6.0 SITE DEVELOPMENT

INTRODUCTION

6.1 Design of historical landfill sites was directed by the 'dilute and disperse' principal, where emissions were accepted provided sufficient dilution occurred. Operational practices were generally poor, and no attempt was made to control leachate generation or build up of landfill gas.

6.2 It is now accepted practice for a modern landfill to be developed and operated on an engineered "containment" basis, to isolate the wastes and to prevent any adverse impact on the surrounding environment. The key feature of such a facility is the containment of any leachate generated within the site, and as necessary, to abstract any excess leachate from the site for safe treatment, recirculation and/or final disposal. The containment measures also serve to prevent landfill gas migrating from the site and presenting an unacceptable risk.

6.3 The containment system is achieved by engineering the sides and base of the site and by lining these with low permeability materials such as naturally occurring clays and/or synthetic geomembranes. Upon completion of infilling, leachate generation is further reduced by the installation of a low-permeability cap. In addition, leachate generation must be controlled during the operational phase by filling in cells sized on the water balance principle as described in the Environmental Protection Agency (EPA) Guidance on Landfill Site Design (EPA, 2000). This involves infilling in discrete cells which will be brought up to final level in succession and capped and restored as quickly as possible.

6.4 The EU Directive on the landfilling of Wastes (1999/31/EC) is also based on the concept of containment, specifying equivalent maximum allowable permeabilities and minimum thickness for the mineral component of containment systems. These depend on the nature of the wastes to be deposited and are summarised in Table 6.1 below.

Table 6.1 Maximum allowable permeabilities and minimum thickness for mineral component of containment systems

Waste Type	Thickness	Permeability
Inert Waste	t > 1.0 m	$K < 10^{-7}$
Household Waste	t > 1.0 m	$K < 10^{-9}$
Hazardous Waste	t > 5.0 m	$K < 10^{-9}$

Note: Thickness to be a minimum of 0.5m if artificial layers are used

6.5 The development of the site will also necessitate the construction of monitoring systems for landfill gas and leachate outside the containment system to ensure the continuing adequacy of the installation.

CAPACITY AND LIFESPAN

6.6 The capacity of the proposed site is approximately 500,000m^3 which will accommodate 20 years of landfilling at the estimated rates of waste input and includes for the requirements of cover materials and settlements within the waste mass. It is envisaged that the site will be constructed and infilled in a phased manner as discussed in section 7.0.

SITE CONSTRUCTION WORKS

Earthworks

6.7 During the development of the proposed landfill all peat and boulder clay will be stripped from the surface to the in situ rock level or below to the proposed formation levels detailed in Figure 6.1. The excavated peat will be stored on areas of the existing site. The boulder clay excavated will be utilised for the construction of the perimeter bunds while it is proposed to utilise the excavate rock for producing the construction material i.e. drainage layers thereby minimising the need to import material from external sources. The disposal area will be bounded by a minimum 30m wide buffer zone.

6.8 All existing monitoring boreholes installed for the geotechnical site investigation within the disposal area shall be removed and sealed prior to installation of the lining system.

Engineered Containment System

6.9 The site will be designed and operated on a containment basis in accordance with the EU Landfill Directive (1999/31/EC). This is based on engineering the base and side slopes of the site, installation of a groundwater drainage system, low permeability containment system incorporating a geomembrane liner, provision of a leachate and landfill gas collection and management system and ultimately a low permeability capping layer (Figure 6.1).

Groundwater Drainage

6.10 The base and sides of each cell will be prepared by cutting or filling as necessary to achieve the desired profile. These will then be covered by a 300 mm deep layer of fines free crushed rock aggregate with a minimum permeability of 1 x 10^{-3} m/s with a network of collection drains. The base of each cell will have a minimum 1:25 gradient towards the collection pipelines and 1:100 cross fall gradient (Figure 6.2).

6.11 The drainage blanket will intercept any groundwater seepage below the landfill, deliver it under gravity to the constructed wet lands prior to discharging to the existing watercourse i.e. Sruhanpollandoo stream to the north of the site.

Surface Water Drainage

6.12 In order to engineer the site it will be necessary to culvert the Sruhanpollandoo stream which runs along the north eastern boundary of the proposed site. In addition to this a surface water collection pipeline will be installed around the perimeter of the proposed landfill to collect surface water falling towards the landfill area. The surface water pipelines will join to the north of the proposed site and pass through a constructed wetland prior to discharging to the Sruhanpollandoo stream (Figure 6.2).

Lining System

6.13 The proposed containment will be a composite lining system which is illustrated in Figure 6.3. The lining system on the base will comprise a 500 mm thick layer of Bentonite Enhanced Soil (BES) installed on top of the groundwater drainage blanket over a separation geotextile. The BES will have a maximum permeability of 1 x 10^{-10} m/s and will be rolled and compacted to the desired falls (1:25 towards leachate collection pipeline and 1:100 cross-falls) to form a smooth surface suitable for covering by the geomembrane liner. The BES will extend over the base and up the side slopes to a vertical height of 2 m.

6.14 The liner will be a 2 mm thick High Density Polyethylene (HDPE) geomembrane in accordance with the EPA Landfill Design Guidance (EPA, 2000). The liner, which is available in rolls of width varying from 5.0 m to 9.3 m, will be site welded to form a continuous membrane across the lined area. This operation, including the installation of the BES, will be subject to full Construction Quality Assurance (CQA) procedures. The installation will then be covered by a protective geotextile prior to receiving a 500 mm deep blanket of 16/32 mm sized crushed rock aggregate. This will provide a drainage blanket for efficient removal of any excess quantities of leachate which may be generated.

6.15 The sides of the cells will be engineered to form slopes suitable to receive lining. These will be of the order of 1:3 (Vertical : Horizontal) the first 2m (vertical) and there after 1:2 (Vertical : Horizontal). It is proposed to achieve this slope using rock excavated from the floor of the site. The liner will be brought up the entire length of the side slopes and secured at the top in an anchor trench.

6.16 The composite lining system beyond the 2 m vertical height (extent of BES layer) above the base will take the form of geomembrane overlying a proprietary Geosynthetic Clay Layer (GCL). The 500mm leachate drainage layer will be replaced by a geonet for the leachate drainage on the side slopes.

Power Supply

6.17 The nearest three phase power supply is located over 4km away and to provide the site with a three phase supply would involve the erection of pylons to carry the cables onto site. This would is not considered appropriate for the location of the proposed site and as such electricity for the operation of site equipment and plant will be generated from an on site generator. This will be enclosed in a sound proofing container and buried into the embankment adjacent to the leachate holding tanks as shown on Figure 6.7. The sizing of this generator will be undertaken during the detailed design stage. In the event that a three phase power supply is available nearby in the future, consideration would be given to utilising this with any cabling being placed underground hence avoiding the erection of pylons in the area.

