

Project KEA

Operational & Technical Overview Report

for: South Island Resource Recovery Limited Resource Consent Application



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EXECUTIVE SUMMARY

Babbage Consultants Limited (“**Babbage**”) has been engaged by South Island Resource Recovery Limited (“**SIRRL**”) to prepare a resource consenting application for the establishment of an Energy from Waste (“**EfW**”) facility, known as Project Kea.

This report provides an Operational and Technical Overview of the EfW facility and forms part of the supporting documentation package for the resource consent application.

The EfW facility will nominally operate 24 hours per day, 365 days per year converting municipal and construction solid waste that would otherwise be sent to landfill, into electrical energy through the process of combustion.

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1 INTRODUCTION

According to the Ministry for the Environment, the majority of Municipal Solid Waste (“MSW”) generated in New Zealand is sent to landfill for disposal. Large amounts of valuable resources are not only lost to landfill but also negatively impact the environment through fugitive methane emissions, odour emissions and water and soil pollution. [Source: <https://environment.govt.nz/facts-and-science/waste/estimates-of-waste-generated/>]

In many parts of the developed world, the use of landfills is increasingly phased out as governments begin to realise the negative environmental impact that landfills have. Countries with modern waste management strategies use a combination of technologies and strategies to deal with their waste volumes which include efforts to eliminate, reduce, reuse, recycle and recover before resorting to disposal into landfill.

That waste which cannot be eliminated, reused, or recycled should have its energy recovered rather than simply disposing of it to landfill. A key component of recovering energy is the use of Energy from Waste (“EfW”) plants to recover energy from that waste which cannot be either reused or recycled and which would otherwise be destined for landfill.

EfW plants have evolved significantly over the last 30 years due to technological advancements and an ever-increasing pressure from society to reduce emissions from all types of industry in general. Today’s modern plants utilising the best technology have emissions control equipment which reduce the level of contaminants being released to the environment to such a low level that these plants are now constructed within populated cities.

The most developed countries have a holistic waste management strategy that prioritises recycling and composting and then energy recovery ahead of landfill. This maximises recycling, promotes the circular economy and virtually eliminates landfills.

In comparison New Zealand has comparatively low levels of recycling, virtually no energy recovery and relies heavily on landfills as the corner stone of its waste management strategy.

The chart below demonstrates how far behind New Zealand is with respect to countries recognised as having a modern holistic waste management strategy.

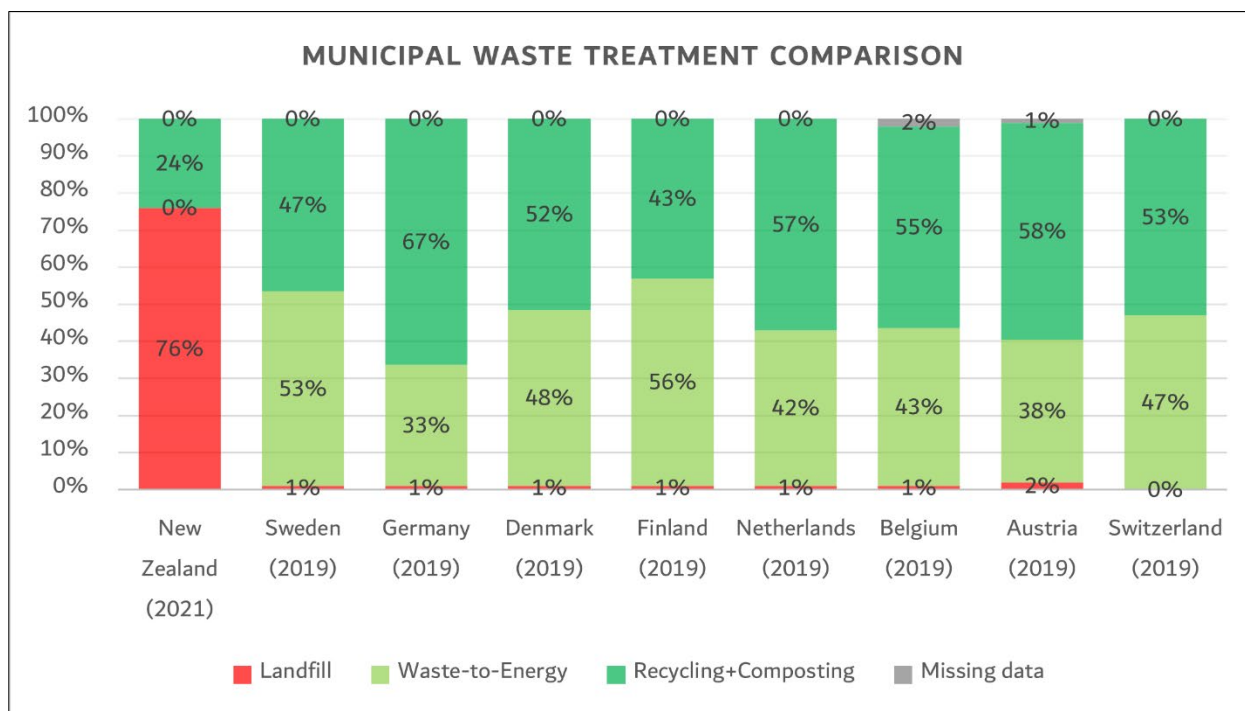


Figure 1: Municipal waste treatment comparison

(Source: Ministry for Environment of NZ and Confederation of European Waste-to-Energy Plants)

South Island Resource Recovery Limited (“**SIRRL**”) believes that New Zealand needs to do far better with respect to a holistic waste management strategy and take lessons from those countries successfully implementing such strategies.

To support this, SIRRL is proposing to construct and operate what will be New Zealand’s first significant scale energy from waste plant utilising the best available techniques developed around the world.

Best Available Techniques (BAT) outlines the advanced and proven techniques for the prevention and control of industrial emissions for Waste Incineration plants. *[Refer JRC118637 Best Available Techniques Reference Document for Waste Incineration. Also refer Technical Report 5 for an assessment of Project KEA against BAT with respect to air emissions control.]*

The technology employed by SIRRL not only includes the Best Available Techniques regarding the combustion process and the recovery of waste energy into electricity, but it also incorporates the very latest proven technology to appropriately deal with the key air emissions stream to ensure that the overall facility has a positive environmental impact.

Simply put, an EfW plant burns the MSW in a specially designed furnace to recover the energy from the waste in the form of heat. This heat is then used to boil water to create steam. The steam is then used to

drive a steam turbine which in turn drives an electrical generator to produce electricity. Thus, the overall process converts the energy within MSW into electricity.

Burning MSW produces several by-product streams that need to be appropriately dealt with in a way that they themselves do not negatively affect the environment nor pose unacceptable risk to human health. The key by-product streams that need to be mitigated are combustion emissions, grate ash and fly ash. How these three by-product streams are used and/or disposed of is critical to the overall environmental impact of an EfW facility. (Note, the term “fly ash” in this proposal denotes the product which comes from the outlet of the bag filters. It contains actual fly ash from the combustion process plus residual products from the flue gas treatment system arising from the injection of both hydrated lime and activated carbon.)

The grate ash is available for use as an aggregate in road construction. Although common practice in some other parts of the world, this is not currently done in NZ. As part of our EfW initiative, we are working with a potential aggregate consumer to test grate ash samples and gain approval for its use as a roading aggregate in New Zealand.

Combustion fly ash has historically been one of the most difficult combustion by-products to dispose of in an environmentally acceptable way. Fly ash is a hazardous product containing significant contaminants and it is our view that disposal of raw fly ash to landfill is simply not an acceptable environmental solution. We have therefore included a fly ash treatment process which uses a vitrification process to melt the fly ash and then quench it in a water bath. This melting process followed by rapid cooling converts the fly ash into an amorphous glass type product which can be categorised as an ‘Industrial Slag’. This industrial slag is a very stable and inert product with very low leachability. It has a potential use as an additive in concrete or concrete block manufacture and we are currently working with a potential aggregate consumer to obtain approval for its use in New Zealand.

The efficient use of water and the elimination of liquid waste discharges is also a key factor in the design of the facility. A process wastewater treatment and recycle system is employed to eliminate any process liquid waste stream being discharged to the environment. How this is achieved is outlined later in this report.

Domestic wastewater discharge from the amenities will be treated through a standard bio-cycle treatment plant and disposed of to land through an onsite drip field.

The EfW facility will run continuously 24/7 with annual shutdowns of the plant in a staged manner to undertake scheduled preventative maintenance. The design of the process is such that annual maintenance can occur without impacting on the continuity of waste collection and consumption.

The operational performance of the plant, particularly including the emissions control system, is continuously monitored and controlled through advanced process automation. As is common for such plants overseas, our EfW plant will not only report operational performance to regulatory authorities on an annual basis but will make the performance data available publicly, on-line and in real time.



The EfW facility includes a main building approximately 52.5m high and a stack 75m high. New Zealand architects and landscape architects have designed the exterior of the plant to fit within the landscape using colours and shapes drawn from the rural environment to reduce its visual impact.



Figure 2: Project Kea 3D Image viewed from SH1

Some examples of modern EfW plants around the world include:

Table 1. Sample of EfW Plants around the world

Plant	Image
<p>Amager Bakke in Copenhagen Denmark</p>	
<p>EveRé in Marseille France</p>	

[Uvélia](#) in Liège Belgium



[Hai'An](#) plant in Hai'An China



[Lincolnshire](#) plant in
Lincolnshire UK



[Kwinana plant](#) in Western
Australia – under construction
October 2022



2 KEY FACTS AND FIGURES

Table 2. Key facts and figures

Item	Capacity
MSW diverted from landfill	365,000 tonnes per year (approx.) 1,000tpd at 100% Capacity
Energy supplied to local network / industry	Operational Mode 1: 30MW electricity <i>(Equivalent to around 62,000 houses @3.5MWh/y/house)</i> Operational Mode 2: 20MW electricity + 40tph Steam
Operational times	24hrs per day, 365 days per year
Grate ash produced	80,000 tonnes per year (approx.)
Industrial Slag produced (vitrified fly ash)	20,000 tonnes per year (approx.)
Metal Recovered	5,500 tonnes per year (approx.)
Water consumed	2,500m ³ per day (approx.)
Process wastewater discharged to the environment	Zero
Incineration Temperature	850°C minimum
Oxygen percentage in flue Gas	6% minimum
Operating Range (turndown)	110% maximum: 30% minimum
Net CO _{2-eq} effect vs Landfill [1]	-75,000tpa (net avoided carbon burden)
Total trucks per day [2]	67
Total staff employed [3]	86
Main building height	52.5m (approx.)
Main stack height	75m
MSW storage (enclosed in building)	7,000 tonnes (approx. 7 days capacity)
Baled Construction Waste (enclosed in building)	45,000 tonnes (approx. 3 months capacity)
Emission Standards Met	European Directive 2010/75/EU
<i>[1] Net GHG benefit (measured as CO₂ equivalent) of EfW compared to landfill. Refer <i>Technical Report 9 – Life Cycle Analysis - SLR</i></i>	
<i>[2] Includes MSW import and By-product stream export plus assumes 100% of MSW arrives via road.</i>	

[3] Directly employed staff

3 WASTE TYPES AND ORIGIN

3.1 Origin of Waste and available volumes

The EfW plant will consume 1,000 tonnes of waste per day. The waste will be a combination of both municipal solid waste and construction waste that would otherwise be sent to landfill.

The expected regional sources of the waste are anticipated to be:

Table 3. Expected regional sources

Region	Percentage of Project Kea's waste volume
Christchurch	71%
Dunedin	15%
Central Otago	14%

3.2 Composition of Waste

The representative composition of the MSW and CW feedstock is shown in Table 4.

The ratio between municipal and construction waste will vary, however, for the purposes of assessing the EfW Plant operation a representative ratio of 50/50 has been used.

The composition of the MSW is taken from the Solid Waste Analysis Protocol (SWAP) data produced by the Christchurch City Council in 2019.

The composition of the CW was provided by Renew Energy Limited who collect and will supply construction waste to the EfW facility.

Significantly the following should be noted:

- The facility will not knowingly accept any hazardous waste. The facility is not a hazardous waste disposal facility.
- It is not intended to burn end-of-life tyres.
- Recycling occurs prior to the MSW being received at the EfW plant. The plant desires only that waste which is non-recyclable and would otherwise be sent to landfill.
- The facility provides a solution for using treated timber as biomass as the Flue Gas Treatment ("FGT") system captures and removes the contaminants released when burning treated timber.

Please refer *Technical Report 16*, which outlines in more detail the Waste Acceptance Criteria.

Table 4: Approximate waste composition

Waste Category	MSW [2]	CW [3]	Weighted Average	Renewable	% Renewable
	50%	50%	Waste Composition		
Rubbish	24.28%	0%	12.14%	N [1]	
Recyclable Paper and Cardboard	16.75%	15%	15.88%	Y	15.9%
Compostable Greenwaste	11.28%	20%	15.64%	Y	15.6%
Recyclable Plastics	10.60%		5.30%	N	
Non-compostable Greenwaste	8.17%		4.09%	Y	4.1%
Soft plastics	7.66%	6%	6.83%	N	
Non-recyclable paper	7.27%		3.64%	Y	3.6%
Clothing and textiles	5.45%	10%	7.73%	N	
Timber	1.90%	30%	15.95%	Y	16.0%
E-Waste	1.63%		0.82%	N	
Glass	1.45%	3%	2.23%	Y	2.2%
Ferrous Metals	1.22%	2%	1.61%	Y	1.6%
Non-Ferrous metals	0.88%		0.44%	Y	0.4%
Nappies and Sanitary	0.74%	1%	0.87%	N	
Concrete, Ceramics, Rubble	0.53%	7%	3.77%	Y	3.8%
Hazardous waste	0.06%		0.03%	N	
Domestic Batteries	0.05%		0.03%	N	
Kitchen food waste	0.05%		0.03%	Y	0.0%
EPS (polystyrene)	0.03%		0.02%	N	
Aerosol cans	0.00%		0.00%	N	
Rubber	0.00%	6%	3.00%	N	
	100.00%	100%	100%		63%

Notes:

[1] The exact composition of "Rubbish" is not identified in the CHC SWAP 2019 Report. Therefore, conservative approach is to assume Combustible and as Non-renewable

[2] Refer CHC SWAP 2019 report item 5. It is assumed that the lesser quantities from both Dunedin and Otago will be similar in composition to that MSW from Christchurch hence the CHC SWAP data has been used to represent the full MSW quantity.

[3] Composition provided by Renew Energy Limited

General Notes:

1. % Composition is on a weight basis (w/w). Refer CHC SWAP 2019 report item 5.



3.3 Percentage of “Renewable” energy

As can be seen from Table 4, the waste being consumed by the EfW facility contains both organic and fossil fuel derived waste.

Renewable energy is defined as energy which is obtained from organic or biogenic material [Appendix A – MfE factsheet “*A waste to energy guide for New Zealand*”, August 2020].

Energy which is obtained from waste which is derived from fossil fuels is not considered renewable energy.

Accordingly, the % renewable energy that the EfW plant produces is directly connected to the composition of the waste feed stock. Based upon the representative waste composition, the EfW facility will produce around 63% renewable electricity.

This number can be considered conservative as nearly 25% of the MSW composition identified by the SWAP data is generically called “Rubbish” without any additional identification. We have assumed for the sake of conservatism that this rubbish is not a renewable energy source.

3.4 Impact of waste quality and variability

The composition of waste can be quite variable and as such the plant is designed to accommodate a wide range of waste compositions and critically a range of calorific values.

The typical waste composition given in table 2 has been assessed as having a calorific value of 11,000 kJ/kg and this is used for the ‘nominal’ scenario.

However, all aspects of the plant (including combustion and emissions treatment technology) are designed to accommodate and achieve the stipulated emissions criteria across a range of waste calorific values from 7,000kJ/kg up to 13,000kJ/kg where that waste confirms to *Technical Report 16 – Waste Acceptance Criteria*.

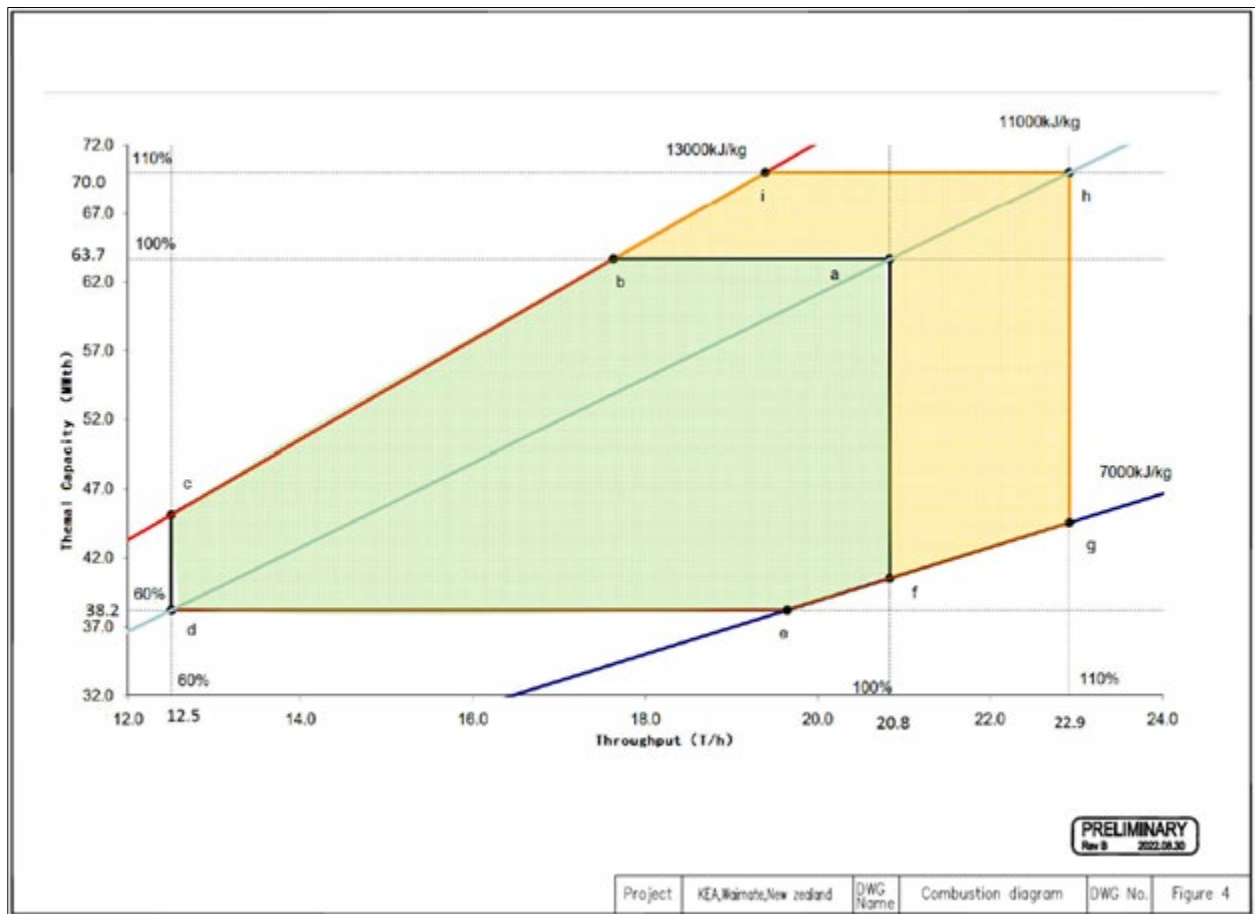


Figure 3: Operational envelope for MSW of varying calorific value

3.5 Effect of progressively increasing recycling and composting going forward

As New Zealand continues to improve its recycling and composting initiatives going forward, this will potentially lead to a change in the residual waste composition being delivered to the plant.

As plastic/paper/cardboard recycling increases then this could lower the CV of the waste. Conversely, as the level of composting of green and putrescible waste increases then this could increase the CV of the waste.

Accordingly, the facility is designed to be able to handle a wide range of waste calorific values that may arise from changing recycling behaviours going forward.

3.6 Current and future waste availability

Waste volumes nationally are stable to increasing, and excluding recovered waste, the total volume of suitable waste in the South Island was estimated as 1.8m tonnes in 2021. Suitable waste has been

estimated utilising MfE data and reports. MfE only collects waste volume data for Class 1 and more recently Class 2 landfills. The following waste volumes went to landfill during the 2015 to 2021 period:

Table 5: Waste Volumes to Landfill between 2015 and 2021

Year	North Island Class 1 Landfill tonnage received	South Island Class 1 Landfill tonnage received	Total
2015	3,222,415.37	727,951.58	3,950,366.95
2016	3,404,947.65	702,947.11	4,107,894.76
2017	3,494,308.76	736,514.46	4,230,823.22
2018	3,705,275.47	730,206.93	4,435,482.40
2019	3,499,671.95	707,455.29	4,207,127.24
2020	3,382,918.60	742,148.74	4,125,067.34
2021	3,537,798.32	804,686.46	4,342,484.78

Source: MfE response attached in Appendix B obtained under OIA request.

MfE estimated in 2021 that New Zealand disposed of 19,629,581 tonnes of waste to all landfill types, as follows:

Table 6: Estimated waste destination by landfill type in New Zealand 2021 (tonnes)

Waste destination	Eunomia forecast	BERL forecast	Total %
Class 1 landfill	3,870,889	4,192,290	21
Class 2 landfill	3,048,973	3,302,130	17
Class 3 landfill	76,227	82,553	0.4
Class 4 landfill	4,497,235	4,870,642	25
Farm dumps	1,613,005	1,746,933	9
Recovery	5,076,640	5,498,155	28
Total waste generated	18,124,683	19,629,581	100

Source: BERL Report, Waste to Energy, June 2019; % column added for information.

