



chapter 03
Land

Singapore's limited land area, coupled with a high rate of waste generation, poses a unique challenge.

LAND

Solid waste has a very visible impact on the state of the environment. Left alone, it is unsightly and smelly. Worse, it presents a threat to public health, water quality and even the eco-system.

Singapore faces a unique challenge, due to our limited land area and the high rate of waste generation typical of urbanised societies.

Our solid waste management strategy (Towards Zero Landfill and Towards Zero Waste) can be summarised as follows:

- **Volume reduction** through incineration
- **Reuse and Recycle** to reduce waste disposed of at incineration plants and the landfill
- **Waste minimisation** to reduce waste generated.

WHERE IT ALL GOES

Collection

In order for waste volumes to be reduced through incineration, all solid waste must first be collected. With strict anti-dumping laws and an efficient waste collection system, illegal dumping is not a major problem in Singapore.

Waste collection is a highly regulated industry in Singapore. The public waste collection system covers all households, trade premises and public places.

Collection of refuse takes place daily to prevent decomposition of organic wastes, a potential health hazard. The island is divided into nine geographical sectors. Pre-qualified companies bid to provide collection services for each sector through an open tender. Contracts awarded from 2004 onwards are for a period of 7 years. The National Environment Agency (NEA) also requires the public waste collection companies to provide recycling services for the sectors that they are serving under the National Recycling Programme.

Waste collection for industrial and commercial premises is carried out by licensed waste collectors.

Singapore, Litter-Free

Singapore's reputation for cleanliness rests on a reliable and regular waste collection system and efficient cleaning of public areas. NEA is responsible for cleaning Singapore's streets, drains, beaches and public walkways. To increase efficiency, much of this cleaning is mechanised.

We are also raising public awareness of the impact of litter on the environment. The "Singapore, Litter-Free" initiative aims to get everyone attending large-scale public events such as parties, parades and rallies to clean up after the events.

For more about the programme, see Chapter 5.

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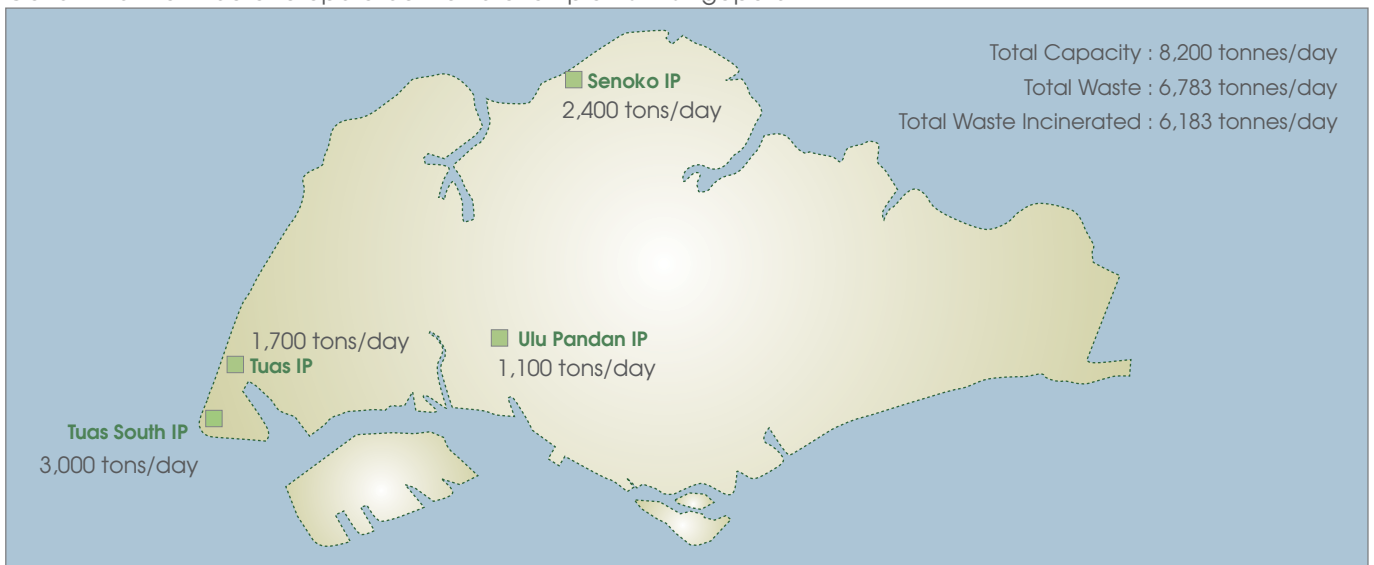
[Refuse bunker in an incineration plant]

