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Output 6

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المدينة - استشاريون في الإدارة البيئية والتخطيط العمراني



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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/m³ 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/m³, 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 transitional 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.

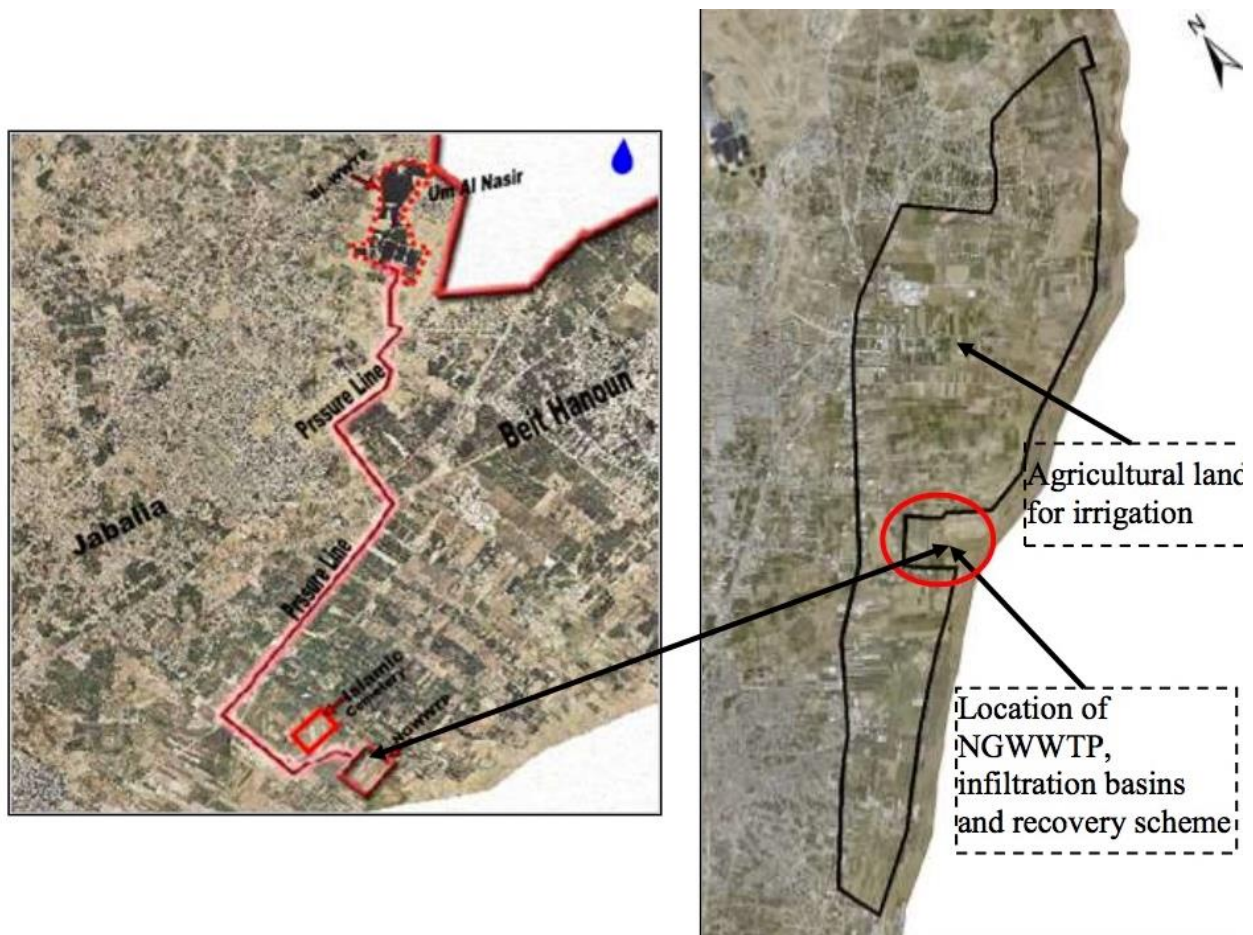


Figure 1: Main components of the NGEST project

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 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.

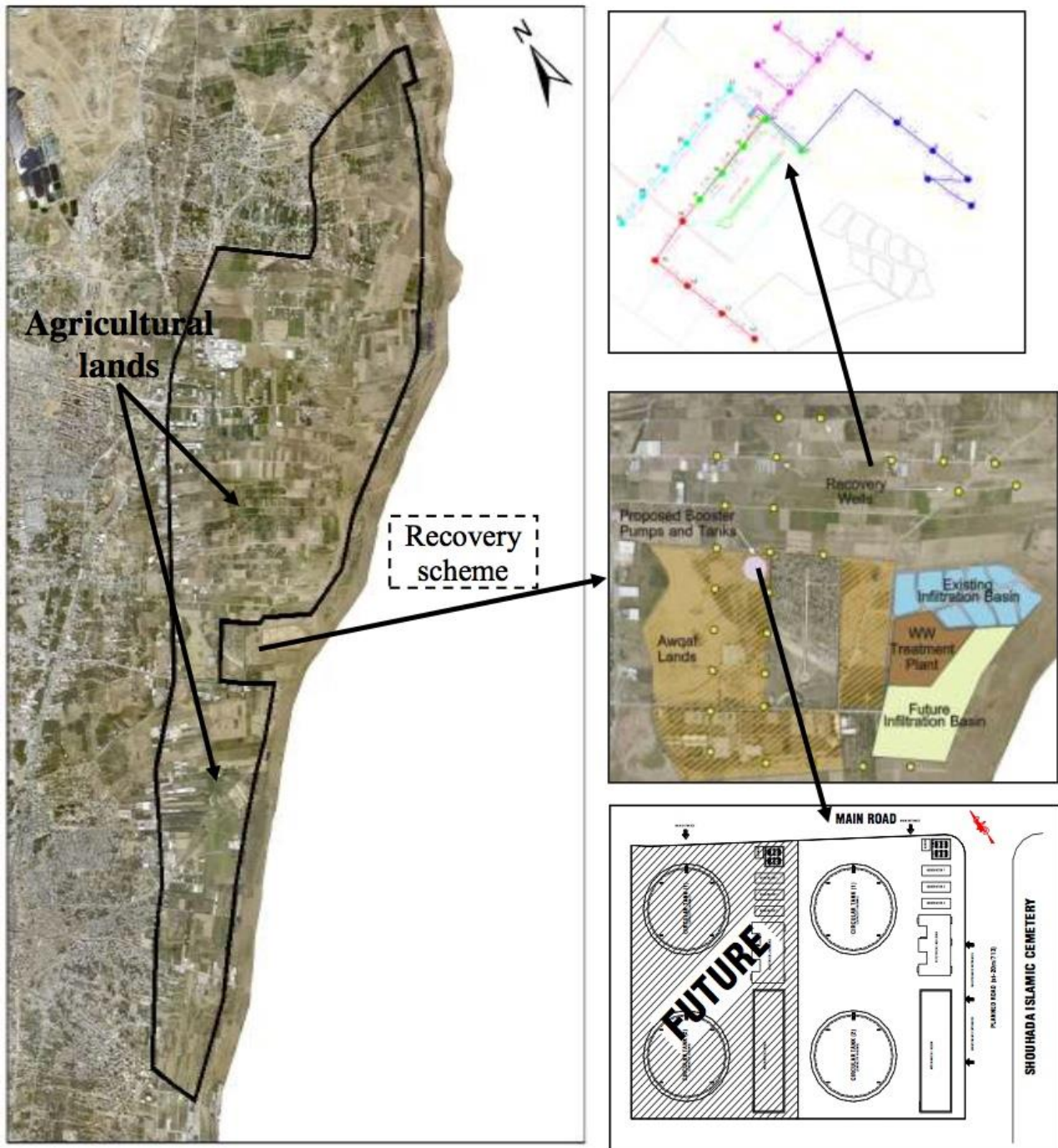


Figure 2: The proposed irrigation Project (figure on the left), NGWWTP and existing and future Infiltration basins (figure on the center right), recovery wells (figure on the top right) and storage tanks for all phases of the project (figure on the bottom right)