Building from both BERLs analysis for MfE, and MfE OIA data, it can be estimated that within the South Island in 2021:

Table 7: Estimated waste destination by landfill type in South Island 2021 (tonnes)

Waste destination	Total %	Estimated South Island landfill tonnage received 2021
Class 1 landfill	21	804,686
Class 2 landfill	17	651,413
Class 3 landfill	0.4	15,327
Class 4 landfill	25	957,960
Farm dumps	9	344,866
Recovery	28	1,072,915
Total waste generated	100	3,847,168

Excluding recovered volumes, 1,800,965 tonnes of waste has been estimated to have gone to Class 1 and Class 2 landfills, and Farm dumps in the South Island of which Project Kea has secured access to approximately 365,000 tonnes which equates to just 20% of the total available quantity.

Accordingly, SIRRL consider it extremely unlikely that any positive changes in recycling behaviour or other positive initiatives to minimise overall waste volumes will affect the volumes of waste received by Project Kea.

SIRRL has signed conditional Heads of Agreement with waste suppliers to provide the yearly waste volumes to the plant.

4 FACILITY AND PROCESS OVERVIEW

4.1 Facility

The facility is to be constructed on a 14.85ha site on the corner of Morven-Glenavy Rd, South Canterbury, NZ.

Central to the site is the main powerhouse which contains the two boilers, the emissions control equipment and the vitrification process for treating fly ash. On the western end of the main building is the approach bridge for receiving trucks that bring waste into the facility, the unloading hall, and the waste storage bunker.

South of the main powerhouse is the baled waste storage shed, a water treatment building and workshop facilities.

North of the main powerhouse is the site administration and amenities building and car parking.

A future rail siding is included in the overall master plan for the site to support delivery of waste to the site by rail.

Light vehicles have a dedicated entrance way from Morven-Glenavy Rd on the eastern boundary and heavy vehicles have a separate dedicated entrance way of Morven-Glenavy Rd on the southern boundary.

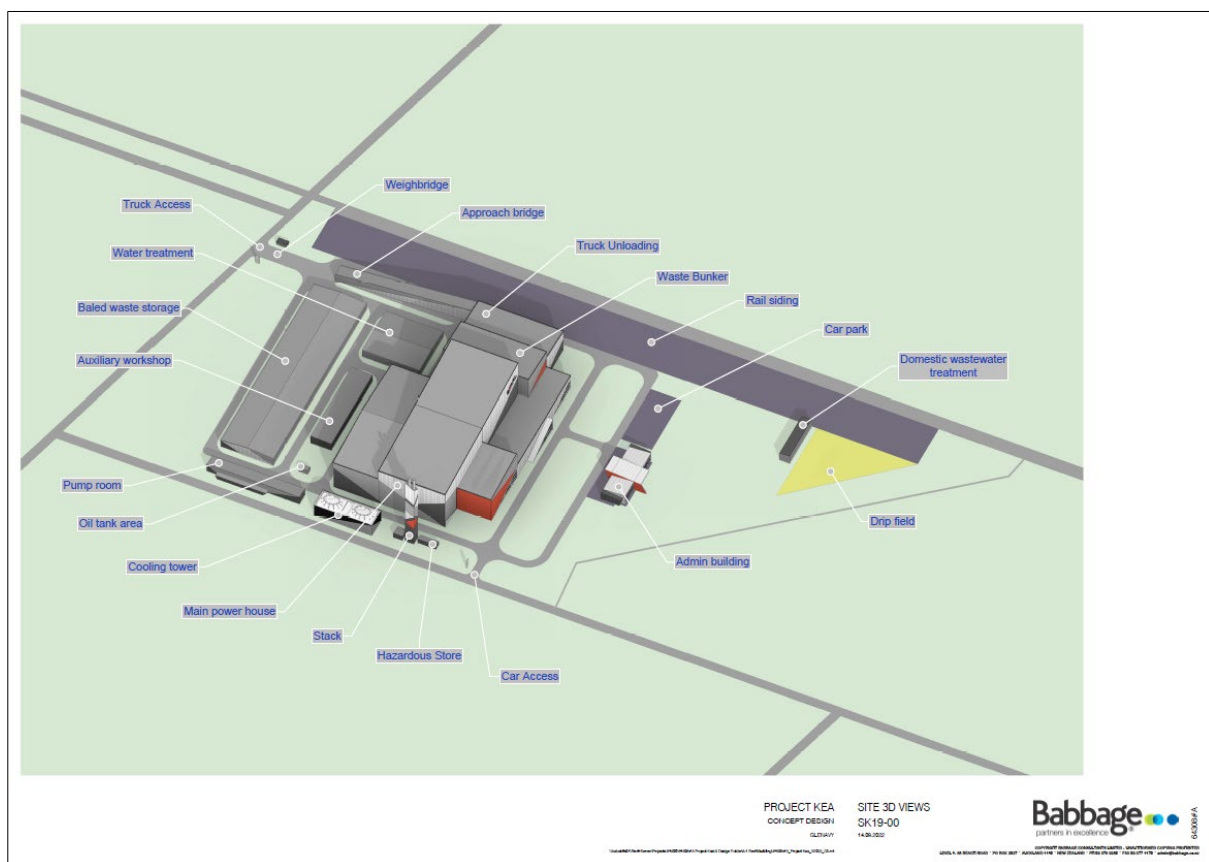


Figure 4: Project Kea Proposed 3D Image

4.2 Process

The facility essentially has four main processes that work in parallel to successfully recover energy from waste and convert it into electricity while mitigating potential negative impacts on the environment. These are:

- Combustion process (recovering heat energy from MSW and treating the flue gas emissions)
- Steam and electricity generation process (using the recovered heat to produce electricity and optionally steam)
- Treatment process for solid by-product streams
- Treatment process for contaminated wastewater

4.2.1 Overall Flow Diagram

The plant contains two duplicate combustion lines each consuming 500tpd of waste which are able to operate independently of each other. Combined they consume 1,000tpd of waste.

The main steps in the Combustion process, including flue gas treatment, are outlined in Figure 5.

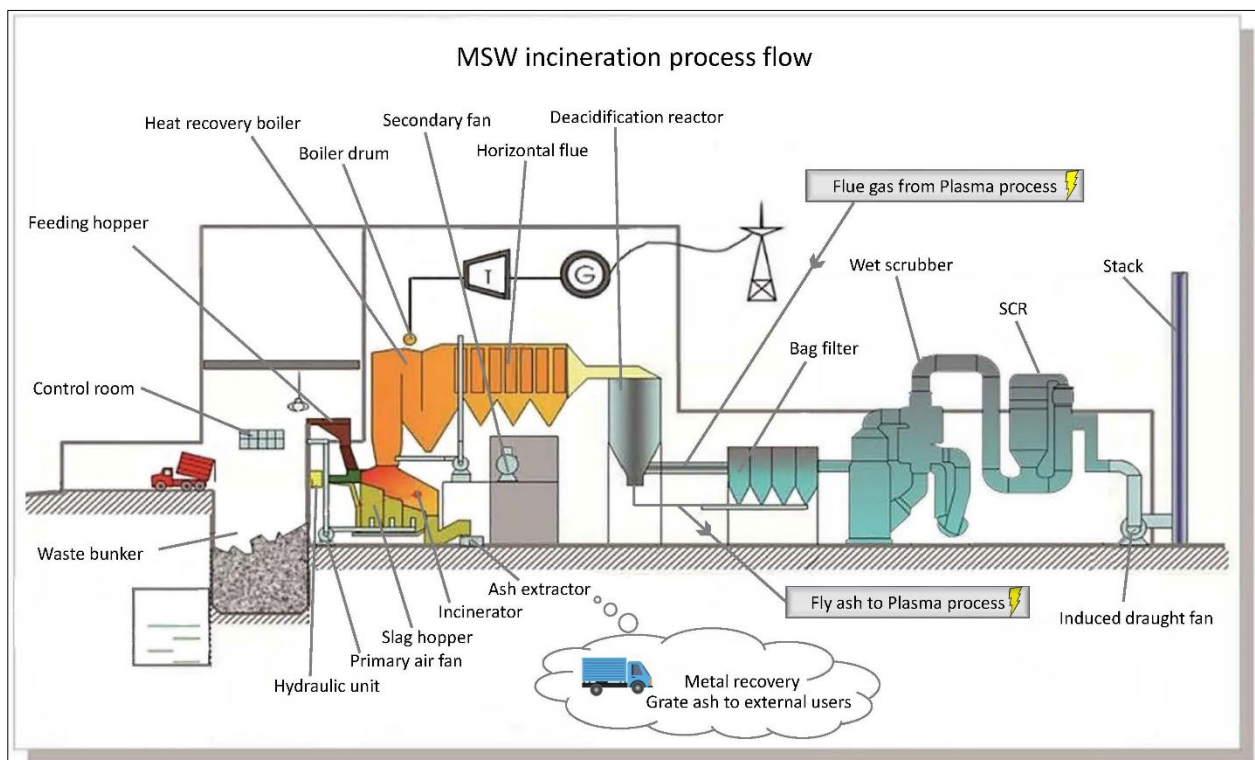


Figure 5. EFW combustion steps including flue gas treatment

4.2.2 Overall Mass Balance

A full mass balance for the plant has been developed covering the scenarios of both varying waste calorific values and the two different modes of energy generation (explained later in this report).

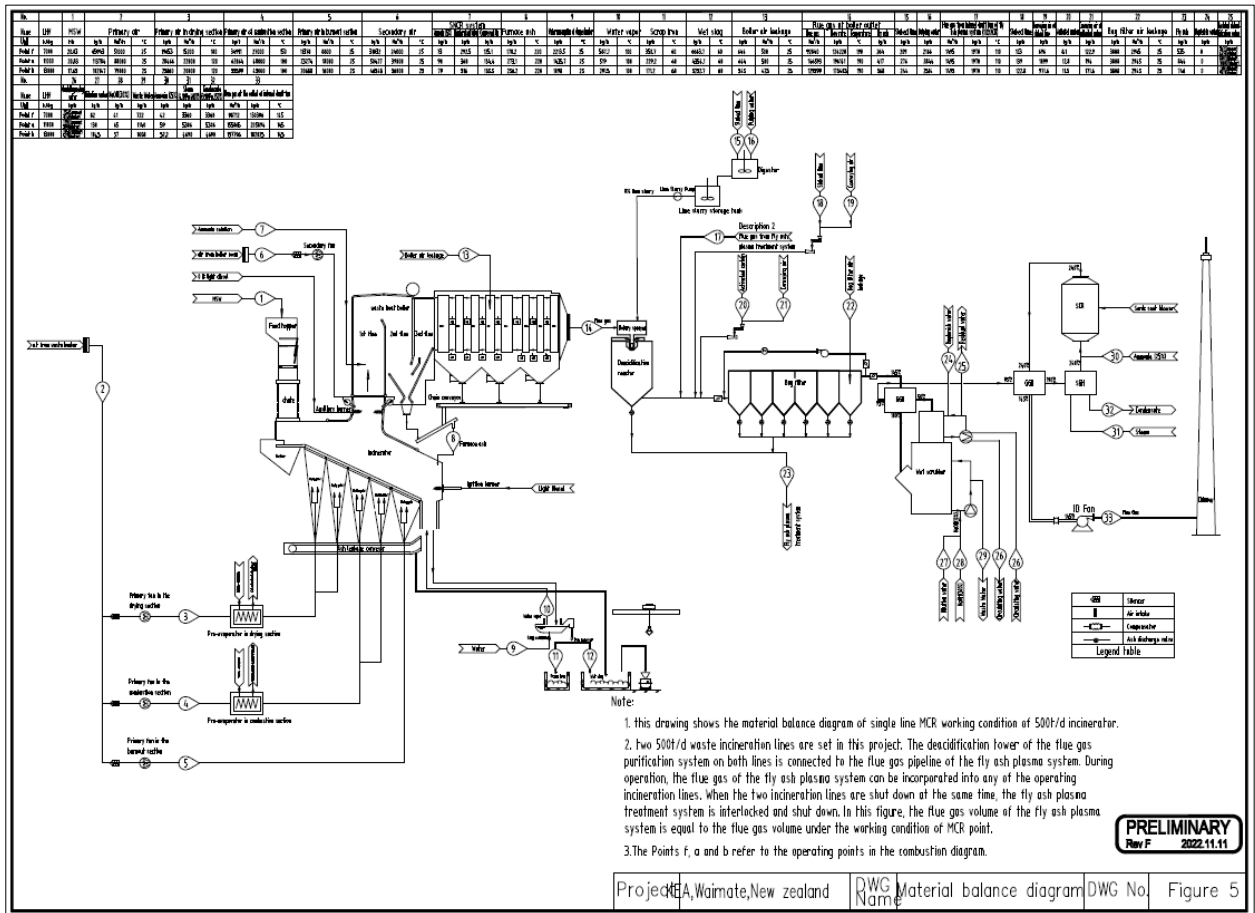


Figure 6: Main Process Mass Balance



5 WASTE RECEPTION, STORAGE AND ODOUR CONTROL

5.1 Waste Logistics and delivery to site

5.1.1 Pre-delivery offsite sorting

The plant desires waste which has already had any re-usable and recyclable materials removed. This therefore requires sorting activities to occur as a function of waste collection and before the waste is delivered to the EfW facility.

The EfW facility does not have any recycling or waste sorting functions for MSW that is delivered to the site.

5.1.2 Initial delivery solution – road

Initially the waste feedstock will be brought to the EfW facility by road using several potential truck configurations. The trucks will drive directly into the main building and tip waste directly into the internal waste bunker. There will be no external exposed storage of any waste on site.

Trucks delivering waste will have a dedicated pathway from State Highway 1 along Carrolls Rd and into the heavy vehicle entrance on site. All trucks will exit site and proceed to their destination via the same route.

To support this increased traffic activity along Carrolls Rd, the project will include the upgrade of Carrolls Rd including widening, sealing, upgrading the SH1/Carrolls Rd intersection and improving safety at the Carrolls Rd level crossing [*refer Technical Report 8*].

Confirmations from Murphy Farms Ltd and Morven-Glenavy Irrigation Scheme have been obtained for supporting the necessary amendments to the easements and upgrade works. [*Refer: Appendix C*]

5.1.3 Future delivery solution – road & rail

In the future it is intended to migrate as much of the transport of waste to the facility from road onto rail. For this reason, the design of the site incorporates the ability to construct a future rail siding to facilitate the arrival of waste by rail.

Using rail, the waste would arrive either containerised or baled. Provision is made on site to store containers (both full and empty) and also for the enclosed storage of baled waste.

The enclosed storage of baled construction waste ensures that both visual and windblown litter effects are mitigated and also provides the ability to have fire suppression systems in place to mitigate against fire risk.

5.2 Waste Reception

5.2.1 Loose MSW

Trucks bringing waste to the EfW site proceed directly up the approach bridge into the unloading hall.

Once in the unloading hall, the trucks back up and tip their load directly into the waste bunker. The waste bunker has capacity for around 7 days' worth of waste feedstock.

Moisture contained within the waste in the bunker may form a leachate which is collected from the base of the bunker. This leachate is sent into the furnace for safe disposal.

The waste bunker and the unloading floor are held under slight vacuum, causing an inflow of air up the approach tunnel. This vacuum and subsequent inwards air flow is what retains any odours within the facility and mitigates against release to the external environment.

The combustion process requires a significant amount of air, and the vacuum is created by drawing this combustion air from the space above the waste bunker, which in turn draws air from the unloading hall. This ensures that odour laden air is drawn into the furnace whereby the odorous components are destroyed during the combustion process.

The facility also has a secondary odour scrubbing system which is used to treat odorous air from the bunker during the in-frequent situations when both furnaces are shut down.



Figure 7: Trucks in the unloading hall tipping waste directly into the waste bunker beyond.



Figure 8: Truck tipping waste from the unloading floor into the waste bunker

5.2.2 Baled CW

Baled waste, which comprises construction waste, will also be delivered to site. These bales of waste will be delivered by truck and unloaded by forklift (or the like) either directly in the unloading hall or alternatively directly into the baled waste storage shed.

5.3 Waste Storage

5.3.1 Loose MSW

Loose waste delivered by truck is stored internally within the facility in the waste bunker.

The waste bunker holds approximately 7,000 tonnes of waste.

A leachate sump is located at the corner of the waste bunker to collect any leachate coming from the waste. The leachate is then pumped into the furnace for disposal as part of the combustion process.



Figure 9: Waste bunker during construction with the gantry for the grapple hook installed.

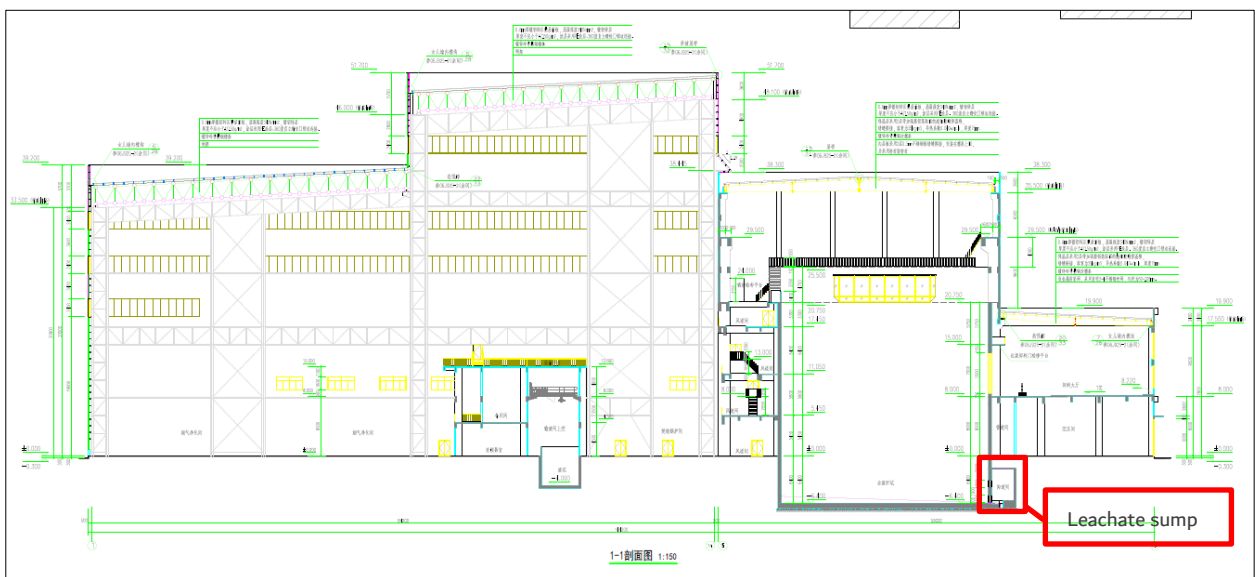


Figure 10: Leachate sump is located at the base of the waste bunker

5.3.2 Baled CW

Baled construction waste which is not immediately sent to the waste bunker is stored in a dedicated warehouse on site. The warehouse is fully enclosed.

As needed, baled waste is taken from the storage warehouse into the unloading hall where the bales are dropped into a chute which feeds into a debaler. The debaler pulls the bales apart and deposits the loose construction waste into the main waste bunker.

5.3.3 Vermin Control

The control strategy for rodent vermin will be the same as used in NZ for food manufacturing industries. This essentially involves using approved bait station devices deployed along a primary perimeter control line at the boundary of the site and a secondary perimeter control line around the individual buildings including near any doorways or openings.

5.4 Odour Control

MSW contains significant organic and biogenic material that creates odour due to decomposition. This odour, or more specifically the odour laden air, must be contained and treated within the facility to ensure that no detectable odour occurs beyond the site.

5.4.1 Primary odour control

The primary odour control measure is to unload and store MSW in a bunker that is totally enclosed within the facility. The bunker is held under negative pressure to ensure that no odorous air escapes from within the building to the environment.

The negative pressure is created by the furnace supply fans drawing the furnace feed air from the bunker space and delivering that air into the furnace to support the combustion process.

This ensures that any odorous elements are both contained and destroyed without being released to the environment.

The bunker is designed to nominally operate at around -50Pa. The negative pressure is maintained by control of the doors between the bunker and the unloading hall and the door at the entrance to the entry tunnel. The design of the openings between the unloading hall and the bunker are such that the negative pressure in the waste bunker is maintained with only one furnace operational. Each furnace operating at design capacity draws around 88,000Nm³/h of combustion air from the bunker which has a volume of around 70,000 m³. This results in approx. 1.25 air changes per hour which mitigates against odorous elements escaping to the external environment. When both furnaces are operational, the air change rate doubles to 2.5 air changes per hour.

A further door is placed at the entrance of the approach tunnel which takes trucks to the unloading floor. This door is operated to allow a truck either in or out and is otherwise set partially closed as part of the

negative pressure control which ensures an inwards airflow is maintained up the ramp into the plant, again mitigating against odorous air escaping to the external environment.

The unloading doors between the waste bunker and the unloading hall are controlled to maintain a nominal 0.5-1m/s air flow velocity through the doors which prevents the escape of odour from the waste bunker through the unloading door into the unloading hall.

5.4.2 Secondary odour control

The secondary odour control measure is only used in the infrequent situations when both furnaces are shut down. In this situation air cannot be drawn from the waste bunker and unloading floors and fed to the furnaces and therefore a secondary dedicated odour scrubbing system is provided.

