

Gwynedd Council

Llwyn Isaf Landfill

Closure Report

15 October 2013

AMEC Environment & Infrastructure UK Limited

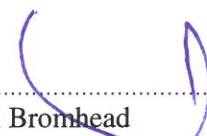
Report for

Medwyn Williams
Waste Treatment Service
Siambrau Banc Barclays
5-7 Stryd Bangor
Caernarfon
Gwynedd
LL55 1AT

Main Contributors

Charlotte Pearson

Issued by
Charlotte Pearson

Approved by
Julian Bromhead

**AMEC Environment & Infrastructure
UK Limited**

Canon Court, Abbey Lawn, Abbey Foregate,
Shrewsbury SY2 5DE, United Kingdom
Tel +44 (0) 1743 342 000
Fax +44 (0) 1743 342 010

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UK Limited

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Document Revisions

No.	Details	Date
1	Draft for Client Comment	14 August 2013
2	Final Report	15 October 2013

Purpose of this Report

Gwynedd Council has appointed AMEC Environment & Infrastructure (UK) Ltd (AMEC) to prepare and submit a Closure Report for Llwyn Isaf Landfill (Environmental Permit No EPR/YP3138UJ\V003). This report is produced in accordance with the current Natural Resources Wales/Environment Agency (NRW/EA) guidance (LFD 1 v2, March 2010) and Landfill Closure Report Template V3. The Closure Report has been produced so that the site can move towards definitive closure under the Landfill Directive (Council Directive 1999/31/EC).

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1. Introduction

1.1 Report Context and Purpose

Gwynedd Council wishes to apply to Natural Resources Wales (NRW) to progress the Llwyn Isaf Landfill Site to 'definite closure'. This Closure Report has been prepared in accordance with current Natural Resources Wales/Environment Agency (NRW/EA) Guidance¹.

The site is divided into four areas as follows:

Area 1 comprises the weighbridge, disused site control office, the disused waste reception and pulveriser building which also houses the former site welfare offices. Part of Area 1 was subject to a partial surrender application in 2012/2013. The application was accepted and a Notice of Surrender was issued on 7 February 2013 (Reference YP3138UJ/S004). The area surrendered houses the Anaerobic Digestion facility operated by Biogen UK Limited. Area 1 now covers an area of approximately 0.55 ha.

Area 2 is a closed landfill site that received waste between 1986 and 2000 and was capped and restored over ten years ago.

Area 3 comprises the current landfill which was operated as a non hazardous landfill under the requirements of the Landfill Directive (Council Directive 1999/31/EC). It covers an area of approximately 2.34 ha. The landfill is operated on the principle of engineered containment. The three cells have been developed from south to north. Landfilling in Area 3 commenced in Cell 1 in January 2009. Waste filling in Cell 1 was completed at the end 2009; filling of Cell 2 was completed in March 2011 and Cell 3 was completed in March 2012.

Cell 1 and part of Cell 2 were capped in 2011 and the remainder of Cell 2 and Cell 3 were capped in 2012 with work being completed by August 2012. Construction Quality Assurance (CQA) Reports were submitted to the Environment Agency in 2013 (AMEC Report references 28587rr153i2 dated May 2013 and 28587rr670i1 dated 31 January 2013).

Area 4 lies to the east of Areas 1 and 3 and is separated from the rest of the installation by a public road. It was the subject of two variation applications (YP3138UJ/V002 and YP3138UJ/V002) in 2011/2012 and comprises the surface water management system for Areas 1 and 3 collecting surface water runoff from the site and discharging it to the Afon Desach via an oil interceptor and two infiltration/attenuation lagoons.

Part of Area 1 and all of Area 3 and Area 4 are within the installation boundary for the permit YP3138UJ.

¹ Environmental Permitting Regulations (England and Wales 2010) Regulatory Guidance Series, No LFD 1 – Understanding the Landfill Directive. Environment Agency, March 2010 (V2).

Additional guidance for Landfill (EPR 5.02) How to comply with your environmental permit -Closing your landfill, Consultation Document March 2013.

1.2 Installation Details

1.2.1 Location and Access

The Llwyn Isaf site is located approximately 17 km to the southwest of Caernarfon at National Grid Reference (NGR) SH 450 488. Access to the site is from a private road off the A487 which was constructed across agricultural land in 2008 which joins a minor public road immediately to the east of the site entrance.

