METITO

Commitment to a Cleaner Environment

Saadiyat Sewage Treatment Plant, UAE- Abu Dhabi

A Case Study

Introduction

The Tourism Development and Investment Company (TDIC) is the master developer for key cultural, residential and tourism destinations in Abu Dhabi. TDIC philosophy is based on delivering best practices across every segment in which it operates – be it luxurious resorts, eco tourism or world class cultural hubs.

Just 500 meters off the coast of Abu Dhabi, TDIC is developing Saadiyat Island, a unique place that will offer visitors, housing, cultural, social and entertainment facilities. Leighton Contracting, the main infrastructure development contractor of the island, chose Metito to construct and put into operation new sewage treatment works to serve the Saadiyat cultural district which encompasses Zayed National Museum, Saadiyat Beach, Saadiyat Marina, the Golf Course, an International School, Saadiyat Promenade, Arab World Museum, Saadiyat Lagoons, Saadiyat Retreat and Saadiyat Reserve 5 stars hotel.

In view of the prestigious nature of this development, the membrane bioreactor technology (MBR) was chosen for the project. MBR produces high quality effluent that can be safely used in open irrigation with no health hazard. Treated and disinfected effluent from STW is discharged to an irrigation network to be re-used for landscape irrigation.

Scope of Work

The project was awarded to Metito on design and build basis, that included design, supply, civil construction, installation, commissioning and operation for 1 year.

The sewage treatment plant (STP1) was designed to allow for an increase in capacity to accommodate the rise in occupancy of Saadiyat Island. The plant current average design flow is 11,000 m^3/day whilst the maximum design capacity is 16,500 m^3/day.

The plant comprises the following key stages:

- Inlet works
- Equalisation tank
- Biological treatment
- Disinfection
- Sludge handling
- Odour control

Process Description

Inlet Works

Flow from the pumping stations arrives at a receiving chamber, where it is directed to the inlet works pre-treatment station. The station includes sand, oil and grease removers, a sand classifier, two fine screens (one duty and one stand-by), and one screw compactor for screened material.

Mechanical Screens

Raw sewage from the reception chamber passes through screens to remove all floating material. Screenings are then discharged to a screw conveyor where they are compressed through a compactor and transferred to a receiving skip. The screened material is transported

off-site by a registered waste contractor and disposed of to landfill.

Grit Removal

Following screening, sewage flows to a vortex type grit chamber where it goes through a rotational flow pattern. The resulting sewage velocity is sufficiently high to prevent the settlement of light organic solids while the heavier sand and grit settle to the bottom of the tank. De-gritted sewage passes through a flow measurement channel to the equalisation tank for further treatment, while collected grit slurry is pumped and delivered to a classifier where water and grit get separated. Water is drained back to the equalisation tank, while solids are transported by conveyor belt to a skip and taken off-site for appropriate disposal.

Equalisation Tank

Flow equalisation overcomes the operational problems caused by varying flow rate patterns, and improves performance of the subsequent processes. Equalisation also buffers BOD fluctuations and eliminates shock loading.

Air under low pressure is supplied through down feed pipes with diffusers to the bottom of the equalisation tank to prevent settling and septic decomposition of organic matter.

Biological Treatment

Aeration Tanks

Sewage is pumped by the feed transfer pumps to the aeration tanks. The aeration tanks provide an aerobic environment to ensure nitrification of ammonia and oxidation of BOD, which is achieved by the provision of high efficiency, fine bubble diffused aeration. The aeration tanks include an anoxic zone for effective de-nitrification.

The air blowers are provided with variable frequency drives linked to a Dissolved Oxygen (DO) meter, to maintain the desired residual DO concentration in the aeration tanks.

Two horizontally mounted rotor aerators are provided in each aeration tank, which help mix the activated sludge and increase the amount of oxygen by creating turbulence in the water.

pH Balancing - Sodium Hydroxide

Alkalinity in wastewater results from the presence of hydroxides (OH^-), carbonates ($CO3^-$), and bicarbonates ($HCO3^-$). The concentration of alkalinity in wastewater is important where biological nutrient removal is used. Alkalinity is maintained within the required range by injecting sodium hydroxide in the aeration tanks.

Membrane Bio-Reactor (MBR) Tanks

Submerged membrane technology is an advanced cost effective technology. The MBR process is a suspended growth activated sludge one that utilises micro porous membranes for solid and liquid separation in lieu of secondary clarifiers (settling tanks).

There is a total of six membrane tanks which combine the function of solid separation and biological degradation. The membrane units remove solids to < 5 mg/l. They are scoured by coarse bubble aeration to prevent fouling. Provision has been made to chemically clean the membranes, usually twice per year, using dilute Sodium Hypochlorite for bio-fouling. A diffuser flushing system is also used to periodically flush the coarse bubble diffusers.