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 m³ 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:

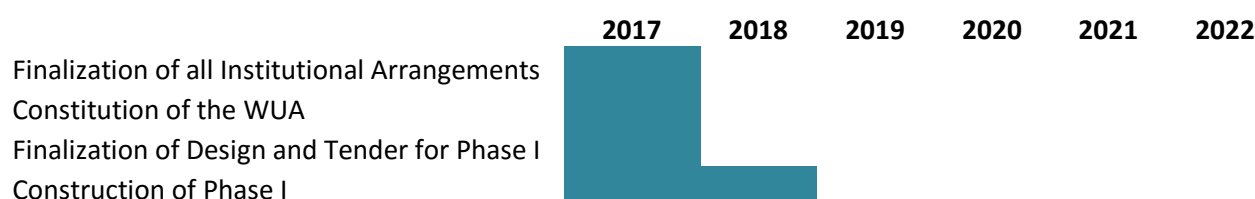
- Develop an irrigation project that assists local farmers to improve profitability and increase the value chain linked to agriculture;
- Test and promote MAR in Palestine;
- Improving groundwater health through introduction of higher quality water, and achieving more sustainable extraction practices;
- Promote the role of WUAs in managing and operating larger irrigation projects.

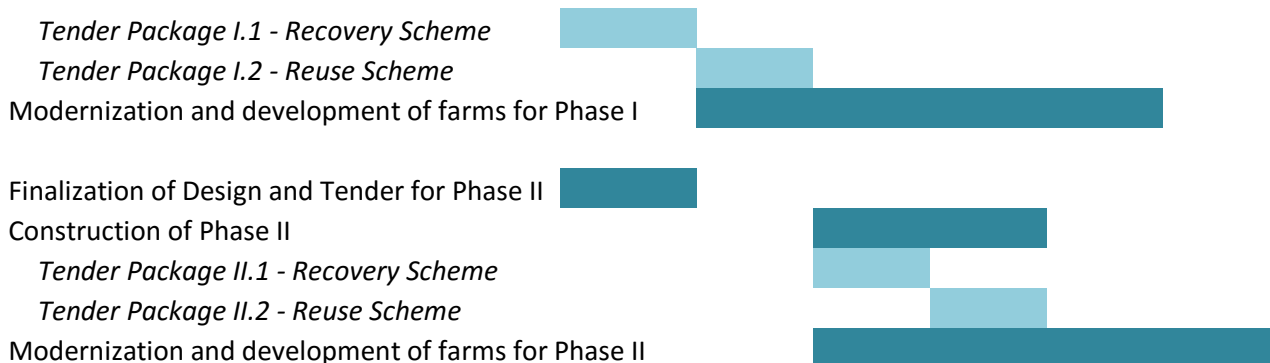
PROJECT COMPONENTS

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 m³/day of treated water by the year 2015 and the full 69,000 m³/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 m³/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 m³ 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 m³/day (necessary to recover the 35,600 m³/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 m³/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 transitional 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 modifications.
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.

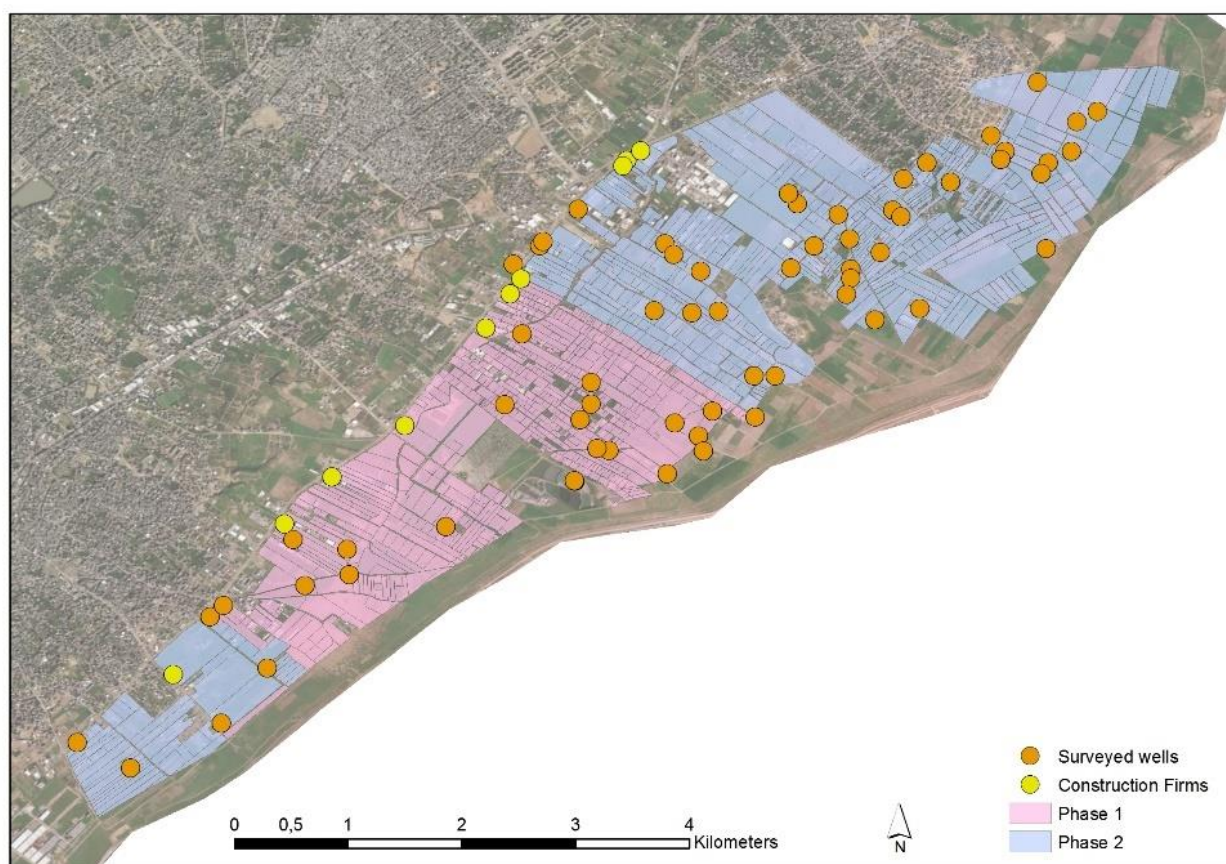


Figure 3: spatial location field survey

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%.

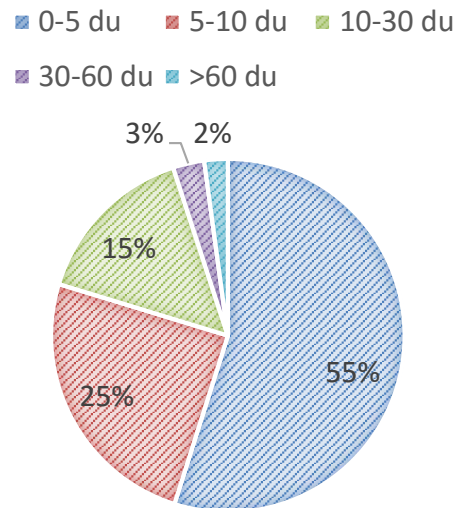


Figure 4. Distribution of farms by size.

