MEDIA FACTSHEET

TUAS NEXUS

The Deep Tunnel Sewerage System (DTSS) Phase 2 and the Integrated Waste Management Facility (IWMF) are iconic flagship projects undertaken by PUB and NEA respectively in the area of used water and solid waste treatment. One of the highlights of the two projects is the co-location of DTSS Phase 2's Tuas Water Reclamation Plant (Tuas WRP) with the IWMF. This will allow PUB and NEA to effectively harness process synergies from used water and solid waste treatment.

Tuas Nexus Synergies

Synergies derived through the co-location of the Tuas WRP and IWMF include:

Used Water and Waste Synergies	
Synergy 1	**Source-segregated food waste** is processed at IWMF into bio-pulp for co-digestion with used water sludge at TWRP to produce biogas.
Synergy 2	**Dewatered sludge** is disposed of at IWMF for incineration and energy recovery. This eliminates the need to truck the dewatered sludge to another location for disposal and reduces the carbon footprint.
Synergy 3	**Grit and screenings** from TWRP is sent to IWMF for thermal treatment. This eliminates the need for the grit to be trucked out to another location for disposal.
Energy Synergies	
Synergy 4	**Electricity generated by the Waste-to-Energy process** will be used to power the operation of both IWMF and Tuas WRP, and the excess electricity will be exported to the grid.
Synergy 5	**Steam** from IWMF will be used at Tuas WRP for its Thermal Hydrolysis Process for pre-treatment of sludge, and for hot water generation in greasy waste treatment.
Synergy 6	**Biogas** from Tuas WRP is sent to the IWMF for energy recovery in biogas superheaters for higher efficiency and to enhance electricity production.
Water Synergies	
Synergy 7	**Treated water** from Tuas WRP is sent to IWMF for its wet flue gas treatment process.
Synergy 8	**Condensate from the sludge drying process** at IWMF is sent to Tuas WRP for used water treatment.
Odour Management Synergies	
Synergy 9	**Odorous air** from TWRP's biosolids building is sent to IWMF and burnt in the sludge incinerator to reduce the need for odour control at Tuas WRP.

About the Deep Tunnel Sewerage System (DTSS)

A superhighway for used water management, the DTSS is a core water infrastructure which provides a cost-effective and sustainable solution to support Singapore's continued growth and meet its long-term needs for used water collection, treatment, reclamation and disposal.

The DTSS uses deep tunnel sewers to convey used water entirely by gravity to centralised WRPs located at the coastal areas. The used water is then treated and further purified into ultra-clean, high-grade reclaimed water called NEWater, with excess treated effluent discharged to the sea.

DTSS Phase 1, comprising the North and Spur Tunnels, the associated link sewers, the Changi WRP and outfall, was completed in 2008. Two NEWater factories, located on the rooftop of the Changi WRP, were officially opened in 2010 and 2017 to facilitate large-scale water recycling.

The DTSS Phase 2 conveyance system comprises the South Tunnel which conveys domestic used water, the Industrial Tunnel for non-domestic used water and associated link sewers. Expected to complete by 2025, DTSS Phase 2 will extend the deep tunnel system to cover the western part of Singapore, including the downtown area and major upcoming developments such as Tengah Town and Jurong Lake District.

Under DTSS Phase 2, a NEWater factory to be integrated with the Tuas WRP will be built to facilitate water recycling, contributing to the goal of increasing NEWater supply from 40% to up to 55% of total water demand in the long term. Tuas WRP will also be integrated with NEA's Integrated Waste Management Facility (IWMF), to harness potential synergies of the water-energy-waste nexus.

Unlike conventional WRPs, the advanced Tuas WRP will be receiving used water flows from the western part of Singapore via two separate deep tunnels – a tunnel to convey domestic used water and another to convey high-strength industrial used water. It will also use membrane bioreactor (MBR) technology to treat both used water sources and to higher standards. Domestic used water will be treated at a 650,000m3/day (or 143 million imperial gallons per day) module and then further purified to NEWater, while industrial used water will be treated at a separate 150,000m3/day (or 33 million imperial gallons per day) module to become Industrial Water and sent back to industries for reuse.

