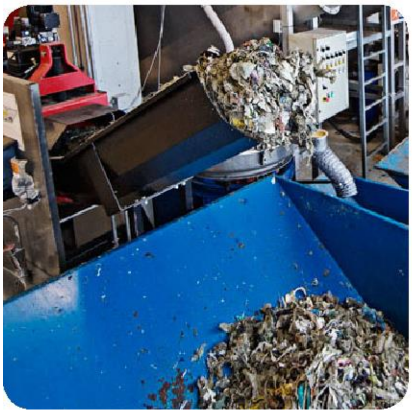
Environmental Permit Application Reference EPR-VP3338RD

Main Application Document

REnescience Northwich



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Quality Management

Prepared by:	Jennifer Stringer M.Eng (Hons), MSc, AIEMA, IEMA	Associate		27/11/2015
Reviewed & checked by:	Dan Smyth] BSc (Jt Hons), MSc, DIC	Senior Director		27/11/2015
Authorised by:	Dan Smyth BSc (Jt Hons), MSc, DIC	Senior Director		27/11/2015
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Prepared by:	Catherine Pittman M.Env (Hons)	Assistant Consultant		27/11/2015
Checked by:	Jennifer Stringer M.Eng (Hons), MSc,	Associate		27/11/2015

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Non-Technical Summary

Introduction

The purpose of this document is to support the environmental permit application for the REnescience Northwich facility. The proposed facility will be sited off the A530 Griffiths Road, Lostock Gralam, Cheshire. It will accept and treat up to 144,000 tonnes per annum of non-hazardous municipal solid waste, fines and commercial and industrial waste s. This will be mixed with hot water and then passed through enzyme reactors. The output from the enzyme reactors comprises solids that are removed for recycling and bio liquid. The bio liquid will then be passed through an anaerobic digester, to produce biogas. The biogas will be used to power gas engines on site, to produce electricity for export to local distribution or to the national grid with waste heat being utilised within the waste treatment process. In addition to the waste treatment activities, up to 30,000 tonnes per annum of waste may be handled within a waste transfer station operation. Source segregated wastes conforming to the permitted waste codes would be delivered directly into the waste transfer station where they will be bulked prior to onward transfer.

The proposed activities are covered by Schedule 1 Part 2 Section 5.4 Part A (1) b (i) and Section 5.4 Part A (1) a (ii) of the Environmental Permitting Regulations (2010) as amended [1].

The Applicant and the Operator of the proposed facility is DONG Energy REnescience Northwich O&M Limited.

Site Location

The site is located on a decommissioned chlorine manufacturing plant to the western side of the ‘Lostock Works’ (see Appendix 2 Figure 1) grid reference SJ 67920 74201. Access is to the site is from the A530 Griffiths Road approximately 0.5 km away. The area is predominantly industrial; the site will be adjacent to Tata Chemical’s soda ash plant and Solvay Chemicals works. The closest public road to the site is the A559 Manchester Road, 170m from the site boundary, with the closest residential receptors 200 m from the site boundary across the road.

Within 5 km of the site there are three sites of special scientific interest (SSSI) and one Local Nature Reserve (LNR). The closest SSSI, Witton Lime Beds is 1.46 km away from the site boundary. The other two SSSIs are Plumley Lime Beds and Tabley Mere, 2.5 km and 4.7 km from the site boundary respectively. The closest European sites are the West Midland Mosses Special Area of Conservation and Midland Meres and Mosses Phase and Phase 2 Ramsars both approximately 9.2 km from site. Ashton’s and Neumann’s Flashes (a local wildlife site) is the closest ecological feature to the site and is located approximately 0.9 km from the site.

Management of Activities

An environmental management system will be developed prior to any operational activities taking place on site. The environmental management system will cover those elements required by ISO14001 and environmental permitting and will accord with the Environment Agency guidance management at waste facilities. This will include the adoption of waste pre-acceptance systems, waste acceptance systems and an electronic waste tracking system.

The management system will define procedures for operating the plant effectively and in compliance with the environmental permit. Planned maintenance routines will be establish to ensure all key plant components remain in good working order.

The facility will be managed and operated by a technically competent and trained workforce. Clear lines of responsibility will be established and these will be defined within the management system.

As part of the management system an accident management plan will be established. This document will identify foreseeable accidents and assess the likely risk posed to the environment accounting for the management procedures which will be in place. Procedures to follow in the event of an incident will be documented.

Operations

Waste is delivered to the site in enclosed vehicles. On arrival at the site waste loads will be weighed on the weighbridge and waste acceptance tests undertaken. Accepted loads will be either directed to the waste bunker to offload for processing and treatment or sent to the waste sorting hall for offloading within the waste transfer station operation. All waste loads will be off loaded within buildings.

Procedures for handling and isolation of non-confirming waste loads will be in place.

The REnescience treatment facility starts by transferring waste from the bunker using overhead cranes. A bag splitter is used to open black bag wastes, followed by removal of any oversized material.

The waste is then mixed with hot water at circa 70 °C prior to feed into the hydrothermal treatment stage. The hydrothermal treatment is carried out in two bio reactor units. Here enzymes are dosed into the waste and water mixture.

By using enzymes to target organic materials entrained in the waste and concentrate these organics into a single output, the process removes contamination from the remaining fractions, thus generating cleaner recyclable materials and enabling a higher degree of recycling to be achieved (the principal benefit of the DONG Energy REnescience process). The process is designed to treat unsorted, residual (‘black bag’) municipal waste and non-hazardous commercial/industrial waste: The REnescience facility will not treat source-segregated recyclables (unless contaminated and therefore unacceptable for recycling) and will complement existing municipal and commercial recycling, helping to raise the overall recycling rate.

The separated organic fraction (in the form of bio liquid) will be further treated using the established anaerobic digestion (AD) process to generate biogas, which will then be used to generate up to around 6.3 MWe gross of renewable electricity in on-site reciprocating gas engines, of which around 5 MWe will be exported to the grid. Waste renewable heat from the gas engines will also be utilised in the REnescience process on site. Separating and concentrating biodegradable material into bio liquid before AD treatment maximises the biogas production for renewable electricity and heat generation, and minimises the residual digestate after de-watering.

The remaining solid fraction will be further processed via a number of mechanical separation stages aimed are removing targeted recyclables.

The four separated waste fractions and their recycling/recovery/disposal routes are as follows:

- **Bio liquid**, containing concentrated organic material in a liquid suspension. This is further treated on-site using AD to yield:
    - **biogas**, used to generate renewable heat and electricity in reciprocating gas engines; and
    - digestate, de-watered to leave **compost-like output (CLO)** that will be suitable for use in land restoration, and
    - a concentrated **nutrient-rich liquid stream**.
- **Recovered recyclable materials**: ferrous and non-ferrous metal and solid plastics (e.g. plastic bottles).
- Other recovered materials such as film plastics, textiles and remaining cardboard, which together form a **refuse-derived fuel (RDF)** or **solid recovered fuel (SRF)** that can be used for energy generation.
- Recovered **inert materials** such as gravel and glass cullet/sand that can be re-used as aggregates.

Energy Efficiency

Energy consumption and production from the REnescience facility has been estimated. The combustion of biogas within the gas engines will produce up to 6.3 MW of renewable electricity, a small portion will be used to meet the parasitic demand of the engines with the remainder being exported to the grid or to local distribution.

The facility also requires electricity to operate the waste processing activities which will be imported from the grid. Process heat will be provided from the gas engines.

The proposed facility has incorporated a number of energy efficiency measures. The inclusion of the four combined heat and power gas engines for generating electricity for export enables waste heat from the power generation to be used within the waste treatment process.

Raw Materials, Water and Waste

The proposed REnescience facility utilises relatively few raw materials. The main input will be the incoming waste stream, in addition small amounts of enzyme, pH dosing chemical and polymers are used. Process chemical usage will be controlled to ensure efficient use of these materials. Fuel will also be consumed to power onsite vehicles and to fuel the start-up boiler.

The REnescience facility is highly water efficient. Once operational the facility should be capable of operating no additional freshwater input. The option for additional water top up will be maintained. Process water demand is supplied by re-circulated water and top up by moisture present in the incoming waste.

The main waste output will comprise recovered recyclables, RDF/SRF and a compost-like output. The separated recyclables will be sent off site for further reprocessing/recycling and the RDF/SRF will be sent for energy recovery. The compost-like output will be used in land restoration.

A nutrient rich aqueous waste is also generated which will be combined with the compost-like output or disposed of.

Emissions

The REnescience facility will include the three emission points to air namely:

- the exhaust stack for up to four reciprocating gas engines which burn biogas generated by the anaerobic digestion (AD) process to produce renewable heat and electricity;
- the enclosed 10 m high gas flare which burns off biogas in the event that biogas production temporarily exceeds the gas engines' demand and the buffer tank capacity; and
- the back-up boiler exhaust stack which is used only during periods when the CHP engines are not operating to provide process and space heating requirements.

There are not process water releases to sewer or to surface water. The only discharge to water will comprise surface run-off that has passed via interceptors and clean rainwater run-off from building roofs.

There are also no point source emissions to land or groundwater.

Odours will be managed in accordance with an Odour Management Plan. As part of the odour management a carbon filter has been included to ensure that air from potentially odorous areas e.g. the waste reception and waste bunker areas are captured and treated prior to release to air.

The main source of noise likely to affect noise sensitive receptors is expected from the CHP engines, due to their external location. These units will be located within acoustic containers and a silencer will be installed to minimise noise associated with the engine stack. Most waste handling and mechanical treatment stages are carried out within buildings or are otherwise enclosed.

Monitoring

The waste treatment activities will be controlled automatically and this will include monitoring of key process parameters to ensure that the plant operates effectively and as designed. A Supervisory Control And Data Acquisition (SCADA) system will monitor, record and control the REnesceince facility.

Emissions from the CHP gas engines will be monitored annually.

Site Condition

A description of the site condition at the time of this application is provided within the Application Site Condition Report. Further intrusive works are currently being carried out to further define the baseline condition, with results likely to be available in December 2015. This information, when available, will be provided to the Environment Agency.

The site condition report will be maintained throughout the life of the facility with the operational phase site condition report and site surrender phase sections being updated accordingly.

Impacts

The effect of emissions to air from the REnescience facility has been assessed using detailed dispersion modelling. The assessment of the effect of these emissions concluded that all predicted concentrations at the sensitive receptors measured are well below the EQS.

A stack height assessment has also been undertaken. The optimum dispersion of pollutants from the biogas engines stack is determined to be 33 m and 10 m for the biogas flare. These heights have been identified as the heights at which the wake effect of nearby buildings is overcome.

Natural England (NE) and Cheshire West and Chester Council (CWCC) were consulted as prior to undertaking the ecological and air quality assessments to inform the Environmental Statement (ES) which accompanied the planning application for the REnescience facility on the scope of assessment required in relation to air quality impacts at designated sites. NE confirmed that since all European sites and SSSIs lie beyond 500m of the REnescience facility, no impacts would be expected at the sites and they do not need to be assessed. NE requested a qualitative description of expected air quality impacts on ’Ashton’s and Neumann’s’ Local Wildlife Site. The air quality assessment concluded that predicted environmental concentrations would be well below the relevant environmental assessment level (EAL).

The assessment of potential effects of odours from the proposed REnescience facility concluded that odour effects would be ‘negligible’.

Noise effects from the REnescience facility have been modelled. The assessment of effects at noise sensitive receptors has been determined to be negligible to low.

Best Available Techniques (BAT)

The application has set out the proposed techniques to be operated at the REnescience facility which have been considered against BAT and alternatives. The proposed techniques are considered to meet BAT and as indicated above, operation of the proposed in accordance with BAT as indicated above is not expected to give rise to significant effects to the environmental or on human health.

Contents

Tables and Appendices

Tables

Appendices

Appendix C **Environmental Risk Assessment**

Appendix D **Air Quality Assessment (including Odour Management Plan)**

Appendix E **Noise and Vibration Assessment**

Appendix F **Application Site Condition Report**

Appendix G **Drainage Strategy**

Appendix H **Environmental Statement**

1 Introduction

1.1.1 The purpose of this document is to support the environmental permit application for the REnescience Northwich (REnescience) facility. The proposed facility will be sited off the A530 Griffiths Road, Lostock Gralam, Cheshire. It will accept and treat up to 144,000 tonnes per annum of municipal solid waste, fines and commercial and industrial wastes. This will be mixed with hot water and then passed through enzyme reactors. The output from the enzyme reactors comprise solids that are removed for recycling and bio liquid. The bio liquid will then be passed through an anaerobic digester, to produces biogas. The biogas will be used to power gas engines on site, to produce electricity for export to local distribution or to the national grid with waste heat being utilised within the waste treatment process. This process is covered by the following sections of Schedule 1 Part 2 of the Environmental Permitting Regulations (2010) as amended [1]:

- Section 5.4 Part A (1) b (i)
- Section 5.4 Part A (1) a (ii)

1.1.2 The facility could also accept source segregated materials which will not be subject to treatment within the REnescience facility, but will be stored and bulked for onward transfer, i.e. a Waste Transfer Station (WTS) Operation. This part of the REnescience facility is expected to handle suitable wastes as and when required and is expected to handle no more than 30,000 tpa of material.

1.1.3 The Applicant and the Operator of the proposed facility is DONG Energy REnescience Northwich O&M Limited (DERN O&M Ltd).

1.2 Site Location

1.2.1 The site is located on a decommissioned chlorine manufacturing plant to the western side of the 'Lostock Works' grid reference SJ 67920 74201. The site is set in a predominantly industrial area of existing and former chemical industry works operated previously by others including ICI, Brunner Mond and INEOS Chlor.

1.2.2 In the area immediately around the site are:

- to the north: rail lines and sidings, open space/pond, warehouses/commercial development and Manchester Road;
- to the east: Solvay chemical works, Tata Chemicals chemical works, INEOS brine purification plant and the Trent and Mersey Canal;
- to the west: a cleared brownfield site and rail siding;
- to the south: Wade Brook, a rail siding and conveyor structure, ECO-Option (formerly Edelchemie) chemical recycling facility, and Griffiths Park.

1.2.3 Access to the site is via an existing private road serving the cluster of industrial facilities on the Lostock Works site, from a junction with the A530 around 0.5 km south of the proposed installation boundary.

1.2.4 The site is located approximately 0.6 km from the residential outskirts of Northwich and Rudheath to the west and south (or around 2 km from Northwich town centre), and 1.2 km from the village of Lostock Gralam to the east.

1.2.5 The closest residences are on the A559 Manchester Road, approximately 180 m to the north of the site boundary, separated from it by rail sidings, a tree belt and area of open space, warehouses and commercial developments, and the A559. There are further residences and commercial land uses along Manchester Road and around the A559 and A530 junction to the east, between the site and Lostock Gralam.

1.2.6 To the south of the site is Griffiths Park, a former lime bed and landfill that has been redeveloped into a park/recreation area. This is separated from the site by a rail siding, Wade Brook, conveyor structure and chemical recycling works, adjacent to the park's northern boundary.