CROPPING SYSTEM

The cropping pattern of the project area is shown in the following Figure 5.

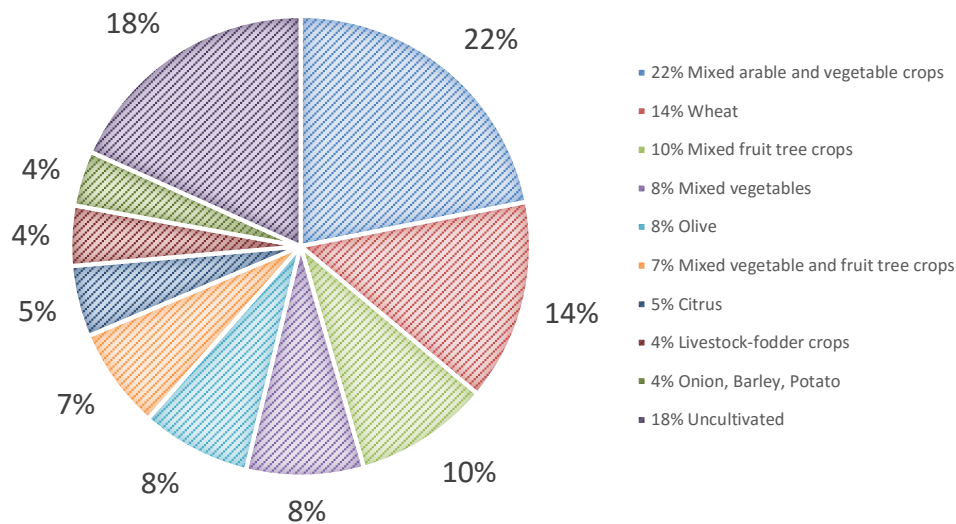


Figure 5: Indicative cropping pattern of the project area

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).

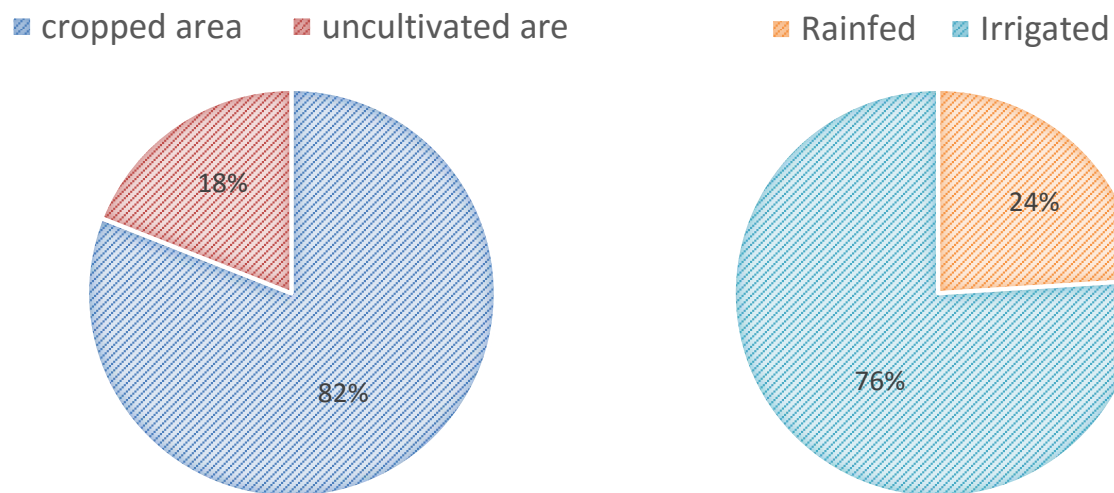


Figure 6. Cropped and Uncultivated Area

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 ranges² from 1 to 1.5 ILS/m³. 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 field survey, farmers provided the following rationale for their stated value for cost of water: a well's pump consumes 10 to 12 liters of diesel per hour to extract 40 to 60 m³/hours at an average depth of 60 to 70 meters. The cost of diesel, on average, is between 6 and 7 ILS/liter. For that reason, the cost of water ranges from a minimum of from 1 to a maximum of 2.1 ILS/m³. On average, it is therefore approximately 1.5 ILS/m³ 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.

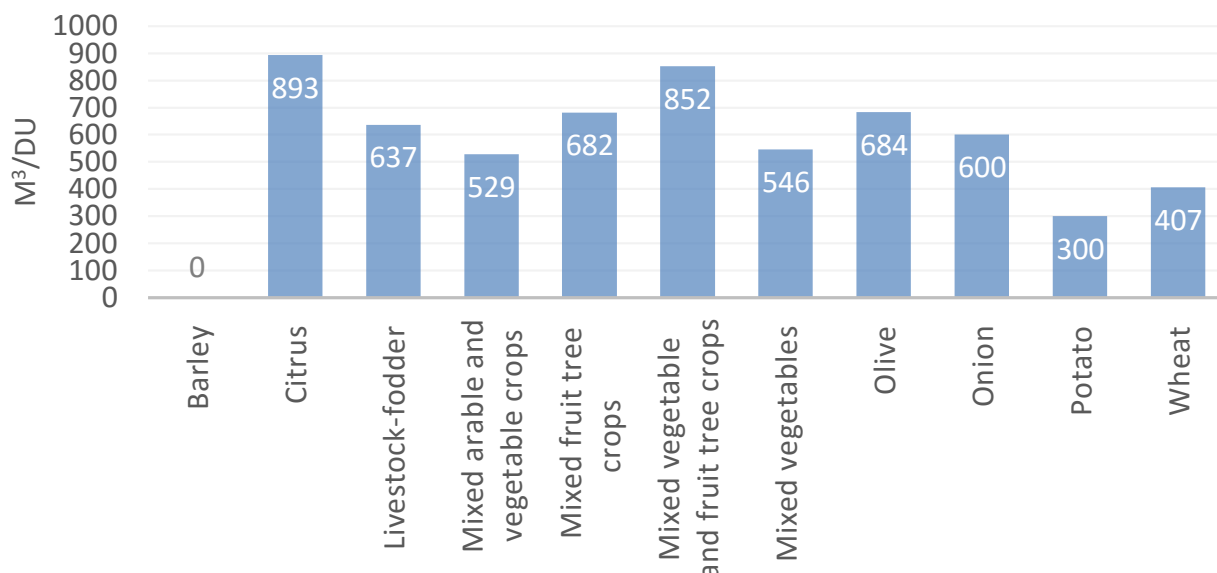


Figure 8. Water use for the current cropping pattern.

Citrus and mixed vegetables with fruit are the most irrigated crops (893 and 852 m³/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 Mm³/year** with an **average daily water requirement of 15,990 m³/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 m³ of water per year on average, and their combined consumption is less than 30,000 m³ 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 km². 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.