With an initial total treatment capacity of 800,000m3/day (176 million imperial gallons per day or 320 Olympic-size pools), Tuas WRP will be the largest MBR facility in the world, but with an overall 30% more compact footprint compared to conventional plants. Tuas WRP's integrated NEWater factory will have an initial capacity of 25 million imperial gallons per day.

The compact Tuas WRP will also incorporate a novel combination of advanced technologies and treatment processes to improve its energy efficiency – doubling the energy recovery compared to conventional plants, reduce plant footprint, produce less sludge for disposal and will be highly automated to minimise manpower needs.

In preparation for this, PUB is testing and validating various used water treatment technologies at the Ulu Pandan wastewater treatment demonstration plant before implementing them in Tuas WRP. This 12,500m3/day (2.75 million imperial gallons per day) demonstration plant won the Water/Wastewater Project of the Year Award at the 2018 Global Water Awards.

The completed DTSS will also streamline the used water network with three centralised collection and treatment points: Changi WRP in the east, Kranji WRP in the north and Tuas WRP in the west.

Once Phase 2 is in place, the existing conventional WRPs at Ulu Pandan and Jurong, as well as intermediate pumping stations, will be progressively phased out and the land freed up for higher value development. The implementation of the entire DTSS will result in a 50% reduction in land taken up by used water infrastructure once it is fully completed, from 300 hectares in the 1990s to 150 hectares in the long term. The land freed up by DTSS is equivalent to about 214 football fields.

Innovative and advanced technologies at Tuas WRP

Lamella Primary Sedimentation Tanks

Used in the initial stages of wastewater treatment, primary sedimentation tanks separate the solids from liquid wastewater by allowing solids to settle to the bottom of these tanks. The settled solids, also known as sludge, will be removed for biogas generation while the liquid wastewater is then sent for secondary treatment. Lamella primary settling tanks uses inclined plates which increases the maximum efficient surface area for solids to settle on with the same tank space. The use of Lamella technology saves up to 40% land footprint compared to conventional Primary Sedimentation.

Membrane Bioreactor (MBR)

MBR technology is used in the secondary stage of wastewater treatment. A bioreactor houses naturally-occurring bacteria which break down waste products in wastewater, after which microfiltration/ ultrafiltration membranes – with fine pores invisible to the eye – filter the remaining impurities. MBR is a more efficient method as it optimises the wastewater treatment process, enabling wastewater to be treated using less steps and less space compared to conventional systems. It also produces a higher quality treated effluent. The treated water is then used as feedwater for NEWater production or supplied to industries.

At Tuas WRP, an integrated NEWater Factory streamlines the production process of NEWater from treated used water. The advanced MBR system eliminates the need for both the secondary settlement tanks found in conventional used water treatment process and the microfiltration/ultrafiltration step in conventional NEWater treatment process. This results in the liquids treatment module in Tuas WRP having a 30% more compact footprint compared to conventional liquids treatment.

Thermal Hydrolysis Process (THP)

THP is part of the solids treatment module at Tuas WRP. The aim of the solids treatment is to recover energy from sludge and reduce the sludge volume for disposal. THP pre-treats sludge for digestion using high temperature (165 degrees Celsius) and pressure to improve the rate of sludge breakdown in digesters, so that more organic content can be converted to biogas. This also reduces the residual amount of solid waste to be disposed.

Upcoming Tenders for Tuas WRP

Tenders Packages	Tentative Calling Dates
Site Development Works	May 2018 (called)
Influent Pumping Stations	Q4 2018
Industrial Liquids Modules	Q1 2019
Domestic Liquids Module - Primary Treatment	Q3 2019
Domestic Liquids Module - Secondary and NEWater	Q3 2019
Product Water Storage and Pumping Facilities	Q4 2019
Biosolids facility and Digesters	Q1 2019
Plant Monitoring and Control System	Q4 2019/ Q1 2020
Administration and Operations Buildings	Q4 2020/ Q1 2021
Site Completion Works	2023
Wet Weather Treatment Facility	2022

About the Integrated Waste Management Facility

In 2017, a total of 7.70 million tonnes of solid waste was generated. While about 61 per cent of waste generated was recycled, our four Waste-to-Energy (WTE) plants incinerated about 2.85 million tonnes in 2017. The amount of waste generated is expected to grow with an increasing population and growing economy. To meet Singapore's long term solid waste treatment needs, NEA is building an Integrated Waste Management Facility (IWMF).