When the furnaces are not running, the unloading doors are closed and the odour extract fans are automatically activated, which extracts the odour laden air to the secondary odour control system.

This secondary system uses a wet scrubber to remove odorous elements from the air comprising both alkali and acid wash solutions. The liquid waste stream from the wet scrubber is treated and recycled through the main process wastewater treatment system. Refer Appendix D for additional drawings.

It's worth noting that these secondary systems are not commonly installed in Europe where in times of shut down they choose to simply close the doors to trap the odour inside the facility. The provision of a secondary odour control system provides additional security against odour escape when no furnaces are running.



Figure 11: Waste Bunker Secondary Deodorising system showing extract fan and scrubbing towers.

6 MAIN COMBUSTION PROCESS

6.1 Feeding the furnaces

Once the waste is in the waste bunker, it is handled by operators who operate two overhead grapple cranes.

The operators use the overhead grapple cranes for two primary purposes:

1. They 'mix' the waste within the bunker by moving it around to create a more homogeneous blend. This achieves a more consistent fuel supply which is then fed to the furnaces
2. They pick up waste and deposit it into the furnace feed chutes where it then travels down onto the furnace grates where the energy in the waste is recovered through combustion.

The operator also sees the nature of the waste being tipped out of the trucks. If it is seen that "unapproved" waste is tipped from a truck (e.g., a load of tyres) then that information is recorded for later discussion with the waste supplier. On isolated occasions, where some item is tipped which cannot be fed to the furnace (e.g., an engine block) then it is picked up by the grapple and placed at the side of the bunker for manual removal from the plant.



Figure 12: Grapple crane used to both mix MSW within the bunker and feed MSW into the furnaces.



Figure 13: Grapple crane operators at work with a view over the waste bunker.

6.2 Main furnaces

The main furnaces are where the waste is combusted to recover the energy contained within. Diesel is used as the start-up fuel until combustion temperatures are stabilised above 850°C at which time the furnaces run solely on waste feedstock. Diesel is also used during shut down to ensure the waste on the grate is fully combusted with the temperatures remaining above 850°C.

A start-up/shut-down cycle occurs nominally once per year for each furnace.

The quantity of diesel consumed by each furnace for a start-up/shut-down cycle is approximately 54,000kg.

The specially designed grate incorporates both a drying section and a combustion section, both of which are force fed conditioned air from underneath.

The heat energy released by the incineration of the waste is recovered in a steam boiler in three steps, in a similar way as in fuel or gas fired boilers for electricity generation:

1. In the economizers, the boiler feedwater is preheated to a temperature below the saturation temperature before it is fed into the steam drum
2. In the evaporator sections the drum water is evaporated to saturated steam

3. Further heat energy is recovered from the flue gas stream into the steam by superheating it above its saturation temperature.



Figure 14: Boiler and heat recovery system

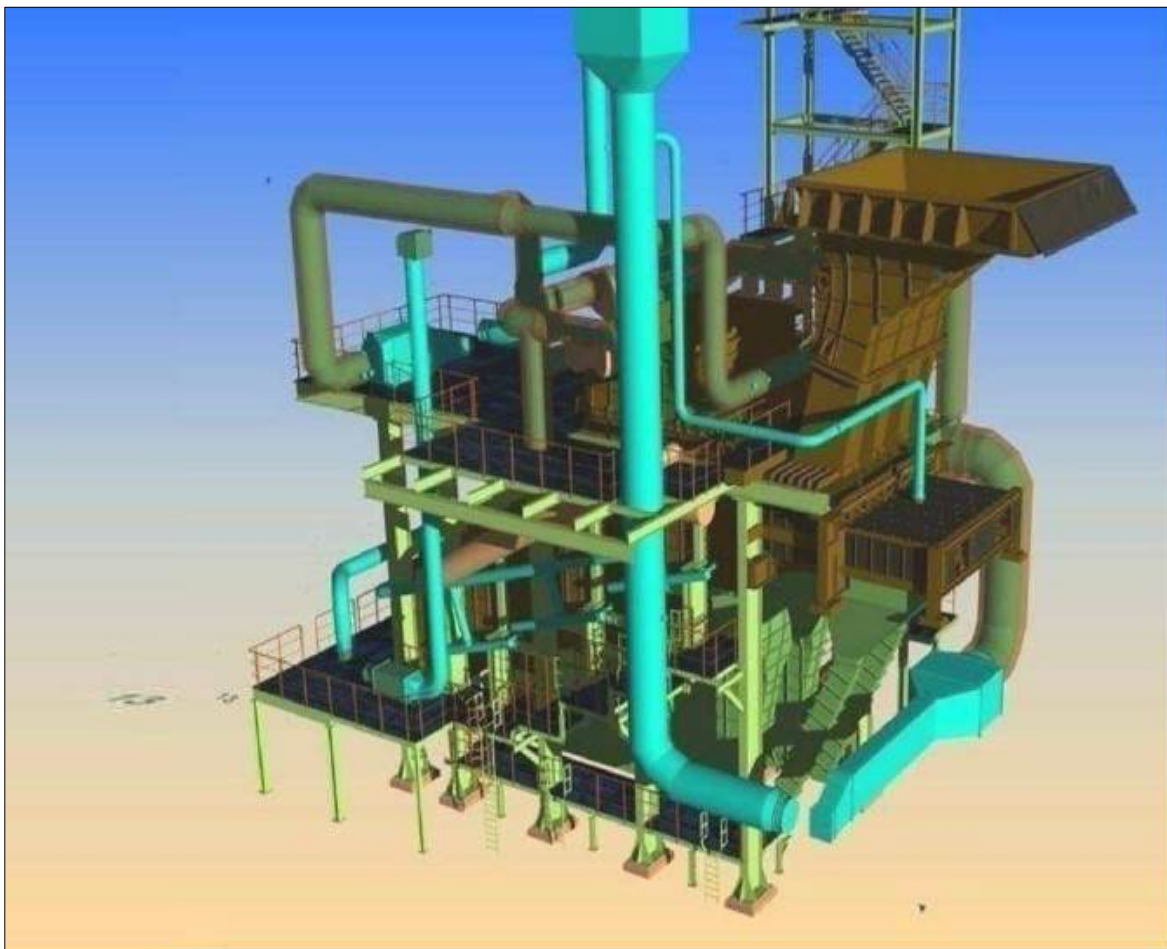


Figure 15: Diagram of furnace feed chute and main furnace

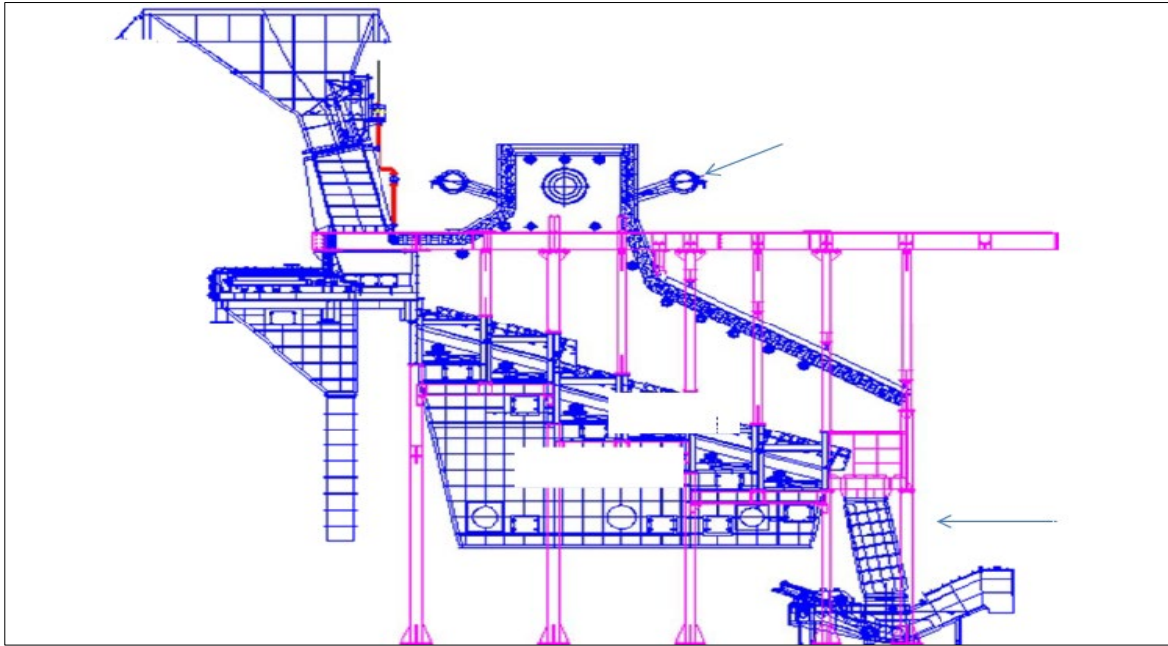


Figure 16: Diagram of furnace feed chute, main furnace and grate ash rejection system



Figure 17: Section of furnace combustion grate

7 FLUE GAS TREATMENT

7.1 MSW incineration contaminants

Combustion of MSW creates a wide range of potential contaminants which if released to the environment in quantity can cause harm to both humans and the wider environment.

The main potential pollutants from the combustion of waste are:

1. Products from incomplete combustion; including carbon monoxide, carbon black, hydrocarbons
2. Particulates; including inert metal salts, metal oxides and ash particles
3. Acid gases: including hydrogen chloride, hydrogen halide, sulphur oxides (SO₂, SO₃), nitrogen oxides, and phosphoric acid
4. Heavy metal pollutants; including lead, chromium, mercury, cadmium, arsenic and other elemental states, oxides and chlorides
5. Dioxins and furans; i.e. PCDD's and PCDF's

Therefore, significant and multi-step technologies are employed for the purposes of stripping the flue gas of contaminants before discharging out the stack into the environment.

Both the main combustion train and the fly ash vitrification process have their own specific flue gas treatment systems which are outlined as follows:

7.2 Main combustion flue gas treatment

The flue gas from the main furnace is treated through a multi-step process to capture and remove contaminants from the gas stream. The treatment process involves the following steps:

Table 8: Main flue gas treatment steps

Treatment Step	Treatment Description	Components removed
Step 1: SNCR	Selective non-catalytic reduction Injection of Ammonia (25%) direct into boiler fire box at 850 – 1100C	NO _x
Step 2: Semi-dry Deacidification	Spray drying of Slaked Lime solution (8%) into the flue gas stream	Acid components
Step 3: Dry Spraying	Injection of Slaked Lime	Acid components
Step 4: Activated Carbon Absorption	Injection of Activated Carbon	Dioxins & Heavy metals
Step 5: Filtration	PTFE filter bags	Particulates and reaction products as salt particles

Step 6: Wet Scrubber	NaOH wash solution	Acid components
Step 7: SCR	Selective catalytic reduction Spray 25% Ammonia solution	NO _x (convert to N ₂ & H ₂ O), decompose dioxins (PCDD and PCDF)

Step 1 – SNCR

Correct optimisation and control of the combustion process results in NO_x levels below 400mg/Nm³.

Injection of an aqueous ammonia solution directly into the incinerator then further reduces NO_x levels through chemical reaction to levels below 200mg/Nm³.

The chemical reaction reduces NO_x to nitrogen and water through the following chemical reaction:

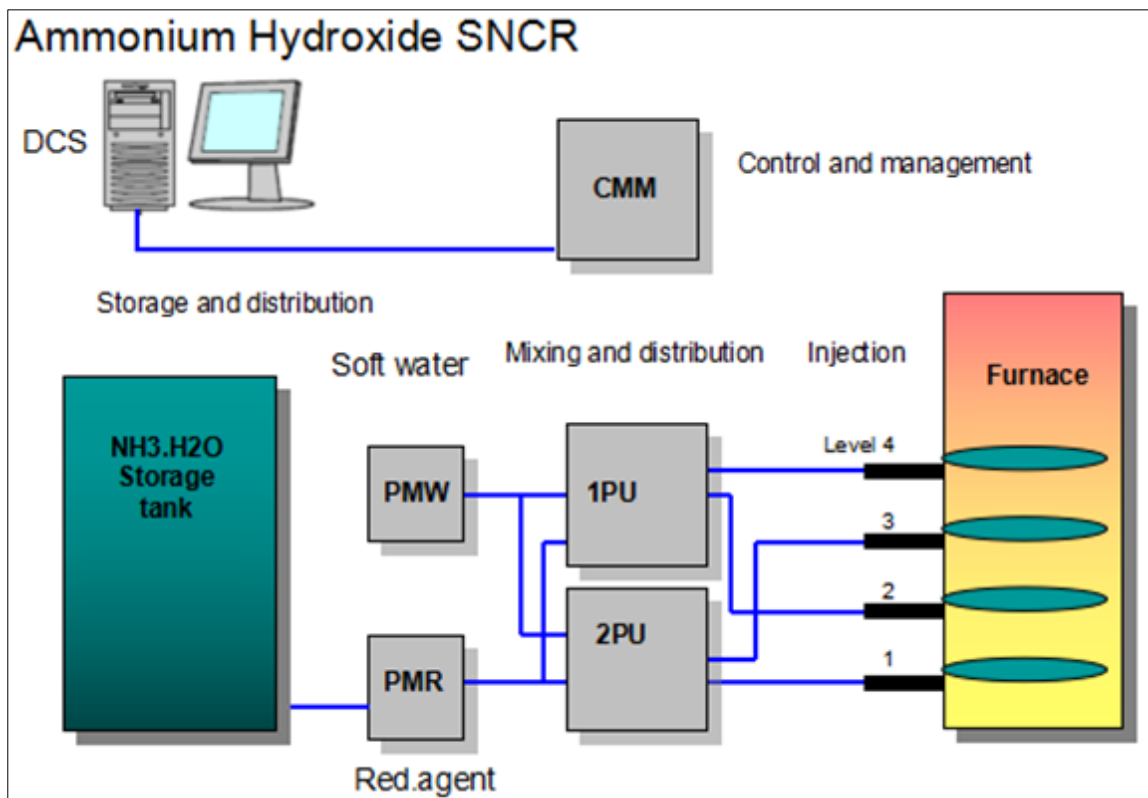


Figure 18: Schematic of SNCR process

Step 2 – Semi-dry deacidification

Flue gas exits the boiler economiser at approximately 190-200°C. This flue gas stream is then directed into the top of the deacidification reaction tower.

A lime slurry (i.e. a mixture of hydrated lime and water) is sprayed from the top of the reaction tower into the hot flue gas stream. The spray is atomised via a rotary atomiser to ensure excellent mixing and contact between the lime slurry and the flue gas. This results in the water component of the lime slurry evaporating and the acid components in the flue gas stream being removed through reaction with the lime.

The residence time of the flue gas in the reaction tower is not less than 20 seconds and it then exits the reaction tower cooled to around 155°C due to the evaporation process.

A portion of the dust formed falls to the bottom of the tower and is removed for treatment with the fly ash. The remaining dust travels with the flue gas stream through to the filter bag house.



Figure 19: Dual semi-dry deacidification reaction towers



Figure 20: High speed rotary atomiser for spraying lime solution into the flue gas stream

Step 3 – Dry deacidification

Following deacidification in the reaction tower, the flue gas is further cleaned of acid components such as SO_x and HCl through contact with dry sprayed lime powder.

Dry lime powder is distributed into the flue gas stream whereby it reacts with acid components. The dust then travels forward to be collected and removed by the bag filters. The quantity of lime sprayed is controlled in proportion to the flow rate of the flue gas.

Step 4 – Activated carbon absorption

Following deacidification, the flue gas is cleaned of dioxin products and heavy metals through contact with activated carbon. The contaminants are captured by the activated carbon which then travels forward in the flue gas stream to also be removed by the bag filters. The quantity of activated carbon added is controlled in proportion to the flow rate of the flue gas.

Step 5 – Bag Filter

Flue gas containing fly ash, lime, activated carbon and reaction compounds then passes through a bag filter to remove particulates, including the activated carbon and the solid reaction products (salt particles) from the flue gas stream.

The bag filter system consists of a 'pre-separation' section whereby the incoming flue gas is first directed at a deflector plate in a settling chamber which allows the larger particulates to fall directly out of the flue gas stream into the fly ash hopper below.

The gas then flows into the bag filters whereby the dust is captured on the outside of the filter bags with the filtered gas passing through the filter bag and exiting the bag house.

Each filter bag is supported by an internal frame. At periodic intervals each filter bag is subject to a pulse of compressed air from the clean side which momentarily reverses the pressure drop across the bag filter. The result of this momentary reverse flow is to dislodge the dust which has collected on the outside surface of the filter bag which then drops into the ash hopper below. The pulse cleaning ensures that the filter bags do not become blinded and ensures that they continue to filter the flue gas stream effectively. The frequency of pulse cleaning is done both on time and through measurement of the differential pressure across the bag filters.

The ash hopper at the base of the bag houses is electrically heated which is used during shut down periods and during start-up to ensure the internal surface of the ash hopper remains above the dew point to avoid any internal condensation.

A critical factor of any bag filter system is the robustness of the system and how the system can accommodate a faulty bag (i.e., a bag gets a hole in it). The bag filter system for each incinerator contains 16 separate bag filter chambers. Each of these chambers can be individually isolated from the other during operation thus allowing for maintenance and replacing bags while the plant is operational.



Figure 21: Dual baghouses



Figure 22: Top of baghouse showing pulse jet cleaning system and chamber isolation valves.

Step 6 – Wet scrubber

The flue gas from the bag filter enters the lower section of the wet scrubber where an NaOH solution is sprayed into the flue gas stream. This evaporating water cools the flue gas while the NaOH reacts with acid components in the gas to form soluble salts such as NaCl, NaF, Na₂SO₃ and Na₂SO₄.

From the lower section the flue gas then flows upwards into the upper section of the wet scrubber where the flue gas is dehumidified prior to exiting the scrubber system.

The system incorporates heat recovery between the incoming and outgoing flue gas to ensure the flue gas is at around 100°C as it enters the scrubber.

Step 7 – SCR De-nitrification

The SCR system further removes NO_x components and oxidises dioxin compounds (PCDD, PCDF). This is achieved through the injection of ammonia solution and subsequent chemical reaction in a SCR reactor.

A heat exchanger is used to boost the temperature of the flue gas to around 240°C to achieve optimum reaction conditions within the SCR. The exiting flue gas is then cooled via heat recovery against the incoming gas stream to around 145°C before discharging out the main exhaust stack.

7.3 Fly ash vitrification flue gas treatment

During the vitrification treatment of fly ash, gas contaminate products are produced that need to be cleaned before discharge to the environment. This gas stream is treated through a dedicated pre-treatment system before then being fed into the main flue gas treatment system for final treatment.

The vitrification flue gas pre-treatment steps are as follows:

Table 9: Plasma flue gas treatment steps

Treatment Step	Treatment Description	Components removed
Step 1: High Temperature Oxidation	Oxidation of flue gasses	Converts gas elements to oxides
Step 2: Water spray quenching	Quenching of flue gas from 1100°C to 95°C Wet scrubbing of contaminants	HCl, HF, SO ₃ , salts, heavy metal, particulate matter
Step 3: Alkali washing	NaOH solution to remove acid contaminants	Acid components
Then fed into main flue gas treatment system immediately following the dry de-acidification reaction tower		

Step 1 – Gas oxidation chamber

Gas products from the plasma furnace that are emitted during the plasma melting process are drawn from the furnace and pass through an oxidation chamber. This chamber converts gas elements to oxides. A small amount of diesel is injected to enable the oxidation process (approximately 14kg/hr).

Step 2 – Water spray quenching and purification

The oxidised gas elements are then cooled using a water spray. This also provides a washing effect removing particulates.

Step 3 – Alkali washing

The cooled gas is then further purified by a caustic spray solution to remove acid components.

The semi-cleaned and cooled vitrification gas stream is then fed into the main flue gas treatment system prior to the dry lime addition step for final cleaning along with the main combustion flue gas.