CONSTRUCTION QUALITY ASSURANCE

6.18 The installation of the lining system will be supervised in accordance with normal Civil Engineering procedures and, in addition, full Construction Quality Assurance (CQA) will be applied to ensure that the materials and workmanship meet the design specification. The installation of the containment layers will be under the supervision of an experienced Engineer and ancillary staff as may be required, to be appointed by Donegal County Council. This will involve the conformance testing of the lining materials and the in-situ welding of the geomembrane. The integrity of fusion welds will be checked by air pressure testing and extrusion welds by spark testing. In addition welds will be subject to destructive testing in shear and peel.

6.19 A detailed CQA Plan for each phase will be submitted to the EPA before development commences.

6.20 At the end of each phase of lining installation, all CQA data will be presented in a report which will be submitted to the EPA before waste infilling commences in that particular phase.

6.21 In addition to CQA, a leak detection survey will be carried out in each lined cell to check the integrity of the lining system, prior to the placement of waste in that cell. There are several such systems which have been used for this purpose. The geoelectric potential method is a standard geophysical technique using the insulating properties of the geomembranes with respect to electrical current to highlight any anomalies in the lining system.

6.22 Leak detection surveys are a recognised procedure within landfill development and provide a useful quality check for the installed lining system.

LEACHATE GENERATION

6.23 Leachate would be produced by rainfall percolating through the waste and it is current standard practice, recommended in the EPA Guidance, to minimise the quantities generated by operating to "water-balance" principles, and limiting cell sizes, by phased disposal and progressive restoration, use of a low permeability cap and by shaping of the final landform to encourage surface water run-off.

6.24 Water balance equations, which model the hydrological balance of a landfill, are available for both the operational and post-closure phases. A simple equation relating to the operational phase can be given by:

$Q = I - E - aW$

where

Q = free leachate generated (m^3 per annum);

I = total liquid input (m^3 per annum);

E = actual evaporative losses (m^3 per annum);

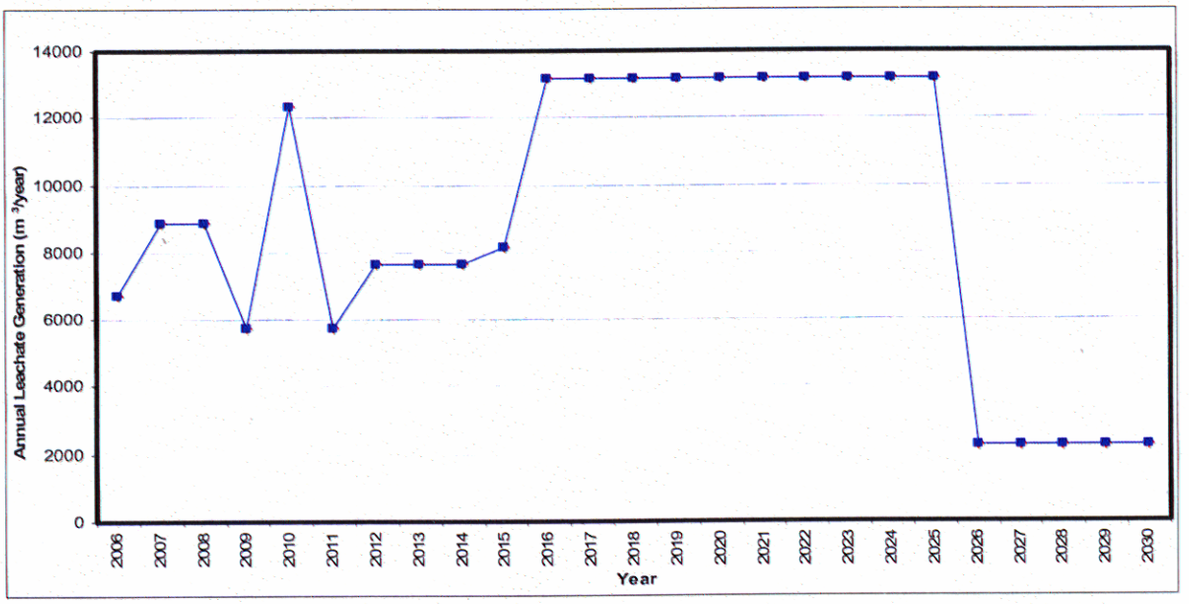
a = absorptive capacity of waste (m^3 per tonne);

W = weight of waste disposal (tpa).

6.25 This equation is typically used to calculate cell sizes on the basis of zero or "negative" quantities of free leachate although seasonal variations and storm events tend to result in excess leachate being produced. This requires a knowledge of the rate of waste input, so that the area exposed to precipitation is limited, and the rainfall is taken up by the absorptive capacity of the waste, typically assumed to be 10%, but which is a function of the waste density and composition.

6.26 It is difficult to make precise predictions at this stage since the exact composition of the waste cannot be defined accurately. The graph 6.1 below illustrates the water balance calculation for the proposed landfill up to 2030. In addition water balance calculations will be carried out twice a year, as recommended in the EU Landfill Directive, and cell sizes adjusted as necessary to control leachate production. From graph 6.1, it can be seen that leachate quantities vary over the operational period of the site between 13,200m^3 and 5,700m^3 per annum depending on the area of the site which is operational. Post closure leachate generation continues at an estimated 2,200 m^3/annum.

Graph 6.1 Water Balance Calculation For Proposed Landfill Up To 2030



Leachate Collection & Treatment

6.27 Control systems are needed at contained landfill sites to enable the safe management of excess leachate and to ensure that the integrity of the lining system is not prejudiced.

6.28 The proposals for the leachate collection system are illustrated in Figure 6.4. The leachate collection system will comprise a 500 mm deep drainage blanket, as previously described, with 225 mm diameter perforated High Density Polyethylene (HDPE) collection pipes at approximately 50 m centres. These pipes are laid to a minimum 1% falls along their length and the floor will incorporate a 4% crossfall. The pipes will discharge into a collection sump at the low points of each of the phases.

6.29 Leachate will then be pumped to a treatment tank where it will be subject to pre-treatment prior to disposal to a Sewage Treatment Works or recirculated through the waste to promote more rapid degradation. The leachate from the Meenaboll site will be transported to the Letterkenny Waste Water Treatment Works when constructed or to an alternative facility agreed with the EPA prior to these works being completed.

6.30 The treatment tanks will be constructed from a steel or glass reinforced plastic tank. The tanks will have a total storage capacity of 1,500m^3. The proposed treatment process will involve the use of a surface or diffused air aeration system followed by a quiescent period to allow settlement.

6.31 The proposed leachate collection and treatment system complies with the accepted and specified standards and practices and should ensure that there is no uncontrolled build up of excess leachate within the landfill.