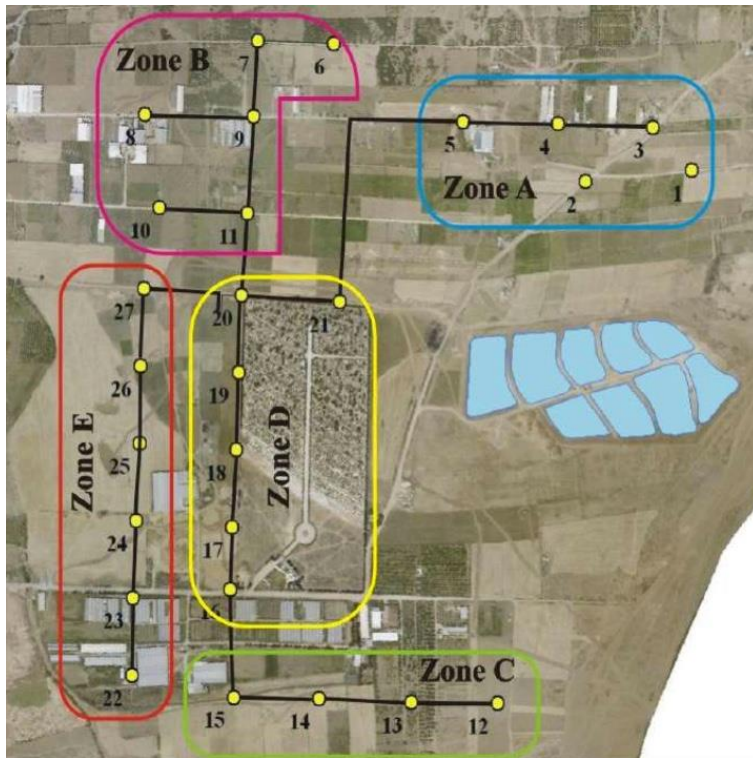


Figure 9: Location of the 27 Recovery Wells

The recovery wells will be able to capture water infiltrated from the NGEST WWTP (i.e.: 35,600 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.

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.

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

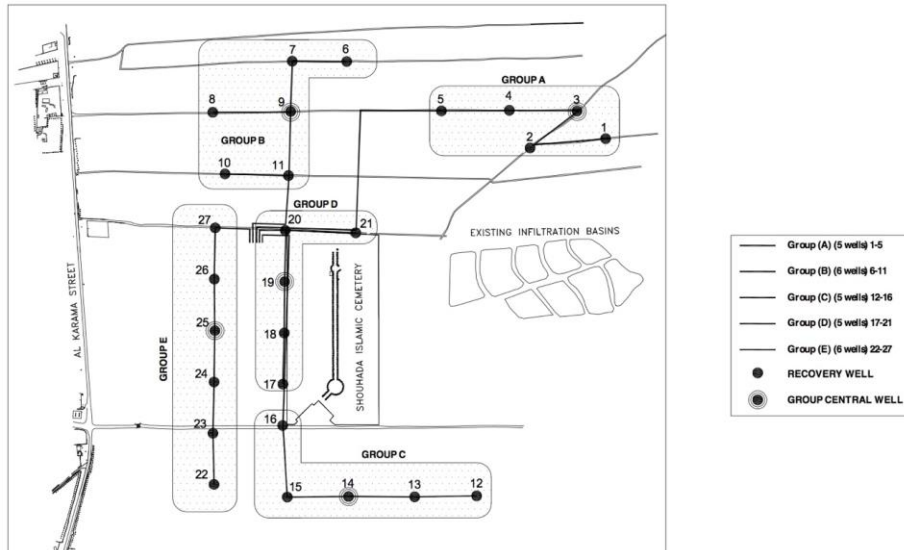


Figure 10: Wells grouping and Piping System

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.

