WASTEWATER TREATMENT PLANT AT NABLUS
**Concept & Location**

Nablus is a Palestinian city in the northern West Bank, approximately 63 kilometers (39 mi) north of Jerusalem, with a population of 126,132. Located in a strategic position between Mount Ebal and Mount Gerizim, it is the capital of the Nablus Governorate and a Palestinian commercial and cultural centre.

Nablus is home to the Palestine Securities Exchange (PSE) and the al-Quds Financial Index, housed in the al-Qasr building in the Rafidia suburb of the city and is considered widely to be the commercial capital of Palestine.

The majority of households are connected to a public sewage system (93%), with the remaining 7% connected through cesspits. The sewage system, established in the early 1950s, also connects the refugee camps of Balata, Askar and Ein Beit al-Ma’. Pipe water is provided for 100% of the city’s households, primarily through a public network (99.3%), but some residents receive water through a private system (0.7%). The water network was established in 1932 by the British authorities and was badly in need for upgrade and repairs, and the Palestinian government decided to establish a dedicated Wastewater Treatment Plant (WWTP) in Nablus, to cope with the increase in population and the associated volume of wastewater generated. Wastewater purification is vital to one of the hottest regions on earth, and crucial to sustaining local agriculture.

The new WWTP sewage treatment facility project will be used to treat sewage water arriving from Nablus (Nablus Stream Base), and which later enters Alexander Stream in the coastal plane. The project was made possible with the aid donated by the German Development Bank (KFW). The clients entrusted Passavant Energy and Environment and their German partner Kinetics, with the task of realising the WWTP at Nablus. Owing to their strong WWTP technical expertise and prior Middle East experience, Passavant Energy and Environment took charge of providing the process design, the electrical and mechanical equipment, while Kinetics assumed the responsibility for the civil works and the underground piping.

The facility employs 50 employees (mostly from Nablus), and so the project also works to mitigate unemployment in Nablus Sector. Currently, on-site work is proceeding according to schedule, while coordination procedures required for the continuous and proper conclusion of the project are being carried out. The establishment of a sewage pipeline from Nablus to the facility will commence soon and shall compose a substantial component of the project’s progress.

The Nablus Waste Water Treatment Plant will treat 5.4 million cubic meters of raw sewage, allowing for greater access to water for agricultural purposes in the region and better living standards for the inhabitants of Nablus upon completion, and Passavant Energy and Environment is proud to have played a part in the development of the historic and important Palestinian city.
Scope of Work

Passavant Energy and Environment were selected to undertake the complete design, construction, delivery, installation, commissioning and testing of a Waste Water Treatment Plant and construction of a 10 km sewage network in Nablus.

Innovation & Highlights

The biological WWTP at Nablus comprises mechanical pretreatment, sludge thickening, sludge digestion and sludge dewatering units. A future expansion will also see the addition of a filtration unit that will be constructed to use the effluent for irrigation and a combined heating and power plant will be added to use the digester gas for power supply.

Since additional expansions are planned to cope with increasing demands in the future, Passavant Energy and Environment installed a common distribution chamber for all stages of Activated Sludge Tanks, as well as the distribution chamber for the Final Sedimentation tanks. One sludge thickening building and one dewatering building were also commissioned for all stages, with consideration of installation reserves of additional machines for extension stages.

The process units offered include Passavant Energy and Environment developed technologies, which have a proven track record and have been applied at many treatment plants worldwide. Examples include the well-known Mammoth surface aerator, screening and grit handling equipment, mechanical and dewatering equipment, as well as Passavant Energy and Environment’s anaerobic sludge digestion technologies.

The WWTP at Nablus is designed to serve the needs of a Population Equivalent of 150,000 and the discharged water will be compliant with leading EU effluent standards. The process of the wastewater treatment at Nablus is divided into the mechanical treatment stage, the biological treatment stage and the sludge treatment stage.

The main features of the plant design include:

**Septage (Partially treated Septic waste) Reception Station** - To receive the partially treated septic wastes which are delivered to the WWTP daily. By design, the Septage reception station will handle approximately 40m3 septage per day.

**Inlet Structure** - Wastewater from the catchment areas of Nablus West flows by gravity via an interceptor to the wastewater treatment plant. The interceptor connects to the Inlet structure and the wastewater is discharged to the coarse screens via the inlet channel. The Inlet channel has been designed to allow the easily extension with the future construction of additional screening lines in the future.

**Screening and Septage Station** - The Screening Station at WWTP Nablus consists of coarse screens, conveyor for coarse screening, fine screens spiral conveyor for fine screenings, and a screening press. The pre-treated water is then flown to the Grit and Grease Removal Chamber. During septage reception, the septage will be screened via a series of coarse and fine screens, and screenings captured in a filter basket from where they are transported and dewatered by a spiral conveyor to a compaction zone and the into the storage
container together with coarse screenings. The screened septage will flow by gravity to an underground storage tank which has storage capacity of one day. The septage will be pumped upstream of the WWTP coarse screens during the low-load period.

