WP3. ACTIONS TO INCREASE THE QUALITY OF NON CONVENTIONAL WATER USED IN AGRICULTURE

Output 3.4. No. of pre and post-treatment and MAR systems realized.

A 3.4.2 Implementation of pre and post-treatments on non-conventional water. Beit Dajan WWTP, occupied Palestine

Responsible partner: WE WORLD

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ABBREVIATIONS AND ACRONYMS

Acronym	Description
BOD	Biological Oxygen Demand
BoQ	Bill of Quantities
CENTA	Fundación Pública Andaluza Centro de las Nuevas Technologies del Agua
COD	Chemical Oxygen Demand
DN	Diameter Nominal
DO	Dissolved Oxygen
FOG	Fat, Oil and Grease
MAR	Managed Aquifer Recharge
TDS	Total Dissolved Solids
TWW	Treated Wastewater
WP	Work Package
WWTP	Wastewater Treatment Plant

1. BACKGROUND

This technical report has been written in the context of the third Work Package (WP3) of the MENAWARA project on *Non-conventional Water Re-use in Agriculture in Mediterranean countries* and more specifically for **Output 3. 4 "Number of pre and post treatment and Managed Aquifer Recharge systems realized"** and **Activity 3.4.2 "Implementation of pre and post-treatments on non-conventional water"** as described in infographic below (Figure 1).

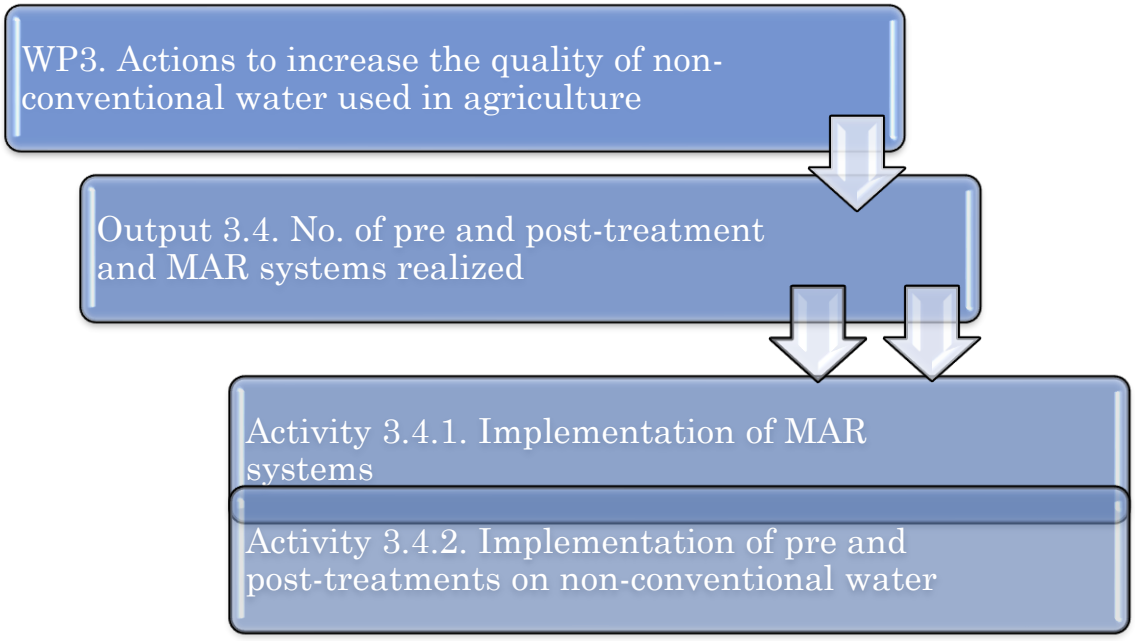

Figure 1. Infographic on the context of this technical report. MAR: Managed Aquifer Recharge.

This is the third technical report for the intervention in Beit Dajan Wastewater Treatment Plant (WWTP), after the technical report written for the minor interventions (Activity 3.2.1) of November 2022 and the preliminary report written on the design of these minor and major interventions by the Spanish Fundación Pública Andaluza Centro de las Nuevas Technologies del Agua (CENTA) of July 2020.

