# Wastewater treatment

## Process overview

**Wastewater information sheet 2**

The land-based wastewater treatment plant at Mangere is designed to manage the bulk of Auckland's wastewater treatment needs well into the 21st century. The technology used at the plant has reduced the treatment cycle of wastewater from 21 days to 13 hours, and the treatment process reduces odours and significantly improves the water quality going into the Manukau Harbour.

The most modern of Watercare's wastewater treatment plants – including the plants at Mangere and Rosedale – use primary (mechanical), secondary (biological) and tertiary (filtration and ultraviolet radiation) methods to treat wastewater comprising domestic and industrial waste.

Stormwater from the older parts of the city, where a combined wastewater and stormwater collection system still exists, and from infiltration and illegal downpipe connections throughout the region, adds to the flow.

The average volume of wastewater treated is 300,000 cubic metres per day – a flow greater than that of the Wairoa River in the Hunua Ranges – in effect making it Auckland's biggest 'river'.

In simple terms wastewater treatment means the separation and extraction of organic and inorganic solids from the liquid waste stream, the removal of chemical nutrients and the lowering of BOD. The biochemical oxygen demand (BOD) is a measure of the strength or pollution potential of the wastewater.

## Pre-treatment

Pre-treatment occurs when wastewater from Auckland's interceptors (main sewers) enters a mixing chamber at the start of the processing.

Air is blown into the wastewater to keep it aerobic and to prevent solids from settling out. Odorous air and gases are extracted at this point (and at numerous stages throughout the treatment process) and passed through odour control filters.

The wastewater flows into six channels, each capable of taking 2,700 litres per second.

A view of one of the stainless steel fine screens prior to installation.

## Screening

Screening is the first line of treatment at the entrance to the wastewater treatment plant. Here six fine screens intercept solid debris (plastic, paper, leaves, wood etc) from the waste stream. The six revolving drum-shaped, three millimetre screens, are constructed of stainless steel and replaced the old-technology, 19 millimetre screens.

The screenings (up to eight tonnes per day) are extracted by screw conveyors, washed and dewatered and transported to a large waste skip which is trucked daily to an offsite landfill.

## Primary treatment

Primary treatment is mechanical and essentially involves separating solids from the liquid waste stream.

### Grit removal

Primary treatment begins after screening in 12 sets of pre-aeration grit removal tanks. Air pumped into the tanks generates a rotary motion which reduces the effective density of the wastewater and allows the grit (sand, silt and gravel etc) to settle out. The organic solids remain in suspension. The grit is collected in hoppers and is removed by screw conveyor and is trucked off-site.

### Sedimentation tanks

The 12 large sedimentation tanks are designed to allow the wastewater to flow slowly through in a smooth motion, free from turbulence, so that the organic solids settle to the bottom. The sludge is collected by scrapers that move continuously along the sloping floors of the tanks. The sludge is pushed into a hopper where it is removed by new centrifugal pumps.

Scum, which rises to the surface, is directed by water jets to a rotary scraper and then conveyed to the sludge sump. Sludge and scum are pumped via gravity thickeners and gravity belt thickeners to anaerobic sludge digesters for secondary biological treatment. (For more details please see the information sheet *Primary Treatment*.)

