	50.92	0.08
160	148	10	50.92	0.08
170	148	10	50.92	0.08
180	148	10	50.92	0.08

182	199	2	50.92	0.08
184	199	2	50.92	0.08
186	201	2	50.93	0.09
188	201	2	50.93	0.09
190	201	2	50.93	0.09
195	201	5	50.94	0.1
200	201	5	50.94	0.1
205	201	5	50.94	0.1
210	201	5	50.94	0.1
220	201	10	50.94	0.1
230	201	10	50.94	0.1
240	201	10	50.94	0.1
260	209	20	50.95	0.11
280	209	20	50.96	0.12
300	209	20	50.97	0.13
320	209	20	50.97	0.13
340	209	20	50.97	0.13
360	201	20	50.97	0.13

Recovery test readings well 23	
Time intervals after stoping pumping (min)	water table readings
2	51.81
2	51.8
2	51.8
2	51.79
2	51.79
5	51.78
5	51.78
5	51.78
5	51.78
10	51.78
10	51.78
10	51.78
20	51.78
20	51.78
20	51.78
20	51.78

Recovery test for Obs. Well 14	
time intervals after stoping pumping (min)	water table readings
2	50.97
2	50.94
2	50.91
2	50.89
2	50.89
5	50.87
5	50.86
5	50.85
5	50.84

Remaining Days to finish the project	64 Days

Date: 28-10-2017 Ref No: SAK-EFF-145/426

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.24

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 24 PUMPING TEST REPORT

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 25/10/2017* at well 24 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.

2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.

2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.

2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.

2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.

These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 24. The pump was started on October, 25, 2017 at 9.00 a.m. and was stopped on October, 25, 2017 at 13.00 p.m.
The duration of the pumping was a total of 4 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	50	60
2	100	60
3	150	60
4	200	60

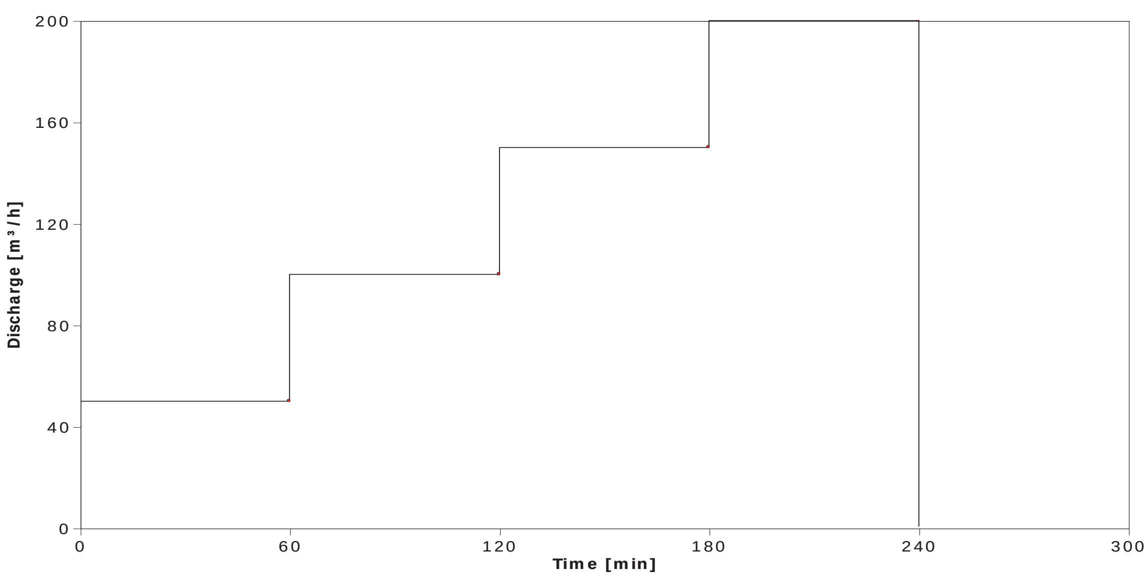


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well and in the observation well No. 25 during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 26 was drawn by Aquifer Test software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

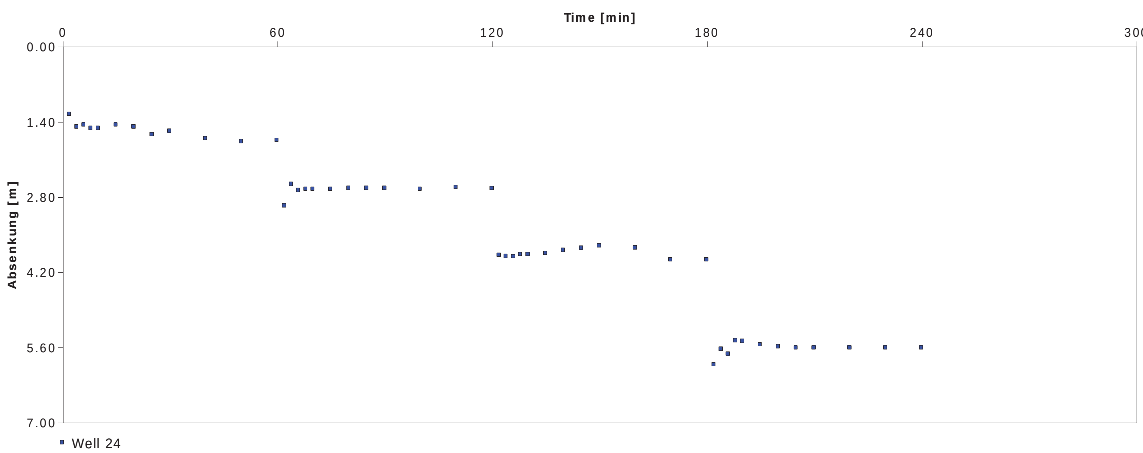
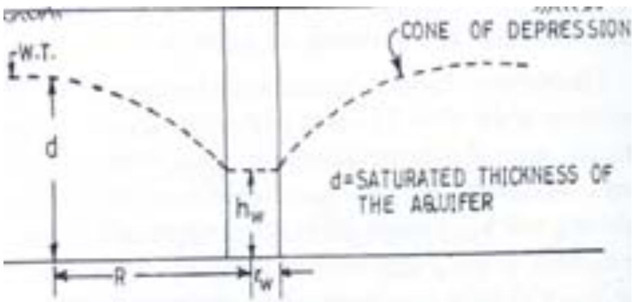


Figure 2: Drawdown curve for step-draw down test in well 27

The hydraulic conductivity was computed using the following formula:

$$Q = \frac{\pi K (d^2 - h_w^2)}{2.3 \log_{10}\left(\frac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	5.62	m
Q	= 200*24 = 4800	m^3/d
R	140	m
d	20	m
r_w	0.15	m
h_w	14.38	m

Then the hydraulic conductivity is computed as = 56 m/d
Transmissivity = 1091 m^2/d

Maximum draw down of well 24 is 5.62 m and maximum drawdown of the observation well 25 is 17 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Table 5 shows the specific capacity of the well at various discharges.

Table 5: Drawdown and specific capacity of well 26

Q (m^3/hr)	Drawdown (m)	Specific Capacity (m^3/d/m)
50	1.75	686
100	2.65	934
150	3.98	905
200	5.62	854

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 4 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

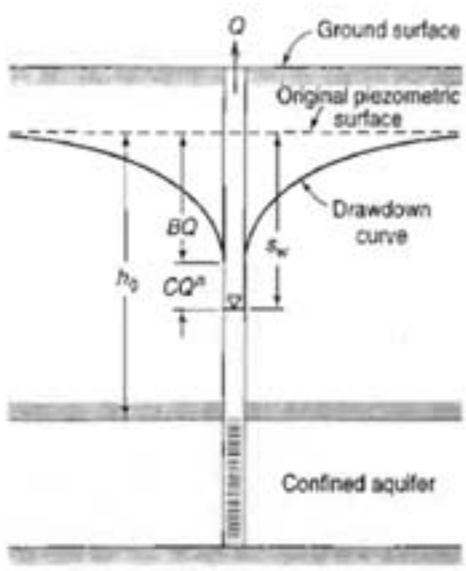


Figure 4: Aquifer losses and well losses

By calculating well losses B and C values can be calculated from figure 5 as follows :

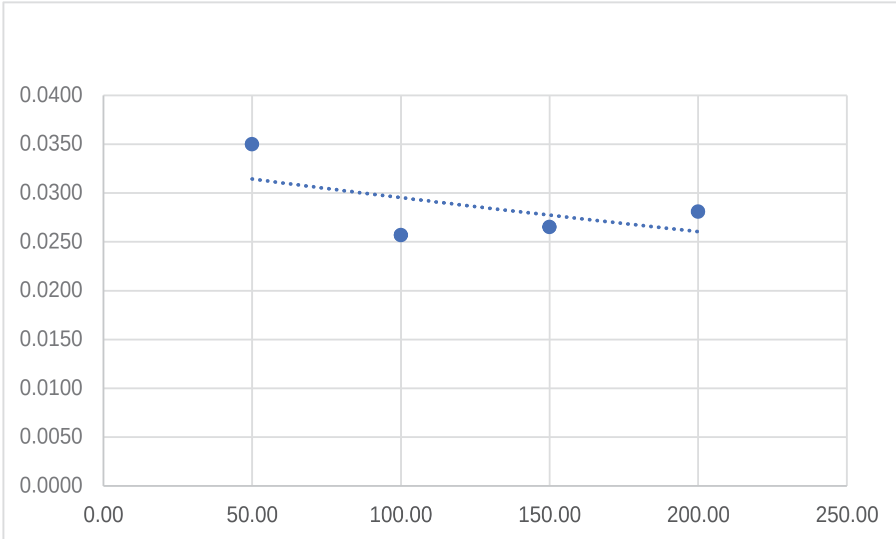


Figure 5: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.022
C = 0.00004

letting n=2

By using these values and the equation above Table 6 presents the estimated well losses and aquifer losses.

Table 6: Well losses and aquifer losses

Q (m^3/hr)	Well losses (m) CQ^n	Aquifer Losses (m) BQ
50	0.10	1.1
100	0.40	2.2
150	0.90	3.3
200	1.60	4.4

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 7 using the following equation:

$$E_w = 100 \frac{Q/s_w}{Q/BQ} = 100 \frac{BQ}{s_w}$$

Table 7: Well efficiency against pumping rate

Q (m^3/hr)	Well efficiency (%)
50	91
100	84
150	78
200	73

6.1.5 Recovery Test Results

At the end of pumping test which continued for 240 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 7 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T \simeq \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=240 min)

t'	t	t/t'	S'
2	242	121	0.360
4	244	61	0.360
6	246	41	0.310
8	248	31	0.140
10	250	25	0.030
15	255	17	0.020
20	260	13	0.002

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q= 200 m^3/hr and s' is 0.28 then **T will be equal to 130 m^2/day**. It was noticed from the recovery data as shown in Table 7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

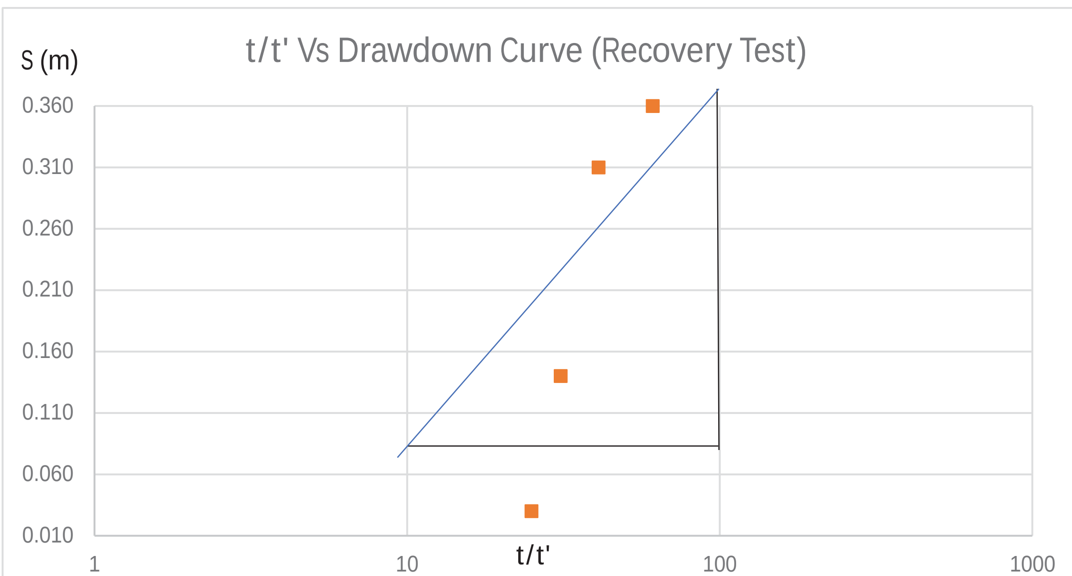


Figure 6: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 5.62 m for 200 m^3/hr. Since the operation of the recovery well 24 will be 180 m^3/hr and the expected draw down will be around 5.2 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 24 the pump should be located 15.6 m below the static groundwater level which is -2.72, and 65.89 m from the top ground level (the groundwater level is 47.57 m) and 66.46 m from finishing level. (the finishing level is 48.14).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 24
Annex 2: Pumping test data sheet readings of well 25
Annex 3: Recovery test data sheet readings of well 24
Annex 4: Recovery test data sheet readings of well 25

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 24	observation well no.: 25
Distance from observation well 28: 150m	
Well depth :	well diameter :12"
Date of test: 22/10/2017	start time 09:00 AM finish time: 13:00 pm
Depth of pump: 62.3 m	water table depth : 50.87 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	50	2	52.14	1.27
4	50	2	52.37	1.5
6	50	2	52.34	1.47
8	50	2	52.4	1.53
10	50	2	52.4	1.53
15	50	5	52.34	1.47
20	50	5	52.37	1.5
25	50	5	52.52	1.65
30	50	5	52.45	1.58
40	50	10	52.59	1.72
50	50	10	52.64	1.77
60	50	10	52.62	1.75
62	100	2	53.84	2.97
64	100	2	53.44	2.57
66	100	2	53.55	2.68
68	100	2	53.53	2.66
70	100	2	53.53	2.66
75	100	5	53.53	2.66
80	100	5	53.51	2.64
85	100	5	53.51	2.64
90	100	5	53.51	2.64
100	100	10	53.53	2.66
110	100	10	53.5	2.63
120	100	10	53.52	2.65
122	150	2	54.76	3.89
124	150	2	54.78	3.91
126	150	2	54.79	3.92
128	150	2	54.75	3.88
130	150	2	54.75	3.88
135	150	5	54.73	3.86
140	150	5	54.67	3.8
145	150	5	54.63	3.76
150	150	5	54.59	3.72
160	150	10	54.62	3.75
170	150	10	54.85	3.98
180	150	10	54.85	3.98
182	200	2	56.8	5.93
184	200	2	56.51	5.64
186	200	2	56.6	5.73
188	200	2	56.35	5.48
190	200	2	56.36	5.49
195	200	5	56.43	5.56
200	200	5	56.46	5.59
205	200	5	56.49	5.62
210	200	5	56.49	5.62
220	200	10	56.49	5.62
230	200	10	56.49	5.62
240	200	10	56.49	5.62

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 24	observation well no.: 25
Distance from observation well 28:	
Well depth :	well diameter :12"
Date of test: 25/10/2017	start time 09:00 AM finish time:13:00 pm
Depth of pump: 62.3	water table depth : 49.50 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	50	2	49.51	0.01
4	50	2	49.51	0.01
6	50	2	49.52	0.02
8	50	2	49.53	0.03
10	50	2	49.54	0.04
15	50	5	49.54	0.04
20	50	5	49.54	0.04
25	50	5	49.54	0.04
30	50	5	49.54	0.04
40	50	10	49.55	0.05
50	50	10	49.55	0.05
60	50	10	49.56	0.06
62	100	2	49.56	0.06
64	100	2	49.56	0.06
66	100	2	49.56	0.06
68	100	2	49.56	0.06
70	100	2	49.6	0.1
75	100	5	49.59	0.09
80	100	5	49.58	0.08
85	100	5	49.58	0.08
90	100	5	49.58	0.08
100	100	10	49.58	0.08
110	100	10	49.58	0.08
120	100	10	49.6	0.1
122	150	2	49.49	-0.01
124	150	2	49.58	0.08
126	150	2	49.6	0.1
128	150	2	49.6	0.1
130	150	2	49.6	0.1
135	150	5	49.61	0.11
140	150	5	49.61	0.11
145	150	5	49.61	0.11
150	150	5	49.61	0.11
160	150	10	49.61	0.11
170	150	10	49.61	0.11
180	150	10	49.61	0.11
182	200	2	49.69	0.19
184	200	2	49.64	0.14
186	200	2	49.65	0.15
188	200	2	49.65	0.15
190	200	2	49.65	0.15
195	200	5	49.66	0.16
200	200	5	49.66	0.16
205	200	5	49.67	0.17
210	200	5	49.67	0.17
220	200	10	49.67	0.17
230	200	10	49.67	0.17
240	200	10	49.67	0.17

Recovery test well 24	
time intervals after stoping pumping (min)	water table readings
2	51.23
2	51.23
2	51.18
2	51.01
2	50.9
5	50.86
5	50.86
5	50.86
5	50.86
10	50.86
10	50.86
10	50.86
20	50.86
20	50.86
20	50.86

Recovery test for Obs. Well 25	
time intervals after stoping pumping (min)	water table readings
2	49.67
2	49.6
2	49.46
2	49.46
2	49.46
5	49.46
5	49.46
5	49.46
5	49.46
10	49.46
10	49.46
10	49.46
20	49.46
20	49.46
20	49.46

Remaining Days to finish the project	57 Days

Date: 04-11-2017

Ref No: SAK-EFF-145/438

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.25

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 25 PUMPING TEST REPORT

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 31/10/2017* at well 25 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.

2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.

2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.

2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.

2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.

These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 24. The pump was started on October, 25, 2017 at 9.00 a.m. and was stopped on October, 25, 2017 at 13.00 p.m.
The duration of the pumping was a total of 4 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	58	30
2	69	60
3	102	15
4	99	25
5	101	20
6	156	30
7	168	10
8	147	20
9	198	200

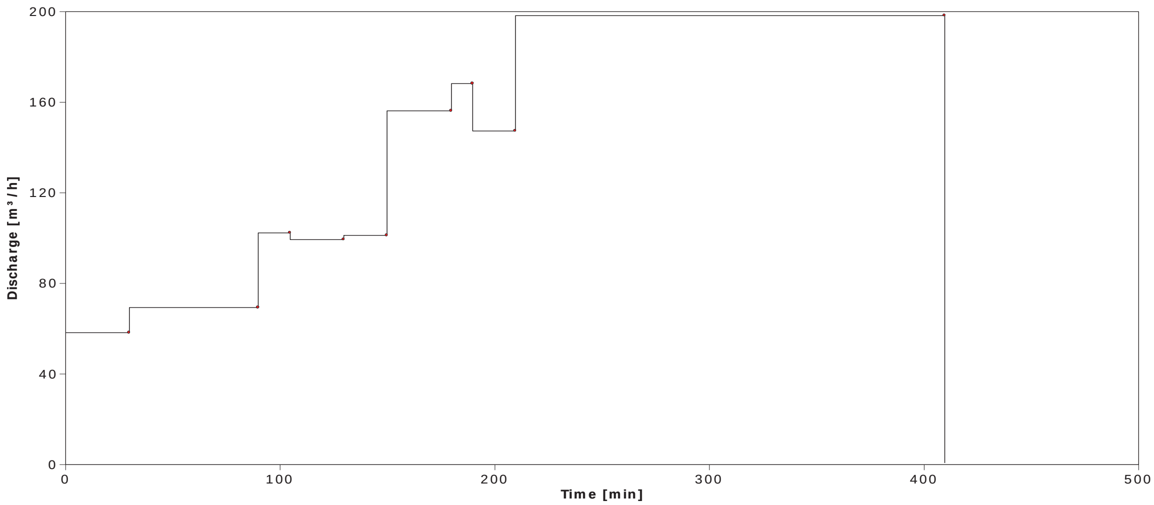


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well and in the observation well No. 24 during the pumping test. Water levels were collected for each flow rate as follows in table 2.

Table 2: Time interval between measurements.

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-90	10
90-100	2
100-120	5
120-150	10
150-160	2
160-180	5

180-210	10
210-220	2
220-240	5
240-270	10
270-410	20

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 3: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 25 was drawn by Aquifer Test software. Figure 2 shows the recorded draw down against time.

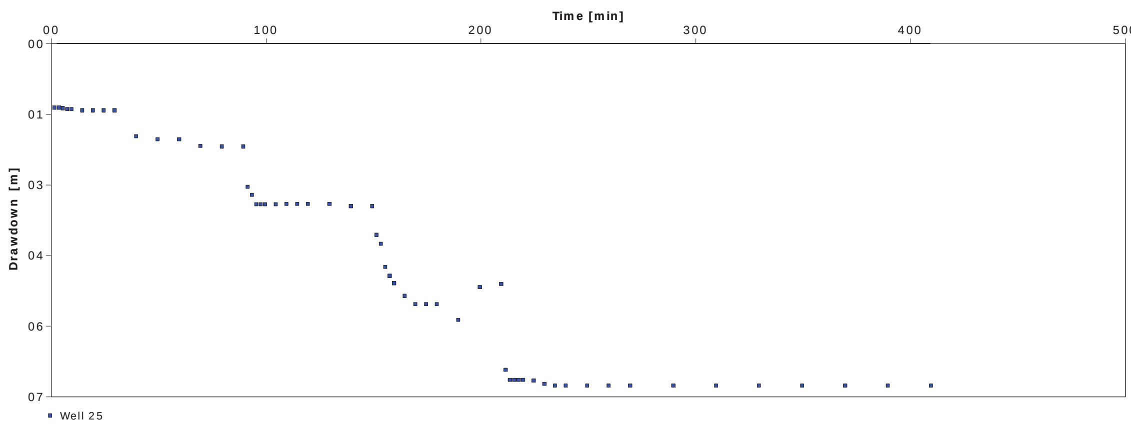
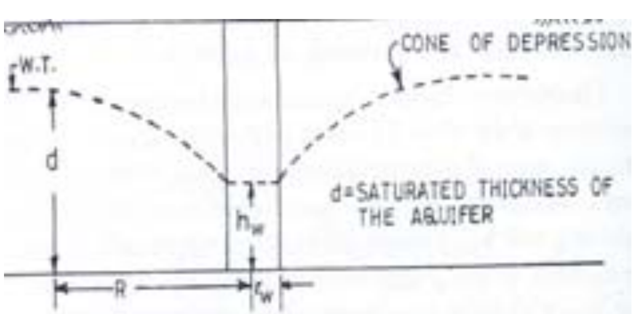


Figure 2: Drawdown curve for step-draw down test in well 27

Hydraulic conductivity

The following formula is used to compute the hydraulic conductivity using the results of the pumping test

$$Q = \frac{\pi K\,(d^2 - h_w^{\ 2})}{2.3\,\log_{10}\left(\dfrac{R}{r_w}\right)} \quad \text{(for unconfined wells)}$$



Where the following parameters are used:

Draw down	6.71	m
Q	= 198*24 = 4752	m^3/d
R	150	m
D	21	m
r_w	0.15	m
h_w	14.29	m

Then the hydraulic conductivity is computed as = 44.098 m/d

Transmissivity = 926.064 m^2/d

Maximum draw down of well 25 is 6.71 m and maximum drawdown of the observation well 24 is 30 cm. When the well will be operated at a rate of 180 m^3/hr (the designed pumping rate) it is expected the draw down at a distance of 150 m will reduce to an amount close to zero.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Table 4 shows the specific capacity of the well at various discharges.

Table 4: Drawdown and specific capacity of well 25

Q (m3/hr)	Sw(m)	Q/sw (m^2/hr)
58	1.25	46.40
69	1.97	35.03
102	3.12	32.69
99	3.11	31.83
101	3.15	32.06
156	5.10	30.59
168	5.41	31.05
198	6.71	29.51

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 4 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

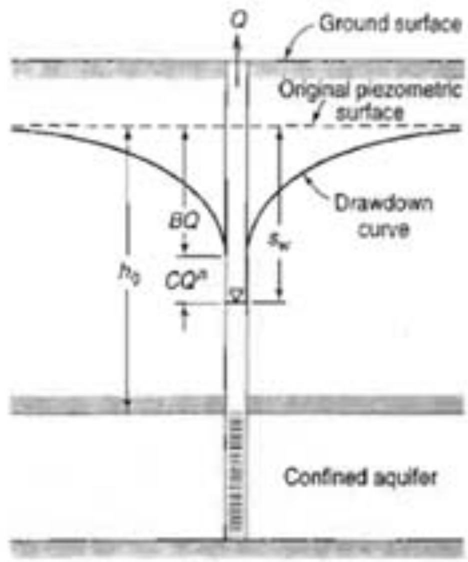


Figure 4: Aquifer losses and well losses

By calculating well losses B and C values can be calculated from figure 5 as follows :

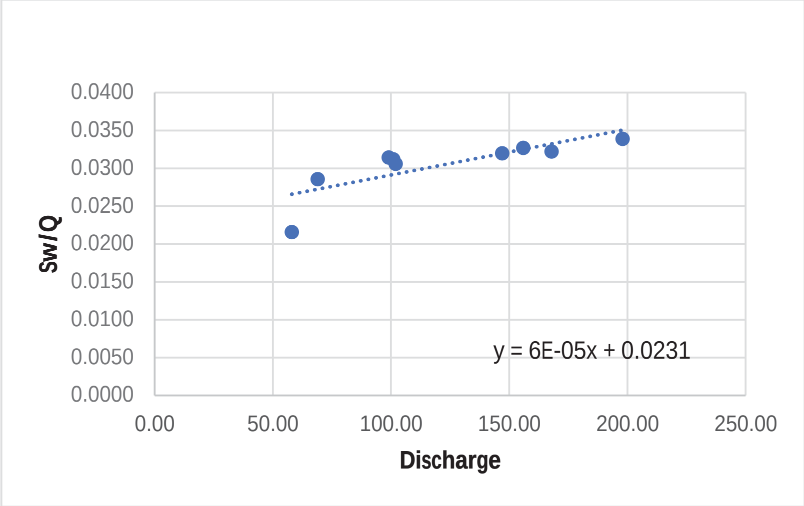


Figure 3: Specific draw down Vs Discharge

Therefore, from figure 5, B and C are as follows:

B = 0.0231

C = 0.00006

letting n=2

By using these values and the equation above Table 5 presents the estimated well losses and aquifer losses.

Table 5: Well losses and aquifer losses

Q	Well losses	Aquifer Losses	Total Losses
58	0.20	1.3398	1.54
69	0.29	1.5939	1.88
102	0.62	2.3562	2.98
99	0.59	2.2869	2.87
101	0.61	2.3331	2.95
156	1.46	3.6036	5.06
168	1.69	3.8808	5.57
147	1.30	3.3957	4.69
198	2.35	4.5738	6.93

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 6 using the following equation:

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{BQ}{s_w}$$

Table 6: Well efficiency against pumping rate

Q	Well Efficiency
58	86.91
69	84.80
102	79.06
99	79.55
101	79.22
156	71.16
168	69.62
198	66.04

6.1.5 Recovery Test Results

At the end of pumping test which continued for 410 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 7 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 7: Recovery test data (Pump shut down at t=240 min)

t'	T	t/t'	S'
2	412	206	0.330
4	414	103.5	0.250
6	416	69.33	0.160
8	418	52.25	0.050
10	420	42	0.040
15	425	28.33	0.040
20	430	21.5	0.030
25	435	17.4	0.020
30	440	14.66	0.020
40	450	11.25	0.020
50	460	9.2	0.020

It was noticed from the recovery data as shown in Table 7 that 99 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

7. Location of Pump:

As noticed in the pumping test the draw down was 6.71 m for 198 m^3/hr. Since the operation of the recovery well 25 will be 180 m^3/hr and the expected draw down will be around 6 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 25 the pump should be located 15 m below the static groundwater level which is (-2.28). The location of the pump will be 64.36 m from the top ground level. (the ground level is 47.08 m) and 64.7 m from finishing level (the finishing level is 47.42).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 25
Annex 2: Recovery test data sheet readings of well 25

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 25	observation well no.: 24
Distance from observation well 28: m	
Well depth :	well diameter :12"
Date of test: 31/10/2017	start time 09:25 AM finish time: 13:00 pm
Depth of pump: 62.3 m	water table depth : 49.87 m

Time (min.)	Pumping rate (m3/hr)	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	58	2	51.07	1.2
4	58	2	51.07	1.2
6	58	2	51.08	1.21
8	58	2	51.1	1.23
10	58	2	51.1	1.23
15	58	5	51.12	1.25
20	58	5	51.12	1.25
25	58	5	51.12	1.25
30	58	5	51.12	1.25
40	69	10	51.64	1.77
50	69	10	51.7	1.83
60	69	10	51.7	1.83
70	69	10	51.83	1.96
80	69	10	51.84	1.97
90	69	10	51.84	1.97
92	102	2	52.64	2.77
94	102	2	52.8	2.93
96	102	2	52.99	3.12
98	102	2	52.99	3.12
100	102	2	52.99	3.12
105	102	5	52.99	3.12
110	99	5	52.98	3.11
115	99	5	52.98	3.11
120	99	5	52.98	3.11
130	99	10	52.98	3.11
140	101	10	53.02	3.15
150	101	10	53.02	3.15
152	156	2	53.59	3.72
154	156	2	53.77	3.9
156	156	2	54.23	4.36
158	156	2	54.4	4.53
160	156	2	54.55	4.68
165	156	5	54.8	4.93
170	156	5	54.97	5.1
175	156	5	54.97	5.1
180	156	5	54.97	5.1
190	168	10	55.28	5.41
200	147	10	54.63	4.76
210	147	10	54.57	4.7
212	198	2	56.27	6.4

214	198	2	56.47	6.6
216	198	2	56.47	6.6
218	198	2	56.47	6.6
220	198	2	56.47	6.6
225	198	5	56.48	6.61
230	198	5	56.55	6.68
235	198	5	56.58	6.71
240	198	5	56.58	6.71
250	198	10	56.58	6.71
260	198	10	56.58	6.71
270	198	10	56.58	6.71
290	198	20	56.58	6.71
310	198	20	56.58	6.71
330	198	20	56.58	6.71
350	198	20	56.58	6.71
370	198	20	56.58	6.71
390	198	20	56.58	6.71
410	198	20	56.58	6.71

Recovery test	
time intervals after stoping pumping (min)	water table readings
2	50.2
2	50.12
2	50.03
2	49.92
2	49.91
5	49.91
5	49.9
5	49.89
5	49.89
10	49.89
10	49.89

Remaining Days to finish the project	70 Days

Date: 22-10-2017 Ref No: SAK-EFF-145/418

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Modified Pumping Test Report for Recovery well no.26

Dear Sir

With reference to the above mentioned subject, please see the attached Modified report. We added a paragraph about Permanent pump location and remove the annex no.04 (Lithology report).

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 26 PUMPING TEST REPORT

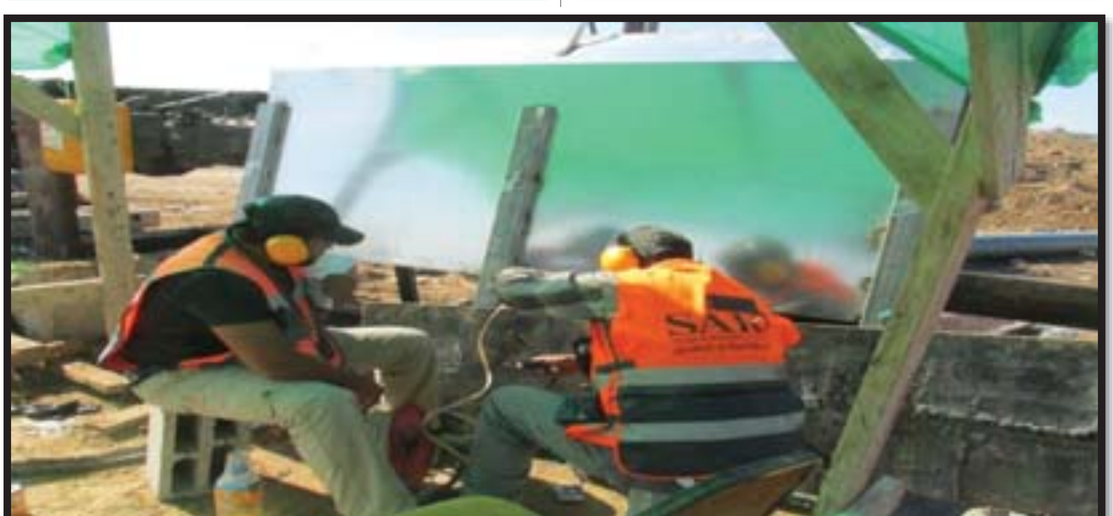


Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 12/10/2011* at well 26 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.

These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 26 . The pump was started on October, 12, 2017 at 10.30 a.m. and was stopped on October, 12, 2017 at 6.30 p.m.

The duration of the pumping was a total of 9 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	50	60
2	100	60
3	150	60
4	200	300

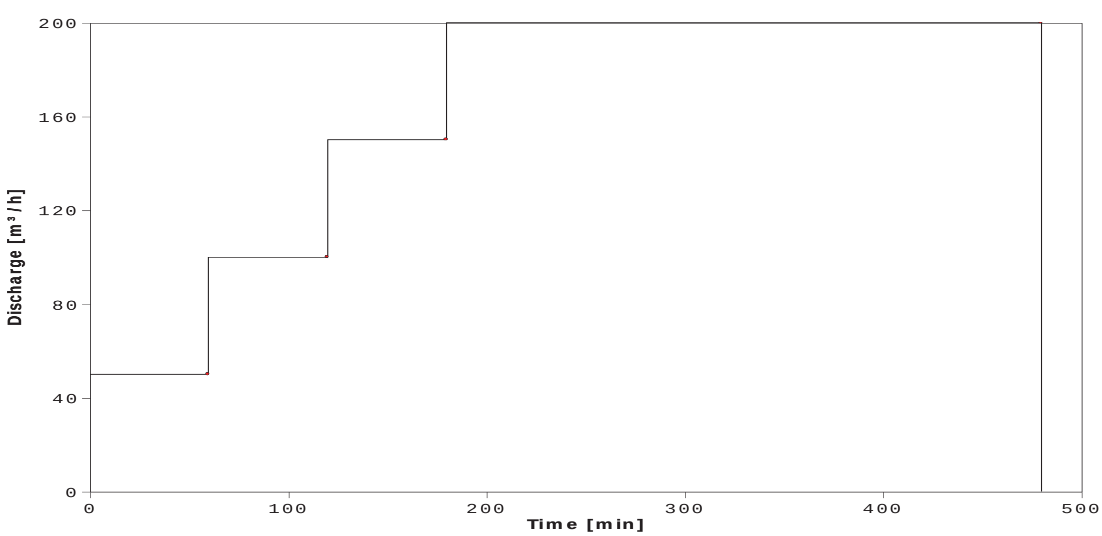


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-360	20
360 to steady state of the well draw down	30

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 26 was checked and analyzed using Aquifer Test software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

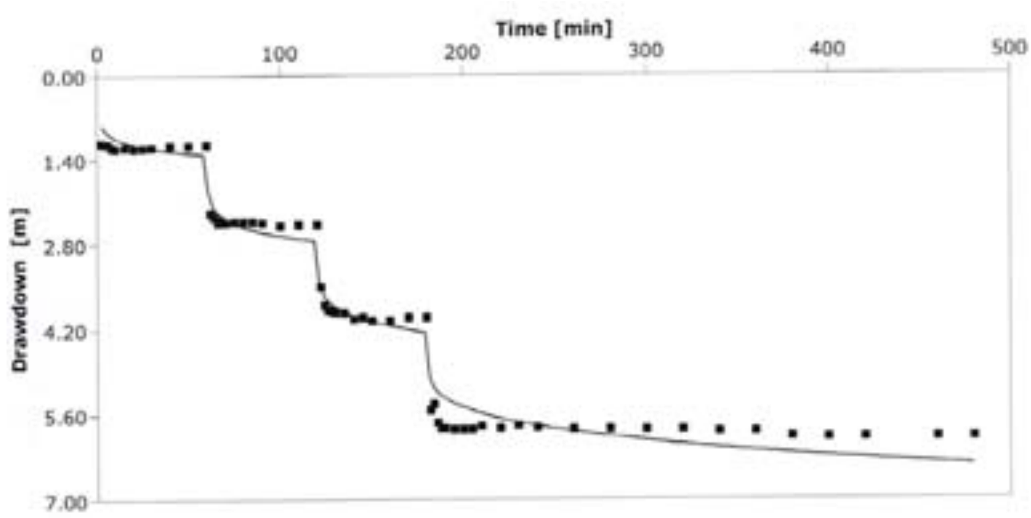


Figure 2: Drawdown curve for step-draw down test in well 26

The software was also used to compute the properties of the aquifer as follows:

Transmissivity = $6.14*10^2$ m^2/d

Hydraulic conductivity = 87.6 m/d

Storage coefficient = $5.00*10^{-1}$

Annex 1 shows the Aquifer Test software analysis report.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Table 5 shows the specific capacity of Well 26 at various pumping values.

Table 5: Drawdown and specific capacity of well 26

Q (m^3/hr)	Drawdown (m)	Specific Capacity (m^3/d)
50	1.2	1000
100	2.5	960
150	4	900
200	6	800

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

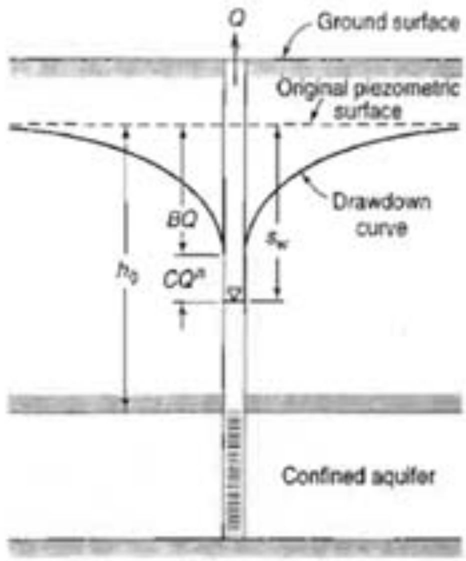


Figure 3: Aquifer losses and well losses

From the above mentioned equation and letting n=2 we have

$$\frac{s_w}{Q} = B + CQ$$

Therefore, by plotting Sw/Q versus Q (see Table 6 and figure 4) and fitting a straight line through the points, the well loss coefficient C is given by the slope of the line and the formation loss coefficient B by the intercept Q=0.

Table 6: Q versus Sw/Q

Q (m^3/hr)	Measured Sw (m)	Sw/Q
50.00	1.20	0.0240
100.00	2.50	0.0250
150.00	4.00	0.0267
200.00	6.00	0.0300

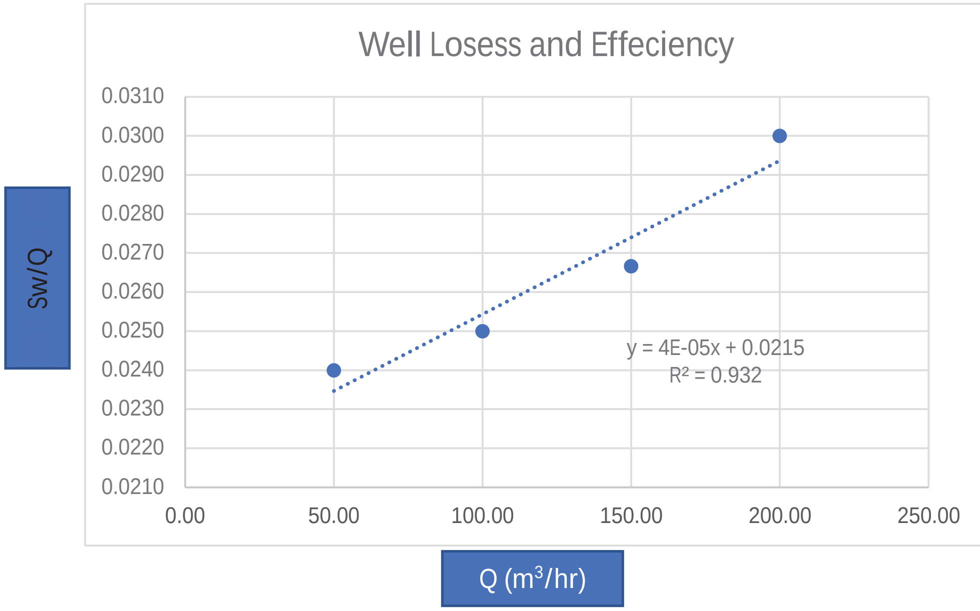


Figure 4: Determination of C and B from graph of Sw/q versus Q

Therefore, from figure 4 B and C are as follows:

B = 0.0215
C = 0.00004

By using these values and the equation above Table 7 presents the estimated well losses and aquifer losses.

Table 7: Well losses and aquifer losses

Q (m^3/hr)	Well losses (m) CQ^n	Aquifer Losses (m) BQ
50	0.10	1.075
100	0.40	2.15
150	0.90	3.225
200	1.60	4.3

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 8 using the following equation:

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{BQ}{s_w}$$

Table 8: Well efficiency against pumping rate

Q (m^3/hr)	Well efficiency (%)
50	91.49
100	84.31
150	78.18
200	72.88

6.1.5 Recovery Test Results

At the end of pumping test which continued for 480 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 9: Recovery test data (Pump shut down at t=480 min)

t' (min)	t (min)	t/t'	S' (m)
2	482	241	0.090
4	484	121	0.070
6	486	81	0.060
8	488	61	0.050

10	490	49	0.040
15	495	33	0.030
20	500	25	0.030
25	505	20.2	0.030
30	510	17	0.025
40	520	13	0.025
50	530	10.6	0.020
60	540	9	0.020
80	560	7	0.020
100	580	5.8	0.020
120	600	5	0.020

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q= 200 m^3/hr and s' is 0.04 then **T will be equal to 915 m^2/day**. It was noticed form the recovery data as shown in Table9 that 98 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

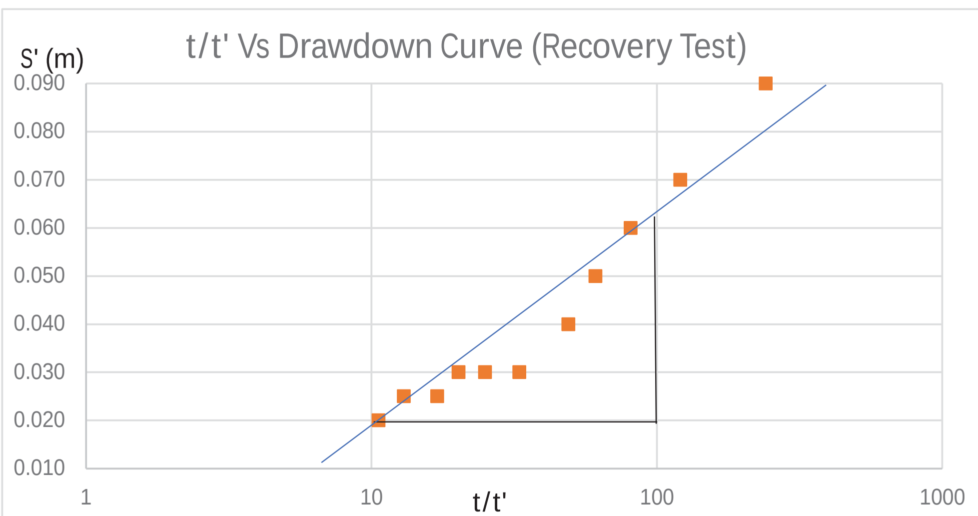


Figure 5: t/t' versus residual drawdown in the recovery test

7. Location of Pump:

As noticed in the pumping test the draw down was 6 m for 200 m3/hr. Since the operation of the recovery well 26 will be 180 m3/hr and the expected draw down will be around 5 m. Based on the current practice of well design and operation (regionally and globally) the location of the pump inside the well should be below the groundwater level of an amount 2 to 3 times of the draw down of the designed pumping rate. Therefore, for well 26 the pump should be located 15 m below the static groundwater level and 64.3 m from the top ground level (the groundwater level is 49.3m).

8. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 26
Annex 2: Recovery test data sheet readings of well 26
Annex 3: Aquifer Test Software Report

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 26	observation well no.: 28
Distance from observation well-1: 185.4 m	distance from observation well
Well depth 79.5	well diameter :12"
Date of test: 12/10/2017	start time 10:30 AM finish time:18.30 pm
Depth of pump: 62.3	water table depth : 49.72 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	50 m3/hr	2	50.85	1.13
4	50m3/hr	2	50.86	1.14
6	50m3/hr	2	50.87	1.15
8	50m3/hr	2	50.92	1.2
10	50m3/hr	2	50.94	1.22
15	50m3/hr	5	50.92	1.2
20	50 m3/hr	5	50.94	1.22
25	50m3/hr	5	50.93	1.21
30	50m3/hr	5	50.92	1.2
40	50 m3/hr	10	50.9	1.18
50	50m3/hr	10	50.9	1.18
60	50m3/hr	10	50.88	1.16
62	100m3/hr	2	52.02	2.3
64	100m3/hr	2	52.08	2.36
66	100m3/hr	2	52.17	2.45
68	100m3/hr	2	52.15	2.43
70	100m3/hr	2	52.17	2.45
75	100m3/hr	5	52.16	2.44
80	100m3/hr	5	52.16	2.44
85	100m3/hr	5	52.16	2.44
90	100m3/hr	5	52.17	2.45
100	100m3/hr	10	52.22	2.5
110	100m3/hr	10	52.2	2.48
120	100m3/hr	10	52.2	2.48
122	150m3/hr	2	53.22	3.5
124	150m3/hr	2	53.53	3.81
126	150m3/hr	2	53.6	3.88
128	150m3/hr	2	53.62	3.9
130	150m3/hr	2	53.64	3.92
135	150m3/hr	5	53.65	3.93
140	150m3/hr	5	53.75	4.03
145	150m3/hr	5	53.72	4
150	150m3/hr	5	53.78	4.06
160	150m3/hr	10	53.78	4.06
170	150m3/hr	10	53.72	4
180	150m3/hr	10	53.72	4
182	200m3/hr	2	55.25	5.53
184	200m3/hr	2	55.16	5.44
186	200m3/hr	2	55.45	5.73
188	200m3/hr	2	55.55	5.83
190	200m3/hr	2	55.55	5.83
195	200m3/hr	5	55.57	5.85
200	200m3/hr	5	55.57	5.85
205	200m3/hr	5	55.57	5.85
210	200m3/hr	5	55.52	5.8
220	200m3/hr	10	55.55	5.83
230	200m3/hr	10	55.51	5.79
240	200m3/hr	10	55.54	5.82
260	200m3/hr	20	55.57	5.85
280	200m3/hr	20	55.57	5.85
300	200m3/hr	20	55.58	5.86
320	200m3/hr	20	55.58	5.86
340	200m3/hr	20	55.62	5.9
360	200m3/hr	20	55.62	5.9
380	200m3/hr	20	55.7	5.98
400	200m3/hr	20	55.72	6
420	200m3/hr	20	55.72	6
460	200m3/hr	20	55.72	6
480	200m3/hr	20	55.72	6

Recovery test	
time intervals after stoping pumping (min)	water table readings
2	49.82
2	49.8
2	49.79
2	49.78
2	49.77
5	49.76
5	49.76
5	49.76
5	49.755
10	49.755
10	49.75
10	49.75
20	49.75
20	49.75
20	49.75
12 hrs	49.73
24 hrs	49.73

Contact Info Address Company Name City, State/Province	Pumping Test - Water Level Data

Project: Recovery scheme
Number:
Client: PWA

Location: Gaza	Pumping Test: Pumping Test well 26	Pumping Well: Well 26
Test Conducted by: SAK	Test Date: 10/15/2017	Discharge: variable, average ra
Observation Well: Well 26	Static Water Level [m]: 49.72	Radial Distance to PW [m]: -

	Time [min]	Water Level [m]	Drawdown [m]
1	2	50.85	1.13
2	4	50.86	1.14
3	6	50.87	1.15
4	8	50.92	1.20
5	10	50.94	1.22
6	15	50.92	1.20
7	20	50.94	1.22
8	25	50.93	1.21
9	30	50.92	1.20
10	40	50.90	1.18
11	50	50.90	1.18
12	60	50.88	1.16
13	62	52.02	2.30
14	64	52.08	2.36
15	66	52.17	2.45
16	68	52.15	2.43
17	70	52.17	2.45
18	75	52.16	2.44
19	80	52.16	2.44
20	85	52.16	2.44
21	90	52.17	2.45
22	100	52.22	2.50
23	110	52.20	2.48
24	120	52.20	2.48
25	122	53.22	3.50
26	124	53.53	3.81
27	126	53.60	3.88
28	128	53.62	3.90
29	130	53.64	3.92
30	135	53.65	3.93
31	140	53.75	4.03
32	145	53.72	4.00
33	150	53.78	4.06
34	160	53.78	4.06

Contact Info Address Company Name City, State/Province	Pumping Test - Water Level Data

Project: Recovery scheme

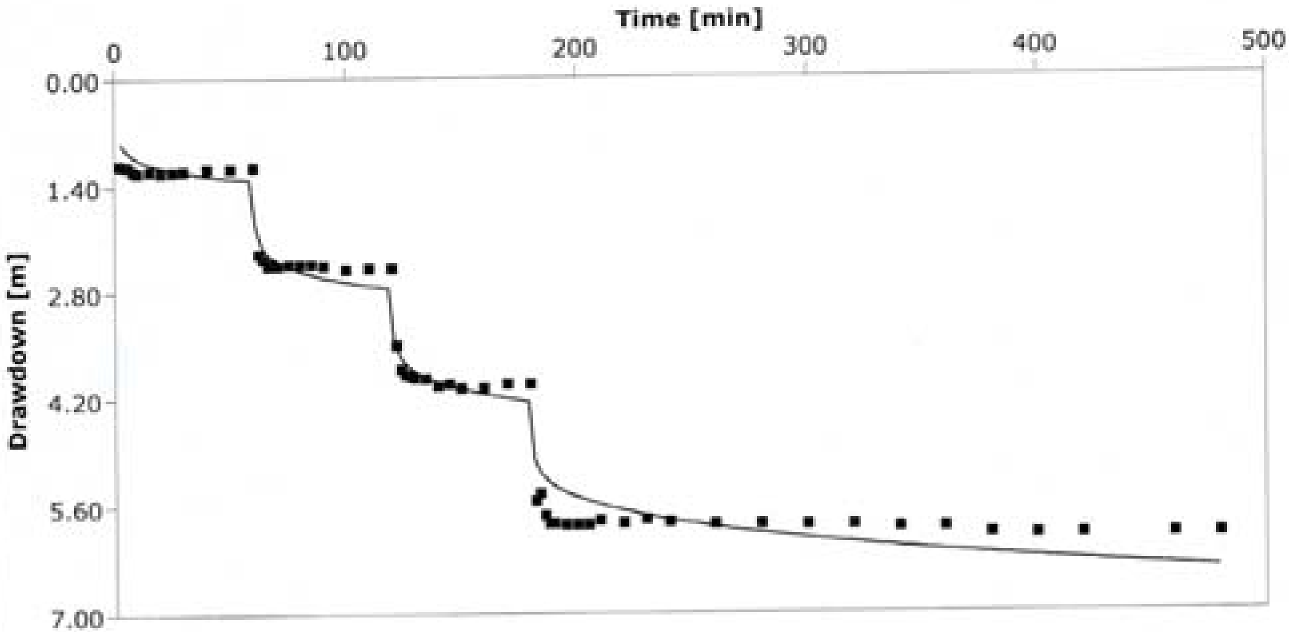
Number:

Client: PWA

	Time [min]	Water Level [m]	Drawdown [m]
35	170	53.72	4.00
36	180	53.72	4.00
37	182	55.25	5.53
38	184	55.16	5.44
39	186	55.45	5.73
40	188	55.55	5.83
41	190	55.55	5.83
42	195	55.57	5.85
43	200	55.57	5.85
44	205	55.57	5.85
45	210	55.52	5.80
46	220	55.55	5.83
47	230	55.51	5.79
48	240	55.54	5.82
49	260	55.57	5.85
50	280	55.57	5.85
51	300	55.58	5.86
52	320	55.58	5.86
53	340	55.62	5.90
54	360	55.62	5.90
55	380	55.70	5.98
56	400	55.72	6.00
57	420	55.72	6.00
58	460	55.72	6.00
59	480	55.72	6.00

Saqqa and Khoudary Co. Ltd Office: (+970)-8-2856888 / Fax: (+970)-8-2859888 Gaza office: Palestine - Gaza - Al-Mat'haf Hotel www.sak.ps <http://www.sak.ps>	Pumping Test Analysis Report Project: Effluent Recovery Scheme Number: Lot1: lot 01- ERW-2015 Client: PWA

Location: gaza	Pumping Test: Well 26 step drawdown test	Pumping Well: Well 26
Test Conducted by: SAK		Test Date: 10/12/2017
Analysis Performed by:	New analysis well 26 theis	Analysis Date: 10/21/2017
Aquifer Thickness: 21.00 m	Discharge: variable, average rate 162.5 [m³/h]	



Calculation using Theis

Observation Well	Transmissiv [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Well 26	6.14×10^{2}	2.92×10^{1}	5.00×10^{-1}	0.15	

	Contact Info Address Company Name City, State/Province	Pumping Test - Discharge Data	Page 1 of 1
		Project: Recovery scheme	
		Number:	
		Client: PWA	

Location: Gaza	Pumping Test: Pumping TesPumping Well: Well 26	
Test Conducted by: SAK	Test Date: 10/15/2017	Discharge: variable, average ra
Observation Well: Well 26		Radial Distance to PW [m]: -

	Time [min]	Discharge [m³/h]
1	60	50.00
2	120	100.00
3	180	150.00
4	480	200.00

Remaining Days to finish the project	73 Days

Date: 19-10-2017 Ref No: SAK-EFF-145/417

To: Center For Engineering and Planning. CEP & Finnish Consulting Group (FCG)
Attention: Mr. Hans Jürgen Matthiensen, Project Manager

Cc: Mr. Mohammed Nazik Rehan, Site Manager – PWA
Mr. Adel Gazzaz, Site Manager – CEP

Project: Effluent Recovery and Irrigation Scheme, First stage, Lot 1&2

Subject: Pumping Test Report for Recovery well no.26

Dear Sir

With reference to the above mentioned subject, please see the attached report.

Best Regards

Suhail Omar
Construction Manager
Saqqa and Khoudary Co.Ltd

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment– NGEST-ICB 01-NGEST/2015 (First Stage)–Lot 1+ 2

Lot1: ICB 01-NGEST/ Lot 01-ERW-2015, Lot2: ICB 01-NGEST/ Lot 02-EBS-2015

RECOVERY Well NO. 26 PUMPING TEST REPORT

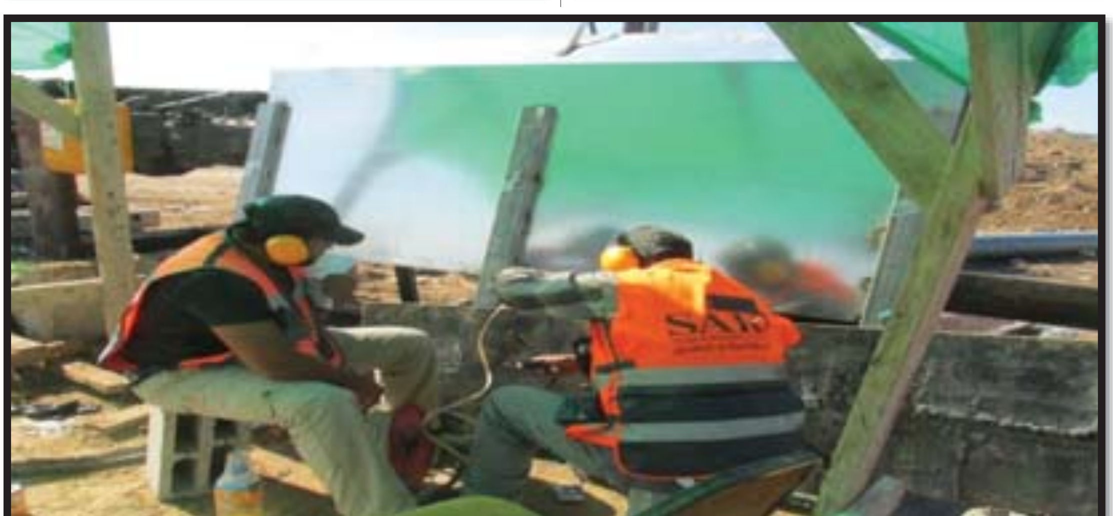


Table of Content

1. PURPOSE

The purpose of this report is to show the technical procedure, test results and findings of the pumping test which performed *on 12/10/2011* at well 26 in the project area, of *Effluent Recovery & Irrigation Scheme of North Gaza Emergency Wastewater Treatment (NGEST)*

2. DEFINITIONS

2.1 Pumping well: a well designed for extracting groundwater, and measuring water levels.
2.2 Aquifer: a formation that contains sufficient saturated permeable materials to yield significant quantities of water, to wells and springs.
2.3 Transmissivity: Measure of the ability of an aquifer to transmit water, the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient, which is also known as coefficient of **Transmissivity**.
2.4 Storage Coefficient: The volume of water that an aquifer releases from or takes into storage per unit surface area of aquifer per unit change in the component of normal head to that surface.
2.5 Hydraulic Conductivity (Permeability): Symbolically represented as *K*, is a property of vascular plants, soil or rock that describes the ease with which water can move through pore spaces or fractures. It depends on the intrinsic permeability of the material and the degree of saturation.

3. GENERAL

An aquifer pumping test is a controlled field experiment which executed to determine the approximate hydraulic properties of water-bearing material. Aquifer Transmissivity, storage capacity, and the respective derived parameters (hydraulic conductivity and the storage coefficient) are basic properties determined by most of test methods. In addition, aquifer boundary conditions (e.g., leaky conditions, barrier boundaries, recharge boundaries), and the spatial and temporal distribution of a cone of depression may also be estimated from the aquifer test data.

These parameters are useful to determine:

- The amount of storage available in an aquifer
- The rate at which water can flow through an aquifer
- The radius of influence, i.e. the distance from a well to the limit of the cone of depression.

The principle of the pumping test involves applying a stress to the aquifer by extracting groundwater from a pumping well and measuring the aquifer response to that stress by monitoring drawdown as a function of time.

4. AQUIFER TESTING METHODOLOGY:

To study the hydrologic properties of the aquifer, one step draw down pumping test with four constant rate pumping test were carried out to study well capacity and to provide enough information about the aquifer. Also to evaluate the loss, efficiency and the productivity of the well.

4.1.Wells Pumping – Recovery Test:

4.1.1. Step-Drawdown Test

Step-Drawdown pumping test was conducted at recovery well no. 26 . The pump was started on October, 12, 2017 at 10.30 a.m. and was stopped on October, 12, 2017 at 6.30 p.m.
The duration of the pumping was a total of 9 hours. The pumping rate was conducted in four steps as follows, in Table 1 and Fig. 1:

Table 1: Pumping Rates during the test

Step	Pumping Rate (m^3/hr.)	Duration (min)
1	50	60
2	100	60
3	150	60
4	200	300

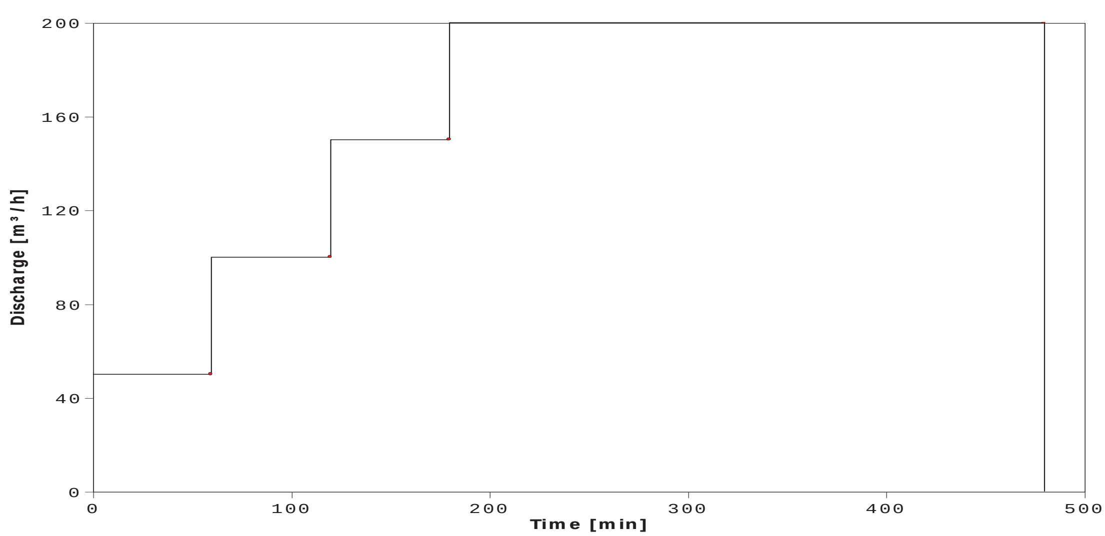


Figure 1: Discharge rate versus Time during the test

During the aquifer test, flow rate, discharge was measured using the flow meter connected to the well discharge pipe. The flow from discharge pipe was discharged away from the well.

Discharge readings during the test are attached in the appendix.

Static water levels were collected for the pumping well prior to the commencement of the pumping test. All water levels measurements were referred to constant reference during the test, e.g. top of the well casing or at a specified distance from the well casing.

Water levels were monitored using the water level sensor in the pumping well during the pumping test. Water levels were collected for each flow rate as follows in table 2 and table 3

Table 2: Time interval between measurements in first, second and third stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10

Table 3: Recommended Time interval between measurements in the fourth stage

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-360	20
360 to steady state of the well draw down	30

At the end of the pumping test, the pumping test stopped, and the recovery test began. Water levels measurements were taken in the pumping well. The recovery measurements were taken at time intervals as follows:

Table 4: time interval between recovery measurements

Time since pump started (min)	Time interval between measurements (min)
0-10	2
10-30	5
30-60	10
60-120	20

5. ANALYSIS OF THE PUMPING – RECOVERY TEST DATA:

5.1. Type of the Aquifer

The aquifer in this area of north Gaza considered being ***unconfined*** according to:

a- The litho logical cross sections of the soil profile of the drilling boreholes (BH1 to BH5)

b- Pilot boreholes drilled in 2003 year by Saqqa & Khoudary Co. for the Palestinian Water Authority of the GDCP Projects.

These boreholes show the water table varies in undulating form and in slope, depending on recharging areas and discharge, pumping from the wells, and permeability. All these boreholes indicated that the aquifer is unconfined.

6. Pumping – Recovery Tests Results

6.1. Step draw down Analysis

6.1.1 Properties of the aquifer

The step draw down pumping data at well 26 was checked and analyzed using Aquifer Test software. Figure 2 shows the recorded draw down against time for the four stages of pumping.

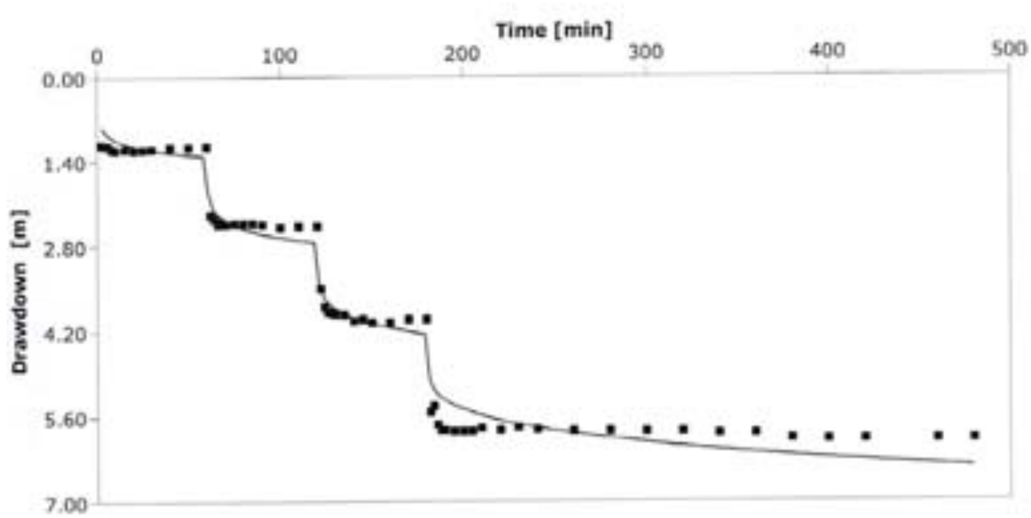


Figure 2: Drawdown curve for step-draw down test in well 26

The software was also used to compute the properties of the aquifer as follows:

Transmissivity = $6.14*10^2$ m^2/d

Hydraulic conductivity = 87.6 m/d

Storage coefficient = $5.00* 10^{-1}$

Annex 1 shows the Aquifer Test software analysis report.

6.1.2 Specific Capacity

The specific capacity of the well is a measure of the productivity of the well, which equal the discharge divided by drawdown in the pumping well. Table 5 shows the specific capacity of Well 26 at various pumping values.

Table 5: Drawdown and specific capacity of well 26

Q (m^3/hr)	Drawdown (m)	Specific Capacity (m^3/d)
50	1.2	1000
100	2.5	960
150	4	900
200	6	800

6.1.3 Well losses

The drawdown at the well includes not only that of the logarithmic drawdown curve at the well face (aquifer losses), but also a well loss caused by flow through the well screen and flow inside of the well to the pump intake. Figure 3 shows the two components of the draw down. Therefore, the total draw down in the well (Sw) can be computed as follow:

$$s_w = BQ + CQ^n$$

where BQ is the aquifer losses and CQ^n is the well losses. n is constant greater than one and reasonably can be assume as 2.

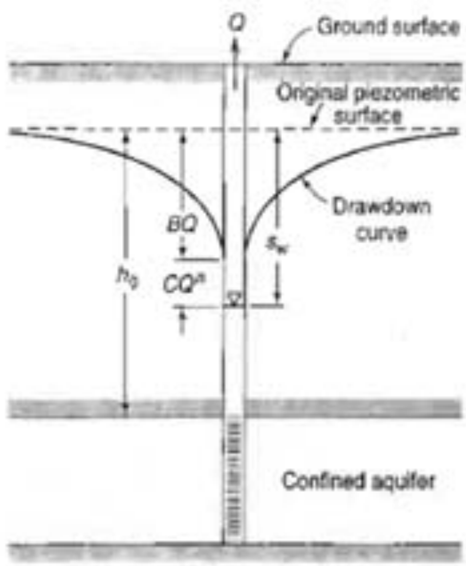


Figure 3: Aquifer losses and well losses

From the above mentioned equation and letting n=2 we have

$$\frac{s_w}{Q} = B + CQ$$

Therefore, by plotting Sw/Q versus Q (see Table 6 and figure 4) and fitting a straight line through the points, the well loss coefficient C is given by the slope of the line and the formation loss coefficient B by the intercept Q=0.

Table 6: Q versus Sw/Q

Q (m^3/hr)	Measured Sw (m)	Sw/Q
50.00	1.20	0.0240
100.00	2.50	0.0250
150.00	4.00	0.0267
200.00	6.00	0.0300

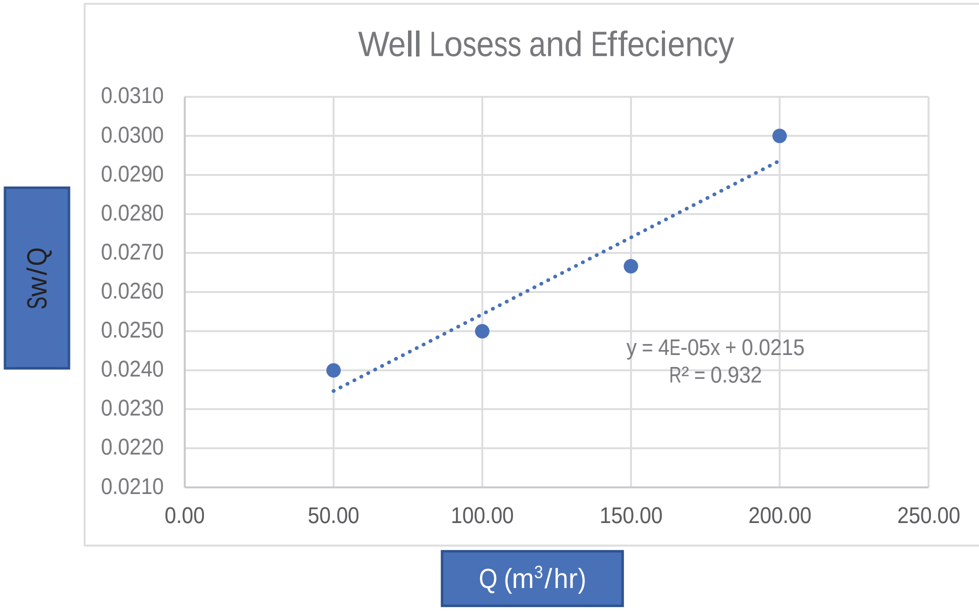


Figure 4: Determination of C and B from graph of Sw/q versus Q

Therefore, from figure 4 B and C are as follows:

B = 0.0215
C = 0.00004

By using these values and the equation above Table 7 presents the estimated well losses and aquifer losses.

Table 7: Well losses and aquifer losses

Q (m^3/hr)	Well losses (m) CQ^n	Aquifer Losses (m) BQ
50	0.10	1.075
100	0.40	2.15
150	0.90	3.225
200	1.60	4.3

6.1.4 Well Efficiency

Depending on the well loss coefficient C and the aquifer losses, the well efficiency can be calculated, as in Table 8 using the following equation:

$$E_w = 100\frac{Q/s_w}{Q/BQ} = 100\frac{BQ}{s_w}$$

Table 8: Well efficiency against pumping rate

Q (m^3/hr)	Well efficiency (%)
50	91.49
100	84.31
150	78.18
200	72.88

6.1.5 Recovery Test Results

At the end of pumping test which continued for 480 min, when the pump is stopped, the water levels in pumping well will begin to rise. This is referred to as the recovery of the water levels, while the measurements of the drawdown below the original static water level (prior to puming) during the recovery period are known as residual drawdown. Table 9 shows the residual drawdown (s') and the recovery time (t'). To compute the transmissivity using the recovery test data the following equation is employed:

$$T = \frac{2.30Q}{4\pi\Delta s'}$$

Table 9: Recovery test data (Pump shut down at t=480 min)

t' (min)	t (min)	t/t'	S' (m)
2	482	241	0.090
4	484	121	0.070
6	486	81	0.060
8	488	61	0.050

10	490	49	0.040
15	495	33	0.030
20	500	25	0.030
25	505	20.2	0.030
30	510	17	0.025
40	520	13	0.025
50	530	10.6	0.020
60	540	9	0.020
80	560	7	0.020
100	580	5.8	0.020
120	600	5	0.020

Thus a plot of the residual drawdown s' versus the logarthim of t/t' forms a straight line (Figure 5). Then by using Q= 200 m^3/hr and s' is 0.04 then **T will be equal to 915 m^2/day**. It was noticed form the recovery data as shown in Table9 that 98 % of the drawdown was recovered in the first 5 minutes it can be concluded that the well is efficient.

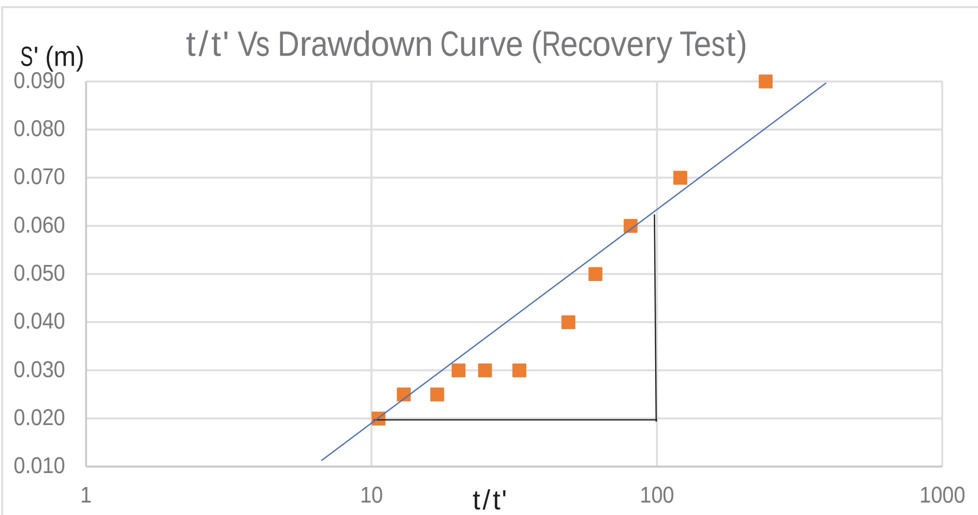


Figure 5: t/t' versus residual drawdown in the recovery test

7. WATER QUALITY

During the pumping test, 2 samples of the pumped water have been taken for chemical analysis and the results will be submitted separately.

APPENDIX

Annex 1: Pumping test data sheet readings of well 26
Annex 2: Recovery test data sheet readings of well 26
Annex 2: Aquifer Test Software Report
Annex 3: The lithology of well 26

Project: Effluent Recovery and Irrigation Scheme Of North Gaza-First Stage (Lot 1 and Lot 2)

Pumping test data sheet	
Pumping well no.: 26	observation well no.: 28
Distance from observation well-1: 185.4 m	distance from observation well
Well depth 79.5	well diameter :12"
Date of test: 12/10/2017	start time 10:30 AM finish time:18.30 pm
Depth of pump: 62.3	water table depth : 49.72 m

Time (min.)	Pumping rate	Time interval (min.)	Depth of water table (m)	Draw down (m)
2	50 m3/hr	2	50.85	1.13
4	50m3/hr	2	50.86	1.14
6	50m3/hr	2	50.87	1.15
8	50m3/hr	2	50.92	1.2
10	50m3/hr	2	50.94	1.22
15	50m3/hr	5	50.92	1.2
20	50 m3/hr	5	50.94	1.22
25	50m3/hr	5	50.93	1.21
30	50m3/hr	5	50.92	1.2
40	50 m3/hr	10	50.9	1.18
50	50m3/hr	10	50.9	1.18
60	50m3/hr	10	50.88	1.16
62	100m3/hr	2	52.02	2.3
64	100m3/hr	2	52.08	2.36
66	100m3/hr	2	52.17	2.45
68	100m3/hr	2	52.15	2.43
70	100m3/hr	2	52.17	2.45
75	100m3/hr	5	52.16	2.44
80	100m3/hr	5	52.16	2.44
85	100m3/hr	5	52.16	2.44
90	100m3/hr	5	52.17	2.45
100	100m3/hr	10	52.22	2.5
110	100m3/hr	10	52.2	2.48
120	100m3/hr	10	52.2	2.48
122	150m3/hr	2	53.22	3.5
124	150m3/hr	2	53.53	3.81
126	150m3/hr	2	53.6	3.88
128	150m3/hr	2	53.62	3.9
130	150m3/hr	2	53.64	3.92
135	150m3/hr	5	53.65	3.93
140	150m3/hr	5	53.75	4.03
145	150m3/hr	5	53.72	4
150	150m3/hr	5	53.78	4.06
160	150m3/hr	10	53.78	4.06
170	150m3/hr	10	53.72	4
180	150m3/hr	10	53.72	4
182	200m3/hr	2	55.25	5.53
184	200m3/hr	2	55.16	5.44
186	200m3/hr	2	55.45	5.73
188	200m3/hr	2	55.55	5.83
190	200m3/hr	2	55.55	5.83
195	200m3/hr	5	55.57	5.85
200	200m3/hr	5	55.57	5.85
205	200m3/hr	5	55.57	5.85
210	200m3/hr	5	55.52	5.8
220	200m3/hr	10	55.55	5.83
230	200m3/hr	10	55.51	5.79
240	200m3/hr	10	55.54	5.82
260	200m3/hr	20	55.57	5.85
280	200m3/hr	20	55.57	5.85
300	200m3/hr	20	55.58	5.86
320	200m3/hr	20	55.58	5.86
340	200m3/hr	20	55.62	5.9
360	200m3/hr	20	55.62	5.9
380	200m3/hr	20	55.7	5.98
400	200m3/hr	20	55.72	6
420	200m3/hr	20	55.72	6
460	200m3/hr	20	55.72	6
480	200m3/hr	20	55.72	6

Recovery test	
time intervals after stoping pumping (min)	water table readings
2	49.82
2	49.8
2	49.79
2	49.78
2	49.77
5	49.76
5	49.76
5	49.76
5	49.755
10	49.755
10	49.75
10	49.75
20	49.75
20	49.75
20	49.75
12 hrs	49.73
24 hrs	49.73

Saqqa and Khoudary Co. Ltd
Office: (+970)-8-2856888 / Fax: (+970)-8-2859888
Gaza office: Palestine - Gaza - Al-Mat'haf Hotel
www.sak.ps <http://www.sak.ps>

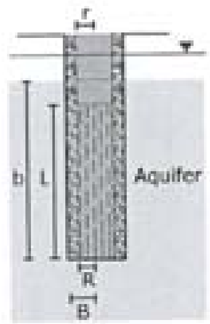
Wells

Project: Effluent Recovery Scheme

Number: Lot1: lot 01- ERW-2015

Client: PWA

Location: gaza



	Name	X [m]	R [m]	L [m]	r [m]
1	Well 26		0.1524	13	0.1524

Saqqa and Khoudary Co. Ltd
Office: (+970)-8-2856888 / Fax: (+970)-8-2859888
Gaza office: Palestine - Gaza - Al-Mat'haf Hotel
www.sak.ps <http://www.sak.ps>

Pumping Test - Water Level Data

Project: Effluent Recovery Scheme
Number: Lot1: lot 01- ERW-2015
Client: PWA

Location: gaza	Pumping Test: Well 26 step drawdown test	Pumping Well: Well 26
Test Conducted by: SAK	Test Date: 10/12/2017	Discharge: variable, average ra
Observation Well: Well 26	Static Water Level [m]: 49.72	Radial Distance to PW [m]: -

	Time [min]	Water Level [m]	Drawdown [m]
1	2	50.85	1.13
2	4	50.86	1.14
3	6	50.87	1.15
4	8	50.92	1.20
5	10	50.94	1.22
6	15	50.92	1.20
7	20	50.94	1.22
8	25	50.93	1.21
9	30	50.92	1.20
10	40	50.90	1.18
11	50	50.90	1.18
12	60	50.88	1.16
13	62	52.02	2.30
14	64	52.08	2.36
15	66	52.17	2.45
16	68	52.15	2.43
17	70	52.17	2.45
18	75	52.16	2.44
19	80	52.16	2.44
20	85	52.16	2.44
21	90	52.17	2.45
22	100	52.22	2.50
23	110	52.20	2.48
24	120	52.20	2.48
25	122	53.22	3.50
26	124	53.53	3.81
27	126	53.60	3.88
28	128	53.62	3.90
29	130	53.64	3.92
30	135	53.65	3.93
31	140	53.75	4.03
32	145	53.72	4.00
33	150	53.78	4.06
34	160	53.78	4.06

Saqqa and Khoudary Co. Ltd
Office: (+970)-8-2856888 / Fax: (+970)-8-2859888
Gaza office: Palestine - Gaza - Al-Mat'haf Hotel
www.sak.ps <http://www.sak.ps>

Pumping Test - Water Level Data

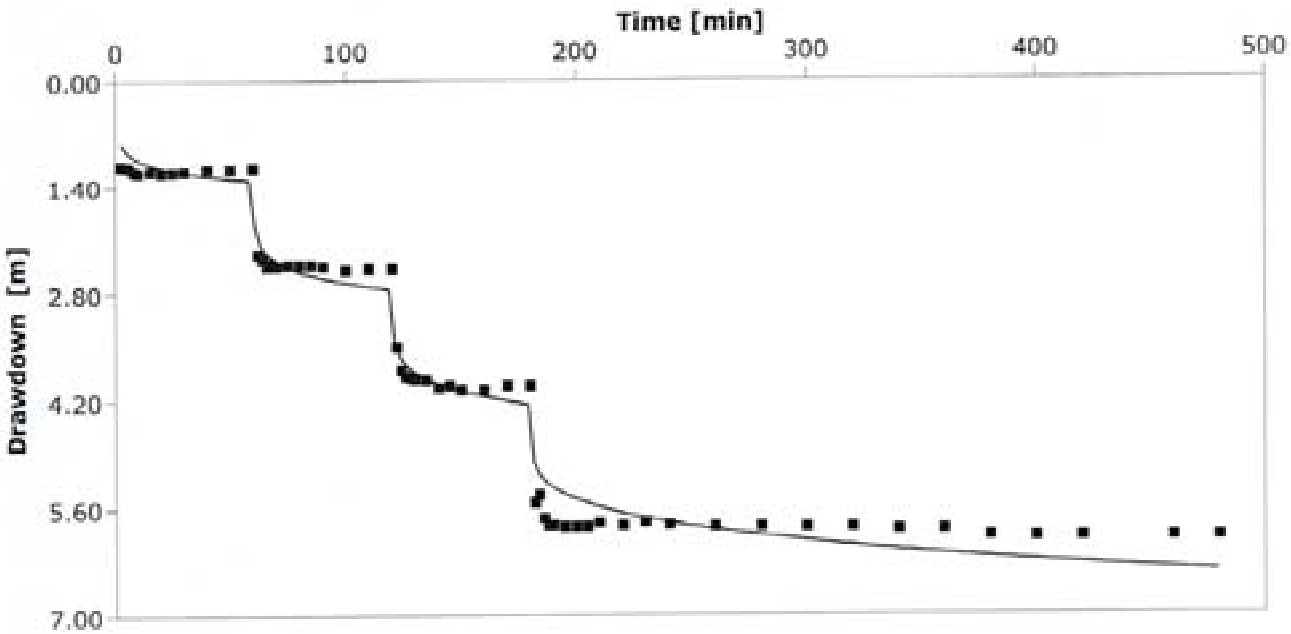
Project: Effluent Recovery Scheme
Number: Lot1: lot 01- ERW-2015
Client: PWA

	Time [min]	Water Level [m]	Drawdown [m]
35	170	53.72	4.00
36	180	53.72	4.00
37	182	55.25	5.53
38	184	55.16	5.44
39	186	55.45	5.73
40	188	55.55	5.83
41	190	55.55	5.83
42	195	55.57	5.85
43	200	55.57	5.85
44	205	55.57	5.85
45	210	55.52	5.80
46	220	55.55	5.83
47	230	55.51	5.79
48	240	55.54	5.82
49	260	55.57	5.85
50	280	55.57	5.85
51	300	55.58	5.86
52	320	55.58	5.86
53	340	55.62	5.90
54	360	55.62	5.90
55	380	55.70	5.98
56	400	55.72	6.00
57	420	55.72	6.00
58	460	55.72	6.00
59	480	55.72	6.00

Saqqa and Khoudary Co. Ltd
Office: (+970)-8-2856888 / Fax: (+970)-8-2859888
Gaza office: Palestine - Gaza - Al-Mat'haf Hotel
www.sak.ps <http://www.sak.ps>

Pumping Test Analysis Report	
Project:	Effluent Recovery Scheme
Number:	Lot1: lot 01- ERW-2015
Client:	PWA

Location: gaza	Pumping Test: Well 26 step drawdown test	Pumping Well: Well 26
Test Conducted by: SAK		Test Date: 10/12/2017
Analysis Performed by:	New analysis 3	Analysis Date: 10/17/2017
Aquifer Thickness: 70.00 m	Discharge: variable, average rate 162.5 [m³/h]	



Calculation using Theis

Observation Well	Transmissiv [m²/d]	Hydraulic Conductivity [m/d]	Storage coefficient	Radial Distance to PW [m]	
Well 26	6.14×10^{2}	8.76×10^{0}	5.00×10^{-1}	0.15	

CCQC

المركز الإستشاري للجودة والمعايرة

Consulting Center for Quality and Calibration

Soil Classification Report

Project Name: *Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)*

Well No.: *RW26*

Well Location: *North Gaza-Gaza Strip*

Supervision: *Joint Venture Association of the Center for Engineering & Planning (CEP) and the FCG International LTD*

Owner: *PWA*

Contractor: *Saqqa & Khouday Contracting Company -SAK-*

Report No.: *GI-17048*
Date: *12/09/2017*

المركز الإستشاري للجودة والمعايرة
CCQC
Consulting Center for Quality and Calibration

Introduction:

The Consulting Center for Quality and Calibration (CCQC) Soil and Material Testing Laboratory has conducted soil classification tests for the mentioned borehole-well- regarding the project *"Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)" in "North Gaza-Gaza Strip"* according to the request of the supervision/contractor on the 07th of Sep., 2017.

The purpose of the study is to investigate the surface and sub-surface condition of the soil, describe the soil profile within the borehole "well", and to determine the physical and mechanical properties of the soil strata to provide necessary information about soil characteristics within the borehole.

The scope of the work was decided by the supervision of the project by drilling the well to about 79.8 m depth to give the necessary information about the soil type within the site.

This report gives the test results of the received samples, which were sampled under the client's responsibility.

Description and Location of the Project:

The project consists of drilling and construction of 14 recovery water well at the project. The report herein for recovery water well No. 26, which were drilled during 7th & 9th of Sep., 2017. The coordinates of the well are: X-153052.5066 & Y-602212.2883.

Laboratory Tests and Method of Analysis:

According to the supervision requirements, soil classification tests were performed. The executed laboratory tests included Sieve analysis; Atterberg Limits; and moisture content tests. Samples of soil were selected by the client in a way representative to the soil strata within the borehole, in addition to a water samples at selected depths, then delivered to the laboratory. An identity number, sample location, and depth within the borehole identified each sample. The tests were performed according to the international standards ASTM and

BS. The soil layers were classified according to the USCS classification system. The following tests with their standard designation were performed:

Test Method	Standard Designation
Description and Identification of Soils (Visual-Manual Procedure)	ASTM D 2488-2009a
Particle Size Analysis of Soils	ASTM D 422-63-Reapproved 2007
Classification of Soils for Engineering Purposes (Unified Soil Classification System)	ASTM D 2487-2011
Laboratory Determination of Water (Moisture) Content of Soil	ASTM D 2216-2010
Liquid Limit, Plastic Limit, and Plasticity Index of Soils	ASTM D 4318-10e1, BS 1377- 1990

Soil Description:

The borehole/well indicated that the soil strata consists of four layers as described in the following:

First Layer: is a dark brown **Sandy Silty Clay-Sandy Lean Clay-**, with no to little gravel (Kurkar) starting from ground surface and extending to 38.0 m below the ground level. The layer is of medium plasticity, contains (0.0-2.6) % gravel, (5.0-23.4) % sand, and (79.2-95.0) % fines. This layer is of low - poor-permeability, where the estimated permeability coefficient ranges from 3.68E-06 to 5.32E-06cm/sec.

Second Type: is a **Poorly Graded Gravel-Sand Mixture,** starting from 38.0 m depth and extending to 56.0 m below, and consisting of yellowish silica sand and white gravel (Kurkar). The soil is containing (3.5-25.2)% sand gravel, (63.6-94.5) sand, and (1.9-15.7) % fines materials. The average size range from (0.317-0.579) mm, and the layer is of good (medium) permeability characteristics with estimated K range from 2.67E-03 to 3.35E-02 cm/sec.

Third Layer: is a light brown **Clayey Silty Sand**, with little gravel (Kurkar) starting from 56.0 m depth and extending to 58.0 m below the ground level. The layer is of medium plasticity, contains 0.6 % gravel, 56.6 % sand, and 42.7 % fines. This layer is of low - poor-permeability, where the estimated permeability coefficient is about 1.80E-05 cm/sec.

شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع ... عمر بن الخطاب - مفترق خربة العدس - تليفون: 08-2130081، جوال: 0592-283740 Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Fourth Type: *is a* ***Poorly Graded Gravel-Sand Mixture,*** *starting from 58.0 m depth and extending to 79.8 m below (to the end of the well), and consisting of yellowish silica sand and white gravel (Kurkar). The soil is containing (4.5-73.8)% sand gravel, (16.7-93.5) sand, and (0.6-11.6) % fines materials. The average size range from (0.386-13.164) mm, and the layer is of good (medium) to slightly high permeability characteristics with estimated K range from 4.21E-03 to 2.77E-01 cm/sec.*

Water Table: was encountered at 49.3 m below the datum.

Summary of soil laboratory test results are shown in the table below.

Depth	Gravel	Sand	F.C %	CU*	Cc	D50	LL	PI	USCS Class	Soil Type	K (cm/sec)
1.0	0.0	5.0	95.0	26.852	0.503	0.046	---	---	CL	Sandy Silty Clay	3.68E-06
4.0	0.0	8.4	91.6	26.847	0.554	0.047	---	---	CL		3.86E-06
11.0	0.0	9.0	91.0	26.846	0.563	0.047	---	---	CL		3.89E-06
17.0	0.0	7.0	93.0	26.849	0.533	0.047	---	---	CL		3.78E-06
25.0	0.0	20.8	79.2	26.823	0.845	0.051	36	13	CL		4.76E-06
30.0	0.5	18.4	81.1	26.827	0.786	0.051	---	---	CL		4.59E-06
34.0	0.0	16.0	84.0	26.833	0.709	0.05	---	---	CL		4.36E-06
37.0	2.6	23.4	74.0	26.81	1.055	0.054	36	12	CL		5.32E-06
39.0	20.7	63.6	15.7	9.739	1.893	0.397	---	NP	SM	Gravelly Sand	2.67E-03
40.0	13.1	73.5	13.4	7.815	1.874	0.36	---	NP	SM	Sand	3.37E-03
42.0	10.9	75.8	13.3	6.71	1.943	0.317	---	NP	SM		3.37E-03
44.0	18.4	79.5	2.1	3.005	0.783	0.416	---	NP	SP		3.12E-02
47.0	6.1	91.2	2.7	2.421	0.838	0.345	---	NP	SP		2.89E-02
50.0	3.5	94.5	1.9	2.806	0.932	0.45	---	NP	SP		3.29E-02
53.0	25.2	71.7	3.1	7.48	0.436	0.579	---	NP	SP	Gravelly Sand	3.35E-02
55.0	8.8	86.1	5.1	2.364	0.842	0.322	---	NP	SP-SM	Sand	2.62E-02
58.0	0.6	56.6	42.7	56.239	3.015	0.18	33	10	SC	Clayey Silty Sand	1.80E-05
60.0	73.8	16.7	9.5	93.25	14.225	11.03	---	NP	GP-GM	Gravel	2.29E-02
61.0	23.7	64.6	11.6	15.706	1.537	0.565	---	NP	SW-SM	Gravelly Sand	4.21E-03
64.0	12.1	80.8	7.1	3.447	0.827	0.449	---	NP	SP-SM	Sand	2.56E-02
66.0	27.1	68.1	4.8	6.537	0.449	0.525	---	NP	SP	Gravelly Sand	2.90E-02
68.0	5.3	88.8	6.0	3.053	0.782	0.386	---	NP	SP-SM	Sand	2.61E-02
70.0	49.4	50.0	0.6	32.847	0.276	4.39	---	NP	SP	Gravelly Sand	9.96E-02
71.0	4.7	94.2	1.0	4.324	1.073	0.764	---	NP	SP	Sand	5.08E-02
73.0	11.6	83.4	5.0	4.8	0.736	0.567	---	NP	SP-SM		3.00E-02
74.0	55.4	42.5	2.1	50.334	0.32	9.743	---	NP	GP	Sandy Gravel	6.42E-02
75.0	61.1	37.2	1.6	35.486	0.23	13.16	---	NP	GP		2.77E-01
78.0	4.7	88.2	7.1	3.166	0.804	0.405	---	NP	SP-SM	Sand	2.53E-02
79.8	4.5	93.5	2.0	3.162	0.897	0.487	---	NP	SP		3.36E-02

المقر الرئيسي: غزة- شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - تليفون: 08-2130081، جوال: 0592-283740 Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

*CU: Uniformity Coefficient (Sieve Analysis)
*Cc: Gradation Coefficient (Sieve Analysis)

The results of the chemical analysis of the water sample are shown in table below:

Parameter		Results		
		54 m	66 m	80 m
pH		7.235	7.478	7.162
EC	µS/cm	1915	2160	2110
TDS	mg/l	1150	1296	1266
Cl	mg/l	362	338	362
NO_3	mg/l	85	100	25

Note: The water samples were tested in Birzeit Lab-Gaza.