The location is shown on Figure 1.

1.2.2 Site Topography and Setting

The site is located on a shallow slope. The surface falls from 145 m AOD in the south south-west to 131 m AOD in the north of the site. It is bordered mostly by trees and shrubs. There is a bund in place to the south east, east and north east of the building in Area 1 which shields it from the road. Area 3 is bound to the east by the closed landfill (Area 2) and to the north by Area 1. To the south there are some trees and shrubs beyond which is agricultural land. To the east of Areas 1 and 3 there is a road and beyond that, Area 4 and the surface water lagoons for the site. Area 4 is bound to the north, east and south by trees, shrubs and agricultural land. An anaerobic digestion (AD) plant has recently been constructed between Areas 1 and 3 which is operated by Biogen UK Limited and is permitted separately.

There is a property located to the eastern boundary of Area 3 which was acquired by Gwynedd Council and is not used as a domestic residence.

Land uses within 500 m of the proposed installation boundary are detailed in Table 1.1.

Table 1.1 Land Uses Within 500 m of the Site

Monitoring Location	Frequency	Parameters
North	Agricultural land and Llyn AONB.	
East	Agricultural land.	
South	Several domestic properties (nearest 475 m), agricultural land and Cors Gyfelog SSSI/Corsydd Eifionydd SAC (20 m).	
West	Closed landfill immediately adjacent. Agricultural land.	

1.3 Report Structure

In general accordance with current NRW/EA Landfill Closure Report Template provided as an Appendix to the draft guidance 'Additional Guidance for Landfill (EPR 5.02) How to comply with your environmental permit - Closing your landfill, Consultation Document March 2013' the structure of this Closure Report is as follows:

- Section 2: Area of the site progressing to definitive closure;
- Section 3: Waste stability;
- Section 4: Site Infrastructure;

- Section 5: Monitoring;
- Section 6: Reporting;
- Section 7: Habitats.

2. Area of Closure

2.1 Area of the Site Progressing to Definitive Closure

The areas of Llwyn Isaf Landfill Gwynedd Council wish to progress to definitive closure are Area 1, Area 3 and Area 4 of the installation as shown in Figure 2 of this Closure Report.

Figure 3 identifies the locations of the monitoring infrastructure across the Llwyn Isaf Site.

3. Waste Stability

3.1 Basal Subgrade and Side Slopes

The three cells at the site were formed by excavation into the reworked gravelly and sandy silty made ground below the site which was a product of backfill from previous aggregate quarrying operations. The base of each cell was formed either within the made ground or underlying natural silty sand and gravelly soils. The side slopes to the excavations were formed at a slope of 1:2.5. The basal and side slope lining system comprised 0.5 m of bentonite enhanced soil (BES) overlain by a 2 mm textured HDPE geomembrane overlain by a protection geotextile and a leachate collection layer. The base of all cells is above groundwater levels. Specific geosynthetics stability analysis was undertaken for each cell and this information is provided in the various design reports as follows:

- Design Report, Specification and CQA Plan for construction of Cell 1, AMEC report ref: 18846rr216 dated May 2008;
- Design Report, Specification and CQA Plan for construction of Cell 2, AMEC report ref: 18846rr651i1 dated 20 July 2009; and
- Design report, Specification and CQA Plan for construction of Cell 3, AMEC report ref: 18846rr855i1 dated 20 August 2010.

All of the analyses demonstrated adequate factors of safety. No instability was noted during basal and sideslope liner construction. The lining system was installed under CQA procedures and verification reports are as follows:

- CQA Validation Report for the construction of Cell 1, AMEC report ref: 18846rr522i1 dated 4 December 2008;
- CQA Validation Report for the construction of Cell 2, AMEC report ref: 18846rr747i1 dated 2 December 2009; and
- CQA Validation Report for the construction of Cell 3, AMEC report ref: 18846rr969i1 dated 24 March 2011.

The cells have been infilled with waste which has increased the confining pressure on the basal and sidewall liner. This will have further increased the factor of safety compared to the construction stage analysis.

3.2 Capping System

All three cells have been capped. The capping system comprises a regulating layer over the waste which is in turn overlain by a 1 mm textured LLDPE geomembrane, geocomposite drainage layer and restoration soils. The finished profiles of the site are shown on the survey in Appendix B. The capping was completed in two phases comprising Cell 1/Cell 2 south and Cell 2 north/Cell 3.