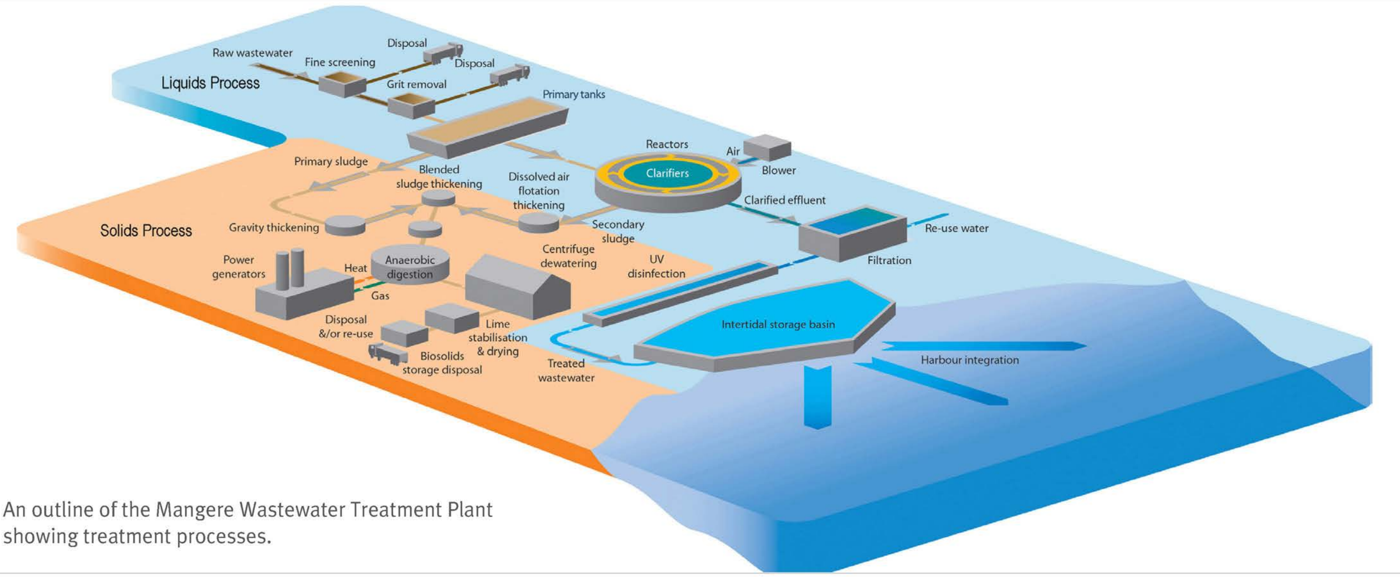
## Secondary treatment

### Reactor/clarifiers and biological nutrient removal (BNR)

At the heart of the treatment plant lies the land-based secondary treatment system. Secondary treatment is carried out in nine large, circular reactor/clarifiers. Each reactor/clarifier has the capacity to hold 31.3 million litres, equivalent to the wastewater treatment requirements of 200,000 people.

The secondary treatment system is known as biological nutrient removal (BNR) and uses a process known as 'activated sludge' (sludge with high levels of bacteria.)

The system relies on the controlled growth of populations of bacteria to biologically 'strip out' organic pollutants (in this case nitrogen and ammonia), and reduce its biochemical oxygen demand (BOD) of the wastewater. BOD is a measure of the strength or pollution potential of the wastewater.




An outline of the Mangere Wastewater Treatment Plant showing treatment processes.

In each unit, eight reactor compartments (four anoxic and four aerobic) are arranged concentrically around an inner clarifier. Effluent from the primary sedimentation tanks is fed proportionately (via the interstage pumping station and splitter boxes) into the anoxic compartments of the reactor.

Activated sludge recycled from the clarifier is fed into the first anoxic compartment where it is mixed with the incoming primary effluent. This so-called 'mixed liquor' then flows through the reactor compartments. Oxygen levels in the different compartments are raised (aerobic) or lowered (anoxic) to select populations of specific bacteria, which break down organic pollutants and remove nitrogen.

The effluent is then passed to the central clarifier where the heavier solids, including bacteria, settle to the bottom. This is then collected and recycled back to the reactor to enable the bacteria to go to work again. Discharged waste activated sludge (or WAS) is passed to the dissolved air flotation (DAF) units for thickening. The clarified effluent from the clarifier is then conveyed to the filtration and disinfection plant for tertiary treatment. (For more details please see the information sheet *Secondary Treatment BNR*.)

## Secondary treatment – solids

### Gravity thickeners

After primary treatment the sludge, still in very liquid form (about 1.5 percent solids), is passed to the gravity thickeners. As sludge enters the thickener tank the heavier sludge gravitates to the bottom (hence 'gravity thickeners'). Inside the tank a 'picket fence' mechanism slowly rotates, breaking up scum mats, releasing entrapped gas and conditioning the sludge. Once full, the top layer of sludge, which is the most liquid (the supernatant), is decanted over a weir and conveyed via the interstage pumping station to the reactor/clarifiers. The remaining settled sludge is sent to the gravity belt thickeners for further thickening before being fed to the digesters.