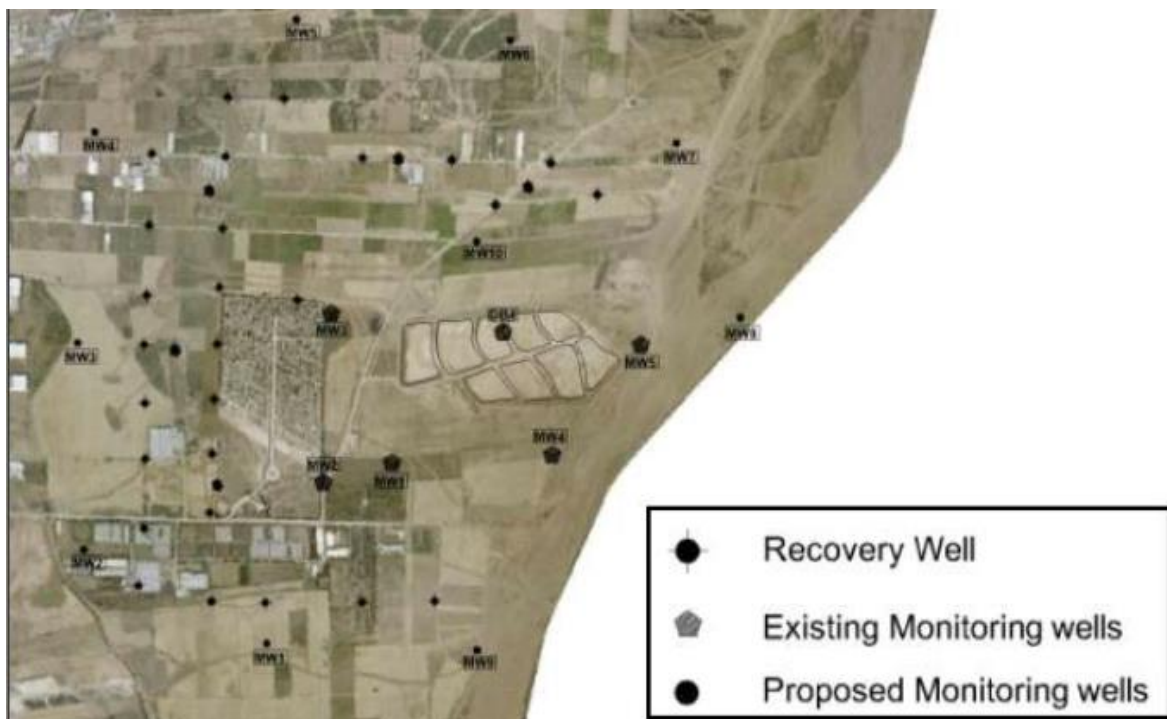


Figure 11: Location of the existing and newly proposed monitoring wells

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

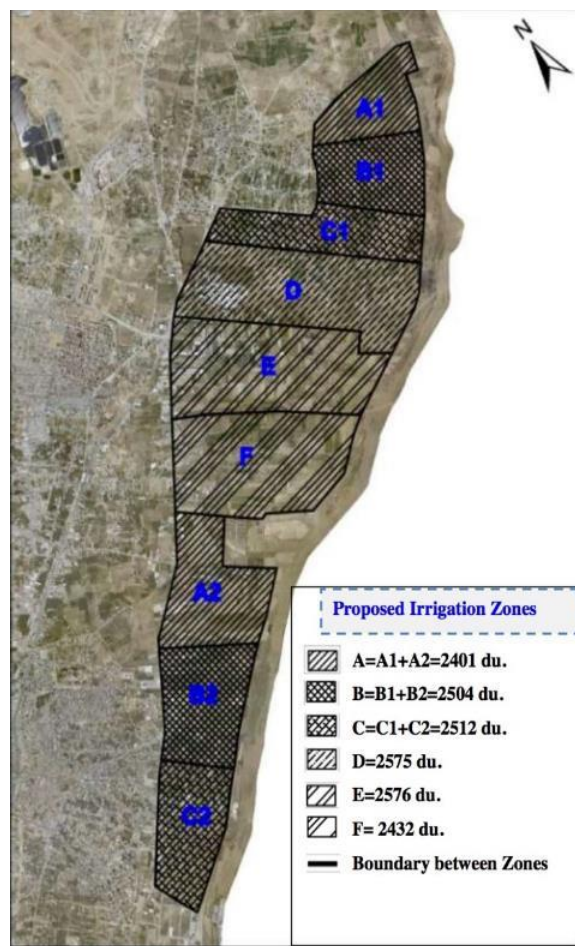


Figure 13: Proposed Irrigation Zones

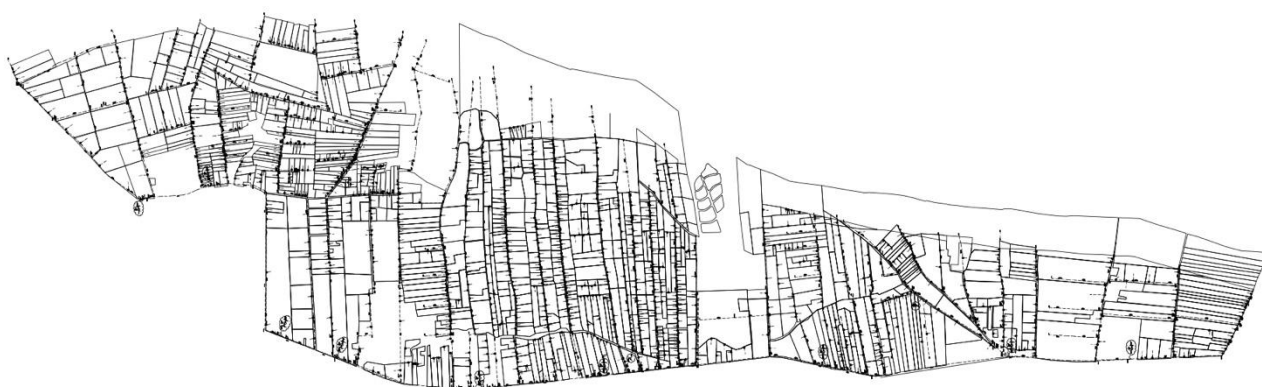


Figure 14: General Layout of the Originally Proposed Irrigation Network

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 throughout 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 m³/year) but including all system losses⁴ and climate change⁵, is estimated to be 11,110,000 m³/year. The net irrigation water requirements (after all system losses are considered), is estimated to be 7,833,484 m³. 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/m³ 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/m³ 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								

DISTRIBUTION OF CROPS OVER LAND [DU] OVER TIME [YEARS]

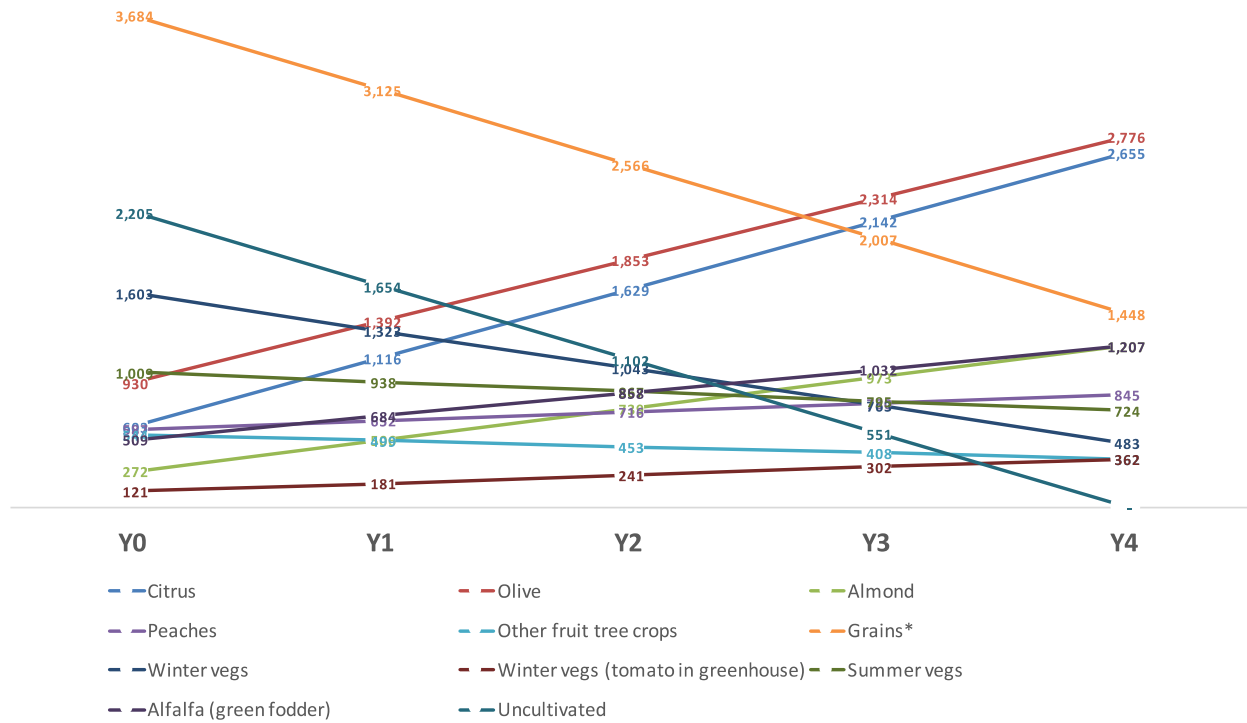


Figure 15: Evolution of the cropping pattern over land [du] over time [years]

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	MACHINE RY	INPU TS	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	37,500		492				37,992
GREENHOUSE)										
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/m³.

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/m³ if energy is provided entirely by the diesel generators, 1.188 ILS/m³ if energy is provided 50% by the national grid and 50% by the diesel generators and 0.916 ILS/m³ 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 M³/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/m³ and of 2.49 ILS/m³.

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		OLIV E	CITRU S	PEACHE S	GRAI N	OTHE R FRUIT CROP	SUMMER VEGETABL E	WINTER VEGETABLE S	WINTER GREENHOUSE S	ALMON D	ALPH A ALPH A
WATER ILS/M³	TARIFF	1.00	1.63	2.49	-0.89	1.76	3.31	6.56	42.51	0.90	1.14