Unlike the existing WTE plants which only incinerate waste, the IWMF will adopt an integrated approach to process various waste streams for higher resource and energy recovery while minimising environmental and land use footprint. The waste streams that IWMF will be handling include incinerable waste, household recyclables collected under the National Recycling Programme, source-segregated food waste and dewatered sludge from the Tuas Water Reclamation Plant (Tuas WRP). A summary of the treatment facilities and capacities is in the table below:

Waste Treatment Facility	Capacity (tonnes per day)
WTE Facility	5,800
Materials Recovery Facility (MRF)	250
Food Waste Treatment Facility	400
Sludge Incineration Facility	800

Table 1 – Summary of the tentative capacities for the treatment of the four waste streams at IWMF

IWMF will be developed in phases. The first phase of IWMF will be completed in 2024 while the whole facility is tentatively planned to be completed in 2027.

Timeline of IWMF Development

NEA will be conducting a Pre-qualification exercise to shortlist potential Engineering, Procurement and Construction (EPC) contractors for the development of the IWMF. The appointed EPC contractors will carry out detailed engineering, construction and commissioning of the IWMF.

Upcoming Milestones	Tentative Dates
Pre-qualification of EPC tenderers and calling of EPC tenders	2H2018
Detailed engineering, construction and commissioning	2H2019 onwards
Completion of the first phase of the IWMF	2024
Completion of the second phase of the IWMF	2027 (TBC)

Waste Streams to be Treated at IWMF

Incinerable Waste

- Of the 8,443 tonnes / day of waste disposed of daily in 2017, about 60 per cent comes from domestic sources while the remaining 40 per cent is from non-domestic sources such as industrial and commercial premises.

- The electricity generated by the existing Waste-To-Energy (WTE) plants is enough to meet about two to three per cent of Singapore's total electricity needs.

- NEA is adopting WTE incineration as it is able to reduce the volume of waste by 90 per cent and thereby help Singapore conserve landfill space.

- The incinerable waste treatment capacity of the IWMF is expected to be 5,800 tonnes/day.

Household Recyclables collected under National Recycling Programme (NRP)

- Public Waste Collectors (PWCs) are required to collect commingled recyclables (paper/cardboard, plastic, metal and glass) from all residential properties.

- Currently, the recyclables are sorted at Materials Recovery Facilities (MRF) operated by PWCs before they are sent to the recycling plants.

- To optimise both process and land use efficiency, the sorting of recyclables will be consolidated and carried out at IWMF's MRF. With better economies of scale and through the use of advanced automatic sorting equipment, the MRF will achieve a high yield of sorted recyclables.

Food Waste

- In 2017, 676,800 tonnes of food waste were generated, of which 16 per cent was recycled. The rest of the food waste was disposed of at the WTE plants via incineration.

- Currently, food waste that is recycled is mainly homogenous food waste from food manufacturers such as spent yeast/grains from beer brewing, soya bean and bread waste. The food waste is segregated at source and sold to recyclers for conversion into animal feed. In addition, more than 50 premises, including hotels and schools, currently segregate their food waste treated them on-site into compost for landscaping purposes or water for non-potable use.

- As part of NEA's overall waste management plan, several initiatives have been planned to help increase food waste recycling in Singapore. One of the initiatives is to collect food waste separately for treatment at the IWMF and subsequently co-digestion with used water sludge at Tuas WRP.

- IWMF's Food Waste Treatment Facility will be able to segregate the inorganic from the organic fractions before turning the latter into bio-pulp suitable for co-digestion

with used water sludge at the Tuas WRP. The co-digestion of food waste and used water sludge will increase biogas production at the Tuas WRP. The biogas produced will be utilised at the IWMF to enhance its overall plant thermal efficiency and power production.

Dewatered Sludge

- The IWMF will also be receiving dewatered sludge from the Tuas WRP for incineration at the Sludge Incineration Facility.

- Fluidised bed incineration technology will be adopted at IWMF's Sludge Incineration Facility.

- End -