3 DESCRIPTION OF THE PROPOSED DEVELOPMENT

3.1 Characteristics of the Development

The following section provides a detailed description of the Drehid Waste Management Facility development. This section encompasses both the permitted facility (granted under ABP Ref. No. PL.09.212059) and the proposed extension and intensification of the facility.

The fundamental features of the facility are listed in Table 3.1.1 as a means of facilitating an understanding of the elements of the development that are permitted, constructed and proposed.

Table 3.1.1 Drehid Waste Management Facility Construction Elements

Description	Permitted (ABP Ref. No. PL.09.212059)	Constructed And/Or Developed	Proposed
Roads			
Site entrance at R403 Regional Road	✓	✓	
Facility Access Road	✓	✓	
Site Road (Around Perimeter of Permitted Facility)	✓	✓	
Site Road (Around Perimeter of Proposed Extension)			✓
Haul Road (From Clay Borrow Area to Site Road)	✓		
Borrow Areas			
Sand and Gravel Borrow Area	✓	✓	
Clay Borrow Area	✓		
Site Infrastructure			
Administration Building	✓	✓	
Maintenance Building	✓	✓	
Weighbridges	✓	✓	
Weighbridge Kiosk	✓	✓	
Wheel wash	✓	✓	
Waste Quarantine Area	✓	✓	
Waste Inspection Area	✓	✓	
Leachate Holding Tanks	✓	✓	
Surface Water Retention/Settlement lagoons (2 off)	✓	✓	
Surface Water Retention/Settlement lagoons (2 off)			✓
Surface and Foul Water Drainage	✓	✓	
Bunded Fuel Storage	✓	✓	
Gas Flare Compound	✓	✓	

Description	**Permitted (ABP Ref. No. PL.09.212059)**	**Constructed And/Or Developed**	**Proposed**
Fencing (Around Perimeter of Permitted Facility)	✓	✓	
Fencing (Around Perimeter of Proposed Facility)			✓
Facility Access Gates	✓	✓	
CCTV Camera System	✓	✓	
Fire main Pump and Hydrant System	✓	✓	
Composting Facility			
Biowaste Composting Facility (25,000 TPA)	✓		
Biofilter and Scrubber	✓		
Maturation Area	✓		
Landfill Phases			
Phases 1-8	✓	Ongoing Construction	
Phases 7-15			✓

The selection, design, construction, operation, and aftercare of landfills should be carried out in accordance with *Council Directive 1999/31/EC (26th of April 1999) on the landfill of waste* (the EU Landfill Directive), which has been implemented in Ireland since the 16th of July 2001. National legislation and guidelines for landfilling, which have been published by the EPA over the past number of years have, in any case, significantly anticipated the requirements of this Directive. Even though several amendments have been incorporated into this Directive during the years of formulation, the basic principles have remained unchanged.

The basic principles for landfill design are summarised below:

Isolate: Prevention of soil, surface water and groundwater pollution by engineering measures or site selection.

Control: Proper management of the site to prevent nuisance during establishment, operation and aftercare.

Monitor: All measures to prevent pollution and nuisance must be checked for effectiveness by monitoring devices.

These principles, which are in accordance with the EU Landfill Directive, have been used in the design of the residual landfill site.

Bord na Móna's current proposal relates to the extension and intensification of the permitted landfill facility to accommodate an additional 240,000 tonnes per annum of non-hazardous waste over a 7 year period, over and above the 120,000 tonnes per annum permitted over 20-years. Phase one of the permitted landfill site is currently in construction. Construction and testing of Cells No.1 and No.2 of Phase No.1 were completed in January 2008. First waste was accepted at the facility in early February 2008. Bord na Móna will progressively restore the site on completion of each phase and will provide for all necessary aftercare measures in accordance with the Environmental Protection Agency (EPA) landfill manuals.

Bord na Móna also intends to develop a biowaste composting facility (planning permission already secured) as an integral part of the Drehid Waste Management Facility. Once operational, this facility will deal primarily with separately collected biowaste from household, commercial and industrial sources. The biowaste will include a source separated organic fraction from household waste, food waste from the service industry and retail outlets and other commercial and industrial biowaste as available. The initial short-term objective of the facility will be to produce compost suitable for usage for landscaping and for the restoration of the landfill.

The permitted facility has been designed, and is being constructed and operated in accordance with the conditions of the Waste Licence (W201-01) issued by the EPA.

3.1.1 Definition of Waste Categories

The categories of waste referred to in this EIS are in accordance with the definitions set out in Appendix 3.1.1: Glossary of Terms of the National Waste Database Report 1998 published by the EPA. The following definitions are therefore used:

Waste: Any substance or object belonging to a category of waste, specified in the First Schedule or included in the European Waste Catalogue (EWC), which the holder discards or intends or is required to discard and anything which is discarded or otherwise dealt with as if it were waste shall be presumed to be waste until the contrary is proved.

Household Waste: Waste produced within the curtilage of a building or self-contained part of a building used for the purposes of living accommodation.

Commercial Waste: Waste from premises used wholly or mainly for the purpose of a trade or business for the purpose of sport, recreation, education, or entertainment, but does not include household, agriculture or industrial waste.

Industrial Waste: Includes waste produced or arising from manufacturing or industrial activities or processes.

Municipal Waste: Household waste as well as commercial and other waste, which, because of its nature or composition is similar to household, waste.

Inert Waste: Waste that, when deposited into a landfill, does not undergo any significant physical, chemical or biological transformations.

Packaging Waste: Any packaging or packaging material covered by the definition of waste in Directive 75/442/EEC.

Hazardous Waste: Means- (i) hazardous waste for the time being mentioned in the list prepared pursuant to Article 1 (4) of Council Directive 91/689/EEC of 12 December, 1991, being either

(I) Category I waste that has any of the properties specified in Part III of the *Second Schedule*, or

(II) Category II waste that

(A) Contains any of the constituents specified in Part II of the *Second Schedule*,

(B) Has any of the properties specified in Part III of said *Schedule*,

(ii) Such other waste, having any of the properties specified in Part III of the *Second Schedule*, as may be prescribed for the purposes of this definition.

Sludges: Pressed, dewatered sludges from Municipal Water and Wastewater Treatment Plants.

In addition, **Residual Municipal Waste**, as defined in the Governments Policy Document *'Preventing and Recycling Waste – Delivering Change'*, means "the fraction of municipal waste remaining after the source separation of municipal waste fractions, such as food and garden waste, packaging, paper and paperboard, metals, glass and (which is) unsuitable for the production of compost because it is mixed, combined or contaminated with potentially polluting products or materials".

Treatment of Waste, also as defined in the Governments Policy Document *'Preventing and Recycling Waste – Delivering Change'*, means "any thermal, physical, chemical or biological processes that change the characteristics of waste in order to reduce its volume or hazardous nature or facilitate its handling, disposal or recovery".

3.1.2 Future Waste Capacity

An estimated breakdown of the types of waste to be landfilled at the facility is provided in Table 3.1.2, while Table 3.1.3 indicates the projected residual waste tonnages to be landfilled at the facility during its lifetime. The proposed additional residual waste volumes over and above the previously permitted volumes are outlined separately in this table and the intensification is proposed to commence during the second half of 2008.

The resultant traffic generation, haulage routes and types of haulage vehicles are outlined in detail in Section 4.9 herein. It should also be noted that there will be no civic amenity type facilities and therefore there will be no traffic generation resulting from members of the general public using the facility.

Table 3.1.2: Breakdown of Waste to be Landfilled at the Drehid WMF

Waste Type	**%**
Domestic Waste	40
Commercial Waste	20
Non-Hazardous Industrial Waste	40
Total	**100**

Table 3.1.3 Annual Tonnages of Waste to be landfilled at Drehid WMF

Year	Permitted (Tonnes)	Proposed Intensification (Tonnes)	Total (Tonnes)
2008	120,000	120,000*	240,000
2009	120,000	240,000	360,000
2010	120,000	240,000	360,000
2011	120,000	240,000	360,000
2012	120,000	240,000	360,000
2013	120,000	240,000	360,000
2014	120,000	240,000	360,000
2015	120,000	120,000*	240,000
2016	120,000	-	120,000
2017	120,000	-	120,000
2018	120,000	-	120,000
2019	120,000	-	120,000
2020	120,000	-	120,000
2021	120,000	-	120,000
2022	120,000	-	120,000
2023	120,000	-	120,000
2024	120,000	-	120,000
2025	120,000	-	120,000
2026	120,000	-	120,000
2027	120,000	-	120,000

* The intensification of the landfilling of waste is proposed to commence in mid 2008 and finish in mid 2015, spanning a 7-year period.

3.1.3 Waste Composition

Table 3.1.4 provides an estimation of the average composition of household, commercial and industrial waste in Ireland. The data in this table has been sourced from a "Municipal Waste Characterisation Survey" carried out in 2005 for the Environmental Protection Agency to improve the level of knowledge available on municipal waste and to advance the methodology used for measuring waste composition in the future. Account has been taken of the changing nature of municipal waste management in Ireland, most notably the switch to recycling, the introduction of use-related charging, and the increasing importance of non-household municipal waste generated by commerce and industry.

The future composition of the waste to be landfilled will however have a reduced percentage of biodegradable waste, in particular paper/cardboard and organics, due to the EU Landfill Directive. However the future relative percentages cannot be accurately determined at this stage, due to the uncertainty regarding the pace and success of the implementation of waste strategies in the Greater Dublin Region.

The EU Landfill Directive imposes environmental and engineering standards for landfills across Europe. The Directive also requires a progressive reduction in the landfilling of Biodegradable Municipal Waste (BMW) and the pre-treatment of wastes before landfilling, to both reduce waste volume and minimise the environmental impact of disposal.

From a baseline of 1995, the amount of BMW allowed to landfill will be as follows:

- 75% of 1995 levels by 2010;
- 50% of 1995 levels by 2013;
- 35% of 1995 levels by 2020

Table 3.1.4 Composition of Waste Landfilled at the Drehid WMF

Waste Type	**Domestic %**	**Commercial %**	**Industrial %**
Organic	29.2	27.1	9.3
Paper	21.6	22.5	18.9
Cardboard	6.6	26.1	27.8
Composites	1.7	1.8	2.7
Plastic	12.5	10.6	18.7
Textiles	8.4	0.7	1.6
Glass	6.3	4.5	1.2
Metal	3.6	3.4	7.6
Wood	0.8	1.0	8.4
Others	9.3	2.3	4.0
Total	**100**	**100**	**100**

3.2 Outline of the Facility

Bord na Móna is developing a waste management facility to include both a composting facility (planning permission already secured) for biowaste and an engineered landfill (permitted landfill and proposed landfill extension) for residual waste.

The permitted engineered landfill consists of eight fully lined phases, each further sub-divided into four to six separate cells (per phase), for the acceptance of residual waste.

The proposed extension to the engineered landfill will consist of a further seven fully lined phases, each sub-divided into four to six separate cells (per phase) for the acceptance of residual waste.

The landfill is fully contained and has been designed in order to provide for both leachate and landfill gas collection.

The Waste Management Facility also includes ancillary infrastructure such as new site entrance, new site roads, administration building, maintenance facility, reception kiosk, weighbridges, wheel wash, waste quarantine and inspection areas, leachate holding tanks, surface water retention/settlement lagoons and landfill gas flare compound. The landfill facility has been fenced with entrance control facilities provided at the main site entrance.

The finished phases will be capped with a low permeability capping system, consisting of a linear low density polyethylene (LLDPE) liner and a compacted clay layer, which will serve to prevent the uncontrolled migration of landfill gas and the infiltration of rainfall into the waste body thereby minimising the quantity of leachate generated.

This final capping will also allow for the collection of clean surface runoff, which will be diverted via a surface water swale to the settlement lagoon and eventually discharging into the Cushaling River, which contributes to the River Barrow catchment. This surface water run-off will be equivalent in quantity terms to pre-development levels. On completion of deposition of waste, the site will be fully restored and an aftercare/monitoring programme will be put in place.

The composting facility, for which planning has already been secured, will comprise a fully enclosed dedicated warehouse type building with all treatment processes, including acceptance of waste, composting, refinement and storage of final products carried out within the building.

The Drehid Waste Management Facility is described in more detail in the following Sections 3.3 to 3.10 inclusive.

3.3 Site Infrastructure

The site infrastructure includes weighbridges, wheel-wash, site security arrangements, bunded waste inspection and quarantine areas, bunded fuel storage, site accommodation, site roads, surface and foul water drainage, leachate holding tanks, maintenance facility, surface water retention/settlement lagoon, landfill gas flare compound and car parking areas.

Planning has already been secured for all the site infrastructure mentioned above as part of the original proposal. Construction of such infrastructure has been completed.

The following sections detail the main elements of site infrastructure and should be read in conjunction with the relevant drawings provided.

3.3.1 Site Security Arrangements

Site security arrangements to prevent unauthorised access at the facility include the following:

- Fencing around the entire boundary of the permitted landfill footprint, with the exception of the site entrance, comprises post and chain link fencing. The fencing layout is shown on Drawing No. 3369-2408 to 3369-2410, with fencing details presented in Drawing No. 3369-2410.
- Palisade type anti-intruder security fencing, 2.4m in height at the site entrance gate area.
- A 2.4m high by 7m wide, electric drive, cantilever security gate that is closed outside normal operating times, located at the site entrance at the R403. This gate is located as shown on Drawing No. 3369-2409 and detailed on Drawing No. 3369-2410.
- The site access at the R403 includes stonewalls and pillars as detailed on Drawing No. 3369-2409
- A CCTV system monitors the facility entrance gate, the access from the R403, weighbridges, waste inspection and quarantine areas, and working face of the landfill.
- Anti-intruder alarms in all lockable site buildings.

The fencing around the proposed landfill extension will comprise post and chain link fencing. The fencing layout proposed is presented in Drawing No. 3369-2409.

In addition to the above, site signage indicating opening times, contact details, fines for littering offences and for unauthorised access is maintained at the site entrance. Details of the site signage are presented on Drawing No. 3369-2409. All visitors to the site are required to log in and out at the weighbridge kiosk. The site security infrastructure is checked daily and any damage is immediately temporarily repaired with any additional permanent repair executed within 48 hours of discovery.

3.3.2 Site Roads and Parking

The layout of the internal road network is shown on Drawing No. 3369-2402 and Drawing No. 3369-2408, with different road types detailed on Drawing Nos. 3369-

2411. The various site road types are constructed in accordance with the following specifications:

- The permitted facility access road, which is approximately 4.8km in length, leads from the site entrance at the R403 Regional Road to the facility entrance and the operations area. This road is 7.5m wide at the entrance and tapers to 6m approximately 150m from the regional road. This road make up (Road Type 1) consists of 45 mm hot rolled asphalt wearing course, lain on 55mm dense bitumen base course, lain on 75mm DBM road base, lain on 150mm clause 804 sub base material, lain on class 6F2 capping.
- The permitted site road has been constructed. The section of site road that leads from the facility entrance to the gas flare compound and the access ramp to Cell No.1 consists of a paved construction. This section of road is 6 m. The road make up (Road Type 1) consists of 45 mm hot rolled asphalt wearing course, lain on 55mm dense bitumen base course, lain on 75mm DBM road base, lain on 150mm clause 804 sub base material, lain on class 6F2 capping.

  In line with the filling of landfill phases, the section of site road that runs between the permitted landfill and the proposed landfill extension will be upgraded to Road Type 2. Waste delivery traffic will use this section of road to access the current landfill phase. This road make up will consist of 40mm dense bitumen macadam wearing course, lain on 60mm dense bitumen macadam base course, lain on 200mm Clause 804 material, lain on previous granular base.

  The remaining section of site road around the permitted landfill footprint involves an unpaved road (Road Type 3) consisting of approximately 300mm of granular material such as recovered construction and demolition waste, on rockfill to suitable formation. The width of the road is 6m.

  The site road around the proposed landfill extension footprint will be of similar unpaved construction.

- The haul road which extends from the clay borrow area to the site road is a 6m wide road (Road Type 3). Construction involves an unpaved road consisting of approximately 300mm of granular material such as recovered construction and demolition waste, on rockfill to suitable formation.

- Access ramps required to access the landfill cells will typically comprise of a 200mm layer of granular material such as recovered construction and demolition waste.

  The access ramp leading from the facility access road to Cell No.1 of Phase No.1 of the permitted landfill footprint has been constructed and is currently in use for waste acceptance.

Where possible, and depending on the suitability of materials, granular material has been and will continue to be composed of suitable recovered construction and demolition waste.

Car parking has been provided for 17 cars, two delivery vans and one coach adjacent to the site administration building.

3.3.3 Hardstanding

Concrete hardstand areas are provided at the waste inspection and quarantine area, fuel storage area and at the leachate storage area. The locations of these areas at the site are shown on Drawing No. 3369-2408 and are detailed on Drawing No. 3369-2414 and Drawing No. 3369-2429. Drainage from these hardstanding areas is pumped/drained to the leachate management area where it is dealt with in combination with the leachate from the lined cells.

3.3.4 Weighbridges

Two proprietary weighbridges are provided at the facility entrance at the locations outlined on Drawing No. 3369-2408. Each weighbridge is capable of weighing vehicles with a gross weight of up to 60 tonnes. Each weighbridge is linked to the weighbridge kiosk, which includes proprietary customised software to allow for the recording of details of each waste movement to the site including the following:

- Haulier name
- Vehicle registration
- Waste source
- Waste type (EWC Code)
- Laden weight
- Empty weight
- Area of deposition on-site.

Two weighbridges have been constructed, one to weigh incoming vehicles and the second to weigh outgoing vehicles. The two weighbridges are considered necessary to allow for the free-flow of vehicular traffic and to ensure efficient turn around times at the facility.

Entry control barriers are provided at each of these weighbridges. If necessary the weighbridges may also be used to record details of construction materials required for the ongoing development of the site.

A weighbridge kiosk as shown on Drawing No. 3369-2408 has been constructed between the two weighbridges. Details of the weighbridge kiosk are presented on Drawing No. 3369-2428.

3.3.5 Wheel wash

A wheel wash has been provided at the site at the location shown on Drawing No. 3369-2408.

The wheel wash is positioned to ensure that waste vehicles leaving the facility do not carry excess soil and material onto the adjoining road infrastructure. It is also positioned before the outgoing weighbridge to ensure that excess material is not carried onto the weighbridge as this can cause technical problems with the weighbridge. The wheel wash has a self-contained water recirculation system. A tank stores water for washing purposes, a pump re-circulates the water back into the tank during washing and a drag chain conveyor discharges solids to a skip for disposal in the adjacent landfill. Water is only discharged to the foul water system during the periodic replenishment of the used process water with fresh water.

3.3.6 Laboratory Facilities

A small laboratory is being established on-site in the administration building which will allow for the carrying out of the routine monitoring requirements at the site including landfill gas and leachate analyses. Groundwater and surface water analyses are carried out on a periodic basis in compliance with licence requirements. The parameters to be analysed include BOD, COD, Electrical Conductivity, Dissolved Oxygen, Ammonia, Phosphorus, etc. and the laboratory will be equipped accordingly. Basic parameters (e.g. dry solids, volatile solids, PH) for process control measures for the composting facility will also be measured in this laboratory. A stove and a small oven for drying samples will be provided in the laboratory. Portable instruments such as a landfill gas analyser, pH and temperature meters, a conductivity meter etc. will be retained on-site in the laboratory.

The full suite of analyses for groundwater or surface water will not be carried out at the site laboratory. An external, accredited laboratory carries out the analysis of samples required under the EPA waste licence conditions.

3.3.7 Fuel/Chemical Storage Areas

Bunded fuel storage has been provided for the diesel fuel and kerosene utilised for the on site plant and equipment.

This bunded fuel storage area has been provided adjacent to the maintenance facility at the site at the location shown on Drawing No. 3369-2408 and has been constructed as detailed on Drawing No. 3369-2429. This bunded fuel store area comprises of a proprietary 20,000 litre ($20m^3$) diesel tank and a 5,000 litre ($5m^3$) kerosene tank located in a bund with a total capacity of $30m^3$.

3.3.8 Waste Quarantine Areas

A waste quarantine area has been constructed in combination with the waste inspection area at the location shown on Drawing No. 3369-2408. This waste quarantine area has been constructed as detailed on Drawing No. 3369-2429. The floor of the waste quarantine area slopes towards an Aco drain that is connected to the foul water system. A 1.5m high reinforced concrete wall on three sides surrounds this bunded area.

3.3.9 Waste Inspection Area

The compactor operator carries out visual inspection of all loads entering the facility at the working face of the landfill. The facility manager and facility supervisor also carry out periodic inspections at the working face, particularly in the case of suspect loads, which may then be diverted to the waste inspection area.

Potentially non-compliant loads entering the landfill are tipped at the waste inspection area and inspected by the facility manager. If the load is non-compliant then the waste contractor is required to remove it off-site. Compliant loads are reloaded by utilising Bord na Móna waste handling plant on-site and deposited at the working face of the landfill.

A bunded waste inspection area in combination with the waste quarantine area has been provided at the location shown on Drawing No. 3369-2408. A 1.5m high reinforced concrete wall on three sides surrounds this bunded area. The waste inspection area has been constructed as detailed on Drawing No. 3369-2429.

3.3.10 Traffic Control

All waste traffic access the facility by turning from the R403 into the site entrance, and then travelling along the facility access road until the facility entrance is reached.

Traffic management to the site is dealt with in more detail in Section 4.9 herein.

Given the length of the access road from the R403, there is no possibility of traffic on the R403 being affected by vehicles queuing to enter the facility.

A road safety audit has been carried out on the design of the site entrance at the R403 road. The audit concluded that the design of the site entrance would have no detrimental impact on the safe use of the R403. The site entrance has since been constructed in accordance to the design and recommendations of the road safety audit. A Stage 3 - Road Safety Audit has since been completed on the constructed site entrance. Kildare County Council has issued a letter confirming satisfaction with the above audit and construction of the site entrance and facility access road as per the planning conditions. A copy of this letter is provided in Appendix 3.3.1.

All waste vehicles, having passed the facility entrance gate, pass to the site weighbridge/ reception kiosk, at the location shown on Drawing No. 3369-2408, where the weight, source, type etc. of waste are recorded and instructions are given as to where to proceed with the waste. Access to both the incoming and outgoing weighbridges is controlled by the usage of security barriers.

An adequate number of signs are positioned strategically around the site to direct users to each phase of the facility in a proper manner. Access to the weighbridge, wheel wash and the working face of the landfill are carried out in a queued formation, controlled by the site operatives.

The traffic routing around the site also ensures that people visiting the administration office, for instance for deliveries, are kept away from the working face of the landfill and from any RCVs or HGVs using the facility.

Car parking is provided for 17 cars, two delivery vans and one coach adjacent to the site administration building.

3.3.11 Sewerage and Surface Water Drainage

The layout of the sewerage system at the site is shown on Drawing No. 3369-2408.

Sewage is generated in the administration building and weighbridge kiosk only and is drained via 100mm diameter PVC pipe work to a proprietary wastewater treatment system and then pumped to the leachate holding tanks for transport off-site. The expected quantity of foul sewage from showers and toilets is 1,000 litres per week (1m^3/week).

As shown on Drawing No. 3369-2408 a proprietary grit interception trap and a proprietary oil interceptor have been installed through which all intercepted run-off from roads within the site are diverted. The outfall from the grit trap and oil interceptor is discharged to the surface water retention lagoons for further treatment, prior to outfall to the surface water environment, as shown on Drawing No. 3369-2408.

Surface water from lined but unfilled landfill cells and run-off from capped areas diverts to the surface water settlement lagoons. Intermediate bunds lined with HDPE liners are provided at each cell to ensure that there is no cross contamination of clean surface water with leachate from a working area.

It is important to note that no leachate or water from high risk areas will be diverted to the settlement lagoon during the lifetime of the facility. The outflow from the water settlement lagoon discharges to the existing surface water drainage system and eventually to the Cushaling River. The description and detail of the settlement lagoons is provided in Section 4.4 herein.

Run-off from the roof of the composting facility will be diverted to the process water tank in the composting facility.

With respect to the composting facility the following main wastewater streams can be identified in composting processes:

- Leachate from fresh and composting biowaste;
- Condensate from within tunnels and post-composting area;
- Water from cleansing equipment, vehicles and floors.

Common practice in operational composting facilities is to re-circulate the wastewater flows in the process. Leachate and condensate from the tunnels and post-composting areas, together with any run-off from hardstand areas (e.g. through cleansing) will be collected in the leachate/wash water tanks. From there, it will be pumped through a mechanical filter, retaining particles in the water, to the process water tank, from where it will be recirculated into the composting tunnels and post-composting area, on to the biofilter, the scrubber, or for cleansing of hardstand areas. However, an access chamber and collection sump will be provided as a contingency measure in each of the two leachate/wash water tanks, which will allow for the pumping of surplus wastewater to the leachate holding tanks, and subsequently to be hauled off-site to the Leixlip Wastewater Treatment Plant by a licensed specialist waste contractor.

3.3.12 Other Services

Other services that have been provided at the site include:

- Telephone system;
- Water from an on-site borehole;
- 400v three phase electricity;
- A standby diesel generator;
- Standby pumps;
- Landfill gas detection system in the site buildings; and

- Meteorological station.

3.3.13 Plant Buildings, Garages

A vehicle maintenance building, sized (18m x 10m x 6m high) to accommodate a landfill compactor, has been provided at the site at the location shown on Drawing No. 3369-2408. This building is a cladded steel portal framed building with a concrete floor as detailed in Drawing No. 3369-2427. This building is fitted with secure storage areas to accommodate power tools, other small plant and equipment. A proprietary bunded container to EPA requirements has been provided for the storage of hydraulic oil in the maintenance building.

3.3.14 Site Accommodation

A site administration building has been provided to include:

- Facility manager's office;
- Assistant facility managers office;
- Administration office;
- Foreman's office;
- Conference/meeting room;
- Laboratory;
- Store rooms and Telemetry room;
- Canteens (x2); and,
- Toilets, showers and changing rooms (x2).

The site administration building is located as shown in Drawing No. 3369-2408. Details of the site administration building are shown on Drawing No. 3369-2424, 2425 & 2426.

It is the intention of Bord na Móna to utilise the meeting room in the administration building for the provision of a public education area for environmental education needs. This public education area is currently being established. Poster presentations and literature on waste management and on the workings of the landfill will be available in this meeting room. Provision will also be made for the inspection of the waste licence and Annual Environmental Reports (AERs) in this room.

In addition, a weighbridge kiosk has been provided at the site at the location shown on Drawing No. 3369-2408. Details of the weighbridge kiosk are shown on Drawing No. 3369-2428.

3.3.15 Fire Control System

Methane is one of the principal components of landfill gas (LFG). In undiluted form, LFG consists primarily of the components methane (approximately 60%) and carbon dioxide (approximately 40%). LFG is the end product of the microbiological degradation of organic material. It is produced under anaerobic conditions, for example in the waste body of a landfill site. The degradation process takes place in different steps, in which the raw organic material is degraded to smaller material, which in the course of the processes, is converted into LFG.

Methane is a flammable gas and may form mixtures with air that are combustible. If uncontrolled, methane can present a fire hazard. The flammability limits in air are between 5% and 15%. The auto ignition temperature of methane is 537^0C. These flammability limits and auto ignition temperature are not applicable to modern landfill sites operated in accordance with BAT.

The principal methods for landfill fire prevention include effective landfill management and appropriate landfill gas (methane) detection and collection. Landfill fires fall into one of two categories, surface and underground fires. Surface fires involve recently buried or loose refuse, situated on or close to the landfill surface in the aerobic decomposition layer. These fires can be intensified by methane.

Surface fires generally burn at relatively low temperatures and are classified as either accidental or deliberate. Causes of surface fires include the following:

- Disposal of undetected smouldering materials into the landfill
- Fires associated with landfill gas control or venting systems
- Fires caused by human error on the part of the landfill operator or users
- Fires caused by construction or maintenance work
- Spontaneous combustion of materials in the landfill
- Deliberate fires, which are caused by the landfill operator to reduce the volume of waste
- Deliberate arson fires, which are set with malicious intent
- These sources of fire are all created from human error and can be avoided by stringent management control measures

Underground fires occur deep below the landfill surface and involve materials that are months or years old. The most common cause of underground landfill fires is an increase in the oxygen content of the landfill, which increases bacterial activity and raises temperatures (aerobic decomposition). These so called "hot spots" can come into contact with pockets of methane and result in a fire.

Oxygen, heat, and fuel are frequently referred to as the "fire triangle." The addition of the fourth element, the chemical reaction, results in a fire "tetrahedron." Taking any of these four elements away will prevent a fire or the fire will be extinguished.

Effective landfill management is vital to efficient landfill fire prevention. Management measures include prohibiting all forms of deliberate burning, thoroughly inspecting and controlling incoming refuse, the immediate compaction of refuse to prevent hot spots from forming, prohibiting smoking on site, and maintaining good site security. These measures are currently in place for the Drehid Waste Management Facility.

In accordance with BAT, and as implemented at the Drehid Waste Management Facility, landfills are required to monitor the emission of LFG (including methane) from the landfill and its surrounding areas, including site buildings. If LFG levels are detected to be high the operator must take immediate steps to mitigate the danger. Landfills must also install a gas collection and control system, which actively removes LFG (methane) using gas recovery wells and vacuum pumps with an interconnected LFG pipe collection network. Once the gas is collected, landfill operators have two choices: (1) burn the gas off (flaring): or (2) convert the gas to an energy commodity, both of which are highly regulated procedures.

A fire main has been provided in the location of the facility infrastructure. This is a separate system from the potable water supply and is provided with water from the surface water retention lagoons on site.

Based on consultation with the fire safety office of Kildare County Council, the firewater requirement is 2,250 litres/min for 60min @ 2 bar pressure. This equates to 135m³ (2,250 litres/min x 60min = 135,000litres = 135m^3).

The retained water level in the surface water retention lagoons is 2m thereby ensuring that there is at least 2,500m^3 of water available at any time for fire fighting requirements. Therefore at any time there is at least 18 times the required volume of fire fighting water available on-site.

In the event of a fire at the composting facility any excess firewater within the compost building will be contained within this fully contained building and collected via the internal drainage system eventually discharging to the leachate/wash water tanks. The combination of the bunded building and the leachate/wash water tanks will provide full firewater retention capacity in the event of fire. This firewater will subsequently be analysed prior to possible tankering off-site to the Leixlip Wastewater plant.

In the event of a fire at the administration building or site garage the firewater will be collected via the surface water drainage system on the adjoining hardstanding and discharged to the surface water retention lagoons. These surface water retention lagoons will have a free-board capacity of at least 1,240m³ in each of the settlement lagoons. In such an event the discharge from the surface water retention lagoons will be cut-off. Again any firewater in the surface water retention lagoons will be analysed, and if necessary tankered off-site to Leixlip Wastewater Plant.

All access roads and ramps to the working face of the landfill are maintained in a suitable condition to allow for fire engine access. A water bowser is available in the event of any small fires on the landfill.

The following additional fire prevention and control measures are provided on-site:

- Training of all site operatives and employees in fire prevention and control;
- Training of all site operatives and employees in emergency response procedures;
- Prominent posting of emergency response contact numbers (fire service, Gardaí, ambulance and other agencies) on-site;
- Prominent posting of an emergency contact number at the site entrance;
- The provision of fire extinguishers and smoke detectors in all site buildings; and
- Smoking is not permitted at the facility.
-

3.3.16 Civic Amenity Facilities

It is not intended to provide civic amenity facilities at the landfill site. As a consequence there is no traffic generated as a result of private householders or small traders transporting waste directly to the site.

3.3.17 Compost Facility and process description

The Compost Facility and associated processes are described in detail in Appendix 3.3.2.

3.4 Phasing of the Landfill

The combined landfill footprint, current permitted landfill and proposed landfill extension, as outlined on Drawing No. 3369-2408 will cover approximately 39ha.

The permitted landfill is being constructed in 8 phases and the proposed landfill extension will be constructed in 7 phases, to make a total of 15 phases. Stripping of the peat layer and preparation of the ground to the formation levels required will take place prior to the development of each phase. The phasing of the development of the landfill and proposed formation levels of the footprint are shown on Drawing No. 3369-2412. Table No. 3.4.2 also schematically represents the phasing of the landfill and presents an estimation of when the various developments will occur at the site. The actual phasing of the development of the proposed landfill extension will be dependant on the timing of the issuing of Planning Permission, amended Waste

Licence, and on the rate of landfilling over the lifetime of the facility.

Prior to the construction of the proposed landfill extension, all vegetation will be cleared and the ground will be stripped of topsoil. The floor of the landfill will be graded in accordance with the formation levels as illustrated on Drawing No. 3369-2412.

After deposition of residual waste, each phase will be temporarily capped with 300mm of low permeability clay/subsoil and seeded. After allowing two years for settlement, the final capping will be installed and full restoration will take place.

Following reprofiling, the final capping system, as detailed in Drawing No. 3369-2417, consisting of a gas collection layer, a low permeability barrier layer, a linear low density polyethylene liner and woven geotextile, a drainage layer, subsoil and topsoil, is placed. Allowing for settlement, the maximum height of the fully completed capped landfill will not exceed 103.25mOD. The proposed final contours for the facility are shown on Drawing No. 3369-2436. Following final capping each phase will be allowed to recolonise with natural species.

The basal liner for subsequent phases will be constructed in conjunction with the deposition of waste into previous phases. Table 3.4.1 provides estimated dates for the commencement of waste deposition, temporary capping, and final capping in the phases of the landfill.
The landfill will also be continually landscaped utilising a combination of slope embankments and tree planting in order to minimise any visual impacts. In addition, as outlined above, on placement of temporary capping each phase will be seeded with grass, which will help to minimise any visual impact at the site.

On the final capping of the landfill footprint the site will be allowed to recolonise to natural species. Details of the landscaping measures for the site are outlined in more detail in Section 4.5 herein. Contouring will also be executed at the landfill to allow surface water run-off from the top of the landfill thereby preventing ponding and minimising the risk of infiltration into the waste body. The surface water drainage scheme is shown on Drawing No. 3369-2408 and Drawing No. 3369-2433 and outlined in more detail in Sections 3.3.11 and 4.4 herein.

Table 3.4.1 Estimated Dates for Operational Activities in Landfill

Phase	Filling Duration	Start of Waste Filling	End of Waste Filling	Completion of Temporary Capping & Start of Gas Collection Via Vertical Wells	Completion of Final Capping
	Months	*Beginning of Month*	*End of Month*	*End of Month*	*End of Month*
Phase 1	13	Feb-08	Feb-09	Mar-09	Mar-11
Phase 2	9	Mar-09	Nov-09	Dec-09	Dec-11
Phase 3	9	Dec-09	Aug-10	Sep-10	Sep-12
Phase 4	9	Sep-10	May-11	Jun-11	Jun-13
Phase 5	9	Jun-11	Feb-12	Mar-12	Mar-14
Phase 6	9	Mar-12	Nov-12	Dec-12	Dec-14
Phase 7	9	Dec-12	Aug-13	Sep-13	Sep-15
Phase 8	9	Sep-13	May-14	Jun-14	Jun-16
Phase 9	9	Jun-14	Feb-15	Mar-15	Mar-17
Phase 10	20	Mar-15	Oct-16	Nov-16	Nov-18
Phase 11	28	Nov-16	Feb-19	Mar-19	Mar-21
Phase 12	28	Mar-19	Jun-21	Jul-21	Jul-23
Phase 13	28	Jul-21	Oct-23	Nov-23	Nov-25
Phase 14	28	Nov-23	Feb-26	Mar-26	Mar-28
Phase 15	23	Mar-26	Jan-28	Feb-28	Feb-30

Table 3.4.2: Phasing of Drehid Site Development (Intensification and Extension)

1/4 YEAR PERIOD	Tonnage Deposited per Annum (tpa)	Total Void Space per Annum (m^3/annum)	Cumulative Tonnage (tonnes)	Cumulative Volume (m^3)	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5	PHASE 6	PHASE 7	PHASE 8	EXTENSION PHASE 9	EXTENSION PHASE 10	EXTENSION PHASE 11	EXTENSION PHASE 12	EXTENSION PHASE 13	EXTENSION PHASE 14	EXTENSION PHASE 15
2007	0	0	0	0															
2007.25	0	0	0	0															
2007.5	0	0	0	0															
2007.75	0	0	0	0															
2008	30,000	37,059	30,000	37,059															
2008.25	30,000	37,059	60,000	74,118															
2008.5	90,000	111,176	150,000	185,294															
2008.75	90,000	111,176	240,000	296,471															
2009	90,000	111,176	330,000	407,647															
2009.25	90,000	111,176	420,000	518,824															
2009.5	90,000	111,176	510,000	630,000															
2009.75	90,000	111,176	600,000	741,176															
2010	90,000	111,176	690,000	852,353															
2010.25	90,000	111,176	780,000	963,529															
2010.5	90,000	111,176	870,000	1,074,706															
2010.75	90,000	111,176	960,000	1,185,882															
2011	90,000	111,176	1,050,000	1,297,059															
2011.25	90,000	111,176	1,140,000	1,408,235															
2011.5	90,000	111,176	1,230,000	1,519,412															
2011.75	90,000	111,176	1,320,000	1,630,588															
2012	90,000	111,176	1,410,000	1,741,765															
2012.25	90,000	111,176	1,500,000	1,852,941															
2012.5	90,000	111,176	1,590,000	1,964,118															
2012.75	90,000	111,176	1,680,000	2,075,294															
2013	90,000	111,176	1,770,000	2,186,471															
2013.25	90,000	111,176	1,860,000	2,297,647															
2013.5	90,000	111,176	1,950,000	2,408,823															
2013.75	90,000	111,176	2,040,000	2,520,000															
2014	90,000	111,176	2,130,000	2,631,176															
2014.25	90,000	111,176	2,220,000	2,742,353															
2014.5	90,000	111,176	2,310,000	2,853,529															
2014.75	90,000	111,176	2,400,000	2,964,706															
2015	90,000	111,176	2,490,000	3,075,882															
2015.25	90,000	111,176	2,580,000	3,187,059															
2015.5	30,000	37,059	2,610,000	3,224,118															
2015.75	30,000	37,059	2,640,000	3,261,176															
2016	30,000	37,059	2,670,000	3,298,235															
2016.25	30,000	37,059	2,700,000	3,335,294															
2016.5	30,000	37,059	2,730,000	3,372,353															
2016.75	30,000	37,059	2,760,000	3,409,412															
2017	30,000	37,059	2,790,000	3,446,471															
2017.25	30,000	37,059	2,820,000	3,483,529															
2017.5	30,000	37,059	2,850,000	3,520,588															
2017.75	30,000	37,059	2,880,000	3,557,647															
2018	30,000	37,059	2,910,000	3,594,706															
2018.25	30,000	37,059	2,940,000	3,631,765															
2018.5	30,000	37,059	2,970,000	3,668,823															
2018.75	30,000	37,059	3,000,000	3,705,882															
2019	30,000	37,059	3,030,000	3,742,941															
2019.25	30,000	37,059	3,060,000	3,780,000															
2019.5	30,000	37,059	3,090,000	3,817,059															
2019.75	30,000	37,059	3,120,000	3,854,118															
2020	30,000	37,059	3,150,000	3,891,176															
2020.25	30,000	37,059	3,180,000	3,928,235															
2020.5	30,000	37,059	3,210,000	3,965,294															
2020.75	30,000	37,059	3,240,000	4,002,353															
2021	30,000	37,059	3,270,000	4,039,412															
2021.25	30,000	37,059	3,300,000	4,076,471															
2021.5	30,000	37,059	3,330,000	4,113,529															
2021.75	30,000	37,059	3,360,000	4,150,588															
2022	30,000	37,059	3,390,000	4,187,647															
2022.25	30,000	37,059	3,420,000	4,224,706															
2022.5	30,000	37,059	3,450,000	4,261,765															
2022.75	30,000	37,059	3,480,000	4,298,823															
2023	30,000	37,059	3,510,000	4,335,882															
2023.25	30,000	37,059	3,540,000	4,372,941															
2023.5	30,000	37,059	3,570,000	4,410,000															
2023.75	30,000	37,059	3,600,000	4,447,059															
2024	30,000	37,059	3,630,000	4,484,118															
2024.25	30,000	37,059	3,660,000	4,521,176															
2024.5	30,000	37,059	3,690,000	4,558,235															
2024.75	30,000	37,059	3,720,000	4,595,294															
2025	30,000	37,059	3,750,000	4,632,353															
2025.25	30,000	37,059	3,780,000	4,669,412															
2025.5	30,000	37,059	3,810,000	4,706,471															
2025.75	30,000	37,059	3,840,000	4,743,529															
2026	30,000	37,059	3,870,000	4,780,588															
2026.25	30,000	37,059	3,900,000	4,817,647															
2026.5	30,000	37,059	3,930,000	4,854,706															
2026.75	30,000	37,059	3,960,000	4,891,765															
2027	30,000	37,059	3,990,000	4,928,823															
2027.25	30,000	37,059	4,020,000	4,965,882															
2027.5	30,000	37,059	4,050,000	5,002,941															
2027.75	30,000	37,059	4,080,000	5,040,000															
2028	-	-	-	-															
2028.25	-	-	-	-															
2028.5	-	-	-	-															
2028.75	-	-	-	-															
2029	-	-	-	-															
2029.25	-	-	-	-															
2029.5	-	-	-	-															
2029.75	-	-	-	-															
2030	-	-	-	-															

3.5 Basal Lining System

3.5.1 Design of Basal Liner

As outlined in Section 3.4 above, the complete landfill facility will be constructed in 15 Phases with each phase encompassing a basal liner consisting of a HDPE liner overlaying a Bentonite Enhanced Sand (BES). Lined cells have been and will continue to be constructed in accordance with the *EPA Landfill Design Manual (2000)*, allowing for the isolation of the deposited waste at the site.

Landfill cells have been and will continue to be constructed on areas cleared of vegetation and peat, either cut or filled, depending on topography, to the formation levels shown on Drawing No. 3369-2412. The basal lining system is capable of containing the generated leachate above the liner particularly prior to the construction of the final capping layer, which will reduce the infiltration to the site and therefore the volume of leachate generated.

The basal lining system constructed at the site consists of a number of different layers as detailed in Drawing No. 3369-2430. The basal lining system, from top to bottom, is described below:

- Leachate drainage layer (thickness 500 mm) with a hydraulic conductivity of greater than $1x10^{-3}$ m/s. A HDPE drainage pipe network is imbedded in the drainage layer to collect the leachate and drain it to a leachate collection sump. The pipe work is surrounded by gravel material (e.g. Clause 505B or equivalent). The slotted leachate pipes have a minimum diameter of 250mm, with slots of 5-6mm and the header lines have a minimum diameter of 355mm;
- Protection layer consisting of a woven geotextile (>750g/m^2) or similar with a high CBR puncture resistance lain underneath the drainage layer;
- Barrier layer consisting of HDPE (high density polyethylene) geomembrane liner (2.0mm). A 2.0mm HDPE liner is chosen because it has to withstand potential corrosion due to leachate and the ability to accommodate settlement in the underlying ground. The membrane has an elongation at break of over 500%;
- Low permeability Bentonite Enhanced Soil (BES) with a hydraulic conductivity of less than or equal to 5×10^{-10} m/s constructed in two lifts of 275mm to give a minimum compacted layer of 500mm. The BES is laid under the HDPE liner and in addition to providing a barrier to leachate migration it also provides the foundation for the HDPE liner.
- Undercell drainage consisting of a herringbone arrangement of drainage pipe work or a 300mm layer of drainage stone.
- Natural mineral subsoils underlie the undercell drainage system. Field tests indicate that the natural mineral subsoil has an average vertical permeability of 8.2×10^{-10}m/sec.

3.5.2 Method Statement for installation of Basal Liner

A detailed method statement for the placement of the basal liner has been prepared at detailed design stage and is in compliance with industry best practice. This method statement was followed during the construction of the basal liner in Cells No.1 & No.2. The following is a summary of the method statement:

1. Clear scrub and other vegetation from the required area as appropriate.
2. Prepare the base for the construction to the desired formation levels through excavation of peat and mineral subsoil to required elevation.
3. Place the undercell drainage system to drain any underlying water
4. Place a separation geotextile top of the undercell drainage system prior to the installation of the BES liner.
5. Place the layer of low permeability BES (at least 500mm, 2 lifts @275mm – allow for compaction).
6. Ensure that the layer of BES is free from any contaminants prior to laying the HDPE liner.
7. Unroll the HDPE membrane panels according to the layout plan for the panels.
8. Weld the panels using a fusion welder with an open channel for air pressure testing.
9. Visually check the liner and test the seams.
10. Unroll the geotextile protection layer according to the layout plan for the panels ensuring an overlap of at least 500mm of the material.
11. Cover the geotextile protection layer with the drainage layer. The drainage layer consists of 16-32mm non-calcareous (<10% $CaCO_3$) stone. Hydraulic conductivity is greater than 1 x 10^{-3} m/s. Extreme care must be taken so as not to damage the geomembrane liner.
12. Excavate the trench in the drainage stone layer for the leachate collection drains.
13. Place and connect the HDPE leachate collection drains.
14. Backfill the trench with drainage stone and complete the drainage layer.

3.5.3 Safety Statement

All work is subject to the Safety, Health and Welfare at Work (Construction) Regulations 2006 (S.I. No. 504 of 2006), and all current legislation. A detailed safety statement is prepared at contract document stage and finalised on commencement of construction of the basal liner.

3.5.4 Quality Control

The lining manufacturer and supplier have a specific quality control and assurance policy in operation that covers all aspects of the manufacture, supply and installation of their liner systems. At manufacture stage there is a systematic dimensional, chemical and physical testing regime in place that checks a variety of liner parameters including durability and thickness undertaken to BS, ISO, ASTM, DIN standards.