### Dissolved air flotation (DAF) thickeners

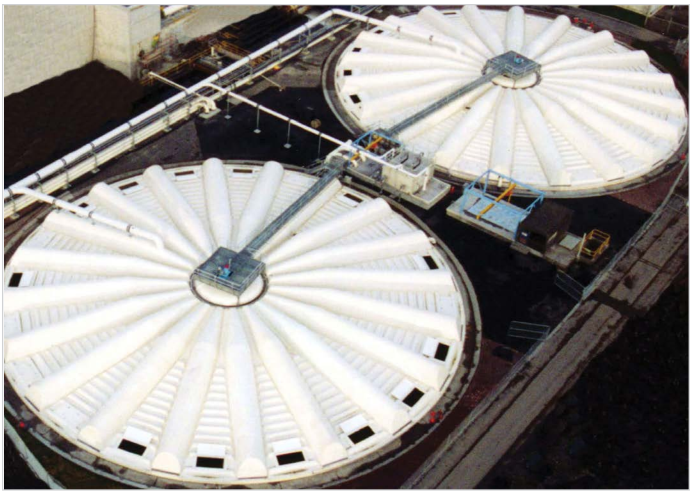
Secondary sludge or waste activated sludge is discharged from the reactor/clarifiers. Before passing to the digesters it is thickened in the DAF (dissolved air flotation) system. The DAF thickening process works on the opposite principle to the primary gravity thickeners. In the DAF system, waste activated sludge, still in highly liquid form (with a solids content of only 0.2 percent), enters saturation tanks where it is mixed with compressed air and pumped under pressure to the floor of the DAF tank where it is released. The sudden release of pressure causes the air to come out of the solution.

Microscopic bubbles adhere to the sludge particles which are then transported to the surface to form a floating blanket. Here a slowly rotating arm skims the top layer of thickened sludge into a float or off-takes compartment. The DAF thickening process increases the solids contents to three per cent – a factor of 15.

The thickened sludge is then piped to the gravity belt thickeners (GBTs) for further thickening, while the liquid effluent is passed back to the reactor/clarifiers.

### Anaerobic digesters

There are seven digesters each with an effective volume of 7,450 cubic metres. Sludge digestion is a complex biological process in which the sludge is heated to 37.0°C. Acid-forming bacteria break down the organic materials into organic acids, which are in turn converted into methane and carbon dioxide gases by methane-forming bacteria. Special pumping and mixing equipment within the digesters means the sludge is well mixed and conditioned. The sludge remains in the digesters for approximately 20 days.



Gravity thickeners thicken primary sludge.

### Gas production

Gas production from the seven digesters is 35,000 cubic metres per day. The biogas is a valuable fuel, supplying four 1.7MW gas engine/generators which can also run on natural gas. These engine/generators contribute to the plant's electricity demand during normal operation and provide all the heat required for the treatment process.