Specific pre-construction geosynthetics stability analysis was undertaken for each cell and this information is provided in the various design reports as follows:

- Design Report, Specification and CQA Plan for the Construction of the Permanent Restoration capping to Cell 1 and Part of Cell 2; AMEC Report ref 28587rr018i1 dated 21 December 2010; and
- Design Report, Specification and CQA Plan for the Construction of the Permanent Restoration capping to Cell 3 and Part of Cell 2; AMEC Report ref 28587rr448i1 dated 12 April 2012.

CQA validation reports were also completed for each phase of capping as follows:

- CQA Completion Report for the Construction of the Permanent Restoration Capping to Cell 1 and Part of Cell 2, AMEC Report ref 28587rr153i2 dated May 2013; and
- CQA Completion report for the Construction of the Permanent Restoration Capping to Cell 3 and Part of Cell 2, AMEC Report ref 28587rr670i1 dated 31 January 2013.

The site survey (Appendix B) identifies the steepest slopes to the capping to be on the eastern margin of cell 3 and western margin of cell 1. The capping slopes are typically 1:2.8 or flatter but locally up to 1:2.4 in part.

The same capping materials were used in the construction of the cap to Cell 3 at Ffridd Rasus landfill in 2013. This site also used restoration soils derived from Llwyn Isaf. Site specific geosynthetics interface testing was undertaken on the materials used at Ffridd Rasus. These values have been input into a post construction interface stability calculation for a 1:2.4 slope at Llwyn Isaf (Appendix A) which gives a factor of safety of sliding of the cover soil of 1.97 which is satisfactory.

3.3 Stability Monitoring

The site (Area 3) will continue to be monitored for evidence of instability when topographical surveys are carried out to assess the settlement of the waste mass. Cells 2 north and 3 were last surveyed in August 2012 following cap completion. Cells 1 and 2 south were last surveyed following capping completion in May 2011. The consolidated topographical survey of the site is included as Appendix B to this Closure Report.

4. Site Infrastructure

4.1 Leachate Infrastructure

Calculations for leachate generation at for Area 3 during filling, following capping and after cap degradation are provided in the Environmental Setting and Design (ESID) report submitted in support of the permit application (AMEC report reference 18846rr091i1(ESID) dated October 2007).

Leachate infrastructure for all 3 cells of Area 3 comprises the following:

- A leachate drainage layer at a thickness of 300 mm over the base and the side slopes of each cell;
- A network of HDPE slotted pipework installed within the leachate drainage layer;
- Two HDPE leachate extraction up slope risers installed in the north/north western corner of each cell and connected to the pipework within the drainage layer;
- Each riser is fitted with a pump to remove the leachate to the leachate collection tank sited to the north of Cell 3;
- Two leachate monitoring points within each cell at opposite sides of the cell.

Leachate is stored in a 30 000 litre (30 m³) bunded leachate storage tank in a leachate compound situated to the north of Area 3 as shown on the site survey in Appendix B. Relocation of the leachate storage tank was agreed with Environment Agency Wales (now NRW) and took place in late 2012. It was moved from its former location in Area 1 due to the construction of the Anaerobic Digestion facility in that area. The tank comprises a polypropylene vessel shell with a draw off valve at the base. The tank, which is cylindrical, is approximately 6 m high with a diameter of 3.8 m. The tank is fitted with a level alarm and bund alarm. The tank is located on a concrete plinth and is double skinned. The capacity of the bund is 10% of the capacity of the tank giving a 110% capacity in accordance with best practice. The tanker filling point is located over a contained concrete area. Leachate from the holding tank is tankered off-site to a suitably licensed wastewater treatment plant.

A full description of the Leachate Management System (for Cell 1 but applies to all of Area 3) is given in the Llwyn Isaf Leachate Management Plan (AMEC report reference 18846n529i2 dated 12 December 2008). The leachate management system is shown on Figure 3.

A Construction Quality Assurance Plan, a Design Report, Specification and Construction Quality Assurance Plan and a Construction Quality Assurance Validation Report for each cell was produced and submitted to the Environment Agency Wales (now NRW) for approval (see Section 3.1).