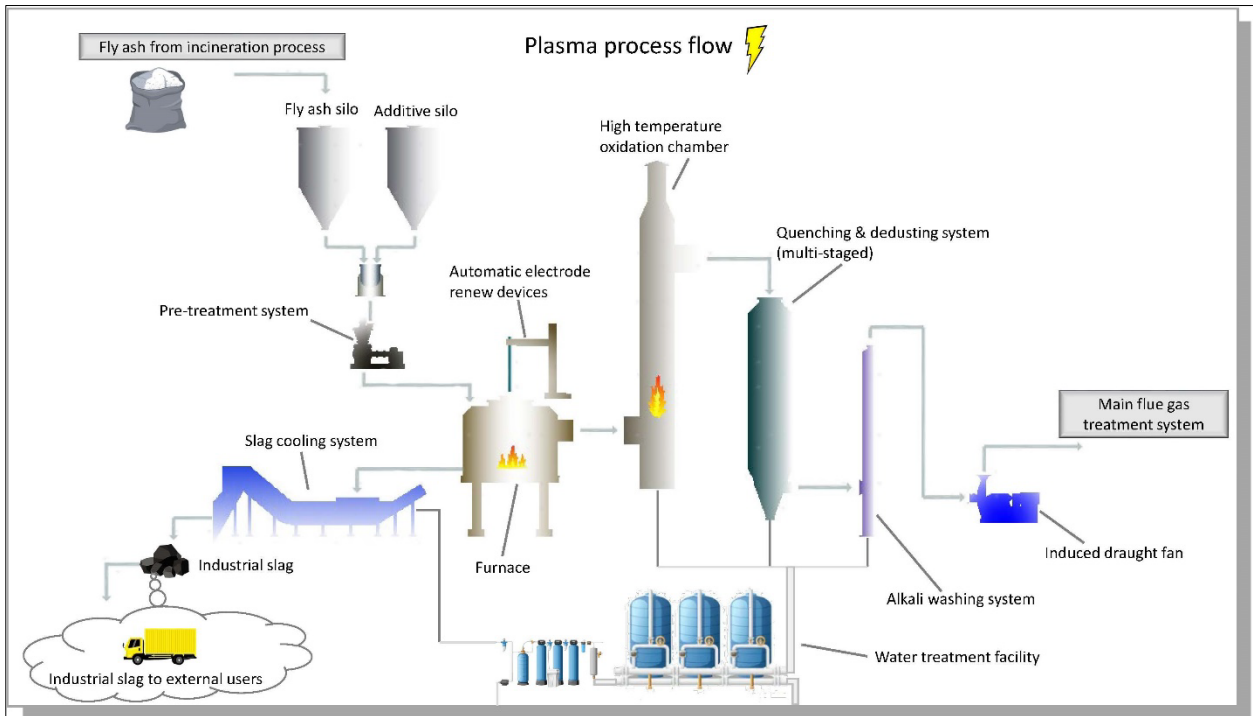


Figure 23: Schematic of Fly ash plasma treatment process

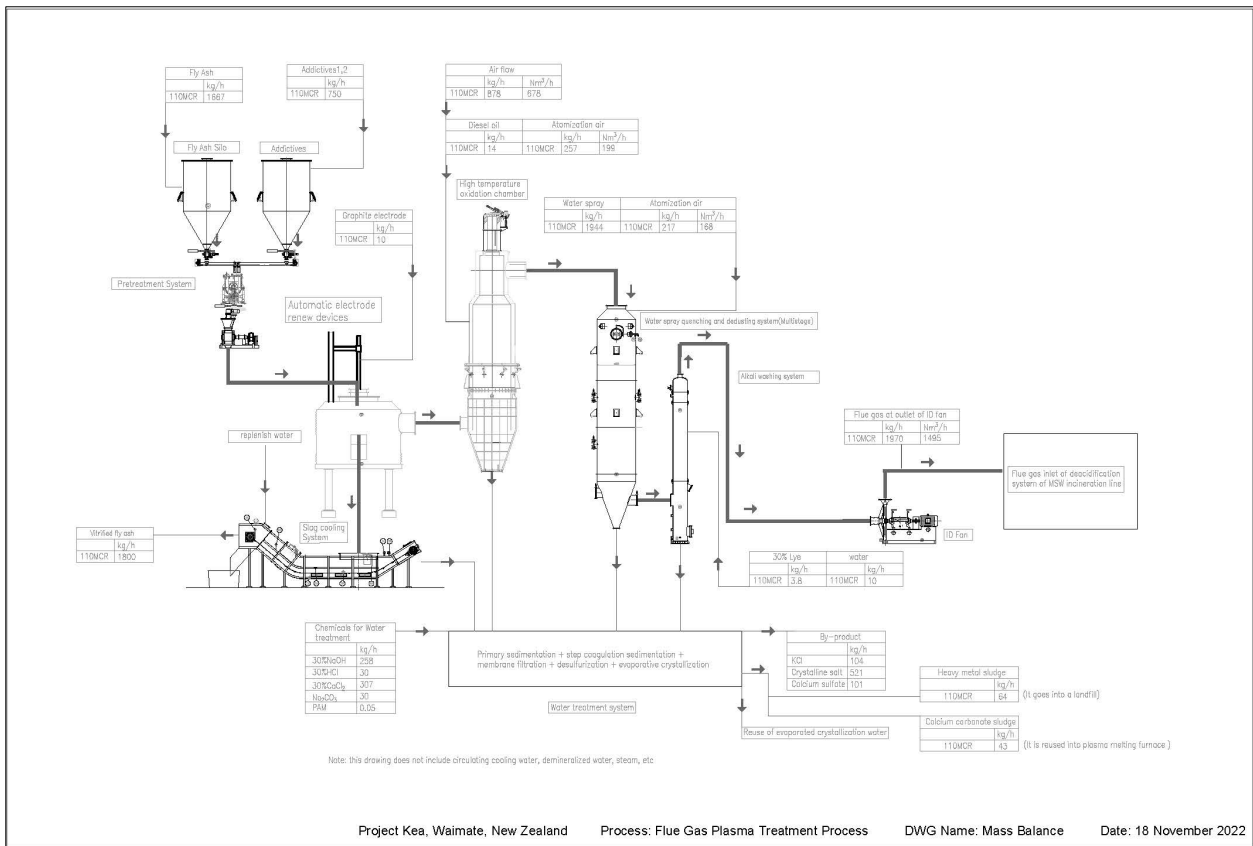


Figure 24: Fly ash plasma treatment process drawing

The quenching and alkali washing stages of the vitrification flue gas generates a contaminated water stream that must then be treated. This is done using a dedicated water treatment plant which removes the contaminants and consequently produces the following by-product streams:

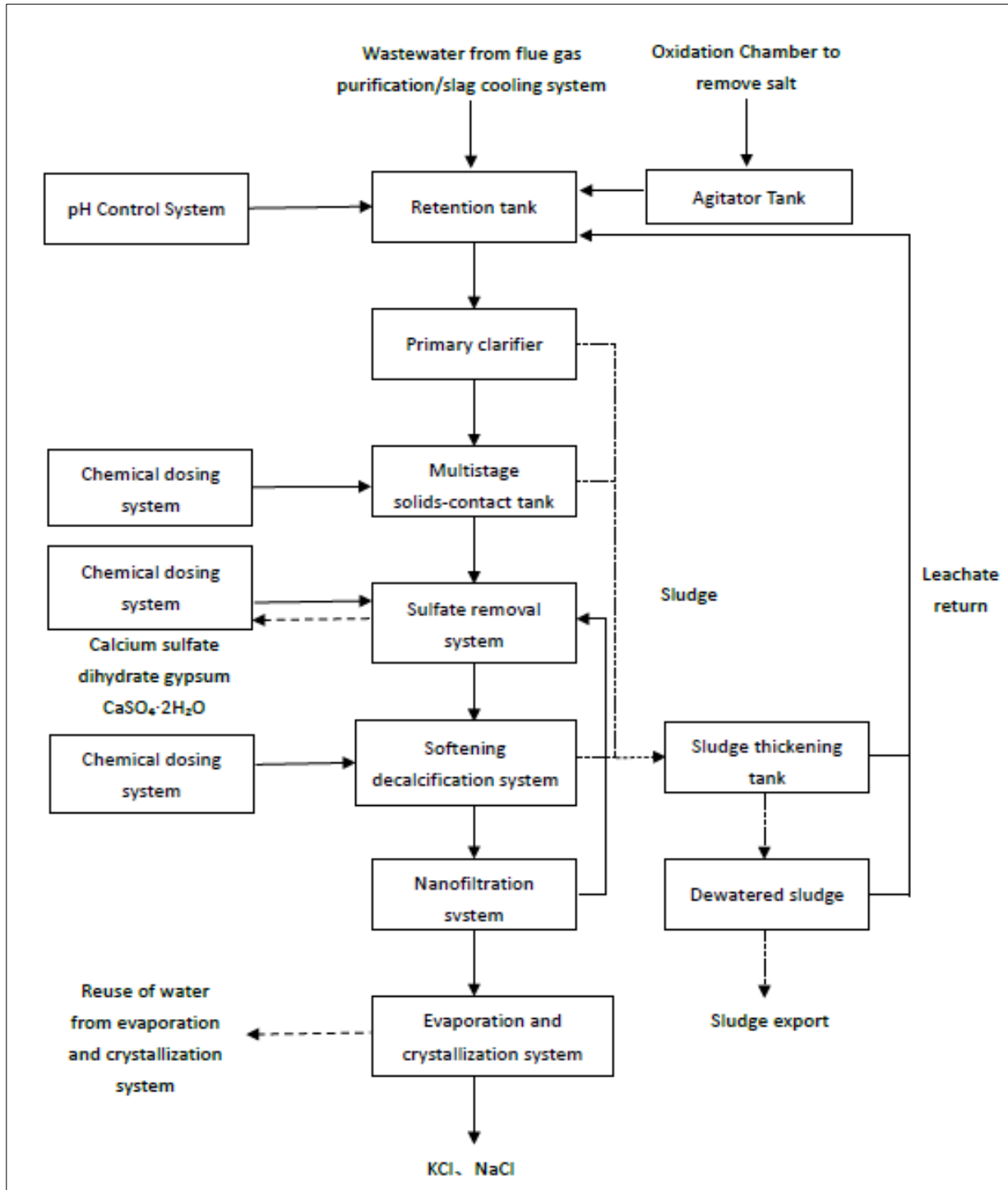


Figure 25: Fly ash plasma treatment process flow diagram



Figure 26: Plasma wastewater treatment plant

8 DESTRUCTION OF DIOXINS AND FURANS

It's not commonly appreciated that all MSW contains dioxins and furthermore that incineration is actually one of the best and most effective ways to destroy these molecules. This is the main reason that such efforts are made to ensure that flue gas temperatures remain above 850°C for more than 2 seconds. This time temperature combination effectively destroys all dioxin compounds.

The area where dioxin compounds can be of concern is through reformation as the flue gas cools down, particularly in the temperature range of 250°C to 500°C. This reformation reaction is known as "Denovo Synthesis".

The elimination of dioxins, furans and PCBs in waste incineration is mainly solved in three steps.

The first step is the decomposition of dioxins in waste at high temperature (i.e., >850°C for >2s) The complete decomposition of dioxins is achieved through the control principle of "3T+E" (i.e., incineration temperature, residence time of flue gas, sufficient turbulence of flue gas and excess oxygen supply).

The second step is to prevent regeneration (i.e., let the flue gas quickly pass through the temperature range of 500~250°C).

The third step is the flue gas cleaning (i.e., the flue gas is sprayed with activated carbon for adsorption of the dioxins followed by removal from the flue gas in the bag filter, additionally the SCR system destroys any remaining dioxins and furans). Currently, technology for online detection of dioxins does not exist due to the very low concentration levels. The approach to control dioxin levels is to continuously monitor those process variables that give rise to their creation.

The issue of dioxins, furans etc in EfW incineration plants was a hot topic in Europe during the 1990's however that debate is now considered closed and no longer an area of contention as the necessary measures required to avoid and control dioxin emissions are now well known and understood.

9 OPERATIONAL CONTROL, REAL-TIME MONITORING AND REPORTING

9.1 Process Control

The entire facility is operated from a central control room using the latest automated process control systems which monitor and control the operation and functions of the plant.



Figure 27: Main process control room

9.2 Monitoring of environmental discharges

The table below outlines the monitoring frequency for the various environmental discharges.

Table 10: Monitoring of environmental discharges

Monitoring Type	Monitoring Items	Monitoring Method	Monitoring Frequency
Flue gas	Particulates, SO _x , NO _x , HCl, CO, HF, O ₂ , CO ₂	According to 2010/75/EU	Real time online monitoring
Process Wastewater	BOD5, CODCr, NH3-N, SS, PH, wastewater quantity	Not applicable as 100% recycle	Not applicable as 100% recycle
Noise	Noise sources such as steam turbines, generators, various pumps, fans, air compressors and so on		Twice per year
Waste analysis	Waste bulk density, moisture content and calorific value	As per relevant regulations and standards	Monthly
Slag	Rate of loss by ignition	As per relevant regulations and standards	Monthly
Dioxins and furans	Dioxin in flue gas and ambient air	On-line sampling	continuous sampling tested monthly for first 2 years, six monthly for years 3 onwards
Odour pollutants	The odour in the ambient air	Sampling and measuring by professional institutions	Quarterly
Heavy metal	Heavy metal in flue gas	Sampling and measuring by professional institutions	Quarterly

Data which is monitored online and in real-time is displayed at the EfW Plant and available online to both regulatory authorities and the public.



Figure 28: Real-time data monitoring and display at CNTY EfW facility

9.3 On-line measurement of combustion components

The facility is controlled from a central control room using plant wide automation systems. The plant control system incorporates on-line real time sensors measuring the operation and performance of all aspects of the plants function including the performance of the flue gas treatment systems.

The performance of the FGT is continuously monitored at the stack through measurement of the following parameters: Particulates, SO_x, NO_x, HCl, CO, CO₂, HF and O₂.

These real-time measurements of operational performance are made available on-line to both regulatory authorities and the public.

On-line measurements are taken from the stack after the ID fan.

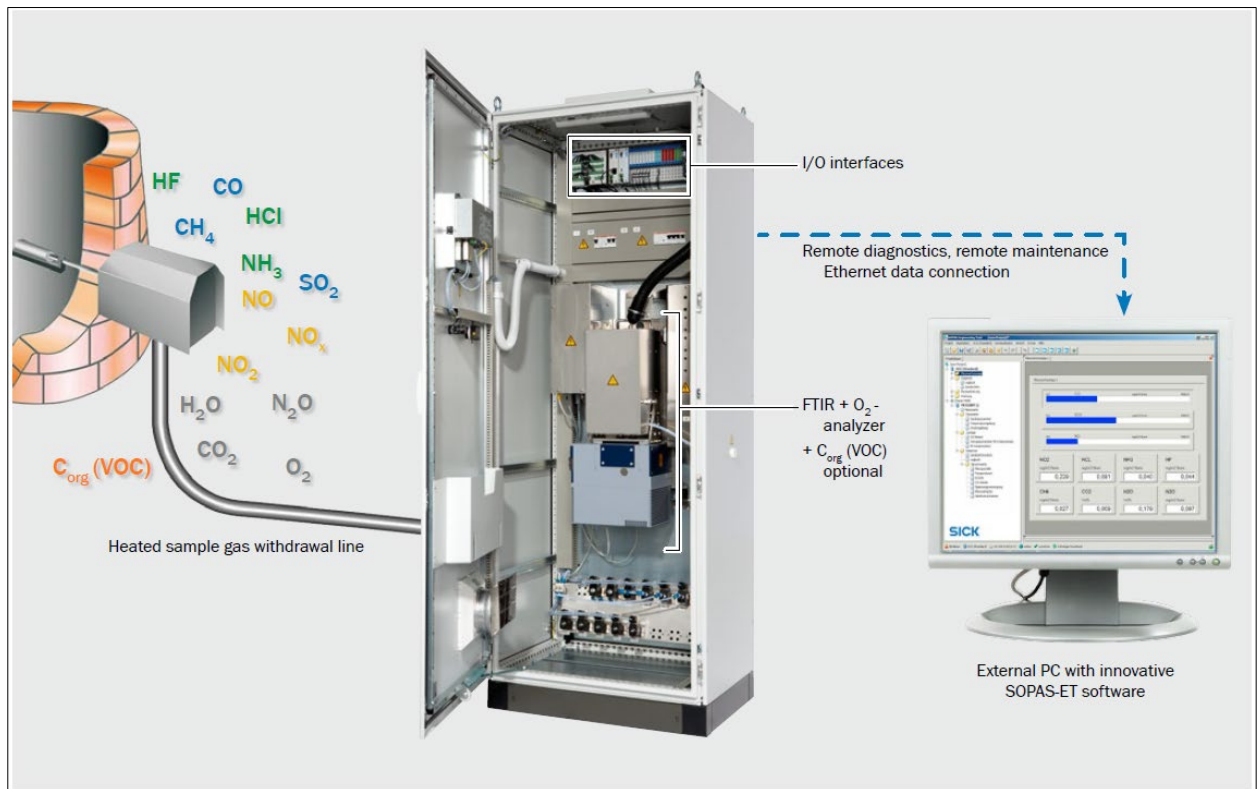


Figure 29: FTIR Analyzer System for emissions monitoring

Refer instrument details in Appendix E.

9.4 On-line sampling and measurement of Dioxins and Furans

A sampling system for dioxin measurement is provided which covers non-standard operating conditions meaning it takes samples from before “start-up” until after “shut-down”. Dioxins from the samples is collected in a dioxin sampling tube which is then sent to an external laboratory for testing at the end of the sampling period.



Figure 30: Sample of Dioxins and Furans Permanent Sampler – AMESA-D

Refer instrument details in Appendix F.

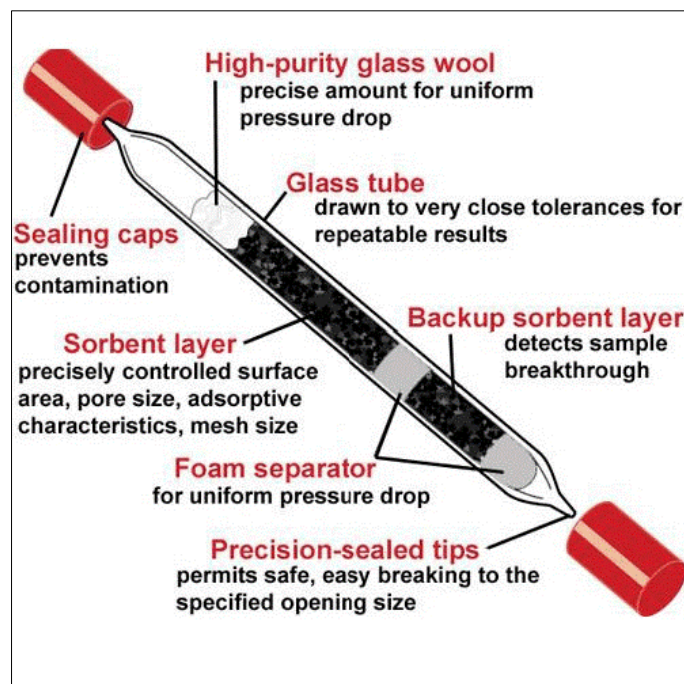


Figure 31: Dioxin sampling tube

During the sampling period a small portion of the flue gas flow is diverted over the sampling station where the dioxins stick to a special material inside a vial. At the same time the flue gas flow is registered continuously. At the end of the sampling period, the vial is replaced, and the sample vial sent to a laboratory where the dioxin content is measured. It is then possible to calculate the average dioxin

concentration per Nm³ over the total sampling period (as also the total gas flow has been counted over the sampling period). This value must be <0.1 ngTEQ/Nm³.

The advantage of this system is that the sampling is not only done during the normal operating conditions (during which dioxin emissions are extremely low) but also during start-up, shutdown, and incidents (during which potentially there are much higher dioxin emissions).

The process variables which give rise to both the creation and destruction of dioxins is well understood and are continuously monitored as part of the plant's operation. With the plant operating in accordance with its design, then the emission of dioxin compounds is controlled.

For Kea it is proposed to initially analyse the samples monthly for the first two years of operation and then move to six monthly analysis conditional upon the facility meeting its emission limits for those first two years. Note, that irrespective of the time between analysis, the sampling remains continuous, so the full operation of the facility remains monitored and measured.

On-line measurements are taken from the stack after the ID fan.

Note PCB's and PAH compounds are not directly measured and there is no requirement to do so under 2010/75/EU. PCBs behave/react chemically in the same way as PCDD/Fs in emissions abatement technology such as SCR, adsorption to activated carbon. This means that the PCB emission (if any) is reduced in the same way as that of PCDD/F's.

10 AIR EMISSION LIMITS COMPLY WITH 2010/75/EU

Contaminant levels in the flue gas being discharged to air via the stack are in accordance with the Directive 2010/75/EU of the European Parliament 24 November 2010, particularly ANNEX VI covering the technical provisions relating to waste incineration plants.

The plant will achieve emission limits as defined in PART 3 (Appendix G) below which in turn comply within the following air shed limits applicable in New Zealand:

- PM₁₀ not to exceed 50 µg /Nm³ (NES-Air Quality)
- PM_{2.5} not to exceed 25 µg/Nm³ (as referenced by CARP)

PART 3

Air emission limit values for waste incineration plants

1. All emission limit values shall be calculated at a temperature of 273,15 K, a pressure of 101,3 kPa and after correcting for the water vapour content of the waste gases.

They are standardised at 11 % oxygen in waste gas except in case of incineration of mineral waste oil as defined in point 3 of Article 3 of Directive 2008/98/EC, when they are standardised at 3 % oxygen, and in the cases referred to in Point 2.7 of Part 6.

- 1.1. Daily average emission limit values for the following polluting substances (mg/Nm³)

Total dust	10
Gaseous and vaporous organic substances, expressed as total organic carbon (TOC)	10
Hydrogen chloride (HCl)	10
Hydrogen fluoride (HF)	1
Sulphur dioxide (SO ₂)	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO ₂), expressed as NO ₂ for existing waste incineration plants with a nominal capacity exceeding 6 tonnes per hour or new waste incineration plants	200
Nitrogen monoxide (NO) and nitrogen dioxide (NO ₂), expressed as NO ₂ for existing waste incineration plants with a nominal capacity of 6 tonnes per hour or less	400

- 1.2. Half-hourly average emission limit values for the following polluting substances (mg/Nm³)

	(100 %) A	(97 %) B
Total dust	30	10
Gaseous and vaporous organic substances, expressed as total organic carbon (TOC)	20	10
Hydrogen chloride (HCl)	60	10
Hydrogen fluoride (HF)	4	2
Sulphur dioxide (SO ₂)	200	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO ₂), expressed as NO ₂ for existing waste incineration plants with a nominal capacity exceeding 6 tonnes per hour or new waste incineration plants	400	200

- 1.3. Average emission limit values (mg/Nm³) for the following heavy metals over a sampling period of a minimum of 30 minutes and a maximum of 8 hours

Cadmium and its compounds, expressed as cadmium (Cd)	Total: 0,05
Thallium and its compounds, expressed as thallium (Tl)	
Mercury and its compounds, expressed as mercury (Hg)	0,05
Antimony and its compounds, expressed as antimony (Sb)	Total: 0,5
Arsenic and its compounds, expressed as arsenic (As)	
Lead and its compounds, expressed as lead (Pb)	
Chromium and its compounds, expressed as chromium (Cr)	
Cobalt and its compounds, expressed as cobalt (Co)	
Copper and its compounds, expressed as copper (Cu)	
Manganese and its compounds, expressed as manganese (Mn)	
Nickel and its compounds, expressed as nickel (Ni)	
Vanadium and its compounds, expressed as vanadium (V)	

These average values cover also the gaseous and the vapour forms of the relevant heavy metal emissions as well as their compounds.