1.2.7 The Trent and Mersey Canal runs roughly north-south between the Tata Chemicals and INEOS chemical works and the A530, to the east of the proposed development site. The canal is used by pleasure craft and its towpath (around 420 m from the proposed development site at the closest point) is a public right of way, separated from the chemical works by security fencing. A further public right of way branches west from the canal towpath to connect with Works Lane, around 250 m north-east of the proposed development site boundary at the closest point. Other public rights of way are present further away, beyond the A559 to the north.

1.2.8 The ecological designated sites within 10 km of the proposed plant are listed below. It should be noted that given the nature of the proposed activities effects from emissions to air at sites within such a large radius is limited. Further discussion of potential effects at ecological designated site is provided in later sections of this report (see section 5).

- West Midland Mosses Special Area of Conservation – 9.2 km from site;
- Midland Meres and Mosses Phase and Phase 2 Ramsars – 9.2 km from site; and
- 16 SSSIs – the two closest being Witton Lime Beds (2.4 km from site) and Plumley Lime Beds (2.6 km from site).

1.2.9 Ashton's and Neumann's Flashes (a local wildlife site) are located approximately 900 m from the site.

1.3 Site plans

1.3.1 A site location plan indicting the site and its setting is provided as Figure 1 in Appendix B. The layout of the main plant and process buildings within the installation boundary is shown in Figure 2 of Appendix B.

1.4 Overview of the Permit Application

1.4.1 The structure of this document is as follows:

Section 1	provides an introduction to the proposed REnescience facility;
Section 2	describes management of activities within the proposed installation;
Section 3	describes the proposed operations and operational controls to be included within the installation;
Section 4	details the emissions from the facility and describes how they are minimised, controlled and monitored during operation;
Section 5	summarises the impacts associated with operational emissions; and
Section 6	includes an assessment of Best Available Techniques (BAT) for key aspects of the REnescience facility.

1.5 Process Overview

1.5.1 The proposed REnescience facility is a bioresource project, comprising stages of mechanical and biological treatment (MBT) of waste and renewable energy generation. It will have a waste input capacity of up to 18 tonnes per hour (tph), equivalent to 144,000 tonnes per annum (tpa) over the course of 8,000 typical annual operating hours. It will treat municipal solid waste (MSW), fines and commercial and industrial wastes.

1.5.2 The REnescience facility will include a 'REnescience' enzymatic waste treatment process developed by DONG Energy, which has been proven at a commercial demonstration plant operating in Copenhagen, Denmark. This facility has operated for five years treating waste from around Europe, including household waste from the UK. The REnescience process uses enzymes to remove organic matter from mixed wastes.

1.5.3 By using enzymes to target organic materials entrained in the waste and concentrate these organics into a single output, the process removes contamination from the remaining fractions, thus generating cleaner recyclable materials and enabling a higher degree of recycling to be achieved (the principal benefit of the DONG REnescience process). The process is designed to treat unsorted, residual ('black bag') municipal waste and non-hazardous commercial/industrial waste: The REnescience facility will not treat source-segregated recyclables (unless contaminated and therefore unacceptable for recycling) and will complement existing municipal and commercial recycling, helping to raise the overall recycling rate.

1.5.4 Some source segregated wastes will be accepted within the WTS. These will be bulked with other recyclables for onward transfer.

1.5.5 In the proposed development, the separated organic fraction (in the form of bio liquid) will be further treated using the established anaerobic digestion (AD) process to generate biogas, which will then be used to generate up to around 6.3 MWe gross of renewable electricity in on-site reciprocating gas engines, of which at least 5 MWe will be exported to the grid. Waste renewable heat from the gas engines will also be utilised in the REnescience process on site. Separating and concentrating biodegradable material into bio liquid before AD treatment maximises the biogas production for renewable electricity and heat generation, and minimises the residual digestate after de-watering.

1.5.6 The four separated waste fractions and their recycling/recovery/disposal routes are as follows.

- **Bio liquid**, containing concentrated organic material in a liquid suspension. This is further treated on-site using AD to yield:
  - **biogas**, used to generate renewable heat and electricity in reciprocating gas engines; and
  - **digestate**, de-watered to leave **compost-like output (CLO)** that will be suitable for use in land restoration, and
  - a concentrated **nutrient-rich liquid** stream.
- Recovered **recyclable materials**: ferrous and non-ferrous metal and solid plastics (e.g. plastic bottles).
- Other recovered materials such as film plastics, textiles and remaining cardboard, which together form a **refuse-derived fuel (RDF)** or **solid recovered fuel (SRF)** that can be used for energy generation.
- Recovered **inert materials** such as gravel and glass cullet/sand that can be re-used as aggregates.

1.5.7 The waste treatment process and main outputs are illustrated in the process flow diagram included as Figure 3 in Appendix B.

1.5.8 The facility will also provide a dedicated space within the sorting hall for source segregated materials which will not be subject to treatment within the REnescience facility, but will be stored and bulked for onward transfer.

2 Management of Activities

2.1 General

2.1.1 An environmental management system (EMS) will be established prior to the facility being commissioned. The scope of the EMS will cover those elements required by ISO14001 and environmental permitting.

2.1.2 DERN O&M Ltd will implement an environmental policy that will underpin the EMS. All staff and contractors will be made aware of the environmental policy as part of the induction training and a copy will made available on site.

2.1.3 The environmental policy shall include commitments to continual improvement and prevention of pollution, compliance with relevant legislation and to identify, monitor and review environmental objectives and key performance indicators independently of the permit.

2.1.4 A system for keeping of all relevant records including but not limited to the following, will be developed and implemented prior to commissioning:

- waste transfer/duty of care documentation;
- records of incidents, accidents and emergencies including details of follow-up; and
- any other records required to be kept by the permit.

2.1.5 As part of the EMS, systems will be developed and implemented for undertaking audits, setting and reporting of environmental performance, objectives, targets and programmes for future improvements. Audits will be conducted at least annually.

2.1.6 Prior to commencing commissioning on waste, all key procedures will be in place as detailed below.

2.2 Operations and Maintenance

2.2.1 Management systems will be established to ensure that those operations which have the potential to give rise to significant environmental effects are controlled. These systems will not only cover normal operation but will also address abnormal operation, including start-up and shutdown and foreseeable accident and emergencies (see Section 2.5 for further detail on accident management). Planned maintenance routines will be established to ensure all key plant components which have the potential to affect the environmental performance of the REnescience facility remain in good working order. Maintenance routines will draw upon manufacturers' recommendations, unless operational experience during the lifetime of the facility would indicate the need for variance.

2.2.2 In particular systems will be developed in relation to the following:

- waste fuel reception and handling, including waste pre-acceptance and waste acceptance procedures;
- operational control of the various waste treatment activities and anaerobic digestion plant;
- operation of the odour control systems;
- storage, handling and removal of wastes from the site;
- site closure plan detailing management during site closure at the end of operations; and
- documented procedure for monitoring emissions.

2.2.3 In development of management systems the measures outlined within the following Environment Agency guidance documents will be incorporated in respect of waste pre-acceptance, waste acceptance and waste tracking (see also detail in Section 3):

- How to comply with your environmental permit, version 6, June 2013; and
- How to comply with your environmental permit. Additional guidance for Anaerobic Digestion version 1, November 2013.

2.3 Competence and Training

2.3.1 The DERN O&M Ltd will provide operator training to ensure that the facility will be operated by a fully trained workforce. Operator training will be undertaken prior to commencing commissioning. Training will not only address normal operations but will also include those actions required in the event of abnormal operations and emergencies.

2.3.2 At least one technically competent person will be employed who holds a valid relevant WAMITAB qualification, or similar. This person(s) will be in place prior to commencing commissioning activities. The DERN O&M Ltd has not yet recruited its operational workforce and therefore the Competent person(s) cannot be identified at this time. Prior to the facility becoming operational the details of the Competent person(s) will be provided, this will include name(s), WAMITAB qualifications held alongside associated certificates to provide supporting evidence of these qualifications. Minimum attendance by a competent will be provided by the technically competent person for at least 25% of operational hours during the first 6 months of operation.

2.3.3 Job specifications will be defined and will include details of relevant qualifications and training (including where relevant on the job training) required for that role. Records of training will be stored and maintained. Records as a minimum will include details relating to the date, type of training and training provider.

2.3.4 All relevant staff (including contractors forming part of the commissioning team and those purchasing equipment and materials) will be made aware of the requirements of the permit, in particular those conditions in relation to emission limits and notification procedures. A copy of the permit will be available for reference within the Control Room.

2.3.5 Procedures will also be in place to ensure that contractors undertaking work at the installation are qualified for the task they are undertaking. Furthermore environmental risks posed by the work of contractors will be assessed and instructions given to allow protection of the environmental whilst contractors are working on site.

2.4 Organisation

2.4.1 An organisation chart for the REnescience facility is provided as Figure 10 in Appendix B and indicates the main lines of responsibility. Roles and responsibilities will be clearly defined within the management system.

2.4.2 Further information on specific aspects of the management systems are provided in the following sections.

2.5 Accident Management

2.5.1 An accident management plan (AMP) will be established prior to commencing operation of the proposed facility. Procedures to follow in the event of an emergency or accident/incident will be in place prior to accepting waste. This will include small incidents such as minor spills and leaks and complaints as well as major incidents such as a fire or explosion. There will be a procedure for recording and allocating appropriate follow-up for accidents, incidents and non-conformances.

2.5.2 To support this application an initial environmental risk assessment is provided in Appendix C. This will be reviewed prior to commencing operation and maintained as part of the AMP throughout the operational life of the facility.

2.5.3 DONG Energy utilises the Bowtie method that is a risk evaluation method. A Bowtie gives a visual summary of all plausible accident scenarios that could exist around a certain Hazard and by identifying control measures the Bowtie displays what is being done to control those scenarios. It is expected that the Bowtie method will be adopted at the REnescience facility.

2.5.4 As part of the design process the proposals will be subject to detailed HAZOP assessment (or equivalent) with a view to designing out safety, health and environmental risks. HAZOP assessments will be recorded and kept on file. Records will include details of any recommendations for improvement alongside any resulting actions/improvements.

2.5.5 The requirements of the European ATEX Directive [1] as recast in 2014 [2] and associated guidance, as transposed in the UK as the Dangerous Substances and Explosives Atmospheres Regulations 2002 [3] (DSEAR) will be considered within the detailed design of the proposed development.

2.5.6 The volumes of biogas held within the REnescience facility will fall below the lower tier COMAH threshold i.e. up to 9 tonnes of biogas will be held which is below the 10 tonne lower Tier COMAH threshold.

2.6 Site Security

2.6.1 The site is enclosed by a 2.5 m green-painted steel palisade fence, with access controlled by barriers. Additional security will be provided by CCTV cameras and intruder alarms. CCTV cameras will relay back to the control room which is available 24 hours per day.

2.7 Energy Efficiency

2.7.1 Information on energy consumption and production for the REnescience facility is provided within Figure 9 of Appendix B. This section provides information on energy consumption and basic energy efficiency measures, further details on specific energy efficiency measures included within the design are detailed in Section 3.

Basic Energy Requirements

2.7.2 In addition to generating renewable energy for export, the plant requires energy to operate. Energy inputs comprise electricity to operate plant and hot water for supply to the REnescience bioreactor.

2.7.3 Heat will be met from energy generated onsite whilst the engines are being operated. Electricity will be supplied from the grid, with the exception of the engine parasitic demand which will be provided by electricity produced from the units. During periods when the engines are shutdown heat to the process will be provided by a start-up boiler.

2.7.4 Table 2.1 below provides a breakdown of energy consumed within the proposed facility by source. Start-up and shutdown energy requirements have been estimated and the basis of this consumption provided in the notes to this table.

Table 2.1 Energy Consumption by Source

Energy Source	Annual Energy Consumption	
	Delivered MWh	Primary MWh
Electricity (from Grid)	8,992	21,581 (1)
Electricity (from engines)	320	507 (2)
Heat (from engines)	25,520	25,520

(1) Primary energy consumption for imported electricity from grid calculated on the basis of a conversion factor of 2.4 as stated in H1 Annex H [4].

(2) Primary energy consumption for electricity from engines calculated on the basis of a CHP engine efficiency of 63%. This is calculated on the basis of the energy in biogas at 15.11 MJ/s which for 8,000 hour operation gives a thermal input of 120,822 MWhrs. Energy produced (see Figure 9 Appendix B) by the engines that is used/exported is 76,280 MWhrs (i.e. 50,760 MWhrs electricity and 25,520 MWhrs heat). Efficiency = 56,160 * 100/120,822 = 63%.

2.7.5 At start-up heat to the process for the AD plant and to heat-up process water for the bioreactors will be provided by the back-up boiler. Electricity will be imported from the grid. During a shutdown electrical demand for plant that will remain operational, e.g. AD plant mixers, the total electrical energy demand will be approximately 40% of normal operational requirements.

Operations and Maintenance

2.7.6 Where relevant, operating procedures will include details of techniques to ensure that the REnescience facility is operated efficiently. Maintenance and housekeeping measures will be developed as part of the preventative maintenance system. This will include details of the measures specifically aimed at maintaining the efficiency of the plant during its operational life. In particular procedures will cover the following items:

- operation of motors and drives - routine checks on operations and conditions;
- compressed air systems - routine checks for leaks, procedures for use of pneumatic tools;
- hotwater systems - routine checks for leaks. Heated systems will be lagged and routine insulation inspections carried out; and
- lubrication systems - schedule for routine lubrication.

Building Services

2.7.7 Energy requirements for buildings services will be low. Energy efficient lighting will be employed where feasible and lights will be turned off in unoccupied buildings where they are not required for safety reasons.

2.7.8 Space heating will only be required in limited areas, such as the control room and administration areas; heating of other process buildings will not be required. Under normal operation space heating will be provided using waste heat from the CHP engines, with a back-up boiler to provide heat in the event that the engines are not operating.

Energy Efficiency Plan

2.7.9 During the operational life of the REnescience facility, energy use will be monitored and recorded. Periodically usage will be reviewed to identify areas for improvement and ensure that any abnormal increase in energy use is investigated and appropriate action taken to resolve the issue.

2.7.10 Any areas where improvements are identified will be incorporated within the energy efficiency plan. This plan will be incorporated within the EMS to ensure that it is regularly reviewed and maintained up to date in the light of technology developments, plant modifications etc.

2.8 Efficient Use of Raw Materials and Water

2.8.1 The REnescience facility requires relatively few raw materials. Table 2.2 provides details of raw materials and expected usage.