More specifically the output 3.4 is described as follows: "Low-cost pre and post-treatments for each WWTP in the intervention areas realized and high quality TWW supplied to irrigation distribution networks adopting more rational irrigation techniques compared to the pre-project situation. MAR

systems (FIA) realized in Arborea by using improved non-conventional water to recharge the phreatic sandy aquifer exploited for agricultural purposes"

This document details the technical aspects of the major intervention realised on the WWTP site of Beit Dajan in occupied Palestine, under this output 3.4 over the period of June 2021 and August 2023 as part of Activity 3.4.2 "Implementation of the post-treatment on non-conventional water" and complimentary to Activity 3.2.1 "Minor interventions on waste water treatment plants to improve efficiency" under output 3.2 "Efficient infrastructures and technical reports".

Before the start of the interventions in Beit Dajan WWTP, several field visits and technical meetings were performed to verify the technical needs to support CENTA in elaborating the technical design for the improvement of the performance of the WWTP. During the implementation, due to unforeseen circumstances and budget changes, some interventions were adapted from those drafted by CENTA in the preliminary technical report. The technical needs were split into two interventions, a major and minor one:

- The minor intervention included the installation of: i) two new submersible pumps in the influent pumping station, ii) electromagnetic flow meters, iii) a Dissolved Oxygen (DO) meter and iv) a new cover for the effluent tank. Minor intervention are discussed into details in the report "Technical Report: Minor intervention in Beit Dajan WWTP, occupied Palestine";
- The major intervention consisted of: i) the replacement of the pre-treatment unit or compact system, ii) the installation of pressure sand filters, iii) the installation of an equalization or buffer tank and iv) the replacement and relocation of the aeration mixers.

The document is structured considering as follows:

1. A general introduction of the area of intervention (Section 2);
2. A general overview of the WWTP design (Section 3) after the implementation of both the minor and major intervention;
3. Detail of the major intervention, its technical specifications and pictures from the field (Section 4) and;
4. Concluding remarks (Section 5).

2. AREA OF INTERVENTION

Beit Dajan is a Palestinian village in the Nablus Governorate in the North Central West Bank as shown in Figure 2. The village's population is around 5000 people with 85% of households connected to the sewer network. The WWTP is located at the eastern edge of Beit Dajan village and has a daily wastewater production around 250-350 m3 /d. The treated wastewater (TWW) is used to irrigate surrounding agricultural lands, which are cultivated with olives, almonds, alfalfa, grapes and lemons.