- 1.4. Average emission limit value (ng/Nm³) for dioxins and furans over a sampling period of a minimum of 6 hours and a maximum of 8 hours. The emission limit value refers to the total concentration of dioxins and furans calculated in accordance with Part 2.

Dioxins and furans	0,1
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- 1.5. Emission limit values (mg/Nm³) for carbon monoxide (CO) in the waste gases:

- (a) 50 as daily average value;
- (b) 100 as half-hourly average value;
- (c) 150 as 10-minute average value.

The competent authority may authorise exemptions from the emission limit values set out in this point for waste incineration plants using fluidised bed technology, provided that the permit sets an emission limit value for carbon monoxide (CO) of not more than 100 mg/Nm³ as an hourly average value.

2. Emission limit values applicable in the circumstances described in Article 46(6) and Article 47.

The total dust concentration in the emissions into the air of a waste incineration plant shall under no circumstances exceed 150 mg/Nm³ expressed as a half-hourly average. The air emission limit values for TOC and CO set out in points 1.2 and 1.5(b) shall not be exceeded.

3. Member States may lay down rules governing the exemptions provided for in this Part.

With respect to the measurement of dioxins and furans, Part 2 (Appendix H) provides equivalence factors for dioxins and furans as follows:

PART 2	
<i>Equivalence factors for dibenzo-p-dioxins and dibenzofurans</i>	
For the determination of the total concentration of dioxins and furans, the mass concentrations of the following dibenzo-p-dioxins and dibenzofurans shall be multiplied by the following equivalence factors before summing:	
	Toxic equivalence factor
2,3,7,8 — Tetrachlorodibenzodioxin (TCDD)	1
1,2,3,7,8 — Pentachlorodibenzodioxin (PeCDD)	0,5
1,2,3,4,7,8 — Hexachlorodibenzodioxin (HxCDD)	0,1
1,2,3,6,7,8 — Hexachlorodibenzodioxin (HxCDD)	0,1
1,2,3,7,8,9 — Hexachlorodibenzodioxin (HxCDD)	0,1
1,2,3,4,6,7,8 — Heptachlorodibenzodioxin (HpCDD)	0,01
Octachlorodibenzodioxin (OCDD)	0,001
2,3,7,8 — Tetrachlorodibenzofuran (TCDF)	0,1
2,3,4,7,8 — Pentachlorodibenzofuran (PeCDF)	0,5
1,2,3,7,8 — Pentachlorodibenzofuran (PeCDF)	0,05
1,2,3,4,7,8 — Hexachlorodibenzofuran (HxCDF)	0,1
1,2,3,6,7,8 — Hexachlorodibenzofuran (HxCDF)	0,1
1,2,3,7,8,9 — Hexachlorodibenzofuran (HxCDF)	0,1
2,3,4,6,7,8 — Hexachlorodibenzofuran (HxCDF)	0,1
1,2,3,4,6,7,8 — Heptachlorodibenzofuran (HpCDF)	0,01
1,2,3,4,7,8,9 — Heptachlorodibenzofuran (HpCDF)	0,01
Octachlorodibenzofuran (OCDF)	0,001

11 ENERGY GENERATION AND OPERATIONAL MODES

11.1 Producing Steam and Electricity

The heat energy recovered from burning the waste is used to generate steam which is then used to drive a steam turbine. The steam turbine then drives a generator which produces electricity for supplying into the local network.

In summary the steps of the steam and electricity generation are as follows:

Step 1 – Boiler feedwater system

Boiler feedwater is supplied from a feedwater tank, chemically treated to protect the internal boiler surfaces from corrosion and scale, de-aerated and then supplied at pressure via the economisers into the boiler drum.

Step 2 – Steam generation

The walls and roof of the combustion furnace are constructed of pipes which hold water. This water boils creating steam which is collected in the steam drum on top of the furnace.

Step 3 – Superheater

Saturated steam is drawn off the steam drum and passed through a superheater. The superheater allows further energy to be recovered from the combustion gas stream into the steam flow.

Step 4 – Steam turbine

The superheated steam is fed to the steam turbine. The steam turbine has stages which allows reduced pressure steam to be tapped off part way for uses other than generating electricity. This permits the facility to have two modes of operation which are:

- Mode 1: 100% electricity generation, or
- Mode 2: 70% electricity generation + 30% steam for use by external users

Step 5 – Electrical generator

Generation of electricity at 110kV to supply into the local electricity network.

Connection to the local Alpine Energy Network (“AEL”) is proposed to be done via a new transmission line approximately 2.5km in length from site to the existing AEL substation on Cooneys Rd. This will allow electricity from the plant to be supplied into the AEL network.

Refer letter from AEL attached in Appendix I.



Figure 32: Steam turbine and generator

Step 6 – Steam condenser

Low pressure steam exiting the turbine which has given up most of its energy is then condensed back into water for recycling back to the boiler feed water tank. Condenser cooling is achieved using cooling towers.

11.2 Operational Modes

The facility recovers energy from MSW and exports it for use by external parties. There are two primary forms of energy that can be exported from the plant. These are electricity and heat (in the form of steam).

Which form of energy is exported depends upon the demands of the users of that energy, which may vary during the course of the year.

Accordingly, the EfW plant will be able to operate in two operational modes and these modes of operation are outlined below.

Mode 1: 100% Electricity output

In operational Mode 1, the EfW facility exports all energy recovered from the MSW in the form of electricity.

The electricity is connected directly into the local electricity network whereby it defaults to providing electricity to users connected to that network with any excess entering the National Grid for wider use.

Mode 2: 70% Electricity and 30% Steam output (Combined Heat and Power)

In operational Mode 2, the EfW facility exports a combination of both steam and electricity. This mode of operation is traditionally known as “Combined Heat and Power (“CHP”).

For the purpose of preliminary capacity design, it is assumed that in Mode 2 the plant would export up to 40tph of steam for use by local industries where it would be used as a heat source to power their respective processes.

Local users within a 4km radius could be supplied with steam by underground pipeline direct into their respective operations.

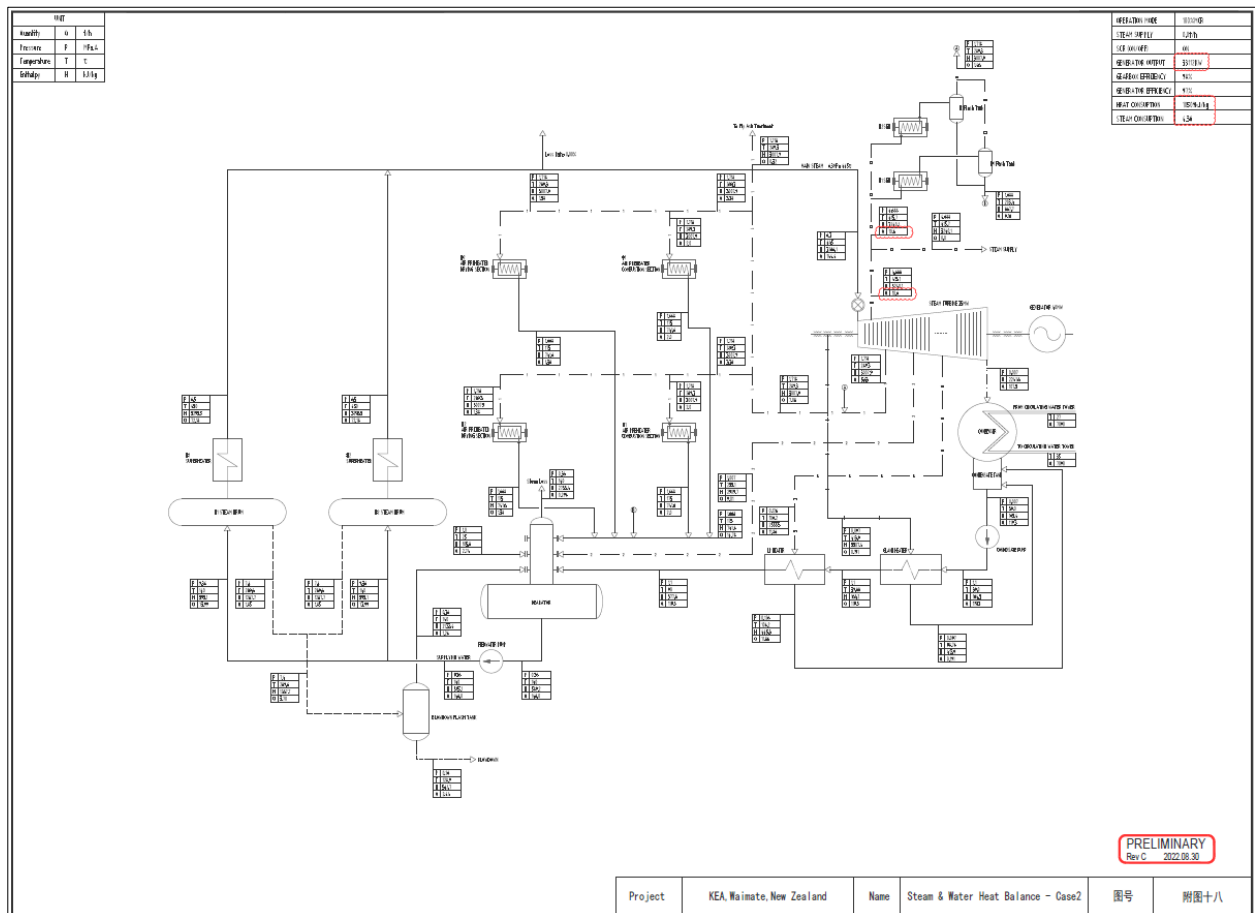


Figure 33: Steam balance drawing – Mode 1: Electricity

12 RECYCLING OR DISPOSAL OF ASH BY-PRODUCTS

The combustion and FGT process creates two primary solid by-product streams, namely grate ash and fly ash.

Internationally it is very common for grate ash to be utilised as a recycled aggregate product in both the concrete and roading industries.

Unlike the Air Emissions standard, no common European standard exists with respect to the use of recycled ash products with each EU member country essentially implementing their own criteria and conditions on its use.

The following table is extracted from Legal situation and current practice of waste incineration bottom ash utilisation in Europe (Appendix J). It outlines the use and standards applied for various European countries which demonstrates the wide variability in how each country regulates the use of recycled ash.

Table 11: Use and standard of ash in various European countries

Country	MSWI plants		IBA mass [Mt/a]	MIBA utilisation		MIBA utilisation rate outside landfills [wt.%]	Reference for utilisation rates	Original title of document regulating MIBA utilisation outside of landfills	Type	Reference for documents
	No [-]	Capacity [Mt/a]		permitted	practised					
Austria	11	2.6	0.53	yes	no	0	(Republic of Austria, 2017a)	Bundesabfallwirtschaftsplan 2017: Technische Grundlagen für den Einsatz von Abfällen als Ersatzrohstoffe in Anlagen zur Zementherzeugung	guidance	(Republic of Austria, 2017a, b)
Belgium	15	3.3	0.47	Flanders: yes Wallonia: yes (mandatory) Brussels capital region: not regulated	yes	69	(Bogush, 2018)	VLAREMA-2012 (Flanders); Arrêté du Gouvernement wallon, 14/06/2001 (Wallonia)	legislation	(Flemish Government, 2012; Government of Wallonia, 2001)
Czech Republic	4	0.65	0.2	yes	no	0	(Šyc, 2018)	Vyhláška č. 294/2005 Sb.	legislation	(Czech Republic, 2005)
Denmark	24	3.7	0.6	yes	yes	99	(Hykš, 2016)	Order N.1672 (2016)	legislation	(Kingdom of Denmark, 2016)
Estonia	1	0.25	0.058	not regulated	-	0	-	-	-	-
Finland	9	1.6	0.3	yes	yes	20	(Rantsi, 2018)	Government Decree on the Recovery of Certain Wastes in Earth Construction (843/2017)	legislation	(Government of Finland, 2017)
France	126	14.7	2.9	yes	yes	80	(Tegebeekers et al., 2015)	Arrêté du 18 novembre 2011 relatif au recyclage en technique routière des mâchefers d'incinération de déchets non dangereux	legislation	(French Republic, 2011)
Germany	68	19.8	4.8	yes	yes	30	(Alwast and Riemann, 2010; Mesters, 2018)	NOR: DEVP1131516A LAGA M19 (annex 6) and LAGA M20 (for leachates)	guidance	(LAGA, 1994, 1995)
Hungary	1	0.42	0.12	not regulated	no	0	-	-	-	-
Ireland	2	0.8	0.14	not regulated	no	0 (partial export)	-	-	-	-
Italy	39	6.1	1.03	yes	yes	85	(Utilitalia, 2019)	Decreto 5 febbraio 1998 including its amendment Decreto 5 aprile 2006, n. 186	legislation	(Italian Republic, 1998, 2006)
Lithuania	1	0.28	0.075	yes	no	0	-	[sakymas 2016 November 25 No. D1-805	legislation	(Lithuanian Government, 2016)
Luxembourg	1	0.17	0.028	not regulated	no	0 (full export)	-	-	-	-
Netherlands	12	7.6	1.9	yes (mandatory)	yes	100	(Born, 2018)	Regeling van 13 december 2007, nr. DJZ2007124397, houdende regels voor de uitvoering van de kwaliteit van de bodem (Regeling bodemkwaliteit)	legislation	(Government of the Netherlands, 2007)
Norway	18	1.8	0.25	not permitted	no	0	-	-	-	-
Poland	6	0.97	0.21	yes	yes	60	(Pajak, 2019)	Poz. 796 - Rozporządzenie Ministra Środowiska z dnia 11 maja 2015 r. w sprawie odzysku odpadów poza instalacjami i urządzeniami	legislation	(Republic of Poland, 2015)
Portugal	4	1.3	0.22	yes	yes	56	(Valorsul, 2017)	Individual permit issued by independent national body (LNEC - Laboratório Nacional de Engenharia Civil))	individual permit	(Valorsul, 2017)
Slovakia	2	0.29	0.062	not regulated	no	0	-	-	-	-
Spain	10	2.4	0.44	Catalonia: yes Rest of Spain: not regulated	yes	58	(Chimenos, 2018)	Ordre de 15 de febrer de 1996 (Catalonia)	legislation	(Generalitat de Catalunya, 1995)
Sweden	34	5.4	0.99	yes	no	0	(Fagerqvist, 2019; Van Praagh et al., 2018)	Återvinning av avfall i anläggningsarbeten Handbok	guidance	(Naturvårdsverket, 2010)
Switzerland	30	3.7	0.82	yes	no	0	(Holm and Simon, 2017)	Verordnung über die Vermeidung und Entsorgung von Abfällen (VEA)	legislation	(Swiss Federal Council, 2015)
United Kingdom	45	12	1.5	yes	yes	99	(Lederer et al., 2018)	Guidance - Use of unbound municipal Incinerator Bottom Ash Aggregate (IBAA) in construction activities: RFS 206	guidance	(United Kingdom, 2019)
Total	463	90	17.6	16	11	54 (or 9.6 Mt/a)	-	-	-	-

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Table 3

Parameters for total and leaching content and other requirements that have to be considered in order to utilise MIBA in the permitted fields of application. Related limit values are given in the supplementary information in Tables S1–55. "non-hazardous waste" means only IBA classified as non-hazardous waste (EU waste code 19 01 12) is allowed to be used. Only countries where MIBA utilisation is regulated are considered in this table.

Country	Parameters specifically defined for MIBA	Permitted field of application	Requirements on		
			total content	leaching content	other requirements
Austria	yes	base layer in road construction (bound and unbound)	Cd, Cr (total), Ni, Pb, TOC	As, Cr (total), Cu, Mo, Ni, Pb, Sb, chloride, sulphate, pH	ferrous metals < 1 wt% DM, non-ferrous metals < 0.8 wt%; Limitations regarding POPs according to (EU, 2004); floating contaminants < 5 cm ³ /kg DM, non-floating contaminants < 1 wt% and glass content < 2 wt%;
	no	secondary raw material in cement production	As, Cd, Co, Cr (total), Hg, Ni, Pb, Sb, Ti	no requirements	
Belgium	no	<u>Flanders</u> : bound and unbound construction material	As, Cd, Cr (total), Cu, Hg, Ni, Pb, Zn, asbestos, benzene, ethylbenzene, styrene, toluene, xylene, benzo(a)anthracene, benzo(a)pyrene, benzo(ghi)perylene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, phenanthrene, fluoranthene, indeno(1,2,3-cd)pyrene, naphthalene, hexane, heptane, petroleum, octane, PCB	As, Cd, Cr (total), Cu, Hg, Ni, Pb, Zn	none
	yes	<u>Wallonia</u> : Certification test (base layer and hydraulic bound material)	petroleum, BTEX, EOX, PAH	Al, As, Cd, Co, Cr (total), Cr (VI), Cu, Hg, K, Mo, Ni, Pb, Sb, Ti, Zn, chloride, cyanide, fluoride, sulphate	
	yes	<u>Wallonia</u> : Regular quality assurance test (base layer and possibly hydraulic bound material)	petroleum, EOX	Al, As, Cd, Co, Cr (VI), Cu, Hg, Mo, Ni, Pb, Sb, Ti, Zn, chloride, cyanide, fluoride, sulphate, nitrate, ammonium, pH, electric conductivity	
Czech Republic	no	application of waste on soil surface	As, Cd, Cr (total), Hg, Ni, Pb, V, hydrocarbons (C10-40), PCB, BTX, EOX, PAH	no requirements	none
Denmark	no	<u>Category 1</u> : unrestricted use in specific construction applications (no MIBA will meet Cat. 1 requirements), <u>Category 2&3</u> : subbase layer in road construction road covered or paved, field covered or paved, subgrade filling in industrial and storage building	As, Cd, Cr (total), Cr (VI), Cu, Ni, Pb, Zn	As, Ba, Cd, Cr (total), Cu, Hg, Mn, Na, Ni, Pb, Se, Zn, chloride, sulphate	non-hazardous waste
Finland	yes	road covered or paved, field covered or paved, subgrade filling in industrial and storage building	no requirements	As, Ba, Cd, Cr (total), Cu, Hg, Mo, Ni, Pb, Sb, Se, V, Zn, chloride, fluoride, sulphate, DOC	non-hazardous waste, particle size < 50 mm;
France	yes	<u>Type 1</u> : maximum 3 m high sublayers of pavements or shoulders of paved road structures, <u>Type 2</u> : maximum 6 m high road embankment or shoulder infrastructures, under the condition to be covered road structures	TOC, hydrocarbons (C10-40), PCB (sum of 28, 52, 101, 118, 138, 153, 180), BTEX, PAH, TEQ	As, Ba, Cd, Cr (total), Cu, Hg, Mo, Ni, Pb, Sb, Se, Zn, chloride, fluoride, sulphate, total dissolved solids	maturations, separation of unburnt material and large metals;
Germany	yes/no ^a	<u>Z2</u> : base course below non-permeable top layer, bound base course below low permeable top layer, bound top layer, anti-noise- and visual protection barriers and foundation of road dams with precipitation protection	Cd, Cr (total), Cu, Ni, Pb, Zn, TOC, PCDD/PCDF, EOX	Cd, Cr (total), Cu, Hg, Ni, Pb, Zn, chloride, sulphate, pH, electric conductivity	maturations > 3 months
Italy	yes	road foundation, cement process, construction of embankments, environmental recoveries	no requirements	As, Ba, Be, Cd, Co, Cr (total), Cu, Hg, Ni, Pb, Se, V, Zn, chloride, cyanide, fluoride, sulphate, nitrate, asbestos, chemical oxygen demand, pH	non-hazardous waste
Lithuania	yes	road, foundation of buildings	TOC, loss on ignition	Cd, Cr (total), Cu, Hg, Ni, Pb, Zn, chloride, cyanide, sulphate, pH, electric conductivity	non-hazardous waste
Netherlands	no	bound and unbound construction material,	benzene, ethylbenzene, toluene, xylene,	As, Ba, Cd, Co, Cr (total), Cu, Hg, Mo,	none

Table 3 (continued)

Country	Parameters specifically defined for MIBA	Permitted field of application	Requirements on		
			total content	leaching content	other requirements
Poland	yes	IBC construction material	benzo(a)anthracene, benzo(a)pyrene, benzo(ghi)perylene, benzo(k)fluoranthene, indeno(1,2,3-cd)pyrene, petroleum, PCB (sum of 28, 52, 101, 118, 138, 153, 180), PAH, asbestos	Ni, Pb, Sb, Se, Sn, V, Zn, bromide, chloride, fluoride, sulphate	non-hazardous waste, separation of light impurities, unburnt material, ferrous and non-ferrous metals and maturation, compliance with PL EN 13242 and Technical requirement WT4 "Unbound mixes for national roads" (Republic of Poland, 2015);
	yes	subbase layer in road construction	TOC, hydrocarbons (sum of C10-40), PCB, BTEX, PAH	As, Ba, Cd, Cr (total), Cu, Hg, Mo, Ni, Pb, Sb, Se, Zn, chloride, fluoride, sulphate, phenol index, dissolved organic carbon, total dissolved solids	
Portugal	no	aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction	Based on individual permit from INEC: no requirements	Based on individual permit from INEC ^b : As, Ba, Cd, Cr (total), Cu, Hg, Mo, Ni, Pb, Sb, Se, Zn, chloride, fluoride, sulphate, dissolved organic carbon, total dissolved solids	Based on individual permit from INEC: compliance with NP EN 13242:2002 + A1:2010
Spain	yes	<u>Catalonia</u> : road subbase, levelling of terrain and embankments, filling and restoration of degradable areas from extractive activities, others	loss on ignition, unburnt material	As, Cd, Cr (VI), Cu, Pb, Zn, total dissolved solids	none
Sweden	no	general use – unbound material	As, Cd, Cr (total), Cu, Hg, Ni, Pb, Zn, PAH low ring number, PAH medium ring number, PAH high ring number	As, Cd, Cr (total), Cu, Hg, Ni, Pb, Zn, chloride, sulphate	none
Switzerland	no	use of waste as raw material and raw meal correction material in the cement industry	As, Cd, Co, Cr (total), Cu, Hg, Ni, Pb, Sb, Sn, Ti, Zn, TOC, hydrocarbons (sum of C5-10), hydrocarbons (sum C10-40), benzene, benzo(a)pyrene, PCB, BTEX, PAH, VOC	no requirements	none
	no	use of waste as grinding additives and aggregates in the cement industry	As, Cd, Cr (total), Cr (VI), Cu, Hg, Ni, Pb, Sb, Zn, TOC, hydrocarbons (sum of C5-10), hydrocarbons (sum C10-40), benzene, benzo(a)pyrene, PCB, BTEX, PAH, VOC	no requirements	none
United Kingdom	no	road, construction of structural platforms, pipe bedding	individual decision	individual decision	non-hazardous waste, compliance with BS EN 13242:2013;

^a Total content limit values are not directly addressing MIBA utilisation, whereas the leaching limit values are specifically addressing MIBA utilisation.