With the installation of the liner system, the manufacturer is required to provide the following services to the Contractor:

a) Technical consultation prior to commencement of the work to familiarise the main contractor with the capabilities of the product, to assist him in determining panel size, installation methodology and design of any special equipment such as spools, carrying frames etc. which may be required.

b) Supply to site of pre-cut panels for the liner to sizes determined by the main contractor complete with interlocks welded on, and sealing tubes.

c) Provision of one or more welding technicians on site to cut and weld panels to dimensions determined by the main contractor on a day to day basis. These personnel also carry out any modifications or repairs that may be required during installation.

d) If requested, the liner manufacturer provides an engineer on site during installation to give advice relating directly to their products.

3.5.5 Quality Assurance

CQA has been carried out for Cells No.1 and No.2 of the initial phase of construction in accordance with the procedures set out above. A comprehensive quality assurance plan is provided by the liner manufacturer to maintain the integrity of all aspects of their quality control, testing and installation regime. An experienced and fully qualified employee of the lining manufacturer is responsible for quality assurance. Installation of the entire containment system, including the installation of the HDPE liner is carried out under the supervision of an experienced, fully qualified Engineer and Bord na Móna resident engineers.

Pre-commissioning tests consist of air testing of the seams between liner sheets. Air is pumped into the seam through a small hole drilled for this purpose. The liner seam is deemed to pass when air at a specified pressure remains at this pressure within tolerances over the test period. Test holes in seams are repaired before full integral testing of the liner. Following testing of all seams the electrical conductivity between the upper and lower faces of the liner is tested.

Pre-commissioning tests of the liner are supplemented by field testing of welds. This involves the testing to destruction of test welds made by the welding specialists under field conditions, and by the Quality Assurance System of the liner welding Contractors.

A leak detection survey for the lined cells is performed. This survey is part of the CQA programme. A mobile survey is performed after the total cell is filled with the drainage layer.

3.6 Material Balance

Table 3.6.1 outlines the estimated type and quantities of materials required to construct the complete facility (permitted and proposed). This table includes for the provision of the basal layer, capping layers and landscaping.

Table 3.6.1 Estimated Material Balance for the construction of the landfill site

Item	Material	Quantity	Source
Material for Bund Construction	Compacted Fill Comprising Clause 616 or similar	200,466 m³	Won on-site
Low Permeability Basal Layer	Bentonite Enhanced Soil - BES; Bentonite(Bentonite is 5% of volume of BES)	7,920 m³	Import
	Bentonite Enhanced Soil - BES; Sand	150,480 m³	Won on-site
Basal Geomembrane Liner	Flexible HDPE geomembrane liner (2.0mm).	316,800 m²	Import
Protection Layer	Layer of woven Geotextile (750g/m^2) or similar	316,800 m²	Import
Basal Drainage Layer	Granular Material e.g. Clause 505B (500mm)	120,915 m³	Import
Daily Cover	Hessian rolls or similar	253,800 m²	Import
Temporary Cover	Low permeability clay (300mm)	109,008 m³	Won on-site
Gas Drainage Layer	Geosynthetic Gas Drainage Layer e.g. EnkaDrain or similar	363,366 m²	Import
Capping Geomembrane Liner	Flexible LLDPE geomembrane liner (2.0mm) or Geosynthetic Clay Liner (GCL) or similar.	367,200 m²	Import
Capping - Low Permeability Layer	Clay 300mm thick Layer	72,675 m³	Won on-site
Protection Layer	Layer of woven Geotextile (750g/m^2) or similar	367,200 m²	Import
Capping Drainage Layer	Granular Material e.g. Clause 505 (300mm) or similar including reprocessed C&D material	109,008 m³	Won on-site
Capping Subsoil	Subsoil (850 mm)	308,862 m³	Won on-site
Capping Topsoil	Topsoil (150 mm)	54,504 m³	Won on-site
Perimeter embankments	Soil/Spoil material	30,000 m³	Won on-site
Sub-bases and hardcore.	Gravel sub-base, for roads/buildings/hardstand areas etc.	33,000 m³	Won on-site
	Clause 804	18,177 m³	Import
	Surfacing (base course + wearing course)	6,857 m³	Import

Two material borrow areas have been permitted at the site, as a source of construction and restoration material over the lifetime of the facility.

A permitted clay borrow area to the northwest of the landfill footprint will be used as a source of material for embankment construction, temporary cover and low permeability clay fraction required for final capping. Every attempt will be made to use material, generated during the stripping and clearing of ground, for embankment construction. This approach has proved successful during the construction of the initial phase of the permitted facility, thereby minimising extraction at the clay borrow area. It is estimated that approximately 382,149m^3 (726,083tonnes) of this material will be required throughout the lifetime of the facility. The sourcing of clay material on-site will prevent the generation of 36,304 traffic movements (round trips) on the public road network over the 20-year lifetime of the facility.

A sand and gravel borrow area has been developed to the south of the landfill footprint as a source of aggregate for various end-uses. The particle size distribution curves of the sand and gravel samples obtained on-site (Section 2.4.4) indicated that the clay/silt content of the granular deposit is very low, therefore washing is not necessary. This was confirmed during the early stages of excavation. The sand and gravel is crushed and screened to generate the different grades of material. The processing of aggregate from the material borrow area is undertaken in accordance with construction programmes and contractor's method statements for the facility.

Sand and gravel material is required for the capping drainage material, sand for the BES layer and sub-base for the road construction. It is estimated that in total approximately 292,488m^3 (526,478tonnes) will be required from the sand and gravel borrow pit throughout the lifetime of the facility. The sourcing of sand and gravel on-site will prevent the generation of 26,324 traffic movements (round trips) on the public road network over the 20-year lifetime of the facility.

The raw Bentonite material for the BES, all geomembrane compounds, the geosynthetic drainage material, the geotextile compounds and the hessian material are sourced on the basis of competitive tendering. These materials are imported on-site on a phased basis in accordance with the construction schedule outlined in Table 3.11.1, Table 3.11.2 and Table 3.11.3.

An estimated 929,900m^3 of material will be generated from the excavation of the landfill footprint (permitted and proposed) to achieve the required formation levels. This material will be retained on site and used for the construction of perimeter embankments, and as subsoil and topsoil in the final capping.

With respect to the composting facility, process control during the composting operation ensures the production of a mature and sanitised compost product. The finished compost will amount to approximately 30-40% weight of the original waste.

Up to 5% of the input may be unsuitable for composting (non-biodegradable materials) and will be deposited to the adjacent landfill.
It is anticipated that the permitted composting facility will produce up to approximately 7,500 – 10,000 tonnes of compost, originating from 25,000 tonnes of biowaste.

In Table 3.6.2 below, the mass balance for the proposed composting process is summarised.

Table 3.6.2 Expected Mass Balance for the Permitted Composting Facility

Input	**(TPA)**
Source separated Household/Commercial/ Industrial biowaste	22,500
Paper/cardboard residues	2,500
Output	**(TPA)**
Evaporation loss (biofilter)	15,000 – 17,500
Residue to landfill (< 5% mass)	< 1,000
Compost	7,500 – 10,000

3.7 Leachate Management

3.7.1 Leachate Management Plan

Leachate produced in a landfill is a liquid, produced from rainwater that has percolated through the waste, picking up suspended and soluble materials that originate from, or are products of, the degradation of the waste.

The control of leachate is paramount in the design and operation of any landfill. Measures are necessary to minimise leachate generation and to collect and remove it in an environmentally safe manner.

The leachate piezometric head in the landfill is controlled primarily by the leachate collection pipe work and removal system, which allows leachate to be pumped through rising mains to the leachate holding tanks.

For the Drehid Waste Management Facility, a herringbone leachate collection system is constructed on top of the basal liner. The leachate drains to leachate collection sumps, from where it is pumped to one of the two leachate holding tanks. The combined volume of the two leachate holding tanks is approximately 400m^3, providing approximately 8 days storage at maximum predicted generation rates.

Following final capping, a leachate re-circulation system will be installed at the facility. From the leachate holding tanks the leachate will be transported via $23m^3$ (5,000 gallons) road tankers to an approved wastewater treatment plant.

Further details of the leachate management plans for the site including the collection and removal system are provided in the following sections.

3.7.2 Annual Quantities of Leachate

Leachate formed in the landfill is a potential source of contamination of both the surface watercourses and the groundwater resources surrounding the landfill site. Leachate is defined as water, which has been in contact with the waste itself, and is generated by the movement of rainwater through the waste body.

Accurate estimates of leachate generation rates are difficult to predict because of the number of factors affecting leachate generation and the temporal variability of precipitation on a daily, monthly, seasonal and annual basis. Furthermore, the amount of runoff water can differ from season to season.

Estimation of leachate generation by a water balance model is recommended in American and British technical guidelines and literature. Pre-closure and post closure generation rates will be different and therefore both should be estimated.

From the viewpoint of necessary treatment of leachate, the volume of leachate generated must be minimised and the separation of 'clean' water and leachate is the basic philosophy in designing the water management system at a landfill site.

Leachate containment and collection has been implemented at the Drehid Waste Management Facility in order to mitigate future impacts on surface water and groundwater quality.

For the purposes of calculating the future leachate generation rate, the following equation may be applied:

$$L_V = P - E - R - AW$$

Where:

L_V	=	leachate volume
P	=	volume of precipitation
E	=	volume lost through evaporation
R	=	volume of runoff from the landfill surface
AW	=	volume lost through adsorption in waste

As detailed in Section 3.4 herein it is proposed to progressively develop the landfill site in 15 phases. When each phase has been filled the waste body will be capped with a low permeability layer and soil. The development and restoration of the landfill site will follow the phasing programme of the landfill.

In the estimation of leachate production rates, the precipitation data from the weather station at Lullymore was used. The evaporation data for the Casement Aerodrome was also utilised. From monthly average precipitation and evaporation data a water balance model was generated to determine the expected seasonal precipitation surplus.

Table 3.7.1 presents the estimated rates of leachate generation. This table shows that the leachate generation will increase to a peak of approximately 2.1m^3/hour in 2015. Daily fluctuations due to peaks in precipitation intensity are not incorporated in this table, as these fluctuations will be equalised by the balancing capacity of the landfill itself and of the leachate holding tanks.

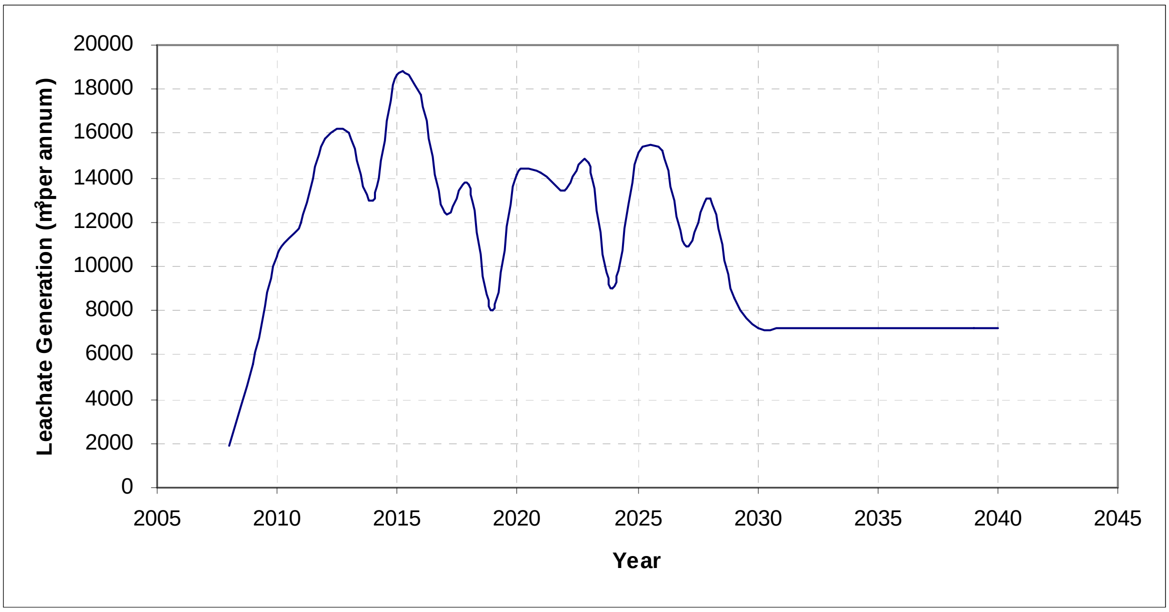
3.7.3 Total Quantities of Leachate

The total quantity to be collected from the lined cells is estimated to be approximately 353,324m^3 up to the year 2040.

Table 3.7.1: Estimated Average Rates of Leachate Generation

Year	Estimated Average Leachate Generation Rate (m^3/hr.)	Estimated Average Leachate Generation Rate (m^3/annum)
2008	0.2	1932
2009	0.6	5588
2010	1.2	10445
2011	1.4	11945
2012	1.8	15801
2013	1.8	16052
2014	1.5	12946
2015	2.1	18610
2016	2.0	17754
2017	1.4	12399
2018	1.6	13649
2019	0.9	8042
2020	1.6	14150
2021	1.6	14250
2022	1.5	13401
2023	1.7	14651
2024	1.0	9044
2025	1.7	15152
2026	1.7	15252
2027	1.2	10940
2028	1.5	13063
2029	1.0	8556
2030	0.8	7245
2031	0.8	7245
2032	0.8	7245
2033	0.8	7245
2034	0.8	7245
2035	0.8	7245
2036	0.8	7245
2037	0.8	7245
2038	0.8	7245
2039	0.8	7245
2040	0.8	7245

Figure 3.7.1: Estimated Average Leachate Generation



- Solid waste composition (organic matter);
- Water balance and water handling on the landfill;
- Recirculation of leachate;
- Age of leachate;
- Operation of the landfill, and;
- Speed of landfilling.

The quality of landfill leachate changes with time as the degradation of waste continues inside the landfill. The degradation phase is generally divided into five successive phases, namely:

(i) Aerobic
(ii) Hydrolysis and fermentation
(iii) Acetogenic
(iv) Methanogenic
(v) Aerobic

These phases are dynamic, with each phase being dependent on the creation of a suitable environment by the preceding stage.

A very important influencing factor on leachate quality is the presence of an acetogenic phase in the landfill body. Because of the high organic content in the waste (easily degradable), acidification by means of formation of volatile fatty acids (VFAs) can result in a low pH value and can as a result, mobilise pollutants. After a certain period (several months to several years) the VFAs are anaerobically degraded to landfill gas but the onset and emergence of acetogenesis has a significant influence on the ultimate leachate quality.

Based on known leachate qualities for similar landfills and assuming comparable waste composition in the landfill, the future leachate quality is likely to resemble the parameters set out in Table 3.7.2. This table derived from the EPA Landfill Site Design Manual (2000) shows the mean composition of acetogenic and methanogenic leachates sampled from large landfills with a relatively dry high waste input rate similar to that proposed for the Drehid Waste Management Facility.

Table 3.7.2: Leachate Composition as per EPA Landfill Site Design Manual (2000)

Parameter	Units	Mean Value	
		Acetogenic Phase	Methanogenic Phase
pH-value		6.73	7.52
conductivity	µS/cm	16,921	11,502
alkalinity (as $CaCO_3$)	mg/l	7,251	5,376
COD	mg/l	36,817	2,307
BOD_{20}	mg/l	25,108	544
BOD_5	mg/l	18,632	374
TOC	mg/l	12,217	733
Fatty acids (as C)	mg/l	8,197	18
Ammoniacal-N	mg/l	922	889
Nitrate-N	mg/l	1.8	0.86
Nitrite-N	mg/l	0.2	0.17
Sulphate (as SO_4)	mg/l	676	67
Phosphate (as P)	mg/l	5.0	4.3
Chloride	mg/l	1,805	2,074
Sodium	mg/l	1,371	1,480
Magnesium	mg/l	384	250
Potassium	mg/l	1,143	854
Calcium	mg/l	2,241	151
Chromium	mg/l	0.13	0.09
Manganese	mg/l	32.94	0.46
Iron	mg/l	653.8	27.4
Nickel	mg/l	0.42	0.17
Copper	mg/l	.013	0.13
Zinc	mg/l	17.37	1.14
Arsenic	mg/l	0.024	0.034
cadmium	mg/l	0.02	0.015
mercury	mg/l	0.0004	0.0002
Lead	mg/l	0.28	0.20

The predicted leachate composition does not take account of the implementation of national policy on waste management, which will divert organic material from landfill. A change in waste composition will alter the characteristics of the leachate generated in the waste disposal area and will most likely lead to a reduction in the concentration of certain contaminants in the leachate.

3.7.5 Water Balance Calculations

As outlined in Section 3.7.2, the water balance model utilised for the calculation of the leachate generation rates takes into account water balance calculations, which have been performed on the projected waste intakes.

3.7.6 Size of Working Area

The size of the working areas is kept to a maximum of 40m by 40m. This size of the working areas is required in order to allow for the efficient operation of the large waste compactors required to compact the waste in a maximum of 3 metre lifts.

3.7.7 Leachate Collection and Removal System

A herringbone leachate collection system is constructed on top of the basal liner with the leachate draining to collection sumps from where the leachate is pumped via side risers to the leachate holding tanks as shown on Drawing No. 3369-2413 and detailed on Drawing No. 3369-2414.

From each of the leachate collection sumps, it is possible to independently pump leachate. This allows for more flexibility with respect to the management of the leachate on-site particularly during the active life of the site. The leachate is pumped from the collection sump via side risers to the leachate transport pipeline from where it feeds via gravity to the foul pumping station located adjacent to the leachate holding tanks as shown on Drawing No. 3369-2414. From this pumping station the leachate is pumped into the leachate holding tanks.

In addition the leachate collection system is also designed in such a manner that following the closure of the landfill and when the leachate levels in the landfill decrease it will be possible to pump the leachate directly from the collection sumps for tankering off-site. This will allow for the option of decommissioning the leachate holding tanks on-site.

The locations of the leachate collection sumps are shown on Drawing No. 3369-2413. Details of the leachate collection sumps are shown on Drawing No. 3369-2414. The leachate collection sumps will also allow for access for cleaning of the leachate collection pipelines if and when necessary. Additional access points for cleaning will also be provided on the leachate mains.

The basal lining system within each of the cells allows for a minimum fall of 1:150 towards the leachate collection sumps as shown by the basal levels included in Drawing No. 3369-2412.

The leachate collection system is installed in accordance with the following specifications:

- Leachate drainage layer (thickness 500 mm) with a hydraulic conductivity of greater than $1x10^{-3}$ m/s. A HDPE drainage pipe network is imbedded in the drainage layer to collect the leachate and drain it to a leachate collection sump. The pipe work is surrounded by gravel material (e.g. Clause 505B or equivalent). The slotted leachate pipes have a minimum diameter of 250mm, with slots of 5-6mm and the header lines have a minimum diameter of 355mm;
- A protecting geotextile is placed below the HDPE drains. This geotextile is at least $1400g/m^2$ with a high CBR puncture resistance.

When the average head of leachate in the waste body is in excess of 1m, the leachate is pumped to the two $200m^3$ leachate holding tanks constructed at the location shown on Drawing No. 3369-2408 and Drawing No. 3369-2408. Details of the leachate holding tanks are given in Drawing No. 3369-2414.
A system control and data acquisition (SCADA) system for monitoring the depth of leachate in each of the phases has been developed at the site that allows for the automatic activation of the pumps in each of the collection sumps. The SCADA system also ensures that leachate is only pumped to the leachate holding tanks when there is sufficient capacity in the tank. If this capacity is not available then an alarm is activated in the administration building and additional tankering of the leachate is arranged.

In addition, the collected leachate will be recirculated within the waste body, under the temporary caps. The layout for the leachate recirculation system and details of the recirculation sump are shown in Drawing No. 3369-2415.

3.7.8 Off-Site Leachate Removal

From the leachate holding tanks, the leachate is transported via 23m3 (5,000 gallons) road tankers to Leixlip Wastewater Treatment Plant for treatment. A copy of the current agreement for the treatment of leachate at the Leixlip facility is provided in Appendix 3.7.1.

It is proposed that the additional leachate produced due to the proposed intensification and extension of the facility will also be treated at Leixlip Wastewater Treatment Plant. Further correspondence has taken place between Bord na Móna and Kildare County Council with respect to this arrangement. A copy of a letter sent to Kildare County Council outlining the revised leachate quantities is provided in Appendix 3.7.1.

The hardstanding area at the leachate holding tanks is sloped at each end towards an Aco drain located in the centre of the hardstanding area. This Aco drain is connected to the foul water pumping station. The leachate management area is surrounded on three sides by a 300mm high bund. The location and details of the leachate holding tanks and the bunded area are shown on Drawing No. 3369-2408 and Drawing No. 3369-2414 respectively.

Table 3.7.3 outlines the estimated leachate quantities to be transported off-site. As shown by this table, it is envisaged that leachate will only be transported to the treatment plant on a five-day per week basis. As outlined, at peak production the maximum daily quantity to be transported to the facility will be of the order of $71m^3$, which equates to 3.1 tankers per day. However over the active lifetime of the facility, up to the end of 2027, the average daily quantity to be transported to the facility will be of the order of $48m^3$, which equates to 2.1 tankers per day.

Table 3.7.3 also illustrates the available leachate retention capacity in the leachate holding tanks and in the landfill body, which shows that there is potential to average the leachate tanker movements over the lifetime of the facility. In particular, during periods of wet weather significant buffering capacity can be provided within the landfill body. Leachate will be recirculated within the landfill body and this will reduce the need to tanker leachate off-site.

From studies carried out into the impact of leachate on municipal wastewater treatment plants, it would appear that less than 4% by volume of high strength leachate would not result in a deterioration of plant performance *(Casey 1994, after Henry 1985)*. The average leachate production by Drehid Landfill is estimated to be $48m^3$/day. It is expected that this quantity of leachate will have the characteristics of 'high strength' leachate for only a 1-2 year period during the operational life of the site.

A municipal wastewater treatment plant with a population equivalent of 4,000 persons (i.e. serving a small town) has a typical design inlet flow of $3{,}000m^3$/ day (i.e. 3 times Dry Weather Flow). The average leachate production from Drehid Waste Management Facility is therefore only 1.6% of the design volume of a typical small sewerage scheme of P.E 4,000 persons.

3.7.9 System for Monitoring the Level of Leachate

As outlined in Section 3.7.8 herein the level of leachate in the waste is continuously monitored using hydrostatic sensors located in the leachate collection sumps and at other locations in the site.

The system for the monitoring of the level of leachate in the waste is shown on Drawing No. 3369-2430. The SCADA system interprets the leachate level and if levels exceed the maximum permitted an alarm is activated and the appropriate action is taken.

Table 3.7.3: Estimated Leachate Quantities to the Wastewater Treatment Plant

Year	Estimated Leachate Generation Rate (m^3/hr.)	Estimated Daily Average Quantity (m^3/day)	Average Daily quantity to WWTP (5 day) (m^3/day)	Retention Capacity Leachate Holding Tanks (m^3)	Retention Capacity Landfill Body (m^3)	No. of Tankers per day @ 23m³ capacity
2008	0.2	5	7	400	3951	0.3
2009	0.6	15	21	400	8180	0.9
2010	1.2	29	40	400	11729	1.7
2011	1.4	33	46	400	18945	2.0
2012	1.8	43	61	400	22619	2.6
2013	1.8	44	62	400	26152	2.7
2014	1.5	35	50	400	30052	2.2
2015	2.1	51	71	400	33311	3.1
2016	2.0	49	68	400	37022	3.0
2017	1.4	34	48	400	40483	2.1
2018	1.6	37	52	400	40483	2.3
2019	0.9	22	31	400	43961	1.3
2020	1.6	39	54	400	43961	2.4
2021	1.6	39	55	400	43961	2.4
2022	1.5	37	51	400	47381	2.2
2023	1.7	40	56	400	47381	2.4
2024	1.0	25	35	400	50709	1.5
2025	1.7	42	58	400	50709	2.5
2026	1.7	42	59	400	53023	2.5
2027	1.2	30	42	400	53023	1.8
2028	1.5	36	50	400	53023	2.2
2029	1.0	23	33	400	53023	1.4
2030	0.8	20	28	400	53023	1.2
2031	0.8	20	28	400	53023	1.2
2032	0.8	20	28	400	53023	1.2
2033	0.8	20	28	400	53023	1.2
2034	0.8	20	28	400	53023	1.2
2035	0.8	20	28	400	53023	1.2
2036	0.8	20	28	400	53023	1.2
2037	0.8	20	28	400	53023	1.2
2038	0.8	20	28	400	53023	1.2
2039	0.8	20	28	400	53023	1.2
2040	0.8	20	28	400	53023	1.2

3.8 Landfill Gas Management

3.8.1 Landfill Gas Management Plan

Landfill gas (LFG) is the end product of the microbiological degradation of organic material. It is produced under anaerobic conditions, for example in the waste body of a landfill site.

The degradation process takes place in different steps, in which the raw organic material is degraded to smaller material that, in the course of the processes, is converted into LFG. In undiluted form, LFG consists primarily of the components methane (approximately 60%) and carbon dioxide (approximately 40%). A more detailed composition is given in Table 3.8.5.

The formation of LFG can be influenced by various factors, e.g. composition of the waste, waste pre-treatment, site characteristics, local and regional climatic conditions, etc. These aspects vary greatly from site to site.

For a mathematical estimate of the LFG formation over time, various models can be used. The most effective and widely applied modelling technique is the use of a first order decay model, in which the degradation of organic material for a landfill site with a specific waste amount can be calculated.

3.8.2 Degradation process

The following distinct stages can be distinguished in a waste body depending on the waste characteristics:

Aerobic stage

In this phase the oxygen present in the landfill is consumed in the (aerobic) degradation of organic compounds. This phase is relatively short (from several days to up to several weeks) since the quantity of oxygen, which is present, is limited.

Hydrolysis stage

This is the step in which the large organic molecules are converted into small soluble molecules such as lower fatty acids, simple sugars and amino acids.

Acetogenic stage

Under anaerobic conditions (absence of oxygen), hydrolysed compounds are degraded by bacteria into fatty acids. In this way, the acidity level (pH) is reduced. The gases that are formed in this phase are mainly hydrogen (H_2) and carbon dioxide (CO_2).

Methanogenic stage

In the methanogenic stage, the fatty acids formed are decomposed into mainly methane (CH_4) and carbon dioxide (CO_2). The methanogenic step can sometimes be reached after only a matter of months. However, it can also take years before the methane is formed. In contrast to the micro-organisms in the acidification phase, the methane forming bacteria are sensitive to sudden changes in the environmental conditions. It is important for this phase that, in all circumstances, the landfill remains under anaerobic conditions.

A landfill is highly heterogeneous. The stages described therefore occur simultaneously in a landfill. The rate of degradation is determined mainly by the temperature and the moisture content within the waste body. Landfill gas generation can be initiated quite rapidly since a part of the organic material can be hydrolysed quickly. The temperature in the landfill remains initially rather high as the result of the heat released during the aerobic degradation (temperature rise to 30 - 50°C). Due to heat loss to the environment, the temperature falls after a period of time, to values that result in a far slower growth of methane forming bacteria. This fall in temperature occurs over a period of several years. Ultimately, the temperature reaches a level similar to the temperature of the environment.

Mobility of free water in the landfill body (leaching) ensures that enzymes and bacteria present in the water obtain access to the organic material that had so far not been degraded. The slow movement of water is one of the reasons that the formation process of landfill gas can take many years. Recirculation of leachate at the facility will help accelerate the process, resulting in earlier stabilisation of the landfilled material. In relatively dry circumstances the degradation process decreases to a lower level, due to the lack of water movement. There is a low gas production however, because of the fact that the landfilled waste has a certain initial humidity and the degradation processes produces some water. Another possible origin of water is the humid atmospheric air that can cause condensation of water in the landfill body. Because the gas is produced in a humid atmosphere, the gas is saturated with water.

3.8.3 Landfill Gas Extraction Systems

Intermediate Gas Collection

An intermediate landfill gas collection system will be implemented following the commencement of waste deposition into the lined cells. Gas collection during the infill of waste will contribute towards effective odour control and will ensure compliance with the EPA circular letter, dated the 20th June 2007, on the design and operation of landfills. A copy of the EPA circular letter is provided in Appendix 3.8.1. The intermediate gas collection system will involve a series of horizontal pipe work at various depths with in the waste body. This pipe work will be installed in conjunction with the building of the waste body.

Permanent Gas Collection

A permanent gas collection and treatment system will be installed at the site on final capping of each phase. The layout of the permanent landfill gas collection system is shown on Drawing No. 3369-2415. A horizontal gas drainage/equalising layer consisting of geosynthetic gas drainage materials, e.g. EnkaDrain or a 300mm layer of drainage material or equivalent will also be placed underneath the final cap.

Horizontal Gas Collection Systems

Intermediate gas collection during the filling of cells is achieved by means of horizontal systems. Following completion of waste deposition and placement of the temporary cap, vertical gas wells will become the primary vehicle for the collection of gas.

Horizontal gas collection involves the progressive placement of horizontal systems of pipe work during the placement of waste. This process is repeated as the waste body climbs in height until the particular cell is filled.

On the construction of all new landfill cells, the leachate collection pipe work will contribute towards gas collection during the initial stage of waste deposition. The ends of the slotted leachate pipes opposite to the leachate sump and side risers will be connected to a gas collection header pipe. The level of leachate in the cell will be maintained at a low level in order to maximise the unsaturated area of the leachate collection pipe work. In this way the effectiveness of the gas collection system will be optimised.

Horizontal gas collection systems are sacrificial in nature due to the fact that the pipe work is inaccessible and cannot be maintained. Furthermore, due to the increasing weight of the waste body as the cell height increases during filling, the lower layers of horizontal pipe work may become damaged and hence affect the flow of gas. It is for this reason that a system of vertical wells is adopted when waste deposition ceases.

Vertical Gas Wells

Vertical gas extraction wells will be drilled into the waste body following the placement of the temporary capping. This will allow effective gas extraction during the period of settlement prior to and after installation of the final capping system.

Typical details are shown in Drawing No. 3369-2417. Typically the vertical gas wells will consist of:

- A vertical shaft with diameters of 500-1,000mm (diameter depending on utilisation of grabbing or drilling technique and on the depth of the landfill body above the bottom liner);

- A vertical, perforated (slotted) HDPE pipe Ø160-200mm, length depending on position and depth of landfill;
- Surrounding gravel 16-50mm;
- Telescopic construction to join the lower slotted pipe with the upper unperforated pipe, and to allow for settlement;
- Vertical, closed (unperforated) HDPE pipe Ø125-160 mm, length 2- 3m;
- Wellhead with monitoring facilities and regulator valve;
- Bentonite sealing layer;

Landfill Gas Transport Pipelines

The landfill gas transport pipelines will connect the gas wells to the flare unit. Interconnecting pipe work will consist of HDPE (SDR 17.6), 1.0MPa (10bar), Ø75mm at well, Ø125 mm for the transport pipelines. All tees, couplers and fittings will be made as click connections. Pipe ends will be provided with end caps and all HDPE pipes will be laid in conformity to the supplier's directions and checked for air tightness in accordance with recognised standards.

Condensation of water in the landfill gas pipelines can potentially be problematic at landfill sites. Since the extracted gas is saturated with water, some condensation of water will occur as a result of the temperature decrease between the landfill body and the gas transport pipeline. Therefore in order to prevent the pipelines from blockage with water, the pipeline must be laid to falls. Pipe work will be laid to falls of at least 1:30. At the lowest points in the pipeline and at strategic locations, special condensate traps must be installed to allow the pipes to drain into the landfill body. A typical landfill gas condensate trap is illustrated on Drawing No. 3369-2417.

Gas Drainage/Equalising Layer

As an integral part of the landfill final capping system, a horizontal gas drainage/equalising layer will be provided to collect LFG from the waste body. This drainage layer will consist of geosynthetic gas drainage materials, e.g. EnkaDrain or 300mm of drainage material e.g. Clause 505 or equivalent. The primary purpose of this gas drainage layer will be to allow for the landfill gas to migrate to the vertical landfill gas extraction wells. The horizontal gas drainage layer is shown as part of the capping layer on Drawing No. 3369-2417.

Flaring equipment

A contract has been signed with Automatic Flare Systems Ltd. for the supply, installation and commissioning of a modular landfill gas flare system for use at the Drehid Waste Management Facility. The system will be supplied in two stages. Stage one of the system will be commissioned in early 2008.

Stage One:

- Stage one includes a 500m^3/hr Enclosed High Temperature Flare chimney and a 2000m^3/hr booster arrangement. The flare chimney is designed to accept a carbon filter and an additional smaller burner arrangement. The carbon filter will be implemented to control odour if the quality of the landfill gas is too low for effective flaring. The additional smaller burner will provide a greater turn down ratio to cope with lower levels of landfill gas.

Stage Two:

- Stage two includes a 1500m^3/hr Enclosed High Temperature Flare chimney. The booster arrangement and electrical control system provided as part of stage one will accommodate the above mentioned 1500m^3/hr flare.

The landfill gas flare will flare in accordance with EU standards in terms of combustion temperature, retention times, emission levels, etc. In particular the landfill gas will be flared at a temperature range of between 1000ºC and 1200ºC with a minimum combustion retention time of 0.3 seconds.

The EPA licence (W201-01) outlines the emission limits for the flare but in general the flare system installed will not exceed the following emission concentrations under standard conditions (temperature 273K, pressure 101.3 kPa, and dry gas at 3% oxygen):

- Carbon monoxide (CO) 50mg/m^3
- Oxides of nitrogen (NOx) 150mg/m^3
- Unburnt hydrocarbons 10mg/m^3

The location for the gas flaring equipment is shown on Drawing No. 3369-2415. The landfill gas flare will be equipped with regulator valves, monitoring valves, ventilator (compressor), flame arrestor, flare and ignition equipment. Details of the landfill gas compound are shown on Drawing No. 3369-2417.

Bord na Móna is committed to carrying out a feasibility assessment of installing a landfill gas utilisation system encompassing a combined heat and power plant. This feasibility study will be carried out following the installation of the final capping system on Phase 1 and the carrying out of the pumping tests.

3.8.4 Volume of Landfill Gas

In order to predict the potential LFG generation at the Drehid Waste Management Facility, a landfill gas generation model, GasSimLite (Release 1.01) was used. The model was developed by the Environment Agency in the UK and it is a conceptual model. It considers the landfill as one unit, as cells are rarely isolated with respect to LFG. The model is divided into two modules, i.e. the source term and the emissions module. The source term relates to the nature and quantity of waste deposited in a landfill. The emissions module takes the output and uses it to calculate the LFG emission to the environment, after allowing for LFG collection, flaring, energy recovery and biological methane oxidation.

The quantity and type of waste deposited at the site, the landfill gas extraction system and the capping system, as outlined in Section 3.9 herein, were used as data in the computer model to predict the volumes of landfill gas.

It assumes that the LFG produced and not collected, is in equilibrium and that it will be emitted at a steady state from the landfill liner or cap. The model also calculates the concentrations of other major and trace gases emitted from flares and engines.

It should be noted however that some uncertainties always remain in the estimate, since the model is a numerical approach to describe a complex biological process.

In theory, one tonne of municipal solid waste will produce approximately 200-250 m^3 of LFG under ideal conditions. This production can take many decades. However, the process is not optimised in a heterogeneous landfill site, thus the actual production will be less. In particular, anaerobic degradation of the waste may not occur in 'dry spots' within the landfill body. In practice the total production may not exceed 70% of the theoretical production. Depending on the local situation this factor may decrease, e.g. in relatively dry areas.

The extraction rate will always be lower than the production rate, because not all gas will be available for extraction. In contrast, as is the case at the Drehid facility, leachate recirculation may enhance the quantity of gas for extraction. The extraction efficiency achievable will therefore be of the order of 55-65%.

The model requires data under three main categories, namely:

- Infiltration;
- Landfill Characteristics; and
- Source

The infiltration information relates to the annual rainfall in the area of the landfill, the landfill characteristics relate to the construction of the landfill and the source relates to the type of waste to be landfilled. Details relating to the gas plant (gas flare or engine) can also be added to the model to predict the trace gases produced by the gas plant.

A mixture of known values and model default values were used. The GasSimLite input data for the model of landfill gas production at the Drehid Waste Management Facility are summarised in Table 3.8.1, Table 3.8.2 and Table 3.8.3. Table 3.8.1 details the main values that were used in the modelling of LFG production for the facility. Table 3.8.2 details the composition of waste landfilled at the facility. The waste profile was derived from the EPA Waste Characterisation Study 2005. Table 3.8.3 details the % capping in each year. This was determined from the phasing plan that was developed for the landfill.

Table 3.8.1: GasSimLite Input Data for Modelling of LFG Production

Data Input Required	Unit	Value
Start date of filling of landfill	Date	2008
Operational period of the landfill	Years	20
Infiltration rate	mm/yr	814
Dimensions of the landfill in metres	metres	450 x 910
Biological Methane Oxidation Rate	%	10% (default)
Proportion of fissures of the capping layer	%	10% (default)
Soil depth in cap	m	1m
Capping construction details	-	Composite
Thickness gas drainage layer	m	0.3
Hydraulic Conductivity of gas drainage layer	m/s	0.0001
Thickness of barrier layer	m	0.3
Hydraulic Conductivity of barrier layer	m/s	0.000000001
Liner construction details	-	Composite
Thickness of liner - BES layer	m	0.5
Hydraulic Conductivity of liner – BES layer	m/s	5×10^{-10}
Thickness of drainage layer	m	0.5
Hydraulic Conductivity of drainage layer	m/s	0.001
Waste input	tonnes/yr	2008: 240,000 2009 to 2014: 360,000 2015: 240,000 2016 to 2027: 120,000
A breakdown of the waste	%	Domestic Waste: 40% Commercial Waste: 20% Industrial Waste: 40%
The composition of the waste for each year.	-	Refer to Table 3.8.2
The amount waste capped in the landfill for each year	%	Refer to Table 3.8.3
The amount of CO_2 and Methane in the landfill gas	%	60% CO_2 40% CH_4
Trace gas profile of the landfill gas	-	Refer to Appendix 3.8.2
Moisture content of the waste		Wet
Waste Density	tonnes/m^3	0.85
Leachate Head	m	1m
Hydraulic Conductivity	m/s	1.00E-09 to 1.00E-05m/s (default)
Effective Porosity	%(v/v)	1 to 20% (default)
Leach Adsorptive Capacity	%(v/v)	1 to 5% (default)

Table 3.8.2: Composition of Waste Landfilled at the Drehid WMF

Waste Type	Domestic	Commercial	Industrial[4]
Paper	21.6%	22.5%	21.9%
Card	6.6%	26.1%	12.5%
Textiles	8.4%	0.7%	6.1%
Combustibles[1]	1.7%	1.8%	1.8%
Putrescibles[2]	30.0%	28.1%	29. 5%
Non-degradables[3]	31.7%	20.8%	28.3%

Source: EPA Waste Characterisation Study 2005, Table 6.31- Irish Municipal Waste Composition Profile

1= Composites

2= Organics, Wood

3= Plastics, Glass, Metal, Others

4 = Average municipal waste composition was used

Table 3.8.3: % of Landfill (Permitted and Proposed) that includes Final Capping System

Year	% Waste Capped	Year	% Waste Capped
2008	0%	2018	83%
2009	0%	2019	89%
2010	0%	2020	86%
2011	21%	2021	92%
2012	49%	2022	89%
2013	54%	2023	86%
2014	58%	2024	91%
2015	73%	2025	88%
2016	80%	2026	92%
2017	87%	2027	90%

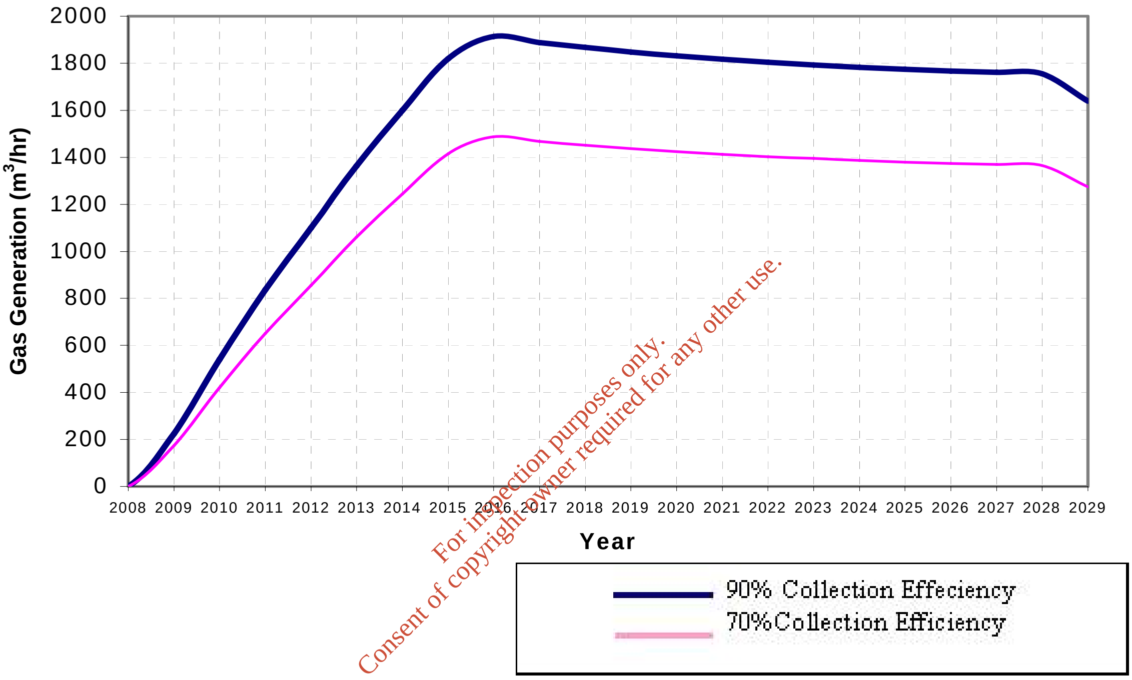
GasSimLite makes a number of assumptions in order to predict LFG levels. The main assumptions are as follows:

- GasSimLite can only be used to determine gas emissions from landfills and cannot be used for emissions from soils or groundwater;
- The model operates at steady state with a minimum time period of one year;
- The model does not determine the pressure generated by the landfill and to simplify the model, pressure has been excluded from all modules;
- GasSimLite determines the emissions for the landfill surface, and emissions for engines and flares. Lateral emissions are not determined, as these are relatively small and are therefore not considered to be significant.

3.8.5 Landfill Gas Model Results

The GasSimLite Model produces two types of result outputs. The total bulk LFG produced over the modelling period is represented in a graph of gas generation versus years. Figure 3.8.1 shows this gas production at the landfill over the period from 2008 to 2029. The second results are the predicted trace gas outputs from the landfill. These results are presented in Appendix 3.8.2.

Figure 3.8.1: Estimated Gas Production for Drehid Landfill



It can be seen from Figure 3.8.1 that a peak in gas production will occur in 2016, with 1,913 m^3/hr of landfill gas being produced. This corresponds to an annual maximum gas generation of 16,711,968 m^3.

These results represent utilisation of 90% of the gas through the on-site landfill gas (LFG) collection infrastructure. There are many factors that affect the efficiency of a LFG collection system, e.g. the design and quality of the landfill cap, the gas collection wells, pipelines, manifolds and blowers. Thus, it may not be possible to collect all of the gas available and the collection of up to 70% of the LFG available is a more conservative estimate for a gas collection system. Table 3.8.4 gives the volumes of LFG available at the landfill for 90% and 70% collection efficiency rates.

Table 3.8.4: Estimated Rates of Landfill Gas Production

Year	Gas Collection (m^3/h)	
	90% efficiency	70% efficiency
2008	0	0
2009	224	174
2010	540	420
2011	836	650
2012	1,100	856
2013	1,364	1,061
2014	1,600	1,244
2015	1,820	1,416
2016	1,913	1,488
2017	1,887	1,468
2018	1,867	1,452
2019	1,848	1,437
2020	1,831	1,424
2021	1,817	1,413
2022	1,804	1,403
2023	1,793	1,395
2024	1,783	1,387
2025	1,774	1,380
2026	1,767	1,374
2027	1,761	1,370
2028	1,755	1,365
2029	1,639	1,275

3.8.6 Landfill Gas Composition

It is predicted that the composition of the landfill gas will be similar to that outlined in the EPA Landfill Design Manual. The main constituents outlined therefore are as outlined in Table 3.8.5.

Table 3.8.5: Typical Landfill Gas Composition

Component	Typical Value (% volume)	Observed Maximum (% volume)
Methane	63.8	88.0
Carbon dioxide	33.6	89.3
Oxygen	0.16v	20.9
Nitrogen	2.4	87
Hydrogen	0.05	21.1
Carbon monoxide	0.001	0.09
Ethane	0.005	0.0139
Ethene	0.018	-
Actealdehyde	0.005	-
Propane	0.002	0.0171
Butanes	0.003	0.023
Helium	0.00005	-
Higher alkanes	<0.05	0.07
Unsaturated hydrocarbons	0.009	0.048
Halogenated compounds	0.00002	0.032
Hydrogen sulphide	0.00002	35.0
Organosulphur compounds	0.00001	0.028
Alcohols	0.00001	0.127
Others	0.00005	0.023

3.9 Capping System

3.9.1 Design of Capping System

The capping system to be implemented at the facility is outlined in the following sections. When each of the landfill phases is filled, a final cover will be constructed on the waste body. In order to limit the risk of damage to the final cap due to waste settlement, a temporary cap comprised of clay will be installed for a period of at least 2 years. During this period, the settlement of the waste body will be measured on a regular basis. Once the settlement has sufficiently decreased and when weather conditions are favourable, the construction of the final capping system will commence.