The appendix of this report shows the geotechnical profile for the well including the full details of test results.

We take this opportunity to thank you for your confidence and hope we will be of more help to you in the near future.

For/Laboratory Manager
Eng. Mohammed Ghanem

المقر الرئيسي: غزة- شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان – تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب – مفترق خربة العدس – تليفون: 08-2130081، جوال: 0592-283740 Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Appendix

Borehole Logs

Borehole No. : Well No. RW26.

Project: Construction of Effluent Recovery and Irrigation Scheme of Nor

Project No: ***

Client: Saqqa & Khouday Contracting Company -SAK-

Water Table: 49.30 m

Location: North Gaza -Gaza Strip

Engineer: Ahmed Ghanem

CCQC
Consulting Center For Quality and Calibration

SUBSURFACE PROFILE				SAMPLE										
Depth (m)	Graphic Log	Elev.	Soil Description	No.	USCS Classification	Fines Content %	Coefficient of Uniformity CU	Coefficient of Gradation Cc	Average Size D50-mm	Kestimated (cm/sec)	Liquid Limit %	Plasticity Index %	Water Content WC%
0.0		0.00	Ground Surface										
1.0			*Sandy Silty Clay* Slightly dark brown Sandy Silty Clay with no to little gravel (Kurkar). The Layer is of medium plasticity.	1	CL	95.0	26.852	0.503	0.046	3.68E-6	---	---	12.2
4.0				2	CL	91.6	26.847	0.554	0.047	3.86E-6	---	---	10.6
11.0				3	CL	91.0	26.846	0.563	0.047	3.89E-6	---	---	14.0
17.0				4	CL	93.0	26.849	0.533	0.047	3.78E-6	---	---	12.6
20.0													

Drill Method: Percussion Cable

Drill Date: Sep., 2017

Hole Size: 0 to 27.0 m 24" & from 27.0 to 79.5 m 18"

Datum: 0.0

X Coordinates: 153052.5066

Y Coordinates: 602212.2883

Checked by: Moh. Ghanem

Sheet: 1 of 4

المركز الإستشاري للجودة والمعايرة
CCQC
Consulting Center for Quality and Calibration

Borehole No. : Well No. RW26

Project: Construction of Effluent Recovery and Irrigation Scheme of Nor

Project No: ***

Client: Saqqa & Khouday Contracting Company -SAK-

Water Table: 49.30 m

Location: North Gaza -Gaza Strip

Engineer: Ahmed Ghanem

CCQC
Consulting Center For Quality and Calibration

SUBSURFACE PROFILE				SAMPLE										
Depth (m)	Graphic Log	Elev.	Soil Description	No.	USCS Classification	Fines Content %	Coefficient of Uniformity CU	Coefficient of Gradation Cc	Average Size D50-mm	Kestimated (cm/sec)	Liquid Limit %	Plasticity Index %	Water Content WC%
21.0													
22.0													
23.0													
24.0													
25.0				5	CL	79.2	26.823	0.845	0.051	4.76E-6	36	13	17.2
26.0													
27.0													
28.0													
29.0													
30.0				6	CL	81.1	26.827	0.786	0.051	4.59E-6	---	---	24.1
31.0													
32.0													
33.0													
34.0				7	CL	84.0	26.833	0.709	0.05	4.36E-6	---	---	49.5
35.0													
36.0													
37.0				8	CL	74.0	26.81	1.055	0.054	5.32E-6	36	12	19.9
38.0		-38.00											
39.0				9	SM	15.7	9.739	1.893	0.397	2.67E-3	---	NP	24.4
40.0				10	SM	13.4	7.815	1.874	0.36	3.37E-3	---	NP	18.3

Drill Method: Percussion Cable

Drill Date: Sep., 2017

Hole Size: 0 to 27.0 m 24" & from 27.0 to 79.8 m 18"

Datum: 0.0

X Coordinates: 153052.5066

Y Coordinates: 602212.2883

Checked by: Moh. Ghanem

Sheet: 2 of 4

المركز الإستشاري للجودة والمعايرة
CCQC
Consulting Center for Quality and Calibration

Borehole No. : Well No. RW26

Project: Construction of Effluent Recovery and Irrigation Scheme of Nort

Project No: ***

Client: Saqqa & Khouday Contracting Company -SAK-

Water Table: 49.30 m

Location: North Gaza -Gaza Strip

Engineer: Ahmed Ghanem

CCQC
Consulting Center For Quality and Calibration

SUBSURFACE PROFILE				SAMPLE										
Depth (m)	Graphic Log	Elev.	Soil Description	No.	USCS Classification	Fines Content %	Coefficient of Uniformity CU	Coefficient of Gradation Cc	Average Size D50-mm	Kestimated (cm/sec)	Liquid Limit %	Plasticity Index %	Water Content WC%
41.0–42.0			***Gravel-Sand Mixture*** Mixture of yellowish fine Sand with little to some white gravel (Kurkar) content and a little fines. Poorly graded soil, non plastic.	11	SM	13.3	6.71	1.943	0.317	3.37E-3	---	---	21.6
44.0				12	SP	2.1	3.005	0.783	0.416	3.12E-2	---	NP	20.4
47.0				13	SP	2.7	2.421	0.838	0.345	2.89E-2	---	NP	20.6
49.0		49.30	***Water Table***										
50.0			***Gravel-Sand Mixture*** Mixture of yellowish fine Sand with little to some white gravel (Kurkar) content and a little fines. Poorly graded soil, non plastic.	14	SP	1.9	2.806	0.932	0.450	3.29E-2	---	NP	21.1
53.0				15	SP	3.1	7.48	0.436	0.579	3.35E-2	---	NP	17.7
55.0				16	SP-SM	5.1	2.364	0.842	0.322	2.62E-2	---	NP	17.4
56.0		56.00	***Clayey Silty Sand*** Light brown Clayey Silty Sand with little gravel (Kurkar). The layer is of medium plasticity.										
58.0				17	SC	42.7	56.239	3.015	0.18	1.80E-5	33	10	28.2
59.0		59.00											
60.0				18	GP-GM	9.5	93.25	14.225	11.038	2.29E-2	---	NP	24.0

Drill Method: Percussion Cable

Drill Date: Sep., 2017

Hole Size: 0 to 27.0 m 24" & from 27.0 to 79.8 m 18"

Datum: 0.0

X Coordinates: 153052.5066

Y Coordinates: 602212.2883

Checked by: Moh. Ghanem

Sheet: 3 of 4

المركز الاستشاري للجودة والمعايرة
CCQC
Consulting Center for Quality and Calibration

Borehole No. : Well No. RW26

Project: Construction of Effluent Recovery and Irrigation Scheme of Nort

Project No: ***

Client: Saqqa & Khouday Contracting Company -SAK-

Water Table: 49.30 m

Location: North Gaza -Gaza Strip

Engineer: Ahmed Ghanem

CCQC
Consulting Center For Quality and Calibration

SUBSURFACE PROFILE				SAMPLE									
Depth (m)	Graphic Log	Elev.	Soil Description	No.	USCS Classification	Fines Content %	Coefficient of Uniformity CU	Coefficient of Gradation Cc	Average Size D50-mm	Kestimated (cm/sec)	Liquid Limit %	Plasticity Index %	Water Content WC%
			Gravel-Sand Mixture Mixture of yellowish fine Sand with a little to some white gravel (Kurkar) content and a little fines. Poorly graded soil, non plastic.										
61.0				19	SW-SM	11.6	15.706	1.537	0.565	4.21E-3	---	NP	21.3
62.0													
63.0													
64.0				20	SP-SM	7.1	3.447	0.827	0.449	2.56E-2	---	NP	23.0
65.0													
66.0				21	SP	4.8	6.537	0.449	0.525	2.90E-2	---	NP	16.6
67.0													
68.0				22	SP-SM	6.0	3.053	0.782	0.386	2.61E-2	---	NP	15.8
69.0													
70.0				23	SP	0.6	32.847	0.276	4.39	9.96E-2	---	NP	17.9
71.0				24	SP	1.0	4.324	1.073	0.764	5.08E-2	---	NP	19.1
72.0													
73.0				25	SP-SM	5.0	4.8	0.736	0.567	3.0E-2	---	NP	17.8
74.0				26	GP	2.1	50.334	0.32	9.743	6.42E-2	---	NP	15.0
75.0				27	GP	1.6	35.486	0.23	13.164	2.77E-1	---	NP	16.6
76.0													
77.0													
78.0				28	SP-SM	7.1	3.166	0.804	0.405	2.53E-2	---	NP	17.9
79.0													
		-79.80		29	SP	2.0	3.162	0.897	0.487	3.36E-2	---	NP	11.0
80.0													

Drill Method: Percussion Cable

Drill Date: Sep., 2017

Hole Size: 0 to 27.0 m 24" & from 27.0 to 79.8 m 18"

Datum: 0.0

X Coordinates: 153052.5066

Y Coordinates: 602212.2883

Checked by: Moh. Ghanem

المركز الإستشاري للجودة والمعايرة
CCQC
Consulting Center for Quality and Calibration

Laboratory Tests Results

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Test of Moisture Content as Received

Project Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Sampling Date Sep. 2017 up to 09/09/2017

Testing Date 11/09/2017

Borehole No. Well No. 26

Depth(m)	Container No.	Container Wt(g)	Wet wt(g)	Dry Wt(g)	WC %	Soil Type
1	A7	31.7	150.3	137.4	12.2	Sandy Silty Clay
4	A13	34.2	175	161.5	10.6	Sandy Silty Clay
11	A21	34.3	160.4	144.0	14.0	Sandy Silty Clay
17	A28	32.3	177.7	161.4	12.6	Sandy Silty Clay
25	A35	32.1	140.6	129.8	17.2	Sandy Silty Clay
30	A37	31.1	146	123.7	24.1	Sandy Silty Clay
34	A43	32.3	188.8	137.0	49.5	Sandy Silty Clay
37	A49	36.4	177.4	154.0	19.9	Sandy Silty Clay
39	A8	31.8	214.4	178.6	24.4	Gravelly Sand
40	A14	33.1	379.3	325.8	18.3	Sand
42	A20	32.5	280.5	236.4	21.6	Sand
44	A27	33.5	266	225.7	20.4	Sand
47	A34	30.2	268.6	227.8	20.6	Sand
50	A42	32.2	264.8	224.2	21.1	Sand
53	A12	32.1	314.1	271.6	17.7	Gravelly Sand
56	A19	32.9	259.3	225.7	17.4	Sand
58	A48	32.5	235.8	191.1	28.2	Clayey Silty Sand
59	A5	34.3	272.8	226.7	24.0	Gravel
61	A26	29.9	317.4	266.9	21.3	Gravelly Sand
64	A33	31.4	263.1	219.8	23.0	Sand
66	A40	32	296.2	257.7	16.6	Gravelly Sand
68	A46	30.5	269.3	236.8	15.8	Sand
70	A4	34.6	302.7	261.9	17.9	Gravelly Sand
71	A15	48.1	377.3	324.4	19.1	Sand
73	A22	31.7	404.1	347.7	17.8	Sand
74	A29	51.2	296.3	264.4	15.0	Sandy Gravel
75	N1	65	806.2	752.0	10.6	Sandy Gravel
78	A36	30.9	346.1	298.2	17.9	Sand
79.8	A41	33	382.4	347.8	11.0	Sand

Tested By: Ah. Isdoudi

المركز الاستشاري للجودة والمعايرة
CCQC
Consulting Center for Quality and Calibration

المقر الرئيسي: غزة – شارع الثورة – عمارة الرجبي بجوار برج أبو رمضان – تليفاكس 08-2886362، جوال 0599-991191، 0598-880379، 0596-995595، 0599-880879
فرع الجنوب: رفح شارع عمر بن الخطاب – مفترق خربة العدس – تليفون 08-2130081، جوال 0592-283740 Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

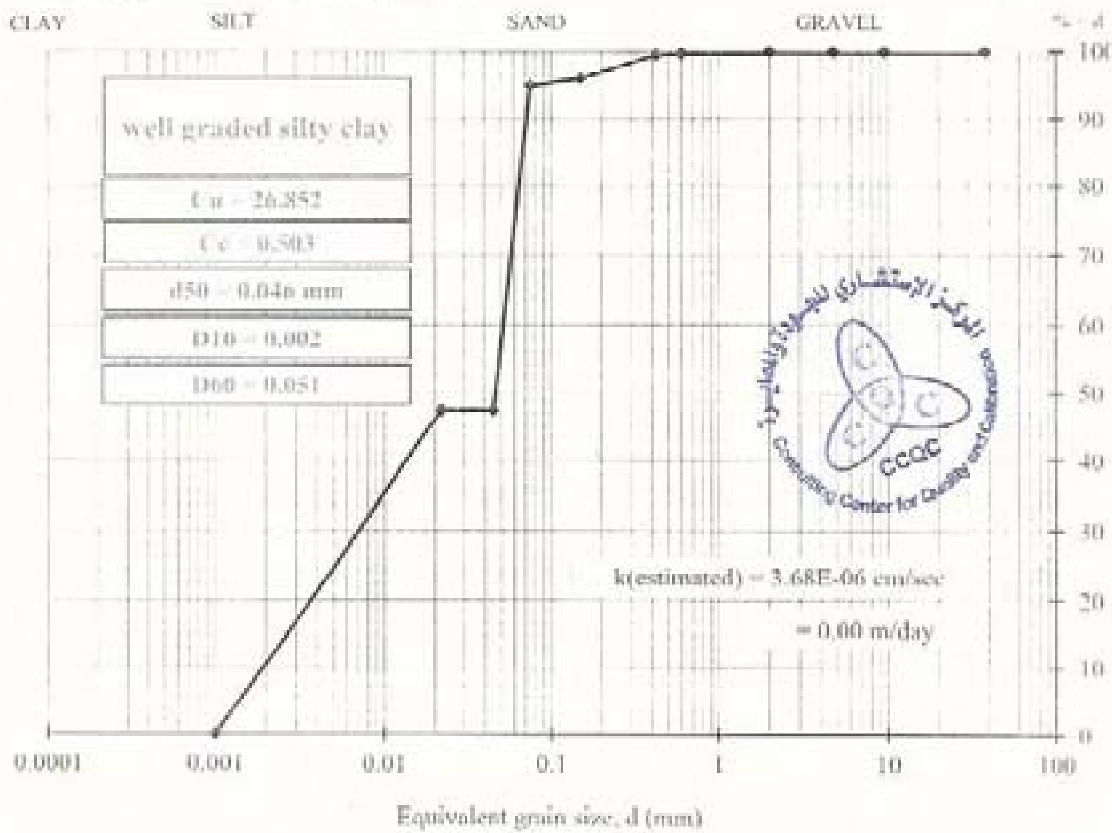
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 1.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	0.0
				Medium gravel	0.0	
				Fine gravel	0.0	
3/8"	9.50	105.7	100.0	Coarse sand	0.0	5.0
Nr. 4	4.75	105.7	100.0	Medium sand	0.5	
Nr. 10	2.00	105.7	100.0	Fine sand	4.5	
Nr. 30	0.600	105.4	99.7	Fines Content (Silt & Clay)	*	95.0
Nr. 40	0.425	105.2	99.5			
Nr. 100	0.150	101.5	96.0			
Nr. 200	0.075	100.4	95.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

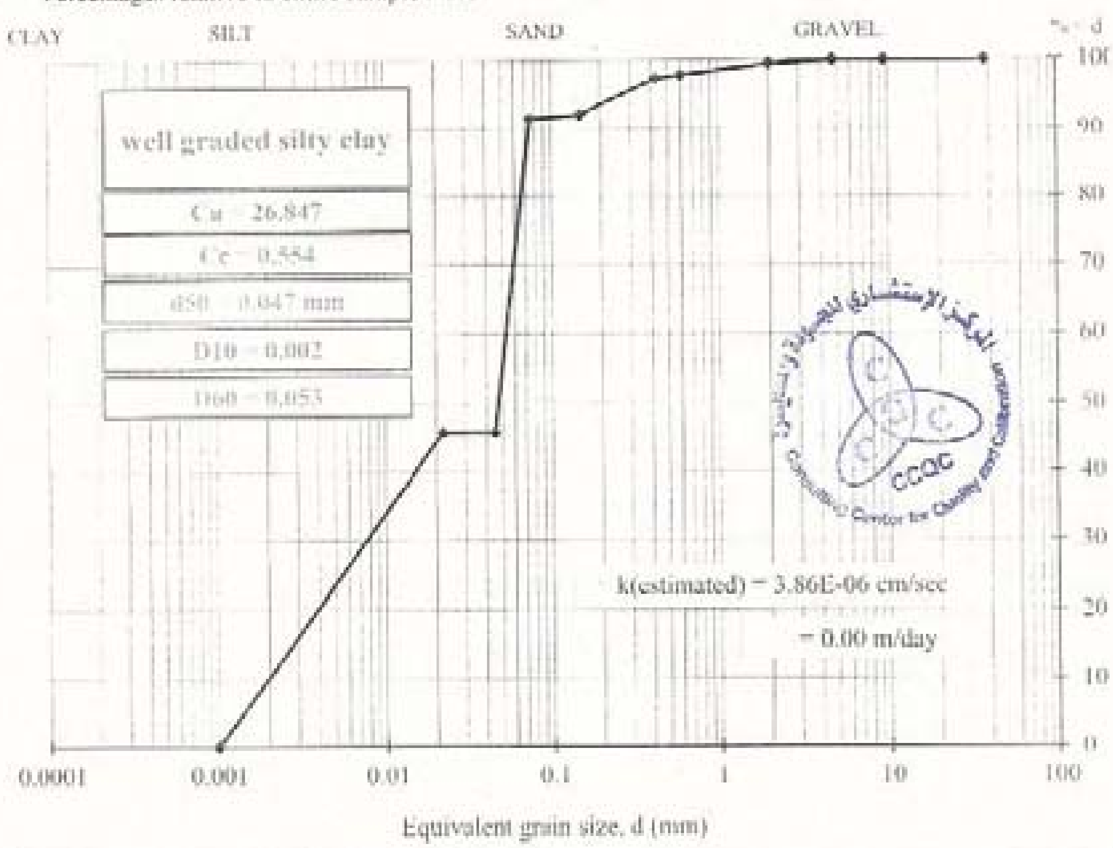
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 4.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	0.0
				Medium gravel	0.0	
				Fine gravel	0.0	
3/8"	9.50	127.3	100.0	Coarse sand	0.5	8.4
Nr. 4	4.75	127.3	100.0	Medium sand	2.1	
Nr. 10	2.00	126.6	99.5	Fine sand	5.7	
Nr. 30	0.600	124.5	97.8	Fines Content (Silt & Clay)	*	91.6
Nr. 40	0.425	123.9	97.3			
Nr. 100	0.150	117.3	92.1			
Nr. 200	0.075	116.6	91.6			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي مجاور برج أبو رمضان - تليفاكس 2886362-08 جوال 0598-991191، 0598-880379، 0598-995595، 0599-800879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق قرية العجمي - تليفون 2130081-08 جوال 0592-283740
Email: ccqcmth@gmail.com, ccqcmth@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

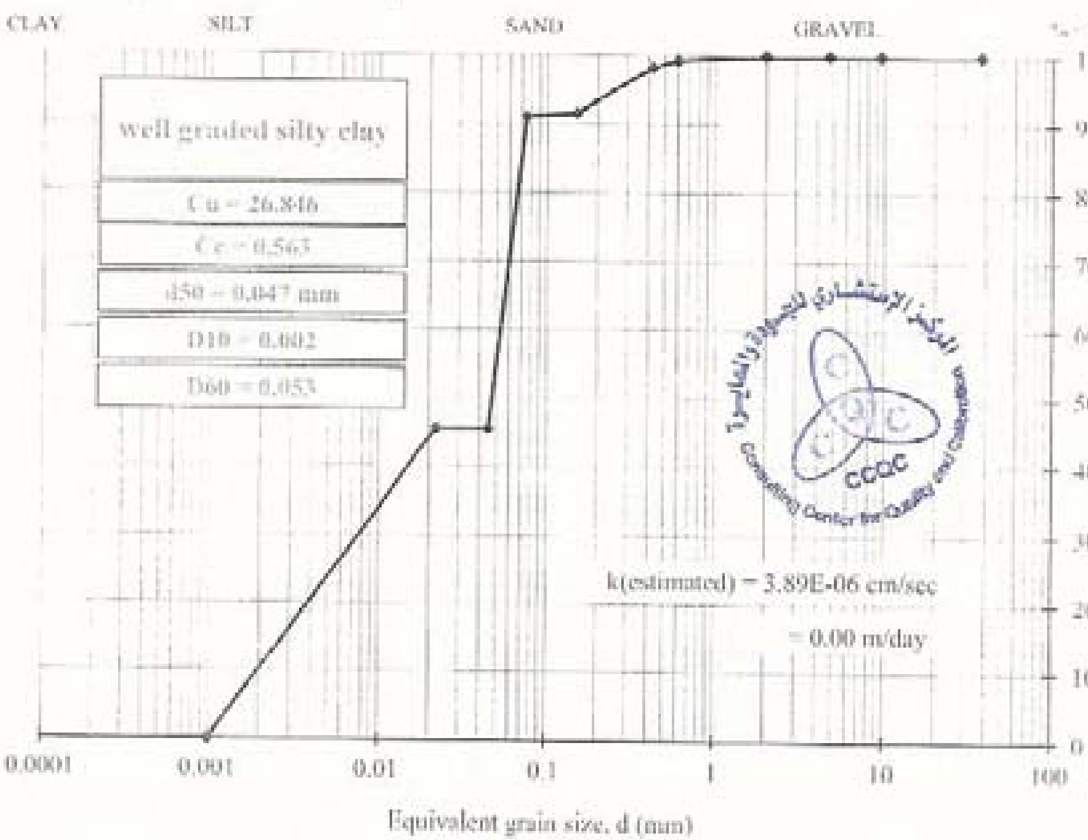
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 11.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	0.0
				Medium gravel	0.0	
				Fine gravel	0.0	
3/8"	9.50	110.6	100.0	Coarse sand	0.0	9.0
Nr. 4	4.75	110.6	100.0	Medium sand	1.7	
Nr. 10	2.00	110.6	100.0	Fine sand	7.2	
Nr. 30	0.600	109.8	99.3	Fines Content (Silt & Clay)	*	91.0
Nr. 40	0.425	108.7	98.3			
Nr. 100	0.150	101.3	91.6			
Nr. 200	0.075	100.7	91.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة

مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

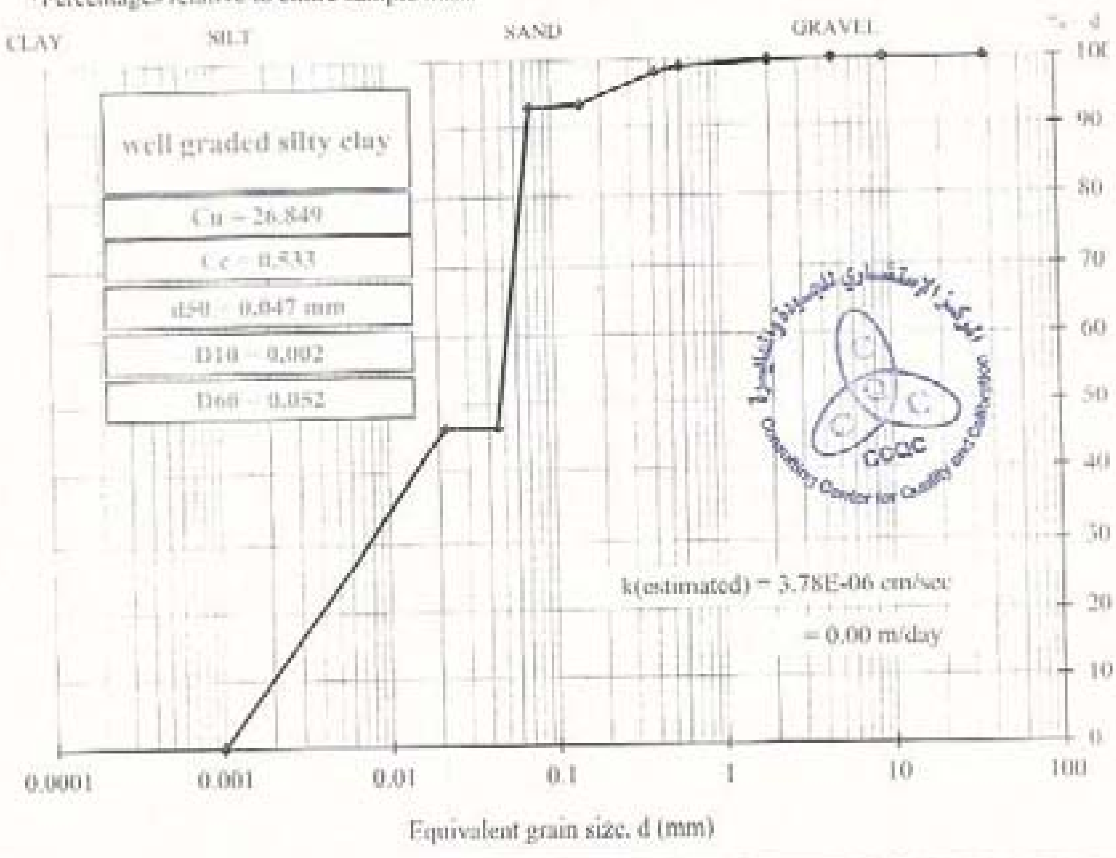
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 17.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	0.0
				Medium gravel	0.0	
				Fine gravel	0.0	
3/8"	9.50	129.1	100.0	Coarse sand	0.2	7.0
Nr. 4	4.75	129.1	100.0	Medium sand	1.6	
Nr. 10	2.00	128.8	99.8	Fine sand	5.2	
Nr. 30	0.600	127.8	99.0	Fines Content (Silt & Clay)	*	93.0
Nr. 40	0.425	126.7	98.1			
Nr. 100	0.150	120.5	93.3			
Nr. 200	0.075	120.0	93.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة- شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان - تلفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-898879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق قرية العدس - تلفون: 08-2130081، جوال: 0592-283740
Email: ccqcenter@gmail.com, ccqcenter@yahoo.com

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

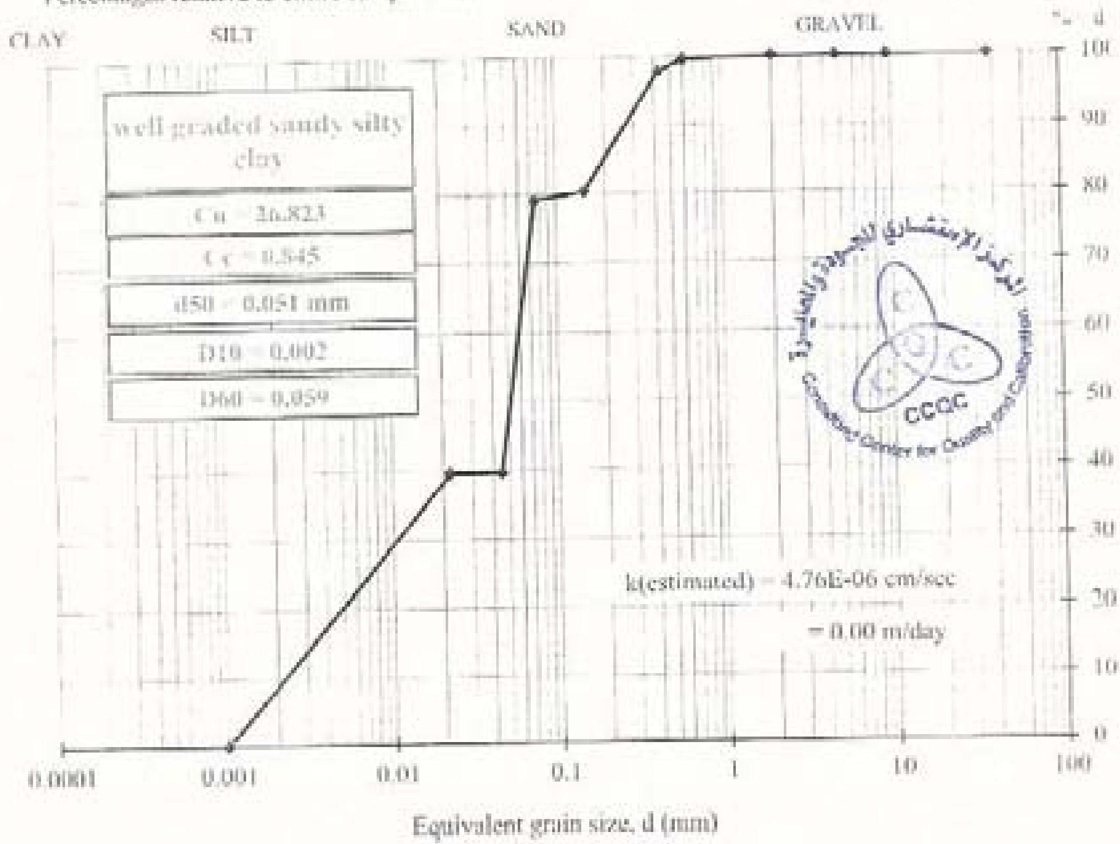
Bore Hole No. RW No. 26

Depth 25.0 m

Mechanical (sieve) analysis			
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %
3/8"	9.50	97.7	100.0
Nr. 4	4.75	97.7	100.0
Nr. 10	2.00	97.7	100.0
Nr. 30	0.600	97.3	99.6
Nr. 40	0.425	95.6	97.9
Nr. 100	0.150	78.5	80.3
Nr. 200	0.075	77.4	79.2
Pan	---	0.0	0.0

Soil Type	%	Tot. %
Coarse gravel	0.0	0.0
Medium gravel	0.0	
Fine gravel	0.0	
Coarse sand	0.0	20.8
Medium sand	2.1	
Fine sand	18.6	
Fines Content (Silt & Clay)	*	79.2

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2806362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق عزبة الحسن - تليفون 08-2130081، جوال 0592-283740
Email: ccqcmltiugmail.com, ccqcmlaiyahoo.com

فحص حدود أتربيرج
Atterberg Limits Test (L.L , P.L, & PI)

Client :	Saqqa & Khouday Contracting Company -SAK-
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)
Lab No.	170907/37-1
Receiving Date:	07/09/2017
Sample Description:	Sandy Silty Clay @ 25.0 m - Well No. 26
Sample selected by:	CCQC Lab
Testing Method:	Determination of Plastic Limit, Determination of Liquid Limit By Cone Penetrometer Method.
Testing date:	10/09/2017

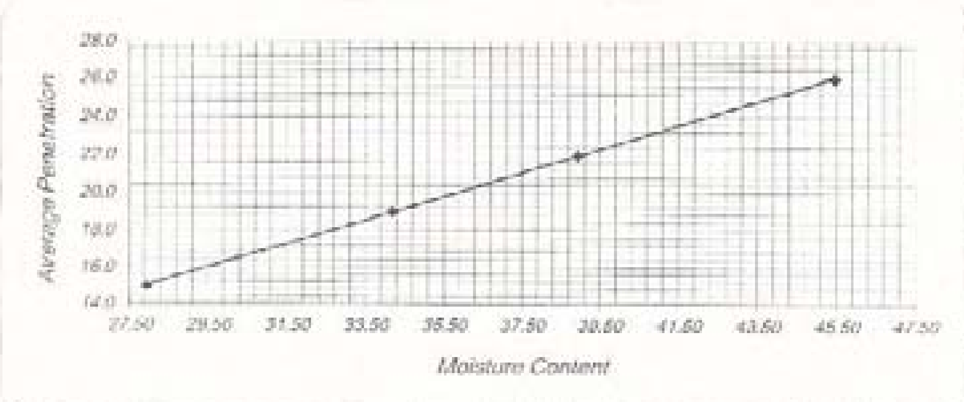
Test Results

Plastic Limit Test:

Test No.	1	2	3	4	Average
Moisture content %	22.5	**	**	**	23.0

Liquid Limit Test:

Test No.	1	2	3	4	5
Average Penetration	15.0	19.0	22.0	26.0	
Moisture content %	27.94	34.18	38.94	45.45	



Liquid Limit L.L	36	%
Plastic Limit P.L	23	%
Plasticity Index PI	13	

Notes:

1- *The sample was tested according to BS 1377:Part 2: 1990: 4.3,5.3*
2- *The above results represent the tested sample only*
3- *Not any reproduction of this report is allowed unless agreed in written permit.*

Tested By
Ahmed

Checked By
Moh. Ghaneem

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق حرية العدس - تليفون: 08-2130081، جوال: 0592-283740 Email: ccqcmt@gmail.com, ccqcmt@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

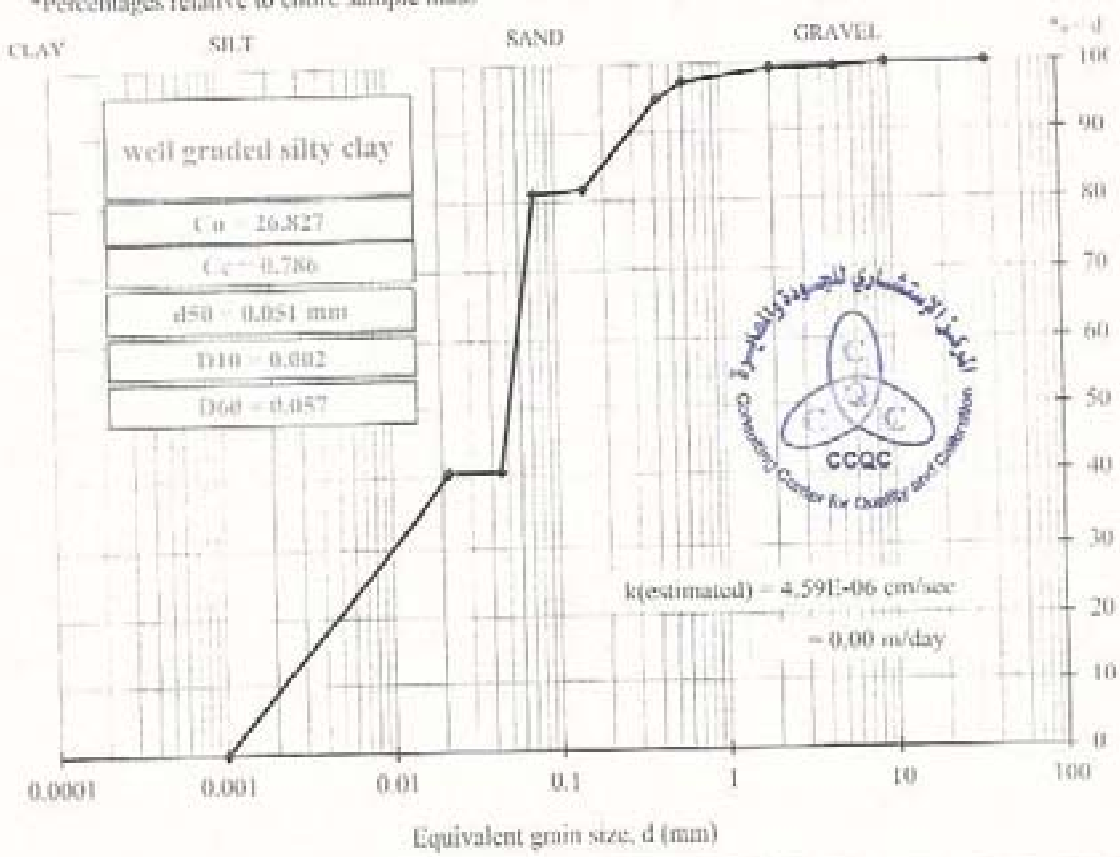
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 30.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	0.5
				Medium gravel	0.0	
				Fine gravel	0.5	
3/8"	9.50	92.6	100.0	Coarse sand	0.2	18.4
Nr. 4	4.75	92.1	99.5	Medium sand	4.4	
Nr. 10	2.00	91.9	99.2	Fine sand	13.7	
Nr. 30	0.600	90.1	97.3	Fines Content (Silt & Clay)	*	81.1
Nr. 40	0.425	87.8	94.8			
Nr. 100	0.150	75.6	81.6			
Nr. 200	0.075	75.1	81.1			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح - شارع عمر بن الخطاب - مفترق طريق القدس - تليفون 08-2130081، جوال 0592-283740
Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

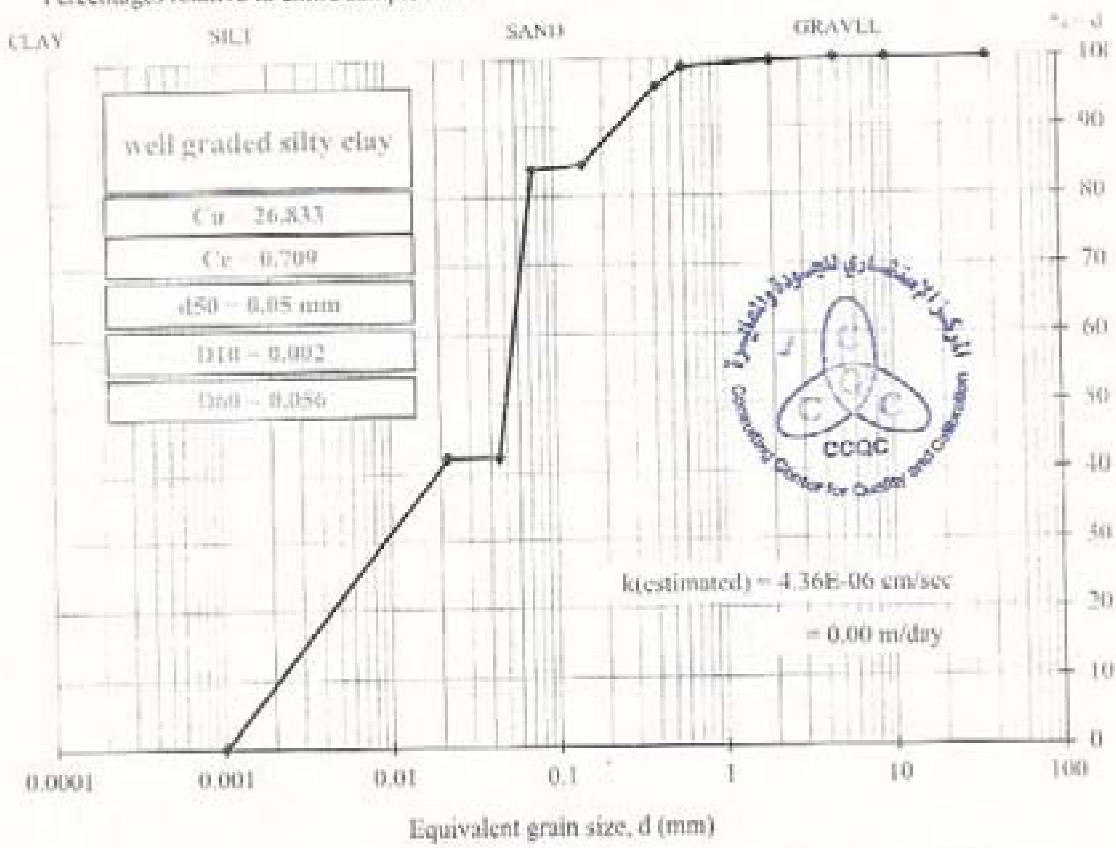
Bore Hole No. RW No. 26

Depth 34.0 m

Mechanical (sieve) analysis			
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %
3/8"	9.50	104.7	100.0
Nr. 4	4.75	104.7	100.0
Nr. 10	2.00	104.3	99.6
Nr. 30	0.600	103.5	98.9
Nr. 40	0.425	100.7	96.2
Nr. 100	0.150	88.6	84.6
Nr. 200	0.075	87.9	84.0
Pan	---	0.0	0.0

Soil Type	%	Tot. %
Coarse gravel	0.0	0.0
Medium gravel	0.0	
Fine gravel	0.0	
Course sand	0.4	16.0
Medium sand	3.4	
Fine sand	12.2	
Fines Content (Silt & Clay)	*	84.0

*Percentages relative to entire sample mass



Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

CCQC

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

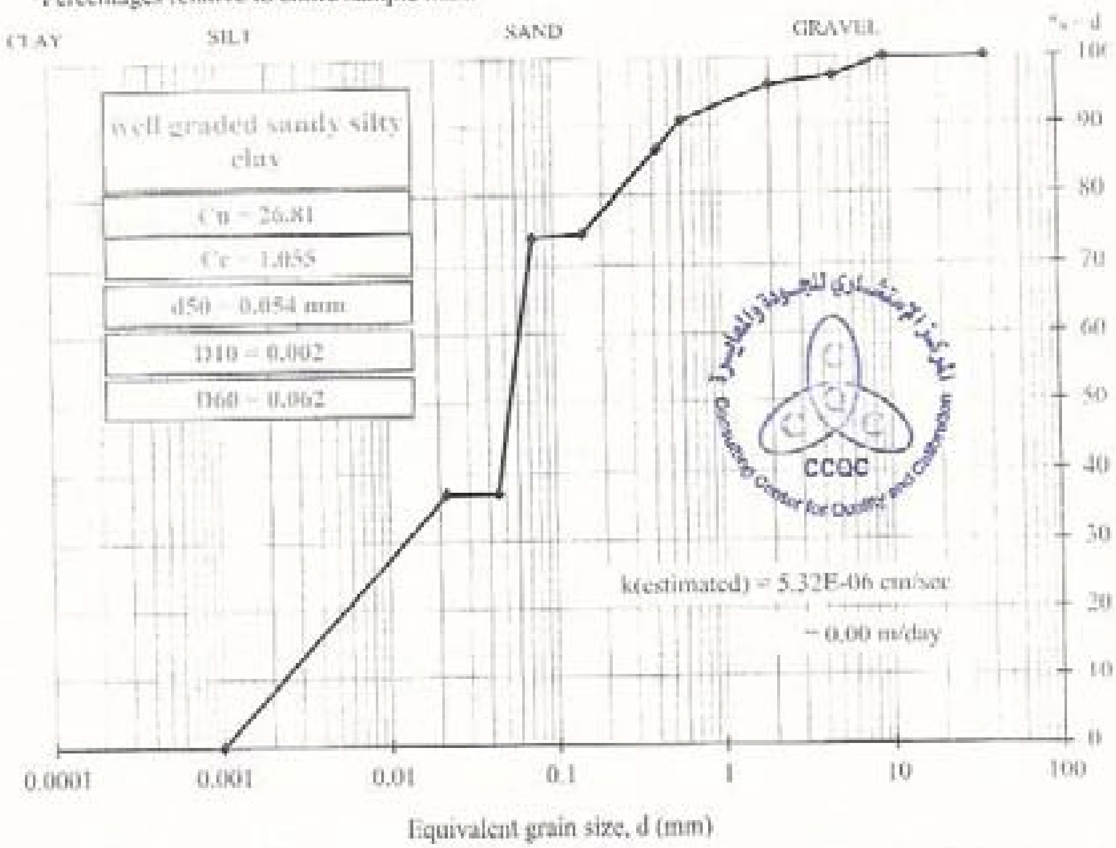
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 37.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	2.6
				Medium gravel	0.0	
				Fine gravel	2.6	
3/8"	9.50	117.6	100.0	Coarse sand	1.4	23.4
Nr. 4	4.75	114.5	97.4	Medium sand	9.5	
Nr. 10	2.00	112.9	96.0	Fine sand	12.5	
Nr. 30	0.600	106.8	90.8	Fines Content (Silt & Clay)	*	74.0
Nr. 40	0.425	101.7	86.5			
Nr. 100	0.150	87.5	74.4			
Nr. 200	0.075	87.0	74.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة- شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان - فاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق عزبة العدس - تلفون: 08-2130081، جوال: 0592-283740
Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

فحص حدود أتربيرج

Atterberg Limits Test (L.L , P.L, & PI)

Client :	Saqqa & Khouday Contracting Company -SAK-
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)
Lab No.	170907/37-2
Receiving Date:	07/09/2017
Sample Description:	Sandy Silty Clay @ 37.0 m - Well No. 26
Sample selected by:	CCQC Lab
Testing Method:	Determination of Plastic Limit, Determination of Liquid Limit By Cone Penetrometer Method.
Testing date:	10/09/2017

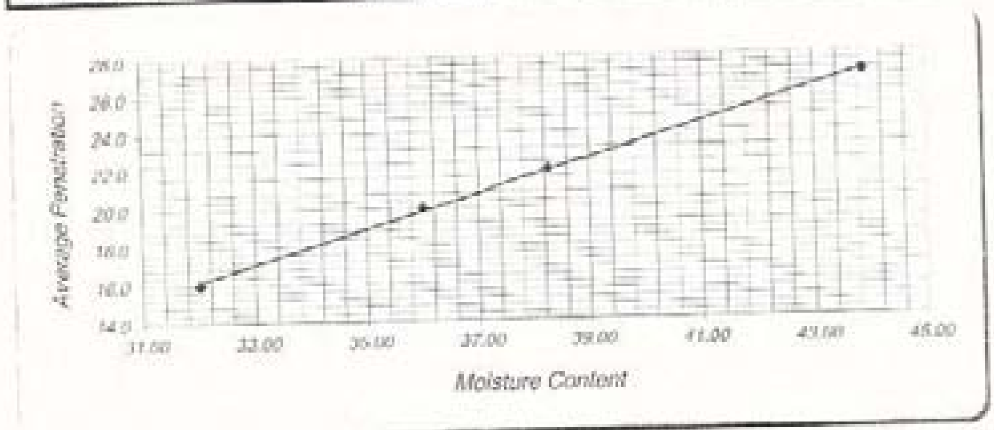
Test Results

Plastic Limit Test:

Test No.		1	2	3	4	Average
Moisture content	%	23.8	**	**	**	24.0

Liquid Limit Test:

Test No.		1	2	3	4	5
Average Penetration		16.0	20.0	22.0	27.0	
Moisture content	%	32.00	36.00	38.26	43.88	



Liquid Limit L.L	36	%
Plastic Limit P.L	24	%
Plasticity Index PI	12	

Notes:

1- The sample was tested according to BS 1377:Part 2: 1990: 4.3,5.3
2- The above results represent the tested sample only
3- No any reproduction of this report is allowed unless agreed in written permit.

Tested By
Ahmed

Checked By
Moh. Ghanem

المقر الرئيسي: غزة- شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-898879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - تليفون 08-2130081، جوال 0592-283740
Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

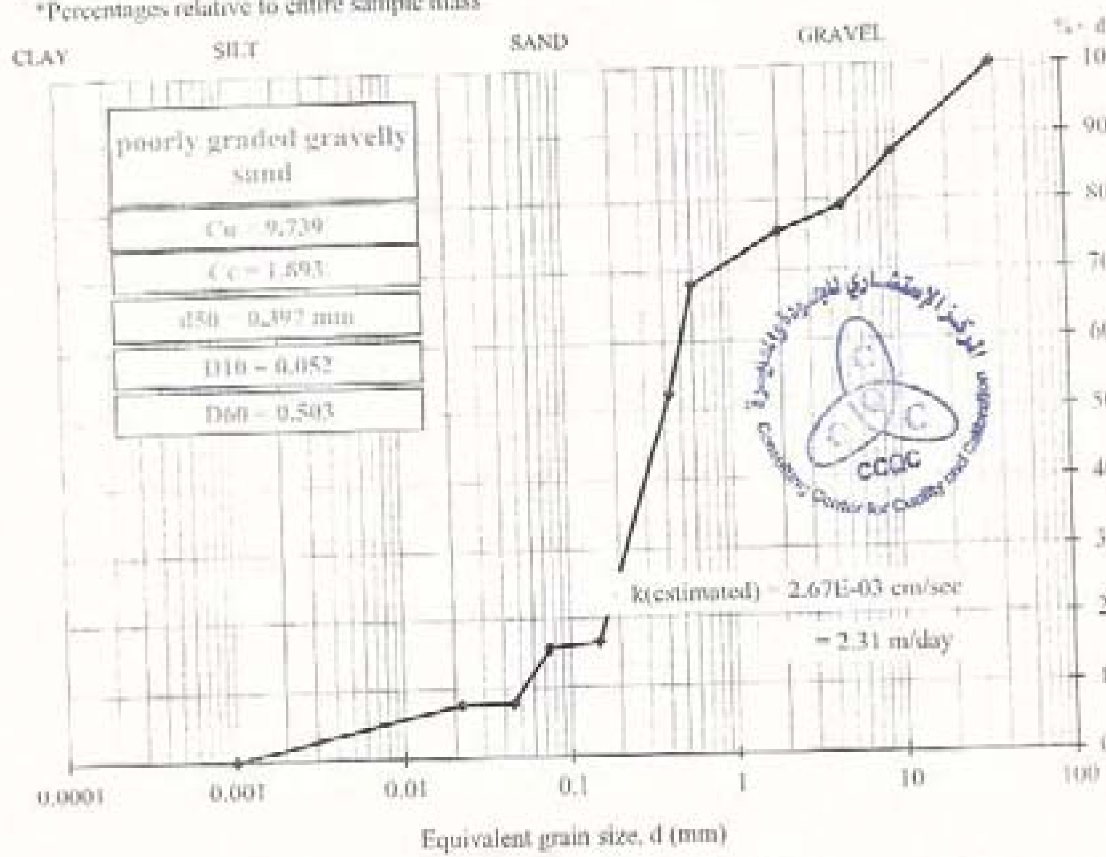
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 39.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	20.7
				Medium gravel	6.4	
				Fine gravel	14.3	
3/8"	9.50	127.9	87.1	Coarse sand	3.6	63.6
Nr. 4	4.75	116.4	79.3	Medium sand	23.4	
Nr. 10	2.00	111.1	75.7	Fine sand	36.6	
Nr 30	0.600	99.8	68.0	Fines Content (Silt & Clay)	*	15.7
Nr. 40	0.425	76.8	52.3			
Nr. 100	0.150	24.3	16.6			
Nr. 200	0.075	23.1	15.7			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - فاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - تليفون: 08-2130081، جوال: 0592-283740
Email: ccqcntl@gmail.com, ccqcntl@yahoo.com

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

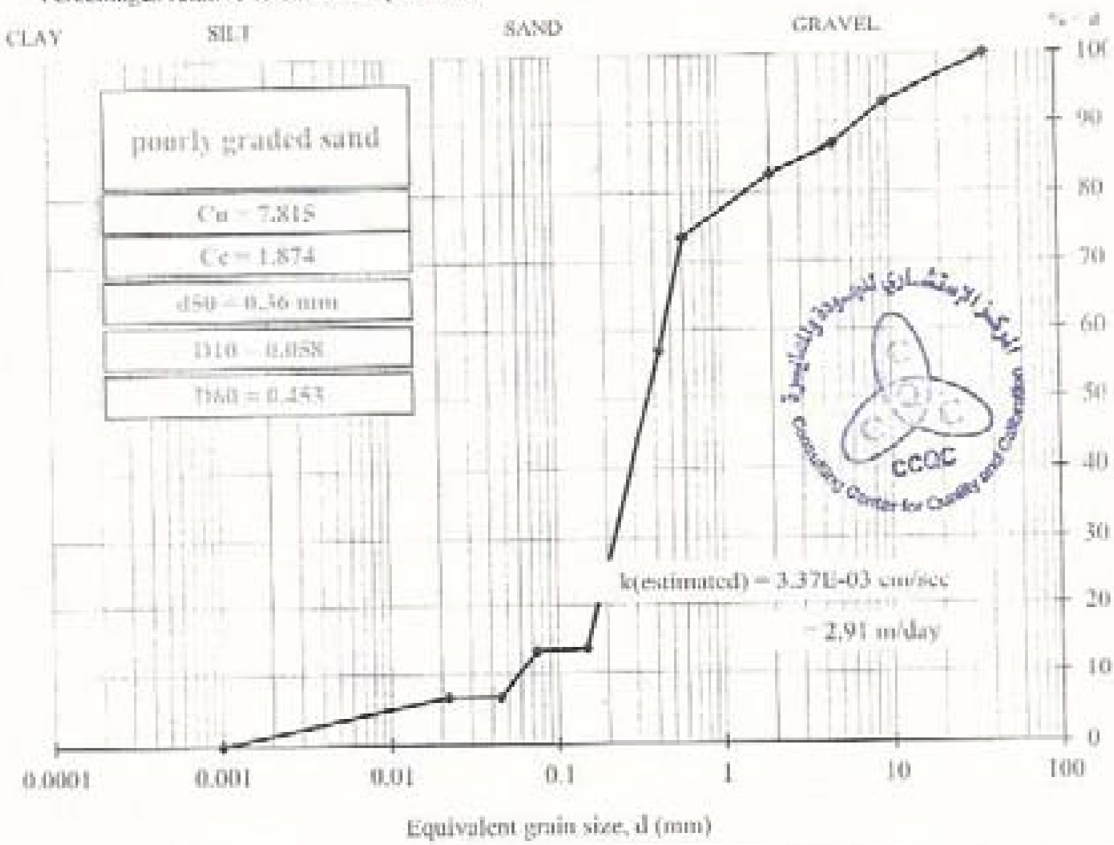
Bore Hole No. RW No. 26

Depth 40.0 m

Mechanical (sieve) analysis			
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %
3/8"	9.50	272.1	93.0
Nr. 4	4.75	254.3	86.9
Nr. 10	2.00	241.8	82.6
Nr. 30	0.600	215.2	73.5
Nr. 40	0.425	166.5	56.9
Nr. 100	0.150	40.3	13.8
Nr. 200	0.075	39.1	13.4
Pan	---	0.0	0.0

Soil Type	%	Tot. %
Coarse gravel	0.0	13.1
Medium gravel	3.5	
Fine gravel	9.6	
Coarse sand	4.3	73.5
Medium sand	25.7	
Fine sand	43.5	
Fines Content (Silt & Clay)	*	13.4

*Percentages relative to entire sample mass



Equivalent grain size, d (mm)

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

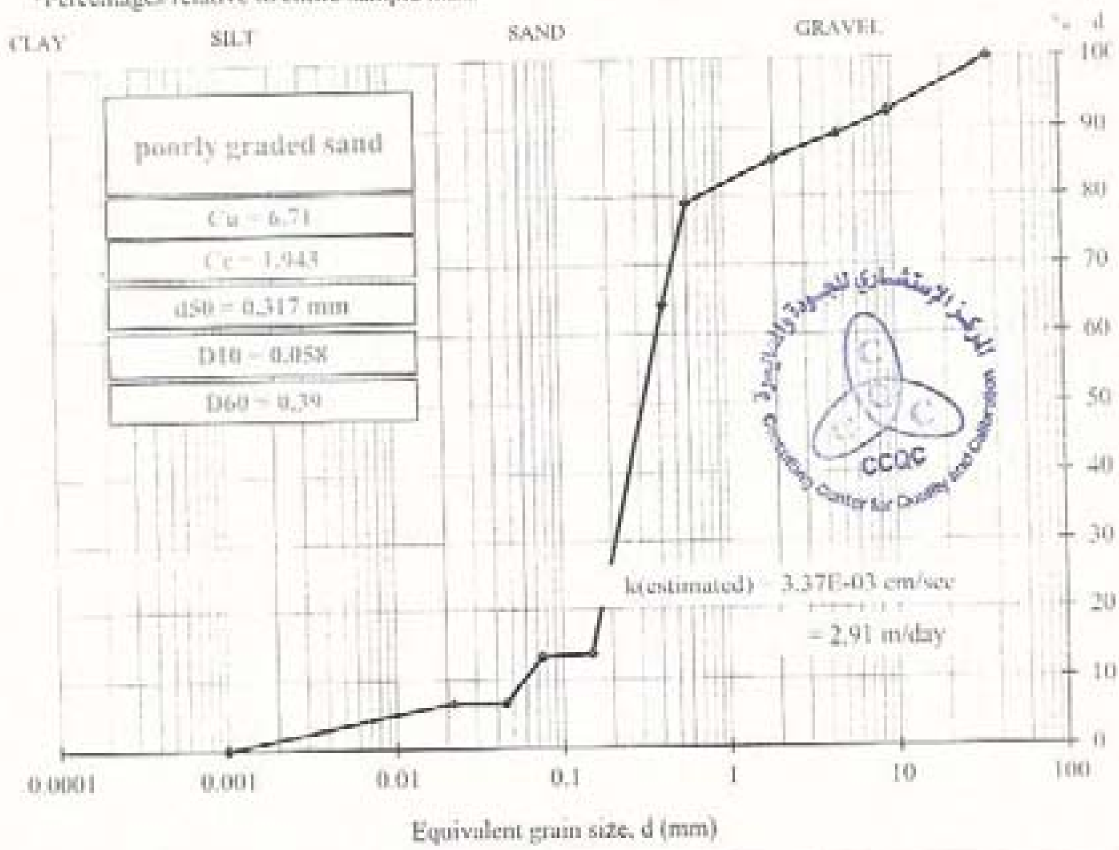
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sawage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 42.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	10.9
				Medium gravel	3.8	
				Fine gravel	7.1	
3/8"	9.50	188.4	92.4	Coarse sand	3.7	75.8
Nr. 4	4.75	181.7	89.1	Medium sand	21.2	
Nr. 10	2.00	174.2	85.4	Fine sand	50.9	
Nr. 30	0.600	161.1	79.0	Fines Content (Silt & Clay)	*	13.3
Nr. 40	0.425	130.9	64.2			
Nr. 100	0.150	28.1	13.8			
Nr. 200	0.075	27.2	13.3			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Grain Size Distribution of Soil

ASTM D 422-63 (2007)

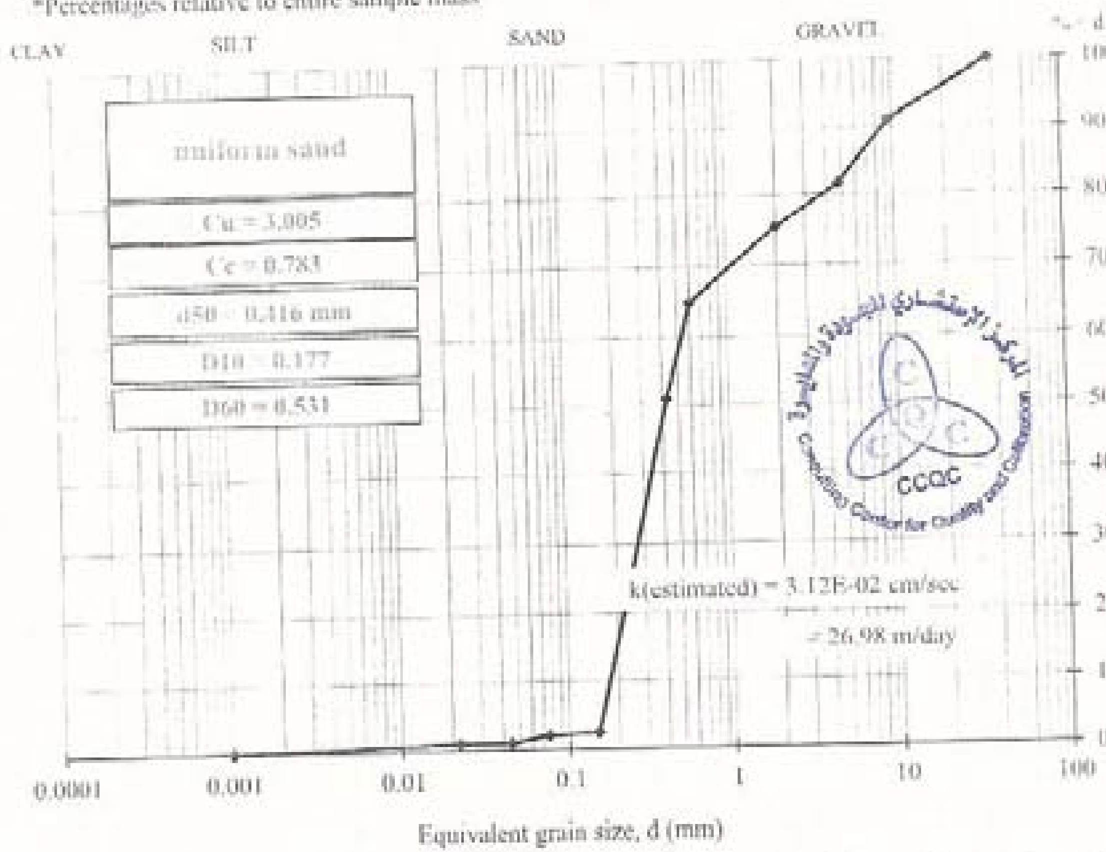
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 44.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	18.4
				Medium gravel	4.4	
				Fine gravel	14.0	
3/8"	9.50	175.1	91.1	Coarse sand	6.1	79.5
Nr. 4	4.75	156.8	81.6	Medium sand	24.5	
Nr. 10	2.00	145.1	75.5	Fine sand	48.9	
Nr. 30	0.600	124.8	64.9	Fines Content (Silt & Clay)	*	2.1
Nr. 40	0.425	98.0	51.0			
Nr. 100	0.150	4.5	2.3			
Nr. 200	0.075	4.0	2.1			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الرحيمي بجوار برج أبو رمضان - الفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجلوبة: رفح شارع عمر بن الخطاب - مفترق خربة العدس - تلفون: 08-2130081، جوال: 0592-283740
Email: ccqcntl@gmail.com, ccqcntl@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

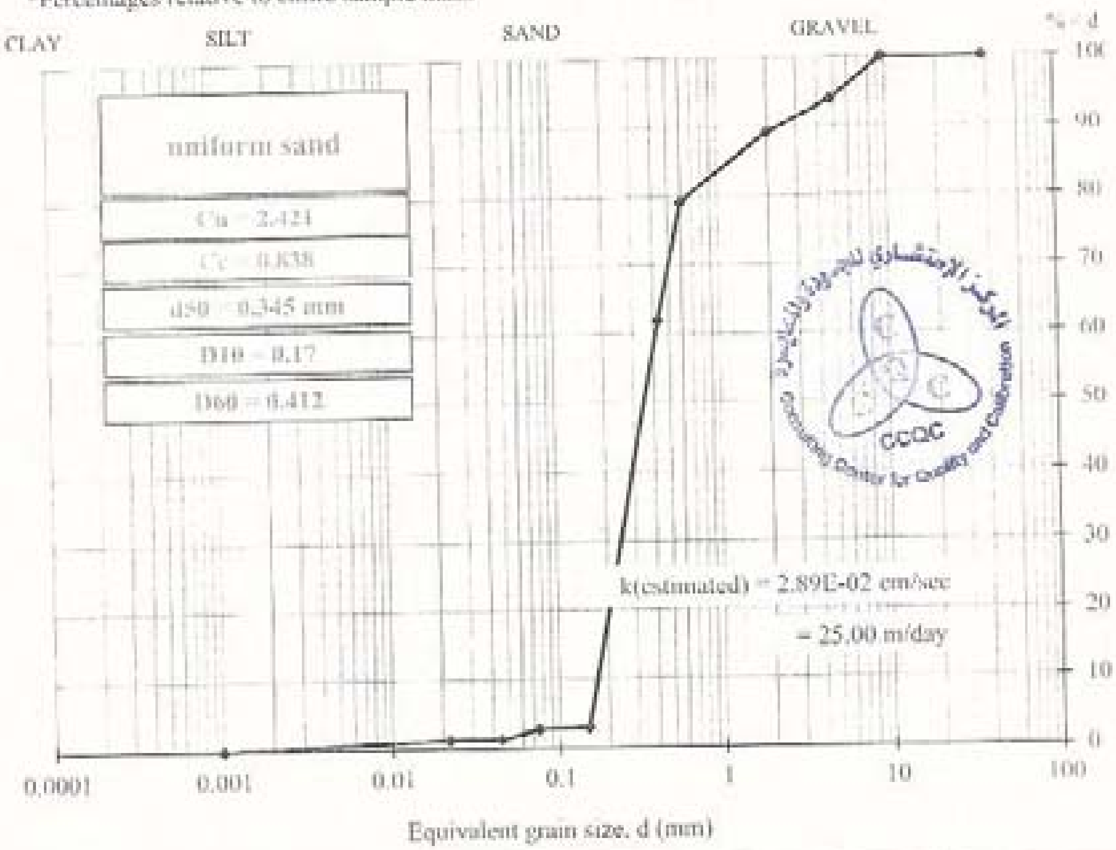
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 47.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	6.1
				Medium gravel	0.0	
				Fine gravel	6.1	
3/8"	9.50	197.6	100.0	Coarse sand	4.7	91.2
Nr. 4	4.75	185.6	93.9	Medium sand	27.4	
Nr. 10	2.00	176.3	89.2	Fine sand	59.1	
Nr. 30	0.600	156.5	79.2	Fines Content (Silt & Clay)	*	2.7
Nr. 40	0.425	122.1	61.8			
Nr. 100	0.150	5.7	2.9			
Nr. 200	0.075	5.4	2.7			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

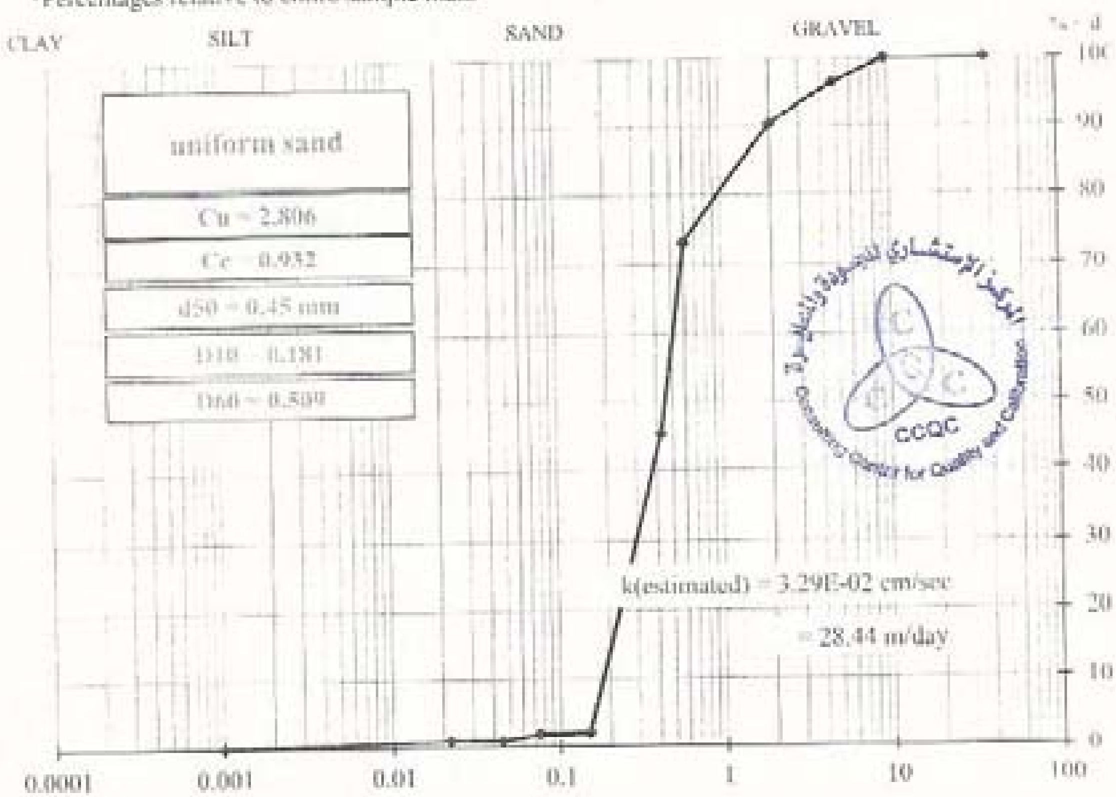
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 - 2)

Bore Hole No. RW No. 26

Depth 50.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	3.5
				Medium gravel	0.0	
				Fine gravel	3.5	
3/8"	9.50	192.0	100.0	Coarse sand	6.1	94.5
Nr. 4	4.75	185.2	96.5	Medium sand	44.9	
Nr. 10	2.00	173.5	90.4	Fine sand	43.5	
Nr. 30	0.600	140.7	73.3	Fines Content (Silt & Clay)	*	1.9
Nr. 40	0.425	87.2	45.4			
Nr. 100	0.150	4.0	2.1			
Nr. 200	0.075	3.7	1.9			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي مجاور برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-901191، 0598-880379، 0598-995595، 0599-898879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - تليفون: 08-2130081، جوال: 0592-283740
Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

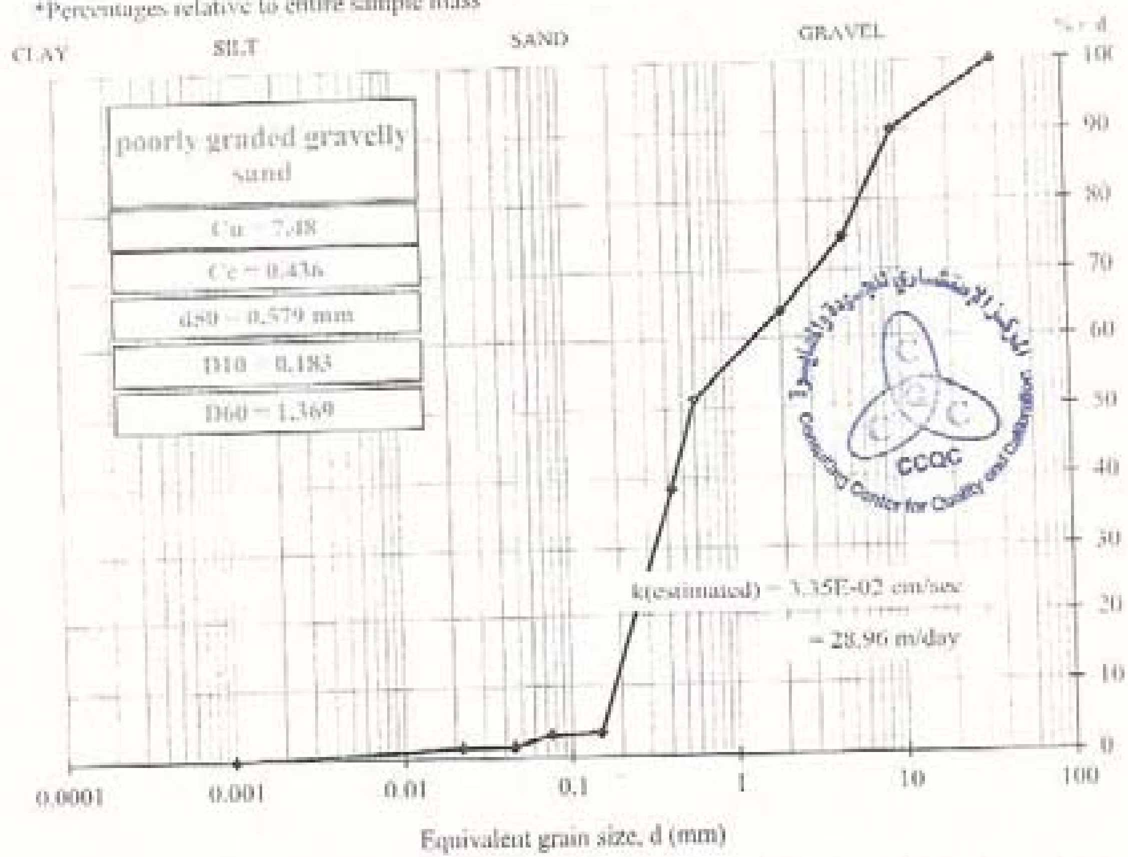
Bore Hole No. RW No. 26

Depth 53.0 m

Mechanical (sieve) analysis			
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %
3/8"	9.50	215.9	90.1
Nr. 4	4.75	179.1	74.8
Nr. 10	2.00	153.2	64.0
Nr. 30	0.600	123.0	51.4
Nr. 40	0.425	92.2	38.5
Nr. 100	0.150	7.8	3.3
Nr. 200	0.075	7.4	3.1
Pan	---	0.0	0.0

Soil Type	%	Tot. %
Coarse gravel	0.0	25.2
Medium gravel	4.9	
Fine gravel	20.3	
Coarse sand	10.8	71.7
Medium sand	25.5	
Fine sand	35.4	
Fines Content (Silt & Clay)	*	3.1

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق حرية الحسن - تليفون: 08-2130081، جوال: 0592-283740
Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

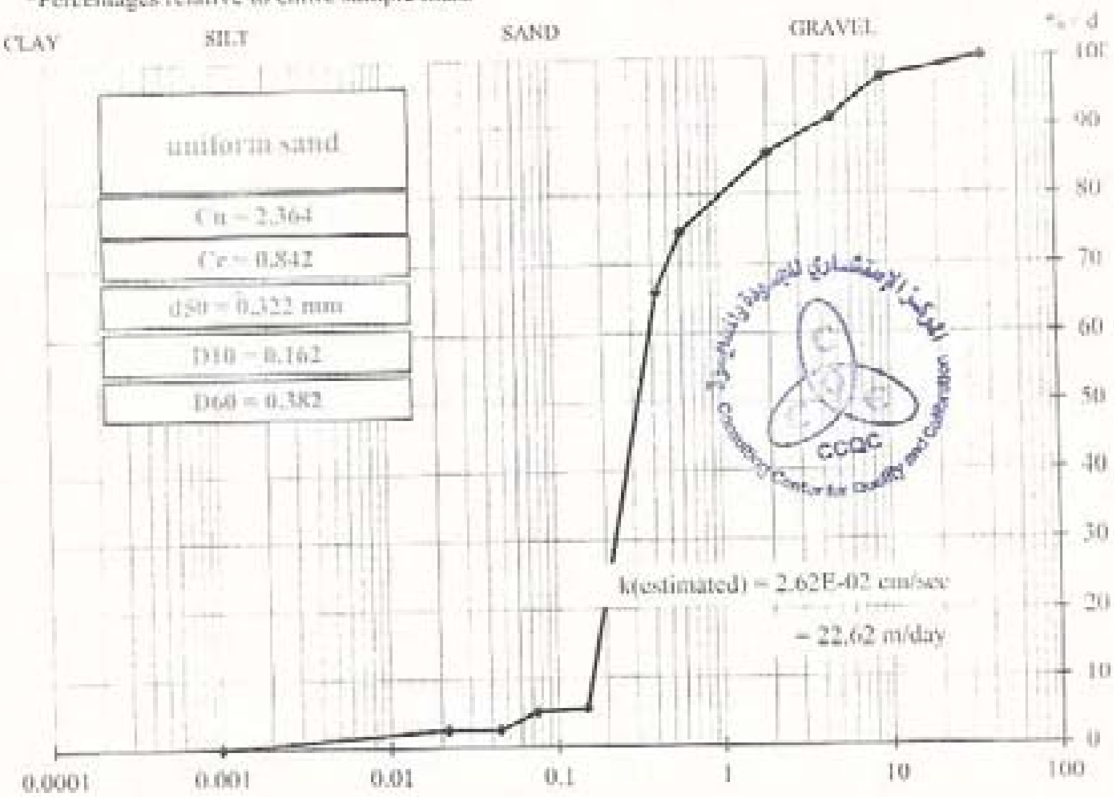
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 55.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Course gravel	0.0	8.8
				Medium gravel	1.4	
				Fine gravel	7.4	
3/8"	9.50	187.4	97.2	Course sand	5.2	86.1
Nr. 4	4.75	175.9	91.2	Medium sand	19.9	
Nr. 10	2.00	165.8	86.0	Fine sand	61.0	
Nr. 30	0.600	143.8	74.6	Fines Content (Silt & Clay)	*	5.1
Nr. 40	0.425	127.5	66.1			
Nr. 100	0.150	10.8	5.6			
Nr. 200	0.075	9.9	5.1			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة- شارع الثورة- عمارة الوميدي بجوار برج أبو رمضان - تليفاكس 2886362-08، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - التلفون: 2130081-08 جوال: 0592-283740
Email: ccqcmt@gmail.com, ccqcmt@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

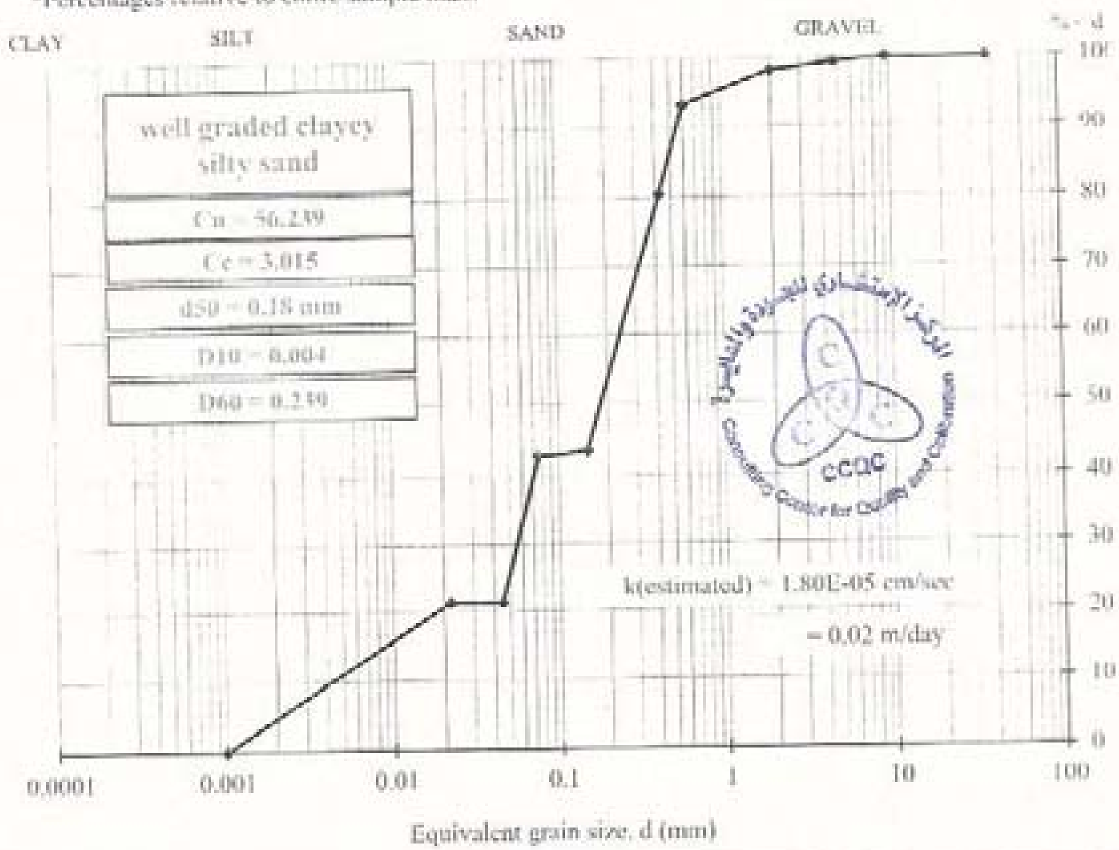
Bore Hole No. RW No. 26

Depth 58.0 m

Mechanical (sieve) analysis			
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %
3/8"	9.50	158.6	100.0
Nr. 4	4.75	157.6	99.4
Nr. 10	2.00	155.7	98.2
Nr. 30	0.600	147.8	93.2
Nr. 40	0.425	127.7	80.5
Nr. 100	0.150	68.9	43.4
Nr. 200	0.075	67.8	42.7
Pan	---	0.0	0.0

Soil Type	%	Tot. %
Course gravel	0.0	0.6
Medium gravel	0.0	
Fine gravel	0.6	
Course sand	1.2	56.6
Medium sand	17.7	
Fine sand	37.8	
Fines Content (Silt & Clay)	*	42.7

*Percentages relative to entire sample mass



فحص حدود أتربيرج
Atterberg Limits Test (L.L , P.L, & PI)

Client :	Saqqa & Khouday Contracting Company -SAK-
Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)
Lab No.	170907/37-3
Receiving Date:	07/09/2017
Sample Description:	Clayey Silty Sand @ 58.0 m - Well No. 26
Sample selected by:	CCQC Lab
Testing Method:	Determination of Plastic Limit, Determination of Liquid Limit By Cone Penetrometer Method.
Testing date:	10/09/2017

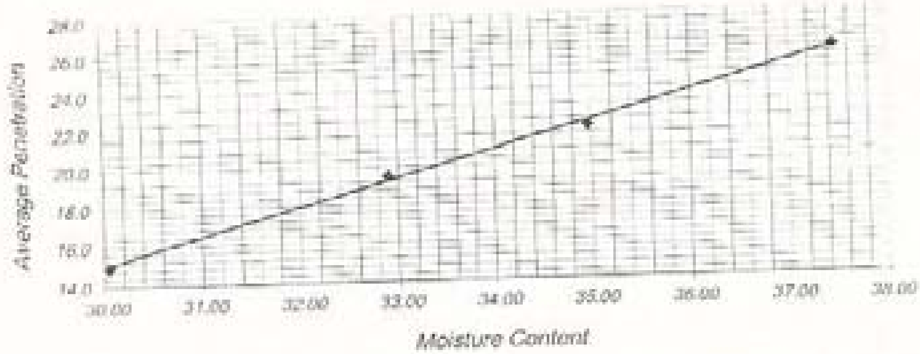
Test Results

Plastic Limit Test:

Test No.	1	2	3	4	Average
Moisture content %	23.1	--	--	--	23.0

Liquid Limit Test:

Test No.	1	2	3	4	5
Average Penetration	15.0	19.5	22.0	26.0	
Moisture content %	30.04	32.90	34.96	37.46	



Liquid Limit L.L	33	%
Plastic Limit P.L	23	%
Plasticity Index PI	10	

Notes:

1- *The sample was tested according to BS 1377:Part 2: 1990: 4.3,5.3*
2- *The above results represent the tested sample only*
3- No any reproduction of this report is allowed unless agreed in written permit.