Table 2.2 Raw Material Consumption

Raw Material	Nature	Expected usage (approximate)	Storage including capacity	Fate	Environmental Effects	Alternatives
Waste Input	Non-hazardous MSW and C&I waste (approx. 83% of input) and Fines (approx.17% of input (see also Table 2.3 & Table 2.4 for further details).	Max. 144,000 tpa.	Waste bunker – circa 3,300 m^3.	Recovered as recyclables; RDF/SRF, CLO or converted to biogas and released to air.	The MSW and fines have the potential to contain relevant hazardous substances, albeit at low concentrations such that the waste is classified as non-hazardous.	Other waste streams would be expected to have similar or increased environmental effects.
Enzyme	Yeast based enzyme such as Ctec3 or similar.	1,600 tpa.	Two x 30 m^3 storage tanks.	Forms part of the bio liquid and released as combustion gases to air.	Product not dangerous to the environment with respect to mobility, persistence, degradability and bioaccumulation potential.	Few alternatives and would be expected to have similar effects.
Polymer		56 m^3/annum.	Supplied in 1m^3 pallet tanks with a maximum of 10 pallets onsite at any time. Pallets will be stored in a bunded area.	Used in dewatering and will transfer into the compost like output and process waters, with residual amounts removed within the nutrient rich stream	Toxic to fish. Not readily biodegradeable.	Alternatives have similar effects.
Activated carbon	Activated granular carbon.	-	Approximately 30m^3 present in each carbon filtration unit.	Not consumed, remains in place and periodically removed for off-site regeneration.	Low toxicity to mammals, low bioaccumulation potential, highly insoluble and immobile.	Alternatives have similar effects.
Sodium hydroxide solution or similar alkali dosing chemical	NaOH solution.	Variable.	15m^3 storage tank located within the AD bund.	Dosed into AD feed for pH adjustment so will be neutralised. Will be lost to process water from dewatering or remain within moisture within CLO, removed also within nutrient rich discharge from the	Highly toxic to mammals, corrosive, toxic effects can be observed in aquatic organisms persistent in water, dissociates to sodium and hydroxide ions giving a high pH depending on buffering capacity.	Alternatives will have similar effects.

Raw Material	Nature	Expected usage (approximate)	Storage including capacity	Fate	Environmental Effects	Alternatives
				evaporator		
Diesel	Diesel (<1% sulphur).	Variable	7 m^3 for refuelling and 10 m^3 for start-up boiler Both tanks will be above ground and double skinned.	Combusted in start-up boiler or onsite vehicles and released as combustion gases to air.	Not readily biodegradable. Persists under anaerobic conditions. Has the potential to bioaccumulate. Harmful, 10 < LC/EC50 < 100 mg/l, to aquatic organisms (estimated). (LC/EC50 expressed as the nominal amount of product required to prepare aqueous test extract). Low acute toxicity to mammals. May cause physical fouling of aquatic organisms	Natural gas could be used within the start-up boiler however would need guaranteed supply which would not be cost effective for infrequent use.
Maintenance Oils and Greases	Various	Variable	Stored in suppliers drums/containers within a bunded area within the workshop.	Used during maintenance activities.	Harmful to aquatic organisms. May cause long-term adverse effects in the aquatic environment. Not expected to be readily biodegradable.	-

Waste Input

2.8.2 Waste input will comprise residual non-hazardous mixed household waste (referred to as 'municipal solid waste', MSW) and commercial or industrial (C&I) waste with similar, suitable composition. It will also accept 'fines', which will have a similar composition to the MSW, being smaller residual particles that result from waste processing/sorting at other facilities. Table 2.3 shows expected typical waste compositions.

Table 2.3: Typical waste composition

Waste fraction	Proportion in MSW	Proportion in fines	Proportion overall *
Paper	13.9%	6.7%	12.7%
Cardboard	5.9%	6.7%	6.1%
Dense plastic	7.4%	4.0%	6.8%
Plastic film	7.6%	2.5%	6.7%
Shoes and textiles	4.3%	0.1%	3.6%
Glass	5.2%	7.4%	5.6%
Miscellaneous combustibles	8.3%	3.4%	7.5%
Miscellaneous non-combustibles	2.1%	4.4%	2.5%
Ferrous metal	2.3%	0.1%	1.9%
Non-Ferrous metal	1.3%	0.8%	1.2%
WEEE **	1.0%	0.3%	0.9%
Hazardous household	1.2%	0.0%	1.0%
Putrescibles (garden)	4.3%	0.6%	3.6%
Putrescibles (food)	31.5%	21.1%	29.7%
Fines (< 10 mm)	3.8%	42.0%	10.3%

* Weighted by expected ratio of MSW to fines, 83% and 17% of total waste by mass accepted, respectively
** Waste electrical and electronic equipment

2.8.3 The EWC codes for wastes to be accepted at the facility are detailed in Table 2.4 below. The table lists all wastes to be accepted at the REnescience facility and separately lists the waste codes which will only pass via the WTS which are essentially source segregated wastes which will be bulked for onward transfer.

Table 2.4 Waste Feed EWC Codes

Waste Code	Description	Via Waste Transfer Station Only
02	**02-01 Wastes from Agriculture etc.** 02 01 03 plant-tissue waste 02 01 04 waste plastics (except packaging) 02 01 07 wastes from forestry 02 01 10 waste metal	02 01 10
	02-03 Wastes from fruit and vegetables etc.	-

Waste Code	Description	Via Waste Transfer Station Only
	02 03 01 sludges from washing, cleaning, peeling, centrifuging and separation 02 03 02 wastes from preserving agents 02 03 03 wastes from solvent extraction 02 03 04 materials unsuitable for consumption or processing 02 03 05 sludges from on-site effluent treatment	
	02-04 Wastes from sugar processing 02 04 01 soil from cleaning and washing beet 02 04 03 sludges from on-site effluent treatment	-
	02-05 Wastes from the dairy products industry [(1)] 02 05 01 materials unsuitable for consumption or processing 02 05 02 sludges from on-site effluent treatment	-
	02-06 Wastes from the baking and confectionery industry 02 06 01 materials unsuitable for consumption or processing 02 06 02 wastes from preserving agents 02 06 03 sludges from on-site effluent treatment	-
	02-07 Wastes from the production of alcoholic and non-alcoholic beverages 02 07 01 wastes from washing, cleaning and mechanical reduction of raw materials 02 07 02 wastes from spirits distillation 02 07 03 wastes from chemical treatment 02 07 04 materials unsuitable for consumption or processing 02 07 05 sludges from on-site effluent treatment	-
03	**03-01 Wastes from wood processing etc** 03 01 01 waste bark and cork 03 01 05 sawdust, shavings, cuttings, wood, particle board and veneer other than those mentioned in 03 01 04	-
	03-03 Wastes from pulp, paper and cardboard production and processing 03 03 01 waste bark and wood 03 03 02 green liquor sludge (from recovery of cooking liquor) 03 03 07 mechanically separated rejects from pulping of waste paper and cardboard 03 03 08 wastes from sorting of paper and cardboard destined for recycling 03 03 10 fibre rejects, fibre-, filler- and coating-sludges from mechanical separation 03 03 11 sludges from on-site effluent treatment other than those mentioned in 03 03 10	-
07	**07-02 Wastes from the manufacture, formulation, supply and use of plastics, synthetic rubber and man-made fibres** 07 02 13 waste plastic	07-02-13
15	**15-01 Waste Packaging** 15 01 01 paper and cardboard packaging 15 01 02 plastic packaging 15 01 03 wooden packaging	15 01 02 15 01 04 15 01 07

Waste Code	Description	Via Waste Transfer Station Only
	15 01 04 metallic packaging 15 01 05 composite packaging 15 01 06 mixed packaging 15 01 07 glass packaging 15 01 09 textile packaging	
	15-02 Absorbents, filter materials etc. 15 02 03 absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02	-
17	**17-02 Wood, glass and plastic** 17 02 01 wood 17 02 02 glass 17 02 03 plastic	17 02 02 17 02 03
19	**19-05 Wastes from aerobic treatment of solid wastes** 19 05 01 non-composted fraction of municipal and similar wastes 19 05 02 non-composted fraction of animal and vegetable waste 19 05 03 off-specification compost	-
	19-06 Wastes from anaerobic treatment of waste 19 06 03 liquor from anaerobic treatment of municipal waste 19 06 04 digestate from anaerobic treatment of municipal waste 19 06 05 liquor from anaerobic treatment of animal and vegetable waste 19 06 06 digestate from anaerobic treatment of animal and vegetable waste	-
	19-12 Wastes from the mechanical treatment of waste 19 12 01 paper and cardboard 19 12 02 ferrous metal 19 12 03 non-ferrous metal 19 12 04 plastic and rubber 19 12 05 glass 19 12 07 wood other than that mentioned in 19 12 06 19 12 08 textiles 19 12 09 minerals (for example sand, stones) 19 12 10 combustible waste (refuse derived fuel) 19 12 12 other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11	19 12 02 19 12 03 19 12 04 19 12 05 19 12 09 19 12 12
20	**20-01 Municipal wastes separately collected fractions** 20 01 01 paper and cardboard 20 01 02 glass 20 01 08 biodegradable kitchen and canteen waste 20 01 10 clothes 20 01 11 textiles 20 01 25 edible oil and fat 20 01 28 paint, inks, adhesives and resins other than those mentioned in 20 01 27 20 01 32 medicines other than those mentioned in 20 01 31 20 01 30 detergents other than those mentioned in 20 01 29 20 01 34 batteries and accumulators other than those mentioned in 20 01	20 01 02 20 01 34 20 01 36 20 01 39 20 01 40

Waste Code	Description	Via Waste Transfer Station Only
	33 20 01 36 discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35 20 01 38 wood other than that mentioned in 20 01 37 20 01 39 plastics 20 01 40 metals 20 01 41 wastes from chimney sweeping	
	20-02 Garden and Park wastes 20 02 01 biodegradable waste 20 02 02 soil and stones 20 02 03 other non-biodegradable wastes	20 02 02
	20-03 Other municipal wastes 20 03 01 mixed municipal waste 20 03 02 waste from markets 20 03 03 street-cleaning residues 20 03 07 bulky waste	-

(1) No more than 10 tonnes total per day on average of any waste with EWC codes02-05-01 or 02-05-02 will be treated.

2.8.4 Hazardous waste, clinical waste or other waste codes not listed above will not be accepted.

Water Use and Water Circuits

2.8.5 The REnescience facility is designed to be highly water-efficient, recirculating water within the process as far as possible to avoid any fresh water requirements during normal operation and avoid the production of effluent requiring treatment and disposal. A water mass balance for the proposed facility is provided in Figure 8, Appendix B.

2.8.6 In normal operation, liquid extracted from the AD digestate will be separated into two streams, some will be re-circulated to the REnescience process (via 2 x 500 m^3 insulated external process water storage tanks), and the remainder will pass through an evaporation unit to both pre-heat and clean a portion of the water. The clean water will subsequently be collected in the clean water tank (15 m^3 insulated storage tank). Water used for washing recovered material in the 2D and 3D mechanical waste treatment stages will be supplied from the clean water tank. It will also supply water for general cleaning of process areas. The output from these cleaning stages are returned to the evaporator unit and re-used.

2.8.7 The evaporator unit will be of a mechanical vapour recompression design. The unit is labelled 'WCU' (water cleaning unit) in Figure 2, Appendix B. This type of evaporation method is energy efficient. During normal operation waste heat from the gas engines will be used to provide heat to the evaporator. The evaporative treatment will concentrate contaminants in the water supplied from the digestate de-watering into a 0.9 tph effluent stream containing around 18% solids. This liquid residue will be stored within a 50m^3 storage tank prior to disposal off-site.

2.8.8 During normal operation, these two streams will provide the water required for the hydrothermal treatment (together with the moisture in incoming waste). Water from the process water tanks and the cleaned water will retain heat from the AD and evaporation processes, respectively, with additional heat being supplied from the CHP engines. During periods when the CHP engines are not operating the back-up boiler will be operated to provide additional heat to the process water supplied to the bioreactor units.

2.8.9 A back-up process water supply will be maintained should additional top-up water be required.

2.9 Avoidance, Recovery and Disposal of Wastes

2.9.1 The purpose of the REnescience facility is to recover high quality recyclables and RDF/SRF. The recovered recyclables form the primary waste output, expected outputs of these materials and fate are provided in **Error! Reference source not found.** below.

Table 2.5: Expected Waste Outputs, including Recovered Recyclables

Waste	Expected Annual Generation (tonnes per annum)	Fate
RDF/SRF	50,760	Use of a fuel for energy generation
Plastic	4,280	Recovery
Ferrous metals	2,460	Recovery
Non-ferrous metals	1,350	Recovery
Inert	11,100	Recovery/Disposal
Compost like output	41,240	Land restoration
Nutrient rich stream	9,520	Combined with CLO or Disposal
Oversize	Variable	Returned to supplier, where possible otherwise disposal

2.9.2 RDF/SRF is generated from the residual material remaining following separation of the bio liquid for further processing within the AD plant and extraction of recyclable materials. The RDF/SRF will be collected in a 3 sided bunker within the sorting hall. Additional storage of RDF/SRF will be provided within the external storage area as indicated in Appendix B, Figure 5. RDF/SRF stored externally will be baled and plastic wrapped prior to being transferred to the external waste storage area. The storage of RDF/SRF bales will meet the requirements of Environment Agency Guidance Note 7.01 [5] i.e. RDF/SRF bales external storage will be no more than:

- 2 m high,
- 20 m long/wide;
- Have volume of no more than 450 m^3; and
- Cover an area of no more than 235 m^2.

2.9.3 The plastic wrapping of the RDF/SRF will encapsulate the material and prevent air and water entering the RDF/SRF and odour or leachate escaping.

2.9.4 Washed separated ferrous and non-ferrous metals from the 'three dimensional' (3D – see section 3 for further detail on the 3D process) stage will be collected in 20 ft containers within the sorting hall. Once full, containers will be closed and washed down, if necessary prior to transfer to the external waste storage area. The waste storage containers will be designed to be fully enclosed and water tight to control water egress or ingress. The waste tracking system will ensure that the content of full containers will be readily identifiable to ensure that containers of segregated materials are not mixed and are transferred off-site to the correct recovery facility.

2.9.5 Plastics removed from the 3D sorting stage will be baled. Approximately 10-15 plastic bales are expected to be generated per day. Bales will be loaded directly on to HGVs for onward transfer.

2.9.6 The inert stream is separated out during the 'two dimensional' (2D – see section 3 for further detail on the 2D process) process stage, following washing and sieving. This material is collected in a bunker and loaded directly into HGVs for onward transfer.

2.9.7 In addition to the primary wastes listed in Table 2.5above, smaller amounts of batteries are also separated out. These will be collected in separate containers and sent off site for disposal at an appropriately licensed facility.

2.9.8 Containers will be returned from the off-site recovery operations for re-use. Empty containers will be stored externally. Prior to re-use containers will be visually inspected to ensure they are not damaged. Damaged containers will be taken out of service and either repaired or disposed of.