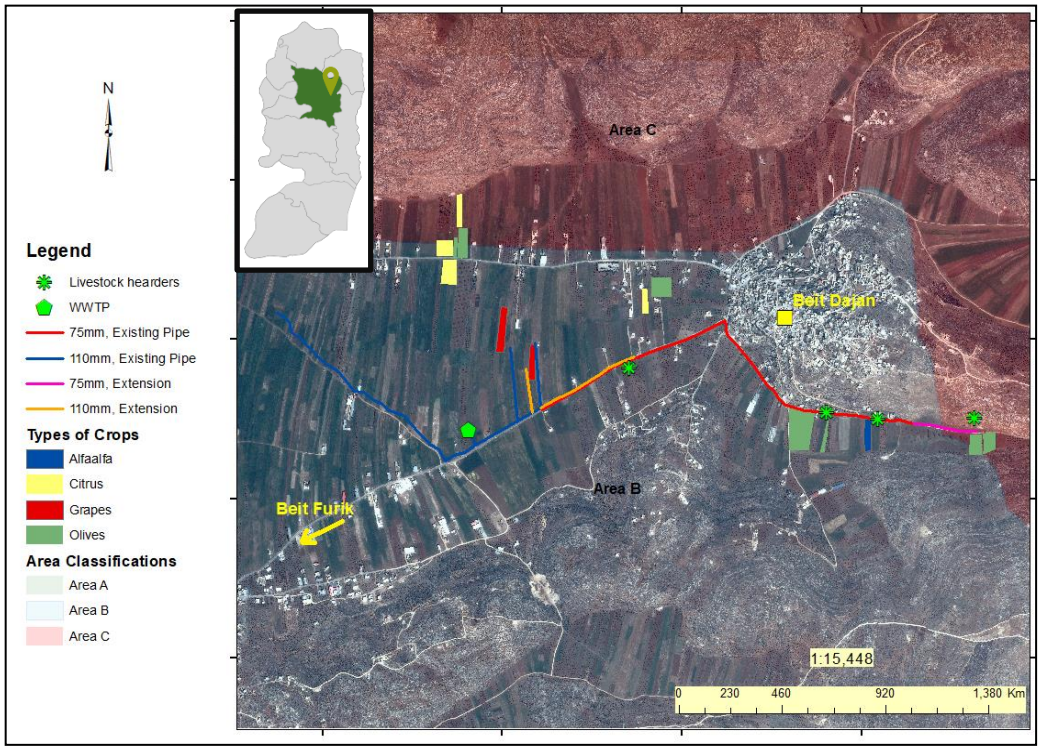

Figure 2. Map to illustrate location of Beit Dajan Village, its wastewater treatment plant (WWTP), the main pipelines of the installed irrigation network and the plots irrigated with treated wastewater (TWW).

3. Beit Dajan WWTP design

The wastewater treatment process of the WWTP of Beit Dajan from the point of entry to the pumping to the irrigation network namely is shown in Figure 3 after the implementation of the minor and major intervention under MENAWARA. After passing through a screen to remove the coarse solids the water is collected in a tank or collection unit and then is pumped to a pre-treatment unit to remove the grit and sand (part of the Total Suspended Solids or TSS) and fats, oils and grease (FOG). Then, the water goes to the aeration tank, then to the secondary 'clarifier' and into an equalization tank in order to remove mainly the organic load, ammonium and phosphorus. From there the water is pumped to sand filters to mainly further reduce the TSS load. Finally, after passing through the chlorination unit the water is collected in an effluent tank with a 500,000 L storage capacity. From there it is ready to be distributed to the irrigation network.

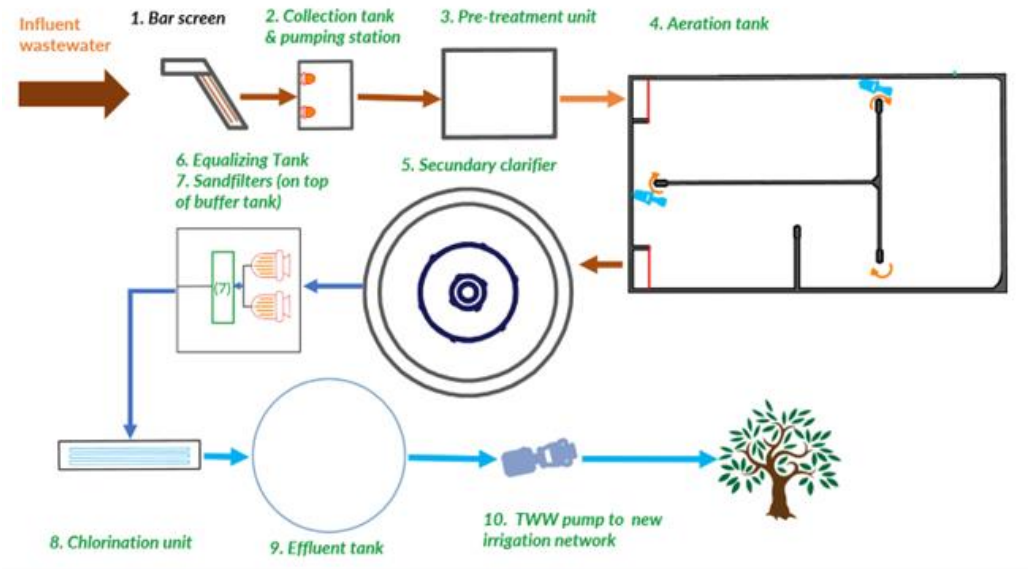

Figure 3. Schematic representation of WWTP of Beit Dajan. Green coloured items indicate rehabilitated or newly constructed assets by the MENAWARA minor and major intervention.

4. Beit Dajan WWTP technical specifications

This section presents the technical specifications of the installed items and performed work included in the major interventions. The full Bill of Quantities (BoQs) of the major intervention submitted for procurement can be found in Appendix 1. All meters and pumps were fully wired, calibrated and verified in operations.