Tested By
Ahmed

Checked By
Moh. Ghanem

المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو ريحان - تليفاكس 08-2886362، جوال 0598-991191، 0598-830379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - التليفون 08-2130081، جوال 0592-283740
Email: ccqcmd@gmail.com ccqcmd@yahoo.com

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

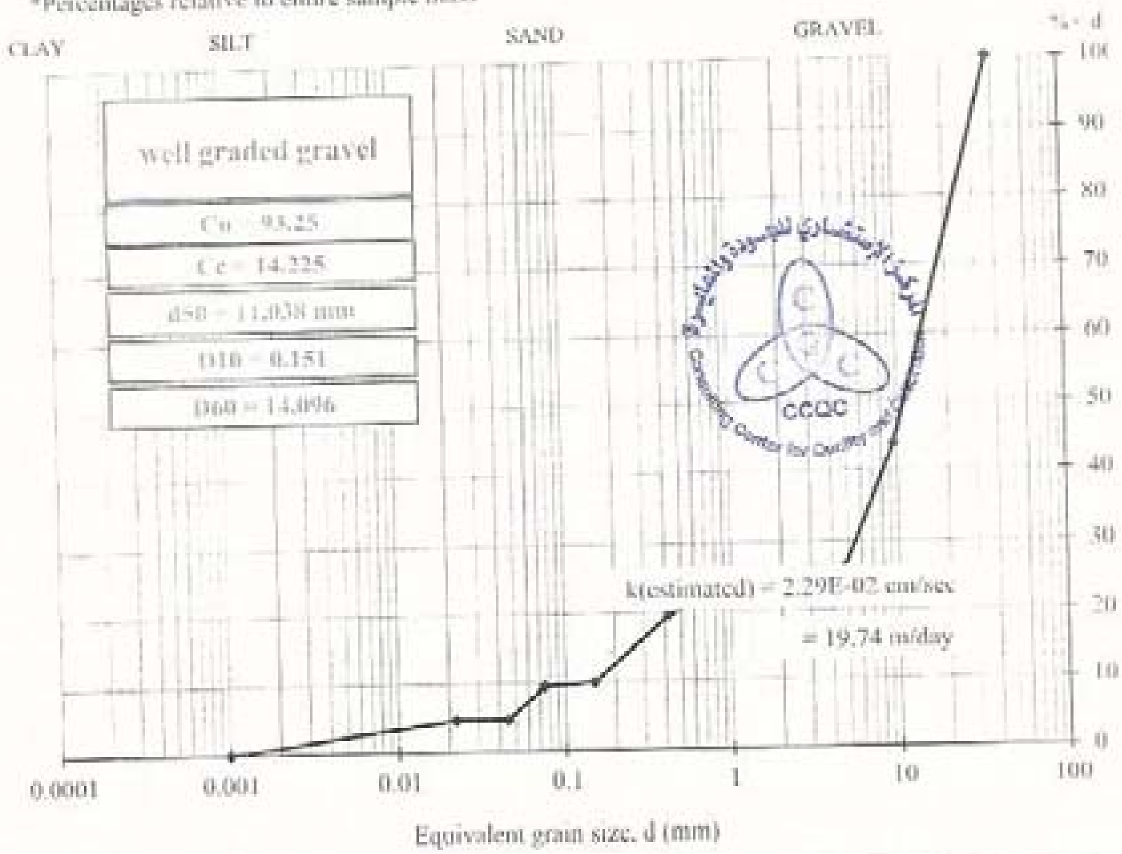
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 60.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	73.8
				Medium gravel	27.8	
				Fine gravel	46.0	
3/8"	9.50	84.4	43.9	Coarse sand	2.8	16.7
Nr. 4	4.75	50.5	26.2	Medium sand	3.7	
Nr. 10	2.00	45.1	23.4	Fine sand	10.2	
Nr. 30	0.600	41.6	21.6	Fines Content (Silt & Clay)	*	9.5
Nr. 40	0.425	37.9	19.7			
Nr. 100	0.150	19.1	9.9			
Nr. 200	0.075	18.3	9.5			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362 جوال 0598-991191، 0598-880379، 0598-995595، 0599-890870
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق طريق العدس - تليفون 08-2130081 جوال: 0592-283740
Email: ccqcmla@gmail.com, ccqcmt@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

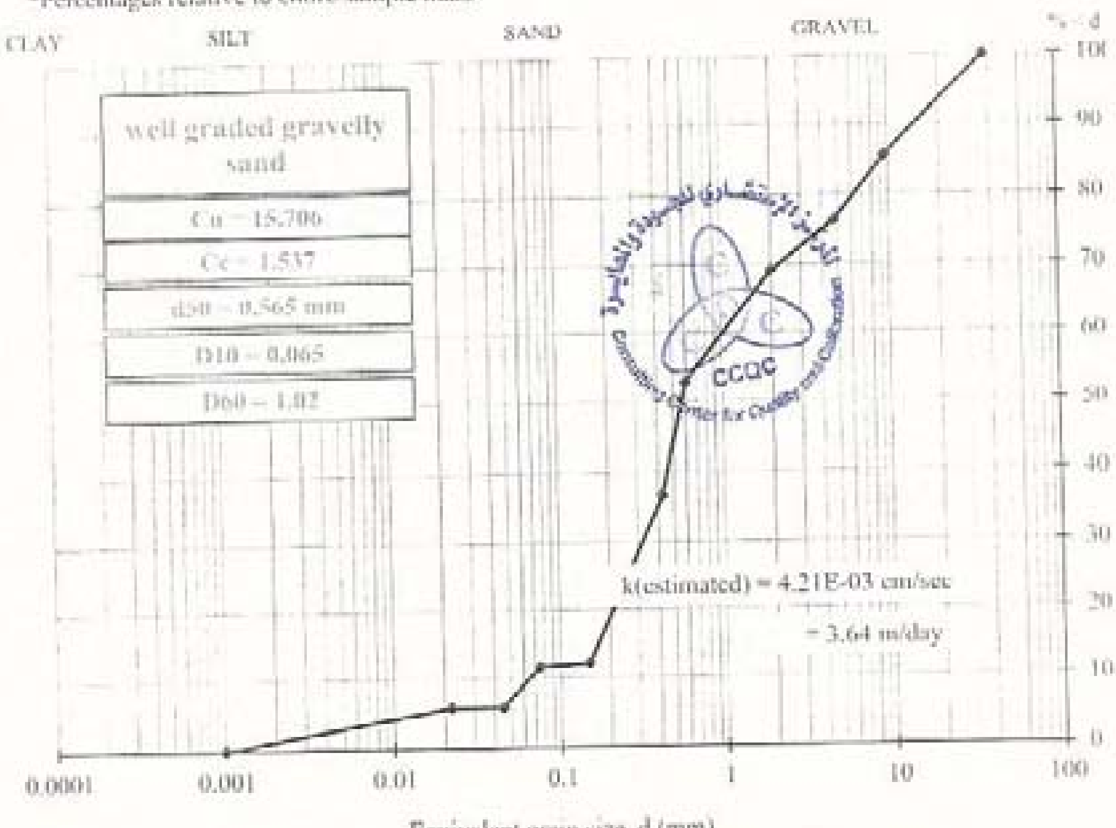
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 61.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	23.7
				Medium gravel	7.2	
				Fine gravel	16.5	
3/8"	9.50	202.7	85.5	Coarse sand	7.2	64.6
Nr. 4	4.75	180.8	76.3	Medium sand	32.3	
Nr. 10	2.00	163.8	69.1	Fine sand	25.1	
Nr. 30	0.600	125.2	52.8	Fines Content (Silt & Clay)	*	11.6
Nr. 40	0.425	87.2	36.8			
Nr. 100	0.150	28.8	12.2			
Nr. 200	0.075	27.6	11.6			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

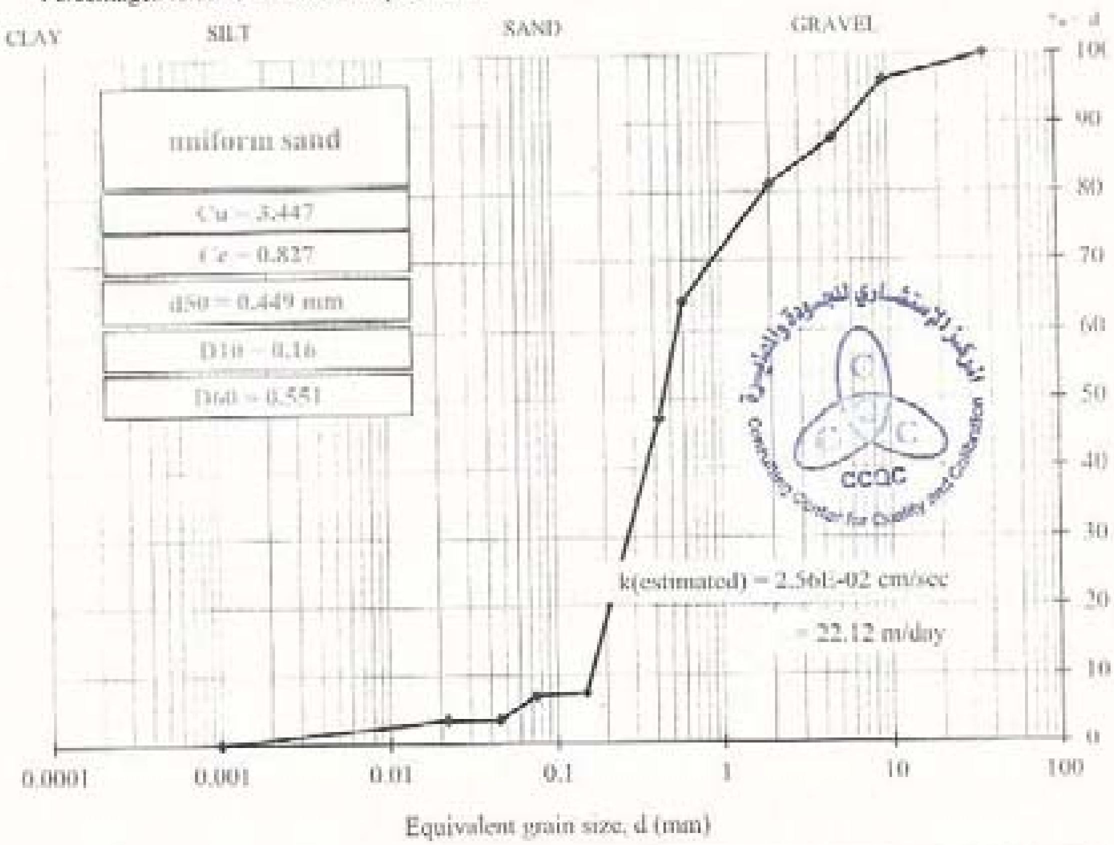
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 64.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	12.1
				Medium gravel	1.9	
				Fine gravel	10.2	
3/8"	9.50	181.3	96.2	Coarse sand	6.8	80.8
Nr. 4	4.75	165.6	87.9	Medium sand	33.8	
Nr. 10	2.00	152.8	81.1	Fine sand	40.2	
Nr. 30	0.600	120.8	64.1	Fines Content (Silt & Clay)	*	7.1
Nr. 40	0.425	89.1	47.3			
Nr. 100	0.150	14.2	7.5			
Nr. 200	0.075	13.3	7.1			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق حرية العدس - تليفون 08-2130081، جوال 0592-283740 Email: ccqcntr@gmail.com, ccqcntr@yahoo.com

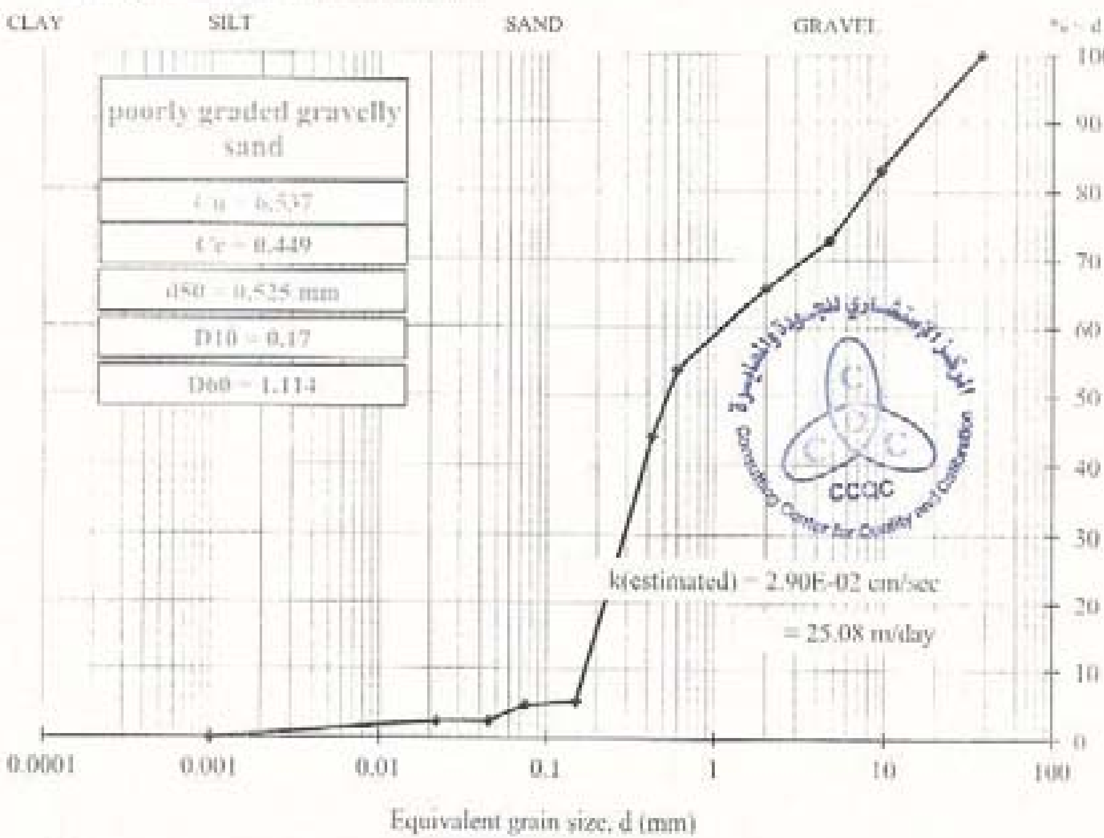
Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)
Bore Hole No.	RW No. 26
Depth	66.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	27.1
				Medium gravel	8.4	
				Fine gravel	18.8	
3/8"	9.50	187.6	83.1	Coarse sand	7.0	68.1
Nr. 4	4.75	164.5	72.9	Medium sand	21.9	
Nr. 10	2.00	148.6	65.8	Fine sand	39.1	
Nr. 30	0.600	121.5	53.8	Fines Content (Silt & Clay)	*	4.8
Nr. 40	0.425	99.2	44.0			
Nr. 100	0.150	11.9	5.3			
Nr. 200	0.075	10.9	4.8			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة - شارع الثورة - عمارة الوحيدي مجاور برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-888379، 0598-995595، 0599-390879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق حرية العلمي - التلفون: 08-2130081 جوال: 0592-283740 Email: ccqcntl@gmail.com, ccqcntl@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

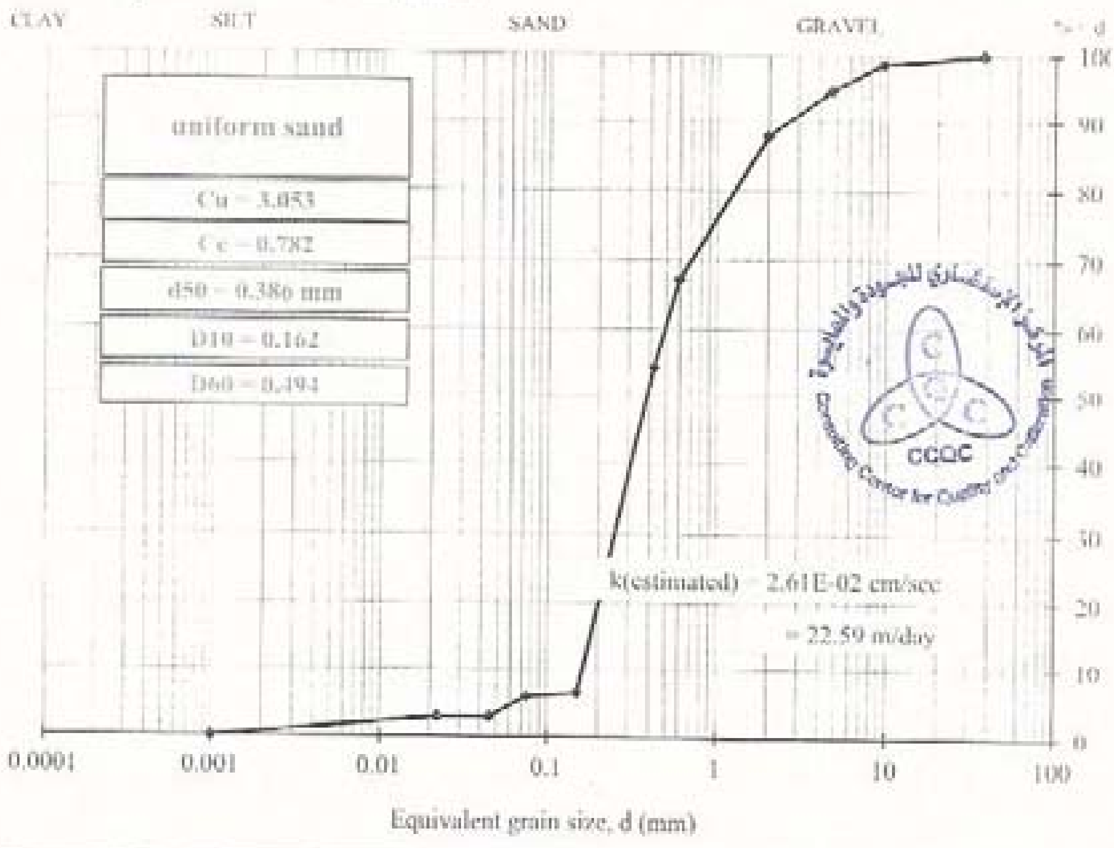
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 68.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	5.3
				Medium gravel	0.6	
				Fine gravel	4.6	
3/8"	9.50	203.6	98.7	Coarse sand	6.8	88.8
Nr. 4	4.75	195.4	94.7	Medium sand	33.5	
Nr. 10	2.00	181.4	87.9	Fine sand	48.5	
Nr. 30	0.600	138.7	67.2	Fines Content (Silt & Clay)	*	6.0
Nr. 40	0.425	112.3	54.4			
Nr. 100	0.150	13.5	6.5			
Nr. 200	0.075	12.3	6.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة- شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تلفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق حرية العلمي - تليفاكس 08-2130081، جوال 0592-283740 Email: ccqcml@gmail.com, ccqcml@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

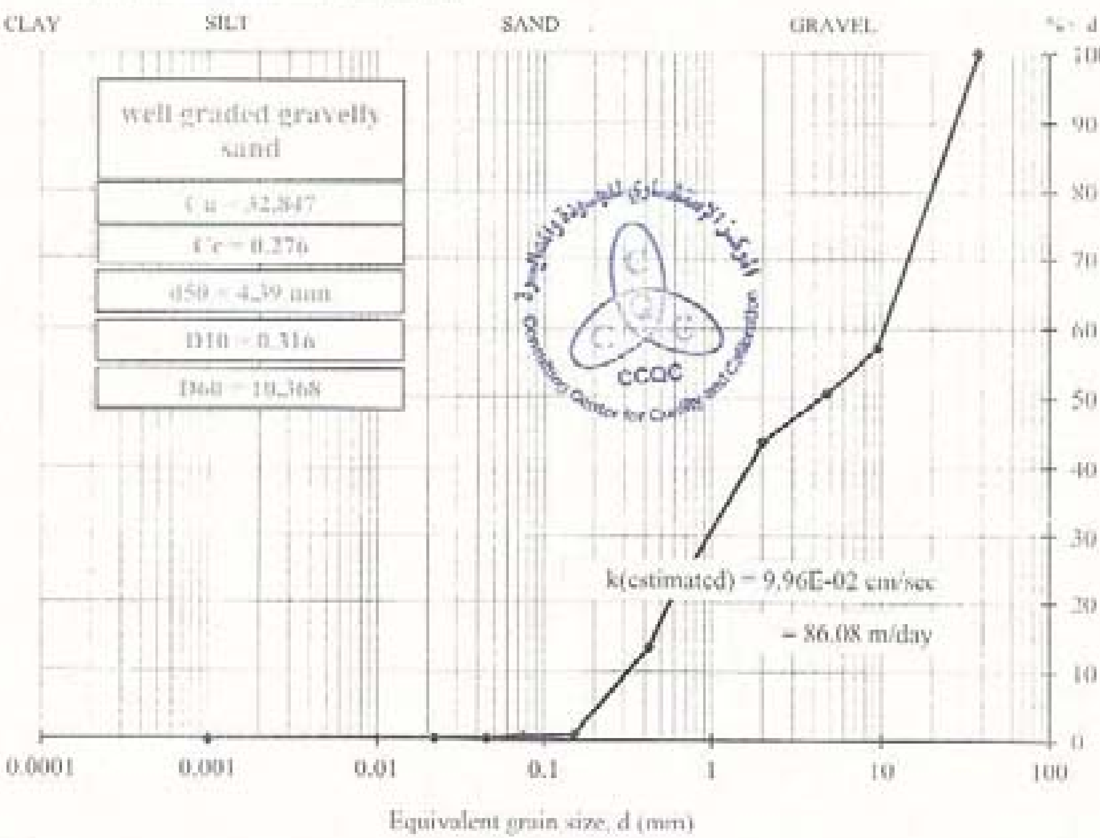
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 70.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	49.4
				Medium gravel	21.2	
				Fine gravel	28.2	
3/8"	9.50	130.2	57.3	Coarse sand	7.0	50.0
Nr. 4	4.75	115.1	50.6	Medium sand	30.0	
Nr. 10	2.00	99.2	43.6	Fine sand	13.1	
Nr. 30	0.600	49.0	21.6	Fines Content (Silt & Clay)	*	0.6
Nr. 40	0.425	31.1	13.7			
Nr. 100	0.150	1.8	0.8			
Nr. 200	0.075	1.4	0.6			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة- شارع الثورة- عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: ... تلفون 08-2130081، جوال 0592-283740 Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

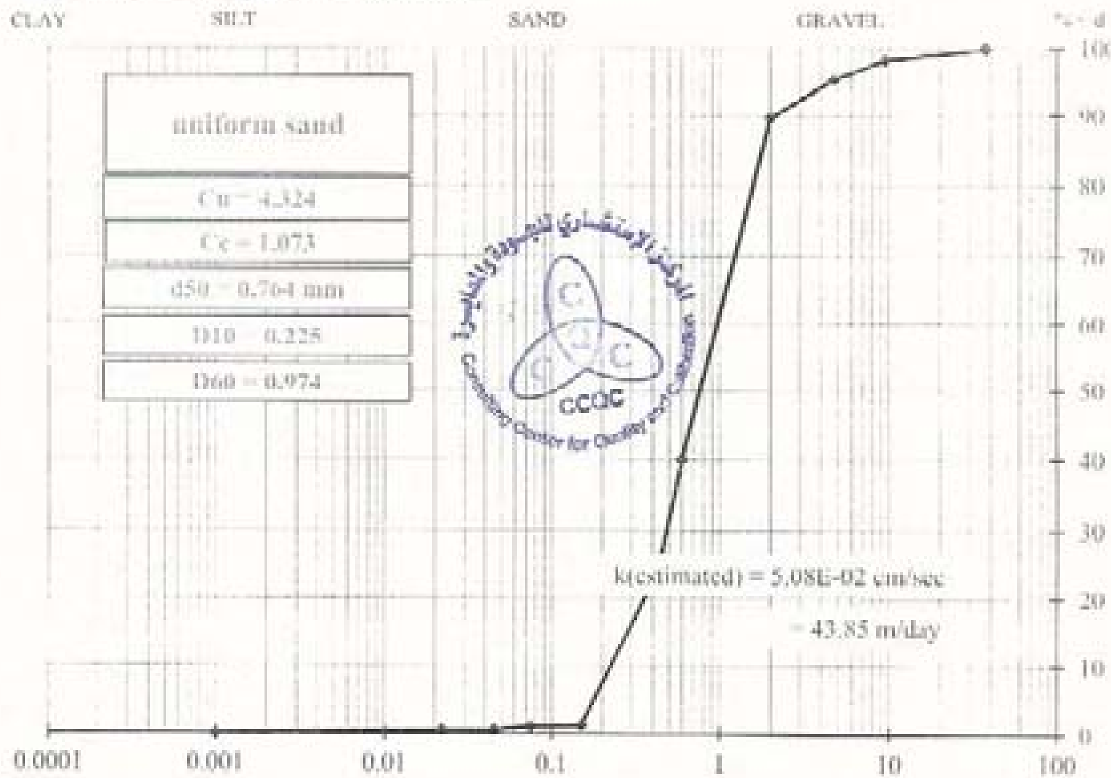
Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)
Bore Hole No.	BW No. 26
Depth	71.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	4.7
				Medium gravel	0.8	
				Fine gravel	3.9	
3/8"	9.50	271.8	98.4	Coarse sand	5.6	94.2
Nr. 4	4.75	263.3	95.3	Medium sand	65.9	
Nr. 10	2.00	247.7	89.6	Fine sand	22.7	
Nr. 30	0.600	110.6	40.0	Fines Content (Silt & Clay)	*	1.0
Nr. 40	0.425	65.6	23.7			
Nr. 100	0.150	3.3	1.2			
Nr. 200	0.075	2.9	1.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة – شارع الوحدة – عمارة الوحيدي بجوار برج أبو رمضان – تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995505، 0599-890879
فرع الجنوب: رفح – مفترق طريق العصر – تليفون 08-2130081، جوال: 0592-283740 Email: ccqcml@gmail.com, ccqcml@yahoo.com

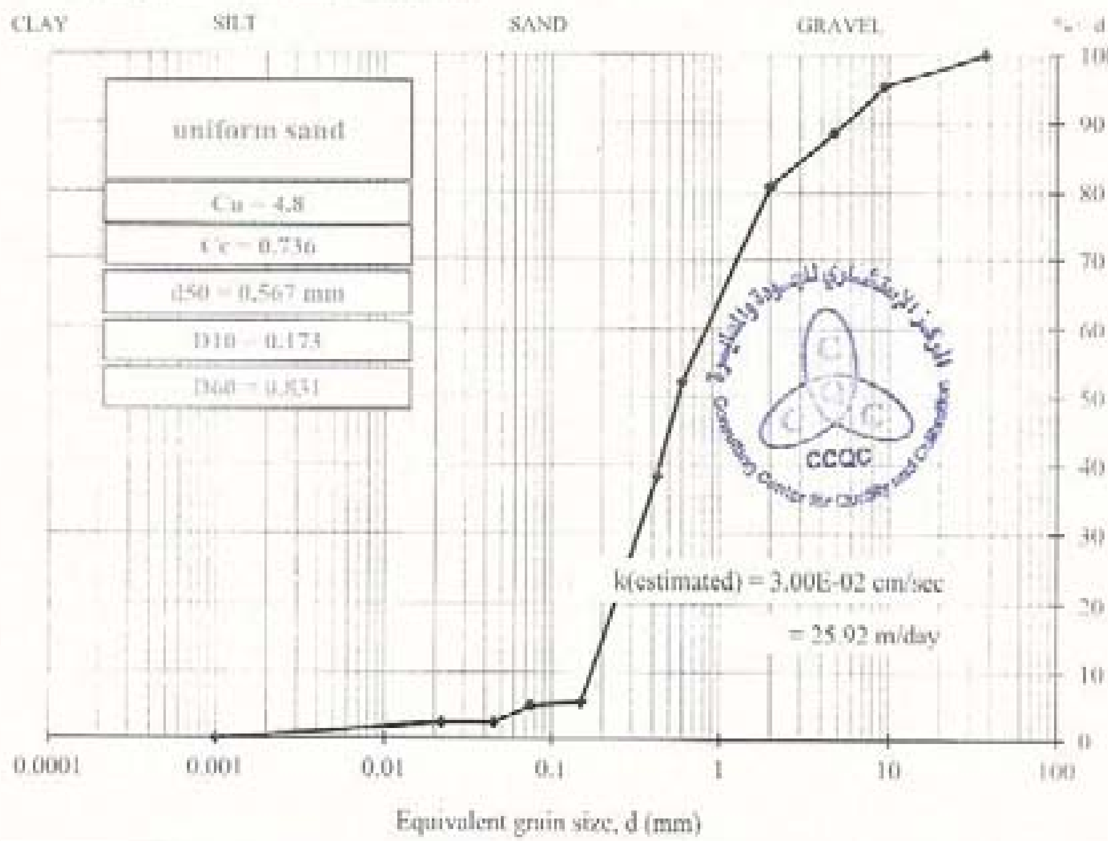
Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICR 01- NGEST /2015 (First Stage) Lot (1 + 2)
Bore Hole No.	RW No. 26
Depth	73.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	11.6
				Medium gravel	2.3	
				Fine gravel	9.3	
3/8"	9.50	301.5	95.4	Coarse sand	7.6	83.4
Nr. 4	4.75	279.4	88.4	Medium sand	42.3	
Nr. 10	2.00	255.3	80.8	Fine sand	33.4	
Nr. 30	0.600	165.2	52.3	Fines Content (Silt & Clay)	*	5.0
Nr. 40	0.425	121.5	38.4			
Nr. 100	0.150	17.2	5.4			
Nr. 200	0.075	15.8	5.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Grain Size Distribution of Soil

ASTM D 422-63 (2007)

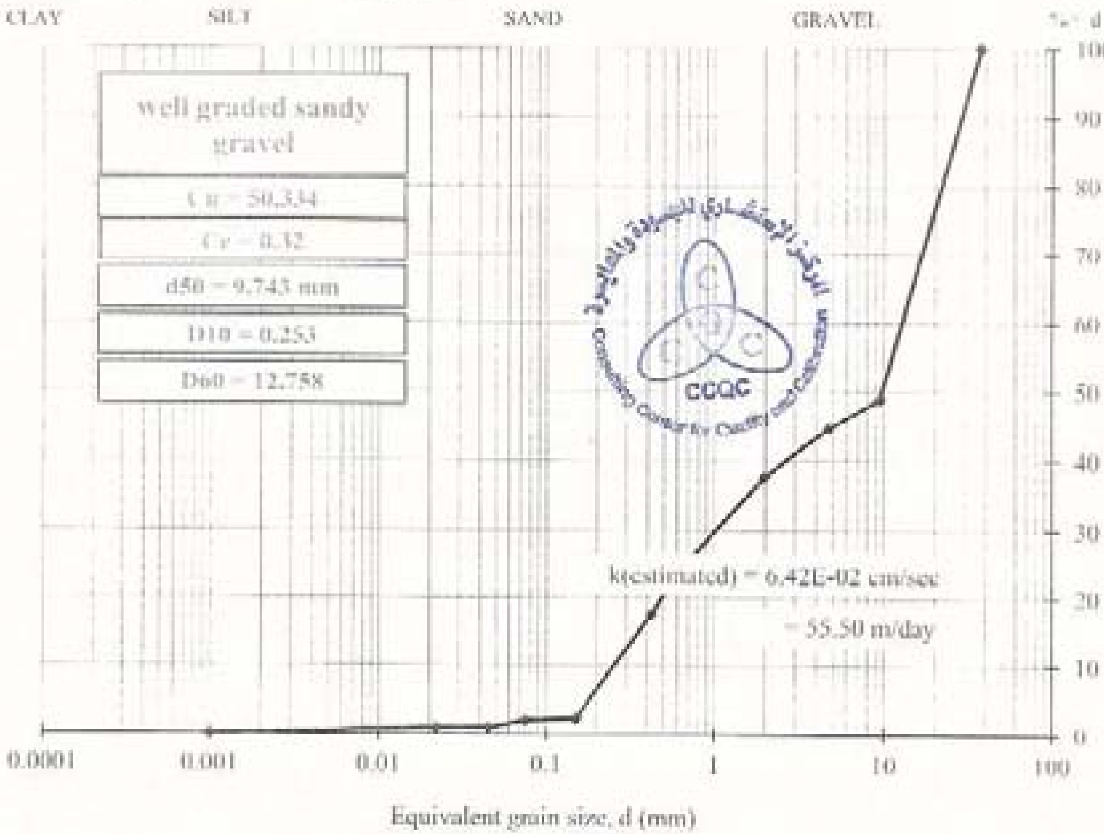
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 74.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	55.4
				Medium gravel	25.2	
				Fine gravel	30.2	
3/8"	9.50	104.6	49.1	Coarse sand	6.8	42.5
Nr. 4	4.75	95.1	44.6	Medium sand	20.3	
Nr. 10	2.00	80.7	37.9	Fine sand	15.5	
Nr. 30	0.600	50.9	23.9	Fines Content (Silt & Clay)	*	2.1
Nr. 40	0.425	37.5	17.6			
Nr. 100	0.150	4.9	2.3			
Nr. 200	0.075	4.4	2.1			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Consulting Center for Quality
& Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

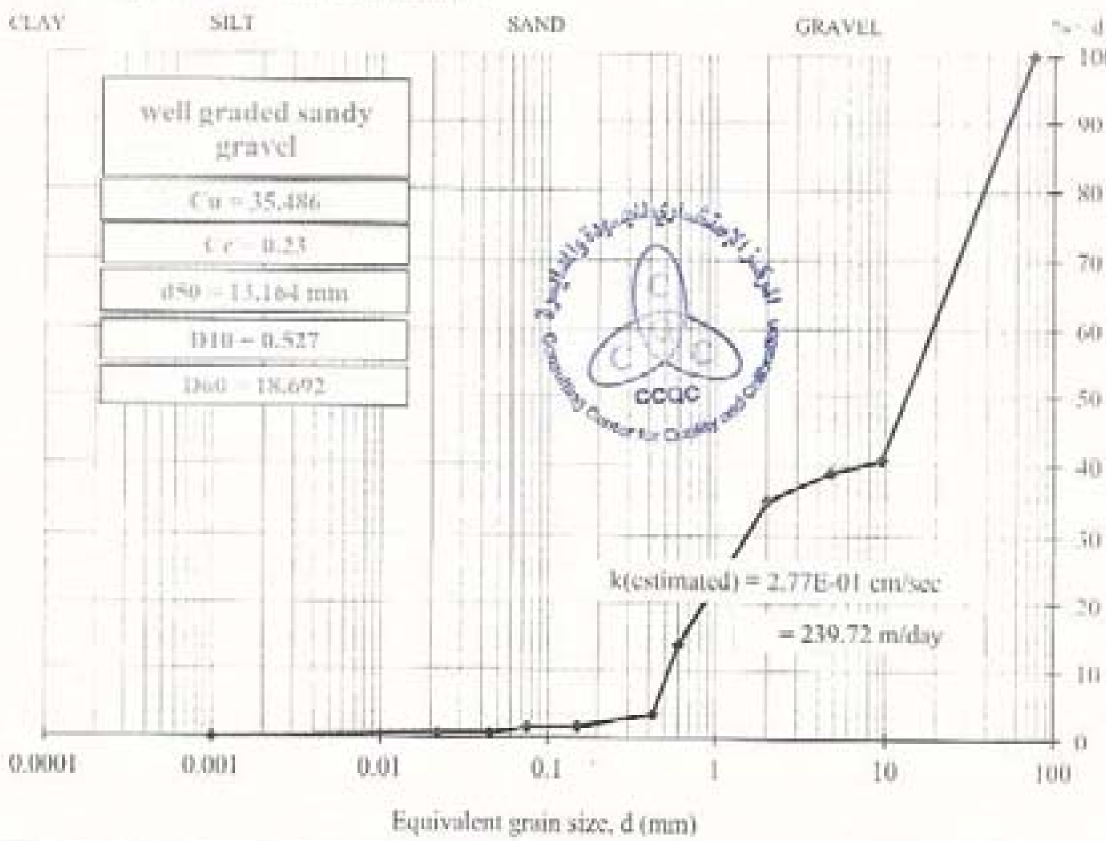
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 75.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	61.1
				Medium gravel	39.5	
				Fine gravel	21.6	
3/8"	9.50	279.6	40.7	Coarse sand	3.9	37.2
Nr. 4	4.75	267.0	38.9	Medium sand	31.4	
Nr. 10	2.00	240.2	35.0	Fine sand	1.9	
Nr. 30	0.600	95.7	13.9	Fines Content (Silt & Clay)	*	1.6
Nr. 40	0.425	24.2	3.5			
Nr. 100	0.150	12.0	1.7			
Nr. 200	0.075	11.1	1.6			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة شارع الثورة - عمارة الوحيدي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880379، 0598-995595، 0599-890879
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - التلفون: 08-2130081، جوال 0592-283740 Email: ccqcmf@gmail.com, ccqcm@yahoo.com

Grain Size Distribution of Soil

ASTM D 422-63 (2007)

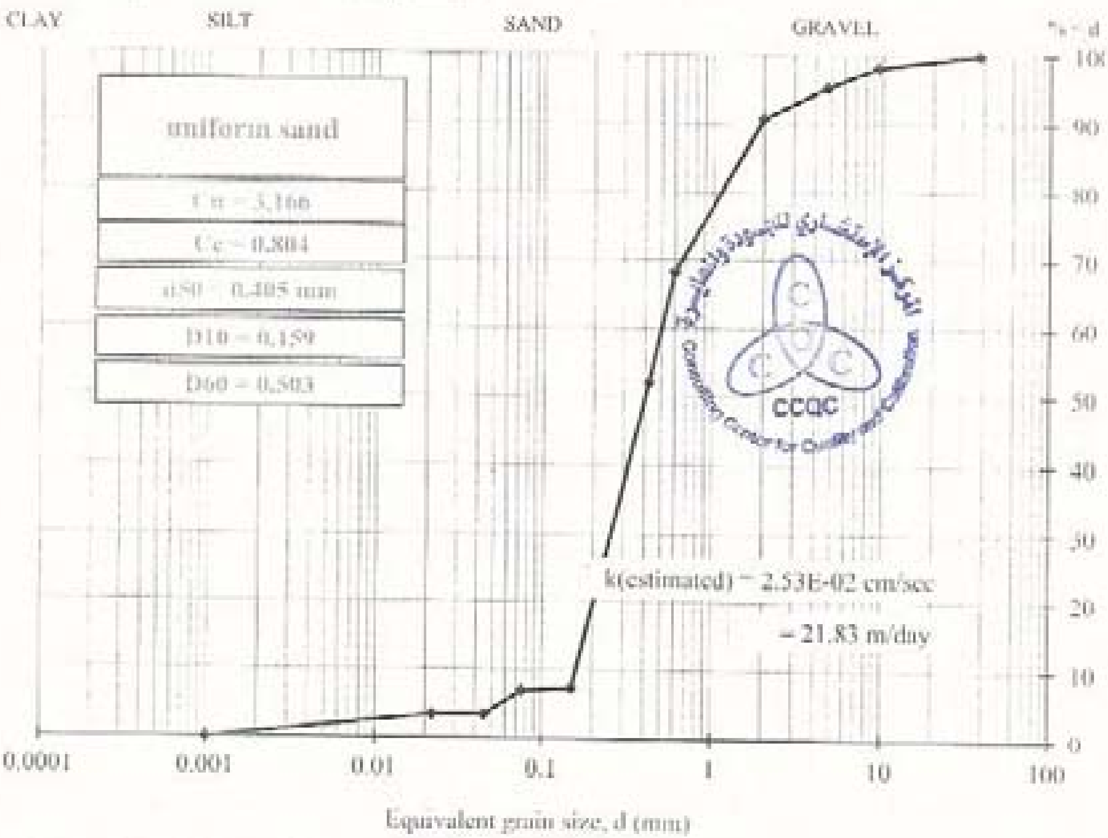
Project: Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)

Bore Hole No. RW No. 26

Depth 78.0 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	4.7
				Medium gravel	0.9	
				Fine gravel	3.8	
3/8"	9.50	262.5	98.2	Coarse sand	4.5	88.2
Nr. 4	4.75	254.7	95.3	Medium sand	38.8	
Nr. 10	2.00	242.8	90.8	Fine sand	45.0	
Nr. 30	0.600	182.4	68.2	Fines Content (Silt & Clay)	*	7.1
Nr. 40	0.425	139.2	52.1			
Nr. 100	0.150	20.1	7.5			
Nr. 200	0.075	19.0	7.1			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



Consulting Center for Quality & Calibration
Soil & Materials Testing Lab

المركز الاستشاري للجودة والمعايرة
مختبر فحص المواد والتربة

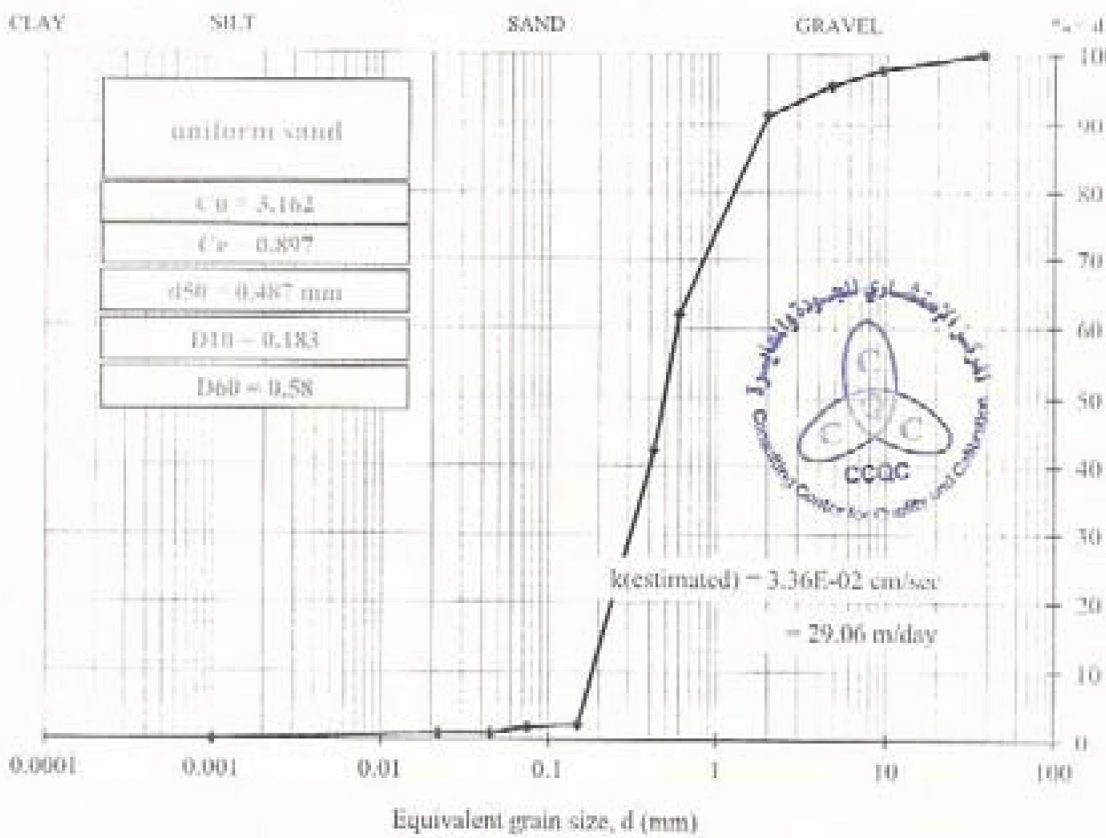
Grain Size Distribution of Soil

ASTM D 422-63 (2007)

Project:	Construction of Effluent Recovery and Irrigation Scheme of North Gaza Emergency Sewage Treatment - NGEST ICB 01- NGEST /2015 (First Stage) Lot (1 + 2)
Bore Hole No.	RW No. 26
Depth	79.8 m

Mechanical (sieve) analysis				Soil Type	%	Tot. %
Sieve Number	Sieve mesh opening, mm	Mass passing, g	Percent passing, %	Coarse gravel	0.0	4.5
				Medium gravel	1.1	
				Fine gravel	3.4	
3/8"	9.50	308.0	97.8	Coarse sand	4.1	93.5
Nr. 4	4.75	300.6	95.5	Medium sand	49.1	
Nr. 10	2.00	287.7	91.4	Fine sand	40.2	
Nr. 30	0.600	195.0	61.9	Fines Content (Silt & Clay)	*	2.0
Nr. 40	0.425	133.0	42.2			
Nr. 100	0.150	7.2	2.3			
Nr. 200	0.075	6.3	2.0			
Pan	---	0.0	0.0			

*Percentages relative to entire sample mass



المقر الرئيسي: غزة- شارع الثورة - عمارة الرجيمي بجوار برج أبو رمضان - تليفاكس 08-2886362، جوال 0598-991191، 0598-880279، 0598-995595، 0599-890679
فرع الجنوب: رفح شارع عمر بن الخطاب - مفترق خربة العدس - تليفون 08-2130081، جوال 0592-283740 Email: ccqcmtl@gmail.com, ccqcmtl@yahoo.com

Annex 5 : Updated GW model

Updating the groundwater model

The impact on groundwater is one of the most important issues that are being associated with the project, that is part of the project has been designed to prevent impacts on the groundwater from infiltrating partially treated sewage.

The groundwater modeling prepared in the original EA of the project resulted that the groundwater quality will be improved after the operation of Part B of the project as the new infiltrated plume will wash out the old plume of partially treated water, however the EA has simulated a worst case scenario where the operation of Part B of the project is delayed and the EA recommended construction of remediation wells to pump out the effluent.

For the current work, the existing groundwater modeling provided during the design and the EA of the updated NGESTP study (2012-2013) is assessed and used as a reference. Visual Modflow (VMF) version 4.6 and its integrated modules are used in the current study. Our approach consists of updating the model to consider the delays in the implementation and operation of the designed stages of the treatment plant as well as the recovery schemes.

The most updated data provided by the client, up to year 2017, is used; i.e. the model was updated considering the followings:

- The actual infiltrated partially treated wastewater quantities and rates from 2012 to 2017,
- The updated locations and numbers of the recovery wells,
- The actual design of the first stage of the recovery wells (14 wells) that constructed by the end of year 2017.
- The updated time schedule for the operation of the treatment plant and the two stages of the recovery wells.

The assessment of the impacts on groundwater considered the abstraction rates of the recovery wells, the possible recharge in the agricultural lands and different scenarios for project implementation. Two scenarios are considered in the current impact assessment:

1. Without the implementation of recovery scheme.
2. With the implementation of recovery scheme. 27 recovery wells will be implemented on two stages; 14 wells that already constructed and to be operated by the end of 2019 and 13 wells to be operated by the end of 2021.

Both scenarios take into account the operation of the WWTP by the beginning of 2018. Therefore, partially treated wastewater will continue to be infiltrated until the beginning of 2018, then, 35,600 m^3/day of treated wastewater will be infiltrated.

1. Modeling Results without Recovery Scheme

Results of the model shows that, at the beginning of year 2018, the pollution plume extends to a distance of about 500 m (nitrate concentration contour line is 80 mg/l) in the North-West direction of the basin (See Figure 1); as wastewater with bad quality has been infiltrated in the basins since 2009 (15,000 – 20,000 m^3/day).

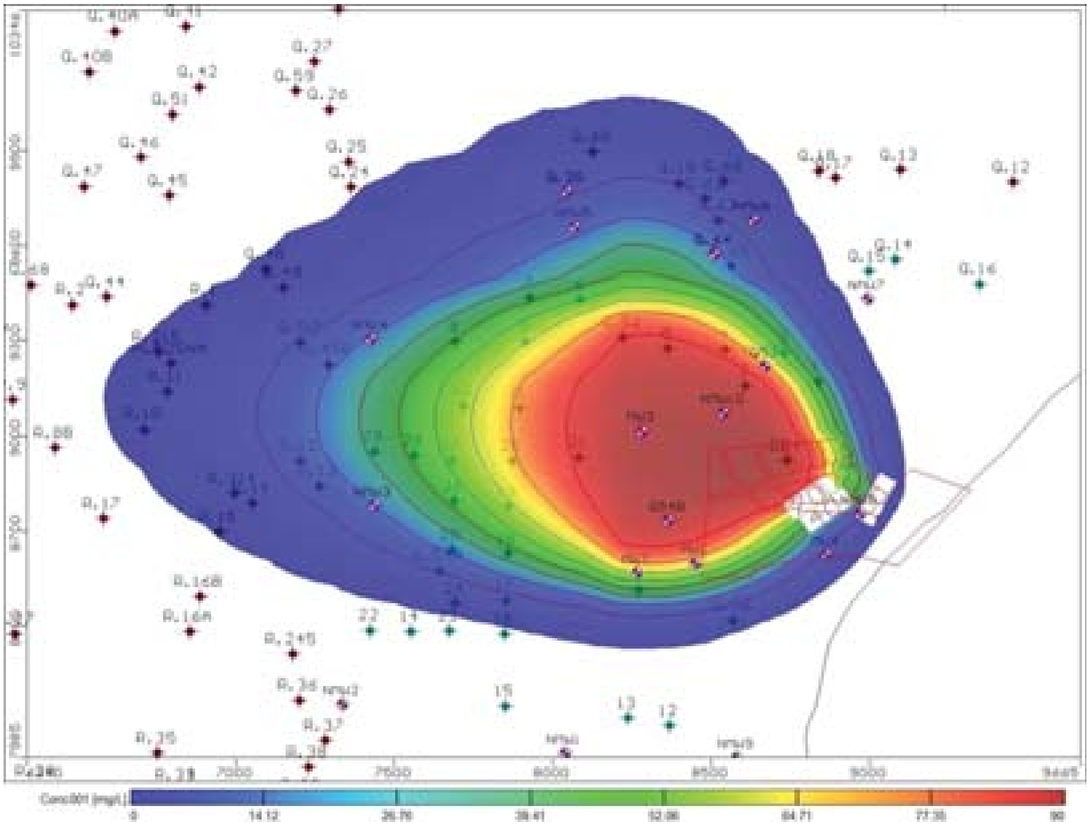


Figure 1: The pollution plume in year 2018 (before the infiltration of treated wastewater, no recovery)

Figure 2 shows the groundwater quality expectations in year 2019 after the operation of the treatment plant. Concentration of the infiltrated treated wastewater will be 10 mg/l. It can be noticed that there will still be polluted zones and some agricultural wells will be affected. Figure 3 shows the same scenario for year 2025 where the groundwater quality is highly improved. However, large polluted zone is still found in the North-west direction, where municipal and agricultural wells exist.

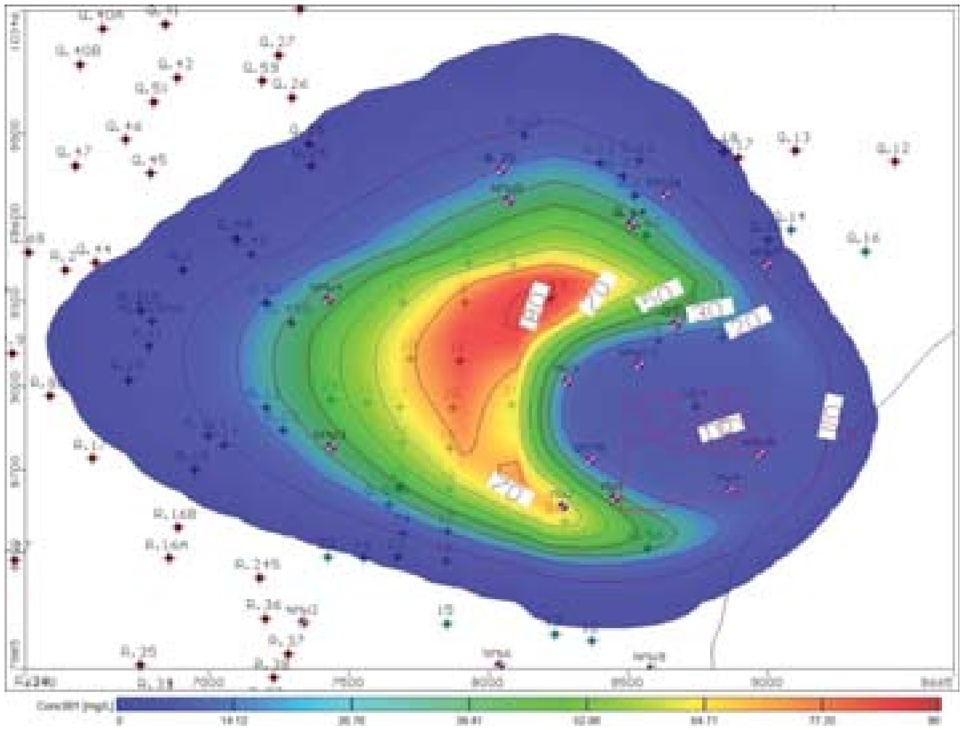


Figure 2: The pollution plume for year 2019 (35,600 m^3 of treated wastewater is infiltrated starting from 2018)

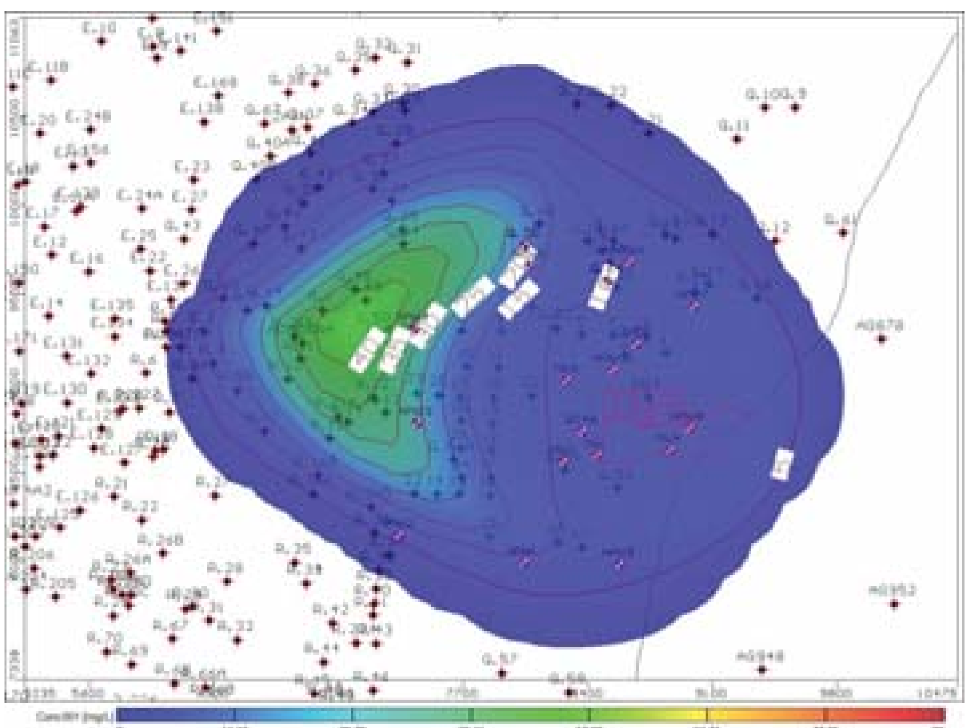


Figure 3: The pollution plume for year 2025 (35,600 m^3 of treated wastewater is infiltrated starting from 2018)

2. Modeling Results with Recovery Scheme

A total of 27 recovery wells, designed to recover the infiltrated treated wastewater, will be implemented and operated on two stages:

- Stage 1: 14 wells, located in the North West direction of the basins, are designed to be operated by the end of 2019.
- Stage 2: 13 wells, located in the North and the South direction of the basins, are designed to be operated by the end of 2021.

In order to specify the optimal locations of these wells, several runs of the model were carried out, as part of the project design, on the base that these wells should be able to capture all pollution; these locations were modified to go in line with the delay in the operation of the treatment plant. Figure 4 shows the pollution plume after the implementation of the first stage of the recovery wells, it can be noticed that the plume is restricted to pass the 14 recovery wells. In addition, it reduces the dilution of the pollutants in the area after the recovery wells.

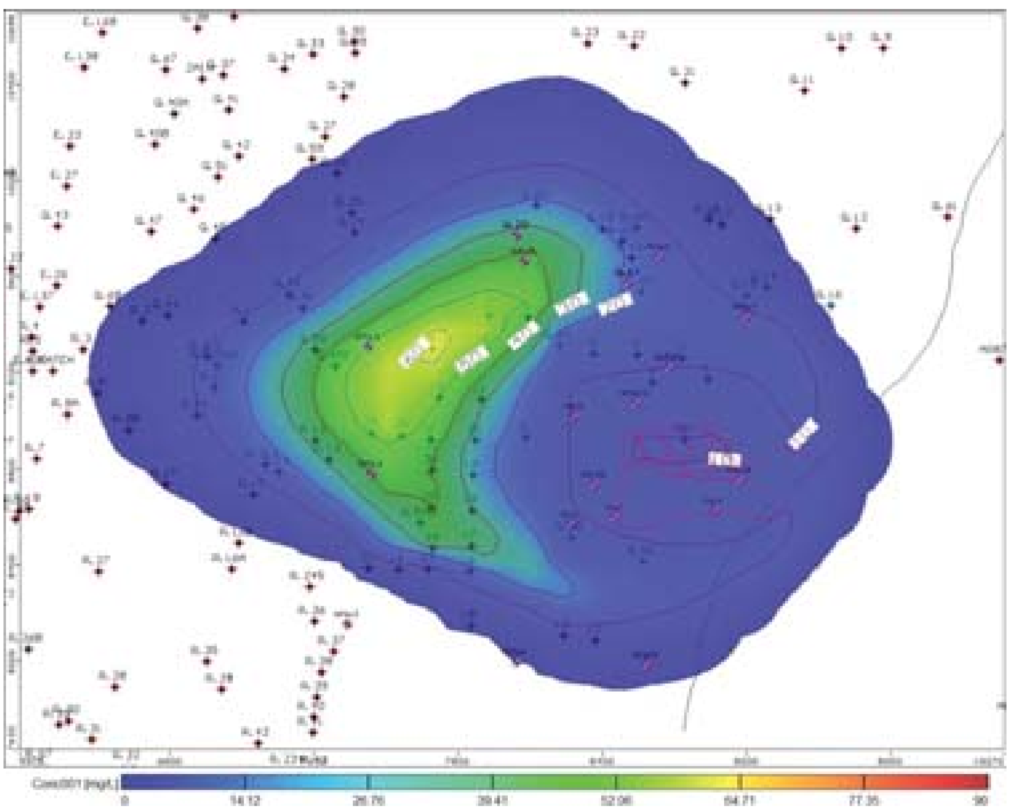
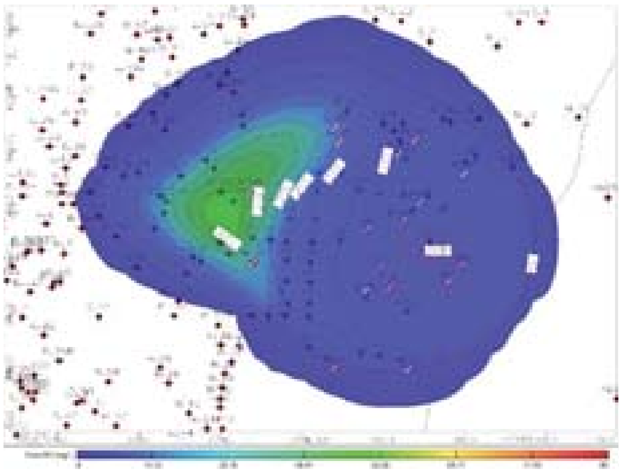
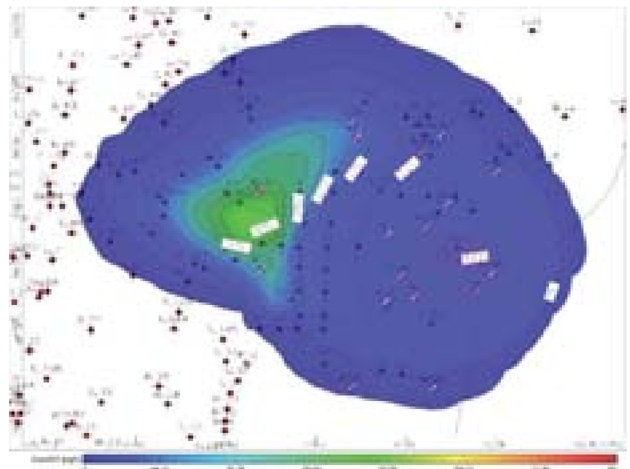


Figure 4: Pollution plume in 2021 (after the implementation of the first 14 wells in 2019)

The second stage of the recovery wells is intended to be implemented to restrict the expansion of the pollution plume; i.e. if only 14 wells continue to operate, the pollution will be extended and more wells will be at risk in year 2025 as shown in Figure 5 (a). In addition, polluted zone will be found in the North-west direction with concentration of pollution of 40 mg/l. While Figure 5 (b) shows that the pollution plume is restricted to pass the 27 recovery wells. In addition, the area of the polluted zone in the North-west direction will be smaller than that the area in the case of operating 14 wells. The presence of this pollution zone in the north-west direction is due to the delay of construction and operation of the 14 wells (stage 1) and 13 wells (stage 2). The pollution escapes the recovery wells and it is difficult be recaptured using the recovery wells since the remaining polluted area is in the downstream. This polluted area will disappear due the dilution with the existing groundwater which will take time. As shown in Figure 6 in year 2042 the pollution disappears.



(a)



(b)

Figure 5: Pollution plume in 2025: (a) without the implementation of Stage 2 of the recovery wells and (b) after the implementation of stage 2 of the recovery wells

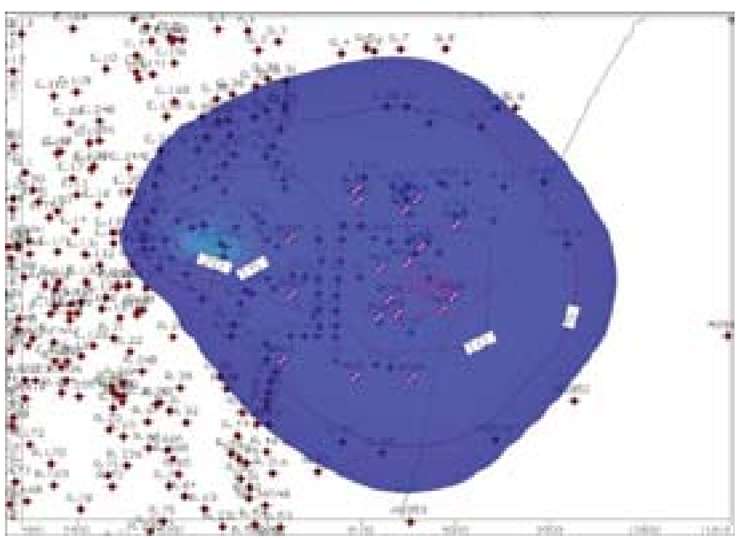


Figure 6: Pollution plume in 2042 after the implementation of stage 2 of the recovery wells

Based on the groundwater modeling and analysis, monitoring plan should be developed. The monitoring plan should include the mitigation measures which has to be considered during the operation of the effluent recovery scheme. The monitoring plan includes the provision of the monitoring wells location, monitoring indicators (parameters to be monitored) and monitoring frequency.

3. Impacts of the Project on Groundwater Elevation

The current water table elevation in the area around the basins is 2 m above mean sea level, as shown in Figure 7. After the operation of the first stage of recovery wells by the end of year 2019, about 20,000 m3/day of groundwater will be recovered (abstracted). This will affect the groundwater table as shown in Figure 8; which indicates the reduction in the water table elevation after two years of operation of the first stage of recovery wells.

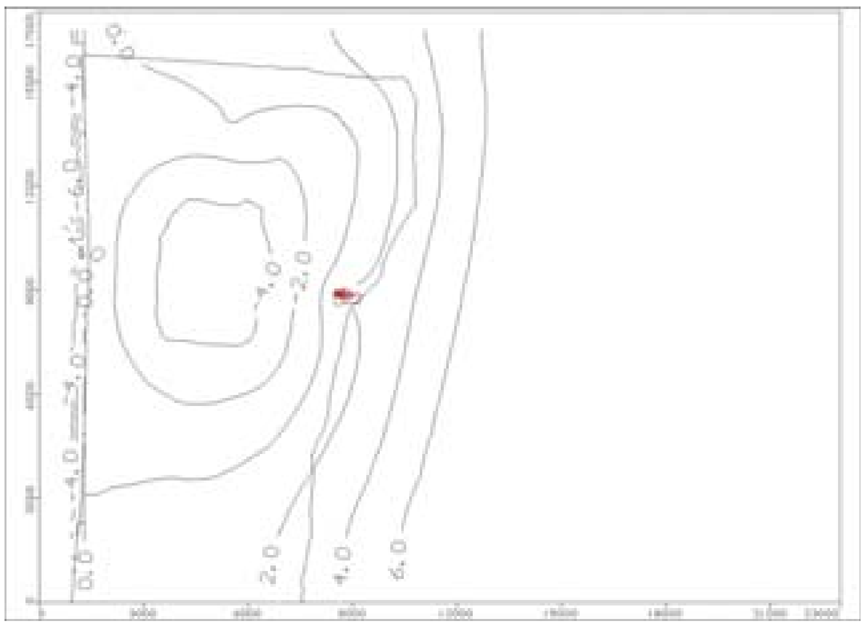


Figure 7: Groundwater Table before the implementation of the first stage of recovery wells in 2018

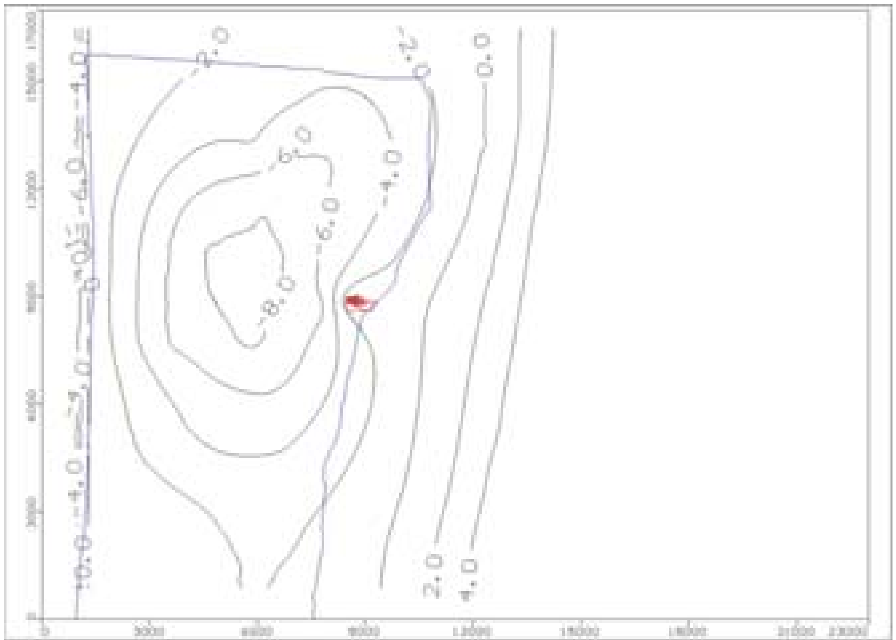
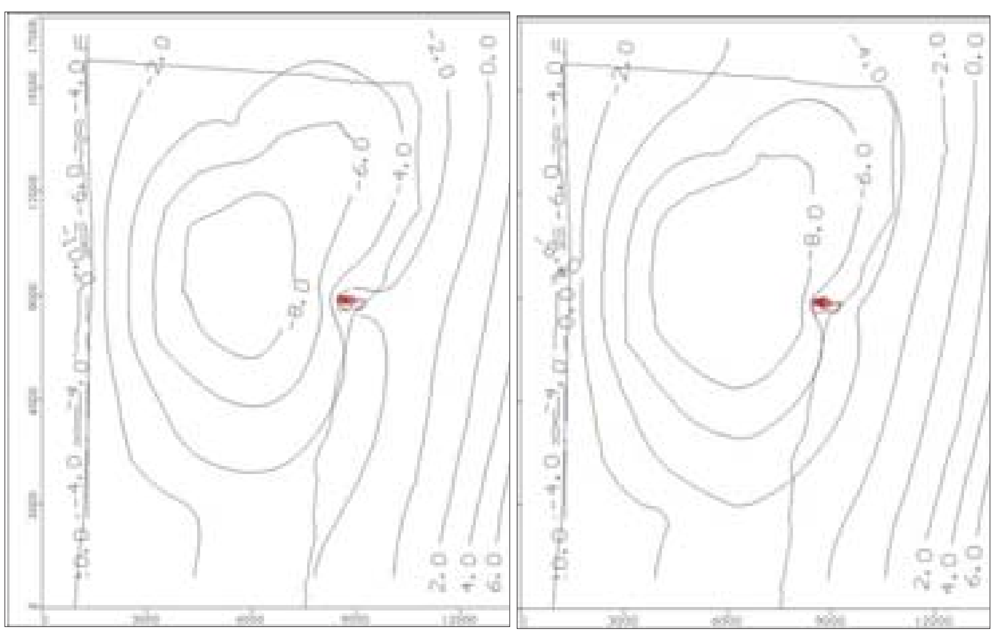


Figure 8: Groundwater Table before the implementation of the second stage of recovery wells in 2021

In 2030, the model estimated that the water table elevation, in the area around the basins, will be between 2 m and 4 m below mean sea level if the second stage of recovery wells is not implemented, as shown in Figure 9 (a). While, in the same area, the water table elevation will be between 4 m and 6 m below mean sea level if the second stage is implemented; as about 18,000 m3/day of groundwater will be abstracted through 13 recovery wells (See Figure 9 (b)).



(a) (b)

Figure 9: Ground water Table in 2030, (a): without the implementation of the second stage of the recovery wells, and (b): with the implementation of the second stage of the recovery wells.

Annex 6: Prefeasibility Study 2017

State of Palestine
Palestinian Water Authority

دولـــــة فلسـطيـن
سلطة الميـاه الفلسطينيـة

SELECTION OF CONSULTING SERVICE FOR COMPLEMENTARY FEASIBILITY STUDY FOR IRRIGATION SCHEME

Output 6

FINAL Complementary Feasibility Study

Final

RFP/feasibility /01/2015; Grant No AFD- MOP / CPS 1060

Submitted by

Joint Venture ALMADINA-TIMESIS S.r.l.

July 2017

TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF DELIVERABLES

Output 1 - Inception Report

Output 2 - Baseline Survey Report

Output 3 - Irrigation Project Review Report

Output 4 – Draft Complementary Feasibility Report

Output 5 – Stakeholder Workshop Presentation

Output 6 – Final Complementary Feasibility Report

ACRONYMS

AFD	French Development Agency
BLWWTP	Beit Lahia Wastewater Treatment Plant site
CAPEX	CAPital EXpenses
CMWU	Coastal Municipal Water Utility
CP	Cropping Pattern
EQA	Environment Quality Authority
FAO	Food and Agriculture Organization of the United Nations
MAR	Managed Aquifer Recharge
MOA	Ministry of Agriculture
MOH	Ministry of Health
MOLG	Ministry of Local Government
NGEST	North Gaza Emergency Sewage Treatment
NWC	National Water Company
OPEX	OPerational EXpenses
PIU	Project Implementation Unit
PWA	Palestinian Water Authority
ToR	Term of Reference
UAWC	Union of Agricultural Work Committees

WB	World Bank
WSRC	Water Sector Regulatory Council
WUA	Water User Association
WWTP	Waste Water Treatment Plant

RESULTS AND RECOMMENDATIONS

KEY RESULTS

- By improving the original design of the water reuse scheme, introducing modernized irrigation methods and a newly proposed cropping pattern, it is possible to save nearly 3.2 Million Cubic Meter of water per year (MCM/year) or 21.5% less water than what was required by the original 2010 design. Less water requirements also leads to reduced energy needs for the recovery of water from the aquifer. More precisely, the proposed changes will save 637 MWh, a reduction in energy consumption of over 15%.
- The introduction of an irrigation schedule that largely differs from the original by providing water to the entire irrigation project each day (instead of on a 6-day rotation with 12 lots irrigated 2 at a time once a week). Pumping water into the system on a constant rate drastically reduces the complexity of managing the irrigation scheduling and eliminates the risk of overdrawing water from the storage tanks and stalling the system.
- Palestinian law restricting the use of treated wastewater for irrigation does not apply to the NGEST reuse scheme because the water used for irrigation for this project is recovered from the local aquifer and not used directly from the NGEST WWTP. The regulation does apply, however, to the quality of water that may be infiltrated into the aquifer: the quality must be either moderate ("C"), good ("B"), or high ("A"). Utilizing poor ("D") wastewater for aquifer recharge is prohibited.
- Three water tariffs options are suggested for covering the OPEX costs (including operating the WUA): farmers will be charged a flat rate of 0.9 or 1.2 or 1.461 ILS/m^3 for water delivered at the farm gate. The lowest rate is possible if all energy requirements are provided by the national grid; the highest fees are necessary to cover the costs in case 100% of electricity is produced by diesel generators. The median rate is possible if a 50/50 mix of energy production is achieved. Even if the operator of the system is charged the highest rate of 1.461 ILS/m^3, this would still be less than what farmers are paying, on average, today.

KEY ASSUMPTIONS

- The feasibility of the project is tested against the most conservative scenario of energy generation, with an assumption that 100% of electricity will be provided by diesel generators.
- The capital investment required for the construction of the irrigation network (and the O&M costs associated with a more complex and expensive network) is assumed to be much higher than previously estimated. The capital investments required for the construction of the irrigation network have seen a 75% increase from the original estimates made in 2010, when the network was designed. Some of this increase is justified by price changes in cost and material over the past 7 years but the largest increase is due to subsequent modifications of the original design which, this *Report* argues, could be streamlined for a better (and less expensive) design of the system.

KEY RECCOMENDATIONS

- The recommended Investment Scenario is for the capital investments (CAPEX) needed for the reuse and recovery scheme to be paid for by the government/donors and the operating costs (OPEX) to be paid for by the farmers. If the proposed cropping pattern and modern irrigation methods are implemented as suggested by this *Report*, this scenario is feasible and profitable for both phases of the project even if 100% of the energy required to operate the scheme is produced by diesel generators.
- The recommended Institutional Arrangement is for the operation of the irrigation system to be a combination of both governmental and non-governmental management. More specifically, the bulk water supplier (CMWU and then, when created, NWC) will own and operate the recovery and reuse infrastructure for the first 3 years. During that time, the WUA would receive intensive capacity building. After the first 3 years of the project, the WUA would assume operation and management of the recovery and reuse scheme, leasing the infrastructure from NWC. The WUA (the farmers) would pay for the OPEX from the start of the organization, as outlined in the Investment Scenario 3 above.
- Design drawings for the water reuse scheme should be improved prior to finalizing the tendering document. Specifically, the network layout should be adjusted after a precise cadastral and topographic survey have been provided.
- The design of the network should be revised to consider the reduced flows that come with the newly proposed Cropping Pattern. By revising the network design with updated cadastral and topographic data and streamlined flow requirements it is likely that the overall cost for constructing and maintaining the reuse system will be significantly reduced.
- Donors' engagement and government assistance to farmers is a critical component for the success of the project. Donors/Government must assist the WUA (and farmers) by providing intensive and continuous training and technical support. Such assistance program should last at least 3 years from the construction of the irrigation network. A provisional budget of $806,000 has been defined for training WUA.
- Managed Aquifer Recharge (MAR) is a key component of the project that, if not managed properly, could not only have ramifications for the project but could also endanger local communities and an essential natural resource. Monitoring is an integral part of MAR management and should be robustly undertaken to determine the effectiveness of the recharge scheme, evaluate water quality and address clogging and other operational issues.

IMMEDIATE ACTIONS

After reviewing the project, this *Report* recommends the following **immediate actions**:

- Finalize and promulgate the draft WUA regulation and establish an NGEST WUA;
- Contract UAWC to provide technical assistance to both the WUA staff and members;
- Hold the negotiations necessary to broker project agreements (*viz*., the Bulk Water Supply agreement, MOU between CMWU and NWC; Lease agreement; WUA Technical Assistance contract, etc);
- A fund should be established and maintained to cover the O&M costs of the recovery and reuse system during the transitionary period of the first 3 years;
- Update the design of Phase I and Phase II: an activity that could lead to revised costs and tendering documents by the end of 2017;
- PWA should immediately begin actively monitoring the infiltration basin and aquifer;
- Start the construction of Phase I of the reuse scheme by early 2018, and initiate the process for construction of Phase II by early 2019.

PROJECT BACKGROUND AND RATIONALE

PROJECT BACKGROUND

The Palestinian Water Authority (PWA) is executing the Northern Gaza Emergency Sewage Treatment (NGEST) Project. Initiated in 2004, the project is being implemented in three phases. **Phase A** of the project comprised the construction of the terminal sewage pumping station at the Beit Lahia Wastewater Treatment Plant site (BLWWTP), the construction of a pressure pipeline to a new site about seven kilometres to the East of Jabalia, the construction of nine infiltration ponds at the new site and the commissioning of the pipeline to allow a large and dangerous emergency partial effluent pond at Beit Lahia to be drained. This phase was entirely completed in 2010.

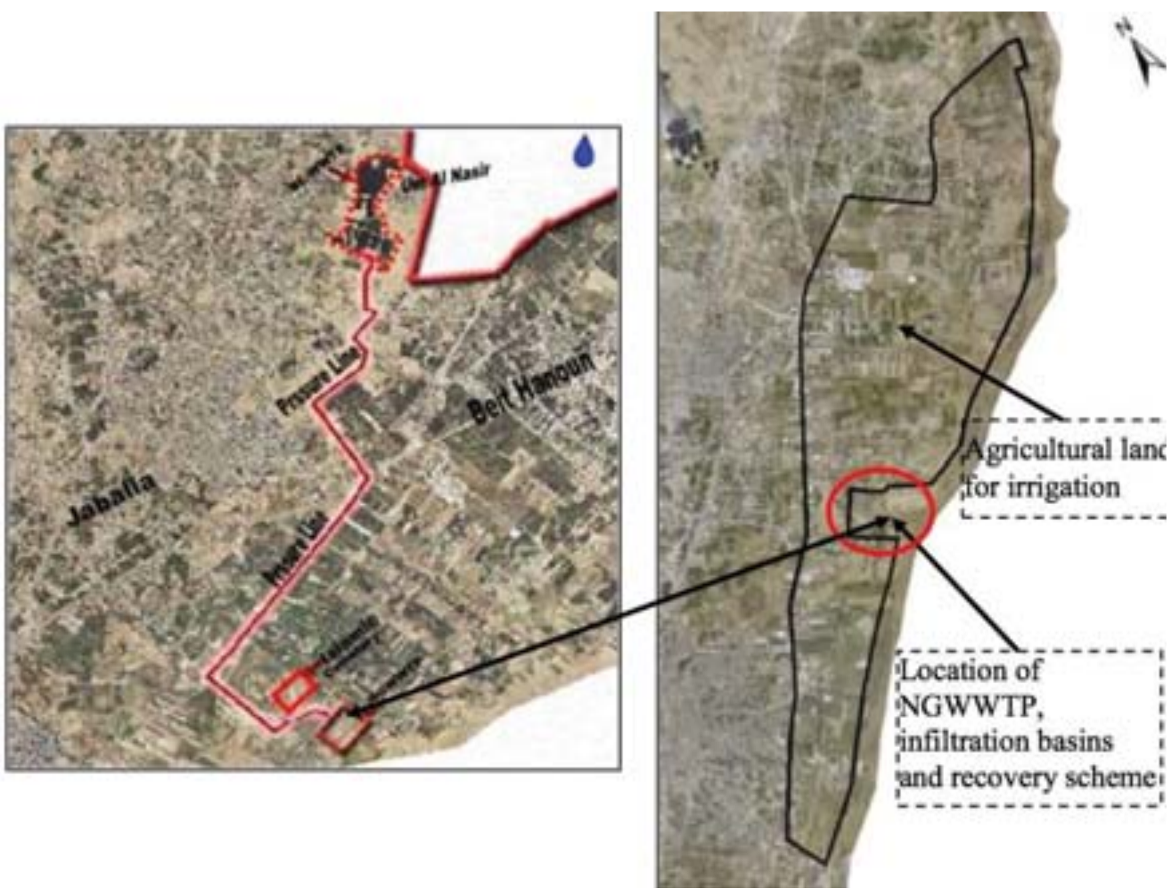


Figure 1: Main components of the NGEST project

Phase B of the project included the construction of the North Gaza Emergency Waste Water Treatment Plant (NGWWTP) at the new site. The first component of the NGWWTP is almost completed and will be fully functioning by the end of 2017, to treat up to 35,600 m^3 of sewage daily. Future expansion of the plant would bring the total treatment capacity to 69,000 m^3/day and will require the construction of an additional infiltration basin.

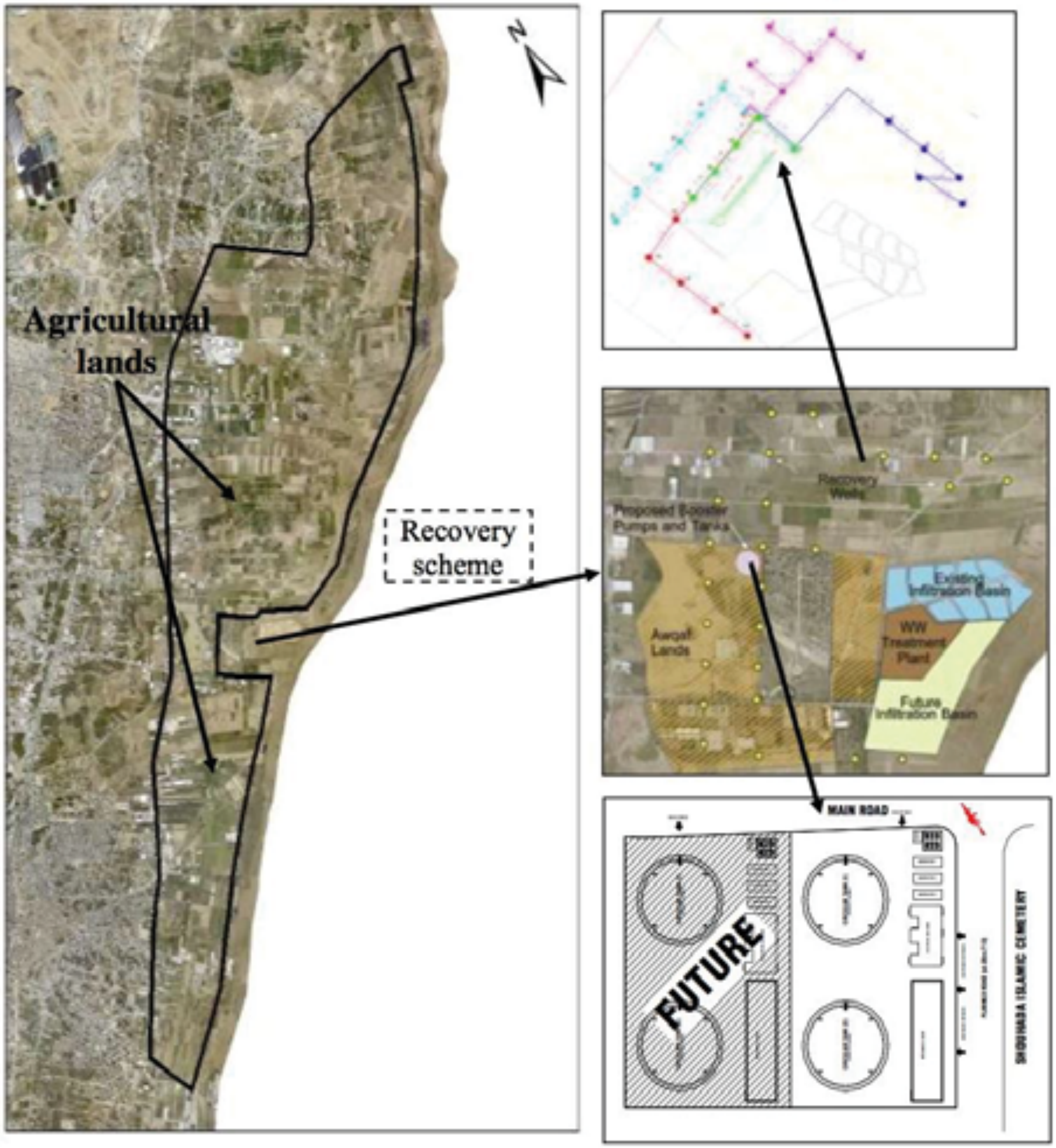


Figure 2: The proposed irrigation Project (figure on the left), NGWWTP and existing and future Infiltration basins (figure on the center right), recovery wells (figure on the top right) and storage tanks for all phases of the project (figure on the bottom right)

A third, **supplementary phase** was later added to the project to recover and reuse the treated effluent after the new WWTP is completed. The treated sewage effluent will be disposed of into infiltration ponds, the water will seep through an unsaturated zone of soil which will facilitate nutrient and pathogen removal, and eventually make its way to the unconfined aquifer. There, the water will be extracted by 28 recovery wells, put into two storage reservoirs, and distributed throughout the network for irrigated agriculture.

THE PRESENT STUDY

Since January 2017, a Consortium of technical consultants has been working with PWA to prepare this Complementary Feasibility Study for the Irrigation Project. The Consortium is comprised of TIMESIS s.r.l. from Italy and AL MADINA LLC from Palestine.

The Consortium has worked with key staff of the PWA over the last several months in order to give the optimal recommendations for re-engaging farmers and making the project feasible. To carry out its task, this project has drawn upon data collection, field visits, and state-of-the-art computer modeling in order to best understand the irrigation project's hydraulics and strategic options. Equally importantly, the *Report* has been built with significant input from not only PWA and other ministries but also farmers, irrigation project and water control structure managers, and other technicians. The result, therefore, is a set of recommendations that are not only carefully crafted engineering solutions but also reflect the farmers needs and desires to cultivate the project area.

COUNTRY AND SECTOR ISSUE AND POLICY

The activities of the NGEST project are in line with the policies and objectives of the National Water Policy (2012 – 2023), the Strategy for the Water and Wastewater Sector (2011-2013), the Draft Water Resources Management Strategy (1997), the National Water Policy (1995), Water Sector Strategy Planning Study (WSSPS, 2000), Water National Plan (NWP) 2000 and Coastal Aquifer Management Plan (CAMP) 1999-2004.

More specifically, this project puts into practice numerous water sector policy principles and statements, as set out in the National Water and Wastewater Strategy for Palestine, 2013, including:

Sustainable management of water resources:

- Water supply must be based on the sustainable development of all water resources (conventional and non-conventional, shared and endogenous).

- Develop additional quantities of water from non-conventional water resources without infringing upon Palestinian Water Rights.
- Recognize water users' associations (including farmers' associations) as formal entities entitled to negotiate and manage shared national water rights on behalf of their members.

Integrated water resources management:

- Agricultural, industrial, and other development and investments must be aligned to the water resource quantity available or to be developed.

Good Governance and Management:

- The responsibilities for water resources governance, being a regulatory function, and water services management, being an operational function, should be separated institutionally.
- Encourage the involvement of formal water users' associations to ensure optimal management of shared water resources (including wells, springs and treated wastewater) used for economic purposes (irrigation, industry, tourism).

Sustainable wastewater management:

- Treated wastewater effluent is considered a water resource and is added to the water balance.

Financial sustainability of water and wastewater utilities:

- Ensure that the abstraction, transmission and distribution of water, together with wastewater collection and treatment, is financially sustainable and that providers of these services can demonstrate their financial reliability as regards to the full recovery of operation, maintenance, capital investment and capital replacement costs.

Protecting the environment from pollution by wastewater:

- Treat all produced wastewater to a quality suitable for safe and productive reuse, in line with national standards, and support the distribution and productive reuse of treated wastewater.
- Priority shall be given to agricultural reuse of treated effluent. Blending of treated wastewater with fresh water shall be made to improve quality where possible. Crops to be irrigated by the treated effluent or blend thereof with freshwater resources shall be selected to suit the irrigation water, soil type and chemistry, and the economics of the reuse operations.

PROJECT CHALLENGES

As described in the NGEST Assessment of Wastewater Treatment and Reuse Practices Report from 2011, there are several challenges and potential constraints to this project. A few of these challenges are outlined below.

Water Reuse Vision

An integrated vision for wastewater reuse issues in Palestine is still missing, which should include awareness-raising, targeted marketing, and a unified tariff. Greater effort should be devoted in producing good quality treated wastewater to be used for various purposes. Most of the treated wastewater (TWW) pilot projects have failed from the beginning, or only partially satisfied its objectives, mainly because:

- Some NGO's provide farmers of TWW with emergency subsidies, without a comprehensive system of follow up or sustainability.
- The absence of wastewater user associations to integrate and complete the role of donors and NGO's.
- The municipality was unable to operate the scheme because of lack of funds and lack of trained staff.
- The idea of reuse was not readily accepted by the farmers who had no incentive to use reclaimed wastewater.
- Some farmers could abstract fresh water from private wells at lower costs than the reclaimed wastewater.
- The effluent quality did not meet the standard required for reuse.

Political & Institutional Constraints

In Palestine, wastewater reuse projects face various political obstacles, in addition to financial, social, institutional, and technical ones. Although the reuse of reclaimed wastewater in Palestine is a priority confirmed in the Palestinian water policy and adopted in the strategies of the relevant institutions, the experience and promotion of water reuse is still in the early stages. The lack of coordination among stakeholders especially between governmental bodies and NGOs and the limited accessibility to data, information, and reports are hindering the scientific evaluation and the monitoring of implemented projects.

The installation of effective treatment systems to provide effluent that complies with water standards is a prerequisite for the success of this project. It is frequently the case that sewage treatment plants in Arab countries do not operate satisfactorily and, in most cases, treated wastewater discharges exceed the legal and/or hygienically acceptable maximum. This is usually due to interrupted power supply, poor infrastructure and the lack of adequately trained staff with the technical skills to operate these plants, as well as the lack of an adequate budget for plant maintenance and operation.

Farmer Adherence

There are several challenges in getting people to adhere to the new scheme. First, the cost of wastewater needs to be equal or less than the cost of extracting the groundwater. So long as it is cheaper to extract from a private well, that is likely where people will get their water from. Second, the water quality and availability from the new irrigation network needs to equal or exceed the existing system. If the new system is of a poor quality or unreliable, farmers will be unlikely to switch. Finally, there is the challenge of overcoming the local tradition of private wells to switch to a collective irrigation scheme. This will likely take awareness raising and perhaps even financial incentives to change the engrained practices of local users.

Training

A lack of technical knowledge and skills can cause failure in project implementation and, in the case of TWW MAR projects, can potentially increase environmental and public health risks. Training programs should be an integral part of the project, and it should include technical, environmental, health and socio-economic aspects. The educational input must provide farmers with an understanding of the details of techniques and their associated hazards and precautions. Capacity building in these areas are discussed in each of the relevant sections of this *Report*.

RATIONALE FOR DONOR INVOLVEMENT

Gaza faces a severe water crisis. Gaza relies almost completely on a coastal aquifer as the sole source of freshwater. However, 95% of the aquifer's water is not safe for drinking without treatment (PWA, 2014). Years of over-abstraction have taken a heavy toll on Gaza's present and future water resources. Annual abstraction of water from the aquifer has been well above the recharge rate by over 100 million cubic meters, almost twice the sustainable rate. Consequently, groundwater levels have declined, seawater from the Mediterranean has infiltrated and salinity levels have increased, making the water unsafe for drinking according to WHO standards (World Bank, 2009).

The over-abstraction and scarcity of drinking water have been exacerbated by crumbling sanitation infrastructure, while the Israeli blockade creates chronic shortages of electricity and fuel, which in turn aggravate contamination and the water crisis. The damage of contamination and over-abstraction is such that the aquifer may become unusable and, if unaddressed, the UN has stated the damage may be "irreversible" by 2020 (UNRWA, 2015a).

As early as 2009, the United Nations Environment Programme (UNEP) emphasized that prolonged over-abstraction and pollution jeopardized the sustainability of Gaza's aquifer unless it was rested (UNEP, 2009). The best suggested solution was to cease abstraction and install a monitoring system to continuously assess recovery. Once the aquifer recovers, sustainable abstraction may be resumed at carefully calculated levels. In the meantime, alternative solutions to the water crisis should be introduced, such as desalination, reduction of the loss of water in the distribution network, and wastewater treatment. Presently the application of wastewater treatment is limited because of the high cost and technological complexity of conventional systems.

In 2014, the Gaza Strip endured the third conflict of full-scale military operations in six years, coming on top of eight years of economic blockade. Reconstruction efforts have been extremely slow relative to the magnitude of devastation, and Gaza's local economy has not had a chance to recover. Socioeconomic conditions are at their lowest point since 1967 (UNCTD, 2015).

Large scale investment in water, electricity and sanitation infrastructure was needed even before the damage inflicted by the military operation in 2014. The operation resulted in severe damage to Gaza's water and sanitation infrastructure, including water wells and networks, tanks, desalination units, wastewater networks and pump stations. The preliminary static value of the damage is estimated by the Palestinian Water Authority at more than $34 million. However, long-term repair of the accumulated damage and decay of the water and sanitation infrastructure will require $620 million (UNCTD, 2015).

If the Gaza Strip is to overcome its uniquely disadvantaged situation, it will need help. Although the international community has failed to prevent these crises in Gaza from taking place, it can still play a role in its reconstruction and survival. Besides the rather stark moral imperative, as this *Report* has shown, the project has the potential to be sustainable and even profitable, arguably making the investment worth the risk on multiple levels.

LESSONS LEARNED FROM SIMILAR PROJECTS IN THE REGION

As stressed elsewhere in this *Report*, the NGEST project is not a treated wastewater for irrigation project. Rather, it is a treated wastewater for managed aquifer recharge project (TWW MAR). This section briefly looks at some of the experiences with MAR and TWW MAR in the region.

MAR in the Middle East and North Africa

Given the water scarcity in many Middle East North African (MENA) countries and the water saving capabilities of MAR, several countries have at least experimented with the technology. Although MAR is conducted in many countries in the region, monitoring is often lacking or information is not published. As a result, the success of many of these schemes cannot be evaluated (Steinel, 2012). Below are brief descriptions of relevant projects.

Israel

Israel has been practicing wastewater treatment and reuse since the ‘50s, including through groundwater recharge (Soil Aquifer Treatment – SAT). The country has a 75% water reuse rate, which is much higher than most other countries [e.g. Spain 12%; Australia 9%] (Mekorot, 2013). Artificial groundwater recharge serves a number of purposes in Israel, such as increasing water reserves for periods of high demand (primarily for irrigation), reducing hydrological deficits, preventing saline intrusion from peripheral areas and ensuring efficient utilization of surplus water from Lake Kinneret (i.e. Lake Tiberias) (DWAF, 2007).

Comprehensive water quality monitoring is normally carried out throughout all stages of the recharge process. However, besides known problems related to clogging of recharge boreholes due to silt build-up and algae in the source water, health concerns have been raised lately, as endocrine disruptors, antibiotics and trace metals have been found in recycled water. In order to protect human health and groundwater quality, some experts are now calling for treatment to drinking water quality standards through desalination of treated sewage effluent by reverse osmosis (Tal, 2013).

The largest SAT facility in Israel is the Dan Region Wastewater Treatment Plant (Shafdan), where sewage water from the Tel Aviv region is treated. Wastewater treatment comprises four stages: pre-treatment, primary, secondary and tertiary treatment. Treatment methods include oxidation ponds, activated sludge and Mechanical Bio-Reactor (MBR). The Shafdan effluents are discharged into the soil for tertiary treatment and to recharge the aquifer. Water is then recovered and transported to the Negev for irrigation. The total effluent supplied for agricultural purposes is 216 million cubic meters per year (Mekorot, 2013).

Jordan

Jordanian law basically prohibits intentional recharge with reclaimed wastewater, as virtually all aquifers are also used for drinking water purposes. Yet as unintentional recharge of treated and untreated wastewater is taking place already through irrigational return flows and leaking sewage pipes, the standard is currently under review. The new standard is likely to loosen the restrictions to allow recharge of tertiary treated wastewater with near drinking water quality to all aquifers.

Jordan has one large recharge dam, Wala dam, where surface runoff is infiltrated via the side walls to recharge production wells downstream. Recently, sedimentation has decreased storage volume and infiltration rates considerably as no sedimentation dams are installed upstream, necessitating the use of recharge wells.

Documentation on recharge volumes, water quality, clogging problems, and resulting increase in groundwater table is not available.

The expenses for MAR dam construction in Jordan are commonly covered by international donors, while the maintenance has to be summoned up by the governmental budget. Hence, the government sees it as cheaper to build a new dam rather than maintain existing ones, which is a significant flaw in the system. An important lesson learned from Jordan is that international donors should ensure that part of the budget is set aside for long-term maintenance during finance negotiations.

Iran

Iran practices aquifer recharge via a cascade of basins including settling basins or floodwater spreading systems (Hashemi et al., 2012). Removal of accumulated sediments is vital for maintaining infiltration rates in the infiltration basins (Mousavi and Rezai, 1999). In the flood spreading systems the accumulation of sediments is used as improvement to the soil for agriculture.

Oman

Oman has 15 recharge release dams that capture runoff from the mountains in the plain with high sediment loads (5 - 6 % of runoff volume) and infiltrate runoff downstream to prevent seawater intrusion and for irrigational reuse. Socio-political reasons and a lack of regulations are the main limiting factors and the recharge scheme does not generate economic benefits for irrigational reuse (Prathapar, 2012).

Saudi Arabia

Saudi Arabia has constructed a number of recharge dams, which are experiencing clogging problems. Sediment removal or release to downstream infiltration basins or the downstream wadi channel need to be undertaken (Al-Muttair et al., 1994). There are investigations to use treated wastewater in fully engineered artificial recharge and recovery systems in alluvial wadi aquifers (Missimer et al., 2012).

Tunisia

Tunisia recharges surface water for agricultural and domestic purposes after retention in small earth dams via basins and recharge wells. In upland areas, the reservoir area with collected sediments is often used for farming and further retained water is hence used for irrigation and not for recharge. Profitability of the schemes is relevantly low (Ouessar et al., 2004). The release of captured flood water for downstream percolation in the wadi is also practiced (Ketata et al., 2011) and simulations showed much higher recharge rates especially when first flush release for silt removal was undertaken (Zammouri and Feki, 2005). In coastal regions seawater intrusions are controlled by recharge of reservoir water via wells (Bouri and Dhia, 2010). The infiltration of treated wastewater has also been investigated in coastal regions (Kallali et al., 2007).

Conclusion

MAR can only be successful if proper management plans and funding are in place and implemented. As seen in the region and around the world, clogging is a major issue, which can only be addressed with monitoring and proper maintenance. As seen in Jordan, international donors should be cautious in only funding the construction – and not also the maintenance – of MAR schemes. Lastly, water quality testing must evaluate not only regular parameters but also other emerging pollutants such as endocrine disruptors, antibiotics and trace metals, as shown in Israel’s experience.