**Grit and Grease Removal Chamber** - Wastewater flows into the grit chambers at the head of the tanks and is discharged at the opposite end via an overflow. In each tank a coarse aeration system with perforated pipes is provided at the opposite side of the grease compartment. A spiral flow of the sewage is created by the force of the aeration and allow the settling down of sand and collecting of light fats and grease at the surface of the separate grease traps.

**Primary Sedimentation Tank** - The primary sedimentation tanks were installed by Passavant Energy and Environment to reduce the suspended solids content of the wastewater before biological treatment and the BOD. The PST was designed with enough treatment capacity to cope with increased demand in future extensions. Both sedimentation tanks were of rectangular design, one active and the other kept on standby for maintenance and repair works. The PSTs used a travelling-bridgetype scraper for removal settled solids (primary sludge).

**Passavant Biological Treatment** - The biological wastewater treatment used at the WWTP at Nablus, is based on the activated sludge process with surface aerations by using the Mammoth Rotor® developed by Passavant Energy and Environment. The process tanks are applied as race track type systems.

Using Passavant Energy and Environment’s innovative system, nitrification and carbon removal are achieved in the aeration zone, while maintaining dissolved oxygen concentration. De-nitrification is achieved in the anoxic zones, i.e. in the zones where the oxygen level has been reduced, due to the biological activity. This system offers high flexibility in operation for optimizing the biological treatment process.

**Distribution Chamber** - Effluent from the primary sedimentation tanks is flown to the distribution chamber of the activated sludge tanks, where the wastewater is mixed with the return activated sludge (RAS) from final sedimentation tanks to form mixed liquor which is then equally distributed to two activated sludge tanks via overflow weirs. Each of the AST lines can be isolated by closing the corresponding penstock.

**Aeration Tanks** - Passavant Energy and Environment installed two independent lines of activated sludge tanks, equipped with surface aerators to provide the oxygen demand for the process, and four agitators were built into each tank to ensure solids suspension and mixing of the tanks. The activated sludge tanks have been designed based on a minimum wastewater temperature of 12°C.

**Final Sedimentation Distribution Chamber** - The mixed liquor of water and biomass is transported from the activated sludge tanks via motorised overflow weirs and pipelines into the distribution chamber of the final sedimentation tanks. Here the mixed liquor was equally distributed to the two final sedimentation tanks via overflow weirs. Final Sedimentation Tanks - In the final sedimentation tanks, Passavant Energy and Environment installed mechanisms to separate the activated sludge from the treated wastewater by gravity. Two circular secondary sedimentation tanks with scrapers and scum collection systems were also developed and installed to improve overall efficiency.
**Sludge Pumping Station** - The sludge pumping station at WWTP Nablus consists of return activated sludge and excess pumping stations. Both pumping stations were designed with the needs of future extensions and constructed in one joint chamber. The flow measurement in both pressure lines are constructed in a separated chambers for the instruments.

**Service Water Supply** - Passavant Energy and Environment installed a service water pumping station before the effluent metering for the WWTP Nablus. The service water supply is provided by a booster station at the outlet flow measurement. The booster station serves a net of underground pipes and hydrants, which is also used for fire fighting purposes. To facilitate this, a compressed air reservoir tank, was included within the process water plant, to reduce the number of operations of these pumps. To serve the needs of the screening plant (screenings press, grit classifiers) and in the sludge thickening and dewatering buildings, the service water network was connected directly to these units.

**Primary Sludge Thickening** - Primary sludge from the primary sedimentation tanks was pumped into a gravity thickener in order to reduce the volume of primary sludge. The thickener has a usable volume of about 550 m³. The residence time of the sludge is designed to be about 2 days. Passavant Energy and Environment installed a picket fence within the thickener for enhancing the gravity thickening process.

**Mechanical Sludge Thickening** - Passavant Energy and Environment installed a mechanical sludge thickening unit to reduce the volume of the excess sludge (ES) as well as the downstream sludge treatment processes, especially the needed treatment volume of the digester.

**Mesophile Anaerobic Sludge Digestion** - The sludge digestion system at WWTP Nablus consisted of one mesophile anaerobic digester with associated mixing, heating, biogas storage and utilisation equipments, and a secondary thickener, based on Passavant Energy and Environment’s proprietary technology and expertise. The thickened primary sludge, scum and the thickened excess sludge were pumped into the mixed sludge tank prior to the digester, and then pumped by feeding pumps to an inoculation mixer.

In the inoculation mixer the sludge was mixed together with the recirculation sludge, so that seeding with the recirculation sludge, which was already undergoing digestion, as well as pre-heating, were achieved at the same time. The inoculation mixer made by Passavant Energy and Environment was constructed in such a way that an entire mixing of both sludge streams took place simultaneously.

