This Memo has been cleared by Frank Clinton for submission to the Board
Signed: Bea Claydon Dated: 27 Mar 14

Environmental Protection Agency
An Ghníomhaireacht um Chaomhnú Comhshaoil

OFFICE OF CLIMATE, LICENSING & RESOURCE USE

INSPECTORS REPORT ON A LICENCE APPLICATION

TO:	DIRECTORS
FROM:	**John McEntagart - Environmental Licensing Programme**
DATE:	27th March 2014
RE:	Application for an Industrial Emissions Licence from **Glanpower Limited**, 19 High Street, Tullamore, County Offaly. Licence Register W0282-01.

Application Details

Type of facility:	Waste to Energy Facility
Class of activity (First Schedule of EPA Acts 1992 to 2013)	11.3(a) and 11.4(b)(ii)
Category of Activity under IED (2010/75/EU):	5.2(a) and 5.3(b)(ii)
Class(es) of Activity under Waste Framework Directive (2008/98/EC) (**P** = principal activity):	3rd Schedule: None 4th Schedule: R1 (**P**), R12 and R13.
Quantity of waste managed per annum:	65,000 tonnes
Classes of Waste:	Household and commercial wastes.
Location of facility:	Derryclure Energy Centre, Derryclure, Tullamore, County Offaly.
Licence application received:	22/06/2012
Third Party submissions:	3
EIS Required:	Yes
Article 14(2)(b)(ii) Notice sent:	18/04/2013
Article 14(2)(b)(ii) reply received	11/07/2013 and 18/11/2013
Article 14 compliance date:	18/11/2013
Article 16(1) Notice sent:	18/07/2013
Article 16(1) reply received:	16/08/2013
Article 16 Compliance date:	16/08/2013

Section 87(1I)(g) Notice sent to Planning Authority/An Bord Pleanala	03/10/2013
Response to Section 87(1I)(g) Notice	31/10/2013 (Offaly County Council), 01/11/2013 (An Bord Pleanala)
Section 76A(3) Notice sent:	19/02/2014
Response to Section 76A(3) Notice received:	18/03/2014
Site Inspection:	16/10/2013

Facility

Glanpower Limited (CRO No. 465847) have applied for an Industrial Emissions Licence (Reg. No. W0282-01) for a new development at Derryclure, Tullamore, County Offaly. The site is about 4.5 ha and is located about 8km south of Tullamore. The site is located directly off the N80 adjacent to Derryclure landfill operated by Offaly County Council (W0029-04), which ceased landfilling activites in October 2011. The site is bounded on the west and north sides by existing hedgerows. The eastern boundary is marked by a palisade fence to the council landfill site and the southern boundary is bounded by Derryclure Woods.

The proposal is a new development and is for of a waste-to-energy (WtE) plant. The proposed facility will utilise 65,000 tonnes per annum (tpa) municipal waste and 10,000 tpa energy crop biomass for the generation of renewable energy, by a system based on pyrolysis technology. The proposed development has been designed to treat the quantities of 'third bin' or 'black bin' waste arising from source separated (2-bin or 3-bin) streams. The facility will not accept 'green bin' (source separated dry recyclable) or 'brown bin' (source separated biodegradable) waste for thermal treatment, in accordance with the minimum pre-treatment obligations specified by the EPA for WtE incineration. Waste will also be subject to pre-treatment at the facility. The facility was granted planning permission by An Bord Pleanála (planning ref. PL19.238420) on 21st July 2011.

Glanpower (founded in 2008) is a wholly Irish-owned and operated company, interested in the development and operation of environmentally sustainable, alternative power generation projects in Ireland and abroad. Since being founded, Glanpower has increasingly focused its attention on the energy-from-waste sector and has identified a pyrolysis system it considers is suitable for the thermal treatment of waste (and biomass).

The proposed facility will consist of one building, which will house, (i) a reception and pre-treatment area, (ii) an enclosed fuel recovery area, (iii) a pyrolysis area, (iv) engine areas, (v) office, visitor reception and staff accommodation, (vi) ancillary accommodation (weighbridge, services including power, water mains, telephone/broadband), and (vii) maintenance areas. Condensing units associated with the steam turbines will be located on the roof of the main building.

Externally the site will be secured by perimeter fencing and gates, and will accommodate, (i) vehicular access roads and pedestrian footpaths, (ii) staff and visitor car parking, (iii) security hut, (iv) service yard (and underground trade effluent

tank). (v) emergency generator, (vi) fuel oil storage tank and bund, (vii) water storage tank and associated pump house, (viii) fuel and lube oil delivery areas, (ix) transformer compound, (x) emergency flare stack, (xi) foul sewage treatment area and (xii) vehicle utilities (wheelwash, weighbridge).

The site layout plan is shown in Appendix 1.

The applicant proposes to accept waste during the hours of 7:00am to 6:00pm Monday to Saturday inclusive. Waste will not be accepted at the site on Sundays or public holidays. Handling, pre-treatment, processing and pyrolysis of waste (R1, R12 and R13 activities) will be carried out within the facility building on a continual basis i.e. 24 hours per day. Based on the requirement for maintenance of pyrolysis/energy recovery plant, the applicant expects the principal activities of pyrolysis and energy recovery (R1 activities) to be carried on for approximately 8,000 hours per annum.

The applicant expects the WtE plant to employ around 50 personnel when fully operational.

Operational Description

The facility has been designed with a nominal pre-treatment capacity of 15 tonnes per hour (waste intake) and the two pyrolysis units provide a total installed capacity of 7.8 tonnes per hour. There are two main steps to produce syngas from waste, as follows:

1. Producing solid recovered fuel (SRF) from waste intake.

This step ensures that unsuitable and potentially hazardous waste materials (e.g., batteries, electrical items) within the incoming waste feed are removed for appropriate recovery/disposal off-site. Glass, metal and hard particles are also removed to enable the recycling of these fractions off-site.
The pre-treatment stage, involving shredding and drying steps, converts the remaining waste into a SRF, which is then subject to pyrolysis (the core process step of the proposed facility).

2. Pyrolysis.

Pyrolysis is the thermochemical decomposition of material at elevated temperatures in the absence of oxygen. In contrast with conventional incineration, the waste material is not directly combusted in a fire. Instead, the material is superheated (in the absence of oxygen) and broken down into a gaseous by-product (synthesis gas or 'syngas') and a solid by-product (char). The solid carbon char generated is used as the fuel to generate heat necessary for pyrolysis to occur.

In this proposed development, pre-treated waste (or SRF) and energy crop biomass will be subjected to pyrolysis. Heat in the pyrolysis flue gas will be recovered (steam generation) for use in a steam turbine for the production of electricity. The syngas generated will be subsequently cleaned and combusted in four gas engines, for the direct generation of electricity. This electricity will be exported to the National Grid. Excess heat energy in the gas engine flue stream will also be recovered for steam generation for use in the steam turbine to produce additional electricity. Residual heat remaining in the engine flue gas will also be recovered for drying waste at the pre-treatment stage.

A summary of the process is shown in Appendix 2. The main process units for the proposed facility are as follows:

1. Waste reception.
The waste reception hall will be air tight and waste will be received in the waste reception hall through double interlock doors. Accepted waste will be tipped onto the floor of the reception hall, where it will be lifted and loaded to the plant pre-shredder hopper. Waste will be stored in the reception hall for a maximum period of 24 hours (48 hours on bank holidays).

2. Waste pre-treatment.
The pre-treatment will consist of (i) pre-shredding, (ii) trommel screen, (iii) drum magnet to remove ferrous metals, (iv) eddy separator unit to remove non-ferrous metals, (v) wind separator unit to remove heavy particles such as glass, ceramic, stone, etc., (vi), drying (see below) (vii) final shredding (< 50 mm), and (viii) baling (if required). The applicant states that the facility has been designed with space available for the installation of optical sorter units, which could be fitted if required for operational improvements.

The applicant states that the pre-treatment of waste will result in a feedstock specification to the pyrolysis unit in line with SRF with a calorific value of 15 – 22 MJ/kg.

Based on the average content of chlorine reported in the SRF used during pyrolysis systems trials, and the pre-treatment system proposed for the Glanpower facility, the applicant expects chlorine levels in the SRF feedstock to be below 1% chlorine.

3. Waste drying.
Waste material for drying will be processed from two sources – firstly material processed through the wind separator units and secondly bale-split material from storage which was previously pre-treated and baled.

The material will be conveyed to a single rotary drum dryer to reduce the moisture content to 5% (±2.5%) before feeding to the pyrolysis chambers. The heat energy for drying will be obtained from gas engine cooling water circuits and steam turbine condenser cooling water circuit. Emissions to atmosphere are released via activated carbon and baghouse filtration.

4. Fuel feed to pyrolysis chamber.
Two identical pyrolysis units (capacity of 3.9 tonnes per hour each) are to be installed and will be fed by a hydraulic feed loading system. The twin hydraulic feed loading system (to each pyrolysis chamber) will squeeze out air from the fuel to ensure that oxygen and nitrogen are excluded. Excluding oxygen prevents combustion of the fuel and the formation of dioxins. Excluding nitrogen ensures the gas from the pyrolysis process is not diluted and minimises the formation of NO_x emissions. The fuel feed will be monitored by camera relayed to a monitor in the control room. Oxygen and nitrogen monitoring will be provided at the pyrolysis chamber.

5. Pyrolysis chambers.
Two identical pyrolysis units will be installed. Figure 1 presents a schematic of a pyrolysis chamber, including main inputs and outputs. The chamber includes a custom vane design within a metal shell (tube retort) which will progressively advance the fuel in an auger fashion along the inside to ensure maximum fuel residence time, uniform constant heat exposure and minimal shell stress while converting the fuel to a gas and char at an optimum rate.