PROJECT DETAILED DESCRIPTION

OVERALL DEVELOPMENT OBJECTIVE AND SPECIFIC OBJECTIVES

The overall project objective is to more sustainably utilize water resources in the Gaza Strip by seeking out alternative water sources for irrigation. Specifically, utilizing treated wastewater for managed aquifer recharge, which will then be recovered for irrigated agriculture throughout the Strip.

When completed the project will have:

- A WWTP capable of handling 35,600 m^3 of waste each day;
- Remediation of the Beit Lahia effluent lake;
- Nine infiltration basin
- 28 recovery wells and a network of 15 monitoring wells;
- 15,000 dunums of irrigated agricultural land.

More specific objectives related to the implementation of the Supplementary Phase of the project include:

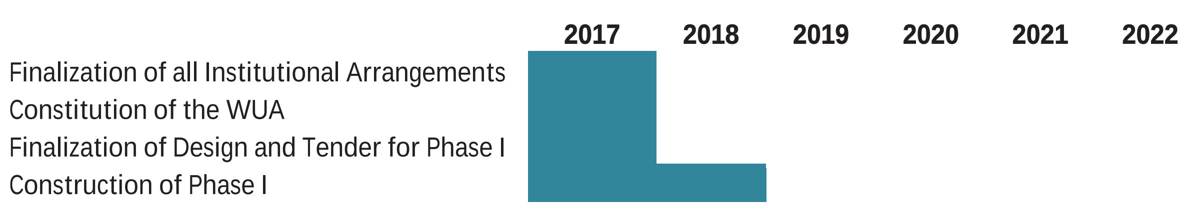
- Develop an irrigation project that assists local farmers to improve profitability and increase the value chain linked to agriculture;
- Test and promote MAR in Palestine;
- Improving groundwater health through introduction of higher quality water, and achieving more sustainable extraction practices;
- Promote the role of WUAs in managing and operating larger irrigation projects.

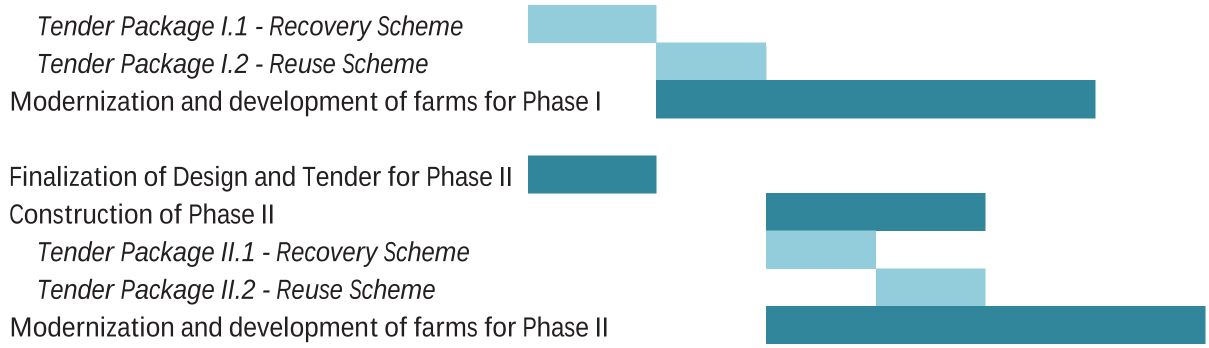
PROJECT COMPONENTS

LOGICAL FRAMEWORK

The logical framework and timetable for implementation is provided in the following Gantt chart. A detailed description of the various activities is provided in the following section.

Table 1: Project's Logical Framework





DETAILED ACTIVITIES

A gross agricultural area, extending for approximately 1,570 ha (15,700 du) in the immediate vicinity of the NGWWTP, has been proposed to benefit from the recovered water as well as the treated sewage sludge. This project component, known as the ‘Supplementary Project’, is divided into two sub-components, namely (i) the Water Recovery Scheme, and (ii) the Reuse Scheme. The original design, concluded in 2010, foresaw the possibility to use 35,600 m^3/day of treated water by the year 2015 and the full 69,000 m^3/day by the design year 2025. The overall implementation of the supplementary component has been subdivided into three phases:

The **First Phase,** originally scheduled for completion by the year 2017 and now possibly facing some delays, includes 14 recovery wells able to capture 16,500 m^3/day – the amount of daily infiltration from the BLWWTP in addition to an extra 10% needed to ensure that the full amount of water infiltrated from the NGEST WWTP is extracted by the recovery wells – and includes all connecting pipes, a 4,000 m^3 water storage tank, a booster station with 5 pumps, 5 monitoring wells and the appropriate irrigation network covering a gross agriculture area of 500 ha (5,000 du). After 6 years of infiltration of poorly treated water from the Beit Lahia pound and BLWWTP, this first stage mainly aims at preventing the pollution plume from reaching agricultural and municipal wells located beyond the recovery wells.

The **Second Phase,** now scheduled for completion by the year 2020, would extend the recovery system by a second row of 14 supplementary wells (along with the previous 14 recovery wells) and will, altogether, capture some 39,100 m^3/day (necessary to recover the 35,600 m^3/day of fully treated wastewater infiltrated once NGEST WWTP starts operating in addition to an extra 10% needed to ensure that the full amount of water infiltrated from the NGEST WWTP is extracted by the recovery wells) and all the related infrastructure (connecting pipes, water tank, booster station, monitoring wells and irrigation networks) to cover an additional gross agriculture area of 1,000 ha (10,000 du).

A **Third Phase**, scheduled for completion by the year 2025, can be constructed after the extension of the NGEST WWTP to treat 69,000 m^3/day of effluent. The recovery and reuse scheme will then need further extension and the **reclaimed water will need to be transferred to other areas in the Gaza Strip**, considering that all the land available around NGEST would already be irrigated with the water produced by the two other stages defined above.

Phase I and Phase II shall be implemented via four separate tendering procedures: two related to Phase I and two related to Phase II. The following table provides a summary of the various tendering packages and proposed implementation schedule.

Phase	Package	Description	2017	2018	2019	2020
I	1	Supply and install 14 recovery wells and concerned connection pipes, the civil works within the booster pumping station, five boosters pumps, one 4,000 m^3 water tank and 5 monitoring wells	X			
	2	Small works related to the procurement and construction of the irrigation network for an area of 500 ha (5,000 du)		X		
II	1	Supply and install 14 recovery wells and concerned connection pipes, the remaining civil works within the booster pumping station, five booster pumps, a second 4,000 m^3 water tank and 5 monitoring wells			X	
	2	Small works related to the procurement and construction of the irrigation network for an area of 1,000 ha (10,000 du)				X

Construction of the various component of the recovery and reuse schemes for both phases represent only one side of the overall project. Additional, critically needed, activities are defined as follows:

- Finalize and promulgate the draft WUA regulation and establish an NGEST WUA. This activity should be implemented as soon as possible and ideally before tendering procedures for the realization of the first phase of the reuse scheme are issued. The proposed timeframe is before the end of the current year 2017.
- Contract UAWC to provide technical assistance to both the WUA staff and members. Also this activity should be implemented as soon as possible and ideally before tendering

procedures for the realization of the first phase of the reuse scheme are issued. The proposed timeframe is before the end of the current year 2017 so that training can be activated in conjunction to the development of the first phase of the reuse scheme. Training activities would then be intensified during the first year and carried on for a period of three years.

- Hold the negotiations necessary to broker project agreements (*viz.*, the Bulk Water Supply agreement, MOU between CMWU and NWC; Lease agreement; WUA Technical Assistance contract, etc). This activity should be implemented as soon as possible and ideally before tendering procedures for the realization of the first phase of the reuse scheme are issued. The proposed timeframe is before the end of the current year 2017.
- Update the design of Phase I and Phase II: an activity that could lead to revised costs and tendering documents by the end of 2017. Such activities must be implemented before tendering procedures for Phase I of the reuse scheme are initiated. Updating the design and tendering documents for both Phases of the project (for the reuse part only) will require the acquisition of more detailed topographic survey and a precise cadastral survey. Considering the small scale of these tasks, it is likely that the entire process of acquiring additional field data and updating the design and tendering document can be completed before the end of the year 2017.
- A fund should be established and maintained to cover the O&M costs of the recovery and reuse system during the transitionary period of the first 3 years. The necessary procedures for the creation of such fund and identification of suitable financial tools to support farmers should be started during the present year 2017 and best completed before the completion of the first stage of the reuse scheme in 2018.
- PWA should immediately begin actively monitoring the infiltration basin and aquifer;

ADDITIONAL TECHNICAL ASSISTANCE PACKAGES

The following Technical Assistance Packages are proposed:

1. Update topographic and cadastral survey of the project area;
2. Update detailed design and tendering documentation for Phase I and Phase II
3. Assistance for finalization of MoUs and Agreements and creation of the WUA;

A short description of each Technical Assistance (TA) Packages is provided below.

UPDATE TOPOGRAPHIC AND CADASTRAL SURVEY OF THE PROJECT AREA

Objectives:	Update the existing topographic survey by expanding the survey area, collect additional survey points and provide a precise cadastral survey of the project area.
Level of Effort:	4 months/man to be divided between 1 senior topographer and supporting staff.
Deliverables:	Revised topographic map and cadastral map
Tentative Budget:	EUR 35,000
Proposed Timetable:	The proposed program shall be implemented between the months of October and November 2017.

UPDATE DETAILED DESIGN AND TENDERING DOCUMENTATION FOR PHASE I AND PHASE II

Objectives:	Prepare updated detail design and tendering document for both Phase I and Phase II of the project for the reuse scheme only.
Level of Effort:	4 months/man to be divided between 1 senior irrigation engineer, 1 junior irrigation engineer with the assistance of mechanical and electrical engineers
Deliverables:	Revised detailed design for both Phase I and Phase II in addition to General and Detail Specifications and Tendering Documents. The update design shall be provided only for the irrigation (reuse) scheme as the existing design for the recovery scheme does not need modificaitons.
Tentative Budget:	EUR 35,000
Proposed Timetable:	The proposed program shall be implemented between the months of November and December 2017, and can be implemented only after updated topography and cadastral survey has been completed.

GOVERNAMENT ASSISTANCE PROGRAMS

Objectives:	Assist parties in negotiating the necessary agreements for project implementation.
Level of Effort:	2 months/man of a senior legal advisor/mediator + local support staff

Deliverables: MoU[1] between CMWU and NWC (for CMWU to initially manage the system); a Contract between CMWU and the WUA (for CMWU to initially operate the system); a Water Supply Agreement between CMWU and the WUA (for bulk water supply); a Contract between the WUA and UAWC (for capacity building of the WUA); Lease agreement between whoever owns the system and whomever is going to operate it and collect fees (depending on the Scenario chosen).

Tentative Budget: EUR 25,000

Proposed Timetable: The proposed program shall be implemented between the months of October and November 2017.

[1] Because NWC and CMWU are both governmental entities, it is arguably more appropriate to have an MOU than a contract but this is open for discussion.

PROJECT APPRAISAL

BASELINE CONDITIONS

FIELD SURVEY

The foundation of this baseline assessment and a primary tool for collecting first-hand current data, the field survey aimed to **investigate the characteristics of the farming system** in the project area. A questionnaire was developed and tested in coordination with PWA. The questions were focused on the farm cropping system, market channels, selling prices, and incomes. Special emphasis was given to the water issue, by inquiring about the current use of water on crops, irrigation methods and the source and cost of water. Specific questions were dedicated to understanding the farmers' willingness to change/enlarge their cropping pattern and the role played by the farmers' associations of the project area. Furthermore, the survey estimated the size of abandoned cultivable land, and farmers were asked to explain why they have stopped cultivating that land.

The field survey was carried out from 18 February to 28 March 2017, by a team of local technical surveyors and international experts, under PWA supervision.

The final distribution of farmers interviewed around each well is shown in Figure 3.

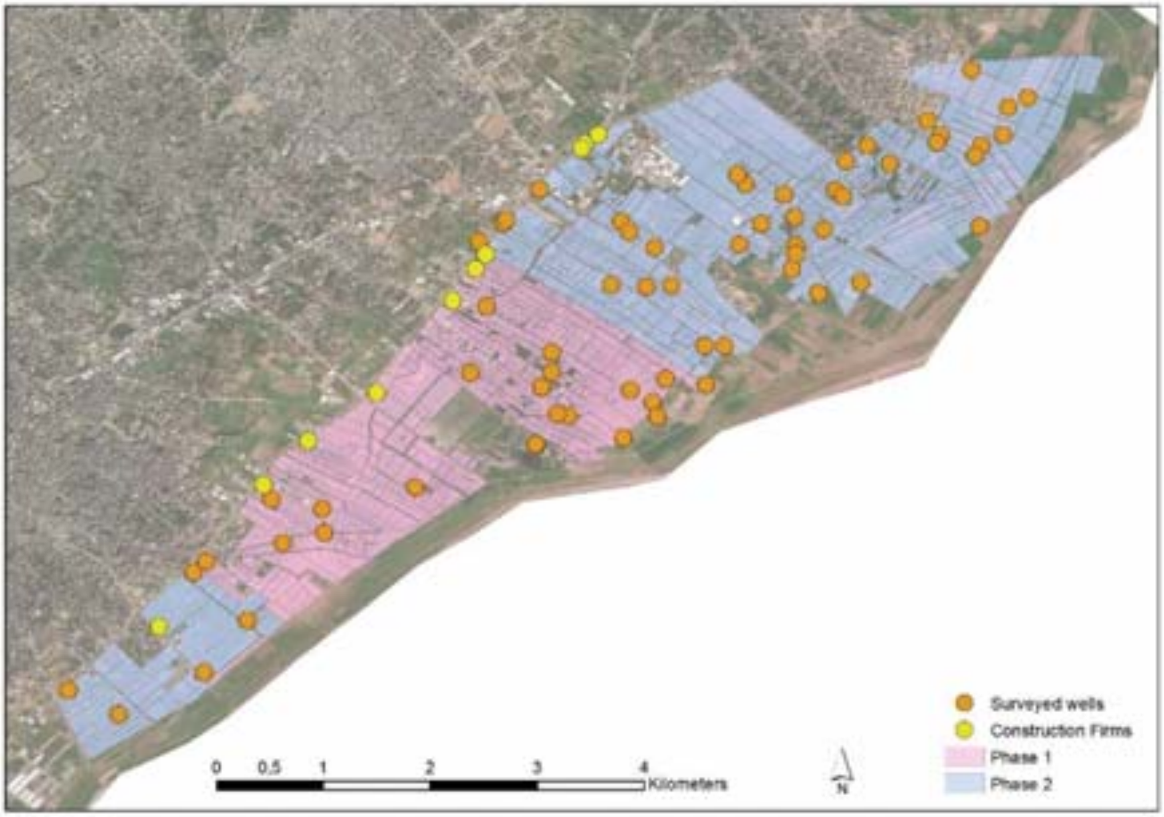


Figure 3: spatial location field survey

The survey resulted in the collection of **420 farm questionnaires**, **9 farm inputs questionnaires**, and **11 industry questionnaires**. The paragraphs below summarize the results obtained from the analysis of the questionnaires.

LAND TENURE AND CROPPING SYSTEM

FARM SIZE AND LAND TENURE

The Project area extends for 1,207 ha (12'068 du). As shown in Figure 4, nearly 55% of the farms are smaller than 5 du, and 25% of them are comprised between 5 and 10 du. The larger farms are only a small portion of the total number: farms larger than 30 du are less than 5%.

The survey highlighted that most farmers own their land (88%), whereas tenants represent just 10%.

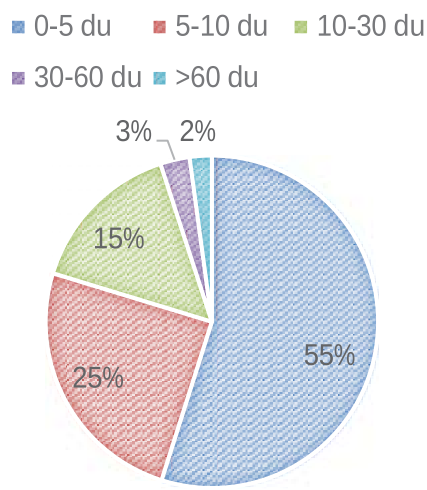


Figure 4. Distribution of farms by size.

CROPPING SYSTEM

The cropping pattern of the project area is shown in the following Figure 5.

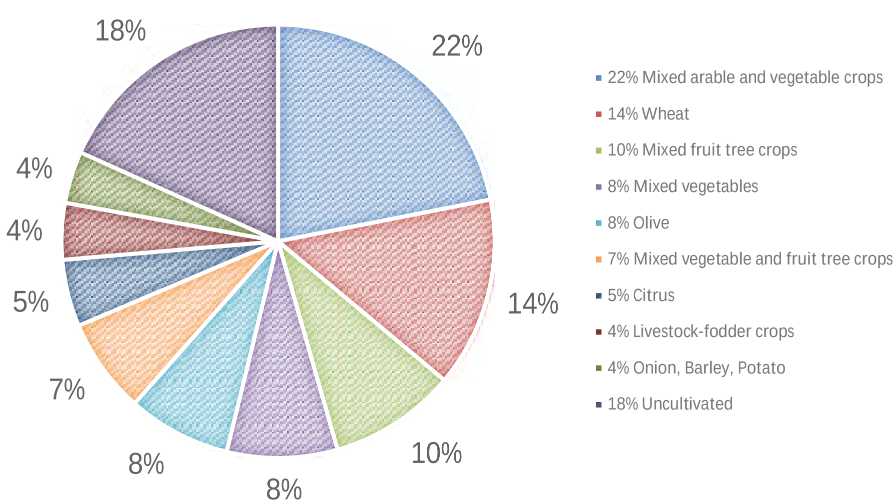


Figure 5: Indicative cropping pattern of the project area

The majority (22%) of the surveyed area is cultivated with mixed arable and vegetable crops. Almost half of the farms has a mixed crop pattern, mostly based on arable, vegetable and fruit tree crops, among which citrus and olive are the most important. Arable crops, such as wheat (14%) and barley (1%), are quite important as staple food for the household. On the other hand, onion, barley and potatoes represent together less than 5% of the cropping pattern.

Almost one fifth of the land, 18%, results uncultivated (Figure 6). Around 24% of total cultivable land is rain-fed, while the remaining 76% is being irrigated through wells (Figure 7).

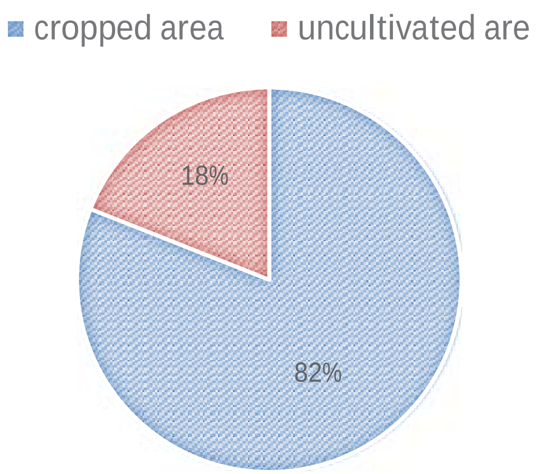


Figure 6. Cropped and Uncultivated Area

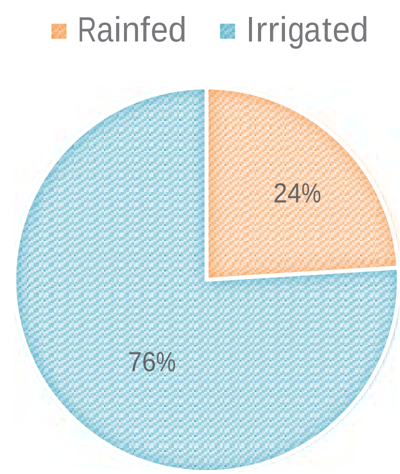


Figure 7: Irrigated and Rainfed Areas

CROP WATER REQUIREMENTS AND WATER CONSUMPTION IN AGRICULTURE

The sole source of water for irrigation is groundwater, which is abstracted from **private wells** evenly distributed throughout the project area. Typically, the same well ("collective well") is shared by more farmers; each farmer provides the fuel necessary for his own shift, while maintenance and administrative costs are equally shared among the group. The survey shows that 92% of the farmers depend on the "collective well" system owned by the remaining 8%.

Wells must be authorized by the government. A legal well pays one-off 4,000 ILS plus 100 ILS/year license. However, there are also "non-legal" wells, estimated to be 3-4 times the number of the legal ones. The government does not close these wells but new unauthorized wells cannot be drilled.

The survey determined that water cost ranges[2] from 1 to 1.5 ILS/m^3. Therefore, use of water is worthwhile only for economically competitive crops.

[2] The value is the average among the ones provided by farmers during the field survey. During the filed survey, farmers provided the following rationale for their stated value for cost of water: a well's pump consumes 10 to 12 litters of diesel per hour to extract 40 to 60 m^3/hours at an average depth of 60 to 70 meters. The cost of diesel, on average, is between 6 and 7 ILS/litter. For that reason, the cost of water ranges from a minim of from 1 to a maximum of 2.1 ILS/m^3. On average, it is therefore approximately 1.5 ILS/m^3 or more.

Figure 8 illustrates the average amounts of water supplied to the unit area for each crop type, as communicated by the interviewed farmers.

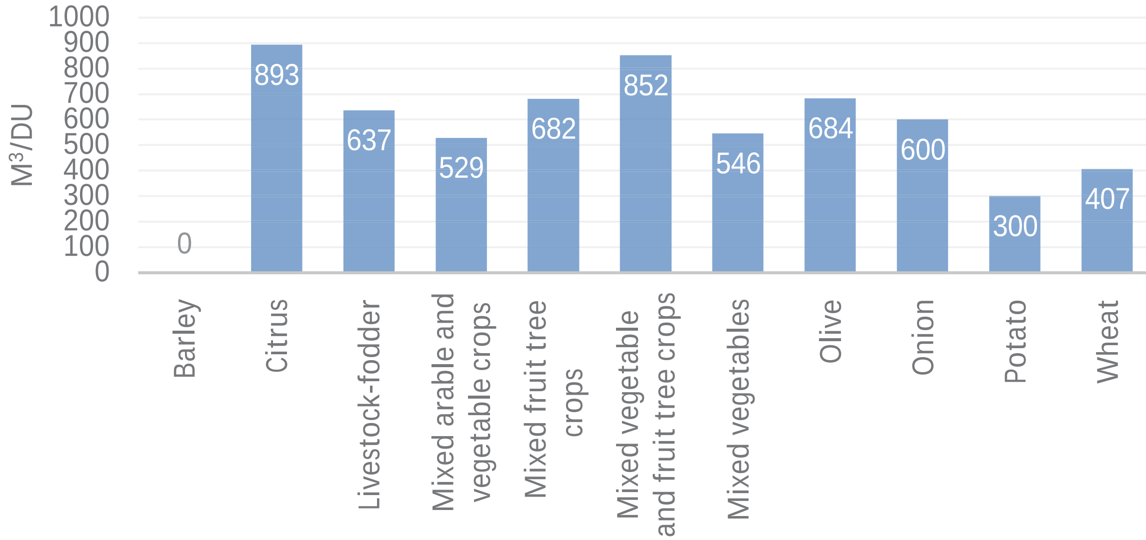


Figure 8. Water use for the current cropping pattern.

Citrus and mixed vegetables with fruit are the most irrigated crops (893 and 852 m^3/du); Barley is rain fed.

The **total crop water requirements** for the agriculture currently developed across the whole 15,000 du is estimated to be **5.8 Mm^3/year** with an **average daily water requirement of 15,990 m^3/day**.

CAUSES OF THE PRESENT LAND ABANDONMENT

As already pointed out, 18% of total project area is currently not cultivated. The survey highlighted that the **main reason for land abandonment** is because of the frequent **land invasions by the Israeli army** (45% of the respondents), which destroys agricultural structures and plantations, as well as periodic herbicide sprays to keep the field clear, which kills the crops and makes farming conditions unhealthy.

The second reason of land abandonment in order of importance is the **lack of financial resources** needed to carry out cropping operations (23%); and **water scarcity** is the third reason (17% of respondents). These last two reasons are strongly linked to the high cost of water extraction.

WATER CONSUMPTION IN THE INDUSTRIES

In the Project area, there are currently 14 industrial facilities extending over a total surface of approximately 50 du (see in Figure 3 their localization): generally, most of them are small factories (less than 10 employees), operating only a few days a week. They use the urban water supply network as their sole source of water, around 2,000 m^3 of water per year on average, and their combined consumption is less than 30,000 m^3 per year. A large majority (>80%) of them is using private wells for their water supply. A few exceptions (<20%) use a combination of private wells and municipal water supply. Less than 20% of the existing factories get their water solely from the municipal water system.

Most of the factories (>70%) do not know the quality of the water they are getting although they all see that the low quality of the water is negatively impacting their products.

VALUE CHAIN

Gaza Strip, with its high population density and reduced connections to a production system because of tensions with Israel, fails to produce consumer goods and food in sufficient quantity and is therefore greatly dependent on imports.

Interviews with the producers showed that the vast majority of the agricultural products are sold in the local market for fresh consumption, through wholesalers or directly by the farmers' family network. At present, the few food industries operating in the area do not usually purchase the farmers' products.

The market chain of horticultural and fruit products is as follows:

farmers → traders, wholesalers, middle men → retailers → consumers.

Next table summarizes revenues, costs and margins for the different crops expressed in the local currency.

Table 2. Summary of the single accounts cultivation statements of agricultural products

FARM/CROPS	REVENUES	COST	MARGIN	NET MARGIN PER KG	NET MARGIN + LH[3] PER KG
APPLE	1,000	2,495	-1,495	-2.99	-2.81

[3] LH: Labour Harvesting

BARLEY	655	1,630	-975	-2.02	-0.36
CITRUS	3,494	3,172	322	0.19	0.52
LEMON	1,400	2,048	-648	-0.65	-0.33
LIVESTOCK	1,582	2,310	-728	-	-
MELON	2,400	2,401	-1	0	0.17
MIXED ARABLE AND VEGETABLE CROPS	3,226	2,267	959	0.36	0.59
MIXED FRUIT TREE CROPS	2,487	2,472	15	0.02	0.34
MIXED VEGETABLES AND TREE CROPS	3,444	1,667	1,777	0.81	0.92
MIXED VEGETABLES	3,407	3,061	346	0.11	0.33
OLIVE	806	2,376	-1,570	-2.92	-2.05
ONION	675	1,837	-1,162	-2.58	-0.58
PEACH	1,000	1,055	-55	-0.11	0.07
POTATO	2,500	1,656	844	0.34	0.50
WHEAT	492	1,438	-946	-2.37	-1.40

The **highest margin** is reached by cultivations of **mixed vegetables and tree crops** (net margin + *labour harvesting* of 0.92 ILS/kg of production); other profitable cultivations are mixed arable and vegetable crops (0.59), citrus (0.52), potato (0.50), mixed fruit (0.34), mixed vegetables (0.33), melons (0.17), peaches (0.07). Other cultivations have a negative margin: the **most unprofitable crop is apple** (-2.81), followed by olives (-2.05), wheat (-1.40), onion (-0.58), barley (-0.36), lemon (-0.33).

ASSESSMENT OF THE NGEST RECOVERY AND REUSE SCHEMES

PROJECT RECOVERY SCHEME

The recovery scheme comprises a system of 28 recovery wells and all related connection pipes as well as 15 monitoring wells. The following three sections provide a more detailed description of each component.

RECOVERY WELLS

There are 28 recovery wells to be constructed across an area extending for approximately 1.3 x 1.3 km^2. These wells are split into 5 (groups) according to their geographical distribution. These zones are named Zone A, B, C, D, E, and F as shown in Figure 9. For each zone, there is a High-Voltage (22kV) node and an electrical service building.

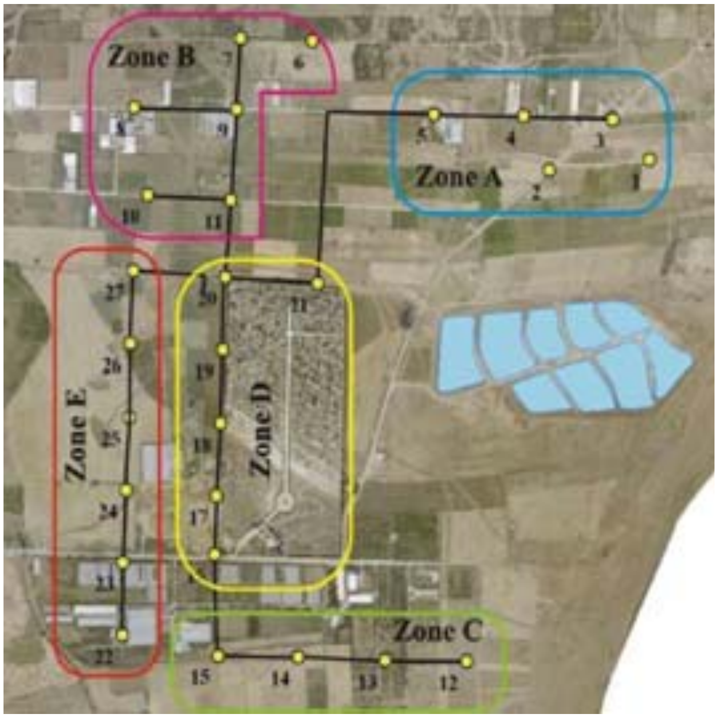


Figure 9: Location of the 27 Recovery Wells

The recovery wells will be able to capture water infiltrated from the NGEST WWTP (i.e.: 35,600 m^3/day) in addition to an extra 10% (i.e.: 3,560 m^3/day) necessary to guarantee that all infiltrated water is captured by the wells.

The number of recovery wells was calculated based on the maximum quantity of water that should be recovered during the peak month of October, which is equal to 50,885 m^3/day. The total number of wells is 28 where each should have a capacity of pumping between 180 m^3/hr to 200 m^3/hr. 25 out of the 28 wells are assumed to be operational always with a capacity of 180 m^3/hr. The three additional wells are included to give more flexibility to the system and serve as a backup in the event of a failure.

According to the numerical modelling results, the exact location of the 28 wells was selected to guarantee that all the water infiltrated from the basin is recovered within 1000 days and cannot move past the row of wells located the farthest (i.e. 750 m) from the infiltration basin itself. Figure 9 shows the locations of the recovery wells.

COLLECTION PIPES

The recovery wells are connected to the water tanks using five collection pipe networks shown schematically in Figure 2 and more in details in Figure 10. The proposed piping system extends for a total of 6.7 km. Most of the collection pipe networks are placed along existing roads and the remaining networks are in new proposed roads.

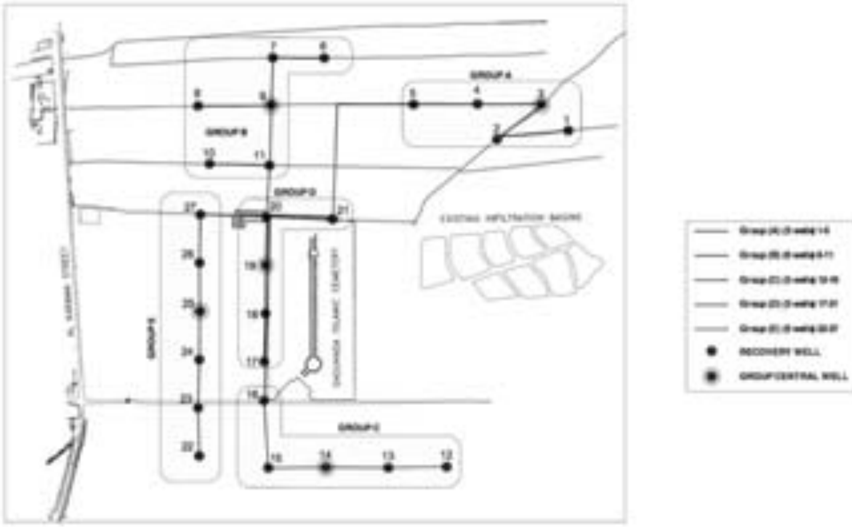


Figure 10: Wells grouping and Piping System

MONITORING WELLS

The water pumped to the irrigation network should be monitored from the moment it is extracted from the ground to the point it is delivered to the farmers.

Samples of water should be therefore be taken and analyzed randomly at farm level, trunk lines, water tanks, and irrigation networks. Constant monitoring should be implemented across the recovery well system. To this extent, a system of 43 wells will be implemented by using the 5 existing monitoring wells, the 28 newly built recovery wells and 10 new monitoring wells.

The location of the 43 wells is provided in the following Figure 11.

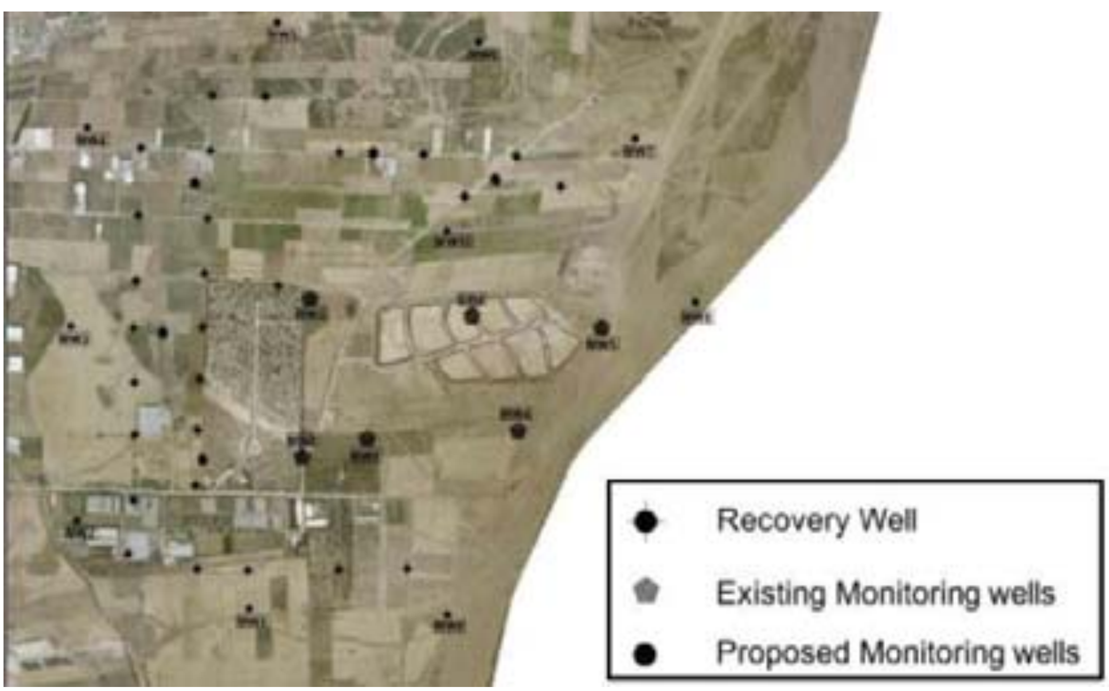


Figure 11: Location of the existing and newly proposed monitoring wells

PROJECT REUSE SCHEME

The gross agricultural area is approximately 1,570 ha (15,700 du) and it is located at the north-east side of the Gaza Strip adjacent to the eastern border as shown in the following Figure 12. The net irrigated area is approximately 1,260 ha (12,600 du) whereas the remaining 300 ha (3,000 du) of land is for other uses such as industrial and residential areas and roads. For optimizing construction and operation scheduling, the entire project was originally subdivided into two main parts (A and B) relative to their locations with the infiltration basins. Part A extended for about 1,010 ha (10,100 du) and Part B for an additional 500 ha (5,000 du) and were respectively located to the north and to the south of the infiltration basins as shown in the following Figure 13.

In accordance with irrigation requirements, irrigation was to be carried out on a six-day rotational basis over six zones of almost equal size, i.e. A (A1 and A2), B (B1 and B2), C (C1 and C2), D, E and F, as shown in the following Figure 13. According to the original design, each day, only one of these six zones would have been irrigated. The original design determined the agricultural land based on cropping patterns, daily and monthly crop water requirements, irrigation methods, and amount of recovered water. The proposed layout of the irrigation network is depicted in Figure 14.

Figure 12: Location of agricultural land

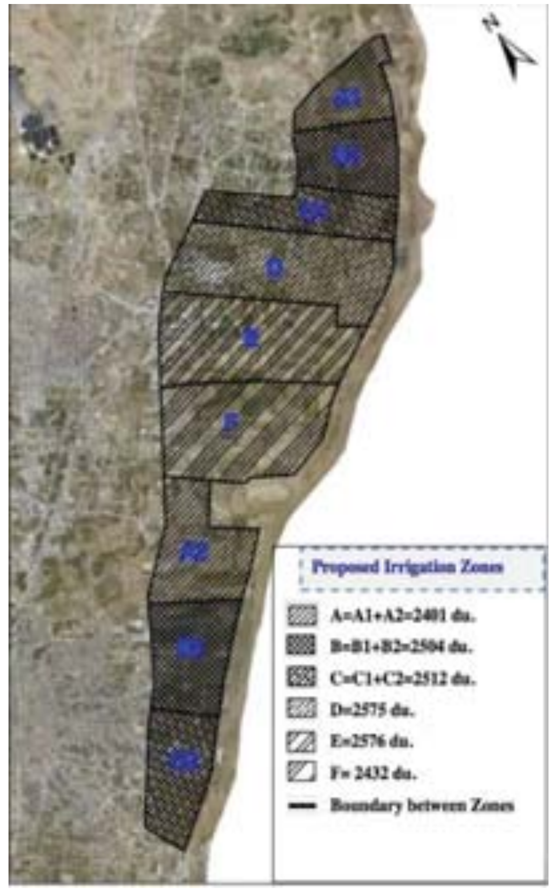


Figure 13: Proposed Irrigation Zones

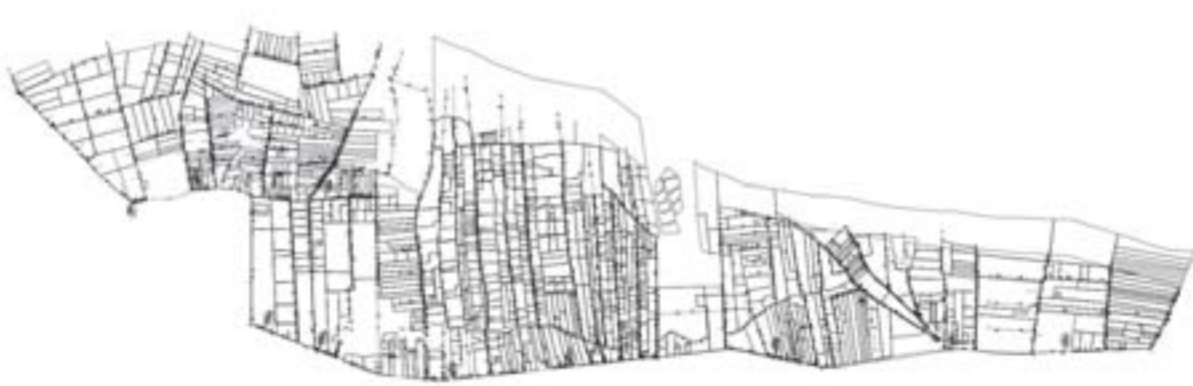


Figure 14: General Layout of the Originally Proposed Irrigation Network

REVIEW OF REUSE SCHEME: ADDITIONAL FINDINGS AND RECOMMENDATIONS

In addition to the key findings listed in the Executive Summary above, the following achievements were obtained while reviewing the original design of the Irrigation Project:

- A review of the original irrigation project layout resolved some of its design inconsistencies and guarantees that a minimum water pressure of 2.5 bars is provided to the farm gate (the original design failed to do so for a sizable number of farms);
- A review of the original design for the recovery scheme confirmed its validity;
- A review of the original design for the reuse scheme confirmed the selection of materials, the general layout and the selection of the pumping system;
- The overall cost for the construction of the water reuse scheme has significantly increased (nearly 75% increase) from its original estimation. Although this might be justifiable in the context of doing construction in Gaza, it still represents a large economic burden for the overall feasibility of the project. While revising the detailed design and tender documents, PWA should consider revising the overall design considering the reduced flows that now, thanks to the new CP, will be delivered across the network. It is possible that such a revision might lead to a cost saving of up to 15-20%. Further to that, it is possible that a further reduction in the overall cost for the construction of the irrigation scheme might be achieved with the adoption of a optimized layout. Particularly, several trunk lines had to be doubled up (sometimes even tripled up) to guarantee that the right water pressure is delivered thought the network. These changes are driving the cost of the construction up and could be optimized with the aid of a proper topographic survey and a further refinement of the original design.

PROJECT ECONOMIC AND FINANCIAL SUSTAINABILITY

The newly proposed development plan assumes that the entire project area (Phase I + Phase II) will be able to adopt the proposed cropping pattern within four years from the completion of the irrigation scheme. The adoption of the new cropping pattern involves not only planting new crops but also modernizing the farm and adapting it to the proposed irrigation method. The cost for the adoption of the cropping pattern and the modernization/development of the farms is expected to be 4.695 Million ILS (approximately 1.3 Million US$) per year for a period of four years assuming that Phase I and II are developed one after the other over a period of two years.

Farmers will require intense training to be able to implement the proposed plan. Additionally, maximizing the output of the irrigation project will require the farmers to cooperate via one Water User Associations (WUA), which has yet to be created. The macro-economic analysis assumes that the WUA should immediately invest approximately 3 Million ILS (approximately 0.8 Million US$) in trainings.

Finally, operating and maintaining the system (on-farm and off-farm, including the water recovery and reuse scheme) will cost anywhere between 7.2 Million ILS (approximately 1.98 Million US$) and 11.4 Million ILS (approximately 3.17 Million US$) per year depending on the cost of energy. The O&M costs include 0.36 Million ILS/year (100,000 US$) for the running costs of the WUA. Farmers will pay for the O&M of the system through their water bills.

In order to track the amount used, water consumed by each farm will be metered at the farm gate. Gross Irrigation water demand, excluding water needs for Industries (estimated to be 70,000 m^3/year) but including all system losses[4] and climate change[5], is estimated to be 11,110,000 m^3/year. The net irrigation water requirements (after all system losses are considered), is estimated to be 7,833,484 m^3. Farmers will be charged for the water delivered to their farms. The tariff farmers will have to pay to cover O&M costs will vary from a minimum of 0.9 ILS/m^3 to a

[4] System losses includes both on farm and off farm losses.

[5] The estimates for water demand assumes that, due the rising of temperatures over the next decades, water requirements for irrigation will increase.

maximum of 1.5 ILS/m^3 depending on the cost of electricity (if entirely provided by the national grid or entirely generated by the stand-by diesel generators installed at the site).

Then, after the new cropping pattern and modernized irrigation methods have been implemented, the irrigation project should generate a stream of revenue that, after the first three years, would provide a steady income of approximately 30 Million ILS/year (approximately 8.3 Million US$/year).

MICRO-ECONOMIC CONDITIONS

The micro-economic analysis of this project looks at the costs and revenues associated with the introduction a new cropping pattern and the modernization of irrigation methods at the farm level where several investments are required to improve productivity and profitability. Within the project area, there exists various current conditions: some farms are cultivated but rely only on rain-fed irrigation; some farms are already cultivated but water is drawn only from wells; large swaths of land are not currently farmed and land levelling and full reclamation might be required.

This section of the *Report* assesses what the net income for farmers would be with and without the project and assesses the availability in the farmers' budget to pay for water.

EVOLUTION OF THE CROPPING PATTERN

The analysis assumes that famers will be able to fully implement the proposed cropping pattern and irrigation methods over a period of four years after the construction of the irrigation network. These changes, changing the existing land use and planting trees and vegetables, are expected to increase land productivity.

The analysis of the value chain has shown that some crops such as fresh fruit (peaches, apricots, plums) are scarcely produced and often imported goods. Olive, as a crop to produce olive oil, is often sold at a low price and profitability might be improved by nearly 50% if olives, especially the better-preserved ones of the right variety, are processed into eatable olives. The new cropping pattern also includes almond as a profitable and long-lasting, easy to preserve, type of crop.

The newly proposed cropping pattern cannot produce the desired increase in production and profits unless farmers are extensively trained (see above for specific recommendations on capacity building for water user associations and farmers). Furthermore, It would be desirable for farmers to unite in associations or cooperatives to jointly handle the supply chain through the use, for example, of refrigeration storage facilities that allow the consumption of perishable products over a longer period of time.

Table 3: Evolution of the Cropping Pattern

LAND DEVELOPMENT OVER TIME [YEARS]

	BEFORE		AFTER		Y1	Y2	Y3	Y4
CROPS AND CROP GROUPS (**)	%	du	%	du	du	du	du	du
CITRUS	5	603	22	2,655	1,116	1,629	2,142	2,655
OLIVE	8	930	23	2,776	1,392	1,853	2,314	2,776
ALMOND	2	272	10	1,207	506	739	973	1,207
PEACHES	5	587	7	845	652	716	780	845
OTHER FRUIT TREE CROPS	5	544	3	362	499	453	408	362
GRAINS*	31	3.684	12	1,448	3,125	2,566	2,007	1,448
WINTER VEGS	13	1.603	4	483	1,323	1,043	763	483
WINTER VEGS (TOMATO IN GREENHOUSE)	1	121	3	362	181	241	302	362
SUMMER VEGS	8	1.009	6	724	938	867	795	724
ALFALFA (GREEN FODDER)	4	509	10	1,207	684	858	1,032	1,207
UNCULTIVATED	18	2.205	0	0	1,654	1,102	551	-
TOTAL	100	12.068	100	12,068	12,068	12,068	12,068	12,068

* GRAINS: WHEAT + BARLEY

** CROPS MARKED IN RED ARE THOSE THAT, IN FUTURE CONDITIONS, WILL OCCUPY LESS LAND IF COMPARED TO PRESENT CONDITIONS

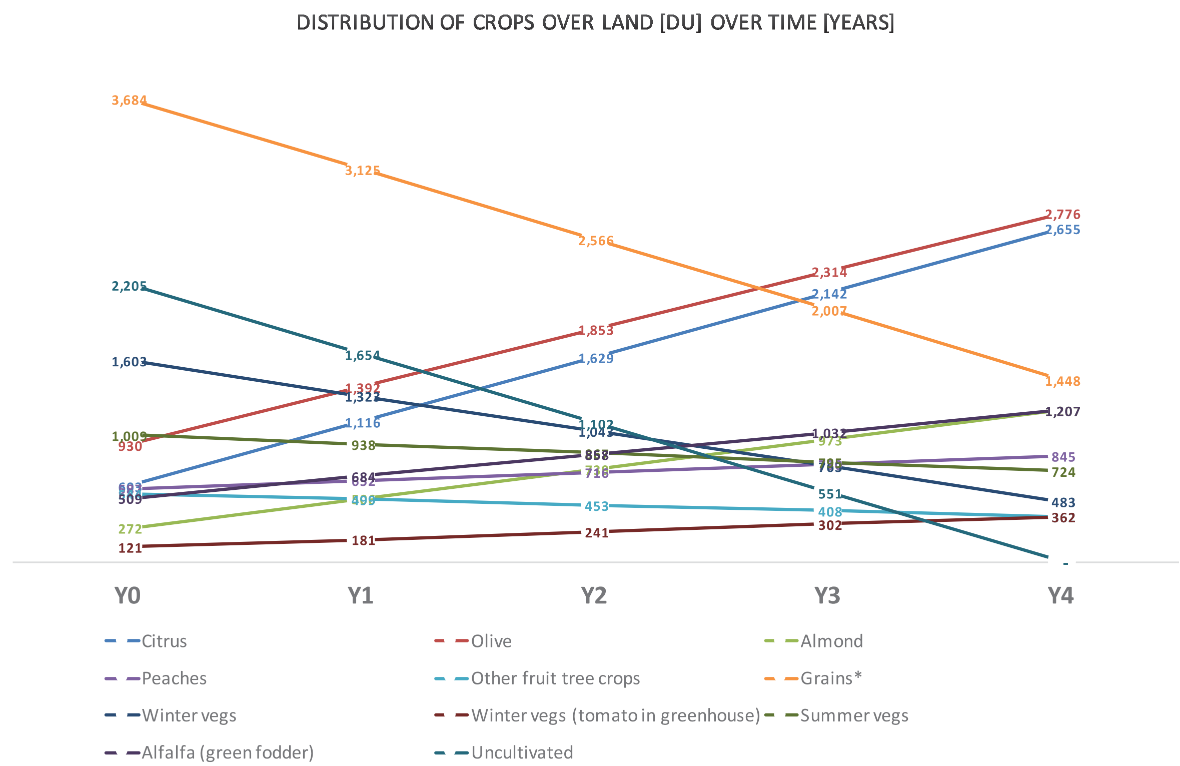


Figure 15: Evolution of the cropping pattern over land [du] over time [years]

FARM-LEVEL INVESTMENTS

Investments at the farm level would be largely spent on an increase in tree plantations and greenhouses placed in areas located away from the border with Israel.

The following table summarizes investments, expressed in Israeli New Shekel (ILS) per dunum (du) by type of crop and by type of material / activity required to produce such crop.

Table 4: Farm-level Investment [ILS] per dunum [du]

CROPS AND CROP GROUPS	*GREEN HOUSE*	*TREES*	*IRRIGATION GRID*	*LABOUR*	*MACHINERY*	*INPUTS*	*TOTAL*
CITRUS		400	380	400	0	200	1,380
OLIVE		800	380	400	0	200	1,780
ALMOND		1,200	380	400	0	200	2,180
PEACHES		1,000	380	400	0	200	1,980
OTHER FRUIT TREE CROPS							-
GRAINS							-
WINTER VEGS							-
WINTER VEGS (TOMATO IN GREENHOUSE)	37,500		492				37,992
SUMMER VEGS							-
ALFALFA (GREEN FODDER)			1,080	80	0	200	1,360

UNCULTIVATED	

Considering the evolution of the cropping pattern, total investments at farm level are provided in the following Table 5.

Table 5: Farm-level investments (ILS x 1,000) evolution during four years of full stage

CROPS AND CROP GROUPS	Y1	Y2	Y3	Y4
CITRUS	708	708	708	708
OLIVE	821	821	821	821
ALMOND	509	509	509	509
PEACH	128	128	128	128
OTHER FRUIT TREE CROPS				
GRAINS				
WINTER VEGS				
WINTER VEGS (TOMATO IN GREENHOUSE)	2,292	2,292	2,292	2,292
SUMMER VEGS				
ALFALFA (GREEN FODDER)	237	237	237	237
TOTAL ILS X 1,000	**4,695**	**4,695**	**4,695**	**4,695**

Based on the new cropping pattern, balance sheet statements have been re-calculated by considering:

- a new cultural organization;
- more modern and efficient farming practices due to training activities and better extensions services;
- better and more effective phytosanitary protection;
- a more rational distribution of the irrigation network of the farm;
- a sizable reduction in net irrigation water demand;
- a higher production, especially of the tree plants due to increased attention to thinning, correct ripening and fruit calibration;
- a water tariff based on the most conservative estimate of 1,461 ILS/m^3.

WATER TARIFF

The water tariff has been conservatively calculated including the effect of climate change, system losses, unexpected events due to pipe breaks, possible defects and/or breaks of the water metering system, possible reading errors of the water metering system and the assumption that 100% of the power requirements to run the recovery wells and the irrigation project will have to be generated by the stand-by generators and not by the national grid.

Ideally the water tariff should be able to cover all OPEX costs including those associated with running the Water User Association. Under these circumstances, farmers should be charged based on the actual amount of water they consumed at a rate of 1.461 ILS/m^3 if energy is provided entirely by the diesel generators, 1.188 ILS/m^3 if energy is provided 50% by the national grid and 50% by the diesel generators and 0.916 ILS/m^3 if energy is provided 100% by the national grid. The details of such estimates are provided in the following tables.

Table 6: Water Tariff based on different energy generation scenarios

SCENARIO	ANNUAL COST FOR O&M AND WUAS [ILS/YEAR]	GROSS WATER REQUIREMENTS [M^3/YEAR]	NET IRRIGATION WATER REQUIREMENTS [M^3/YEAR]	TARIFF ILS/M^3
100% DIESEL	11,443,430	11,110,000	7,833,484	**1.461**
50% DIESEL	9,308,435			**1.188**
100% NATIONAL GRID	7,173,439			**0.916**

The details of the number presented above are given in the following Table 7.

Table 7: Gross and Net Irrigation Water Requirements at farm level and excluding industries

TYPE OF CROP	NET IRRIGATION WATER DEMAND	GROSS IRRIGATION WATER DEMAND
CROP	**m^3/year**	**m^3/year**
CITRUS	2,196,183	3,114,835
OLIVE	1,957,104	2.775,750
PEACHES	531,016	753,138
GRAINS	448,785	636,509
OTHER FRUIT	225,297	319,538
SUMMER VEGETABLES	470,724	667,626
WINTER VEGETABLES	141,871	201,216
WINTER TOMATO GREENHOUSES	51,337	72,811
ALMOND P	750,992	1,065,128
ALPHA-ALPHA P	1,060,174	1,503,639
TOTAL M^3/YEAR	**7,833,484**	**11,110,191**

BREAK-EVEN POINT FOR WATER TARIFF

In order to better qualify how the balance sheet of each individual crop changes by changing the water tariff, the break-even point between costs and revenues was estimated for each crop. The results, displayed in the following table, show that a large part of the crops has costs and revenues balance between a tariff of 0.90 ILS/m^3 and of 2.49 ILS/m^3.

Water price sensitivity is lower in summer and winter vegetables, while only vegetables grown in the greenhouse can withstand a high cost per cubic meter of water.

Table 8: Water tariff that involve zero net margin

CROPS	OLIVE	CITRUS	PEACHES	GRAIN	OTHER FRUIT CROP	SUMMER VEGETABLE	WINTER VEGETABLES	WINTER GREENHOUSES	ALMOND	ALPHA ALPHA
WATER TARIFF ILS/M^3	**1.00**	**1.63**	**2.49**	**-0.89**	**1.76**	**3.31**	**6.56**	**42.51**	**0.90**	**1.14**

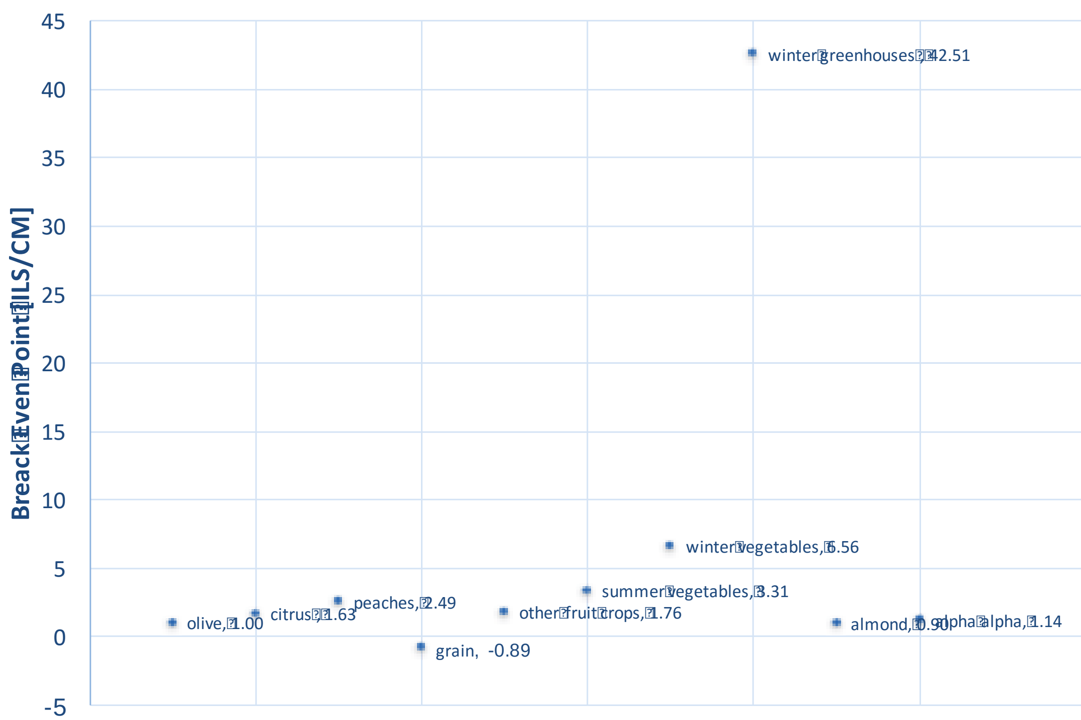


Figure 16: Water tariff that involve zero net margin

It is assumed that the following costs will be paid by the farmers: the Operation & Maintenance (O&M) costs of the recovery scheme, the reuse scheme and the irrigation network inside the farms, the costs for operating the Water User Associations (WUA). The farmers would be charged based on the actual water they consume. Water consumption is measured by a water meter installed at the manhole located at the farm gate.

BALANCE SHEET FOR THE CROPPING PATTERN

A summary and detailed analysis for both costs and revenues associated with each crop as suggested by the newly proposed cropping pattern is provided in the following series of tables.

Table 9 Summary of the Financial Costs [ILS x 1,000]

CROPS	Y1	Y2	Y3	Y4
CITRUS	2,493	3,639	4,784	5,930
OLIVE	2,253	2,999	3,746	4,493
PEACHES	995	1,094	1,192	1,291
GRAINS	3,584	2,943	2,302	1,661
OTHER FRUIT CROPS	857	779	701	622
SUMMER VEGETABLES	2,118	1,957	1,796	1,635
WINTER VEGETABLES	2,854	2,250	1,646	1,042
WINTER TOMATO GREENHOUSES	486	648	810	972
ALMOND	599	875	1,152	1,429
ALPHA-ALPHA	777	975	1,173	1,371
TOTAL FOR THE FINANCIAL COSTS [ILS X 1,000]	**17,016**	**18,159**	**19,302**	**20,445**

Table 10: Summary of the Financial Revenues [ILS x 1,000]

	Y1	Y2	Y3	Y4
CITRUS	3,456	5,044	6,632	8,220
OLIVE	2,672	3,558	4,444	5,329
PEACHES	1,792	1,969	2,146	2,323
GRAINS	2,109	1,732	1,355	978
OTHER FRUIT CROPS	1,253	1,139	1,024	910
SUMMER VEGETABLES	3,751	3,466	3,181	2,896
WINTER VEGETABLES	5,158	4,066	2,975	1,883
WINTER TOMATO GREENHOUSES	1,901	2,534	3,168	3,801
ALMOND	728	1,065	1,401	1,738
ALPHA-ALPHA	1,077	1,351	1,626	1,901
TOTAL FOR THE FINANCIAL REVENUES [ILS X 1,000]	**23,898**	**25,924**	**27,951**	**29,978**

The detailed balance sheet for each crop are provided in “Annex 5: Balance Sheet for Individual Crops”.

MACRO-ECONOMIC CONDITIONS

METHODOLOGY

Cost-benefit analysis (CBA) is a formal analysis technique used in public and private investment projects (Rakhra, 1991) as well as in programs and policies (Stoica, 2005) in order to make a comparative assessment of all the benefits and costs anticipated. It also represents an attempt to measure the costs endured and gains earned by a community or a private company after the project is implemented.

CBA proves its usefulness in feasibility studies (from an economic, environmental, social or technological perspective) by selecting the optimal option for investment projects (Hanley and Spash, 1993). The purpose of using CBA in a sector is to set up pragmatic administrative rules in order to *allocate resources efficiently*.

The use of cost-benefit analysis contributes to determining the financial sustainability as well as profitability of the NGEST water reuse scheme. It also:

a) highlights the economic and financial viability of the NGEST water reuse scheme for different scenarios;
b) enables the identification of possible errors in the design or implementation phase (incorrect information, unrealistic hypotheses, etc.); and
c) enables the correction needed to properly conduct the NGEST water reuse scheme.

GENERAL PROJECT ASSUMPTIONS

Within the CBA, costs are presented in terms of capital investments and operation and maintenance (O&M); the first being a one-time cost and the second being a recurring, yearly, cost.

The entire water recovery and re-use scheme requires capital investments to be implemented over time to provide water in two separate areas (Phase I for 500 ha and Phase II for 1,000 ha). The implementation of each phase has been subdivided into two separate tendering packages. The details are provided in the following Table 11 including the implementation schedule.

Table 11: Tendering Packages and proposed timeframe for the implementation of Phase I and Phase II

		DESCRIPTION	2017	2018	2019	2020
I	1	Supply and install 14 recovery wells and concerned connection pipes, the civil works within the booster pumping station, five boosters pumps, one 4,000 m^3 water tank and 5 monitoring wells	$10,970,996.40			
	2	Small works related to the procurement and construction of the irrigation network for an area of 500 ha (5,000 du)		$7,519,531		

II	1	Supply and install 14 recovery wells and concerned connection pipes, the remaining civil works within the booster pumping station, five booster pumps, a second 4,000 m^3 water tank and 5 monitoring wells	$13,421,602.00	
	2	Small works related to the procurement and construction of the irrigation network for an area of 1,000 ha (10,000 du)		$11,178,400.00

The O&M cost are provided in the following tables assuming three possible scenarios of cost for electricity. The first scenario assumes that energy will be provided 100% by the national grid, the second scenario assumes that 50% of the energy requirements are provided by the national grid and the other 50% by the standby diesel generators installed onsite. The third and most conservative scenario assumes that 100% of the energy requirements are provided by the standby diesel generators.

Table 12: Annual O&M costs (US$ and ILS) assuming all energy is provided by the National Grid

OPERATION AND MAINTENANCE COST (ONLY NATIONAL GRID)		PHASE I	PHASE II
DESCRIPTION	**US$**	**US$**	**US$**
MANPOWER	$180,000	$90,000	$90,000
POWER CONSUMPTION	$1,074,060	$358,020	$716,040
FROM THE GRID (100%)	*$1,074,060*	*$358,020*	*$716,040*
FROM THE DIESEL GENERATORS (0%)	*$0*	*$0*	*$0*
MAINTENANCE AND REPAIR WORKS	$271,574	$137,352	$134,222
CONSUMABLES & MISCELLANEOUS	$360,368	$138,863	$221,505
TOTAL O&M COST USD/YEAR	$1,886,002	$724,235	$1,161,767
WUAS ANNUAL COSTS	$100,000	$100,000	$100,000
TOTAL MANAGEMENT COSTS	**$ 1,986,002**	**$824,235**	**$1,261,767**
TOTAL MANAGEMENT COSTS (ILS)	**ILS 7,173,439**	ILS 2,977,000	ILS 4,558,000
WATER TARIFF (ILS/M^3)	0.918		

Table 13: Annual O&M costs (US$ and ILS) assuming 50% of the energy is provided by the National Grid

OPERATION AND MAINTENANCE COST (50/50)		PHASE I	PHASE II
DESCRIPTION	**US$**	**US$**	**US$**
MANPOWER	$180,000	$90,000	$90,000

POWER CONSUMPTION	$1,665,144	$555,048	$1,110,096
FROM THE GRID (50%)	*$537,030*	*$179,010*	*$358,020*
FROM THE DIESEL GENERATORS (50%)	*$1,128,114*	*$376,038*	*$752,076*
MAINTENANCE AND REPAIR WORKS	$271,574	$137,352	$134,222
CONSUMABLES & MISCELLANEOUS	$360,368	$138,863	$221,505
TOTAL O&M COST USD/YEAR	**$2,477,086**	**$921,263**	**$1,555,823**
WUAS ANNUAL COSTS	$100,000	$100,000	$100,000
TOTAL MANAGEMENT COSTS (US$)	$2,577,086	**$ 1,021,263**	**$1,655,823**
TOTAL MANAGEMENT COSTS (ILS	**ILS 9,308,435**	3,689,000	5,981,000
WATER TARIFF (ILS/M^3)	**1.188**		

Table 14: Annual O&M costs (US$ and ILS) assuming 100% of the energy is provided by the standby diesel generators

OPERATION AND MAINTENANCE COST (ONLY GENERATOR)		PHASE I	PHASE II
DESCRIPTION	**US$**	**US$**	**US$**
MANPOWER	$180,000	$90,000	$90,000
POWER CONSUMPTION	$2,256,228	$752,076	$1,504,152
FROM THE GRID (0%)	*$0*	*$0*	*$0*
FROM THE DIESEL GENERATORS (100%)	*$2,256,228*	*$752,076*	*$1,504,152*
MAINTENANCE AND REPAIR WORKS	$271,574	$137,352	$134,222
CONSUMABLES & MISCELLANEOUS	$360,368	$138,863	$221,505
TOTAL O&M COST USD/YEAR	**$3,068,170**	**$1,118,291**	**$1,949,879**
WUAS ANNUAL COSTS	$100,000	$100,000	$100,000
TOTAL MANAGEMENT COSTS (US$)	**$3,168,170**	**$1,218,291**	**$2,049,879**
TOTAL MANAGEMENT COSTS (ILS)	**ILS 11,443,430**	**ILS 4,400,000**	**ILS 7,404,000**
WATER TARIFF (ILS/M^3)	**1.461**		

Other costs that are included in this CBA are the water tariff, assumed to be 1.461 ILS/m^3, and the investments required at the farm level to support the introduction of the proposed cropping pattern.

Costs for supporting and training the Water User Association (WUA) are assumed to cost 3,000,000 ILS (equivalent to $806,000), divided in 2,000,000 ILS for the first year and 1,000,000 ILS for the second year.

FINANCIAL ANALYSIS

The financial analysis indicates whether the project will generate a positive net cash flow during the evaluation period (profitability) and whether the cumulative cash flow from the start of investment until the final prediction is negative (sustainability).

The analysis of the investment project's cash flow includes both the evaluation of the cash outflows (investment costs as well as and costs at farm level) and cash inflows (revenues at farm level, industries, grant and subsidies). As opposed to the economic analysis, in the financial analysis the cash flow does not include amortization, reserves and other accounting items.

From this perspective, the financial analysis was conducted with the following steps:

1. Estimating revenues and costs of the NGEST area farms and assessing the implications of these parameters on cash flow;
2. Defining the financing sources of investment and analyzing the financial profitability.
3. Determining the funding gap in achieving the investment project and identifying the best mechanisms to attract funding;
4. Checking whether the estimated cash flow could ensure the proper operation of the NGEST project. The investment project is financially sustainable if there is no risk of running out of cash during the operation.

For the financial analysis, the following costs and revenues were taken into account:

Cash Outflows (Costs)

- Capital cost – recovery wells, farm investment
- Costs related to the WUA operation and training
- Operation Costs at farm level including water tariff

Cash Inflows (Revenues)

- Revenues at farm level derived from the new cropping pattern
- Water tariff paid by Industry based on 2 ILS/m^3 per 70,000 m^3 /year
- Reduction of time spent in management of private wells
- Investments paid by Government/Donors
- Public Subsidies based on farm water tariff of 1.461 ILS/m^3 (worse case scenario).

The financial analysis carried out as part of the project's CBA uses market prices (which include VAT and indirect taxes) to check the balance of the investment and the sustainability of the project.

The cash flows accumulated in different years during the evaluation period (25 years) require a fair discount rate. The financial discount rate allows to account for the influence of time on the value of money and reflects the opportunity cost of the investor’s capital.

In general, it is recommended to use a discount rate of 5%, but the model also used 2 more points (7%) and less (3%) to evaluate the sensitivity of the net present value.

SCENARIOS

Five scenarios involving donors, government and farmers have been suggested to evaluate possible project implementation and financing opportunities based on the following elements of the project:

(1) Capital Investment for the Water Recovery Scheme;
(2) Capital Investment for the Water Reuse (Irrigation) Scheme up to the Farm’s Gate;
(3) O&M Cost for the Water Recovery Scheme;
(4) O&M Costs for the Water Reuse (irrigation) Scheme;
(5) Capital Investments for Farm's Development.

The five scenarios are defined as follows

- **Scenario 1** - Full Costs (1 + 2 + 3 + 4 + 5) for Phase I + Phase II. Under this scenario, farmers would pay back the full cost for the construction of both the recovery and the reuse schemes for both phases of the project. On top of that, farmers would cover operation and maintenance costs for the whole system while covering investments and operating costs necessary for the development of their own farms;
- **Scenario 2** - Full Costs (1 + 2 + 3 + 4 + 5) only for Phase I (Phase II will not be built). This scenario is identical to Scenario 1 except that only Phase I of the project will be built;
- **Scenario 3** - Capital Subsidies (consider only costs 3 + 4 + 5) for Phase I + Phase II. Construction costs would be paid by the government/donors and not charged back to the farmers. This scenario assumes that the capital investments necessary to build both Phase I and Phase II of the recovery and reuse schemes would be paid by the government or by a donor and every other cost would be paid by the farmer;
- **Scenario 4** - Capital and O&M Subsidies: this scenario considers only cost (1) and (2) for Phase II and costs (4) and (5) for both Phase I and II. Cost (3) is subsidized by the Government/Donors for several years so that farmers can pay back costs (1), (2) and (3) for Phase II. This scenario assumes that the Government/Donors would cover the cost for the construction of Phase I, but that the farmers will pay back the cost for the construction of Phase II. Farmers would also pay for the development and O&M of their own farm. The cost for the O&M of the recovery and reuse schemes (Phase I + II) would be covered

by the Government/Donors for the first 8 years (i.e. the time needed by the farmers to pay back the construction of Phase II). After that, the farmers will pay for the cost of O&M of the recovery and reuse schemes as well.

- **Scenario 5** - Capital and O&M Subsidies: considers costs (1) and (2) will be paid by the government/donors. Costs (3) and (4) would be subsidized by the Government only until Farmers have paid back Cost (5). Farmers are expected to pay for the development of their own farm. All other costs are paid by the Government/Donors for the first 3 years (i.e. the time it takes for the farmers to be able to pay back for the improvement of their own farm). After that point, farmers will be responsible for paying O&M costs for the whole system.

A schematic representation of the five scenarios is provided in the following Table 15.

Table 15: Investment Scenarios

Scenari o	Description	Cost Paid by the Farmers					Construction Phase to be Paid by the Farmers	
		(1) Capital Investment for the Recovery System	(2) Capital Investment for the Irrigation System up to the Farm's Gate	(3) O&M Cost for Recovery System and Irrigation System	(4) O&M Costs at Farm Level	(5) Capital Investments for Farm's Development	(Phase I)	(Phase II)
1	Full Costs (1 + 2 + 3 + 4 + 5) for Phase I + Phase II;	x	x	x	x	x	x	x
2	Full Costs (1 + 2 + 3 + 4 + 5) only for Phase I (Phase II will not be built);	x	x	x	x	x	x	Not Built
3	Capital Subsidies (consider only costs 3 and 4 and 5) for Phase I + Phase II. Construction costs will be paid by the government and not charged back to the farmers;	Paid by the Government and not charged to the Farmers		x	x	x	Paid by the Government and not charged to Farmers	
4	Capital and O&M Subsidies: consider only cost (1) and (2) for Phase II and costs (4) and (5) for both Phase I and II. Cost (3) is subsidized by the Government/Donors for several years so that farmers can pay back costs (1), (2) and (3) for Phase II.	x	x	Subsidized by Donors/Government until Farmers have paid back the Construction of Phase II	x	x	Paid by the Government and not charged to Farmers	x

5	Capital and O&M Subsidies: considers costs (1), (2), (3) and (4) paid by the government/donors. Costs (3) and (4) are subsidized by the Government until Farmers have paid back Cost (5).	Paid by the Government and not charged to the Farmers	Subsidized by Donors/Government until Farmers have paid back Cost (5) and are able to paid for O&M (3) + (4)	x	Paid by the Government and not charged to Farmers

FINANCIAL SUSTAINABILITY OF THE INVESTMENT PROJECT

The financial sustainability involves having a cumulative positive cash flow for each year of the projections. Therefore, there should be enough cash for smooth running of operations every year (without the risk of lacking liquidity). Demonstrating the financial sustainability of the project makes it necessary to weigh cash inflows with cash outflows for the entire reference period of the project.

In order to determine the profitability of the investment project, it is necessary to calculate the financial performance indicators for the overall investment, as well as the capital invested. The financial performance indicators of the investment project are Financial Net Present Value (FNPV) and Financial Internal Rate of Return (FIRR).

FNPV represents the amount calculated when the estimated investments and operating costs of the project are deducted from the present value of the projected revenues. The investment project is profitable in the financial sense if FNPV has a positive value.

FIRR represents the discount rate for which FNPV is zero or which equals the present value of the financial cash flows projected for the reference period. If this indicator is less than the cost of the capital, the project is not profitable. When it is higher than the cost of capital, the project is acceptable because it will generate a positive FNPV.

The profitability indicators are calculated considering all the investment costs of the project, regardless of its sources of funding. If FNPV is positive and FIRR is higher than the discount rate, the project is profitable. If FNPV is negative and FIRR is lower than the discount rate, the project is not profitable and therefore it needs financial support.

The main results of the financial analysis are summarized in the following table.

Table 16: Main Results of the Financial Analysis

SCENARIO	NET PRESENT VALUE (NPV) [ILS X 1,000]			BENEFIT COST RATIO (BCR)			INTERNAL RATE OF RETURN (FIRR)
	3%	5%	7%	3%	5%	7%	
1	-155,002	-140,864	-130,096	0.772	0.750	0.728	NF
2	-61,389	-56,792	-53,353	0.778	0.753	0.728	NF
3	**17,400**	**12,152**	**7,405**	**1.028**	**1.023**	**1.017**	**10.82%**
4	-52,493	-48,408	-46,166	0.922	0.913	0.902	NF
5	17,400	12,152	7,405	1.028	1.023	1.017	10.82%

ECONOMIC ANALYSIS

An economic analysis for major investment projects determines if the project contributes significantly to total economic welfare. It measures the project benefits depending on the following: the costs avoided due to project implementation; and the external benefits arising from the implementation, neither of which are included in the financial analysis.

In this analysis, the benefits should be seen from the perspective of two key issues. First, the revenues identified in the financial analysis will be corrected by applying a conversion factor. This factor allows the conversion between the economic and the financial prices. Secondly, the attention should focus on the positive externalities arising from compliance with environmental standards. These externalities should be given a monetary equivalent.

In the economic CBA, some cost/benefits cannot be expressed in monetary units but only in qualitative terms. These costs/benefits are:

- Preservation and improvement of the quality of space for human life, as in the case of water pollution when human settlements located near water lose their basic quality.
- Prevention of flora and fauna destruction.
- Maintenance of natural system which will have a positive effect on people, like better mental condition and richer intellectual activities.

Benefits that cannot be expressed in monetary value are also called "intangible" benefits. Those benefits have been ignored in the cost-benefit analysis of the project. The reason is that these benefits cannot be assessed, and their detailed qualitative effects can be better described in an environmental impact assessment.

In the economic cost-benefit analysis the costs are expressed in accounting prices, and are measured in terms of 'resource' cost or 'opportunity' costs.

The economic analysis could be briefly described with the following steps:

- Conversion of market prices into accounting prices;
- Update the estimated costs and benefits;
- Calculation of economic performance indicators (Economic Net Present Value, Economic Rate of Return, benefit/cost ratio).

The corrections to be considered in the economic analysis are the following:

Fiscal Corrections. Fiscal Corrections are necessary because some transfers from one agent to another should be seen as pure transfers, without having an economic impact. For example, the subsidies provided by the government to those who want to invest in the NGEST Irrigation Project represent a pure transfer offering advantages to the beneficiaries, but not creating economic value. The fiscal corrections are made for indirect taxes (VAT), subsidies and pure transfer payments (employer's obligation to pay social security contributions) which are generally included in the eligible costs and/or operating or maintenance costs. However, the prices should also include direct taxes. In addition, if certain indirect taxes/subsidies are aimed at correcting externalities, then they will be included in the analysis. In order to assess the project's economic impact, information on the tax system in the West Bank and Gaza, as calculated by World Bank, was used as presented in the following Table 17.

Table 17: Direct and indirect taxation in Gaza and West Bank

TAX OR MANDATORY CONTRIBUTION	PAYMENT (NUMBER)	NOTES ON PAYMENTS	TIME (HOURS)	STATUTORY TAX RATE	TAX BASE	TOTAL TAX RATE (% OF PROFIT)	NOTES ON TTR
CORPORATE INCOME TAX	2		18	15% - 20%	Taxable Profit	14.23	
CAPITAL GAIN TAX	1			15% - 20%	Capital Gains	0.76	
MUNICIPAL BUSINESS TAX	1			17%	Rental Value of Building	0.28	
EMPLOYEE PAID - PERSONAL INCOME TAX	12		96	5% - 20%	Taxable Salaries	0	withheld
IRRECOVERABLE VAT (ON FUEL)	0			15%	Fuel Consumption	0	
VALUE ADDED TAX (VAT)	12		48	16%	Value Added	0	not included
TOTALS	28		48			15.27	

Correction of labour cost from financial to economic. The correction of financial costs to economic costs of the price of labour has been made. The coefficient used to correct the financial value was 0.3 to consider taxation and social charges.

To carry out a neutral evaluation, positive and negative externalities of the project were not considered.

Based on the consideration presented above, the main results of the economic cost benefit analysis are presented in the following Table 18

Table 18: Main Results of the Economic Cost Benefit Analysis

SCENARIO	NET PRESENT VALUE (NPV) [ILS X 1,000]	BENEFIT COST RATIO (BCR)

	3%	5%	7%	3%	5%	7%	INTERNAL RATE OF RETURN (EIRR)
1	-61,667	-61,628	-61,454	0.909	0.891	0.871	NF
2	-23,386	-24,446	-25,237	0.915	0.894	0.871	NF
3	**118,983**	**99,119**	**83,307**	**1.190**	**1.190**	**1.188**	**61.68%**
4	47,413	36,828	27,978	1.071	1.066	1.059	18.55%
5	118,983	99,119	83,307	1.190	1.190	1.188	61.68%

GENERAL ASPECTS

FINANCING MECHANISMS

The sources of funding provided by the various scenarios of the project are:

- government financial sources
- financial sources of international cooperation
- private financial sources

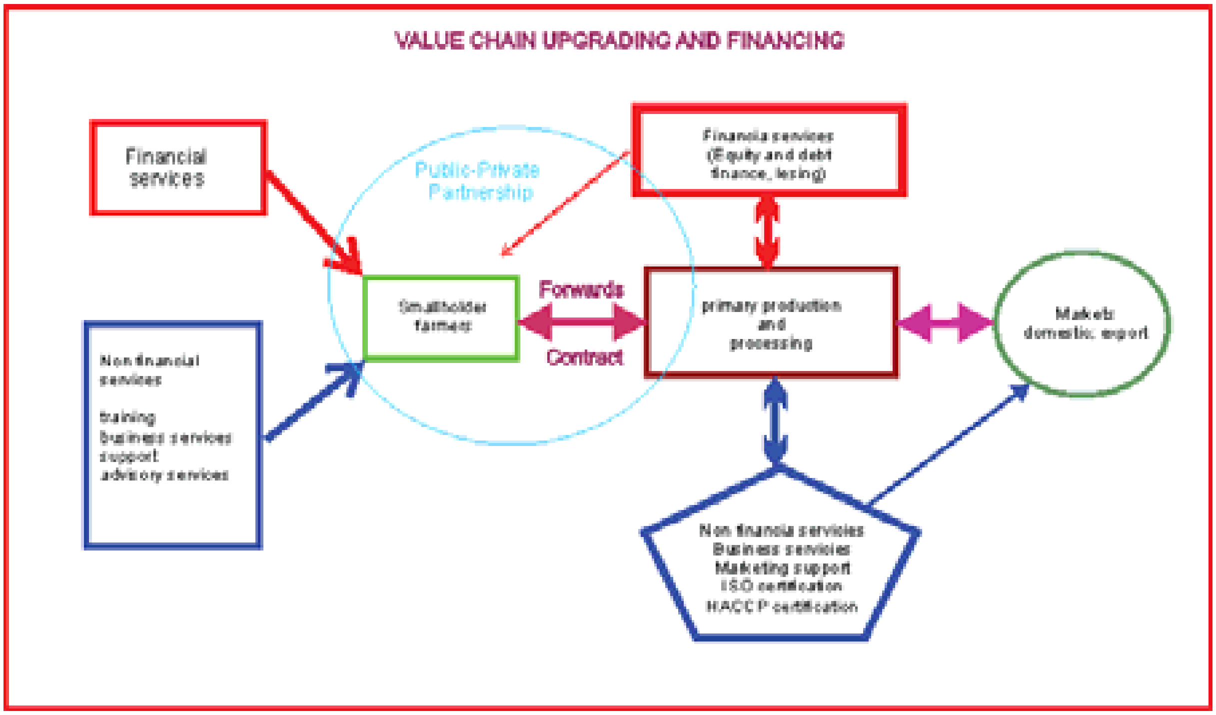
While government finance and international cooperation does not have direct impacts on the financial market system, it is necessary to provide support and guarantees to a private financing system. As we know the banking system requires, turning on a loan, guarantees and payment of the price of money (interest).

Farmers will need to have access to a banking system and most of them do not have enough income or capital to finance investment in farms or parts of the project, so it is necessary to provide them with support tools.

- First, the government must provide for a national guarantee fund supporting the banking system for when, due to personal problems or because of adverse meteorological conditions or distortions in market prices, the farmer is unable to repay the annual instalment of the loan.
- The second important thing is government or donor support for bank interest payments, given the high price of money locally. Farmers can repay the loan principal, but hardly the interest portion.

Farmers interested in the project are largely small companies (1 or 2 dunums) are heterogeneous and have different needs. It is important to identify the various sub-organizations of small owners and to evaluate their needs and constraints. In addition, small farmers do not only need credit for agricultural activities, but also need credit for other family / needs, savings, payment systems and insurance.

Clearly knowledge of the needs of small farmers makes it possible to identify the real needs, in particular regarding the guarantees for the banking system. On systemic risk, agricultural insurance, catastrophic risk programs, price coverage through exchanges of goods or value chains, banks can provide some innovative solutions.



Agriculture value chain development is strongly influenced by:

<u>Financial services</u> Financial services identify the possibility of providing credit easily to small farmers who can expand their business by investing in more profitable crops, plant and machinery, improving the quality of agricultural production and starting up with other farmers on processing products in order to increase the value added on the farm.

On this point, it is important to develop warranty services, such as a **national guarantee fund** that supports the banking system in lending.

Another example of financial services for farms is the establishment of a **national rotation fund** for investment financing for small farmers.

Agricultural insurance must support farmers with regard to the risks of climate change that pose the greatest risk to agriculture and food security. It is clearly necessary to ensure farmers also for losses due to the contingent difficulties of the neighbouring Israel.

Financing needs are not high and are comprised between 1,000-2,000 ILS/du for new tree plantations, so they do not represent important figures to guarantee - only greenhouse construction requires more important investments around 35,000 ILS/du. Other investments relate to corporate mechanization as possible support for company work for medium-sized farms.

Non-financial services: Non-financial services are fundamental to farmers' training for new technologies, low-impact farming practices and organic farming. In addition, credit counselling services and advisory services for the processing and marketing of the products of their own farm are required.

Public-Private Partnerships (PPPs): Another element that could support the development of new financial management models is based on public-private collaboration.

Public-private partnerships (PPPs) enable the involvement of the private sector in the implementation and development of a programme. Various forms of PPPs can be implemented within the program are:

- Partnership with the private sector for better access of small producers to markets and enhancement of quality of production at grassroots level;
- Partnership with the public sector to enforce the necessary legal framework and to develop the indispensable infrastructure;
- Partnership with financial institutions inclusive of commercial banks, microfinance institutions and leasing companies to finance the needs of different stakeholders within value chains and service providers to the value chains;
- Partnership with insurance companies to develop specific products aiming at mitigating risks for stakeholders and financiers;
- Partnership with communities to strengthen their capacities to gradually own and operate productive assets and/or specifically created companies;
- Partnership with local SMEs and entrepreneurs to develop services to value chain stakeholders like processing, storage facilities, transport, maintenance and repair, inputs supply.

JOB IMPACTS

The project in its full version creates new employment, the estimate of the level of direct employment is about 150 new employees and the job security for current employees.

Table 19: Job Created

JOB CREATED	DAYS/YEAR
JOB DAYS CREATED AT FARM LEVEL	**23.741**

JOB DAYS CREATED WUAS			4.400
JOB DAYS CREATED O&M			4.840
TOTAL JOB DAYS CREATED			32.981
INCREMENTAL LABOUR	dd	**32981**	**+ 34%**
	n.people	150	

The government may provide subsidies for young farmers who undertake to work on the farm in order to reduce youth unemployment.

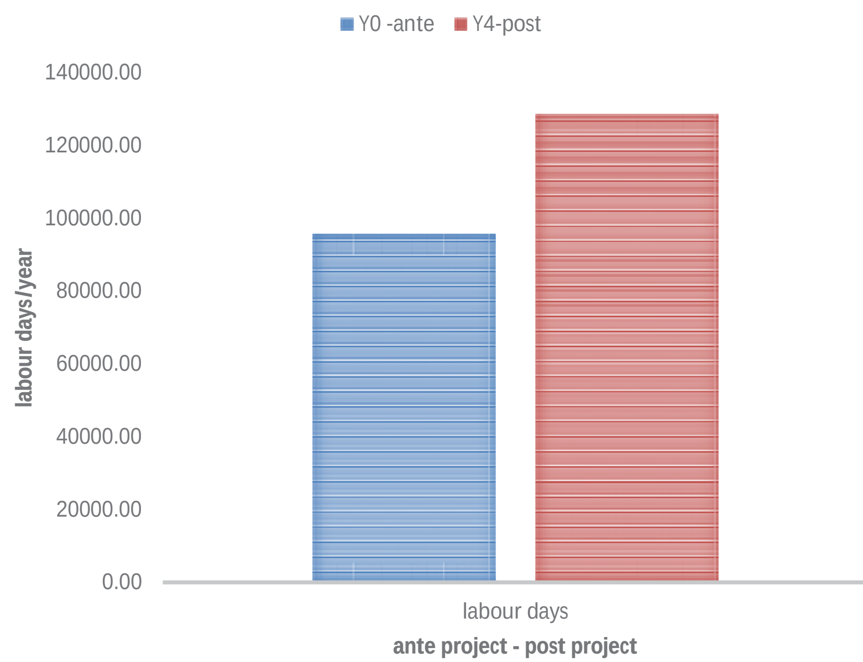


Figure 17: Job created per year before and after the project is implemented

PROJECT IMPLEMENTATION RECOMMENDATIONS

INSTITUTIONAL ARRANGEMENT

BACKGROUND

Traditional irrigation management in Palestine is community-based and informally organized around private wells in Gaza or springs in West Bank. Whereas in the Gaza Strip a small group of farmers share the operation and costs of a private irrigation well and organize the supply of water among themselves on a rotational basis, in the West bank, common irrigation schemes can supply up to a few hundred farmers and thousands of dunums, depending on the size of the spring. The organizational level is thus quite elaborate in West Bank, dealing with O&M, billing, and scheduling for hundreds of farmers in some cases. Still it is mainly informal, the number of WUAs in the Palestinian territories is very limited and the registered ones are very few. Governmental involvement in irrigation, therefore, has been very weak and limited to the licensing of agricultural wells.

INSTITUTIONAL OVERVIEW

Below is a summary of the responsibilities of the institutions that should be involved in the NGEST project, as outlined by the Water Law 2014 and the Draft Water User Association Regulation 2016.[6] It is important to note that the statements below are from the English translation of the laws. If there is a dispute as to the accuracy of a statement, the original Arabic version should be consulted.

As it pertains to this project, the PWA is responsible for (emphasis added):

- Setting a general policy for the planning and evaluation of water and wastewater projects in terms of their economic and social feasibility, setting design and quality control standards, technical specifications, and **monitoring their implementation**.
- Partake in the development of approved **standards of water quality** for various uses, in coordination and cooperation with the competent authorities, and ensure their implementation.

[6] Because the WUA Regulation is a draft, its provisions (outlined here) may be different in the final version.

- The **establishment of advanced monitoring systems** to monitor precipitation, surface flows, groundwater levels, utilization quantities, and water quality, as well as analysis of data to determine the safe and sustainable yield of Water Resources and improve water resources planning;
- Issue **licenses** for the drilling, exploration, extraction or collection of groundwater;
- Set the general policies for determining the water and wastewater **tariff**;
- Order the suspension of water extraction or water supply in cases of a water source or supply system pollution.

The Water Sector Regulatory Council is responsible for monitoring all matters related to the operation of water Service Providers including production, transportation, distribution, consumption and wastewater management. It has the responsibility and power to:

- Approve of **water prices**, costs of supply networks and other services required for the delivery of water and wastewater services, including setting a unified price for the provision of bulk water supply to Service Providers;
- Issue **licenses to Regional Water Utilities** and any operator that establishes or manages the operation of a facility for the supply, desalination, or treatment of water or the collection and treatment of wastewater, and the levying of license fees;
- **Monitor operation processes** related to the production, transport, and distribution of water and operational processes of wastewater management;
- **Monitor water supply agreements**;
- Setting the basis for regulating the extent and percentage of **local authorities' participation** in the general assemblies of water utilities and ensuring implementation.

The National Water Company is responsible for the production and supply of bulk water at a national level. It is responsible for:

- The **supply and sale of bulk water** to water undertakings, local authorities, joint water councils and associations;
- The **extraction of water** from water resources, desalination of water, and **bulk water transmission** in accordance with a license issued by PWA for this purpose;
- The management, upgrade and development of any assets received from PWA;
- The provision of all the means necessary for the development of all activities and **infrastructure works related to the supply of bulk water**; and

- Propose a water supply tariff and submit to the WSRC for approval.

Service Providers include Regional Water Utilities and Water User Associations.

Regional Water Utilities provide water and wastewater services directly to the consumer, and are responsible for the provision of water and wastewater services within its specified administrative and geographical scope.

Water Users Associations are responsible for managing the service of supplying irrigation water at the local level. More specifically, it is responsible for:

- **Operation, maintenance and management of irrigation and drainage systems** in a fair, efficient and economical manner.
- **Produce or purchase water from its sources** at a certain rate and then redistribute it in a fair and timely manner to all farmers in the irrigation unit according to the criteria agreed with PWA;
- Determine the prices of water sold based on the tariff system in force;
- **Install, dismantle, repair and calibrate the means of measuring water** quantities used by water users.

To create a WUA, (at least) three people representing (at least) twenty farmers owning (at least) 100 dunums may submit an application to the Ministry of Agriculture. The application should contain basic information about the members, including the names and identity cards of the founding members, and the land owned or used by all members along with its agricultural pattern and water usage needs. The application should also include information about the Association, including its address, scope of work, and the water source to be used.

The Ministry of Agriculture will study the application and will then forward it to PWA, which in turn decides whether to grant a license to use the water source. If PWA approves the granting of a license, the Minister of Agriculture shall issue a decision to establish the Association. The application shall then be referred to the WSRC for approval to issue the license.

A WUA will be terminated if its approval to use a water source by PWA is cancelled.

The Ministry of Agriculture shall work with PWA and others in training WUAs on the following subjects:

- General training on participation in associations.