^b MIBA has to comply with leaching limit values for Portuguese non-hazardous waste landfill (Portuguese Republic, 2009).



To our knowledge, New Zealand does not currently recycle any incinerator ash products, choosing instead to either return it for depositing within the originating coal mine or disposing it to landfill. To enable ash products to be used as recycled aggregate substitute, there are several environmental and technical aspects that New Zealand aggregate users, standards organisations and regulatory authorities will have to work their way through to permit its use.

SIRRL currently has both grate ash samples and vitrified fly ash samples with a significant New Zealand aggregate consumer for assessment and testing with the ultimate view of enabling the use of recycled ash products in New Zealand.

There are several environmental aspects (such as contaminant levels, leachability) and technical aspects (such as further processing requirements, strength etc) that need to be considered in order for ash products to be utilised as a recycled aggregate.

As New Zealand will likely look to make its own independent assessment of both the environmental and technical impacts of using recycled ash products, this assessment and certification process is likely to take some time. However, given that the plant will not become operational for some three to four years, SIRRL is hopeful that this process can be worked through in New Zealand in a timely manner and that certification can be obtained within this time frame.

If certification is not obtained in time for the commencement of plant operations, then the ash products will be disposed of either into landfill or used as a capping material to cover landfills where those landfills are consented to take such product.

It's worth keeping in mind that if disposal to landfill occurs, that the ash is simply the residual of the MSW that would otherwise have been sent to landfill should the EfW plant not existed in the first place. Contaminants within the ash are only those contaminants that existed within the raw MSW in the first place and as such the disposal of ash to landfill represents more of a lost opportunity (in that it isn't being recycled) as opposed to a net negative environmental impact. In addition, Technical Report 9 assessing the global warming aspect of the plant includes ash to landfill as one of the scenarios.

Existing aggregate market

At a high level, approximately 41 million tonnes of aggregate were used in NZ in 2018 with approximately 10 million tonnes of this total consumed in the South Island [*Refer Appendix K Aggregate Opportunity Modelling for New Zealand July 2021*]. The potential 100,000tpa (i.e. grate ash + vitrified fly ash) of recyclable ash produced by Kea represents just 1% of the quantity consumed in the South Island. Although relatively small in comparison, the fact remains that recycling grate ash still eliminates the environmental burden of quarrying 100,000 tonnes of aggregate per year.

12.1 On-site grate ash processing

The facility will produce in the order of 80,000tpa of grate ash. The high-level steps in the on-site grate ash treatment process are as follows:

Step 1 – Cooling and collection

Once combustion on the furnace grate is complete, the grate ash falls from the end of the grate into a water bath. The water bath functions as a vacuum seal for the furnace and cools the grate ash prior to it being removed.

Step 2 – Metal recovery and grading

The grate ash stream is then passed through a metal recovery process to recover the larger items of both ferrous and non-ferrous metals. Following metal recovery, grate ash is stored prior to exporting from site.

Step 3 – Export

From storage, grate ash is loading onto trucks for export to aggregate customers or landfill.

12.2 On-site vitrification of fly ash

Historically fly ash from EfW plants has been ‘treated’ by binding with Portland cement to form a brick. These bricks reduce the rate of leaching however they are still a hazardous material and are thus stacked and buried in landfills.

Vitrification, which converts the raw fly ash into an industrial slag, provides a far more inert substance which can then be used as an aggregate substitute.

The facility will produce in the order of 20,000tpa of fly ash which will be treated through a vitrification process into industrial slag. The processing rate is approximately 10tph.

This product can be a valuable product for use as an aggregate in concrete and concrete block manufacture.

The high-level steps in the fly ash vitrification process which converts the raw fly ash into an industrial slag is as follows:

Step 1 – Addition of additives

Raw fly ash collected from the bag filters and additives are held in silos prior to being combined and mixed in predetermined quantities and fed into the plasma furnace.



Figure 35: Raw fly ash and additives prior to mixing and feeding to the plasma furnace.

Step 2 – Plasma Furnace

The fly ash / additive mix is fed into the plasma furnace where it is subject to very high temperatures created by a plasma arc. The temperatures (8,000-10,000°C) melt the fly ash mixture.



Figure 36: Plasma furnace (top left) and flue gas treatment process to the right

Step 3 – Vitrified fly ash quenching > Industrial Slag

The molten fly ash is then tapped from the furnace and placed into a water quenching bath. This rapid cooling almost instantly freezes the molten fly ash creating a vitrified material. The vitrified material is now an Industrial Slag.

The quantity of cooling water applied ensures that the water temperature remains at around 60°C thus ensuring rapid quenching and virtually eliminating the production of any steam and corresponding condensation.

Step 4 – Slag grinding and sizing

The slag is then removed from the quenching bath, ground and is then available for use as an aggregate.

Step 5 – Storage and export

Industrial slag is stored in a pit prior to loading onto truck for export to aggregate customers or landfill.



Figure 37: Industrial slag after grinding (vitrified fly ash)

13 OTHER BY-PRODUCTS

13.1 Metal recovery

Ferrous and non-ferrous metals contained in the waste will end up in the grate ash product.

Ferrous metals are extracted from the grate ash using magnetic separation with an expected recovery efficiency of around 80%.

Non-ferrous metals (primarily aluminum, copper etc.) are extracted from the grate ash using eddy current separation with an expected recovery efficiency of around 50%.

Based upon the typical waste composition given in Table 4 this equates to approximately 4,700tpa of ferrous and 800tpa of non-ferrous metal recovery, totaling 5,500tpa.

Recycling both ferrous and non-ferrous metals offsets the need to manufacture those same metals from raw materials which obviously supports the circular economy. Steel is essentially 'infinitely recyclable' and currently NZ manages to recycle around 85% of its steel scrap from the building and infrastructure sectors. This equates to over 500,000 tonnes annually and results in a per tonne saving of 1,249kg CO_{2-E}.
[Refer: Appendix L Steel Recycling Report; HERA Report No. R5-89v2:2021]

The total estimated recovered metal from the EfW plant is around 5,500tpa and this quantity is dependent upon waste composition.

13.2 Sodium Chloride

Sodium chloride is a by-product stream from treating the flue gas from the fly ash vitrification process.

Sodium chloride is crystalized and available for export to external industrial users.

Communications are currently on-going with potential customers regarding the use of this by-product stream.

13.3 Potassium Chloride

Potassium chloride is a by-product stream from treating the flue gas from the plasma process.

Potassium chloride is crystalized and available for export to external industrial users.

Communications are currently on-going with potential customers regarding the use of this by-product stream.

13.4 Gypsum

Gypsum (Calcium sulfate) is a by-product stream from treating the flue gas from the plasma process.

Gypsum is crystalized and available for export to external industrial users.

Communications are currently on-going with potential customers regarding the use of this by-product stream.

13.5 Metal Hydroxide (Waste Stream)

Heavy metals that exist in the waste will ultimately end up in either the grate ash or the fly ash.

Given the temperature at which the vitrification process operates at, low boiling point metals (such as Lead and Zinc) that are in the fly ash will boil off and enter the flue gas stream.

The flue gas treatment system then captures these contaminants and concentrates them into a sludge product. This sludge product is a hazardous substance and is sent from site to a certified hazardous waste facility for further treatment and disposal.

The vitrification process creates around 1T of sludge per day.

Communications with WasteCo NZ Ltd have confirmed that they can treat the metal hydroxide sludge to enable safe disposal to landfill [*refer letter from WasteCo in Appendix M*].

It is worth remembering that these heavy metal contaminants are only those that exist within the waste in the first place, and which would otherwise be dispersed throughout landfill. The EfW process essentially captures and concentrates these contaminants so that they may be suitably processed and disposed of in a controlled way, as opposed to them being dispersed throughout a landfill.

14 WATER SUPPLY AND CONSUMPTION

14.1 Water supply

It is intended to source water for the facility from ground water under the site.

A separate consenting application for obtaining and using water will be undertaken once the main consent application for the facility has been concluded. The application will include assessment of ground water availability and interference affects in accordance with ECan's consenting requirements.

The eventual water take consent application will be based around the following demands.

14.2 Water consumption

The plant will consume around 2,390m³ of water per day. As shown in the table below the major consumptions are through evaporation in the following areas of the process:

- Cooling tower evaporation: as part of the steam condensing system
- Wet scrubber evaporation: as part of the flue gas treatment system
- Grate ash pit evaporation: capturing hot grate ash from the furnace

Table 12: Daily water consumption

Process	Water consumed per day	Percentage of daily consumption
Cooling tower evaporation	1,320 m ³	55%
Flue gas treatment evaporation	480 m ³	20%
Grate ash pit evaporation	430 m ³	18%
Miscellaneous minor consumption	160 m ³	7%
Total	2,390 m³	100%

15 TREATMENT OF CONTAMINATED PROCESS WASTEWATER

Two process wastewater treatment systems are employed to enable 100% recycling of process wastewater and the capture of by-product streams for use in wider industry. The two systems are:

- Main process wastewater treatment system, and
- Vitrification gas cleaning wastewater treatment system

15.1.1 Main process wastewater treatment

The main combustion and FGT process creates contaminated liquid streams that need to be collected and treated. These contaminated liquid streams predominately come from:

- FGT wet scrubber
- Fly ash vitrification quenching bath
- Bunker odour scrubber (when periodically used)

Treatment essentially involves the removal of contaminants from the liquid stream so that a) the liquid component can be recycled, and b) the contaminant component can be appropriately disposed of back into either the main combustion or vitrification process.

Table 13: Main process contaminated water treatment

Treatment Step	Treatment Description
Step 1: Flocculation and Sedimentation	Removal of contaminants through flocculation and sedimentation. Removed contaminants re-cycled to furnace.
Step 2: Filtration	Removal of contaminants through filtration. Removed contaminants re-cycled to furnace.
Step 3: Reverse Osmosis	Removal of final contaminants through Reverse Osmosis (RO). Removed contaminants re-cycled to furnace. Treated clean water returned to process water storage tank for reuse.
Step 4: Disposal of contaminants back to combustion process	Sludge and liquid stream containing contaminants is sprayed back into the combustion process. Contaminants ultimately end up in fly ash for treatment in vitrification process.
Step 5: Recycling of treated water	Cleaned liquid stream recycled back into the process for reuse.

15.1.2 Vitrification wastewater treatment

The vitrification process creates a wastewater stream from the flue gas quenching and washing steps.

Treatment of this wastewater stream involves the addition of sodium hydroxide, hydrochloric acid, calcium chloride and sodium carbonate.

By-product streams of potassium chloride, sodium chloride and calcium sulphate are recovered from the treatment process for export to customers.

Table 14: Plasma process contaminated water treatment

Treatment Step	Treatment Description
Step 1: Primary clarifier	Remove impurities to waste stream
Step 2: Chemical treatment	Remove impurities to waste stream
Step 3: Sulphate removal	Capture calcium sulphate
Step 4: Decalcification	Remove impurities to waste stream
Step 5: Nanofiltration	Recovery of NaCl and KCl
Step 6: Evaporation and crystallization	NaCl and KCl granular by-product streams

16 DOMESTIC WASTEWATER TREATMENT AND DISPOSAL

The facility has an office and administration building which contains the normal facilities including lunchroom and toilets.

The domestic wastewater originating from these sources is treated through a standard biological treatment plant and discharged onto land through a drip field irrigation system.

The domestic wastewater and process wastewater streams and treatment systems are completely separated.

For standards of treatment and the calculation of the drip field area refer *Technical Report 14 – Domestic Wastewater Treatment System: Babbage 2022*.

17 MATERIALS AND SUBSTANCES STORED ON SITE

The EfW facility requires several chemical additives of varying quantities to support the operation and maintenance of the plant. These chemicals are detailed in *Technical Report 3 – Hazardous Substances Report: Babbage 2022*.

18 OTHER MISCELLANEOUS TECHNICAL ITEMS

18.1 Start-up diesel generators

Once in operation the EfW plant generates its own electricity supply. However, to enable initial start-up of the facility or during periods when the turbine/generator set is down for servicing, it is necessary to provide an external electricity supply.

To cover these situations, three diesel powered generators (each 2MW) will be permanently located on site to provide the necessary power to support the facility. On-site generators will be used as currently the local network does not have the capacity to provide the necessary quantity of electricity required to start the plant and standby generators provide immediate access to power in the event of a turbine/generator failure allowing for continuity of plant operation.

18.2 Operational turn-down

The facility has significant ability to alter its operational capacity to accommodate any fluctuations in the quantity of waste available. This flexibility is achieved through having two furnace lines each with significant turndown capability.

The waste consumption at 100% capacity is 365,000tpa. The facility can operate up to 110% capacity (401,500tpa) or reduce capacity right down to 30% capacity (109,500tpa).

Table 15 shows the various operational configurations giving rise to the wide range of available operational capacities.

Table 15: Operational turndown

Operating point	% of Full Design Capacity	MSW consumption (tph)	Total MSW Consumption (tpa)
Maximum (2 Boilers)	110%	45.8	401,500
Design Point (2 Boilers)	100%	41.67	365,000
Minimum (2 Boilers)	60%	25	219,000
Maximum (1 Boiler)	55%	22.92	200,750
Design Point (1 Boiler)	50%	20.83	182,500
Minimum (1 Boiler)	30%	12.5	109,500

18.3 Protection of groundwater from waste leachate contamination

The waste bunker is constructed below ground level and is used to store waste prior to feeding to the furnaces. The waste in the bunker can form a leachate liquid which freely drains to the base of the bunker where it is collected in a sump and extracted for disposal by spraying into the main combustion furnace.

The bunker is constructed with a central core of reinforced concrete with waterproof impermeable layers applied to both the inside and the outside of the bunker structure. This ensures that the leachate is sealed on the inside of the bunker and that ground water is sealed on the outside of the bunker.

The main bunker floor is approximately 8m deep with a gently sloping floor to direct the leachate to the sump. The sump is located at the lower end of the bunker floor to collect the leachate liquid.



Figure 39: Waste bunker under construction

Bunker Floor

The preliminary design of the bunker floor is shown in the following diagram. Final details will be determined following detailed structural design.

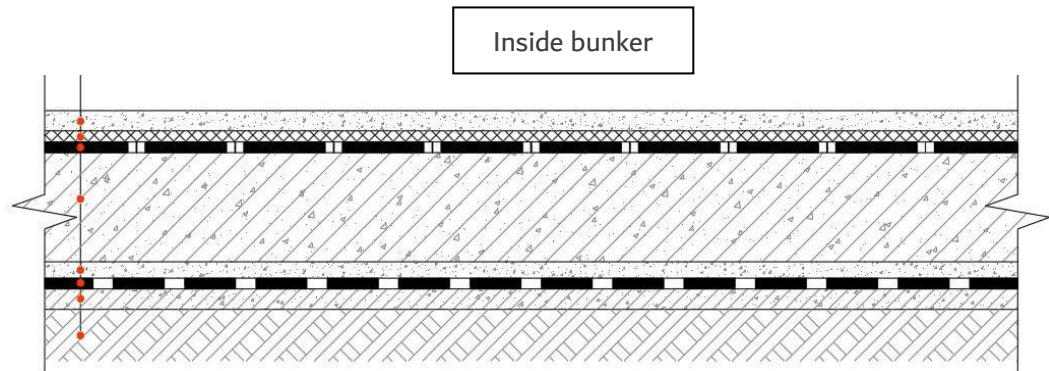


Figure 40: Bunker floor design

The individual structural layers of the bunker floor (inside to outside) are:

1. 100mm thick polymer fiber concrete – contoured to create 1% fall
2. Epoxy-Coal Tar Based waterproofing. DFT not less than 1mm.
3. Deep Penetrating Sealer (DPS) waterproofing
4. In-situ poured reinforced concrete slab
5. 50mm thick fine grade concrete protective layer
6. 4mm thick SBS modified asphalt layer
7. 100mm thick concrete base
8. Compacted sub-grade

Bunker Walls

The diagram below outlines the preliminary design of the bunker walls. Final details will be determined following detailed structural design.

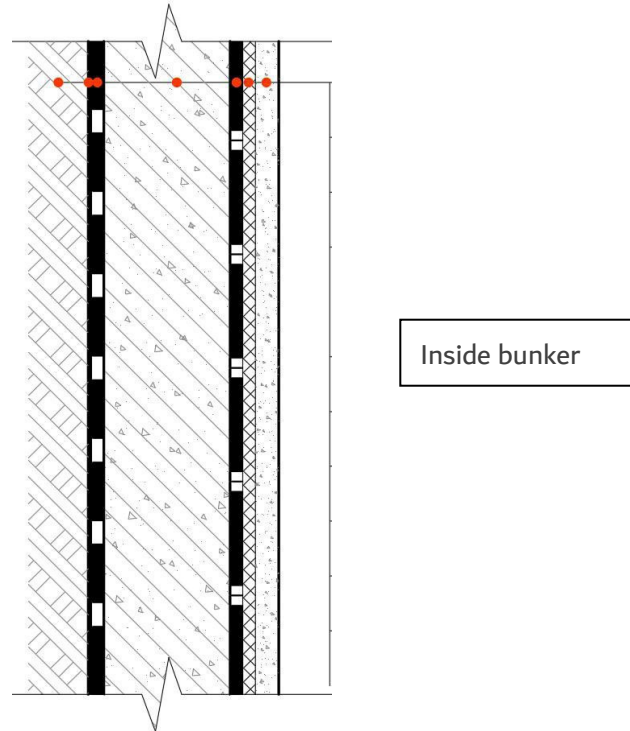


Figure 41: Bunker wall design

The individual structural layers of the bunker walls (inside to outside) are:

1. Epoxy-Coal Tar Based waterproofing. DFT not less than 1mm.
2. Deep Penetrating Sealer (DPS) waterproofing
3. In-situ poured reinforced concrete slab
4. Polymer mortar skim coat
5. 4mm thick SBS modified asphalt layer
6. 5mm thick PE foam sheet protective layer
7. Compacted back-fill

Hydrostatic gradient provides additional protection against ground water contamination

The ground water levels on site are expected to fluctuate between 2 and 8 meters below existing ground level (mbgl). Refer *Technical Report 17 – Groundwater and Surface Water Assessment: Babbage 2022*.

The base of the bunker will be around 8m below existing ground level.

The following factors exist which provide additional protection to the ground water in the extremely unlikely circumstance whereby the leachate sump loses its integrity:

1. The leachate sump will be constructed at the base of the bunker.
2. Leachate free drains to the sump meaning the pressure at the leachate sump inside the bunker is essentially atmospheric (0barg) as there is no static head other than the shallow level of the leachate in the sump.
3. The relative pressure on the outside of the leachate sump will range between 0.2barg (when ground water level is 8mbgl) and 0.8barg (when ground water level is 2mbgl).
4. The resulting pressure gradient means that should any crack occur in the leachate sump and there be a breach in the waterproof membranes, then the hydrostatic pressure difference between the outside and inside of the sump will result in the ground water leaking into the leachate sump and not the leachate leaking outwards into the ground water.

To provide additional comfort as to the ongoing integrity of the bunker, monitoring bores will be installed both up and down gradient of the bunker. This will allow direct sampling of the ground water outside the bunker. Should any leachate be detected then this would indicate a failure of the internal membrane and a crack in the bunker sump and remedial works would be undertaken.