2.9.9 The external RDF&SRF/recyclable storage area comprises a concrete pad which drains to a sealed sump. The sump will be tested (e.g. for pH and conductivity) to check for contamination and manually drained to remove rainfall or other liquid which accumulates. If clean rainwater the content will be pumped to the surface water drainage system and discharged into Wade Brook. If contamination is present or suspected arrangements will be made for the sump contents to be out-loaded into a road tanker for off-site disposal.

2.9.10 In the event of any recovered materials being identified as unsuitable for recovery/recycling as identified in Table 2.5 above, the material will either be reprocessed or sent for offsite disposal.

2.9.11 Compost like output will be collected in the CLO store pending transfer off-site. The nutrient rich stream from the evaporator will be collected in a 50 m^3 storage tank. Both of these streams have the potential for re-use, however due to the fact that they are generated from mixed waste sources their use as compost or fertiliser is currently not expected. The CLO will therefore be sent for land restoration. The nutrient rich stream will either be combined with the CLO or removed to an appropriately licensed disposal site. Opportunities for alternative recovery/re-use options for these streams will be kept under review with a view to diverting this material to a beneficial use, this may include review of the feasibility of recovery e.g. via an end of waste application once sufficient operational data are available.

2.9.12 Activated carbon is used within both the odour abatement and biogas desulphurisation. In both cases the activated carbon will be contained within a unit. Periodically the activated carbon will require replacement and will be removed off-site for regeneration.

2.9.13 In addition to the primary waste outputs above, small amounts of maintenance and office wastes will be generated.

2.10 Facility Wide issues

2.10.1 DERN O&M Ltd is the sole operator of the REnescience facility and therefore multi operator requirements are not applicable to this application. The proposed site location sits within the Lostock Works which includes a number of other industrial manufacturing operations. DERN O&M Ltd will establish communication procedures where relevant to enable effective interface management of adjacent activities, particularly in the event of an incident with the potential to affect neighbouring operations.

3 Operations

3.1 Incoming Waste and Raw Material Management

3.1.1 Two residual waste streams will be accepted by the proposed development: mixed municipal solid waste (MSW) (including fines) and suitable commercial and industrial (C&I) waste. Both of these residual waste streams will be sourced from existing waste transfer stations (WTS); C&I sites and sorting facilities. All waste will therefore be delivered in bulk using HGVs with enclosed containers.

Waste Pre-acceptance and Waste Acceptance Procedures and Delivery

3.1.2 Through contractual arrangements, DERN O&M Ltd will require that only waste loads with EWC codes listed in the permit will be accepted at the REnescience facility. At the pre-acceptance stage information will be obtained from the supplier in writing relating to the waste to be accepted, this could include information on the type of process producing the waste, waste quantity, waste analysis and hazards associated with the waste and a representative sample for analysis, as appropriate to the waste stream to be accepted. All analysis will be carried out by a suitably qualified laboratory. This information will be used to undertake a technical assessment to ensure the waste is suitable for storage and processing at the REnescience facility and that it falls within the permitted waste types that can be accepted. Record of pre-acceptance tests will be kept on file and for long term contracts should be regularly reviewed and maintained up to date. Such records will be kept for a minimum of 2 years. Back-up copies of electronic records should also be maintained off-site.

3.1.3 A waste tracking system will be established which will ensure that the information obtained at the pre-acceptance stage, should this lead to a delivery arriving at site, can follow the waste through the process or waste transfer station operation. The waste tracking system will be capable of providing up to date information on:

- Waste delivered in each load;
- total amount of unprocessed waste stored;
- type and and amount of waste removed from the site.

3.1.4 On entering the site, vehicles will be weighed at a weighbridge station and waste acceptance checks will be carried out, in accordance with BAT requirements under Section 2.12 of Sector Guidance note S5.06, before any waste can be accepted at the installation. This will involve an electronic check that the waste has an appropriate waste transfer note and that the waste is a type that can be accepted by the REnescience facility. Electronic checks will also determine whether they will be processed within the REnescience facility or whether they are a source segregated load destined for bulking and onward transfer within the waste transfer station (WTS operation) and ensure the vehicle is directed accordingly to the bunker hall or to the sorting hall respectively.

3.1.5 A visual spot check of the waste will also be undertaken during the unloading process. Waste should be appropriately labelled and will be checked to confirm quantities are consistent with those documented in accompanying waste transfer information.

3.1.6 Wastes will only be accepted where there is sufficient capacity to accept the waste. All wastes received will be entered into the waste tracking system which will include as a minimum:

- Date of arrival at site;
- Details of waste producer;
- Details of any previous holders of the waste;
- The unique tracking reference number;
- Results of pre-acceptance and where completed acceptance analysis;
- Record of the amount delivered; and
- Confirmation of whether it is to be processed within the REnescience facility or directed to the WTS.

3.1.7 Waste acceptance procedures will be implemented which define periodic spot sampling of incoming waste delivered.

3.1.8 Waste delivery vehicles will unload waste into the waste storage bunker. The waste bunker will be approximately 6m below ground. Both the bunker and the HGV unloading area will be fully enclosed in the reception and bunker hall of the main building. Based on the design waste processing rate of 18 tph, the waste storage bunker will be able to hold up to 3 days' waste supply, although typical residence time will be less than this due to continuous operation.

3.1.9 Unloading space will be provided for up to three HGVs at any one time to the bunker. The HGVs used for waste delivery will use bulk ejector trailers that offload waste using a push ejector system. Access into the waste reception hall will be through fast-acting automatic roller shutter doors that will be kept closed in-between HGV movements. This will minimise the potential for odour to be released from the waste reception area. The waste reception hall, waste bunker and conveyor/pre-sorting area will be kept under slight negative pressure, drawing air inwards (e.g. when the doors are opened for HGVs to enter), with the air exhausted through activated carbon to control and minimise odour. Within the unloading area, a front-end loader and floor-washing hoses will be used as required to move any minor waste spillages during unloading into the waste bunker.

Waste Transfer Station

3.1.10 Waste destined for the WTS will be delivered to dedicated bunkers within the sorting hall where they will be stored and bulked up for onward transfer along with other recovered separated recyclables.

Waste Rejection

3.1.11 Any waste load that is identified as not being suitable for treatment at the REnescience facility will be rejected and returned to its origin or sent for alternative disposal. A temporary storage area for rejected waste consignments will be provided in the north-east part of the site, although it is expected that most loads would be returned immediately. Any rejected waste loads would remain in their enclosed container (they would not be unloaded in this storage area) and would be collected within two working days, so this temporary storage will not have any significantly greater odour potential than ordinary arriving waste consignments.

3.1.12 Waste quarantine procedures will be in place outlining the process for handling and segregating rejected waste.

Fuel Delivery

3.1.13 Fuel for the start-up boiler and for onsite vehicles will be delivered to the oil storage tank. Prior to off-loading, the tank level will be checked to confirm that there is sufficient space for the delivery. Only once available capacity has been confirmed will the loading connection point be unlocked and the delivery hose connected.

3.1.14 The storage tank will be fully compliant with the Oil Storage Regulations [6], see Table 2.2 for further details.

3.1.15 All fuel oil deliveries will be overseen by a fully trained operative.

Other Storage

3.1.16 Enzyme for use within the REnescience reactor will be stored within two storage tanks located within the building housing the feed system into the bioreactors. Deliveries will be made by road tanker via a connection point located outside the building.

3.1.17 All deliveries will be overseen by an operative to ensure that the correct material is being delivered and connections for offloading only made following confirmation that there is sufficient capacity within the storage vessel for the delivery.

3.2 Waste Treatment and Processing

3.2.1 A travelling crane will be used to load waste from the waste bunker onto a conveyor system via a hopper. (A second crane will be installed as a backup to allow continued operation during crane maintenance.) Waste will be initially passed through a bag-opener and then through a drum separator to remove oversized (>450 mm diameter) material. Oversized material will be stored in containers or bunkers in the conveyor/pre-sorting area of the building pending collection and transport for treatment at an alternative facility. Following the drum separator, non-oversized MSW will be transported by enclosed conveyor to hydrothermal treatment stage at the start of the REnescience process.

3.2.2 The action of the crane will also provide mixing of the MSW and fines within the storage bunker. This will avoid allowing waste to have a long residence time in the bunker or allowing anaerobic conditions to develop, thereby minimising odour generation.

3.2.3 If any waste is visually identified in the waste bunker as being unsuitable for treatment (e.g. due to being substantially oversized or potentially hazardous), it will be extracted using the travelling crane and stored in containers in the conveyor/pre-sorting area pending transport for treatment or disposal at an appropriately licensed facility. Within this building, a separate demarcated area will be provided for temporary storage of any potentially hazardous waste that is removed and isolated.

REnescience enzyme treatment

3.2.4 The first stage of the REnescience process is hydrothermal treatment, in which waste will be fed initially into two enclosed tanks, one per bioreactor, to be mixed with water pre-heated to circa 70°C.

3.2.5 During normal operation, the water added in the hydrothermal treatment stage will be fully supplied by a mixture of water recirculated from de-watering the digestate produced by the AD treatment stage and clean water from the evaporator unit. It will retain heat from the AD treatment, being around 50 °C, and will be stored in two 500 m^3 insulated buffer tanks located externally to the south of the bioreactor hall. Additional heating to the required approximately 70 °C will utilise waste heat from the biogas engines.

3.2.6 In the event of a cold start-up, water for the hydrothermal treatment stage may require pre-heating by a 1.5 MW start-up-fired boiler.

3.2.7 Following hydrothermal treatment, the waste will then be fed into each of the two bioreactors for enzyme treatment. These horizontal cylindrical tanks will each be approx. 52 m long and 5.2 m diameter with a capacity of ~1000 m^3 and typically holding 270 m^3 of mixed waste and water, set in cradles that allow continuous rotation at a rate of around 1 rpm. This will ensure effective waste mixing and allow the enzymes to reach all of the organic content of the waste. Hydrothermal treatment will be a batch process, with batches of around 2.5 t allowed to flow into the corresponding bioreactor three times per hour.

3.2.8 The bioreactors will be set on a slight incline, allowing the waste mix to flow through them over the course of a 12-18 hour residence time. In the course of around the first five meters of the bioreactors the waste mix will cool to around 50 °C, which is the optimum operating temperature for the enzyme process, and the enzymes will be added. Enzymes will be supplied from two insulated 30 m^3 tanks located in the bioreactor hall.

3.2.9 Inside the bioreactors, enzymes will break down the organic material, reducing it to a bio liquid in which remaining solid non-organic material (metals, plastics, etc) is entrained. This bio liquid mixed with remaining solid waste items will flow via control valves out of the bioreactors, and the solid material will be separated.

3.2.10 In the event that the liquid needs to be drained from the bioreactors, for example for unplanned maintenance the liquid would be drained into a temporary storage container. The drained material would be returned into the bioreactor once processing activities recommenced.

3.2.11 The bioreactors will be suitably lagged to avoid heat loss and maintain the reactor temperatures. The external reactor length with be located within a bunded area which will drain to a sump.

3.2.12 Any rainwater collecting within the bund zone will be tested (e.g. pH and conductivity) and if contaminated or suspected to be contaminated the water will be recycled back into the process or pumped into a road tanker for off-site disposal. If clean rainwater the water will be discharged via a manually activated valve into the surface water system. The manual valve installed will be designed to be closed and will need manual action to open the valve.

Separation of bio liquid and solids

3.2.13 Bio liquid will be initially drained from the solid material as this is moved by perforated screw conveyor to the mechanical sorting process. The bio liquid will be passed through a separation system consisting of multiple stages combining screening, floatation and to further separate small inert materials (sand, gravel) that were entrained or suspended in it. Organic matter separated out (i.e. clumps that were not broken up in the bioreactor) will be crushed if needed and then circulated back into the bio liquid stream. The bio liquid will then be pumped into two c.2,000 m^3 storage tanks located outside the waste processing building, pending AD treatment. Typically, 49 tph of bio liquid will be produced from the original 18 tph waste and circa 40 tph water inputs to the bioreactors, with approximatly13% of the bio liquid being organic matter and approximately 87% being water and salts. A further c. 500 m3 tank will be provided to separately store off-spec bio liquid if necessary, pending further treatment.

3.2.14 Separated inert material will be washed and moved by conveyor to a storage bunker pending transport for re-use as aggregates. Inert recovered material will therefore be collected for transport off-site.

3.2.15 Other solids will pass on to the mechanical sorting stage.

Mechanical sorting

3.2.16 The solid material will be separated into 'two dimensional' (2D, <40 mm sized flat materials such as textiles, plastic film, undigested cardboard) and 'three dimensional' (3D, >40 mm sized metals and solid plastic) fractions in a ballistic separator.

3.2.17 The 2D fraction will be pressed to de-water it. The bio liquid pressed out will be circulated back through sieves and into the bio liquid storage tanks, as described above. The remaining 2D material will then pass through three washing and sieving steps using clean water and will be separated into two outputs:

- inert material; and
- mixed 2D material including plastic and textiles that form RDF/SRF.

3.2.18 The inert material collected from the 2D stage is combined with inert material separated from the bio liquid sieving stage. A total of 1.4 tph of inert material will be separated from the 18 tph waste input.

3.2.19 The RDF/SRF will undergo a final de-watering stage and then be transported by conveyor to storage containers located in the sorting hall, pending onward transport for use as fuel in other facilities. In total, typically 6.4 tph of RDF/SRF will be produced from the original 18 tph waste input. Depending on RDF/SRF customer requirements, a plastic wrap baling system may instead be used for RDF/SRF rather than containers. Additional overflow storage space will be provided in an external covered area opposite the loading building; this allows for storage should regular collections be interrupted (e.g. over bank holiday weekends).

3.2.20 Any batteries will be collected and sent for disposal at an appropriate facility.

3.2.21 The 3D fraction will be washed using clean water (with the wash water then passed through the 2D sieving stages described above to capture any suspended material for recovery) and will then be dried by storing it for one day in a bunker of approx. 300 m^3 capacity located in the sorting area of the main building. This storage is provided as the 3D fraction is not large enough to require continuous processing: from this bunker, conveyors will move the 3D material through three mechanical sorting stages for around four to six hours per day.

3.2.22 Overband magnets will be used to separate ferrous metals from the mixed 3D waste, recovering around 0.31 tph of separated ferrous metal (depending on the amount in the original waste input).

3.2.23 An eddy current separator will be used to separate non-ferrous metals, recovering around 0.17 tph of separated non-ferrous metal (depending on the amount in the original waste input).

3.2.24 Finally, Near Infrared (NIR) sorting will be used to separate 3D plastic (e.g. drinks bottles, containers and similar). Around 0.54 tph of plastic is expected to be recovered, depending on the amount in the original waste input. The plastics will be baled and stored within the sorting hall prior to off-site removal for re-processing. Additional storage will be provided within the external storage area, where required.

3.2.25 Ferrous metal and non-ferrous will be stored in separate 20 ft capacity containers in the mechanical sorting/loading area of the building. The separated metal fractions will be collected for transport off-site to be recycled.