- Specialized training in the fields of financial, administrative and technical affairs necessary for the operation of the Association in accordance with the plans and programs established by PWA;
- Develop the operational plan, management and water distribution operations;
- Develop a maintenance plan for waterways, sockets and pumping mechanisms;
- Directly implement operation and maintenance plans; and
- Evaluation and follow-up.

During the transitionary period while the NWC, WUAs, and other new institutions are created, the relevant governmental authorities, official institutions, civil society organizations, and local authorities should continue to exercise their existing responsibilities and powers.

PUTTING IT ALL TOGETHER

Although it is clear which institutions should be involved in the various aspects of this project, what is not clear is where that authority exactly starts and stops. For example, it is stated that WUAs are responsible for "supplying irrigation water at the local level." But reasonable people may disagree with where that management should start in this project. Does it start at the recovery wells? At the booster station? Or somewhere else?

The main ambiguity, however, is regarding the responsibilities of NWC and the WUA. NWC is responsible for the extraction of water and bulk water transmission. Yet the WUA may "purchase ***or produce***" water, suggesting that the WUA may also be able to extract water itself without purchasing it from NWC. In the new Water Law, NWC is given the responsibility to sell to "associations", including WUAs. That statement alone, however, does not logically necessitate that associations *must* buy from NWC.

Moreover, the WUA is responsible for the irrigation system, which in the case of the NGEST project, coincides with the bulk water transmission system. In other words, the recovery wells extracting water and the pipes bringing the water to the farm gate can be characterized in one of two ways: 1) as bulk water supply (and therefore under the purview of NWC) or 2) as an irrigation system (and therefore under the purview of the WUA), or some combination thereof.

Below are three scenarios for O&M, which are meant to provide a starting point for discussions by Palestinian stakeholders on how best to run the project.

TERMS

Before introducing the scenarios, there should be some clarification of terms:

"**Recovery System**" includes the 28 recovery wells and 15 monitoring wells.

“**Reuse System**” includes all connecting pipes, two 4,000 m^3 water storage tanks, a booster station with 10 pumps, and an irrigation network of 126km of pipelines, which transports the water from the recovery wells to the farm gate and the water metering system.

“**On-Farm System**” is the infrastructure on each individual farm, including the tertiary pipe network to bring the water from the farm gate to the crops.

INSTITUTIONAL SCENARIOS

For the management of irrigation systems, world experience has generally followed three basic arrangements:

1) the government officials continue to manage the systems after completion;
2) the government turns the systems over to farmers to manage them; or
3) the government and farmers manage the systems jointly, meaning some parts of the physical system (generally the larger elements) are managed by governmental agencies while the smaller ones are the farmers' responsibility.

These scenarios are put into the NGEST context and discussed below.

It should be noted that during this transitional period, neither NWC nor the WUA exist. It is envisioned, therefore, that CMWU will handle the responsibilities of NWC until it is created and able to function. The WUA, which should be created as soon as practicable, will also be assisted by CMWU until it is ready.

Scenario 1 – Governmental Management

1. In this scenario, the Recovery and Reuse Systems would be owned and operated by the NWC.
2. This would mean:
    a. NWC will own and operate the Recovery System;
    b. NWC will own and operate the Reuse System;
    c. The farmers will own and be responsible for operation of the On-Farm System, with the WUA helping to coordinate farmers for technical assistance and capacity building with modern irrigation techniques and the proposed cropping pattern.

The main benefit of this scenario is that it is a simple, straightforward arrangement, whereby the governmental body that specializes in water distribution handles the supply.

The main detriments of this scenario are that it seems to contradict the spirit (if not the letter) of the law, which envisions a greater role for the WUA, and may perpetuate some of the problems with a centralized, governmental approach.

Countries have historically entrusted the management of their irrigation systems to government agencies, on the assumption that they will have the capacity and motivation to achieve high performance standards. The opposite has proven true, as documented reports and literature have shown the performance deficiencies of many government-managed irrigation systems has increased (see, *e.g.*, World Bank, 1997).

The deteriorated performance of irrigation systems under government agencies is generally the resultant of the following:

- the failure to operate and maintain systems adequately;
- the financial burden of subsidizing agencies to manage the system has become more onerous for many governments due to the low fee recovery rates from farmers;
- major difficulties in maintaining subsidies for irrigation systems that perform sub-optimally;
- difficulties in implementing water pricing and cost recovery as a traditional economic solution of "getting the prices right";
- local information constraints and inappropriate incentives for government employees.

Many of the issues delineated above have been problems in the Gaza Strip, and so significant consideration should be given to whether a governmental approach will achieve the goals of this project.

Scenario 2 – Water User Association Management

1. In this scenario, the Recovery and Reuse Systems are owned and operated by the WUA.
2. This would mean:
    a. WUA will own and operate the Recovery System;
    b. WUA will own and operate the Reuse System;
    c. The farmers will own and be responsible for operation of the On-Farm System, with the WUA helping to coordinate farmers for technical assistance and capacity building with modern irrigation techniques and the proposed cropping pattern.

The main benefit of this scenario is that it firmly places control and management into the hands of the WUA. As mentioned above, several benefits are expected to accrue from involving the WUA in owning and managing the network, including greater overall sustainability of the project.

The greatest detriment of this scenario is that NWC (CMWU) is much more knowledgeable and much better positioned to handle the system than the WUA. The WUA will need significant capacity building and technical assistance to step into this role, as discussed below.

For this approach, governments have followed two different methods to hand over irrigation systems to farmers. Some have favored the quick establishment of the WUA and a rapid transfer of responsibilities to it. Most countries, however, have favored a phased handing over, accompanied by training programs for the leaders of the WUA. The general belief is that a phased program has better chance of success and provides more opportunities to change course, if required.

Scenario 3: Joint Management

1. In this scenario, NWC would own (and for the first few years, also operate) the Recovery and Reuse Systems with the ultimate goal of transferring operation and management to the WUA.
2. This would mean:
   a) NWC would own the Recovery System, and operate it for the first three years of the project.
   b) NWC would own the Reuse System, and operate it for the first three years of the project.
   c) During the first three years, the WUA would receive intensive capacity building.
   d) After the first three years of the project, the WUA would assume operation and management of the Recovery and Reuse Systems.
   e) NWC would continue to own the Recovery and Reuse Systems but would lease them to the WUA.
3. The farmers will own and be responsible for operation of the On-Farm System, with the WUA helping to coordinate farmers for technical assistance and capacity building with modern irrigation techniques and the proposed cropping pattern.

The main benefit of this scenario is that it blends the resources and knowledge of the NWC (CMWU) with the appropriate level of input and phased-in management by the users (WUA).

This scenario also dovetails nicely with the recommended **Investment Scenario 3**, where the capital investments necessary to build both Phase I and Phase II of the Recovery and Reuse schemes would be paid by the government (or by a donor), and the O&M of the Recovery and Reuse schemes and the capital expenditures and O&M of the On-Farm development would be paid by the farmers.

The main detriment of this scenario is that it is a more complex arrangement, necessitating various agreements and contracts between parties to delineate roles and responsibilities.

If this Scenario is chosen, the WUA could contract CMWU to manage the Recovery and Reuse Systems for a limited period of time, say 3 years. Also during that time, the WUA could contract the Union of Agricultural Work Committees (UAWC) to manage the training and extension services to the farmers to establish the executive capacity needed within the WUA.

Complete governmental or complete farmer management are both relatively rare in the world. The in-between option of joint management has become the norm, albeit with different variations. The Consultant recommends that PWA take advantage of world experience and select a joint management model.

WATER USER ASSOCIATIONS

WUAS IN GAZA

Groundwater is the sole source of water for irrigation farming in the target area. Water is abstracted from private wells evenly distributed throughout the project area. Typically, the same well is shared by more farmers – a "collective well". Namely, a farmer owns one well and other neighboring farmers share the operation and maintenance costs for using the pumping system and the water. Each farmer of the group has his own pipeline connecting the well to his farm. The baseline survey of this Complementary Feasibility Study shows that 92% of the farmers depend on the "collective well" system, owned by the remaining 8%.

Usually, the farmers using a collective well do not sign any formal agreement, neither are they linked by an association or a cooperative. Each farmer provides the fuel necessary for his own shift, while maintenance and administrative costs are equally shared among the group. However, conflicts may arise because some farmers do not pay his share in due time, thus undermining the efficient operation of the well.

The few existing WUAs in Gaza are generally small and loosely organized. This low level of organization makes it difficult to initiate joint actions. They are also faced with harsh economic and financial circumstances, including limited access to the international market for agricultural products. Greater farmer cooperation under the umbrella of a WUA could yield significant gains.

COMMON TASKS OF WUAS

The main tasks and activities commonly found in WUAs include:

- Choose and specify the water source and take part in the planning, designing and implementation.
- Define the roles and responsibilities to manage, operate and maintain the water source and its structures.
- Solve conflicts among water users by achieving a fair water distribution among the users.
- By mutual control and increased sense of ownership and responsibility, reduce violations over water.
- Take part in the tasks and functions for the management of irrigation projects.
- Help to develop irrigation efficiency at a field and network level, also by facilitating the spread of modern irrigation techniques.

TRAINING NEEDS AND CAPACITY BUILDING

A capacity building program should be carried out to enable the WUA to achieve its mandate.

On-farm technical assistance and training on irrigation topics, in conjunction with best agricultural practice, will be handled by the Ministry of Agriculture and the non-profit organization Union of Agricultural Workers Committees (UAWC).

Table 20: WUA capacity building and training needs; estimated costs for 20 farmers

TOPIC	NO. PARTICIPANTS	DURATION (DAYS)	ESTIMATED COST (US$)
FACILITATION AND TRAINING SKILLS	10	30	$120,000.00
DESIGN, OPERATION AND MAINTENANCE OF MODERN IRRIGATION TECHNOLOGIES, SUCH AS ON-FARM LOW PRESSURE SYSTEMS, LOCALIZED IRRIGATION, ETC. BASIC LEVEL.	20	15	$120,000.00
DESIGN, OPERATION AND MAINTENANCE OF MODERN IRRIGATION TECHNOLOGIES, SUCH AS ON-FARM LOW PRESSURE SYSTEMS, LOCALIZED IRRIGATION, ETC. ADVANCED LEVEL.	20	10	$80,000.00
DESIGN, OPERATION AND MAINTENANCE OF MODERN ON-FARM SURFACE IRRIGATION SYSTEMS.	20	5	$40,000.00

DESIGN, OPERATION AND MAINTENANCE OF ON-FARM DRAINAGE SYSTEMS.	20	7	$55,000.00
ON FARM DRAINAGE, DRAINAGE WATER REMOVAL AND CONVEYANCE OUT OF THE IRRIGATION AREAS TOWARDS THE DRAINAGE OUTFALLS	20	10	$80,000.00
SOIL SCIENCE, SALT LEACHING, LAND RECLAMATION	20	5	$40,000.00
COMPUTER MODELS APPLICATION IN I&D	5	5	$10,000.00
GIS AND REMOTE SENSING APPLICATION FOR IMPROVED WATER MANAGEMENT IN I&D	5	5	$10,000.00
I&D MANAGEMENT TRANSFER (INCLUDING PARTICIPATORY IRRIGATION MANAGEMENT/WUAS FORMATION PROCESS AND BACKSTOPPING)	5	15	$30,000.00
STUDY TOUR TO ABROAD (TO BE SELECTED)	5	7	$52,500.00
USE OF THE AGRO-METEO STATIONS NETWORK. INTERPRETATION OF WEATHER FORECASTING AND RECOMMENDATION FOR FARMERS	5	15	$112,500.00
IRRIGATION METHODS AND SCHEDULE FOR EFFECTIVE PEST AND DISEASE CONTROL	20	7	$56,000.00
		Total	**$806,000.00**

ECONOMIC SUSTAINABILITY OF WUAS AND COSTS

While they may be entitled to claim subsidies or state assistance, WUAs are usually largely self-financing, the bulk of their income being provided by their participants. For NGEST, it is presumed that farmers will cover the costs related to the WUA's management and basic activities (e.g. office rent, administration staff salaries etc.) from the beginning of the organization. Additionally, farmers are expected to pay the OPEX costs of the recovery and reuse scheme, and any on-farm development. The proposed water tariff options in this Report have been made with these expenditures in mind.

It should be noted that, because they are non-profit, WUA-specific legislation could confer powers on WUAs to take and impose compulsory measures. These can include: the right to impose compulsory membership/participation on those who benefit from the WUA’s activity; the right to levy compulsory charges regarding, for example, the costs of maintaining an irrigation system; the right to make binding operational rules concerning, for example, the use and allocation of irrigation water; compulsory access rights over land for the purpose of operation and maintenance and if necessary the rights to compulsorily acquire land; and the right to recover outstanding fees and charges on the basis of direct execution (for example by imposing a lien over the land of a debtor) without needing first to obtain a judgment in the civil courts (FAO, 2007). None of these powers are currently in the Draft WUA Regulation. If they are not included in the final version, some aspect of these concerns must be addressed in whatever contractual agreement is brokered between the WUA and either CMWU or PWA.

Table 21 shows an estimated cost breakdown for the establishment and operation of a WUA (gathering approximately 20 farmers) for the NGEST Water Reuse Scheme.

Table 21: Estimated costs for the establishment and operation of one WUA, for 1 year

ITEM	UNIT	COST (USD)
4X4 CAR	1	25,000 USD
OFFICE AUTOMATION EQUIPMENT FOR ADMINISTRATIVE AFFAIRS	Forfeit	25,000 USD
SALARY FOR ADMINISTRATIVE STAFF	1	30,000 USD
RUNNING COSTS	Forfeit	20,000 USD
	Total	100,000 US$

COST SHARING MECHANISMS

Typically, WUA costs include some, or all, of the following:

- The cost of obtaining a permit to abstract and use water and/or to drain water or to dispose of wastewater together with any water use and wastewater disposal charges payable pursuant to such permit;
- Charges in respect of water supplied to the WUA on a contractual basis by a state agency or some other bulk water supplier;
- The WUA's own costs of operating and maintaining the infrastructure under its authority, which may include staff salaries, office expenses (including the costs of rent, utilities and

communication), operation costs including the costs of electricity if pumps are used, system maintenance including routine and annual maintenance, the maintenance of an emergency reserve fund, small replacement fund, transport expenses, purchase of equipment, social charges and taxes; and

- Investment costs for the construction, rehabilitation or reconstruction of infrastructure.

As mentioned above, a key feature of WUAs across the world is that they are usually self-funding, at least as far as operating costs are concerned. The typical sources of WUAs finance include fees and charges for services provided by WUAs to its participants as well as loans, grants and subsidies, income from assets or capital owned by WUAs, and fines from participants who have breached its operating rules.

The way in which the level of fees is determined can be left up to WUAs or specified in the relevant legislation. The amounts payable by individual WUA participants can be based on, for example, the volume of water supplied (if the main WUA service is water provision), flat rate charged per hectare of land (in case of a range of different and not easily measurable services provided by WUA), or value of possessed agricultural land. For the NGEST project, a proposal is made to charge the farmers based on the water delivered to their farms at a rate that ranges between 0.9 and 1.5 ILS/m^3. This fee would cover the expenses of the O&M of the Recovery and Reuse Systems and running the WUA organization.

If farmers are not able to pay the fee until after the irrigation season is over and they have harvested their crops, a range of solutions can be applied, such as: participants can pay deposits, the WUAs can borrow money by way of a loan or bank overdraft or issuing bonds, or receiving governmental or other grants.

Ideally, a WUA fund would be established to provide support for the creation and early administration of the WUA (an initial capital of, say, US$ 1 million). Otherwise the WUA may fail due to low membership fees from the farmers in the NGEST project area, most of whom own small plots of land.

RECOMMENDATIONS

- **Immediately pass enabling legislation for the creation of WUAs**

The Draft WUA Regulation from 2016 should be finalized, promulgated and implemented as quickly as possible. The draft Regulation sets out the basic parameters within which the design of each individual WUA can be crafted. Several important legal rights, however, have not been addressed.

One of those legal rights is the long-term right to abstract water from a natural source or, depending on which Scenario is chosen, a long term contractual right with a bulk water supplier (e.g. NWC). As written, the Draft WUA Regulation states that PWA may cancel a WUA's right to use a water source; it does not say what process or justification would be required for PWA to do so. Moreover, if PWA cancels a WUA's right to use a source, the Regulation states that the WUA will be terminated by the Ministry of Agriculture. This prospect may have a chilling effect in WUA members' willingness to contribute to the long-term investment needs of the system. Although PWA's cancellation may be appealed, if the Association and its work may be terminated at the whim of a ministry, that creates an impression of a less secure institution overall.

Additionally, as mentioned above, WUAs will very often need to have express legal rights to do things like impose compulsory membership/participation on those who benefit from the WUA's activity; the right to levy compulsory charges regarding, for example, the costs of maintaining an irrigation system; compulsory access rights over land for the purpose of operation and maintenance and if necessary the rights to compulsorily acquire land; and the right to recover outstanding fees and charges on the basis of direct execution (for example by imposing a lien over the land of a debtor) without needing first to obtain a judgment in the civil courts. Without this authority, the work of the WUA may be significantly hampered.

- **International Norms**

To mitigate health and environmental risks, common international norms and standards for the quality of irrigation water should be followed.

STAFFING REQUIREMENTS OF THE PIU

The Project Implementation Unit (PIU) should have a multi-disciplinary technical team. Table 22 illustrates the proposed PIU composition.

The PIU shall assist field activities, and act as coordination unit for related on-farm initiatives. The PIU shall be directly linked with the future WUA that will be established to manage irrigation water distribution.

Table 22: PIU Staff Composition

NO.	AREA OF EXPERTISE	INSTITUTION	QUALIFICATION
1	On farm irrigation technology and water distribution	CMWU	Eng.
2	Land reclamation	CMWU	Eng.
3	Information Technology	CMWU	Eng.

4	Plant Production and Soil Fertility	MoAg	MSc
5	Plant Protection	MoAg	MSc
6	Agro-meteorology	MoAg	MSc
7	Rural Extension	MoAg	MSc
8	Administration		

Expert on On-farm irrigation technology and water distribution

Duties / Responsibilities:

- Review the irrigation requirements and water balance analysis performed and recommend further detailed studies as needed;
- Assist relevant team members in the preparation of work programs and schedules;
- Develop a quality assurance program for civil works for the irrigation component, and train staff on the in implementation of the quality control program;
- Operates power equipment and hand tools to install, maintain and repair irrigation systems and related components including irrigation lines, sprinkler heads, control panels, valves, pumps, etc.;
- Checks system for proper operation and timing. May participate in the design or modification of new or existing systems. Performs seasonal maintenance such as system charging and draining;
- Maintains inventory of related parts and supplies. May lead workers on irrigation projects and work on other grounds related assignments as needed.

Expert on Land reclamation

Duties / Responsibilities:

- Advise farmers about appropriate land management and conservation practices, adapted to the project environment;
- Advise other experts about environmental management and conservation;
- Design specific plans to reclaim non-cultivated areas in the project zone;
- Apply knowledge or research findings to address environmental problems;
- Train personnel in technical or scientific procedures;

- Interact with the other technical staff and maintain a positive relationship with farmers.

Expert on Information Technology

Duties / Responsibilities:

- Design, program, and maintain IAS website using HTML5/JavaScript/CSS. Interface with SQL databases as required;
- Maintain Microsoft SharePoint site layout and permissions. Develop custom SharePoint lists and libraries;
- Contribute to Social Media system including creating original content, assisting users in content generation, and account management;
- Interact with and provide services to the other members of the staff in a highly dynamic and occasionally time-critical environment.
- Perform other duties as required.

Expert on Plant Production and Soil Fertility

Duties / Responsibilities:

- Support farmers in designing sustainable and productive cropping patterns;
- Help in crop budgeting & planning;
- Take soil samples, prepare and submit them for testing;
- Review soil test results and provide advice to farmers;
- Inspect crops in accordance with guidance;
- Record crop outcomes as requested;
- Manage required field services such as fertility, soil amendments, crop
- production, and more;
- Maintain crop and financial data in accordance with requirements;
- Interact with the other technical staff and maintain a positive relationship with farmers.

Expert on Plant Protection

Duties / Responsibilities:

- Identify plant protection problems in the project area and provide technical support for the promotion of safe and sustainable plant protection activities, based on IPM solutions;

- Design and conduct periodic reviews and appraisals of the situation of plant pest and pesticide problems in the project area and advise farmers on necessary actions to implement pest and pesticide management programmes;
- Provide advice to IAS in training technical personnel through targeted training programmes, workshops and seminars related to plant protection and maintain close relations with international and national research institutions for the transfer of research findings;
- Perform other related duties as required;
- Interact with the other technical staff and maintain a positive relationship with farmers.

Expert on Agro-meteorology

Duties / Responsibilities:

- Mainstreaming agro-met advisory services into the agricultural extension system;
- Developing and engaging in the delivery of a training plan to improve skills within the extension system for interpretation and analysis of climate information to inform agronomic advice;
- Developing and engaging in education programs for farmers regarding benefits of agro-met advisory services.
- Supporting integration of agro-met within extension packages.
- Reviewing proposed approaches for dissemination and communication of climate information and feedback.

Expert on Rural Extension

Duties / Responsibilities:

- Encourage farmers to adopt best practice techniques by providing exposure to new knowledge, information, skills, inputs and processes;
- Assess individual farms and making technical recommendations for improved production and sustainability;
- Collaborate with farmers in developing processing and post-harvest schemes;
- Suggest research priorities to research committees;
- Organise and manage field days, speak at grower groups, write fact sheets and publications, present courses;
- Interact with the other technical staff and maintain a positive relationship with farmers.

Expert on Administration

Duties / Responsibilities:

- Support team leader in ensuring effective and efficient financial management system;
- Maintain efficient and effective financial system;
- Support in periodic financial planning, including Annual Plan and Budget (APB);
- Supervise general administration of IAS;
- Perform other duties as required.

INSTITUTIONAL CAPACITY ASSESSMENT

There are a number of particular skills that need to be developed for the successful implementation of the NGEST project, including management of MAR and sludge as well as the design, operation and maintenance of modern irrigation technologies. Communication and cooperative approaches should also be fostered through trainings on developing the WUA or community awareness to bolster support for the project.

In order to adequately assess the specific capacity development needs for each aspect of the project, this *Report* has interwoven capacity building throughout each section: Managed Aquifer Recharge; Farmer Assistance; WUAs; and Operation and Maintenance of the Irrigation System. Therefore, although there are recommendations below for Institutional Capacity Building, overall capacity development should be viewed through the context of the entire *Report*.

RECOMMENDATIONS

A capacity development system for the Water Sector in Palestine already exists and a substantial amount of resources are being invested to enhance capacities in this sector (PWA, 2016). Compared to some other countries, where capacity development efforts have to be developed from scratch, Palestine boasts a substantial foundation of sufficiently developed institutions and a high number of human resources investments. Palestinian Universities, polytechnics, industrial secondary schools and vocational training schools produce a constant inflow of trained professionals for the water sector, and international donors have expended considerable sums for training of water sector stakeholders.

However, there needs to be better coordination of capacity development initiatives with policies and strategies so that there is a more efficient utilization of resources and the training better meets the needs of the sector. In particular, PWA, NWC, CMWU and the WUA need targeted capacity building to implement the water law, to make effective and efficient use of increased investments, and to maintain the existing and new infrastructure.

In addition, work needs to be done to create an environment in which skill and knowledge acquisition can take place, including, for example, fostering a professional atmosphere in which technical growth is rewarded and there are incentives for participation, allocating a sufficient budget for on-going development, and ensuring monitoring and follow-up of capacity development efforts.

Below is a truncated list of institutional capacity building recommendations. As mentioned above, for a more detailed analysis of capacity development needs, see the other relevant sections of this *Report*.

Capacity Development Coordination. There is a need for sector-wide monitoring and evaluation of capacity development interventions. The current lack of the monitoring and evaluation is directly correlated with the need for coordination, but also lends itself to the mismanagement of limited resources, decline in performance and loss of value for money spent. It is expected that the newly created Capacity Development Directorate of PWA will lead this coordination as well as execute the recommendations contained in PWA's Water Sector Capacity Development Policy and Strategy of 2016.

Focus on Practical Skills. There should be increased focus on the development of practical knowledge and competencies to address existing and emerging water sector challenges, for example negotiation with the Joint Water Committee, and how to build, manage, repair and renew a modern irrigation system.

Encourage On-going Capacity Development. Water professionals need to refresh and expand their knowledge base in a number of training days each year to be able to excel in their work. Organizational Capacity Development Action plans, covering a 3-5 year period, should be prepared by the relevant units and persons within the respective organizations. These plans should be approved by the organization itself, endorsed at national level, and updates should be made annually.

Help Prepare CMWU. Because CMWU will likely handle the operation and management of the NGEST Recovery and Reuse schemes until the creation of the NWC and WUA, the capacity of CMWU should be expanded to provide this service. Additionally, there may be the need to modify the current mandate of the CMWU to reflect this change.

Sludge Management. Training is needed that tackles sludge collection, treatment, or dumping and sludge management. Sludge represents a completely new sector, which should be organized and well regulated in order to benefit from it.

MAR Training. A simplistic view that treating water to near drinking standards before recharge will protect the aquifer and recovered water is incorrect. For example chlorination, to remove pathogens that would be removed in the aquifer anyway can result in water recovered from some aquifers containing excessive chloroform. In some locations, drinking water injected into potable aquifers has resulted in excessive arsenic concentrations on recovery due to reactions between injected water and pyrite containing arsenic. Source water that has been desalinated to a high purity dissolves more minerals within the aquifer than water that has been less treated (Dillon, 2009).

Therefore, PWA (and any other ministry that will be responsible for the MAR scheme) needs to understand how this aquifer will interact with the recharged water. More specifically, it should have hydrogeological and geotechnical knowledge, as well as knowledge on water storage and treatment design, water quality management, hydrology and modelling, monitoring and reporting. It needs to understand pathogen inactivation and biodegradation. The response of an aquifer to any water quality hazard depends on specific conditions within the aquifer, including temperature, presence of oxygen, nitrate, organic carbon and other nutrients and minerals, and prior exposure to the hazard, so the Authority should receive adequate training on these subjects.

Additionally, PWA (and any other ministry that will regulate the MAR scheme) should acquire basic stratigraphic and hydrogeological information for each well drilled. This information should be stored in departmental data bases, which would ideally be publically accessible on the web.

Create a MAR Unit. The human resources at PWA are limited as the number of staff is already not sufficient to perform all needed tasks (e.g. data evaluation, quality control) let alone to fulfil new tasks related to MAR. Therefore, it is recommended to create a MAR unit to handle strategic planning and the oversight of MAR activities.

FARMER CAPACITY BUILDING

PRESENT FARMERS' ORGANIZATIONS

The Union of Agricultural Work Committees (UAWC) is the main organization[7] active in the project area, already working with a few farmers. UAWC is a non-profit organization founded by a group of volunteers and agronomists in response to the vulnerable socio-political circumstance of farmers that resulted from occupation policies in confiscating lands and water in the early eighties. The Union aims to help Palestinian farmers to market their produce and provides

[7] Other smaller organizations operating in the area: Ma'an Development Center and Cooperative associations (Beit Hanoon Association- farmers union association)

agricultural employment opportunities through a framework of cooperation with domestic, Arab, and international agricultural development institutions.

Since year 1993, UAWC developed its organizational structure, consisting of a general assembly, board of trustees, general director, and two executive directors, in the West Bank and Gaza Strip. UAWC initially focused on forming Agricultural Cooperatives and Committees in different Palestinian rural areas. UAWC receives funding from numerous western governments and aid organizations including the European Commission, World Vision Australia, AusAID, and FAO. UAWC is also in partnership with many international and local organizations like Action Against Hunger, Oxfam, NARC and LRC.

There is a continuous cooperation between the Union and governmental bodies, like MoAg. Relationships are also established with international development agencies, like FAO.

The activities carried out by UAWC with farmers of the target area include development and revamping of the agricultural sector, such as land reclamation; building greenhouses; products quality enhancement and new crops introduction. Depending on the kind of project, farmers may get financial support depending on the type of crop. There may also be special technical, logistical and financial support for exporting goods such as strawberries and medical herbs, which usually ensure a good revenue.

IMPROVING FARMERS TECHNICAL SKILLS

The farmers interviewed during the baseline survey stated they need technical assistance to better manage their farm. Specifically, about 83% of the respondents declared they would like to improve their knowledge on farm mechanization, with a specific focus on irrigation practices and methods. Know-how on greenhouse management and soil amelioration are the two other topics mostly demanded by the farmers (17%). Plant protection and fertilization techniques seem well known by the farmers, as only 1% of the respondents stated the need for more assistance on this subject.

According to the outcomes of the baseline survey and the agronomic characteristics of the new proposed irrigated cropping system, the following training and technical assistance needs have been identified for the farmers:

Training on appropriate use of irrigation. So far, the irrigation practice has been left in the domain of individual farmers without any technical assistance. Underground water is being managed without considering the actual water requirements of crops, after computing the water balance of the area. Without an appropriate approach to irrigation, the amount of water supplied to crops is often under- or overestimated hence causing low yields and problems of uncontrollable pests and diseases on the cultivated crops. The envisaged training program has the objective to make the farmers fully capable to design an irrigation plan suitable for their cropping pattern for various irrigation methods (e.g. surface, sprinkle or drip irrigation).

Training on integrated pest management (IPM). It has been observed that use of pesticides on crops is often high in north Gaza, although these products are quite expensive since imported from Israel. Pests outbreaks are common in the target area, probably because of irrigation misuse (see above). However, farmers lack specific knowledge on effective methods for preventing pests and diseases, which should allow them to drastically reduce the amount of sprayed pesticides, so saving money and making the farming environment healthier. The IPM method has been conceived in the '70. It is a pest control strategy that uses a variety of complementary strategies including: mechanical devices, physical devices, genetic, biological, cultural management, and chemical management. These methods are done in three stages: prevention, observation, and intervention. It is an ecological approach with a main goal of significantly reducing or eliminating the use of pesticides while at the same time managing pest populations at an acceptable level. IPM practices have been so far successfully implemented on vegetables and fruit tree crops in the Middle East. These crop groups represent 65% of the new cropping pattern proposed for the project.

Training on Integrated Plant Nutrient Management (IPNM). This methodology has been devised by the Food and Agriculture Organization of the UN. It allows to match crop nutrient needs with sufficient accuracy to prevent surplus of fertilization. This in turn limits soil and water chemical pollution which usually is a consequence of the use of mineral fertilizers. The purpose is to maintain or enhance soil productivity through a balanced use of mineral fertilizers combined with organic sources of plant nutrients, including biological nitrogen fixation. IPNM focuses first on the seasonal or annual cropping system (namely, the entire crop rotation applied by a farm), rather than on an individual crop; secondly, on the management of plant nutrients in the whole farming system; and, thirdly, on the concept of village or community areas rather than individual fields. The proper application of IPNM, among others, allows to minimize the use of mineral fertilizers which are particularly costly in Gaza, because imported from Israel.

Farming field schools (FFS) for effective training on IPM and IPNM. The Farmer Field School is a form of adult education, which evolved from the concept that farmers learn optimally from field observation and experimentation. It was initially developed to help farmers tailor their IPM practices to diverse and dynamic ecological conditions, but subsequently the method has embraced also other relevant topics for improving farmers' technical skills. In regular sessions from planting till harvest, groups of neighboring farmers observe and discuss dynamics of the crop's ecosystem, under the guidance of a facilitator (usually an agricultural extensionist, well trained on running a FFS). Simple experimentation helps farmers further improve their understanding of functional relationships within the agro-ecosystem (e.g. pests-natural enemy population dynamics and crop damage-yield relationships). In this cyclical learning process, farmers develop the expertise that enables them to make their own crop management decisions. Special group activities encourage learning from peers, and strengthen communicative skills and group building. Farmer Field Schools for vegetable crops have been successfully implemented by FAO in Egypt, Jordan, Syria, Iraq and in Palestine (West Bank).

BUILDING FARMERS' CAPACITY ALONG THE VALUE CHAIN

Supporting farmers in establishing organizations. Collective action can create a more effective market chain that is more stable and can produce the products required at the time needed and of the quality wanted. As a group, producers can provide a more stable and higher quality supply of raw material, which also improves the economic efficiency of the value chain. The higher bargaining power and improved access to markets for group members are made possible by creating a link with other actors along the chain (retailers, traders and processors). However, a farmer organisation cannot be simply created by a top-down approach from the government (for example, by providing strong subsidies to farmers if they join an organisation; or providing inputs for free). Many worldwide experiences clearly show that farmers organisations (under the shape of cooperatives, associations, etc.) fail when members are not fully convinced that collective action is really an opportunity for them to grow and improve their lives. Farmer organisations also fail when their members do not firmly aim at economic independence, but rather rely on external aid. The survey carried out in the project area highlighted that farmers work on individual basis. Even when they share collectively the same private well, everybody keeps on working on his own. It is also noted that only one organisation is existing in the project area, joining a small number of farmers.

To cope with this reluctance toward cooperation, farmers should be invited - through a tailored training programme - to progressively share their activities. For instance, an initial stage of farmer collective action may be started just by purchasing the farming inputs together, which will allow a discount from the seller. Then, farmer collective action can further evolve in growing crops together, according to a cropping plan that has been specifically designed to meet the market needs in a certain period of the year. When collective crop production is finally carried out relationships with the merchants (wholesalers, traders at any level of the supply chain) can be strengthened and options of contract farming may become feasible. Furthermore, associated farmers may start processing the raw materials and their marketing action will become more targeted and complex. By following this progressive process, the farmers' organisation purchasing power and its share of added value along the supply chain will increase.

Training on post-harvest operations and food processing and establishing suitable physical structures. This training programme requires high investments and well established farmer's organisations, which will handle the operations and run the post-harvest and processing structures. The survey carried out by the consultant highlighted that in northern Gaza the existing food industries do not buy raw food materials from the local farmers but they rather import it from Israel, probably because the industry cannot find the required amounts according to its needs. While this specific demand from the industry could be properly satisfied by an organised group of farmers (see above), on the other hand organised and well trained farmers could start simple post-harvest processing activities, such as sorting and packing fresh fruit and vegetables; preparing plant preserves, purée, jams, etc. Another option would be processing dairy products, considering the good milk production from cows, sheep and goats which are being reared in the project area.

All the above-mentioned activities will improve products quality and introduce new products into the local market which will increase the farmers' earnings.

However most of the farmers seem they cannot afford the cost of the initial investment (e.g. purchasing a refrigerator unit, packaging materials, other equipment for processing), nor bank loans seem available in north Gaza. Therefore, external aid should be foreseen together with sound training sessions.

MANAGED AQUIFER RECHARGE

Managed aquifer recharge (MAR), also known as enhanced recharge, water banking and sustainable underground storage, is the purposeful recharge of water to aquifers for subsequent recovery or environmental benefit. MAR can be used to store water from various sources, such as stormwater, reclaimed water, mains water, desalinated seawater, rainwater or even groundwater from other aquifers. With appropriate pre-treatment before recharge and sometimes post-treatment on recovery of the water, it may be used for drinking water supplies, industrial water, irrigation, toilet flushing, and sustaining ecosystems. The figure below shows the basic MAR process for an unconfined aquifer.

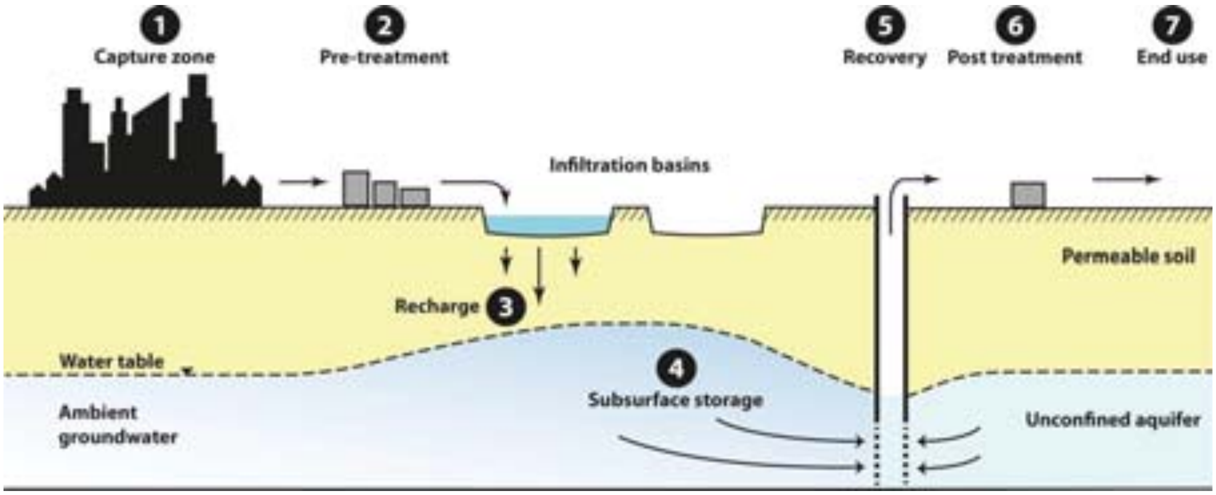


Figure 18: Schematization of Managed Aquifer Recharge System (Source: Dillon, 2009)

Several past documents describe the NGEST Project as if it is a treated-wastewater-for-irrigation project. It is not. Rather, it is a treated-wastewater-for-managed-aquifer-recharge project, where the recovered water will be used for irrigation. The difference is significant and has considerable implications for the feasibility and sustainability of the project. Outlined below are some of the central considerations and concerns for managing this segment of the project.

REGULATORY ISSUES

The main objectives of MAR regulations should be the protection of groundwater from pollution and the assurance of public health. Topics covered in a regulatory framework often include technical issues, water quality requirements to protect groundwater and human health, regulations on the authorization to recharge and to recover water, and institutional arrangements (NRC, 2008).

The quality of the water extracted from the aquifer should meet the most stringent standards related to the intended water use. The quality of the water of a recharged aquifer is a function of multiple factors, including:

- the quality of the recharge water;
- the recharge method used;
- the physical characteristics of the vadose zone and the aquifer layers;
- the water residence time;
- the amount of blending with other sources;
- the history of the recharge.

Setting requirements for indirect recharge is not an easy task. The quality of infiltrated water may be dramatically improved when percolating through the vadose zone, thanks to retention and oxidation processes. These processes affect organic matter, nutrients, microorganisms, heavy metals and trace organic pollutants. However, though much is known about these processes (Bouwer, 1996; Drewes & Jekel, 1996), forecasting the efficiency of the treatment provided by infiltration through the vadose zone and lateral transfer in the saturated zone is complex. Performances depend on a number of factors such as depth of the unsaturated zone, physical and mineralogical characteristics of the soil layers, heterogeneity, hydraulic load, infiltration schedule and infiltrated water quality (Dillon, 2009).

Therefore, particularly when transfer through the vadose zone is part of the treatment intended to bring the water up to the required water quality, pollutant removal tests should be performed, at the laboratory and onsite, to ensure the water achieves the desired quality. The example of the Dan Project in Israel shows that submitting secondary effluents to a Soil Aquifer Treatment system in a dune sand aquifer can result in the production of a nearly potable water (Sack, Icekson-Tal & Cikurel, 2001).

The complexity of reactive transport processes in the unsaturated zone highlights two of the main stumbling blocks that must be taken into consideration if treated wastewater is being considered for MAR: one specific challenge is to have numerical models that can include all of the hydro-biogeochemical processes involved in reactive transport, while a second, more operational, is the need to have a complete biogeochemical and hydrogeological characterisation specific to each MAR site. These should be taken into consideration in assessing the capacity building needs of PWA and other stakeholders involved in managing the NGEST project.

Several countries (the United States and Australia, for example) have developed guidelines for the use of treated wastewater for recharge (USEPA 2004, 2012; WHO 2006a, b). These guidelines focus mainly on the health and environmental risks that result from the presence of pathogenic microorganisms, suspended solids and dissolved organic carbon in this water. There are few recommendations concerning trace element contents in water (e.g. USEPA 2012), except as concerns five trace metals. These are: (i) arsenic; (ii) nickel, which is only weakly toxic but which accumulates in plants; (iii) cadmium, which is considered to be the metallic pollutant of greatest concern due to its rapid accumulation in plants and its proven toxicity even at low concentrations (acceptable daily intake (ADI) 0.057 mg/day/individual); (iv) mercury, which can be highly mobile; and (v) lead, the injection of which, even at low doses, can cause neurotoxic and hepatotoxic disturbances (Dillon et al. 2009a).

Although these guidelines exist, no country has yet adopted a specific set of legal provisions on MAR, rather regulating the different stages of MAR-related activities through existing legislation on groundwater abstraction, wastewater discharge and treated wastewater reuse. Land use planning and environmental impact assessment legislation add to the complexity of the regulatory frameworks currently available for MAR schemes.

Under many countries prevailing water resources legislation (e.g. Israel, South Africa, Spain, USA, Australia), groundwater which has been recharged with TWW is subject to the extraction and management rules of native groundwater, and is regulated accordingly through abstraction licenses or concessions from the un-differentiated groundwater pool.

IMPLICATIONS FOR THE APPLICATION OF PALESTINIAN WASTEWATER REGULATIONS

The Palestinian Wastewater Regulations (PS 742/2003) lay out the water quality standards that must be met for various uses of treated wastewater. As has been discussed in past NGEST documents, the Palestinian standards are stricter than most international guidelines for wastewater reuse because they prohibit the use of treated wastewater for irrigating any type of vegetable, regardless of the quality of water produced. There has been some expressed concern whether this regulation applies to the NGEST irrigation scheme, which would significantly restrict the types of crops farmers could grow in the project area and, as a result, have severe implications for the financial sustainability of the project.

But the concern of whether the regulation applies to the irrigation scheme stems from the misunderstanding of the nature of this project highlighted at the beginning of this section. The NGEST project does not entail using treated wastewater for irrigation *directly*. Instead, it uses treated wastewater for managed aquifer recharge. Later, after the wastewater has infiltrated through the soil and mixed with the native groundwater, it will be recovered and used for irrigation. The recovered water, therefore, is no longer "treated wastewater," and so the restrictions set out in the regulation for the use of treated wastewater for irrigation do not apply.

That being said, the regulation also covers the water quality standards that must be met for using treated wastewater *for aquifer recharge*. The regulation states, first, that direct injection into the aquifer is prohibited. Second, it states that the use of poor quality water ("D") is prohibited. The quality of water used must be either moderate ("C"), good ("B"), or high ("A"). See the below Table 23 for the basic parameters for each category.

Table 23: Palestinian reuse standards (PS 742/2003)

CLASS	QUALITY	BOD MG/L	TSS MG/L	FEACAL COLIFORM MPN/100ML
A	High	20	30	200
B	Good	20	30	1,000
C	Medium	40	50	1,000

D	Low	60	90	1,000

The NGEST reuse and recovery scheme will utilize the Soil Aquifer Treatment (SAT) infiltration methodology, not direct injection. Additionally, the quality of water expected to be infiltrated is high ("A"). Not only is the water coming out of the NGEST WWTP anticipated to be of a high quality but as the water moves through the unsaturated zone during SAT, the water quality is expected to improve even further.

The project, therefore, is in complete compliance with the Palestinian regulation, so long as the water quality parameters for aquifer recharge are met.

OPERATION AND MAINTENANCE

Clogging is the most limiting technical problem in artificial recharge and can only be managed with regular maintenance and pretreatment. Clogging can be caused by various mechanisms like physical clogging by suspended solids, chemical clogging due to precipitation or clay dispersion, mechanical clogging due to entrapped air or biological clogging due to microbial growth (Bouwer, 2002). Clogging leads to the decrease in porosity and hydraulic conductivity and is experienced at the bottom of infiltration basins as well as around injection wells. There are two basic principles for the management of clogging: (a) pretreatment of recharge water and (b) redevelopment (Brown et al., 2006).

Apart from maintenance related to clogging, regular inspections of the facility are needed to assess if any repair works or cleaning is needed. This could include the cleaning of any screens, change of batteries, lubrication or replacement for equipment prone to wear and tear, repair of damage done by natural forces or vandalism. If mechanical or electrical parts are involved their proper functioning needs to be tested.

RECOMMENDATIONS

REGULATING EXTRACTION

MAR is one of the measures that can be implemented to secure water supply, compensate for some effects of climate change and, more generally, handle the quantity and quality of groundwater bodies. It is not, however, a substitute for groundwater management based on decreasing abstraction and adapting withdrawal to resource availability.

There are a number of private wells in the Gaza Strip, only some of which are officially registered. Thousands of wells are estimated to have been drilled without authorization, which has contributed to more rapid deterioration of the aquifer. (UNEP, 2014) To protect the aquifer and for the success of the NGEST project, both the authorized and unauthorized agricultural wells should cease operation.

In order to do that, PWA, which is the institution responsible for issuing and renewing licenses for agricultural wells, plans to include a new clause in the next annual renewal of licenses that specifies that the operation of an agricultural well should be stopped when reuse water is available. At the same time, the voluntary adhesion to the new irrigation scheme shall be pursued.

There are several challenges in getting people to adhere to the new scheme. First, the cost of wastewater needs to be equal or less than the cost of extracting the groundwater. So long as it is cheaper to extract from a private well, that is likely where people will get their water from. Second, the water quality and availability from the new irrigation network needs to equal or exceed the existing system. If the new system is of a poor quality or unreliable, farmers will be unlikely to switch. Finally, there is the challenge of overcoming the local tradition of private wells to switch to a collective irrigation scheme. This will likely take awareness raising and perhaps even financial incentives to change the engrained practices of local users.

MAR TRAINING

There are various institutes within the Gaza Strip that currently provide training regarding water and wastewater management. These institutes should be encouraged to establish short courses for MAR operators and regulators. These could also help ensure risk management plans are designed and implemented effectively and management issues are understood and addressed.

More is said on the needs of MAR training in the section on Institutional Capacity Building.

AQUIFER PROTECTION

It is recommended to develop a holistic MAR strategy and to implement transparent and comprehensive regulations specifying maintenance, monitoring and reporting requirements. Regulations should also address water allocation, ownership issues and demand management.

GROUNDWATER MONITORING

OVERALL MONITORING STRATEGY

Before preparing a groundwater monitoring plan, the overall strategy of the groundwater monitoring program should be defined to guide the development of the plan. In this sense, "strategy" refers to the manner in which a hypothetical release from a regulated unit will be detected or measured. Examples of issues that should be addressed when developing a monitoring strategy include:

- The type of monitoring data needed;
- The locations (both horizontal and vertical) from which the samples are to be collected (i.e., definition of "target monitoring zones");
- The manner in which the samples will be obtained; and
- The ability of the monitoring features to rapidly detect a change in groundwater quality.

Development of a groundwater monitoring strategy is illustrated in Figure 19 and Figure 20. As shown in these figures, the potential sources of contamination and the aquifer of concern should be characterized before developing a groundwater monitoring strategy because selection of target monitoring zones cannot be made until the source and the aquifer have been evaluated, usually through a detailed hydrogeological evaluation of the site. When evaluating the ability of a monitoring system to rapidly detect a release from a potential source, the impact of preferential flow paths and vertical gradients should be carefully evaluated; a two-dimensional analysis of groundwater elevation may not reveal actual upgradient or down gradient locations of groundwater flow. The presence of vertical gradients may significantly effect the selection of monitoring locations.

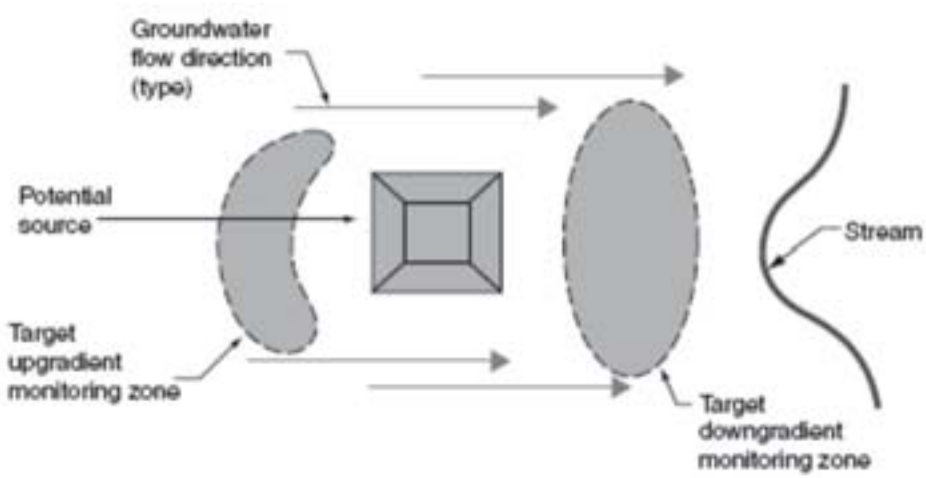


Figure 19: Plan view of typical unconfined aquifer groundwater monitoring system

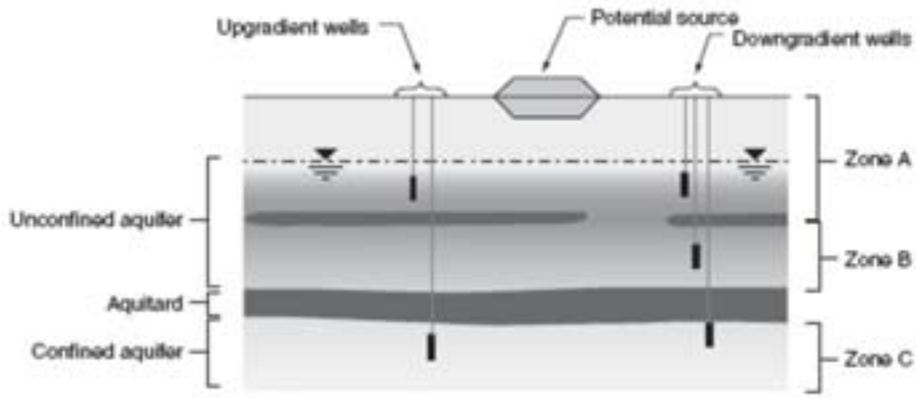


Figure 20: Vertical cross section of target monitoring zones.

MONITORING LOCATIONS AND PARAMETERS

Locating the appropriate monitoring point locations is essential in designing a monitoring network capable of providing data of adequate quality. Selected monitoring locations should provide the most reliable data needed to detect or assess a groundwater contaminant plume. To verify that the monitoring network can accomplish this goal, target monitoring zones must be selected based on the site hydrogeologic conditions and anticipated contaminant pathways. Figure 21 shows the recommended locations of the monitoring wells which was set up based on the location of the recovery wells.

The groundwater monitoring program in the NGEST Project is designed to evaluate the status of the groundwater quality after infiltration of partially treated and treated wastewater. The monitoring wells are distributed in two rows: around 400 to 500 m from the infiltration basin and the second row will be of 1100 to 1200 m from the basin. The first monitoring well row should be located before the first row of the recovery wells in the direction of the infiltration basin, and the second row of the monitoring wells should be located after the second row of the recovery wells to check the quality of groundwater outside the recovery wells areas. The monitoring network will also use the existing 5 monitoring wells constructed recently by PWA and used to monitor the infiltration basin. In addition, the recovery wells will be part of the monitoring network as shown in Figure 21.

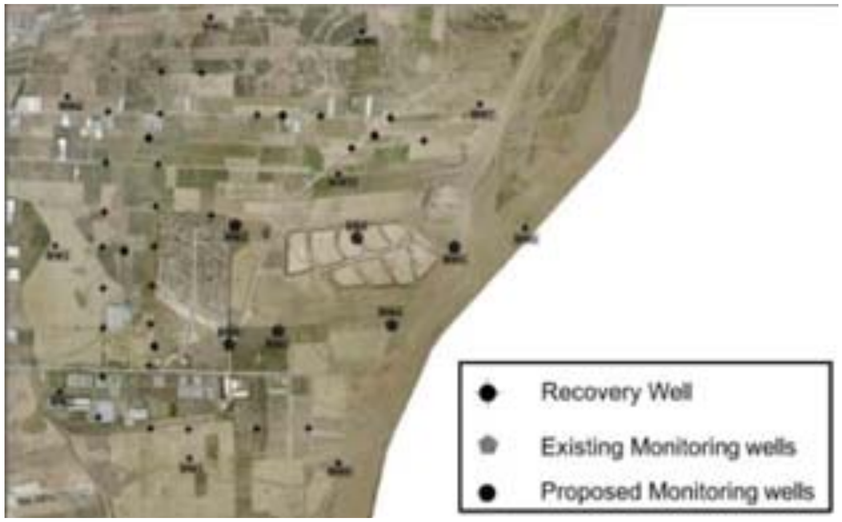


Figure 21: Monitoring wells location

The main objective of monitoring is to check the groundwater quality after infiltration and check the operation of SAT process. The consultant made extensive reviews of similar projects such Gosh Dan Project where several parameters are monitored. Among these parameters, the consultant proposed in Table 24 some parameters which would reflect the status of groundwater after infiltration and could be analysed in Gaza Strip laboratories.

Table 24: Monitored Parameters and Frequency of Monitoring

WATER LEVEL	Monthly
PH	Four Times a year
TDS	Four Times a year
BOD	Four Times a year
COD	Four Times a year
DOC	Four Times a year
TC	Four Times a year
AMMONIA AS N	Four Times a year
NO_3	Four Times a year
NO_2	Four Times a year
T.N	Four Times a year
CL	Four Times a year
DETERGENT	Four Times a year
F.C	Four Times a year
PHOSPHORUS	Four Times a year
HEAVY METALS	Four Times a year
O_2	Four Times a year
NITROGEN AND OXYGEN ISOTOPES	Four Times a year

MG	Four Times a year

Samples will be collected from the monitoring wells to characterize the geochemistry of groundwater. The nitrogen and oxygen isotopes of groundwater nitrate will be used in conjunction with other geochemical data to place constraints on potential nitrate sources.

CONCLUSION

This *Complementary Feasibility Report* brings mostly good news. By reworking the original design, the project can save 21.5% of the water use while using 15% less energy, and can operate with a less complex irrigation schedule. It was determined that the project is in full compliance with Palestinian law, and should be financially sustainable by farmers. The review resulted in a new cropping pattern and design network, and offered a range of scenarios for the water tariff and O&M of the Recovery and Reuse Systems.

This *Report* also confirmed the validity of the original design for the recovery scheme and of the original design for the reuse scheme, confirming the selection of materials, the general layout and the selection of the pumping system. The newly proposed system fixes design inconsistencies of the original so that a minimum water pressure of 2.5 bars is provided to every farm gate.

The good news, however, is contingent. The water and energy savings, simplified irrigation schedule, and farmer profitability are contingent on improving the original design of the reuse scheme, introducing modernized irrigation methods and adopting the newly proposed cropping pattern. The project's compliance with Palestinian law is contingent on a minimum level quality of water coming from the WWTP and being disposed of in the infiltration basins. And the project's feasibility overall is contingent on carrying out robust capacity building for ministerial and farmer stakeholders, and of adequately monitoring the Managed Aquifer Recharge component of the project.

Ultimately, therefore, the feasibility and success of the project hinge on whether all the essential stakeholders cooperate to fulfill their role.

ANNEXES

ANNEX 1: DRAFT MOU

A Memorandum of understanding (MOU) is a document describing a bilateral or multilateral agreement between parties. It expresses a convergence of will between the parties, indicating an intended common line of action. It is often used to establish a clear understanding of how common activities will practically function and each party's role and compensation. The contents of an MOU must (a) identify the contracting parties (b) spell out the subject matter of the agreement and its objectives (c) summarize the essential terms of the agreement, and (d) must be signed by the contracting parties.

Similar to a contract, a memorandum of understanding is an agreement between two or more parties. Unlike a contract, however, an MOU need not contain legally enforceable promises. While the parties to a contract must intend to create a legally binding agreement, the parties to an MOU may intend otherwise. For example, an MOU may recite that the parties “agree to promote and support the joint use of facilities.” This type of provision establishes an important public statement of cooperation, but it does not constitute a legally enforceable obligation. Alternatively, an MOU may outline the terms of an agreement but state that each party’s responsibilities are only enforceable “in the event that the parties’ decide to enter a joint use agreement.” Additionally, a non-legally binding MOU may be useful to serve as an agreement between two or more departments within a single public entity where a contract may not be legally appropriate.

Although there can be legal distinctions between contracts and MOUs, there may be no legal or practical difference if they are written with similar language. The key is whether the parties intend to be legally bound by the terms of the agreement. If so, they have likely created a legally enforceable contract regardless of whether they call it a contract or an MOU. Therefore, parties should address the legal status of their agreement early in the negotiation process.

Successful MOUs require a lot of thought, effort, and cooperation to reach agreement on a range of issues. In addition to the subjects listed above, an MOU can also cover issues such as: (a) who bears responsibility for the costs of maintenance and repairs, (b) insurance and liability, (c) staffing and communications, and (d) conflict resolution. Below is a sample MOU which lays out the basic provisions of an agreement. To agree on any specifics, however, it is highly advised that the parties meet to discuss the terms of the MOU, ideally with a mediator, facilitator or other neutral third party.

Sample

MEMORANDUM OF UNDERSTANDING

BETWEEN [AGENCY]

AND [AGENCY]

1. **Parties.** This Memorandum of Understanding (hereinafter referred to as "MOU") is made and entered into by and between the [agency name], whose address is ______ , and the [agency name], whose address is ______ .

2. **Purpose.** The purpose of this MOU is to establish the terms and conditions under which the NGEST Project partners will coordinate and function.

3. **Duration of MOU.** This MOU shall become effective upon the last signature by the authorized officials from the (list partners) and will remain in effect until modified or terminated by any one of the partners by mutual consent. In the absence of mutual agreement by the authorized officials from (list partners), this MOU shall end on (end date of partnership).

4. **Responsibilities of [agencies]**. [Delineate all obligations of the first party listed above. Include the agency's responsibilities for costs and expenses related to NGEST, including the cost of wages, salaries, beneficial use of equipment belonging to other agencies while acting pursuant to this MOU.]

5. **Responsibilities of [other agencies].** [Delineate all obligations of the other agencies listed above. Identify the agency covered by this MOU, and include the agency's responsibilities for costs and expenses related to NGEST, including the cost of wages, salaries, benefits and use of equipment belonging to an agency while acting pursuant to this MOU.]

6. **General Provisions**
   A. Each Party pledges in good faith to go forward with this MOU and to further the goals and purposes of this MOU, subject to the terms and

conditions of this MOU. The Parties shall attempt to resolve disputes through good faith discussions.

B. Either Party may unilaterally withdraw at any time from this MOU by transmitting a signed writing to that effect to the other Party. This MOU and the public/private partnership created thereby shall be considered terminated sixty (60) days from the date the non-withdrawing Party actually receives the notice of withdrawal from the withdrawing Party.

C. By mutual agreement, which may be either formal or informal, the Parties may modify the list of intended activities set forth in Paragraph 4.0 above and/or determine the practical manner by which the goals, purposes and activities of this MOU will be accomplished. However, any modification to any other written part of this MOU must be made in writing and signed by both Parties or their designees. Applicable Law. The construction, interpretation and enforcement of this MOU shall be governed by the laws of the State of Palestine. The courts of the State of Palestine shall have jurisdiction over any action arising out of this MOU and over the parties.

D. Entirety of Agreement. This MOU, consisting of [insert number], pages, represents the entire and integrated agreement between the parties and supersedes all prior negotiations, representations and agreements, whether written or oral.

E. Severability. Should any portion of this MOU be judicially determined to be illegal or unenforceable, the remainder of the MOU shall continue in full force and effect, and either party may renegotiate the terms affected by the severance.

F. Third Party Beneficiary Rights. The parties do not intend to create in any other individual or entity the status of a third party beneficiary, and this MOU shall not be construed so as to create such status. The rights, duties and obligations contained in this MOU shall operate only between the parties to this MOU, and shall inure solely to the benefit of the parties to this MOU. The provisions of this MOU are intended only to assist the parties in determining and performing their obligations under this MOU.

The parties to this MOU intend and expressly agree that only parties signatory to this MOU shall have any legal or equitable right to seek to enforce this MOU, to seek any remedy arising out of a party's performance or failure to perform any term or condition of this MOU, or to bring an action for the breach of this MOU.

Partner name

Partner representative

Position

Address

Telephone

E-mail

Partner name

Partner representative

Position

Address

Telephone

E-mail

Date:

(Partner signature)

(Partner name, organization, position)

Date:

(Partner signature)

(Partner name, organization, position)

ANNEX 2: WATER SUPPLY CONTRACT COMPONENTS

Either CMWU or NWC will need to sign a bulk water supply agreement with the WUA. Given the complexity and legal sensitivity of such an agreement, an actual contract is not included here. Instead, below is a list of thirteen areas that should be covered in any future water supply contract. This list is not exhaustive (it doesn't include boilerplate contract components, for example) but it does cover the items most needed for a comprehensive agreement.

1. Price and non-price terms

A bulk supply agreement should include both price and non-price terms so that the parties know what services are being provided at what price.

The price terms could include:

- a standing charge and volumetric rate for each water supply;
- charges for any volumes of water the WUA takes that are above the maximum amount allowed in the agreement;
- a minimum charge that the WUA pays whether it takes any water or not;
- a capital contribution to the connection cost;
- charges for the provision of information; and
- rules about the periodic adjustment of charges.

The non-price terms could include the ownership and responsibility for the assets used in the supply (discussed below), how charges are to be paid and how the parties are to operate the bulk supply.

2. Ownership of and responsibility for the assets

The agreement should be clear about who owns and who is responsible for operating the assets that are used to provide the bulk supply (which will depend on which Scenario is chosen). One way of doing this would be to include a detailed operational plan, which, as well as defining ownership and operating responsibilities, could include details such as maximum flow rate. This information will help in resolving any operational problems and will have a bearing on the price terms of the contract.

3. Measuring the water supplied

A bulk supply agreement should specify how the water supplied is to be objectively quantified. In this case, a meter will likely be used, which will need to measure the water supplied to the degree of accuracy specified in the agreement. To ensure the accuracy of meter readings, meters should be tested (ideally, the type of test should also be specified in the agreement). Even with testing, there can be occasions when a meter is found to be faulty. To prevent a possible impasse between the parties the bulk supply agreement could specify the mechanism for determining the volume of water supplied in this case.

4. **Quality of the water supplied**

The agreement usually states the quality of the water to be provided and how it is to be assessed. This could be done by specifying the water quality parameters the non-potable water should meet. It is the WUA receiving the bulk supply that is responsible for the quality of water supplied to its customers (the farmers) but NWC (CMWU) must inform the WUA of any events that might lead to harmful water being supplied.

5. **Adjusting prices**

Price terms can be set in different ways. For example, some bulk supply agreements include volumetric charges for the supply of water. Other bulk supply agreements include contributions to the capital costs of building the bulk supply assets or the ongoing costs of operating the bulk supply.

As well as setting out the price terms, the bulk supply agreement might also explain how those price terms are to be adjusted to allow for inflation. Typically, bulk supply agreements include provisions for annual adjustments to the price terms to allow for inflation, although the parties could agree different frequencies of adjustment. The adjustments could be by set amounts, percentages or linked to measures of specific costs or general inflation. If the parties agree that no adjustment is to be made to the price, they could set this out for clarity.

6. **Interruptible or firm supply**

The bulk supply agreement should include details of any allowed interruptions. It would need to explain the number and duration of interruptions that NWC could make and under what conditions interruptions could happen. There might be a link between when NWC can make interruptions and interruptions for planned maintenance, emergencies and water shortages.

7. **Interruptions of supply to carry out planned maintenance**

Planned maintenance can disrupt the flow of water from NWC to the WUA. The WUA will want to know when maintenance will happen so that it can make alternative arrangements to supply the farmers.

The bulk supply agreement could put a requirement on NWC to minimize the frequency and length of any disruption to the bulk supply as a result of planned maintenance work. The agreement would need to define what is meant by 'planned maintenance'.

The agreement might set out the process by which NWC would consult the WUA over the timing of planned maintenance. It could specify how far in advance NWC should notify the WUA of the planned maintenance. The agreement might also allow a reasonable period for the WUA to express its views and could require NWC to consider them before making a final decision on the timing and duration of the maintenance.

8. Co-operation in emergency situations

Emergency situations could arise during the period of a bulk supply agreement that affect the quality of the water supplied, the volumes of the water supplied or some other aspect of the bulk supply agreement. It would be helpful if the agreement defined what is meant by an 'emergency' and explained how the parties would deal with one.

Obligations on parties to cooperate in an emergency could include:

- cooperating to prevent an emergency from occurring;
- notifying the other party of the existence and cause, if known, of the
- emergency;
- ensuring, as far as is reasonably practicable, that any emergency has the minimum possible effect on the supply of water;
- agreeing reductions in supply where this is reasonable to prevent or mitigate the effects of an emergency;
- ensuring that priority is given to vulnerable customers if a supply of water is restricted because of an emergency, and co-operate in agreeing categories of vulnerable customers;
- using all reasonable endeavors to restore the supply;
- investigating the cause of an emergency that has occurred; and
- sharing any lessons learned to prevent a recurrence of the emergency.

9. Co-operation at times of water shortage

The agreement could specify what is to happen during a time of water shortage. It might also place an obligation on both parties to cooperate in such situations.

The terms relating to water shortages could include:

- a definition of the circumstances under which NWC may limit the water it supplies under the agreement;
- an obligation for NWC to notify the WUA if it intends to impose a temporary ban on the use of water by some or all of its customers; and
- provisions relating to the actions the WUA should take to reduce water taken from the bulk supply in the event of a water shortage.

10. Liability for planned and unplanned interruptions

To give the WUA comfort that it would be adequately compensated for losses arising due to unplanned non-emergency interruptions, the agreement might include categories of costs such as:

- costs incurred in securing alternative sources of supply. The parties may wish to include a non-exhaustive list of potential alternative sources that would need to be deployed – for example, tankered water supplies; and
- GSS (guaranteed standards scheme) payments to customers.

To provide greater certainty, the agreement might allow for liquidated damages, that is, an estimate in advance of the losses the WUA might incur if the supply was not made available. To limit NWC's risk exposure, the liabilities in the agreement might be capped.

11. Duration

It might take many years for the revenues from the bulk supply to cover the cost of the dedicated bulk supply assets. A bulk supply agreement might therefore need to be long enough to allow for the parties to recover the costs of the assets. On the other hand, a long duration agreement can create problems if circumstances change and the agreement is no longer beneficial for one or both parties.

12. Dispute resolution

Disputes might arise from time to time with regard to the bulk supply agreement. It would be sensible for the agreement to include a provision to resolve disputes. It is best if this is comprised of an internal escalation process that must be followed before a matter may be referred to arbitration, the courts or some other form of formal adjudication.

Some energy contracts specify a time limit after which a party cannot raise a dispute about the other party's previous performance of the contract. For example, the contract might specify that parties must raise a dispute about an incorrect payment within a year of the payment being made.

13. Termination

The agreement should set out how it can be terminated by either or both parties. Ways in which a bulk supply agreement could be terminated include:

- on a date specified in the agreement;
- on either party giving a specified period of notice;
- by mutual agreement;
- if the WUA is terminated;
- if there is a material breach of the contract that is not remedied. A material breach could include repeated failure to pay on time or a one-off failure to pay on time which was not corrected within a specified period, or a persistent failure to supply.

ANNEX 3: SOCIAL AND ENVIRONMENTAL IMPACT ASSESSMENT

INTRODUCTION

The summary below was prepared as part of the deliverable "Supplementary Environmental and Social Impact Assessment (SESIA)", which involved the preparation of an independent ESIA of the North Gaza Emergency Sewage Treatment Project (NGESTP), Effluent Recovery & Reuse System and Remediation Works.

The specific objectives related of this SESIA were as follow:

- Highlight the legislation under which the project will be implemented. Besides the Palestinian Laws and Regulations, the study also highlighted the Regional Laws and Regulations, especially from Jordan, Israel and Egypt, associated with wastewater reuse and sludge management and reuse. In addition, the International Standard and Guidelines, including World Bank (WB) procedures and FAO and WHO Guidelines were highlighted.
- Provide baseline environment and socio economic conditions of the project components.
- Identify of the possible positive and negative social impacts, permanent or temporary, of the project components. In addition, the analysis and mitigation measures will be developed to reduce the negative impacts resulted from the project component.
- Identify of any potential temporary or permanent land acquisition requirements associated with civil works. In addition, develop the outline of the vulnerable groups that might be affected by the project and identify the appropriate mitigation measures
- Develop an Environmental and Social Management Plan (ESMP) and monitoring plan to manage, mitigate and monitor any possible negative impacts. Moreover, a capacity assessment of the implementing party to implement the ESMP and recommendations for any capacity-building needs

In addition, as assessment was made for sludge management for the sludge resulting from the North Gaza Wastewater Treatment Plant (NGWWTP) and intended to be used in agriculture as part in the effluent recovery and reuse scheme or in emergency cases to be dumped to landfill.

The study was undertaken throughout July - October 2012. The team developed a cross-sectional study that used a multi-data source approach including site visits, primary data, secondary data, surveys and site measurements.

ENVIRONMENTAL BASELINE CONDITION OF THE PROJECT COMPONENTS

a. General Characteristics of the Project areas

Beit Lahia Wastewater Treatment Plant (BLWWTP) and Effluent Lake

- BLWWTP was constructed in 1976. It is located some 1.5 km east of the town center of the Beit Lahia, northern part of Gaza Strip.
- BLWWTP was built in sand dunes overlying a clay layer of variable thickness with un-continuous impermeable clay layer. It was constructed in stages and modification and rehabilitation activities were performed in order to increase capacity of the plant.

  • During the past few years the situation escalated. With the increase of wastewater network connection, the volume of wastewater inflow had far exceeded the plant's treatment capacity that have led to deterioration of the effluent quality and have led to clogging effects in the neighboring sand dune areas. The ongoing decrease of the infiltration capacity of the flooded areas and the increasing wastewater volumes have resulted in the formation of enduring ponds and finally a lake.
- Over the years the effluent lake had a volume of about 2 million m3 of foul wastewater, which covers around 300 dunums and continued to rise and was threatening to flood the whole sewage collection system and the neighboring communities.
- Starting in 2007 (NGESTP was starting to be implemented), almost 90% of the effluent lake had been dried due to weathering and limited discharge to the lake. Currently the wet area occupies around 10% of the total lake.

Agriculture Land Proposed for irrigation/Sludge use

- The area in the vicinity of NGWWTP is assigned designated to benefit from the recovery water and the treated sewage sludge in the agricultural activities.
- The proposed area is divided into two zones according to its location from NGWWTP. Zone A (northern part of NGWWTP) with about 10,100 dunums whereas, Zone B (southern part of NGWWTP) with about 5,000 dunums. Most of the area is considered as under rain-fed conditions.
- Citrus, Olives, fruits and vegetables are among the crops grown in the proposed agriculture land for reuse scheme.

b. Physical and Biological Environment of the project areas

- The project sites have a typical semi-arid Mediterranean climate with long hot and dry summer (from 25^{o}C in summer and 13oC in winter with maximum daily temperature can reach 29-30^{o}C and the minimum temperature is around 9^{o}C). The proximity of the Mediterranean Sea has a moderating effect on temperatures and promotes high humidity throughout the year. The prevailing wind direction is South West with an average speed of 4.2 m/s (winter) and from North West (summer).

- The average annual evaporation rate is around 1,900 mm/y (5.2 mm/day). The maximum evaporation rate increases during the summer and may reach over 6 mm/day between June and August.
- Ambient air and noise quality at the project sites are consider normal with a slightly high on BLWWTP due to more rapid population surrounding the area.
- The dominate soil type in the irrigation area can be considered as heavy soil with a deep soil profile, which means will not limit root penetration for deep rooted crops. The irrigation scheme assessment was done with taking into account the climate change through the mentioned 10 years by increase the air temperature of 1.5oC.
- The soil at different locations of the effluent lake has a normal pH range and Organic Matter content with negative and low Fecal Coliform. In addition, the Electrical Conductivity at the wet part indicates the higher number due to remaining heavy metal from the stabilized sludge that is present in the top layers of the effluent lake.
- No major fault type formations have been observed in Gaza Strip area.
- Mainly aquatic birds and the reptiles (rats, snake, crows, barn owl and other wild species) are present at the BLWWTP and the Effluent Lake. The effluent lake provides breeding, nesting, roosting and feeding habitats for different birds' species. Typical effluent lake landscape consists of sand dunes covered with Acacia shrubs.
- In the proposed agriculture land for effluent recovery reuse, many Olive, Plum, Almond, Citrus or Orchards have been encountered at agriculture land allocated for irrigation of recovered water and sludge reuse. Many wildlife species; particularly birds were found to inhabit these agro-ecosystems.

c. Water (groundwater quality) of the project components

- The water quality in this study focused on chloride and nitrate concentrations (the most important contamination indicators in the groundwater in the Northern Gaza aquifer).
- The highest chloride sources are expected in the areas affected by seawater intrusion and the deeper groundwater layer (generally exceed 250 mg/l). The seawater intrusion zone covers the western part with 2 to 3 km inland the aquifer. Most of the municipal wells were concentrated in this zone and due the high pumping rate of these wells resulted in accelerating the seawater intrusion.
- NO3 concentration exceeds the WHO drinking water guidelines in most of the Northern Gaza aquifer. In 2003 at the infiltration site (adjacent to NGWWTP), the maximum nitrate concentration in the groundwater was about 30 mg/l due to the operation of the infiltration basin using partially treated wastewater.

- Cl concentration in the wells close to the infiltration basin ranges between 350 to 650 mg/l (till the middle of 2012). The trend of the chloride concentration recorded is steady since 2011 in some wells. In addition, Nitrate concentration for the same period ranges between 20 to 120mg/l.
- From the analysis it found that the groundwater is free of Salmonella, Nematodes and Amoeba & Gardia. However, the total Bacteria ranges between 30 to 395 cfu/ml and the total coliform ranges between 6 to 50 cfu/100 ml in some wells.
- The heavy metals concentrations in all analyzed wells were less than the Palestinian standard values for irrigation. However, there were some wells that have concentrations of Boron and Mercury higher than the standard values.
- The groundwater quality under the effluent lake and the BLWWTP sites is improving after drying the lake.
- According to the groundwater modeling result, the recovered water is not expected to have bacteria, including fecal coliform due to the infiltration process (treated by the soil). In fact, the water quality, especially after the NGWWTP will have better quality than the wastewater reuse. However, to ensure the public health concern related to wastewater and sludge reuse, the monitoring plan is determined in the monitoring plan (including the mitigation measures for epidemiology).
- There is no archeological or historical site as well as the protectorate areas nearby the project component sites. The only site consider important and respected (psychologically important) by the community is the El Shuhada Cemetery, which is nearby the location of storage tanks and booster pumps (water distribution network).

POSITIVE ENVIRONMENTAL AND SOCIAL IMPACTS

The positive environmental and social impacts of the project are:

1. The recovered effluent from the groundwater will be an important source of irrigation water, as water resources in the Gaza Strip are scarce; especially during summer time, as a source of water will be continuously available.
2. The groundwater quality is suitable for Unrestricted Use. The only restriction is for the Total-N, which is higher than 15 mg/l. This could be considered as an advantage for agricultural use. However, it is advisable to restrict the use the recovered water for uncooked vegetables at least for the first year of implementation.
3. The recovery scheme will limit the horizontal dispersion and the vertical building up of the water table, which without recovery will have a negative impact on current land use.
4. Effluent reuse of the recovered water will solve the problem of the disposal of wastewater, as it will be treated and injected for agricultural use.

5. The groundwater quality after drying the lake is improving.
6. Sludge has a high content of organic matter that can help conserving soil organic matter, and sludge stimulates biological activity in the soil.
7. The sludge reuse brings possibility for farmers to supply their lands with organic fertilizer at low costs and reliably available. It is expected that the sludge will cost as low as the transport cost of around 1 ILS/50 kg (compare with 50 ILS/50 kg for Israeli imported fertilizer). Another level of competition reported was with the Palestinian organic fertilizers (each dunum needs about 8 cubic meter from this fertilizer. That cost around 850 ILS per ton which is relatively expensive). Thus, the produced sludge will be a competitive product if it cost less than 300 ILS/T.
8. The sludge reuse is environmentally the best solution compared to disposal inland fills or incineration plants and appealing solution for sustainable sludge management.
9. Sludge is one of the outputs of the project, and will increase the income for those who work in sludge trading,
10. Sludge reuse will work for reduction of chemical fertilizers.
11. Reduction of health risks associated with exposure of villagers or inhabitant surrounding the effluent lake and BLWWTP to environmental risks and nuisance released from the BLWWTP, such as effluent lake flooding and the risk of water borne disease, will be seen. In addition, the project will protect the livelihood status of people who suffered due to the flooding of BLWWTP,
12. The provision of recovered water will reduce the cost of water needed for irrigation in the area. The utilization of the recovered water of high quality and of less price might work for the benefit of the farmers (increase their profits)
13. The new lands gained due to the decommissioning of BLWWTP will be used in agriculture activities or as a recreational or residential place.
14. Potential increase of the price of lands and dwellings due to the implementation of the project,
15. Provision of jobs due to the implementation of the project components, both during construction and operation phase.
16. After decommissioning of BLWWRP, it will considerably reduce odor, mosquitoes and flies.
17. As soon as the NGWWTP is completed and starts its operation (2013) the infiltration of a high-quality effluent in the infiltration ponds will begin to compensate the negative effects on groundwater.
18. The construction of the site and the carrier line will improve the road network connecting the existing and the emergency area.

NEGATIVE ENVIRONMENTAL IMPACT ANALYSIS AND THEIR MITIGATION

a) During Construction Phase

i. Air Quality and Noise Pollution (low impact and temporary)

It is concluded that the air quality impacts associated with dust generation will be of "low" significance. However, whenever the dust emission becomes higher than normal and create disturbance to the workers and project activities, it is recommended to spray the location with water to reduce the impact.

ii. Gaseous Emissions (low impact and temporary)

Air emission impacts associated with the proposed project will be of "low" significance. However, to reduce and minimize the impact, it is recommended to check the vehicles regularly for the exhaust gas and minimize the vehicles and heavy equipment movement at the same time.

iii. Noise (low impact and temporary)

The noise generation is not expected to represent a significant issue to local residents (due to distance from the residential area, only during the day time and on a short period). The most affected people from noise impacts are the construction workers. The mitigation measures recommended in the ESMP and Monitoring Plan for control of noise and air emissions, especially to the workers are based on compliance with the Palestinian Outdoor Noise Standards.

iv. Vibration (low to medium impact and temporary for the water distribution networks and low impact and temporary for other project components)

The closest sensitive structure to the site of the booster pumps (due to psychological perspective of the respected site according to the people in Gaza) is El Shuhada Cemetery (around 10 m away). Consequently, medium vibration impacts could be anticipated to occur. The mitigation measures proposed during the construction of water distribution network component (storage tank and booster pump), near the El Shuhada Cemetery area are as follows:

- The base camp (workers site camp) and place for storage of equipment have to be on the future land dedicated for future expansion (pumps and the storage tanks).
- The construction of the storage tank and the booster pumps room including the generators and the electrical rooms have to be separated and not overlapped.
- The ready mix concrete is preferred to be used instead of onsite concrete mix. Beside the reduction of the dust transmitted to the agricultural land due to mixing onsite and

reduction of the hazardous wastes and other solid wastes on site, the vibrational load will be also reduced significantly (use of concrete pumps will be advantageous).

- In addition, due to the sensitivity of the groundwater, the vibration around the wells construction site should be minimized in order to avoid groundwater contamination due to potential spills.

v. Construction Waste and Handling of Hazardous Waste (low to medium impacts)

Based on the expected waste generation associated with the proposed NGESTP project activities, the impact will be of "low to medium" significance. The following mitigation measures are proposed:

- Onsite domestic sewage collection and disposal (adequate sanitation facilities) shall be provided by the contractor for construction workers' needs.
- Site waste management plan should be developed by the contractor prior to commencement of construction works.
- The burning of any type of wastes should be avoided.
- The reused clay or excavated sand should be stockpiled and stored away from
- Nearby sanitary landfill should be notified to receive the unusable non-hazardous construction wastes or damaged construction materials.

vi. Soil Contamination during Decommissioning of BLWWTP (medium impacts)

Soil may be exposed to contamination due to the movement of construction vehicles and equipment. The contamination will occur due to oil and fuel spills from the engines of machines, and also due to polluted wheels (importing pollutants from outside of the site). It is concluded, based on the above, impacts associated with soil contamination will be of "medium" significance. Mitigation measures proposed during the decommissioning of the treatment plant are as follows:

- The decanting activities should be done with a care and the pipe should be have sufficient length to prevent the spillage to the ground
- Preventive maintenance for any vehicle or equipment that has an engine that leaks oil or fuel.
- Preparing a special fuelling and oil change station on site to contain any possible fuel or engine oil spill. Otherwise fuelling and oil change should be conduct in the private oil stations out of site (concrete paved station on site).
- If any machine is broken on site, a containment system should be used to prevent the spill of oil or fuel on the soil.

- The vehicles moving in and out of site should be checked at the inlet gates of BLWWTP to assure that they are not importing pollutants through the wheels.
- The paved path / concrete paved parking or loading and uploading sites can be made to ensure that the vehicle will not transport the pollutant from the site.

vii. Remediation Works at the Effluent Lake

The best options for financially and technically feasible options (excluded the land investment cost) are the Phytoremediation, clay placement and three layers clay placement. The most sensitive criteria for the remediation selection is the land investment. As the land is being rented and the longer term of the remediation activities will affect the initial cost, in addition, the three layers of clay cap is not necessary as the contamination does not need deep soil replacement, the clay cap placement is the most suitable option, financially and technically.

Heavy machinery and vehicles might be used are excavators and heavy trucks. Impacts associated with remediation works will be of "medium" significance. Mitigation measures proposed during the remediation works of the effluent lake are as follows:

- Standard protection to the workers during the overall remediation activities
- Special tools for handling the dangerous wildlife found
- On site sanitation should be established for the workers
- Avoid the disturbance of the existing plants and wildlife as much as possible during the site preparation
- Handle with care found wildlife (catchment dangerous wildlife). It is recommended to seek the assistance from Ministry of Health and Ministry of Agriculture for the best practice for handling the catch dangerous wildlife
- Minimize the soil contamination by site management plan (place for temporary storage, handling, transportation and disposal)
- Replanting the affected plant that has to be displaced. If the replanting is not feasible, planting 2 new trees to compensate 1 removed tree has to be done by the contractor
- Notification to the designated landfill should be done prior to the soil disposal.

viii. Changes in Hydrology and Groundwater Quantity and Quality (low impact)

During the construction of the recovery scheme, remediation of effluent lake and decommissioning of BLWWTP there will be no impact on groundwater. It is expected the depth of the excavation will not significantly impact the groundwater but the wells construction. It is recommended to hire the highly qualified contractor for wells establishment. Therefore, the impact negligible for decommissioning and remediation activities and low impact on the water distribution networks (only for wells construction).

The mitigation measures to avoid the hydrology of groundwater quantity and quality are similar to the general wells construction. To reduce the impact on wells construction, highly qualified contractor has to be contracted, isolate the access and the site area to avoid outside disturbance that can make the land fallen down to the wells.

ix. Health and Safety (low to medium impacts)

During the construction phase, as the proposed project are at a large distance from the nearest population or residential area and on the agriculture land, the health of the population is not expected to be significant and considered minimal.

Negative impacts will mainly concern the works for construction of new facilities, which are mainly within water distribution networks. It will have few limited negative impacts such as temporary discomfort and localized pollution to the communities caused by worksites (noise, exhaust fumes, dust and vibration, risk of accidents due to increased traffic in the project impact area, the presence of workers, very limited disruption of wildlife and vegetation, poor management of handled products: fuels and lubricants as well as worksite waste, etc.).

However, although the impact is considered low and temporary for the communities, the mitigation measures are developed to minimize the impact. In addition, due to the health and safety of the workers, which accidents might occur on site in various construction project activities, mitigation measures are as well developed to mitigate the risk of health and injuries to the workers. Mitigation measures developed to minimize the risk related to health and safety, both for community and workers are:

- Raising awareness campaigns to workers and community members to promote safety, and health and safety monitor should be appointed. The monitor can be chosen from among community members who accepted to work in the project.
- Workers should wear standard protection especially due to the dangerous wildlife on BLWWTP and effluent lake sites.
- Workers should be trained to cover the completed parts and keep their work areas safe. In case of causing an accidents, the workers should be penalized either by deduction of salaries or dismissal.
- Existing utilities (especially at BLWWTP and water distribution network), if exist, would be located and staked before construction begins, including and at intersections of other pipes and crossings. This would confirm the location and depth to ensure new construction does not impact the existing utilities.

5. The identification of the existing infrastructure (other pipelines, cables, etc) has to be identified prior to the construction phase.

- Heavy equipment would not normally be operating over the existing utilities during construction of the new line. If heavy equipment or trucks must cross the existing utilities, thus additional soil cover is needed to protect the existing pipe.
- Onsite inspectors would be present during construction to verify that the construction contractor is following engineering specifications and meeting regulatory requirements.
- Workers should take the following steps to protect themselves from falls during high construction:
    - Use 100% fall protection when working on higher construction site
    - Participate in all training programs offered by the employer (contractor).

      c) Follow safe work practices identified by worker training programs.
    - Inspect equipment daily and report any damage or deficiencies

As a mitigation measure, safety measures should be put into consideration and addressed with the workers. The contractor and the PMU are mainly responsible for any safety procedures to be applied

x. Archaeological Disturbance (low impact)

Surveys in the area of the BLWWTP and Effluent Lake concluded that there is no archaeological sites were identified. The confirmation letter was sent to the Archaeological Authority for assurance and clarification of the assessment and the replied letter indicating that the project components (including the irrigation lands) have non-existence of the archaeological site.

Although the sites do not have any archaeological importance, the Jordanian Antiquities Law still applicable and can be applied if there is any archaeological and valuable objects is found.

xi. Ecological Disturbance (medium impacts)

Wetland ecosystem and vertebrates living at the area surrounding the BLWWTP and the effluent lake might be affected during the decommissioning of the treatment plant and the remediation works of the effluent lake.

Although the biodiversity, especially fauna identified within the vicinity of the project sites (effluent lake and BLWWTP), are commonly found, it is not belong to endanger wildlife and in fact it could cause a vertebrate pest outbreak or other health impact, the mitigation measures have to be developed to avoid the ecological disturbance and provide safe and adequate relocation for found wildlife and re-plantation for the fauna. Based on the ecological disturbance impact, the project at BLWWTP and effluent lake will have significant medium impacts.

However, due to the decommissioning activity and the remediation of the effluent lake, after the finalization of the works activities, the site will provide a permanent positive impact. The biodiversity disturbance of the site due to the remediation works and decommissioning activities, either by relocation, temporary shelter or re-plantation to another site or still within the project site area, will be compensated with the long term positive impact. In addition, as the fauna and flora found in the project site is a local and not belong to the endanger species, they will easily adapted and continue their life cycle.

Mitigation measures to reduce and minimize the impact of the existing wildlife and plantation within the BLWWTP and effluent lake are as follow:

- Standard procedure for health and safety of the workers at the site, especially the equipment that protect them from the wildlife.
- Equipment to handle the vertebrates should be prepared (this includes cages, snake sticks, net, etc.) in case of the found vertebrate during the activities.
- Assistance from the staff of Ministry of Health and Ministry of Agriculture is needed to advice the contractor for temporary relocation of the found wildlife.
- Re-plantation of the trees, if needed, should be done by the contractor, if it is needed. The re-plantation can be done within the area of the effluent lake.
- Avoid the disturbance of the nesting, breeding site. The found nesting or breeding found has to be handled with care and replace it to the safe site.

Regarding the water distribution network site, there is an opportunity that the networks will be laid in agricultural land and impose on the existing crops and local animals around the site. Mitigation measures shall be developed to limit and to reduce the impacts. Based on the ecological assessment, the project will have low to medium impacts.

Mitigation measures develop to avoid the crop and animal disturbances in the vicinity are as follow:

- Temporary construction fences have to be installed prior to the construction of the water networks and other components for recovery water distribution to avoid the fallen of the local animal and to localize the site from the local animals.
- In case the destruction of the crops or plants at the farms near the construction of the recovery water distribution network, compensation has to be settled.
- If it is needed, the replanting or trees relocation (temporary or permanently) has to be done. If the relocation or replanting of the existing trees is not feasible, the

compensation of planting 2 trees (for removal of one tree) has to be done in the other area. It is advisable to plant locally trees.

xii. Land Use and Accessibility (medium impacts)

During the decommissioning and remediation activities, the impact on land use and accessibility is considered “low”. Regarding the land use and accessibility of the water distribution networks for the recovery reuse scheme, the main impact on roads traffic will be during possible lying of water distribution networks along or across main roads. In addition to the limited access road for the community during construction, this access difficulty will have more impacts on elderly people, handicapped and children, who may accidentally fall in open trenches or make tedious long cycles before they reach their targeted locations.

Mitigation measures proposed are as follow:

- Selection of suitable location for temporary storage of construction materials, equipment, tools and machinery prior to starting construction, especially on the site that is close to El Shuhada Cemetery.
- The employed machinery drivers should receive training on safe utilization of their machines to minimize accidents risks.
- Clear signs indicating the project site and temporary fences shall be installed prior to the preparation of the site, especially the water distribution networks area.
- Avoid the side of the road for all the temporary storage materials and the place for standby equipment.
- All the activities have to be during the daytime and have to be scheduled to avoid conjunction with the school and working peak hours (morning and afternoon).
- The traffic department should be informed and involved to manage the traffic during the congested time. In addition, the preferred route and an alternative road have to be recommended by the traffic department.
- If the digging (open trenches) is not completed within a day period, the clear sign (by light or fluorescence lights) has to be considered to determine and identify the site during the night.
- When the land use and accessibility is disturbed and the safety of the communities passing by the project location is triggered (especially to the children, handicapped or the elderly who might use the access road), the temporary access road has to be considered with the traffic department assistance.
- Temporary resettlement that might occur during the preparation and the construction phase has to be defined and accordingly has to be compensated.

b) During Operation Phase

i. Air Emissions and Noise Pollution (low to medium impacts)

The impact of such air emissions are considered minor, because the diesel generators are only expected to operate temporarily during power cut-offs. The compliance of generator emissions with Palestinian Standard for Ambient Air will be sufficient to safeguard against unacceptable air emissions impacts to the neighboring areas.