Recirculation of Leachates

6.32 Recirculation of collected leachate will be required where accelerated stability is to be achieved. A comprehensive leachate recirculation system will also be provided under the proposed capping system in order to facilitate the process.

Phasing

6.33 It is now accepted practice, particularly with the advent of containment sites, for landfills to be designed and operated in a series of discrete phases. For Meenaboll Phases 1 and 2 will be developed with one cell in each while Phases 3, 4 and 5 will consist of two cells which will be designed to water balance principles to control leachate generation. The time for completion will depend on waste input rates. The phases of this development are shown in Figure 6.5.

6.34 Consistent with good landfill practice, new infill areas will be progressively prepared in advance of tipping activities. Following completion of infilling, groups of cells will be capped and progressively restored.

6.35 The layout and phasing of the site has been designed to minimise visual intrusion, as far as practicable, by infilling cells along the northern area of the site first.

LANDFILL GAS COLLECTION SYSTEM

6.36 Landfill gas, the principle constituents of which are Methane and Carbon Dioxide, is generated as the putrescible fractions within the landfill degrade. Carbon Dioxide levels predominate during the early aerobic stage of degradation. The anaerobic stage, in a mature landfill, produces a ratio of Methane to Carbon Dioxide of 2:1. The potential risks associated with these relate primarily to the flammability of Methane and the asphyxiant properties of Carbon Dioxide. Consequently, a landfill gas collection system will be incorporated into the development to provide the necessary control. Further details of the landfill gas collection system are provided in section 9.

6.37 The engineered composite lining system proposed for the landfill base and sides, together with the capping system when infilling is completed should provide an adequate barrier to the uncontrolled migration of landfill gas to the atmosphere or surrounding strata. As a result provision must be made for an active gas extraction system to ensure that gas generated within the landfill mass can be disposed off in a controlled manner. For this purpose the proposed site will have a series of gas wells installed after waste infilling. The wells will then be connected to the permanent gas flaring unit via a HDPE collection pipe (Figure 6.6).

SITE INFRASTRUCTURE

6.38 Modern landfills require a substantial amount of associated infrastructure in order to operate to current guidelines and licence requirements. The following paragraphs describe the various elements of the site infrastructure that will be installed as part of the proposed development. These facilities will allow for good operational practices to be applied in respect to waste acceptance, recording, control and emplacement as well as leachate and landfill gas management.

6.39 The site infrastructure area will include:

- Site identification board
- Site Office
- Weighbridge
- Wheelwash
- Haul Road
- Security Fencing
- Leachate holding tank
- Waste Inspection/Quarantine area
- Surface water drainage
- Site services
- Car parking
- Landfill Gas Flare
- Leachate treatment facility
- Recycling Area
- Plant Maintenance Shed
- Fuel Storage Area
- Electrical Generator
- Settlement Ponds
- Constructed Wetlands

6.40 A site identification and information board will be erected at the site entrance and will include details of the operator, licence details, opening hours and contact and emergency telephone numbers.

6.41 A site office as shown in Figure 6.10 will be provided at the facility and will be designed to blend into the surrounding environment by the use of external finishes with traditional finishes. The site office will incorporate the following main elements:

- an administration office;
- a weighbridge management system;
- a general reception area;
- car parking facilities;
- sanitary facilities – showers and toilets;
- kitchen and canteen area.

6.42 A surface mounted weighbridge will be installed adjacent to the site office and will be sufficiently far from the county road to avoid queuing. It will have a minimum length of 15m and a minimum load weighing capacity of 60 tonnes. It will be linked to a weighbridge management system which will record all relevant information on waste and cover materials entering the site.

6.43 A wheelwash will be constructed on the exit route from the waste disposal area sufficiently far from the public road to allow removal of excess dirt from vehicle wheels. Pressure jets will be used to wash tyre surfaces and the underbody of vehicles. All contaminated water from the wheelwash is discharged to the leachate holding tank.

6.44 The site will be accessed through an existing Coillte Teoranta track to the north of the site. The site entrance will be improved with sightlines along the adjacent County road. The layout of the internal road network is shown in Figure 6.7. A 6m wide concrete haul road will be constructed from the site entrance to a point approximately 200m from the site entrance. Beyond the end of the concrete haul road a 200mm deep layer of crusher run stone, 6m wide will provide access through the site.

6.45 Street lighting will be provided to areas which operate after darkness. This includes access from the public road to site reception area, weighbridge, wheelwash, leachate treatment system and gas flare. All external lighting shall be designed so as to prevent direct spillage of light onto the adjacent county road. It is proposed to generate a three phase power supply on site using a 400kVA generator. A single phase electricity supply, water supply and telephone will also be provided on site.

6.46 A 2.4m high security fence will enclose the boundaries of the facility (Figure 6.10). Gates will be provided in the fence to allow access to adjacent land for maintenance. The site will be secured outside operating hours. A detail of the security fence can be seen in Figure 6.8.

6.47 A leachate treatment facility will be installed and will provide storage capacity and a treatment system using diffused air or surface aerated oxygenation method to biologically and chemically treat leachate. The tanks will be constructed partially below ground, with a total depth of 4.0m, only 2m of which will be above ground level to minimise the visual impact of these structures. In addition bunds will be constructed between the leachate tanks and the county road to screen them from view.

6.48 A waste inspection and quarantine area will be located adjacent to the site office (Figure 6.7) and will be a concrete area with a concrete wall constructed around 3 sides. Drainage from this area will be independent of the rest of the reception area and will be designed so as it can be diverted to the leachate treatment system.

6.49 The surface water from the site roads will be directed to gulleys and pass through an oil interceptor and settlement lagoons prior to discharging to the Constructed Wetlands in the northern area of the site.

6.50 Car parking facilities will be provided adjacent to the site office for site staff and visitors.

6.51 A landfill gas flare will be provided to the north east of the landfill as illustrated in Figure 6.7 and will be introduced after infilling in Phase I has been completed to allow for the extraction of landfill gas.

6.52 A fuel storage area, located adjacent to the northern boundary of the proposed facility, will provide a fuelling point for all site vehicles. The storage area will comprise a 10,000 litre tank within a bunded area with a capacity of 110% of the storage tank.

6.53 One of the initial construction tasks undertaken by Donegal County Council, when site works commence, will be the construction of the surface water settlement ponds to the north of the proposed landfill area. The primary purpose of the settlement ponds is to allow any sediment in suspension in the surface water to settle out prior to entering the constructed wetlands and discharging to the adjacent stream.