3.2.26 The remaining treated 3D fraction waste will comprise RDF/SRF, which will be stored as described above for SRF/RDF from the 2D stage.

3.2.27 In total, the 2D and 3D washing will require clean process water. This water will be supplied by re-circulation from dewatering of the AD digestate, via the evaporator. The AD stage and water recirculation are described further below.

Anaerobic digestion

3.2.28 Bio liquid from the bio liquid storage tanks will be pumped initially into one of two fully enclosed buffer storage tanks of c. 1,200 m^3 capacity. A third tank of the c. 500 m^3 will be provided to store any off-spec bio liquid pending re-treatment or if necessary transport off-site for disposal.

3.2.29 From the buffer tank, bio liquid will be pumped into one of four fully enclosed 6,000 m^3 volume AD tanks, each typically holding 5,000 m^3 of material. The AD tanks will be constructed of reinforced concrete walls and base with a flexible roof. The AD tanks will be constructed on-site from pre-cast and pre-stressed concrete panels of circa 200 mm thickness. The walls will be externally insulated and protected externally by a steel sheet cladding system.

3.2.30 In the AD process, the bio liquid will be digested by bacteria under anaerobic conditions, converting it to biogas comprising methane (CH_4, typically 60% of the biogas), carbon dioxide (CO_2, typically 40% of the biogas) and other trace gases including hydrogen sulphide (H_2S). Mesophilic digestion will be used. Depending on its residence time in the buffer tanks, the bio liquid may be warmer or cooler than the optimum temperature. If necessary, it will be re-heated using waste heat from the gas engines.

3.2.31 Digestion will be a continuous process, with a residence time of around 20 days. Mechanical stirrers will agitate and mix the material within the tanks to promote an even distribution of substrate and active biology in the digester. Pressure and temperature conditions will be monitored using automated sensors overseen by a plant operator to avoid problems such as foaming. Pressure relief valves and water locks will be fitted to each AD tank to prevent catastrophic failure should overpressure develop, although the engines and the flare will be used as the primary controls to maintain a low pressure in the tanks.

3.2.32 The biogas will collect in in the upper part of the digestion and post-digester tanks, which will be of reinforced concrete construction with flexible, sealed dome tops and in total across the six tanks and pipework will hold up to circa 7,300 m^3 of biogas. Produced biogas will pass through desulphurisation, siloxane polishing and drying stages before being used in the gas engines.

3.2.33 Desulphurisation will be by injecting air into biogas oxidises the H_2S to elemental sulphur which binds itself to the activated carbon surface. Biogas drying is achieved through cooling the biogas and thereby condensing water vapour which is collected and returned to the AD digestor units. The combination of gas cooling and ctyivated carbon will also be used to control siloxane in the biogas.

3.2.34 The liquid digestate will be pasteurised at 70 °C for at least 1 hour. The pasteurisation stage has been included post digestion to minimise energy requirements. The output from the digester is at approximately 40 °C and therefore heat input to achieve minimum pasteurisation temperatures can be more efficiently achieved. There are further efficiencies from undertaking pasteurisation at this stage for the dewatering stage (see paragraph 3.2.36). Heat to this stage is provided by the CHP engines (Figure 9, Appendix B identifies energy consumption for this stage).

3.2.35 Liquid digestate produced by the AD process will be pumped to two 2,500 m^3 post-digester (digestate storage) tank. Digestate production will be at a rate equivalent to approximately 46.2 tph.

3.2.36 Following pasteurisation, the digestate will be de-watered within a decanter and the water will be re-circulated into the REnescience process. Polymer dosing is included to aid the dewatering process. The high pasteurisation temperatures will mean the digestate viscosity is lower, therefore polymer dosing rates will be reduced compared to dosing systems in which the digestate is cooled. The water removed from the dewatering stage will also be at a higher temperature, given this water is either treated in the evaporator or re-used for mixing within fresh incoming waste additional heat input to these stages is minimised. The remaining dewatered digestate, now a CLO, will be stored in the CLO store pending transport off-site by HGV. The CLO has a relatively low odour potential after degassing and low biological activity. The CLO store will be a covered, three sided structure with an impermeable concrete base which drains to a sump. Approximately 5.2 tph of CLO will be produced.

3.2.37 During normal operation, bio liquid from the REnescience process will provide the AD feedstock (substrate) and water from the digestate will be re-circulated back to the bioreactors. During partial shutdowns for annual maintenance, works will be managed so that if AD tanks require emptying (e.g. to check their internal condition), one tank would be emptied at a time and substrate to re-start the AD process can be provided from the other tanks, rather than using an external source. The option to use substrate from external plant in exceptional circumstances will be maintained.

Electricity generation and export

3.2.38 Biogas from the digesters will provide fuel for four reciprocating gas engines, each connected to an electrical generator producing approx.1.5 MW of electricity. Sufficient space has been allowed for a possible fifth engine. These gas engines will be located in separate containers in the southern part of the site. Containers will be mounted on hard standing. Their exhaust gases will flow to a single shared 33 m high exhaust stack or bundle of flues to assist atmospheric dispersion of pollutants generated by the combustion, which will be primarily oxides of nitrogen (NOx) and carbon monoxide (CO).

3.2.39 The gas engines will typically run in continuous 24-hour operation (aside from periods of maintenance), but the REnescience facility will have the flexibility to operate without one or more engines, depending on commercial considerations, electricity demand and the rate of biogas production. Flexibility to stop one or more engines allows the remaining engines to work at their design load, at which they are most fuel efficient, rather than being turned down to reduce generation.

3.2.40 Electricity generated by the gas engines will supply the engine parasitic demand. The remaining electricity generated up to 6.3MW (assuming all gas engines are operating at their design load) will be stepped up to 132 kV using transformers located adjacent to the existing substation, near the southern boundary of the site and exported to the national grid or private wire to local industrial consumers via the proposed development's substation. The grid connection will be via cable terminating at the transformer busbars (equipped with appropriate safety equipment including circuit breakers). The cable will connect to the existing 132 kV substation, immediately adjacent to the site's south east corner.

3.2.41 3.2 MW of waste heat from the gas engines will be circulated using a heat exchanger to the AD tanks, hydrothermal treatment stage and office building. The remaining cooling for the gas engines will be provided by forced-draft radiators fitted to each engine.

Gas flaring

3.2.42 A 10m high enclosed gas flare located in the southern part of the site will be provided as a back-up to flare biogas in the event that biogas production temporarily exceeds the gas engines' demand digester's capacity. Flaring will not be routine and it is anticipated that the flare will only be required intermittently throughout the year. Providing for flaring biogas if necessary avoids the risk of venting uncombusted biogas, which although having passed through the desulphurisation stage could still have the potential for odour and global warming impact.

Commissioning

3.2.43 The REnescience bioreactors and the AD process will require an initial commissioning period to start up the processes, and then are likely to ramp up to full production over the course of around four to six months. During that period waste deliveries to site would also ramp up in line with the treatment capacity.

3.2.44 The AD commissioning stage will take around three to four months in total. The construction programme will prioritise construction of at least one AD digester and post-digester tank, gas engine, and the associated equipment (pipework, pumps, stack and flare, transformers and grid connection) for the end of 2016. This first digester tank will be commissioned using circa 200 m^3 of separately collected food waste or pulped fines (which will develop the correct bacteria culture to process the REnescience bio liquid) and around 1,500 m^3 of biologically active substrate from another AD facility in Q1 2017, allowing first operation by the end of March 2017. This stage of commissioning on food waste or pulped fines feedstock will take up to one month.

3.2.45 Material from the first digester tank will then be used to commission the remaining tanks in sequence, in order that overall the AD facility will be fully operational and ready to receive bio liquid from the REnescience process as that is commissioned and ramps up production of bio liquid. All construction, including the REnescience plant and balance of AD plant, will be complete by the end of March 2017. Commissioning of the REnescience bioreactors and ramp-up of bio liquid production will occur in parallel with the commissioning of the remaining three AD digestion tanks and equipment during the remainder of H1 2017.

3.2.46 During the one-month commissioning of the first AD tank, the digestate used for start-up will be sourced from an existing AD facility in the region, transported in road tanker vehicles and loaded directly into the first AD tank on the REnescience site without being exposed in the open. The food waste or pulped fines start-up material will likewise be transported in enclosed road tankers and added to the AD tank using its feed system, which will have been commissioned in advance. This approach avoids any handling or storage of start-up material for the AD tank in the open and hence avoids potential for odour emissions.

3.2.47 The REnescience facility would maintain the option to import digestate, albeit only likely to be required on very rare occasions. The waste codes included in section 2 have included digestate from other waste management facilities to enable flexibility for this option to be maintained.

4 Emissions and Monitoring

4.1 Emissions to Air

4.1.1 The REnescience facility will include the three emission points to air namely:

- the exhaust stack for up to four reciprocating gas engines which burn biogas generated by the anaerobic digestion (AD) process to produce renewable heat and electricity;
- the enclosed 10 m high gas flare which burns off biogas in the event that biogas production temporarily exceeds the gas engines' demand and the buffer tank capacity; and
- the exhaust stack from back-up boiler which is used only during periods when the CHP engines are not operating to provide process and space heating requirements.

4.1.2 Under normal operation biogas will be burned within the gas engines and released to air via a 33m stack. Releases to air from the engines will predominantly comprise water vapour and carbon dioxide with low concentrations of nitrogen oxides (NOx), carbon monoxide (CO) and unburned hydrocarbons (VOCs). The primary mechanism for controlling pollutants will be through combustion control and fuel selection. The selected engines will include lean burn control to minimise emissions to air. No additional abatement is required to provide further exhaust gas cleaning.

4.1.3 Both the enclosed gas flare and back-up boiler releases are not intended for use under normal operation. The flare will operate to combust excess biogas giving rise to releases of NOx, CO and unburned hydrocarbons.

4.1.4 The back-up boiler will operate burning diesel and will release combustion gases including NOx, and oxides of sulphur (SOx) from a 7m stack.

4.2 Emissions to Land

4.2.1 There are no point source emissions to land from operation of the proposed REnescience facility.

4.3 Emissions to Surface Waters and Sewer

4.3.1 There are no process water releases to surface water or sewer.

4.3.2 Surface rain water run-off from non-process areas and building roofs will be discharged to Wade Brook. Surface waters from the external HGV circulation and vehicle parking areas will pass via a class 1 oil interceptor (with integral high level alarm).

4.3.3 The external vehicle fuelling station area will be isolated by way of a perimeter drainage channel which will discharge via a separate class 1 forecourt oil interceptor also with integral high level alarm.

4.3.4 Rainwater collecting in the bunded area will be subject to a bund management procedure. Where rainwater is declared clean these waters will be manually discharged to surface water. If the rain water is suspected or found to be contaminated this water will be removed to road tanker for off-site disposal at a suitably licensed facility or recycled into the process.

4.3.5 An indicative drainage plan is provided as Figure 6, Appendix B. Further detail on the proposed drainage strategy is provided in Appendix G.

4.4 Fugitive Emissions to Air

4.4.1 Potential fugitive releases to air from the operations at the REnescience facility include:

- Dust associated with incoming waste and handling and storage of waste outputs; and
- Odour from waste handling, processing and operation of the AD facility.

Dust

4.4.2 The REnescience facility is considered to have a low potential for fugitive dust releases.

4.4.3 The majority of materials received, handled and stored at the facility will be moist or will be handled in a wet environment, minimising the potential for fugitive dust releases.

4.4.4 However, incoming waste, most notably the fines fraction; black bag opening and handling of certain residues e.g. separated inert material could have the potential for dust releases. In addition to processing and handling in a generally wet/moist environment the following measures are used to minimise the potential for fugitive dust emissions:

- Deliveries will be in enclosed vehicles which will outload within a building directly into the waste bunker.
- The waste bunker has access doors for offloading of delivery trucks which will be kept shut other than during off-loading of incoming material.
- The waste bunker will be maintained under a slight negative pressure;
- Separated waste fractions will be stored in containers. The exception will be RDF/SRF which will be plastic wrapped.

4.4.5 Further consideration of fugitive dust releases is provided in Appendix C and Appendix D.

Odour

4.4.6 The activities carried out and materials handled at the REnescience facility have the potential to generate odour. At the design stage measures have been incorporated into the design to manage activities such that odours are effectively controlled.

4.4.7 Odour controls included within the design will include:

- Delivery of incoming waste within enclosed containers;

- Fully enclosed waste reception building and 2D/3D material handling and loading hall with automatic doors which will remain shut other than for access;
- Secondary odour control via carbon filter units to manage potentially odorous air from the waste reception and waste bunker areas;
- Effective dispersion of releases from the sorting hall;
- Fully enclosed bioreactor units;
- Containment of all residues within containers, bales and/or within a building;
- Fully enclosed bio liquid storage tanks, AD tanks and associated pipework;
- Continuous pressure monitoring on bio liquid and AD tanks alongside monitoring of gas production rates to enable early detection of a potential leak; and
- Combustion of off-gas in a high temperature flare.

4.4.8 Further consideration of odour and odour control from the facility is provided in Appendix C, D and G.

Litter

4.4.9 Many of the measures described above for controlling fugitive dust and odour releases (such as contained deliveries, handling within enclosed buildings and storage of residues within containers/plastic wrapping of bales/enclosed stores) will also assist in avoiding litter escape.

4.4.10 Given the above the potential for litter escape from the facility is considered to be low.

Pests

4.4.11 The risk of pest infestation will be minimised by effective handling and containment of waste materials, alongside management of materials to avoid lengthy storage prior to processing.

4.4.12 Pest management (including birds) will be incorporated within the site management procedures.

4.4.13 DERN O&M limited will contract specialist pest control services to undertake surveillance and maintain pest control.

4.5 Fugitive Emissions to Surface Water or Sewer

4.5.1 Potential fugitive releases to surface water from the operations at the REnescience facility include:

- Leaks and spills from tanks and pipework containing liquids;
- Leaks from the bioreactor units;
- Leaks and spills from material deliveries; and
- Carry over from oil interceptors.

4.5.2 All liquid tanks and pipework containing liquids (excluding site drains) will have primary containment which is designed to be leak free and constructed from materials suitable for the materials it will contain. Secondary containment bunds will also be provided for all liquid storage tanks and as far as practicable for associated pipework. The key exception will be the oil storage tanks which will be double skinned and designed to be compliant with the Oil Storage Regulations [6].

4.5.3 The whole AD plant will be located within a concrete bund. The bund has been sized to contain 25% of the total tankage which is larger than 110% of the largest AD tank.

4.5.4 The external portion of the bioreactor units will be located within a bunded area which has been sized to contain 110% of the liquid from a bioreactor unit.

4.5.5 A bund management procedure will be adopted at the site to monitor the integrity of bunds and to ensure they remain free of rainwater accumulation. Rainwaters will be tested (e.g. pH and conductivity) and where suspected or confirmed as contaminated arrangements made for emptying and disposal of the bund contents off-site to a suitably licensed facility or where suitable returned to the process. Clean water that cannot be returned for process use will be emptied using manually activated valves and discharged into Wade Brook via the surface water discharge point. These valves are designed to remain closed other than when manually openned.