The final capping system has the following objectives:

- Minimise infiltration of water into the waste;
- Promote surface drainage and maximise runoff;
- Control gas migration; and
- Provide a physical separation between the waste body, plant and animal life.

The final capping for the landfill is detailed on Drawing No. 3369-2417.

The final cover will consist of a number of different layers, namely:

- Top soil (150 mm) consisting of local topsoil to support vegetative growth;
- Subsoil (850 mm) consisting of local subsoil;
- Mineral drainage layer (300 mm), consisting of granular material or equivalent. The drainage layer will have a hydraulic conductivity of more than $1x10^{-3}$ m/s;
- Protection layer consisting of a woven geotextile (>750g/m^2) or similar with a high CBR puncture resistance;
- Barrier layer consisting of a LLDPE liner (2.0mm) or Geosynthetic Clay Liner (GCL) or equivalent lain on 300mm of compacted clay reused from the temporary cap;
- Gas drainage layer/equalising layer consisting of geosynthetic gas drainage materials, e.g. EnkaDrain or equivalent. Complementary horizontal HDPE gas drains (diameter 75-125mm) lain in the drainage layer will also be considered.

In addition, in areas where trees are to be planted, a water permeable geotextile membrane will be placed above the drainage layer. The purpose of this geotextile membrane is to prevent root penetration through the drainage layer and into the barrier layer.

The shape of the landfill will support the final cover. Slopes will be no steeper that 1:3 for stability reasons. A detailed stability calculation on the slopes will be made in conjunction with the preparation of the construction documents and drawings for the capping for each phase of the landfill. The slopes at the top of the landfill will have to be no less than 1 in 30 in order to assist gravity drainage and to limit the possibility of ponded water. The final contours generally proposed for the site are shown in Drawing No. 3369-2436 and Drawing No. 3369-2437.

3.9.2 Method Statement for Construction

A detailed method statement for the installation of the final capping system will be prepared in conjunction with the preparation of the tender documents for installation of the capping system. This method statement will be in compliance with industry best practice.

The following is a summary of the method statement using an LLDPE geomembrane as part of the capping system:

1. Remove the temporary capping layer, recovering and stockpiling the clay where feasible. Prepare the base for the construction to the desired formation levels.
2. Extend the vertical gas collection wells to levels determined by final contours.
3. Place the gas drainage layer consisting of geosynthetic gas drainage materials, e.g. EnkaDrain or equivalent.
4. Place the layer of low permeability compacted clay (300mm) reusing the clay

from the temporary cap where feasible.

5. Ensure that the layer of compacted clay is free from any contaminants prior to laying the LLDPE liner.
6. Unroll the LLDPE geomembrane panels according to the layout plan for the panels.
7. Weld the panels using a fusion welder with an open channel for air pressure testing.
8. Visually check the liner and test the seams.
9. Unroll the woven geotextile (or similar) protection layer according to the layout plan for the panels ensuring an overlap of at least 500mm of geotextile.
10. Cover the woven geotextile (or similar) with the mineral drainage layer. Extreme care must be taken so as not to damage the geomembrane liner.
11. Beneath areas to be planted with trees place the water permeable geotextile membrane above the drainage layer.
12. Place and connect the landfill gas collection pipe work.
13. Place the 850mm of locally sourced subsoil ensuring that compaction is minimised.
14. Place the 150mm of locally sourced topsoil again ensuring that compaction is minimised.
15. Seed the topsoil in accordance with best horticultural practice.

3.9.3 *Safety Statement for Construction*

All work will be subject to the Safety, Health and Welfare at Work (Construction) Regulations 2006 (S.I. No. 504 of 2006), and all current legislation. A detailed safety statement will be prepared at contract document stage and finalised on commencement of construction.

3.9.4 *Quality Control*

The lining manufacturer and supplier will be required to have a specific quality control and assurance policy in operation which covers all aspects of the manufacture, supply and installation of their liner systems. At manufacture stage there will be a systematic dimensional, chemical and physical testing regime in place that checks a variety of liner parameters including durability and thickness undertaken to BS, ISO, ASTM, DIN standards.

With the installation of the capping system, the liner manufacturer will provide as standard the following services to the Contractor:

a) Technical consultation prior to commencement of the work to familiarise the main contractor with the capabilities of the product to assist him in determining panel size, installation methodology and design of any special equipment such as spools, carrying frames, etc., which may be required.

b) Supply to site of pre-cut panels to sizes determined by the main contractor complete with interlocks welded on and sealing tubes.

c) The manufacturer will provide one or more welding technicians on-site to cut and weld panels to dimensions determined by the main contractor on a day to day basis. These personnel will also carry out any modifications or repairs which may be required during installation.

d) The liner manufacturer will be required to provide an engineer on site during installation to give advice relating directly to their products.

3.9.5 Quality Assurance

The liner manufacturer, in order to maintain the thoroughness of all aspects of their quality control, testing and installation regime, will establish a comprehensive quality assurance plan. Quality assurance will be controlled by an experienced and fully qualified employee of the lining manufacturer.

Installation of the entire containment system, including the installation of the LLDPE liner will be carried out under the supervision of an experienced and fully qualified Resident Engineer and all ancillary staff as may be required.

Pre-Commissioning tests will consist of air testing of the seams between liner sheets. Air is pumped into the seam through a small hole drilled for this purpose. The liner seam is deemed to pass when air at a specified pressure remains at this pressure within tolerances over the test period. Test holes in seams are repaired before full integral testing of the liner. Following testing of all seams the electrical conductivity between the upper and lower faces of the liner is tested.

Pre-commissioning tests of the liner are supplemented by field tests of welding effectiveness by the testing to destruction of test welds made by the welding specialists under field conditions, and by the Quality Assurance System of the liner welding contractors. A leak detection survey for the capped cells will also be performed which will be part of the CQA programme.

3.9.6 Programme for Monitoring Landfill Settlement and Stability

The amount of settlement within landfills is difficult to predict and will depend on a number of factors such as the timing of waste deposition, the type of waste, the compaction equipment utilised, the depth of the waste etc. It is important however to monitor the extent of settlement at the landfill as the settlement process may cause damage to the cap, the gas collection and drainage systems. In particular the extent of differential settlement should be assessed.

A complete contour survey of the site will be undertaken on an annual basis. These surveys will facilitate detailed monitoring of landfill stability and settlement.

In particular at the point of installation of the temporary capping system on completion of the cells, a number of reference points will be identified for monitoring landfill settlement that can easily be located on site drawings.

The reference points will be taken at 20m intervals on designated section lines, which can be easily identified on site. The existing levels as of the date of installation of these points and their position will be taken and recorded on the appropriate drawing.

In the first two years following installation of the temporary cap, levels from these reference points will be taken on a quarterly basis in order to determine the rate of settlement at the site prior to the installation of the final capping layer. If the rate of settlement appears to be significant at the end of this period then the installation of the final capping layer will be delayed until relatively stable conditions have been achieved. For the next two years following the installation of the final capping layer levels will be taken at a six monthly frequency in order to determine the rate of settlement due to the installation of the final capping layer. Thereafter levels for these reference points will be taken on an annual basis. A visual assessment will also be carried out to identify areas of localised differential settlement.

All external landfill slopes will be designed and constructed to afford slope stability. However all slopes will be assessed annually by a qualified civil/geo-technical engineer. These surveys will facilitate detailed monitoring of landfill stability and settlement.

3.9.7 Specification for Daily Cover

The working face and the inclined front face of the working cell is covered on a daily basis with natural soils won on-site, recovered construction and demolition fines, stabilised biowaste or proprietary alternatives such as hessian, biodegradable geo-synthetic sheets etc.

3.9.8 Specification for Intermediate Cover

Intermediate cover for the landfill will comprise of, for instance, suitable demolition and construction waste such as sub-soils and clays, which will be installed as required to a depth of no less than 150mm.

3.9.9 Specification for Temporary Capping

The temporary capping layer will be installed using locally sourced low permeability clay, which will be installed in lifts of 150mm to a total depth of 300mm. This clay will be sourced from the clay borrow area on-site. The maximum amount possible of this clay will be salvaged for re-use in the final capping layer.

3.10 Restoration and Aftercare

The commitments to restoration and aftercare are as follows:

- On cessation of filling at each cell of the landfill a temporary cap will be installed which will be seeded with grass.
- Following a period of approximately two years to allow for settlement, the final capping layer will be installed which will include a low permeability liner and soil layer.
- This final capping will initially be seeded with grass to limit dust blow on these areas.
- The site will then be left to recolonise with natural species.
- The site will be landscaped in accordance with the landscape proposals outlined in Section 4.5 herein.
- Gas extraction and leachate treatment will continue post closure.
- Monitoring of gas, surface and groundwater quality and other parameters as outlined in Section 3.15 will continue post closure.

The recommendations outlined in Section 4.5, dealing with the landscaping of the site will be put in place. These recommendations will be reviewed, if necessary, as the site develops.

3.11 Construction Schedule

The construction schedule and sequence for the permitted landfill and proposed landfill extension is as outlined in Table 3.11.1, Table 3.11.2, and Table 3.11.3. The schedule outlined below however is contingent on the timing of the review of the waste licence and on the availability of suitable contractors. In particular, the construction of the basal lining system will not take place in the inclement weather conditions prevalent during winter months. The construction schedule should be read in conjunction with the proposed timing of the phasing of the landfill as outlined in Section 3.4.

Table 3.11.1: Completion Dates for Already Constructed Elements of the Permitted Drehid Waste Management Facility

Construction and Development Activities – Permitted Facility	Completion Date
Constructed surface water retention lagoons at borrow areas. Excavated required material from borrow areas and imported any additional construction materials. Constructed access route to the facility from the R403 regional road. Erected palisade fence and gate at the site entrance. Erected perimeter chain-link fence around the landfill facility. Cleared the area in Phase No. 1 of the landfill, removed all peat and levelled the ground to formation levels.	April 2007
Prepared the formation levels underlying cells 1 & 2 (Phase No. 1) for the acceptance of the basal layer.	July 2007
Constructed waste containment embankments for cells 1 & 2 (Phase No. 1)	July 2007
Placed the basal layer of BES, laid the HDPE liner and laid the protective geotextile within cells 1 & 2 (Phase No. 1). The basal liner was returned along the embankment slopes.	September 2007
Placed the leachate collection layer in cells 1 & 2 (Phase No. 1). Constructed leachate collection sump, leachate riser, interconnecting pipe work and leachate holding tanks.	December 2007
Constructed the site infrastructure including weighbridges, wheel wash, hardstand areas, administration building, site roads, wastewater collection system, oil interceptor, grit trap and surface water lagoons (1&2).	January 2008
First waste accepted at the facility.	February 2008

Table 3.11.2: Estimated Timetable for the Construction and Development of Remaining Elements of the Permitted Drehid Waste Management Facility

Construction and Development Activities – Permitted Facility	Estimated Completion Date
Construct landfill gas treatment compound and install gas flare system.	June 2008
Place the basal layer of BES, lay the HDPE liner and lay the protective geotextile within cells 3, 4 & 5 (Phase No. 1). The basal liner will be returned along the embankment slopes. Place the leachate collection layer in cells 3, 4 & 5 (Phase No. 1). Construct leachate collection sump, leachate riser and interconnecting pipe work.	June 2008
Clear the area in Phase No. 2 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 2 for the acceptance of the basal layer. Construct waste containment embankments for Phase No. 2. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 2. The basal liner will be returned along the embankment slopes. Place the leachate collection layer in Phase No. 2. Construct leachate collection sump, leachate riser and interconnecting pipe work.	December 2008
Place temporary capping layer for Phase No. 1. Install vertical gas collection wells and gas collection pipe work for Phase No.1	March 2009
Clear the area in Phase No. 3 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 3 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 3. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 3. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	September 2009
Place temporary capping layer for Phase No. 2. Install vertical gas collection wells and gas collection pipe work for Phase No.2	December 2009
Clear the area in Phase No. 4 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 4 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 4. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 4. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	June 2010

Construction and Development Activities – Permitted Facility	**Estimated Completion Date**
Place temporary capping layer for Phase No. 3. Install vertical gas collection wells and gas collection pipe work for Phase No.3.	September 2010
Clear the area in Phase No. 5 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 5 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 5. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 5. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	March 2011
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 1.	March 2011
Place temporary capping layer for Phase No. 4. Install vertical gas collection wells and gas collection pipe work for Phase No.4.	June 2011
Clear the area in Phase No. 6 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 6 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 6. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 6. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	December 2011
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 2.	December 2011
Place temporary capping layer for Phase No. 5. Install vertical gas collection wells and gas collection pipe work for Phase No.5.	March 2012
Clear the area in Phase No. 7 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 7 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 7. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 7. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	September 2012
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 3.	September 2012
Place temporary capping layer for Phase No. 6. Install vertical gas collection wells	December 2012

Construction and Development Activities – Permitted Facility	Estimated Completion Date
and gas collection pipe work for Phase No.6.	
Clear the area in Phase No. 8 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	June 2013
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 4.	June 2013
Place temporary capping layer for Phase No. 7. Install vertical gas collection wells and gas collection pipe work for Phase No.7.	September 2013
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 5.	March 2014
Place temporary capping layer for Phase No. 8. Install vertical gas collection wells and gas collection pipe work for Phase No.8.	June 2014
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 6.	December 2014
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 7.	September 2015
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 8.	June 2016

Table 3.11.3: Timetable for the Construction and Development of the Proposed Extension to the Drehid Waste Management Facility

Construction and Development Activities – Proposed Facility	Estimated Completion Date
Construct Surface Water Lagoons, (No. 3 & 4) and associated drainage works	January 2014
Clear the area in Phase No. 9 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	March 2014
Clear the area in Phase No. 10 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	December 2014
Place temporary capping layer for Phase No. 9. Install vertical gas collection wells and gas collection pipe work for Phase No.9.	March 2015
Clear the area in Phase No. 11 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	August 2016
Place temporary capping layer for Phase No. 10. Install vertical gas collection wells and gas collection pipe work for Phase No.10.	November 2016
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 9.	March 2017
Clear the area in Phase No. 12 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8.	December 2018

Construction and Development Activities – Proposed Facility	Estimated Completion Date
Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 10.	November 2018
Place temporary capping layer for Phase No. 11. Install vertical gas collection wells and gas collection pipe work for Phase No.11.	March 2019
Clear the area in Phase No. 13 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	April 2021
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 11.	March 2021
Place temporary capping layer for Phase No. 12. Install vertical gas collection wells and gas collection pipe work for Phase No.12.	July 2021
Clear the area in Phase No. 14 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8. Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	August 2023
Place temporary capping layer for Phase No. 13. Install vertical gas collection wells and gas collection pipe work for Phase No.13.	November 2023
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 12.	July 2023
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 13.	November 2025
Clear the area in Phase No. 15 of the landfill, remove all peat and level the ground to the formation levels. Prepare the formation levels underlying Phase No. 8 for the acceptance of the basal layer. Construct waste containment embankments within the boundary of Phase No. 8.	December 2025

Construction and Development Activities – Proposed Facility	**Estimated Completion Date**
Place the basal layer, lay the HDPE liner and lay the protective geotextile within Phase No. 8. The basal liner will be returned along the embankment slopes. Place the leachate collection layer. Construct leachate collection sump, leachate riser and interconnecting pipe work	
Place temporary capping layer for Phase No. 14. Install vertical gas collection wells and gas collection pipe work for Phase No.14.	March 2026
Place temporary capping layer for Phase No. 15. Install vertical gas collection wells and gas collection pipe work for Phase No.15.	February 2028
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 14.	March 2028
Construct final capping layer. Make adjustments to vertical gas collection wells and collection pipe work. Complete all landscaping measures for Phase No. 15.	February 2030

3.12 Site Construction and Material Borrow Areas

It is proposed to intensify the acceptance of waste for a period of 7 years and construct the proposed extension to the Drehid Waste Management Facility following the successful application to the EPA for an amended Waste Licence and to An Board Penal for Planning Permission.

The construction works associated with this development involve normal construction activities such as excavation, filling, pumping, pipe laying, concrete works, structural steel work, road construction, mechanical installation etc. Blasting is not envisaged for this development.

In the following sections, potential impacts which may occur during the construction phases of the landfill and in particular relating to the borrow areas at the Drehid Waste Management Facility are outlined. Mitigation measures addressing these potential impacts are also outlined.

The potential impacts and mitigation measures presented in Section 4 of the EIS relate both to the landfill and to the borrow areas on the site. However in order to provide additional clarity the specific elements relating to site construction and the borrow areas are presented separately in this section.

3.12.1 General

3.12.1.1 Description of Clay Borrow Area

The location of the clay borrow area is as shown on Drawing No. 3369-2402, with plan and sections of the clay borrow area shown on Drawing No. 3369-2432. Planning permission for the periodic excavation of the clay borrow area, as a source of low permeability clay for the construction of embankment/bunds and landfill capping material, has already been secured.

Construction of the facility to date has not necessitated the excavation of the clay borrow area due to the availability of suitable materials, for the construction of embankments and bunds, exposed during the stripping and clearing of areas to required formation levels. Bord Na Móna will endeavour to continue this construction approach for the remainder of the facility.

The plant to be used will include a D6 bulldozer, tracked excavator, and trommel screen for processing the clay extracted from the borrow area. The clay will be dug out using a combination of the bulldozer and tracked excavator and loaded into the trommel screen for processing. The processed clay will be hauled to the landfill phase under construction using 25 tonne dump trucks. The trommel will feed the processed clay directly into the trucks or onto a stockpile depending on the immediate requirement for

clay. Stockpiled clay will be loaded into the trucks using tracked excavators. It is not intended that significant stockpiles will be constructed at the clay borrow area as the clay will be utilised within a maximum of two to three days during the construction periods. Some stockpiles will be however formed for the ongoing provision of cover at the facility. These clay stockpiles will be covered with industrial tarpaulin to prevent dust.
Similar to the landfill footprint, the clay borrow area will be progressively restored on a phased basis. When each area of the borrow area has been fully exploited the area will be graded to ensure that the side slopes are safe.

There will also be times when a specific working area of the borrow area will not be fully worked and six months to a year may elapse before the extraction of clay recommences at this area. This is due to the cyclical nature of the clay requirements at the landfill due to the construction schedule for the lined cells and capping as outlined in Table 3.11.1, Table 3.11.2 and Table 3.11.3. Because of the low permeability of the clay, and the fact that the water table will be close to the ground level, there is very little potential for dust to be generated from the clay borrow area when it is not in use.

Following the full realisation of the clay borrow area when the landfill has been fully restored the clay borrow area will also be fully restored. Any side slopes, which at that time had not been regarded, will be regarded to a safe side slope. The borrow area will be allowed to flood to form a lake. The restoration plan is detailed on Drawing No. 3369-2437.

3.12.1.2 Description of Sand & Gravel Borrow Area

The location of the sand and gravel borrow area, already permitted and partially excavated, is as show on Drawing No. 3369-2402, with plan and sections of the sand and gravel borrow area shown on Drawing No. 3369-2431. The sand and gravel borrow area is used on a periodic basis for the provision of sand for use in the Bentonite Enhanced Soil (BES) layer of the basal barrier. The sand and gravel borrow area will also be used to provide granular material for the capping drainage layer on the landfill and also granular sub-bases for the facility roads.

During construction phases at the facility, screens are utilised for processing the sand and gravel extracted from the borrow area. The processed material is hauled to the landfill phase under construction using 25 tonne dump trucks. Screens feed the processed materials directly into trucks or onto separate stockpiles depending on the immediate requirements. Stockpiled sand and gravel is loaded into the trucks using tracked excavators. Stockpiles of sand and gravel are maintained in the vicinity of the sand and gravel borrows area to ensure continuity of construction.

Similar to the landfill footprint, the sand and gravel borrow area will be progressively restored on a phased basis. When each area of the borrow area has been fully exploited the area will be graded to ensure that the side slopes are safe.

There will also be times when a specific working area of the borrow area will not be fully worked and six months to a year may elapse before the extraction of sand and gravel recommences at this area. This is due to the cyclical nature of the material requirements at the landfill due to the construction schedule for the lined cells and capping as outlined in Table 3.11.1, Table 3.11.2 and Table 3.11.3. Because of the high water table there is no potential for dust to be generated during this period.

Following the full realisation of the sand and gravel borrow area when the landfill has been fully constructed the borrow area will also be fully restored. Any side slopes, which at that time had not been regarded, will be regarded to a safe side slope. The sand and gravel borrow area will be allowed to flood to form a lake. The restoration plan is detailed on Drawing No. 3369-2437.

3.12.1.3 Construction Management Plan

A Construction Management Plan has been drawn up prior to the commencement of construction activities, in order to minimize the impacts to the environment during construction. This procedure will continue during the construction of the remainder of the facility. The Construction Management Plan details the allowable working day, construction traffic, parking arrangements and incorporates environmental protection measures and is included as a part of the contract for any part of these works. Provisions to reduce the environmental impact of the construction activities include the following:

- Contractors are required to ensure that no pollution or obstruction of ground water and watercourses is caused by their operations.
- Contractors are required to comply at a minimum with the provisions of BS 5228 (Noise Control on Construction and Demolition Sites), Part I & Part 2, 1997.
- Where necessary, contractors are required to erect suitable noise barriers to minimise disturbance and avoid nuisance when operating machines at night (between 2000 hours and 0800 hours).
- Limiting vibration caused by construction plant to the maximum permitted values in BS6472, 1992 (Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz).
- Contractors are required to take reasonable precautions to ensure that all wastewater discharged shall not be harmful to or cause obstruction or deposit in drains and to prevent oil, grease or other objectionable matter being discharged into drains.
- Contractors are required, during the execution of works, to keep all plant and

materials and all equipment connected with the construction of the works in good working order, clean and tidy.

- Contractors are required to remove any waste materials from the site to a licensed waste facility.
- Contractors are required to ensure that the public roads in the vicinity of the site are maintained free from all mud, dirt and rubbish, which may arise from or by reason of the execution of the works. To facilitate this, Contractors are instructed to use the already installed wheel wash at the facility.
- Disposal of excess concrete on any part of the construction site is prohibited.
- Contractors are required to provide a designated bin for washing down the chutes of concrete lorries on site.
- Contractors are required to keep the construction compounds free and clear of excess dirt, rubbish piles and scrap wood etc. at all times. Contractors are required to keep the designated parking area and other common areas clear and free of rubbish and debris.
- Contractors are required to be responsible for the disposal of all wood, food, food packaging and paper generated during the construction phase and are required to furnish containers and vehicles to collect and haul these items and dispose of them to a licensed waste recovery facility. Dumping of these items within the construction site is prohibited.
- Scrap materials, rubbish, etc. must be hauled out of the work areas (daily) and disposed of by the Contractor on a daily basis to a licensed waste recovery facility.
- Contractors are required to obtain any necessary permits from the Local Authority or Environmental Protection Agency for the disposal of waste.
- At the completion of the work, contractors are required to leave the construction area in a neat, clean and orderly condition.
- Individual contractors are required to provide sanitary facilities that are adequate for their construction personnel. Sanitary facilities include proper wash down WC's with sewer connections, or if this is impractical, chemical closets.
- All temporary buildings associated with construction of the development must comply with the Safety, Health and Welfare at Work Regulations (2005). On completion of the works, contractors must remove them entirely with all slab, drains and water mains and restore the surface of the land to its original condition or other reasonable conditions.

In addition, any excavated material generated during the construction of the facility is reused on site, where appropriate. Parking facilities for construction vehicles and private transportation are located within the development site. Temporary site fencing is erected and maintained to secure the site during the construction phase.

3.12.2 Noise

Noise impacts will arise at night-time or during weekend periods. For this reason all earthmoving, construction and site development is not undertaken after 20.00. The remoteness of the site further contributes towards the mitigation of noise impacts.

In addition all plant and machinery used on-site complies with the EC (Construction Plant and Equipment) Permissible, Noise Levels Regulations 1988 (SI No. 320 of 1988) at all times. Periodic assessment is undertaken to identify noisy plant and any necessary modifications or repairs are made.

All site activities continue to be planned with a view to minimising the impact of noise. This is achieved by practical means such as locating stockpiles of excess excavated material in areas where they provide acoustical screening. Facility access roads are located internally within the site, such that, they are a significant distance from any dwellings.

Construction contractors are required to take all necessary precautions to ensure the enjoyment of privacy by third parties, and are at all times required to comply with the recommendations of BS 5228, Noise Control on Construction and Open Sites, Part 1 1984, Code of Practice for Basic Information and Procedures for Noise Control. Monitoring of noise levels is undertaken during the construction of the facility as outlined in Section 3.15.6 to ensure compliance with the relevant standards.
The following table outlines the results from a noise survey undertaken during the initial construction stage of the permitted facility.

Table 3.12.1: Noise Monitoring Results – March 2007 - dB(A) and 30-minute intervals

Location	Date	Time	Leq	L_{10}	L_{90}	Comments
DAYTIME MONITORING						
N1	22nd March 2007	14.47	51.5	44.8	34.2	Dominant noise sources included facility construction activity to the northeast, site activity from the stud (Approx 500m west from N1) including a radio and constant birdsong. Distant traffic, a dog barking and a passing tractor also contributed to noise levels.
N2	22nd March 2007	13.43	39.9	42.3	32.0	Facility construction activities were not audible at this location. Dominant noise sources included distant traffic to the northwest and frequent traffic passing along the L5025 road. Occasional dogs barking to northwest also contributed to noise levels.
N3	22nd March 2007	13.01	40.4	41.1	32.6	Dominant noise sources included distant traffic to the northwest and frequent traffic passing along the L5025 road. Constant bird song and a moderate breeze in surrounding vegetation also contributed to noise levels. Occasionally site activities were slightly audible to the southwest
N4	22nd March 2007	17.27	74.4	78.6	49.3	Dominant noise source at this location is passing vehicles on the R403 road. Constant birdsong and a passing helicopter also contributed to noise levels. Site activities were occasionally audible at N4.
N5	22nd March 2007	16.11	47.4	39.9	32.5	Dominant noise sources include distant traffic to the northeast and occasional site activity to the northwest. Constant bird song and a slight breeze in surrounding vegetation also contributed to noise levels.

Table 3.12.2: Noise Monitoring Results – December 2007 - dB(A) and 30-minute intervals

Location	Date	Time	Leq	L_{10}	L_{90}	Comments
DAYTIME MONITORING						
N6	10th December 2007	14:45	41.2	42.3	38.3	Mushroom facility and stud farm were dominant sources, traffic on adjacent roads audible. Birdsong and passing aircraft also contributed to noise levels. Foliage noise also audible.
NIGHT TIME MONITORING						
N6	10th December 2007	22:08	36.0	38.0	32.4	Mushroom facility was dominant source, traffic on adjacent roads audible. Birdsong and passing aircraft also contributed to noise levels. Foliage noise also audible. Helicopter circling overhead. Modified cars (large bore exhausts) racing on main road in distance.

It should be noted however that given the size of the Bord na Móna site, the location of the landfill within the site and the distance from the landfill footprint to any residences combined with the mitigation measures outlined results in minimal noise impact associated with the construction of the facility.

Potential impacts and mitigation measures for noise for both the waste management facility and the borrow areas have been addressed in Section 4.1.2 of the EIS.

The construction area, including the borrow areas, is located in a predominantly rural location. Noise emissions specific to the borrow areas arise through a number of sources, e.g.:

- The operation of plant and machinery during the initial site preparation works at the borrow areas including the construction of the settlement lagoons.
- The operation of earthmoving plant and screening equipment during the extraction and processing of the clay, sand and gravel.

Generally noise emissions arise on an intermittent basis depending on the activity level of certain plant and equipment. While noise emissions arise through the operation of a number of noise sources, the most significant noise sources at the borrow areas have been identified as follows:

- Screening plant for the processing of clay, sand and gravel
- 2 No. Tracked Excavator
- 1 No. Dragline Excavator
- 1 No. D6 Bulldozer
- 1 No. Site Tractor
- 1 No. Road Sweeper
- 25 tonne Dump Trucks

In theory, the operation of such plant in conjunction with the other plant for the overall facility results in an activity L_{Aeq} of between 67 and 80 dBA at a distance of 10 metres (L_{Aeq} is defined as the equivalent continuous A-Weighted sound pressure level in dB). The activity L_{Aeq} is the value of the equivalent continuous A-Weighted sound pressure level determined at a distance of 10 m from and over the period of a given activity.

Details of the activity L_{Aeq} of the various sources of plant/equipment including those at the borrow areas are presented in Table 4.1.2. The noise impact of the sources specific to the borrow areas (as outlined in Table 4.1.3) are detailed in Section 4.1.2.

As outlined therein, at any given time during construction a maximum of two or three items of plant or equipment are operating. The attenuation by beam spreading (distance) ensures that the impact at the nearest houses is substantially reduced. The theoretical impact of three items of plant or equipment operating at the facility is 46.2 dBA at the nearest house. As can be seen in Table 3.12.2, the actual noise level measured at N6 (Newly built house) during a construction phase was 41.2 dBA, thus validating the theoretical approach adopted.

During the normal operation of the landfill i.e. outside of periods of construction when the borrow areas are dormant the impact will be substantially lower than this.

As all traffic will follow the same dedicated access route to the facility the noise impacts relating to the construction traffic entering the facility, from the R403, are addressed cumulatively with the noise impacts relating to waste haulage in Section 4.1.2 herein.

There are currently no statutory limits for the control of environmental noise in Ireland. In practice noise limits have been established for industrial activities having regard to local circumstances and the need for environmental protection. In 1995 the EPA issued a Guidance Note in relation to noise for scheduled activities. Although this guidance relates specifically to IPC licensed activities, it does provide a useful noise criterion. The Guidance Note states that *"…ideally, if the total noise level from all sources is taken into account, the noise level at sensitive locations should be kept below an* L_{ArT} *value of 55 dB(A) by day time. At night to avoid disturbance the noise level at noise sensitive locations, should not exceed a* L_{ArT} *value of 45 dB(A)."* In addition, "*audible* *tones and impulsive noise at sensitive locations at night should be avoided irrespective of the noise level".* Furthermore, the EPA Waste license for the facility sets similar limits for noise at the site.

Overall, the proposed site is extremely remote and plant and machinery operating within the site does not give rise to significant noise impacts at any residential property.

3.12.3 Dust

Due to the granular nature of some of the material required for the construction of the landfill, wind blown dust can impact on the surrounding environment during construction; however the measures detailed below mitigate their impact.

All embankments and soil stockpiles are vegetated immediately following placement to anchor the soil and reduce the surface area open to the environment. In periods of dry weather, spraying of the access routes and other exposed areas is undertaken to help reduce dust emissions. The temporary and permanent wheel washes on site ensure that the vehicles using the landfill site do not cause dust emission.

Given the nature of the activity permitted and currently undertaken at the borrow areas, dust generation is inevitable. The commencement of the extraction and processing of clay in the clay borrow area will generate a level of dust. This is exacerbated during periods of dry windy weather. However it is envisaged that the expected dust emission levels from the clay borrow area will not exceed 350 mg/m²/day. Dust monitors have been installed onsite at the locations shown on Drawing No. 3369-2407. In particular dust monitoring at these locations is and will continue to be carried out during the operational phases of the borrow areas. Dust monitoring carried out, during excavation and processing of material at the sand and gravel borrow area for the construction of the initial phase of the facility, has provided assurance that mitigation measures and good construction practices are effective in achieving dust levels below 350 mg/m²/day.

Likely sources of dust associated with the borrow areas include the following:

- Construction trucks carrying dust on their wheels;
- Unvegetated stockpiles of construction materials including processed clay, sand and gravel;
- Excavation and processing of clay from the clay borrow areas;
- Excavation of sand and gravel materials;
- The grading and processing of construction materials including the screening of the clay.

The control of dust at the site is addressed in Sections 3.3.5, 3.14.6 and 4.1.1 of the EIS. In summary the following mitigation measures relating to the borrow areas have been provided/implemented:

- The wheel-wash at the facility is positioned to ensure that construction vehicles do not carry excess soil and material onto the shared haul road to the landfill.
- In periods of dry weather, spraying of the haul routes and other exposed areas is undertaken to help reduce dust emissions.
- All clay stockpiles are vegetated immediately following placement to anchor the clay and reduce the surface area open to the environment.

The extraction of material from the borrow areas has a negligible effect on the environment. Given that the borrow areas are enclosed within the Bord na Móna site, it is considered that the nuisance due to dust generated is negligible for the local residents.

3.12.4 Climate

Given the nature of the activities proposed at the borrow areas potential impacts are not expected on the local climate of the area.

3.12.5 Groundwater

A previously permitted sand and gravel borrow pit and clay borrow area are located within the site boundary (See Drawing 3369-2402). The clay borrow area will be used to provide clay for the landfill capping layers and as a backup source of material for the construction of embankments. The sand and gravel borrow pit has provided and will continue to provide sand for the Bentonite Enhanced Soil (BES), granular material for the mineral drainage layer in the landfill and for the facility roads sub-grades. As the sand and gravel borrow pit has been excavated partly into the water table the provision of drainage of the pit area and treatment/settlement of the drainage water was required prior to discharge to the adjacent existing surface water system.

As the discharge contains clay and silt particles, a settlement lagoon has been installed between the pit and the existing surface water system to allow for settlement of fines. As detailed in the planning process for the permitted facility, minor changes in the shape of the shallow water table in the vicinity of the pit are likely to result from the excavation. The impact of these changes are localised and are considered insignificant.

Groundwater sampling is carried out to ensure that the groundwater environment is not adversely impacted during the construction of the facility.

3.12.6 Surface Water

Section 4.4 of the EIS details potential impacts and proposed mitigation measures relating to surface water. The extent of the borrow areas in relation to the site surface water drainage network is illustrated on Drawing No. 3369-2433 of the EIS. Where surface water features cross the borrow areas or the landfill footprint, the surface water drainage network is diverted.

The main potential adverse impact is considered to result from sediment-laden run-off entering the existing site drainage network. To this end, surface water settlement lagoons have been constructed for the previously permitted landfill and the borrow areas. Additional settlement lagoons will be constructed for the proposed landfill extension.

All precipitation falling on stripped areas of the landfill footprint and any restored areas is diverted into the surface water swale and flows by gravity to the settlement lagoons for the landfill area.

In the sand and gravel and clay borrow areas all precipitation falling and infiltration into the active area of the borrow pits is drained or pumped into the settlement lagoons, from where it is discharged to the existing environment. This is to ensure that the extraction of materials from the borrow areas does not adversely impact on the surface water environment.

One of the primary construction tasks undertaken was the construction of the surface water settlement lagoons to the south of the previously permitted Facility. The construction of these lagoons required the movement of clay to raise embankments and the compaction of the base layer. Sediment laden run-off from bare soil has the potential to adversely impact on the quality of the surface water environment adjacent to the Facility. The embankments were planted immediately following their construction, to anchor the soil. Temporary silt traps were constructed for the duration of the construction of the surface water lagoon. A similar construction approach is proposed for the construction of the proposed additional surface water lagoons.

The earthworks required to construct the embankments for the initial stage of the permitted landfill were only undertaken following the construction of the surface water swale and surface water holding lagoons.

All run-off from the construction area was then diverted to the lagoon, prior to discharge to the existing surface water environment. The paved road and other hardstand areas in the operations area were constructed with gullies to drain all surface water run-off and allow settlement prior to discharge via an oil interceptor and grit trap, to the surface water lagoon and subsequently to the adjacent, surface water environment.

The contractor appointed to undertake the earthworks was required to ensure that all appropriate measures were taken to minimise the impact on the surface water environment. Precautionary measures, such as having hydrocarbon spill kits on-site, was required, to deal with minor leakages and spills. Regular inspections of equipment were undertaken to detect leakages of hydraulic fluids and/or hydrocarbon.

As part of the monitoring programme, surface water samples were taken and will continue to be taken, upstream and downstream of the facility at regular intervals to determine if the construction is adversely affecting the surface water environment.

Based on the success of the measures implemented to mitigate the risk to the surface water environment during the initial stage of construction of the permitted facility, the impacts on the surface water environment during the construction of the proposed landfill extension are not considered significant.

3.12.7 Landscape

Potential visual impacts and mitigation measures outlined within the scope of Section 4.5 of the EIS, which are applicable to the construction and borrow areas, are outlined in the following sections.

Potential visual impacts occur as the result of the following specific site development works at the borrow areas:

- Alterations to existing landforms to accommodate the development.
- Landscape infrastructure works, both 'hard' and 'soft' (e.g. planting, ground-shaping, etc)
- The excavation of materials from the borrow areas for the construction of the basal and capping layers.

The impact of a development on the character of the landscape is dependent on the vulnerability and sensitivity of the affected landscape, and its ability to accommodate change. The following is a summary of the potential impacts.

The greatest levels of visual impact arising from the construction of the facility will be on views from the County road (L5025) north of the northern site boundary, and on a small number of properties and road users located to the southwest.

The remaining views within the 5km study area will experience negligible to low/moderate visual impact, generally due to the screening capacity of intervening vegetation.

All attempts will be made to integrate the development into the site, in particular by establishment of effective tree/shrub screens to site boundaries to reduce visual impact on surrounding receptors. A restoration plan has been proposed for the mitigation of visual and landscape impacts caused by the proposed landfill extension. The main features of this plan are:

- Planting of locally occurring native woodland on the northern perimeter of the site to develop an initial screening vegetation
- Similar planting on capping of the landfill, in order to integrate the landfill into the existing landscape, and facilitate the potential development of the site into an amenity area.
- The formation of two lakes following decommissioning of borrow pits.
- Recommendations for hedgerow planting along the minor road directly to the north of the site in order to limit the currently open views.
- Grassing of the mound with native species.

3.12.8 Ecology

Potential impacts on the ecology of the overall facility have been described in Section 4.6 of the EIS. Designated conservation areas within 10 km of the development are listed in Table 2.7.2 There will be no direct impacts on any designated conservation areas as all are located some distance from the development; the nearest site, the Grand Canal (pNHA 002104) is 900m from the facility access road and approximately 5km from the landfill footprint. Sediment release into the surface water drains present on the Timahoe Bog area could potentially reach the river Barrow cSAC, causing an indirect impact. However, the river Barrow is a considerable distance from the site activity boundary (approximately 20km) and any impact would be insignificant. Nonetheless, mitigation measures have been implemented to prevent pollution of the surface waters through siltation.

There will be a minor impact on animal and bird populations in the vicinity of the proposed development. This may include disturbance and loss of areas of semi-natural habitat for feeding, breeding and cover.

The removal of vegetation and associated earth works during the construction phase at the landfill footprint, results in the release of sediments, giving rise to a risk of siltation in streams in the area. This can be potentially damaging to the aquatic ecology and requires mitigation to avoid significant impact. Section 3.12.6 above gives details on mitigation measures required to prevent pollution of surface waters.

Following are mitigation measures, which have been implemented to reduce the potential impacts of the development on the local ecology:

- The location of the development has been selected to avoid impacts on any designated areas and sites of international or national ecological value.
- Any removal of scrub or other areas of semi-natural habitat is carried out in accordance with best practice in order to minimise impacts on breeding birds.
- Surface run-off from roads and hardstanding within the facility are fed through

petrol/oil interceptors, which have been designed with sufficient capacity for the catchment.

- Concrete (including waste and wash-down water) is contained and managed appropriately to prevent pollution of watercourses. Foul drainage from all site offices and construction facilities is contained and disposed of in an appropriate manner to prevent pollution of watercourses.
- All leachate from the landfill and surplus wastewater is contained and removed off-site for disposal to approved wastewater treatment facilities, thus avoiding potential adverse impacts on watercourses.
- Silt laden run-off is collected in settlement lagoons which have been installed at the borrow areas.

3.12.9 Cultural Heritage

Potential impacts and mitigation measures relating to the cultural heritage of the overall facility have been described in Section 4.8 of the EIS. Although no archaeological sites were identified during the walkover carried out during the planning stage of the permitted facility, the recovery of a flint blade from the surface area in the vicinity of SMR 009:019 suggested the possible presence of further archaeological activity in the area.

Bogs are an important resource for the archaeological record and given the archaeologically sensitive nature of the bog there is the possibility of finding further archaeological deposits such as fulachta fiadhs and ritual deposits.

The vegetation will be removed from the area of the preferred landfill extension prior to any construction activities. This will assist in determining if any features of archaeological significance, such as toghers, are present, and will indicate the archaeological potential of the area.

A suitably qualified archaeologist monitored the removal of vegetation and drain cutting carried out prior to the construction of the initial phase of the permitted waste management facility. This work was undertaken well in advance of commencement of construction works. A report of the findings of the follow up survey was submitted to The Heritage and Planning Division of the Department of Environment, Heritage and Local Government for review. A similar approach will be undertaken for the construction of the proposed landfill extension.

3.12.10 Traffic

It is considered that the construction of the proposed landfill extension at Drehid WMF will result in a minor impact on traffic flows along the adjoining road network. Potential impacts and mitigation measures relating to traffic on the site have been described in

Section 4.9 of the EIS.

Most of the plant and equipment required for the earthworks programme are transported to the site and remain on-site for the interval required to construct each phase. As outlined in Section 3.6 a significant percentage of the materials required for the construction of the facility, in particular the clays, sand and granular material is won on-site.

The potential clay required for the construction of the landfill (Bund construction, temporary cover and capping) is calculated to be in the order of 382,149m^3. A successful approach used during the construction of the initial phase of the permitted facility to use excavated material, from stripping and clearing activities, to construct bunds and embankments will mean that all required additional clay can be achieved using a previously permitted clay borrow area of approximately 10 hectares.

The amount of sand required for the basal layer is calculated to be in the order of 150,480m^3. The amount of granular material for the mineral drainage layer is approximately 109,008m^3, and the amount required for the sub-grade for roads on site is approximately 33,000m^3. These volumes of sand and gravel can be obtained from the previously permitted sand and gravel borrow area of 12.7 hectares.

The resultant traffic due to the construction of the facility is outlined in Section 4.9. In addition the construction of the landfill will not result in any surplus material being hauled off-site.

Appropriate traffic warning signs have been erected, at appropriate locations, to warn oncoming traffic of the facility and to ensure the safety of other road users. Adequate sightlines are available at the site entrance on the R403.

A temporary wheel wash was provided within the site, prior to the construction of the permanent wheel wash, to ensure that soil and debris are not carried to the public road. The permanent wheel wash is now installed, commissioned and available for use by construction vehicles.

As the borrow areas are located within the Bord na Móna site there will be no traffic impacts associated with this activity except for those within the site. The plant and equipment required for the extraction and processing of the clay are transported to the site and remain on-site for the interval required to construct or cap each phase. Trucks hauling clay, sand and gravel remain within the site and do not need to use the local public road network to haul to the landfill footprint.

3.12.11 Human Beings

Potential impacts and mitigation measures relating to human beings for the overall site have been described in Section 4.7 of the EIS. The following paragraphs reiterate those applicable to the construction and borrow areas.

There will be no disruption to the social travel patterns of those residing adjacent to the subject lands. The regional road network and the purpose built private access road, from the R403 to the permitted facility entrance, are used to access the Drehid Waste Management Facility. No public roads will be severed by the development, nor will any pedestrian routes.

There are no impacts on human health due to the construction activities on the site.

There are no Listed or other buildings of significant architectural or cultural heritage within the vicinity of the site, save for Coolcarrigan House. This dwelling is located some 2.5km from the previously permitted landfill footprint and proposed extension and is screened from the facility by an extensive coniferous forestry plantation to the west of the house.

There is no visual impact on any of the surrounding items or facilities of tourist potential. The amenity and tourist potential thereafter, especially of the waterways, are only compromised if those seeking to travel to such, might consider the impact of the additional traffic movements along the surrounding regional routes, as an intrusion. The Grand Canal is at such a distance from the facility, that along with the existing and permitted vegetation cover, views of the development from the Grand Canal will be non-existent.

Therefore, with the exception of the licensing system to control the roads to be used by the haulage vehicles, and the landscaping and other aforementioned controls that have been/will be incorporated especially in compliance with relevant planning conditions, no further measures are suggested.

3.12.12 Material Assets

Potential impacts and mitigation measures relating to material assets for the overall site have been described in Section 4.10 of the EIS. The following paragraphs address those applicable to the construction and borrow areas.

The development has the potential to create a reduction on the value and amenity enjoyed by the owner/occupants of all such structures adjacent, due to the operation of this waste management facility in terms of noise, dust and vehicular movements.

In mitigation, construction activities including activity at the borrow areas are only operational during periodic construction phases as outlined in the schedule provided in Table 3.11.1, Table 3.11.2 and Table 3.11.3.

3.12.13 Interaction of the Foregoing

The impacts of construction activities in all areas of the development, including the previously permitted borrow areas, and the measures proposed to mitigate these impacts, have been previously detailed in the EIS and herein. However, there is also the potential for interactions between impacts associated with the construction and borrow areas. The result of these interactions may either exacerbate the magnitude of the impact or may in fact ameliorate it. As part of the requirements of an Environmental Impact Statement, the interactions of the impacts on the surrounding environment need to be addressed.

These interactions have been mitigated as follows:

- Dust suppression and vehicle wheel washes are utilised to mitigate the impact of wind blown dust around the site and to nearby dwellings.
- Landscaping measures to mitigate both the visual impact and noise impact of the development.
- The construction of screening berms to the north end of the landfill mitigates any visual impact during construction.

While there is potential for the above impacts to interact and result in a cumulative impact, the mitigation measures outlined above have been successful in minimising environmental degradation to insignificant levels during the construction of the initial stage of the development.