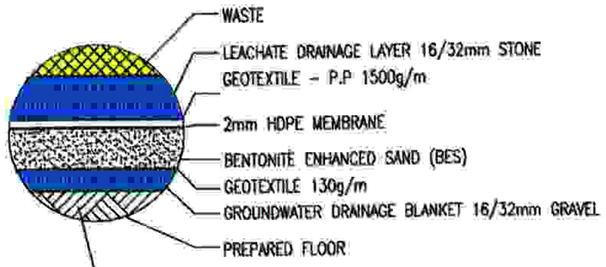
6.54 Constructed wetlands will also be provided prior to the construction works commencing on site. The size of this constructed wetland will be determined at the detailed design stage and if necessary additional land on the opposite side of the county road to the north west of the site will also be utilised. The Constructed wetlands will primarily be designed to deal with the potential suspended solids generated during constructed periods.

REFERENCES

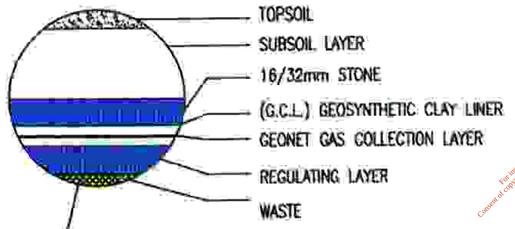
1. The Environmental Protection Agency Landfill Manual – Landfill Site Design 2000

FIGURES

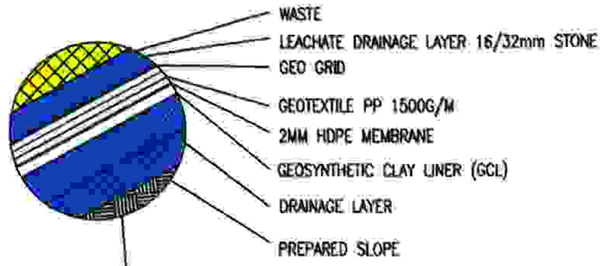
ENGINEERED BASE OF LANDFILL

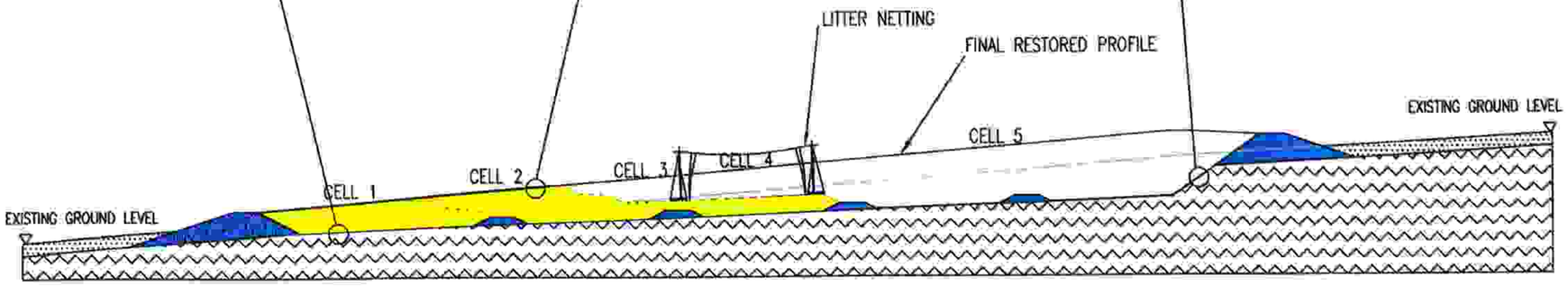


ENGINEERED SURFACE OF LANDFILL



ENGINEERED SIDE SLOPE OF LANDFILL





KEY:

EXISTING GROUND LEVEL LEVEL IN PROPOSED LANDFILL AREA

LANDFILL WASTE

TERMON PELITE (METAMORPHOSED MUDSTONE)

QUARRY BACKFILL MATERIALS

PEAT

SCALE:NTS

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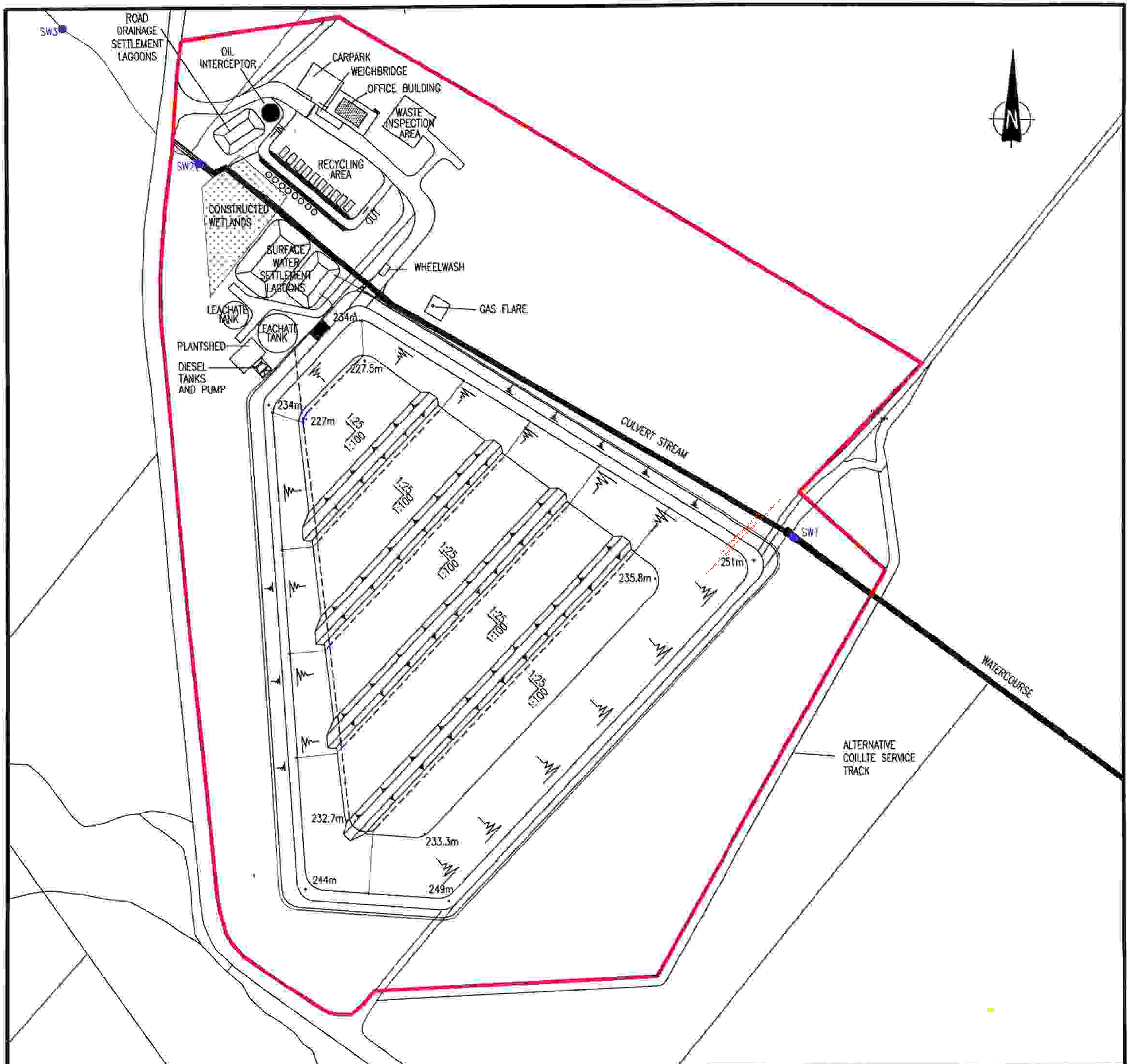
Donegal County Council