4.1. Replacement of the pre-treatment compact system

The treatment objective of the pre-treatment is to remove mechanically coarse solids such as debris and sand as well as grease and other floating material. The previous pre-treatment compact unit installed at the site was not functioning since a few years most likely due to lack of cleaning and maintenance absence of automated washing system. The newly installed unit in June 2022 is more performing than the previous model and has an integrated washing system. It consists of 2 parts:

1. Screw filter (including the integrated washing system) to remove and compact coarse suspended solids with diameter greater than the 3 mm mesh of the screen.
2. Sandblasting and oil flotation section to remove finer solids such as sand particles and fats, oil and greases with continuous extraction.

In conclusion, the installation of this pre-treatment aimed at significantly reducing the Total Suspended Solids (TSS) and Fat, oil and greases (FOG) in the wastewater. Table 1 shows the technical specifications of the installed unit. The BoQ for the unit can be found in Appendix 1 and the detailed specifications in Appendix 2.

Table 1. Specifications of the installed pre-treatment compact system for waste water with 500 ppm and sand content of 5% at Beit Dajan WWTP, occupied Palestine.

Item	Specification
General	
Feed wastewater type	Municipal
Maximum inlet flow	46.8 m3/h
Sedimentation	>95% of target particles
Usable volume of tank	2.23 m3
Usable tank surface	1.10 m2
Air consumption	8 Nm3/h 0.2 bar max 0.5 bar
Extraction of FOG	Up to 70%
Screw filter with compaction module	
Filtration spacing	3 mm
Solid extraction capacity	0.18l/s
Solid compaction	30-40%
Integrated filter washing device	Included
Integrated washing device for compaction	Included

area	
Level probe for control of wastewater level inside the screw filter module	Included
Installed Power	1.1Kw
Horizontal bottom auger for the transport of settled sand	
Nominal diameter of coil	DN200
External coil diameter	Diameter 185 mm
Rotation speed	5 rpm
Installed power	0.55 kW
Inclined screw for extraction of sand	
Nominal diameter of coil	DN150
External coil diameter	Diameter 168 mm
Rotation speed	21.5 rpm
Sand extraction capacity	0.14l/s
Installed power	0.55 kW
Floating extraction system with floating auger	
Drain pipe diameter	DN150
Extraction of oils, fats and supernatants	1400l/h
Installed power	0.55 kW
Overflow device on auger filter box	
Overflow device to discharge excess waste in case of supercharging	Included
Blower for air supply	
Blower for air supply	Included
Installed Power	0.4 kW
Pump relaunching floating material	
Type	Volumetric pump
Flow rate	1-25m3/h
Material	Carbon steel

All waste material (FOG, coarse solids and sand) are collected on site in black plastic containers with interior bags. Figure 4 shows the installation of the pre-treatment unit in June 2022.

Figure 4. Installation of the pre-treatment unit at the Beit Dajan WWTP on the 7th of June 2022.

4.2 REPLACEMENT OF THE AERATION MIXERS

The old mixer in the aeration tank was dysfunctional and in need of replacement. It is an essential part of the rehabilitation of the WWTP. Having mixing in the aeration tank is important to ensure that both food (organic matter, nitrogen (N) and phosphorus (P)) and Oxygen reaches the microorganisms in the sludge so that organic pollution measured through Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) can be reduced. The submersible mixer was installed at the start of 2022 as shown in Figure 5 and Table 2 presents the summarized specifications of the mixers. The detailed BoQ and technical specifications are shown in Appendix 1 and 3. As the mixer is an essential part, a back-up spare mixer was supplied to the Village Council of Beit Dajan in case of breakdown of the first one.

Table 2. Specifications of submersible mixer in aeration tank installed at Beit Dajan WWTP.

Item	Specification
Type	Compact Submersible Mixer
Motor rated power	1.5 kW
Motor speed	958 tours per min
Motor efficiency	81.4%
Weight	62 kg

Figure 5. New installed submersible mixer in the aeration tank at Beit Dajan WWTP.