3.13 Site Management

3.13.1 Hours of Operation

The facility operates, as permitted, on a daily basis from 8.00am to 6.30pm Monday to Saturday each week. Waste is accepted at the facility between the hours of 8.00am to 6.00pm. This allows time for the daily cover of the waste at the landfill.

The aeration of the composting process will operate on a continuous basis (24 hours per day; 7 days per week), and will be computer controlled in the absence of an operator on-site.

The facility will only operate outside these hours when required to cater for the later arrival of refuse vehicles due to breakdown or other exceptional circumstances. Waste that is accepted at the composting facility at or near closure of operating hours will be unloaded in the acceptance area and stored overnight and handled during the next working day.

3.13.2 Plant and Equipment

The following plant and equipment is employed on-site:

- 1 No. waste compactor
- 1 No. back-hoe excavator
- 1 No. D6 dozer
- 1 No. site tractor
- 1 No. water bowser
- 1 No. road sweeper
- 1 No. diesel pump
- 1 No. standby generator

A dump truck (typically A25 or equivalent) will be procured for the movement of low permeability clay for use in temporary capping.

The following plant specific to the composting facility will also be employed on site.

- 1 No. industrial front end loader
- 1 No. 360° hydraulic excavator with a grab attachment
- 1 No. trommel screen
- 1 No. shredder (periodic basis only)

3.13.3 Waste Acceptance Procedures

Waste acceptance procedures comply with the EPA's Draft Landfill Manual on Waste Acceptance (1998) and in accordance with Council Decision 2003/33/EC (The criteria and procedures for the acceptance of waste at landfills, pursuant to Article 11 of, and

Annex II to, Directive 1999/31/EC (Landfill Directive)).

Only household, commercial and non-hazardous industrial wastes which have been pre-treated or are not suitable for pre-treatment are accepted onto the site. Suitable construction and demolition waste is also accepted on-site for the construction of various elements of the landfill site.

Waste is accepted at the facility only from customers who are holders of a waste collection permit, unless exempted, under the Waste Management (Collection) Permit Regulations 2001. The facility does not accept waste delivered directly by the general public and a civic amenity facility is not provided at the Drehid Waste Management Facility.

Waste contractors using the site are required to have a contract with Bord na Móna. This ensures that all contractors have been assessed in advance and the general composition of the waste is known. Any contractors who arrive on-site without such a contracted agreement are refused entry and turned away.

Only household, commercial and non-hazardous industrial wastes that have been subject to treatment or are not suitable for treatment are accepted onto the site for deposition to the landfill.

The waste contractor/carrier is required to provide documentation, which allows a written record to be maintained for each load of waste arriving at the facility. The following information is recorded:

a) the date;
b) the name of the carrier (including if appropriate, the waste carrier registration details);
c) the vehicle registration number;
d) the name of the producer(s)/collector(s) of the waste as appropriate;
e) the name of the waste facility (if appropriate) from which the load originated including the waste licence or waste permit register number;
f) a description of the waste including the associated EWC codes;
g) the quantity of the waste, recorded in tonnes; and,
h) <u>the treatment, where applicable, to which the waste has been subjected</u>.

Bord na Móna also records the following information:

a) the name of the person checking the load; and,
b) where loads or wastes are removed or rejected, details of the date of occurrence, the types of waste and the facility to which they were removed.

Loads suspected of being non-compliant entering the landfill are tipped at the waste inspection area and inspected by the facility manager/supervisor. If the load is non-compliant then the waste contractor is responsible for removing it off-site. Compliant loads are reloaded utilising Bord na Móna waste handling plant on-site and deposited at the appropriate working face of the landfill.

Following logging of authorised vehicles at the in-weighbridge these vehicles are directed to the working face of the landfill. The compactor operator also carries out visual inspections of all loads entering the facility, at the working face of the landfill, to ensure that no undesirable material is mixed through the waste.

The landfill only accepts waste delivered in fully contained or covered heavy goods vehicles (HGVs). It is a requirement of the waste contractor using the site that delivery vehicles are stable enough to traverse the landfill, mechanically unload and exit the site without danger of overturning.

Bord na Móna also cross references the relevant documentation submitted by the various waste contractors delivering waste to the landfill with documentation from licensed/permitted facilities to ensure that the waste is actually being treated at these facilities.

These procedures will help Bord na Móna to determine whether or not, where applicable, the waste to be deposited at the landfill has been subject to treatment.

Waste acceptance procedures within the composting facility are outlined in detail in Appendix 3.3.2, as part of the facility description.

3.13.4 Waste Handling

Waste from the HGVs is deposited at the active landfill face as directed by the site operative on duty at the working face. The waste is spread and compacted in a maximum of 3m lifts using a steel-wheeled compactor with a typical gross weight of 40 tonnes. The compactor passes backwards and forwards over the waste until the desired level of compaction is achieved. The working face will be kept to a maximum of 40m by 40m. The waste is covered at the end of each working day using natural soils, recovered C&D fines or proprietary daily cover materials such as hessian etc.

Waste handling procedures within the composting facility are outlined in detail in Appendix 3.3.2.

3.13.5 Site Management Structure

The management of the site is generally in accordance with that outlined in Table 3.13.1. These permanent on site staff are currently employed directly by Bord na Móna.

In addition to the above, specialised contractors are employed on-site from time to time for the construction of the landfill cells, in particular for the installation of the basal liners, leachate and landfill gas collection and treatment systems and final landfill caps.

The personnel employed at the facility are suitably experienced and qualified to fill the role for which they are employed.

Table 3.13.1: Site Management Structure

Position	**Duties/Responsibilities**	**Qualifications/Training**
Site Manager	Overall management and responsibility for the site	Engineering degree or equivalent
Resident Engineer(s)	Responsibility for effective and legally compliant operation of the site, including leachate collection and gas flaring	Engineering degree
Assistant Site Manager	Assistant to site manager with specific responsibility for the compost facility	Engineering degree or equivalent
Site Supervisor	Overall site supervision Waste acceptance(Level I check)	Training in waste management
Weighbridge Operator	Waste acceptance(Level I check) Operation of weighbridge	Training in EPA waste acceptance procedures
Machine Operators	Waste handling both for the landfill and compost facility, drainage installation	Training in operation of industrial loaders, tracked excavators, bulldozers etc.
General Operatives	General maintenance and repairs, litter picking, road cleaning etc.	

3.13.6 Raw Materials and energy

The estimated usage of raw materials such as soils and clays on-site and the material balance for the composting facility are outlined in Section 3.6.

The envisaged usage of fuel, hydraulic oil, electricity and water is estimated to be as outlined in Table 3.13.2:

Table 3.13.2: Estimated Raw Materials and Energy Usage for Operation of Facility (Landfill Facility and Composting Facility)

Material/Resource	Annual Usage per Annum	Amount Stored On-Site
Hydraulic Oil	1,500 litres	500 litres
Electricity	400,000 kilowatt hours per annum	Not stored
Diesel	150,000 litres	20,000 litres
Water	650 m^3 (Domestic Requirement)	Not Stored
Water	1000 m^3 (Composting Requirement)	Stored in Process Water Tank

As outlined in Appendix 3.3.2, experience in operational facilities shows that enclosed composting facilities for biowaste have an almost closed water balance

3.14 Nuisance Controls

3.14.1 General

The waste management facility is operated in compliance with EPA waste license (W201-01). The conditions of the licence include measures to minimise or prevent nuisance to the public occurring as a result of the operation of the facility. A complaints register detailing any complaint received from the general public in respect of the operation of the facility is maintained at the site. The following sections detail the nuisance control measures undertaken at the site.

3.14.2 Bird Control

The presence of scavenging birds such as crows and gulls is continuously monitored. Environmental nuisance resulting from the activities of scavenging birds at the facility is controlled and minimised by the following measures:

- The site accepts residual waste and waste which is not suitable for treatment and therefore contains a lower biodegradable fraction compared to traditional landfill sites and attracts less scavenging birds.
- The active working face is kept as small as possible and all other areas are covered.
- Daily cover material such as hessian, construction and demolition fines, biodegradable geosynthetic sheeting or soil is placed on the working faces at the end of each working day.
- The use of netting as a deterrent to scavenging birds is implemented at the site if necessary.
- A trained falconer is employed on the site on a regular basis; the frequency of the visits is reviewed periodically.
- A kite and helium balloons are flown over the active areas of the site daily.
- Imitation predatory hawks are positioned at strategic locations around the active area of the landfill as a deterrent to scavenging birds.
- Other deterrent systems such as distress calls and starting pistols have been considered and will be deployed if necessary.
- The composting process will be completely enclosed, including the storage of biowaste, mixing of biowaste, compost refinement and storage;
- Mature compost is not particularly attractive for birds, as it has the characteristics of a humus-like material (comparable to peat) rather than (fresh) biowaste.

3.14.3 Fire Control

A number of fire control measures have been put in place at the site as detailed in Section 3.3.15. These include the following:

- The working face of the landfill is maintained as small as possible.
- A water supply to the site, surface water holding lagoons and fire hydrants have been provided.
- A water bowser is available to deal with any small fires on the landfill.
- All site operatives and employees are trained in fire prevention, control and emergency response procedures.
- Emergency response contact numbers (fire service, Gardaí, ambulance and other agencies) are posted in prominent locations.
- Fire extinguishers and smoke detectors are provided in all site buildings.
- Smoking is not permitted at the waste management facility.

In the event of a fire at the composting facility any excess firewater within the compost building will be contained within the building and collected within the internal drainage system eventually discharging to the leachate/wash water tanks. This firewater will subsequently be analysed prior to possible tankering off-site to an approved wastewater plant.

3.14.4 Litter Control

The following measures are employed at the site to control litter:

- All waste is immediately compacted following tipping using the on-site waste compactor.
- The active working face is kept as small as possible and all other areas are covered.
- Daily cover material such as hessian, construction and demolition fines, biodegradable geo-synthetic sheets or soil is placed on the working face at the end of each working day.
- Modern litter netting systems are employed at the working face of the landfill.
- In the event of failure of the litter netting system, the fencing around the site will also prevent litter from being blown off site. This fence is regularly inspected by site operatives and cleaned if required.
- Regular inspection and litter collection is undertaken at the site and adjoining land.
- All waste entering the facility is in covered vehicles. Bord na Móna excludes any contractor failing to comply with this requirement from entering the site.
- The approach roads to the site are monitored on at least a daily basis and in the event of litter being found on these roads, site staff promptly remove it and deposit it in the appropriate manner at the landfill site.
- General clean-up and attendance work is carried out on a weekly basis by site staff around the entire perimeter of the landfill footprint, on all internal haulage roads and on approach roads.

- The waste that will be composted on site will consist of separately collected biowaste, which contains only very limited amounts of components that could potentially cause litter problems (e.g. plastic, paper).
- There will be no external storage of waste intended for composting.
- Residues hauled to the landfill from the composting facility will be in covered vehicles;
- All site areas will be inspected and cleaned regularly.

3.14.5 Odour Control

Odour emission from the landfill site is reduced and controlled as follows:

- The size of the working face is minimised.
- The waste is immediately and thoroughly compacted after it is deposited.
- Daily cover material such as hessian, construction and demolition fines, biodegradable geo-synthetic sheets or soil is placed on the working face at the end of each working day.
- The daily cover is augmented with a weekly covering of a mineral clay layer.

In addition to the above, a permanent gas collection system, in the form of vertical gas wells, will be installed following the placement of the temporary cap on each cell. Until such time that this permanent gas collection system is in place, an intermediate gas collection system in the form of sacrificial horizontal perforated pipe work systems will be implemented for the extraction of gas during the deposition of waste. The gas flare procured for the site will be utilised to combust the numerous compounds in landfill gas that have the potential to cause malodours.

With respect to the composting facility, the main reasons for the occurrence of (excessive) odour emissions from composting facilities are:

- Existence of anaerobic conditions in the fresh biowaste or in the composting material;
- Composition of the biowaste in the composting process, especially:
  - High concentrations of sulphur containing materials;
  - High concentrations of nitrogen containing components causing ammonia emissions
- Temperatures in the composting process exceeding 65°C.

Consequently, the main measures for reducing odour emissions can be divided into four categories:

1. Management of the fresh biowaste handling and influencing the composition of the material fed into the composting process
2. Prevention of anaerobic conditions, i.e. allow sufficient passive or active aeration of the composting material and prevention of very wet process

conditions;

3. Monitoring and maintaining of temperature below 65°C;
4. Application of emission reduction techniques.

Management of fresh biowaste and material composition

Fresh biowaste as delivered to the facility is likely to be partially anaerobic, due to storage at the location of production and transport. As long as the biowaste is contained in a waste collection/transport vehicle this will not lead to emissions, since the material is not being handled. However, unloading of the material at the site and further handling may lead to odour emissions. To prevent emissions to the surroundings, the acceptance/unloading of all biowaste will be carried out indoors under negative pressure.

The mixing of the biowaste prior to composting in the tunnels will be executed in the same enclosed building. The hall will be equipped with air ducts in the top of the roof, which collect the hall air and transport the air to a biofilter. Since the hall will be under slight negative pressure, the emissions via open doors will be minimised.

To prevent delivered biowaste from getting anaerobic and odorous, all biowaste will be pre-treated and placed into the composting tunnels within one day of arrival and acceptance at the facility.

The input to the composting facility will vary. Appropriate mixing of waste streams prior to composting will be required to allow for a proper composting process and for the production of the desired quality compost. However this mixing is also essential to minimise odour emissions. The mixing will ensure that the composting mass:

- Has the appropriate dry solids content (approximately 40%) and has an adequate porosity, such as to facilitate the aeration process and prevent the formation of anaerobic zones in the composting mass during the process. This will be achieved by mixing relatively dry and wet feedstock (e.g. paper/card and green waste), and if required, the adding of a structure material e.g. wood chips;
- Has the appropriate C/N-ratio (approximately 30:1) to prevent excessive emissions of N-containing odour components. This will be achieved by mixing feedstock which is low in N-content (e.g. green waste) with feedstock that has a higher N-content (household biowaste);

Aeration of composting material

The first stage of the composting in the pre-compost tunnels will be the most critical with respect to odour emissions, since easily biodegradable components, e.g. sugars, proteins and fats are degraded at a high rate, thus causing gaseous by-products.

The entire composting process will be executed in completely enclosed composting tunnels or post-composting area. Applying a high aeration rate, thus ensuring the supply of sufficient oxygen to the composting mass, will prevent occurrence of anaerobic conditions in the first phase of the composting process in the tunnels. As the composting process proceeds in the post-composting area, less easily biodegradable components are degraded (e.g. cellulose structures) at a lower rate, reducing the risk of anaerobic conditions. The air supplied to the post-composting area in the later stages of the process can be regulated as required. All process air from the composting bays will be collected and treated by the scrubber/biofilter.

Monitoring of temperature

If composting temperatures exceed approximately 65°C, odour emissions increase significantly, due to the changes in process biochemistry. Excessive increase in composting temperatures will be especially relevant in the first stage of the composting in the compost tunnels when, due to the fast degradation, a lot of energy will be released.

Temperature sensors will be used to measure the temperature in the tunnels and subsequently in the post-composting area. The computer control system ensures that the composting temperature will not exceed 65°C, by adding more fresh process air to the biowaste. This reduces the odour load in the process air, which will be transported to the biofilter.

Due to the slow degradation in the maturation stage, temperatures will normally not raise above 65°C. If this happens incidentally, the variable blowers will increase the fresh process airflow to cool the maturating biomass.

Application of emission reduction techniques

As described in Appendix 3.3.2, all process air from the composting process will be collected and treated in the air scrubbers and biofilters.

Practical experiences with biofilters of this type show that, if properly designed and operated, an odour removal efficiency of a minimum of 95% can be achieved. To assess the potential impact of odour emissions from the composting facility, odour dispersion calculations have been carried out as detailed in Section 4.1.3 herein.

3.14.6 Roads

The deposition of mud and debris on the local and regional road network is both unsightly and dangerous. A wheel wash has been constructed at the site as outlined in Section 3.3.5 to prevent any mud and dust from being deposited on the adjoining roads. The adjoining roads are monitored on a regular basis.

3.14.7 Traffic Control

The traffic control measures are outlined in Sections 3.3.10 and 4.9 herein.

3.14.8 Vermin Control

It is recognised that poorly managed landfill sites have the potential to attract vermin such as rats and flies. Strict control procedures have been put in place at the Drehid Waste Management Facility in order to control the population of vermin. The vermin population is controlled by the rapid and efficient compaction of waste to reduce interstitial spaces in the waste body. Regular covering of the waste as outlined previously is also employed at the site. All plant equipment and tipping areas are cleaned regularly. The composting process will be completely enclosed, including storage of biowaste, mixing, composting and compost refinement.

In very dry weather, which can result in conditions which can cause odours or fly infestation on the site, industrial sprays will be used to mitigate against these nuisances. A record is kept as to the occurrence of vermin at the site.

A detailed Vermin Control Plan has been developed as part of the Environmental Management Plan for the waste management facility. This Plan incorporates the following elements:

- A site map showing the positions and numbers of each bait point;
- A bait point monitoring routine has been established with monthly inspection records for the facility filled up by the vermin control company and signed by the facility manager;
- Inspection records for the bait points describe any signs of vermin and highlight any vermin attractions on site;
- The facility manager is responsible for acting on the findings of the monthly inspection records;
- A vermin control manual containing the bait point location maps, product details/specifications for the baits used and the monthly inspection records is maintained and kept at the facility.

A firm of professional vermin control experts have implemented the Vermin Control Plan. Baiting has been undertaken in a professional manner and every precaution has been taken to avoid non-target species. In particular the bait is placed in areas, which are not accessible to non-target species and where possible dead or dying vermin are removed as soon as possible. It should be noted however that vermin such as rats normally return to their nests to die.

3.15 Environmental Monitoring

The following sections describe the monitoring programmes that have been established at the Drehid Waste Management Facility. Specific elements of monitoring are also required during the construction and aftercare phases at the site and these requirements are also addressed.

All environmental monitoring is carried out under the conditions of the waste licence (W201-01) for the facility, issued by the EPA. Emission Limit Values (ELV) has been set by the EPA for many of the parameters to be monitored. Exceeding these values is considered to be a non-compliance with the waste licence.

The primary aims of these monitoring programmes are to comply with legislation, the requirements of the EPA, to monitor the quality of the environment in the vicinity of the site and identify any adverse impacts from the development of the facility.

As part of the Waste Licence an Annual Environmental Report (AER) is formulated that collates and reports all monitoring data each year. A comparative assessment is made with data from previous years. This report is submitted to the EPA before the March 31st each year.

3.15.1 Dust Monitoring Programme

Dust is monitored using Bergerhoff gauges, as specified in the German Engineering Institute VDI 2119 document "Measurement of Dustfall Using the Bergerhoff Instrument (Standard Method)". Gauges are installed around the landfill footprint at the locations shown on Drawing No. 3369-2407 with the grid references tabulated below.

Table 3.15.1: Dust Monitoring Locations

Reference No.	Grid Reference
D1	E274919, N232625
D2	E275648, N231406
D3	E273796, N231611
D4	E274265, N230932

Dust monitoring is carried out on a monthly basis. The limit of activity derived dust deposition measured at the above monitoring points is 350 mg/m^2/day, based on 30 day composite samples.

In addition to the above the site and adjoining roads are inspected on a daily basis for evidence of excessive generation of airborne dust. This inspection is carried out by Bord na Móna personnel and by the site contractor during the various construction phases. Any remedial actions, such as road cleansing, are then implemented.

3.15.2 Groundwater Monitoring Programme

Groundwater quality is monitored at both upgradient and downgradient sampling locations.

All groundwater sampling is carried out by trained personnel from Bord na Móna or a suitable firm of consultants and all off-site analyses is carried out by an accredited laboratory.

Monitoring Sites

For the location of monitoring points, refer to Drawing No. 3369-2407. Reference numbers and grid references are outlined in Table 3.15.2.

Table 3.15.2: Groundwater Monitoring Locations

Location	Reference No.	Grid Reference
Upgradient		
Bedrock Monitoring Borehole	GW1D	E274767, N232294
Subsoil Monitoring Borehole	GW1S	E274782, N232286
Bedrock Monitoring Borehole	GW4D	E275153, N231756
Subsoil Monitoring Borehole	GW4S	E275153, N231740
Bedrock Monitoring Borehole	GW6	E274765, N232278
Deep Bedrock Monitoring Borehole	GW7	E274784, N232999
Downgradient		
Bedrock Monitoring Borehole	GW2D	E275305, N230640
Subsoil Monitoring Borehole	GW2S	E275305, N230656
Bedrock Monitoring Borehole	GW3D	E274347, N230902
Subsoil Monitoring Borehole	GW3S	E275153, N231740

Operational Phase

The main elements of the programme during the operational phase are as follows:

- The wells are sampled in accordance with industry standard protocols and guidelines prepared by the EPA. Samples are handled and transported in accordance with the same accepted protocols;
- The samples recovered from these wells are analysed for the list of parameters in Table 3.15.3, which is in accordance with the parameters set out in the facility waste license (W201-01).
- Data is collated, tabulated and reported, including interpretation and comparison with the previous year's data. The data is presented within the AER, which is submitted to the EPA.

During the post closure phase of the landfill, monitoring will continue in compliance with EPA conditions for the monitoring of restored landfills.

No monitoring of groundwater additional to that outlined for the operational phase is required during the construction phase at the site.

Table 3.15.3: Groundwater Monitoring Frequency

Parameter	Monitoring Frequency
Visual Inspection/Odour	Monthly
Groundwater Level (wells)	Monthly
Electrical Conductivity	Monthly
Ammoniacal Nitrogen	Monthly
Chloride	Monthly
Sulphate (SO_4)	Annually
Metals/ non metals	Annually
Boron	Annually
Cadmium	Annually
Calcium	Annually
Chromium	Annually
Copper	Annually
Iron	Annually
Lead	Annually
Magnesium	Annually
Manganese	Annually
Nickel	Annually
Potassium	Annually
Sodium	Annually
Zinc	Annually
List I/II organic substances (Screen)	Annually
Mercury	Annually
Nitrate	Annually
Total P/orthophosphate	Annually
Faecal Coliforms	Annually
Total Coliforms	Annually

3.15.3 Landfill Gas Monitoring Programme

Landfill gas monitoring wells have been installed outside of the landfill footprint. Additional wells will be installed as the landfill progresses.

For the location and reference points for the monitoring wells, refer to Drawing No. 3369-2407. These reference numbers and grid references are outlined in Table 3.15.4.

Table 3.15.4: Landfill Gas Monitoring Well Locations

Reference No.	Grid Reference
1	E274555, N231927
2	E274554, N231878
3	E274554, N231828
4	E274553, N231779
5	E274501, N231771
6	E274463, N231771
7	E274410, N231771
8	E274360, N231771

Landfill gas monitoring for Methane, Carbon Dioxide and Oxygen is carried out on a monthly basis during the operational phase of the landfill. Atmospheric Pressure and Trend are also monitored on a monthly basis. These monitoring wells are used to assess whether or not landfill gas is escaping in an uncontrolled manner.

A permanent gas alarm system has been installed in the site buildings, which continuously monitors landfill gas. A gas analyser is permanently available on-site and is used for spot checks should high levels of landfill gas be suspected by site personnel. Ambient measurements of landfill gas are also carried out on site.

On temporary capping, gas collection wells placed at 40metre centres will also be used to monitor gas composition, flows and pressure within the waste body. The frequency of monitoring will be at least monthly for both landfill gas emissions and atmospheric pressure.

During the post closure phase of the landfill, monitoring will continue in compliance with EPA conditions for the monitoring of restored landfills.

No additional monitoring of landfill gas will be required during the construction phase. However, it should be noted that the monitoring frequency may change depending on site conditions and frequency of monitoring may be increased under the following circumstances:

- When increases in gas quantity or changes in gas quality are observed.
- If problems occur with the gas collection system.
- If additional buildings or services are constructed within 100m of the site.

Landfill derived gas concentration limits measured in any building or borehole are:

Methane - ***Greater than or equal to 1.0% v/v***
Carbon Dioxide - ***Greater than or equal to 1.5% v/v***

3.15.4 Leachate Monitoring Programme

Trained personnel from Bord na Móna or a suitable firm of consultants carry out all leachate sampling and an accredited laboratory carry out all off-site analyses.

The elements of the leachate monitoring programme are largely similar to the groundwater programme during the operational phase and are as follows:

- The sample is taken in accordance with industry standard protocols and guidelines prepared by the EPA. Samples are handled and transported in accordance with these protocols;
- The samples recovered from these sources are analysed for the list of parameters in Table 3.15.5, which is in accordance with the parameters set out in the facility waste license (W201-01).

During the post closure phase of the landfill, monitoring will continue in compliance with EPA conditions for the monitoring of restored landfills.

No additional monitoring of leachate will be required during the construction of any of the subsequent phases at the site.

All data is collated, tabulated and reported, including interpretation and comparison with the previous year's data. This information is presented in the AER, which is also submitted to the EPA.

Table 3.15.5: Leachate Monitoring Frequency

Parameter	Monitoring Frequency
Visual Inspection/Odour (Holding Tank only)	Daily
Leachate Level	Weekly
Biochemical Oxygen Demand	Quarterly
Chemical Oxygen Demand	Quarterly
Chloride	Annually
Ammoniacal Nitrogen	Annually
Electrical Conductivity	Annually
Ph	Annually
Metals/non metals	Annually
Boron	Annually
Cadmium	Annually
Calcium	Annually
Chromium	Annually
Copper	Annually
Iron	Annually
Lead	Annually
Magnesium	Annually
Manganese	Annually
Nickel	Annually
Potassium	Annually
Sodium	Annually
Zinc	Annually
Cyanide (Total)	Annually
Fluoride	Annually
List I/II organic substances	Annually
Mercury	Annually
Sulphate	Annually
Total P/orthophosphate	Annually
Total Oxidised Nitrogen	Annually

3.15.5 Meteorological Monitoring Programme

A meteorological station has been installed on-site prior to commencement of operation of the facility.

Precipitation volume, wind force and direction, evapotranspiration, temperature, and barometric pressure are continuously monitored on-site.

Again all data is collated, tabulated and reported in the AER, which is submitted to the EPA on an annual basis.

3.15.6 Noise Monitoring Programme

Noise monitoring is carried out on an annual basis. The survey is undertaken in accordance with the methodology specified in the 'Environmental Noise Survey Guidance Document' published by the EPA.

There are six noise monitoring locations. The locations for noise monitoring are as outlined in Drawing No. 3369-2407 and tabulated below.

Table 3.15.6: Noise Monitoring Points

Reference No.	Grid Reference
N1	E273095, N231446
N2	E274374, N233202
N3	E274933, N232734
N4	E272974, N228094
N5	E275563, N230238
N6	E273254, N231287

Additional rounds of noise monitoring will take place during the construction of additional phases of the permitted landfill and proposed landfill extension.

Noise emission limits are as follows:

Day dB(A) L_{Aeq}(30 minutes) = 55

Night dB(A) L_{Aeq}(30 minutes) = 45

Noise monitoring is undertaken by suitably qualified persons employed by Bord na Móna or by consultants retained by Bord na Móna. The results of the noise monitoring undertaken at the facility and an interpretation of these results are reported in the AER submitted to the EPA.

3.15.7 Air Monitoring Programme

The landfill gas flare system will generate emissions to air. Monitoring of the emissions to air at the enclosed high temperature gas flare will be in accordance with Table 3.15.7.

Table 3.15.7: Air Monitoring Frequency

Parameter	Monitoring Frequency
Inlet	
Methane (CH_4) % v/v	Weekly
Carbon Dioxide ($C0_2$) % v/v	Weekly
Oxygen (0_2) % v/v	Weekly
Process Parameters	
Combustion Temperature	Quarterly
Residence Time	Quarterly
Outlet	
Carbon Monoxide (CO)	Continuous
Nitrogen Oxides ($N0_X$)	Biannually
Sulphur Dioxide ($S0_2$)	Biannually
Particulates	Annually

3.15.8 Odour Monitoring Programme

A daily record of the odours observed by on-site personnel is maintained. Any odours observed and reported by members of the public off-site are also recorded. The occurrence of odour is also compared with climatic conditions. The control measures, including the installation of the air management system at the composting plant, landfill gas extraction system and landfill gas flare, will help to minimise any problems at the site.

3.15.9 Emissions to Water Monitoring Programme – Surface Water Lagoons

Continuous monitoring takes place at the inlet and outlet of the surface water lagoons. Instrumentation linked to the SCADA system monitors the following parameters:

- Dissolved Oxygen
- PH
- Electrical Conductivity
- Flow Rate

An actuated valve at the surface water lagoon outlet is controlled by the SCADA system. This valve is programmed to close should any of the above parameters fall outside permitted levels. The volume of surface water discharged to the surrounding environment is also controlled through the same actuated valve and SCADA system.

All other scheduled water sampling is carried out by trained personnel from Bord na Móna or by a suitable firm of consultants retained by Bord na Móna. All analyses, with the exception of on-site readings, are carried out by an accredited laboratory.

The elements of the Emissions to Water monitoring programme are as follows:

- The surface water is sampled in accordance with industry standard protocols and guidelines prepared by the EPA. Samples are handled and transported in accordance with accepted protocols;
- The samples recovered from these monitoring points is analysed for the list of parameters in Table 3.15.8, which is in accordance with the parameters set out in the facility waste license (W201-01).

During the post closure phase of the landfill, monitoring will continue in compliance with EPA conditions for the monitoring of restored landfills.

Data is collated, tabulated and reported including interpretation and comparison with the previous year's data. This information is presented in the AER, which is submitted to the EPA.

Table 3.15.8: Emissions to Water Monitoring Frequency

Parameter	Monitoring Frequency
Visual Inspection/Odour	Daily
Lagoon Level	Daily
Dissolved Oxygen	Daily
Electrical Conductivity	Daily
Ammoniacal Nitrogen	Weekly
Chloride	Weekly
Ph	Weekly
Total Suspended Solids	Weekly
Biochemical Oxygen Demand	Quarterly
Chemical Oxygen Demand	Quarterly
Metals/non metals	Annually
Boron	Annually
Cadmium	Annually
Calcium	Annually
Chromium	Annually
Copper	Annually
Iron	Annually
Lead	Annually
Magnesium	Annually
Manganese	Annually
Nickel	Annually
Potassium	Annually
Sodium	Annually
Zinc	Annually
List I/II organic substances (Screen)	Annually
Mercury	Annually
Sulphate (SO_4)	Annually
Total P/orthophosphate	Annually
Faecal Coliforms	Annually
Total Coliforms	Annually

3.15.10 Receiving Water Monitoring Programme – Cushaling River

Receiving water quality is monitored downstream of the facility. There are no surface water channels upstream of the site. A number of surface water channels originate within the property boundary.

A visual inspection of all surface water streams on and adjacent to the site is carried out by site personnel on a weekly basis.

During construction phases, a visual inspection of surrounding surface water is carried out on a daily basis to ensure that clay/mud/sand etc. is not impacting on the water quality. No additional monitoring of surface water is required during the construction phase at the site.

Monitoring Sites

For the location and reference numbers for the monitoring points refer to Drawing No. 3369-2407. These reference points and respective grid references are outlined in Table 3.15.9 below

Table 3.15.9: Surface Water Monitoring Points

Reference No.	Grid Reference
SW1	E271899, N229194
SW2	E276295, N226545
SW3	E276309, N232484
SW4	E271580, N231225

In addition, the need for further monitoring locations will be determined on an annual basis.

The elements of the Receiving Water monitoring programme are as follows:

- The surface water is sampled in accordance with industry standard protocols and guidelines prepared by the EPA. Samples are handled and transported in accordance with accepted protocols;
- The samples recovered from these monitoring points are analysed for the list of parameters in Table 3.15.11, which is in accordance with the parameters set out in the facility waste license (W201-01).
- Biological monitoring is undertaken as follows. Kick samples are taken and analysed annually, in accordance with EPA guidelines, to determine the invertebrate colony of the surface water environment. A relationship between water quality and macroinvertebrate community structure is determined in the form of a 'Q' value, where Q1 represents poor quality water and Q5 represents good quality water. The locations at which these samples are obtained is the same as the locations the kick samples were obtained as part of the baseline survey, with grid references tabulated in Table 3.15.10.

Table 3.15.10: Biological Sampling Locations

Reference No.	Grid Reference
T1	E276875, N227490
T2	E269650, N230150

Table 3.15.11: Receiving Water Monitoring Frequency

Parameter	Monitoring Frequency
Visual Inspection	Weekly
Levels	Quarterly
Dissolved Oxygen	Quarterly
Electrical Conductivity	Quarterly
Ammoniacal Nitrogen	Quarterly
Chloride	Quarterly
Ph	Quarterly
Total Suspended Solids	Quarterly
Biochemical Oxygen Demand	Quarterly
Chemical Oxygen Demand	Quarterly
Metals/non metals	Annually
Boron	Annually
Cadmium	Annually
Calcium	Annually
Chromium	Annually
Copper	Annually
Iron	Annually
Lead	Annually
Magnesium	Annually
Manganese	Annually
Nickel	Annually
Potassium	Annually
Sodium	Annually
Zinc	Annually
List I/II organic substances (Screen)	Annually
Mercury	Annually
Sulphate (SO_4)	Annually
Total P/orthophosphate	Annually
Faecal Coliforms	Annually
Total Coliforms	Annually

During the post closure phase of the landfill, monitoring will continue in compliance with EPA conditions for the monitoring of restored landfills.

Data is collated, tabulated and reported including interpretation and comparison with the previous year's data. This information is presented in the AER, which is submitted to the EPA.

3.15.11 Ecological Monitoring Programme

The site will be maintained and monitored on a regular basis after commencement of the landscape planting scheme, as part of the final restoration plan, to confirm that the planted trees, shrubs, grasses etc. have sufficiently established at the site.

As outlined in Section 3.14.2 site personnel monitor the numbers of scavenging birds such as gull and crow regularly and any significant increases in populations are dealt with by the control measures outlined herein.

3.16 Contingency Arrangements

3.16.1 Contingency Plans for any Emergency On-Site.

Any accidents and other emergencies are handled by on-site personnel in accordance with Bord na Móna emergency response procedures. Emergency response contact numbers for the relevant authorities including the Fire Service, Gardaí, or Ambulance Services are prominently posted on-site. All site operatives and other relevant employees of Bord na Móna are regularly trained in emergency response procedures and in fire prevention and control.

Site safety procedures are adopted to protect any persons from injury on-site. Should injury occur, the site operatives are the first to administer assistance. Emergency and first-aid materials are available in the site buildings. Emergency and first-aid procedures are also prominently displayed in the site buildings, adjacent to the waste inspection and quarantine area and adjacent to the surface water settlement lagoons.

The primary contingency for the facility relates to fire control, which is dealt with in some detail in Section 3.3.15 herein.

3.16.2 Contingency Plans for any Breakdowns On-Site

The regular maintenance of all plant and equipment utilised on-site is undertaken in accordance with the manufacturer's guidelines. This maintenance programme helps to minimise occurrences of breakdowns on-site. In the event of any breakdown the item of plant or equipment is promptly repaired or replaced. As previously outlined, a maintenance facility has been provided on site to facilitate this maintenance programme. All plant and equipment, in particular leachate pumps, are checked on a daily basis.

3.16.3 Contingency Plans in Respect of Absentee Staff

Fully trained staff are deployed to the site in the event of sickness of key personnel. In addition plant operators are sourced from local plant contractors should the need arise.

3.16.4 Contingency Procedures outside Normal Operating Hours

The site is unattended by Bord na Móna staff during the night, Sundays and Bank Holidays. However site personnel and other employees of Bord na Móna are available in the event of any emergency at the site outside of normal working hours. An emergency contact number is prominently posted at the site entrance.

Local emergency services have been informed of contact numbers for key Bord na Móna personnel. Outside normal working hours security personnel are provided at the site who also have the relevant contact numbers.

These security arrangements have been implemented in order to guard against unlawful trespass and vandalism. Basic routines exist whereby any cash, records and equipment are either taken off-site daily or secured in the administration building. These procedures are in the interest of overall security.

3.16.5 Contingency Plans in the Event of Environmental Contamination

The potential for the build up of landfill gas in site buildings has been addressed by the provision of gas alarms and gas venting underneath the buildings. The basal liners and gas extraction system also ensure that the risk of uncontrolled subsurface migration of landfill gas is minimal. In the unlikely event of significant levels of landfill gas being found in any of the gas monitoring wells around the site or in any site buildings, the area is fully investigated and mitigation measures such as the installation of vertical gas barriers or drainage layers is undertaken.

The transfer of leachate from the leachate holding tanks to the road tankers takes place in a drained and bunded area. The potential for impacts from leachate spills is therefore minimised.

The leachate containment system installed, encompassing a combination of low permeability clays and a HDPE liner, prevents the possibility of a significant groundwater contamination incident. In the unlikely event of the need to contain the dispersion of groundwater, extraction wells will be installed downgradient of the site.

The discharge from the surface water settlement lagoon to existing surface water drainage system and eventually the Cushaling River is monitored on a regular basis. In the unlikely event that deterioration in the surface water quality being discharged is detected an isolating weir will be provided. This isolating weir will allow for the retention of all surface water on-site until the spill event is investigated and remediated. It will also be possible to provide emergency pumping from the surface water retention lagoon to the leachate holding tanks or a lined area in the event of a continued spillage.

4 POTENTIAL IMPACTS AND PROPOSED MITIGATION MEASURES

4.1 Air

4.1.1 Dust

4.1.1.1 Potential Impacts

Wind blown dust emissions may arise during the operation and construction of the proposed extension, which may negatively impact the surrounding environment. The deposition of dust and mud on the local roads is both unsightly and dangerous. Dust may be a particular problem during periods of dry windy weather.

Potential sources of dust include the following:

- HGVs and RCVs carrying dust on their wheels;
- Unvegetated stockpiles of construction materials;
- Exposed soil surfaces prior to laying of the liner;
- The grading and processing of construction materials; and
- The laying and reengineering of the various capping and basal lining layers.

4.1.1.2 Proposed Mitigation Measures

The control and monitoring of dust at the site has been addressed previously in Sections 3.12.3 and 3.14.6 herein. The mitigation measures adhered to for the control of dust for the Drehid Waste Management Facility are further outlined below:

- The wheelwash, which has already been constructed at the entrance to the facility, will ensure that dust emissions are not caused from the tyres of vehicles using the facility.
- The wheelwash is positioned to ensure that waste vehicles leaving the site do not carry excess soil and material.
- The waste is immediately and thoroughly compacted after it is deposited.
- Daily cover material such as hessian, biodegradable geo-synthetic sheets or soil is placed on the working face at the end of each working day.
- The daily cover is augmented with a weekly covering of a mineral clay layer.
- All landfilling activities take place within an embankment, which will be extended in accordance with development of the landfill. This will help to capture and mitigate any dust emissions from the working face.
- Screening berms, to be grassed and planted, have been developed to the west and north of the landfill footprint and these will be extended to the east of the extended footprint. These screening berms provide for significant attenuation of any dust arising.
- In periods of dry weather, spraying of the access road and other exposed areas will be undertaken to reduce dust emissions, as required.

- All embankments and soil stockpiles will be vegetated immediately following placement to anchor the soil and reduce the surface area open to the environment.
- Access roads will be regularly inspected and cleaned when necessary
- A complaints register is also maintained on-site and should any complaints relating to dust emissions be submitted, then these will immediately be dealt with.
- There will be no open storage of waste;
- All tipping and mixing of biowaste will be onto designated tipping areas within the enclosed reception area of the composting building. Thus any dust generated will be contained within the building. The fresh biowaste will be relatively wet in nature, not giving rise to dust emissions when treated;
- The composting operation will be undertaken within fully enclosed buildings and all air emissions will be diverted through bio-filters prior to discharge to the ambient atmosphere;
- The dry solids content of the compost will be kept below 65-70% by process control measures, since higher dry solids contents may give rise to excess dust formation; and,
- All site areas will be inspected and cleaned regularly.

4.1.2 Noise Emission Impacts

4.1.2.1 Characteristics of Proposal

The Drehid Waste Management Facility, for which planning permission has been granted, began operations in February 2008 and will have an operating life of approximately 20 years. The landfill, with a capacity of 120,000 tonnes per annum (TPA), will be developed in 8 phases, while the composting facility will have an ultimate capacity of 25,000 (TPA) of waste. The main noise sources associated with the composting plant will be housed inside a building.

The main potential noise source emissions from the proposed landfill extension and intensification, which is the subject of this EIS, are associated with the mobile plant on-site and traffic hauling waste to the site. The same noise sources will be on-site for all 15 phases of landfill development (i.e. the 8 Phases already permitted and the proposed additional 7 Phases). The noise generation will be akin to that associated with agricultural farm activity.

4.1.2.2 Target Criterion

For outdoor noise at residential properties the basic criterion for night-time normally lies in the range 35 - 45 dB(A), while the day-time criterion is normally 45 - 55 dB(A) (Ref. EPA's Guidance Note For Noise In Relation to Scheduled Activities, 1995).

For construction development noise there are no Irish Standards. The National Roads Authority's *Guidelines for the Treatment of Noise and Vibration for National Road Schemes, October 2004* recommend maximum permissible noise levels at the façade of dwellings during construction activities as follows:

Table 4.1.1: Maximum permissible noise levels at the façade of dwellings during construction

Days & Times	LAeq(1hr) dB
Monday to Friday 07:00 to 19:00 hrs	70
Monday to Friday 19:00 to 22:00 hrs	60[1]
Saturday 08:00 to 16:30 hrs	65
Sundays and Bank Holidays 08:00 to 16:30 hrs	60[1]

Note 1: Construction activity at these times, other than required in respect of emergency works, will normally require the explicit permission of the relevant local authority

All construction will be carried out in accordance with BS 5228: Part 1: 1997 (Noise Control on Construction and Open Sites - Part 1: Code of Practice for Basic Information and Procedures for Noise Control).

4.1.2.3 Construction Noise Sources and Leq Measurements

The main noise activity associated with proposed development will be the construction of the extended landfill area, and associated excavation at the clay borrow and sand and gravel areas. Leq measurements taken of soil/material excavation and material transfer noise sources at other sites at 20m from the geometric centre of activity when equipment was in continuous operating mode are given in Table 4.1.2.

Table 4.1.2: Noise Levels from Construction Noise Sources

Noise Source	Leq dB(A) Levels
Readymix truck	70
Large dozer	73
Excavator	73
Volvo dump truck	71

4.1.2.4 Calculation and Prediction of Construction Noise

Methodology

Predicted noise levels due to construction activities take account of the worst case scenario whereby the landfill is in operation in conjunction with construction activities. The predicted noise levels generated by construction activity at a particular location can be calculated according to the following formula:

$$\mathbf{Lp2 = Lp1 + \Delta L\psi - \Sigma\Delta L}$$

where,

Lp2 = Sound Pressure level in decibels at Residence.

Lp1 = Sound pressure level in decibels at 20 metres.

$\Delta L\psi$ = correction for direction effects in a horizontal plane,

$\Sigma\Delta L = \Delta Ld + \Delta La + \Delta Lr + \Delta Ls + \Delta Lv + \Delta Lg + \Delta Lw$, and

where,

ΔLd = geometric spreading (spherical radiation) and is calculated according to:

$\Delta Ld = 20 \log_{10} (d_1/d_2)$, where, d_1 is the residence distance in metres, while d_2 is 20m.

ΔLa = air absorption

ΔLr = reflection and diffraction

ΔLs = screening

ΔLv = vegetation

ΔLg = ground absorption

ΔLw = wind gradients

The attenuation effects due to reflection and refraction in the predictive calculation is assumed to be zero. Attenuation due to the effect of ground absorption has been calculated in accordance with the procedure described in *Calculation of Road Traffic Noise,* Department of Transport, Welsh Office, HMSO, 1988. A conservative correction of 0.1dB/100m has included in the prediction calculations to allow for the attenuating effects of air absorption. A minimum correction of -5dB has been included in the prediction calculations to allow for the screening effects of acoustic berms. At the nearest residential property, the effect of wind gradients can increase a noise emission by up to 7.0 dB(A). This downwind effect has been taken into consideration in the calculations.

Prediction

Table 4.1.3 gives the construction noise level predictions at locations specified in Table 4.1.3 and indicated on Drawing 3369-2407. The predicted levels include noise emissions from activity in the clay and sand and gravel borrow areas, activities within the landfill footprint area, composting and the transfer of materials between these areas. The maximum noise levels will prevail when construction activities are at the closest location to each noise sensitive location. Typical levels will prevail for a period in excess of 50% of the construction phase.

Table 4.1.3: Construction noise levels

Location	Projected Noise Levels Leq (1hr) dB(A) – Daytime Maximum	Projected Noise Levels Leq (1hr) dB(A) – Daytime Typical
N1	43.8	35.7
N2	41.3	38.7
N3	44.9	40.7
N4	<35	<35
N5	36.6	<35
N6	46.2	37.8

The noise levels predicted in Table 4.1.3 are considered typical of the noise levels associated with this industry. All predicted noise levels comply with the criteria outlined in Section 4.1.2.5 herein. All construction will be carried out in accordance with BS 5228: Part 1: 1997 (Noise Control on Construction and Open Sites - Part 1. *Code of Practice for Basic Information and Procedures for Noise Control*). Operators of all mobile equipment will be instructed to avoid unnecessary revving of machinery. Where possible the contractor will be instructed to use the least noisy equipment. With efficient use of well maintained mobile equipment considerably lower noise levels (3-6 dB(A)) than those predicted can be attained.