PROJECT
MEENABOLL LANDFILL PROJECT

TITLE
TYPICAL SECTION THROUGH THE SITE

FIGURE
6.1



KEY

GENERATOR

GROUNDWATER

SURFACE WATER

SW1 PROPOSED SURFACE WATER TESTING POINT

SCALE: 1:2000

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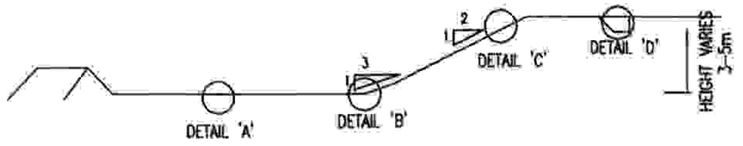
MEENABOLL LANDFILL PROJECT

TITLE

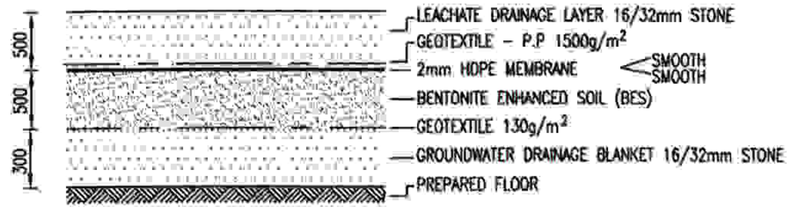
SURFACE WATER AND GROUNDWATER MANAGEMENT

FIGURE

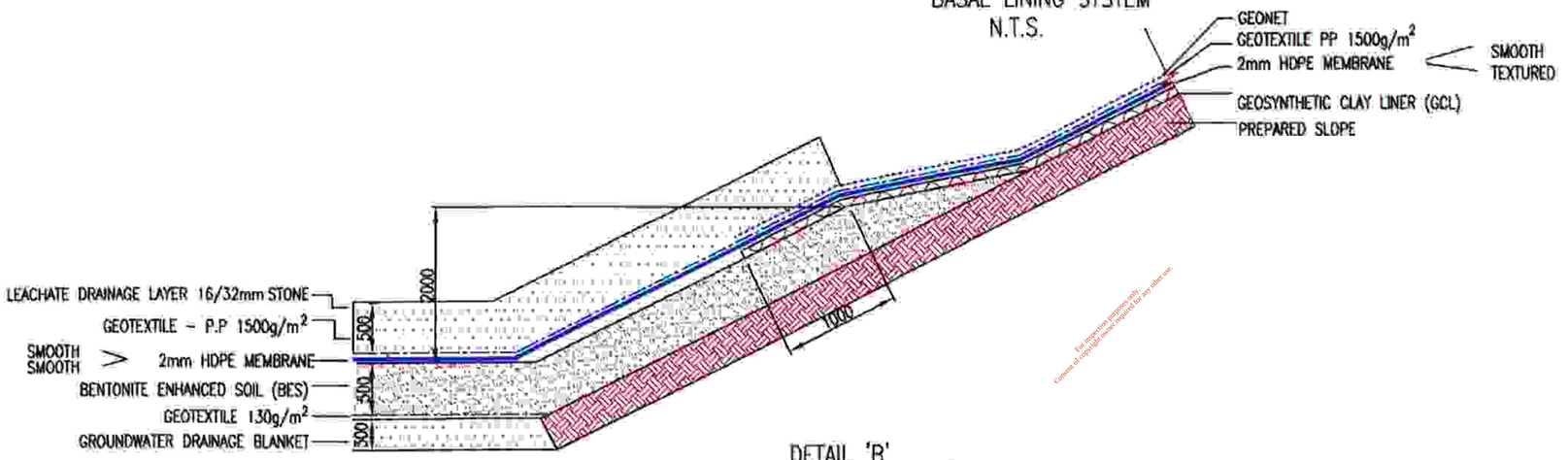
6.2



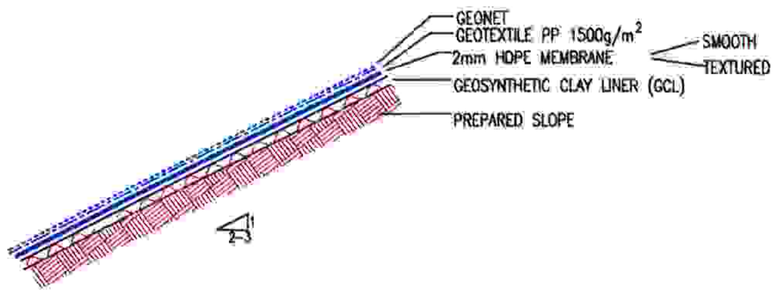
SCHEMATIC SECTION
N.T.S.



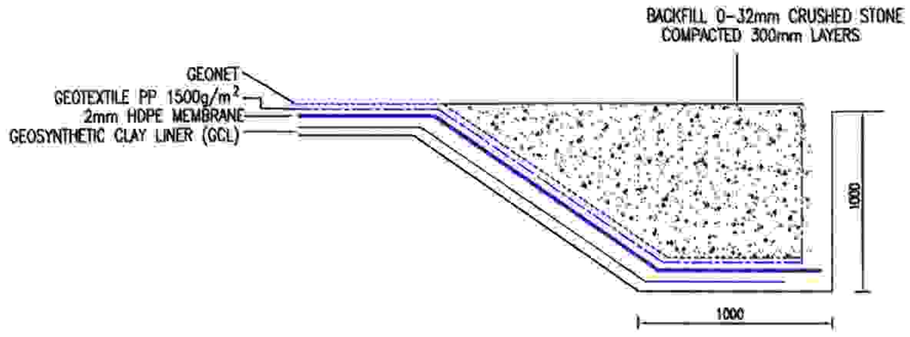
DETAIL 'A'
BASAL LINING SYSTEM
N.T.S.



DETAIL 'B'
BES/GCL INTERFACE
N.T.S.