**Digestor Mixing** - Passavant Energy and Environment employed their patented Digestion system at WWTP Nablus, to ensure full overall mixing in the digester by injecting digester gas through gas booster and gas lances. This eliminates the need for additional mechanical mixing which allowed the mixing system within the digester to be equipped for achieving the best mixing result.

**Digestor Gas Production and Gas System** - During the degradation of the organic dry solids by the anaerobic digestion, biogas is produced as one of the natural by-products of this biochemical process. This biogas is a mixture of about 2/3 methane and 1/3 carbon dioxide. In order to protect the digester against accumulation of pressure, Passavant Energy and Environment installed a special combined protection device for gas over-pressure and sub-pressure, in the gas hood.
Gas Utilisation Plant (Biogas Pre-Treatment) – The generated biogas was withdrawn via the gas withdrawal dome out of the head of the digester with a pipeline. The gas was then flown into the gravel filter constructed by Passavant Energy and Environment, which allowed the pre-dewatering and pre-filtering (coarse filtering) of the biogas. The condense water was then separated at the surface of the filling material (gravel) and collected at the bottom of the filter.

Combined Heat and Power Unit – One of the primary goals behind the WWTP at Nablus was to recover energy from the waste and return it to the energy grid. The Combined Heat and Power Unit (CHP) installed by Passavant Energy and Environment served this purpose. The CHP was heated with combined full automatic digester gas excess pressure burners which were equipped with special safety and regulation armatures. The heated water flowed through the lines from the boilers to the distributor battery. Heating circulating pumps delivered a part of this water to the heat exchangers which were constructed by Passavant Energy and Environment. Power was produced when the digester gas was burnt and the waste heat from cooling and waste gas was used for heating of water. The hot water was delivered over the heat distributors to the heating circuit.

Boiler Plant - The biogas used in the boiler plant with dual fuel burner, was first driven to the gas filtering devices, to ensure optimum operational efficiency. The Gas Filtration plant consisted of a ceramic filter that was constructed by Passavant Energy and Environment, which achieved fine-purification. During this process fine polluted matter and the remaining moisture were filtered out of the gas and dumped into a collection chamber, while the purified gas was flown on to the boiler station.

Secondary Thickener – To store and further thicken the digested sludge, Passavant Energy and Environment installed a gravity secondary thickener. The secondary thickener was also equipped with an agitator to ensure homogenisation of the digested sludge before pumping to the dewatering plant. The digested sludge was pumped by eccentric screw pumps to the dewatering feed tank depending on the operation of the dewatering machines.

Sludge Dewatering – The WWTP plant at Nablus also featured a Sludge Dewatering Plant that was housed inside a dedicated facility. Sludge dewatering was carried out by two belt filter presses. The building was equipped with ventilation devices, drainage systems and an overhead crane, and also included a control room for the low voltage distribution switchgear.

Lime Stabilisation - The dewatered sludge was typically unstable and not easy to handle. To stabilise the sludge, quicklime (CaO) powder was often added to the sludge. The lime mixing, dosing and storage plant installed by Passavant Energy and Environment housed an open hopper eccentric mixer pump, a storage silo (40m³) and filling and discharge equipment. Besides this, the dewatered sludge cake from the belt filter presses was mixed with the quicklime powder in order to increase the dry solids content up to 28–30%. Furthermore the lime also helped by serving as a sterilising agent on the sludge. Passavant Energy and Environment developed a flexible system by which the dewatered and conditioned sludge was discharged onto a trailer for disposal or distribution to the sludge storage area as needed.

Sludge Liquor Storage Tank – Passavant Energy and Environment installed a sludge liquor storage tank for the short term storage of sludge liquors during high load periods to ensure optimum biological treatment performance. Liquor from the primary thickener, mechanical thickening plant, dewatering plant, and drainage from the sludge drying beds were flown by gravity to an underground sludge liquor storage tank from where it was pumped to the AST distribution chamber during night flow when the load to the WWTP was low.

Sludge Drying Beds – Passavant Energy and Environment incorporated the dry and hot weather of Nablus into the dewatering and drying sludge. To do this, the company built sludge drying beds that were used during the hot summers. This also helped the WWTP to reduce operation costs of the sludge dewatering plant. At peak activity, Passavant Energy and Environment employed 2 engineers for design and contract management, 2 commercial experts for shipping and purchasing and around 85 personnel, in addition to 10 site engineers, to achieve rapid progress on site.

The WWTP Nablus is well on its way to scheduled completion and will prove to be a tremendous boon to the infrastructure needs of this important town in historic Palestine. Passavant Energy and Environment will also be awarded an additional contract for 2 years operational assistance including training of operator’s staff, post completion of installation works on site. Passavant Energy and Environment’s unique European expertise and technology, and Middle East experience have proved to be a major benefit to the launch of the Wastewater Treatment Plant and the Nablus WWTP is an important milestone in the company’s history.