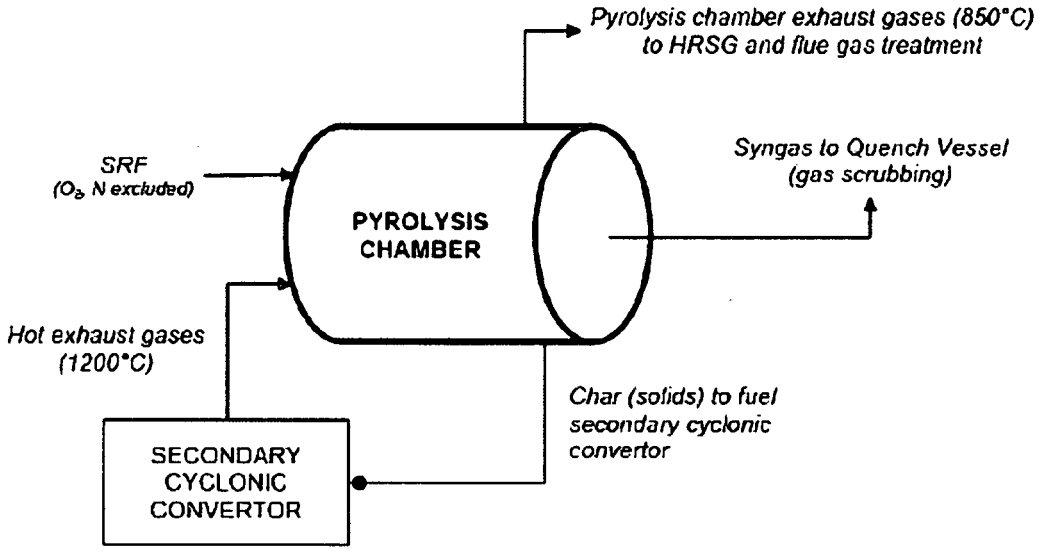


Figure 1 Pyrolysis Chamber Overview

SRF is thermally decomposed within the rotary kiln chamber at temperatures of 700±50°C into (i) a carbon and hydrogen rich synthesis gas (termed "syngas") and (ii) a solid carbon based char. Any inert material in the SRF remains in the char.

The syngas exits the chamber through a water cooled extraction pipe and is forced through an impingement baffle to separate heavy particles. The heavier char particles will fall into the bottom of the hopper and will be extracted through a rotary valve to the char system (see below). The syngas with remaining fine dust content will then be directed for gas scrubbing, conditioning and ultimately combustion.

The char fraction is conveyed to a secondary cyclonic converter (burner) as a fuel for the system and the hot exhaust gases (1,200°C) from the secondary cyclonic converter provides the heat energy for thermal decomposition (pyrolysis) of the SRF. The thermal energy in the hot exhaust gases heating the pyrolysis chamber will be recovered in a heat recovery steam generator (see below).

6. Char recovery and delivery system.
From each of the two pyrolysis units, char (consisting of solid carbon ash) will be recovered and delivered to the two secondary cyclonic convertors. The carbon char has minimal hydrocarbon content, chlorine, sulphur and contaminants. The applicant submitted results of analysis of char derived from 100% MSW pyrolysis feed.

7. Secondary cyclonic convertors (thermal oxidisers).
There will be two secondary cyclonic convertors to support the two pyrolysis units and they will be fuelled from SRF-derived char coming from the pyrolysis units. The secondary cyclonic convertors will initially be primed/fired with low sulphur kerosene, but once the char feed is sufficient to sustain the combustion temperature, the kerosene supply to the burners will be isolated. Combustion air will come from the waste reception hall, and the combustion will abate the odours in this air. Figure 2 provides an overview of the inputs and outputs of a secondary cyclonic convertor.

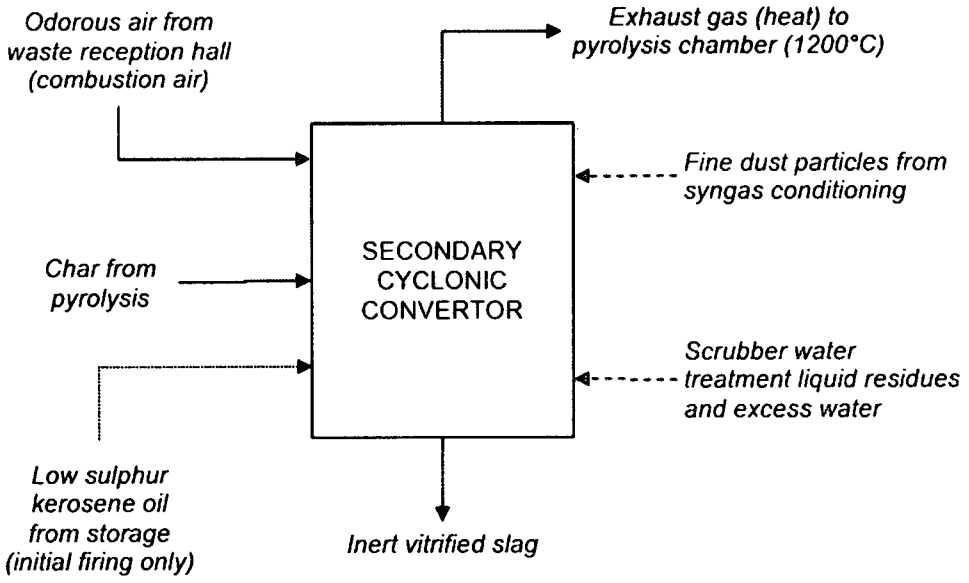


Figure 2. Overview of secondary cyclonic convertor.

The secondary cyclonic converters have been designed specifically to operate with carbon char as the primary fuel, but will also periodically handle the intermediate residue streams arising from syngas conditioning and scrubber water treatment.

Entry of the char to the secondary cyclonic convertor is regulated by automatic temperature and oxygen level control, providing for a temperature of 1,150°C for over two seconds. The requisite combustion temperature will be guaranteed by the provision of a *residence tube*. There will be monitoring of temperature at the the top of the secondary cyclonic convertor, the retort surface, and the inlet and the outlet of the *residence tube*.

The combustion air required is determined from the char mass and the char characteristics based on the measured oxygen levels in the flue gases leaving the secondary cyclonic convertor. Negative pressure will also be maintained with pressure alarm and automatic shutdown provided.

Within the secondary cyclonic convertors, the hot gases are forced into a cyclonic downward action causing the heavy ash to melt and fly outward onto the walls, where it flows down and out of the convertor in the form of a vitrified slag. Molten slag falls into a water trough, where it solidifies. The applicant has confirmed (with analysis) that the slag output is an inert vitrified, non-leaching material.

Residence Tube

The interconnection between the secondary cyclonic convertor and the pyrolysis chamber has been designed, by means of a *residence tube*, to ensure sufficient residence time is provided for the desired combustion at the operating temperature. This is in accordance with Article 50(2) of the IED. The applicant confirmed that a residence time of 2 seconds at 1,150°C will be achieved by using computational flow dynamics modelling and the design calculations for the system.

The combination of the pyrolysis stage with a subsequent combustion stage with energy recovery and flue-gas treatment that provides for operational emission levels to air within the BAT associated emission ranges is identified as BAT in the Waste Incineration Bref note.

8. Syngas scrubbing.
The syngas produced by the pyrolysis unit is a mixture of light gases, heavier gases and condensable organics. The light gases include hydrogen, carbon monoxide, carbon dioxide, methane, ethane and similar short chain hydrocarbons. The syngas, at this stage, also includes particulates, tars and other constituents which are to be removed in the gas scrubbing system. There will be two identical syngas scrubbing systems to support the two pyrolysis units. Each system comprises three main steps, as follows:

(1) Venturi quench vessel - here the syngas is cooled, which is required to condense the heavier organic oils and tars. Liquid effluent from this vessel is directed to the scrubber water treatment system.
(2) Gas wash tower. The gas wash tower will remove solids and gas soluble contaminants while cooling the syngas prior to entry into the packed bed scrubber. Liquid effluent from this vessel is directed to the scrubber water treatment system.
(3) Scrubbing towers and demister system. The cooled syngas enters a packed bed scrubber operated in a two stage system. The scrubbing liquid (pH corrected) removes soluble acid gases. The first stage will carry over oils in the water most of which will settle in the reservoir tank. The second stage removes finer particles. Any residual oils not captured in the quench tower will be separated in the scrubber sump. Prior to syngas exiting the scrubbing tower systems, dual demister pads will remove excess moisture in the syngas stream.

9. Syngas conditioning (pre-engine syngas stage).
Having scrubbed the syngas, it must then be conditioned to ensure optimum engine performance. There are five steps in conditioning the syngas, as follows:

(1) Cyclone separator and demister system. Removal of any remaining fine dust (carbon char) particles and moisture/aerosols. Captured liquor will be directed to the water treatment system for the removal of hydrocarbons.
(2) Gas meter. A turbine gas meter, positioned on each of the two gas lines, will determine the flow to the syngas engines.
(3) CV (calorific value) analyser – a high speed process gas analyser for monitoring and control of calorific value, Wobbe index[1], specific gravity and air/fuel ratio. Following the CV analyser step, the two gas lines are combined to allow for distribution to the syngas engines.
(4) Activated carbon Filter – removes contaminants and impurities.
(5) Ceramic fine filter – will remove fine particles (< 150 – 210 μm) and any remaining condensate vapour. Solid matter will fall to the bottom of the hopper section of the filter unit, where it will be discharged directly to a collection drum. The residue (carbon char) will be reprocessed within the secondary cyclonic convertor. Condensate build-up will be drained via

[1] The Wobbe Index is the corrected representation of the heating value of natural gas arriving, from the gas line, at the orifice where a burner is located. It is an indicator of the interchangeability of fuel gases such as natural gas, liquefied petroleum gas (LPG), and town gas. The Wobbe Index is used to compare the combustion energy output of different composition fuel gases.

siphon/condensate separator and directed to the water treatment system. The applicant states that the ceramic filters achieve particulate reduction below 5mg/m^3.

10. Heat recovery from pyrolysis.
The applicant will install a single heat recovery steam generator (HRSG) to capture heat from the two pyrolysis flue gas streams. A second unit will also be installed to recover heat from the gas engines. Steam produced will be utilised in a 1.24 MW steam turbine for the generation of electricity.

11. Syngas engines.
The scrubbed and conditioned syngas will provide the fuel for the gas engines for electricity generation. There will be four gas engines, with a combined generating capacity of 9.6 MWe. A gas analyser will be supplied on the engine package. The syngas will be monitored for oxygen level, immediately before the emergency flare and syngas engine. The tie-in point for the gas flare will be after the CV analysers (where the twin gas lines merge) and before the activated carbon filters (where the gas line diverges before the gas engines).

The Waste Incinceration Bref note states that, for an installation using a combination of pyrolysis with subsequent combustion, the use of gas engines to generate electricity is BAT.

12. Heat recovery from syngas engines.
As noted earlier, the heat contained in the engine exhaust gas will be recovered in a HRSG, separate to that associated with the pyrolysis units, where the two HRSGs will feed a single steam turbine and generator.

13. Steam turbine.
The two HRSG units produce steam to feed into a condensing steam turbine that will drive an electrical generator.

14. Flue gas treatment and odour abatement.
There will be two main sources of flue gas emissions, i.e., exhaust gas from the pyrolysis chambers and exhaust gas from the gas engines. In addition there will be two sources of odorous air, as follows:
- The waste reception hall and materials recovery area.
- Waste drying. The dryer feed air will come from the waste reception hall.