The Project/Resident Engineer will closely supervise all construction activity. Construction activity due to its nature is a temporary activity and thus any impacts will be short term. The construction of the landfill will be completed in 15 Phases, as outlined in Table 3.4.1 herein, with each construction phase lasting a limited period of approximately 6 months. All construction works will be carried out during day-time.

Construction Road Traffic Noise Impacts

As outlined previously, the site infrastructure works (access road, administration building, surface water lagoons, leachate holding area etc.) and Phase 1 of the permitted landfill footprint have been constructed. The construction traffic to be generated by the remaining phases of construction, including Phase 2 to 8 of the permitted landfill and Phase 9 to 15 of the proposed extension, is as outlined in Section 4.9.6 herein. Taking account of the worst case scenarios whereby 100% of this construction traffic arrives to the site from the north or the south, the impacts represent an increase of less than 1% on the existing traffic flow in either direction.

There is a logarithmic relationship between traffic movements and noise levels. Typically doubling the road traffic flow will increase the noise levels by about 3 dB(A). It is therefore predicted that the increase in road traffic along the approach roads due to the construction of the remaining phases of the Drehid Waste Management Facility will result in an increase in noise levels at residences (potential noise sensitive receptors) of less than 1 dB(A) in a worst case scenario. This is considered a negligible and imperceptible increase.

4.1.2.5 Noise Impacts from Facility Operations

The main noise sources associated with operation of the landfill are presented in Table 4.1.4 and the main noise sources associated with the operation of the composting facility are presented in Table 4.1.5. These noise sources are similar for all 15 phases of the landfill including the 8 No. phases already permitted and the 7 No. phases of the proposed landfill extension. The noise levels given in these tables were recorded from similar type of plant working on landfill sites/composting facilities at locations throughout the country.

Table 4.1.4: Main noise sources for proposed landfill development, typical noise levels and duration of activity

Noise Source	Noise Level dB(A) @ 20m	Duration of Activity
Waste compactor	69	8hrs/day
D6 dozer	74	8hrs/day
Back-hoe excavator	73	8hrs/day
Tractor	67	8hrs/day
Roadsweeper	67	8hrs/day
Electric Submerged Pumps	48	8hrs/day

Table 4.1.5: Main noise sources for proposed compost facility and typical noise levels and duration of activity

Noise Source and Comments	Noise Level dB(A) @ 10m	Duration of Activity
One Front End Loader	77	8hrs/day
Excavator/Grab	76	8hrs/day
Shredder	85	4hrs/5 day
Trommel	86	8hrs/day
Roll/off truck	77	4hrs/day
Air Blowers (Ventilation)	47 (outside)	24hrs/day

<u>Projected Noise Levels</u>

The projected noise levels are the accumulated levels from on-site operations of the landfill and composting facility. The projected maximum noise levels given in Table 4.1.6 assume that all plant (fixed and mobile) are operating together and that downwind conditions exist for each prediction location.

The attenuation effects due to reflection and refraction in the predictive calculation is assumed to be zero. Attenuation due to the effect of ground absorption has been calculated in accordance with the procedure described in *Calculation of Road Traffic Noise,* Department of Transport, Welsh Office, HMSO, 1988. A conservative correction of 0.1dB/100m has included in the prediction calculations to allow for the attenuating effects of air absorption. A minimum correction of -5dB has been included in the prediction calculations to allow for the screening effects of acoustic berms.

Table 4.1.6: Projected noise levels from operation of the Drehid Waste Management Facility

Location	Projected Noise Levels L_{eq}(1hr) dB(A) – Daytime Maximum
N1	35.6
N2	38.2
N3	44.3
N4	30
N5	32.2
N6	35.1

Note: The maximum projected noise levels can be reduced by up to 2 dB(A) depending on which phase of landfill is being worked (distance effect)
Typical levels at each location will be in the region of 10 dB(A) less than the predicted maximum

Commentary

All predicted noise levels comply with the criteria for maximum operational noise levels outlined in Section 4.1.2.2 herein. Note that N3 is located north of the activity boundary, and is not in close proximity to any residential dwellings or other noise sensitive receptors.

4.1.2.6 Road Traffic Impacts from Waste Management Facility

The road traffic flows generated by the Drehid Waste Management Facility will be those associated with site staff movements and material deliveries to and from the site.

The proposed landfill extension and intensification that forms the subject of the EIS will result in additional road traffic of approximately 87 HGV movements per day. The stress testing, also outlined in Section 4.9.6, shows that the full loading of the potential operational traffic, due to the proposed intensification and extension of the Drehid Waste Management Facility, on any one of the potential haul routes will not exceed a 2.7% increase on any of the individual routes, even in the unlikely event that all the traffic comes from either the south or north.

There is a logarithmic relationship between traffic movements and noise levels. Typically doubling the road traffic flow will increase the noise levels by about 3 dB(A).

The increase in road traffic along the approach roads will increase the noise levels at residences (potential noise sensitive receptors) by less than 1 dB(A) in a worst case scenario. This is considered to be a negligible and imperceptible increase.

4.1.2.7 Vibration

There will be no perceptible increase in road traffic generated ground vibration. Road traffic generates low levels of ground vibration (<0.1mm peak particle velocity at 20m and these are indistinguishable by humans).

4.1.2.8 Mitigation Measures for Noise Control

The following mitigation measures will be adhered to during the construction and operation of the facility:

- Only proper silenced plant is operated on site and the Resident Engineer/Facility Manager will ensure that unnecessary revving of machines is avoided.
- Mobile plant is throttled down or turned off when not in use
- Screening Berms will be constructed to the north, east and west of the landfill footprint, as extended. Construction of the berms to the north and west has already advanced as part of the initial phase of construction at the facility.

4.1.2.9 Conclusion

The noise emission from the facility will be kept well within that is recommended in the EPA's *Guidance Note for Noise in Relation to Scheduled Activities*. There will be no tonal or impulsive noise emissions from the site and the night-time emissions from the ventilation system will be inaudible at all residences at less than 25 dB(A).

The noise emissions associated with road traffic will result in a negligible noise impact at all residences.

4.1.3 Odours

4.1.3.1 Odour Modelling

4.1.3.1.1 Introduction

Odour Monitoring Ireland was commissioned by TOBIN Consulting Engineers to carry out an odour impact assessment the proposed intensification and extension of the Drehid Waste Management Facility, County Kildare. The purpose of this assessment was to determine the potential for the generation of odour impact on the surrounding area and consequently to propose odour mitigation measures to minimise the potential odour impact.

As outlined in Section 1.1, Bord na Móna has planning permission and a waste licence for the deposition of 120,000 TPA of waste to the engineered landfill site and for the composting of 25,000 TPA of biodegradable waste in the composting plant at the Drehid Waste Management Facility. The operational life of this facility is 20 years. That permission also provides for all associated site development works including the development of an access road from the R403 Regional Road to the site. Construction of the facility commenced in August 2006 and the facility has commenced accepting waste in February 2008.

The current proposal relates to the extension and intensification of the permitted landfill facility to accommodate an additional 240,000 TPA of waste (over and above that already permitted) for 7 years. After 7 years the development will revert back to receiving the currently permitted 120,000 TPA for the remaining permitted operational life of the facility.

Utilising library based odour emission data and atmospheric dispersion modelling techniques, the predicted overall odour impact of the facility can be determined. The key odour impact sources associated with the operation of the facility are identified and odour minimisation strategies outlined. Contours of odour concentrations for the 98th and 99.5th percentile are predicted for the proposed landfill and composting operations in order to examine the extent of any odour impact and the effectiveness of proposed odour minimisation protocols.

In comparison with the odour annoyance criterion, presented in Table 4.1.9, it is predicted that an odour impact will not occur during facility operations given the implementation of the odour management, minimisation and mitigation techniques outlined herein

4.1.3.1.2 Olfactometry

Olfactometry using the human sense of smell is the most valid means of measuring odour (Dravniek et al, 1986) and at present is the most commonly used method to measure the concentration of odour in air (Hobbs et al, 1996). Olfactometry is carried out using an instrument called an olfactometer. Three different types of dynamic dilution olfactometers exist:

- Yes/No Olfactometer
- Forced Choice Olfactometer
- Triangular Forced Choice Olfactometer.

In the dynamic dilution olfactometer, the odour is first diluted and is then presented to a panel of screened panellists of no less than four (CEN, 2003). Panellists are previously screened to ensure that they have a normal sense of smell (Casey et al., 2003). According to the CEN standard screening must be performed using a certified reference gas *n*-butanol. The screening is applied to eliminate anosmia (low sensitivity) and super-noses (high sensitivity). The odour analysis has to be undertaken in a low odour environment such as an air-conditioned odour free laboratory. Analysis should always be performed preferably within 6 hours of sampling.

4.1.3.1.3 What is an odour unit?

The odour concentration of a gaseous sample of odorant is determined by presenting a panel of selected screened human panellists with a sample of odorous air and varying the concentration by diluting with odourless gas, in order to determine the dilution factor at the 50% detection threshold. The Z_{50} value (threshold concentration) is expressed in odour units (Ou_E m^{-3}).

Simply, one odour unit is the concentration of an odorant, which induces an odour sensation to 50% of a screen panel

Although odour concentration is a dimensionless number, by analogy, it is expressed as a concentration in odour units per cubic metre (Ou_E m^{-3}), a term which simplifies the calculation of odour emission rate. The European odour unit is that amount of odorant(s) that, when evaporated into one cubic metre of neutral gas (nitrogen), at standard conditions elicits a physiological response from a panel (detection threshold) equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic meter of neutral gas at standard conditions. One EROM is that mass of a substance (n-butanol) that will elicit the Z_{50} physiological response assessed by an odour panel in accordance with this standard. *n*-Butanol is one such reference standard and 1 EROM is equivalent to 123ug of *n*-butanol evaporated in one cubic metre of neutral gas at standard conditions (CEN, 2003).

4.1.3.1.4 Characterisation of odour

The sense of smell plays an important role in human comfort. The sensation of smell is individual and unique to each human and varies with the physical condition of the person, the odour emission conditions and the individual's odourous education or memory. The smell reaction is the result of a stimulus created by the olfactory bulb located in the upper nasal passage. When the nasal passage comes in contact with the odourous molecules, signals are sent via the nerve fibres where the odour impressions are created and compared with stored memories referring to individual perceptions and social values. Since the smell is individual some people will be hypersensitive and some will be less sensitive (anosmia). Therefore, the sense of smell is the most useful detection technique available as it specialises in synthesising complex gas mixtures rather than analysing the chemical compound (Sheridan, 2000).

4.1.3.1.5 Odour qualities

An odour sensation consists of a number of inter-linked factors. These include:

- Odour threshold/concentration
- Odour intensity
- Hedonic tone
- Quality/Characteristics
- Component characteristics

The odour threshold concentration dictates the concentration of the odour in $Ou_E\ m^{-3}$. The odour intensity dictates the strength of the odour. The Hedonic quality allows for the determination of pleasantness/unpleasantness. Odour quality/characteristics allow for the comparison of the odour to a known smell (i.e. turnip, like dead fish, flowers). Individual chemical component identity determines the individual chemical components that constitute the odour (i.e. ammonia, hydrogen sulphide, methyl mercaptan, etc.). Once odour qualities are determined, the overall odour impact can be assessed. This odour impact assessment can then be used to determine if an odour minimisation strategy is to be implemented and if so by which technique.

4.1.3.1.6 Perception of emitted odours.

Complaints are the primary indicators that odours are a problem in the vicinity of any facility. Perceptions of odours vary from person to person, each with their own individual fingerprint. Several conditions govern a person's perception of odour:

- **Control:** A person is better able to cope with an odour if they feel it can be controlled.
- **Understanding:** A person can better tolerate an odour impact if they understand its source.

- **Context:** A person reacts to the context of an odour as we do to the odour itself.
- **Exposure:** When a person is constantly exposed to an odour they may lose their ability to detect that odour. For example, a plant operator who works in the facility may grow immune to the odour.

From these criteria, we can predict that odour complaints are more likely to occur when:

- A new facility locates in areas where people are unfamiliar with such facilities;
- When a new process establishes within an existing facility; and,
- Or when an urban population encroaches on an existing facility.

The ability to characterise odours being emitted from the facility will help to develop a better understanding of the impact of the odour on the surrounding receptors. It will also help to implement and develop better techniques to abate odours using existing technologies and engineering design.

4.1.3.1.7 Characteristics of landfill / composting odour emissions and development

Odours from landfills potentially arise due to:

- Fugitive landfill gas emission from daily, intermediate and/or temporary cover areas.
- Uncontrolled landfill gas leakages from side embankments and/or capped areas within the landfill.
- Fugitive landfill gas emissions from untapped vertical and horizontal landfill gas vents, leachate side slope risers and chambers.
- Volatilisation, air flow stripping and venting of odorous gases from the active face/active cell.
- Puff odour emissions from deposition and spreading of waste.
- Uncontrolled emissions from the landfill flaring system and leachate treatment facility.

Over 300 compounds have been identified as contributors to landfill odours. These compounds are either components of waste placed in the landfills or are degradation products. Carbon dioxide and methane make up the main constituent percentage of landfill gas and are essentially non-odorous. Other odorous compounds include organic acids (acetic acid, butyric acid; hexanoic acid), terpenes (limonene, alpha Pinene, alpha Carene), mercaptans (methanthiol, ethanthiol, etc.), amines (ethanolamine, dimethylamine, trimethylamine, etc.) and hydrogen sulphide (Sheridan, 2003). Most of these compounds have very low odour threshold concentrations as illustrated in Table 4.1.7. Different concentrations and mixtures of these compounds can intensify or reduce odour threshold concentration, determined as synergism and antagonism, respectively therefore emphasising the benefits of olfactometric techniques over alternative analytical chemical techniques.

Table 4.1.7: Odour threshold concentration of various odorous compounds commonly found in the air streams of landfill gas

Compound name	Molecular Formula	Odour description	Odour threshold (ppm (v/v))
Mercaptans			
Allyl mercaptan	CH_2CHCH_2SH	Disagreeable, garlic	0.0001
Methyl mercaptan	CH_3SH	Rotten cabbage	0.0005
Propyl mercaptan	C_3H_7SH	Unpleasant	0.0005
Ethyl mercaptan	C_2H_5SH	Decayed cabbage	0.0003
Sulphides			
Hydrogen sulphide	H_2S	Rotten eggs	0.0005
Dimethyl di sulphide	$C_2H_6S_2$	Rotten cabbage/vegetables	0.0003- 0.0068
Carbon disulphide	CS_2	Intense Rubber/skunk	0.006-0.010
Amines			
Trimethyl amine	$(CH_3)_3N$	Pungent, fishy	0.0004
n-Butyl amine	$CH_3(CH_2)NH_2$	Sour, ammonia	0.080
Organic acids			
Acetic acid	CH_3COOH	Sour	1.0
Butyric acid	$CH_3(CH_2)_2COOH$	Sweet rancid	0.0004
Valeric acid	$CH_3(CH_2)_4COOH$	Rancid	0.0008

Odours from composting facilities potentially arise from the following sources:

- The uncontrolled anaerobic biodegradation of proteins and carbohydrates to produce unstable intermediates in the waste inlet stream.
- Directly from the accepted materials and poor material handling/management practices,

- Incorrect processing of waste and composting material.
- Positive wind pressure on buildings, open doors and temperature increases will increase positive pressure within biological treatment facilities and may cause the fugitive release of odour from such facilities. Incorporating efficient air extraction systems maintaining negative ventilation and appropriate treatment of extracted air within an odour control system will reduce/eliminate odour impact.

Material coming onto a site may already have developed a strong odour due to the nature of the material itself or to the way it has been stored. For example:

Material stored under anaerobic conditions: fresh organic material stored in plastic bags or insufficiently ventilated containers. The potential for odour increases if the organic material has high moisture content, has been kept in an anaerobic state for a number of days, and/or has been subjected to high temperature and direct sunlight. (e.g. grass clippings, fresh plant material, wet leaves, food waste, etc).

Material that has a low C:N ratio: this can be a particular problem if the material also has a high moisture content. (e.g. sewage sludge or other high nitrogen sludges, food waste, etc).

4.1.3.1.8 Atmospheric dispersion modelling of odours: What is dispersion modelling?

Any material discharged into the atmosphere is carried along by the wind and diluted by wind turbulence, which is always present in the atmosphere. This process has the effect of producing a plume of air that is roughly cone shaped with the apex towards the source and can be mathematically described by the Gaussian equation. Atmospheric dispersion modelling has been applied to the assessment and control of odours for many years, originally using Gaussian form ISCST 3 and more recently utilising advanced boundary-layer physics models such as ADMS and AERMOD (Keddie et al. 1992). Once the odour emission rate from the source is known, ($Ou_E\ s^{-1}$), the impact on the vicinity can be estimated. These models can effectively be used in three different ways:

- Firstly, to assess the dispersion of odours and to correlate with complaints;
- Secondly, in a "reverse" mode, to estimate the maximum odour emissions which can be permitted from a site in order to prevent odour complaints occurring; and,
- Thirdly, to determine which process is contributing greatest to the odour impact and estimate the amount of required abatement to reduce this impact within acceptable levels (McIntyre et al. 2000).

In this latter mode, models have been employed for imposing emission limits on industrial processes, odour control systems and intensive agricultural processes (Sheridan et al., 2002).

4.1.3.1.9 AERMOD Prime

The model used for modelling the odour dispersion from the Drehid Waste Management Facility is BREEZE AERMOD Prime. This model is a third generation model utilising advanced boundary-layer physics. The most important parameters needed in the meteorological data are wind speed, wind direction, Monin Obukhov length, mechanical mixing height, friction velocity, etc. for each hour. AERMOD is run with a sequence of hourly meteorological conditions to predict concentrations at receptors for averaging times of one hour up to a year. It is necessary to use many years of hourly data to develop a better understanding of the statistics of calculated short-term hourly peaks or of longer time averages. Utilities associated with the dispersion model allow computation of ground level concentrations of pollutants over defined statistical averaging periods, consideration of building wake/downwash effects and the effects of elevated terrain in the vicinity of the plant.

4.1.3.1.10 Establishment of odour impact criterion for landfill and composting odours

Odours from landfill and composting operations arise mainly from the volatilisation/leakage of odorous gases from organic matter. Some of the compounds emitted are characterised by their high odour intensity. A sample of a report carried out in the Netherlands ranking 20 generic and 20 environmental odours according to their like or dislike by a group of people professionally involved in odour management is illustrated in Table 4.1.8 (EPA, 2001).

Table 4.1.8: Ranking of environmental odours according to like and dislike (i.e. odour character)

Environmental Odours	Mean dislike ranking	Reference
Intensive Agriculture	12.8	EPA, 2002
Waste water treatment	12.9	EA, 2002
Green fraction composting	14.0	EA, 2002
Landfill	14.1	EA, 2002
Abattoir/Slaughter house operation	17.0	EPA, 2002

As can be observed, landfill odours are 8.5% more dislikeable than intensive agricultural odours and wastewater treatment odours and 20% more likeable than Abattoir/Slaughterhouse odours (see Table 4.1.6). Green fraction composting and landfill odours are similar in their dislike ability and therefore it is rational to suggest that a similar odour impact criterion may be used based on these facts.

An odour threshold concentration of 1 Ou_E m^{-3} is the level at which an odour is detectable by 50% of screened panellists. According to research on wastewater treatment works, the odour recognition threshold is approximately 3-5 times this concentration and is liable to cause offence (3-5 Ou_E m^{-3} at the 100% percentile).

An odour impact criterion of less than or equal to 3.0 Ou_E m^{-3} is implemented in England for Boghborough Landfill and is accepted in the planning applications for this facility to limit odour impact (Longhurst, 1998). Odours from abattoirs/slaughterhouses are considered more offensive than odours from landfills (see Table 4.1.8) and an odour impact criterion of less than or equal to 1.50 Ou_E m^{-3} at the 98^{th} percentile was established by regulatory agency the EPA to limit odour nuisance in the vicinity of such enterprises (EPA BAT Notes, 2002). Accordingly, the Environment Agency have classified landfills under the less than or equal to 1.50 Ou_E m^{-3} at the 98^{th} percentile of hourly averages over a meteorological year. This is considered a long-term exposure odour impact criterion. In order to ascertain any likely short-term odour impact exposure, the 3.0 Ou_E/m^3 at the 99.5^{th} percentile is also assessed.

Table 4.1.9: Odour annoyance criteria for dispersion modelling

Concentration Limit Ou_E m^{-3}	Percentile value %	Application
Dutch (MPTER and Complex 1 Model)		
≤3.5	98th	Wastewater treatment works existing site, rural area or industrial estate.
≤3.0	98th	Compost facility existing site
≤1.5	98th	Wastewater treatment works new site, rural area or industrial estate.
English (ADMS model)		
≤5	98th	Wastewater treatment works greenfield site,
Environment Agency (EA 2002)		
≤1.5	98th	Limit value for wastewater treatment plants, landfills and other high risk odour categories
≤3.0	98th	
Ireland (ISC ST Complex 1 section) (EPA 2002)		
≤1.5	98th	Target limit for new pig production facility/Limit value for tanning and mushroom compost industry
≤3.0	98th	Limit value for new pig production facility/Limit value for tanning and mushroom compost industry.
≤6.0	98th	Limit value for existing pig production facility
≤1.5	98th	Limit value for new abattoirs/slaughterhouses
≤5.0	98th	Limit value for existing abattoirs/slaughterhouses
England (Complex 1 model) (Longhurst (1998)		
≤3.0	98th	Acceptable guideline for elimination of significant odour impact in vicinity of landfill. Used for planning application for Boghborough Landfill
Ireland (ISCST3 & AERMOD Prime)		
≤3.0	99.5th	Guideline value to assess short term worst case meteorological dispersion of odours in the vicinity of a facility

In accordance with the odour annoyance criteria presented above, the following recommendations are made with respect to the proposed extension and intensification of the facility, namely:

- All residential dwellings/sensitive locations should be located outside the 1.50 $Ou_E\ m^{-3}$ at the 98th percentile of hourly averages over a meteorological year.
- All residential dwellings/sensitive locations should be located outside the 3.0 $Ou_E\ m^{-3}$ at the 99.5th percentile of hourly averages over a meteorological year.

The proposed odour impact criteria are sufficiently conservative to provide protection to the community at large taking into account latest suggested odour impact criteria by environmental agencies in Ireland, UK and Netherlands. In the case of the composting facility, all odour sources capable of generating offensive odours will be enclosed inside the main building, sealed and negatively ventilated to an odour control system. The 99.5th percentile of hourly averages is used to complement the 98th percentile of hourly averages to take account of predicted downwind odour concentrations during short time worst-case meteorological conditions thereby providing added protection to the public at large.

These odour impact criterions will be presented and analysed within the odour risk dispersion modelling as presented in Section 4.1.3.3 herein.

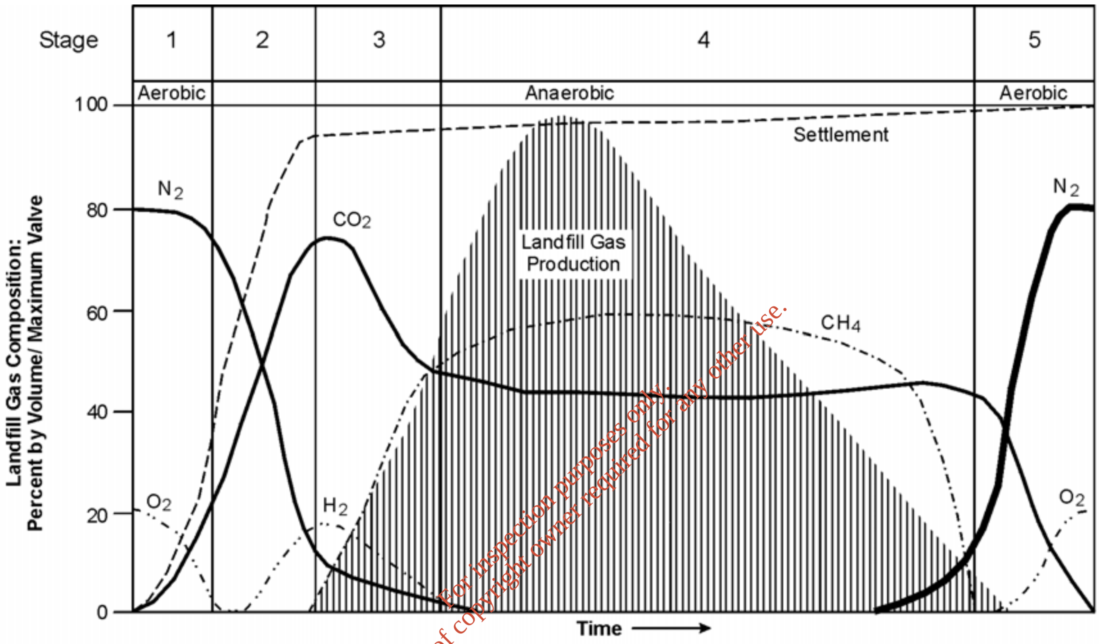
4.1.3.1.11 Landfill development and operation

The proposed landfill footprint at Drehid Waste Management Facility will cover an area of 39 ha and will be developed in 15 phases over a twenty-year period. The waste deposition methodology entails the placement of municipal solid waste (MSW) in an engineered landfill while spreading and compacting it with heavy equipment. Layers of MSW are added in approximately 2.50 to 3 metre lifts over time until a required height is reached. Daily cover materials are used to control the blowing of waste material around the site, prevent flies, rodents, birds and other vectors from coming in contact with the waste. In addition, the cover will minimise the release of odours from the deposited waste. As each phase progresses, an intermediate capping of between 100 mm to 300 mm of suitable material to control odours is applied to the surface. Either horizontal / vertical (either alone or in combination) landfill gas collection systems will be used to prevent the emissions of landfill gas from the waste body. The landfill gas will be extracted to a landfill flare / gas utilisation plant (if installed) for combustion. In addition, when the final height of the waste body is reached a temporary cap of low permeability material will be applied to the final lift.

4.1.3.1.12 Landfill gas (LFG) generation

LFG is produced by the biological decomposition, volatilisation or chemical reaction of waste constituents in a landfill. Biological degradation of organic waste is the main mechanism for LFG production in landfills containing predominantly municipal solid waste. LFG production proceeds through a series of chemically distinct stages. The major components of LFG and the various phases of gas generation are shown in Figure 4.1.1.

Figure 4.1.1: Changes in composition of landfill gas



(*Source: Modified Figure C.3 from UK Department of the Environment, Waste Management Paper 26B, 1995*).

Waste decomposition is aerobic until the oxygen supply in the waste mass is exhausted. The main gaseous products of aerobic degradation are carbon dioxide and water vapour. The waste then proceeds through a series of anaerobic stages, the most significant being the steady methanogenesis phase, which typically begins from 3 to 6 months in the Irish climate and peaks at approximately 2 to 3 years after waste placement. At this stage, LFG consists of approximately 50% methane and 50% carbon dioxide (by volume). Steady state methanogenesis gas production can continue for several decades before LFG production rates decline and LFG generation at the landfill is no longer significant. In recent times, the k factor for generation rate has changed due to higher compaction rates of waste and the application of small vacuum upon the waste when landfilled. A reduction in the oxygen content in the waste body has resulted in higher k factors at earlier stages in the decomposition process. There is no typical figure for the length of time that LFG will be produced, but it can be expected to continue for at least 20 years after final waste deposition. In addition, the production of landfill gas will be slower and over longer periods of time especially if low biodegradability materials such as wood chip are incorporated into the cover. After several decades a semi-aerobic and ultimately aerobic environment is achieved in the remaining stabilised wastes. In some cases, LFG production can recommence if changes occur at the site, which reactivate microbial activity, for example, if development occurs on the site or if moisture levels within the waste increase.

4.1.3.1.13 Landfill odour generation, release and minimization

The formation of odorous compounds at a landfill is usually limited to the active face, operational area, gas leakage around leachate side slope risers, landfill gas extraction wells, discontinuous flare operation, leachate lagoon and insufficient intermediate, temporary and permanent capping of cells.

As waste is taken into the landfill facility and filled into cells, anaerobic conditions will predominate, with the incomplete breakdown of polysaccharides, proteins and carbohydrates from organic matter. This incomplete methanogenesis process will allow for the release of volatile fatty acids, sulphur containing compounds, volatile organic compounds and nitrogen containing organics, which have low odour detection thresholds. The amount formed depends upon a variety of considered non-exhaustive factors including nature and moisture content of the waste, amount of oxygen present, and temperature generation inside the landfill. Any gases generated tend to rise through the deposited waste at a rate predominately dictated by atmospheric pressure, cover material factors and landfill gas extraction rate. This rate is affected by coverage methodology, operational procedures and management practices. The amount of gases emitted will vary from landfill to landfill and will be different for a single landfill at different times (e.g. physical soil type, changing landfill content, organic content of waste and meteorology).

Once emitted into the air, landfill gases are carried on surface level winds. While this dilutes the gases with fresh air, it can also disperse them towards local residences. Naturally, wind speed and direction determine whether local residents will notice landfill odours so that the degree of the odour perception will vary greatly from day to day. At locations near the landfill, the worst time of the day may be early morning or late in the evening. This is when winds tend to be most gentle, providing the least dilution of the odours (i.e. stable weather conditions). Atmospheric pressure swings can result in changes in the efficiency of the collection system used to abstract landfill gas and careful optimisation of vacuum pressure within the gas collection pipework can facilitate control of this scenario.

To limit odour formation and release from a facility the following protocols are incorporated into the management of the landfill. Such a management plan should consider a holistic approach to odour control and be primarily modelled and continuously assessed through the implementation of an odour management plan. An odour management plan integrates various tools in order to support management decisions that minimise odour impacts. The tools include:

- An emission inventory of odour sources on the site;
- Odour impact assessment for the analysis and prediction of odour dispersion on and around the site. The dispersion model has already been prepared, the results of which are included in Section 4.1.3.3. herein;
- Strategies for assessing and predicting the effectiveness of odour mitigation strategies;
- Performance assessment procedures through on site assessment including a detailed odour complaint logging system and follow up procedure; and,
- Landfill gas and operations management plans to include key preventative maintenance and control techniques on site.

An odour management plan at the Drehid Waste Management Facility provides for a holistic assessment of operations, management and engineering design in order to eliminate any potential odour impact. Table 4.1.10 illustrates the potential odour risks matrix associated with landfill operations.

Table 4.1.10: Odour risk matrix for assessment of odour impact potential from landfills

Risk level	Risk assessment factors				
	Terrain and Location	**Weather**	**Waste types**	**Site operations**	**Leachate management**
High	Site located up gradient or raised above sensitive receptor. Substantial residential development within close proximity of the disposal area. Sensitive receptors such as schools, hospitals, OAP homes, recreational within 250m.	Receptors downwind of site. Interaction of wind direction and terrain impacting on receptors. High rainfall.	Inputs of highly odorous waste such as sewage sludge/screenings etc. Delivery of odorous wastes by open vehicle. Wastes likely to react with leachate (i.e. sulphate based wastes, etc.	Large working areas. Large exposed flanks with poor cover. Multiple emission sources combined to create an additive effect. Poor levels of daily cover. Open leachate chambers. No/poor gas extraction system. Capping programme out of sequence with installation of gas management infrastructure. Frequent excavations into waste.	Spray re-circulation of leachate. Uncovered storage of young odorous leachate. Discharge of odorous leachate to sewer through residential areas. Leachate methane stripping exhaust to air.
Medium	Receptors located in a valley or depression adjacent to the site. Some sensitive receptors or residential development within 500m of the site. Other developments within 1 km of the site.	Receptors mainly upwind of the site. No significant interactions between wind direction and terrain. Moderate rainfall.	Domestic and occasional inputs of specific odorous waste indicated above.	Reduced size of working area Limited areas of exposed flanks. Moderate cell depth/surface areas. Other odour sources nearby Limited number of open leachate chambers. Gas abstraction installed. Capping programme in line with extension of gas system.	Storage of mature leachate. Covered storage tanks with filtered venting. Methane stripping exhaust vented through a biofilter.

Risk level	Risk assessment factors				
	Terrain and Location	**Weather**	**Waste types**	**Site operations**	**Leachate management**
Low	Flat terrain. Surrounding woodlands and hedges. Few residential receptors within 1,000m.	All receptors upwind of the site. No wind terrain interactions. Low rainfall	Largely inert wastes. Limited quantities of commercial and industrial wastes.	Small working area. Very limited areas on cell embankments Good levels of temporary and daily cover. Gas well spacing based on field measurements a of collection effectiveness. Leachate wells under abstraction. Several adjacent odour sources.	No storage of leachate.

As can be observed from Table 4.1.10 there are a number of primary factors associated with odours. The main factors controllable within landfill operations include:

- Daily cover amount and type;
- Intermediate cover and temporary capping type;
- Gas management system set-up (i.e. gas volumes abstracted and density of vertical and sacrificial horizontal gas collection pipework if included);
- Active and operational area;
- Leachate management system;
- Waste depth and cell embankments area and cover type and characteristics;
- Phased capping approach;
- Waste acceptance type (including transport design-waste in covered trailers) and filling procedures;
- Management plans to include condensate, gas, operational and odour; and,
- Training and auditing procedures for personnel.

Other risk factors, which are less controllable, include weather conditions and the number of residential/commercial premises in the vicinity of the landfill.

By eliminating the risks associated with odour emissions through an odour management plan, the risks associated with odour detection and complaint can essentially be eliminated.

Landfill operators must remain vigilant in order to prevent situations that can lead to adverse odour impacts on neighbouring communities. Good landfill practices greatly reduce general site odours and reduce impact from odours that could lead to complaints. General practices include:

- Adequate compaction;
- Prompt disposal and burial of malodorous wastes;
- Effective use of appropriate types of daily, intermediate and temporary cover,
- Progressive landfill gas management and abstraction (implement as the phase progresses);
- Minimise embankment areas and design with minimisation of gas leakage and rainfall etching in mind;
- Progressive capping and restoration;
- Effective leachate management;
- Effective condensate management in the landfill gas collection network (i.e. prevention of the blockage of the landfill gas by condensate build up),

In keeping with the national waste policy, organic waste content of landfilled waste must be reduced over a phased time period. It is rational to suggest that odour emission rates and hence odour impact area will reduce significantly due to the implementation of these practices. Regular visual and monitoring surveys will be performed on the capped areas (active, intermediate, temporary and permanent) for gas leakage. The leachate storage plant is operated to prevent any odour emissions emanating from the facility. Best international practice in terms of landfill gas flaring will be implemented at the site. All odour management systems will be document controlled through the Environmental Management System (EMS) with all operators educated on standard operating and emergency response procedures. Phased capping will be implemented in order to limit the areas of exposure and risks of odour emissions.

4.1.3.1.14 Composting odour control and minimisation.

The previously permitted composting facility will incorporate the following key elements of design in order to prevent untreated odour release from the facility:

- All input material handling and composting operations will take place within an enclosed building in order to prevent the fugitive release of odours from the facility.
- The composting building will be fitted with doors, which will be maintained in the closed position while in operation.
- The composting facility will be divided into key areas to include waste acceptance and amendment, primary composting and screening and finished composting and screening. This will facilitate the focused ventilation of odorous air from the facility.
- The composting processes will be maintained under a negative extraction of approximately 3 AC/hr. This odorous air will be directed to an odour control unit, which will remove the odorous compounds before release to atmosphere. The expected odour threshold control from the composting building will be less that or equal to 500 Ou_E/m^3. This will ensure no odour impact from the composting operations and facilitate easy control of the process in terms of odour.

Key management strategies for the control of odour from composting facilities include:

- Knowledge of delivery schedule or pattern: Knowing when a potentially odorous load is likely to arrive facilitates readiness to deal with the material immediately, minimising the likelihood for potential odours to escape off-site.
- Incorporate the material quickly. Have a stock of porous, high-carbon material on hand, which can be mixed immediately with the incoming material. Examples, currently being used with success include wood chips, wood shavings, or sawdust, dry leaves and straw. This helps to balance the C:N ratio, absorb the moisture in wet materials and add porosity so that the mixture can remain aerobic.
- Handle loads of potentially offensive feedstock inside an enclosed area

ventilated by an odour control system.

- If the material must be stored before blending/handling, add a blanket of saw dust or over size composted material to cover the material to minimise potential odorous emissions.
- Ensure the facility can process the organic material as soon as or within a short time frame (24 hrs) it enters the facility.

Process optimising strategies include the following basic elements:

- Checking of the carbon to nitrogen ratio (C:N) when preparing the composting mix. In-feed mixes with a C:N ratio of less than 25 are likely to lose nitrogen in the form of ammonia. A ratio of 25-40 is better, with 30 being considered ideal for most materials.
- Checking the moisture content of the compost mix: while too little moisture will slow the composting process, too much moisture will cause anaerobic conditions—as all of the small spaces in the material will be filled with water and not enough space is available for the air required by aerobic micro organisms. Moisture content between 40 and 60% is considered a good air/moisture balance to support aerobic processes.
- Above neutral pH mix. Basic mixtures above pH 8.5 will release nitrogen as ammonia.
- Porosity is important in formulating the composting mix: a mixture consisting of nothing but fine textured materials will likely become compacted as the composting process develops, preventing air from penetrating the pile. To maintain porosity when composting include some coarser material (such as wood shavings or chips) so that air can continue to move freely through the material as it breaks down. This is particularly important in systems where the material will not be turned during active composting.
- Ensure that material is aerated to maintain aerobic conditions. The continuous monitoring of interstitial Oxygen within the composting mix will help ensure maintenance of appropriate Oxygen levels within the material.
- Appropriate pile size; air will not be able to infiltrate the compost pile homogenously if the pile is too deep; this results in various maturation rates for the composting process.

4.1.3.1.15 Odour Management Plan

The Odour Management Plan (OMP) is a core document detailing operational and control measures appropriate to management and control of odour at waste management facilities. The format of the OMP provides sufficient detail to allow operators and maintenance staff to clearly understand the odour management operational procedures for both normal and abnormal conditions.

The OMP includes sufficient feedback data to enable site management (and regulatory inspectors) to audit site operations on odour management. An example of some of the issues to be considered are summarised as follows.

- A summary of the entire site, odour sources and the location of receptors;
- Details of site management responsibilities and procedures for reporting faults, identifying maintenance needs, replenishing consumables and complaints procedure;
- Odour management equipment operation procedures (e.g. correct use of equipment, process, materials, checks on equipment performance, maintenance and inspection;
- Operator training;
- Housekeeping;
- Maintenance and inspection of plant (both routine and emergency response);
- Spillage/contaminated surface management procedures;
- Record keeping – format, responsibility for completion and location;
- Emergency breakdown and incident response planning including responsibilities and mechanisms for liaison with the local authority; and,
- Mechanisms for ongoing liaison with the local community.

The OMP will be regularly reviewed and updated. It forms the basis of a documented environmental and odour management system for the operating site. The Odour Management System (OMS) documentation defines the roles of the facility operator and staff and sets out templates in relation to the operating of the facility and reporting procedures to be employed. Requirements of the OMP will be implemented throughout the site with a branched management system implemented in order to share responsibility around the site. The site manager will ensure all works are performed in accordance with the OMP. The OMP will be integrated in the overall Environmental Management System for the site.

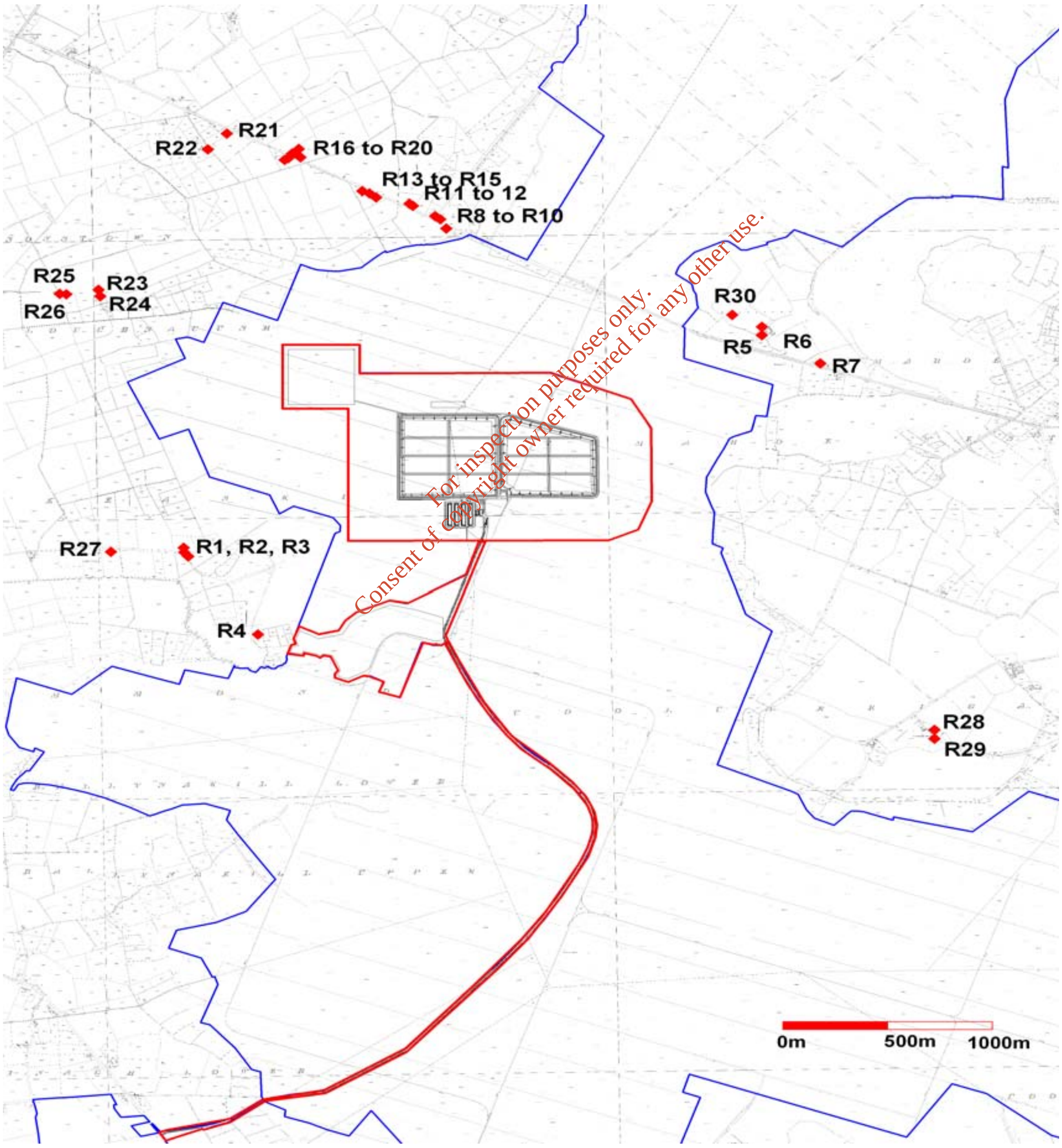
4.1.3.2 Materials and methods

This section describes the materials and methods used throughout the odour impact assessment study.

4.1.3.2.1 Site location

The location of the Drehid Waste Management Facility is outlined in the Figure 4.1.2.

Figure 4.1.2: Location of the Drehid Waste Management Facility and boundary and relative location of sensitive receptors (♦) in the vicinity of the facility.



4.1.3.2.2 Odour emission rate calculation

The measurement of the strength of a sample of odorous air is only part of the problem of quantifying odour.

Area source mass emission rates/flux as encountered in landfill environments were calculated as either $Ou_E\ m^{-2}\ s^{-1}$ or $Ou_E\ s^{-1}$ depending if they are being represented as discrete point sources or area sources in the atmospheric dispersion model.

The odour emission rate from the composting operations was based on a mass emission rate of Ou_E/s as a result of ventilation rate and odour threshold concentration in the exhaust stack.

4.1.3.2.3 Meteorological data

Four years worth of hourly sequential meteorology data was screened for the operation of AERMOD Prime. This allowed for the determination of the worst-case year scenario for the overall impact of odour emissions from the proposed landfill operation on the surrounding population. Dublin Airport 2003 to 2006 inclusive was screened. This met station is at a similar elevation as the site (6 to 10 metre difference). This was observed as the most valid met station for the following key reasons:

- Birr, Mullingar or Kilkenny do not have the regulatory require amount of cloud cover data and therefore not considered valid for dispersion modelling.
- Shannon, Malin Head, and Rosslare met stations are considered estuarine/ costal and not considered valid.
- Casement aerodrome suffers from bias southwesterly wind direction.

4.1.3.2.4 Terrain data

Terrain effects were not accounted for in the dispersion model. Building wake effects were accounted for in the modelling scenarios (i.e. flare control room on flare, composting building on odour control unit) as this can have a significant effect on the odour plume dispersion at short distances.

4.1.3.3 Results

This section describes the results of the modelling undertaken to determine the potential odour impact in the area of the Drehid Waste Management Facility including the extension and intensification of the landfill assuming worst-case phase odour emissions are used. This section should be read in conjunction with Section 3 herein, which describes the proposed development.

4.1.3.3.1 Odour dispersion modelling scenarios

Four data sets for odour emission rates were calculated to determine the potential odour impact of the facility operation utilising the individual source odour emission data in Table 4.1.11.

These scenarios included:

1. Predicted overall odour impact area of the proposed facility during worst case Phase 4 (of the landfill) operations (ref: Scenario 1),
2. Predicted overall odour impact area of the proposed facility during worst case Phase 8 (of the landfill) operations (ref: Scenario 2),
3. Predicted overall odour impact area of the proposed facility during worst case Phase 13 (of the landfill) operations (ref: Scenario 3),
4. Predicted overall odour impact area of the proposed facility during worst case Phase 15 (of the landfill) operations (ref: Scenario 4),

A worst-case odour-modelling scenario was chosen to estimate worst-case odour impact from the proposed landfill and composting operations.