4.5.6 The waste bunker will be constructed to be water tight. During operation the bunker will be inspected from time to time to monitor the integrity of the bunker and where defects are identified a programme for repair established.

4.5.7 The oil interceptors to be installed at the REnescience facility will be designed to an appropriate British Standard and will include integral high level alarms. Maintenance and emptying of the interceptors will be carried out routinely to ensure they remain in good working order.

4.6 Noise and Vibration

4.6.1 The main noise source likely to affect noise sensitive receptors is expected to be from the CHP engines, due to their external location. These are housed in acoustic containers.

4.6.2 Most mechanical waste handling and sorting equipment, including the ballistic separator unit is installed within buildings. The main exception is the Renescience bioreactor units. Whilst a portion of the rotating bioreactors are external, the main noise source i.e. the electric gear drives are located internally.

4.6.3 Other external plant include pumps, dewatering plant etc. and these will be housed within enclosures.

4.6.4 The gas engine stack will be fitted with a silencer unit, details of the expected specification for this unit are provided in the Noise and Vibration Assessment in Appendix E.

4.6.5 Significant vibration effects from operation of the REnescience facility are not expected and detailed assessment of vibration was scoped out of the Noise and Vibration Assessment.

4.7 Monitoring of Emissions to Air

4.7.1 Emissions from the proposed CHP engines will subject to periodic stack emissions testing. The engine stack will be provided with suitable access and sampling arrangements to undertake periodic monitoring in accordance with Environment Agency Guidance M1 [7].

Table 4.1: Emissions Limits and Monitoring from the CHP Engines (Emission point A1)

Pollutant	Monitoring Method	Monitoring Frequency	Emission Limit (mg/Nm^3 at 6% O_2)
NO_x	BS EN 14792	Periodic	500

4.7.2 The start-up boiler is a minor source of emissions from the REnescience facility. No emissions monitoring for the purpose of reporting under the permit is proposed for emissions from the biogas flare or back-up boiler. During maintenance tests the boiler maintenance contractor will undertake tests to ensure the unit is functioning correctly.

4.8 Monitoring of Emissions to Water

4.8.1 Releases to water will comprise surface run-off that has passed via interceptors and clean rainwater run-off from building roofs. Routine monitoring of this discharge is not proposed.

4.9 Process Monitoring

4.9.1 Process monitoring will be carried out and all stages will be controlled automatically from the control room. A Supervisory and Control and Data Acquisition (SCADA) system will be installed to monitor, record and control the facility.

Table 4.2: Expected Key Process Monitoring Parameters

Process Stage	Parameter	Frequency
Bioreactors	Feed rate	Continuous
Bioreactors	Enzyme dosing	Continuous
Bioreactors	Feed water temperature	Continuous
Bioreactors	Reactor temperature	Continuous
Bio liquid	Temperature	Continuous
Bio liquid	pH	Continuous
AD Tanks	High level	Continuous
AD Tanks	Temperature	Continuous
AD Tanks	Gas pressure	Continuous
AD Tanks	pH	Continuous
AD Tanks	Hydraulic loading rate	Continuous
Biogas	Gas production rate	Continuous

Process Stage	Parameter	Frequency
Biogas	Gas pressure	Continuous
Biogas	Gas H_2S concentration	Continuous
CHP engines	Produced electricity	Continuous
CHP engines	Exported electricity	Continuous
CHP engines	Waste heat to process	Continuous

4.10 Off-site Monitoring

4.10.1 No off-site monitoring during the operation of the facility is proposed.

5 Impacts Summary

5.1.1 To support this application a number of environmental impact assessments have been completed. The full details of these assessments are appended to this application and a reference to the full assessment is given where relevant for the environmental issues detailed below.

5.2 Emissions to air

5.2.1 An air quality assessment has been undertaken to support this application and full details of the assessment are reported in Appendix D. The assessment is the same report and dispersion modelling undertaken to inform the Environmental Statement, which accompanied the Planning Application. It should be noted that at the time of the planning application up to five CHP engines were being considered of two different sizes. This application is based on four units all of the larger size modelled. The total biogas volume being burned in the CHP engines has not changed. Similarly the total mass emissions and emissions characteristics (total flowrate, velocity, temperature, pressure, concentration etc.) from the four units will not change.

5.2.2 The approach to the assessment of emissions from the exhaust stacks has involved the following key elements:

- Establishing the background Ambient Concentration (AC) from consideration of Air Quality Review & Assessment findings and assessment of existing local air quality through a review of available air quality monitoring and Local Air Quality Management (LAQM) projections in the vicinity of the proposed site.
- Quantitative assessment of the operational effects on local air quality from stack emissions utilising a “new generation” Gaussian dispersion model, ADMS.
- Assessment of Process Contributions (PC) from the REnescience facility in isolation, and assessment of resultant Predicted Environmental Concentrations (PEC) taking into account cumulative impacts.
- Comparison of the PEC with the relevant air quality objective.

5.2.3 The dispersion modelling was undertaken using ADMS 5, a version of the ADMS (Atmospheric Dispersion Modelling System) developed by Cambridge Environmental Research Consultants, calculating the mean concentration over flat terrain, but also allowing for the effect of plume rise, buildings, complex terrain and deposition.

5.2.4 Modelling was carried out utilising five years of hourly meteorological data (between 2013 and 2014) from Manchester Ringway, located approximately 16 km north-east of the site.

5.2.5 Modelling for the biogas engines and flare has been based on highly conservative assumptions that they will run all year round for 8,760 hours. No modelling was carried out specifically for the start-up boiler; however it is considered that its effects will be included within the modelling of the biogas engines and flare, since the additional 760 hours compensates for the likely emissions associated with the start-up boiler.

5.2.6 Long-term (annual-mean) NO_2 and benzene and short-term (8 hour) CO have been modelled and subsequently compared with the relevant annual mean objectives. For short-term NO_2, the objective is for the hourly-mean concentration to not exceed 200 µg.m^{-3} more than 18 times per calendar year. Therefore, the 99.79th percentile of hourly NO_2 has been modelled.

5.2.7 The effect of terrain and wake effects from surrounding buildings has been incorporated into the dispersion model. Surface roughness of terrain has also been incorporated with a surface roughness length of 0.5 m assigned during meteorological processing to represent the average urban surface characteristics across the study area.

5.2.8 Modelling of point source impacts was undertaken using a grid of 10 km by 10 km, with a grid spacing of 50 m. Modelling was also carried out at the façades of existing local receptors, at locations where changes in pollutant concentrations are anticipated to be greatest due to the proposed development.

Determination of Appropriate Stack Height

5.2.9 The stack height selected for the optimum dispersion of pollutants from the biogas engines stack is determined to be 33 m, based on the Stack Height Determination. This height has been identified as the heights at which the wake effect of nearby buildings is overcome.

Dispersion Modelling Assessment Results

5.2.10 Results of the dispersion modelling show that the maximum long-term and short-term PCs exceed the 1% and 10% levels for the relevant Environmental Quality Standard (EQS) for NO_2 and Benzene. These emissions should therefore not be screened out as insignificant under the criteria set out within the EA H1 guidance. However the maximum PEC is 51.4% and 27.3% of the EQS for NO_2 and Benzene respectively, therefore no significant effect on local air quality is expected.

5.2.11 The maximum PC for the 1 hour 99.79th percentile for NO_2 is 31.9% of the EQS, and the PEC is 46.6% of the EQS, hence no significant effect is expected.

5.2.12 The highest PC and PEC for the 8 hour running maximum for CO are 0.1% and 6.5% of the EQS respectively. These levels are considered to be insignificant.

5.2.13 Dispersion modelling to predict the contributions to local receptors around the application site also shows that all predicted concentrations at the sensitive receptors measured are well below the EQS.

5.3 Odour Impacts

5.3.1 A qualitative risk-ranking assessment of the odour impacts of emissions from the proposed development on local sensitive receptors was carried out. The assessment aimed to estimate the odour-generating potential of operational activities (the Source Odour Potential), taking into account the magnitude of the odour release, how odorous the emission is and the relative pleasantness/unpleasantness of the odour.

5.3.2 An evaluation of the effectiveness of the pollutant pathway for odour was then used along with the Source Odour Potential to predict the Risk of Odour Exposure at the receptor location. From this a prediction of the likely odour effect at each sensitive receptor was made taking into account receptor sensitivity.

5.3.3 The compounds present in the process are moderately to very odorous, indicating a ‘medium’ or ‘large’ Source Odour Potential. However mitigation for odour is incorporated into the facility’s design and within an Odour Management Plan (see Appendix D) and as such few residual emissions are expected. Therefore, the Source Odour Potential from the facility is taken to be ‘medium’.

5.3.4 Low sensitivity receptors are located within 20 m of the site boundary, comprising of industrial and business users. The Risk of Odour Exposure for a medium Source Odour Potential and a highly effective pathway is ‘medium’.

5.3.5 The likely Odour Effect resulting from a medium Risk of Odour Exposure and low receptor sensitivity is ‘negligible’. Therefore the residual effects from fugitive emissions of odour from the proposed development are not likely to be significant.

5.4 Appropriate Assessment

5.4.1 The need for an Appropriate Assessment is set out in Article 6(3) of the Habitats Directive and transposed into British law through Regulation 61 of the Habitats Regulations. The Habitats Directive implements the precautionary principle to relevant designated areas, meaning that projects can only be permitted on determination that there will be no adverse effect on the integrity of a Special Protection Area (SPA) or a Special Area of Conservation (SAC).

5.4.2 Under Government policy, sites designated under the Convention on Wetlands of International Importance (Ramsar sites) are given equivalent status to SPA and SACs. For this reason an Appropriate Assessment should also consider any Ramsar sites present.

5.4.3 The closest SPA/SAC/Ramsar sites are the West Midlands SAC and Midlands Meres and Mosses Phase 1 and Phase 2 Ramsars which are located approximately 9.2 km from the REnescience site.

5.4.4 There is a single site of special scientific interest (SSSI), namely Witton Lime Beds part of which lies within 2 km of the REnescience site. Plumley Lime Beds SSSI and part of Tabley Mere SSSIs are within 5km of the REnescience site. Marshall’s Arm Hartford local nature reserve (LNR) is located within 5km of the REnescience site. The closest ecological feature is the Ashton’s and Neumann’s Local Wildlife Site.

5.4.5 Natural England (NE) and Cheshire West and Chester Council (CWCC) were consulted on the scope of assessment required in relation to air quality impacts at designated sites as prior to undertaking the ecological and air quality assessments to inform the Environmental Statement (ES) which accompanied the planning application for the REnescience facility. NE confirmed that since all European sites and SSSIs lie beyond 500m of the REnescience facility, no impacts would be expected at the sites and they do not need to be assessed. NE requested a qualitative description of expected air quality impacts on 'Ashton's and Neumann's' Local Wildlife Site. The air quality assessment provided in Appendix D concluded that predicted environmental concentrations would be well below the relevant environmental assessment level (EAL).

5.5 Emissions to Water and Sewer

5.5.1 The proposed plant will not give rise to process emissions to water and sewer. The only discharges arising will be surplus rainwaters, which will discharge to surface waters.

5.5.2 Water accumulating in the sump which drains the external waste storage areas will be inspected to determine whether the water is contaminated. Clean water will be pumped into the surface water drainage system. Contaminated water shall be removed by road tanker for off-site disposal.

5.5.3 Surface waters consisting of clean rainwater will be pumped to the surface water drainage system and discharged into Wade Brook. For this reason emissions to water and sewer do not require further assessment.

5.6 Noise and Vibration

5.6.1 Appendix E of the application provides details of the assessment of noise and vibration effects from the operation of the proposed development. As detailed in this assessment significant vibration effects are not expected and so were screened out from detailed assessment.

5.6.2 Noise levels arising from the operational activities were predicted using SoundPLAN Version 7.2 sound modelling software, implementing the methodology within ISO 9613-2:1996. The sound model made use of standard meteorological conditions and a ground factor of 0.5. The significance of the operational effects of noise to residential receptors has been assessed using the methodology contained within BS 4142.

5.6.3 The noise assessment was based on a combination of long-term and attended short-term surveys to obtain values of the background (L_{A90}) and residual (L_{Aeq}) sound levels at five locations.

5.6.4 Noise emissions from the facility are generally not predicted to be tonal or impulsive by design, which would otherwise increase the significance of the noise impact.

5.6.5 At all Noise Sensitive Receptor locations the noise level rating does not exceed the background sound levels, for both daytime and night-time periods, which BS 4142:2014 states is an indication of the specific sound source having a low impact, depending on context.

5.6.6 The assessment highlighted that for the closest Noise Sensitive Receptors there will be very little change from baseline conditions. Where noise from the site is audible it is predicted that this will not cause any changes to behaviour or attitude or a perceived change in quality of life. Therefore with respect to national planning guidance in the National Planning Policy Framework, Noise Policy Statement for England and Planning Practice Guidance for Noise, it is likely that the level of noise will be within the ‘No Observable Effect Level’ and would in the worst case not exceed the ‘Lowest Observed Adverse Effect Level’.

5.6.7 With consideration for the context, the impact of noise from the operation of the REnescience facility is expected to be negligible or low. Due to the sensitivity of receptors being identified as medium, noise from the facility will result in a direct permanent negligible or minor adverse effect on receptors.

5.6.8 Mitigation for noise generated by operations is incorporated into the design of the facility (see section 4 for details) and is considered to be BAT. As a result of this, noise effects are expected to be minor adverse at worse and hence it is anticipated that further mitigation measures will not be required.

5.7 Global Warming

5.7.1 The global warming potential (GWP) for the REnescience facility has been estimated using the H1 Software Tool. Electricity imported from the grid and methane emissions from the biogas CHP engines both contribute to the overall GWP. The total GWP for the facility is 8,275.

5.7.2 Contributions from burning the biogas and associated electricity and heat used within the facility have been excluded. Biogas is formed from the organic carbon containing materials extracted from the incoming waste and will comprise carbon based compounds from species which have recently been grown (i.e. short cycle carbon) consequently this has a GWP factor of zero.

5.8 Photochemical Ozone Creation Potential (POCP)

5.8.1 Emissions from the combustion of biogas within the CHP engines, flare and back-up boiler give rise to releases of nitrogen oxide; carbon monoxide; benzene and methane, all of which contribute to photochemical ozone creation effects. The POCP for the REnescience facility has been estimated using the H1 Software Tool. The total POCP from all sources has been established at 1,889.8.

5.8.2 The POCP has been established on a highly conservative basis and includes continuous releases from both the CHP engines and the flare for the whole year.