(1) Pyrolysis exhaust gas (from the secondary cyclonic converters used for the combustion and recovery of energy from the char) – this will be treated using selective non-catalytic reduction (SNCR) using ammonia/urea injection and a ceramic filter. SNCR will be provided at the residence tube between the secondary cyclonic convertors and the pyrolysis chambers. The treatment system is designed to ensure compliance with Annex VI of the IED. Exhaust gas from the two units will be released via the primary stack which will be equipped with a variable diameter, laminar flow chimney, designed specifically for this facility incorporating fan control. Treated flue gas will be directed through a continuous emissions monitoring system (CEMS).

(2) Syngas engine exhaust – this will be treated using selective catalytic reduction (SCR).

(3) Waste reception hall and materials recovery area, and waste dryer. The main building will be accessed by delivery via an interlock area located to the rear of the building. Air in the waste reception hall will be vented to a number of points and odour abated as required, i.e., secondary cyclonic

convertors as combustion air and activated carbon and baghouse filtration for air from waste dryer.

15. Scrubber water treatment system.
Water treatment is required to treat the spent liquids used for syngas scrubbing and syngas conditioning. A multi-step water treatment system will be employed to treat and recycle this water. Spent scrubber liquor from the scrubbing and conditioning is directed to two water reservoirs where pH adjustment may be applied. The water is then directed through centrifuge, media filtration, electrolysis, activated carbon filtration and reverse osmosis to remove contaminants in a step-wise approach. Excess water will be diverted to the secondary cyclonic convertors.

Emissions

Air

There will be six major emissions to atmosphere, the primary stack (combustion of char), four gas engine stacks (combustion of syngas) and waste dryer stack. There is also the potential for a seventh major emissions point through the emergency generator which will provide electricity to the installation in the event of an external power cut.

The combustion of char has the potential to produce a number of emissions which are regulated by Chapter IV and Annex VI of Directive 2010/75/EU on industrial emissions (IED), namely:

- Nitrogen monoxide (NO) and nitrogen dioxide (NO_2), expressed as NO_2;
- Sulphur Dioxide (SO_2);
- Total Dust (PM_{10} and $PM_{2.5}$);
- Carbon Monoxide (CO);
- Total Organic Carbon (TOC);
- Hydrogen Fluoride (HF) and Hydrogen Chloride (HCl);
- Dioxins and Furans (PCDD/PCDFs);
- Cadmium (Cd) and Thallium (Tl);
- Mercury (Hg);
- the sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (CO), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V).

The combustion of syngas has the potential to produce emissions of NO_x, CO, particulate matter (PM_{10} and $PM_{2.5}$) and volatile organic compounds (VOCs).

The waste dryer has the potential to produce emissions of odour, particulates and VOCs.

The emergency generator has the potential to produce emissions of sulphur dioxide.

Emissions from the proposed WtE facility have been modelled using the AERMOD dispersion model. The modelling exercise was carried out in line with the Agency's *Air Dispersion Modelling from Industrial Installations Guidance Note (AG4).* The model used five years (2004-2008) of meteorological data from Birr, County Offaly, terrain data and considered building downwash. The model used a nested grid extending to a 8.8 km x 8.8 km grid with its centre at the primary stack (A2-1). The

model considered maximum flow conditions and emission limit values included in the RD.

The applicant also provided a cumulative air quality impact assessment by taking into account emissions from the flare at Derryclure Landfill (W0029-04). The cumulative impact assessment did not include odour, because the landfill is now fully closed and capped. The results of the air dispersion modelling are detailed in Table 1 below.

Table 1: Air Dispersion Modelling Results for emissions at ELVs in RD.

Parameter	Background Concentration Note1	Process Contribution	Predicted Environmental Concentration (PEC)	Air Quality Standard (AQS)
	All results are in $\mu g/m^3$ unless otherwise stated			
NO_2 Note 2				
1-hour (99.8%ile)	13	77.8	90.8 Note 3	200 Note 4
Annual mean (human health)	6.5	3.8	10.3	40 Note 4
Annual mean (vegetation)	6.5	3.8	10.3	30 Note 4
SO_2				
1-hour (99.7%ile)	4.6	32.9 (271.4 Note 5) Note 3	37.5 (276 Note 5) Note 3	350 Note 4
24-hour (99.2%ile)	2.3	10.9 (102.3 Note 5) Note 3	15.5 (106.9 Note 5) Note 3	125 Note 4
Annual mean (vegetation)	2.3	1.6	3.9	20 Note 4
PM_{10}				
24-hour (90.4%ile)		1.7	13.2 Note 3	50 Note 4
Annual mean	11.5	0.6	12.1	40 Note 4
$PM_{2.5}$				
Annual mean	11.5	0.6	12.1	25 Note 4
CO				
8 hour	400	19.9	419.9	10,000 Note 6
TOC (as benzene)				
Annual mean	0.4	0.4	0.8	5 Note 4
HCl				
1-hour (arithmetic mean)	0	7	7	750 Note 7
HF				
1-hour (arithmetic mean)	0	0.7	0.7	160 Note 8
Annual mean	0	0.03	0.03	16 Note 8 0.4 Note 9
Hg				
1-hour	0.00286	0.016	0.01886	7.5 Note 7
Annual mean	0.00143	0.0007	0.00213	1 Notes 6 0.25 Note 7
Cd & Ti				
Annual mean	0.0002 Note 10	0.0007	0.0009	0.005 Note 11
Other heavy metals				
1-hour	0	0.14	0.14	400 Note 7
Annual average	0	0.006	0.006	0.006 Note 11, 12
Dioxins/Furans	(fg/m^3) Note 13	(fg/m^3)	(fg/m^3)	
max. annual average	28 – 46 Note 14	1.19	29 – 47	300 Note 6

Odour units 1-hour (98%ile)	(OU_E/m^3) 0	(OU_E/m^3) 0.24	(OU_E/m^3) 0.24	(OU_E/m^3) 1.5 Note 15

Note 1: Background data was taken from the Agency's publication *Air Quality in Ireland 20011, Key Indicators of Ambient Air Quality, Environmental Protection Agency 2012* (Zone D).
Note 2: The model assumed a 100% conversion of NO_x to NO_2, a conservative assessment.
Note 3: Background added in accordance with Agency's Air Dispersion Modelling from Industrial Installations Guidance Note (AG4).
Note 4: Council Directive 2008/50/EC on ambient air quality and cleaner air for Europe, transposed through S.I. 180 of 2011.
Note 5: Predicted ground level concentration with operation of emergency generator.
Note 6: World Health Organisation.
Note 7: UK Environment Agency has Environmental Asssessment Levels (H1 Guidance, Annex F).
Note 8: Human Health air quality guidelines set by UK DEFRA (Expert Panel on Air Quality Standards, (2008) and Addendum to Guidelines for Halogens and Hydrogen Halides in Ambient Air Provisional Guidelines for Hydrogen Iodide and Hydrogen Fluoride for Protecting Human Health against Chronic Systemic Effects, May 2009.
Note 9: TA-Luft (2002) standard for HF and inorganic gaseous compounds of fluorine, protection against significant disadvantages.
Note 10: Background data on cadmium + thalium was not available so the cadmium value alone was used. As background thalium levels would be at similar level, this does not undermine the assessment.
Note 11: Council Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air, transposed through S.I. 58 of 2009.
Note 12:. This is the standard for arsenic, the most stringent of the standards in Council Directive 2004/107/EC, outside cadmium. It is extremely unlikely that all of "other heavy metals" will be arsenic.
Note 13: 1 femtogram (fg)/m^3 = 1 x 10^{-15} g/m^3. Baseline results for dioxins given as sum of cumulative impacts (in the absence of the WtE facility) and baseline monitoring data firstly as (i) Non-detects = zero, (ii) Non-detects = limit of detection.
Note 14: Based on monitoring carried out at Carranstown, Co. Meath for Indaver's application for an incinerator (W0167-02). As both locations are rural, similar levels are expected.
Note 15: UK Defra (odour Guidance for Local Authorities, March 2010).

The data in Table 1 identifies the predicted environmental concentration (PEC) of the regulated pollutants (at the emissions limit values included in the RD) meet the relevant air quality standards/guidelines and indicates that emissions from the proposed facility will not cause significant environmental pollution. The RD (Schedule C.1.2) requires extensive monitoring of emissions to air, in particular emissions monitoring for the primary stack are in line with Annex VI of the IED. Article 42 of the IED states that Chapter IV of the IED (provisions for waste incineration and waste co-incineration plants) *"shall not apply to gasification or pyrolysis plants, if the gases resulting from this thermal treatment of waste are purified to such an extent that they are no longer a waste prior to their incineration and they can cause emissions no higher than those resulting from the burning of natural gas".* Accordingly the extensive monitoring requirements applied to the primary stack are not applied to the exhausts from the gas engines. This matter is explored further on page 18 of this report under the heading "End of waste – Syngas".

The RD (Schedule C.1.1) also requires extensive process controls in order to mitigate emissions. Table 2 outlines the emissions abatement techniques for each pollutant and Appendix 3 outlines the fate of contaminants in the SRF entering the pyrolysis chamber.

Table 2. Emissions abatement techniques for each pollutant

Parameter	Abatement techniques
NO_x	Hydraulic loading system excludes nitrogen and oxygen from feed prior to pyrolysis in chamber. Packed bed scrubber. SNCR (pyrolysis exhaust, A2-1) and SCR (exhausts from gas engines, A2-2 through A2-5).
SO_2	Pyrolysis and packed bed scrubber (treats syngas before gas engines).
Particulates	Heavy particles in the gas exiting the pyrolysis chamber are

(PM_{10} and $PM_{2.5}$)	separated via impingement baffle. Fine dust content is then removed by conventional single stage cyclone separator. Remaining entrained particles are removed by pressure drop and impingment during the wet cleaning process (quench tower, packed bed scrubber). Ceramic filters capture particulates resulting from char combustion. Syngas scrubbing and conditioning for gas engine emissions (A2-2 through A2-5). Dust cyclone and baghouse filtration for A2-6 (waste dryer stack).
CO	Combustion control (A2-1 through A2-5).
TOC	Combustion control (A2-1 through A2-5). Activated carbon filtration for A2-6 (waste dryer stack).
HCl	Removed and neutralised by wet scrubbing (packed bed scrubber)
HF	Gas scrubbing.
Hg	Reduction to metallic form by pyrolysis and entrapment in the gas scrubber.
Cd & Ti	Reduction to metallic form by pyrolysis and entrapment in the gas scrubber.
Other heavy metals	Reduction to metallic form by pyrolysis and entrapment in the gas scrubber.
Dioxins/Furans	Pyrolysis feedstock prevents formation of dioxins and the pass through of pre-existing dioxin and related compounds.
Odour	Activated carbon filtration (A2-6, waste dryer stack).

The potential for fugitive emissions is controlled through handling waste indoors.

The abatement systems proposed for the installation, and the emissions limit values included in the RD, are consistent with BAT for a waste pyrolysis installation.