4.3 CONSTRUCTION OF THE EQUALIZATION TANK

An equalization tank was added to the design and installed to buffer the effluent flow and generate more stable effluent quality for the farmers. Initially, it was suggested that the tank would be a pre-fabricated tank, however it was finally opted for a concrete buffer tank for financial and space constraints. The tank was constructed in February 2022.

Table 3 gives the specifications of the equalization tank and Figure 6 shows the construction phase of the tank. The detailed BoQ can be found in the Appendix 1 including the excavation works performed and Appendix 4 shows the detailed drawings of the tank.

Table 3. Technical specifications of the installed equalization tank.

Item	Specification
Material	Reinforced Concrete
Total Volume	65 m^3
Dimensions	Internal dimensions: 4,5 m width x 4,5m length x 3.2 m height
Slab	Reinforced concrete (20 m^2)
Base	Compacted base coarse layer (40 cm) Blinding Concrete (10 cm) Gravel

Figure 6. Foundation works for construction of the equalization tank in November 2021 at Beit Dajan WWTP.

4.4 INSTALLATION OF THE PRESSURED SAND FILTERS

As post-treatment, to further enhance the quality of the effluent and further decrease the concentration of TSS and turbidity in order to protect the irrigation network from any kind of clogging, pressured sand filters and to increase the chlorination efficiency were included in the design and installed in November 2022 after the secondary clarifier and equalization tank. Next to mechanical removal of particles, this filtration step is also a biological treatment increasing the inactivation of pathogens. The media, the size and grade of the filling material used in the filters and the load applied, the backwashing frequency, all are factors influencing the removal efficiency of turbidity. The 2 installed sand filters are filled with gravel with a particle size range between 0.85-2.65 mm as detailed in **Table 4**. More details on the BoQ of the sand filters and the technical specifications can be found respectively in Appendix 1 and Appendix 5. Two high pressure centrifugal pumps were installed to pump the water from the equalization tank to the sand filter under a pressure of around 10 bar. Appendix 6 provides more technical details about these pumps.

Table 4. Technical specifications of the two installed sand filters at Beit Dajan WWTP.

Item	Specification
Filtration surface area	1.4 m2 (0.7 m2- for each tank)
Operating pressure	10 bar
Backwash:	Not included, but sand washing outside the filter chamber
Filtration speed	16 m/h at a flow rate of 38 m3/h
Diameter filtrated particles	Up to 10 µm
Gravel quantity	1200 kg (600 kg each filter)
Gravel size	0.85 -2.65 mm
Pressure Pumps	Quantity: 2 High-pressure multistage centrifugal pump Rated power: 15 kW Maximum operating pressure: 16 bar Maximum inlet pressure: 1 MPa

As shown in the picture in Figure 7, the sand filters were installed above the equalization tank.

Figure 7. Sand filters installed on top of the equalization tank and connected to the chlorination unit.

5. CONCLUSION

Compared to the original proposed design in the preliminary technical report, there were no adaptations done for the major intervention. Though the impact of the major interventions are connected to the impacts of the minor intervention, it can be concluded that the activities of the major intervention significantly improved the WWTP of Beit Dajan and were necessary to obtain TWW of an adequate quality to irrigate the crops of the farmers of Beit Dajan. This is described in detail in the report "Output 3.5: Report on the efficiency of the implemented pre and post treatments and MAR systems". In general, for each installed technology, adequate training of the operators is pertinent. **Table 5** summarizes the value for replication for each technology part of the major intervention in Beit Dajan WWTP in rural or local areas.

Table 5. Summary of the major intervention in Beit Dajan's WWTP and value for replication in rural areas.

WWTP technology	Value for local application
Pre-treatment unit	Efficient mechanical treatment solution for FOG and TSS removal, easy operation and maintenance but each component of the unit should be available on the local market and local technical knowledge about the technology needs to be present.
Pressure sand filters	Valuable solution to obtain TWW for agriculture use for reducing TSS and subsequently increasing the chlorination efficiency. Yet, as preventative measure, a bypass should be foreseen in order to protect the sand filter for TSS overload. Different operational modes including automatic backwash make the unit easy to operate.
Aeration tank	Operation is relatively complex and needs intensive monitoring of various parameters to ensure efficient removal of organic load and achieve treatment objectives. If the operation can be automated, the technology can be more valuable for local application.