Disposal

With limited land for landfills, Singapore's policy is to incinerate all incinerable waste that is not recovered, reused or recycled. Incineration reduces waste volume by up to 90%. About 91% of waste collected is incinerated. The remaining 9% that cannot be incinerated is disposed of at Semakau Landfill, along with the ash generated from incineration.

Singapore currently has four government-owned and operated incineration plants for general waste.

Government-owned and operated incineration plants in Singapore



By-products of incineration

Electricity

962 million kWh from waste heat, or 2-3% of Singapore's total electricity.

Scrap metal

16,500 tonnes in 2004, which were sold to a local steel mill for reprocessing into steel for the construction industry.

Air pollution

Advanced air pollution control equipment such as dry lime reactors, electrostatic precipitators and catalytic bag filters ensure compliance with emissions standards.



'Island-fill'

Pulau Semakau began its life as an offshore landfill in 1999, when the last remaining landfill on Singapore's mainland had been exhausted. Covering 350 hectares, it has a capacity of 63 million cubic metres and an expected lifespan of 30 to 40 years.

The landfill space was created by enclosing Pulau Semakau and a small adjacent island (Pulau Sakeng) with a rock bund. The bund is lined with an impermeable membrane and a layer of marine clay to ensure that used water generated in the landfill is contained within the landfill area. Monitoring wells dot the perimeter at 100-metre intervals to measure the surrounding water quality.

Today, all non-incinerable waste and incineration ash are loaded into barges which make the 25-km sea journey from Tuas Marine Transfer Station to Pulau Semakau. The barges are equipped with hatch covers to prevent waste from being



blown off during transportation. Once the waste arrives, huge excavators transfer it onto large, off-road trucks. The waste is then transported to the tipping sites for final disposal.



Not a wasteland

Five years on, birds and plants are thriving on Pulau Semakau, and the air quality remains good.

This idyllic state is possible due to the careful construction of the landfill space. Efforts were made to protect the marine ecosystem, especially mangroves and corals near the landfill. 13 hectares of mangrove were replanted to replace those removed during construction of the bund. The replanted mangroves now also serve as a biological indicator of the safety and ecological soundness of the landfill.



TOWARDS ZERO LANDFILL

From 1970 to 2000, the amount of solid waste disposed of increased six times to 7,600 tonnes per day¹