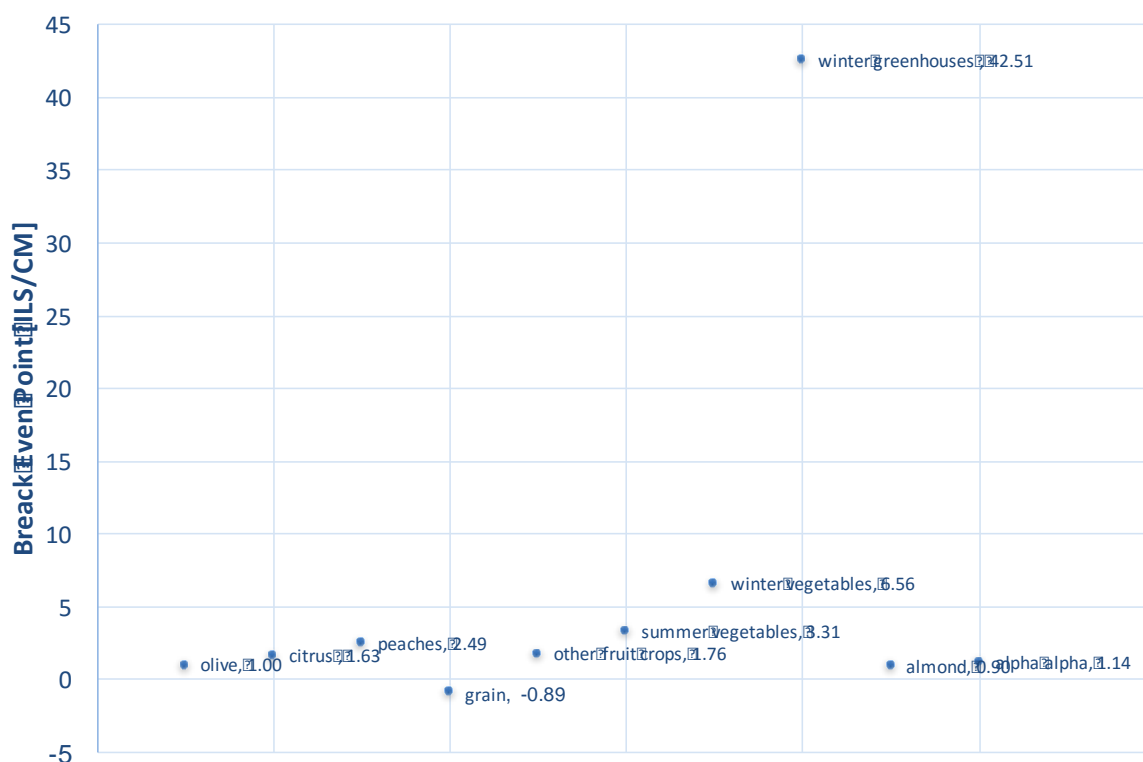


Figure 16: Water tariff that involve zero net margin

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
<i>FROM THE GRID (50%)</i>	\$537,030	\$179,010	\$358,020
<i>FROM THE DIESEL GENERATORS (50%)</i>	\$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/M³)	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
<i>FROM THE GRID (0%)</i>	\$0	\$0	\$0
<i>FROM THE DIESEL GENERATORS (100%)</i>	\$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/M³)	1.461		

Other costs that are included in this CBA are the water tariff, assumed to be 1.461 ILS/m³, 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/m³ per 70,000 m³ /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/m³ (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

Scenario	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
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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).

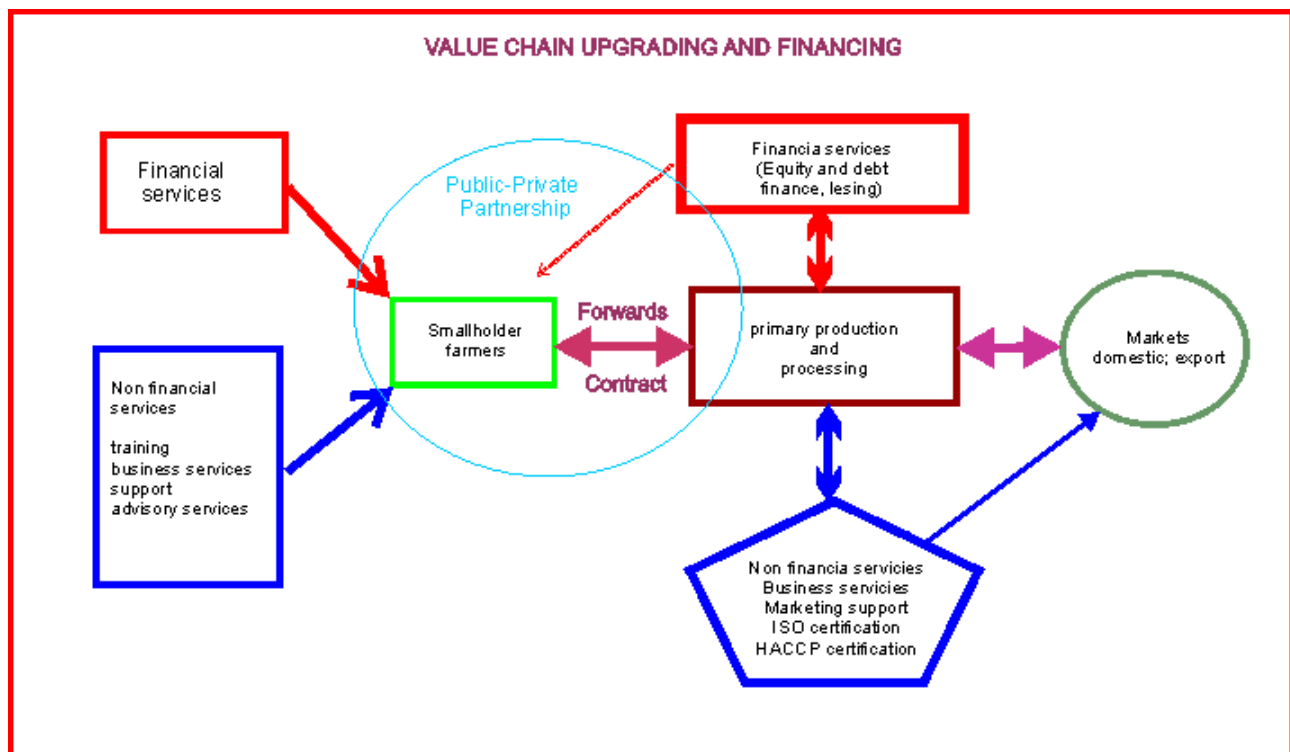
Farmers will need to have access to a banking system and most of them do not have enough income or capital to finance investment in farms or parts of the project, so it is necessary to provide them with support tools.

- 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:

Financial services 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.

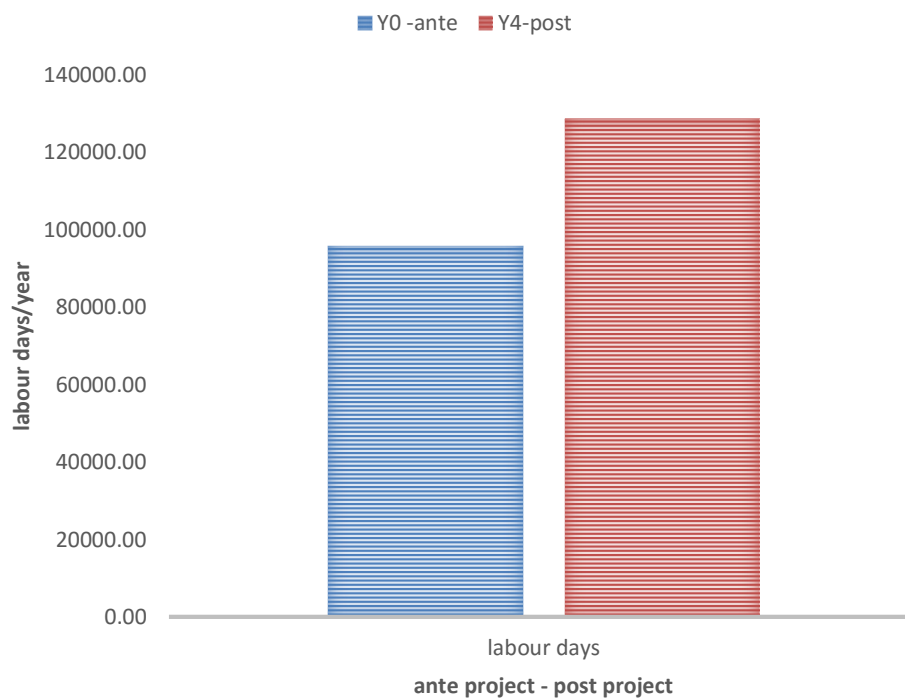


Figure 17: Job created per year before and after the project is implemented

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 m³ 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/m³. 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 organization⁷ 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.