DETAIL 'C'
SIDE SLOPE LINING SYSTEM
N.T.S.



DETAIL 'D'
ANCHOR TRENCH LINING SYSTEM
N.T.S.

SCALE: NTS

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MEENABOLL LANDFILL PROJECT

TITLE
LINING DETAILS

FIGURE
6.3

KEY

- GENERATOR
- LEACHATE COLLECTION PIPE
- LEACHATE SUMP
- RE — RODDING EYE
- SSR — SIDE SLOPE RISER
- LEACHATE PUMPING MAIN

SCALE: 1:2000

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MEENABOLL LANDFILL PROJECT

TITLE

LEACHATE MANAGEMENT SYSTEM

FIGURE

6.4

KEY

- GENERATOR
- PHASE 1
- PHASE 2
- PHASE 3
- PHASE 4
- PHASE 5

SCALE: 1:2000

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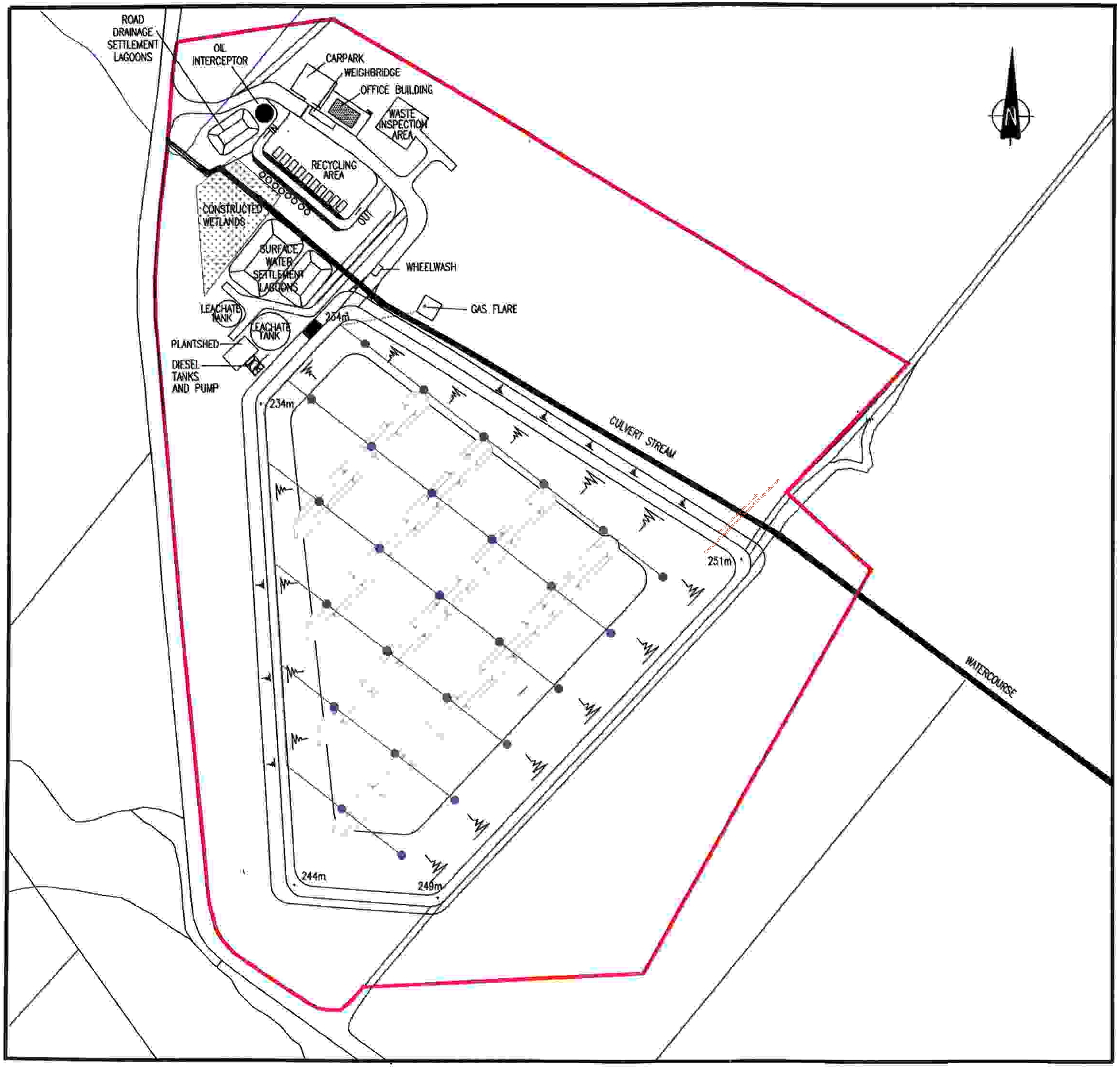
TITLE