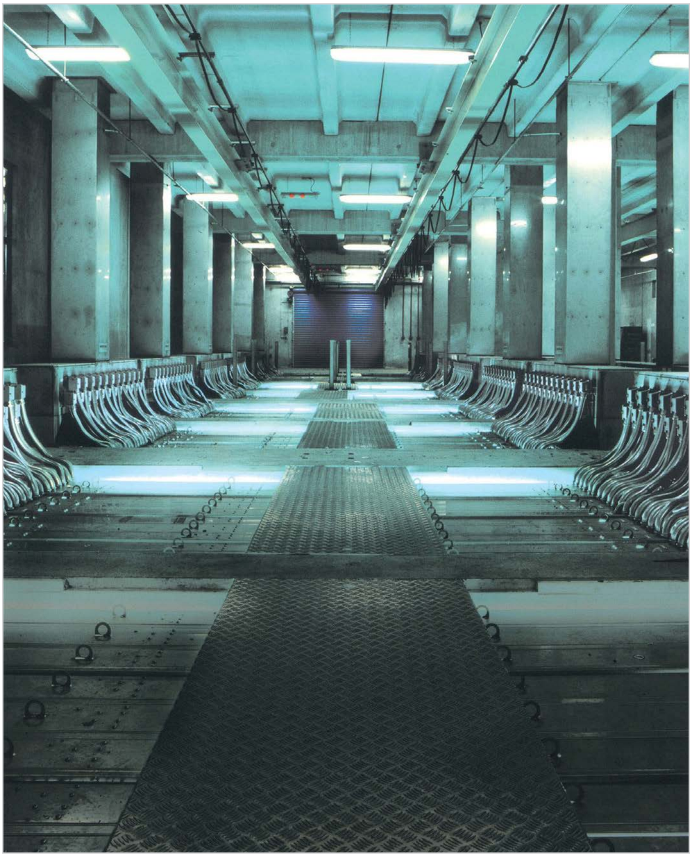
## Tertiary treatment

### Ultraviolet (UV) disinfection

The land-based tertiary treatment process is carried out in the filtration and UV disinfection plants. The UV disinfection facility at Mangere is one of the the largest in the Southern Hemisphere. The plant, which contains the latest UV disinfection technology, is designed to reduce pathogens in the effluent stream significantly. This ensures a very high quality treated effluent entering the harbour.

Prior to the disinfection process, secondary treated wastewater from the clarifiers will pass through large anthracite coal filters. Filtration down to a level of 15 microns removes any remaining larger particles to clean the treated wastewater, further enabling maximum UV light penetration.

At the heart of the disinfection system is a high performance mercury vapour lamp rated 300 watts covered with a hard quartz tube. There are 12 channels each with three banks of multiple UV lamps – altogether 7,776 UV lamps. The filtered treated wastewater will pass through these channels enabling UV light to kill off remaining pathogens in the water. (For more details please see the information sheet *Tertiary treatment – Ultraviolet (UV) disinfection*.)



A view inside the UV disinfection facility gallery which altogether holds 7776 UV lamps.

The 17 hectare intertidal storage basin and discharge pump station near Puketutu Island.

### Intertidal storage basin

After UV treatment, the wastewater will be conveyed via the distribution channel, which runs along the causeway to Puketutu Island. Here it will enter the 17 hectare intertidal storage basin from which it will be discharged twice a day, passing through the discharge pump station at a rate of 25 cubic metres per second.

## Tertiary treated – solids

### Dewatering plant

After approximately 20 days in the digesters, the sludge, reduced in volume by 50 percent, is piped to the dewatering plant.

The dewatering plant complex consists of two sludge tanks, a gallery of progressive cavity pumps, a polymer dosing plant, six centrifuges, a conveyor and load-out system. In order to help thicken the sludge and aid its dewatering, a polymer solution is added to encourage the solids to flocculate or stick together in the centrifuges.

The surplus liquid (centrate) from the centrifuge process is returned to the front end of the plant via the Western Interceptor.

The limed, dewatered sludge now known as process biosolids is conveyed to the adjacent biosolids storage building where it is held in concrete bunkers prior to disposal. The storage building is designed to hold up to four days production of biosolids (1200 tonnes). Biosolids are disposed of on-site in a rehabilitation site, Pond 2.

## Odour control

Odour control is an important aspect of the wastewater treatment process. Odourous air is collected from various sections of the treatment plant by ventilation fans and passed through biofilters. The filters contain beds of media made up of scoria and bark designed by Watercare scientists. Odourous compounds are removed by physical and bacterial processes in the biofilters before being discharged to air.

The biofilters treat air extracted from the various stages of the treatment plant including the pre-treatment mixing chamber, the primary tanks, the gravity thickeners, the splitter boxes and the biosolids dewatering building.

### Emergency by-pass

In case of a major failure in the treatment process or to divert flooding owing to excessive flows, a system of bypasses exists. These include a cut-out which by-passes the primary tanks, another which by-passes the reactor/clarifiers and on very rare occasions an emergency bypass channel which is designed to lead wastewater around the plant to the intertidal storage basin.

## Treatment plant control room

The latest computerised distribution control system allows plant engineers to monitor and control the entire plant and its many complex operations from computerised graphic displays. Watercare Laboratory Services staff maintain a vigilant watch over all stages of treatment, carrying out over 100 tests on the final effluent each month. These tests show that the quality of the treated effluent discharged to the harbour exceeds internationally accepted standards and has been markedly improved by the new treatment process.

Shift engineers in the control room monitor the many complex operations at the Mangere Wastewater Treatment Plant.