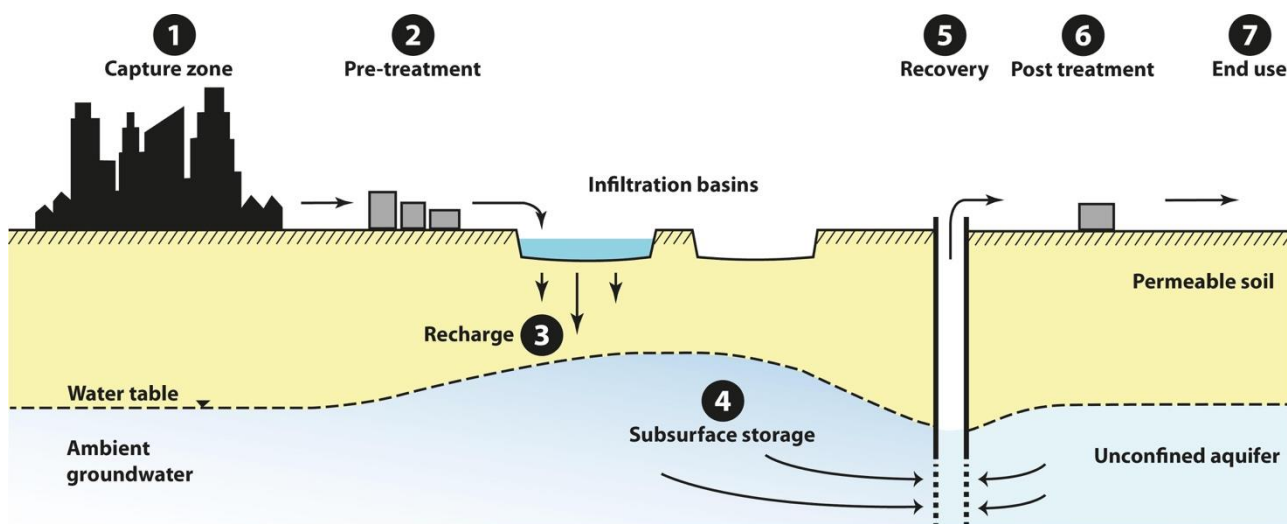


Figure 18: Schematization of Managed Aquifer Recharge System (Source: Dillon, 2009)

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, Ickson-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.

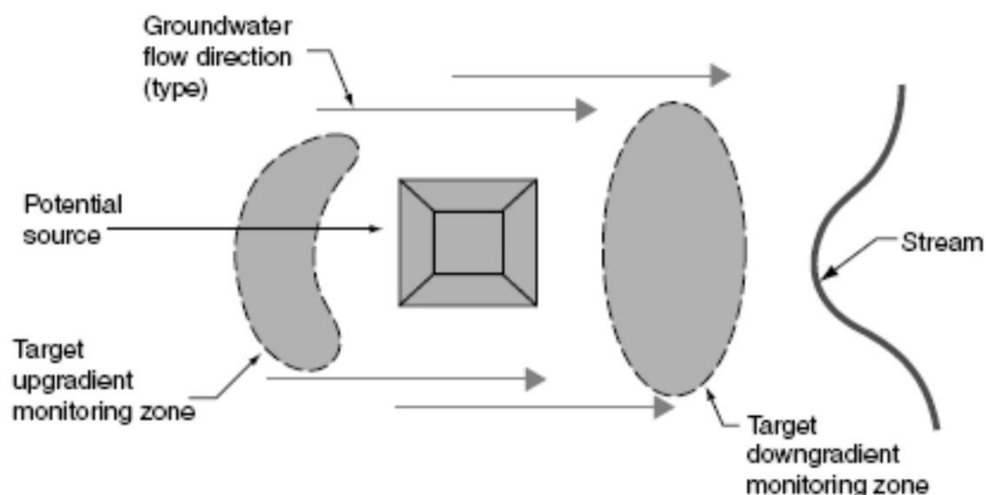


Figure 19: Plan view of typical unconfined aquifer groundwater monitoring system

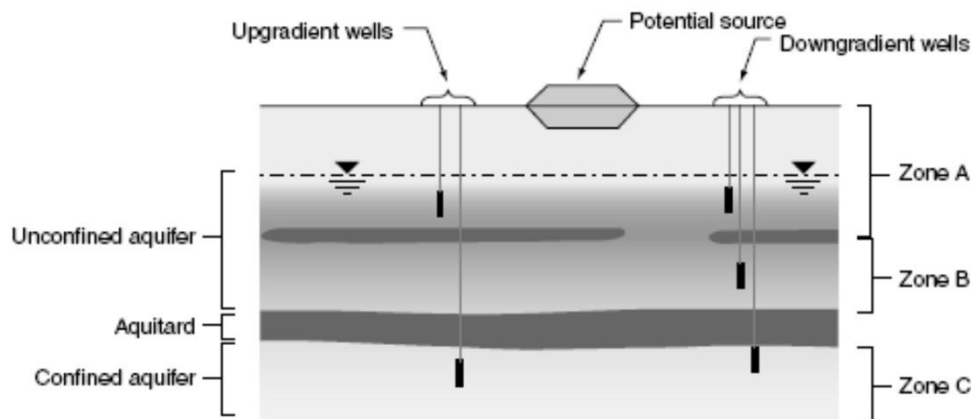


Figure 20: Vertical cross section of target monitoring zones.

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.

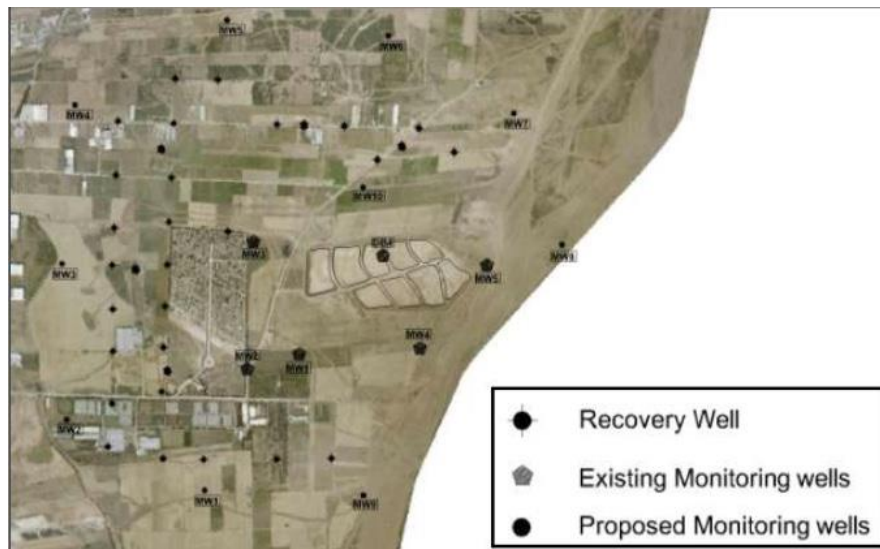


Figure 21: Monitoring wells location

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 as 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
NO₃	Four Times a year
NO₂	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
O₂	Four Times a year
NITROGEN AND OXYGEN ISOTOPES	Four Times a year

MG	Four Times a year
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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°C in summer and 13°C in winter with maximum daily temperature can reach 29-30°C and the minimum temperature is around 9°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 BLWWTP, 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 unloading 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 outweigh 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 be 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.