Emissions to Sewer

There are no emissions to sewer proposed for the facility.

Emissions to Surface Waters

There will be no process emission from the facility to surface water.

Storm Water Runoff

There will be one surface water emission point (SW1) for uncomtaminated run-off from internal site roadways, pavement, yard areas and roof run-off. Run off discharges via petrol interceptors, grit traps and underground surface water attenuation to a drainage ditch that ultimately drains to the Clodiagh River, about 5km from the site. The rate of discharge will be controlled and limited by hydrobrake.

The attenuation structure and hydrobrake flow control device have been designed in accordance with the Greater Dublin Strategic Drainage Study (GDSDS), to provide a maximum discharge rate of 8.62l/s. The attenuation tank has been sized to provide sufficient capacity for a 1:30 year storm. In the case of greater rainfall amounts, up to a 1:100 year rainfall event, these

stormwaters will be retained within the boundary of the site (either within the attenuation tank, on the surface of paved areas, or low lying landscaped areas, etc.). A high level overflow will be provided from the storage structure to the ditch network to allow storm events in excess of the 1:100 year event to overspill to the ditch network.

In the event of fire on-site, the surface water outfall SW1 will be shut and firewater will be contained within the attenuation tank and underground surface water network to prevent the potential release of pollutants which may be contained in the firewater.

The RD includes the usual conditions regarding the control of surface water run-off, bunding and firewater retention as well as requiring trigger levels to be agreed by the Agency for the stormwater discharge to the drainage ditch.

Emissions to ground/groundwater:

There will be one emission point to groundwater, the discharge from the site sanitary effluent treatment system (Sequencing Batch Reactor). The RD requires the treatment system and percolation area to satisfy the criteria set out in the EPA's waste water treatment manuals. The discharge of the treatment plant (MGW1-1) will be sampled on a quarterly basis.

There will be no fugitive or uncontrolled emissions from the facility to ground or groundwater. The proposed activities will not give rise to an emission into an aquifer containing the List I and II substances specified in the Annex to Council Directive 80/68/EEC as amended.

Two groundwater monitoring wells have been installed on-site and these have been incorporated into the RD.

Wastes Generated:

The pre-treatment (including drying) of waste (65,000 tonnes per annum) will generate approximately 50,000 tonnes per annum (tpa) of solid recovered fuel (SRF) through the removal of dry recyclable fractions, non-conforming waste and moisture content.

The plant has been sized to treat up to 62,400 tonnes per annum of SRF based on 8,000 hours of operation per year. SRF and energy crop biomass (10,000tpa) will be the materials that ultimately fuel the pyrolysis and gas engine systems.

The main waste arisings will be 3,200 tonnes per annum (5% of waste intake) of inert, vitrified slag residue arising from the combustion of pyrolysis-derived char in the secondary cyclonic convertors. The quantity of this residue will be minimised by ensuring a consistent level of pre-treatment, monitoring of system temperature and oxygen levels and scheduled maintenance of all plant and equipment. The applicant currently proposes to send the vitrified slag residue to landfill for disposal, although it may seek approval for use of the material as an aggregate for road building / land cover at a later date.

Metals, glass and hard particles removed at the pre-treatment stage will be sent for off-site recycling. Similarly non-conforming waste items arising in

waste consignments (e.g. hazardous materials, WEEE, etc.) will be quarantined for recovery or disposal off-site. Table 3 presents the applicant's estimate of waste residues for disposal/recovery. As can be seen from the Table 3, the quantity of residual waste consigned to disposal/recovery should not exceed 15% of the annual waste intake, a much lower figure than for conventional incinceration (which might be 30% or more).

Table 3. Maximum Quantity of Residual Waste Consigned for Disposal/Recovery from the Proposed Facility.

Waste for Consignment (Disposal)	**% Intake**	**Quantity (tonnes per annum)**
Hard particles (stones, glass, ceramics, other)	Up to 7.5%	4,875
Vitrified slag arising from char combustion	Up to 5%	3,200
Hazardous waste	0.9%	585
Total	Up to 13%	8,660

Process residues arising, including scrubber water treatment residues, flue gas treatment residues and waste oils will be reprocessed within the pyrolysis system preventing the requirement for treatment as waste off-site. Solid and liquid residues arising from these steps will be combusted in the secondary cyclonic convertor. Oil based residues (hydrocarbons) will be added to the SRF feedstock prior to pyrolysis. Up to 6,000 tpa of residues (mainly oil and liquid residues) may be generated.

In its BAT assessment, the applicant stated that only those residues which may be safely reprocessed within the pyrolysis system will be recirculated. Where residues arising have the potential for disruption of system operation leading to accumulation of metals, these will not be recirculated but rather, sent off-site under permit for suitable treatment. Analysis of the slag, the residues and the char is required through Schedule C.4 of the RD and the test programme in order to ensure the risks of combustion of materials in the secondary cyclonic convertors is as per the licence application, and that materials are appropriately recovered/disposed. The frequency and scope of the monitoring of these materials may be amended under Condition 6.7.

Washdown of the floor of the waste reception area will drain to an effluent storage tank and will be tankered off-site for treatment. Silt from wheelwash will also be generated and removed for disposal. The wheel wash recycles water and will have an overflow to the effluent storage tank.

Noise:

The applicant identified that, in accordance with the Agency's Guidance note NG4 (*Guidance Note for Noise: Licence Applications, Surveys and Assesments in Relation to Scheduled Activities*), the existing environment was not determined to be a 'Quiet Area' or an 'Area of Low Background Noise'. The facility is 350m from the nearest noise sensitive location.

The main sources of external noise will be, cooling units for the pyrolysis units, engine heat rejection unit, electrical transformers, dryer exhaust, emergency generator and roof-mounted condenser units associated with the

steam turbine. The majority of the noisy equipment will be housed in acoustic enclosures and indoors.

The applicant carried out a noise model which indicated noise emissions would not cause a breach of the noise limits included in the RD. The model considered two scenarios, (i) noise from the facility breakout only (29.5 dBA at nearest noise sensitive receptor) and (ii) all sources that will be operational during normal operation (31.1 dBA at nearest noise sensitive recepetor).

Nuisance:

All waste delivery trucks will be enclosed and all waste activities will take place indoors to reduce the potential for bird nuisance, wind blown litter and vermin. The waste reception hall and materials recovery will be maintained under negative air pressure to avoid any odour, dust and windblown litter problems. Standard BAT measures for vermin control and general nuisance mitigation are proposed.

Condition 6.11 of the RD requires the licensee to undertake weekly inspections of the facility and immediate surrounds for nuisances caused by litter, vermin, birds, flies, mud, dust and odours.

Use of Resources

Energy: WtE facilities provide a renewable source of energy and are in line with EU and national policy to promote renewable energy sources. The facility will be a net exporter of energy and the SRF recovered from waste is its primary fuel. The facility qualifies as a waste recovery operation using the R1 formula in the revised Waste Framework Directive (2008/98/EC). To qualify as a waste recovery operation, new incinerators must have an efficiency factor of 0.65 as a minimum, using the R1 formula[1] to calculate energy efficiency. The applicant has calculated an energy efficiency factor of 0.68 for this facility (MSW only), therefore qualifying as a waste recovery operation.[2]

The pyrolysis technology proposed has been developed as an efficient system to convert energy crop biomass and pre-treated waste into a clean gas for use in CHP (combined heat and power) and electricity production. The process has been designed to be inherently energy efficient by utilising the char produced by pyrolysis as a fuel source for the system.

The facility generates electricity directly from the syngas engines, but also by using the heat recovery steam generators linked to a steam turbine for the recovery of residual heat energy. The applicant stated that the combined efficiency of this approach is more efficient than gas turbine technology. In particular the applicant states it chose gas engines over the gas turbine technology due to their higher open cycle efficiency (35% compared to 28%) and other operational and maintenance practicalities.

[1] R1, indicator of energy efficiency for thermal treatment of waste, calculated in line with the *European Commission Guidelines on the Interpretation of the R1 Energy Efficiency Formula for Incineration Facilities dedicated to the Processing of Municipal Solid Waste according to Annex 11 of the Directive 2008/98/EC on Waste.*

[2] The applicant calculated a R1 value of 0.86 when biomass included, but the EC guidelines (in above footnote), consider the value for MSW only when determining if an operation is recovery or not.

High Peformance CHP: Council Directive 2004/8/EC (as amended) on the promotion of cogeneration based on useful heat demand in the internal energy market defines high efficiency cogeneration, as providing primary energy savings of at least 10% compared with the references for separate production of heat and electricity. Glanpower have calclulated their primary energy savings at 17.9%, and accordingly consider the the overall system can be classified as a high efficiency CHP plant. An application to establish the proposed facility as a High Efficiency CHP plant is currently being assessed by the Commission for Energy Regulation (CER).

Materials: Urea and ammonia will be used in the emissions to air abatement systems (SCR and SNCR).

- Fuel

The facility proposes to use up to 10,000 tpa biomass (wood chip) to supplement the SRF (up to 62,400 tpa) generated. The applicant also expects to use up to 18 tpa kerosene in the operations.

- Electricity

The facility will be a net exporter of electricity to the national grid (8.84 MW).

- Water

Water (for domestic, floor washdown and fire-fighting requirements) will be sourced from connection to the public mains and will be stored on-site in a 1000m^3 capacity tank.

- Greenhouse gas emissions

While the operation of the Energy Centre will result in the emission to atmosphere of greenhouse gases (namely CO_2 and minor quantities of N_2O), it also results in the avoidance of greenhouse gas emissions from two other sources, in particular:

1. The electricity produced at power plants burning fossil fuels. The electricity produced by pyrolysis reduces utility CO_2 emissions.
2. Landfill gas (methane) generation, as the waste is thermally treated instead of going to landfill.

Annex I of Directive 2003/87/EC on greenhouse gas emissions trading exempts municipal waste incinerators from the directive requirements. In relation to the general obligations under the Kyoto Protocol, the application of BAT, energy recovery, and emissions scrubbing for NO_x at the proposed facility comply with the general principles of the Protocol.

With regard to reducing the climate impact of the installation under IED, the RD requires an energy efficiency audit and an assessment of resource use efficiency. The EMP objectives and targets include use of cleaner production (including production related carbon footprint).

Waste Management, Air Quality and Water Quality Management Plans

The Midlands Regional Waste Management Plan 2005 - 2010 identifies the need for a minimum 150,000 tonnes per annum WtE facility to serve the Region's future waste management requirements. The overall waste management targets established in the plan are 46% recycling, 37% thermal treatment and 17% landfill. The scale and nature of the proposed facility is consistent with the requirements of the plan. Currently there is no waste to energy (thermal treatment) facility in the region.