4.1.3.3.2 Odour emission rates from individual processes during landfill and composting operations.

This section describes the odour emission rates/flux used within the dispersion model.

4.1.3.3.2.1 Odour emission flux / concentration for the Drehid waste management facility processes

Table 4.1.11 illustrates the specific odour emission rate/fluxes used to determine an overall odour emission rate from the proposed operations. Each odour source emission factor is presented as either an emission flux (Ou_E m^{-2} s^{-1}) or emission rate (Ou_E s^{-1}) depending on source characteristics.

Table 4.1.11: Odour emission flux / concentration for each individual process within facility operation

Odour source	Odour emission flux ($Ou_E\ m^{-2}\ s^{-1}$)[7]
Active face and operational area[1]	9.25
Active cell / Intermediate capped area[2, 8]	1.69
Temporary capped cell[3, 8]	0.67
Permanent capped cell[4, 8]	0.10
Leachate storage tanks[5]	Fully closed
Landfill flare/ gas utilisation engines[6]	724 $Ou_E\ m^{-3}$
Composting facility exhaust stack[7]	500 Ou_E/m^3

Notes:

[1] denotes active face / operational area will be covered with suitable cover material at night and at weekends/ bank holidays.

[2] denotes active cell which will be covered with a minimum of 150mm of suitable cover material, which will be compacted over the operational phase so as to eliminate any exposed surfaces of waste to atmosphere.

[3] denotes a minimum of 300 mm of soil which will be used as temporary cover material. All embankments are designed to ensure sufficient cover to prevent the leakage of gas and rainfall water etching.

[4] denotes permanent capping which will be installed in accordance with EPA Landfill Design Manual. LFG abstraction will be take place at the leachate well risers.

[5] denotes leachate holding tanks which are covered with impermeable covers. The influent balancing tank will be maintained under negative extraction.

[6] denotes the LFG management system which will be operated to ensure effective abstraction is applied to all gas abstraction infrastructure installed on site. All active gas vents will be immediately connected to the LFG management system, which is in keeping with standard practice in landfills in Ireland. The combustion plant will be operated to ensure all odourous gases are oxidised to a level of less than 724 Ou_E/m^3 in the exhaust stack of the flare.

[7] denotes that the odour control unit installed on the negative air extraction system of the composting process will achieve a minimum performance of less than 500 Ou_E/m^3 on the exhaust stack.

[8] denotes that gas infrastructure will be installed in accordance with EPA guidance and circulars. This will be provided to ensure that odourous gases generated within the waste body are captured effectively and directed to the landfill gas flare. Where

necessary and as identified in walk over surveys, abstraction wells will be installed to prevent the emissions of landfill gas to atmosphere. Landfill gas infrastructure will be installed at a minimum within each phase.

4.1.3.3.2.2 Odour emission rates from proposed landfill and composting operations for atmospheric dispersion modelling Scenarios 1, 2, 3 and 4

Tables 4.1.12, 4.1.13, 4.1.14 and 4.1.15 illustrate the overall odour emission rates from the Drehid Waste Management Facility assuming implementation of odour minimisation and abatement strategies outlined herein which are in accordance with best international practice. Four scenarios were chosen to estimate the worst-case potential odour impact from the waste management facility. Modelling scenarios representing Year 2011, Year 2014, Year 2020 and Year 2027 of operations were performed to assess the phased development of the site for the most significant odour emission rate periods.

Table 4.1.12: Predicted overall odour emission rate from landfill and composting operation during Year 2011 operations (Phase 4 – ref Scenario 1)

Phase 4 - Year 2011						
Source identity	**Surface area (m^2)**	**Volumetric airflow rate (Am^3/s)**	**Odour emission flux ($Ou_E/m^2/s$)**	**Odour threshold conc. (Ou_E/m^3)**	**Odour emission rate (Ou_E/s)**	**% Contribution**
Active Face and operational area	1,600	-	9.25	-	14,800	13.26
Leachate storage	0	-	9.61	-	0	0
Intermediate capped area	21,300	-	1.69	-	35,997	32.25
Temporary capped area	55,231	-	0.67	-	37,005	33.15
Permanent capped area	20,769	-	0.10	-	2,077	1.86
Landfill flare / gas utilisation	-	3.33		724	2,411	2.16
Composting plant	-	38.68		500	19,340	17.33
Total odour emission rate	**-**	**-**	**-**	**-**	**111,630**	**100**

Table 4.1.13: Predicted overall odour emission rate from landfill and composting operation during Year 2014 operations (Phase 8 – ref Scenario 2)

Phase 8 - Year 2014						
Source identity	**Surface area (m^2)**	**Volumetric airflow rate (Am^3/s)**	**Odour emission flux ($Ou_E/m^2/s$)**	**Odour threshold conc. (Ou_E/m^3)**	**Odour emission rate (Ou_E/s)**	**% Contribution**
Active Face and operational area	1,600	-	9.25	-	14,800	11.71
Leachate storage	0	-	9.61	-	0	0
Intermediate capped area	23,100	-	1.69	-	39,039	30.88
Temporary capped area	56,906	-	0.67	-	38,127	30.16
Permanent capped area	112,694	-	0.10	-	11,269	8.91
Landfill flare / gas utilisation	-	5.33	-	724	3,859	3.05
Composting plant	-	38.68	-	500	19,340	15.30
Total odour emission rate	-	-	-	-	**126,434**	**100**

Table 4.1.14: Predicted overall odour emission rate from landfill and composting operation during Year 2020 operations (Phase 13 – ref Scenario 3)

Phase 13 - Year 2020						
Source identity	**Surface area (m^2)**	**Volumetric airflow rate (Am^3/s)**	**Odour emission flux ($Ou_E/m^2/s$)**	**Odour threshold conc. (Ou_E/m^3)**	**Odour emission rate (Ou_E/s)**	**% Contribution**
Active Face and operational area	1,600	-	9.25	-	14,800	12.91
Leachate storage	0	-	9.61	-	0	0
Intermediate capped area	20,900	-	1.69	-	35,321	30.82
Temporary capped area	20,816	-	0.67	-	13,947	12.17
Permanent capped area	266,084	-	0.10	-	26,608	23.22
Landfill flare / gas utilisation	-	6.33	-	724	4,583	4.00
Composting plant	-	38.68	-	500	19,340	16.88
Total odour emission rate	**-**	**-**	**-**	**-**	**114,599**	**100**

Table 4.1.15: Predicted overall odour emission rate from landfill and composting operation during Year 2027 operations (Phase 15 – ref Scenario 4)

Phase 15 - Year 2027						
Source identity	**Surface area (m^2)**	**Volumetric airflow rate (Am^3/s)**	**Odour emission flux ($Ou_E/m^2/s$)**	**Odour threshold conc. (Ou_E/m^3)**	**Odour emission rate (Ou_E/s)**	**% Contribution**
Active Face and operational area	1,600	-	9.25	-	14,800	13.14
Leachate storage	0	-	9.61	-	0	0
Intermediate capped area	19,400	-	1.69	-	32,786	29.11
Temporary capped area	14,160	-	0.67	-	9,487	8.42
Permanent capped area	316,440	-	0.1	-	31,644	28.09
Landfill flare / gas utilisation	-	6.33		724	4,583	4.07
Composting plant	-	38.68		500	19,340	17.17
Total odour emission rate	**-**	**-**	**-**	**-**	**112,640**	**100**

4.1.3.3.3 Results of odour dispersion modelling for Drehid Waste Management Facility operations

AERMOD Prime was used to determine the overall odour impact of the Drehid Waste Management Facility as set out in odour annoyance criteria in Section 4.1.3.1.10 The output data was analysed to calculate:

1. Predicted odour emission contribution of overall facility operation (ref: Scenario 1) (Table 4.1.12) to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.5 Ou_E m^{-3} (see Figure 4.1.3).

2. Predicted odour emission contribution of overall facility operation (ref: Scenario 1) (Table 4.1.12) to odour plume dispersal at the 99.50th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (see Figure 4.1.4).

3. Predicted odour emission contribution of overall facility operation (ref: Scenario 2) (Table 4.1.13) to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.5 Ou_E m^{-3} (see Figure 4.1.5).

4. Predicted odour emission contributions of overall facility operation (ref: Scenario 2) (Table 4.1.13) to odour plume dispersal at the 99.50th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (see Figure 4.1.6).

5. Predicted odour emission contribution of overall facility operation (ref: Scenario 3) (Table 4.1.14) to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.5 Ou_E m^{-3} (see Figure 4.1.7).

6. Predicted odour emission contribution of overall facility operation (ref: Scenario 3) (Table 4.1.14) to odour plume dispersal at the 99.50th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (see Figure 4.1.8).

7. Predicted odour emission contribution of overall facility operation (ref: Scenario 4) (Table 4.1.15) to odour plume dispersal at the 98th percentile for an odour concentration of less than or equal to 1.5 Ou_E m^{-3} (see Figure 4.1.9).

8. Predicted odour emission contribution of overall facility operation (ref: Scenario 4) (Table 4.1.15) to odour plume dispersal at the 99.50th percentile for an odour concentration of less than or equal to 3.0 Ou_E m^{-3} (see Figure 4.1.10).

These computations give the odour concentration at each 150-metre x y Cartesian grid receptor location that is predicted to be exceeded for 2% (98%ile) (175 hours) and

0.50% (99.5%ile) (44 hours) of four years of hourly sequential meteorological data.

This allows for the predictive analysis of any potential impact on the neighbouring sensitive locations while the facility is in operation. It also allows the operators of the facility to assess the effectiveness of the odour abatement/minimisation strategies. This odour dispersion modelling assessment sets out the minimum odour minimisation and mitigation strategies to be implemented by the site. Continuous assessment of the effectiveness of such strategies as laid out in the landfill gas, operations and odour management plans should highlight any issues with facility operations and mitigate any issues immediately.

4.1.3.4 Discussion of results

This section discussed the results obtained during the dispersion modelling assessment.

4.1.3.4.1 Scenario 1-Phase 4 - Year 2011 assessment

The plotted odour concentration for less than or equal to 1.50 and 3.0 Ou_E m^{-3} at the 98th and 99.5th percentile for Scenario 1 is illustrated in Figures 4.1.3 and 4.1.4. As can be observed in Figures 4.1.3 and 4.1.4, the odour plume spread for year 2011 of operation remains within the landowner's boundary. Table 4.1.16 illustrates the predicted maximum ground level concentration (GLC) at each of the nearest residential premises in the vicinity of the site. As can be observed from Figures 4.1.3 and 4.1.4 and Table 4.1.16, it is predicted that all residences in the vicinity of the facility will perceive an odour concentration less than or equal to 1.50 and 3.0 Ou_E m^{-3} for the 98th and 99.5th percentile of hourly averages over four years of meteorological data. From this assessment, it is predicted that there will be no long-term or short-term odour impact in the vicinity of the facility given the implementation of the odour minimisation and mitigation measures outlined herein.

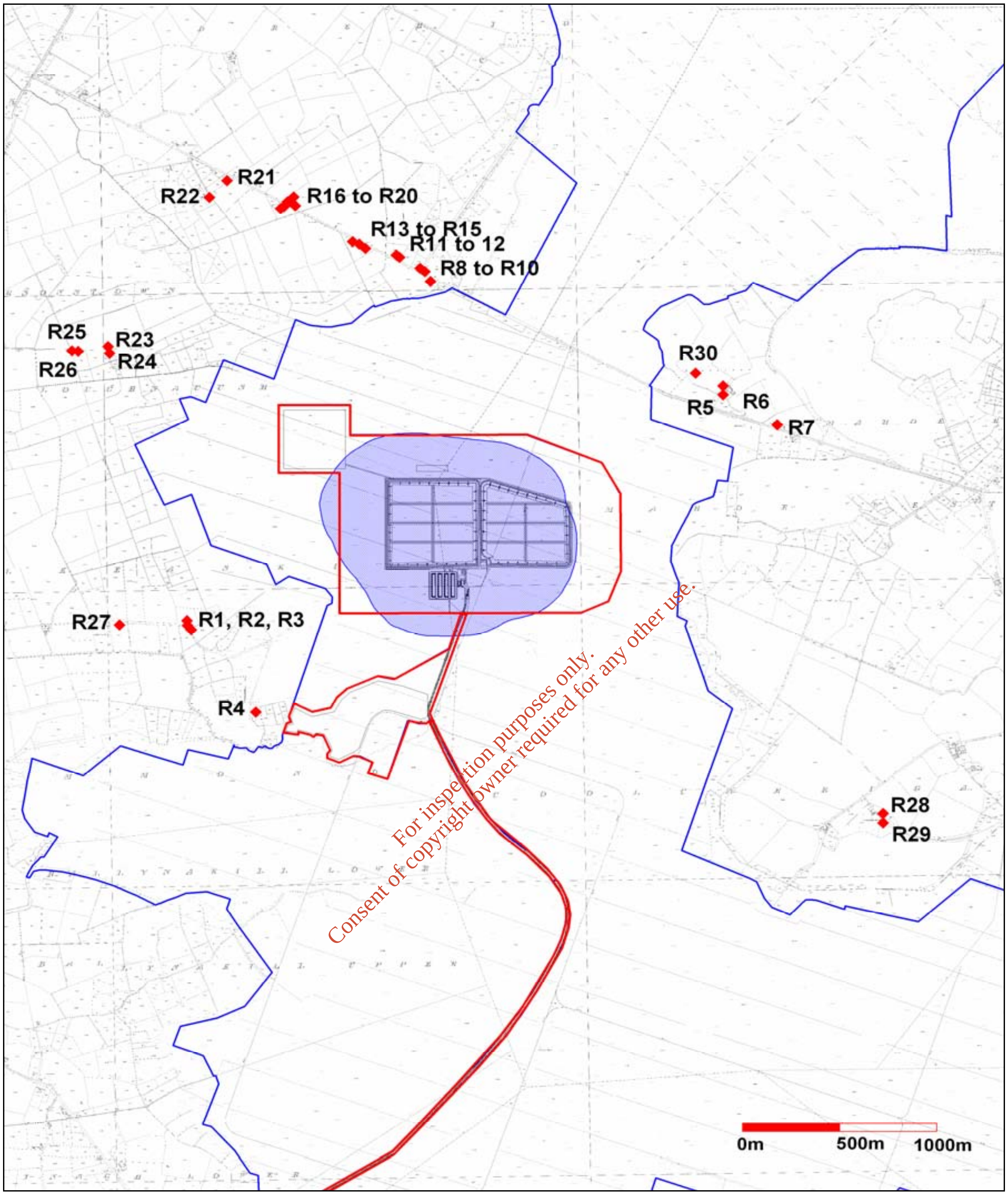


Figure 4.1.3: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 1.5 Ou_E m^{-3} (▬▬) for the 98th percentile of hourly averages for Scenario 1

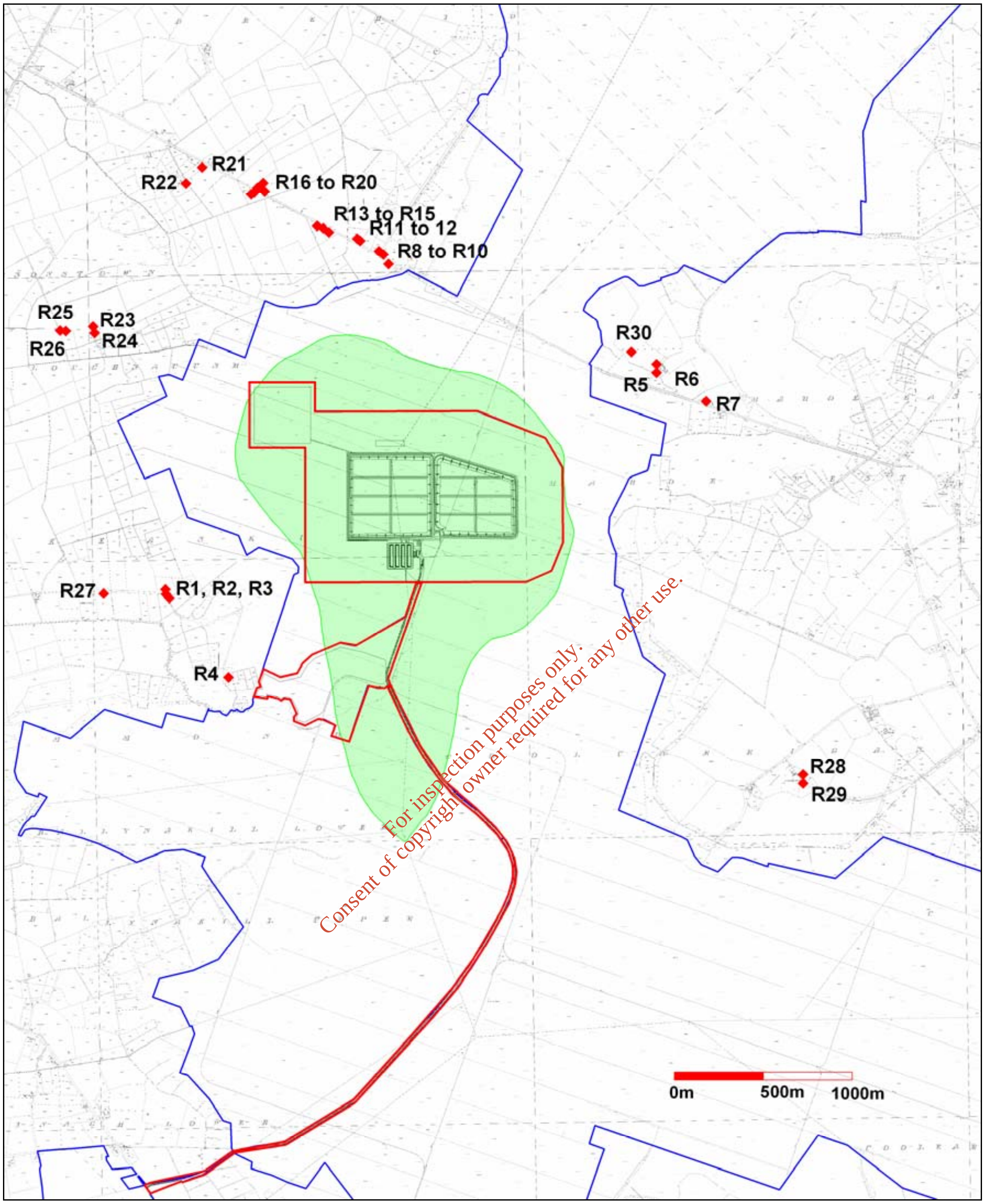


Figure 4.1.4: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 3.0 OuE m-3(▬) for the 99.5th percentile of hourly averages for Scenario 1

Table 4.1.16: Predicted ground level concentrations at receptors in the vicinity of the proposed waste management facility for Scenario 1

Receptor identity	X coordinate	Y coordinate	98th percentile odour concentration (Ou_E/m^3)	99.5th percentile odour concentration (Ou_E/m^3)
R1	273050.6	231483.8	0.2	0.7
R2	273052.8	231457.8	0.2	0.7
R3	273072.2	231434	0.2	0.7
R4	273404	230990	0.1	0.7
R5	275809.7	232703.2	0.4	1.2
R6	275809.7	232751.5	0.4	1.2
R7	276087.7	232541.5	0.3	1.1
R8	274303.3	233316	0.3	1.4
R9	274274.9	233369.9	0.2	1.4
R10	274249.4	233386.9	0.2	1.4
R11	274144.4	233446.5	0.2	1.4
R12	274127.4	233457.8	0.2	1.4
R13	273968.5	233494.7	0.3	1.3
R14	273937.3	233517.4	0.2	1.3
R15	273903.3	233531.6	0.2	1.3
R16	273608.3	233724.5	0.2	1.1
R17	273599.7	233772.7	0.2	1.0
R18	273568.5	233747.2	0.2	1.0
R19	273551.5	233721.7	0.2	1.0
R20	273531.7	233710.3	0.2	1.0
R21	273256.5	233860.7	0.2	0.8
R22	273165.7	233769.9	0.2	0.8
R23	272652.2	232927.3	0.2	0.9
R24	272643.7	232964.2	0.2	0.9
R25	272490.5	232938.7	0.2	0.8
R26	272459.3	232941.5	0.2	0.7
R27	272703.3	231460.7	0.1	0.5
R28	276632.4	230442.2	0.1	0.5
R29	276632.4	230391.2	0.1	0.5
R30	275668	232820	0.4	1.3

4.1.3.4.2 Scenario 2-Phase 8 - Year 2014 assessment

The plotted odour concentration for less than or equal to 1.50 and 3.0 Ou_E m^{-3} at the 98th and 99.5th percentile for Scenario 2 is illustrated in Figures 4.1.5 and 4.1.6 As can be observed in Figure 4.1.5, the odour plume spread for the 98th percentile of hourly averages for year 2014 of operation remains within the landowner's boundary. Figure 4.1.6 illustrates the short-term odour impact assessment. As can be observed all receptors in the vicinity of the facility will perceive an odour concentration less than 3.0 Ou_E/m^3 at the 99.5th percentile. Table 4.1.17 illustrates the predicted maximum ground level concentration (GLC) at each of the nearest residential premises in the vicinity of the site. As can be observed in Table 4.1.17, it is predicted that all residences in the vicinity of the facility will perceive an odour concentration less than or equal to 1.50 and 3.0 Ou_E m^{-3} for the 98th and 99.5th percentile of hourly averages over four years of meteorological data. From this assessment, it is predicted that there will be no long-term or short-term odour impact in the vicinity of the facility given the implementation of the odour minimisation and mitigation measures outlined herein.

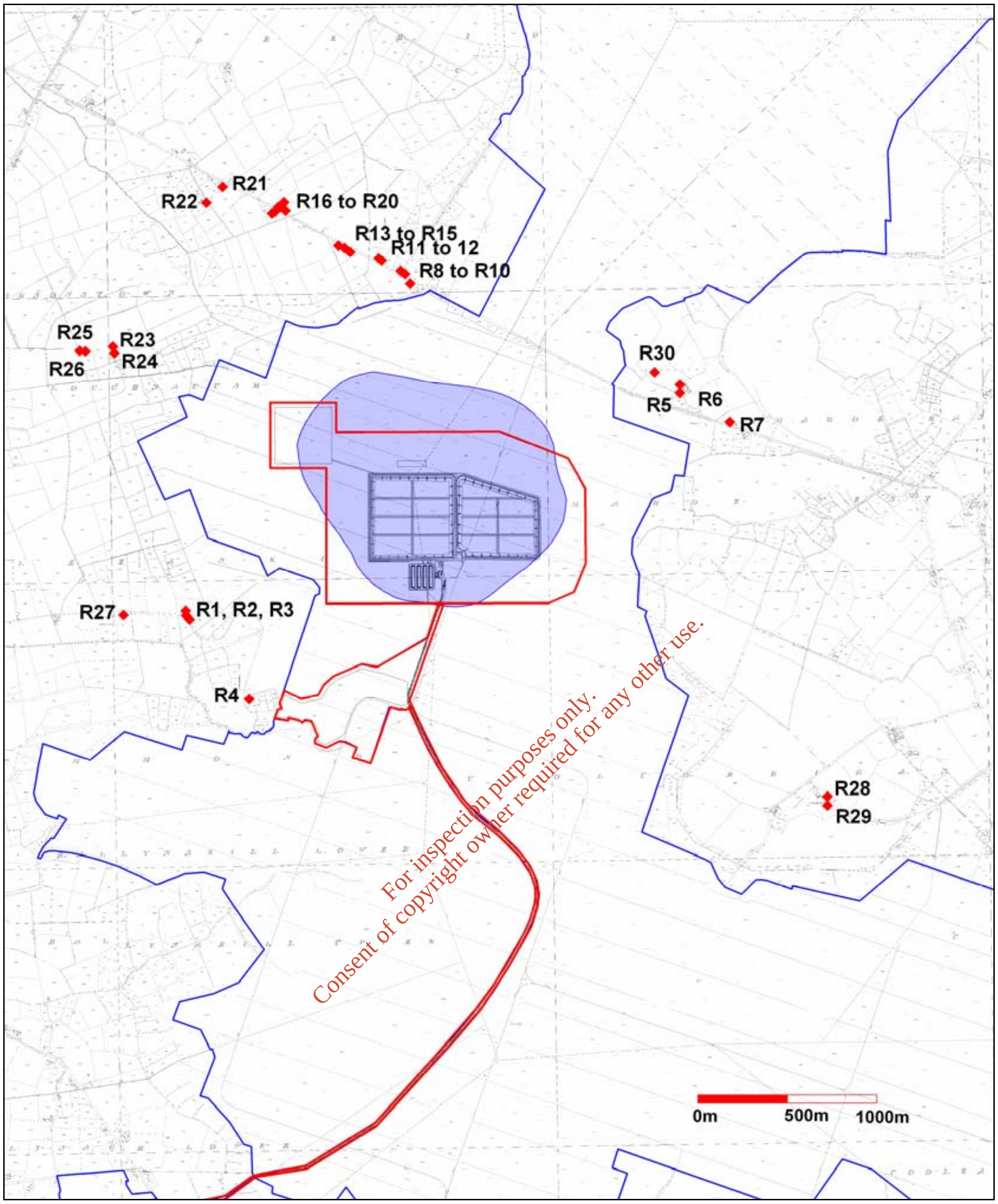


Figure 4.1.5: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 1.5 Ou_E m^{-3} (▬▬) for the 98th percentile of hourly averages for Scenario 2

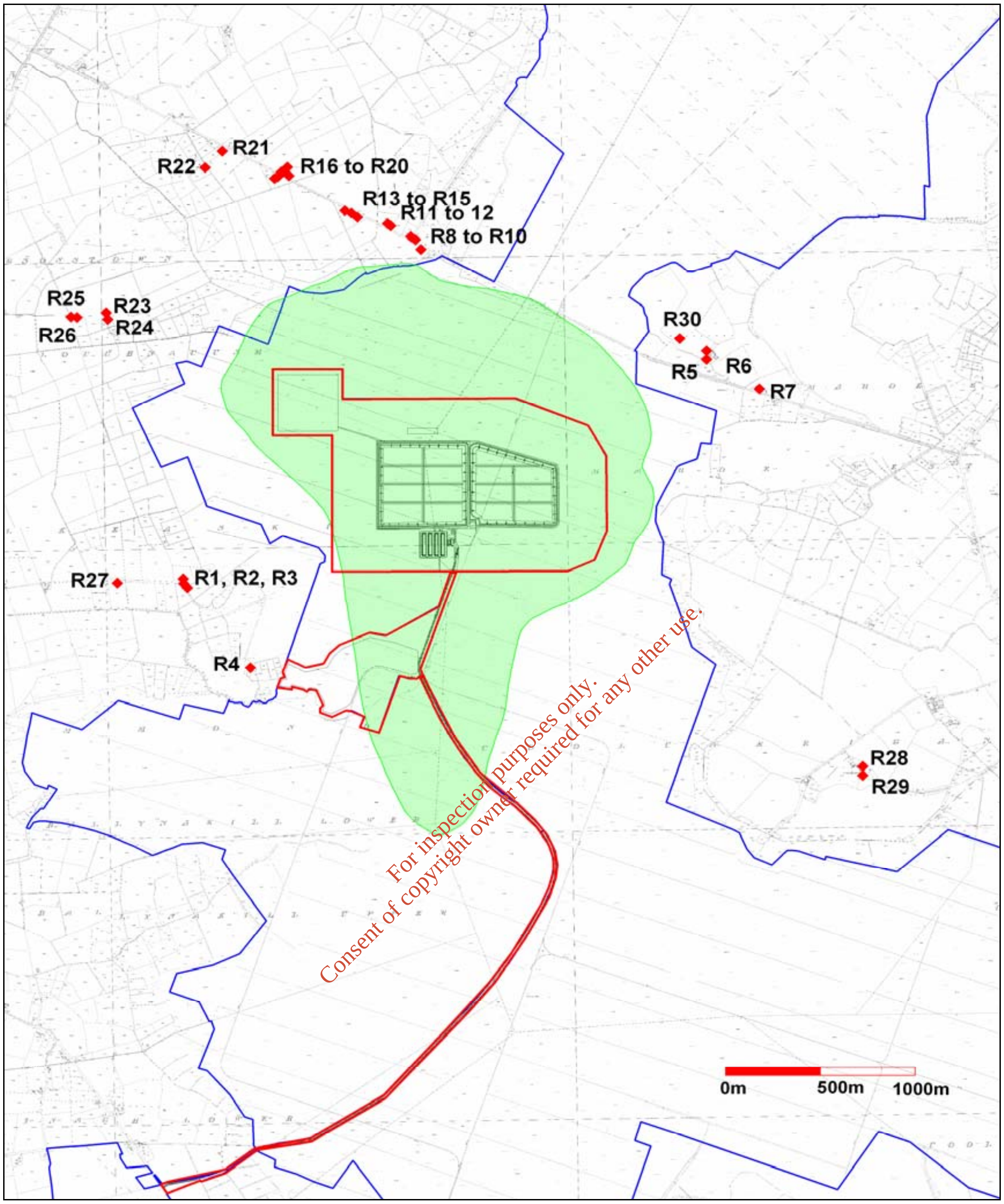


Figure 4.1.6: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 3.0 $Ou_E\ m^{-3}$ (▬) for the 99.5th percentile of hourly averages for Scenario 2

Table 4.1.17: Predicted ground level concentrations at receptors in the vicinity of the proposed waste management facility for Scenario 2

Receptor identity	X coordinate	Y coordinate	98th percentile odour concentration (Ou_E/m^3)	99.5th percentile odour concentration (Ou_E/m^3)
R1	273050.6	231483.8	0.2	0.6
R2	273052.8	231457.8	0.2	0.6
R3	273072.2	231434	0.2	0.6
R4	273404	230990	0.1	0.7
R5	275809.7	232703.2	0.5	1.8
R6	275809.7	232751.5	0.5	1.7
R7	276087.7	232541.5	0.4	1.5
R8	274303.3	233316	0.4	2.5
R9	274274.9	233369.9	0.4	2.4
R10	274249.4	233386.9	0.4	2.4
R11	274144.4	233446.5	0.4	2.2
R12	274127.4	233457.8	0.4	2.2
R13	273968.5	233494.7	0.4	2.1
R14	273937.3	233517.4	0.4	2.1
R15	273903.3	233531.6	0.4	2.0
R16	273608.3	233724.5	0.3	1.5
R17	273599.7	233772.7	0.3	1.4
R18	273568.5	233747.2	0.3	1.4
R19	273551.5	233721.7	0.3	1.4
R20	273531.7	233710.3	0.3	1.5
R21	273256.5	233860.7	0.3	1.2
R22	273165.7	233769.9	0.3	1.2
R23	272652.2	232927.3	0.3	1.3
R24	272643.7	232964.2	0.3	1.3
R25	272490.5	232938.7	0.2	1.2
R26	272459.3	232941.5	0.2	1.2
R27	272703.3	231460.7	0.1	0.5
R28	276632.4	230442.2	0.2	0.6
R29	276632.4	230391.2	0.2	0.6
R30	275668	232820	0.5	1.8

4.1.3.4.3 Scenario 3-Phase 13 - Year 2020 assessment

The plotted odour concentration for less than or equal to 1.50 and 3.0 Ou_E m^{-3} at the 98^{th} and 99.5^{th} percentile for Scenario 3 is illustrated in Figures 4.1.7 and 4.1.8. As can be observed in Figure 4.1.7, the odour plume spread for the 98^{th} percentile of hourly averages for year 2020 of operation remains within the landowner's boundary. Figure 4.1.8 illustrates the short-term odour impact assessment. As can be observed all receptors in the vicinity of the facility will perceive an odour concentration less than 3.0 Ou_E/m^3 at the 99.5^{th} percentile. Table 4.1.18 illustrates the predicted maximum ground level concentration (GLC) at each of the nearest residential premises in the vicinity of the site. As can be observed in Table 4.1.18, it is predicted that all residences in the vicinity of the facility will perceive an odour concentration less than or equal to 1.50 and 3.0 Ou_E m^{-3} for the 98^{th} and 99.5^{th} percentile of hourly averages over four years of meteorological data. From this assessment, it is predicted that there will be no long-term or short-term odour impact in the vicinity of the facility given the implementation of the odour minimisation and mitigation measures outlined herein.

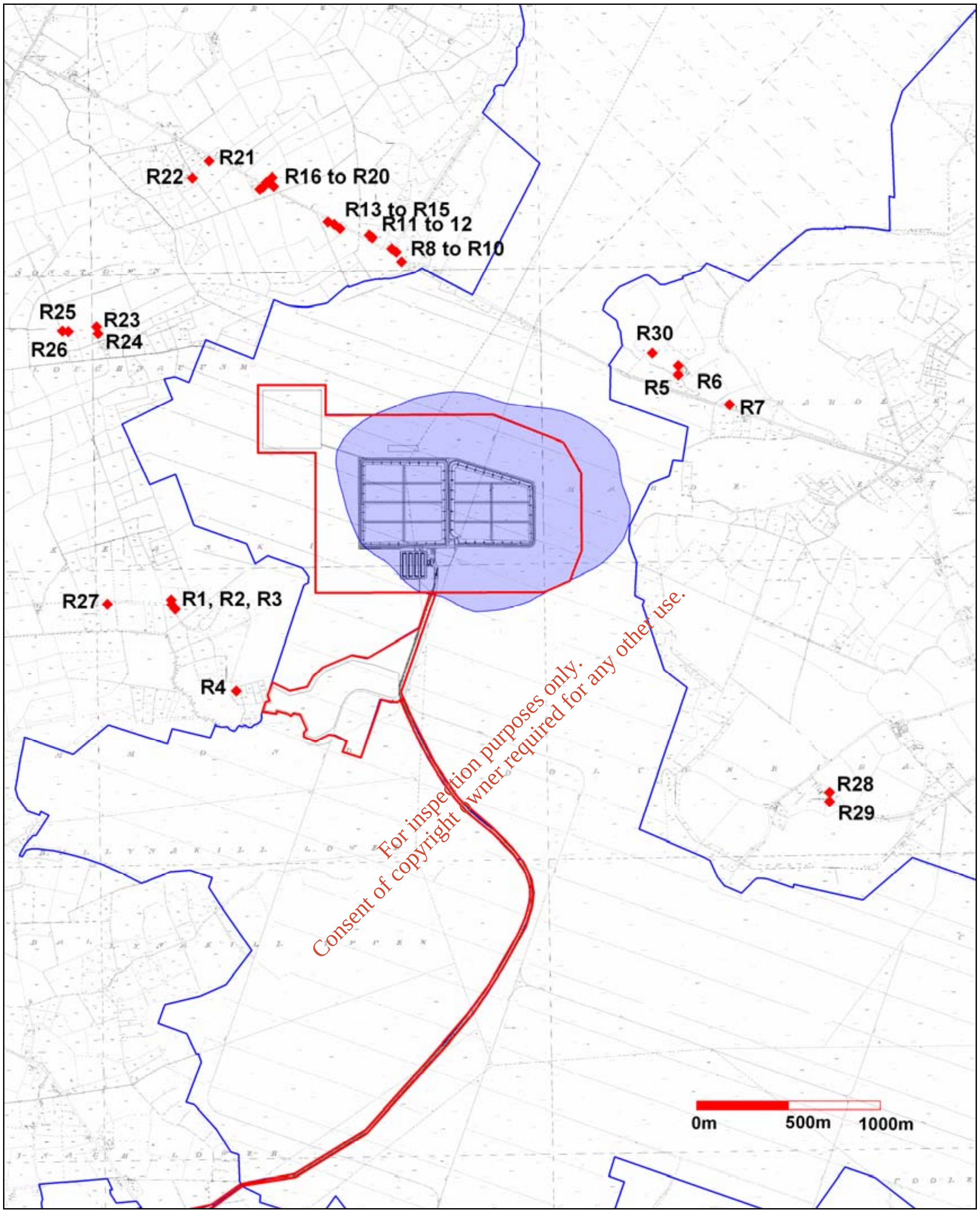


Figure 4.1.7: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 1.5 OuE m-3 (▬) for the 98th percentile of hourly averages for Scenario 3

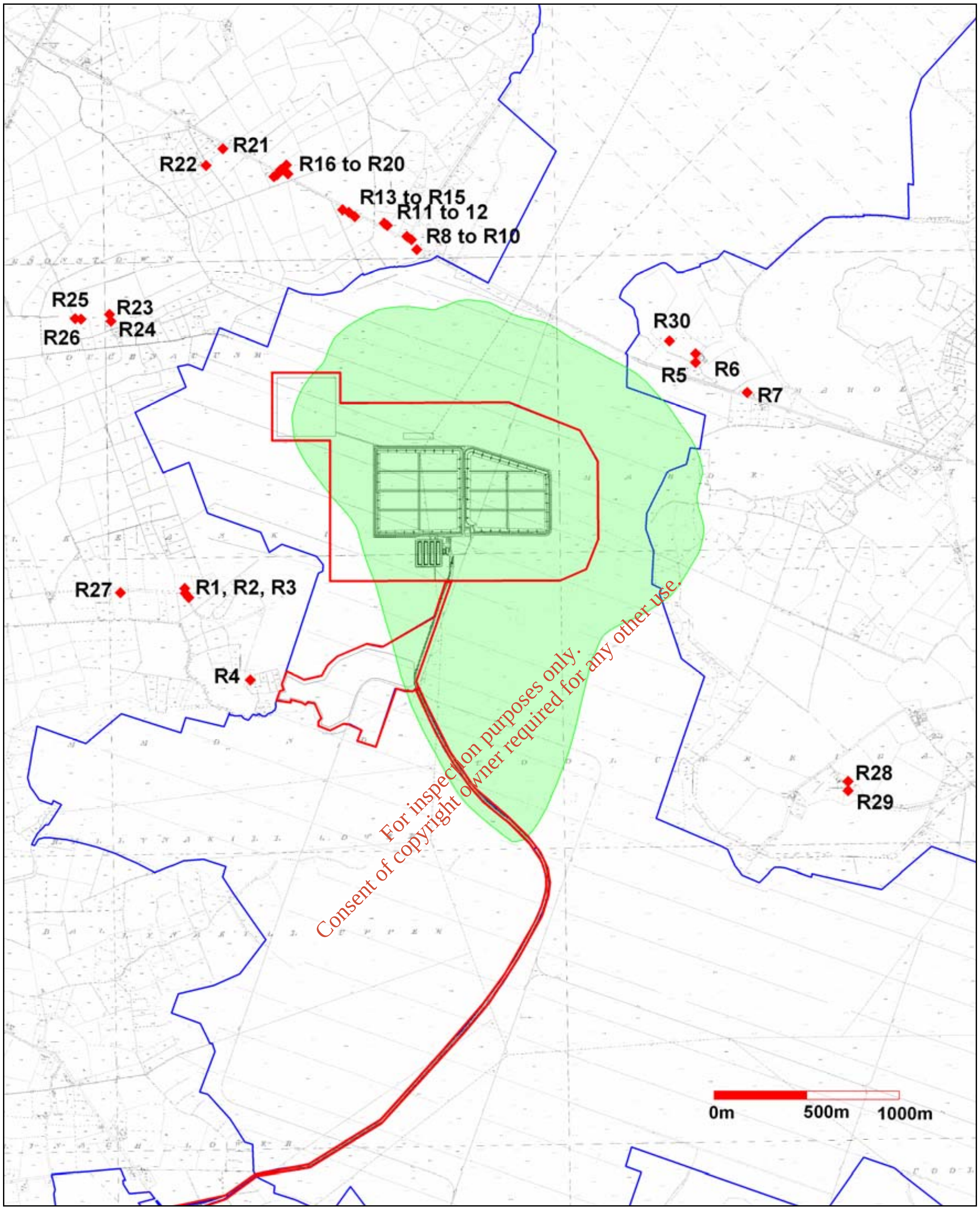


Figure 4.1.8: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 3.0 OuE m-3 ( ) for the 99.5th percentile of hourly averages for Scenario 3

Table 4.1.18: Predicted ground level concentrations at receptors in the vicinity of the proposed waste management facility for Scenario 3

Receptor identity	X coordinate	Y coordinate	98th percentile odour concentration (Ou_E/m^3)	99.5th percentile odour concentration (Ou_E/m^3)
R1	273050.6	231483.8	0.1	0.5
R2	273052.8	231457.8	0.1	0.5
R3	273072.2	231434	0.1	0.5
R4	273404	230990	0.1	0.6
R5	275809.7	232703.2	0.6	2.2
R6	275809.7	232751.5	0.6	1.9
R7	276087.7	232541.5	0.5	1.8
R8	274303.3	233316	0.4	1.9
R9	274274.9	233369.9	0.4	1.8
R10	274249.4	233386.9	0.4	1.7
R11	274144.4	233446.5	0.4	1.6
R12	274127.4	233457.8	0.4	1.6
R13	273968.5	233494.7	0.4	1.4
R14	273937.3	233517.4	0.3	1.4
R15	273903.3	233531.6	0.3	1.3
R16	273608.3	233724.5	0.3	1.0
R17	273599.7	233772.7	0.2	1.0
R18	273568.5	233747.2	0.2	1.0
R19	273551.5	233721.7	0.3	1.0
R20	273531.7	233710.3	0.3	1.0
R21	273256.5	233860.7	0.2	0.8
R22	273165.7	233769.9	0.2	0.9
R23	272652.2	232927.3	0.2	0.8
R24	272643.7	232964.2	0.2	0.8
R25	272490.5	232938.7	0.2	0.8
R26	272459.3	232941.5	0.2	0.8
R27	272703.3	231460.7	0.1	0.4
R28	276632.4	230442.2	0.2	0.6
R29	276632.4	230391.2	0.2	0.6
R30	275668	232820	0.6	2.1

Scenario 4-Phase 15 - Year 2027 assessment

The plotted odour concentration for less than or equal to 1.50 and 3.0 Ou_E m^{-3} at the 98^{th} and 99.5^{th} percentile for Scenario 4 is illustrated in Figures 4.9 and 4.10. As can be observed in Figure 4.9, the odour plume spread for the 98^{th} percentile of hourly averages for year 2027 of operation remains within the landowner's boundary. Figure 4.10 illustrates the short-term odour impact assessment. As can be observed all receptors in the vicinity of the facility will perceive an odour concentration less than 3.0 Ou_E/m^3 at the 99.5^{th} percentile. Table 4.1.19 illustrates the predicted maximum ground level concentration (GLC) at each of the nearest residential premises in the vicinity of the site. As can be observed in Table 4.1.19 it is predicted that all residences in the vicinity of the facility will perceive an odour concentration less than or equal to 1.50 and 3.0 Ou_E m^{-3} for the 98^{th} and 99.5^{th} percentile of hourly averages over four years of meteorological data. From this assessment, it is predicted that there will be no long-term or short-term odour impact in the vicinity of the facility given the implementation of the odour minimisation and mitigation measures outlined herein.