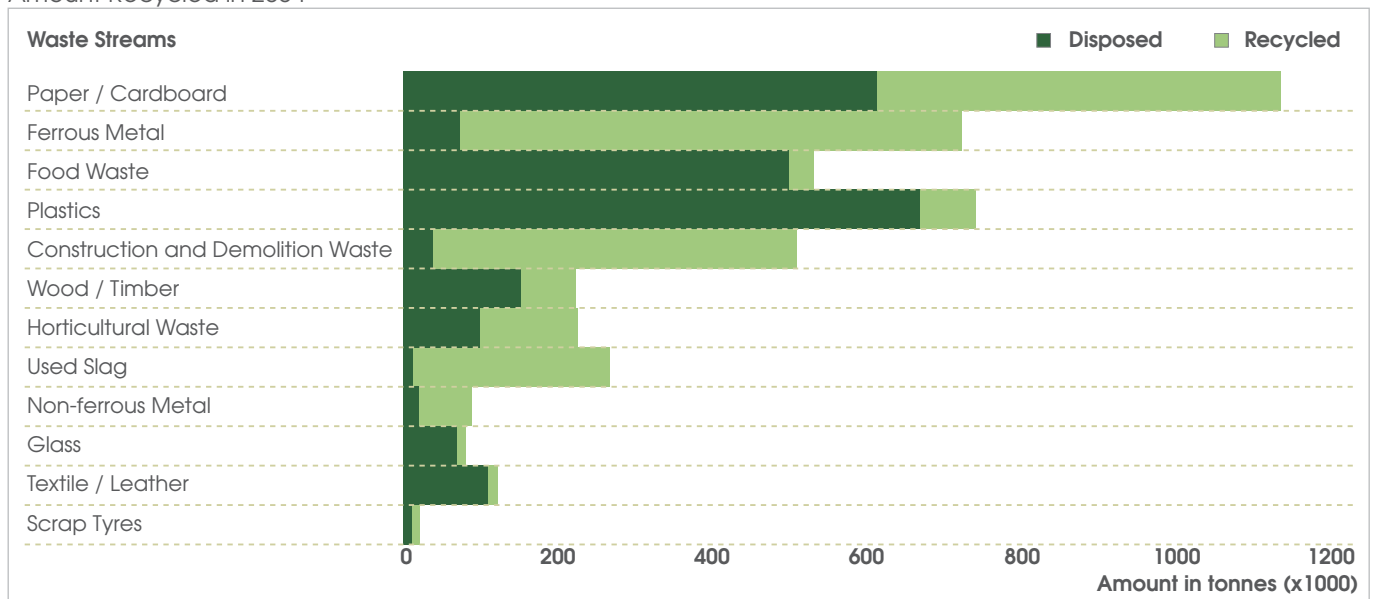
At this rate, Singapore will need a new incineration plant every 5-7 years and a 350-hectare landfill every 25-30 years. This is unsustainable for a small city-state. This is why - Singapore is now pursuing a strategy of 'Towards Zero Landfill'.

Our efforts at recycling and waste minimisation are paying off. In 2004, the waste disposed of dropped to 6,800 tonnes per day – a reduction of about 11% compared to 2000.

Reducing incinerable waste

Since the early 1990s, Singapore has been promoting recycling as a means of reducing waste. In 2004, the overall rate of recycling increased to 48% as compared to 40% in 2000.

Amount Recycled in 2004



¹ See Annex for more details.

The only way we will be able to further reduce waste and increase recycling is to get the wider community involved. With this in mind, NEA has introduced several programmes since the 1990s. These include the:

- National Recycling Programme
- Recycling Programme for Condominiums
- Recycling Bins at Public Places
- Recycling Programme for Schools
- Recycling Programmes for Industrial and Commercial Premises.

(See Chapter 5 for more on these programmes).



Reusing incineration ash

The incineration process produces bottom ash. Rather than dumping it in landfill, countries like Germany and the Netherlands use the ash to build roads – an application that Singapore is currently exploring.

A stretch of road in the Jurong Industrial Estate has as its base material, bottom ash from the Senoko Incineration Plant.



More than ash

Instead of the usual granite, a stretch of road in the Jurong Industrial Estate has as its base material, bottom ash from the Senoko Incineration Plant. The 150-metre stretch of Jalan Buroh was a pilot project.

The ash was aged for eight to ten weeks before use, to stabilise the materials. After aging, the ash was processed to remove ferrous and non-ferrous metals, and unburned materials. 1,200 tonnes of this ash was used as the road-base, which was then laid over with an asphalt mix.

The road has been in use since May 2002 and found to be safe. Monitoring of groundwater and surface quality shows that using the ash will not cause water pollution.