Ireland has renewable energy targets required under EU Directive 2009/28/EC, obligations regarding greenhouse gas emissions under the Kyoto Protocol, and under the Landfill Directive 1999/31/EC, targets for the diversion of biodegradable waste from landfill.

I consider that the proposed development is consistent with the aforementioned plans and targets.

Compliance with Directives/Regulations

Industrial Emissions Directive (2010/75/EU)

This installation falls within the scope of the following categories of Annex 1 of Council Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control).

- Category 5.2 – *Disposal or recovery of waste in waste incineration plants or in waste co-incineration plants:*

  (a) for non-hazardous waste with a capacity exceeding 3 tonnes per hour;

- Category 5.3(b) – *Recovery, or a mix of recovery and disposal, of non-hazardous waste with a capacity exceeding 75 tonnes per day involving one or more of the following activities, and excluding activities covered by Directive 91/271/EEC:*

  (ii) pre-treatment of waste for incineration or co-incineration;

The Recommended Decision (RD) as drafted takes account of the requirements of the Directive. BAT is taken to be represented by the guidance give in European IPPC Bureau Reference (BREF) Document on BAT for Waste Incineration (July 2006).

Baseline Report

A Baseline Report, in accordance with Article 22(2) of the IED, was submitted with the application. As the European Commission has not yet established guidance on the content of the baseline report, the scope of the report was aligned to the requirements of the relevant European and Irish legislation. The report included the necessary information on present and past uses of the site, as well as soil and groundwater contaminant levels, sufficient to make a quantitative comparision upon definitive cessation of activities as per Article 22(2) of the IED.

Chapter IV of Directive 2010/75/EU and European Union (Waste Incineration Plants and Waste Co-Incineration Plants) Regulations 2013 (S.I. No. 148 of 2013).

Chapter IV of the Industrial Emissions Directive and the European Union (Waste Incineration Plants and Waste Co-Incineration Plants) Regulations 2013 (S.I. No. 148 of 2013) have replaced the Incineration of Waste Directive 2000/76/EC, the Air Pollution Act, 1987 (Municipal Waste Incineration) Regulations, 1993 (S.I. No. 347 of 1993); and the European Communities (Incineration of Waste) Regulations 2003 (S.I. 275 of 2003).

Chapter IV of the IED sets stringent operational conditions and technical requirements for waste incinerators. The RD takes account of these requirements.

Processing of Residues

As noted earlier, the proposed pyrolysis system provides for the reprocessing of residue streams arising from the flue gas treatment and scrubber water treatment

operations. Glanpower states that the residues arising retain a residual energy value which can be realised by processing the residues back into the system. Glanpower consider this reprocessing of the residues is consistent with the requirements of Chapter IV of the IED and in particular Article 53(1), which states:

"Residues shall be minimised in their amount and harmfulness. Residues shall be recycled, where appropriate, directly in the plant or outside."

Waste acceptance specification

The composition of pyrolysis-derived char is directly influenced by the composition of fuel materials input to the pyrolysis chambers. The quality of waste materials used is therefore critical to ensure the composition of char meets both operational and environmental requirements.

Glanpower intend to optimise the pre-treatment of waste materials in order to meet a strict SRF feedstock specification. The pre-treatment stage has been designed to ensure that all non-conforming and hazardous materials are removed from the material feed for pyrolysis and consequently are also absent from the char. The appropriate feedstock specification has been determined and is specified in the licence application. The RD (Condition 8.4) requires the licensee to monitor the SRF quality on a quarterly basis to confirm it meets the required specification.

Waste Framework Directive (2008/98/EC)

The RD takes account of the legislative provisions of the *European Communities (Waste Directive) Regulations 2011 (S.I. No. 126 of 2011)*, which transposed the Waste Framework Directive into Irish law.

The following activites (under the Waste Framework Directive) will be carried out at the proposed development:

- R1 – *use principally as a fuel or other means to generate energy* (principal activity);
- R12 – *Exchange of waste for submission to any of the operations numbered R 1 to R 11 (if there is no other R code appropriate, this can include reliminary operations prior to recovery including preprocessing such as, amongst others, dismantling, sorting, crushing, compacting, pelletising, drying, shredding, conditioning, repackaging, separating, blending or mixing prior to submission to any of the operations numbered R1 to R11)."*
- R13 – *Storage of waste pending any of the operations numbered R1 to R 12 (excluding temporary storage (being preliminary storageaccording to the definition of 'collection' in section 5(1)), pending collection, on the site where the waste is produced)".*

End of Waste – Syngas

Article 42(1), Chapter IV, of the IED states that:

This Chapter shall apply to waste incineration plants and waste co-incineration plants which incinerate or co-incinerate solid or liquid waste.

This Chapter shall not apply to gasification or pyrolysis plants, if the gases resulting from this thermal treatment of waste are purified to such an extent that they are no longer a waste prior to their incineration and they can cause emissions no higher than those resulting from the burning of natural gas.

From the above, one can see that Chapter IV of the IED does not apply to the combustion of syngas in the gas engines provided that:

1. The syngas is no longer a waste prior to incicneration, and
2. Emissions (arising from the combustion of the syngas) will be no higher than those resulting from the burning of natural gas.

1. Article 6 of the Waste Framework Directive sets out the conditions under which waste that has undergone recovery may no longer be considered a waste. These conditions, and Glanpower's response, are as follows:

   a) *The substance or object is commonly used for specific purposes;*

   Glanpower response: The specific purpose of the syngas is to fuel the gas engines and Glanpower considers this to be a standard/common use for the material.

   b) *A market or demand exists for such a substance or object;*

   Glanpower response: The market or demand for the syngas relates to the demand for renewable sources of electrical power. The Renewable Energy Directive (2009/28/EC) and the Irish Renewable Energy Action Plan have established ambitious targets for the growth in renewable energy and the utilisation of the syngas to generate electricity will help achieve these targets.

   c) *The substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and*

   Glanpower response: The applicant states that there are a number of gas engines on the market that have been specifically designed to operate using industrial gases with similar properites (e.g., lower calorific value fuels than natural gas). The applicant states that a gas engine manufacturer has confirmed that the specification of the syngas produced by the Glanpower pyrolysis system will be suitable for combustion in their engine unit. The applicant goes on to state that the engines produce electrical power with a comparable level of emissions (NOx and CO) when compared with the combustion of natural gas used in similar applications. Glanpower consider, therefore, the syngas will fulfil the technical requirements for use in the gas engines.

   The removal of contaminants from the syngas compares well with the required cleanliness specifications of the UK Gas Supply Regulations and the EASEE European Gas Quality Specification document CBP 2005-001/02.

   Glanpower compared the composition of syngas with a sample group of fuel gases (i.e., average of ten different sources of natural gas). The syngas contains similar components to natural gas, but with lower percentages of hydrocarbons and higher precentages of nitrogen, hydrogen, oxygen, carbon monoxide and carbon dioxide. Methane and other hydrocarbon gases are around 30% of syngas where they are about 90% of natural gas, so the calorific value of syngas is proportionally lower.

The applicant states there are two types of quality specifications for gas in the UK, those set out in the Gas Safety (Management) Regulations or GS(M)R, which relate to the supply of domestic gas, and those which relate to specific commercial and industrial contracts which will be plant/contract specific and will relate specifically to the requirements of an end user.

Glanpower states that the GS(M)R have been used by the Environmental Agency Technical Advisory Group as a means of reference for developing the Biomethane Injection Protocol[1]. The GS(M)R provides a limited set of requirements in relation to the pollutant parameters (hydrogen sulphide, total sulphur and impurities such as water, glycol, amines, methanol, oils, salts, chlorides, sand, dirt and carbon).

When deriving a comparison standard for the 'biomethane-to-grid' quality protocol, the UK EA, concentrated on a risk assessment approach and considered the impacts of the trace gases on people and the environment from their use. The risk assessment considered about 250 trace gases from a database of trace gas analysis for landfill gases and biogases. For each trace gas, a concentration was identified, a health criteria value established and a risk assessment carried out considering the critical pathway. In the case of the UK biomethane-to-grid protocol, the pathway was the use of the gas in a gas cooker within a small kithchen. Glanpower consider that the use of this risk methodology approach to establish a specification for the syngas would ensure that no hazardous effects/impacts will arise from its combustion.

d) The use of the substance or object will not lead to overall adverse environmental or human health impacts.

Glanpower response: The emissions-to-atmosphere impact assessment (see above) indicates the use of the syngas will not lead to overall adverse environmental or human health impacts.

Glanpower compared the typical UK natural gas composition with a typical waste derived syngas specification.The data indicated similar or very low levels of sulphur, hydrogen sulphide, halogenated hydrocarbons, ammonia, PAHs and heavy metals. Based on this data, Glanpower consider that the combustion of syngas will not lead to the release of any greater level of pollutants than the combustion of natural gas when compared with the allowable UK specifications and the Risk Assessed limits of the UK EA Biogas Injection Protocol.

Glanpower consider that the combustion of syngas, in general, produces lower emissions than conventional liquid and solid fuels. They note the composition of the syngas strongly influences the level of emissions. In particular, hydrogen and carbon monoxide in the syngas results in elevated combustion temperature that facilitates the thermal formation of NO and NO_2. In contrast, higher temperatures

[1] Revised draft Quality Protocol for biomethane, Development of an end of waste Quality Protocol for biomethane for injection into the gas grid, or for use as a fuel in suitable designed applicances, Environment Agency and WRAP (UK), February 2013.

promote complete combustion, reducing the emission of volatile organic compounds.

In regard to the fate of contaminants in the waste, Glanpower states they are all removed from the syngas before syngas combustion, and so syngas combustion will produce similar emissions to emissions from the combustion of natural gas.

Glanpower states that the pyrolysis plant and the syngas produced will be subject to a monitoring regime that will ensure that a quality specification is met at all times. Glanpower also states that, in the event that the gas or the upstream waste pre-treatment plant cannot meet the quality specification, the production of syngas will cease and any residual quantities flared. The RD (Condition 8.6) requires the licensee to agree the syngas specification before operations begin.

2. The applicant has compared gas engine performance data for emissions of NOx, CO and SOx for both natural gas and syngas, using a similar engine to that proposed at the facility. Emission levels were similar for both fuel types.

R1 value

The designation of the waste activity at the installation as a recovery activity (R1) is determined by the R1 formula where the calculations considers MSW only, as per the *European Commission Guidelines on the Interpretation of the R1 Energy Efficiency Formula for Incineration Facilities dedicated to the Processing of Municipal Solid Waste according to Annex 11 of the Directive 2008/98/EC on Waste*. Using conservative assumptions for the case where biomass is excluded, the applicant calculated a R1 value of 0.68.[1] As this value is above 0.65, the activity can be considered a recovery activity for the purposes of the Waste Framework Directive. The RD (Condition 7) requires the licensee to calculate the R1 value on an annual basis to confirm its on-going status as a recovery activity.