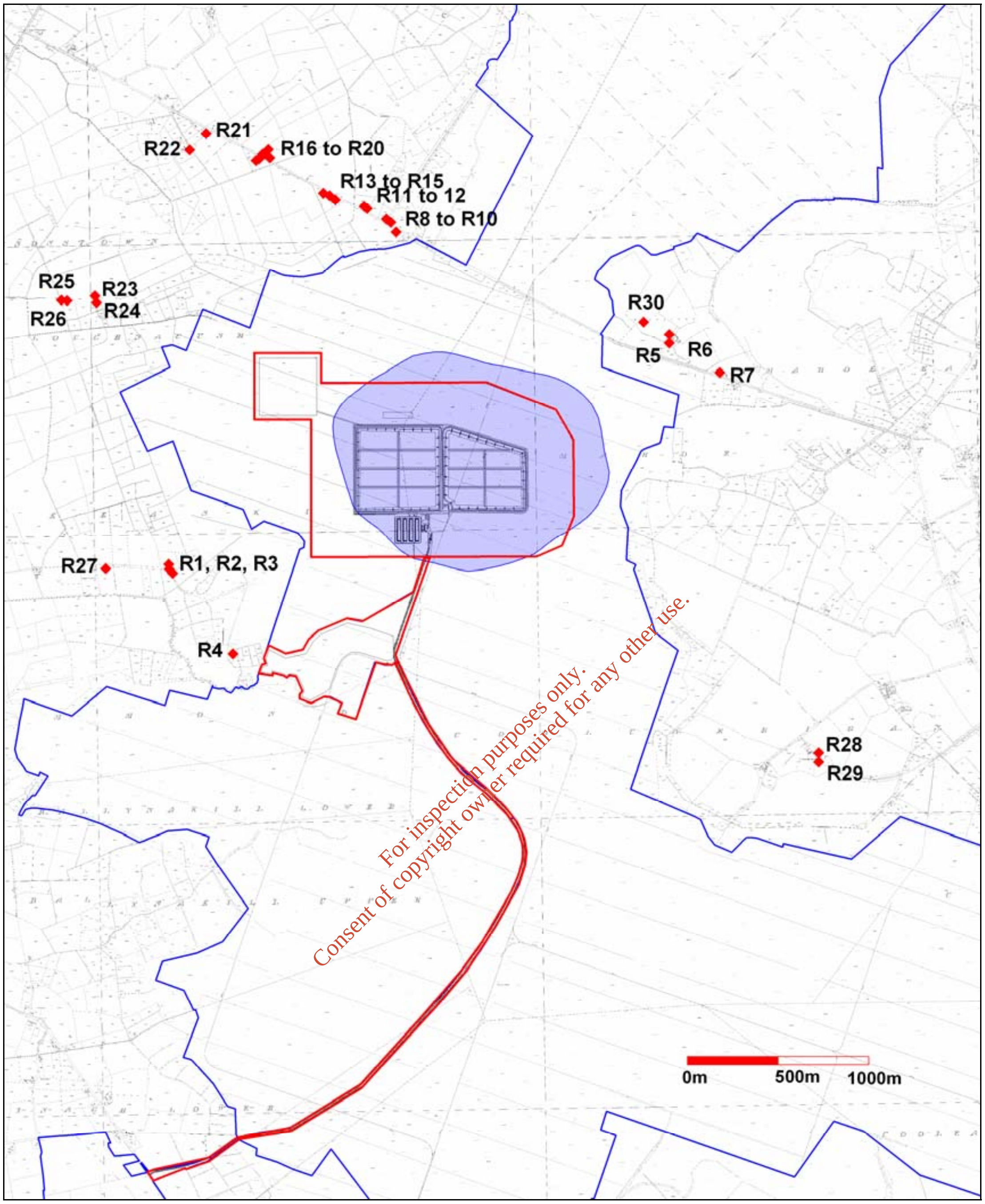


Figure 4.1.9: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 1.5 OuE m-3 (▬) for the 98th percentile of hourly averages for Scenario 4

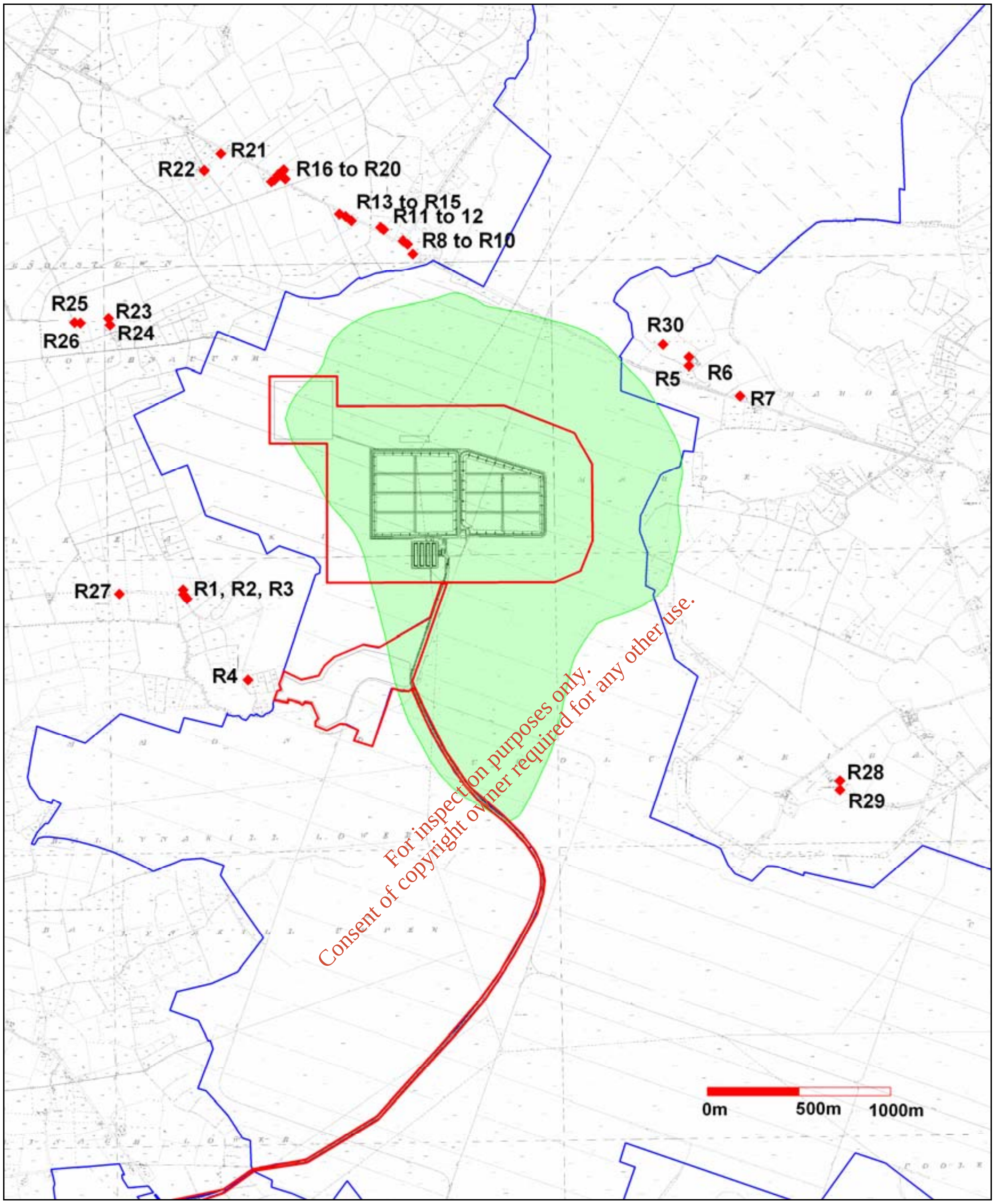


Figure 4.1.10: Predicted odour plume spread of overall waste management facility to an odour plume spread of ≤ 3.0 Ou_E m^{-3} (▬▬) for the 99.5th percentile of hourly averages for Scenario 4

Table 4.1.19: Predicted ground level concentrations at receptors in the vicinity of the proposed waste management facility for Scenario 4

Receptor identity	X coordinate	Y coordinate	98th percentile odour concentration (Ou_E/m^3)	99.5th percentile odour concentration (Ou_E/m^3)
R1	273050.6	231483.8	0.1	0.5
R2	273052.8	231457.8	0.1	0.5
R3	273072.2	231434	0.1	0.5
R4	273404	230990	0.1	0.6
R5	275809.7	232703.2	0.6	2.0
R6	275809.7	232751.5	0.6	2.0
R7	276087.7	232541.5	0.5	1.8
R8	274303.3	233316	0.4	2.0
R9	274274.9	233369.9	0.4	1.8
R10	274249.4	233386.9	0.4	1.7
R11	274144.4	233446.5	0.4	1.6
R12	274127.4	233457.8	0.4	1.5
R13	273968.5	233494.7	0.4	1.4
R14	273937.3	233517.4	0.4	1.3
R15	273903.3	233531.6	0.3	1.3
R16	273608.3	233724.5	0.3	1.0
R17	273599.7	233772.7	0.2	1.0
R18	273568.5	233747.2	0.2	1.0
R19	273551.5	233721.7	0.3	1.0
R20	273531.7	233710.3	0.3	1.0
R21	273256.5	233860.7	0.2	0.8
R22	273165.7	233769.9	0.2	0.9
R23	272652.2	232927.3	0.2	0.9
R24	272643.7	232964.2	0.2	0.8
R25	272490.5	232938.7	0.2	0.8
R26	272459.3	232941.5	0.2	0.8
R27	272703.3	231460.7	0.1	0.4
R28	276632.4	230442.2	0.2	0.6
R29	276632.4	230391.2	0.2	0.6
R30	275668	232820	0.6	2.0

4.1.3.4.4 Conclusions

The following conclusions were drawn from the study:

1. A worst-case odour dispersion modelling assessment was performed to ascertain any potential odour impacts form the operation of the waste management facility. Four years of hourly sequential meteorological data were utilised within the dispersion model.

2. For Scenario 1 - year 2011 of operation, it is predicted that all sensitive receptors will perceive an odour concentration of less than 1.50 and 3.0 Ou_E/m^3 for the 98^{th} and 99.5^{th} percentile of hourly averages over four years of meteorological data (see *Figur*es 4.1.3 and 4.1.4 and Table 4.1.16).

3. For Scenario 2 - year 2014 of operation, it is predicted that all sensitive receptors will perceive an odour concentration of less than 1.50 and 3.0 Ou_E/m^3 for the 98^{th} and 99.5^{th} percentile of hourly averages over four years of meteorological data (see Figures 4.1.5 and 4.1.6 and Table 4.1.17).

4. For Scenario 3 - year 2020 of operation, it is predicted that all sensitive receptors will perceive an odour concentration of less than 1.50 and 3.0 Ou_E/m^3 for the 98^{th} and 99.5^{th} percentile of hourly averages over four years of meteorological data (see Figures 4.1.7 and 4.1.8 and Table 4.1.18).

5. For Scenario 4 - year 2027 of operation, it is predicted that all sensitive receptors will perceive an odour concentration of less than 1.50 and 3.0 Ou_E/m^3 for the 98^{th} and 99.5^{th} percentile of hourly averages over four years of meteorological data (see Figures 4.1.9 and 4.1.10 and Table 4.1.19).

6. From this assessment, it is predicted that there will be no short or long-term odour impact in the vicinity of the Drehid Waste Management Facility during operation. Strict landfill gas, operations and odour management plans ensure sufficient odour mitigation measures are implemented at the facility. Each management plan will ensure that the operations of such mitigation is maintained at the necessary high level to ensure that there will be no odour impact in the vicinity of the site.

4.1.3.4.5 Mitigation Measures

The following mitigation measures are provided:

- Landfill gas, operations and odour management plans will be prepared and implemented for the waste management facility. Each plan will be document controlled through the Environmental Management System. All members of staff are trained in the operation and maintenance of each plan. Standard Operating and Emergency Response Procedures will be developed and all members of staff trained in their application. The plans will be reviewed and updated as necessary in accordance with best international practice.
- Facility operations and landfill gas management are performed in accordance with the guidance and direction provided by the Environmental Protection Agency.

4.1.4 Landfill Gas

4.1.4.1 Potential Gas Migration

The basal liner provides a significant barrier to landfill gas flow. The most likely pathway for landfill gas migration is up through the waste to discharge to atmosphere. Nonetheless, a network of gas monitoring wells will be installed around the landfill footprint, which is designed to detect gas migration. These gas monitoring wells have already been installed for Phase No.1 of the previously permitted landfill footprint.

The nearest dwelling is approximately 1km from the landfill footprint. Given the considerable distance to the nearest houses and the relatively restricted pathways for flow of landfill gas through the peat and mineral subsoil it is unlikely that there will be any difficulty with gas migration to these houses. Uncontrolled landfill gas migration will further be minimised by the installation of the horizontal landfill gas drainage layer and the vertical landfill gas extraction system in the waste cells.

4.1.4.2 Volumes and constituents of landfill gas

The estimated volume of landfill gas generated by the Drehid Waste Management Facility is presented in Table 3.8.4 with an expected typical composition for landfill gas presented in Table 3.8.5 in Section 3.8. Based on these two tables it is possible to estimate the potential for emissions of various landfill gases. The results of these calculations are presented in Table 4.1.20.

It should be noted however that this estimation is for uncontrolled landfill gas migration and does not take into account the provision of any mitigation measures, in particular the horizontal landfill gas extraction system, vertical landfill gas extraction system and final capping.

Results from the model show that the most significant components generated as a result of the degradation of the waste are methane and carbon dioxide, which will both reach peak values in 2016. The estimated peak generation rate for methane is approximately 1220m^3/h while that for carbon dioxide is 643m^3/h. As shown the rate of production decreases significantly in the years following closure, falling to 516m^3/h and 272m^3/h for methane and carbon dioxide respectively in 2040 and reducing further to 130m^3/h and 69m^3/h for methane and carbon dioxide respectively in 2065. Similarly the rates of production for the other gas compounds will decrease following closure and final capping of the landfill.

Table 4.1.20: Predicted Emissions of Certain Landfill Gas Constituents (m³/hour)

Year	Gas Production (90% Collection Efficiency) (m^3/h)	Methane (m^3/h)	Carbon Dioxide (m^3/h)	Oxygen (m^3/h)	Ethane (m^3/h)	Ethene (m^3/h)	Organosulphur Compounds (m^3/h)	Hydrogen Sulphide (m^3/h)
2008	**0**	0.00	0.00	0.000	0.000	0.000	0.00000	0.00000
2009	**224**	142.91	75.26	0.358	0.011	0.040	0.00002	0.00004
2010	**540**	344.52	181.44	0.864	0.027	0.097	0.00005	0.00011
2011	**836**	533.37	280.90	1.338	0.042	0.150	0.00008	0.00017
2012	**1,100**	701.80	369.60	1.760	0.055	0.198	0.00011	0.00022
2013	**1,364**	870.23	458.30	2.182	0.068	0.246	0.00014	0.00027
2014	**1,600**	1020.80	537.60	2.560	0.080	0.288	0.00016	0.00032
2015	**1,820**	1161.16	611.52	2.912	0.091	0.328	0.00018	0.00036
2016	**1,913**	1220.49	642.77	3.061	0.096	0.344	0.00019	0.00038
2017	**1,887**	1203.91	634.03	3.019	0.094	0.340	0.00019	0.00038
2018	**1,867**	1191.15	627.31	2.987	0.093	0.336	0.00019	0.00037
2019	**1,848**	1179.02	620.93	2.957	0.092	0.333	0.00018	0.00037
2020	**1,831**	1168.18	615.22	2.930	0.092	0.330	0.00018	0.00037
2021	**1,817**	1159.25	610.51	2.907	0.091	0.327	0.00018	0.00036
2022	**1,804**	1150.95	606.14	2.886	0.090	0.325	0.00018	0.00036
2023	**1,793**	1143.93	602.45	2.869	0.090	0.323	0.00018	0.00036
2024	**1,783**	1137.55	599.09	2.853	0.089	0.321	0.00018	0.00036
2025	**1,774**	1131.81	596.06	2.838	0.089	0.319	0.00018	0.00035
2026	**1,767**	1127.35	593.71	2.827	0.088	0.318	0.00018	0.00035
2027	**1,761**	1123.52	591.70	2.818	0.088	0.317	0.00018	0.00035
2028	**1,755**	1119.69	589.68	2.808	0.088	0.316	0.00018	0.00035
2029	**1,639**	1045.68	550.70	2.622	0.082	0.295	0.00016	0.00033
2030	**1,530**	976.14	514.08	2.448	0.077	0.275	0.00015	0.00031
2031	**1,432**	913.62	481.15	2.291	0.072	0.258	0.00014	0.00029
2032	**1,340**	854.92	450.24	2.144	0.067	0.241	0.00013	0.00027
2033	**1,255**	800.69	421.68	2.008	0.063	0.226	0.00013	0.00025
2034	**1,176**	750.29	395.14	1.882	0.059	0.212	0.00012	0.00024
2035	**1,104**	704.35	370.94	1.766	0.055	0.199	0.00011	0.00022
2036	**1,036**	660.97	348.10	1.658	0.052	0.186	0.00010	0.00021
2037	**973**	620.77	326.93	1.557	0.049	0.175	0.00010	0.00019
2038	**914**	583.13	307.10	1.462	0.046	0.165	0.00009	0.00018
2039	**860**	548.68	288.96	1.376	0.043	0.155	0.00009	0.00017
2040	**809**	516.14	271.82	1.294	0.040	0.146	0.00008	0.00016
2041	**763**	486.79	256.37	1.221	0.038	0.137	0.00008	0.00015
2042	**717**	457.45	240.91	1.147	0.036	0.129	0.00007	0.00014
2043	**677**	431.93	227.47	1.083	0.034	0.122	0.00007	0.00014
2044	**637**	406.41	214.03	1.019	0.032	0.115	0.00006	0.00013

Year	Gas Production (90% Collection Efficiency) (m^3/h)	Methane (m^3/h)	Carbon Dioxide (m^3/h)	Oxygen (m^3/h)	Ethane (m^3/h)	Ethene (m^3/h)	Organosulphur Compounds (m^3/h)	Hydrogen Sulphide (m^3/h)
2045	**602**	384.08	202.27	0.963	0.030	0.108	0.00006	0.00012
2046	**568**	362.38	190.85	0.909	0.028	0.102	0.00006	0.00011
2047	**536**	341.97	180.10	0.858	0.027	0.096	0.00005	0.00011
2048	**507**	323.47	170.35	0.811	0.025	0.091	0.00005	0.00010
2049	**479**	305.60	160.94	0.766	0.024	0.086	0.00005	0.00010
2050	**453**	289.01	152.21	0.725	0.023	0.082	0.00005	0.00009
2051	**428**	273.06	143.81	0.685	0.021	0.077	0.00004	0.00009
2052	**405**	258.39	136.08	0.648	0.020	0.073	0.00004	0.00008
2053	**384**	244.99	129.02	0.614	0.019	0.069	0.00004	0.00008
2054	**363**	231.59	121.97	0.581	0.018	0.065	0.00004	0.00007
2055	**345**	220.11	115.92	0.552	0.017	0.062	0.00003	0.00007
2056	**327**	208.63	109.87	0.523	0.016	0.059	0.00003	0.00007
2057	**309**	197.14	103.82	0.494	0.015	0.056	0.00003	0.00006
2058	**293**	186.93	98.45	0.469	0.015	0.053	0.00003	0.00006
2059	**278**	177.36	93.41	0.445	0.014	0.050	0.00003	0.00006
2060	**264**	168.43	88.70	0.422	0.013	0.048	0.00003	0.00005
2061	**251**	160.14	84.34	0.402	0.013	0.045	0.00003	0.00005
2062	**238**	151.84	79.97	0.381	0.012	0.043	0.00002	0.00005
2063	**226**	144.19	75.94	0.362	0.011	0.041	0.00002	0.00005
2064	**215**	137.17	72.24	0.344	0.011	0.039	0.00002	0.00004
2065	**204**	130.15	68.54	0.326	0.010	0.037	0.00002	0.00004

4.1.4.3 Proposed Mitigation Measures

It is considered that the combined effects of the following measures will adequately control potential gas migration:

1. The provision of a landfill gas flare at the site for treatment of the landfill gas collected.
2. The installation of horizontal gas collection systems in each of the 15 phases of the landfill in conjunction with the deposition of waste.
3. The installation of the vertical gas collection system in each of the 15 phases of the landfill after installation of the temporary cap.
4. Passive and forced gas extraction from the landfill.
5. The installation of the horizontal gas equalising layer on top of the waste body.

It should also be noted that there is a considerable distance to the nearest dwelling, which is approximately 1km from the landfill footprint (permitted and proposed extension). The gas flare emissions will be maintained at limits to minimise the risk to the surrounding environment. The emission limits will be further diluted by air dispersion in the ambient atmosphere.

Intermediate gas collection during the filling of cells is achieved by means of horizontal systems. Horizontal gas collection involves the progressive placement of horizontal systems of pipe work during the placement of waste. This process is repeated as the waste body climbs in height until the particular cell is filled.

Following completion of waste deposition and placement of the temporary cap, vertical gas wells will become the primary vehicle for the collection of gas.

The landfill gas collection vertical wells, which will be placed at approximately 40 metre centres, will also be used to monitor gas composition, flows and pressure within the waste body.

Landfill gas monitoring wells have also been installed outside of the landfill footprint between the waste body and the nearest dwellings even though the nearest residential dwelling is approximately 1km to the northeast of the proposed landfill extension footprint.

Landfill gas monitoring for Methane, Carbon Dioxide and Oxygen are carried out on a monthly basis during the operational phase of the landfill. Atmospheric Pressure and Temperature are also monitored. Suitably qualified personnel carry out the monitoring. The gas monitoring wells are used to assess whether or not landfill gas is escaping in an uncontrolled manner.

A permanent gas alarm system has also been installed in the site buildings, which continuously monitors for landfill gas. A gas analyser is permanently available on-site and is used for spot checks should high levels of landfill gas be suspected by site personnel. The site buildings have also been constructed with landfill gas barriers, which allow for the passive venting of any potential landfill gas underneath the buildings.

Landfill derived gas concentration limits measured in any building or borehole are:
Methane - ***Greater than or equal to 1.0% v/v***
Carbon Dioxide - ***Greater than or equal to 1.5% v/v***

If these trigger levels are attained within buildings or enclosed spaces, then the affected areas is evacuated and the emergency services notified.

Regular monitoring will be maintained on emissions from the landfill gas flare, to ensure limits are maintained.

4.1.4.4 Landfill gas flare

A contract has been signed with Automatic Flare Systems Ltd. (AFS) for the supply, installation and commissioning of a modular landfill gas flare system. This system will flare the landfill gas extracted from the waste body through the installation of horizontal and vertical landfill gas extraction systems in the waste cells of the Drehid Waste Management Facility. The system will be supplied in two stages. Stage one of the system will be commissioned in early 2008.

Stage One:

- Stage one includes a 500m^3/hr Enclosed High Temperature Flare chimney and a 2000m^3/hr booster arrangement. The flare chimney is designed to accept a carbon filter and an additional smaller burner arrangement. The carbon filter will be implemented to control odour if the quality of the landfill gas is too low for effective flaring. The additional smaller burner will provide a greater turn down ratio to cope with lower levels of landfill gas.

Stage Two:

- Stage two includes a 1500m^3/hr Enclosed High Temperature Flare chimney. The booster arrangement and electrical control system provided as part of stage one will accommodate the above mentioned 1500m^3/hr flare.

The location for the gas flaring equipment is shown on Drawing No. 3369-2415. The landfill gas flare will be equipped with regulator valves, monitoring valves, ventilator (compressor), flame arrestor, flare and ignition equipment. Details of the landfill gas compound are shown on Drawing No. 3369-2417.

The flare unit design ensures combustion and destruction of landfill gas within the flare chamber. Landfill gas is removed from the landfill cells under negative pressure and introduced into the landfill gas flare chamber. The gas is held within this chamber for at least 0.3 seconds at a minimum temperature of 1000^{0}C to ensure a 98% destruction removal efficiency (DRE) of landfill gas components.

The landfill gas flare will result in emissions of exhaust gases from the stack. Emission limit values are provided in the Waste Licence (W201-01) and the EPA Landfill Site Design Manual. Table 4.1.21 provides emission limit values based on the Facility Waste Licence, EPA Landfill Site Design Manual and good facility management practice. Typical values for emissions measured on an Automatic Flare Systems Ltd. (AFS) landfill gas flare are also outlined in Table 4.1.21.

As can be observed from the dataset in Table 4.1.21, the measured values from an AFS flare unit are significantly less than the corresponding limit values. The lowest emission limit value typically set for flare units is Hydrogen Fluoride. The predominant sources for Hydrogen Fluoride gas is from the burning of coal and other mineral matrixes that contain fluorine (i.e. brick manufacturing). Typically, residual waste landfills do not contain high concentrations of fluoride ions and hence it is not expected that Hydrogen fluoride will form a significant component of the Landfill gas. In accordance with recommendations from Automatic Flare Systems Ltd (AFS), the landfill flare unit will be capable of achieving an emission limit value of 5 mg m^{-3} at mass flows greater than 0.05 kg hr^{-1}.

Table 4.1.21: Emission limit values for Landfill Gas flare Units

Parameter	Emission limit Values	Typical emission values measured from an AFS flare system
Nitrogen Oxides as (NO_2)	< 150 mg m^{-3}	46 mg m^{-3}
Carbon monoxide (CO)	< 50 mg m^{-3}	14 mg m^{-3}
VOCs	<20 mg m^{-3} (at mass flows >0.10 kg hr^{-1})	-
Hydrogen Chloride	< 50 mg m^{-3} (at mass flows >0.30 kg hr^{-1})	-
Hydrogen Fluoride	< 5 mg m^{-3} (at mass flows >0.05 kg m^{-3})	-
Unburnt Hydrocarbons	<10 mg m^{-3}	Non - detectable

Based on Table 4.1.21 and the estimated volume of landfill gas generated by the permitted and proposed facility as presented in Table 4.1.20, it is possible to estimate the potential for emissions of these components from the landfill gas flare. The results of these calculations are presented in Table 4.1.22.

Table 4.1.22: Maximum Predicted Emissions from the Landfill Gas Flare

Year	Gas Extraction (m^3/h)	Carbon monoxide (kg/h)	Particulates (kg/h)	Nitrogen Oxides (kg/h)	Hydrocarbons (kg/h)	VOCs (kg/h)
2008	**0**	0.0000	0.0000	0.0000	0.0000	0.0000
2009	**224**	0.0112	0.0291	0.0336	0.0022	0.0045
2010	**540**	0.0270	0.0702	0.0810	0.0054	0.0108
2011	**836**	0.0418	0.1087	0.1254	0.0084	0.0167
2012	**1,100**	0.0550	0.1430	0.1650	0.0110	0.0220
2013	**1,364**	0.0682	0.1773	0.2046	0.0136	0.0273
2014	**1,600**	0.0800	0.2080	0.2400	0.0160	0.0320
2015	**1,820**	0.0910	0.2366	0.2730	0.0182	0.0364
2016	**1,913**	0.0957	0.2487	0.2870	0.0191	0.0383
2017	**1,887**	0.0944	0.2453	0.2831	0.0189	0.0377
2018	**1,867**	0.0934	0.2427	0.2801	0.0187	0.0373
2019	**1,848**	0.0924	0.2402	0.2772	0.0185	0.0370
2020	**1,831**	0.0916	0.2380	0.2747	0.0183	0.0366
2021	**1,817**	0.0909	0.2362	0.2726	0.0182	0.0363
2022	**1,804**	0.0902	0.2345	0.2706	0.0180	0.0361
2023	**1,793**	0.0897	0.2331	0.2690	0.0179	0.0359
2024	**1,783**	0.0892	0.2318	0.2675	0.0178	0.0357
2025	**1,774**	0.0887	0.2306	0.2661	0.0177	0.0355
2026	**1,767**	0.0884	0.2297	0.2651	0.0177	0.0353
2027	**1,761**	0.0881	0.2289	0.2642	0.0176	0.0352
2028	**1,755**	0.0878	0.2282	0.2633	0.0176	0.0351
2029	**1,639**	0.0820	0.2131	0.2459	0.0164	0.0328
2030	**1,530**	0.0765	0.1989	0.2295	0.0153	0.0306
2031	**1,432**	0.0716	0.1862	0.2148	0.0143	0.0286
2032	**1,340**	0.0670	0.1742	0.2010	0.0134	0.0268
2033	**1,255**	0.0628	0.1632	0.1883	0.0126	0.0251
2034	**1,176**	0.0588	0.1529	0.1764	0.0118	0.0235
2035	**1,104**	0.0552	0.1435	0.1656	0.0110	0.0221
2036	**1,036**	0.0518	0.1347	0.1554	0.0104	0.0207
2037	**973**	0.0487	0.1265	0.1460	0.0097	0.0195
2038	**914**	0.0457	0.1188	0.1371	0.0091	0.0183
2039	**860**	0.0430	0.1118	0.1290	0.0086	0.0172
2040	**809**	0.0405	0.1052	0.1214	0.0081	0.0162
2041	**763**	0.0382	0.0992	0.1145	0.0076	0.0153
2042	**717**	0.0359	0.0932	0.1076	0.0072	0.0143
2043	**677**	0.0339	0.0880	0.1016	0.0068	0.0135
2044	**637**	0.0319	0.0828	0.0956	0.0064	0.0127
2045	**602**	0.0301	0.0783	0.0903	0.0060	0.0120

Year	Gas Extraction (m^3/h)	Carbon monoxide (kg/h)	Particulates (kg/h)	Nitrogen Oxides (kg/h)	Hydrocarbons (kg/h)	VOCs (kg/h)
2046	**568**	0.0284	0.0738	0.0852	0.0057	0.0114
2047	**536**	0.0268	0.0697	0.0804	0.0054	0.0107
2048	**507**	0.0254	0.0659	0.0761	0.0051	0.0101
2049	**479**	0.0240	0.0623	0.0719	0.0048	0.0096
2050	**453**	0.0227	0.0589	0.0680	0.0045	0.0091
2051	**428**	0.0214	0.0556	0.0642	0.0043	0.0086
2052	**405**	0.0203	0.0527	0.0608	0.0041	0.0081
2053	**384**	0.0192	0.0499	0.0576	0.0038	0.0077
2054	**363**	0.0182	0.0472	0.0545	0.0036	0.0073
2055	**345**	0.0173	0.0449	0.0518	0.0035	0.0069
2056	**327**	0.0164	0.0425	0.0491	0.0033	0.0065
2057	**309**	0.0155	0.0402	0.0464	0.0031	0.0062
2058	**293**	0.0147	0.0381	0.0440	0.0029	0.0059
2059	**278**	0.0139	0.0361	0.0417	0.0028	0.0056
2060	**264**	0.0132	0.0343	0.0396	0.0026	0.0053
2061	**251**	0.0126	0.0326	0.0377	0.0025	0.0050
2062	**238**	0.0119	0.0309	0.0357	0.0024	0.0048
2063	**226**	0.0113	0.0294	0.0339	0.0023	0.0045
2064	**215**	0.0108	0.0280	0.0323	0.0022	0.0043
2065	**204**	0.0102	0.0265	0.0306	0.0020	0.0041

A dispersion modelling assessment was also carried out to assess the potential air quality impacts of such a landfill gas flare with maximum output in year 2016 to be located at the Drehid Waste Management Facility.

4.1.4.4.1 Air dispersion assessment using Screen 3

Screen 3 is an US EPA regulatory model used to assess the worst-case dispersion estimates from typical sources such as point, area, flare and volume sources. A full meteorological (all stabilities and wind speeds) screen can be used to assess the worst-case dispersion estimate from a landfill gas flare emission point source. The source characteristics are inputted into the model along with typical emission rates to provide a worst-case dispersion estimate.

Table 4.1.23 illustrates the input parameters for the Screen 3 model used to assess the potential air quality impacts from the landfill gas flare.

Table 4.1.23: Input parameters for Screen 3 model

Input parameter	**Estimated units**
Flare stack height	7.5 metres
Flare stack inside diameter	1.552 metres
Flare stack gas temperature	1273 Kelvin
Flare efflux velocity	11.79 m s^{-1} (based on a Ratio of 9:1 fresh combustion air to landfill gas which is typical of flares)
Receptor height	Various receptor heights were used to assess worst-case air quality impact. 2 metres represents a person head height and 4 metres represents first floor height in a two storey house, etc.
Urban/rural mixing height	Rural mixing height was chosen as the Facility is located in a rural area
Ambient air temperature	The average ambient air temperature in Kelvin used is 282 Kelvin.
Emission rate	The emission rates used were the maximum emission limit values set by the appropriate regulatory authorities. The maximum potential volumetric flow from the flare, occurring in 2016, was used. (See Table 4.1.22). These were chosen as they represent the maximum worst case emission estimates from a landfill flare unit (g s^{-1})
Grid size	An automated grid size was chosen to allow for selection of maximum air quality impact estimation at specific grid location (metres)
Meteorological option	A full meteorological screen was chosen to estimate worst-case dispersion estimates.
Terrain height	Two terrain heights were chosen to estimate the effects of terrain on air quality impacts. Obviously, the closer the receptor to stack emission height the worst case the air quality impact. 0 and 8 metres were chosen.

Table 4.1.24 illustrates relevant European and international air quality guidelines for those compounds assessed using the Screen 3 dispersion model.

Table 4.1.24: Air quality guidelines for compounds assessed using the Screen 3 model

Compound	EC Limit Value ($\mu g\ m^{-3}$)	WHO Guideline value ($\mu g\ m^{-3}$)	OEL (24 hour reference period)* $\mu g\ m^{-3}$	OEL (15 minute reference period) $\mu g\ m^{-3}$
Nitrogen dioxide	200***	200 (40)**	125	9,000
Hydrogen Fluoride as F	-	-	-	2,500
Fluoride as F	-	1000	62.5	-
Carbon monoxide	10,000****	-	-	-
Hydrogen Chloride	-	-	125	10,000

* denotes an Occupational Exposure Limit which is the maximum permissible concentration of a chemical agent in the air at a work place to which humans can be exposed in relation to an eight hour day (EH 40, 2001). Enterprise Ireland have recommended that to make a valid comparison for a 24 hour exposure, one fortieth of the 8 hour OEL should be used.

** denotes annual limit value for the protection of human health (Statutory Instruments, S.I. No. 271 of 2002-Air Quality Standards Regulation, 2002)

*** Expressed as a 1 hour limit

**** Expressed as an 8 hour limit

<u>Screen Modelling 3 Results</u>

The maximum emission concentrations as presented in Table 4.1.21 were used as input values along with source characteristics (Table 4.1.23) in the atmospheric dispersion model, Screen 3. This allows for the assessment of a worst case dispersion estimate for the determination of potential air quality impacts in the vicinity of the landfill gas flare unit.

The closest resident is located approximately 1,236 metres southwest of the landfill gas flare location. The next nearest residents are located in excess of 1,300 metres from the landfill gas flare.

Table 4.1.25 illustrates the predicted ambient air concentrations of relevant air quality compounds emitted from the flare unit and their respective ground level concentrations (GLCs). As can be observed it is demonstrated that in accordance with those relevant ambient air quality guidelines the flare unit will have no air quality impact on any of the nearest residences. The maximum impact concentrations for all modelled scenarios as presented in Table 4.1.25 will occur between 159 metres and 464 metres from the landfill gas flare unit location.

This maximum concentration for all compounds modelled is significantly lower than the ambient air quality guidelines.

Table 4.1.25: Estimated worst-case ground level concentrations (GLC) of potential compounds emitted from the landfill gas flare.

Parameter	Emission Limit Values (mg m^{-3})	Flagpole Receptor Height (m)	Terrain height above base of stack (m)	Predicted maximum 1 hr concentration (µg m^{-3})	Distance from stack (m)
Carbon Monoxide	< 50	2.0	0	10.15	464
		4.0	0	9.96	446
		8.0	0	11.40	349
		8.0	8	33.79	159
Nitrogen Oxides	< 150	2.0	0	29.35	464
		4.0	0	30.30	446
		8.0	0	34.34	349
		8.0	8	101.80	159
Hydrogen Fluoride	< 5	2.0	0	0.9828	464
		4.0	0	1.006	446
		8.0	0	1.15	349
		8.0	8	3.410	159
Hydrogen Chloride	< 50	2.0	0	9.828	464
		4.0	0	10.06	446
		8.0	0	11.50	349
		8.0	8	34.10	159
Un-burnt Hydrocarbons	< 10	2.0	0	1.96	464
		4.0	0	2.02	446
		8.0	0	2.289	349
		8.0	8	6.789	159

Conclusions

A maximum worst-case modelling scenario was used to assess the air quality impact of the landfill flare unit. Based on the modelling, the landfill gas flare unit will have no ambient or GLC air quality impact in the vicinity of the flare.

According to the model, the estimated highest ambient concentration of all compounds occurs between 159 and 464 metres from the landfill gas flare. All receptors will perceive lower GLC's for the modelled compounds than recommended air quality concentrations; therefore the flare unit will cause no air quality impact.

The flare unit will cause no ambient air quality impact on any of the nearest residences as demonstrated by the approved US EPA and Irish requested EPA dispersion model for a worst-case dispersion estimate of the flare units.

4.1.5 Aerosols

4.1.5.1 Potential Impacts

Aerosols can typically be generated from leachate treatment plants where aeration of the leachate is taking place. However the aeration or treatment of leachate is not carried out or proposed at the Drehid Facility. As outlined, leachate is transported off-site for treatment at Leixlip Wastewater Treatment Plant. In addition recirculation of the leachate will take place beneath the temporary cover and/or the final capping of the landfill. It is considered that aerosols will therefore not be generated at the site and as such no mitigation measures are proposed or required.

The production of bioaerosols, such as actinomycetes, bacteria, fungi, antropods, and protozoa, from biowaste composting facilities has generated some concern. Several studies have been carried out both in Europe and the United States investigating the generation and effect of bioaerosols on workers and the neighbouring population at a range of composting facilities.

One such study has been undertaken by a group of international experts on bioaerosols, risk assessment and composting who investigated the impact of bioaerosols on workers at composting facilities. The study found that although some types of bioaerosols (mainly *Aspergilus fumigatus*) are present in the air at composting facilities, available epidemiological evidence does not support the suggestions of allergic, asthmatic, or acute or chronic respiratory diseases in the general public at or around the several open air and one enclosed composting facility studied.

Their overall conclusion that 'composting facilities do not pose any unique endangerment to the health and welfare of the general public' is based on the fact that on-site workers at composting facilities were regarded as the most exposed part of the community, and where workers health was studied, for periods of up to 10 years on a composting site, no significant adverse health effects were found. A separate study showed that microbial and endotoxin emissions from an enclosed composting facility fitted with a biofilter are generally low and similar to background concentrations found in ambient air.

Most bioaerosols generated during the permitted composting process occur during the mechanical treatment of biowaste and the first stage of composting. These processes will be fully enclosed. All process steps in the facility will be equipped with air extraction and biofilter treatment of process air. It is therefore envisaged that no significant emissions of bioaerosols will occur from the proposed facility and that no impacts are expected.

4.1.6 Mitigation measures

Since it is envisaged that aerosol emissions are not significant and no potential impacts are expected, no specific mitigation measures have been identified. During the mechanical treatment stage of the permitted compost facility, workers will wear respiratory protective equipment, i.e. facemasks. All mechanical equipment such as front-end loader/360° hydraulic excavator will be fitted with air filters and the machine cabins will have a positive pressure environment.

4.2 Climate

4.2.1 Potential Impacts

4.2.1.1 Local Climate

No potential impacts are expected on the local climate of the area.

4.2.1.2 Global Climate

Both methane and carbon dioxide emissions resulting from the degradation of waste on site are classified as greenhouse gases and as such have the potential to contribute to global warming. Under the Kyoto protocol the European Union aims to reduce the emissions of such gasses by 8% below 1990 levels by the period 2008-12. As a result Ireland has agreed to limit the increase in its net greenhouse emissions to 13% above 1990 levels by the period 2008 to 2012. Carbon dioxide resulting from the bioconversion of biowaste is not considered a net contributor to greenhouse gas emissions, since the carbon is stored in the biomass for a limited number of years (short carbon cycle), where as in the case of fossil fuels the carbon is stored for millions of years (long carbon cycle). Therefore, there will be no net contribution to greenhouse gas emissions.

4.2.2 Significant Effects

The potential impact of this development on the global climate must be considered while taking into account current landfills and their emissions. As the landfill is to operate its gas management under Best Available Techniques (BAT) the level of emissions will be substantially lower than that of older sites. Consequently the closure of older sites and the operation of the landfill will have a positive impact in reducing Ireland's emissions and therefore aiding the effort to reach the targets set out by the Kyoto Protocol.

4.2.3 Mitigation Measures

In order to reduce the potential impact of landfill gas emissions from the landfill, mitigation measures have been proposed which include the collection and flaring of the landfill gas. The conversion of methane gas to carbon dioxide is possible by flaring and as carbon dioxide has a lower global warming potential than methane the flaring of the landfill gas will be undertaken in the short term. It is envisaged that the landfill gas flare will be installed in the first half of 2008 at the Drehid Waste Management Facility and landfill gas will be collected as soon as it becomes feasible to do so i.e. when there are sufficient volumes available for flaring.

If sufficient and constant volumes of landfill gas are generated within the waste body it is recommended that the installation of the combined heat and power (CHP) plant be commissioned within the facility. This aspect can only be assessed when the landfill gas potential is assessed during the operation of the facility. It should be noted however that the diversion of organic material away from landfill (as required under the Landfill Directive) will significantly reduce the volumes of landfill gas generated in residual landfill and that the provision of a CHP plant may not be feasible.

4.3 Geology and Hydrogeology

4.3.1 Significant Impacts

4.3.1.1 Potential Impacts on Soils and Geology

The natural soil and geological environment has been impacted by past industrial activity undertaken within the proposed property. Since the cessation of peat harvesting the lands have largely remained unaffected by human activity or development. Some small scale, localised peat cutting still occurs at the margins of the existing bog to meet local requirements. The previously permitted Drehid Waste Management Facility commenced accepting waste in February 2008 and involves the development of 139ha within an overall landholding of 2,544ha. The proposed extension and intensification to the Drehid Waste Management Facility will result in the site activity boundary being increased to 179ha.

As part of the development of the waste management facility 'Avoidance of Impacts' was incorporated into certain designs, to minimise or significantly reduce potential impacts.

Within the site activity boundary, which comprises approximately 179ha of land, discrete compartments can be defined, where activities associated with the construction and operation of the facility will occur. The significant defined areas within the site activity boundary are detailed below:

- The entire landfill footprint (including the permitted and proposed area) will comprise 39ha at full extent after 20 years;
- The already permitted clay borrow area which will extend to 10ha at full extent, to provide construction and capping material for the landfill throughout its operational lifetime;
- The already permitted sand and gravel borrow area (12.7ha) which will provide enough construction material, source sand for Bentonite Enhanced Soil (BES) and drainage material for the facility (including both the permitted and proposed landfill phases);
- The all ready permitted facility reception, internal road network, waste acceptance/management hardstanding and compost facility which will cover a further 1.2ha at full extent;
- The water settlement and stormwater retention lagoons (permitted and proposed), which comprise a total floor area of approximately 0.9ha; and,
- The already permitted and constructed access road from Killinagh Upper to facility entrance comprises 3.0ha over a distance of approximately 4.8km.

Based on the above, the actual area within the site activity boundary (permitted and proposed) where the geological environment will be impacted comprises approximately 67ha, which is approximately 37% of the area within the site activity boundary. The geological environment over a large area within the site activity boundary (179ha) will therefore remain unaffected by site activities.

Earthwork and excavation are likely to cause the greatest impact on the soil environment during the construction phase. It should be noted that the vast majority of the material required for the construction of the facility infrastructure is available within the confines of the site activity boundary, therefore construction disruption will not impact on the surrounding environment, i.e. the general public will not be impacted during the construction of the facility.

All excavations within the site will be terminated in the unconsolidated material; therefore there is no potential impact on the bedrock environment. It is necessary to progressively clear the peat material from the landfill footprint and the borrow areas in order to win construction material or achieve formation levels for landfill construction. Peat has been removed from the administrative area, sand and gravel borrow pit and Phases 1 and 2 of the landfill. Further excavations will be phased over the overall 20 year lifetime of the facility and therefore the potential impact of such activity will also be phased.

The potential impact associated with exposed soil surface principally relate to sediment laden run-off to watercourses. The greatest risk of sediment run-off occurs during wet weather. Management and control of water falling on worked areas are an important aspect in minimising the impact of construction. The implementation of such measures has ensured that surface water discharges have been of good quality. Much of the infrastructure and mitigation measures outlined herein have already been put in place for the construction of the initial stage of the Drehid Waste Management Facility, with the remaining measures to be implemented on a phased basis.

Mitigation measures are proposed below to reduce the impact on the soil environment.

4.3.1.2 Potential Impacts on Hydrogeology

The landfill design is cognisant of the hydrogeological setting of the proposed site and the recommendations of the Groundwater Response Matrix for landfills. The regional hydrogeological setting of the site, in terms of aquifer potential and groundwater vulnerability, does not preclude the development of a residual, non-hazardous landfill at the proposed site. The Response Matrix for Landfill Selection indicates that the site falls within the R1 zone. The R1 zone is the lowest risk category in the matrix for landfill selection.

Therefore in terms of land-use zoning the development of a landfill is acceptable, subject to guidance outlined in the EPA Landfill Design Manual or conditions of a waste licence.

Both the permitted landfill and the proposed landfill extension have been designed taking into account all relevant guidelines and recommendations of the EPA Landfill Design Manual.

The 'Avoidance of Impact' was incorporated into the design of the landfill to have as low impact as possible on the groundwater environment. Laboratory testing of the mineral subsoil, based on 10 No. tri-axial constant head permeability tests, indicates that the in-situ natural vertical permeability of the quaternary overburden varies between 2.2 $x10^{-10}$ metres/second (lower limit) to 1.5 x 10^{-9} (upper limit), with an average vertical permeability of 6.78 x 10^{-10} metres/second. This low permeability natural mineral subsoil is overlain by a 0.5m thick barrier layer of Bentonite Enhanced Soil (BES), which is processed to achieve a permeability of less than or equal to 5 x 10^{-10}m/sec. The BES is in turn overlain by a geomembrane HDPE liner, to prevent leakage of leachate. A high permeability drainage blanket overlies the geomembrane, with leachate collection pipework embedded. This drainage blanket and pipework creates a fast-track for leachate movement to leachate collection sumps, thus further reducing the risk to the groundwater environment. All leachate generated within the landfill body will be exported from the site for treatment at an approved wastewater treatment plant.

An impact assessment of the liner design was undertaken to determine the potential risk from leakage from the liner system. The lining system for the landfill is cognisant of the guidance offered in the EPA Landfill Site Design Manual. The composite lining system for the containment of leachate within the landfill is in accordance with the design manual and comprises an upper layer of 2mm HDPE geomembrane and a lower layer of 0.5m thick Bentonite Enhanced Soil (BES).

The EPA design manual includes information on rates of leakage that could be expected through the HDPE geomembrane liner (Appendix C of the EPA Landfill Design Manual). The leakage calculations detailed in the manual assume that the watertable is at or below the base of the landfill liner system, to allow a vertical drainage for potential leakages.

Based on studies undertaken by Giroud et al (1989), an empirical formula has been defined to evaluate the volume of leakage through a defect in the geomembrane of a composite liner. The total potential leakage through the liner system and artificial geological barrier has been calculated as 0.076m^3/ha/year. At full landfill extent (39 ha) the potential leakage of leachate to the natural subsoil will comprise approximately 3m^3/year.

The Waste Management Paper 26B (Dept. of Environment, HMSO,1995) provides information on flow rates through lining systems, using flow estimations based on Darcy's Law of flow in saturated media. The breakthrough of the $3m^3$/year of leachate would occur at the base of the BES after 31.25 years. The travel time of the leachate through 10 metres of the natural subsoil, with an average permeability of 6.78×10^{-10}m/sec would take a further 467 years. This indicates that even allowing for a defect in the geomembrane liner the risk to the groundwater environment is negligible.