SITE PHASING

FIGURE

6.5



KEY

■	GENERATOR
——	GAS COLLECTION PIPELINE
●	GAS BOREHOLE

SCALE: 1:2000

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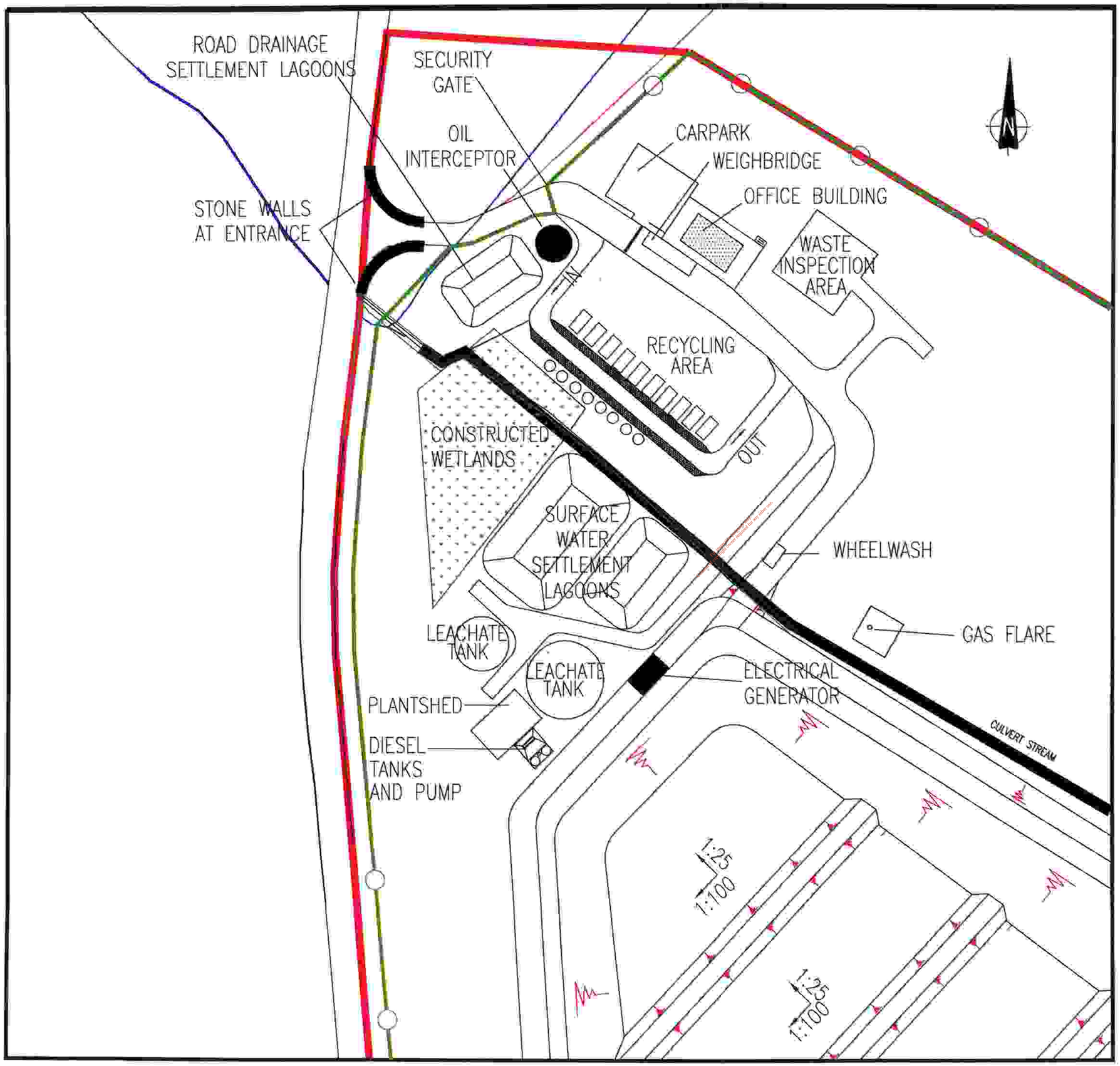
TITLE
LANDFILL GAS MANAGEMENT SYSTEM

FIGURE
6.6



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Donegal County Council

PROJECT
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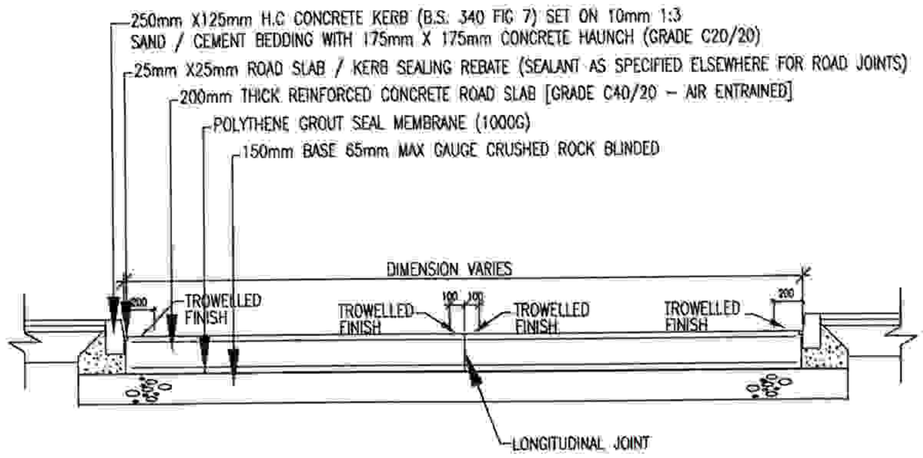
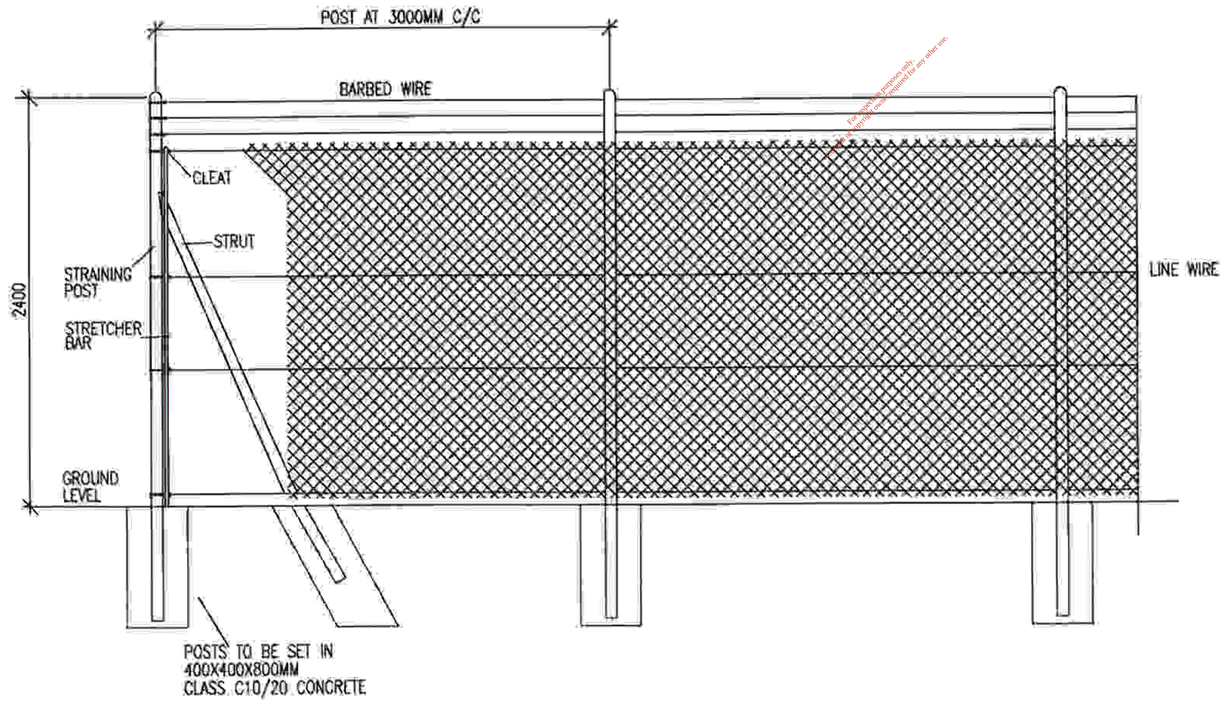
TITLE
SITE INFRASTRUCTURE

FIGURE
6.7



TYPICAL SECTION THROUGH CONCRETE ROAD
SCALE N.T.S.