Stockholm Convention

Ireland's *National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (POPs)* was finalised by the Agency in November 2012. Unintentionally formed POPs associated with waste incineration include PCDDs and PCDFs, commonly known as dioxins and furans. The Plan identifies that in 2010, the estimated releases of dioxins to air from waste incineration was comparatively insignificant compared with open burning activities (e.g. backyard burning, vehicle and building fires) which contributed up to an estimated 5,000 times more dioxin emissions than controlled incineration. The waste incineration sector has a high standard of pollution abatement in order to comply with Chapter IV and Annex VI of the IED (formerly WID) and routine monitoring of emissions is undertaken.

The source category controls identified for waste incinerators are licensed operations in accordance with the IED, and associated monitoring requirements imposed as part of the licence. The RD has taken account of these measures and ensures that dioxin emissions from the facility are closely regulated and controlled.

Clean Air for Europe (CAFÉ) Directive (2008/50/EC)

The air dispersion modelling study undertaken indicates that emissions from the facility will not result in a breach of the statutory air quality limits as specified in S.I. No. 180 of 2011 (transposed CAFÉ Directive).

[1] The applicant calculated a R1 value of 0.86 if biomass was fully incorporated.

Emissions Trading Directive (2003/87/EC)

Municipal waste installations are not required to hold a permit under the EC (Greenhouse Gas Emissions Trading) Regulations, 2004 (S.I. No. 437 of 2004).

Water Framework Directive (2000/60/EC)

The only emission to surface water or groundwater from the facility is stormwater and the package waste water treatment plant and percolation area. The RD takes account of the Water Framework Directive, as relevant.

Environmental Liabilities Directive (2004/35/EC)

The applicant submitted a Closure/Decommissioning Management Plan (DMP) and Environmental Liabilities Risk Assessment (ELRA) as part of the licence application, discussed further below (under Fit and Proper Person).

In the RD, Conditions 10.2.1 and 12.2.2 require the licensee to update the Decommissioning Management Plan (DMP) and Environmental Liabilities Risk Assessment (ELRA) prior to the commencement of the activity. The RD also requires the licensee to agree to the satisfaction of the Agency financial provisions to underwrite the costs of the DMP and the ELRA prior to commencement of the activity.

Seveso Directive (96/82/EC)

The *EC (Control of Major Accident Hazards Involving Dangerous Substances) Regulations (S.I. No. 74 of 2006)*, also known as the Seveso II Regulations, do not apply to the activities at the facility.

Appropriate Assessment

Three Natura 2000 sites are located within 10km of the facility.

Table 3. Natura 2000 sites within 10 km of the facility

Site Code	**Designation**	**Description**	**Distance**
000571	Charleville Wood, SAC	Annex I habitats: Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles, Annex II species: *Vertigo moulinsiana.*	3 km
002162	River Barrow and River Nore, SAC	Annex I habitats: principally alluvial wet woodlands and petrifying springs, priority habitats, but also old oak woodlands, floating river vegetation, estuary, tidal mudflats, *Salicornia* mudflats, Atlantic salt meadows, Mediterranean salt meadows, dry heath and eutrophic tall herbs. Annex II species: Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Nore Freshwater Pearl Mussel, Crayfish, Twaite Shad, Atlantic Salmon, Otter, Desmoulin's Whorl Snail *Vertigo moulinsiana* and the Killarney	5 km

		Fern.	
004160	Slieve Bloom Mountains, SPA	Species: *Circus cyaneus* (Hen Harrier) breeding site.	9.5 km

A screening for Appropriate Assessment was undertaken to assess, in view of best scientific knowledge and the conservation objectives of the site, if the proposed activity, individually or in combination with other plans or projects is likely to have a significant effect on a European Site(s). In this context, particular attention was paid to the European sites at **Charleville Wood, SAC, River Barrow and River Nore, SAC and Slieve Bloom Mountains, SPA** and the Agency considered, for the reasons set out below, that the proposed activity is not directly connected with or necessary to the management of those sites as European Sites and that it can be excluded on the basis of objective scientific information, that the proposed activity, individually or in combination with other plans or projects, will have a significant effect on a European site, and accordingly the Agency determined that an Appropriate Assessment of the proposed activity is not required.

It has been determined that this facility does not have the potential for significant effects on any European site due to the nature and scale of the WtE plant operations and the distance between the installation and the designted sites.

Environmental Impact Assessment Directive(85/337/EEC)

The applicant submitted an Environmental Impact Statement (EIS) which was prepared in support of planning application Ref. No. 10/307 and planning appeal Ref. No. PL19.238420. Two Environmental Impact Assessments (EIAs) were carried out, one by Offaly County Council (Planning Authority) and one by An Bord Pleanala, and the Agency consulted with both bodies. Planning permission was granted for this development by An Bord Peanála on 21st July 2011.

I have considered and examined the content of the EIS and other material (information submitted in the licence application, the planning permission, planning inspectors report, correspondence between the Agency and the planning authority and An Bord Pleanala regarding the EIA and submissions made by third parties in relation to the EIS). I consider that having examined the relevant documents and with the addition of this Inspector's Report that the likely significant direct and indirect effects of the activity have been identified, described and assessed in an appropriate manner as required in Article 3 and in accordance with Articles 4 to 11 of the EIA Directive as respects the matters that come within the functions of the Agency. I consider that the EIS also complies with the Environmental Protection Agency (Industrial Emissions) (Licensing) Regulations (S.I. No. 137 of 2013, as amended).

Environmental Impact Assessment (EIA)

An EIA, as respects the matters that come within the functions of the Agency, has been carried out in accordance with Section 83(2A) of the EPA Acts.

Consultation was carried out between the Planning Authority, An Bord Pleanala and the Agency, in accordance with Section 83(2A) of the EPA Acts. The submissions and observations exchanged between the Planning Authority, An Bord Pleanala and the Agency, have been considered as part of this assessment. All third party

submissions/observations received which are relevant to impacts on the environment have also been considered and taken into account.

The submitted EIS and the assessment preceding this part of the Inspectors Report address the likely significant direct and indirect effects arising from the activity, as respects the matters that come within the functions of the Agency.

Likely significant effects

The following section identifies, describes and assesses the main likely significant direct and indirect effects of the proposed activity on the environment for each of the following factors: human beings, flora, fauna, soil, water, air, climate, the landscape, material assets and cultural heritage. The main mitigation measures proposed to address the range of predicted significant impacts arising from the activity have also been outlined.

1. Human Beings

Likely significant effect	Description of effect	Mitigation measures proposed
Human health and well being	Air emissions (direct inhalation and ingestion through water and food intake as a result of contamination of surface water, soil or crops).	Flue gas treatment systems, air dispersion modelling carried out.
	Odour and dust nuisance	Flue gas treatment systems, wheelwash and site maintenance.
	Noise from on-site activities	Noise attenuation at significant noise sources, noise modelling carried out.

2. Flora & fauna

Likely significant effect	Description of effect	Mitigation measures proposed
Ecological impacts	Potential impacts of the proposed development on the flora & fauna of the site and its environs.	Screening for Appropriate assessment (AA) concluded that AA was not required. EIA also identified no significant impact on flora and fauna elsewhere, and local ecology.
Impact of air emissions	Impact of air emissions on designated sites.	Air dispersion modelling indicated no impact with extensive flue gas treatment system.

3. Soil

Likely significant effect	Description of effect	Mitigation measures proposed
Soil contamination	Accidental leaks and spillage of potentially polluting substances, e.g. oils.	Bunding of storage tanks, spill kits.
	Disposal of sanitary effluent to ground.	Design of waste water treatment systems & percolation areas in accordance with EPA manual.

4. Water

Likely significant effect	Description of effect	Mitigation measures proposed
Surface water / groundwater contamination	Accidental leaks and spillages during operation	Surface water management system includes silt trap, oil interceptor, attenuation tank, monitoring and control of discharge, bunding of storage areas, spill kits. Surface water drainage design incorporates shut-off of discharge in the event of contamination.
Impact on groundwater quality	Percolation of treated waste water	Design of waste water treatment systems & percolation areas in accordance with EPA manual.
Fire-water	Discharge of contaminated fire-water	Study to determine need for fire-water retention and requirement to provide as necessary. Fire-water risk management programme will be developed.

5. Air

Likely significant effect	Description of effect	Mitigation measures proposed
Air quality impact	Adverse impact on air quality due to air emissions from WtE plant.	Flue gas treatment systems, air dispersion modelling carried out.
Odour	Nuisance due to odour emissions	Flue gas treatment systems, air dispersion modelling carried out.
Noise	Nuisance due to noise emissions	No significant impact

6. Climate

Likely significant effect	Description of effect	Mitigation measures proposed
Acidification	Emissions of NOx and SO_2	Flue gas treatment system, compliance with emission limit values of Annex VI of IED
Greenhouse gas (GHG) emissions	GHG emissions (CO_2 and small amounts of N_2O) from WtE plant.	WtE plant avoids GHG emissions from other sources – fossil fuel power plants and landfill gases.

7. Landscape, Material Assets & Cultural Heritage

Likely significant effect	Description of effect	Mitigation measures proposed
Public utilities and natural resources	Use of water	Water comes from mains. Small quantities used. Fire-fighting water will be stored. Water conservation measures will be applied.

	Sewerage	On-site sewerage treatment system.
	Storm water Drainage	Storm water drainage and attenuation system will be installed.
	Energy use	Energy efficiency and conservation measures will be applied at WtE plant.
Waste and biomass	Residual waste	Recovery of recyclable waste streams. Reduction in quantity of waste destined for landfill, including biodegradable fraction. Use of biomass with waste helps reduce quantity of resultant ash waste.

Assessment of parts 1 to 7

An EIA as regards the functions of the planning authorities was carried out by the planning authority and An Bord Pleanala when granting planning permission for the development (Planning Ref. PL19.238420). That EIA addressed the significant likely effects of the construction and operational phases of the development. The Planning Authority and An Bord Pleanala did not provide any additional observations to the Agency.

The detailed assessment set out before this section of the report fully considers the range of likely significant effects on human beings, flora, fauna, soil, water, air, climate, landscape, material assets and cultural heritage, as respects the matters that come within the functions of the Agency, with due regard given the mitigation measures proposed to be applied.

A matrix of potential significant interaction of impacts is provided in Section 15.5 of the EIS and reproduced below in Figure 3. I have considered the interaction between the factors referred to in parts 1-7 above and the interaction of the likely effects identified (as well as cumulative impacts with other developments in the vicinity of the activity). The EIS identifies mitigation measures to address identified potential significant interactions. The RD includes conditions as considered appropriate to key interactions associated with the licensable activity.