4.2 Leachate Infrastructure Maintenance

An inspection audit of the leachate infrastructure will be carried out by Gwynedd Council on an annual basis. All aspects of the infrastructure will involve a careful check for signs of damage which may result in the system not working effectively and for issues such as access. The

annual inspection will also include an assessment of the leachate monitoring data with the results compared with the conceptual model and the objectives of the monitoring plan. Any inconsistencies found will be investigated in consultation with NRW and the conceptual model and the Leachate Management Plan will be updated.

In addition to the annual planned inspection, all infrastructure will be checked as part of the routine monitoring undertaken in the aftercare period. Leachate monitoring frequency is described in Section 5.1. This will be carried out by Gwynedd Council. During each visit, Gwynedd Council will inspect the monitoring and abstraction points to ensure they do not fall into disrepair and to identify if any maintenance is required.

As part of the routine inspection Gwynedd will perform the following checks:

- All leachate abstraction and monitoring points remain safe and clear to access and are clearly identified;
- All leachate abstraction and monitoring points are clearly visible and free from damage which could prevent monitoring or abstraction taking place;
- The depth to the base of all leachate monitoring points will be recorded and checked against previous readings to check for evidence of silting or blocking.

Records will be kept of each site visit and all information gathered will be recorded on the monitoring record sheets.

Where remedial work is minor (for example repair to leachate pumps) Gwynedd Council will either complete the required work or employ suitable qualified personnel to make the required repairs as soon as practicably possible.

Where it is determined damaged infrastructure requires major remedial work (for example cleaning or unblocking an upslope riser or leachate monitoring point) or replacement the following contingency plan will be initiated:

- An assessment of the work required will be made by Gwynedd Council to determine the most suitable means of repair/replacement and set the timescales for the work to be undertaken and completed and NRW informed;
- Any replacement monitoring or extraction points which are required will be sited having regard for the guidance given in the EA Technical Guidance Note 'Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water' (TGN02);
- Any redundant leachate abstraction or monitoring point will be sealed and capped to remove a potential pathway for fugitive emission of landfill gas. Any required work will be agreed with NRW beforehand but it is likely that abandoned monitoring points will be sealed with cement-based grout or bentonite and capped in a manner that prevents any confusion with active monitoring points;
- A Construction Quality Assurance (CQA) Plan will be drawn up for the required work and forwarded to NRW for approval;
- Gwynedd Council will employ suitably qualified personnel to undertake the remedial work in accordance with the CQA Plan. All work will be independently assessed by a qualified CQA Assessor;

- A CQA Completion Report will be submitted to NRW detailing all the activities carried out on site and where appropriate, the materials used including any testing undertaken;
- All site infrastructure drawings and monitoring reports will be updated to reflect any changes made.

4.3 Landfill Gas Infrastructure

In-waste Gas Extraction System

Within the landfill body there are a total of 20 gas extraction wells installed across the 3 cells of Area 3 (identified on Figure 3) and are summarised as follows:

- Gas extraction wells GW1 to GW4 were installed in Cell 1, to depths of between 6 m below ground level (bgl) and 8 m bgl, on 17 June 2010;
- Gas extraction well GW5 was installed in Cell 1 and GW6 to GW11 were installed in Cell 2 between 8 and 10 March 2011. Gas extraction wells GW5 to GW11 were drilled to depths of between 5.3 m bgl and 12.8 m bgl; and
- Gas extraction wells GW12 and GW17 were installed in Cell 2 and GW 13 to GW20 (excluding GW17) were installed in Cell 3 to depths 6.0 m bgl and 10.3 m bgl between 20 and 22 March 2012.

The gas extraction wells were installed through the landfilled wastes prior to installation of the landfill cap. The gas extraction wells are shown on Figure 3 and details of the wells are presented in Table 2.1.