CHAIN LINK FENCE WITH EXTENSION ARMS FOR BARBED WIRE (SECURITY FENCE)

SCALE: NTS

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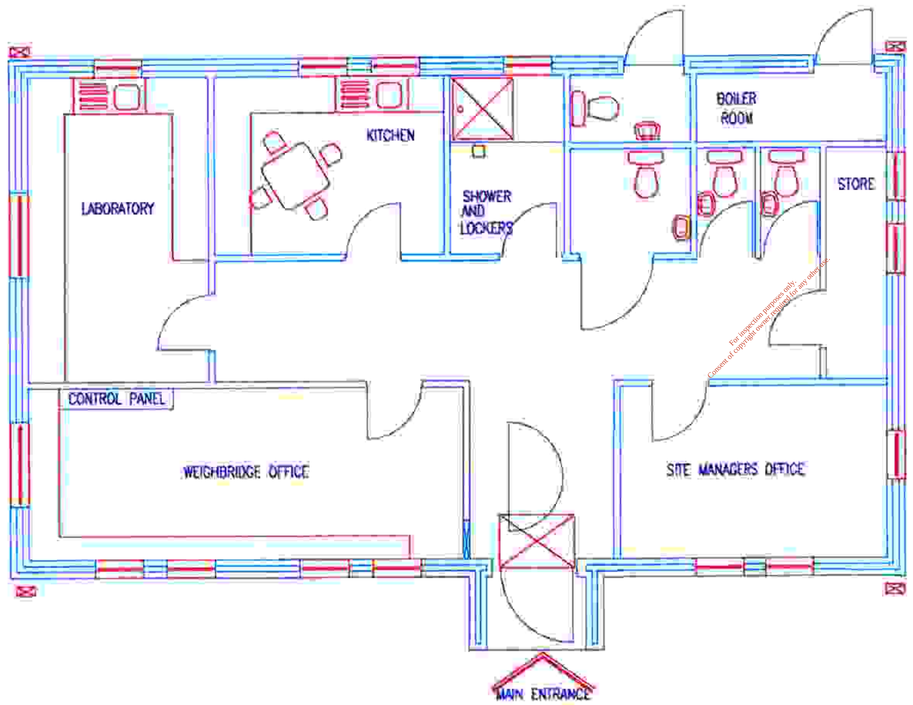
MEENABOLL LANDFILL PROJECT

TITLE
ENGINEERING DETAILS

FIGURE
6.8



SCALE: 1:100

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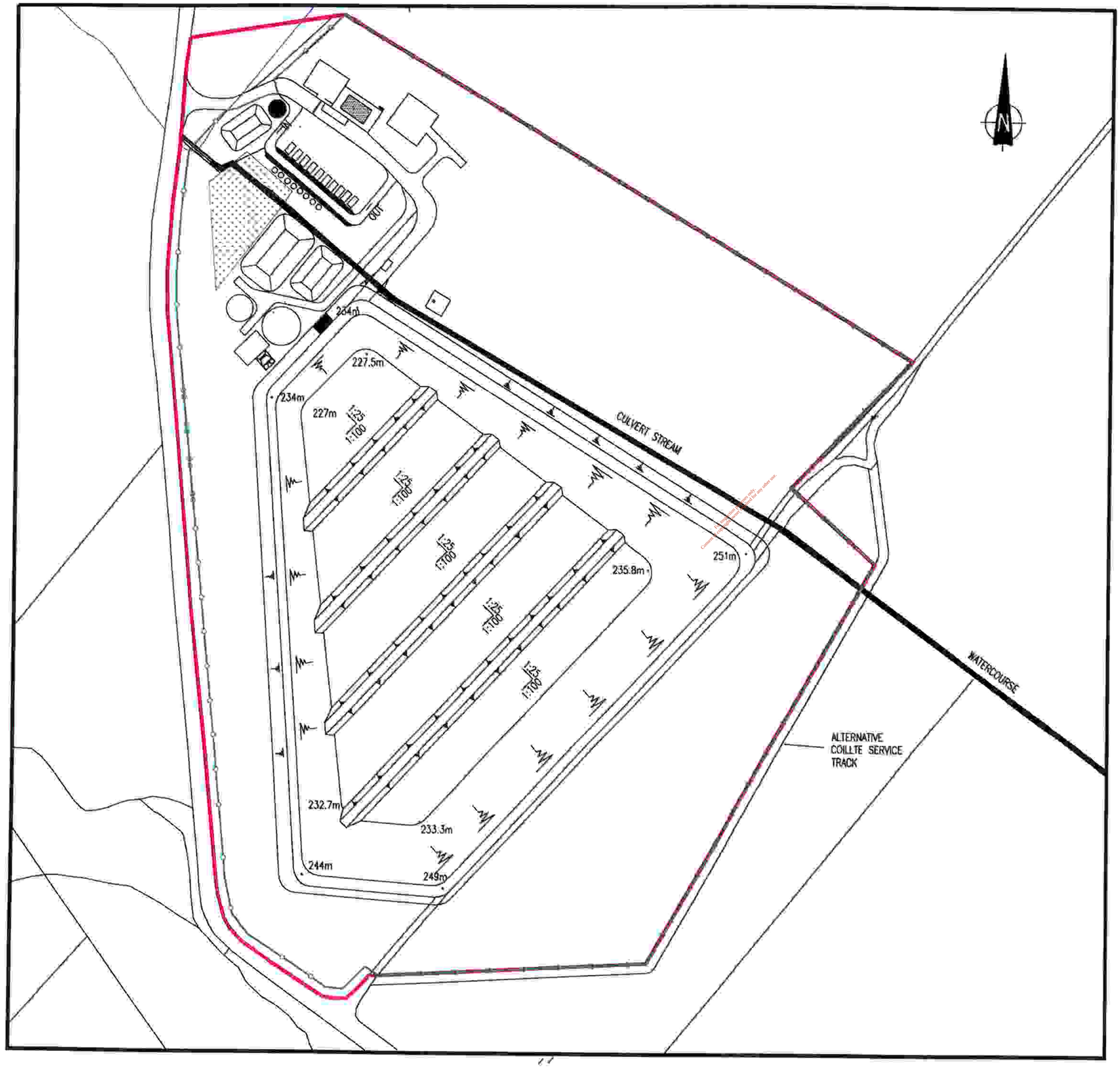
Donegal County Council

PROJECT
MEENABOLL LANDFILL PROJECT

TITLE
SITE OFFICE PLAN

FIGURE
6.9



KEY

SITE PERIMETER SECURITY FENCE

SCALE: 1:2000

KIRK McCLURE MORTON
CONSULTING ENGINEERS

Comhairle Chontae Dhún na nGall
Donegal County Council

PROJECT

MEENABOLL LANDFILL PROJECT

TITLE

SITE FENCING

FIGURE

6.10