I am satisfied that proposed mitigation measures are adequate. I do not consider that the interactions identified are likely to cause or exacerbate any potentially significant environmental effects of the activity if the installation is operated in accordance with the conditions of the RD.

Environmental Media	Human	Landscape and Visual Impacts	Flora and Fauna	Geology, Soils and Hydrogeology	Surface Water	Air	Climate	Noise	Archaeology and Cultural Heritage	Traffic	Material Assets
Human		o	o	o	o	\	\	\	o	\	+
Landscape and Visual Impacts	o		o	\	o	o	o	o	\	\	o
Flora and Fauna	o	o		\	o	o	o	o	o	o	o
Geology, Soils and Hydrogeology	o	\	\		o	o	o	o	\	o	o
Surface Water	o	o	o	o		o	o	o	o	o	o
Air	\	o	o	o	o		+	o	o	-	o
Climate	\	o	o	o	o	+		o	o	\	o
Noise	\	o	o	o	o	o	o		o	\	o
Archaeology and Cultural Heritage	o	o	o	\	o	o	o	o		o	o
Traffic	\	\	o	o	o	-	\	\	o		o
Material Assets	+	o	o	o	o	o	o	o	o	o	

Neutral	o
Imperceptible positive/negative	\
Slight negative:	-
Significant negative:	--
Slight positive	+
Significant positive	++

Figure 3. Interaction of Impacts

Overall Conclusion on Environmental Impact Assessment

All matters to do with emissions to the environment from the activity proposed (existing activity and proposed new development), the licence application documentation and EIS have been considered and assessed by the Agency. The assessments carried out by the planning authority and An Bord Pleanala and the submissions and observations exchanged between the planning authority and An Bord Pleanala, and the Agency, have been considered as part of this assessment.

I consider that having examined the relevant documents and with the addition of this Inspector's Report that the likely significant direct and indirect effects of the activity have been identified, described and assessed in an appropriate manner as required in Article 3 and in accordance with Articles 4 to 11 of the EIA Directive, as respects the matters that come within the functions of the Agency.

It is considered that the mitigation measures as proposed and the licence conditions included in the PD will adequately control any likely significant environmental effects from the activity.

Cross Office Liaison

I have consulted with Brian Quirke (Resource Use Unit) regarding Ireland's *National Implementation Plan for the Stockholm Convention on Persistent Organic Pollutants (POPs)* and the National Hazardous Waste Management Plan.

Best Available Techniques (BAT)

BAT for the activity is taken as the techniques set out in the European IPPC Bureau Reference (BREF) Document on BAT for Waste Incineration (July 2006), which also considers the use of waste pyrolysis. I have examined and assessed the application documentation and I am satisfied that the site, technologies and techniques specified in the application and as confirmed, modified or specified in the attached Recommended Decision comply with the requirements and principles of BAT. I consider the technologies and techniques as described in the application, in this report, and in the RD, to be the most effective in achieving a high general level of protection of the environment having regard - as may be relevant - to the way the facility is located, designed, built, managed, maintained, operated and decommissioned.

Fit & Proper Person Assessment

The 'fit and proper person' assessment requires three areas of examination:

i. Technical Ability

The applicant's management team are appropriately qualified and experienced with regard to their technical ability to carry out the proposed waste activities.

ii. Legal Standing

Neither the applicant, Glanpower Limited, nor any of its Directors, have been convicted of any relevant offence.

iii. Financial Standing

Reports containing:

- a Closure/Decommissiong Management Plan (DMP);
- Environmental Liabilities Risk Assessment (ELRA); and
- quantification of financial provision,

were provided by the applicant in 2013. The Agency's *Guidance on Environmental Liability Risk Assessment, Residuals Management Plans and Financial Provision*, EPA 2006, was followed in the preparation of the report.

In relation to the DMP, the following deficiencies in the submitted document were identified:

- There is no contingency provided for unplanned/unexpected closure of the facility and the liabilities arising in such a scenario.
- The costs have not been adjusted for inflation.

Condition 10.2.1 of the RD requires a revised DMP to be agreed by the Agency prior to commencement of the activity.

The ELRA addressed those costs not identified in the DMP which could potentially arise in the event of incidents or accidents. In relation to the ELRA, the following deficiencies in the submitted document were identified:

- The risk of unsuitable waste being accepted at the site, despite the recommended controls in the licence, was not considered.
- The ELRA did not consider the *worst case scenario*, instead it considered just the *most likely scenario*.

The estimated 'most likely' cost of unknown environmental liabilities was €243,255. However an upper 'worst case scenario' of €1,000,000 is also estimated. Glanpower state that they have a comprehensive insurance programme, including potential environmental liabilities. In particular Glanpower state the insurance policy covers environmental accidents/incidents for Glanpower plants in Ireland to a value of €5million.

Condition 12.2.2 of the RD requires the submission of a revised ELRA prior to commencement of the activity.

The applicant has proposed that financial provision will be required, quantified as follows:

Known liability – closure	DMP	€566,000
Known liability – restoration and aftercare management	DMP	N/A (clean closure expected)
Unknown liability	ELRA	€243,255 (insurance cover of €1m proposed)

Glanpower state that it has adequate resources to fund the cost of implementation of the DMP via reserved charges on Glanpower's net assests. In particular Glanpower projects that it should have €2 million worth of net assets (based on depreciation of equipement and plant at 7% annually over 15 years with sales at 50% of the net asset value). I consider this approach to financial provision for the DMP needs to be reviewed before being accepted by the Agency.

Condition 12.2.3 of the RD requires the making of a financial provision that is agreeable to the Agency prior to commencement of licensed activities.

It is my view, and having regard to the provisions of Section 84(5) of the EPA Acts and the Conditions of the RD, that the applicant can be deemed a Fit & Proper Person for the purpose of this licence application.

Proposed Decision

I am satisfied that the conditions set out in the RD will adequately address all emissions from the facility and will ensure that the carrying on of the activities in accordance with the conditions will not cause environmental pollution.

Submissions

There were three submissions made in relation to this application.

(i) Peter Sweetman and Associates, Rossport South, Ballina, County Mayo, received 06/07/2012

Mr. Sweetman makes one point in his submission.

(i) Mr. Sweetman asserts that no EIA has been perfomed and that granting a PD would be contrary to ECJ ruling 50/09.

Response: Both Offaly County Council and An Bord Pleanala carried out an EIA from the planning perspective and the Agency, in this report, has carried out an EIA from the licensing perspective. An Bord Pleanala and Offaly County Council responded to the Agency's Section 87(1I)(g) notice looking for comments on the licence application. Accordingly, I consider that an EIA has been performed.

(ii) Health Service Executive, Dublin Mid-Lenister, received 24/07/2012

In its submission the HSE recommends that any licence granted would include a requirement to monitor (1) noise levels from the proposed operation, (2) air quality at the proposed facility to include monitoring of dust, odour etc. (3) rodents and vermin at the proposed facility and (4) all effluent including spills at the proposed facility.

Response:

The RD provides the following monitoring requirements, which I consider addresses the HSE's concerns:

1. annual noise monitoring (Condition 6.14);
2. emissions monitoring (Condition 6.1 and *Schedule C: Control & Monitoring)*; and
3. Weekly inspections for dust, odour and vermin (Condition 6.11).
4. There is no process effluent from the activity. Condition 9 (Accident Prevention and Emergency Response) covers spills and other incidents.

In addition to the above, the RD includes limit values and control measures for the issues raised by the HSE.

(iii) John Deering, received 13/09/2012

Mr. Deering makes eleven points in his submission, although not all relate to the IED licence application.

1. Mr. Deering is concerned that Glanpower is no longer planning to proceed with a proposal to treat landfill gas from the adjacent landfill and feels mislead on the matter.

Response: Glanpower is not obliged to treat the landfill gas, so this matter does not affect the licence.

2. Mr. Deering expresses concern that public presentations from Glanpower regarding their proposal were very technical for a lay person. He considers the discussion about operating in the absence of oxygen was to overcome local fears of an incinerator.

Response: The Agency was not present at Glanpower's public presentations and is not in a position to comment on them. The licensing role is to consider emissions from the installation and how they should be controlled.

3. Mr. Deering is concerned there is insufficient waste for the installation and that waste would be sourced from elsewhere, increasing the carbon footprint of the project.

Response: The licence application indicates there should be sufficient waste in the region for the installation. However, Glanpower may source waste from outside the region, in line with Ministerial Direction Circular WIR: 04/05.

4. *Mr. Deering queries the need to have considered sensitive receptors such as hospitals, schools, retirement homes, if the process is completely clean.*

   Response: There will be emissions from the installation, and the impact of these emissions on sensitive receptors has been assessed and determined not to be significant.

5. *Mr. Deering states that the EIS does not reflect the environment in which he lives.*

   Response: I have reviewed the EIS and have visited the site, and I consider the EIS reflects the environment of the location for the purposes of IED licensing and for the purposes of carrying out an EIA.

6. *Mr. Deering states the information put forward by Glanpower has been of little comfort to him, because the technology they propose to use is new to the County, and when offered the opportunity to witness the technology in operation, the plant had broken down.*

   Response: The technology associated with this development is new technology, but I consider it reflects BAT, as per the European IPPC Bureau Reference (BREF) Document on BAT for Waste Incineration (July 2006). The fact that the technology supplier's installation was not operating on the day Mr. Deering visited it, does not mean it will not operate successfully for Glanpower, and in particular does not mean emissions from the Glanpower installation will cause significant environmental pollution.

7. *Mr. Deering states that he trusts the health, safety and wellbeing of residents and farmers in the area will be fully protected by the Agency in its decisions and should some accident occur, the Agency will be held accountable. In this regards, he urges the Agency to have independent analysis of all figures and calculations provided in Glanpower's licence application.*

   Response:The health, safety and wellbeing of residents and farmers in the area have been considered in the licence application and addressed in the RD. If an accident occurs at the installation, Glanpower will be accountable.

Mr. Deering also expressed concerns regarding planning matters that are outside the scope of the licence, e.g., road infrastructure and the location chosen for the installation.

Charges

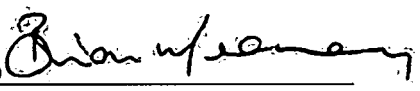
A charge of **€56,684** is proposed in the RD, based on the predicated enforcement effort for the installation. A substantial proportion of this charge (€27,200) is due to emissions to air monitoring. If this monitoring does not take place in 2014, the Agency can refund/waive the costs to the level of monitoring that does take place.

Recommendation

In preparing this report and the Recommended Determination I have consulted with Agency technical and sectoral advisors including Mr Brian Meaney.

I have considered all the documentation submitted in relation to this application and recommend that the Agency grant a licence subject to the conditions set out in the attached RD and for the reasons as drafted.