Surplus sludge is drawn from the membrane tanks at approximately 1.4% to 1.8 % dry solids, and is transferred to a tank.

Disinfection

The MBR process removes a large portion of bacteria from sewage. However, the effluent from the system may contain some pathogens due to contamination. For this reason, Sodium Hypochlorite is dosed into a Chlorine Contact Tank to remove or inactivate the remaining pathogenic bacteria.

After disinfection, TSE from Saadiyat STP-1 is transferred to a treated water tank, and is used for irrigation on Saadiyat Island and as top-up water for Saadiyat Beach Golf Course Lake 15.

Sludge Handling

Excess sludge from the MBR tanks is pumped intermittently by the sludge recycle pumps to the SAS tank. The tank

is provided with an aeration system to prevent the settling of suspended solids. SAS sludge is then transferred by progressive gravity pumps to sludge centrifuges for dewatering, aided by polymer injection.

Dewatered sludge is conveyed via screw conveyors to sludge skips, where it is taken off site by a registered waste contactor for disposal at landfill.

Odour Control

Structures that may generate odour include:

- Inlet works (channels & chambers)
- Equalisation tank
- SAS tank
- Centrifuges housing

All of these structures will be vented to the atmosphere via an odour control system.

The odour control unit includes two counter-current scrubbers in series, followed by an activated carbon vessel as a deodorising unit (DU). In addition, a second line of counter current scrubbers which are connected to the same activated carbon vessel, are connected together with a stand-by fan.

Counter Current Scrubbers

Hydrogen Sulphide laden air passes through the inlet ductwork and enters the odour control wet chemical scrubber.

Gases move vertically upwards from the low-level side inlet through the packing contained in the tower. A downwards flow of scrubbing liquor intimately mixes with the up-flowing gas resulting in removal of the sulphur based compounds. A conductivity meter monitors the conductivity of the re-circulating liquor.

From the first packed section of the scrubber gases pass to the second packed section where the process is repeated thus providing the final cleaning of foul air. Gases then exit the tower through a mist eliminator. Free drops of water are removed from the gas stream by impact on the chevron collection elements. Collected moisture coalesces into a sheet of liquid that drains freely back into the scrubber vessel.

Activated Carbon Unit

The activated carbon vessel is used to further reduce the low H_2S concentrations after the scrubbers.

The vessel is filled with regenerable activated carbon on which the malodorous organic compounds are adsorbed, and the incoming hydrogen sulphide catalytically oxidised in the fine pore structure of the carbon. The carbon used

is vapour phase activated carbon that has been specifically developed for odour removal in sewage treatment operations.

A detection of hydrogen sulphide at the upper air sampling port indicates when the activated carbon has no further adsorption capacity for hydrogen sulphide, at which time it is regenerated.

Design Standards

The odour control installation is designed to the following standards:

Flow Rate	10.000m^3/hour
Maximum H_2S inlet concentration under natural ventilation	500
Mean H_2S inlet concentration under natural ventilation	200 ppm
Air Temperature	Ambient
Maximum H_2S outlet concentration	0.00047 ppm

Influent Characteristics

The STP is designed to treat domestic sewage. The influent characteristics are summarised in below table:

No.	Parameter	Unit	Value
1	Flow (Average)	m^3/d	11000
2	Peak Flow Daily	m^3/h	458.3
3	Pumping Hours	Hours /d	24
4	pH		7.5
5	TSS	mg /l	270
6	BOD^5	mg /l	290
7	COD	mg /l	590
8	NH_4-N	mg /l	30
9	TKN-N	mg /l	40

Environmental Impact

The project had a prerequisite requirement that necessitated the execution of an environmental impact assessment study before commissioning of the sewage treatment works. To accommodate this requirement, an Operation Environmental Management Plan (OEMP) was prepared to ensure that the operational activities of the Saadiyat STP-1 are managed in such a way that minimises the risks associated with land, water and air pollution, all in accordance with the requirements outlined in Federal Law No. 24 of 1999 for the Protection and Development of the Environment, and the Abu Dhabi Emirate Environment, Health and Safety Management System (EHSMS) Regulatory Framework (Decree 42 of 2009).

Main Benefits to the Client

Saadiyat Island is a bare land that is not connected to Abu Dhabi main sewage drainage system. This STP plant treats sewage generated on the island and the treated water is then used for irrigation purposes to maintain the green environment in the island. The need to construct a pipeline connection to the nearest sewage mains and additional pumping stations are eliminated, thus minimising the investments/financial exposure required.

Process Schematic Diagram