Table 2.1 Gas Well Details

Gas Well	Top of Waste (m AOD)	Drill Depth (m)
GW1	144.232	6.0
GW2	146.013	8.0
GW3	145.070	6.5
GW4	145.257	7.5
GW5	143.665	5.3
GW6	148.284	11.5
GW7	148.817	12.8
GW8	143.639	7.1
GW9	143.907	6.5
GW10	143.273	7.8
GW11	147.082	10
GW12	142.15	6.6
GW13	142.13	6.2

Table 2.1 (continued) Gas Well Details

Gas Well	Top of Waste (m AOD)	Drill Depth (m)
GW14	141.53	7.0
GW15	143.52	10.3
GW16	144.19	8.8
GW17	143.67	6.0
GW18	141.40	7.5
GW19	142.77	7.4
GW20	142.42	6.8

The gas wells were drilled with a 450 mm continuous flight auger. They comprise a plain 160 mm diameter MDPE well casing for the first 2.1 m below existing ground level, with the remainder of the well consisting of slotted 160 mm diameter MDPE casing with a gravel surround (non calcareous 20 mm single sized gravel pack) installed to 2.0 m below ground level, with the plain pipe surrounded by a pre mixed bentonite seal to proposed final ground levels.

The following CQA documents describe the design and the installation of the gas extraction system for Area 3:

- Cell 2 Gas Extraction CQA plan, AMEC report ref 28587rr074i1 dated 11 February 2011;
- CQA Plan for the Construction of Gas Wells for Cell 3 at Llwyn Isaf landfill, AMEC Report ref 28587rr447i1; and
- CQA Plan for Ring Main Installation prepared by Envirocare Europe Ltd dated 18 June 2013.

As part of the capping works each well pipe was oversleaved with a 250 mm HDPE pipe to which a geomembrane skirt was welded. The annulus between the two pipes was sealed with a flexiseal coupler. Each individual gas extraction well is fitted with a valve to allow the balancing of the system.

The wells were reconnected to the temporary extraction system on completion of the capping works. Cell 1 and part of Cell 2 were capped in 2011 and the remainder of Cell 2 and Cell 3 were capped in 2012 with work being completed by August 2012. A new perimeter gas collection ring main, associated well connections and dewatering (condensate) drains is under construction in August 2013 and a CQA verification report will be made available on completion.

Landfill Gas Flare

The gas extraction system is connected via a series of pipework to a high temperature (HT) ground flare with automatic flame temperature control rated at 200 cubic meters per hour and a combustion chamber temperature of 1000°C minimum when methane concentration is above 28%. Full details of the flare and associated equipment are provided at Appendix C. This permanent unit was installed early August 2012 and replaced a hired open flare and is located in

the compound to the north of Cell 3 adjacent to the haul road as shown on the site survey in Appendix B.

External Landfill Gas Boreholes

A total of 7 landfill gas boreholes external to the engineered cells have been installed around the periphery of the landfill area as shown on Figure 3. Boreholes G1 to G7 were installed in 2008. G1 was replaced by G1A in 2012 when the original borehole was lost during landscaping works for the AD facility at the site. The external boreholes are monitored to enable the effectiveness of the on-site landfill gas management and control systems in preventing lateral migration of landfill gas to be assessed. The external gas monitoring boreholes are spaced at intervals in excess of the guideline spacing of 50 m (LFTGN 03 EA guidance on the management of landfill gas). However the Landfill Gas Management Plan produced for the site (AMEC report ref: 28587rr366i2 Llwyn Isaf Landfill Site – Landfill Gas Management Plan dated 19 March 2012) demonstrated this is considered to be sufficient given the relatively uniform nature of the strata and the distance to sensitive receptors.

Additional Landfill Gas Control Measures

During the aftercare period there may be insufficient gas to support continual combustion. In these circumstances the results of the routine system monitoring which will provide data on the gas flows and concentrations within the different parts of the site will be used to determine the most appropriate operational regime both in respect of the suction applied to the wells and the operational sequence of the flare, with the objective of ensuring that extraction and gas utilisation are optimised.

If the situation arises where there is insufficient methane to support combustion, other measures will be considered to control the landfill gas flare. These may include one or more of the following:

- Use of support fuel to be injected into the flare intermittently (on demand) or continuously;
- Intermittent extraction and flaring;
- Use of low calorific flares; and
- Biological methane oxidation.

4.4 Landfill Gas Infrastructure Maintenance

An inspection audit of the landfill gas management infrastructure will be carried out by Gwynedd Council on an annual basis. All aspects of the landfill gas management infrastructure will involve a careful check for signs of damage which may result in the system not working effectively and for issues such as access. The annual inspection will also include an assessment of the landfill gas monitoring data with the results compared with the conceptual model and the requirements of the gas management plan. Any inconsistencies found will be investigated in consultation with NRW and the conceptual model and the Gas Management Plan will be updated.