Please refer *Technical Report 17 – Ground Water and Surface Water Assessment* for indicative locations of the monitoring bores.

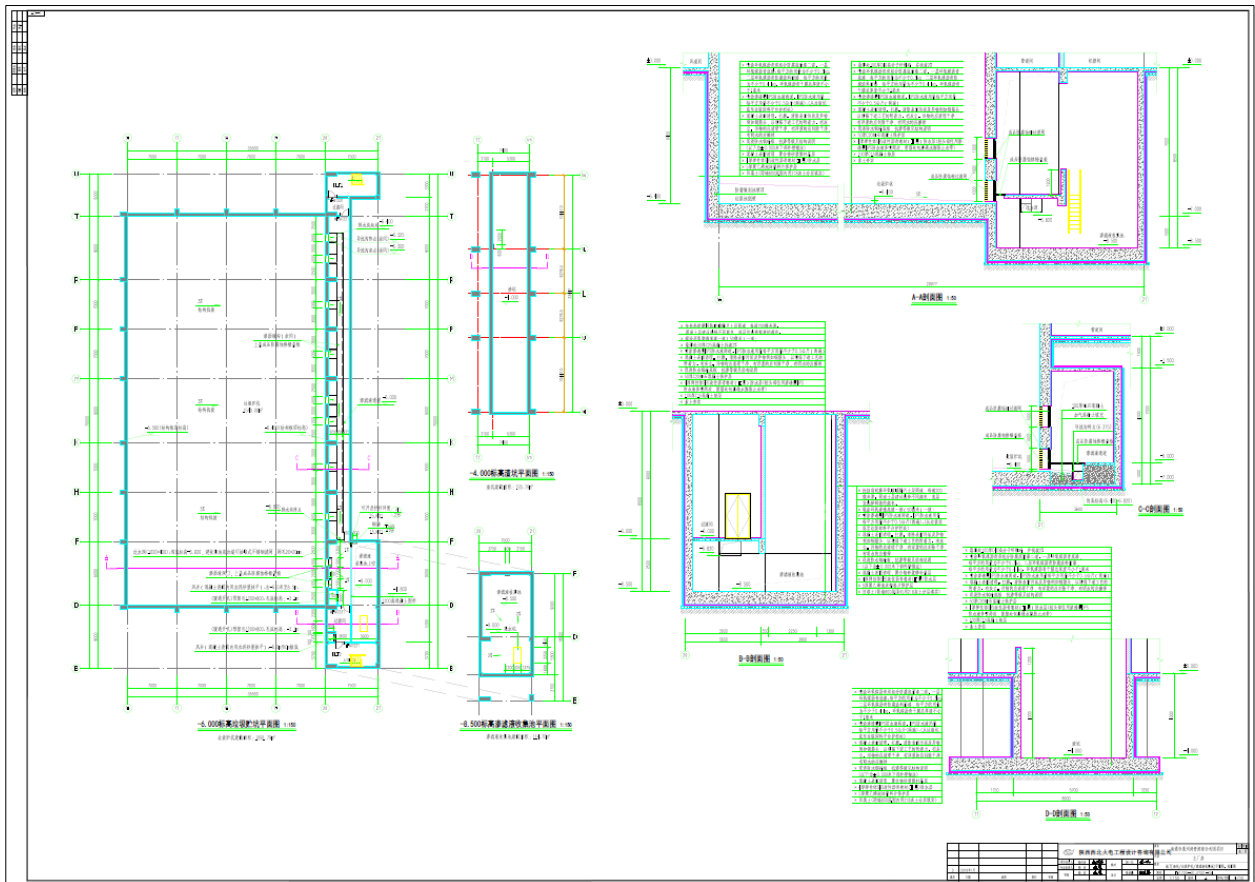


Figure 42: Construction details of waste bunker and leachate sump

19 ANNUAL SURVEY AND MAINTENANCE

19.1 Boilers and FGT lines

It is necessary to undertake yearly maintenance and inspection on each of the boiler lines. This can be achieved without interrupting the supply of waste into the facility because the facility has two separate furnaces and energy recovery lines and the shutdown of each can be staggered at different times of the year.

The necessary maintenance windows are created by firstly running the facility at high capacity to reduce the level of waste held within the bunker. When the bunker is at a sufficiently low level, then a line is shut down for maintenance. With one line down the capacity of the facility is reduced to 55% (i.e., one boiler line runs at 110% capacity) and accordingly over the next 14 days the bunker will return to full.

The shutdown boiler is returned to service within 14 days thus returning the capacity of the plant back to 100%.

The process is then repeated to provide a maintenance window for the 2nd boiler line.

19.2 Turbine and generator set

The turbine and generator set have a yearly maintenance schedule that does not require them to be shut down. Generally, a major service which requires a shutdown occurs around every 4 years.

To accommodate a maintenance shut for the turbine and generator the plant is designed with a turbine bypass whereby the steam from the boilers is fed past the turbine, through a pressure reduction set and to the condenser.

During this period of maintenance there will not be any generation or export of electricity, however, the bypass system ensures that the facility can continue to receive waste.

20 RESILIENCE AND CONTINGENCY PLANNING

20.1 Interruption in MSW supply

The on-site storage of waste includes up to 7,000 tonnes of waste in the internal bunker and up to 45,000 tonnes of baled construction waste in the dedicated storage warehouse. Assuming both storage capacities are operating at 50% then this would provide 26 days operation at full combustion capacity.

We believe this level of storage, coupled with the ability to turn down the combustion capacity of the facility, provides adequate risk protection against unforeseen interruption of waste supply to site.

20.2 Interruption in ash removal

Generally, the ash by-products will be exported from site daily. In cases where storm or other events close roads or make export by truck temporarily not possible, then the by-products will be stored on site internally until export logistics can resume. Site has the capacity to store up to 30 days of ash by-products should the need arise within an area in the waste storage warehouse.

20.3 Resilience to climate change events

In selecting the site and designing the plant, consideration has been given to overall resilience against increasing climatic events as follows:

20.3.1 Flooding Risk

The site and all operational buildings and systems will be elevated circa 150mm above the forecasted 500yr flood event. This provides significant security for the facility against all practicable flood events.

Refer: *Technical Report 11 – Flood Risk Assessment: Babbage 2022*

20.4 On-site fire protection

20.4.1 Waste Bunker

A fire starting in the waste bunker due to an ignition source within the waste is a very real risk in EfW plants. Accordingly, the waste bunker has a dedicated fire detection and firefighting system using water cannons to control and extinguish any fire event.

20.4.2 Baled Waste Storage and Wider Site

The site has a dedicated fire water tank with dual fire water supply pumps (duty/standby) to supply firefighting water to the various buildings. Buildings, including the baled waste storage warehouse, will have active fire suppression systems to control and extinguish any fire event.

21 APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of South Island Resource Recovery Limited Resource Consent Application as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards and should not be construed as legal opinions. Where opinions or judgements are to be relied on, they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Babbage Consultants Limited.

Appendix A A Waste-to-Energy Guide for New Zealand August 2020

Document link:

<https://environment.govt.nz/assets/Publications/Files/waste-to-energy-guide-for-new-zealand.pdf>

Appendix B MfE Data on Waste Volumes to Landfills



Vin Smith
Renew Energy Limited
vin@renewenergy.nz

Dear Vin Smith

Thank you for your email of 12 August 2022 to the Ministry for the Environment requesting the following under the Official Information Act 1982 (the Act):

“...The Ministry for the Environment collects data from all Class 1 landfills on the volume of waste disposed of in New Zealand, for many reasons including the imposition of a waste disposal levee. Please supply the following information under the Official Information Act 1982:

1. *The total volume of waste disposed of in landfill annually within the North and South Islands by region for the year 2015 onwards*
2. *The volume of waste disposed of at each Class 1 landfill annually within the South Island for the year 2015 onwards*

The provision of this data by spreadsheet would be appreciated. The following information is also sought:

3. *Clarification of what waste volume data is collected from Class 2 landfills within New Zealand.”*

For part one of your request, please see the table below:

Year	North Island Class 1 Landfills Total Tonnage Received	South Island Class 1 Landfills Total Tonnage Received
2015	3,222,415.37	727,951.58
2016	3,404,947.65	702,947.11
2017	3,494,308.76	736,514.46
2018	3,705,275.47	730,206.93
2019	3,499,671.95	707,455.29
2020	3,382,918.60	742,148.74
2021	3,537,798.32	804,686.46

Please note total tonnage data received is not available regionally.

For part two of your request, I am withholding the information requested in full, pursuant to section 9(2)(b)(ii) under the Act, to protect information where the making available of the information would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information.

For part three of your request, ‘clarification of waste volume data collected from Class 2 landfills within New Zealand’. Waste volume data that is collected from Class 2 landfills within New Zealand includes gross tonnage of waste received, and diverted tonnage of waste (such as material that is reused or recycled). Gross and diverted tonnage data have only been reported since 1 Jan 2023 and no historical time series is available.

In terms of section 9(1) of the Act, I am satisfied that, in the circumstances, the withholding of this information is not outweighed by other considerations that render it desirable to make the information available in the public interest.

You have the right to seek an investigation and review by the Office of the Ombudsman of my decision to withhold information relating to this request, in accordance with section 28(3) of the Act. The relevant details can be found on their website at: www.ombudsman.parliament.nz.

Please note that due to the public interest in our work the Ministry for the Environment publishes responses to requests for official information on our [OIA responses page](#) shortly after the response has been sent. If you have any queries about this, please feel free to contact our Ministerial Services team: ministerials@mfe.govt.nz.

Yours sincerely

A handwritten signature in black ink that reads "Glenn Wigley". The signature is written in a cursive, flowing style.

Glenn Wigley
Director - Policy and Regulatory, Waste and Resource Efficiency

Appendix C MFL and MGI Letters of Support to Upgrade SH1 Intersection

Bruce Murphy
4634 Waimate Highway
Murphy Farms Ltd.

Paul Duder
Babbage Consultants Ltd
Email: pduder@babbage.co.nz

3 November 2022

Dear Mr Duder,

Re: Project KEA

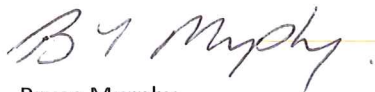
Murphy Farms Ltd ("MFL") has had discussions with South Island Resource Recovery Ltd ("SIRRL") about their proposed energy from waste plant known as Project KEA and furthermore has agreed to sell land to SIRRL to support their proposed development.

As part of the development, SIRRL also propose to upgrade Carrolls Rd and the intersection with State Highway 1.

We have seen the proposed intersection upgrade details and understand that it will require an area of land (circa 0.2145ha) to be made available from MFL to Waka Kotahi to facility the necessary intersection upgrade.

We confirm that in principle we are supportive of Project KEA and are happy to work with SIRRL with a view too making the necessary land available to enable the intersection upgrade.

Your sincerely,



Bruce Murphy
Director
Murphy Farms Ltd.



7 November 2022

Attention: Kevin Stratful
South Island Resource Recovery Limited

Dear Kevin,

Project Kea

Morven-Glenavy Irrigation Scheme (“**MGI**”) has been in discussions with South Island Resource Recovery Ltd (“**SIRRL**”) and understand that SIRRL have conditionally purchased an area of land (“**the SIRRL site**”) to construct an Energy from Waste Plant. The project is known as Project KEA.

MGI own the strip of land (Part RES 1316; Parcel Id: 3466208) on the western boundary of the SIRRL site. The MGI strip of land lies between the SIRRL site and the South Island Main Railway Line and is used to convey irrigation water.

As part of Project KEA, SIRRL wish to construct a rail siding and thus will need to occupy a portion of this MGI land.

MGI confirms that it will make available the land by way of a commercial lease to enable SIRRL to construct and operate a rail siding, subject to Project Kea obtaining the necessary resource consents to proceed.

We also understand that Project KEA will include upgrading the SH1/Carrolls Rd intersection. The upgrade will require widening of the intersection which will encroach on easements held by MGI for the purposes of operating and maintaining irrigation races which are part of the MGI irrigation scheme.

MGI confirms that it supports amendments to the easements as necessary to enable the upgrade of the SH1/Carrolls Rd intersection, on the understanding that such amended easements ensure the continued overall function of the affected MGI irrigation races.

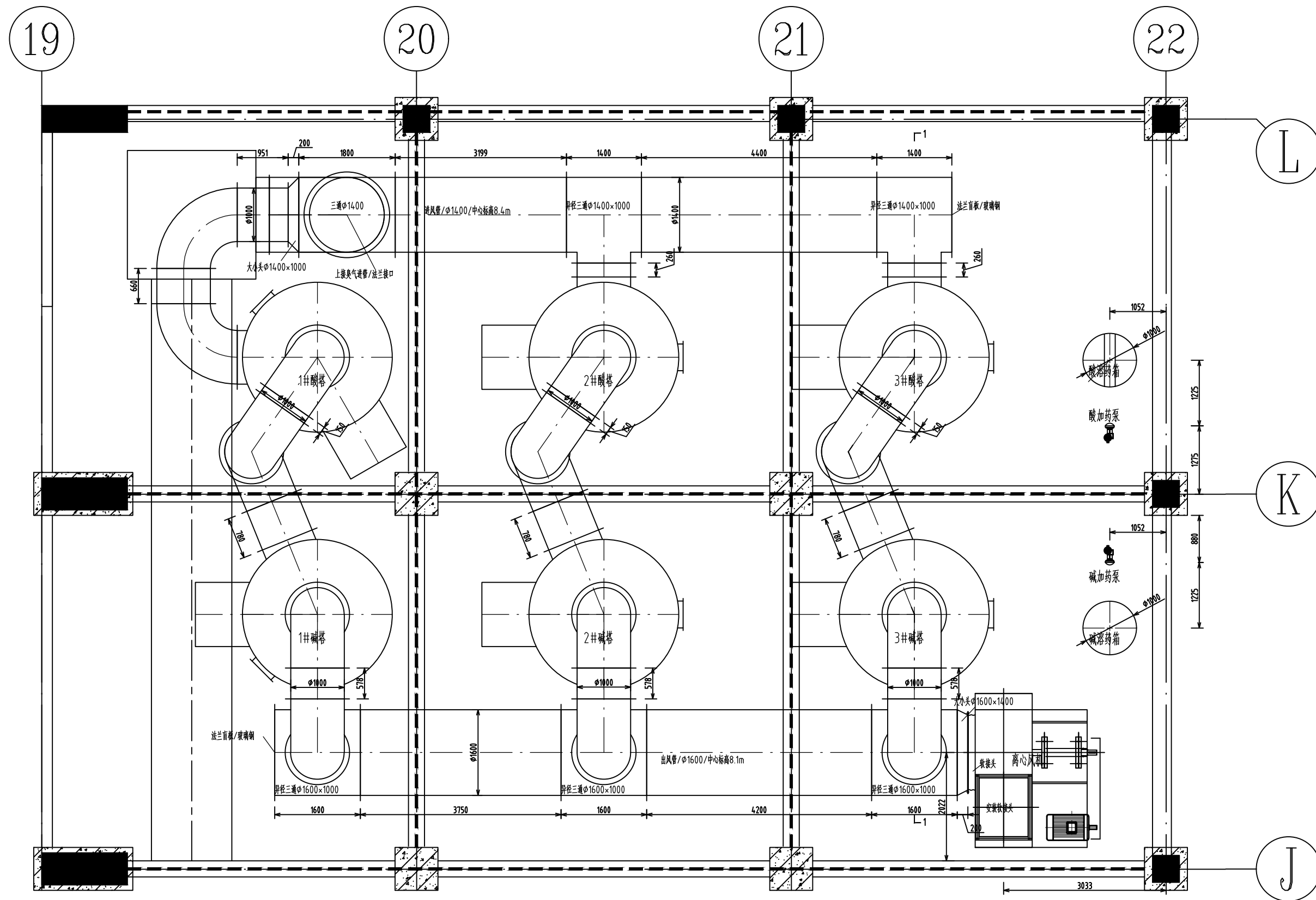
Yours Faithfully,

A handwritten signature in black ink, appearing to read 'Craig Evans', written in a cursive style.

Craig Evans
Chief Executive Officer

Morven Glenavy Ikawai Irrigation Company Limited
26 Glenavy – Tawai Road, Glenavy
RD10, Waimate 7980

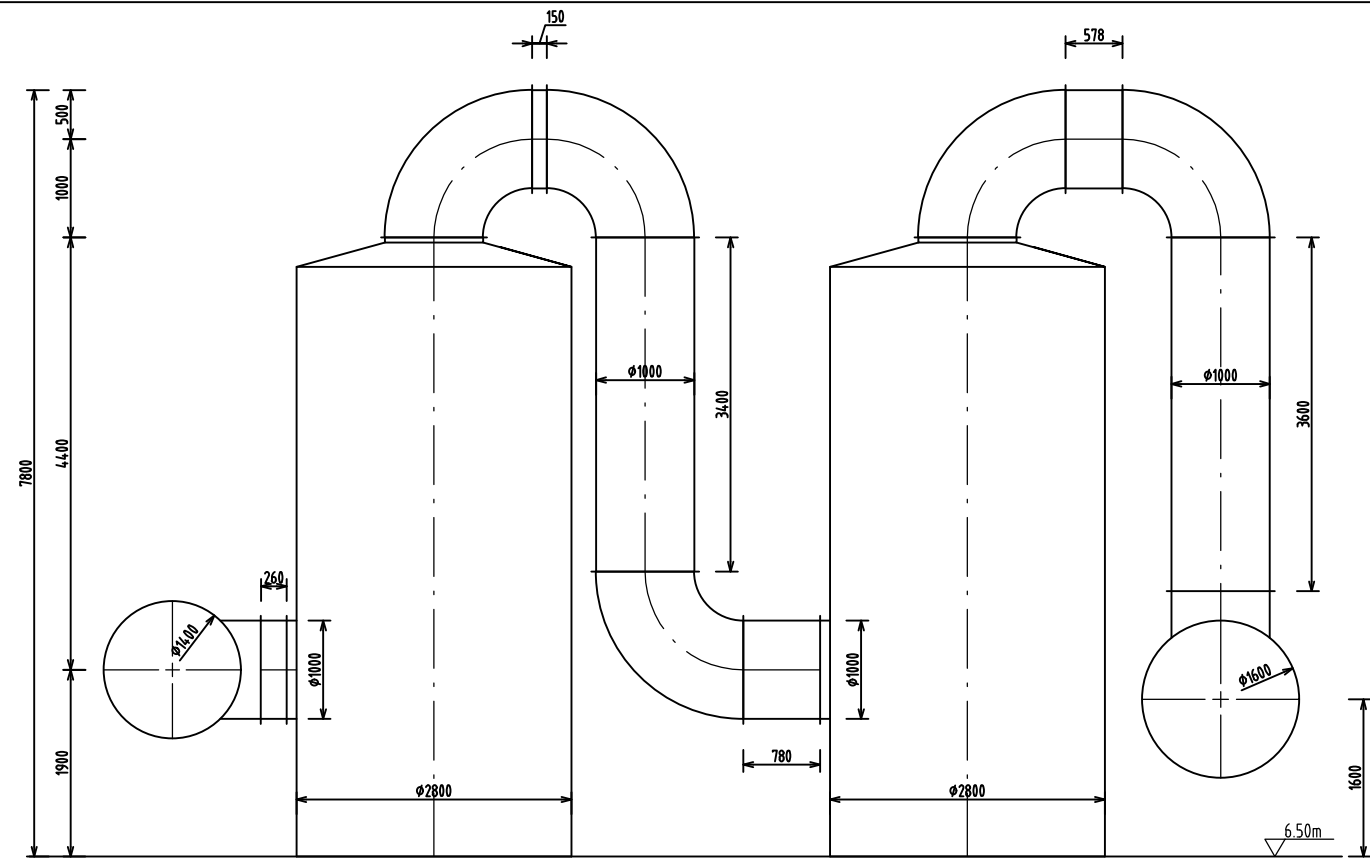
Appendix D Secondary Odour Control Drawings



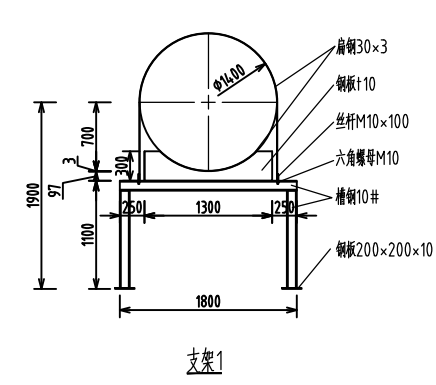
- 说明:
1. 风管材质玻璃钢, 安装单位施工;
 2. 管件与管件、管件与设备、管件与塔、管件与管道全部法兰连接, 螺栓材质304不锈钢, 法兰对接用EVA双面自粘半密封, 可在EVA基础上增加涂漆特粘密封胶密封, 管件所有接口处密封严密, 不漏水、不漏气;
 3. 设备位于卸料平台, 设计地坪标高6.5m.