A relatively higher impact will be on the Pumping Station staff, which may be exposed to intermittent pumping noise. The standard protection of the workers, including earmuffs, has to be practiced all the time, especially at the Pumping Station area.

ii. Odor

The operation of the water distribution network system is not expected to have significant impacts on odor. However, due to the remaining pond #7 that will be used as the emergency pond, the operation of anaerobic ponds will have significant impact associated with generation of odor (mainly H2S) and vectors that mostly generated from raw sewage storage. The mitigation measures proposed for Pond #7 is as follows:

- Minimum standard is set to consider as an emergency (monitoring plan is presented at ESMP section). Maximum permissible level of the overflow or raw wastewater discharge in the pond is 2 m height.
- Maintaining high performance of biological treatment of wastewater. In addition, to be as far as possible from odor recipients and keeping buffer zones between odorous units and neighbors.
- The aerator from the aeration tank can be installed on the pond to maintain reasonable dissolved oxygen in the water to avoid anaerobic conditions.

iii. Vibration

Concerning the vibration at the effluent lake and the decommissioning site (including remaining pond #7 and the PS adjacent to pond #7), the impacts is considered negligible. The main impact (medium impact) expected during the operation of the water distribution network is on the site of booster pump (special attention has to be made to reduce the vibration impact at the pumping station and the generator to minimize the impact due to the close distance with the El Shuhada Cemetery). The mitigation measures to minimize the vibration impacts of the machines are:

- Tree plantation, heavy leaf trees to absorb the vibration and noise generated, is recommended to be planted at the Cemetery area along the proposed main road at the other side of the pumping station.
- Maintenance of the machines and equipment has to be maximized (less than the standard period required).

iv. Water Resource Contamination

The impacts on groundwater is one of the most important issues associated with the reuse project, as part of the project has been designed to prevent impacts on the groundwater from infiltrating partially treated sewage. To identify the impact of the groundwater, the verification of the available water quality monitoring (four rounds from PWA) has been analyzed and the groundwater modeling with different scenarios has been run (with and without recovery schemes and different scenarios of recovery wells implemented (12 wells and 25 wells) and during the different year of implementations; 12 wells implemented on the year 2013 and 2015). Based on the modeling results, the groundwater monitoring plan has been developed.

The groundwater monitoring programme is the key mitigation measures to indicate the water resource contamination. The groundwater monitoring programme will be explained in detailed on the following section, ESMP.

v. Impacts on Local Agriculture, Public Health and Water Resources

Based on the design project report three scenarios that considered the expected water quality recommended are as follows:

- Scenario I: It is more advisable to cultivate orchards on the available area to the west of the project along Al Karama Road. Based on crops water requirements, the available reclaimed water is just enough to irrigate 5,375 dunums divided into citrus, olives, fruit trees, alfalfa and grains (water quality does not have impact on the crops selection)
- Scenario II: Wastewater will be treated more effectively and consequently the effluent will be of better quality in general. The quantity of effluent diverted to the infiltration basin will increase to approximately 23,100 m3 daily. This reclaimed water will be used to irrigate additional land to 7,525 dunums in total.
- Scenario III: This Scenario assumes that the planned WWTP in East Jabalia will work with its full capacity by year 2025. The quality of reclaimed water (39,160m3/day) is expected for unrestricted use. The quantity of reclaimed water will be enough to irrigate about 12,577 dunums. In this scenario vegetable crops will be introduced with an area of 1,258 dunums.

vi. Decommissioning of BLWWTP on Groundwater Quality (positive impacts)

After decommissioning the lake and BWWTP, a positive impact will be clearly found on the groundwater quality in the aquifer under the lake.

vii. Recovery Water Quantity and Quality (medium impacts)

Based on the groundwater modeling and analyses, the recovery water quantity and quality is expected to be acceptable for agricultural irrigation for unrestricted crops, but unacceptable to be used for drinking water. Besides continuous groundwater monitoring, public awareness is needed to ensure that the community is not using the recovery water as a drinking water.

Although the NGWWTP is located nearby the Israeli border, the flood risk is not expected to cross the fence to Israeli border due to the topographical nature of the project site. In addition, as the groundwater modeling result from different scenarios, the plume will not be significantly crossed the Israeli border as the infiltration basins are located more than 300 m downstream of the border and with the recovery wells implementation, the wells will accelerate the flow in the downstream direction away from the Israeli border.

After decommissioning the lake and BWWTP, a positive impact will be clearly found on the groundwater quality in the aquifer under the lake.

viii. Land Use of Effluent Lake Remediate and Decommission of Beit Lahia Wastewater Treatment Plant (medium impacts)

In one year period, the remediation activities will be finalized. Afterward, the remediated effluent lake can be used for agriculture purposes or residential, depending on the Urban Planning of the area and El Awqaf future plan.

After the completion of the remediation works, depending on the urban planning of the area and the future plan of Ministry El Awqaf, the land use of the effluent lake will be mitigated. Based on the soil assessment prior to the completion of the remediation works, there are two options of land use which can be applied:

- To be used as an agriculture land. Although the area will not need additional filling or leveling, but due to the huge amount of the soil excavated at the nearby landfill site (Johr Eldeek) that will be implemented during 2018, if needed, the excavated soil can be transported to the effluent lake site as far as the soil is considered good. The soil quality has to be determined (soil analysis done at the landfill site, by the landfill management), before transporting it to another area.

The agreement between Ministry of Awqaf and the Land Authority or the Ministry of Economic in addition to the agreement of the Landfill management shall be reached prior to transferring the soil to the effluent lake. According to the capacity analysis during the EA of NGESTP, a maximum of 1.5 million m3 of soil can be transferred to fill the effluent lake

- To be used for residential purposes. Additional soil for leveling and soil conditioning, if needed, at the effluent lake site when the urban planning of the area is dedicated for residential area. The soil analysis will not be crucial as the option 1 and the agreement shall be reached only between Ministry El Awqaf and the Ministry of Economic and Land Authority in addition to the agreement of the landfill management for transporting the soil to the remediated effluent lake.

Due to the remaining pond # 7, the mitigation measures are developed to minimize the impacts due to the operation of pond # 7. The impact on the land use and accessibility of the decommissioning land and remaining pond #7 is of "medium" significance. Mitigation measures developed to reduce the impacts are as follows:

- Fences surrounding pond # 7 have to be constructed to reduce the accessibility of the community to the pond area. During the Public consultation, Beit Lahia Mayor announced that there is a budget allocated to build the permanent fence around the pond #7. The agreement between PWA and Beit Lahia Municipality can be reached on the construction procedures.
- There should be 10-15 m distance between the pond area and the fences to be constructed on the surrounding pond.
- The trees shall be planted nearby the fences, in order to reduce the odor or nuisance and separate the pond site from the surrounding neighboring area and future land use of the other decommissioning ponds. Planted trees will also bring positive impact on the visual impact.
- The site is only connected to one main gate and the access road to the neighboring site in addition the pond site should be connected with the pumping station at the vicinity for ease access

ix. Public Health related to Using Recovery Water for Irrigation (medium impacts)

Health protection measures which can be applied to the agricultural use are:

- Crop restriction
- Human exposure control and promotion of hygiene

Adopting crop restriction as a means of health protection in reuse schemes will require a strong institutional framework and the capacity to monitor and control compliance with regulations and to enforce them. Farmers must be advised why such crop restriction is necessary and be assisted in developing a balanced mix of crops so that production of surplus of a specific crop is avoided.

Control measures aimed at protecting agricultural field workers and crop handlers include:

- The provision (and insistence on the wearing) of protective clothing, the maintenance of high levels of hygiene and immunization against (or chemotherapeutic control) selected infections.
- Risks to consumers can be reduced through cooking the agricultural products before consumption and by high standards of food hygiene, which should be emphasized in the health education associated with irrigation schemes.
- Local residents should be kept fully informed on the use of recovery water in agriculture so that they, and their children, can avoid these areas.
- Special care must always be taken to ensure that agricultural workers or the public do not use irrigation water for drinking or domestic purposes by accident or for lack of an alternative.

All measures should be coordinated with the awareness campaign of using treated wastewater and pilot projects of using treated wastewater for irrigation. According to the clarification from the PWA team responsible for the effluent reuse study and pilot projects in Gaza, currently there are ongoing projects related to the awareness and the pilot projects, i.e. awareness workshops carried out for farmers, operators and managers of recovered wastewater (and more awareness will be carried out during the operationalization of the pilot projects).

Recovered water reuse, as it is demonstrated on the groundwater modeling concluded that there is no indication of bacteria or viruses, including the Fecal Coliform. The combination use of recovered water and the sludge for the same area proposed will not have significant impact to the soil, as only the nitrate is considered higher than standard (in this regard, it is not recommended to be used as a drinking but is considered an advantage for the agriculture).

Concerning the epidemiology due to the reuse of the recovered water and sludge for irrigation and soil at the irrigated land, based on the expected water quality, there will be no bacteria, viruses and other related pathogens that lead to the waterborne diseases, i.e. cholera, hookworm, diarrheal diseases or other helminthic infections is expected. However, the monitoring of the epidemiological diseases shall be done by the Ministry of Health through the health centers, especially the health centers within the area of the irrigated land using the recovered water and sludge. Once there is indication of patient with symptom of the diseases mentioned above, the Ministry of Health shall report the case to PWA to investigate the water quality of the water distribution network and sludge quality. The investigation should conclude the source of the infections or diseases.

When the source is due to the recovered water or sludge reuse, the emergency procedure shall be prepared by the PWA in coordination with CMWU to stop the distribution for further investigation. When the infections or diseases resulted from other source, the standard procedure of the Ministry of Health concerning the outbreak or endemic should be followed.

x. Contamination from Reuse and Disposal of Sludge (medium impacts)

When the sewage sludge fails to meet Rule 503 Class-A on sludge use requirements, it will pose hazardous health and environmental impacts if applied to the lands for agriculture use. The potential contamination will affect soil, air, groundwater and crops. If for some reason the sludge fails to meet Class-A requirements, it will be disposed in a landfill. The most probable impact is high concentration of pathogens (over 1000 cells/100 ml). High concentrations of heavy metals (higher than those in Class- A standards) are not expected as verified by the sludge analysis results.

Concerning the reuse of the recovered water and the reuse of the sludge at the same area proposed, according to the groundwater analysis and current measurement, the recovered water does not contain any possible health risk as well as heavy metal that could have a significant effect on crops. In addition, based on the sludge analysis and the treatment technology at NGWWTP and low content of heavy metal found, the sludge is already stabilized and predicted to meet the Class A rules for sludge reuse.

However, the importance parameter to be ensured for recovered water is the pH and for the sludge is the stability of the sludge. Using the combination of the recovered water and the sludge are not expected to have high significant negative impacts on crop and soil. In addition, with the sludge reuse implementation schedule, sludge monitoring plan and the groundwater monitoring plan implemented during the operation phase, the impact associated is considered low. The importance of the monitoring plan for sludge and recovered water are highly significant. Accordingly, with the possibility of lack of enforcement, the trained qualified personnel for management and monitoring plan has to be taken into consideration. The good management monitoring practice, documentations and reporting has to be well defined and prepared accordingly

Proposed mitigation measures for emergency situation when the sludge is not meeting the requirement of Rule 503 Class A include:

- Sludge not meeting these requirements should not be used for agricultural purposes and should be disposed to landfills.

- As a protection measure in this project, is limiting the sludge application for vegetables that are eaten uncooked despite the fact that Rule 503 Class A sludge allows sludge application for all types of vegetables.
- Adhering to the monitoring and testing requirements
- If the sludge does not meet the Class-A requirements especially with respect to pathogen concentration it should be mixed with lime (the same way that floating sludge is treated) and disposed to landfills.
- Training and guidance for farmers and sludge transporters regarding healthy handling and usage of sludge in agriculture.
- Some precautions to protect farmers are to wear suitable clothes, gloves and boots; washing before eating; and using a facemask if the sludge is dusty.
- Vehicles should be carefully selected for their local suitability and transport routes chosen so as to minimize inconvenience to the public. Special care must be taken to prevent vehicles carrying mud onto the highway.
- Enclosed trucks should be used for transporting treated sludge to prevent sludge spill and to avoid any odor release.
- Keeping good communication between customer, regulator, public and stakeholders including landowners and retailers.

NEGATIVE SOCIO ECONOMIC IMPACTS AND THEIR MITIGATIONS

- Decommission of the BLWWTP will reduce water that some of the farmers relied upon to water their plants. Indicating that their income might be affected that will be mitigated through: i) Provision of recovered water of a competitive price to minimize the potential impacts. ii) Due to the fact that the sewage untreated water should be banned, appropriate laws shall be developed to criminalize the use of untreated water
- Potential risk for the people in the adjacent areas due to having no fence around Pond #7 that might affect children. Mitigation measures will be through constructing fences.
- The use of lands might be limited due to the pond as having recreational activities; especially in case of not having a fence surrounding the pond #7. In addition, the construction of residential compounds in decommissioned area will be limited due to the existence of the pond. Again, the fence will be the most appropriate mitigation.
  - The construction of the carrier pipes will have negative impact due to noise and obstruction of traffic and use of agricultural land during the construction stages.

The project should reduce the disturbance to community using most appropriate environmental mitigation measures in addition to information sharing.

- Due to the unfavorable odor, mosquitoes and flies might affect the health of the adjacent communities. The flies should be combated using hygienic and environmentally friendly procedures.
- The sludge reuse for fertilizer might affect those who work in the chemical fertilizers sector in Gaza Strip, especially, those who import fertilizers. Integrating laborers in the new market could be an appropriate mitigation measure.
- Negative impact on the livelihood status of those who operate wells. Potential loss of income for those who own and operate the wells that will be closed due to project implementation. The laborers and the well owners might be affected severely. It could be mitigated by provision of appropriate compensation i.e. jobs or monetary.
- Put limitation to the plantation of certain crops in the beneficiaries who will use the recovered water. Orientation sessions should be presented to raise farmers awareness regarding the type of crops that should be planted using recovered water
- Expropriation for the areas of lands needed to construct the recovery well and lands needed for the project. The 27 well and the expansion of the treatment plant need about 18,175 m2 (please note, during the social investigation, the wells implementation considered was 27, as it was stated on the design report). Mitigation measures include protective procedures should be applied to limit the resettlements; avoiding small plots in order not to raise poverty and compensation should be paid in a full market price.

POTENTIALLY AFFECTED PARTIES

According to the ranking for the most affected groups who has no alternative livelihood approach were ranked and recognized as follow:

1. The Operators of wells (who are uneducated, untrained) might suffer due the termination of wells. They are maximum 10 people. The magnitude of their vulnerability shall be mitigated

2. The Owners of wells (who might be terminated) will be badly affected due to losing a valuable asset (the well), as well as, being in critical need for alternative source of water, which will cost a lot. In addition, some of them used to gain his income through selling water which will not be available (indicating that his income will be badly affected)
3. Those who Rent Lands from Awqaf for a few amount of money that includes the cost of water. They will be affected in sense of losing their lands and paying for water.
4. The Owners of small plots of lands who will be expropriated during the construction of the recovery wells. Some of them have small plot of lands that don't exceed one dunum. The wells will pass in the middle of such plots of lands and the remaining land will be too small for any use.
5. Other Project Affected Persons due to the implementation of the project during the construction activities

The mitigation of impacts described in detailed in the mitigation measures section. However the discussion of mitigation measures with the above mentioned affected groups based on the entitlement characteristics, any one that might be affected due to expropriation should be compensated. It is recommended to develop a Resettlement Action Plan in order to identify accurately the Project Affected Persons (PAPs), their entitlement, compensation valuation and mechanisms proposed for compensation.

Residual Impacts and Costs of Applying Mitigation Measure

This discussion will cover the whole potential impacts resulted due to land acquisition and expropriation during the preparation, construction and operation phase.

The estimated cost for applying the different activities related to the potential expropriation and land acquisition will be mainly based on:

- Cooperation with the municipalities and other organizations Negotiation with the Awqaf
- Negotiation with the affected people

Therefore, any budget estimations for such activities is based on non-solid rationale

Willingness to Pay, Cost Analysis and Tariff Survey

Surveys have been conducted for willingness to pay for the wastewater and sludge reuse, water distribution network and cost analysis including proposed tariffs for the effluent recovery. The result is a stand-alone report that is presented in Annex 8.

Regarding the increment cost of the reuse system, the draft vision toward the reuse system is under developed. The study includes tariff assessment; cost analysis for water reuse as well as the sludge reuse. However, the tariff survey and willingness to pay conducted under this study should be taken into consideration.

Resettlement Action Plan (RAP)

Based on findings and the consultant's recommendation in addition to the WB approval, the RAP should be prepared as a document due to the certainty of the OP 4.12 triggered.

Once the RAP ToR is cleared (by the donors), work towards the RAP is underway. In specific, the RAP should provide details on how the affected parties are identified, consulted on the project and the adverse impacts they will experience, the compensation, and the modes of grievance redress that is available to them. More specifically, detailed information on the operators of the wells (license or unlicensed), owners of wells, those who rent lands from the Awqaf should be developed, and owners of small plots of lands who will be affected /expropriated; permanently or temporary (due to the disturbances; i.e. land use and accessibility, traffic, etc) should be identified.

Project Alternative

Basically, the objectives of the Effluent Recovery and Reuse, in addition of decommissioning of BLLWTP and remediation works of Effluent Lake adjacent to BLWWTP is to improve the environmental, socio economic and public health conditions in Gaza Strip, especially at the project areas. Accordingly it is expected, by definition, that the environmental and social benefits will overweigh the impacts.

All the environmental and social negative impacts discussed are mainly site-specific and could be managed / minimized through implementing the proposed mitigation measures as described earlier. Comparing the benefits to the impacts in a strategic level, it could concluded that the "no project alternative" is not supported from the environmental and social perspective, given that the project impacts will be controlled as recommended in this ESIA.

In addition, the implementation shall be implemented and start to be operated before 2015, otherwise the recovery scheme will not be able to catch the pollution and they will affect the irrigation wells around the recovery wells.

Environmental and Social Management Plan (ESMP)

ESMP was developed to reduce or eliminate the negative impacts of the project component. The table of the ESMP both during construction and operation phase (environmental and social perspectives) are presented at the following tables (Table 1 – Table 3). The tables also include the monitoring plan, the institutional responsibility for inspection and monitoring including the budget proposed for management and monitoring proposed. The Institutional set up and the roles and responsibility for implementation and supervision during the construction and operation phase of the project components is presented on detailed on the main report of SESIA.

Grievances and Compensation

All grievances received verbally or in written shall be documented in a grievance register and handled by the PMU (PWA). It is of importance to react as quickly as possible to the grievance of the citizens. A best practice standard is to acknowledge all complaints within 10 days. Due to the different character of the complaints, some of them cannot be resolved immediately. In this case medium or long-term corrective actions are required, which need a formal procedure recommended to be implemented within 30 days:

1. The petitioner has to be informed of the proposed corrective measure.

2. In case if a corrective action is not required, the petitioner has also to be informed accordingly.

3. Implementation of the corrective measure and its follow up has to be communicated to the complainant and recorded in the grievance register

The comprehensive grievance mechanism including the institutional responsibility, monitoring, responses procedure and disclosure of the grievance is presented at the main report of the SESIA.

Cash flow, and their respective representations in the financial statements, represent the best explanatory force in providing the reader strong information related to the project performance to create a positive cash flow resulting from the current management processes and/or investment/financing processes. The analysis of cash flow also allows the analyst to verify the existence of proper financial balance between sources of raising investment and the use of the same.

A cash flow statement is a listing of the flows of cash into and out of the project: Revenues and subsidies/grant are the cash inflow, Investments and the costs are the cash outflows. The balance is net cash flow at a specific point in time.

Scenario 3 considers a situation where the construction costs relating to the work of recovery of the waters and of the wastewater reuse projects, provided both in Phase 1 and in 2 are paid in full by funds provided by Donors or the government. The other operating costs of the plant and the maintenance are, however, by paying a water tariff by farms benefiting from irrigation.

The basic aspects of financial and economic analysis, which Scenario 3 has been submitted, are summarized below.

A) Financial analysis

Farm-level investments for an estimated total of about 18.7 million ILS (orchard plants, plant irrigation adjustments etc.) have been graduated over a period of four years.

Staff training activities, much smaller in scope, were instead paid on the first year.

The civil works and the equipment of the recovery wells - tank and booster system, (30,83 million ILS) based on the executive design, were planned to be carried out between the first and the second year of the twenty-five years of the analysis. The 24th year will require procedures for the rebuilding of some of the equipment at the end of useful life, with an estimated cost of 10 mln ILS.

Investments for the implementation of the consortium irrigation network (99,33 million ILS) , to be carried out as a result of the progress of the previous work, are attributed to the second and third year, at the end of which can be considered the final construction stage.

So the project management phase begins. Even for the irrigation network, after twenty-five years, it will be necessary to partially reconstruct the less durable components of the plant.

In the gradual phase of the investment, the irrigation management phase begins with the project.

In the first 4 years, farmers will increase their costs due to the progressive introduction of orchards and greenhouses. From the 4th year, with the full production of orchards and greenhouses, costs and revenues are estimated constant for the remaining 21 years.

It should be considered that farm management costs include, of course, irrigation costs (in the net income statement the cost of irrigation on farms is calculated as the water tariff multiplied by cubic meters of irrigated water).

The water tariff includes the general costs of recover, distribution and control of the irrigation network.

With regard to the investments and the related management costs, the revenues of the project consist of:

- Farm revenues: are calculated on the basis of surveys and estimates carried out in the early months of the year even at project farms;
- Water tariff paid by Industry: 70,000 cubic meters of water per year, consumed by industrial activities in the area at a tariff of 2ILS / CM;
- From the time saving of the farmers, for the lack of irrigation water coming from private wells; These time savings have been prudently estimated, and the hours saved by farmers can be dedicated to the farm, or to other, paid jobs;
- Last but not least, payments by Government / Donors, after one year, come to cover the investments already made for the project under consideration.

The cash flow balance, obtained from the costs and revenues just described, leads to a highly positive result in financial terms. The result holds high values even during the simulations; These were carried out by applying incremental interest rates, at which two financial indicators (Financial Net Present Value and Benefit Cost Ratio), maintains full performance.

B) Economic Analysis

The components of economic analysis include investment and management costs, as highlighted in the previous chapter.

To these have been added:

- Correction of labour cost from financial to economic, consisting of the attribution of labour costs, linked to social costs, such as payroll & social security tax rate;
- VAT Investment Adjustment;
- VAT Revenues / Costs Adjustment.

From the sum of these amounts to the financial ones, an economic flow has been estimated, which, according to the present, shows a good robustness of the project. In fact, by performing simulations with incremental interest rates, even economic analysis after the financial one keeps values steadily positive.

A cash flow statement is a listing of future flows of cash that occurred during the life of the project. A cash flow statement is not only concerned with the amount of the cash flows but also the timing of the flows. In this analysis, a forecast of expected flows and outflows for the next 25 years of project has been made.

ANNEX 5: BALANCE SHEET FOR INDIVIDUAL CROPS

Table 25: Balance sheet for Citrus

Citrus	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		1,800.00	1.72	*3,096.00*	
	Costs	Q.ty/du	NIS/unit.	NIS/dun	
Tillage	n.	1.50	100.00	150.00	
Chemical Fertilizers	kg.	80.00	5.00	400.00	
Organic Fertilizers	kg.	400.00	0.50	200.00	
Soil Disinfection	kg.				
Plant Protection*	kg.	4.00	100.00	400.00	
irrigation	m3	827.20	1.50	1,240.80	
Harvesting Labour	dd	14.00	40.00	560.00	
Harvesting machinery	h				
Depreciation of the plant	1,380	duration yrs	35.00	39.43	
TOTAL				*2,990.23*	***105.77***
Labour & Enterprise					665.77

Table 26: Balance sheet for Olive

Olive	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
olive oil 50%		45.00	16.00		
tables olive %		300.00	4.00	*1,920.00*	
	Costs	Q.ty/du	NIS/unit.	NIS/dun	
Tillage	n.	2.00	60.00	120.00	
Chemical Fertilizers	kg.	40.00	5.00	200.00	
Organic Fertilizers	kg.	450.00	0.50	225.00	
Soil Disinfection	kg.				
Plant Protection	kg.	3.00	40.00	120.00	
irrigation	m3	705.10	1.50	1,057.65	
Harvesting Labour	dd	8.00	40.00	320.00	
Harvesting machinery	h	5.00	6.00	30.00	
Olive's milling	kg.	45.00	3.50	157.50	
Depreciation of the plant	1,780	duration yrs	40.00	44.50	
TOTAL				*2,274.65*	*-354.65*
Labour & Enterprise					-34.65

Table 27: Balance sheet for Peaches

Peaches	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		1,100.00	2.50	***2,750.00***	
	Costs	**Q,ty/du**	**NIS/unit.**	**NIS/dun**	
Tillage	n.	2.00	60.00	120.00	
Chemical Fertilizers	kg.	60.00	5.00	300.00	
Organic Fertilizers	kg.	300.00	0.50	150.00	
Soil Disinfection	kg.				
Plant Protection	kg.	5.00	80.00	400.00	
irrigation	m3	628.60	1.50	942.90	
Harvesting Labour	dd	4.00	40.00	160.00	
Harvesting machinery	h				
Depreciation of the plant	1,980.00	duration yrs	35.00	56.57	
TOTAL				***2,129.47***	***620.53***
Labour & Enterprise					*780.53*

Table 28: Balance sheet for Grains

Grains	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		450.00	1.50	***675.00***	
	Costs	**Q,ty/du**	**NIS/unit.**	**NIS/dun**	
Tillage	n.	1.33	60.00	79.80	
Chemical Fertilizers	kg.	40.00	5.00	200.00	
Organic Fertilizers	kg.	100.00	0.50	50.00	
Irrigation pipes (/5 y)	ml	1400.00	0.70	196.00	
Plant Protection	kg.	4.00	15.00	60.00	
irrigation	m3	309.90	1.50	464.85	
Harvesting Labour	dd	8.00	40.00	320.00	
Harvesting machinery	h				
Seedings	kg.	20.00	2.25	45.00	
TOTAL				***1,415.65***	***-740.65***
Labour & Enterprise					*-420.65*

Table 29: Balance sheet for Other fruit crop

Other fruit crops	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		750.00	3.35	***2,512.50***	
	Costs	**Q,ty/du**	**NIS/unit.**	**NIS/dun**	
Tillage	n.	2.50	60.00	150.00	
Chemical Fertilizers	kg.	60.00	5.00	300.00	
Organic Fertilizers	kg.	250.00	0.50	125.00	
Soil Disinfection	kg.				
Plant Protection	kg.	5.00	80.00	400.00	
irrigation	m3	622.30	1.50	933.45	
Harvesting Labour	dd	8.00	40.00	320.00	
Harvesting machinery	h	5.00	6.00	30.00	
Depreciation of the plant	1,800.00	duration yrs	20.00	90.00	
TOTAL				***2,348.45***	**164.05**
Labour & Enterprise					**484.05**

Table 30: Balance sheet for Summer vegetables

Summer vegetables	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		5,000.00	0.80	***4,000.00***	
	Costs	**Q,ty/du**	**NIS/unit.**	**NIS/dun**	
Tillage	n.	1.50	100.00	150.00	
Chemical Fertilizers	kg.	40.00	5.00	200.00	
Organic Fertilizers	kg.	500.00	0.50	250.00	
Soil Disinfection	kg.	1.00	100.00	100.00	
Plant Protection	kg.	15.00	25.00	375.00	
irrigation	m3	650.10	1.50	975.15	
Harvesting Labour	dd	15.00	40.00	600.00	
Irrigation pipes (/5 y)	ml	800.00	0.70	112.00	
Seedings	kg.	1.00	60.00	60.00	
TOTAL				***2,822.15***	***1,177.85***
Labour & Enterprise					***1,777.85***

Table 31: Balance sheet for winter vegetables

Winter vegetables p	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		3,000.00	1.30	*3,900.00*	
	Costs	Q,ty/du	NIS/unit.	NIS/dun	
Tillage	n.	1.50	100.00	150.00	
Chemical Fertilizers	kg.	50.00	5.00	250.00	
Organic Fertilizers	kg.	400.00	0.50	200.00	
Soil Disinfection	kg.	1.00	100.00	100.00	
Plant Protection	kg.	12.00	25.00	300.00	
irrigation	kg.	293.90	1.50	440.85	
Harvesting Labour	dd	20.00	40.00	800.00	
Irrigation pipes (/5 y)	ml	800.00	0.70	112.00	
Seedings	kg.	1.00	60.00	60.00	
TOTAL				*2,412.85*	*1,487.15*
Labour & Enterprise					2,287.15

Table 32: Balance sheet for winter tomato greenhouses

winter tomato greenhouses p	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		7,000.00	1.50	*10,500.00*	
	Costs	Q,ty/du	NIS/unit.	NIS/dun	
Tillage	n.	1.50	100.00	150.00	
Chemical Fertilizers	kg.	40.00	5.00	200.00	
Organic Fertilizers	kg.	400.00	0.50	200.00	
Soil Disinfection	kg.	1.00	100.00	100.00	
Plant Protection	kg.	25.00	25.00	625.00	
irrigation	m3	141.80	1.50	212.70	
Harvesting Labour	dd	30.00	40.00	1,200.00	
Harvesting machinery	h				
Seedings	kg.	0.02	8,000.00	120.00	
Depreciation of greenhouse	mq	750.00	50.00	1,875.00	**20 year*
TOTAL				*4,682.70*	*5,817.30*
Labour & Enterprise					7,017.30

Table 33: Balance sheet for Almond

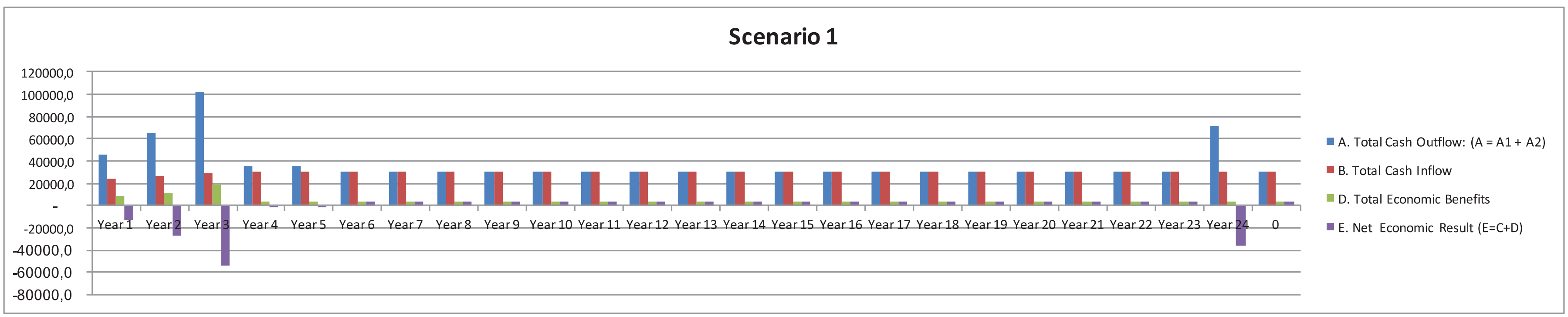
Almond	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		180.00	8.00	***1,440.00***	
	Costs	**Q,ty/du**	**NIS/unit.**	**NIS/dun**	
Tillage	n.	2.00	60.00	120.00	
Chemical Fertilizers	kg.	40.00	5.00	200.00	
Organic Fertilizers	kg.	300.00	0.50	150.00	
Soil Disinfection	kg.				
Plant Protection	kg.	8.00	25.00	200.00	
irrigation	m3	622.30	1.50	933.45	
Harvesting Labour	dd	3.00	40.00	120.00	
Harvesting machinery	h				
Depreciation of the plant	2,180.00	duration yrs	25.00	87.20	
TOTAL				***1,810.65***	***-370.65***
Labour & Enterprise					-250.65

Table 34: Balance sheet for Alpha-Alpha

alpha-alpha	Revenues	Q.ty kg/du	NIS/kg	NIS/dun	*Margin*
		4,500.00	0.35	***1,575.00***	
	Costs	**Q,ty/du**	**NIS/unit.**	**NIS/dun**	
Tillage	n.	0.00	100.00		
Chemical Fertilizers	kg.	0.00	5.00		
Organic Fertilizers	kg.	0.00	0.50		
Soil Disinfection	kg.				
Plant Protection	kg.	0.00	25.00		
irrigation	m3	878.50	1.50	1,317.75	
Harvesting Labour	dd	6.00	40.00	240.00	
Harvesting machinery	h				
Depreciation of the plant	1,360.00	duration yrs	4.00	340.00	
TOTAL				***1,897.75***	***-322.75***
Labour & Enterprise					-82.75

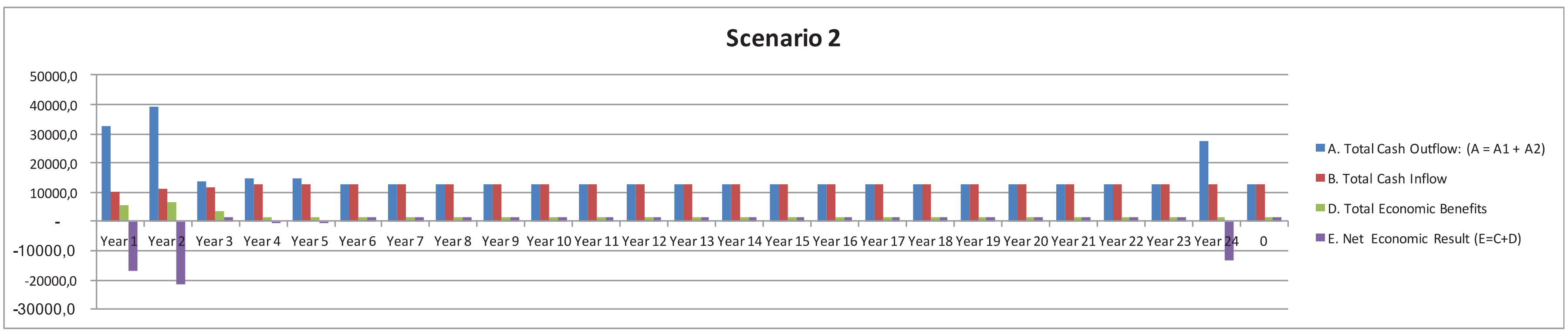
SCENARIO 1 – FULL COST/SOLUTION 1

Value in ILS*000									=>																		
Details			**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**
A. Cost: Cash outflow: (NIS)																											
A1. Capital Cost																											
Investment cost at Farm level				4,695	4,695	4,695	4,695																				
Training activities			1,456	1,456																							
Recovery wells tank ans booster			22,997	7,838																						10,000	
Irrigation network				27,161	72,169																					30,000	
A2. Operating Cost (Recurrent Expenses)																											
Farmers pay off the investment						3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742	3742
Cost at Farm level (including	1.50	ILS/CM)	21,814	23,622	25,430	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
Total investment	*147,162*																										
A. Total Cash Outflow: (A = A1 + A2)	944,282		46,266	64,771	102,295	35,675	35,675	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	30,980	70,980	30,980
B. Benefit: Cash inflow: (NIS)																											
Direct & indirect benefit																											
Revenue at Farm level			23,898	25,924	27,951	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978
Water tariff paid by industry 70,000 cr *	2.0	ILS/CM	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
Time saved for non management of private wells			657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657
Paid by Government/Donors																											
Subsidies			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. Total Cash Inflow	757,216		24,695	26,721	28,748	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775
C. Cash Flow Results: (C=B-A)	-187,067		-21,572	-38,050	-73,547	-4,900	-4,900	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-205	-40,205	-205
Financial Internal Rate of Return	#NUM!		FNPV@3%	-155,002	BCR@3%	0.772																					
Scenario 1 full stage investment			FNPV@5%	-140,864	BCR@5%	0.750																					
			FNPV@7%	-130,096	BCR@7%	0.728																					
D. Economic Valuation																											
Economic benefit																											
Correction of labour cost from financial to economic			2830	3668	5993	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
VAT Investment Adjustement			3680	5600	11547	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement			1729	1871	2012	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
D. Total Economic Benefits			8,238	11,138	19,552	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904
E. Net Economic Result (E=C+D)			-13,333	-26,912	-53,994	-996	-996	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	3,700	-36,300	3,700
Economic Internal Rate of Return	#NUM!		ENPV@3%	-61,667	BCR@3%	0.909																					
Scenario 1 full stage investment			ENPV@5%	-61,628	BCR@5%	0.891																					
			ENPV@7%	-61,454	BCR@7%	0.871																					



SCENARIO 2 – FULL COST/SOLUTION 2

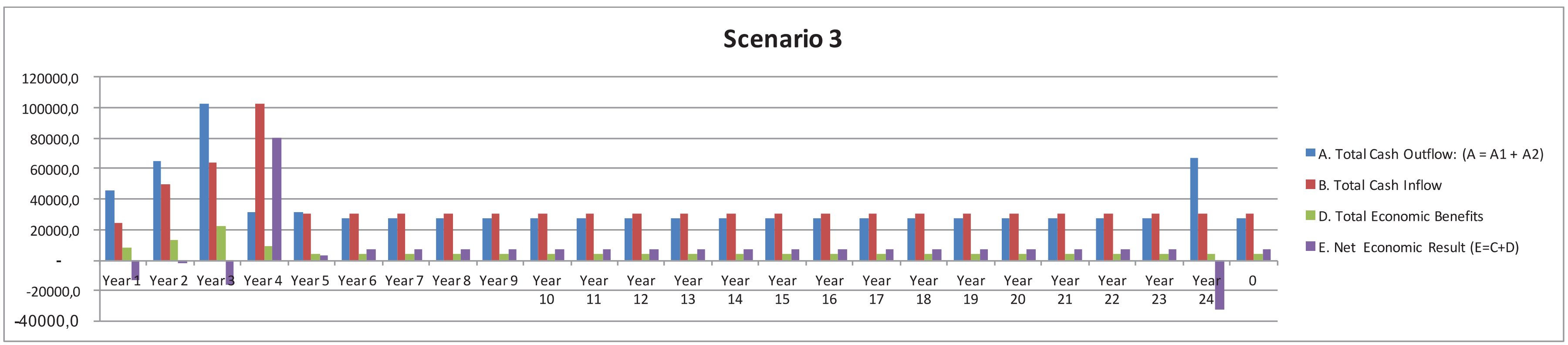
Value in ILS*000										=>																		
Details				**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**
A. Cost: Cash outflow: (ILS)																												
A1. Capital Cost																												
Investment cost at Farm level					1,925	1,925	1,925	1,925																				
Training activities				597	597																							
Recovery wells, tank ans booster system				22,997																							5,000	
Irrigation network					27,161																						10,000	
A2. Operating Cost (Recurrent Expenses)																												
Farmers pay off the investment						1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492	1492
Cost at Farm level (including water tariff	1.50	ILS/CM	)	8,944	9,685	10,426	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168	11,168
Total investment		*57,126*																										
A. Total Cash Outflow: (A = A1 + A2)		**383,109**		32,537	39,367	13,843	14,585	14,585	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	12,660	27,660	12,660
B. Benefit: Cash inflow: (NIS)																												
Direct & indirect benefit																												
Revenue at Farm level				9,798	10,629	11,460	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291	12,291
Water tariff paid by industry 40,000 cm	*	2.0	ILS/CM	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Time saved for non management of private wells				269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269	269
Paid by Government/Donors																												
Subsidies				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. Total Cash Inflow		**311,023**		10,147	10,978	11,809	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640	12,640
C. Cash Flow Results: (C=B-A)		**-72,085**		-22,390	-28,389	-2,034	-1,944	-1,944	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-19	-15,019	-19
Financial Internal Rate of Return		**#NUM!**		FNPV@3%	-61,389	BCR@3%	**0.778**																					
Scenario 2 only Phase I investment				FNPV@5%	-56,792	BCR@5%	**0.753**																					
				FNPV@7%	-53,353	BCR@7%	**0.728**																					
D. Economic Valuation																												
Economic benefit																												
Correction of labour cost from financial to economic				1160	1504	2457	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718	718
VAT Investment Adjustement				3680	4346	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement				710	768	827	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885	885
D. Total Economic Benefits				5,550	6,618	3,284	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602	1,602
E. Net Economic Result (E=C+D)				-16,840	-21,771	1,250	-342	-342	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	1,583	-13,417	1,583
Economic Internal Rate of Return		**#NUM!**		ENPV@3%	**-23,386**	BCR@3%	**0.915**																					
Scenario 2 only Phase I investment				ENPV@5%	**-24,446**	BCR@5%	**0.894**																					
				ENPV@7%	**-25,237**	BCR@7%	**0.871**																					



SCENARIO 3: CAPITAL SUBSIDIES

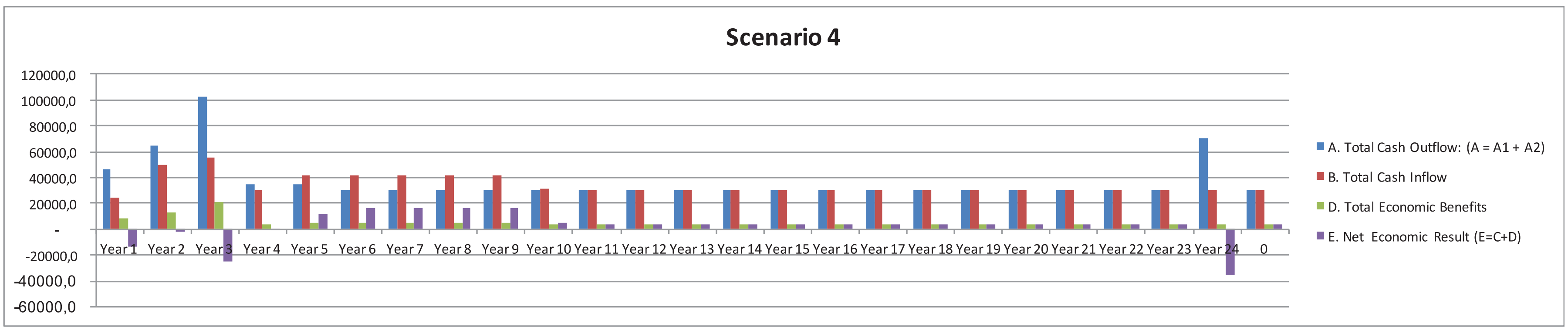
Value in ILS*000									=>						
Details			**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**
A. Cost: Cash outflow: (ILS)															
A1. Capital Cost															
Investment cost at Farm level				4,695	4,695	4,695	4,695								
Training activities			1,456	1,456											
Recovery wells tank ans booster system			22,997	7,838											
Irrigation network				27,161	72,169										
A2. Operating Cost (Recurrent Expenses)															
Cost at Farm level (including water tariff= 1.50 ILS/CM)			21,814	23,622	25,430	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
Total Investment	*147,162*														
A. Total Cash Outflow: (A = A1 + A2)	**861,958**		46,266	64,771	102,295	31,933	31,933	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
B. Benefit: Cash inflow: (NIS)															
Direct & Indirect benefit															
Revenue at Farm level			23,898	25,924	27,951	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978
Water tariff paid by Industry 70,000 cm *	2.0	ILS/CM	140	140	140	140	140	140	140	140	140	140	140	140	140
Time saved for non management of private wells			657	657	657	657	657	657	657	657	657	657	657	657	657
Paid by Government/Donors				22,997	34,999	72,169									
Subsidies															
B. Total Cash Inflow	**887,381**		24,695	49,718	63,747	102,945	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775
C. Cash Flow Results: (C=B-A)	**40,663**		-21,572	-15,053	-38,548	71,011	-1,158	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537
Financial Internal Rate of Return	**10.82%**		FNPV@3%	**17,400**	BCR@3%	**1.028**									
Scenario 3 Capital cost payd by Donors			FNPV@5%	**12,152**	BCR@5%	**1.023**									
			FNPV@7%	**7,405**	BCR@7%	**1.017**									
D. Economic Valuation															
Economic benefit															
Correction of labour cost from financial to economic			2830	3668	5993	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
VAT Investment Adjustement			3680	5600	11547	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement			1729	3480	4462	7206	2154	2154	2154	2154	2154	2154	2154	2154	2154
D. Total Economic Benefits			8,238	12,748	22,002	8,956	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904
E. Net Economic Result (E=C+D)			-13,333	-2,305	-16,546	79,967	2,746	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442
Economic Internal Rate of Return	**61.68%**		ENPV@3%	**118,983**	BCR@3%	**1.190**									
Scenario 3 Capital cost payd by Donors			ENPV@5%	**99,119**	BCR@5%	**1.190**									
			ENPV@7%	**83,307**	BCR@7%	**1.188**									

Details	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**
Recovery wells tank ans booster system											10,000	
Irrigation network											30,000	
Cost at Farm level (including water tariff= 1.50 ILS/CM)	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
A. Total Cash Outflow: (A = A1 + A2)	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	67,238	27,238
Revenue at Farm level	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978
Water tariff paid by Industry 70,000 cm *	140	140	140	140	140	140	140	140	140	140	140	140
Time saved for non management of private wells	657	657	657	657	657	657	657	657	657	657	657	657
B. Total Cash Inflow	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775
C. Cash Flow Results: (C=B-A)	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537	-36,463	3,537
Correction of labour cost from financial to economic	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
VAT Investment Adjustement	0	0	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
D. Total Economic Benefits	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904
E. Net Economic Result (E=C+D)	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442	-32,558	7,442



SCENARIO 4 - CAPITAL AND O&M SUBSIDIES/SOLUTION 1

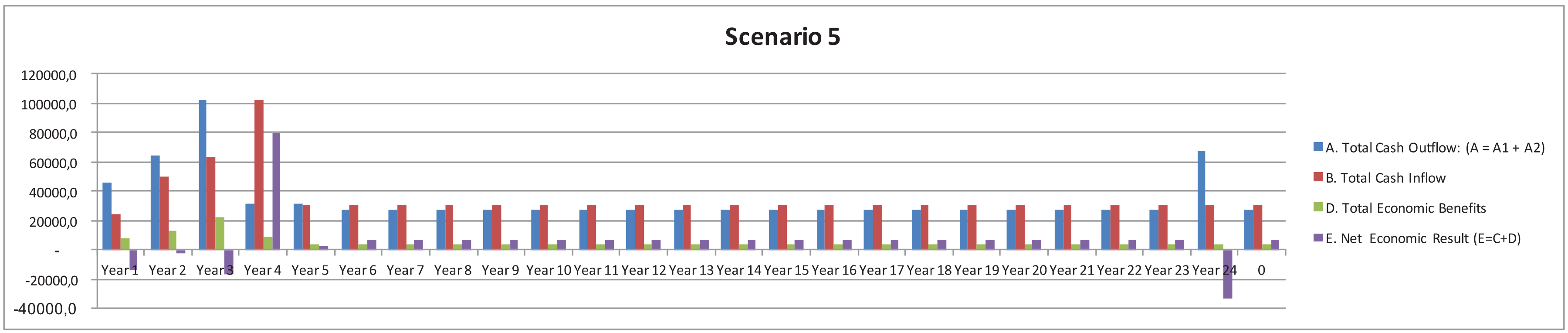
Value in ILS*000									=>																	
Details			Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24
A. Cost: Cash outflow: (ILS)																											
A2. Operating Cost (Recurrent Expenses)																											
Farmers pay off the investment						3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150	3150
Cost at Farm level (including water ta 1.50	ILS/CM	)	21,814	23,622	25,430	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
Total investment	*147,162*																										
A. Total Cash Outflow: (A = A1 + A2)	931,258		46,266	64,771	102,295	35,083	35,083	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	30,388	70,388	30,388
B. Benefit: Cash inflow: (NIS)																											
Direct & indirect benefit																											
Revenue at Farm level			23,898	25,924	27,951	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978
Water tariff paid by industry 70,000 cm *	2.0	ILS/CM	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140
Time saved for non management of private wells			657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657	657
Paid by Government/Donors				22,997	27,161																						
Subsidies				3,433	6,866	11,443	11,443	11,443	11,443	11,443	11,443	1,047							0								
B. Total Cash Inflow	865,637		24,695	49,718	55,909	30,775	42,218	42,218	42,218	42,218	42,218	31,822	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775
C. Cash Flow Results: (C=B-A)	-28,331		-21,572	-15,053	-46,386	-4,308	7,135	11,831	11,831	11,831	11,831	1,434	387	387	387	387	387	387	387	387	387	387	387	387	387	-39,613	387
Financial Internal Rate of Return	#NUM!		FNPV@3%	-52,493	BCR@3%	0.922	investm. Phase I		80,007																		
Scenario 4 Capital cost phase 1 paid by government subsidies for 9 years to farmer payd capital cost pha			FNPV@5%	-48,408	BCR@5%	0.913	subsidies		80,007																		
			FNPV@7%	-46,166	BCR@7%	0.902	9 year of subsidies																				
D. Economic Valuation																											
Economic benefit																											
Correction of labour cost from financial to economic			2830	3668	5993	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
VAT Investment Adjustement			3680	5600	11547	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement			1729	3480	3914	2154	2955	2955	2955	2955	2955	2228	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
D. Total Economic Benefits			8,238	12,748	21,454	3,904	4,705	4,705	4,705	4,705	4,705	3,978	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904
E. Net Economic Result (E=C+D)			-13,333	-2,305	-24,932	-404	11,841	16,536	16,536	16,536	16,536	5,412	4,292	4,292	4,292	4,292	4,292	4,292	4,292	4,292	4,292	4,292	4,292	4,292	4,292	-35,708	4,292
Economic Internal Rate of Return	18.55%		ENPV@3%	47,413	BCR@3%	1.071																					
Scenario 4 Capital cost phase 1 paid by government subsidies for 9 years to farmer payd capital cost pha			ENPV@5%	36,828	BCR@5%	1.066																					
			ENPV@7%	27,978	BCR@7%	1.059																					



SCENARIO 5 - CAPITAL AND O&M SUBSIDIES/SOLUTION 2

Value in ILS*000										=>					
Details			**Year 0**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Year 9**	**Year 10**	**Year 11**	**Year 12**
A. Cost: Cash outflow: (ILS)															
A1. Capital Cost															
Investment cost at Farm level				4,695	4,695	4,695	4,695								
Training activities			1,456	1,456											
Recovery wells tank ans booster system			22,997	7,838											
Irrigation network				27,161	72,169										
A2. Operating Cost (Recurrent Expenses)															
Cost at Farm level (including water tariff= 1.50	ILS/CM	)	21,814	23,622	25,430	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
Total investment	*147,162*														
A. Total Cash Outflow: (A = A1 + A2)	**861,958**		46,266	64,771	102,295	31,933	31,933	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
B. Benefit: Cash inflow: (NIS)															
Direct & indirect benefit															
Revenue at Farm level			23,898	25,924	27,951	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978
Water tariff paid by industry 70,000 cm *	2.0	ILS/CM	140	140	140	140	140	140	140	140	140	140	140	140	140
Time saved for non management of private wells			657	657	657	657	657	657	657	657	657	657	657	657	657
Paid by Government/Donors				22,997	34,999	72,169									
Subsidies				3,433	6,866	8,483					0	0	0	0	0
B. Total Cash Inflow	**887,381**		24,695	49,718	63,747	102,945	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775
C. Cash Flow Results: (C=B-A)	**40,663**		-21,572	-15,053	-38,548	71,011	-1,158	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537
Financial Internal Rate of Return	**10.82%**		FNPV@3%	**17,400**	BCR@3%	**1.028**	investm. Fram level		8,782						
Scenario 5 Capital cost payd by government and and O&M payd by government until repa			FNPV@5%	**12,152**	BCR@5%	**1.023**	subsidies		8,782						
			FNPV@7%	**7,405**	BCR@7%	**1.017**	3 year of subsidies								
D. Economic Valuation															
Economic benefit															
Correction of labour cost from financial to economic			2830	3668	5993	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
VAT Investment Adjustement			3680	5600	11547	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement			1729	3480	4462	7206	2154	2154	2154	2154	2154	2154	2154	2154	2154
D. Total Economic Benefits			8,238	12,748	22,002	8,956	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904
E. Net Economic Result (E=C+D)			-13,333	-2,305	-16,546	79,967	2,746	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442
Economic Internal Rate of Return	**61.68%**		ENPV@3%	**118,983**	BCR@3%	**1.190**									
Scenario 5 Capital cost payd by government and and O&M payd by government until repa			ENPV@5%	**99,119**	BCR@5%	**1.190**									
			ENPV@7%	**83,307**	BCR@7%	**1.188**									

Details	**Year 13**	**Year 14**	**Year 15**	**Year 16**	**Year 17**	**Year 18**	**Year 19**	**Year 20**	**Year 21**	**Year 22**	**Year 23**	**Year 24**
Recovery wells tank ans booster system											10,000	
Irrigation network											30,000	
Cost at Farm level	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238
A. Total Cash Outflow: (A = A1 + A2)	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	27,238	67,238	27,238
Revenue at Farm level	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978	29,978
Water tariff paid by industry	140	140	140	140	140	140	140	140	140	140	140	140
Time saved for non management of private wells	657	657	657	657	657	657	657	657	657	657	657	657
Subsidies	0	0	0	0	0	0	0	0	0	0		
B. Total Cash Inflow	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775	30,775
C. Cash Flow Results: (C=B-A)	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537	3,537	-36,463	3,537
Correction of labour cost from financial to economic	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750	1750
VAT Investment Adjustement	0	0	0	0	0	0	0	0	0	0	0	0
VAT Revenues/Costs Adjustement	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154	2154
D. Total Economic Benefits	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904	3,904
E. Net Economic Result (E=C+D)	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442	7,442	-32,558	7,442



Annex 7: GCF Concept Note

Concept Note

Water Banking and Adaptation of Agriculture to Climate Change in Northern Gaza

Palestine | Agence Française de Développement (AFD)

25th November 2017

GREEN CLIMATE FUND

Project/Programme Title:	**Water Banking and Adaptation of Agriculture to Climate Change in Northern Gaza**
Country(ies):	Palestine
National Designated Authority(ies) (NDA):	Environment Quality Authority (EQA)
Accredited Entity(ies) (AE):	French Development Agency (AFD)
Date of first submission/ version number:	*[2017 – 11 - 21] [V.0]*
Date of current submission/ version number	*[YYYY-MM-DD] [V.0]*

GREEN
CLIMATE
FUND

Concept Note

The Green Climate Fund (GCF) is seeking high-quality projects or programmes.

The Accredited Entity is encouraged to submit a concept note, in consultation with the National Designated Authority, to present a project or programme idea and receive early feedback and recommendation.

Notes
• The maximum number of pages should **not exceed 12 pages**, excluding annexes. Proposals exceeding the prescribed length will not be assessed within the indicative service standard time of 30 days. • As per the Information Disclosure Policy, the concept note, and additional documents provided to the Secretariat can be disclosed unless marked by the Accredited Entity(ies) (or NDAs) as confidential. • The relevant National Designated Authority(ies) will be informed by the Secretariat of the concept note upon receipt. • NDA can also submit the concept note directly with or without an identified accredited entity at this stage. In this case, they can leave blank the section related to the accredited entity. The Secretariat will inform the accredited entity(ies) nominated by the NDA, if any. • Accredited Entities and/or NDAs are encouraged to submit a Concept Note before making a request for project preparation support from the Project Preparation Facility (PPF). • Further information on GCF concept note preparation can be found on GCF website Funding Projects Fine Print.

A. Project / Programme Information (max. 1 page)

A.1. Project or programme	☒ Project ☐ Programme	**A.2. Public or private sector**	☒ Public sector ☐ Private sector
A.3. Is the CN submitted in response to an RFP?	Yes ☐ No ☒ If yes, specify the RFP: ___________	**A.4. Confidentiality**[1]	☐ Confidential ☒ Not confidential
A.5. Indicate the result areas for the project/programme	<u>Mitigation:</u> Reduced emissions from: ☒ Energy access and power generation ☐ Low emission transport ☐ Buildings, cities and industries and appliances ☒ Forestry and land use <u>Adaptation:</u> Increased resilience of: ☒ Most vulnerable people and communities ☒ Health and well-being, and food and water security ☐ Infrastructure and built environment ☒ Ecosystem and ecosystem services		
A.6. Estimated mitigation impact (tCO2eq over lifespan)	71 000	**A.7. Estimated adaptation impact (number of direct beneficiaries and % of population)**	200 000 (50% of Gaza City population)
A.8. Indicative total project cost (GCF + co-finance)	Amount: USD 42 500 000	**A.9. Indicative GCF funding requested**	Amount: USD 32 000 000
A.10. Mark the type of financial instrument requested for the GCF funding	☒ Grant ☐ Reimbursable grant ☐ Guarantees ☐ Equity ☐ Subordinated loan ☐ Senior Loan ☐ Other: specify___________________		
A.11. Estimated duration of project/ programme:	Disbursement period: 2019-25	**A.12. Estimated project/ Programme lifespan**	20 years
A.13. Is funding from the Project Preparation Facility requested?[2]	Yes ☐ No ☒ Other support received ☐ If so, by who:	**A.14. ESS category**[3]	☐ A or I-1 ☒ B or I-2 ☐ C or I-3
A.15. Is the CN aligned with your accreditation standard?	Yes ☒ No ☐	**A.16. Has the CN been shared with the NDA?**	Yes ☒ No ☐
A.17. AMA signed (if submitted by AE)	Yes ☒ No ☐ If no, specify the status of AMA negotiations and expected date of signing	**A.18. Is the CN included in the Entity Work Programme?**	Yes ☒ No ☐
A.19. Project/Programme rationale, objectives and approach of programme/project (max 100 words)	The main strategic focus of the Palestinian National Adaptation Plan (NAP) is about reducing water and food insecurity, which is well aligned with the Palestinian NDC. According to the NAP, many sectors in **the Gaza Strip are considered to be particularly vulnerable to the negative consequences of climate change and its effects on decreasing water resources**. Already under significant pressure from rapid demographic growth, economic development and restrictions on water mobilization investments, freshwater resources in Palestine are predicted to become scarcer. Climate change causes decreases in annual precipitation and one of the impacts of rising temperatures is the increase in		

[1] Concept notes (or sections of) not marked as confidential may be published in accordance with the Information Disclosure Policy (Decision B.12/35) and the Review of the Initial Proposal Approval Process (Decision B.17/18).

[2] See here for access to project preparation support request template and guidelines

[3] Refer to the Fund's environmental and social safeguards (Decision B.07/02)

	water demand from crops. The project will **develop an integrated and low-emission water management scheme capable of reducing the impact of increasing aridity due to climate change, while depolluting a strategic aquifer for the population of Gaza.** The project will be implemented by the Palestinian Water Authority.

B. Project / Programme details (max. 8 pages)

B.1. Context and Baseline (max. 2 pages)

Acute water scarcity in Palestine is a strong determinant of the vulnerability of its population, in particular in rural areas. The Palestinian national adaptation plan and the initial national communication to the UNFCCC have identified water and food security as the most vulnerable issues in Palestine, with knock-on implications for all sectors. This is also highlighted in the National Determined Contribution (NDC).

The geopolitical situation substantially reduces the Palestinian's adaptive capacities, thereby compounding climate vulnerabilities to "manmade" constraints and limitations of access to the water resource, in particular in the Gaza Strip and in rural areas of the West Bank.

Palestine has one of the lowest *per capita* water availability in the world. The average domestic water consumption is only 72 liters per capita per day (l/c/d) in the West Bank and 96 l/c/d in the Gaza Strip, below the 100 l/c/d minimum recommended by the World Health Organization.

The impacts of climate change identified at regional level or in neighboring countries broadly apply to the Palestinian situation. Studies have attempted to model the impacts of climate change on Palestine's water resources: the regional climate model PRECIS (Providing Regional Climates for Impact Studies) and the IPCC A1B emissions scenario, predict a decrease in precipitations of 15% by mid-century and 23% by the end of the century, lowering per capita internal water resources in Palestine to 67 m^3 (cubic meter) by 2050 compared to 190 m^3 in 2010. The discharge of the Jordan River is projected to decrease by 22% by mid-century and 30% by the end of the century. Previous modelling studies suggest even larger impacts on the Jordan River: simulations using the GLOWA-Jordan River Regional Climate model coupled with the hydrological model WaSiM forecasts discharge reductions of up to 40% by 2070-2099 (Khatib 2009, cited in UNDP 2010). The Japanese Meteorological Agency Atmosphere General Circulation Model (JMA-AGCM) run for the eastern Mediterranean JMA-AGCM projects a 82-98% collapse in the Jordan River flow (at an unspecified location) by 2100 (Kitoh et al. 2008, cited in UNDP 2010).

Further, the UNDP's analysis of climate vulnerability in Palestine highlights climate risks as a humanitarian threat, placing the Palestinians within the policy realm of disaster risk management and emergency response operations. Current high levels of food and water insecurity in Gaza and the West Bank are forecast to be exacerbated by climate change, on account of worsening food growing conditions (the agricultural sector consumes over two-thirds of water abstracted or flowing from springs in Palestine) and a fragile water supply infrastructure. **Combining population growth forecasts and regional climate change projections, it has been estimated that Palestine will experience a water deficit of 271 M**m^3**(**million cubic meters)**a year by 2020.**

Increasing temperatures, due to climate change, also mean an increase in crop demand for water, as evapotranspiration (direct consequence of photosynthesis and plant growth) is an increasing function of temperature. In this context, productivity of irrigated agriculture is four to six times that of rain fed agriculture for most crops in the West Bank and Gaza Strip, yet this form of agriculture amounts to less than 25% of the total cultivated area. Access restrictions, water scarcity and population growth is leading to an increasing pressure on groundwater resources for irrigation, sometimes with irreversible consequences including quality deterioration.

In this context, making use of non-conventional water resources, such as Treated Wastewater (TWW) is considered a prerequisite for any sustainable development of irrigation in Palestine, thereby increasing the profitability and climate resilience of Palestinian agriculture.

In Palestine, 50 Mm^3 of TWW is generated every year. If a fraction of this, for example 60% (i.e. 30 Mm^3) met agricultural quality requirements and were used for irrigation, it would entail a 20% increase in water available for Palestinian farmers, enough to irrigate an additional 3 500 ha and create 15 000 jobs (*Source: FAO*). Whereas many other countries with dry conditions, are already making use of this resource for irrigation (up to 80% of the TWW can be reused), this potential has not yet been realized in Palestine, mostly due to insufficient infrastructure and capacities to effectively utilize TWW for irrigation.

Water and sanitation, drinking water and associated sewage networks and waste water treatment plants (WWTP) projects, have multiplied over the years in Palestine, mainly through donor funding (KfW, WB, AFD being the main partners of the Palestinian government in this sector), but also by way of public funding. In Gaza, the North Gaza Emergency Sewage Treatment (NGEST) plant (funded by WB, AFD and the EU), in the outskirts of Gaza City, will be up and running early 2018 at a capacity of 36 500 m^3/day (13.3 Mm^3 per year). The NGEST plant will alleviate the pressure on the existing WWTP (Beit Lahia), functioning at six times its design capacity and will help solve the acute environmental and health hazards caused by the accumulation of waste water in Gaza.

In the baseline situation, non-treated waste water is currently stored in precarious basins outside of Gaza City (posing a threat to nearby populated areas) and transferred to infiltration basins, where it penetrates the aquifer resulting in severe pollution of the groundwater of high water table (rejection of these waters to sea is not an option, for environmental and geopolitical reasons), threatening the livelihoods and health of both rural and urban population when using this highly polluted water for agriculture and drinking.

The finalization of the NGEST plant offers the opportunity to increase water and food security in the Gaza strip by generating a “new” and non-conventional resource for agricultural purposes, by way of infiltration in the aquifer (after tertiary treatment), recovery of treated waste water (diluted in ground water then extracted by wells), and development of an efficient irrigation scheme downstream. Infiltration of treated waste water in the aquifer will both increase the quantity and the quality (depollution) of the groundwater, thereby increasing its availability and suitability for agricultural purposes and, by the same token, preventing massive contamination and subsequent proliferation of water-borne diseases within the population of Gaza city and its rural outskirts (an estimated 200 000 people would be affected positively by the project).

The cycle of production and reuse of TWW relies on an energy mix supplying the power for the functioning of the NGEST WWTP, the Recovery scheme (which involves pumping from the aquifer) and to pressurize the drip irrigation network at the end line. The current power concept consists of an external supply from the grid and on-site generation from emergency generators with sufficient capacity to cover the load of the facility (estimated at 9 MVA). The overall power supply situation in Gaza is constrained due to general geopolitical circumstances and options for extending existing supply via the distribution network are limited because of cost of fuel for the local power plant or due to difficulties in fuel availability, in particular the limitations to increase the supply from cross-border sources.

Consequently, the Palestinian Water Authority (PWA) seeks, together with other responsible stakeholders (in particular the Palestinian Energy and Natural Resources Authority, PENRA) to **identify the most viable, long-term sustainable power supply option for the NGEST facilities during its whole life-cycle**.

Closing the water cycle, by the reuse of treated water, calls for increased coordination between several stakeholders (the Palestinian Water Authority and the Ministry of Agriculture, as well as PENRA, and EQA based in Ramallah, and the farmers benefiting from the project). Close and careful monitoring of water quality of water used for irrigation or for recharge the aquifer will be guaranteed. Enforcing regulations for the use of the treated water and monitoring of the quality and quantity of water in the aquifer will be key challenges of the project.

B.2. Project / Programme description (max. 3 pages)

The project fits within the National Adaptation Plan (NAP) for Palestine, as well as its focus on the “water security – food security” nexus within Palestine’s Nationally Determined Contributions (NDS), as an adaptation action for the following “highly vulnerable” sectors: Agriculture/Irrigation Water/ Improve water-use efficiency and using alternatives water resources. It is also in line with the NDC’s objectives in terms of Energy for the Gaza Strip: “Use of renewable energy, such as solar, to reduce imported energy”.

Indeed, the project will generate a “new” water resource for agriculture and, as a co-benefit, depollute the aquifer used for both domestic and agricultural purposes in the Gaza Strip. It will target amongst the most vulnerable population in the sub-region, prone to political instability compounded with the effects of climate change on increasing aridity and overall water insecurity.

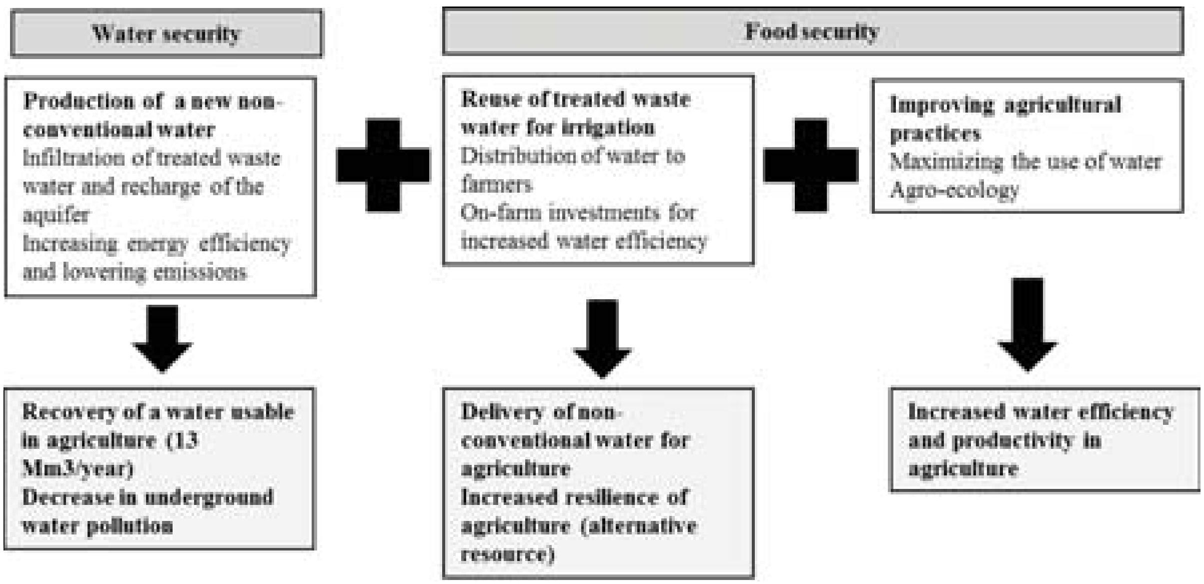
The project’s goal is to **develop an integrated and low-emission water management scheme capable of reducing the impact of increasing aridity due to climate change, by delivering water for sustaining agriculture and increasing the resilience of of highly vulnerable population in the Gaza Strip**.

The specific objectives of the project are as follows:

O1. Reduce the vulnerability of Gaza’s coastal aquifer and secure sustainability of access to drinking and agricultural water;

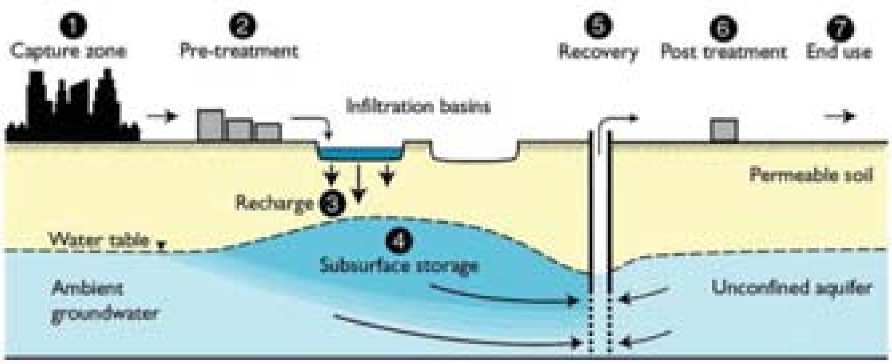
O2. Promote climate resilient and water-efficient agriculture;

O3. Enhance the institutional and operational capabilities for integrated and resilient water management.



Main outputs of the project are:

OUTPUT 1: Reducing Gaza's vulnerability to climate change by delivering a "Treated Waste Water Reuse Scheme" based on (i) the rehabilitation of infiltration basins in the vicinity of the NGEST plant, in order to allow the vertical transfer and tertiary treatment (filtration by sandy soil) of treated waste water from the plant to the aquifer, in the amount of 36 500 m^3/day ; (ii) the drilling of recovery wells (14) "downstream" from the NGEST plant in order to extract the corresponding volume, store it in a reservoir and make it available for agricultural purposes. The following schematic illustrates this well-known "infiltration – recovery" approach to reuse of treated waste water:



OUTPUT 2: Deliver a public irrigation scheme, based exclusively on drip irrigation, for the distribution of unconventional water to farmers over an area of 1 200 ha, including primary, secondary and tertiary (drip irrigation) distribution networks;

OUTPUT 3: Reducing GHG emissions by expanding the portfolio of on-site generation by a Photovoltaic system (5,1 MWp) in designated areas within the NGEST project to allow making the power supply more sustainable through the increase of emission-free and independent renewable energy (a co-generating facility is already in place, in order to produce energy from the organic solid waste generated by the plant);

OUTPUT 4: Support the Palestinian government and the PWA, in particular, in expanding its strategy for the reuse of waste water in other parts of Palestine, capitalizing and replicating the lessons learned from the programme.

The "Reuse Cycle" will rely on the production of 36 500 m^3/day of treated waste water by the NGEST plant, and its transfer to nearby 1 200 ha of agricultural land. This represents about 10 000 m^3/ha/year which is sufficient water for relatively intensive agricultural production using drip irrigation, **which will therefore be performed with minimal withdrawal from the aquifer.** This will benefit 1 000 vulnerable households in providing them with a secure source of water for agriculture, in addition to providing them with a modern, water-efficient irrigation networks and appliances. The water filtered a first time to the aquifer through the infiltration basins and, a second time, by irrigation on agricultural land (minus the part evaporated) will further dilute the underground pollution and restore the quality of the aquifer used for agricultural and drinking purposes. It should therefore reduce the vulnerability and preserve the health of 200 000 people living in Gaza City and North Gaza governorate (50% of its population in the current estimation).

Securing the flow of unconventional water to the aquifer and its transfer to agricultural lands depends on the performance of the NGEST plant + Recovery Scheme (NGEST + RS) and, in particular, on the reliability of its power supply (mainly constrained by restrictions on access to electricity due to the geopolitical situation). By adding the photovoltaic (PV) system to NGEST, the annual supply from the grid in 2018 is reduced by 24% and the required annual energy from the emergency diesel is taken down by 27% allowing the NGEST facility to reduce its diesel consumption by 30%, leading to the saving of 1,3 million liters of diesel fuel. **This will result in lower emissions amounting in 70 989 tCO_2eq over the 20 years lifespan of the project**. Accordingly, the PV share in 2018 reaches 24% of the total annual power generation, the diesel share is 38,8 %, the grid share is 22,2 % and the biogas share is 16%.

The NGEST WWTP + RS power supply without PV and the current supply options lead to an overall Levelized Cost of Energy (LCOE) of 0,23 USD/kWh. **NGEST with the PV option installed has an overall LCOE of 0,2 USD/kWh , making it 0,03 USD/kWh cheaper than the “no PV option”. This will generate a saving in present value of 15,5 MUSD**.

Further, the project will include a “soft” component dedicated to reinforce the PWA as the coordinator of “Reuse actions”, in particular with the ministry of agriculture. Support to the PWA in the form of a technical assistance will ensure quality of works and of the monitoring of the aquifer in qualitative and quantitative terms. Broader support to the Palestinian government will be delivered in order to strengthen its strategy for the use of non-conventional water, namely for adaptation of agriculture to climate change. The proposed institutional framework envisages a joint management of the TWW reuse scheme between the PWA and the farmers, organized in a Water Users Association (WUA). The WUA will be supported by the government and the project, technically (the first five years) and financially (the first three years), and will be responsible for operation and maintenance of the irrigation network (the recovery scheme will remain under public management. A water tariff will be applied for access to TWW (~.33 USD/m^3), which is calculated to cover 100 % of OPEX costs after the first three years (investment costs are covered by the government/donor agencies as grants, except for on-farm investments to be reimbursed by the farmers through the tariff over the first 3 years, when OPEX costs are covered by public funding).

The project’s components are as follows:

C1. Production of non-conventional water for resilient agricultural purposes

- Infiltrate (tertiary treatment and production of a water fit for agricultural production) and recover treated waste water coming from NGEST WWTP.

C2. Develop a low emission water-reuse system

Expand the portfolio of on-site generation of power by the introduction of a photovoltaic system

C3. Enhancing the resilience of local agriculture through an improved irrigation system

- Develop of a water-efficient irrigation network (drip irrigation) over 1 200 ha;
- Provide extension services to farmers, in order to promote water-efficient practices based on drip-irrigation technology.

C4. Improve the capacity of the Palestinian government, the PWA and the Water Users Association

- Enhance capacity of the NDA to follow-up and contribute to the implementation of the water component of the National Adaptation Plan;
- Support the PWA in upscaling the experience in other location in the West Bank;
- Build the capacity of the WUA, support operation and maintenance of the scheme,

C5. Project management

The project will be managed by the PWA, which will directly implement the recovery scheme downstream from the NGEST WWTP and coordinate with other line agencies for the irrigation/agriculture component (Ministry of Agriculture) and for the energy component (PENRA).
The PWA will aslo be I charge of implementing and monitoring the Environmental and Social Impacts Management

Plan.
Following the signature of the Paris Protocol between the PLO and Israel in 1995 (also called Oslo 2), the Palestinian Water Authority (PWA) was established by the Palestinian Authority as an independent public entity attached to the President of the PA. The PWA's mission is to manage, develop and protect water resources through integrated and sustainable water supply for citizens and ensure the protection of the environment and the achievement of the development goals for the Palestinian society.
PWA is one of AFD's more important partners in its cooperation and assistance programme with the PA. Since 1998, the water and sanitation sector has been a priority for AFD, representing up to half of its commitments for Palestine (a total of 130 M€ since 1998).
AFD's investments have supported PWA's strategies and include: improving access to drinking water, extension of sanitation networks, wastewater treatment plants, water resources management, developing the sector governance and ensuring sustainable development goals in the water sector.
In the context of increasing water scarcity, PWA launched a "treated wastewater reuse programme" mainly directed to the agricultural sector (representing ~80% of extracted fresh water). Several pilots have been implemented so far and the legal framework is fully developed with clear guidance and usage of TWW for agricultural purposes.

The Gaza Strip presents, in general, a comparatively high level of operational risk due to the geopolitical situation; its population presents nevertheless a high level of vulnerability, in environmental, social and economic terms, that is exacerbated by the effects of climate change, in particular on increasing aridity and scarcity of water resources.
In the particular case of the project, three specific risks can be identified at this stage:

- **Quality of the water in the aquifer and related health issues** (in the process of its use for agriculture or through drinking): a monitoring and management system will be put into place, following the recommendations of the ESIA, in order to closely follow the quality of the water exiting the WWTP and extracted from the aquifer with regard to the applicable thresholds for (i) infiltration of water in aquifers and (ii) reuse in agriculture;
- **Power needs of the WWTP+RS**: as mentioned above, in the baseline scenario, the system relies on a relatively insecure, and unsustainable, energy mix due to limited access to the grid and to diesel for the generators. This situation will be improved by introducing a PV system, minimizing the dependency on diesel and electricity from the grid;
- **Acceptance of TWW**: willingness to use and pay for TWW is usually an issue -due, among other things, to cultural considerations. The infiltration of the TWW in the aquifer and its dilution with the underground resource, as well as the quality management system in place, should strongly mitigate this risk.

B.3. Expected project results aligned with the GCF investment criteria (max. 3 pages)

The following table summarizes the way the project will contribute to meeting the GCF's investment criteria:

Paradigm-shift Objective	*Expected result of the project*
Increased climate-resilient sustainable development	Develop an integrated and low-emission non-conventional water management scheme capable of reducing the impact of increasing aridity due to climate change, by delivering water in quality and quantity for sustaining agriculture and of vulnerable populations in the Gaza Strip. This will increase the resilience of half of the total population of Gaza City.
Fund-level Impacts	
Tonnes of carbon dioxide equivalent (t CO_2eq) reduced as a result of Fund-funded projects/ programmes Reduced emissions through increased low-emission energy access and power generation	71 000
Total Number of direct and indirect beneficiaries; **Number of beneficiaries relative to total population** **1.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions** 1.2 Number of males and females benefiting from the adoption of diversified, climate-resilient livelihood options (including fisheries, agriculture, tourism, etc.)	1 000 farmers benefiting from non-conventional water for agriculture; 1 000 households with improved income (5 000 people, 50% women) 200 000 people protected from water pollution 50% of population of Gaza City 1 000 farmers (90% male at this stage; prior to a more in depth gender analysis)
2.0 Increased resilience of health and well-being, and food and water security 2.2 Number of food-secure households (in areas/periods at risk of climate change impacts) 2.3 Number of males and females with year-round access to reliable and safe water supply despite climate shocks and stresses	1 000 200 000 ; 50% women
3.0 Increased resilience of infrastructure and the built environment to climate change threats 3.1 Number and value of physical assets made more resilient to climate variability and change, considering human benefits	1 irrigation scheme, the economic and physical viability of which is dependent on water flow generated by TWW. Value = 15 MEUR
Project/Programme Outcomes	
Number of technologies and innovative solutions transferred or licensed to promote climate resilience as a result of Fund	1 infiltration and recovery scheme from aquifer (technology transfer from US and Israel)

support.	
5.0 Strengthened institutional and regulatory systems for climate-responsive planning and development 5.1 Institutional and regulatory systems that improve incentives for climate resilience and their effective implementation.	Improved institutional and regulatory systems for REUSE and enhanced enabling environment.

C. Indicative financing / Cost information (max. 3 pages)

C.1. Financing by components (max ½ page)

Please provide an estimate of the total cost per component and disaggregate by source of financing.

Component	Indicative cost (USD)	GCF financing		Co-financing		
		Amount (USD)	Financial Instrument	Amount (USD)	Financial Instrument	Name of Institutions
C1. Production of non-conventional water for agricultural purposes	20 000 000	15 000 000	Grant	5 000 000		AFD
C2. Enhancing the resilience of local agriculture through an improved irrigation system	19 000 000	14 500 000	Grant	4 500 000	Grant	AFD
C3. Improve the capacity of the PA and PWA	2 500 000	2 000 000	Grant	500 000		AFD
C4. Project management	1 000 000	500 000	Grant	500 000	Grant	AFD
Indicative total cost (USD)	42 500 000	32 000 000		10 500 000		

C.2. Justification of GCF funding request (max 1 page)

The water treatment facilities implemented within the NGEST project, to be completed in 2018, are the result of a long and coordinated effort of several donor agencies (since 2006), in partnership with the PWA. The complexity of the works related to the high capacity of the plant, the need to find alternative sources of energy (bio-digester) / (solar), but also the political and security situation in Gaza, explain this lengthy involvement. At this moment in time, the full extent of the NGEST plant (funded by World Bank, AFD and the European Commission) is nearly completed and a first batch of recovery wells and a reservoir are under implementation.

The remaining actions to convert this water treatment project into a full model of integrated management of water resources, by reuse of non-conventional water for agriculture, are not funded to date (additional 15 wells and reservoir, irrigation scheme, and a photovoltaic system are needed). To this end, AFD intends to direct the totality of its annual donation for Palestine to co-fund this project, in the amount of USD 10 500 000 covering only part of the 42 500 000 USD needed to complete this transition.

The incremental costs associated with this paradigm change, incur in the context of growing aridity due to climate change and correspond to the additional investments needed to produce, recover and store a high quality non-conventional water resource (in the amount of 13 Mm^3/year), as well as those needed to transfer this resource to close-by areas of agricultural production (1 200 ha), and distribute it to farmers. Other incremental costs will be incurred in order to **increase the energy efficiency and lower the emissions of the NGEST WWTP + Recovery Scheme** (NGEST + RS), by introducing a photovoltaic (PV) system.

Finally, the reuse of this "new" water resource in agriculture, and the *closing of the water cycle*, in order to enhance the resilience of famers in Gaza to aridity and climate change impacts, implies hard and soft investments for development of water-efficient irrigation and, thereby increasing the productivity and income of highly vulnerable rural households in Northern Gaza.

In order to cover these incremental costs related to the shift in paradigm towards integrated water security and adaptation of agriculture to climate change, the support of the GCF is needed in the form of a grant, additional to the contribution by AFD. This level of concessionality is justified by the fact that the PA has no borrowing capacity, nor sufficient public funding to cover the costs of this project.

C.3. Sustainability and replicability of the project (exit strategy) (max. 1 page)

The project is implemented by the Palestinian Water Authority in the context of the Water Law, which calls for a joint management of public infrastructure between the Government and users.

The preferred scenario to ensure the sustainability of the project is organized as follows:

1. The PWA would own (and for the first few years, also operate) the Recovery and Reuse Systems with the ultimate goal of transferring the operation and management to the Water Users Association (WUA);

2. This would imply that:
   - PWA would own the Recovery System, and operate it for the first 3 years of the project;
   - PWA would own the Reuse System, and operate it for the first 3 years of the project;
   - During the first three years the WUA and Ministry of Agriculture in addition to PWA would receive intense capacity building;
   - After the first three years of the project, the WUA would assume operation and management of the Recovery and Reuse systems;
   - PWA would continue to own the systems but would lease them to the WUA.

3. The farmers will own and be responsible for operation of the On-Farm System (tertiary drip irrigation network), with the support of the WUA helping to coordinate farmers for technical assistance and capacity building with modern irrigation techniques and the proposed cropping pattern.

In financial terms, the sustainability and replicability of the project depends on the involvement of various donors, government and farmers, as per their capacity to cover the following costs:

(1) Capital Investment for the Water Recovery Scheme;

(2) Capital Investment for the Water Reuse (irrigation) Scheme up to Farm's Gate;

(3) O&M costs for the Water Recovery Scheme;

(4) O&M costs for the Water Reuse (irrigation) Scheme;

(5) Capital Investment for Farm's Development.

At this stage, the preferred scenario involves Capital and O&M subsidies from the Government, in a context of high vulnerability of the population. Costs (1) and (2) will be paid by the Government/Donors. Costs (3) and (4) would be subsidized by the Government only until Farmers have paid back cost (5). Farmers are expected to pay for the development of their own farm. All other costs are paid by the Government/Donors for the first 3 years (i.e. the time it takes for the farmers to be able to pay back the improvement of their farm). After that point, farmers will be responsible for paying O&M costs for the whole system (evaluated at .33 USD/m^3).

C.4 Engagement among the NDA, AE, and/or other relevant stakeholders in the country (max ½ page)

A pre-identification mission from the AE has been organized in July 2017 including a field visit to Gaza and meetings with the NDA (the Environment Quality Authority , EQA), which has confirmed its interest for the project and for its development into a funding proposal. Hereunder a relevant exert of the aide-mémoire of this mission:

"In this context, the production of non-conventional water and its reuse is one of the components of the PA's NAP . As mentioned above, development of WWTPs and, in general the growing rate of harvesting of waste water presents an opportunity to consolidate REUSE investments in Palestine in order to close the "water cycle" ;

⇨ *This could take the form of a* ***National REUSE Programme: Closing the Water Cycle for Adaptation of Agriculture to Climate Change****, the first phase of which could batch together a set of projects in West Bank* *and Gaza, of similar maturity.* ***AFD would be interested in co-funding its implementation and in presenting this programme to the Green Climate Fund in order to raise the necessary complementary financial resources.***

⇨ *The mission has met with PWA, the Ministry of Agriculture and the EQA which have shown interest in moving forward along these lines. AFD will need official confirmation, namely from the EQA – GCF's National Designated Agency- of the PA's commitment to support the presentation of this programme to the GCF through the AFD."*

Following this mission, follow-up meetings with the NDA have identified the project in Gaza as a high priority for the PA, with an urgent need for action. Further meetings have also allowed confirming AFD's commitment to funding this project with the full amount of its annual support programme to Palestine for 2018.

The EQA will remain fully on-board, alongside the PWA, for the final steps of project preparation (mainly the elaboration of the Gender Assessment and Action Plan) and appraisal of this project, which is expected to take place during the second Quarter of 2018.