In addition to the annual planned inspection, all infrastructure will be checked as part of the routine monitoring undertaken in the aftercare period. Landfill gas monitoring is described in Section 5.2. This will be carried out by CH4 Consultants as current landfill gas management

contractors and during each visit, they will inspect the monitoring and abstraction points to ensure they do not fall into disrepair and to identify if any maintenance is required.

Planned maintenance and that which has been identified through inspections will be carried out by suitably experienced CH4 personnel. An experienced CH4 engineer is available on standby should the need arise for maintenance outside normal operational hours.

As part of the above inspections, Gwynedd Council or their gas management contractors will perform the following checks:

- All in waste extraction wells and external monitoring points remain safe and clear to access and are clearly identified;
- All in waste extraction wells and external monitoring points are clearly visible and free from damage;
- The depth to the base of all external monitoring points will be recorded and checked against previous readings to check for evidence of silting or blocking;
- The flare is in working order.

Where it is determined damaged infrastructure requires major remedial work (for example replacement of a gas well) an assessment of the work required will be made by Gwynedd Council to determine the most suitable means of repair/replacement and set the timescales for the work to be undertaken and completed and will inform NRW. Repairs and maintenance will be undertaken as needed and as soon as practicable.

If an occurrence such as the significant ingress of air or leakage of gas is detected, the system will be shut down automatically or manually by a qualified member of staff following documented shut down procedures. It will not be restarted until the ingress or leak has been identified and repaired.

Where required a Construction Quality Assurance (CQA) Plan will be drawn up for the required work and forwarded to NRW for approval. Gwynedd Council will employ suitably qualified personnel to undertake the remedial work in accordance with the CQA Plan. All work will be independently assessed by a qualified CQA Assessor. A CQA Completion Report will be submitted to NRW detailing all the activities carried out on site and where appropriate, the materials used including any testing undertaken.

All site infrastructure drawings and monitoring reports will be updated to reflect any changes made.

The flare will be maintained by the suppliers, ASF, for the first three years after installation (2012) and will be inspected by ASF every 4 months. Maintenance of the flare will be carried out in accordance with the Manufacturer's recommendations to ensure that the flare runs efficiently at all times.

The flare is inspected visually during each monitoring visit for signs of faults and deterioration. If any faults are apparent, they will be rectified by the ASF engineer. If the ASF engineer is unable to rectify the fault then a suitable contractor will be used to trace and repair the fault. The operation and maintenance manuals will be kept at the site office.

Any faults will be recorded in a site log. The site log will be made available for inspection on request. NRW will be informed immediately, where practicable or unless agreed with them, in

the event of detection of a failure of the landfill gas flare or of damage to any of its components. There may be some circumstances where it is not possible to inform NRW immediately, for example if the failure occurs outside normal office hours. In such cases, NRW will be notified as soon as practicably possible.

Performance indicators such as differential pressure gauge and flow meter readings will permit a gas field technician to identify problems between scheduled services and often before they become a significant issue. The performance of the flare, when in operation, will be assessed regularly by the monitoring and logging of the following parameters:

- Field vacuum (mb);
- Stability of vacuum readings;
- Delivery pressure;
- Stability of gas pressure readings;
- Gas quality CH₄, CO₂, O₂;
- Differential pressure across fine filter (mb);
- Differential pressure across flame arrestor (mb);
- Flow rate through plant;
- Temperature of combustion; and
- Valve positions.

Interim maintenance will be carried out following the identification of a problem from this data. A copy of the latest Service Sheet completed by ASF is provided at Appendix C.

In the event of unplanned down time, e.g. flare failure, ASF would be notified immediately. They would hold all of the essential components in stock for repair. If it is considered, based on a risk assessment of site-specific circumstances, that repair of the flare could not occur in time to prevent significant build up of gas within the site, which could result in significant fugitive emissions, a temporary flare would be hired to control the landfill gas until the necessary repairs were affected.

A record of the problem and any remediation, repairs or maintenance undertaken will be kept on site and available for review by the NRW. Where the identified problem is considered to pose a risk to the environment or human health, NRW will be notified immediately.

4.5 Groundwater Infrastructure

As the base of the landfill is above the groundwater table there is no groundwater management at the site.