序号	设备名称	规格型号	单位	数量	备注
1	离心风机	风量90000m ³ /h/风压2300Pa/90KW/右旋90°/材质钢衬玻璃钢/配进出口密闭防腐材质软接头/减震器, 风机最低处设排水口(DN40, 单头外丝接口), 变频电机, 带独立冷却风扇	台	1	
2	酸加药泵	MS1C138C31, 流量310L/h, 压力7bar, 功率0.37kW, 过流材质PVC	台	1	
3	碱加药泵	MS1C138C31, 流量310L/h, 压力7bar, 功率0.37kW, 过流材质PVC	台	1	
4	酸溶药箱	1000L/白色/PE/配低、中、高信号输出磁翻板液位计(需耐酸腐蚀), 配搅拌机(需耐酸腐蚀)	台	1	
5	碱溶药箱	1000L/白色/304/配低、中、高信号输出磁翻板液位计, 配搅拌机	台	1	
6	塔	风量30000m ³ /h/喷淋量120m ³ /h(2台7.5kW液下泵)/塔规格Φ2800*6300, 配低、中、高液位信号输出磁翻板液位计, 材质玻璃钢	座	6	1、2、3#酸塔, 1、2、3#碱塔

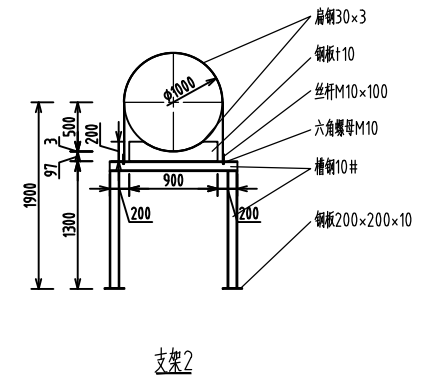
江苏天楹环保能源成套设备有限公司				建设单位	
				工程名称	
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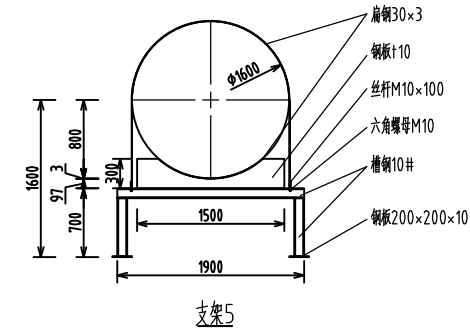
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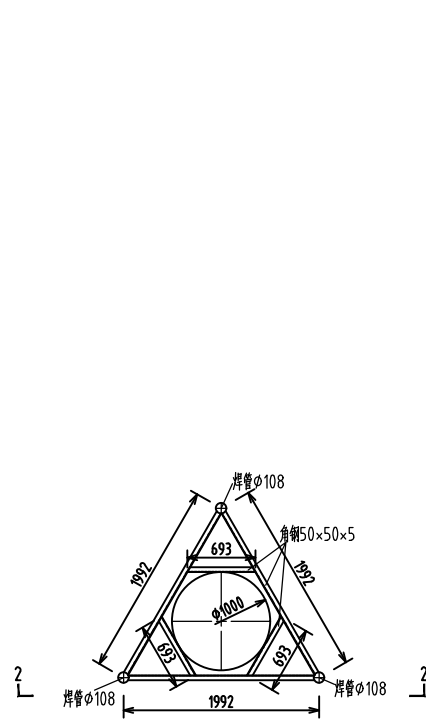
支架1



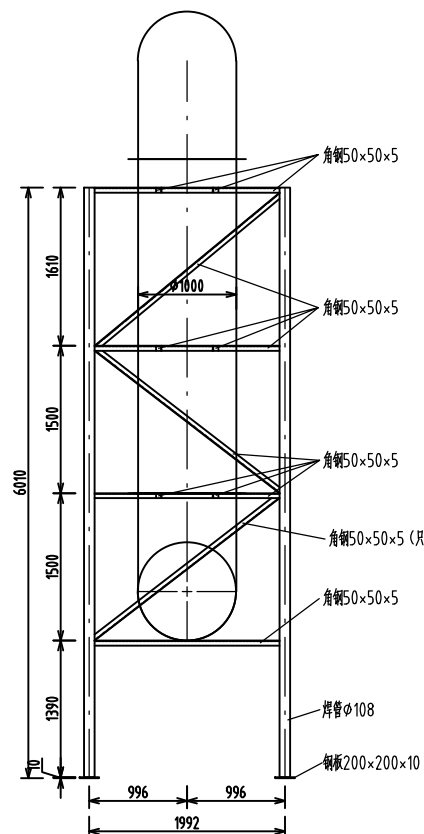
支架2



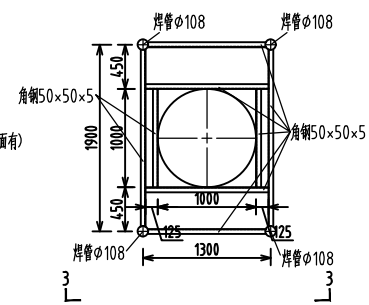
支架5



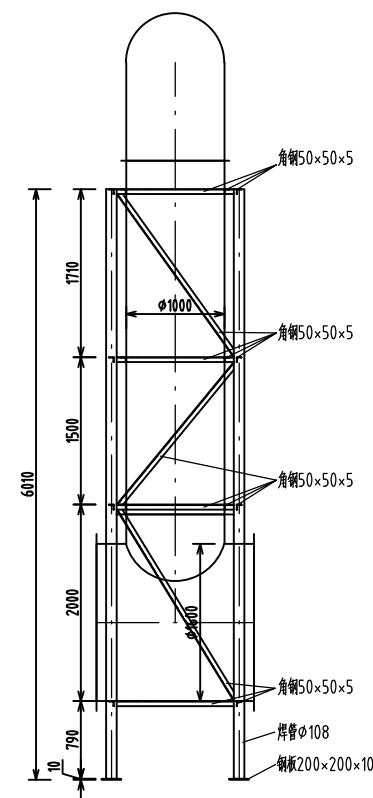
支架3



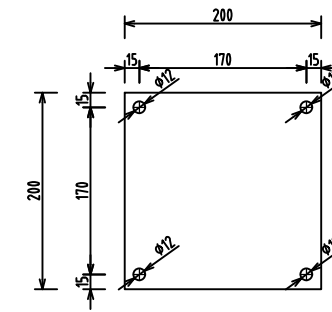
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支架4

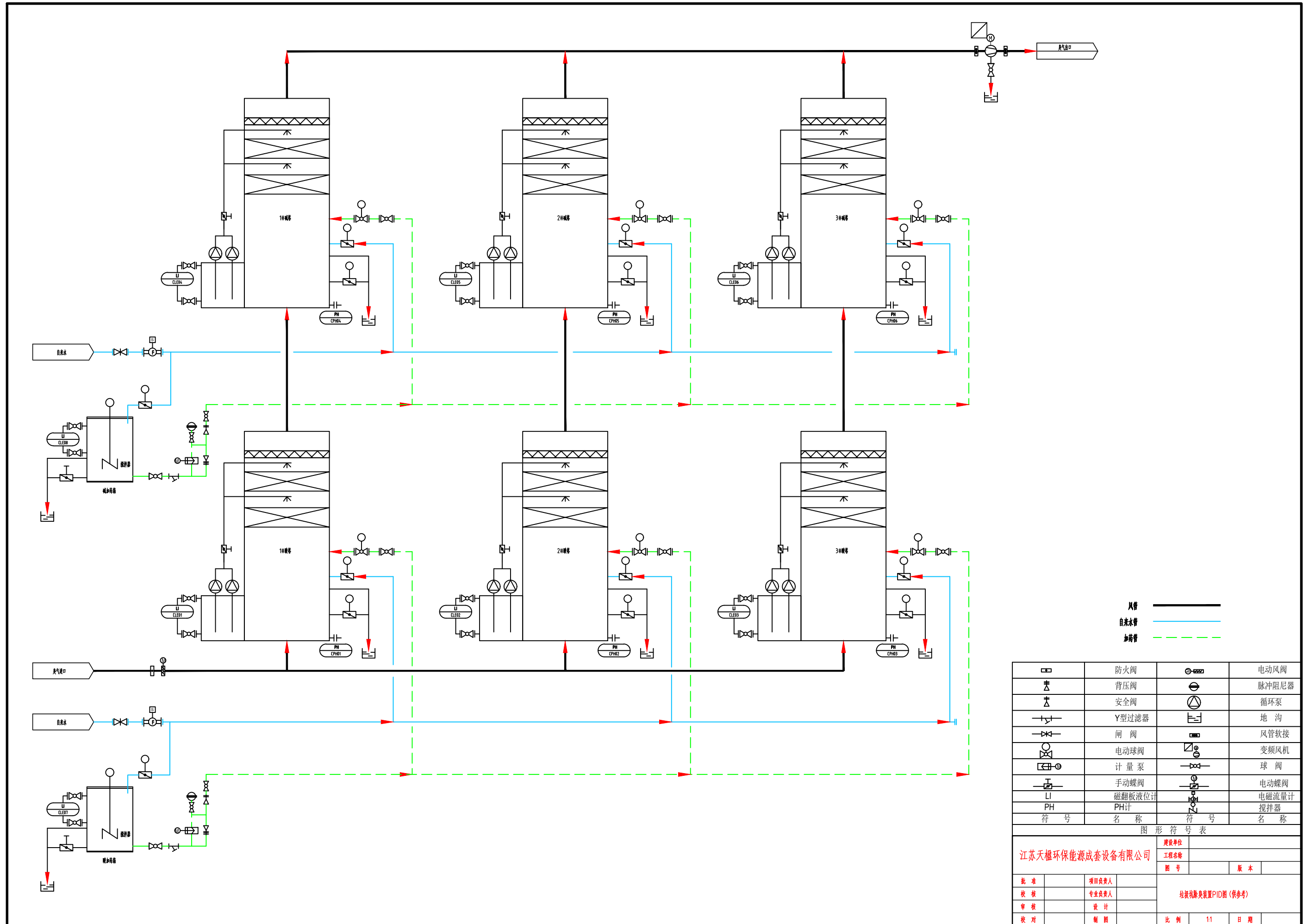


3-3



200x200x10钢块开孔示意图

江苏天楹环保能源成套设备有限公司		建设单位	
		工程名称	
批准	项目负责人	图号	版本
核定	专业负责人	除臭风管立面图(供参考)	
审核	设计		
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		日期	



Appendix E FTIR Analyzer System for Emissions Monitoring

Document Link:

https://cdn.sick.com/media/docs/4/74/674/Product_information_MCS100FT_FTIR_Analysis_System_en_IM0018674.PDF

Appendix F Dioxins and Furans Permanent Sampler – AMESA-D

Document Link:

https://www.envea.global/design/medias/envea_amesa_d_dioxins_furans_pcb_pop_emission_permanent_sampler_eninIT.pdf

Appendix G 2010/75/EU PART 3

PART 3

Air emission limit values for waste incineration plants

1. All emission limit values shall be calculated at a temperature of 273,15 K, a pressure of 101,3 kPa and after correcting for the water vapour content of the waste gases.

They are standardised at 11 % oxygen in waste gas except in case of incineration of mineral waste oil as defined in point 3 of Article 3 of Directive 2008/98/EC, when they are standardised at 3 % oxygen, and in the cases referred to in Point 2.7 of Part 6.

- 1.1. Daily average emission limit values for the following polluting substances (mg/Nm³)

Total dust	10
Gaseous and vaporous organic substances, expressed as total organic carbon (TOC)	10
Hydrogen chloride (HCl)	10
Hydrogen fluoride (HF)	1
Sulphur dioxide (SO ₂)	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO ₂), expressed as NO ₂ for existing waste incineration plants with a nominal capacity exceeding 6 tonnes per hour or new waste incineration plants	200
Nitrogen monoxide (NO) and nitrogen dioxide (NO ₂), expressed as NO ₂ for existing waste incineration plants with a nominal capacity of 6 tonnes per hour or less	400

- 1.2. Half-hourly average emission limit values for the following polluting substances (mg/Nm³)

	(100 %) A	(97 %) B
Total dust	30	10
Gaseous and vaporous organic substances, expressed as total organic carbon (TOC)	20	10
Hydrogen chloride (HCl)	60	10
Hydrogen fluoride (HF)	4	2
Sulphur dioxide (SO ₂)	200	50
Nitrogen monoxide (NO) and nitrogen dioxide (NO ₂), expressed as NO ₂ for existing waste incineration plants with a nominal capacity exceeding 6 tonnes per hour or new waste incineration plants	400	200

- 1.3. Average emission limit values (mg/Nm³) for the following heavy metals over a sampling period of a minimum of 30 minutes and a maximum of 8 hours

Cadmium and its compounds, expressed as cadmium (Cd)	Total: 0,05
Thallium and its compounds, expressed as thallium (Tl)	
Mercury and its compounds, expressed as mercury (Hg)	0,05
Antimony and its compounds, expressed as antimony (Sb)	Total: 0,5
Arsenic and its compounds, expressed as arsenic (As)	
Lead and its compounds, expressed as lead (Pb)	
Chromium and its compounds, expressed as chromium (Cr)	
Cobalt and its compounds, expressed as cobalt (Co)	
Copper and its compounds, expressed as copper (Cu)	
Manganese and its compounds, expressed as manganese (Mn)	
Nickel and its compounds, expressed as nickel (Ni)	
Vanadium and its compounds, expressed as vanadium (V)	

These average values cover also the gaseous and the vapour forms of the relevant heavy metal emissions as well as their compounds.

- 1.4. Average emission limit value (ng/Nm³) for dioxins and furans over a sampling period of a minimum of 6 hours and a maximum of 8 hours. The emission limit value refers to the total concentration of dioxins and furans calculated in accordance with Part 2.

Dioxins and furans	0,1
--------------------	-----

- 1.5. Emission limit values (mg/Nm³) for carbon monoxide (CO) in the waste gases:

- (a) 50 as daily average value;
- (b) 100 as half-hourly average value;
- (c) 150 as 10-minute average value.

The competent authority may authorise exemptions from the emission limit values set out in this point for waste incineration plants using fluidised bed technology, provided that the permit sets an emission limit value for carbon monoxide (CO) of not more than 100 mg/Nm³ as an hourly average value.

2. Emission limit values applicable in the circumstances described in Article 46(6) and Article 47.

The total dust concentration in the emissions into the air of a waste incineration plant shall under no circumstances exceed 150 mg/Nm³ expressed as a half-hourly average. The air emission limit values for TOC and CO set out in points 1.2 and 1.5(b) shall not be exceeded.

3. Member States may lay down rules governing the exemptions provided for in this Part.

PART 4

Determination of air emission limit values for the co-incineration of waste

1. The following formula (mixing rule) shall be applied whenever a specific total emission limit value 'C' has not been set out in a table in this Part.

The emission limit value for each relevant polluting substance and CO in the waste gas resulting from the co-incineration of waste shall be calculated as follows:

$$\frac{V_{\text{waste}} \times C_{\text{waste}} + V_{\text{proc}} \times C_{\text{proc}}}{V_{\text{waste}} + C_{\text{proc}}} = C$$

V_{waste} : waste gas volume resulting from the incineration of waste only determined from the waste with the lowest calorific value specified in the permit and standardised at the conditions given by this Directive.

If the resulting heat release from the incineration of hazardous waste amounts to less than 10 % of the total heat released in the plant, V_{waste} must be calculated from a (notional) quantity of waste that, being incinerated, would equal 10 % heat release, the total heat release being fixed.

C_{waste} : emission limit values for waste incineration plants set out in Part 3

V_{proc} : waste gas volume resulting from the plant process including the combustion of the authorised fuels normally used in the plant (wastes excluded) determined on the basis of oxygen contents at which the emissions must be standardised as set out in Union or national law. In the absence of legislation for this kind of plant, the real oxygen content in the waste gas without being thinned by addition of air unnecessary for the process must be used.

C_{proc} : emission limit values as set out in this Part for certain industrial activities or in case of the absence of such values, emission limit values of plants which comply with the national laws, regulations and administrative provisions for such plants while burning the normally authorised fuels (wastes excluded). In the absence of these measures the emission limit values set out in the permit are used. In the absence of such permit values the real mass concentrations are used.

Appendix H 2010/75/EU PART 2

ANNEX VI

Technical provisions relating to waste incineration plants and waste co-incineration plants

PART 1

Definitions

For the purpose of this Annex the following definitions shall apply:

- (a) 'existing waste incineration plant' means one of the following waste incineration plants:
- (i) which was in operation and had a permit in accordance with applicable Union law before 28 December 2002,
 - (ii) which was authorised or registered for waste incineration and had a permit granted before 28 December 2002 in accordance with applicable Union law, provided that the plant was put into operation no later than 28 December 2003,
 - (iii) which, in the view of the competent authority, was the subject of a full request for authorisation before 28 December 2002, provided that the plant was put into operation not later than 28 December 2004;
- (b) 'new waste incineration plant' means any waste incineration plant not covered by point (a).

PART 2

Equivalence factors for dibenzo-p-dioxins and dibenzofurans

For the determination of the total concentration of dioxins and furans, the mass concentrations of the following dibenzo-p-dioxins and dibenzofurans shall be multiplied by the following equivalence factors before summing:

	Toxic equivalence factor
2,3,7,8 — Tetrachlorodibenzodioxin (TCDD)	1
1,2,3,7,8 — Pentachlorodibenzodioxin (PeCDD)	0,5
1,2,3,4,7,8 — Hexachlorodibenzodioxin (HxCDD)	0,1
1,2,3,6,7,8 — Hexachlorodibenzodioxin (HxCDD)	0,1
1,2,3,7,8,9 — Hexachlorodibenzodioxin (HxCDD)	0,1
1,2,3,4,6,7,8 — Heptachlorodibenzodioxin (HpCDD)	0,01
Octachlorodibenzodioxin (OCDD)	0,001
2,3,7,8 — Tetrachlorodibenzofuran (TCDF)	0,1
2,3,4,7,8 — Pentachlorodibenzofuran (PeCDF)	0,5
1,2,3,7,8 — Pentachlorodibenzofuran (PeCDF)	0,05
1,2,3,4,7,8 — Hexachlorodibenzofuran (HxCDF)	0,1
1,2,3,6,7,8 — Hexachlorodibenzofuran (HxCDF)	0,1
1,2,3,7,8,9 — Hexachlorodibenzofuran (HxCDF)	0,1
2,3,4,6,7,8 — Hexachlorodibenzofuran (HxCDF)	0,1
1,2,3,4,6,7,8 — Heptachlorodibenzofuran (HpCDF)	0,01
1,2,3,4,7,8,9 — Heptachlorodibenzofuran (HpCDF)	0,01
Octachlorodibenzofuran (OCDF)	0,001

Appendix I Alpine Energy Letter re Connection to AEL Network



To Babbage Consultants Ltd

Mr Paul Duder

Re: Project KEA

Alpine Energy Ltd ("AEL") has met with South Island Resource Recovery Ltd ("SIRRL") and discussed their proposed energy from waste plant known as Project KEA.

Project KEA would generate around 30MW of electricity which would be fed into the local AEL network. Any excess electricity generated by Project KEA that was not then consumed by users on the AEL network would then flow into the National Grid via the AEL network.

We have investigated and concluded that it is very feasible for Project KEA to be connected to the AEL network. We have concluded that the most likely solution would be for AEL to run a new network transmission line from the Project KEA site to the existing AEL substation located on Cooneys Rd. At the substation, the KEA electricity can then be supplied into the wider AEL network.

The new transmission line would be approximately 2.5km in length and likely designed for 110kV to best support future load increases on the AEL network.

Regards,

A handwritten signature in black ink, appearing to read 'Johan HL Hendriks', written over a light blue circular stamp.

Johan HL Hendriks
Planning Manager
Alpine Energy Ltd

Appendix J Bottom Ash in Europe – Legal Situation

Document Link:

<https://doi.org/10.1016/j.wasman.2019.11.031>

Appendix K Aggregate Opportunity Modelling for NZ

Document Link:

<https://doi.org/10.21420/DQKB-ET09>

Appendix L Steel Recycling Report HERA Report No. R5- 89v2:2021

Document Link:

<https://www.hera.org.nz/wp-content/uploads/R5-89-Steel-Recycling-Report-v2.pdf>

Appendix M WasteCo Letter for Disposal of Metal Hydroxide



WasteCo NZ Ltd
421 Blenheim Road
Christchurch 8041

Renew Energy Limited
PO Box 5168
Nelson, 7040

Attention: Paul Taylor, Director Southland Island Resource Recovery Limited

13 September 2022

Dear Paul,

DISPOSAL OF METAL HYDROXIDE

Thank you for the recent discussions about the treatment and disposal of metal hydroxide.

I can confirm that WasteCo can safely collect and transport the metal hydroxide from the Energy from Waste Plant in Glenavy.

The metal hydroxide will be taken to our hazardous waste treatment facility which is currently being designed. Our chemists have reviewed the metal hydroxide's chemical composition and can confirm that it can be treated to enable safe disposal to landfill.

Metal hydroxide sludge (dry base) element composition

Element	Composition	Unit
Na	2~10	%
Si	1~4	%
S	1~9	%
Cl	4~21	%
K	1~10	%
Ca	5~20	%
Fe	1~8	%
Cu	2~5	%
Zn	12~28	%
Pb	6~20	%
O、 H, Other O, H, etc.	21~32	%
Mg、 Ni、 Cd、 Cr Mg, Ni, Cd, Cr, etc.	Minor quantity	

Page 1 of 2

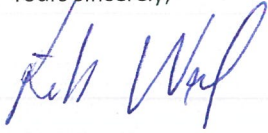
Phone: 03 341 1111

Web: www.wasteco.co.nz

Office: 421 Blenheim Road, Upper
Riccarton, Christchurch
Postal: PO Box 160074, Hornby,
Christchurch 8441, New
Zealand

It is anticipated that the hazardous waste facility will be operational in late 2023 / 24 in advance of the Energy from Waste plant being commissioned.

Yours sincerely,



Rik West
Technical Industrial Services Manager
WasteCo NZ Ltd.

Page 2 of 2

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