Even allowing for this negligible risk to the groundwater environment, the landfill is designed to reduce any risk to the groundwater environment. The formation level of the landfill will be lowered into the natural mineral subsoil so that the planned leachate level (1m above the HDPE liner) is at or below the natural watertable in the lands surrounding the footprint. The design, which is fully consistent with the Landfill Directive and the EPA Landfill Design Manual, creates a hydraulic trap, whereby the water level inside the lining system is at or below the water level outside of the lining system, thereby removing the hydraulic head that would create the pressure for leachate to leak through the liner system.

The excavation of the peat material and mineral subsoil is required to allow the landfill be constructed in such a manner as to create a groundwater hydraulic trap. Even allowing for this excavation the groundwater vulnerability will not be affected and the rating will remain as Low Vulnerability, owing to the thickness and low permeability of the subsoil. In addition an undercell drainage network will be installed comprising a network of drains or 300mm of drainage stone with a groundwater pump sump which will prevent hydraulic uplift and facilitate the construction of the landfill footprint. This methodology has already been successfully followed for Phase 1 of the landfill at the Drehid Waste Management Facility.

4.3.1.3 Potential Impacts on Water Supplies

The baseline assessment indicates that there are no groundwater abstraction wells for potable supply within 1km of the landfill footprint. Due to the low permeability of the natural subsoil and the thickness of the unconsolidated material, the potential impacts on any domestic wells or boreholes in the broad vicinity of the landfill are considered low. Based on hydrogeological conditions in this region the zone of contribution to domestic wells is small and would not extend to the site.

The landfill will not impact upon the quality or abstraction rate of any supplies in the area. The landfill is outside of the source protection zones of both the Robertstown well field and the Johnstown Bridge well field. The landfill will not impact upon these major abstraction areas.

4.3.2 Mitigation Measures

The following mitigation measures have been employed on site for initial stages of construction of the previously permitted waste management facility including Phase 1 of the landfill. These mitigation measures will also be employed for the remaining phases of the previously permitted waste management facility and for the proposed intensification and extension.

4.3.2.1 Geology

During the construction of the facility and especially when excavation of unconsolidated material is required, standard approved working methods have been and will continue to be employed to reduce the risk to the surrounding environment. Exposed soil surfaces have the potential to flow from the site to surface water channels. Temporary and permanent water control measures, comprising temporary sediment control measures and permanent settlement lagoons, existing and proposed, will control the quality of any water discharged from the Drehid Waste Management Facility. Details of the water control measures are included in Section 4.4 (Surface Water) herein.

During the course of progressive ground clearance for the landfill footprint, the clay borrow area and the sand and gravel borrow area, the excess soil material has been and will continue to be used to create visual berms. To mitigate soil erosion, all exposed soil surface will be anchored by vegetation and/or by use of ground stabilisation geogrids. During construction work and until vegetation has anchored the embankments, any water accumulating on exposed soil are diverted through settlement lagoons.

All potentially polluting materials, including hydraulic fluid, engine oil and fuel, are stored in bunded areas to ensure total containment in the unlikely event of failure of the storage tank. This reduces the risk of soil contamination due to activity of plant and equipment.

Any standing water accumulating within the landfill footprint, where waste has not been placed, will continue to be diverted to the settlement lagoons, to enhance retention, lower velocity and allow suspended solids to fall out of suspension prior to discharge to the adjoining surface water network.

Due to the minimal disturbance of the geological environment, the mitigation measures are restricted to the stabilisation of exposed soil surfaces.

4.3.2.2 Hydrogeology

The engineering measures utilised in the construction of this facility are aimed at the containment of leachate within the landfill liner system and the collection of leachate for subsequent treatment off-site. The design has also taken account of the groundwater protection response matrix. The design of the containment system is in accordance with the EU Landfill Directive and the EPA Landfill Design Manual.

A composite basal lining system was developed to maximise the protection offered. This basal liner has already been installed for Phase 1 of the landfill and will be utilised for the remaining phases of the permitted landfill footprint. This basal lining system will also be utilised for the proposed extension.

The primary containment system is the HDPE liner. The second protection layer is an engineered low permeability layer of 500mm of Bentonite Enhanced Soil (BES), with a permeability value of less than or equal to 5 x 10^{-10}metres/second, which forms a low permeability barrier to impede vertical percolation. The BES layer in Phase 1 of the previously permitted landfill has been constructed in accordance with this requirement.

The low permeability of the natural overburden material (vertical permeability varying between 2.2 x 10^{-10}m/sec to1.5 x 10^{-9}m/sec) offers further protection to the groundwater environment, in addition to those measures employed in the engineering of the facility.

A leachate collection system, comprising a permeable drainage layer with leachate collection pipework, has been installed on top of the basal liner, with a gradient towards the leachate sump to the extreme southeast of the landfill, for Phase 1 of the previously permitted landfill. The leachate collection system will be extended for all phases of the landfill. The leachate is pumped to the leachate holding tanks, which will be emptied periodically and tankered off-site to approved wastewater treatment facilities. The leachate management system is described in more detail in Section 3.7 herein.

All effluent from the proprietary wastewater treatment plant serving the administration building (i.e. liquid fraction) is also diverted to the leachate holding tanks. Therefore, the contaminant loading on the area will be minimal as there will be no direct discharge of potentially polluting material to the groundwater environment.

The run-off from internal roads and the low risk hardstanding areas is collected centrally, from where the accumulated water is diverted through a sediment grit trap, a three chamber oil interceptor and finally discharged to one of the 4 No. facility surface water lagoons, two of which have already been constructed. A fixed rate outfall is maintained from the surface water retention lagoons to the adjoining site drainage network, which eventually drains to the Cushaling River via the existing Bord na Móna surface water lagoon which services the southern portion of the Timahoe Bog. The fixed rate outfall from the facility surface water retention lagoons ensures that during extreme rainfall events peakflows will be retained within the site.

Periodic sampling of the groundwater, from the monitoring boreholes installed within the site, has been undertaken to demonstrate the background quality of the groundwater. The groundwater sampling results presented in Section 2.4.10 herein provide detailed background information on the existing and construction phase groundwater quality. These groundwater wells will continue to be sampled during the operational lifetime of the facility. The quality of the groundwater samples will be compared to the samples obtained as part of the baseline study to determine if the site operations are having an effect on the surrounding environment. Two additional groundwater monitoring points, constructed downgradient of the landfill footprint in January 2008, form part of the groundwater sampling regime.

Given the above mitigation measure and the landfill design employed to contain the leachate within the landfill, it is considered that the impact on the geological and hydrogeological environment will not be significant.

4.4 Surface Water

4.4.1 Introduction

The purpose of this section is to detail the potential impacts on the surface water environment as a result of the construction and operation of the Drehid Waste Management Facility. This section details the water management measures, which reduce the potential impact of the site activities and other mitigation measures, which reduce the risk on the surface water environment. A significant number of measures have already been constructed at the Facility and these will also be addressed in this section.

4.4.2 Potential Impacts

The industrial harvesting of peat has now ceased within the site and re-colonisation of the bog surface is well established in many areas of the site. The majority of the peat reserves have been exported from the site. The drainage channels within the site have been excavated to the base of the peat material. The drainage ditches within the site both store water and transmit it to the central drain. The storage within the drainage ditches may be a factor of the capacity of the central drain. The storage of run-off water in the drainage network will lessen the impact of sediment mobilisation to receiving water, due to the low velocity of the water and the retention time in the drains.

Based on an assessment of the drainage pattern, approximately 1,178ha of the southern bog, in which the site activity boundary is situated, drains to the Figile River sub-catchment. Two surface water channels of the Figile River sub-catchment originate within the southern portion of the applicant's property, the Cushaling River that drains 573ha of the property and the Abbeylough River that drains the remaining 605ha. All surface water draining from the operations area of the facility (including the permitted landfill footprint and proposed extended landfill footprint), the sand and gravel borrow area, and the clay borrow area drain to the west to the Cushaling River, which is a tributary of the River Figile. The access road from the R403 to the facility entrance passes through the sub-catchment of the Abbeylough Stream, which is also a tributary of the River Figile.

Potential impacts on the surface water environment due to the waste management facility will be associated with water draining to the Figile River sub-catchment. The construction of the waste management facility has the potential to have a negative impact on the surface water environment if not managed properly. All activities and construction will be confined to a 179ha landbank, which is referred to as the site activity boundary.

The site activity boundary is shown on Figure 2.5.1, which also shows the principal catchment area within the region. Within the 179ha activity boundary a significant portion will remain unaffected by the facility.

The surface water drainage pattern will only be impacted in areas of the site where construction occurs. It is proposed to use the existing Timahoe Bog drainage infrastructure and to minimise the construction area footprint. It is proposed to re-route drainage channels at the periphery of the construction zones to minimise the volume of water that could potentially be impacted. The re-routing of the drainage channels, as shown on Drawing No. 3369-2433, will not significantly impact on the regional drainage, as the water will continue to discharge to the main central drain and continue to discharge to the Cushaling River. Water control measures and discharge management will be maintained where construction occurs. The rerouting of some of the drainage channels has already taken place during the construction of the initial stage of the facility including Phase 1 of the landfill.

The design of the facility has taken account of the risk that the development poses to the surface water environment and provision has been made in the design to mitigate these risks at source. The landfill design specification, as detailed in Sections 3.3 to 3.10 of the EIS, indicates the proposed construction method and phasing of the landfill, which is in accordance with BAT and relevant EU legislation.

Reference to Section 4.3 (Soil and Geology) indicates that the risk to the groundwater environment is low due to the natural low permeability of the mineral subsoil. However, due to the naturally low permeability of the subsoil across most of the site the management of surface water is an important aspect of the development.

Within the site activity boundary the significant defined areas associated with the waste management facility are as follows:

- The entire landfill footprint (including the permitted and proposed area) will comprise 39ha at full extent after 20 years;
- The already permitted clay borrow area which will extend to 10ha at full extent, to provide construction and capping material for the landfill throughout its operational lifetime;
- The already permitted sand and gravel borrow area (12.7ha) which will provide enough construction material, source sand for Bentonite Enhanced Soil (BES) and drainage material for the facility (including both the permitted and proposed landfill phases);
- The all ready permitted facility reception, internal road network, waste acceptance/management hardstanding and compost facility which will cover a further approximate 1.2ha at full extent;
- The water settlement and stormwater retention lagoons (permitted and proposed), which comprise a total floor area of approximately 0.9ha.

Rainwater falling on these areas will be managed and discharged to the receiving waters in a controlled manner. Groundwater seepages to excavation will be minor and insignificant during heavy rainfall events, due to the low permeability of the clay material throughout much of the site. Any seepage to excavation will be treated in the same manner as captured rainwater.

Plant and equipment moving around in the base of any excavations founded on the mineral subsoil will disturb the soil. Rainwater falling on the disturbed soil will result in sediment laden water that will be discharged from the excavation to the adjoining drain network. Sediment laden waters have the potential to result in a negative impact on the surface water quality.

It is proposed that during the ground clearance for each of the remaining phases of the landfill, as with the initial phase already constructed, water control measures will be implemented by the contractor to limit the volume of water that requires treatment. The contract documents specify the necessity for the contractor to take all precautions needed to prevent sedimentation of water channels. Contractors are required to specify temporary sediment control measures (i.e. grit traps or similar) that are employed during the course of construction.

It is proposed to construct additional permanent surface water settlement lagoons to cater for the proposed landfill extension area in addition to those already permitted and constructed at the site. The additional settlement lagoons will be required during the operation of the landfill extension. The settlement lagoons have been designed to provide adequate surface water retention time to allow suspended solids to fall out of suspension prior to discharge. The location of the surface water lagoons and design details are shown on Drawing No. 3369-2433, Drawing No. 3369-2434 and Drawing No. 3369-2435.

The division of the landfill footprint into phases reduces the area of construction into discrete compartments, which minimises the area of exposed soil surfaces. This construction detail significantly reduces the potential impact of sediment laden run-off affecting the surface water environment by limiting the areas where water may accumulate sediment.

The facility will have an operational life of 20 years. The construction of the proposed extension to the already permitted landfill footprint will be divided into 7 No. phases (Phase No. 9- No. 15). The permitted landfill footprint, comprising some 21.2ha, will now be phased over a 7.5 year period and the extended landfill footprint, comprising some 17.8ha, will provide the remaining 12.5 years of landfill capacity, should permission be granted for the rates applied for herein.

It is proposed to develop the water management system in three stages, during the lifetime of the facility. The water management requirement within the landfill will be at its maximum following the capping of the final phase of the landfill. At this stage the water run-off from the capped landfill, covering the entire 39ha will be collected in the surface water swale, from which it will drain to the 4 No. settlement lagoons. The settlement lagoons have been sized to cater for an extreme rainfall event during the period when it is at its full capacity.

The regional hydrological setting will not be significantly impacted by the proposed development. The impact of the temporary reduction in contribution to the surface water environment, due to the export of water falling on areas where waste has been placed (i.e. leachate) will be negligible to the overall flows in the Cushaling River. The net contribution will be restored to natural levels following the installation of the capping system.

The excavation of material from the borrow areas will also require a degree of water control. Excavations of material from the clay borrow area will be undertaken for relatively short durations over the lifetime of the facility. The borrow area will be divided into small cells which will be worked to completion before moving onto the next cell. Therefore the floor area of exposed soil will be small. As with the landfill footprint the water accumulating within the floor of the clay borrow area has the potential to negatively impact on the quality of the surface water if not properly managed. All water accumulating within the clay borrow area will be diverted to settlement lagoons prior to discharge to the receiving artificial drainage network. Discharge limits for suspended solids will be adhered to, in order to ensure that the outfall quality is sufficient.

With respect to the sand and gravel borrow area, it is proposed to periodically dewater the saturated material and extract sand and gravel. Sand and gravel will be removed in a dry working area. Extraction from the sand and gravel area undertaken at present has revealed the presence of interbedded silt layers within the sand and gravel horizons with layers increasing in thickness towards the borrow pit boundary. By periodic dewatering, it will be possible to work out the sand and gravels areas without disturbing the silt layers, thereby reducing the volume of material extracted, and consequently reduce suspended solids concentrations to be treated and provide for the extraction of a higher grade material. As site construction will take place on a periodic basis, it will also only be necessary to extract sand and gravel on a periodic basis. It is proposed to dewater/extract material primarily during the late spring/summer/autumn period, thereby reducing the potential impact on the River Cushaling.

The settlement lagoon already constructed for the sand and gravel borrow area is shown on Drawing 3369-2433. This settlement lagoon is capable of treating 420 m^3/hour allowing an adequate retention time of 11.5 hours. Additional settlement of suspended solids will be provided within discrete sump areas within the sand and gravel area.

The re-routing of the artificial drainage ditches/main drain will not significantly impact the receiving environment. The rerouting will however reduce the risk of waters draining from upgradient of the site coming in contact with areas of the facility where site activities occur.

As detailed above waste deposition only takes place in lined cells of the active phase. Cells which have been lined and which accept waste will generate leachate, which originates from rainwater percolating through the waste material. The design standards used in the lining of the landfill prevent lateral and vertical movement of this leachate. The volume of leachate generated within the landfill throughout its lifetime is discussed in more detail in Section 3.7 of this EIS. The development of the site and the lining of the landfill, with a low permeability liner is undertaken on a progressive basis. The containment of leachate within the waste body significantly reduces the risk to the surface water environment.

A perimeter drain/swale will be excavated around the outer boundary of the landfill footprint. The perimeter swale has already been excavated to the south and east of Phase 1 of the landfill as part of the construction of the initial stage of the facility. All rainwater run-off from the capped landfill will be collected in the swale. The water in the swale drains to the south of the footprint from where the captured water is discharged to the settlement lagoons to allow settlement of particles prior to discharge to the receiving environment.

The water intercepted from the constructed paved roads and low risk hardstanding within the compost facility within the site is managed to ensure no uncontrolled water discharges to natural surface water bodies. The quality of the run-off will not be significantly impacted due to activities on-site. The stormwater collected in the gully system is collected and diverted through a sediment grit trap and oil interceptor, prior to discharge to the settlement lagoon for final polishing. All vehicles leaving the site are required to pass through a wheelwash, to ensure that debris and soil from the site do not impact on the public roads.

The site access road from the R403 road to the facility entrance is similar to public roads and run-off from these roads is not contaminated and does not pose a risk to the surface water environment. Run-off from these roads drains to the adjoining lands and ultimately to the existing artificial site drainage network.

4.4.3 Mitigation Measures

During the construction phase and the operational phase a high standard of environmental engineering practices will continue to be utilised to minimise the impact of the facility on the surrounding surface water environment.

The proposed site drainage layout is outlined on Drawing No. 3369-2433. Site drainage details including those of the surface water settlement lagoons are presented on Drawing No. 3369-2434 and Drawing No. 3369-2435.

In order to reduce the risk of sediment laden water adversely impacting surface water, measures will be implemented to divert such water through treatment systems (settlement lagoons) prior to discharge to receiving waters. During the construction period all water pumped from the base of excavations is pumped to temporary/mobile sediment control devices, comprising grit traps or devices of similar efficiency. The contract documents specify the necessity for the contractor to take all precautions needed to prevent silt laden run-off discharging directly to watercourses and limits of sediment in discharges to be maintained. Periodic sampling of discharges is a requirement of the contract.

As shown on Drawing No. 3369-2433, two surface water lagoons (SWL1 and SWL2) are constructed on the site and will cater for phases No. 1-8 of the landfill footprint as permitted. As shown on Drawing No. 3369-2433, two additional lagoons will be constructed for the landfill extension (SWL3 and SWL4). The construction of the lagoons will be phased during the progressive development of the landfill phases. The settlement lagoons will mitigate the potential of sediment laden run-off impacting the surface water environment in the environs of the landfill extension. The lagoons are designed to reduce the potential impact at source. It should be noted that the overall capacity of the lagoons has been designed based on the size of the landfill footprint (permitted and proposed extension) and hardstand areas. The additional lagoons will be constructed in two construction periods. Surface water lagoon No. 3 (SWL3) will be constructed prior to the construction of Phase No. 9 of the landfill and surface water lagoon No. 4 (SWL4) will be constructed prior to the construction of Phase No. 11 of the landfill.

Details of the proposed settlement lagoons and the design rationale to achieve the required outfall water quality are presented below. The proposed site drainage layout is outlined on Drawing No. 3369-2433. Details including those of the surface water settlement lagoons are presented on Drawing No. 3369-2434 and Drawing No. 3369-2435.

4.4.3.1 Criteria for Design of the Settlement Lagoons

Landfill footprint

It is proposed to construct the additional water settlement lagoons to the south of the previously permitted landfill footprint and adjacent to the already constructed settlement lagoons for the existing facility. All water collected on soil surfaces will have adequate retention time to allow suspended solids to fall out of suspension and the provide stormwater storage during extreme rainfall events. The completed phases of the landfill will be progressively restored/vegetated, thereby significantly reducing the potential generation of suspended solids.

It is important to note that no leachate will be diverted to the surface water retention lagoons during the lifetime of the facility. Only water collected from exposed soil surfaces, i.e. unlined areas of a phase or capped areas of a filled phase, will be diverted to the settlement lagoons.

The surface water lagoons are founded with the material sourced on-site and compacted during construction to ensure stability. Following the earthworks associated with the formation of the lagoons, the integrity of the lagoons is secured by laying HDPE geomembrane liner.

In order to ensure the sizing of the proposed retention lagoons is adequate, the Ciria Publication – Design of Flood Storage Reservoirs was used for design guidance. A provision of a storm freeboard was accounted for in the design of the lagoons, which provides temporary storage of stormwater in the event of intense short duration rainfall events. The settlement lagoons were sized to allow adequate settlement and retention time in the lagoon prior to discharge to the surface water environment.

Meteorological data was sourced from the closest rainfall gauge at Lullymore. The matrix of extreme rainfall events, detailing rainfall durations and return periods for the rainfall gauge at Lullymore is included in Appendix 2.3.2. The extreme rainfall event chosen for the sizing of the stormwater freeboard design was a rainfall event of 6 hours duration, with a 1 in 50 year return period. The amount of rainfall associated with such an event comprises 48mm precipitation, which equates to an hourly rainfall of 8mm/hour. As detailed above the highest daily rainfall recorded at Lullymore was 69mm over a 24 hour period (3mm/hour), which is significantly less than the design storm to which the settlement lagoon is designed.

Interpretation of the meteorological data and its run-off behaviour over the 6 hour storm event allows an estimation of the peak rainfall runoff intensity. The surface water management system is designed to capture and control the runoff and allow outflow to recieiving waters at a regulated rate. The calculation sheets for the run-off and management system is shown in Appendix 2.5.5.

Based on the progressive phasing of the landfill it is considered that the greatest stress on the management/control of the surface water run-off will occur when the landfill has extended to full extent and final capping has been undertaken. The landfill will be capped with low permeability clay with slopes towards a perimeter swale, into which all rainwater will report during extreme rainfall events. It should be noted that such extreme rainfall events are not uniform over a storm event. A storm rainfall distribution can be viewed as occurring with a pseudo-normal distribution, which usually commences with low rainfall, rises to a peak and diminishes slowly.

Water run-off from the landfill assumes no losses to the system, i.e. no evaporation, no plant moisture uptake, no infiltration to soil, therefore the design accounts for 100% of the rainfall. Therefore the volume reporting to the swale can be taken to be the maximum volume of rainwater that will require treatment in the settlement lagoons prior to discharge.

The water from the swale is pumped to the settlement lagoons via a surface water pump chamber with an overflow pipe also provided from the swale to the lagoons in the event of extreme rainfall. In the design of the settlement lagoons, the rate of pumping combined with the outlet rate will determine the rate at which water enters the lagoon. It is proposed that the outfall rate will be maintained at 8.3litres/second/ha of land drained (using a flow constriction). Therefore, over the full extent of the landfill footprint and hardstand areas the discharge rate will be maintained at approximately 334 litres/second or 1,200m^3/hour (i.e. 8.3 litres/sec/hectare over the full 40.2 hectare development site).

In extreme events it is proposed to utilise the stormwater freeboard to temporarily store the water. The perimeter swale will also provide flow attenuation to the run-off from the landfill and will provide additional storage capacity.

With reference to the calculation sheets included in Appendices 2.5.5 and 2.5.6, the cumulative run-off reporting to the swale will be of the order of 12,100 m^3 during a 6 hour, 1 in 50 year storm event. The swale is designed to ensure that it can safely convey the run-off to the surface water settlement lagoon treatment system. The design capacity of the swale is 4,613m^3 (when water depth is 0.5m). The required maximum storage capacity of the swale is 3,820m^3. Therefore, the capacity of the swalw is in excess of design requirements. (by 793m^3 when water depth is 0.5m). The storage capacity in the swale is designed to ensure that storm peakflow attenuation is available so as not to overwhelm the settlement lagoons.

The water management system (i.e. swale and the settlement lagoon freeboard) is capable of holding the maximum cumulative run-off during the design storm event, while maintaining a regulated outfall rate to receiving waters.

Settlement lagoons design is based on creating a low energy water environment to settle out suspended solids from aqueous suspension. The theory behind the design of the settlement lagoons is the application of Stoke's Law. The settlement lagoons have been designed to provide sufficient retention time and a low velocity environment to allow suspended solids of a very small particle size to fall out of suspension prior to allowing the water to outfall to the receiving environment. Interpretation on Stoke's Law of settlement indicates a 12 hour retention time will allow 100% removal of sand and silt down to 10um. The design calculation of the settlement lagoons are detailed in Appendix 2.5.6. The efficiency of the settlement lagoons is considered sufficient to ensure the quality of the water will meet discharge limits.

2 No. settlement lagoons have been constructed at the site. It is proposed to construct 2 No. additional lagoons in parallel to cater for the full extent of the landfill. The outfalls from each lagoon will be regulated to ensure that outfall volumes do not exceed greenfiled rates of run-off of 8.3 litres/second/hectare (i.e. 334 litres per second).

The landfill settlement lagoons will be progressively constructed in advance of the progressive development of landfill phases within the site. It is proposed to construct an additional 2 No. settlement lagoons to treat all run-off water from the landfill and hardstand areas. Settlement Lagoon No. 3 will be constructed at the site prior to the construction of Phase 9 of the landfill, while Settlement Lagoon No. 4 will be constructed prior to the construction of Phase 11 of the landfill.

The design criteria of the landfill settlement lagoons are detailed below:

- Length: 120m;
- Width: 15m;
- Retention Water Height: 2.175m;
- Stormwater Freeboard 1.15m;
- Embankments constructed at 1:1 inside embankment gradient and 1:1.5 outside embankment gradient.
- The lagoons will be founded on mineral subsoil, with the embankments constructed with mineral subsoil. The lagoons will be fully lined with HDPE geomembrane liner;
- All water will flow into the settlement lagoons from the perimeter swale by gravity flow, therefore the risk of equipment malfunction is minimised;
- A fixed outfall from the settlement lagoons will be maintained at an outfall rate of 8.3 litres/second/ha (maximum discharge of 334 litres/sec over full landfill extent of approximately 40.2 ha);
- The outfall to the receiving water will be regulated using a fixed flow valve or similar;
- A 12 hour retention time will be provided within the settlement lagoons;
- Regular monitoring of the quality of the outfall water will be undertaken;

In terms of the capacity of the Cushaling River to transmit the water discharged from the site, the channel capacity was assessed at the 2 No. locations where site specific hydrometric readings were taken (ref.: Section 2.5.3.2 of EIS). The carrying capacity of the river channel was determined by utilising Manning's Equation.

The maximum channel capacity of the Cushaling River at the western boundary of the site is estimated to be approximately 8,550 litres/sec, with a channel cross sectional area of approximately 9.5m^2. The maximum channel capacity of the Cushaling River at Dillon's Bridge, where the Cushaling River flows under the R403 road, is estimated to be approximately 9,900 litres/sec, with a channel cross sectional area of 6.61m^2. The culvert under the R403 is a concrete box culvert, of dimensions 3m high and 2.2m wide. The stream channel upstream and downstream of the bridge is incised deeply into the ground and extends to up to 6-7m, with shallow flood plains which attenuate flow in the mid part of the stream.

With respect to the discharges from the site it is proposed to discharge a maximum of 334 litres/sec from the full 40.2ha site during extreme rainfall events. This discharge will occupy approximately 4% of the channels carrying capacity. It should be noted that the water discharged from the site would naturally drain to the Cushaling River. The proposed facility will gather this water and treat it prior to outfall at a regulated rate, thereby ensuring that the channel does not become overloaded at any stage.

All surface water discharged from the site will comprise clean treated surface water. The water discharged will be diverted through settlement lagoons to reduce any potential for siltation of the river channel. The surface water quality of all water discharged from the site will be monitored to ensure the receiving water quality is not impaired. As is not proposed to discharge any leachate or any other potentially contaminated material from the site, the physico-chemical assimilative capacity of the Cushaling River will not be impacted.

Borrow Areas

Settlement lagoons have already been permitted adjacent to the clay borrow area and the sand and gravel borrow pit area to settle sediment from these locations prior to outfall. The settlement lagoon adjacent to the sand and gravel borrow area has already been constructed to facilitate the extraction of materials for the construction of the initial stages of the facility. The settlement lagoons are founded on the natural mineral subsoil, which comprises a gravelly silt/clay, with an average permeability of 6.78x10^{-10}m/sec. The settlement lagoon for the sand and gravel area is located outside the area of granular material and founded on the low permeability silt/clay.

With respect to the settlement lagoon for the sand and gravel borrow areas, extraction occurs on a cellular basis. The lateral extent of this sand and gravel deposit is limited and defined by site investigations. Therefore the volume of water diverted to the settlement lagoon will be limited. Suction pumps will be utilised to locally reduce water levels to facilitate extraction of material. All pumped water will be diverted through a settlement lagoon prior to discharge. The piezometric level of the groundwater environment in the area of the sand and gravel deposit is monitored.

Pumped water from the sand and gravel extraction area will be transmitted to the existing settlement lagoon of dimensions 50m length x 12m width x 2m depth, giving an overall retention capacity for 1,200m^3. This settlement lagoon will provide adequate retention time to allow settlement out of suspended solids prior to discharge to the Cushaling River.

As outlined previously, the clay borrow area will be divided into cells that will be worked for fixed durations until a new cell is excavated. Each clay borrow area cell will comprise approximately 0.7ha. In order to maintain a dry working floor and afford the water accumulating within each cell treatment prior to outfall to the adjoining drain network, a previously permitted settlement lagoon of dimensions 40m length x 10m width x 2m deep will be constructed, giving an overall retention of 800m^3 of water.

It is not proposed to provide stormwater freeboard in either the clay borrow area retention lagoon or the sand and gravel borrow area retention lagoon. Freeboard is not required in these structures as the water will be pumped from a lower elevation to the retention lagoons.

4.4.3.2 Summary

All potentially contaminated effluent, including leachate, captured rainwater from high risk areas and the liquid fraction of the domestic effluent, is diverted to the leachate holding tanks, from where the effluent will be exported from the site to an approved wastewater treatment facility.

There will be no uncontrolled discharge from the facility to the surface water environment. Regular sampling of the surface water environment is undertaken downstream of the waste management facility to ensure that on-site activities are not causing an adverse impact on the natural water quality. This information will be compared to the water quality data already existing to determine any cumulative impacts or negative trends.

Given the above mitigation measures and the high design standard to which the Drehid Waste Management Facility, including landfill and ancillary infrastructure, is constructed, the risk to the surface water environment is significantly reduced. The measures employed will ensure that there is no adverse impact on the surface water environment; in fact the treatment of the water prior to outfall should improve the water quality on the Cushaling River.

4.5 Landscape

4.5.1 Potential Impact of the Proposed Development

4.5.1.1 Scope of the Impact

The impacts on a landscape vary according to the nature of the project. Impacts from a waste management facility are perceived as negative, regardless of the demand and need for such a facility. It is likely that the proposed extension and intensification of the Drehid Waste Management Facility would be perceived to have a negative medium term impact on the visual and landscape character of the surrounding area, largely due to increased visible traffic and the extra landfill mound proposed to the east of that already permitted.

The significance of the impacts would depend on the sequence and management of waste operations and to a lesser degree on the establishment of vegetation to screen the site. Negative impacts would be reduced slightly by the implementation of early planting to facilitate screening.

The proposed extension and intensification of use will have an impact on the visual and landscape character of the surrounding area. These impacts are likely to arise from factors including the following:

Landfill Works

Landfill operations, i.e. the deposition of waste at the facility, commenced in February 2008 and will continue for 20 years.

The landfill will be constructed in 15 phases with the stripping of the peat layer and preparation of the ground to the formation levels required taking place prior to the development of each phase. The phasing of the development is as outlined in Section 3.4 of this EIS.

The phasing of the landfill site will cause general noise and physical disturbance, arising from vehicle movement, to householders and road users, and will create a visual impact in the area. Access will be via a haul road leading north from the R403.

Site Entrance

The site entrance consists of natural stone covered pillars and walls (see plate 15 and 16). Tree and shrubs have been planted along the entire boundary of the site with the grounds of Allenwood Celtic AFC.

Increases in Traffic
The proposed extension and intensification will result in an increase in traffic along the R403 as outlined in Section 4.9 of this EIS, and will create a negative visual impact.

Litter control measures
The following measures will continue to be employed at the site to control litter:

- All waste is immediately compacted following tipping using the on-site waste compactor.
- The active working face is kept as small as possible and all other areas covered.
- Daily cover material such as hessian, biodegradable geo-synthetic sheets or soil is placed on the working face at the end of each working day.
- Modern wind blow netting systems are employed at the working face of the landfill.
- In the event of failure of the wind blow netting system the proposed fencing around the site will also prevent litter from being blown off site. This fence will be regularly inspected by site operatives and cleaned if required.
- Regular inspection and litter collection will be undertaken at the site and adjoining land if and when necessary.
- All waste entering the facility will continue to be in covered vehicles. Bord na Móna will exclude any contractor failing to comply with this requirement from entering the site.
- A general clean-up and attendance work will regularly be carried out by site staff at the facility.

4.5.1.2 Impact on Landscape Character

The impact of a development on the character of the landscape is dependent on the vulnerability and sensitivity of the affected landscape, and its ability to accommodate change.

The site of the proposed extension and intensification of the Drehid Waste Management Facility is a cutaway bog within the Western Boglands Landscape Character Area as indicated in the Kildare County Council County Development Plan 2005-2011. A policy objective of the Plan is to recognise that cutaway boglands represent degraded landscapes and/or brownfield sites and thus are potentially robust to absorb a wide variety of sympathetic developments.

Views from outside of the site boundary are limited, however, due to intervening vegetation, and therefore impact on character in the wider landscape is generally low. The retention of as much of the existing tree/scrub cover as possible, and minimal interference with the existing landscape within the activity boundary, in conjunction with new planting will prove valuable in mitigating the visual impact of the extension and intensification of use.

4.5.1.3 Predicted Visual Impacts

In the medium term, visual impact arising from the phased development will be moderate. The permanent visual impact of the waste management facility will be reduced somewhat by restoration proposals being put in place (Drawing 3369-2437, Restoration Plan). On completion of the life span of the site and landscape restoration, there will be permanent low to moderate visual impact as a result of the landfill mounds.

The main groups, which may experience visual impact arising from the extension and intensification of use of the waste management facility, will be residential and farm properties located within the vicinity of the site.

North

Those properties located on the county road (L5025) between Timahoe and Drehid Cross Roads.

The viewpoints indicated in photoplates 2 and 3 (Figure 4.5.1) have open views of the site for the intensification and extension of the waste management facility. There will be significant short-term negative impact on these viewpoints for the duration of landfill works. Views are generally evident where there is a gap in roadside vegetation, or where there is little intervening high vegetation between the viewer and the site. The visual intrusion is a result of the open and flat nature of the landscape and low height of screening vegetation (see photomontage 2). Proposed mitigation measures as detailed in the Restoration Plan will reduce the long-term impact of the proposal.

Photomontages 4 and 5 (Figure 4.5.1) show how the visual impact of the proposal is greatly reduced when intervening vegetation screens much of the proposed facility. The visual impact of the landfill mounds will be greatly reduced when intervening vegetation screens much of the mound. This is the case for most views from the north of the site. The impact here would be moderately negative in the short term, and in time the landfill will take on the appearance of 2 small hills in the landscape, with neutral and low residual impact.

Carbury Hill is an elevated area, 5km from the landfill footprint, within a generally flat landscape and, as such, commands distant views in every direction. As shown on Photomontage 7 intervening mature vegetation screens the site, landfill mounds and any visual impact arising from the extension and intensification of use from this viewpoint. This, combined with the effects of distance would render visual impact on this location as negligible.

East

Properties on the county road (L1019) south of Timahoe.

The view from the east is represented by photoplate 1 and photomontage 1 the location of which are shown on Figure 4.5.1. There are open views towards the site, but intervening hedgerows and vegetation will screen the landfill mounds and visual impacts resulting from the extension and intensification of use. The visual impact on this viewpoint is negligible.

West and South

Properties along the county road (L5024) between Drehid Cross Roads and Windmill Cross Roads, including those located on minor lanes with access from the latter road. Properties along the R403, including those located on minor roads with access from the regional road.

Existing views are shown in photoplates 5-14 taken from the locations shown on Figure 4.5.1. Impact on these views would be low to moderately negative in the short term and neutral and low in the long-term, after landscape restoration has been carried out (see photomontages 3, 4, 5 and 6).

Viewpoint 11, the closest to the site on the western side, shows that part of the landfill mounds will be openly visible through the intervening vegetation (see photomontage 4). The visual impact will be moderately to significantly negative during the lifespan of the waste management facility. This impact will reduce on maturing of screening vegetation as proposed in the Landscape Restoration Masterplan. Long-term visual impact will be low to moderate, on completion of restoration activities.

Impact on roads and footpaths

The county road (L1019) south of Timahoe is relatively flat, and contains very few open views towards the waste management site. Generally, views are restricted by roadside and intervening vegetation, and visual impact is negligible (see photomontage 1).

Viewers in the west are between 2.5 and 4km from the waste management facility, with intervening tree belts, and will experience low to moderate visual impact where there are gaps in intervening vegetation (see photomontage 3 and 5).

The county road (L5025) to the north of the waste management facility will experience moderate to significant visual impact where there are open views, and low impact where intervening vegetation limits views (see photomontage 2).

The R403 passes within 2km of the site, south of Derrinturn, with some limited views of the landfill mounds and associated activities (photo-plate 10). Travelling further south, views are limited by roadside and intervening vegetation and by distance (plate 12).

There will be limited, but significant views of the landfill mounds from minor roads to the southwest (see photoplate 11 and photomontage 4).

There will be no views of the previously permitted waste management facility and its proposed extension from the Grand Canal Way.

4.5.1.4 Impacts of the Development on the Historical and Man-made landscape

Section 2.6.7 outlined briefly how history has shaped the receiving environment and how it influences the wider landscape surrounding the development.

Impacts on the historical and man-made landscape arising as part of the development include the change of land use from peat extraction to waste management, with a resulting change in landscape character and impact on a limited number of panoramic views of the wider landscape. The site has a history of large-scale peat extraction with subsequent heavy machinery. The extension and intensification of use of the facility will have medium-term low to moderate negative impact. Buildings will be decommissioned on capping of the landfill with no residual impact on the historical and man-made landscape as a result of the buildings. The landfill mounds will be a permanent feature on the landscape after completion of works but the intensification of use will have no further impact on the historic and man-made character.

4.5.1.5 The 'Do-nothing' Impact

All components of the environment are constantly changing due to a combination of natural and human processes. When predicting likely impacts it is important to remember that there are two available for comparison: the existing environment and the environment as it will be in the future if no development of any kind were to take place – the 'do nothing' impact.

In visual terms, the existing facility already has some landscape and visual impact on the surrounding landscape, and will continue to have an impact.

4.5.1.6 Summary of Impacts

In conclusion, the greatest levels of visual impact arising from extension and intensification of use as described will be on views from the county road (L5025) north of the northern site boundary, and on a small number of properties and road users located to the southwest (see photomontage 4)

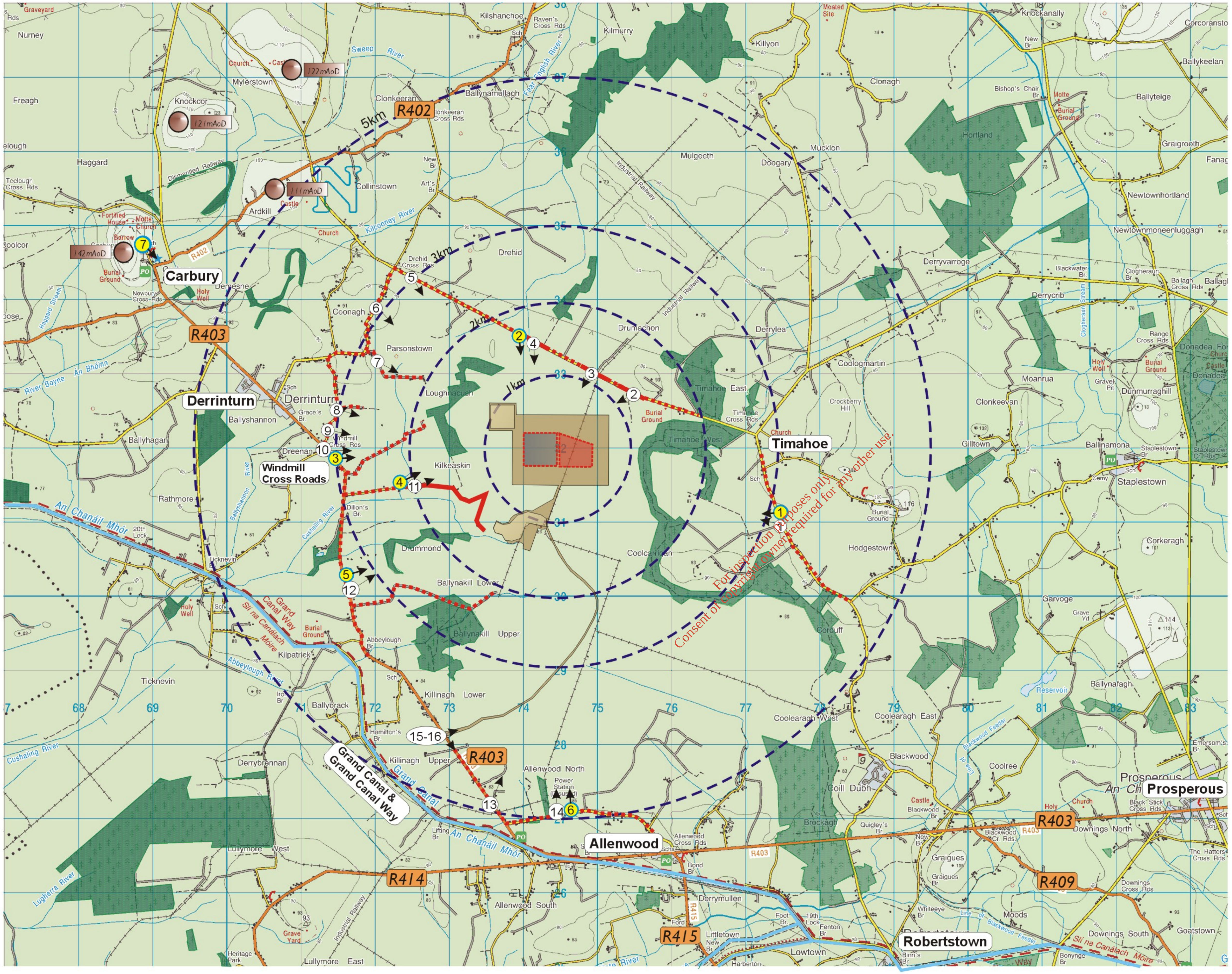
The remaining views within the 5km study area will experience negligible to low to moderate visual impact, generally due to the screening capacity of intervening vegetation.

4.5.2 Mitigation Measures

A restoration plan has been prepared for the mitigation of potential visual and landscape impacts caused by the Drehid Waste Management Facility. This is provided in Drawing No. 3369-2437.

The main features of this plan are:

- Planting of locally occurring native woodland on the northern perimeter of the site to develop an initial screening vegetation
- Similar planting in the vicinity of the proposal on capping of the landfill, in order to integrate the landfill into the existing landscape, and facilitate the potential development of the site into an amenity area.
- The formation of two lakes following decommissioning of borrow pits.
- Provision of hedgerow planting along the county road directly to the north of the site in order to limit the currently open views.
- The construction of a screening berm to the north, east and west of the landfill footprint, as extended, which will be grassed with native species.



KEY

- Site Boundary
- Borrow Pits
- Permitted Landfill Footprint
- Proposed Landfill Footprint
- Plate locations
- Photomontage locations
- Potential open view of landfill site from roads and associated residential and business properties
- Potential glimpsed view of landfill site from roads and associated residential and business properties
- Area of higher ground
- Kilometres distance from centre of application Landfill Footprints
- Significant water courses and bodies
- Surrounding vegetation

0   1km   2km   4km

Scott Wilson
incorporating
FERGUSON McILVEEN

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DREHID WASTE MANAGEMENT FACILITY

VISUAL IMPACT AND PLATE LOCATIONS

FIGURE 4-5-1 Rev A

February 2007
DL07138
Drawn: AM - Checked: DB

KEY

Permitted Landfill Mound

Proposed Landfill Mound

Part of landfill mound potentially visible in this view

Part of landfill mound screened by intervening vegetation

Note: Proposed landfill (blue) is in front of permitted landfill (green) in this view

Photomontage 1

View west from the County road (L1019) south of Timahoe. Hedgerows and vegetation will screen the landfill mounds from this stretch of road.

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KEY

Permitted Landfill Mound	*Part of landfill mound potentially visible in this view*
Proposed Landfill Mound	*Part of landfill mound screened by intervening vegetation*

Note: Permitted landfill (green) sits in front of proposed landfill (blue) in this view

Photomontage 2

View south from the County road (L5025) from Timahoe to Drehid Cross Roads. Roadside hedgerows and intervening vegetation will partially screen the landfill mounds from this stretch of road.

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KEY

Permitted Landfill Mound

Part of landfill mound potentially visible in this view

Proposed Landfill Mound

Part of landfill mound screened by intervening vegetation

Note: Permitted landfill (green) sits in front of proposed landfill (blue) in this view

Photomontage 3

View east from the R403 at Windmill Cross Roads south of Derrinturn. Roadside hedgerows and intervening vegetation will screen the landfill mounds from this stretch of road.

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KEY

Permitted Landfill Mound

Proposed Landfill Mound

Part of landfill mound potentially visible in this view

Part of landfill mound screened by intervening vegetation

Note:Permitted landfill (green) sits in front of proposed landfill (blue) in this view

Photomontage 4

View east from the minor road accessed from the R403 west of the site. The landfill mounds will be partially visible from this location.

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KEY

Permitted Landfill Mound

Part of landfill mound potentially visible in this view

Proposed Landfill Mound

Part of landfill mound screened by intervening vegetation

Note: Permitted landfill (green) sits in front of proposed landfill (blue) in this view

Photomontage 5

View north east from a gateway on the R403 southwest of the site. Dense vegetation will screen the landfill mounds from this location.

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KEY

Permitted Landfill Mound

Proposed Landfill Mound

Part of landfill mound potentially visible in this view

Part of landfill mound screened by intervening vegetation

Note: Proposed landfill (blue) is in front of permitted landfill (green) in this view

Photomontage 6

View north from entrance to Allenwood GAA club 4.5km south of the waste management facility. Dense vegetation will screen the landfill mounds from this location.

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February 2008 DL07138

KEY

Permitted Landfill Mound

Proposed Landfill Mound

Part of landfill mound potentially visible in this view

Part of landfill mound screened by intervening vegetation

Note: Proposed landfill (blue) is in front of permitted landfill (green) in this view

Photomontage 7

View south east from Carbury Hill. Dense vegetation will screen the landfill mounds from this location.

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