D. Supporting documents submitted (OPTIONAL)

☒ Map indicating the location of the project/programme

☒ Diagram of the theory of change

☐ Financial Model

☐ Pre-feasibility Study

☐ Evaluation Report of previous project

Self-awareness check boxes

Are you aware that the full Funding Proposal and Annexes will require these documents? Yes ☒ No ☐

- Feasibility Study
- Environmental and social impact assessment or environmental and social management framework
- Stakeholder consultations at national and project level implementation including with indigenous people if relevant
- Gender assessment and action plan
- Operations and maintenance plan if relevant
- Loan or grant operation manual as appropriate
- Co-financing commitment letters

Are you aware that a funding proposal from an accredited entity without a signed AMA will be reviewed but not sent to the Board for consideration? Yes ☒ No ☐

Annexes 8-13

Annex 8

A. Project Affected Person Lands

No.	Name	Reason for deducting land	Well / Street No.	Area Owned (m2)	Well area that affects the Land (m2)	Street area that affects the Land (m2)	Total area that affects the Land (m2)	% Land to be deducted due to well
1	Ibrahim Mady	Construction of Well	RW8	1500	50	0	50	3%
2	Badr Aly Sons	Construction of Well	RW5	Wasn't Interviewed	50	0	50	Less than 25%
3	Abu Dawod ElNagar	Construction of Well	MW7	Wasn't Interviewed	4	0	4	Less than 25%
4	Ahmed Ebeid	Construction of Well	RW4	2000	50	0	50	3%
5	Adib ElShorfa	Construction of Well	RW2	3000	50	0	50	2%
6	Tahany Dardona	Construction of Well	RW11 & Street	426	50	30	80	19%
7	-	Well & Street	MW1	Wasn't Interviewed	4	0	4	Less than 25%
8	Tawfik ElTayeb	Construction of Well	MW5	3000	4	0	4	0.10%
9	Rabie ElZein	Construction of Well	MW4	Wasn't Interviewed	4	0	4	Less than 25%

10	Rabie ElSoltan	Construction of Well	MW10	5500	4	0	4	0.10%
11	Said ElGamal	Construction of Well	RW21	5800	50	0	50	1%
12	Aida Dardona	Construction of Well	RW3	3000	50	0	50	2%
13	Abdel Aal ElZein	Construction of Well	RW12	10000	50	0	50	1%
14	Atteya Mansour	Construction of Well	RW1	5500	50	0	50	1%
15	Anan Nabhan	Well & Street	RW9 & Street	600	275	93	368	46%
16	Ghazy ElZein	Construction of Well	MW6	4000	4	0	4	0.10%
17	Mahrous Nasr	Construction of Well	RW7	Wasn't Interviewed	50	0	50	Less than 25%
18	Mahmoud Sabry ElMotawek	Construction of Well	RW10	4500	50	0	50	1%
19	Mahmoud Ebeid	Well & Street	RW13	9000	50	500	550	6%
20	Hany Nasr	Construction of Well	RW6	1000	50	0	50	5%
21	-	Construction of Well	MW9	Wasn't Interviewed	4	0	4	Less than 25%

B. The PAPs Who Will Lose Their Work as A Well Operator

Serial number	Governorate	Municipality	Name	Pap	Legality	
1	North gaza	Jabalia	Hisham Younis Hussein Elar	Operator	Legal	Alternative water from reused wells
2	North gaza	Jabalia	Salem Mohamed Salem Alarour	Operator	Legal	Alternative water from reused wells
3	North gaza	Jabalia	Abdul Qader Mohammed Abed Rabbo Abu Khussa	Operator	Legal	Alternative water from reused wells
4	North gaza	Jabalia	Zayed Shokry Zayed Elar	Operator	Legal	Alternative water from reused wells
5	North gaza	Jabalia	Montaser Hussein yousef nasr	Operator	Legal	Alternative water from reused wells

Serial number	Governorate	Municipality	Name	Pap	Legality	
6	North gaza	Jabalia	Ahmed Mohammed Shuraitah Elsharatha	Operator	Legal	Alternative water from reused wells
7	North gaza	Jabalia	Rajab Amin Alabd Awad	Operator	Legal	Alternative water from reused wells
8	North gaza	Jabalia	Mahmoud Jaber Darwish Abou Rashid	Operator	Legal	Alternative water from reused wells
9	North gaza	Jabalia	Mohammed Ahmed Saleh	Operator	Legal	Alternative water from reused wells
10	Gaza	Gaza	Mohamed Hashim Hamouda Darwish Dardouna	Operator	Legal	Alternative water from reused wells
11	North gaza	Jabalia	Bashir Abu-Amer	Operator	Legal	Alternative water from reused wells
12	North gaza	Jabalia	Ahmed Farah ahmed Nasr	Operator	Legal	Alternative water from reused wells
13	North gaza	Jabalia	Ayesh Mohammed Saeed Abu Khussa	Operator	Legal	Alternative water from reused wells
14	North gaza	Jabalia	Youssef Gabriel Salem Abu Zuhair	Operator	Legal	Alternative water from reused wells
15	North gaza	Jabalia	Youssef Abed Rabbo Mohammed Abu Khussa	Operator	Legal	Alternative water from reused wells

C. WELL OWNERS

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
1	Q13	Jabalia	Male	Hassan Khalil Ali Elskafi	Partial ownership	Legal	Alternative water from reused wells	Permanent
2	Q13	Jabalia	Male	Samih Abd Mohamed Jarour	Partial ownership	Legal	Alternative water from reused wells	Permanent
3	Q13	Jabalia	Male	The hiers of Mansour Ahmed Aljdaba	Partial ownership	Legal	water from reused Alternative wells	Permanent
4	Q14	Jabalia	Male	Ali Mohamed Ali Shanan	partial ownership	Legal	water from reused Alternative wells	Permanent
5	Q14	Jabalia	female	Anan Ahmed Nabhan	partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
6	Q14	Jabalia	Male	Fared Ahmed Nabhan	partial ownership	Legal	water from reused Alternative wells	Permanent
7	Q14	Jabalia	Male	Ismael Nabhan	partial ownership	Legal	water from reused Alternative wells	Permanent
8	Q14	Jabalia	Male	Ismael Ragb Saleh	partial ownership	Legal	water from reused Alternative wells	Permanent
9	Q14	Jabalia	Male	Kasem Mohamed Mohamed Elhag Ali	partial ownership	Legal	water from reused Alternative wells	Permanent
10	Q14	Jabalia	Male	Omar Ragb Saleh	partial ownership	Legal	water from reused Alternative wells	Permanent
11	Q14	Jabalia	Male	Saleh shehta Saleh Elqanou	partial ownership	Legal	water from reused Alternative wells	Permanent
12	Q14	Jabalia	Male	Talal Ahmed Hassan Nabhan	partial ownership	Legal	water from reused Alternative wells	Permanent
13	Q14	Jabalia	Male	Talal Mohamed Mahmoud Rehan	partial ownership	Legal	water from reused Alternative wells	Permanent
14	Q14	Jabalia	Inheritance	The heirs of Attia Saleh Qanou	partial ownership	Legal	water from reused Alternative wells	Permanent
15	Q15	Jabalia	Male	Abd Elhamed Abd Elaziz Mahmoud Abou Khussa	Partial ownership	Legal	water from reused Alternative wells	Permanent
16	Q15	Jabalia	Male	Abdallah Ahmed Elabd Allah	Partial ownership	Legal	water from reused Alternative wells	Permanent
17	Q15	Jabalia	Male	Ahmed Hassan Ismael Nabhan	Partial ownership	Legal	water from reused Alternative wells	Permanent
18	Q15	Jabalia	female	Fatma Mohamed Ahmed Nabhan	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
19	Q15	Jabalia	Male	Gaber Ibrahim Mohamed Abou Khater	Partial ownership	Legal	water from reused Alternative wells	Permanent
20	Q15	Jabalia	female	Hoda Mohamed Hussien Mansour	Partial ownership	Legal	water from reused Alternative wells	Permanent
21	Q15	Jabalia	Male	Ibrahim Elsaid Hussien Elnagar	Partial ownership	Legal	water from reused Alternative wells	Permanent
22	Q15	Jabalia	Male	Khalil Masoud Ibrahim Mansour	Partial ownership	Legal	water from reused Alternative wells	Permanent
23	Q16	Jabalia	Male	Abd Elmoaty Mohamed Ashour Alosh	Partial ownership	Legal	water from reused Alternative wells	Permanent
24	Q16	Jabalia	female	Aeisha Hekmat Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
25	Q16	Jabalia	Male	Ahmed Mohamed Salem Eltaloly	Partial ownership	Legal	water from reused Alternative wells	Permanent
26	Q16	Jabalia	Male	Aish Eid Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
27	Q16	Jabalia	Male	Akram Diab Ali Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
28	Q16	Jabalia	Male	Ans Darwish Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
29	Q16	Jabalia	Male	Ashour Mohamed Ashour Alosh	Partial ownership	Legal	water from reused Alternative wells	Permanent
30	Q16	Jabalia	female	Azhar Mohamed Shehab	Partial ownership	Legal	water from reused Alternative wells	Permanent
31	Q16	Jabalia	Male	Emad Ahmed Abd Elrahman	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
				Khedr	ownership		wells	
32	Q16	Jabalia	Male	Fakhry Ali Abd Elrahman Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
33	Q16	Jabalia	female	Fatma Ahmed Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
34	Q16	Jabalia	female	Fatma Hashim Omar Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
35	Q16	Jabalia	female	Firyal Gomaa Elnadr	Partial ownership	Legal	water from reused Alternative wells	Permanent
36	Q16	Jabalia	female	Ghalia Ragb Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
37	Q16	Jabalia	female	Hekmat Soliman Ali Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
38	Q16	Jabalia	Male	Ibrahim Saled Dawood Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
39	Q16	Jabalia	Male	Karama Diab Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
40	Q16	Jabalia	female	Karima Diab Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
41	Q16	Jabalia	female	Layla Hemat Soliman Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
42	Q16	Jabalia	Male	Mahmoud Gomaa Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
43	Q16	Jabalia	Male	Mahmoud Mohamed Youssef Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
44	Q16	Jabalia	Male	Mohamed Gawad Diab Ali Ganed	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
45	Q16	Jabalia	Male	Mohamed Gomaa Mohamed Mahra	Partial ownership	Legal	water from reused Alternative wells	Permanent
46	Q16	Jabalia	Male	Mohamed Mesbah Halawen	Partial ownership	Legal	water from reused Alternative wells	Permanent
47	Q16	Jabalia	female	Nadya Youssef Mohamed Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
48	Q16	Jabalia	female	Nariman Raafat Ashour Alosh	Partial ownership	Legal	water from reused Alternative wells	Permanent
49	Q16	Jabalia	Male	Raed Hamza Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
50	Q16	Jabalia	female	Ragaa Moustafa Nasr Mahra	Partial ownership	Legal	water from reused Alternative wells	Permanent
51	Q16	Jabalia	Male	Reyad Ahmed Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
52	Q16	Jabalia	female	Sabha Khamis Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
53	Q16	Jabalia	female	Safaa Moustafa Mohamed Mahra	Partial ownership	Legal	water from reused Alternative wells	Permanent
54	Q16	Jabalia	Male	Samir Ahmed Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
55	Q16	Jabalia	Inheritance	The hiers of Khalil Mohamed Khalil Mahra	Partial ownership	Legal	water from reused Alternative wells	Permanent
56	Q16	Jabalia	Inheritance	The hiers of Mohamed Abd Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
57	Q16	Jabalia	female	Wafaa Moustafa Mahra	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
58	Q16	Jabalia	Male	Yassin Youssef Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
59	Q16	Jabalia	Male	Youssef Elabd Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
60	Q16	Jabalia	Male	Zeyad Ahmed Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
61	Q16	Jabalia	Male	Zeyad Gomaa Elhalawen	Partial ownership	Legal	water from reused Alternative wells	Permanent
62	Q17	Jabalia	female	Taghrid Ragb Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
63	Q17	Jabalia	female	Amal Mohamed Ali	Partial ownership	Legal	water from reused Alternative wells	Permanent
64	Q17	Jabalia	female	Anaam Ragb Mahmoud Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
65	Q17	Jabalia	female	Andaleb Ragb Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
66	Q17	Jabalia	Male	Ayman Ragb Eid/Mariem Mosaa Rizk Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
67	Q17	Jabalia	Male	Eid Ragb Mohamed Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
68	Q17	Jabalia	female	Fatma Mahmoud Ibrahim Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
69	Q17	Jabalia	female	Fatma Mohamed Ali	Partial ownership	Legal	water from reused Alternative wells	Permanent
70	Q17	Jabalia	Male	Ghazy Ramdan Elzein	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
71	Q17	Jabalia	Male	Hamza Ibrahim Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
72	Q17	Jabalia	Male	Ibrahim Hamouda Elzein	Partial ownership	Legal	water from reused Alternative wells	Permanent
73	Q17	Jabalia	female	kawthar Youssef Ibrahim Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
74	Q17	Jabalia	female	Manal Fouad Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
75	Q17	Jabalia	Male	Sherif Mohamed Ali Elzein	Partial ownership	Legal	water from reused Alternative wells	Permanent
76	Q17	Jabalia	Inheritance	The Hiers of Abd Elal Ismael Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
77	Q17	Jabalia	Male	Youssef Ibrahim Youssef Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
78	Q17	Jabalia	Inheritance	Nherited Mohammed Al-Naouq	Partial ownership	Legal	water from reused Alternative wells	Permanent
79	Q17	Jabalia	Male	Abdul Karim Nasr	Partial ownership	Legal	water from reused Alternative wells	Permanent
80	Q17	Jabalia	Male	Adnan Nasr	Partial ownership	Legal	water from reused Alternative wells	Permanent
81	Q17	Jabalia	Male	Mahmoud Al-Najjar	Partial ownership	Legal	water from reused Alternative wells	Permanent
82	Q17	Jabalia	Inheritance	Nherited Ibrahim Ali Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
83	Q19	Jabalia	Male	Abd Elkhalek Mohamed Khallah	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
84	Q19	Jabalia	female	Aeisha Saleh Abou Warda	Partial ownership	Legal	water from reused Alternative wells	Permanent
85	Q19	Jabalia	Male	Falah Zeyad Nabhan	Partial ownership	Legal	water from reused Alternative wells	Permanent
86	Q19	Jabalia	Male	Fouad Hamad Hanon	Partial ownership	Legal	water from reused Alternative wells	Permanent
87	Q19	Jabalia	Male	Mohamed Kaied Elnagar	Partial ownership	Legal	water from reused Alternative wells	Permanent
88	Q19	Jabalia	Male	Sameih Eid Mohamed Garour	Partial ownership	Legal	water from reused Alternative wells	Permanent
89	Q19	Jabalia	Male	Abdul Rahman Tamraz	Partial ownership	Legal	water from reused Alternative wells	Permanent
90	Q19	Jabalia	Male	Mohammed Abu Wardah	Partial ownership	Legal	water from reused Alternative wells	Permanent
91	Q19	Jabalia	Male	Rawhy Al Taieb	Partial ownership	Legal	water from reused Alternative wells	Permanent
92	Q19	Jabalia	Male	Malik Abu Wardah	Partial ownership	Legal	water from reused Alternative wells	Permanent
93	Q19	Jabalia	Male	Abu Abdullah Madoukh	Partial ownership	Legal	water from reused Alternative wells	Permanent
94	Q19	Jabalia	Male	Hassan Abou El Hassany	Partial ownership	Legal	water from reused Alternative wells	Permanent
95	Q19	Jabalia	Male	Riad Nasr	Partial ownership	Legal	water from reused Alternative wells	Permanent
96	Q19	Jabalia	Male	Essam Abu Wardah	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
97	Q19	Jabalia	Male	Abdul Karim Al-Tayeb	Partial ownership	Legal	water from reused Alternative wells	Permanent
98	Q19	Jabalia	Male	Raafat Ezzo Nabhan	Partial ownership	Legal	water from reused Alternative wells	Permanent
99	Q19	Jabalia	Male	Khalil Bader Al-Adham	Partial ownership	Legal	water from reused Alternative wells	Permanent
100	Q19	Jabalia	Male	Sobhy Mohamed Abou warda	Partial ownership	Legal	water from reused Alternative wells	Permanent
101	Q52	Jabalia	Male	Abd Elbary Ragb Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
102	Q52	Jabalia	Male	Abd Elhady Hamza Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
103	Q52	Jabalia	Male	Abd Elhakim Mohamed Ganed	Partial ownership	Legal	water from reused Alternative wells	Permanent
104	Q52	Jabalia	Male	Abd Elhay Awad Elmotwak	Partial ownership	Legal	water from reused Alternative wells	Permanent
105	Q52	Jabalia	Male	Abd Elmeinem Ramdan Elnagar	Partial ownership	Legal	water from reused Alternative wells	Permanent
106	Q52	Jabalia	Male	Abd Elrahman Ahmed Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
107	Q52	Jabalia	female	Aeisha dahier Shaker Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
108	Q52	Jabalia	female	Aeisha Mahmoud Abou Warda	Partial ownership	Legal	water from reused Alternative wells	Permanent
109	Q52	Jabalia	Male	Ahmed Mohamed Elnagar	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
110	Q52	Jabalia	Male	Ali Abd Elrahman khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
111	Q52	Jabalia	female	Amnaa Khedr and others	Partial ownership	Legal	water from reused Alternative wells	Permanent
112	Q52	Jabalia	female	Eibtsam Ahmed Mosaa Shabaan and others	Partial ownership	Legal	water from reused Alternative wells	Permanent
113	Q52	Jabalia	Male	Goudy Abd Elrahman Ahmed Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
114	Q52	Jabalia	Male	Hany Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
115	Q52	Jabalia	female	Manal Ahmed Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
116	Q52	Jabalia	Male	Mohamed Talb Khedr	Partial ownership	Legal	water from reused Alternative wells	Permanent
117	Q52	Jabalia	Male	Shabaan Ali Khedr and associates	Partial ownership	Legal	water from reused Alternative wells	Permanent
118	Q53	Jabalia	Male	Abd Rabeia Soltan	Partial ownership	Legal	water from reused Alternative wells	Permanent
119	Q53	Jabalia	Male	Ahmed Abd Mahd Soliman	Partial ownership	Legal	water from reused Alternative wells	Permanent
120	Q53	Jabalia	Male	Aly Waheib Gamal Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
121	Q53	Jabalia	female	Amnaa Saleh Saleh Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
122	Q53	Jabalia	Male	Awad Mohamed Mahra	Partial	Legal	water from reused Alternative	Permanent

Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
123	Q53	Jabalia	female	Bahia Ahmed Mahmoud Suleiman	Partial ownership	Legal	water from reused Alternative wells	Permanent
124	Q53	Jabalia	Male	Basel Ibrahim Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
125	Q53	Jabalia	Male	Darwish Moustafa Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
126	Q53	Jabalia	Male	Gohar Ibrahim Khalil Elbatsh	Partial ownership	Legal	water from reused Alternative wells	Permanent
127	Q53	Jabalia	Inheritance	Inherited Deeb Abed Rabbo Sultan Yassin	Partial ownership	Legal	water from reused Alternative wells	Permanent
128	Q53	Jabalia	Male	Ismail Mohamed Mutawaq	Partial ownership	Legal	water from reused Alternative wells	Permanent
129	Q53	Jabalia	Male	Majestic beauty Hassan Hamouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
130	Q53	Jabalia	female	Mariam Ayesh Suleiman	Partial ownership	Legal	water from reused Alternative wells	Permanent
131	Q53	Jabalia	Male	Mohamed Gomaa Mahra	Partial ownership	Legal	water from reused Alternative wells	Permanent
132	Q53	Jabalia	Male	Mohamed Mahmoud Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
133	Q53	Jabalia	Male	Mohamed Mohamed Sultan	Partial ownership	Legal	water from reused Alternative wells	Permanent
134	Q53	Jabalia	Male	Mohammad Yousuf Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
135	Q53	Jabalia	Male	Moneb Gamal Hamouda	Partial	Legal	water from reused Alternative	Permanent

Seri al	Well numbe r	Municipalit y	Sex	the PAP Name of	Type of ownership	Legalit y	for well taken Reason	of Duration impact
					ownership		wells	
136	Q53	Jabalia	Male	Nasser Saleh Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
137	Q53	Jabalia	Male	Omar Sultan Rabea	Partial ownership	Legal	water from reused Alternative wells	Permanent
138	Q53	Jabalia	Male	Ragb Ismael Elnagar	Partial ownership	Legal	water from reused Alternative wells	Permanent
139	Q53	Jabalia	Male	Saeed Abd Soliman	Partial ownership	Legal	water from reused Alternative wells	Permanent
140	Q53	Jabalia	Male	Samir Abd Rabei El soltan	Partial ownership	Legal	water from reused Alternative wells	Permanent
141	Q53	Jabalia	female	Sowen zakria Ahmed Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
142	Q53	Jabalia	female	Suad Abdel-Rahman Alloush	Partial ownership	Legal	water from reused Alternative wells	Permanent
143	Q53	Jabalia	female	Suad Mohammed Al-Suleiman	Partial ownership	Legal	water from reused Alternative wells	Permanent
144	Q53	Jabalia	female	Tahany Saleh Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
145	Q53	Jabalia	Male	Zakaria Ahmed Abdallah Dardouna	Partial ownership	Legal	water from reused Alternative wells	Permanent
146	Q54	Jabalia	female	Fatima Mohamed Saad Hartani	Partial ownership	Legal	water from reused Alternative wells	Permanent
147	Q54	Jabalia	Male	Hassan Khalil Ibrahim Abu Warda	Partial ownership	Legal	water from reused Alternative wells	Permanent
148	Q54	Jabalia	Male	Mohamed Ahmed Saleh	Partial	Legal	water from reused Alternative	Permanent

Seri al	Well numbe r	Municipalit y	Sex	the PAP Name of	Type of ownership	Legalit y	for well taken Reason	of Duration impact
					ownership		wells	
149	Q56	Jabalia	Male	Ahmed Awad Junid	Partial ownership	Legal	water from reused Alternative wells	Permanent
150	Q56	Jabalia	Male	Ibrahim El Sayed Hassan al-Najjar	Partial ownership	Legal	water from reused Alternative wells	Permanent
151	Q56	Jabalia	Male	Mohamed Hashem Hamouda Darwish	Partial ownership	Legal	water from reused Alternative wells	Permanent
152	Q56	Jabalia	female	Aisha Ali Obaid Da'mh	Partial ownership	Legal	water from reused Alternative wells	Permanent
153	Q56	Jabalia	female	Amal Mohamed Junaid	Partial ownership	Legal	water from reused Alternative wells	Permanent
154	Q56	Jabalia	female	Amna Mohammed Hussein Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
155	Q56	Jabalia	Male	Anas Darwish Junaid	Partial ownership	Legal	water from reused Alternative wells	Permanent
156	Q56	Jabalia	Male	Anisa Noman Junaid	Partial ownership	Legal	water from reused Alternative wells	Permanent
157	Q56	Jabalia	Male	Awad Arabi Junaid and others	Partial ownership	Legal	water from reused Alternative wells	Permanent
158	Q56	Jabalia	Male	Eid Hussein Rashid al-Najjar	Partial ownership	Legal	water from reused Alternative wells	Permanent
159	Q56	Jabalia	Male	Gallet Ramadan al-Najjar	Partial ownership	Legal	water from reused Alternative wells	Permanent
160	Q56	Jabalia	Male	Ghassan Mohammed Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
161	Q56	Jabalia	Male	Hamed Mohamed Dardounh	Partial	Legal	water from reused Alternative	Permanent

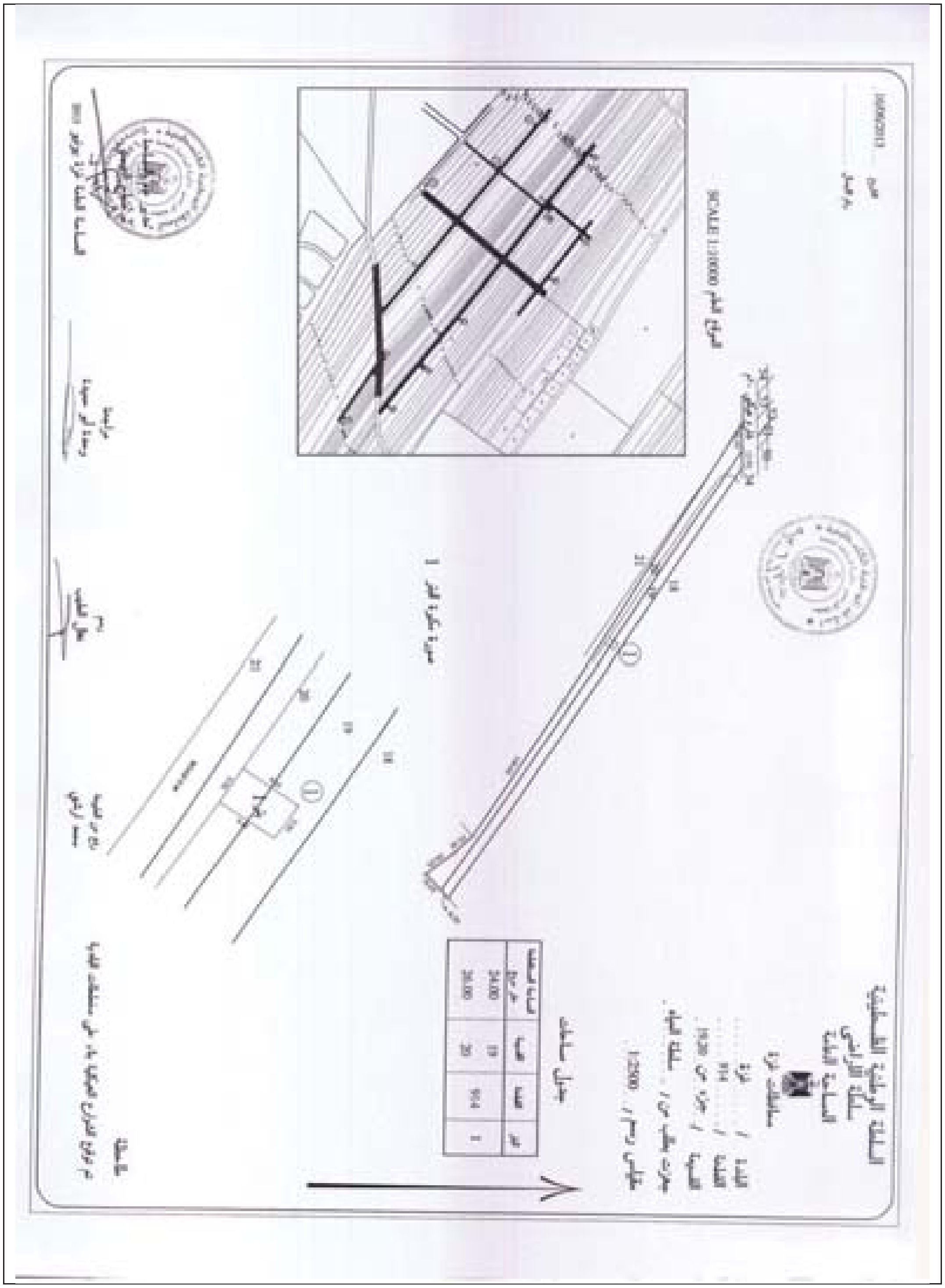
Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
162	Q56	Jabalia	Male	Hamza Mohammed Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
163	Q56	Jabalia	Male	Ibrahim Ahmed Abdullah Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
164	Q56	Jabalia	female	Inherited Mustafa Abdel Aal Ismail Zain	Partial ownership	Legal	water from reused Alternative wells	Permanent
165	Q56	Jabalia	Male	Kamel Hamouda Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
166	Q56	Jabalia	female	Mariam Ahmed Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
167	Q56	Jabalia	Male	Masoud Abdel Aal Ismail Zain	Partial ownership	Legal	water from reused Alternative wells	Permanent
168	Q56	Jabalia	Inheritance	Mohamed Eid Mohammed Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
169	Q56	Jabalia	Male	Mohamed Mohamed Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
170	Q56	Jabalia	Male	Mohamed Noaman Ismail El Zein	Partial ownership	Legal	water from reused Alternative wells	Permanent
171	Q56	Jabalia	Male	Mohammed Hamdi Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
172	Q56	Jabalia	Male	Mohammed Junaid Arabi	Partial ownership	Legal	water from reused Alternative wells	Permanent
173	Q56	Jabalia	Male	Musleh Noman Junaid	Partial ownership	Legal	water from reused Alternative wells	Permanent
174	Q56	Jabalia	female	Mzionh Noman Ismail Junaid	Partial	Legal	water from reused Alternative	Permanent

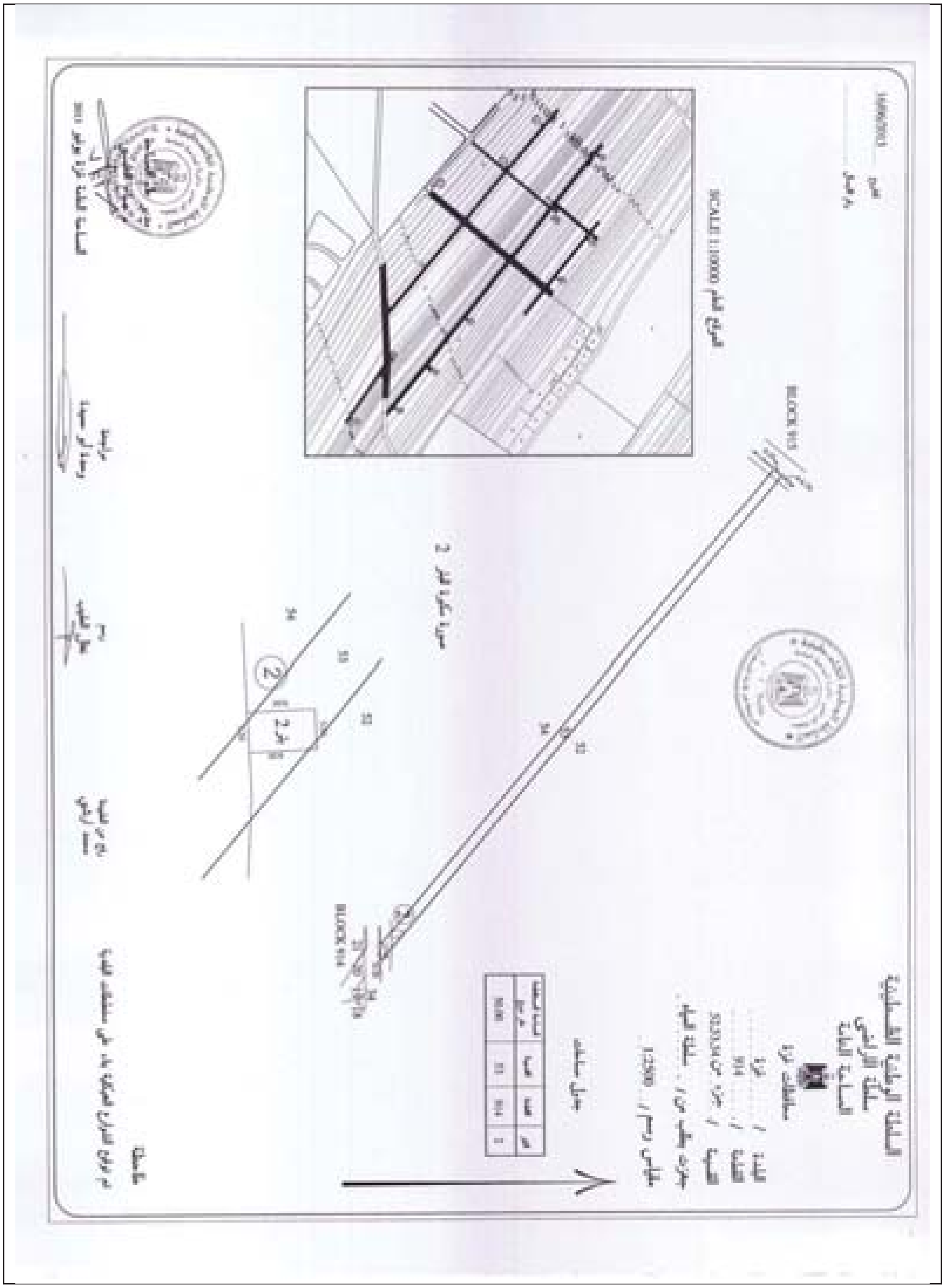
Seri al	Well numbe r	Municipalit y	Sex	the PAP Name of	Type of ownership	Legalit y	for well taken Reason	of Duration impact
					ownership		wells	
175	Q56	Jabalia	Male	nherited Junaid Ismail Abdel Aal	Partial ownership	Legal	water from reused Alternative wells	Permanent
176	Q56	Jabalia	Male	Noman Ismail Junaid	Partial ownership	Legal	water from reused Alternative wells	Permanent
177	Q56	Jabalia	Male	Omar Noaman Zein	Partial ownership	Legal	water from reused Alternative wells	Permanent
178	Q56	Jabalia	Male	Ramez Mohamed Alloush	Partial ownership	Legal	water from reused Alternative wells	Permanent
179	Q56	Jabalia	Male	Rashid Mohammed Dardounh	Partial ownership	Legal	water from reused Alternative wells	Permanent
180	Q56	Jabalia	Male	Shaaban Junaid Arabi, and others	Partial ownership	Legal	water from reused Alternative wells	Permanent
181	Q56	Jabalia	Inheritan ce	Suad Ismail Noman Junaid	Partial ownership	Legal	water from reused Alternative wells	Permanent
182	Q56	Jabalia	Male	Yasser Talal basil	Partial ownership	Legal	water from reused Alternative wells	Permanent
183	Q65	Jabalia	Male	Abdul Hakim Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
184	Q65	Jabalia	Male	Abdul Karim Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
185	Q65	Jabalia	female	Amira Mohamed Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
186	Q65	Jabalia	Male	Eid Said Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
187	Q65	Jabalia	female	Khadija Abdul Hay El Gamal	Partial	Legal	water from reused Alternative	Permanent

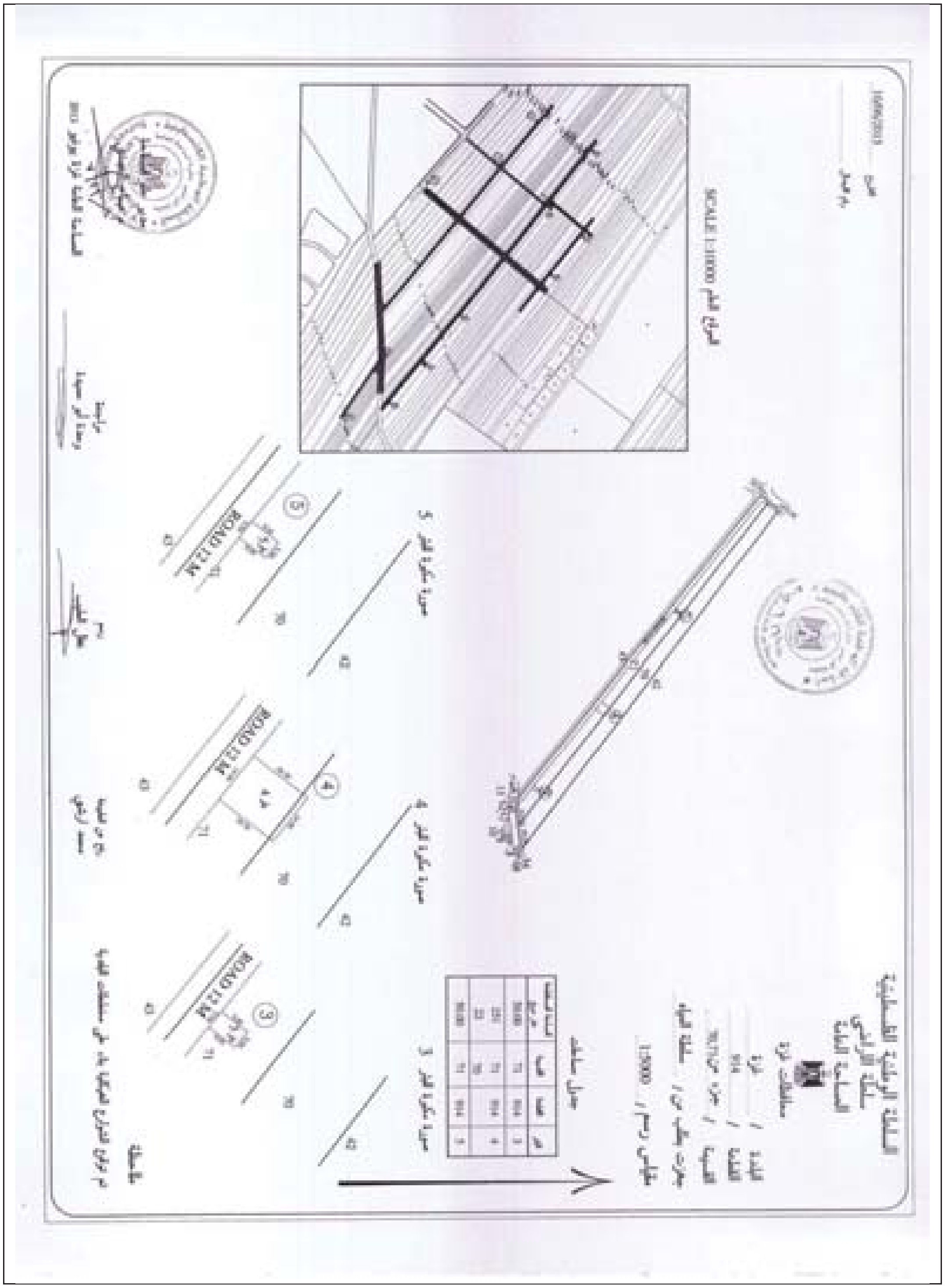
Serial	Well number	Municipality	Sex	the PAP Name of	Type of ownership	Legality	for well taken Reason	of Duration impact
					ownership		wells	
188	Q65	Jabalia	Male	Mohammed Rizk Hartani	Partial ownership	Legal	water from reused Alternative wells	Permanent
189	Q65	Jabalia	Male	Nabiel Gomaa El Zein	Partial ownership	Legal	water from reused Alternative wells	Permanent
190	Q65	Jabalia	female	Nawal Mohammed Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
191	Q65	Jabalia	Male	Raed Ashour Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
192	Q65	Jabalia	female	Sabah Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
193	Q65	Jabalia	Male	Saleh Mohammed Eid	Partial ownership	Legal	water from reused Alternative wells	Permanent
194	Q86	Jabalia	Male	Yahya Kamel Khader	Partial ownership	Legal	water from reused Alternative wells	Permanent
195	Q86	Jabalia	Male	Abdul Rahman Khadr	Partial ownership	Legal	water from reused Alternative wells	Permanent
196	Q86	Jabalia	female	Ghalia Abu El Hasana	Partial ownership	Legal	water from reused Alternative wells	Permanent
197	Q86	Jabalia	Male	Mahmoud Khader	Partial ownership	Legal	water from reused Alternative wells	Permanent
198	Q86	Jabalia	Male	Mohamed Mahmoud Khader	Partial ownership	Legal	water from reused Alternative wells	Permanent
199	Q86	Jabalia	Male	Mohammed Abu Khader good	Partial ownership	Legal	water from reused Alternative wells	Permanent
200	Q86	Jabalia	Male	Samir Yousef al-Najjar	Partial	Legal	water from reused Alternative	Permanent

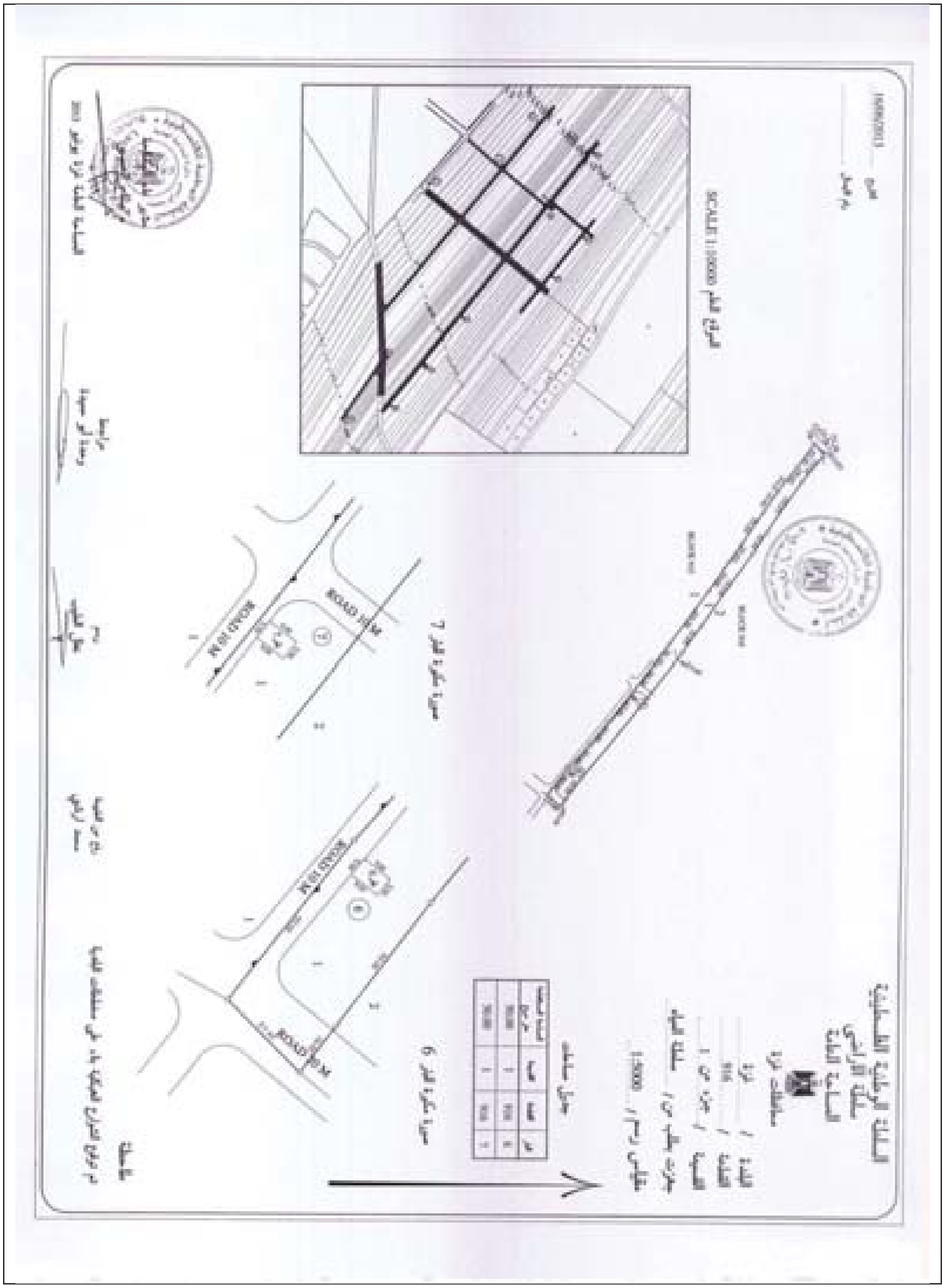
Seri al	Well numbe r	Municipalit y	Sex	the PAP Name of	Type of ownership	Legalit y	for well taken Reason	of Duration impact
					ownership		wells	
201	Q86	Jabalia	Inheritan ce	The heirs of Fatima Mohamed Gouda	Partial ownership	Legal	water from reused Alternative wells	Permanent
202	Q86	Jabalia	Male	Yahya Khader & Co.	Partial ownership	Legal	water from reused Alternative wells	Permanent

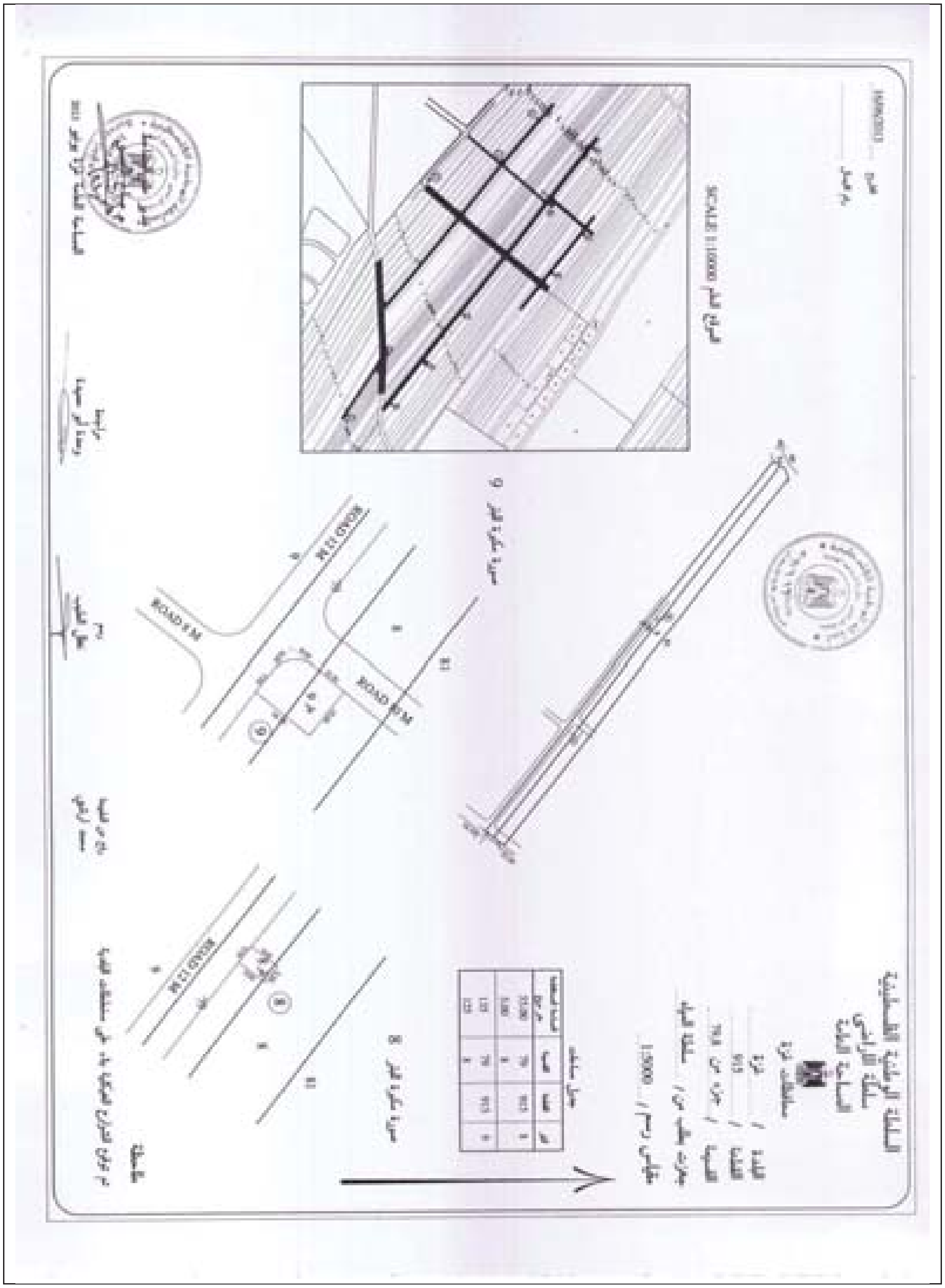
Annex 9 : Maps

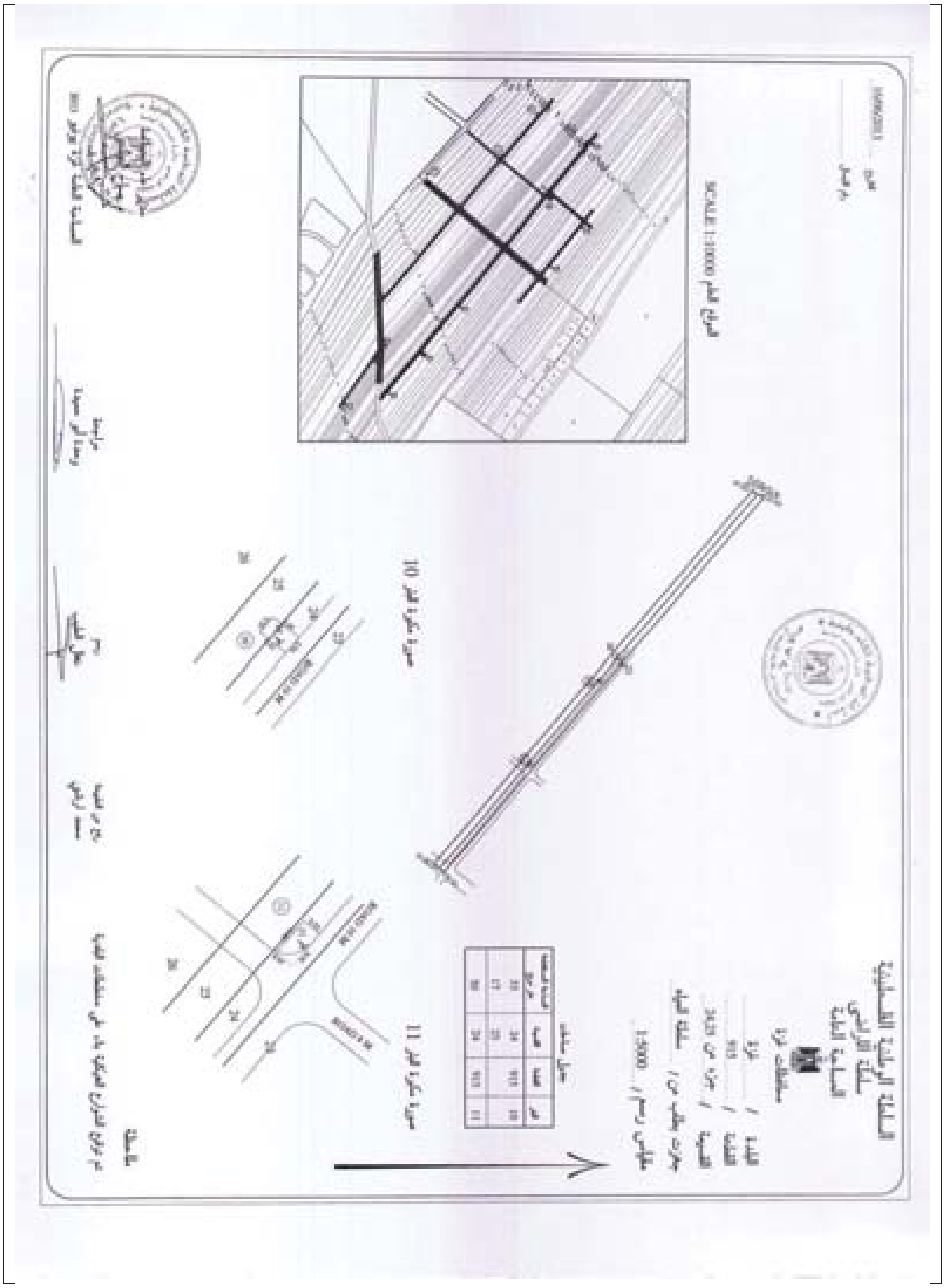


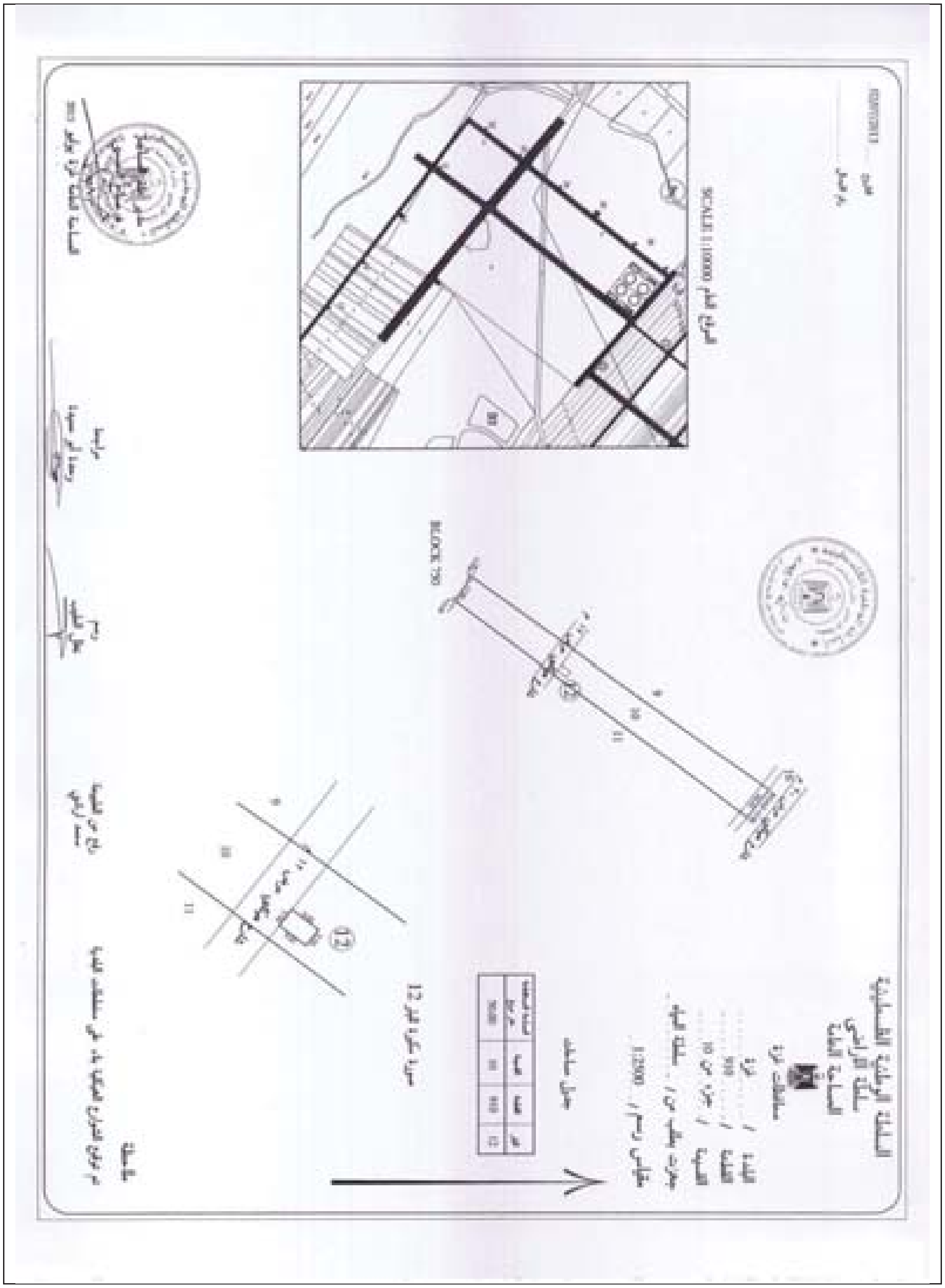


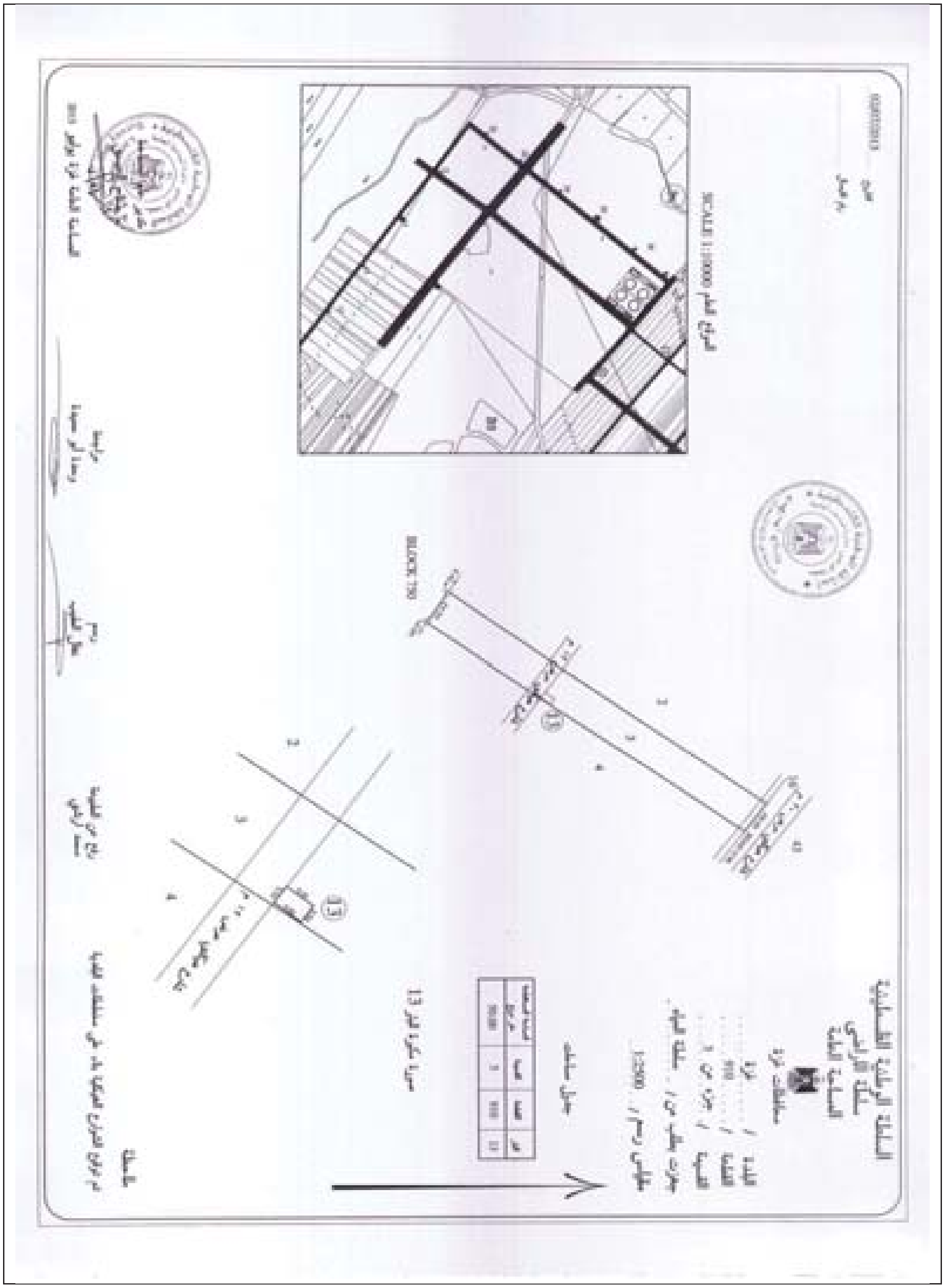

ROAD 12 M
ROAD 12 M
ROAD 12 M

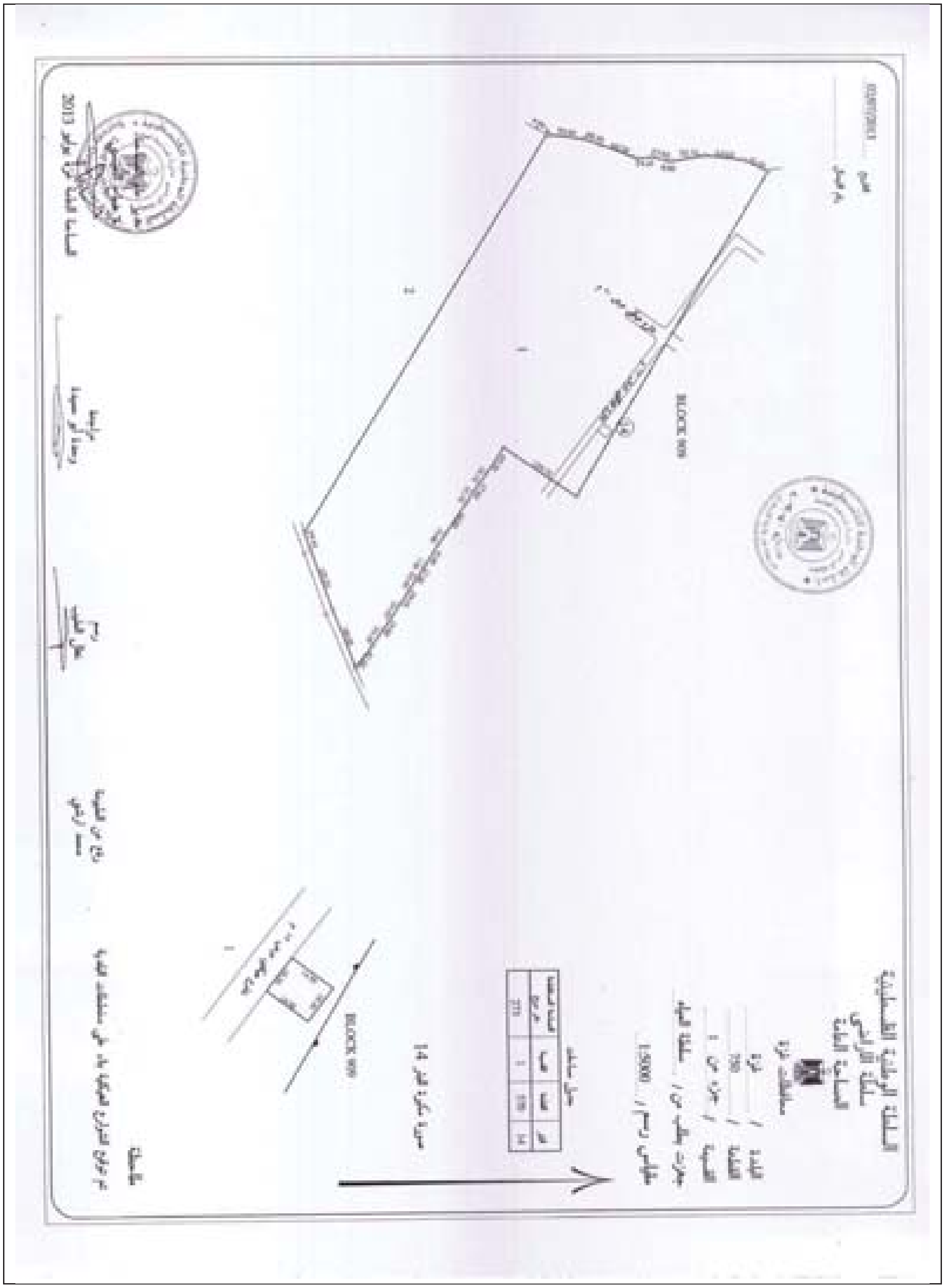

SCALE 1:10000
ROAD 10 M
ROAD 10 M
ROAD 10 M
ROAD 10 M

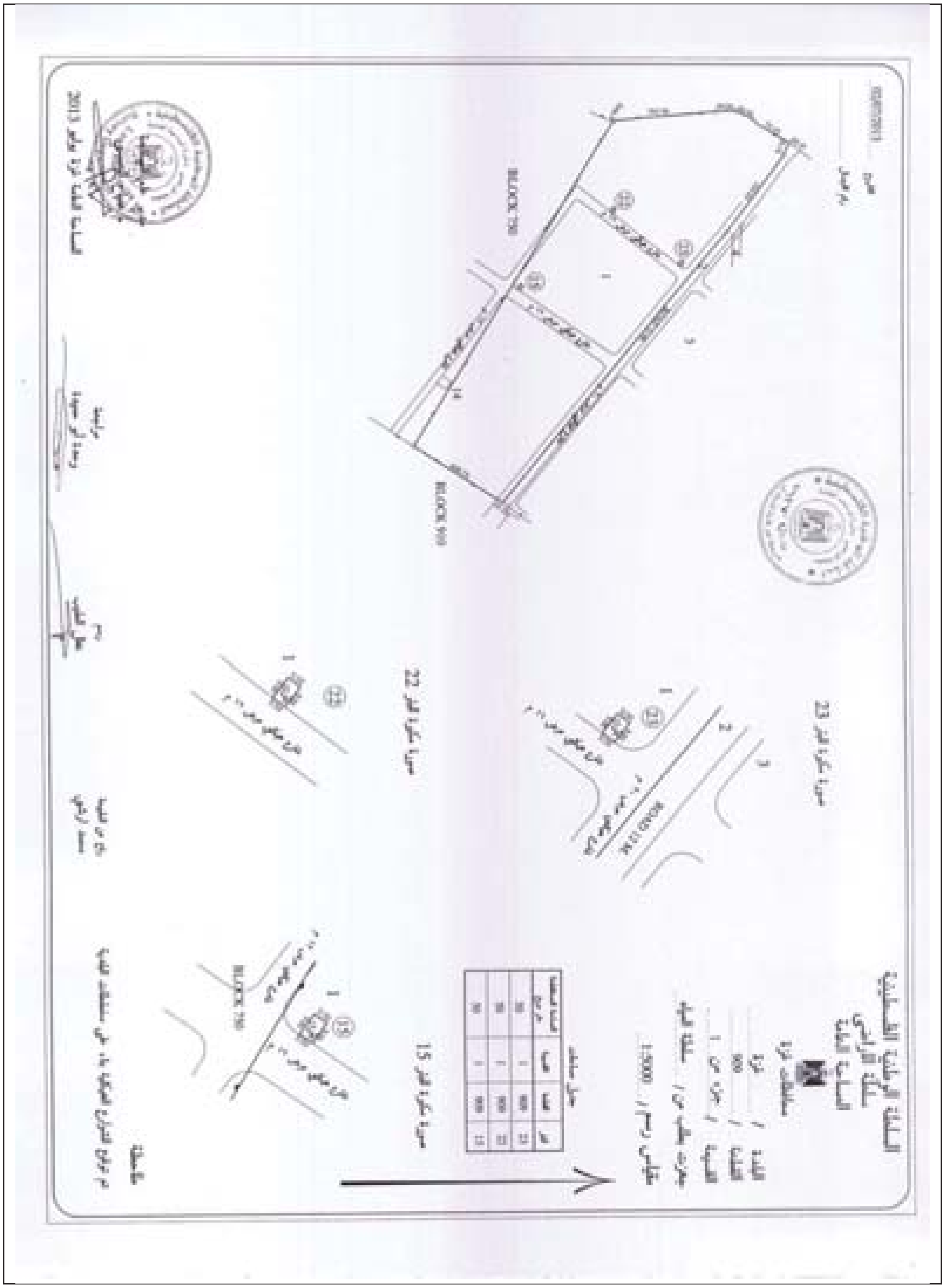

SCALE 1:10000
ROAD 12 M
ROAD 8 M

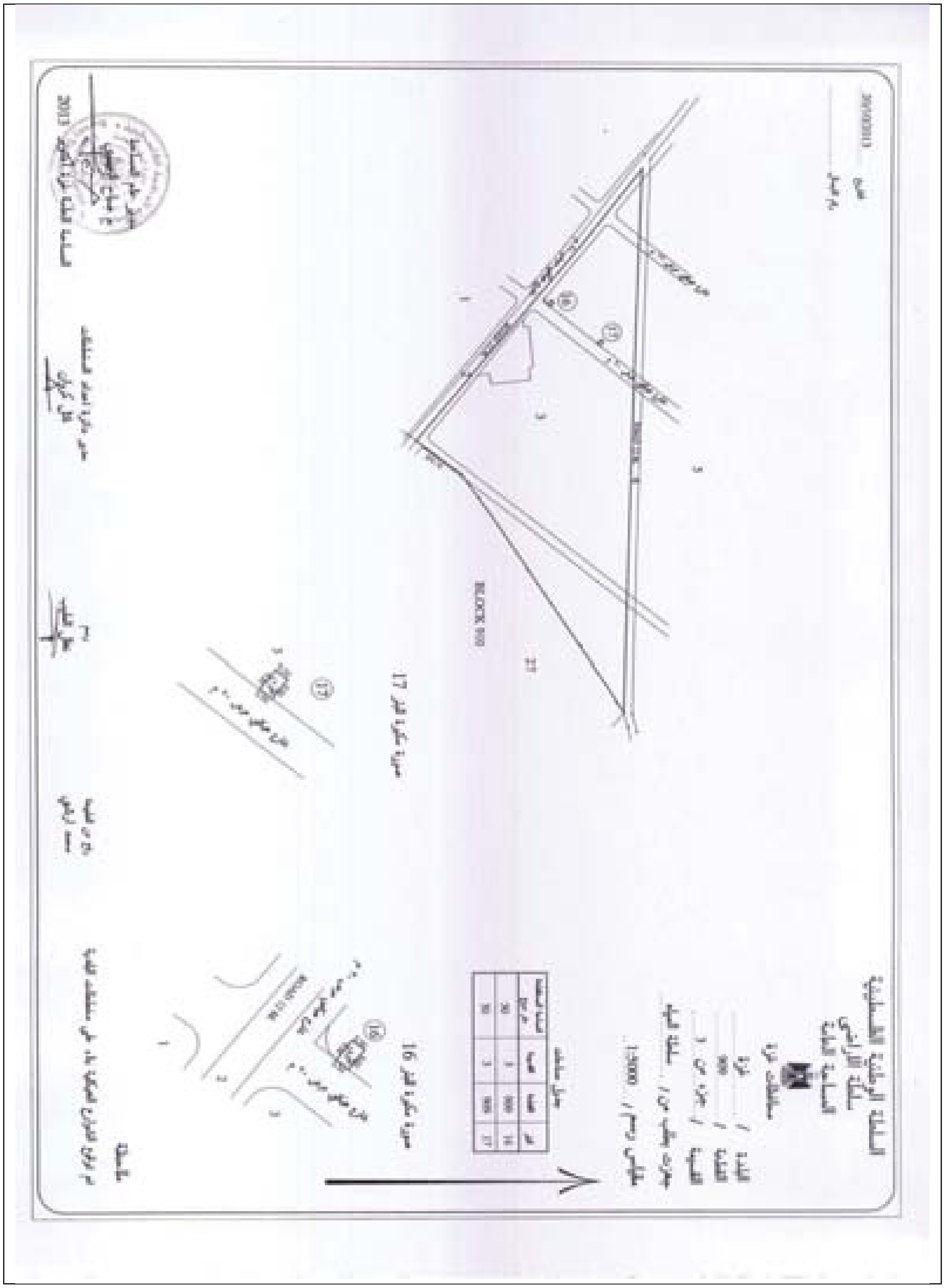


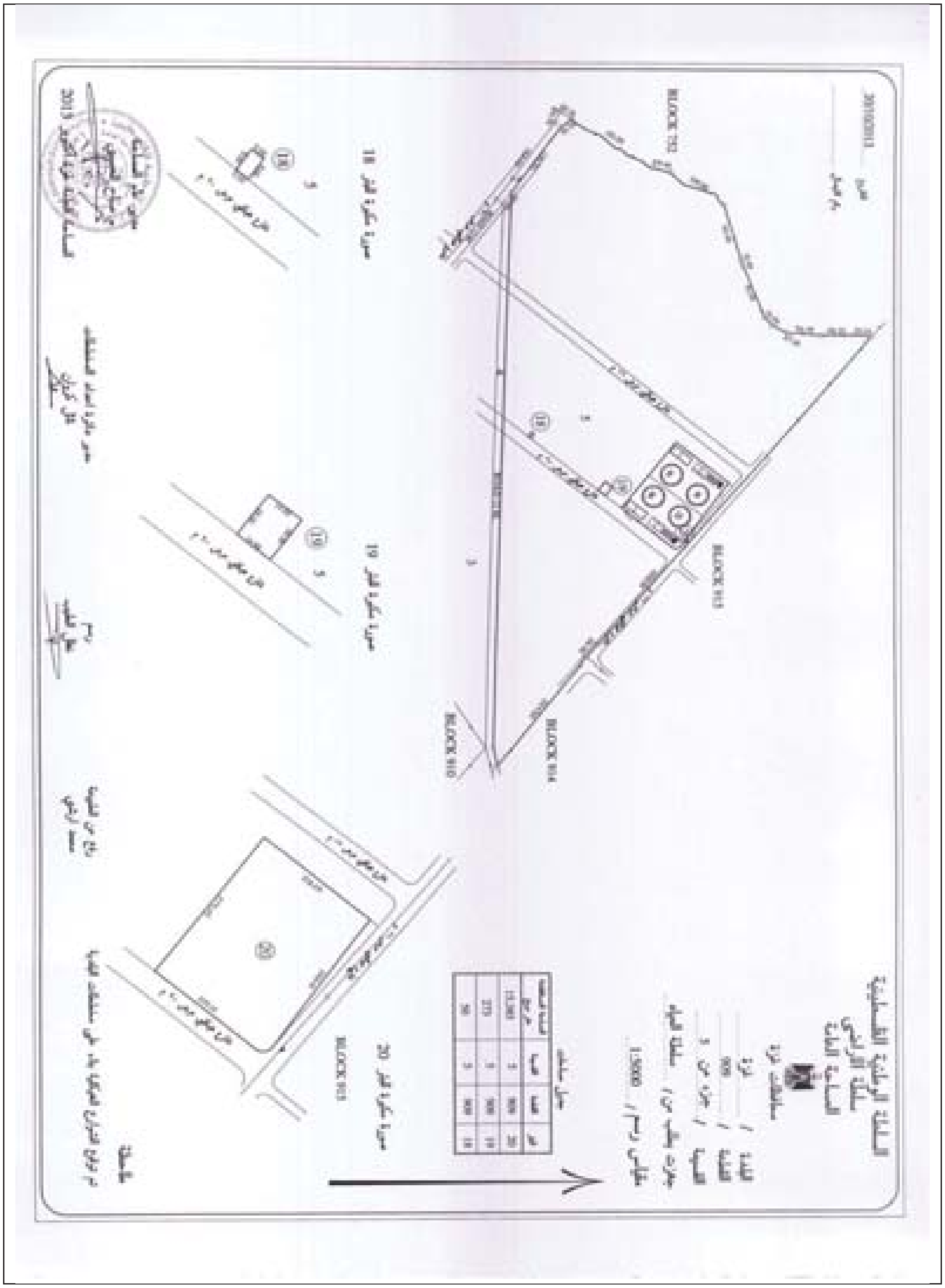


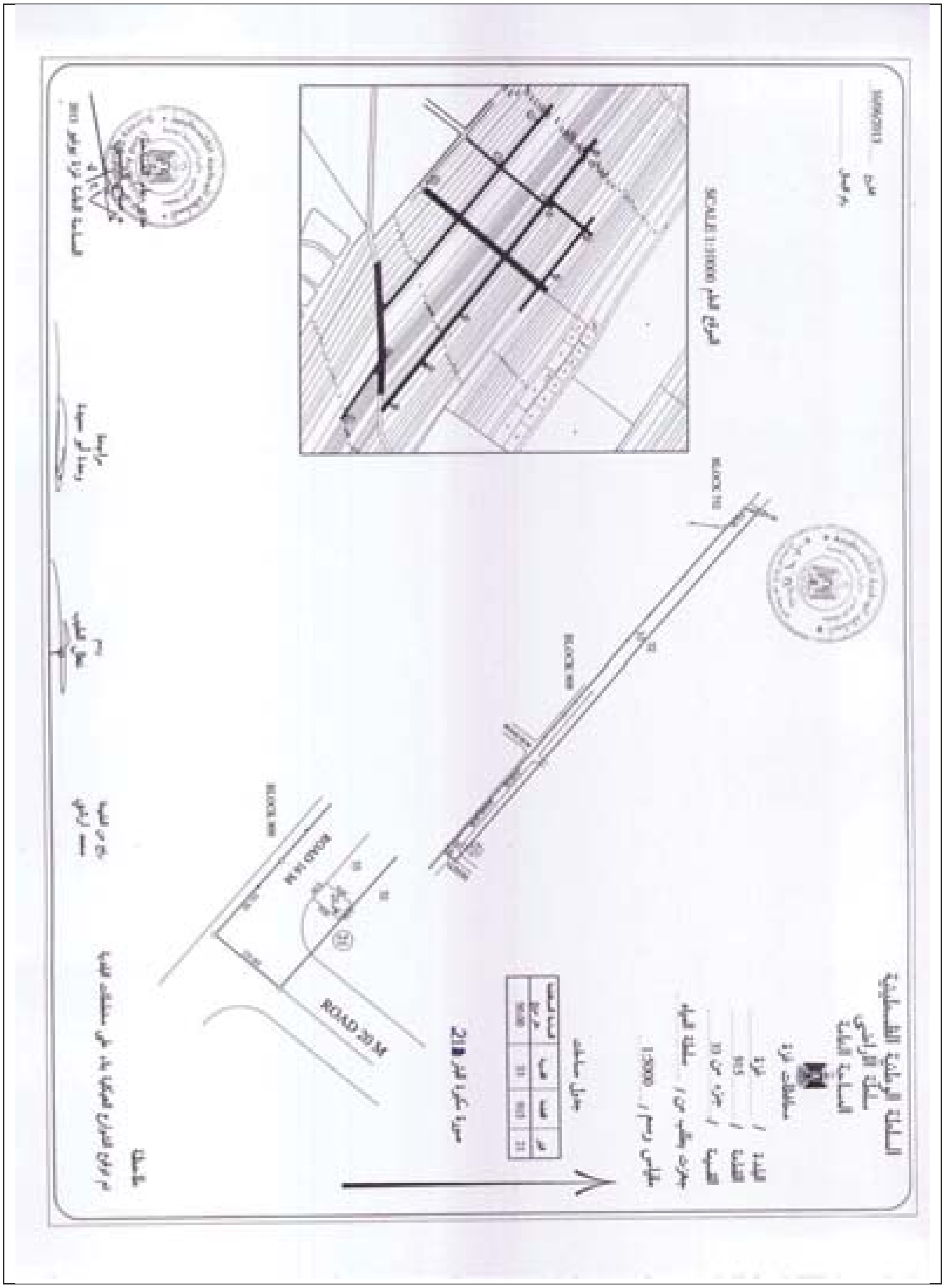


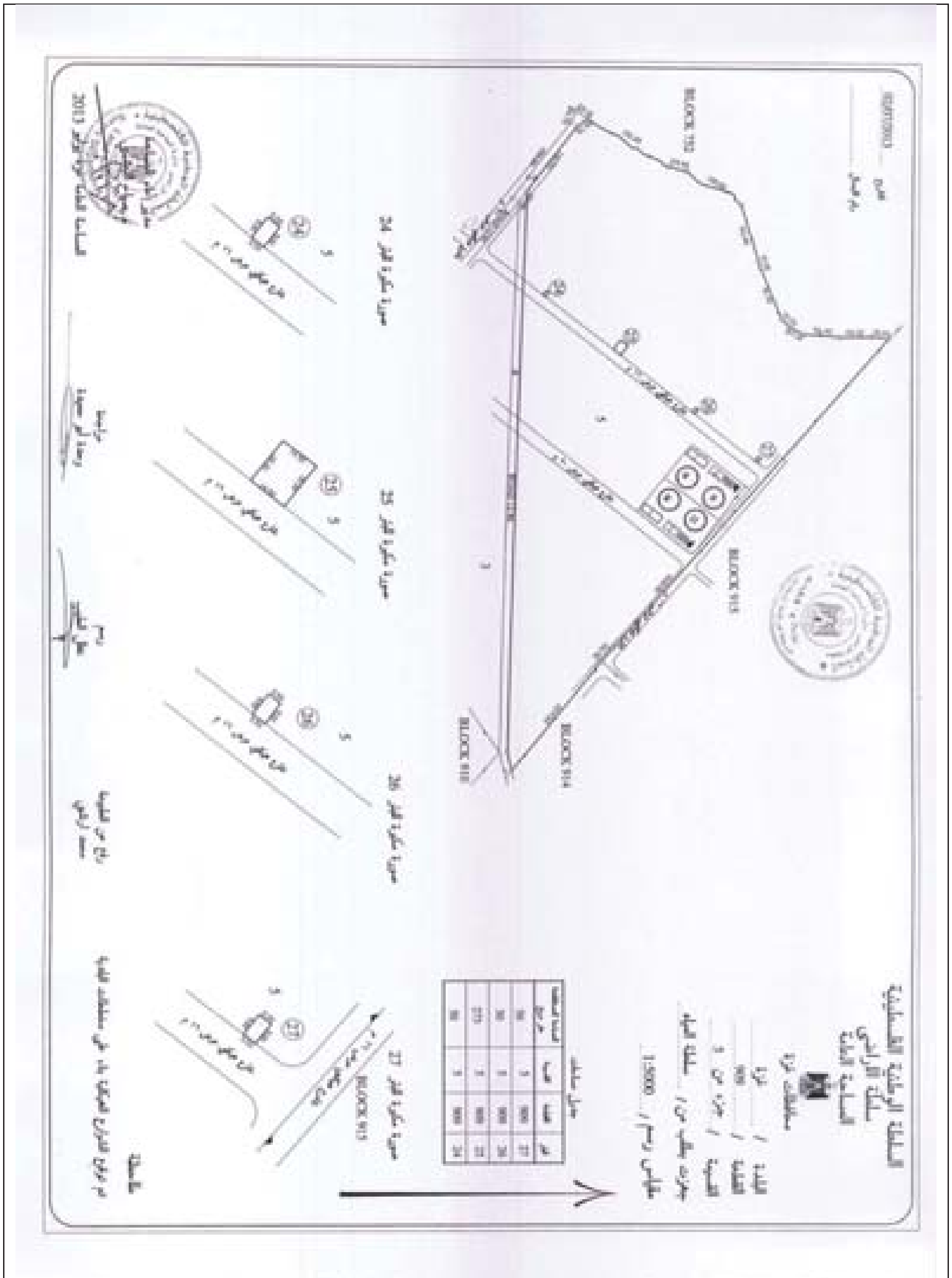







السلطة الوطنية الفلسطينية
BLOCK 913
BLOCK 914
BLOCK 910
BLOCK 732


ROAD 20 M
ROAD 14 M



Annex 10: Ministerial Decree 4/284/11 of Year 2013: Acquisition of Endowment Land

بسم الله الرحمن الرحيم

السلطة الوطنية الفلسطينية

مجلس الوزراء

قرار مجلس الوزراء رقم (4/ 11/284/م.و/إ.هـ) لسنة 2013م

بشأن استملاك أرض وقف لصالح مشروع شمال غزة الطارئ للصرف الصحي

بعد الاطلاع على القانون الأساسي المعدل لسنة 2003م وتعديلاته،

وعلى قانون الأراضي (استملاكها للمنفعة العامة) رقم (24) لسنة 1943م وتعديلاته، ولاسيما المادة (24) منه،

وعلى قانون رقم (5) لسنة 1995 بشأن نقل السلطات والصلاحيات،

وعلى قرار رئيس الوزراء رقم (11/155/ر.م.و/إ.هـ) لسنة 2012م بشأن

تعيين السيد/ زياد شكري الظاظا نائباً لرئيس الوزراء وتفويضه ببعض صلاحيات رئيس الوزراء،

وبناءً على مقتضيات المصلحة العامة،

وبناءً على الصلاحيات المخولة لنا قانوناً،

قرر مجلس الوزراء في جلسته الرابعة والثمانين بعد المائتين المنعقدة بمدينة غزة بتاريخ (2013/03/19م) ما يلي:

المادة (1)

الاستملاك المطلق لقطعة الأرض الواقعة في القطعة رقم (909) من القسيمة رقم (5) من أراضي الوقف والبالغة مساحتها (17.5)– سبعة عشرة ونصف– دونماً لصالح مشروع شمال غزة الطارئ للصرف الصحي.

المادة (2)

تعويض وزارة الأوقاف والشؤون الدينية قطعة أرض حكومية تعادل قيمة الأرض المستملكة في المادة (1) أعلاه.

المادة (3)

على الجهات المختصة كافة– كلٌ فيما يخصه– تنفيذ أحكام هذا القرار، ويعمل به اعتباراً من تاريخ صدوره، وينشر في الجريدة الرسمية.

صدر في مدينة غزة بتاريخ: 19 من مارس لسنة 2013م

07 من جماد الأول لعام 1434هـ

زياد شكري الظاظا

27/3

نائب رئيس مجلس الوزراء

1/1

قرار مجلس الوزراء

Palestinian National Authority
Ministry Of Local Government
Minister Office

السلطــــة الوطنيــــة الفلسطينيـــة
وزارة الحكـــم المحلـــي
مكتـــب الوزيـــر

الرقم: و.ح/م/875
التاريخ: 2013/04/01

02 Apr 2013
3/1/2013

1151 / د ا ر
13/4/1

سعادة الأخ/م. ابراهيم رضوان . . . . حفظه الله

رئيس سلطة الأراضي،

السلام عليكم ورحمة الله وبركاته ......

الموضوع/ استكمال اجراءات مبادلة أرض مشروع شمال غزة الطارئ للصرف الصحي وتخصيص قطعة أرض جديدة ومبادلتها مع وزارة الأوقاف لصالح مشروع الاسترجاع وإعادة الاستخدام.

الملف

بداية نهديكم خالص التحيات والتقدير، ونتمنى من الله العلي القدير أن يديم عليكم ثوب الصحة والعافية، وبالإشارة إلى الموضوع أعلاه، يرجى العلم بأن عملية اجراءات مبادلة جزء من القسيمة رقم 27 من القطعة رقم 910 والبالغة مساحتها 294,183 دونم لم تستكمل حتى تاريخه حيث أنه تم الاتفاق على عملية مبادلة هذه القطعة بأرض بديلة وذلك حسب عقد الاتفاق المؤرخ بتاريخ 2004/06/16م بين سلطة المياه الفلسطينية ووزارة الاوقاف والشئون الدينية "مرفق رقم ١"، والجميع على علم بأن سلطة المياه استلمت الأرض وقامت بإنشاء أحواض ترشيح ومحطة معالجة الصرف الصحي على تلك الأرض ومن المتوقع انتهاء انشاء المحطة بنهاية هذا العام.

وبناء على قرارات مجلس الوزراء الفلسطيني السابقة وللحفاظ على أرض الوقف يرجى منكم عمل ما ترونه مناسبا نحو تحديد أرض مناسبة من الارض الحكومية واتمام الاجراءات القانونية لعملية المبادلة حسب الأصول.

أما بخصوص عملية مبادلة جزء من أرض القسائم رقم (5,3) من القطعة رقم 909 والبالغ مساحتها 17.5 دونم بقطعة أرض حكومية وتخصيصها لصالح مشروع شمال غزة الطارئ للصرف الصحي وذلك استكمالا لإنشاء 27 بئرا استرجاعيا واثنين من خزانات المياه ومحطة لضخ المياه المسترجعة في شبكة المزارعين المستفيدين من المشروع، يرجى العلم بأن لجنة تخصيص الأراضي الحكومية قد أوصت باجتماعها المنعقد بتاريخ 2013/04/02 بالموافقة على عملية مبادلة أرض الأوقاف بأرض حكومية وتخصيصها لصالح مشروع شمال غزة الطارئ للصرف الصحي. "مرفق رقم ٢".

Gaza (Abu Khadra complex) - Tel:2820273 - Fax: 2866844 - غزة - مجمع الدوائر الحكومية (أبو خضرة)
Minister Office-Tel:[illegible] - Fax:[illegible]

Palestinian National Authority
Ministry Of Local Government
Minister Office

السلطـــة الوطنيـــة الفلسطينيـــة
وزارة الحكـــم المحلـــي
مكتـــب الوزيـــر

وعليـــه وحرصـــا منـــا علـــى حـــل مشـــكلة الصـــرف الصـــحي وتقـــديرنا لموقـــف الجميـــع المحـــافظ علـــى حقـــوق وزارة الأوقـــاف ، نأمـــل مـــن معـــاليكم الإيعـــاز لجهـــات الاختصـــاص باســـتكمال اجـــراءات عمليـــة المبادلـــة لأرض أحـــواض الترشـــيح ومحطـــة المعالجـــة الحاليـــة الواقعـــة بالقســـيمة رقـــم 27 مـــن القطعـــة رقـــم 910 والبـــالغ مســـاحتها 294,183 دونـــم وكـــذلك الارض التـــي ســـيتم انشـــاء منظومـــة الاســـترجاع واعـــادة اســـتخدام الميـــاه المعالجـــة فـــي الزراعـــة عليهـــا وذلـــك فـــي القســـائم رقـــم (5,3) مـــن القطعـــة رقـــم 909 والبـــالغ مســـاحتها 17.5 دونـــم مـــع وزارة الأوقـــاف بمســـاحة أرض حكوميـــة وتخصيصـــا لصـــالح مشروع شمال غزة الطارئ للصرف الصحي.

وتفضلوا بقبول فائق الاحترام والتقدير....

أ. محمد جواد/عبد الخالق الفرا

وزيـــر الحكـــم المحلـــي

المرفقات /
- مرفق رقم 1 صورة عن عقد الاتفاق
- مرفق رقم 2 صورة عن توصية لجنة التخصيصات

صورة الى /
- و.أ. الوكيل المساعد
- ملف المياه والصرف الصحي
- رئيس سلطة المياه

Gaza (Abu Khadra complex) - Tel:2820273 - Fax: 2866844 - (غزة - مجمع الدوائر الحكومية (أبو خضرة)
Minister Office-Tel-[illegible]

Annex 11: Provisional Contract with the Ministry of Endowment

بسم الله الرحمن الرحيم

دولة فلسطين
وزارة الأوقاف والشئون الدينية

التاريخ: ٢٨ ربيع آخر ١٤٢٥ هـ
الموافق: ١٦/٦/٢٠٠٤م
الرقم: ...
المرفقات:

مرفق رقم ١

عقد اتفاق مبدئي

بشأن استخدام قطعة الأرض رقم (٩١٠) قسيمة رقم (٢٧)

والمشترين ككل من:

- فريق أول: وزارة الأوقاف والشئون الدينية
- فريق ثاني: سلطة المياه الفلسطينية.

تقديراً من وزارة الأوقاف والشئون الدينية للمساهمة في حل مشكلة معالجة المياه العادمة للمنطقة الشمالية بمحافظة الشمال، وحيث أن الأوقاف تمتلك القطعة رقم (٩١٠)، قسيمة رقم (٢٧)، وهي أرض وقف صحيح.

وبما أن الفريق الثاني يرغب في استخدامها لعمل محطة لمعالجة المياه العادمة لمحافظة الشمال، وبناءً عليه فقد اتفق الفريقان على ما يلي:

١- أن تقوم سلطة المياه بمتابعة توفير الأرض اللازمة للفريق الأول وذلك بتوفير بديلاً من الأراضي الحكومية بدل هذه الأرض.

٢- أن هذا الاتفاق مؤقت لحين إتمام الإجراءات القانونية والشرعية لعملية الاستبدال بين الفريقين.

٣- أن يتعهد الفريق الثاني بعدم البدء بأي أعمال على هذه الأرض قبل إتمام إجراءات الاستبدال، واستلام الفريق الأول للأراضي البديلة وتسجيلها حسب الأصول لدى دائرة تسجيل الأراضي.

٤- يمنح الفريق الثاني كتاب تخصيص من الأوقاف لاستخدام هذه الأرض وذلك من أجل تقديمه للجهات المولة فقط، وأن هذا الكتاب لا يخل بما تم الاتفاق عليه في البنود السابقة، ولا يلزم وزارة الأوقاف بتسليم الأرض أو أي إجراء قانوني آخر إلا بعد تسلم الأوقاف للأراضي البديلة وتسجيلها في ملكيتها بسلطة الأراضي (الطابو) حسب الأصول.

وعلى هذا تم الاتفاق.

فريق أول
وزارة الأوقاف والشئون الدينية
عمر مصطفى الجعيدة
١٦/٦/٢٠٠٤

دولة فلسطين
وزارة الأوقاف والشئون الدينية

فريق ثاني
سلطة المياه الفلسطينية

Annex 12 Notifications of Land Acquisition

السلطة الوطنية الفلسطينية
وزارة الحكم المحلي
بلدية جباليا النزلة
خدمة أفضل - لحياة أجمل

Palestinian National Authority
Ministry of Local Government
Jabalia AL.Nazih Municipality
Better Service for Beautiful Life

بلدية جباليا النزلة

إلى السيد/ .... حفظه الله

السلام عليكم ورحمة الله وبركاته ...

الموضوع/إشعار بفتح الشارع التفصيلي رقم (   ) من أرضكم
من المقسم رقم (   ) في القسيمة رقم (٦٢) من القطعة رقم (٩/٥)
حسب المخطط التفصيلي المصدق شرق جباليا - نفوذ بلدية جباليا

تهديكم بلدية جباليا النزلة عاطر تحياتها وتتمنى لكم موفور الصحة و العافية .

وبالإشارة للموضوع أعلاه نفيد سيادتكم علماً بأن البلدية قد قررت الشروع في فتح الشوارع الهيكلية والتفصيلية المصدقة من اللجنة المركزية لتنظيم وبناء المدن بمحافظات غزة بجلستها رقم ٢٠١٣/١م بتاريخ ٢٠١٣/١/٩م والذي تم نشره بالصحف ووضعه موضع التنفيذ ، والذي يستقطع أجزاء من أرضكم في القسيمة المشار إليها.

لذا واستناداً لأحكام قانون تنظيم المدن رقم ٢٨ لسنة ١٩٣٦ ، ومن أجل تنفيذ مشروع استرجاع وإعادة استخدام المياه العادمة في المنطقة الزراعية شرق جباليا والحاجة إلى فتح هذه الشوارع لتمديد الشبكات والتوزيع لأماكن الآبار والتخزين ولمقتضيات المصلحة والمنفعة العامة فإن اللجنة المحلية للتنظيم والبناء ببلدية جباليا ستقوم بفتح هذا الشارع وتطلب من سيادتكم إزالة أية عوائق أو أسيجة أو أسوار أو أية إنشاءات ثابته أو أية أشجار أومزروعات تقع في مسار وحدود الشارع التفصيلي المذكور بأرضكم حسب المخطط المصدق تمهيداً للدخول لأرضكم لفتح الشارع المذكور من قبل البلدية ومن أجل تطويره وذلك خلال مدة شهر من تاريخ استلامكم لهذا الإشعار ، وأن البلدية ستعمل على تكميل الإجراءات القانونية بشأن أية حقوق عن نسبة الإستقطاع الزائدة من أرضكم للشارع المذكور حسب ما هو مقرر عليه في قانون تنظيم المدن رقم ٢٨ لسنة ١٩٣٦ .

نأمل منكم التعاون لما فيه المصلحة والمنافع العامة.

بمزيد من التقدير و الإحترام

بلدية جباليا النزلة

14/5/13

تاريخ استلام الإشعار
/ / ٢٠

موظف البلدية / المباشر
الاسم ....
التوقيع ....

مستلم الإشعار
الاسم ....
التوقيع ....