Signed

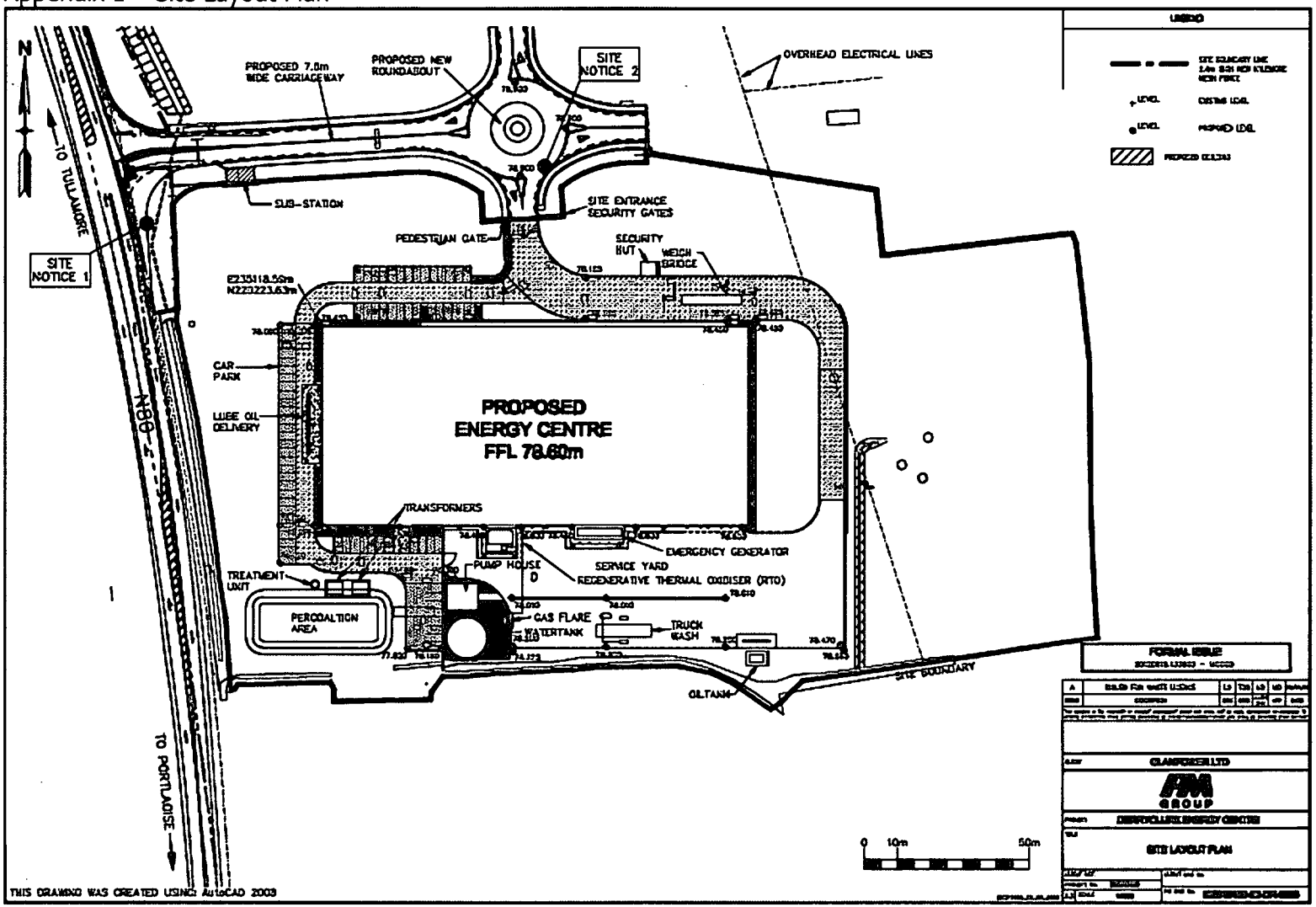
pp 

John McEntagart

Procedural Note

In the event that no objections are received to the Proposed Decision on the application, a licence will be granted in accordance with Section 43(1) of the Waste Management Acts 1996-2011.

Appendix 1 – Site Layout Plan



Appendix 2 – Summary of Process

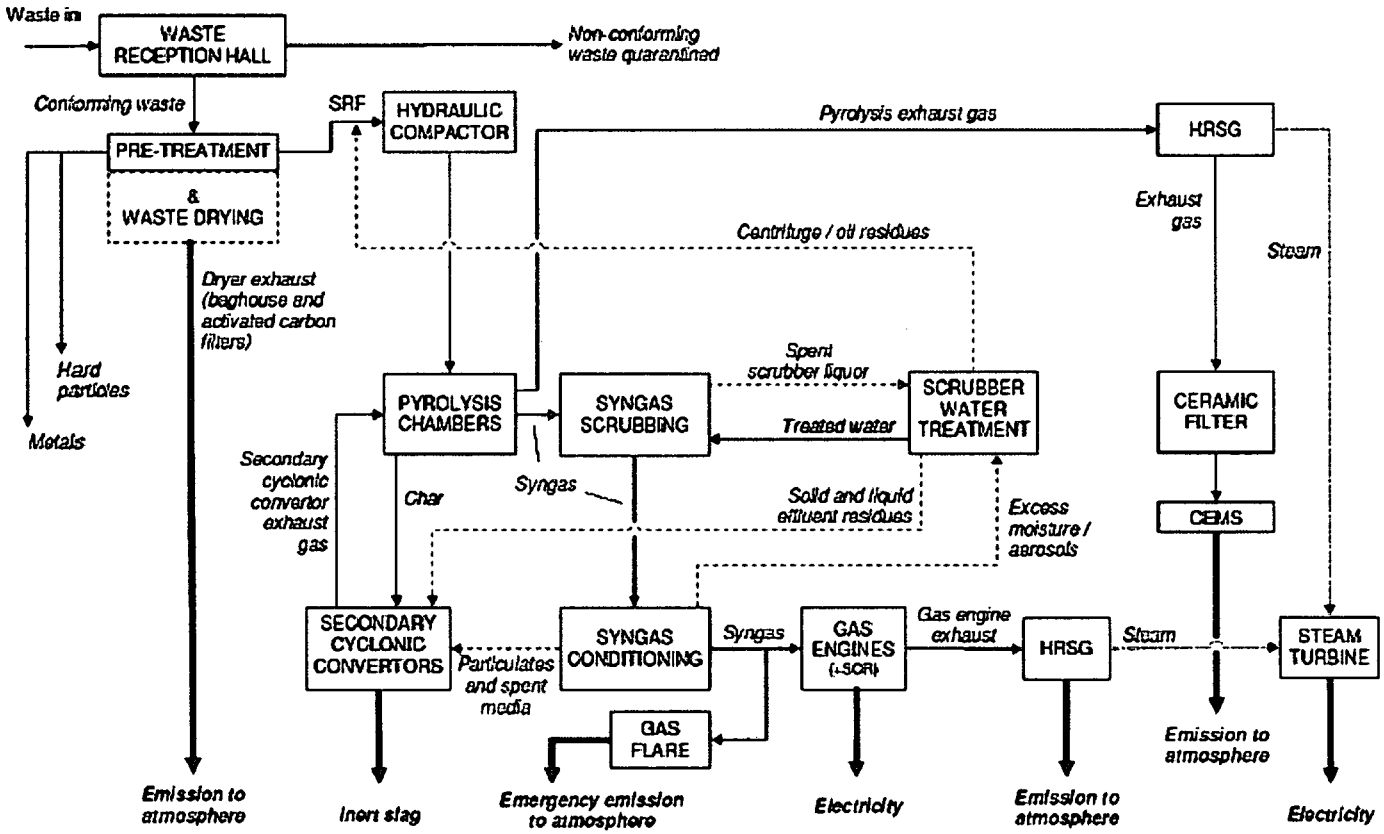


Figure 2.1: Simplified Process Flow Diagram

Abbreviations: SRF = Solid Recovered Fuel; HRSG = Heat Recovery Steam Generator; CEMS = Continuous Environmental Monitoring System; SCR = Selective Catalytic Reduction

Appendix 3. Environmental Fate of contaminants.

Component	Primary Action	Secondary Action	Environmental Fate
Moisture	All water content flashes to steam in pyrolysis retort. Some reacts with carbond to produce H_2 and CO.	Water vapour condensed withing syngas quench, CO and H_2 in gaseous form remain in syngas.	Excess water is cleaned in water treatment plant. CO and H_2 combusted for CO_2 and H_2O in gas engines.
Ash content	Stays in char	Melts but does not boil fo in secondary converter	Forms a vitrified slag, capturing many solids that do not melt. Ceramic filtration removes ash dust from pyrolyser exhaust.
Sulphur	Boils and forms a gas phase within pyrolysis retort.	Stripped from gas stream and put into solution in quench.	Ends up in liquid effluent that is neutralised by pH correction.
Chlorine	Forms a gas (HCl) phase within pyrolysis retort.	HCl stripped from gas stream and put into solution in quench.	Converts to sodium chloride solution in the water (brine) during gas quench and washing.
Arsenic	Boils and forms a gas phase within retort.	Stripped from gas stream and put into solution in quench	Contained in solution
Cadmium	Remains in solid phase and retained in char.	Boils off to a gaseous form in secondary convertor.	Reformed to micro solid as cooled in HRB (heat recovery boiler). 99.9% collected in ceramic filter.
Fluorine	Forms a gas within retort.	Stripped fom gas stream and put into solution in quench.	Water neutralised by pH correction.
Chromium	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Copper	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Lead	Melts to liquid phase but retained in char.	Retained in char.	Encapsulated in slag.
Mercury	Boils and forms a gas phase	Reformed to solid on	Settles as a sludge at bottom of oils

	within retort.	quench.	separation.
Nickel	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Manganese	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Vanadium	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Zinc	Remains in solid phase and retained in char.	Boils off to a gaseous form in secondary convertor.	Reformed to micro solid as cooled in HRB. May be collected in ceramic filter.
Titanium	Remains in solid phase and retained in char.	Boils off to a gaseous form in secondary convertor.	Encapsulated in vitrified slag.
Thallium	Boils and forms a gas phase within retort.	Remains in solid phase and retained in char.	Encapsulated in vitrified slag.
Beryllium	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Tin	Remains in solid phase and retained in char.		Encapsulated in vitrified slag.
Tellurium	Remains in solid phase and retaine in char.	Boils off to a gaseous form in secondary convertor.	Reformed to micro solid in HRB. Collected in ceramic filter.
Selenium	Boils and forms a gas phase within retort.	Dissolves in gas quench water	Stays in solution (liquid effluent).
Antimony	Remains in solid phase and retained in char.		Encapsulated in vitirified slag.
Cobalt	Remains in solid phase and retained in char.		Encapsulated in vitirified slag.