ANNEX 4: PROJECT OPERATION AND FINANCE MANUAL

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					65.77

Table 26: Balance sheet for Olive

Olive	Revenues	Q.ty/kg/du	NIS/kg	NIS/dun	Margin
olive oil 50%		45.00	16.00		
table olive 5%		300.00	4.00	1,200.00	
	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					4.65

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					80.53

Table 28: Balance sheet for Grains

Grains	Revenues	Q.ty/kg/du	NIS/kg	NIS/dun	Margin
		1,150.00	2.50	2,875.00	
	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 1/5")	ml	1400.00	0.70	980.00	
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				2,415.65	-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
		50.00	35.35	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 (1/5")	ml	800.00	0.70	560.00	
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	Revenues	Q.ty/kg/du	NIS/kg	NIS/dun	Margin
		1,000.00	1.30	1,300.00	
	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 (1/5")	ml	800.00	0.70	560.00	
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	Revenues	Q.ty/kg/du	NIS/kg	NIS/dun	Margin
		1,000.00	1.50	1,500.00	
	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	160.00	
Depreciation of greenhouse	mq	750.00	50.00	37,500.00	*20 year
TOTAL				39,682.70	5,817.30
Labour & Enterprise					39,017.30

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	1,180.00	duration yrs	25.00	187.20	
TOTAL				1,810.65	-370.65
Labour & Enterprise					-150.65

Table 34: Balance sheet for Alpha-Alpha

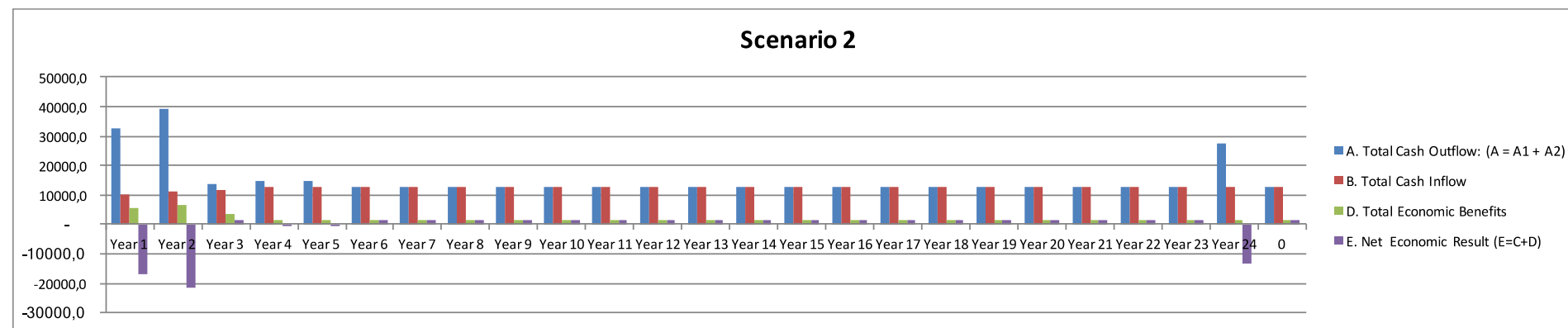
alpha-alpha	Revenues	Q.ty/kg/du	NIS/kg	NIS/dun	Margin
		4,500.00	0.35	1,575.00	
	Costs	Q.ty/du	NIS/unit.	NIS/dun	
Tillage	n.	0.00	100.00		
Chemical Fertilizers	kg.	0.00	5.00		
Organic Fertilizers	kg.	0.00	0.50		
Soil Disinfection	kg.				
Plant Protection	kg.	0.00	25.00		
irrigation	m3	878.50	1.50	1,317.75	
Harvesting Labour	dd	6.00	40.00	240.00	
Harvesting machinery	h				
Depreciation of the plant	1,360.00	duration yrs	4.00	140.00	
TOTAL				1,897.75	-322.75
Labour & Enterprise					-182.75

SCENARIO 1 – FULL COST/SOLUTION 1

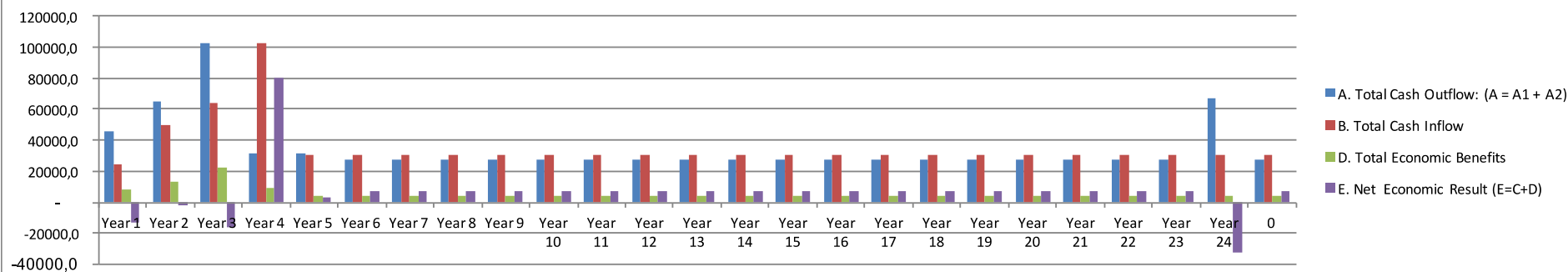
Scenario 1



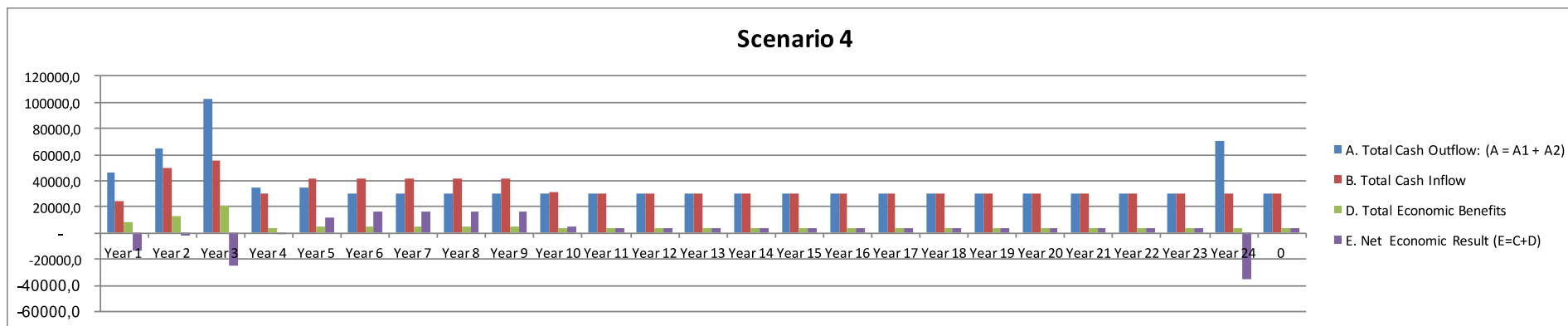
SCENARIO 2 – FULL COST/SOLUTION 2

[illegible]

SCENARIO 3: CAPITAL SUBSIDIES

[illegible]

SCENARIO 4 - CAPITAL AND O&M SUBSIDIES/SOLUTION 1

[illegible]

SCENARIO 5 - CAPITAL AND O&M SUBSIDIES/SOLUTION 2

[illegible]