6 BAT Assessment

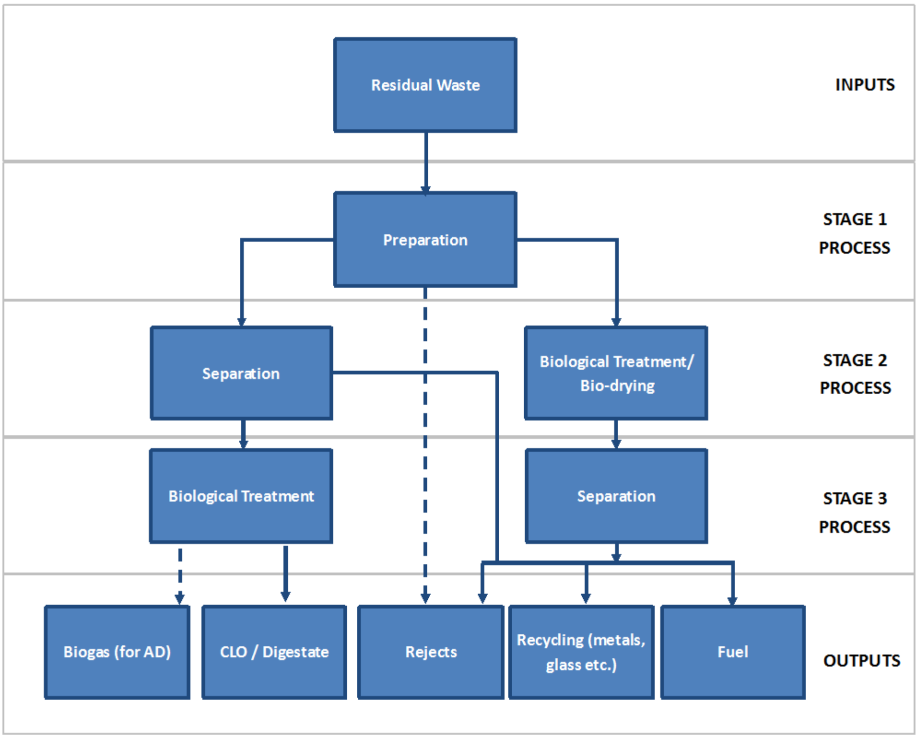
6.1.1 In addition to BAT as outlined in Sections 2, 3 and 4 this section provides further consideration of the proposed techniques to be operated at the REnescience facility specifically considering:

- Waste Treatment Techniques
- Odour Abatement

6.2 Waste Treatment Techniques

6.2.1 Mechanical Biological Treatment (MBT) is a generic term that covers a wide range of waste treatment processes, including that proposed for the REnescience facility. MBT is a residual waste treatment process that typically involves waste preparation followed by both mechanical and biological treatment processes. It is typically a modular process that reduces the biodegradable components of a waste stream and extracts a proportion of recyclables. A biological process is used to stabilise the organic fraction of the waste stream. The advantage of MBT is that it has the potential to stabilise the organic components and increase recycling opportunities for non-source-segregated wastes. As there are a large number of different processes that can be employed for MBT systems, configurations can vary widely and the quality of the output and products recovery can vary significantly. Figure 6.1 below provides an overview of the various stages for any MBT operation.

Figure 6.1: Overview of Typical MBT stages.



6.2.2 Given the modular nature of MBT and wide variety of configurations, there is no single set of benchmarks for comparing alternatives. The following provides a qualitative assessment of the proposals, broken down into three stages and reviews how the proposed design has sought to minimise environmental effects and is considered BAT for the Northwich site:

- Waste preparation
- Mechanical treatment
- Biological treatment

Waste preparation

6.2.3 Waste preparation is typically required for any residual waste stream prior to biological treatment. Techniques employed can vary from simple bag splitters to through to combinations of one or more mechanical waste preparation techniques. Typical systems employed at MBT plant include:

- bag splitters;
- hammer mills;
- shredders;
- rotating drums;
- ball mills;
- wet rotating drums with knives.

6.2.4 The REnescience plant preparation stage comprises bag splitters and drum separator to remove oversize followed by the bioreactor. This proposed combination of techniques enables effective extraction and breakdown of organic materials from the waste mixed stream (include paper and cardboard) into the liquid phase. Its gentle action allows a significant portion of the recyclables to pass through the separation stage without significant size reduction, allowing for downstream mechanical separation to produce higher quality recyclables.

6.2.5 To achieve this, enzyme and hot water are mixed with the incoming waste and fed into the bioreactor. Water consumption is minimised to an initial fill at start-up. Operational water input is provided by recycling of water alongside water present as moisture in the incoming waste resulting in no routine freshwater usage.

6.2.6 Energy input into the bioreactor stage is required in two forms, electricity to drive the rotating bioreactor units and heat to the hot water to achieve the temperatures required for effective enzyme treatment. Energy input to heat the hot water supply is minimised by making use of residual heat in the water from the evaporator stage combined with utilising waste heat from the CHP engines.

6.2.7 Electrical energy is required to power the bag splitters and drum separator. Alternative waste preparation techniques operating shredders, rotating drums and ball mills etc. will also have an associated electrical energy demand.

6.2.8 The use of waste heat and use of recycled waters minimises the effect on resource consumption.

6.2.9 Whilst there are alternative options to the drum separator, environmental effects are expected to be at least similar. These operations alone cannot deliver the output required to tie into the downstream processing and therefore need to be used in combination with the hydrothermal treatment stage.

6.2.10 The selected combination of waste preparation techniques has been chosen to enable effective extraction of organic material from the waste feed, minimising residual organics within the remaining solid fractions. It is a gentle preparation stage which achieves effective organics extraction without the need for significant mechanical impact on the waste e.g. the need for waste shredding or other size reduction. This has associated advantages downstream in the quality of recyclable outputs from the mechanical sorting stage.

Mechanical Separation

6.2.11 The mechanical separation stage will comprise a number of techniques designed to separate out specific recyclables. Commonly available mechanical separation techniques are summarised in Table 6.2 below.

Table 6.1: Emissions Limits and Monitoring from the CHP Engines (Emission point A1)

Separation Technique	Separation Property	Materials Targeted
Trommels and Screens	Size	Oversize – paper and plastic Small – organics, glass, fines
Manual Separation	Visual examination	Plastic, contaminants, oversize
Magnetic Separation	Magnetic properties	Ferrous metals
Eddy Current Separation	Electrical conductivity	Non-ferrous metals
Wet Separation Technology	Differential densities	Light – plastic, organics Heavy – stones, glass
Air Classification	Weight	Light – plastic, paper Heavy – stones, glass
Ballistic Separation	Density and Elasticity	Light – plastic, paper Heavy – stones, glass
Optical Separation	Diffraction	Specific plastic polymers

6.2.12 From the above table the techniques selected are appropriate to the wastes being targeted for segregation.

6.2.13 Initially the bio liquid is separated from the solid fractions via a combination of drainage within a perforated screw conveyor, followed by vibrating sieves.

6.2.14 The initial use of ballistic separators enables the separation of the solid stream into larger heavier 3D materials (metals and large plastics) and smaller lighter 2D fractions (textiles, plastic film and undigested cardboard). This enables downstream separation to be more effectively targeted at specific streams within the 2D and 3D downstream processing stages.

6.2.15 The combination of magnetic separators and eddy current separators are widely employed at waste treatment facilities for the recovery of metal wastes. These techniques are effective at removing the target metal fractions prior to onward transfer and further off-site recovery. Given the effectiveness of these techniques and confidence in this proven technology and its widespread acceptance within the waste industry for metals recovery the use of magnetic separation and eddy current separation is considered BAT.

6.2.16 Plastics are separated out using a NIR sorter and leaving residual material which is combined with the RDF/SRF output from the 2D processing. The use of optical separators, such as NIR has the advantage over other techniques for plastic separation of segregating different plastic polymers. For this reason they have been selected for the REnescience facility

6.2.17 All 3D fractions are subsequently washed enabling recovery of residual organics from the separated recyclables into the process water for further process use and maximising recovery into the bio liquid stream of any further organics removed, minimising water consumption and avoiding the generation of significant volumes of aqueous effluents and also maximising the quality of the recovered separated and cleaned recyclables.

6.2.18 The 2D stage provides further removal of inert material and batteries leaving a residual RDF/SRF material. All streams undergo washing to maximise recovery of residual organics with wash waters from this stage being collected and returned back into the process. Further recovery of water containing organics is achieved by dewatering the SRF/RDF with the additional benefit of producing a drier output for energy recovery.

6.2.19 The above description describes how the combination of mechanical sorting techniques seeks to maximise separation of targeted recyclables, maximise recovery of organics for conversion to bio liquid and minimisation of water consumption. Separated materials from the mechanical sorting stage will be sent for off-site recycling or recovery (including energy recovery).

Biological Treatment

6.2.20 Biological treatment options typically include:

- Composting;
- Anaerobic digestion (AD);
- Biodrying

6.2.21 Given that the pre-treatment stage utilising hydrothermal treatment produces a bioliquid, traditional composting and bio drying techniques that are better suited to the treatment of solid biological waste streams are not considered further.

6.2.22 The proposed treatment of the bioliquid will be via anaerobic digestion. This section considered the design of the proposed AD stage and subsequent management of the biogas.

6.2.23 The anaerobic digestion stage combines the following stages:

- Digestion
- Post Digestion
- Pasteurisation (or hygienisation)
- Digestate dewatering
- Biogas treatment
- Power generation

6.2.24 Digestion will take place within reinforced concrete digester tanks built to relevant BS standards (for example, BS 8007 (Code of practice for design of concrete structures for retaining aqueous liquids), BS 8110 (Structural use of concrete code of practice for design and construction) and Eurocode 2 (BS EN 1992, Design of concrete structures). This type of tank construction is considered to provide improved containment and avoid potential problems historically associated with failure of poor quality steel tank designs. Although the tanks have been selected on the basis of improved containment reliability a secondary bund will be provided which will contain more than 110% of the largest tank and 25% of the total working volume of tanks within the AD bund. This will not only ensure containment in the event of pipe, valve or connection failure, it would also contain a catastrophic failure of a tank.

6.2.25 The installation of multiple tanks allows flexibility should one tank need to be taken out of service e.g. for maintenance. Should this occur the tank will be re-seeded with material from the remaining operation tank, although REnescience have included for importing material from an off-site AD plant should this not be feasible for any reason.

6.2.26 A continuously fed stirred tank AD system has been selected which is well suited to low solid digester designs and therefore appropriate for the proposed bio liquid feed. The stirred tank will include mechanical stirring to continuously mix the contents. Slow speed mixers will be employed with the advantage of reduced energy consumption. Motors and gear boxes will be located in an accessible position to allow for ease of maintenance.

6.2.27 Heat to the digestion stage will utilise waste heat from the biogas CHP engines.

6.2.28 As detailed in section 4, the AD process will be automatically controlled and key process control parameters will be monitored and controlled via the SCADA system.

6.2.29 Pasteurisation or hygienisation can be undertaken pre- or post-digestion. For the proposed design pasteurisation will be carried out post digestion. As detailed in paragraphs 3.2.34 and 3.2.36, this approach has been adopted to maximise energy efficiency and also provide benefits in reduced polymer dosing within the subsequent dewatering stage.

6.2.30 Biogas treatment combining desulphrisation, siloxane control and drying is required prior to combustion within the CHP engines. This technique is not suitable where the biogas is to be injected into the grid or for use as vehicle fuel due to limits on oxygen content of the biogas for these applications. However for biogas combustion in gas engines the proposed combination of air injection followed by adsorption on activated carbon provides effective desulphurisation of the biogas.

6.2.31 The treated biogas is combusted to produce electricity for export the local network or to the grid. Up to four gas engines can operate providing operational flexibility to stop one or more engines to operate near their design load, at which they are most efficient, rather than being turned down to reduce generation. The use of waste heat within the process as discussed above and in Section 3, maximises the overall efficiency of the REnescience facility.

6.2.32 The above techniques are considered consistent with BAT for the AD stage.

6.3 Odour Abatement

6.3.1 Previous sections of this document provide an outline of plant to be provided and activities that would be undertaken at the REnescience facility. Given the nature of the activities there is the potential for odours. An odour management plan has been developed which identifies the key odour sources and provides details on the proposed management and controls that will be in place to ensure the risk of odour emissions and complaints is minimised. As part of the proposed odour control measures odour abatement is proposed.

6.3.2 This section provides additional supporting information for the selected abatement that will be installed (Carbon Adsorption) and gives a comparison with alternative technologies that could be implemented as part of odour control measures within the facility.

6.3.3 There are a number of options available for odour abatement, which vary in performance and impact. The five options to be considered here are as follows:

- Carbon Adsorption (dry scrubbing);
- Biofiltration;
- Regenerative Thermal Oxidation;
- Wet Chemical Scrubbing; and
- Dispersion only.

6.3.4 A number of additional odour abatement options are available however for the reasons identified below these have been excluded from further consideration. These include:

- Cryogenic condensation - The facility has no use for liquid nitrogen and flow rates from the ventilation are 20 times greater than the economic flow rate established for this technology.
- Catalytic oxidation - Catalyst poisons such as sulphur and silicon are present, which make this abatement option unreliable for this application.

- UV treatment - There is limited evidence of the efficacy of this technology, and there have been examples where this method has failed for this application type in the past.
- Ozone treatment - Likewise this option is rejected due to lack of evidence for the technology's effectiveness.
- Odour masking - This option is primarily an emergency mitigation method, aiming to replace odour with a more pleasant odour, rather than controlling odour emissions.
- Concentrators and recuperative oxidisers - Investigation into this method suggests that gas consumption would be greater than Regenerative Thermal Oxidation, and there is potential for some odorants not being able to be concentrated via the zeolite.

6.3.5 Taking combustion air for the engines from the waste reception hall remains under consideration but has not been selected at this stage owing to the need to pre-heat the air, significant distance for ductwork and because the engines demand for air is lower than the air volume to be treated. Further, in the event that the engines were not operating a back-up odour abatement system would still be required,

6.3.6 A brief summary of each of the five odour abatement options considered within this assessment is given below, and following this an evaluation of these options is provided in order to establish BAT for odour control at the REnescience facility.

Option 1 – Carbon Adsorption

6.3.7 Carbon adsorption involves passing contaminated air through a bed of activated carbon, which results in contaminants being adsorbed onto the surface of the bed; effectively cleaning the air. In order to treat the 72,650 m^3/hr of ventilated air, two units will be required to run in parallel.

6.3.8 The carbon removes the potentially odorous species which are adsorbed on to the activated carbon. The life of the carbon bed is limited by the quantity of adsorbed, odorous contaminant species. The proposed units have been sized to handle up to three times the estimated load and have in excess of 12 months bed life for the carbon.

6.3.9 Pre-filtration of air can be necessary due to fine solids having the ability to bind the carbon bed. For the proposed unit an array of filter panels and filter bags will be included.