Recycling non-incinerable waste

Besides bottom ash, there is a sizeable amount of other non-incinerable waste disposed of at the landfill, such as sludge, silt, shipyard waste, construction and demolition waste. We have made progress in getting industries to recycle some of these wastes.

Construction and demolition (C&D) Waste

There are now four C&D waste recycling facilities in Singapore to sort and process C&D waste into secondary aggregates and other products for the construction industry.

Copper slag

Used copper slag from the marine industry can be processed and reused in grit blasting and to manufacture concrete-paving blocks and ready-mix concrete. There are three facilities that recycle copper slag.

Steel slag

There is also a facility processing steel slag from the scrap iron mill to produce road-building material.



[Construction and demolition waste recycling facility]

WHERE WE GO FROM HERE

Following the successful privatisation of waste collection, the government plans to increase **private sector participation** in the incineration industry. For example, the fifth incineration plant will be developed by the private sector through a Design, Build, Own and Operate arrangement.

No matter how efficiently incineration plants and landfills are run, they are still not sustainable solutions in the long term.

Even as we continue to encourage recycling, we need to go a step further by moving '**Towards Zero Waste**'. By doing so, we are targeting to solve the problem at source, by eliminating the unnecessary generation of waste.

NEA has started some modest initiatives in this area, including a campaign to encourage retailers to use fewer plastic bags and remind customers not to take more than they need.

Besides such educational and promotional efforts, NEA is also studying other countries' best practices, to see if any of the practices can be adopted in Singapore.



Land set aside for landfill cannot be used for other purposes like housing, factories and offices. Land is a scarce resource that Singapore can ill-afford to waste. NEA is tackling the root of the problem by trying to minimise waste and thereby prolong the use of the landfill for as long as possible.



CLEAN LAND

The condition of our land is inextricably linked to that of our water. Contaminated land leads to contaminated water and vice-versa. As both are especially precious resources in Singapore, we take a systematic approach to controlling both land and water pollution.

As with other forms of pollution, land pollution that is not visible to the naked eye is often more dangerous than what you can see.

Many industries use hazardous substances and generate toxic industrial wastes which could harm human health and devastate the environment. Once released, such substances or wastes may be extremely hard to clean up and their effects might last for decades. Hence, prevention is definitely better than cure.

In Singapore, both hazardous substances and toxic industrial wastes are well managed and controlled, without any major spillage of hazardous substances or illegal disposal of toxic industrial wastes.

Hazardous substances

Hazardous substances are those that:

- pose a potential for mass-disaster;
- are highly toxic and pollutive;
- generate wastes which cannot be safely and adequately disposed of; or
- are harmful to the environment.



Toxic industrial wastes

Toxic industrial wastes are wastes which by their nature and quality are potentially detrimental to human health and/or the environment and require special management, treatment and disposal. Examples are spent acids, spent solvents, spent etchants, waste oil and waste sludge.

Biohazardous wastes

All hospitals and government clinics in Singapore follow guidelines for managing and disposing of biohazardous wastes. Three companies here are licensed to collect such wastes and have dedicated incinerators for these.

Radioactive hospital wastes, on the other hand, are not allowed to be incinerated. These are dumped at the sanitary landfill site operated by NEA.

WHAT WE DO

NEA controls the movement, storage and use of hazardous substances, and the disposal of toxic industrial wastes. Essentially, this involves:

- planning and building plan control;
- licensing control;
- monitoring and enforcement.



Planning and building plan control

The first step in prevention is the “cradle-to-grave” approach. Only companies which can manage, store and use hazardous substances safely, as well as dispose of their wastes effectively, are allowed to set up here.

The second step is to consider where such industries should be located. NEA vets all new industrial building proposals in Singapore to ensure that industries set up only in appropriate **industrial zones**. Industries dealing with hazardous or toxic industrial wastes are sited away from residential areas and water catchment areas. (At the same time, NEA also ensures that new homes are not sited within the hazard zone). These procedures minimise public exposure and safeguard our precious water resources.