There are a number of up gradient and down gradient boreholes for monitoring the landfill site (Areas 2 and 3). Of these the following boreholes are used to monitor groundwater quality in the vicinity of Area 3 in accordance with Environment Agency Guidance Technical Guidance Note 'Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water' (TGN02):

- M47, GW2 and GW5 located up gradient of the site;
- GW3, GW4, M17 and M36, located downgradient of the site;
- DAS is located on the eastern margin of the closed landfill (Area 2).

The location of the groundwater monitoring points is shown on Figure 3. Borehole logs were provided at Appendix ESID 3 to the ESID report (AMEC report 18846rr091i1 dated October 2007) produced in support of the application for the environmental permit and a borehole log for GW5 is included in the Technical Note produced to comply with Improvement Condition No6 of Table S1.3 of the Environmental Permit (AMEC Report reference 28587n665i2 dated 21 August 2009).

4.6 Groundwater Infrastructure Maintenance

An inspection audit of the groundwater monitoring infrastructure will be carried out by Gwynedd Council on an annual basis. All aspects of the infrastructure will involve a careful check for signs of damage which may result in the system not working effectively and for issues such as access. The annual inspection will also include an assessment of the groundwater quality monitoring data with the results compared with the conceptual model and the objectives of the monitoring plan. Any inconsistencies found will be investigated in consultation with the NRW. The annual environmental report for the site will review groundwater data and consider this in the context of the Hydrogeological Risk Assessment (HRA). The HRA is due a formal update in 2014.

In addition to the annual planned inspection, all infrastructure will be checked as part of the routine monitoring undertaken in the aftercare period. Groundwater quality monitoring frequency is described in Section 5.3. This will be carried out by Gwynedd Council. During each visit, Gwynedd Council will inspect the monitoring points to ensure they do not fall into disrepair and to identify if any maintenance is required.

As part of the routine inspection Gwynedd will perform the following checks:

- All monitoring points remain safe and clear to access and are clearly identified;
- All monitoring points are clearly visible and free from damage which could prevent monitoring taking place;
- The depth to the base of all monitoring points will be recorded and checked against previous readings to check for evidence of silting or blocking.

Records will be kept of each site visit and all information gathered will be recorded on the monitoring record sheets.

Where remedial work is minor (for example damage to above ground external casing or access) Gwynedd Council will either complete the required work or employ suitable qualified personnel to make the required repairs as soon as practicably possible. NRW will be informed above of any work undertaken including the reasons why and the action taken.

Where it is determined damaged infrastructure requires major remedial work (for example cleaning or unblocking a borehole) or replacing the following contingency plan will be initiated:

- An assessment of the work required will be made by Gwynedd Council to determine the most suitable means of repair/replacement and set the timescales for the work to be undertaken and completed;
- Any replacement boreholes which are required will be sited having regard for the guidance given in the Environment Agency Technical Guidance Note 'Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water' (TGN02);
- Any redundant borehole will be sealed and capped to remove a potential pathway for the contamination. Any required work will be agreed with NRW beforehand but it is likely that abandoned boreholes will be sealed with cement-based grout or bentonite and capped in a manner that prevents any confusion with active monitoring points;
- A Construction Quality Assurance (CQA) Plan will be drawn up for the required work and forwarded to the NRW for approval.

4.7 Surface Water Infrastructure

The surface water infrastructure at Llwyn Isaf landfill site is described in the following documents:

- Surface Water Management Plan (Revised) (AMEC report ref: 18846n591i1 dated 30 April 2009);
- Environmental Permit Variation Application for the installation of a new surface water management system (AMEC report ref: 28587rr143i2 dated 27 June 2011); and
- Environmental Permit Variation Application to amend proposed location of surface water lagoon (AMEC report ref: 28587n383i1 dated 23 January 2012).

The surface water management system will collect surface water runoff from the site and discharge it to the Afon Desach via an attenuation lagoon. Surface water from part of Area 3 is discharged to an infiltration basin north east of Area 3. Some runoff from Areas 1 and 2 is discharged to a soakaway in the northern part of Area2 as shown on the survey plan in Appendix B.