Option 2 - Biofiltration

6.3.10 Biofiltration involves biological oxidation taking place within a packed system. Biofilters contain a biomatrix with micro-organisms present, which will decompose the potentially odorous substances as the air flows through the material and as a result metabolise the odours into non-odorous substances. The more effective method of biofiltration for handling odours carried by VOCs is achieved using an intermittently irrigated, high surface area media.

6.3.11 In order to remove biodegradable VOCs the process requires approximately a one minute contact time for a high surface area media (such as Coir fibre) or two minutes contact time for a permanent media (such as pumice). This process would require either Coir fibre or a hybrid pumice stone/coir fibre bed for the biomatrix. The levels of humidity, porosity, temperature, pH and contact time within the biofilter need to be controlled in order to maximise performance. Nutrient additions may be required over time and a humidifier would need to be used to keep humidity levels optimal, which could produce between 100-200 litres/hour of water, depending on the dust load.

6.3.12 Bio filters use water, the irrigation flow rate for unit of the size required for the REnescience facility would need an instantaneous flow of 72 m^3/hr. In practice irrigation should only be required to take place for around 30 seconds every few hours to maintain moisture levels.

6.3.13 An air flow of 72,650 m^3/hr (the air flow for combined main ducts) would result in a 70% estimated removal VOCs, achieving an output VOC concentration of 0.09 ppm.

Option 3 – Regenerative Thermal Oxidation (RTO)

6.3.14 This process involves combustion of VOCs at high temperatures of around 850°C, with the aim of producing water vapour and carbon dioxide from the VOCs, whilst recovering a significant proportion of the heat energy used to heat the waste gas stream to oxidation temperatures. RTO uses ceramic, in-line heat exchangers and a direction flow change to recover heat, and can in optimal conditions achieve 98% thermal recovery, thus only utilise 2% of the fuel required to maintain the elevated temperatures.

6.3.15 Due to the low odour levels anticipated to be produced by the facility it is predicted that a two canister RTO would provide sufficient odour control for the REnescience facility. The heat balance for an RTO of the size required at the REnescience facility shows that the very low VOC levels only contribute 1kW to the large energy requirement of 473 kW gas usage, hence additional energy input (472 kW) would be high.

6.3.16 Odours to be treated may be contaminated by other pollutants, hence when starting up the operation these gases should not be used until the appropriate combustion chamber temperature has been achieved. Hence initially additional fuels such as natural gas, or this case biogas (if available) would be needed to fuel the start-up of the unit making this option unattractive.

Option 4 - Wet Chemical Scrubbing

6.3.17 The process of wet chemical scrubbing involves passing the air to be treated vertically through a packed tower with recirculating liquor percolating downwards in a counter-current operation. The liquor generally consists of an aqueous solution containing sodium hydroxide with an oxidising agent (e.g. sodium hypochlorite (bleach) or hydrogen peroxide). The liquor adsorbs the odorous contaminants from the airflow, generating a steam plume, effluents and sludge that require further treatment. Releases from the scrubbing vents must be hot enough to avoid a visible plume forming in proximity to the vent, in order to prevent condensation or adsorption of odorous substances by the condensing water vapour.

6.3.18 The odorous VOCs are generally not easily scrubbed with the aqueous reagents, for this reason odour removal is predicted to be 60-70%. Furthermore the scrubber liquor used introduces an additional odour source, which will further reduce odour performance. A dust filtration system may also be required in order to prevent blockage of the tower and increased cleaning maintenance.

6.3.19 Due to the nature of the raw materials involved suitable chemical storage would be required for the aqueous liquor solution. However the odour level is low, hence the associated chemical consumption would also be low and as such chemicals could be stored in IBC containers on bunded platforms, which represents a cost effective method of storage.

6.3.20 There are also several issues with chemical dosing and storage that need to be considered. Firstly there is a requirement for winterisation for the stored chemicals, which may involve trace heating and lagging as potential options. Furthermore there are safety issues in regards to storage and handling of hazardous chemicals, hence spill handling and safety policies need to be put into place and a safety shower be required in proximity to the storage areas and scrubber.

6.3.21 In order to operate the scrubbers a water supply and effluent disposal facility would be required, and there needs to be a programme in place for changing the absorbent within the unit.

Option 5 – Dispersion only

6.3.22 Dispersion relies solely upon low odour levels dispersing naturally in the air (often from a stack) to ensure low ground level concentrations. This could be an effective method since the odour levels from the facility are anticipated to be low and as such could provide environmental benefits since there are no additional energy requirements or waste produced.

6.3.23 However in the event of generation of higher odour levels or adverse weather conditions to prevent adequate dispersion there would be no additional mitigation in place, which introduces a risk that this option would not provide effective control under all foreseeable conditions. This method also relies heavily on the accuracy of the odour data and odour modelling to determine the appropriate stack height for dispersion. If subsequently data inputs are deemed in accurate alternative additional abatement would be required.

Assessment of odour abatement options

6.3.24 Based on the above overview, a further discussion of the odour abatement options available for the REnescience facility is provided below comparing the performance and relative advantages and disadvantages of the five options considered.

6.3.25 For each of the abatement options considered the same extraction systems will be required, therefore the cost of extraction would remain common to all methods.

Odour Removal Performance

6.3.26 Odour removal performance is a key consideration in reducing risk of emissions of odour to air. Biofiltration and wet chemical scrubbing provide the least effective method due to the nature of these technologies producing an odour; chemical scrubbing in addition to this only presents a 60-70% removal rate for odour. Dispersion can be a highly effective method provided that the conditions are optimal for dispersion; however a change in odour load or weather conditions can cause odour to not be fully dispersed and would leave the exceedance unmitigated. Thermal oxidation can similarly prove effective providing the required elevated temperatures are maintained.

6.3.27 When correctly applied carbon adsorption is the most efficient and reliable of the control technologies and will achieve the lowest odour exhaust limit compared with the other technologies. In addition it is capable of handling almost any odorant that may be present; albeit to maintain effective in removing odorous materials, the activated carbon will require periodic replacement and is generally limited by the more poorly adsorbed resistant contaminant species.

Emissions

6.3.28 Carbon adsorption and wet chemical scrubbing should only produce 'cleaned' gas from the unit following either process which will be released to air. Dispersion would result in release of untreated odour emissions through the stack, albeit with effective dispersion under most conditions. Thermal oxidation however would give rise to emissions to air of water vapour and carbon dioxide from combustion of VOCs and potentially other trace combustion products.

6.3.29 Biofiltration requires the medium to be irrigated at regular intervals, in addition to a humidifier to keep humidity levels optimal for the filter medium, which could produce 100-200 litres/hour of waste water dependent on dust load. Therefore, there would need to be a method of disposal for the water generated within the system. Chemical scrubbing requires the reagents used as adsorbents to be replaced at frequent intervals, for this reason an effluent disposal facility would be required, to dispose of reagents and any water used within the system giving rise to an additional aqueous release.

Raw materials

6.3.30 The five abatement options vary in the raw materials required to enable operation. Dispersion requires no additional raw materials relying solely on the extraction unit and a stack to disperse the odour. Likewise RTO requires very few materials, generally only necessitating fuel input in the start-up process to elevate the temperature to maintain combustion temperatures, when VOC emissions are unsuitable.

6.3.31 The remaining three options require a number of raw materials; carbon adsorption requires filters and the carbon medium to be changed to prevent blockage. Biofiltration necessitates the filter medium to be changed, and inputs of nutrients, as well as water to maintain humidity, although the volume of nutrients and water remain fairly low. Wet chemical scrubbing requires inputs of reagents including sodium hydroxide and bleach, as well as the necessary storage requirements for these materials.

Waste

6.3.32 Dispersion creates no solid waste, similarly regenerative thermal oxidation has no associated solid waste output.

6.3.33 Carbon adsorption and biofiltration methods produce waste from the filters or carbon and routinely these require replacement. Although activated carbon requires replacement, this does not need to be disposed of. The spent activated carbon can be removed off-site for regeneration and subsequently reused. The waste from the biofilter option similarly does not necessarily require disposal and generally the biomatrix can be composted.

Energy consumption

6.3.34 The electricity and heat input levels vary widely between the five options; with the lowest requirements from the dispersion option, which only requires energy for the ventilation and extraction system. The highest energy demands are from thermal oxidation, which has a high energy requirement to maintain the high temperatures required by the process. Carbon adsorption and chemical scrubbing both have similar levels of energy input, greater than that of biofiltration which has very few energy requirements outside of extraction and irrigation.

Reliability

6.3.35 Reliability of a control option is dependent on several factors including those related to maintenance, operator interface and robustness. Carbon adsorption is perhaps the most simple and robust method, that requires little operation and maintenance, with the exception of changing of filters and the carbon matrix once exhausted. Likewise biofiltration involves little maintenance and operator interface, except for changing filters, nutrient dosing etc., however periodic maintenance represents a major project.

6.3.36 RTO has a highly reliable performance, which becomes increasingly efficient as contaminant levels increase; furthermore it has minimal operator interface and no major maintenance requirements. Wet chemical scrubbing has the advantage of being able to respond to odour load changes, through automatic dosing, however effectiveness is dependent on a relatively light odour load. Additionally the process requires frequent operator intervention, however continuous operation can occur without major maintenance occurring.

6.3.37 Finally, the use of dispersion requires little in the way or maintenance and operator input, apart from ensuring that extraction systems are operational, as would be the case for all the control options. Although an effective and reliable option, this method is will vary according to dispersion conditions and odour load.

Cost

6.3.38 The total cost of an abatement option not only takes into account the capital expenditure to install the option but also additional costs from its operation including energy and raw materials. For all of the abovementioned technologies it is assumed an indicative cost of between £250-350,000 will be required to manufacture and install the extract ducting. The costs outlined below therefore will be in addition to this.

6.3.39 Table 6.2 below provides a summary of the estimated costs involved for each of the control options.

Table 6.2: Indicative costs for odour control methodologies.

Control option	Capital Expenditure	Annual electrical cost	Other utility cost (annual)	Other utility
Carbon Adsorption	£250,000	£27,000	£9,700	Carbon
Biofiltration	£900,000	£15,500	£3,000	Water and Nutrients
Regenerative Thermal Oxidation	£700,000	£105,390	£114,000	Gas
Wet Chemical Scrubbing	£400,000	£27,000	£10,000	Reagents and Water
Dispersion Only	£30,000	£8,000	£0	Electrical only

6.3.40 RTO represents the most expensive option when combining the large capital outlay, alongside the high electricity and gas costs required to power the process. Biofiltration likewise is an expensive option with the greater capital expenditure due to the size of the unit required, but fewer electricity and operational costs from water and nutrients required. Chemical scrubbing has a reasonably high capital outlay and intermediate level electrical and utilities costs from the reagents and water required. Carbon adsorption has similar electrical and utility costs as scrubbing, the main cost of utility being carbon which is expensive at £2000 per tonne to dispose of and replace. Dispersion represents the most cost effective option, since the outlay is minimal and the only other costs incurred are for electricity to extract the emissions.

Conclusions

6.3.41 The five options considered for odour emission control at the REnescience facility have relative advantages and disadvantages in relation to their odour removal effectiveness, other environmental effects, reliability, inputs and associated outputs and finally costs. Their relative performance is summarised in Table 6.3 below.

6.3.42 On balance, it is important to select an option which can achieve the effective odour reduction levels, whilst simultaneously minimising the material inputs and outputs, in order to achieve cost effective solution. Based on the comparison of these factors as discussed above summarised in Table 6.3 below a combination of carbon filters and dispersion has been selected for odour control and is considered to represent BAT for this application. Carbon filters will be installed to provide abatement of air from the waste reception and bunker areas and effective dispersion will be applied for releases from the sorting hall, which due to the materials handled in this area presents a lower odour potential.

6.3.43 Carbon adsorption is a highly effective method of odour removal which is guaranteed to meet any imposed limit for the duration of the carbon beds lifetime and it is capable of working on almost any odour emissions present. Furthermore it is a simple and robust technology, requiring little operator interface and no other energy input other than electricity. In terms of raw material and waste generation, the carbon and dust filters will need to be replaced at intervals; however it is possible for the carbon to be regenerated or potentially be used for fuel, helping to minimise waste generated. Although not the cheapest option available in respect to capital expenditure, raw material and energy costs, overall it represents one of the more cost effective options of the five technologies considered.

Table 6.3: BAT comparison of odour control methodologies.

Technology	Option 1 Carbon Adsorption	Option 2 Biofiltration	Option 3 Regenerative Thermal Oxidation	Option 4 Wet Chemical Scrubbing	Option 5 Dispersion Only
Odour Removal Performance	Can handle almost any odorant present. Adsorption capacity maximum 300g/kg activated carbon.	Limited odour performance, high odour removal however process generates own associated odour Exhaust quality limited to 1500-2000 OU_E/m^3.	Effective providing unit temperatures high enough to not produce odour from process.	Low, between 60-70% odour removal in addition to the odour generated by the reagents.	Effective providing appropriate conditions (stack height, weather etc.) are met to assist dispersion of odour.
Emissions	Emission of 'cleaned' air following process.	Media requires irrigation, however flow rate is low. Humidifier required producing 100-200 litres/hour dependent on dust load.	Emission of water vapour and carbon dioxide to air from unit.	The absorbents within the units need to be regularly changed; hence effluent disposal facility required.	Untreated odour emission to air.
Raw Materials	Replacement filters and carbon.	Filter media, water, nutrients.	Conventional gas to start up process.	Reagents – bleach or hydrogen peroxide. Water supply also required.	None.
Waste	Activated carbon can be reused several times or used for fuel.	Filter media for disposal once disintegration occurs.	None- products water vapour and carbon dioxide released to air.	Sludge from process which requires further treatment.	None.
Energy Consumption	Higher around 25-75 kWh per tonne waste fuel produced.	Low around 15 kWh per tonne waste fuel produced.	Highest consumption for electricity and gas. High energy consumption - 473 kW of gas usage.	Generally higher, with similar electricity costs to carbon adsorption.	Lowest, electricity solely for odour extraction system.
Reliability	Simple and robust. Requires almost no operator interface; however filters and carbon need replacement.	Little maintenance, operator intervention and operational costs.	Very reliable performance, little operator interface or maintenance requirements.	Requires greater operator involvement and more frequent maintenance, but generally doesn't require major maintenance.	Option with least maintenance and operator input.
Cost	Capital cost can be high. Also high costs for carbon approximately £2000/tonne to dispose of and replace.	Higher cost due to size of unit required.	Highest capital costs in addition to significant energy input costs.	Generally higher cost to install and operate in terms of electrical costs. Also costs of reagents and water required.	Lowest cost as no intervention required, only costs for extraction system.

References

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4 Environment Agency, H1 Environmental Risk Assessment – annex h, version 2 April 2010.

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6 SI 2001/2954. The Control of Pollution (Oil Storage) (England) Regulations 2001.

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Contact

Jennifer Stringer
Associate

RPS Planning & Development
6-7 Lovers Walk
Brighton
East Sussex
BN1 6AH

T: +44 (0) 1273 546 800
stringerj@rpsgroup.com

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