Finally, NEA vets the actual building plans to ensure that industrial facilities are designed to prevent pollution. Developers of major projects such as chemical plants are required to conduct a Quantitative Risk Assessment study.

Licensing control

At the same time, only people or companies with the appropriate equipment and training are allowed to handle hazardous substances and toxic industrial wastes. A licence or permit is required for:

- **import, transportation, sale, storage and/or use** of hazardous substances
- **collection** of toxic industrial wastes or hospital wastes
- **transportation** of hazardous substances or toxic industrial wastes exceeding certain quantities.

Monitoring and enforcement

To ensure compliance with regulations, NEA carries out regular monitoring and enforcement.

NEA screens all import of hazardous substances to ensure that hazardous substances are imported only by licensed contractors. NEA also screens all imports and exports of ozone depleting substances, to ensure that both the originating and receiving countries are parties to the Montreal Protocol¹. All **transboundary movements** of hazardous wastes are closely tracked to ensure compliance with the Basel Convention¹.

NEA officers carry out **audit checks** to ensure the safe storage and handling of hazardous substances, safe treatment and disposal of toxic industrial wastes. Road checks are also carried out to ensure that such substances and wastes are being transported lawfully.



Partnership and education

NEA has been working in partnership with the industry associations to further improve the management and control of hazardous substances. The emphasis is on greater **co-regulation**, for example annual safety audits by installations storing or using large quantities of hazardous substances.

Another important aspect of preventing mishaps is **training and education**. NEA organises courses on safe practices in handling hazardous substances and toxic industrial wastes and hazardous substances. Drivers of road tankers and tank containers carrying hazardous substances and flammable materials are required to undergo a Hazmat Driver Course and attend refresher courses every two years.

Land remediation

Despite the best prevention measures, minor or undetected leaks may accumulate over the years and contaminate the land. If a site was previously used for carrying out pollutive activities (for example, an oil refinery, oil terminal or chemical plant), the owner or occupier must carry out a study to assess the extent of contamination before it can be redeveloped for non-industrial uses. If necessary, the site will then have to be cleaned up to acceptable standards for the new uses.

Because the potential impact on public health is high, NEA oversees the process closely. These steps serve to protect future occupants of the site.

¹ See Chapter 7.

FUTURE DIRECTIONS

While Singapore already has an effective package of measures, we realise that the ultimate prevention is to avoid the risk in the first place. With this in mind, we are addressing the source of the risk by working with industries to minimise hazardous wastes.

Clean technology

At the planning stage, NEA advises industries on clean technologies to minimise waste generation.

Waste audits

NEA encourages industries that generate large quantities of wastes to carry out waste audits. The audits help industries to identify areas where waste reduction is possible. There are competent consultants in Singapore to carry out such waste audits.

The ultimate prevention is to avoid the risk in the first place.

Waste exchange

Waste to one company may be a resource to another. NEA helps to link industries and facilitate waste exchange between them. This minimises the final quantity of hazardous wastes disposed of.

Reuse and recycling

NEA also facilitates waste recycling companies in setting up recycling plants. There are currently about 160 such plants in Singapore, providing an avenue for smaller companies (which would find it impractical to operate their own facilities) to recycle their wastes.



Waste not, want not

Spent solvents

- 40,000 m³ collected per year
- 18,000 m³ recovered through distillation and reused
- 22,000 m³ unrecoverable and used as supplementary fuel for toxic waste incinerators.

Photographic wastes

- 1,000 m³ collected and treated per year
- Silver extracted through electrolysis
- Remaining liquid treated and neutralised in a water reclamation plant before discharge into the sewers.

Spent etchants

- 22,000 m³ generated and recycled per year.

We will continue to explore ways to minimise hazardous wastes, even as we track new discoveries of hazardous wastes.