فلسطين - مدينة جباليا - شارع البحر
Palestine - Jabalia Town - AL Baher St.
P.BOX.2749
+970 8 2476014 +970 8 2477020 +970 599 417196 jab.mun@hotmail.com www.jabalia.mun.ps

NOTIFICATION OF LAND ACQUISITION IN JABALIA DATED 13TH OF MAY 2013

Annex 12: Price Lists from the Ministry of Agriculture

قيمة الاضرار $				
	عمر 1-3	عمر 3-5	عمر 5-10	عمر > 10
حمضيات	50	70	100	250
زيتون	30	50	80	250
فواكه	30	60	90	200
لوزيات	20	40	70	150

PRICE LIST FROM THE MINISTRY OF AGRICULTURE

PRICE IN $

	AGED 1-3	AGED 3-5	AGED 5-10	> 10
CITRUS TREES	50	70	100	250
OLIVE TREES	30	50	80	250
FRUIT TREE	30	60	90	200
STONE FRUIT TREE	20	40	70	150

Annex 13: Photos of Site Visits and Consultations

Group meeting with the project affected persons 24th of April 2018

PWA representative and the RAP and ESIA consultants

Clarification session between PWA and the PAPs 24th of April 2018

Site visit to show the PAPs well locations

Meeting with the PAP

Meeting with a PAP

Further clarifications from PWA

	
Clarification meeting	Meeting with project affected family
	
Meeting with well operator April 2018	Scoping meeting 23rd of April 2018
	
Scoping meeting presentation 23rd of April 2018	Scoping meetings participants 23rd of April 2018

Submitted to:

Palestinian Water Authority
Project Management Unit Directorate building
Al Wehda Street, in front of Ministry of Health
Shaath building, 4th floor
Al Rimal, Gaza City

North Gaza Emergency Sewage Treatment Project, Reuse System and Remediation Works

Resettlement Action Plan

Draft report

May 2018

Prepared by:

EcoConServ Environmental Solutions
12 El-Saleh AyoubSt., Zamalek,
Cairo, Palestine 11211
Tel: + 20 2 27359078 – 2736 4818
Fax: + 20 2 2736 5397
E-mail: genena@ecoconserv.com

Universal Group-Gaza
Tel: 972-8-2825557
972-8-2820979
Mobile 972/ 599734817
E-mail: uggaza@palnet.com

Contents

List of tables, figures and boxes

TABLES

FIGURES

BOXES

Jordanian Dinar 1 = 1.4110 $ (May 2018)
Israeli new shekel = 0.2803 $ (May 2018)

LIST OF ACRONYMS

AFD	Agence Française de Développement
ARAP	Abbreviated Resettlement Action Plan
ESIA	Environmental and Social Impact Assessment
FS	Feasibility Study
LAL	Land Acquisition Law
MDLF	Municipal Development and Lending Fund
MoF	Ministry of Finance
MoLG	Ministry of Local Governance
NGESTP	North Gaza Emergency Sewage Treatment Project
NGO	Non-Governmental Organization
OP	Operational Policy
PAP	Project Affected Persons
PLA	Palestinian Land Authority
PNA	Palestinian National Authority
PWA	Palestinian Water Authority
RAP	Resettlement Action Plan
ToRs	Terms of Reference
WB	World Bank

GLOSSARY

Words	Definition
Abbreviated Resettlement Plan	Establish a baseline through the census of PAPs that will comprise socio-economic data, the inventory of assets lost, and the compensation and resettlement benefits awarded to the PAPs.
Census	Household survey that covers all Project Affected Persons irrespective of entitlement or ownership. It provides a complete inventory of all project affected persons and their assets. It can be used to minimize fraudulent claims made by people who move into the area affected by the project in the hope of being compensated and/or resettled.
Compensation	Payment in cash or in kind to replace losses of land, housing income, and other assets caused by the project.
Cut-off Date	The date of the census prior to which, the occupation or use of the project area, qualifies residents or users of the project area as affected persons.
Displaced persons	Refers to all the people who, on account of the activities listed above, would have their (1) standard of living adversely affected ; or (2)right, title, interest in any house, land (including premises, agricultural and grazing land) or any other fixed or movable asset acquired or possessed temporarily or permanently; (3) access to productive assets adversely affected, temporarily or permanently; or (4)business, occupation, work or place of residence or habitat adversely affected; and "displaced person" means any of the displaced persons.
Environmental Impact	An effect (both positive and negative) on an environmental resource or value resulting from infrastructure development projects.
Environmental and Social Impact Assessment (ESIA)	A systematic procedure for enabling the possible environmental and social impacts of development projects to be considered before a decision is made as to whether the project should be given approval to proceed.
Full replacement cost	Market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes. For land in urban areas, it is the pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes. For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any

	labor and contractors' fees, plus the cost of any registration and transfer taxes. In determining the replacement cost, depreciation of the asset and the value of salvage materials are not taken into account, nor is the value of benefits to be derived from the project deducted from the valuation of an affected asset. Where domestic law does not meet the standard of compensation at full replacement cost, compensation under domestic law is supplemented by additional measures so as to meet the replacement cost standard.
Involuntary Resettlement (IR)	The unavoidable displacement of people and/or impact on their livelihood, assets and common property resulting from development projects that create the need for rebuilding their livelihood, sources of income and asset bases.
Monitoring	The process of repeated observations and measurements of environmental and social quality parameters to assess and enable changes over a period of time.
Project Affected Person	Includes any people, households, firms or private institutions who, on account of changes that result from the project will have their (i) standard of living adversely affected, (ii) right, title, or interest in any house, land (including residential, commercial, agricultural, forest, and/or grazing land), water resources, or any other moveable or fixed assets acquired, possessed, restricted, or otherwise adversely affected, in full or in part, permanently ore temporarily; and/or (iii) business, occupation, place of work or residence, or habitat adversely affected, with or without displacement
Public Involvement	The dialogue encompassing consultation and communication between a project proponent and the public. It includes dissemination, solicitation and presentation of information
Rehabilitation/Resettlement	A term often used to describe the process of reestablishing lifestyles and livelihoods following resettlement. The term is also used to describe construction works that bring a deteriorated structure back to its original conditions.
Resettlement Action Plan (RAP)	A time-bound action plan with a budget, setting out resettlement strategy, objectives, options, entitlements, actions, approvals, responsibilities, monitoring and evaluation
Social Impact	An effect (both positive and negative) on a social issue resulting from infrastructure development projects.
Stakeholders	Those who have an interest in project development and who will be involved in the consultative process, and includes any individual or group affected by, or that believes it is affected by the project; and any individual or group that can plan a significant role in shaping or affecting the project, either positively or negatively, including the host community/population.
Vulnerable Groups	Distinct groups of people who might suffer excessively from resettlement effects, such as, the old, the young, the handicapped, the poor, isolated groups and single parents.

EXECUTIVE SUMMARY

1. Project Background

The Palestinian Water Authority (PWA) is executing the Northern Gaza Emergency Sewage Treatment (NGEST) Project. Initiated in 2004, the project is being implemented in three phases. Phase A of the project comprised the construction of the terminal sewage pumping station at the Beit Lahia Wastewater Treatment Plant site (BLWWTP), the construction of a pressure pipeline to a new site about seven kilometers to the East of Jabalia, the construction of nine infiltration ponds at the new site and the commissioning of the pipeline to allow a large and dangerous emergency partial effluent pond at Beit Lahia to be drained. This phase was entirely completed in 2010.

Phase B of the project included the construction of the North Gaza Emergency Waste Water Treatment Plant (NGWWTP) at the new site. The first component of the NGWWTP is almost completed and was fully functioning at the end of 2017, to treat up to 35,600 m3 of sewage daily. Future expansion of the plant would bring the total treatment capacity to 69,000 m3/day and will require the construction of an additional infiltration basin.
A third, supplementary phase was later added to the project to recover and reuse the treated effluent after the new WWTP is completed. The treated sewage effluent will be disposed of into infiltration ponds, the water will seep through an unsaturated zone of soil which will facilitate nutrient and pathogen removal, and eventually make its way to the unconfined aquifer. There, the water will be extracted by 28 recovery wells, put into two storage reservoirs, and distributed throughout the network for irrigated agriculture.

2. Potential negative impacts pertaining to land acquisition and livelihood deterioration

The project will result the following impacts:

1. Impact on the well owners whose wells will be closed (12 wells). Faced by a sudden close of their wells, these people are faced by a situation of valuable asset loss (the well) in addition to a critical need for an alternative source of water, most likely being higher in cost. Adding to the latter, some of the wells' owners who used to make financial profits out of selling water will be badly affected. A total number of 202 persons are affected due to the termination of wells. (refer to Annex I C)
1. Impacts on the owners of small plots of lands who will be expropriated during the construction of the 14 wells. A total of 19 people are expected to be affected, some of who's lands are small plots with areas that do not exceed a dunum. Since wells will be constructed within the vicinity of the lands plot areas, the remaining plot of land will be of no use. The existence of a recovery well inside the land will additionally, result in a decline in the land value.

2. Economic impact on the operators of wells. Well termination will result in a total loss of income of those who made a living from operating the wells. The numbers of those faced with the situation is limited to 15 people; therefore the magnitude of their vulnerability can be mitigated.
   It worth mentioning that, to limit the adverse impacts on private land well owners and operators, PWA planned the locations of all monitoring wells on roads.

A comprehensive avoidance mechanism was adopted by PWA, through the following procedures:

1- Constructing phase one's wells in state owned lands. As such, the first phase of the project resulted no impacts pertaining to land acquisition.
2- Selection of lands that are of less value for the PAPs, examples of those include lands that are located at a distance from the main roads.
3- Installing all monitoring wells in the roads to avoid impacts on the private lands.
4- As much as possible, avoided small plots of lands that might result in significant impacts on the PAPs
5- All physical assets were entirely avoided in order to minimize the unfavorable impacts.

3. LEGAL FRAMEWORK

The project is governed by international and national regulations. Thes are as follows:

- The International Finance Corporation (IFC) performance standards: Performance Standard 5: Land Acquisition and Involuntary Resettlement:
- World Bank Safeguard policies related to involuntary resettlement: OP 4.12 on Involuntary Resettlement
- Existing Palestinian legal and policy framework for land acquisition: According to Law No.24 of year 1943 modified by Law No. 2 of year 1953 on "Land Expropriation for Public Projects" and its articles (3) and (21), the Government can expropriate up to 25% of any privately-owned land for public interest reasons - without compensating the owners. Exceptions are made to owners who prove to be significantly damaged by land expropriation. Owners are however, entitled to ask for compensation for all crops and trees, buildings and fixed structures on the expropriated 25% area of the land.

4. ELIGIBILITY AND MODE OF COMPENSATION

The first criteria for eligibility will be the cut-off date:

1. Well owners cut-off date will be the 31st of May 2018
2. Well operators cut-off date will be defined upon operating the irrigation network
3. Land owners cut-off date will be the 31st of May 2018

The second criteria for eligibility will be the legality of the PAPs status. Identified PAPs are basically classified into the following categories in the donor policies:

a. Those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country);
b. Those who do not have formal legal rights to land at the commencement of the inventory, but have a claim to such land or assets; provided that such claims are recognized under the law of the country or process identified in the resettlement plan;

- **Arrangement for delivery of compensation**

The Permanent land acquisition and compensation will be applied as follows:

1- The Design Department of PWA has provided a detailed map on land acquisition scope in order to identify the land acquisition area.
2- The PAPs were consulted with during the preparation of the RAP in order to provide them with the information with regards to their rights, valuation procedures and grievances and redress mechanism.
3- After receiving the approval of the AFD on the ESIA and the RAP, the documents will be translated and disclosed to the PAPs in the Municipalities, the PWA website and the AFD website. Thereafter, the resettlement activities will be executed.
4- A continuous dialogue will be applied with the PAPs as part of stakeholder engagement activities
5- The Compensation Committee will disburse the compensation value according to the following system:
    a. Full compensation will be given before the construction,
    b. Complete legal procedures for land acquisition will be documented by the PWA.

- **Transitional support**

The Palestinian Law related to expropriation does not stipulate any transitional support activities. That is also the case with the project owner (the Palestinian Water Authority is not the implementing agency for land acquisition) deeming the provision of transitional support relatively difficult to obtain.

- **Vulnerable groups assistance**

The Palestinian Law related to expropriation allows the implementing agencies to avoid the vulnerable groups. With regards to the NGEST project, vulnerable groups anticipated are:

1- Owners of small plots whose lands will be used by the project are defined as vulnerable due to penetration through the middle of their lands. The remaining parts of the lands will be of no use to the PAPs. The PWA tries to avoid or minimize the impacts on those groups through modifying the route of the streets, avoiding entering into the middle of lands, as well as, avoiding well construction in the areas located directly on the roads. (The price of plots of lands located directly on the road is relatively higher)

2- Owners of lands who were eligible for land expropriation under the Excretion Law "*Ifraz*". Some of these have already lost of 25.0% of their lands previously due to the implementation of other projects. Expropriating another 25.0% of their lands will be a complete critical impact. Such category should be avoided

3- Female-headed owners of small plots of lands should be provided by similar alternative lands in locations close to the expropriated lands. A provision of job to one of the sons could however, be a much better alternative.

5. INSTITUTIONAL ARRANGEMENTS

Following are the key entities that will handle resettlement activities:

1- Palestinian Water Authority
2- Municipalities of Gaza and Jabalia
3- Palestinian Land Authority
4- Ministry of Local Governance
5- Ministry of Finance
6- Cabinet
7- Ministry of Agriculture

6. STAKEHOLDER ENGAGEMENT ACTIVITIES

The study research team undertook multi-dimensional consultation activities that included an exchange of information, providing the marginalized, voiceless, youth and women with information about the project as well, obtaining information on their concerns regarding the project's various implementation phases. Owing to time constrains, teams were mobilized to consult with both community people and stakeholders in parallel.

Following are the main consultation activities to date that will be supplemented by additional engagement activities:

- The study team visited the project area in order to define various stakeholders during April 2018
- Meetings were conducted during April 2018 in order to develop an engagement plan that is locally tailored for the residential communities with the study team members
- Based on the identification of stakeholders and PAPs, various questionnaires and guidelines were prepared in order to engage: i) the PAPs (land owners- well owners and well operators, ii) Governmental municipalities , iii) the CBOs, iv) health facility, v) Ministry of Endowment and Ministry of Agriculture
- The study team divided various engagement activities of the project to:
    a. Screening
    b. Scoping phase and data collection phase and,
    c. Public consultation phase.
    d. Final report disclosure

Following are the main concerns raised during the consultation activities

Issue raised	Comment raised	Response
Institutional set-up	The project should focus on the importance of the institutional framework as it is the basis for the operation and success of this project. He explained that the Palestinian legislation classifies this water as groundwater because it mixes with groundwater after its infiltration.	One of the outputs of the study is the environmental management plan, which assigns who will do what. I suggest forming an institutional body from all the stakeholders to manage, organize, monitor, and operate the project components. This study should result realistic and applicable procedures
Monitoring requirements	There is a lack of monitoring in all project stages. It's recommended to engage the relevant authorities in this progress. He mentioned the Ministry of Health, Agriculture, Environment, and the municipalities.	PWA will develop a detailed monitoring scheme for all project activities including E&S performance
Land acquisition and role of municipality	Municipalities should be involved in the process of land acquisition and compensation to contribute in resolving disputes, if any. The Ministry of Agriculture and other Agricultural Institutions should be involved in the development of the project operation plan. He focused on developing a clear vision of water pricing and whether there is a cost recovery.	In full compliance with the Palestinian land acquisition regulations, the municipalities will be engaged and consulted in the process of compensation
Participation of community in the scoping session	There is an absence of community institutions from all project activities! We recommend engaging the farmers in the consultative process of the project.	During scoping phase, we managed to meet with various community members in their premises. However, the scoping session is allocated for experts who might provide guidance to enrich the ESIA. This is in full compliance with EQA and IFC standards
Termination of private wells	The Private wells within the area of the recovery wells, Will it be closed or merged with system	Few number of private wells will be terminated
Pollutants	Is there any examination of the microbes (ex: hepatocellular virus) pollute the groundwater through infiltration?	PWA developed and will continue measuring various pollutants
Well operators mitigation measures	How well operators will be mitigated?	Well operators have been interviewed and mitigation measures will be proposed in the RAP study

7. MONITORING AND EVALUATION (M&E) OF RAPACTIVITIES

Monitoring and Evaluation (M&E) are key components of the RAP and have the following objectives:

- Monitoring specific situations or difficulties arising from implementation and aligning the implementation with objectives and methods set out in the RAP;
- To verify that project activities have been effectively completed with respect to quantity, quality and timeliness;

- Evaluation of medium and long-term impacts of resettlement on affected households' livelihood, environment, local capacities and economic development.

In carrying out all activities related to monitoring, evaluation and supervision, consideration will be given to the vulnerability issues. The different vulnerable groups referred to above should be consulted during the monitoring process to guarantee that their concerns are handled fairly.

8. BUDGET AND TIME PLAN

- **Budget**

Budget estimation in NGESTP project is not a straightforward task due to several reasons including the following:
PLA provides alternative lands and assets, rather than money compensations owing to their limited monetary resources. As previously explained, the Palestinian Land Authority is challenged by a lack of financial resources, limiting its ability to cover the high costs. The situation is no better in the Ministry of Finance, as the current political situation causes significant shortage in the government's financial resources. The intention is therefore, to exchange the expropriated land with other governmental land. This process is to be coordinated with the Palestinian Land Authority and through the Ministry of Local Governance.

With regards to well compensation, provision of water and low cost municipality water is one of the most practical scenarios that will be applied. Consequently, estimating budget for project compensation activities will not be realistic. However, two major issues will necessitate a certain figure to be presented under the budget, these are as follows:

- The proposed budget allocated for monitoring and evaluation activities will be about 15000$
- The capacity building activities will be about 21000$

- **Time plan**

The second phase of the NGESTP includes the establishment of 14 recovery wells, termination of 12 wells, as well as establishing a water irrigation network system covering an area of 5,000 agricultural dunums. The system is expected to start its first stage operations by the end of 2018 for a period that ranges from 12 to 15 months. Given the absence of a time plan for the project implementation

.

1. INTRODUCTION

1.1. Project Background

The Palestinian Water Authority (PWA) is executing the Northern Gaza Emergency Sewage Treatment (NGEST) Project. Initiated in 2004, the project is being implemented in three phases. Phase A of the project comprised the construction of the terminal sewage pumping station at the Beit Lahia Wastewater Treatment Plant site (BLWWTP), the construction of a pressure pipeline to a new site about seven kilometers to the East of Jabalia, the construction of nine infiltration ponds at the new site and the commissioning of the pipeline to allow a large and dangerous emergency partial effluent pond at Beit Lahia to be drained. This phase was entirely completed in 2010.

Phase B of the project included the construction of the North Gaza Emergency Waste Water Treatment Plant (NGWWTP) at the new site. The first component of the NGWWTP is almost completed and was fully functioning at the end of 2017, to treat up to 35,600 m3 of sewage daily. Future expansion of the plant would bring the total treatment capacity to 69,000 m3/day and will require the construction of an additional infiltration basin.
A third, supplementary phase was later added to the project to recover and reuse the treated effluent after the new WWTP is completed. The treated sewage effluent will be disposed of into infiltration ponds, the water will seep through an unsaturated zone of soil which will facilitate nutrient and pathogen removal, and eventually make its way to the unconfined aquifer. There, the water will be extracted by 28 recovery wells, put into two storage reservoirs, and distributed throughout the network for irrigated agriculture.

1.2. General Project Information

In 2013, a Supplementary Environmental and Social Impact Assessment Study was conducted to the North Gaza Emergency Sewage Treatment Project. The project consisted of three main Parts; Part 'A': Terminal Pump Station, Pressure line and nine infiltration basins, Part 'B', construction of New Waste Water Treatment Plan to replace the old Beit Lahia WWTP, and Part 'C': Recovery and Reuse Scheme.

Part 'A' was completed and is functioning since Apr 2009, pumping partially treated sewage from the old BLWWTP site to the new infiltration basins site. The project is connected with Part 'B', which is anticipated to function during the first quarter of 2018 and the sewage will be treated (through Part 'B' the new WWTP) then infiltrated in the basins (adjacent to Part 'B'). Part 'C' of the project was divided into two stages. Each stage consists of, 14 Recovery Wells, booster pump station, 4,000 m^3 storage tank and irrigation network. Part 'C1' has been financed by World Bank and Part 'C2' (the Project) is anticipated to be financed by AfD and the Green Climate Fund.

1.3. Project Components

The recovery wells will capture the infiltrated water through the nine infiltrated basins (Part 'A') and convey the recovered water to the irrigation network to deliver for nearly 15,000 dunums.

The Project includes: rehabilitation of nine infiltration basins in the vicinity of the NGEST plant, drilling of 14 recovery wells "downstream" from the NGEST plant, drilling of 5 monitoring wells, storage in one reservoirs, installation of primary, secondary and tertiary (drip irrigation) distribution networks over 1 200 ha, support the Palestinian government and the PWA, extension services to farmers and installation of a

Photovoltaic system (5,1 MWp), Photovoltaic systems were not part of the initial project and initial impact assessment.

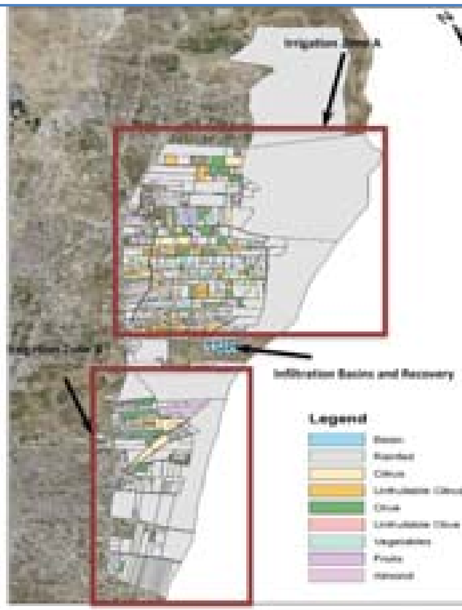


Figure 1-1: Areal view of irrigation zone

Figure 1-2: Recovery wells

Recovery wells will be able to capture water infiltrated from the NGEST WWTP (i.e.: 35,600 m3/day) in addition to an extra 10% (i.e.: 3,560 m3/day) necessary to guarantee that all infiltrated water is captured by the wells.

The number of recovery wells was calculated based on the maximum quantity of water that should be recovered during the peak month of October, which is equal to 50,885 m3/day. The total number of wells is 28 where each should have a capacity of pumping between 180 m3/hr to 200 m3/hr. 25 out of the 28 wells are assumed to be operational always with a capacity of 180 m3/hr. The three additional wells are included to give more flexibility to the system and serve as a backup in the event of a failure.

The exact location of the 28 wells was determined based on the numerical modeling results, to guarantee that all the water infiltrated from the basin is recovered within 1000 days and cannot escape beyond the furthest row of wells (i.e. 750 m) from the infiltration basin.

1.4. Description of the project areas

The project area of influence[1] is located in North Gaza Governorate. The project will mainly influence three settlements, namely, Jabalia, Beit Lahia and Beit Hanoun as well as Um El Nasr village. The following map presents the project's areas of influence

Figure 1-3: Project Area of Influence

Demographic characteristics: In 2007, approximately 1.4 million Palestinians resided in Gaza Strip, almost one million of whom were UN-registered refugees. The current population is estimated to be in excess of 1.5 million, distributed across five Governorates. Gaza City, which is the biggest governorate, has about 400,000 inhabitants. The other two main Governorates are Khan Younis (population 200,000) in central Gaza, and Rafah (population 150,000) in the South. The majority of people live in refugee camps[2]...

The population of the North Gaza Governorate according to 2012 statistics is around 265,355[3]. As could be observed from the table below, the population growth in project area of influence is high and was observed to increase during the last five years. The population projection calculated by the Feasibility Study was based on the assumption that a gradual decline in the population growth rate will be seen starting in 2012. It is anticipated that population growth will reach 1.11% by 2040, after peaking at 3.5% in 2011.

[1] Area of Influence OP 4.01, Annex A, para. 6: *The area* likely to be affected by *the project*, *including all its ancillary aspects*, such as power transmission corridors, pipelines, canals, tunnels, relocation and access roads, borrow and disposal areas, and construction camps, as well as *unplanned developments induced by the project* (e.g., spontaneous settlement, logging, or shifting agriculture along access roads).

[2] Environmental Assessment of Gaza Strip, following the escalation of hostilities in December 2008 – January 2009 United Nations Environment Programme

[3] PCBS, 2011

Economic Activities: With a growing population and a shrinking economy, real Gross Domestic Product (GDP) per capita is close to 30% below the 1999 level. The overall economic picture is one of negative growth. PCBS estimates that the GDP in 2006 had a negative growth rate of 6.6 %. It estimates that real GDP growth in 2007 was a mere 0.5%, while results from the first quarter suggest that growth in 2008 is slightly negative. Similarly, the International Monetary Fund (IMF) recorded a drop in GDP of 0.5 % in 2007, and a modest growth of 0.8 % in 2008. This is probably due to a continued, yet marginal drop in economic activity in Gaza, given its already low base, matched with a modest rise in economic activity (PCBS (2007) 'Economic forecasts for 2007'). These figures are representative of already severely limited economic activity before Operation Cast Lead, which resulted in the destruction of significant remaining economic assets, implying further declines.

Labor Force Conditions: With regards to human activities in the project sites, the estimations provided were based on the meetings conducted with the municipalities, and is to be considered only as guiding information. Agricultural activities are the main employment activities in Beit Hanoun, Um El Nasr and Beit Lahia. The governmental posts are, however, occupied by 62.4% of the labor force in Jabalia.
Statistical data showed that the majority of employees work in services (63.3%), while people working in commerce, hotels and restaurants are only 18.3%. Diversity according to gender is relatively high as 86.6% of the females work in services sector, while 59.6% of males work in the same sector. However, 20.7% of the males work in commerce versus null of the females in the same field.

2. RESETTLEMENT IMPACTS

2.1. Project impacts

2.1.1 Potential positive impacts

The reuse scheme project will result in various positive impacts that can be summarized as follows:

- Contribute to solve the problem of water scarcity especially during summer time, as a source of water will be continuously available
- Partially solve the problem of the disposal of wastewater, as it will be treated and injected for agricultural use,
- The provision of good quality water will reduce the cost of water needed for irrigation in the area. The utilization of the recovered water of high quality and of less price might work for the benefit of the farmers, increasing their profits.
- Sludge is one of the outputs of the project, and will increase the income for those who work in sludge trading
- Sludge reuse will work for reduction of chemical fertilizers that affect the health of people.
- Put limitation to importing sludge from abroad. Relying on the sludge might save money needed to import chemical fertilizers

2.1.2 Potential negative impacts pertaining to land acquisition and livelihood deterioration

The project will result the following impacts:

1. Impact on the owners of wells who will be terminated (12 wells). They will be affected due to losing a valuable asset (the well) as well as, being in critical need for alternative source of water that might be of higher cost. Moreover, some of the wells' owners who used to make financial profits out of selling water will be badly affected. The total affected persons due to the termination of wells are 202 (refer to Annex I C)
2. Impacts on the owners of small plots of lands who will be expropriated during the construction of the 14 wells. 19 people will be affected among which some of them own small plots of lands that don't exceed one dunum. As wells will be constructed inside the plots of lands, the remaining plot of land will not be of use. Additionally, the value of land will be declined due to the recovery well established inside the land.
3. Economic impact on the operators of wells. They will suffer due to the termination of wells. They will expose to completely loss of income. They are limited to 15 people; therefore the magnitude of their vulnerability can be mitigated.

It worth mentioning that all monitoring wells will be constructed in the side roads. The PWA adopted this approach in order to put limitation to adverse impacts.

The PWA provided detailed information about the lands needed to implement the project and the numbers of wells that will be affected. Thereafter, the Study team applied a census survey using quantitative and qualitative tools that enabled the description of the Project Affected Families' socioeconomic conditions. It was obvious that all land acquisition activities will be permanent, as well as, the expropriation of wells.

Summarizing the project impacts, the following table provides detailed information about the potential impacts:

Table 2-1: Project impacts on lands

Item	Square meters
Lands needed to construct the recovery component (recovery wells- monitoring wells)	
Wells within the area of the ground retrieval own / jurisdiction of the Municipality of Jabalia	1,440 **m²**
Monitoring wells within the area of land in the influence of the special municipality of Jabalia	28 **m²**

Source: Palestinian Water Authority

The above mentioned impacts will influence the socioeconomic conditions of 15 well operators, 202 well owners who share the ownership of 12 wells and 19 land owners. The total directly affected persons are therefore estimated to be 236 persons.

2.1.3 Avoidance mechanism

PWA adopted a comprehensive avoidance mechanism through the following procedures:

1- **Constructing phase one's wells in state owned lands. As such, the first phase of the project caused no impacts pertaining to land acquisition.**
2- **Lands selected are of less value for the PAPs, for example, the lands that are located far from the main roads.**
3- **All monitoring wells were installed in the roads to avoid affecting the private lands**
4- **Small plots of lands that might result in severe impacts on the PAPs were avoided**
5- **All physical assets were entirely avoided in order to minimize the unfavorable impacts.**

Table 2-2: Summary of project impacts

Detailed list of impacts		Permanent Land Acquisition				Temporary Land Acquisition (during construction)			
		Total amount of land	**Total HHs affected**	**Total HH/persons affected**	**# of businesses affected**	**Total amount of land**	**Total HH affected**	**Total HH displaced**	**# of businesses affected**
Construction of recovery wells and monitoring wells									
Location Site	Jabalia Municipality	1440 m^2	19	*142	0	0	0	0	0
		28 m^2	0	0					
Termination/ use limitation of wells									
		12 wells	202 persons	*(HH persons are 1505)		0	0	0	0
					*15 well pumps operators (HH persons are 112)	0	0	0	0
* Estimated number of households based on the conducted interviews average									

The study team conducted consultation meetings with all those people during the data collection process. A structured questionnaire was applied for each category. The survey indicated that the vulnerability among well operators is relatively higher than the other groups. They will lose their sole source of income. Some of them have been found to be old people who cannot find an alternative job. The second category is the female-headed families who will lose their lands. Their living conditions reflected their poor socioeconomic conditions.

2.2. Socio-economic survey:

This section will summarize the results and findings of the socio-economic studies and surveys.

2.2.1. Description of the project affected persons

Based on the definition provided by the WB about the Project Affected Persons, the total project affected owners of lands are 19 people. The operators of the pumps that extract water out of wells are 15 persons. 202 partial well owners will be affected.

Two factors further caused inflation in the number of project-affected members, those being:

1- The average number of family members is about 7.45 people per each household
2- Most of the PAPs live with extended families

2.2.1.1 Land owners

The total surveyed sample was limited to 12 people out of 19 persons. 17 of the PAPs are males and 2 are females. This section will present the results of these 12 project affected persons interviewed using structured questionnaire:

- The total area of affected land is estimated at 50 square meters. Only one person will lose about 275 square meters of land. The reason for land acquisition is mainly to establish a recovery well.
- All of the surveyed sample have legal ownership of their lands (*Tabou*)
- Their age category is between 32 -75 years. The average age is estimated at 50.6 years.
- Four of them have completed secondary education and five completed university. The remaining completed preparatory education.
- The range of land ownership varies between 426 m^2-10000 m^2. The average owned land is about 2801.1. m^2
- 19 land owners will lose less than 10% of their lands, while six of them will lose 10-less than 20%. Those who will lose about two third of their lands are only 3 persons. Two people, however, will lose between 80-100% of their lands.
- The main occupation of the PAPs is farming; Three of them, however, work as administrative staff, teacher, and businessman. One of the females is a housewife.
- Three of the households' members reported having a disabled family member.

- Affected lands are mainly used for agricultural purposes. Few of the PAPs (2 persons) use their lands to raise poultry.
- The total estimated number of trees is 1200 (citrus-lemon-olive-stone fruit trees and other types of trees) to be re-calculated prior to the actual implementation.
- The average annual revenue of the lands cultivated by crops and trees is estimated at 800 $. However, the cost of land expenses reported by the sample was 700 $. That was an indication of the poor productivity of lands.
- The average price of the square meter in the affected land is about 38.5 JD (55 US$)
- The majority of affected lands are cultivated by traditional crops. Few of them are cultivated by citrus, guava and other types of trees.

2.2.1.2 Well owners

- Wells anticipated to be terminated or limited in use are 12 wells, owned by 202 persons. 74.8% of the owners are males, while 25.2% are females.
- Each well is owned by more than one person. A single well can be owned by up to 39 persons. On average the well was owned by 17 people.
- The well owners declared the legality of ownership of their wells
- Well construction is significantly expensive in the Palestinian Territory. That was the motive of having more than one partial owner participating in well ownership. The average cost of well is about 50000- 60000 $
- The average annual maintenance cost is 275 $. However, in a few cases the maintenance cost might go up to 4500 $.
- The PAPs reported that the well water extraction cost covers both the expenses of well operators and fuel. The cost does not, however, cover the price of water
- Given the fact that PAPs use the wells' water to irrigate their farms, they were not able to calculate the annual revenue of the well. Additionally, providing water to irrigate their lands will be proper compensation that enables them to restore their livelihood conditions.

2.2.1.3 Well operating workers

- The total number of well operators is 15 persons. They operate 12 wells. They have relatively the most vulnerable conditions. The study team managed to interview 11 of the well operators, all of whome were males.
- Most of the operators received limited education; 6 completed preparatory education, 2 dropped out before completing primary school, 1 reached secondary education and only 1 completed university level education. 1 of the interviewed operators is completely illiterate. Such limited education will present challenges in finding alternative employment and possible job opportunities.
- The average household size is about 7 persons.
- Three of them have at least one disabled member of family, suffering either mental disorders or physical paralysis.
- The majority of them earn less than 267.5 US$ per month. They however, spend about 322 US$. This was an indication that they might have a secondary work. Each household has at least one working person.
- They allocate their whole salary to house expenses. However, their contribution represents only half of the required household expenses.

- Regarding social insurance, no one of them have any kind of social insurance. They can be described as daily wage workers.
- The well operators will be expected to lose their source of income with no potential compensation other than the one mentioned in the Labor Law No. 7 of year 2000. Consequently, the Ministry of agriculture proposed to provide alternative jobs to those PAPs.

3 LEGAL FRAMEWORK

This section aims at summarizing the social legislations, regulations, guidelines (that govern the implementation of the project. This will include reference to Palestinian legislation and major regulations, as well as to World Bank OP 4.12, Involuntary Resettlement.

3.1 The International Finance Corporation (IFC) performance standards

Performance Standard 5: Land Acquisition and Involuntary Resettlement:
Objectives:

- To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.
- To avoid forced eviction.
- To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost4 and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.
- To improve, or restore, the livelihoods and standards of living of displaced persons.
- To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

Requirements:

- Provision of detailed project design. The client feasible alternative project designs to avoid or minimize physical and/or economic displacement, while balancing environmental, social, and financial costs and benefits, paying particular attention to impacts on the poor and vulnerable
- When displacement cannot be avoided, the client will offer displaced communities and persons compensation for loss of assets at full replacement cost and other assistance[11] to help them improve or restore their standards of living or livelihoods, as provided in this Performance Standard.
- The client will engage with Affected Communities, including host communities, through the process of stakeholder engagement described in Performance Standard 1. Decision-making processes related to resettlement and livelihood restoration should include options and alternatives, where applicable. Disclosure of relevant information and participation of Affected Communities and persons will continue during the planning, implementation, monitoring, and evaluation of compensation payments, livelihood restoration activities, and resettlement to achieve outcomes that are consistent with the objectives of this Performance Standard.[16]
- The client will establish a grievance mechanism consistent with Performance Standard 1 as early as possible in the project development phase. This will allow the client to receive and address specific concerns about compensation and relocation raised by displaced persons or members of host communities in a timely fashion, including a recourse mechanism designed to resolve disputes in an impartial manner.
- Where involuntary resettlement is unavoidable, either as a result of a negotiated settlement or expropriation, a census will be carried out to collect appropriate socio- economic baseline data to identify the persons who will be displaced by the project, determine who will be eligible for

compensation and assistance,[17] and discourage ineligible persons, such as opportunistic settlers, from claiming benefits. In the absence of host government procedures, the client will establish a cutoff date for eligibility. Information regarding the cut-off date will be well documented and disseminated throughout the project area.

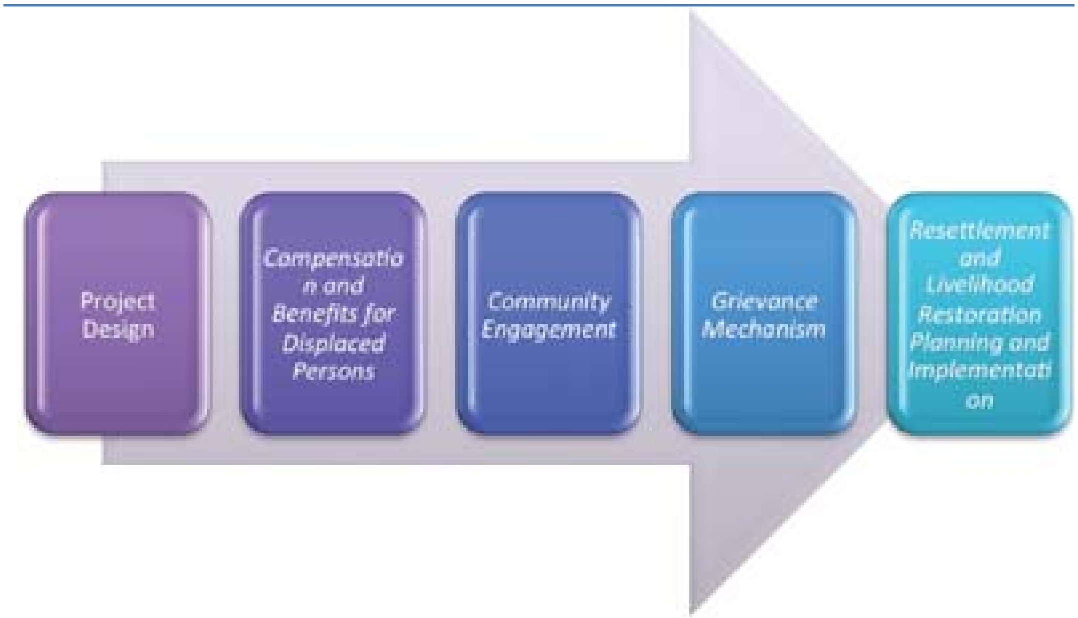


Figure 3-1 :Requirements of Performance Standard 5: Land Acquisition and Involuntary Resettlement

3.2 World Bank Safeguard policies related to involuntary resettlement

3.1.1. OP 4.12 on Involuntary Resettlement

World Bank BP/OP 4.12 on Involuntary Resettlement was developed with main common objectives of mitigating the negative social impacts resulting from land acquisition or affecting the sources of livelihoods as a result of development project. The thorough review for the mentioned guidelines showed the following:

- The policy was drawn with the general human rights framework in recognition for the protection of the ownerships and also safeguarding the interests of the poor and vulnerable groups in particular
- OP 4.12 harmonizes all the key principles and terminologies related to involuntary resettlement. The main guiding principle is that: where physical or economic displacement is unavoidable, the funding agency requires the promoter to develop an acceptable resettlement tool (this may include a Resettlement Policy Framework or a Resettlement Action Plan). The plan should incorporate and follow the right to due process, and to meaningful and culturally appropriate consultation and participation, including that of host communities.
- WB OP 4.12 is an important and key reference addressing the international funding agencies requirements for handling involuntary resettlement impacts.

- According to the WB's safeguard policy on Involuntary Resettlement, physical and economic dislocation resulting from WB funded developmental projects or sub-projects should be avoided or minimized as much as possible. Unavoidable displacement should involve the preparation and implementation of an Abbreviated Resettlement Action Plan (RAP) or a Resettlement Policy Framework (RPF), to address the direct economic and social impacts resulting from the project or sub-project's activities causing involuntary resettlement.

The following instruments may be utilized to implement the resettlement activities:

- Resettlement Action Plan
- Resettlement Policy Framework
- Process Framework

In projects triggering OP 4.12 the task team must decide which of the above three instruments are appropriate for the project in question, and the necessary documentation must be prepared by appraisal.

A Resettlement Action Plan (RAP) or abbreviated RAP – depending upon the scale of impacts - is prepared when all the details of the project are known at appraisal.

In projects where the extent and location of resettlement and/or land acquisition cannot be known at appraisal, e.g. in projects with multiple sub projects, a Resettlement Policy Framework is prepared. An RPF should include information on how subsequent RAPs are developed both with regard to substance and process.

The third instrument, Process Framework that restricts access to legally designated parks or protected areas without acquiring the land outright is applied in conservation projects.

Involuntary resettlement resulting from development projects, if unmitigated, will give rise to difficult economic, social, and environmental risks which may lead to: i) dismantling production systems, ii) impoverishing people when their productive assets or income sources are lost, iii) relocating people to environments where their productive skills may be less applicable and the competition for resources is greater, iv) resettling people into community institutions and social networks are weakened, v) dispersing kin groups and, vi) diminishing or losing cultural identity, traditional authority, and the potential for mutual help.

On the other hand well-designed and well-implemented resettlement programs may represent good development opportunities. By providing proactive mitigation measures, the policy is used to ensure that Project Affected Persons (PAPs) are not negatively affected by Bank financed projects. The Bank's involuntary resettlement policy is a road map to be used by practitioners in the identification, preparation, and implementation of

WB funded programs with a focus on minimizing negative social and economic impacts on PAPs and their community as a whole.

With the above focus in mind, the following discussion presents a brief overview of OP 4.12 Policy Objective and Principles. The scope and coverage of the RPF and the subsequent process of preparing and approving a Resettlement Action Plan (RAP) are highlighted including the identification of different categories of PAPs, measures for protecting vulnerable PAPs, eligibility procedures and criteria as well as assets valuation.

3.1.2. The principle policy objectives of OP 4.12 are:

- Involuntary resettlement should be avoided where feasible, or minimized by exploring all viable alternative project designs.
- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs.
- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

3.1.3. Eligibility Criteria

A project triggering OP 4.12 is required to develop a satisfactory procedure to the Bank, for establishing the criteria by which PAPs will be deemed eligible for compensation and other resettlement assistance. The procedure includes provisions for meaningful consultations with: (i) Project affected persons and communities, (ii) Local authorities, and, as appropriate, (iii) Nongovernmental organizations (NGOs), and (iv) grievance mechanisms.

The aim of including the eligibility criteria in the RAP is to ensure that PAPs suffering a complete or partial loss of assets or access to assets are clearly defined and recognized as eligible for some kind of assistance, according to their legal rights to the land, if established that they occupied the land before the claim cut-off date. The Bank OP4.12 specifically proposes general categories for eligibility, as follows:

1) Category One: Individuals who have formal legal rights to land are the owners of lands within the 28 km located in the agriculture area. They are entitled to receive full compensation defined in the price lists

2) Category Two: Individuals, who do not have formal legal rights to land, but have a claim to such land or assets[4]. They are mainly the tenants who have no documents that declare the tenancy relation with the owners. They are entitled to receive compensation during the tenancy duration reported by the owner. The owner will delegate the tenants to receive the compensation

3.3 Existing Palestinian legal and policy framework for land acquisition

According to Law No.24 of year 1943 modified by Law No. 2 of year 1953 on "Land Expropriation for Public Projects" and its articles (3) and (21), the Government can expropriate up to 25% of any privately-owned land for public interest reasons - without compensating the owners. Exceptions are made to owners who prove to be largely damaged by this land expropriation. However, owners are entitled to compensation for all crops and trees, buildings and fixed structures on the expropriated 25% area of the land.

In case the Government needs the whole plot of land, negotiations are made to reach an agreement with owners. However in case of pressing time demands to expropriate land to a specific project serving public interest, the government is entitled to seize the land immediately and then to initiate compensation negotiations with owners/users (Law 2/1953, Article (12)).

3.2.1. Actual procedures and mechanisms for land expropriation

In order to be able to comprehend the land acquisition procedures, it is essential to identify the entities and authorities contributing to land acquisition process:

1- Palestinian Water Authority (the owner of the project) (PWA)
2- Municipality of Jabalia and Gaza
3- Ministry of Local Governance (MLG)
4- Palestinian Land Authority (PLA)
5- The Cabinet
6- The Central Committee
7- Ministry of Endowment (MoE)
8- Ministry of Agriculture (MoA)
9- Ministry of Finance (MoF)
10- Project affected persons (PAP)

Table 3-1: Legal procedures adopted for land acquisition purposes

Procedures	Responsibility	Time frame
Land allocated for well construction		
PWA identifies the lands required by the project.	PWA	Accomplished

[4] provided that such claims are recognized under Palestinian laws or become recognized through a process identified in the involuntary resettlement plan

Procedures	Responsibility	Time frame
PWA to define the cut-off date and disclose the cut-off date to the PAPs which is the 31st of May 2018	PAPs with the PWA in full cooperation with municipalities and ministries	Immediately
PWA communicate with the municipalities in order to identify the technical specifications of the required land	PWA in full cooperation with the municipalities	Six months before implementation
The municipalities develop the technical documents to the PWA.	PWA in full cooperation with the municipalities	Five months before implementation
PWA forwards the documents to the Palestinian Land Authority and the Ministry of Local Governance who raise the land acquisition to the Central Committee responsible of land acquisition for public benefit.	PWA in full cooperation with PLA and MLG	Four months before implementation
The municipalities prepare an inventory survey to verify the ownership of lands after receiving the maps and coordinates from the PWA,	PWA in full cooperation with PLA and MLG	Four months before implementation
The municipalities apply the procedures required to change the type of land use.	PWA in full cooperation with PLA and MLG	Four months before implementation
PWA and the concerned Municipalities provide PLA with detailed information on the land and properties to be expropriated	PWA in full cooperation with PLA and MLG	Three months before implementation
The PWA announces in a daily newspapers the government's intent to expropriate the specified lands and provides full details about the project and grievance duration (60 days after publishing the advertisement)	PWA in full cooperation with PLA and MLG	Three months before implementation
The municipalities inform the PAPs with the exact period to submit their complaints related to land acquisition (60 days)	PWA in full cooperation with PLA and MLG	Three months before implementation
PLA investigate diversified complaints and propose solutions	PLA in cooperation with the PWA	Two months before implementation
Any objection on principle to the acquisition must be lodged within 60 days of publication of the Land Expropriation for Public Benefit.	PAPs with the PLA and PWA	Two months before implementation
30 to 90 days later, the case is presented to the Prime Ministry for endorsement, which must take place within 6 months (starting 30 days after the announcement of Expropriation for Public Benefit).	PWA in full cooperation with PLA and MLG	Two months before implementation
The endorsed decision is published in the official newspaper	PWA in full cooperation with PLA and MLG	One month before implementation

Procedures	Responsibility	Time frame
PLA and Municipality of Gaza form a committee of five officials to provide a compensation estimate[5]. Evaluations are based on current land values and prices to land of similar quality.	PWA in full cooperation with PLA, MOA and MLG	Three months before implementation
A valuation committee from the PWA and PLA evaluate the appropriate compensation of wells	PWA in full cooperation with PLA, MOA and MLG	Three months before implementation
In case of having any crops and trees, the Ministry of agriculture provides detailed valuation list of the affected crops/ trees	PWA in full cooperation with PLA, MOA and MLG	Three months before implementation
Details of all land units included in the Prime Ministerial decree are announced, including names of owners and the number and description of the units.	PWA in full cooperation with PLA, MOA and MLG	Three months before implementation
Affected persons have 30 days to discuss compensation with concerned authorities.	PAPs with the PWA in full cooperation with PLA, MOA and MLG	One month before implementation
Owners have the right to object to the offered compensation and may request mediation.	PAPs with the PWA in full cooperation with PLA, MOA and MLG	One month before implementation
Municipality/PLA may form a second committee to conduct a second evaluation	PAPs with the PWA in full cooperation with PLA, MOA, municipalities and MLG	One month before implementation
They propose the alternative lands to be given to the PAPs	PAL	They have already proposed alternative lands
The level of compensation is finalised upon ratification by the Ministry of Finance	PAPs with the PWA in full cooperation with MOF	One month before implementation
If no agreement is reached, owners have the full right to recourse to Courts.	PAPs with the PWA in full cooperation with MOF	
Judicial involvement when no agreement is reached. However, such ac	PAPs	
Wells operators/ owners		

[5]The officials are the regional directors of the four ministries: Public Works; Finance; and Agriculture together with a representative of the PLA and the Audit Bureau. Although the composition is official, the law specifically empowers the Director of PLA to call upon any advice in a review of compensation if necessary.

Procedures	Responsibility	Time frame
PWA to define the wells that will be terminated and conduct a census to define the current operators	PAPs with the PWA in full cooperation with municipalities	After operating irrigation scheme
PWA to define the cut-off date and disclose the cut-off date to the PAPs	PAPs with the PWA in full cooperation with municipalities and ministries	Upon operating the irrigation scheme
PWA to inform the municipalities about the wells to be terminated	PAPs with the PWA in full cooperation with municipalities	After operating irrigation scheme
The municipalities to negotiate with the owners and operators	PAPs with the PWA in full cooperation with municipalities	After operating irrigation scheme
Propose compensation mechanism and communicate with the PAPs: 1- Provision of water of low cost to the owners 2- Provide job opportunities to the operators	PAPs with the PWA in full cooperation with municipalities	After operating irrigation scheme
Upon reaching an agreement the PWA to apply remedial actions	PAPs with the PWA in full cooperation with municipalities	After operating irrigation scheme

3.2.2. Guidelines for court mediation in case of compensation disputes

In case no agreement is reached regarding the compensation, court mediation can be requested by one or both parties. In order to reach a compromise, the court must take into consideration the following guidelines:

1- The fact that the property was seized without the owner/user's consent should not influence the court in estimating the value of the compensation.

2- Fair compensation is to be achieved through assessing the current market value of the property at the day the government published its intention to expropriate the property in two national newspapers, and to disregard any improvements or developments made after that date.

3- When estimating the leasing fees to be paid to the landowner, the Court appraises the yearly rental fees reflective of the value at the date of the official notification.

4- When assessing the losses due to damage, the Court estimates the compensation based on the amount of decrease in the property's value as in the previous points.

5- Reduction in the value of the portion of the property not expropriated must be compensated for. The related compensation estimate should not exceed half of the compensation originally entitled to the landowner for the expropriated section.

6- Considering the harm done to the owner as a result of dividing the land property or as a result of the practices delegated by this Law.

7- The accrued amount is not to be paid to those concerned before the Registrar of Titles issues a certificate that states that the property is not subject to any mortgage payments. In that case, the amount must be deposited in the State Treasury.

8- If the amount is deposited in the State Treasury - since the owner did not present official documents or for any other reason - it must be kept for one year from the date of the final verdict. Exceptions are made if the Court decides that the amount can be disbursed before the one year deadline, i.e., in cases where the compensated person was able to present an official document from the Land Registration Department stating the ownership of the land or infrastructure proving the entitlement to compensation.
9- The compensation or leasing fees paid to the State Treasury or the entitled person(s) frees the condemner from any claims related to the land.

Finally, and after the compensation has been paid to the land owners by the State Treasury – or temporarily deposited in the State Treasury, the title to the land in question is transferred to the Condemner.

4 ELIGIBILITY AND MODE OF COMPENSATION

This section provides information about the following issues:

- Eligibility criteria of persons entitled to receive compensation (or other forms of assistance in lieu of compensation)
- Description of valuation procedures used to establish compensation rates for land, structures or other fixed assets.
- Description of arrangements for delivery of compensation to displaced persons
- Compensation rates for all categories of land acquisition, affected structures, other fixed assets
- Transitional support
- Arrangements for recalculation of compensation rates in case of prolonged delay in delivery of compensation

4.1 Eligibility criteria and entitlement matrix

The aim of including the eligibility criteria in the RAP is to ensure the PAPs who suffer a complete or partial loss of lands, crops, trees and assets or access to them will be clearly defined and recognized as eligible for some kind of assistance regardless to their legal rights to the land.

- The first criteria for eligibility will be the cut-off date:
  - Well owners cut-off date will be the 31st of May 2018
  - Well operators cut-off date will be defined upon operating the irrigation network
  - Land owners cut-off date will be the 31st of May 2018
- The second criteria for eligibility will be the legality of the PAPs status. Identified PAPs are basically classified into the following categories in the donor policies:
  - Those who have formal legal rights to land (including customary and traditional rights recognized under the laws of the country);
  - Those who do not have formal legal rights to land at the commencement of the inventory, but have a claim to such land or assets; provided that such claims are recognized under the law of the country or process identified in the resettlement plan;

Although Palestinian legislation has not mentioned the entitlement to compensation for those who do not have legal rights, such persons have been compensated in the course of operational practice if they were previously regarded as the apparent owners of the affected properties.

The following table will present the people entitled for compensation, assistance and livelihood restoration as they were previously affected by the project

TABLE 4-1: ENTITLEMENT MATRIX OF THE NGESTP PROJECT

No	Type of Losses	Level of Impact	Entitled Person(s)	Compensation Policy & Standards	Type of compensation to be applied	Responsible entity
A. LOSS OF AGRICULTURAL LAND						
a.1	Loss of arable and grazing agricultural land or access to it	Permanent (complete or partial) loss of all or part of arable and grazing land located in the ROW	Farmers / Individuals who have **formal legal ownership rights** to land (Tenants or owners)	Four scenarios of compensation are adopted 1- Provision of Alternative land • Provide alternative lands equivalent to the same expropriated Lands. The owners should receive the alternative lands. Thereafter, they will arrange for the compensation of tenants (if any) 2- Provide cash compensation equivalent to the market price 3- Provide job opportunity to one of the HH members, particularly if the plot of land is too limited	Alternative land Cash compensation Job opportunity Provision of water	Palestinian Land Authority Municipality PWA

No	Type of Losses	Level of Impact	Entitled Person(s)	Compensation Policy & Standards	Type of compensation to be applied	Responsible entity
				4- Provision of water		
B. LOSS OF ASSETS (wells)						
b.1	Restriction to use the wells	Permanent limitation of well (complete or partially limitation)	Well owners who have legal ownership of wells (partial ownership)	• Palestinian Law stipulated the provision of compensation of affected assets • Valuation of wells should be applied and cash compensation to be provided • Otherwise Water should be provided to the well owners from recovered water	Cash compensation	PWA Municipalities Palestinian Land Authority
b.2	Restriction to use the wells	Permanent limitation of well (complete or partially limitation)	Workers who operate the pumps in the wells	Two scenarios have been developed to the workers • The well operator receives a compensation equivalent to one month per each one working year (according to labor law) • Provide the workers with alternative job of similar work conditions to the current occupation in the water	Cash compensation Alternative job	Project contractor/ PWA Municipalities

No	Type of Losses	Level of Impact	Entitled Person(s)	Compensation Policy & Standards	Type of compensation to be applied	Responsible entity
				distribution project		
C. Loss of Standing Crops, Trees, and Plants						
c.1	Loss of standing crops, trees, or plants or access to them	Permanent (complete or partial) loss of standing crops, trees, or plants	Farmers or individuals who cultivate the land and who have formal legal ownership rights to the crops on which the crops are	**Crops** • Enable the farmers to harvest their crops. **Trees** • Ministry of Agriculture provides price lists that will be adopted along with the project activities. Thereafter cash compensation is delivered	Allowance to harvest crops Cash compensation	PLA Ministry of Agriculture

4.2 Methodology of Assets valuation and the compensation packages

The valuation methodology of the crops and assets' compensation is vital for the RAP study in order to facilitate the compensation process. Following is a summary of valuation process for various types of impacts:

Table 4-2: Methodology of Asset valuation

Type of loss	Valuation mechanism	Entity responsible for valuation
Private lands	The Palestinian Land Authority provides alternative lands to the owners of lands. The alternative land will be similar to the expropriated lands.	Palestinian Land Authority
Well	An evaluation committee will valuate the price of wells that will be terminated permanently. The proposed values will be negotiated with the PAPs. Well operators will receive alternative job opportunity or at least will be guided to employment offices	Ministry of Agriculture PWA Ministry of finance
Crops and trees	The Ministry of Agriculture develops price lists of the affected crops and trees (see sample in Annex VI) The lists will be updated and provided to the PLA and Ministry of Finance to be the basis of compensation	Ministry of Agriculture PWA Ministry of finance

4.3 Arrangement for delivery of compensation

The Permanent land acquisition and compensation will be applied as follows:

1- The Design Department in PWA has provided a detailed map on land acquisition scope in order to identify the land acquisition area.
2- The PAPs were consulted with during the preparation of the RAP to provide them with the information regarding their rights, valuation procedures and grievances and redress mechanism.
3- After receiving the approval of the AFD on the ESIA and the RAP, the documents will be translated and disclosed to the PAPs in the Municipalities, the PWA website and the AFD website. Thereafter, the resettlement activities will be executed.

4- A continuous dialogue will be applied with the PAPs as part of stakeholder engagement activities
5- The Compensation Committee will disburse the compensation value according to the following system:1) Full compensation will be given before the construction, 2)complete legal procedures for land acquisition will be documented by the PWA.

4.4 Transitional support

The Palestinian Law related to expropriation does not stipulate any transitional support activities. That is also the case with the project owner (the Palestinian Water Authority is not the implementing agency for land acquisition) consequently, the provision of transitional support will be relatively difficult to be obtained.

4.5 Arrangement for recalculation of compensation

In case of any prolonged delay related to the project implementation the following procedures will be applied:

a. Verification of the inventory developed for the PAPs
b. Palestinian Land Authority in cooperation with the Ministry of Agriculture should update crops and trees price lists.
c. The PLA in cooperation with the interested municipalities will inform the PAPs about the modified project time plan. In addition, the value of compensation of the potential affected lands/crops/trees and assets will be defined and forwarded to the financial department in the PWA.

4.6 Vulnerable groups assistance

The Palestinian Law related to expropriation requires the implementing agencies to avoid the vulnerable groups. Regarding the NGEST project, it is anticipated that the vulnerable groups are:

1- Owners of small plots who's lands will be used by the project are defined as vulnerable due to penetration through the middle of their lands. The remaining parts of the lands will be of no use to the PAPs. The PWA tries to avoid or minimize the impacts on those groups through modifying the route of the streets, avoiding entering into the middle of lands, as well as, avoiding well construction in the areas located directly on the roads. (The price of plots of lands located directly on the road is relatively higher)
2- Owners of lands who were eligible for land expropriation under the Excretion Law "*Ifraz*". Some of these have already lost of 25.0% of their lands previously due to the implementation of other projects. Expropriating another 25.0% of their lands will be a complete critical impact. Such category should be avoided

3- Female-headed owners of small plots of lands should be provided by similar alternative lands in locations close to the expropriated lands. A provision of job to one of the sons could however, be a much better alternative

4-

5 INSTITUTIONAL ARRANGEMENTS

This section identifies the organizations and/or agencies primarily responsible for resettlement implementation. It describes the capacity of these entities for effective implementation by reference to links to authority, prior experience with resettlement, and number and training of their personnel.

This section also briefly describes the implementation timetable, establishing that key implementation measures to apply the resettlement activities.

5.1 Institutional Responsibilities

The following scheme provides an overview of the institutional responsibilities for implementation the Resettlement Action Plan.

Authorities and Agencies	Responsibilities
During planning phase	
Palestinian Water Authority	• Describe the scope of lands and assets required by the project • Communicate with other governmental entities • Prepare a RAP in cooperation with independent consultant • Shed light on the proposed compensation • Apply maximum avoidance mechanism to reduce the involuntary resettlement • Propose the best strategies to consult with the community • Prepare the permissions and decrees in cooperation with other entities
Municipalities of Gaza and Jabalia	• Final definition of lands and conditions for acquisition • Verifying the need of lands and prepare an inventory • Prepare the technical documents related to the project components
Ministry of Local Governance	• Final confirmation of land ownerships of the land to be acquired • Contribute with the Palestinian Land Authority along with the project life
Palestinian Land Authority	• Identify all affected persons, advising them of their rights, • Follow-up on all matters of the public and PAPs concern and with regard to any complaints that may arise during the implementation process. • Directly contact affected persons either individually or in groups. • Propose alternative lands to replace the affected lands
Ministry of Finance	• Allocate budget for compensation
Cabinet	• Develop the land expropriation decree • Endorse the final land acquisition profile of the project

Authorities and Agencies	Responsibilities
Ministry of Agriculture	• Provide price lists of the crops and trees • Propose the compensation of wells • Coordinate with the Ministry of finance regarding the proposed compensation
During negotiation and grievances	
Municipalities	• Conduct consultation meetings with the project affected people at the project areas, inform them about the RAP and their right to obtain compensations, and explore their priorities and preferences • Collect the grievances to be shared with the PLA
Palestinian Land Authority	• Disclose grievances channels to the community • Identify all affected persons, advising them of their rights. • Follow-up on PAPs concerns and with regards to complaints that may arise during the implementation process. • Directly contact affected persons, either individually or in groups. • Develop a grievance lodger
Palestinian Water Authority	• Participate in the process of negotiations and grievances • Document all activities related to the negotiations and grievances • Prepare quarterly reports
During the RAP implementation phase	
Municipalities	• Undertake community liaison (day to day operation) • Collaborate with the other entities • Transfer received complaints to the PLA
Palestinian Land Authority	• Establish values for compensation • Adjudicate on grievances • Plan negotiation and establish final offer • Recommend acceptance of compensation- package to Ministry of Finance or land authority • Adjudicate on appeal against land acquisition values to courts
Ministry of Finance	• Certify compensation agreements and transfer funds to PAPs
Palestinian Water Authority	• Certify the compensation agreement and develop the required compensation • Collect the grievances raised by the PAPs, document and report them to the bank • Monitor PAPs implementation procedures
External Monitoring consultant	• Ensure compliance with funding agreements • Evaluate and monitor the process

5.2. Capacity building

According to a rapid needs assessment conducted for the above mentioned entities, it was obvious that they are capable to conduct most of RAP related activities. It was found however, that they still lack information on certain activities. Training modules are proposed to enhance the capacity of the interested entities, as well as, enable them to fulfill the requirements of the WB. Three training courses are the core of the RAP, they are as follows:

- WB policies related to resettlement activities: OP 4.12 and resettlement instruments.
- IFC performance standard 5 pertaining to land acquisition and involuntary resettlement
- Communication and negotiation skills
- Skills of documentation and filing: this module attempts to provide the entities with filing skills that will be needed for reporting and auditing missions of the WB. Documentation of grievances and compensation documents both on the central and regional level will facilitate reporting to the bank
- Monitoring and evaluation: Is one of the most crucial trainings required to enhance the monitoring skills of PWA staff

In addition to the above trainings, it is important that the Social Development Officers working within the Project Management Unit in the PWA are provided with information on the community issues related to the project through the following two courses to enable:

- Participatory approach: to engage the community in taking part in the project activities. This approach will be useful to enhance the dialogue between the PWA and the communities hosting the project
- Awareness and communication skills: Awareness and communication are important for the nature of the project, especially for informing the community on restrictions imposed on land use, constraint that is unknown to most people. Provision of such training will therefore be useful to the SDOs in order to provide PAP's with information on the restriction of land use.

Table 5-1: Proposed capacity building activities

Training module	Learning objectives	Duration& date	Proposed trainees	Proposed cost
WB policies related to resettlement activities	• Acquire a full understanding of the OP 4.12 regulations • Obtain a full understanding of the needed actions within this policy and its instruments (RPF-RAP)	1 day for the theoretical part 2 days for the on the job training *Prior to the resettlement implementation*	PWA – PLA-Municipalities-MoA- MoF-MoLG	5000 $
IFC performance standard 5 pertaining to land acquisition and involuntary resettlement	• Acquire proper understanding of IFC requirements pertaining to land acquisition	1 day for the theoretical part 2 days for the on the job training *Prior to the resettlement implementation*	PWA – PLA-Municipalities-MoA- MoF-MoLG	5000 $
Communication and negotiation skills	• Obtain proper understanding of communication methods, strategy and outreaching • Train on negotiation skills needed with the PAPs	1 day for the theoretical part 2 days for the on the job training *Prior to the resettlement implementation*	PWA – PLA-Municipalities-MoA- MoF-MoLG	5000 $
Skills of documentation and filling	• Obtain a full understanding of the filing process • Obtain a full understanding of the needed items to apply a good and comprehensive documentation • Gain the ability to develop a report about the grievance and redress • Keep records and document various compensation related	1 day for the theoretical part 2 days for the on the job training *Prior to the resettlement implementation*	PWA – PLA-Municipalities-MoA- MoF-MoLG	5000 $

	documents			
Monitoring and evaluation	• To understand the monitoring definition and the role of monitoring and evaluation in the project • To learn about effective monitoring and evaluation tools and reporting formats	2 days for the workshop 2 days on the job training *Prior to the resettlement implementation*	PWA – PLA-Municipalities-MoA- MoF-MoLG	6000 $

6 STAKEHOLDER ENGAGEMENT ACTIVITIES

The stakeholder engagement chapter aims at highlighting the key consultations, community engagement activities and their outcomes, in addition to outlining the validity and reliability of the collected data.

6.1 Regulatory Context

6.1.1 World Bank requirements for stakeholder engagement and public consultation

The policies pertaining to stakeholder engagement activities according to the World Bank are:

- o World Bank Procedure (BP 17.50)
- o Waorld Bank Operational Policy (OP 4.01)

6.1.2 IFI requirements for stakeholder engagement and public consultation

PWA has committed to developing the Project in line with good international practice standards and in particular the IFC PS 2012. The specific standard of reference is:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts
- PS1 requires a systematic approach to stakeholder engagement, which considers the views, interests and concerns of stakeholders, particularly those within the AOI . Such an approach is designed to help build and maintain a constructive relationship with Project stakeholders. PS1 also requires the development of a Grievance Mechanism (GM) for the Project, which needs to be disclosed to affected communities and project workers, as appropriate, to ensure there is good understanding of the process.
- PS1 also states that in addition to meeting the requirements of the Performance Standards, 'clients must comply with applicable national law, including those laws implementing host country obligations under international law'.[6]

6.2 Stakeholder Engagement Objectives

[6] IFC PS (2012): Overview (Para 5, page ii).

The objective of the Stakeholder Engagement is to ensure safe and successful Project delivery by:

- **Informing** stakeholders, including persons or groups who are directly or indirectly affected by a project, as well as those who may have interests in a project and/or the ability to influence its outcome, either positively or negatively;
- **Listening** to their comments, ideas and concerns and recording the same for follow up;
- **Communicating and implementing** a viable community grievance mechanism.
- **Avoiding** conflict by addressing impacts and issues raised by stakeholders promptly; particularly with the communities that will not be served by the project
- Ensuring that fears and anxieties about the nature, scale and impact of the operation have been properly considered in the development and management of the Project;
- **Accessing** and making good use of existing local knowledge of the area;
- **Avoiding** any misconceptions about the project and properly manage expectations;

Thereafter the results will provide proper documentation of stakeholder feedback and accordingly, enhance the resettlement activities.

6.3 Consultation Methodology and Activities

The study research team undertook multi-dimensional consultation activities that included an exchange of information, providing the marginalized, voiceless, youth and women with information about the project as well, obtaining information on their concerns regarding the project's various implementation phases. Owing to time constrains, teams were mobilized to consult with both community people and stakeholders in parallel.

Following are the main consultation activities to date that will be supplemented by additional engagement activities:

- The study team visited the project area in order to define various stakeholders during April 2018
- Meetings were conducted during April 2018 in order to develop an engagement plan that is locally tailored for the residential communities with the study team members
- Based on the identification of stakeholders and PAPs, various questionnaires and guidelines were prepared in order to engage: i) the PAPs (land owners- well owners and well operators, ii) Governmental municipalities , iii) the CBOs, iv) health facility, v) Ministry of Endowment and Ministry of Agriculture
- The study team divided various engagement activities of the project to:
    e. Screening
    f. Scoping phase and data collection phase and,
    g. Public consultation phase.
    h. Final report disclosure

- All activities conducted were documented with photos and lists of participants in order to warrantee appropriate level of transparency.

6.4 Strengths and Limitation of consultation

6.4.1 Strengths of the consultation

1- Local mobilizers were recruited from Gaza Strip to facilitate conducting consultation meetings and collecting primary data
2- The local mobilizes proposed the main stakeholders that will play role or have interest in the project based on a list of potential stakeholders provided by the consultant
3- They managed to facilitate various meetings conducted with the governmental and non-governmental entities in their premises
4- Prior to each consultation event, the local mobilizers exert remarkable effort to invite the community people. This is made by the distribution of flyers, posters and meeting with the local authorities
5- The CBO recruited managed to facilitate all permissions required to meet with any of stakeholders

6.4.2 Limitation of the consultation

1- Consultation activities did not manage to meet with All PAPs who will lose their wells, lands…etc
2- Concerns raised about the cost of water and the detailed of project implementation were not responded to due to the absence of information

6.5 Project Stakeholders

The RAP focuses on various stakeholders who might be affected by the project and the municipalities that will participate in resettlement activities.

A systematic approach has been adopted to identify Project stakeholder, including:

- defining the Project's AOI which basically covers Jabalia, Um El Nasr, Beit Hanoun and Beit Lahia;
- scoping and identifying stakeholder group that could be affected (directly or indirectly) by the Project, or have an interest in it;
- identifying vulnerable groups; and
- reviewing AOI , stakeholders and vulnerable groups during each SEP update and, if necessary, revise based on current Project context.

In order to ensure that the engagement process is inclusive, individuals and groups who may find it more difficult to participate and those who may be 'directly and differentially or disproportionately affected by the Project, or disadvantaged in sharing development benefits and opportunities, because of their vulnerable status' were identified.[7] It will be important for the Project to ensure specific steps are taken to access these groups and offer them the opportunity to engage in discussion about the Project and their interactions with it.

Table 6-1 Vulnerable Groups

Vulnerable Group	Description and Relationship to the Project
Women and Female-headed households, and low-income women	**Women might lose their source of income or lands. They tend to be vulnerable. Particularly, if they own small plots of lands.**
People with disabilities or chronic diseases	**People with disabilities/ or have at least one family member with disability or chronic diseases often have a lower ability to gain employment and generate income. The physically disabled are likely to be particularly vulnerable members of the community as they tend to need more support and often rely on family care.**
Elderly (men and women)	**Elderly (men and women) are likely to have a more limited ability to work; there may be challenges for them to gain employment with the Project.**

The following table summarizes various stakeholders who have interest/influence of the project or might be affected by project activities.

Table 6-2: Description of Project Stakeholders

Stakeholder Category	**Stakeholder Group**	**Potential Implications for Stakeholder Groups**
PAPs	• The owners of wells • The owners of lands • Well operators	This group are the ones affected by project activities and their livelihood might be deteriorated They will have interest and will be impacted by project activities
	Vulnerable groups within the local communities	Vulnerable groups may be likely to be adversely affected by environmental and social impacts, while also being least likely to benefit from the Project. They will have interest and will be impacted by project activities

[7] IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts; para. 12

National government stakeholders	Palestinian Water Authority	Project owner
	Palestinian Land Authority	Responsible for provision of alternative lands to the affected land owners
	Ministry of Finance	Responsible for provision of any monetary compensation
	Ministry of Agriculture / Agricultural Directorate	This Ministry is involved in crop valuation and irrigation scheme cost Have shown interest in the project
Local/provincial government stakeholders	Municipalities in Gaza, Jabalia, Beit Lahia	Responsible for provision of lands and other facilities to the project. They will participate in the operation phase Have interest and will be positively impacted by project activities
Civil society organization	Palestinian non-governmental NGOs' network	Responsible for raising farmers awareness about irrigation water Have interest and will be positively impacted by project activities
	Water Users Association	The direct beneficiary of the project and will participate actively in project implementation procedures

6.6 Summary of Key consultation activities conducted to date (May 2018)

The key consultation activities during the course of the project could be divided into the following:

Table 6-3: Summary of consultation activities conducted to date

No	Stakeholder	Date	Meeting objectives	Meeting outcome
1.	PWA	8th of April 2018	• A preliminary meeting to introduce the study objective and update the data required in the inception phase	• PWA shared information about issues related to: a. Updating project information b. Challenges c. Land required d. Mitigation of unfavorable impacts
2.	the Ministry of Endowment representative	10th of April 2018	• To inform the participants about the project • To define any land needed by the project	• There

3.	Jabalia municipality	10th of April 2018	• Sharing information about the project rehabilitation activities • Collect information about their perception of the project • Awareness strategies and community participation • Capacity building of the municipality to monitor project activities	• The project positive impacts pertaining to environmental aspects • Potential measures required to put limitation of the adverse impacts
4.	Beit Hanoun municipality	11th of April 2018	• Sharing information about the project rehabilitation activities • Collect information about their perception of the project • Awareness strategies and community participation • Capacity building of the municipality to monitor project activities	• The project positive impacts pertaining to environmental aspects • Potential measures required to put limitation of the adverse impacts
5.	Gaza municipality	11th of April 2018	• Sharing information about the project rehabilitation activities • Collect information about their perception of the project	• The project positive impacts pertaining to environmental aspects • Potential measures required to put limitation of the adverse impacts
6.	Ministry of Agriculture	11th of April 2018	• Land acquisition related to the project • The price of generated water • Farmers' perception of the reused water • Awareness raising requirement	• Limited reluctance from the farmers was reported • Awareness raising activities are essential • The exact water tariff to be shared with the farmers
7.	Palestinian Land Authority	15th of April 2018	• Land acquisition related to the project procedures and responsibility • Price of lands • Responsibility for compensating wells operators and crops	• Land acquisition procedures to be adopted by the PLA
8.	Ministry of Local Government	16th of April 2018	• Defining the role of MLG • Identify the proposed compensation and responsibility of compensation	• MLG role is limited to expropriation of lands • They review the urban development plans and assure no transections with the project
9.	PWA, the consultant with the PAPs	22nd of April 2018	• Provide information about the project	• PWA provided the available information to date

	This meeting with supplemented with site visits and additional meetings		• Respond to farmers and PAPs concern	• PWA and the consultant documented various concerns raised: a. Land required to construct the wells b. Remedial actions c. The need not to terminate the private well until the project is fully and properly functioning d. Reduce water cost
10.	Palestinian non-governmental organizations network	24th of April 2018	• Provide information about the project • Define further engagement with the community • Define the required data to be shared with farmers • Propose awareness raising role in full cooperation with the NGOs	• The required data needed was mainly: a. Information about pricing system b. Required lands c. Compensation for lands


Figure 6-1:Meeting with El Awqaf


Figure 6-2: Meeting with Jabalia municipality


Figure 6-3: Meeting with Beit Hanoun municipality


Figure 6-4: Meeting with Gaza municipality

Figure 6-5: Ministry of Agriculture

Figure 6-6: Palestinian Land Authority

Figure 6-7: Meeting with the PAPs on the 22nd of April

Figure 6-8: Meeting with one of the PAPs

The above mentioned activities supplemented the activities conducted in 2012. Additionally, a scoping session was prepared and implemented.

6.7 The Scoping consultation event

The scoping meeting was held on the 23rd of April 2018 and was attended by a wide range of stakeholders including various municipalities, academics, NGOs, Palestinian Water Authority, Ministries and consultation firms.

Following is a summary of the main issues raised during the scoping session related to resettlement

Table 6-4: Summary of discussion

Issue raised	Comment raised	Response
Institutional set-up	The project should focus on the importance of the institutional framework as it is the basis for the operation and success of this project. He explained that the Palestinian legislation classifies this water as groundwater because it mixes with groundwater after its infiltration.	One of the outputs of the study is the environmental management plan, which assign who will do what. I suggest forming an institutional body from all the stakeholders to manage, organize, monitor, and operate the project components. This study should result realistic and applicable procedures
Monitoring requirements	There is a lack of monitoring in all project stages. It's recommended to engage the relevant authorities in this progress. He mentioned the Ministry of Health, Agriculture, Environment, and the municipalities.	PWA will develop a detailed monitoring scheme for all project activities including E&S performance
Land acquisition and role of municipality	Municipalities should be involved in the process of land acquisition and compensation to contribute in resolving disputes, if any. The Ministry of Agriculture and other Agricultural Institutions should be involved in the development of the project operation plan. He focuses on Developing a clear vision of water pricing and whether there is a cost recovery.	In full compliance with the Palestinian land acquisition regulations, the municipalities will be engaged and consulted in the process of compensation
Participation of community in the scoping session	The absence of community institutions from all project activities! We recommend engaging the farmers in the consultative process of the project.	During scoping phase, we managed to meet with various community members in their premises. However, the scoping session is allocated for experts who might provide guidance to enrich the ESIA. This is in full compliance with EQA and IFC standards
Termination of private wells	The Private wells within the area of the recovery wells, Will it be closed or merged with system	Few number of private wells will be terminated
Pollutants	Is there any examination of the microbes (ex: hepatocellular virus) pollute the groundwater through infiltration?	PWA developed and will continue measuring various pollutants
Well operators mitigation measures	How well operators will be mitigated?	Well operators have been interviewed and mitigation measures will be proposed in the RAP study

By the end of this session the PWA and ESIA consultant (UG/ ECOCONSERV) made it clear that all comments raised will be fully and properly addressed

6.8 Stakeholder Engagement Program

The section of the SEP provides details of the engagement to be undertaken during planning, construction and operation of the Project

6.8.1 Communication Methods

Community members indicated that they are comfortable receiving information about the Project via local leaders (family heads), teachers, religious leaders, representatives of civil society organisations, as well as elected members of parliament. They also suggested that a "SDO" should be put in place by the Project. Since this suggestion was received, the Project has hired and put in place the Social team[8] to liaise with the community on a regular basis.

Stakeholder engagement activities are being / planned to be conducted through the following engagement methods:

- Public hearing
- letters and phone calls;
- notice boards;
- distribution of Project Information Documents (PIDs);
- key informant interviews (KIIs);
- focus group discussions (FGDs) with key stakeholders (including vulnerable);
- Comment forms as part of the grievance mechanism

6.8.2 Proposed stakeholder engagement and disclosure activities

Following is a preliminary stakeholder engagement program that will be fine-tuned on quarterly basis during the construction and operation phases:

6-5: Stakeholders Engagement & Disclosure Activities

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Preparation Phase					
Land required and termination of private wells	o Brief summary about the lands required and potential impacts o Lists of project affected persons (well owners- land owners – well operators)	Three months prior to any land acquisition	PWA	o PAPs o Municipalities o Ministry of Agriculture o Palestinian Land Authority o Awqaf o Ministry of Local Government	o Face to face meetings o Group meetings o Posters to be disclosed on the billboard
Proposed remedial actions and compensation	o Summary of remedial actions o Discussion and negotiation about proposed actions	Three months prior to any land acquisition	PWA	o PAPs o Municipalities o Ministry of Agriculture o Palestinian Land Authority o Awqaf o Ministry of Local Government	o Face to face meetings o Group meetings o Posters to be disclosed on the billboard
Resettlement Timeframe	o Time line of project activities	One month prior to construction activities	PWA and the contractor	o Municipalities and local community people	o Provide a time plan to the municipalities
Job opportunities	o List of available opportunities including duration and application details o Monitoring reports; o Health and safety instructions; o Labour rights	1 month prior to beginning of construction	Social Development Officer in PWA and the contractors	o Young people o Workers unions	o List of available opportunities at SDO office o Posters in the municipalities and PWA premises o Advertisement

Issue	Information & Documents for Disclosure	Disclosure timeframe	Responsibility	Target groups	Communication Channel
Construction Phase					
Job opportunities	o List of available opportunities including duration and application details	3 weeks-1 month prior to beginning of operation	Social Development Officer in PWA and the contractors	o Young people o Workers unions	o List of available opportunities at SDO office o Posters in the municipalities and PWA premises o Advertisement

6.9 Proposed Grievance and Redress Mechanism

Grievances are a problematic issue for the majority of developmental projects. Thus, this section should be handled carefully in order to settle any potential disputes that might rise with the hosting communities. This section will cover the following issues:

1. Responsible entity for implementing the grievances' mechanism
2. Grievances tiers that encourage inclusion of marginalized group (women, poor, illiterate and handicapped groups)
3. Grievances channels that are locally tailored
4. Response to grievances procedures
5. The role of locally based organizations
6. Dissemination of the results of the submitted grievances to the community
7. Monitoring of grievances activities

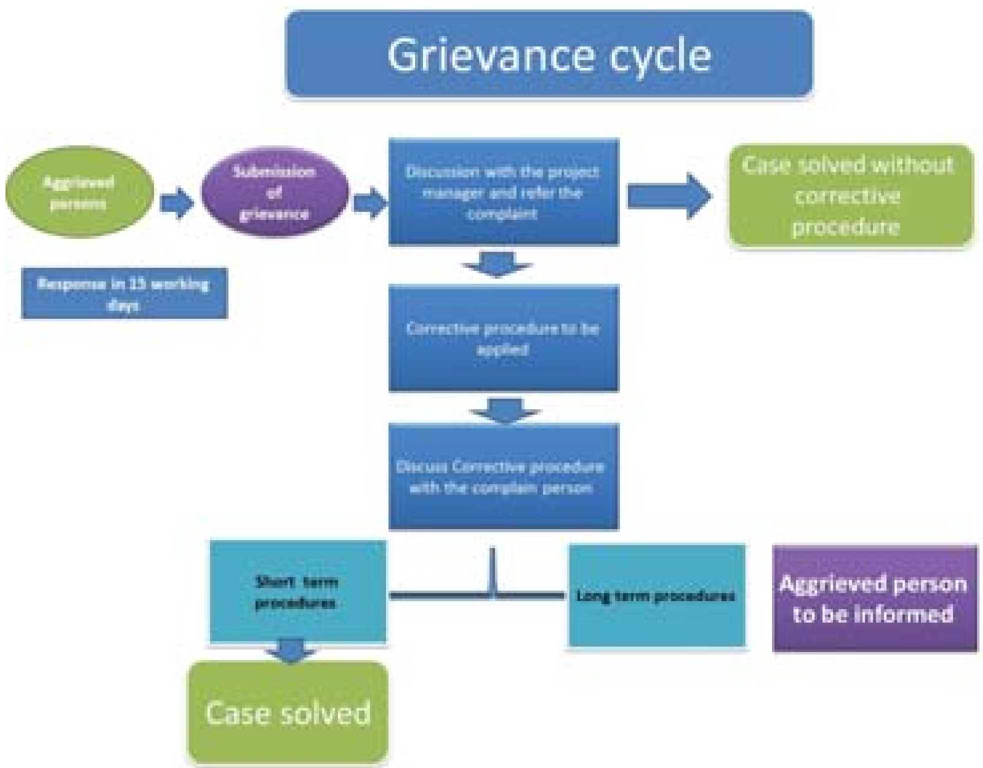


Figure 6-9: Grievance and Redress Mechanism Cycle

Generally speaking, all grievances received verbally or in written shall be documented in a grievance register, handled by the PMU in PWA. It is of ultimate importance to react as quickly as possible to the grievance of the citizens.

A best standard practice is to acknowledge all complaints within 10 days. However, due to the different nature of the complaints, not all can be resolved immediately. In this case medium or long-term corrective actions are required, necessitating a formal procedure, recommended to be implemented within 30 days:

1. The petitioner has to be informed of the proposed corrective measure.
2. In case if a corrective action is not required, the petitioner also has to be informed.
3. Implementation of the corrective measure and its follow up has to be communicated to the complainant and recorded in the grievance register

In order to enable the PWA to implement the grievances mechanism appropriately, a Social Development Officer should be hired and integrated in the PMU

6.9.1 Institutional Responsibility for the Grievances

PMU within the implementing agency (PWA) will be the main entity responsible for handling the grievances. The Social Development Officer (SDO) working within the PWA in cooperation with the municipalities will address all grievances raised by community people, particularly the ones related to resettlement activities. The main tasks of the SDO are:

1. Raise people's awareness about the exact grievances mechanisms
2. Collect the grievances received through different communication channel
3. Document grievances received
4. Direct the grievance to the responsible entities to solve the problem
5. Follow up how the problem was addressed and solved
6. Document, report and disseminate the grievances results
7. Monitoring of grievances activities

- Raising community awareness about the grievance mechanism should be handled as follows: brochures should be developed and sent to the main stakeholders, PAPs, CBOs, municipalities, mosques and churches.
- Documentation of the activities should be handled carefully and thoroughly. A monthly report should be prepared about received grievances, how they were solved and the level of satisfaction of the affected person towards the solution. This report should be published on the website.

6.9.2 Grievances tiers

The World Bank's OP 4.12 advances a "first tier grievance management mechanism", which will be a function of the Project, to provide aggrieved people with an avenue for amicable settlement without necessarily pursuing a court case.

The absence of a first tier grievance mechanism in Palestinian law means there are difficulties addressing minor issues that otherwise should be resolved within a short period of time. The absence of such mechanism denies project affected groups the direct channel for grievance and delays resolution of disputes in an appropriate time prior to resettlement. In order to avoid delay in dispute resolution, it is essential for the government to consider adopting the first tier grievance redress mechanism advanced by the Bank OP 4.12. If need arises, aggrieved people would however remain free to open a Court case without having registered their grievance with this first-tier mechanism.

A grievance is an important process that should be tackled carefully. The PWA receives grievances from the petitioners, and any other channels. According on information collected during the site visits, the Project affected persons showed no knowledge of appropriate channels through which they can submit their grievances. The following procedures will therefore be applied in order to have clear grievance's mechanisms:

First tier of grievances:

1. The PWA will assign a Social Development Officer (might be more than one) who will be responsible of receiving all grievances from all different stakeholders.
2. The SDO will inform the community about grievances mechanism, whom to address to solve the complaints, solution for the problems and document all grievances received. Moreover, the SDO will be responsible for following up the problem until it is solved. The turnaround time for the response /resolution should be 15 days.

Second tier of grievances:

In case of having unsolved complain, the affected person might follow the second level of grievances:

1. A Grievance Mediation Committee should be formed among the municipalities and other entities. It will be responsible for the discussion of the unsolved complains, propose solutions, take decisions and play a mediation role with the affected persons.
2. A regular meeting should be assigned by the Compensation Committee. The complainants can attend these meetings.

6.9.3 Grievances channels

Due to the diversity of the socioeconomic characteristics of the PAPs, the communication channels to receive grievances were locally tailored to address all affected groups. The following are the main channels through which grievances will be received:

1. Hotline (a mobile number for the SDO to be informed to project affected areas).
2. The second channel is through religious institutes in the area (mosque or church)
3. CBOs will be appropriate channel among rural areas
4. Regular meetings with community people to be conducted and applied by the influence stakeholders
5. Website for educated people who have access to the internet
6. Influence people and Mediation Committee

6.9.4 Response to grievances

Response to grievance will be through the following channels

1. The response of the grievance will be through the same channel used to submit the problem. For example, those who sent their grievances in writing should receive their response in written form, those who used the website should receive an email, those who phoned should receive a telephone call from the SDO telling the solution of their problems
2. The second channel is through religious institutes in the area (mosque or church)
3. Response to grievances should be handled in appropriate time frames to communicate to community people feelings of quick and efficient responsiveness to their concerns. This could possible limit the problems arising.

6.9.5 Monitoring of grievances

All grievances activities should be monitored in order to verify the process. Monitoring will be carried out for the following indicators:

1. Number of received grievances monthly (Channel, gender, age, basic economic status of the complainants should be mentioned)
2. Type of grievance received (according to the topic of the complaint)
3. Number of grievances solved
4. Dissemination activities done
5. Satisfaction with solutions
6. Documentation efficiency
7. Efficiency of response to grievance provided

6.9.6 Disclosure of grievances

All grievances activities should be disclosed in the municipalities, CBOs and PWA website. A monthly report should be prepared for the most frequent grievances faced and how they were solved. This report will be disclosed through the PWA website, CBOs, municipalities.

6.9.7 Responsibilities for Monitoring and Reporting

Monitoring and documenting activities to be undertaken by the Social Development Officer in the environmental and social unit are described below:

- reviewing and revising, as needed, the list of stakeholders to ensure that the register is accurate and complete;
- monitoring consultation activities conducted with government representatives and local communities;
- monitoring the effectiveness of the engagement process in managing impacts by tracking feedback received during engagement activities;
- reviewing/auditing the implementation of SEP;
- monitoring and responding to grievances received; and
- Reviewing and revising, as needed, the engagement activities programme to determine if additional activities are required.

All engagement activities are being documented by the E&S Team, in order to review records and track performance.

The E&S will measure the performance of the SEP by documenting and tracking the indicators outlined in Table 7.1 below.

7 MONITORING AND EVALUATION (M&E) OF RAPACTIVITIES

Monitoring and Evaluation (M&E) are key components of the RAP and have the following objectives:

- Monitoring of specific situations or difficulties arising from implementation and of the compliance of implementation with objectives and methods set out in the RAP;
- To verify that project activities have been effectively completed with respect to quantity, quality and timeliness;
- Evaluation of medium and long-term impacts of resettlement on affected households' livelihood, environment, local capacities and economic development.

In carrying out all activities related to monitoring, evaluation and supervision, consideration will be given to the vulnerability issues. The different vulnerable groups referred to above should be consulted during the monitoring process in order to insure that their concerns are handled fairly.

7.1 Internal Monitoring

A wide range of tools could serve for monitoring purposes. The previously mentioned socio-economic survey can serve as a participatory tool for defining monitoring indicators. Moreover, periodic Participatory Rapid Appraisals (PRA) will allow the consulting with the various stakeholders (local government, Local Committees, community leaders and PAPs). These will involve obtaining information, identifying problems and finding solutions through participatory means, which may include key informant interviews, focus group discussions (FGD), community public meetings, structured direct field observation, and in-depth case studies of problems or success stories.

Box 7-1: Guidelines for the Monitoring Indicators

The main indicators that will be monitored regularly are the following:

a) Checking that the **screening activities that have been carried out** in order to determine the need for the preparation of a RAP

b) **Payment of compensation** to PAPs in various categories, according to the compensation policy described in the RAP; with special focus on the vulnerable groups and no discrimination according to gender, tribal backgrounds or any other factor

c) **Delivery of technical assistance**, relocation, payment of subsistence and moving allowances

d) Delivery of **income restoration** and social support entitlements

e) **Public information dissemination** and consultation procedures

f) Adherence to **grievance procedures** and outstanding issues requiring management's attention and equality of access

g) Attention given to **the priorities of PAPs** regarding the options offered

h) Co-ordination and **completion of resettlement activities** and award of civil works contracts

7.2 External Monitoring

In accordance with WB requirements for consultant procurement, an organization for the independent monitoring and evaluation of RAP implementation should be hired. The organization should be specialized in social sciences and experienced in resettlement monitoring. The organization should start its work as soon as the updated RAP has been approved.

The rationale behind hiring an external institution is to ensure that the overall objective of the resettlement plan is achieved in an equitable and transparent manner. In addition to reviewing the issues covered by the internal monitoring progress report, the external agency shall also evaluate and assess:

- The competence and effectiveness of the project implementing agencies
- Adequacy of compensation, development and transitional assistance techniques provided for the PAPs
- Ability to reach the most vulnerable PAPs
- Consultation and public disclosure of the RAP
- Effectiveness of the grievance redresses mechanism

Evaluation, however, is intended to ensure that policies (both Palestinian and the WB's) have been adhered to and provide the feedback needed for adjusting strategic directions. Evaluation, thus, has the following objectives:

- General assessment of the compliance of resettlement activities with the objectives and methods as set out in this RAP
- Assessment of the compliance of resettlement activities with the laws, regulations and safeguard policies cited above
- Assessment of resettlement and relocation procedures as they have been implemented

- Evaluation of the impact resettlement and relocation has on incomes and standard of living, with the focus on the poor and the most vulnerable
- Identification of actions to improve the positive impacts of the program and mitigate its possible negative impacts

The evaluation of resettlement activities will be part of general assessment and review activities undertaken for the project as a whole.

8 BUDGET AND TIME PLAN

8.1 Budget

Budget estimation in NGESTP project is not a straightforward task due to several reasons including the following:
PLA provides alternative lands and assets, rather than money compensations owing to their limited monetary resources. As previously explained, the Palestinian Land Authority is challenged by a lack of financial resources, limiting its ability to cover the high costs. The situation is no better in the Ministry of Finance, as the current political situation causes significant shortage in the government's financial resources. The intention is therefore, to exchange the expropriated land with other governmental land. This process is to be coordinated with the Palestinian Land Authority and through the Ministry of Local Governance.

With regards to well compensation, provision of water and municipality water of law cost is one of the most practical scenarios that will be applied. Consequently, estimating budget for project compensation activities will not be realistic. However, two major issues will necessitate a certain figure to be presented under the budget, they are as follow:

- The proposed budget allocated for monitoring and evaluation activities will be about 15000$
- The capacity building activities will be about 21000$

8.2 Time plan

The second phase of the NGESTP includes the establishment of 14 recovery wells, and termination of 12 wells, as well as a portion of the water system and will cover an area of 5,000 agricultural dunums. It is expected to start work at this stage by the end of 2018 for a period ranging from 12 to 15 months.

.

Table 8-1: Tentative time plan

	Activities	Year 2019	1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun	1-Jul	1-Aug	1-Sep	1-Oct	1-Nov	1-Dec	1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun
During the preparation phase																				
a-1	Consulting with the governorate and the municipality																			
a-2	Agriculture directorate developed the price lists of crops and trees																			
a-3	Conducting the RAP inventory																			
a-4	Formation of the GRM																			
a-5	Consultation with the PAPs																			
a-6	Capacity building to the SDOs																			
During the resettlement implementation																				
b-1	Consultation with the PAPs																			
b-2	Compenation delivered to the PAPs																			
b-3	Documentation of the compensation activities																			
b-4	Documentation of Grievances recipients and responses																			
b-5	Documentation of operation and efficiency assessment of the RAP																			
During Monitoring and evaluation																				
c-1	Quarterly reports to be developed																			
c-2	Evaluation activities Mid-term evaluation Final impact																			