The surface water drainage system within Area 3 comprises a series of surface water drains constructed in the restoration soils to collect surface flows from the geocomposite drainage layer within the restoration capping system. The capping system is profiled so that water is shed to the perimeter where surface water drainage ditches will direct the flow to the nearby surface water ditches located to the south and west of Cell 1 and to the north and west of Cell 3. Surface water then drains from these ditches via a series of pipework to an attenuation lagoon to the north-north east of the landfill and via pipework to a smaller infiltration lagoon to the east of the landfill as shown on Figure 3. The lagoons have been sized to allow for a 1 in 100 year storm event with a 20% uplift for climate change in accordance with Planning Policy Statement 25 and EA recommendations.

From the attenuation lagoon, surface water discharges via a Hydrobrake flow control device to the Afon Desach. The system has been designed to discharge a maximum flow of 20 l/s into the river regardless of head in the attenuation lagoon to ensure that surface water input to the Afon

Desach does not exceed that of the green field runoff rate for the site. The infiltration lagoon performs as a soakaway to ground.

There are a number of surface water sample points and these are shown on Figure 3 and described below:

- Sample point B is located to the north of the site on a small tributary which feeds into the Afon Desach;
- Sample point C is located to the north east of the site in the Afon Desach and is the downstream sample point;
- Sample point D is the permitted discharge from the surface water attenuation lagoon into the Afon Desach. Sampling commenced in September 2012 following commissioning of the attenuation lagoon;
- Sample point D2 is located in a lake to the north of the site;
- Sample point E is located approximately 300 m downstream from sample point C on Afon Desach (off Figure 3);
- Sample point W is located to the east of the site on the Afon Desach downgradient of the infiltration basin; and
- Sample point Y is situated to the south east of the site in Afon Desach and is the upstream sample point.

Surface water quality monitoring is described in Section 5.4.

4.8 Surface Water Infrastructure Maintenance

An inspection audit of the surface water infrastructure will be carried out by Gwynedd Council on an annual basis. All aspects of the infrastructure will involve a careful check for signs of damage which may result in the system not working effectively and for issues such as blockages. The annual inspection will also include an assessment of the surface water monitoring data with the results compared with the conceptual model and the objectives of the monitoring plan. Any inconsistencies found will be investigated in consultation with NRW and the conceptual model and the Surface Water Management Plan will be updated.

In addition to the annual planned inspection, all infrastructure will be checked as part of the routine monitoring undertaken in the aftercare period. This will be carried out by Gwynedd Council. During each visit, Gwynedd Council will inspect the surface water drainage ditches and the infiltration and attenuation ponds to ensure they do not fall into disrepair and to identify if any maintenance, such as desilting is required.

As part of the routine inspection Gwynedd will perform the following checks:

- All surface water drainage ditches and the infiltration and attenuation ponds will be checked for blockages;
- All monitoring points are clearly visible and accessible to ensure monitoring can be carried out.

Records will be kept of each site visit and all information gathered will be recorded on the monitoring record sheets.

Where remedial work is minor (for example clearing a ditch or access) Gwynedd Council will either complete the required work or employ suitable qualified personnel to make the required repairs as soon as practicably possible.

Where it is determined damaged infrastructure requires major remedial work (for example replacement of surface water drains or culverts the following contingency plan will be initiated:

- An assessment of the work required will be made by Gwynedd Council to determine the most suitable means of repair/replacement and set the timescales for the work to be undertaken and completed;
- A Construction Quality Assurance (CQA) Plan will be drawn up for the required work and forwarded to NRW for approval;
- Gwynedd Council will employ suitably qualified personnel to undertake the remedial work in accordance with the CQA Plan. All work will be independently assessed by a qualified CQA Assessor;
- A CQA Completion Report will be submitted to NRW detailing all the activities carried out on site and where appropriate, the materials used including any testing undertaken;
- All site infrastructure drawings and monitoring reports will be updated to reflect any changes made.

4.9 Cap Maintenance

The following documents describe the installation of the cap for Area 3:

- Design Report, Specification and CQA for the Construction of the Permanent Restoration Capping System to Cell 1 and Part of Cell 2, AMEC Report ref: 28587rr018i1 dated 21 December 2010;
- CQA Completion Report for the Construction of the Permanent Restoration Capping to Cell 1 and Part of cell 2, AMEC Report ref: 28587rr153i2 dated May 2013;
- Design Report, Specification and CQA for the Construction of the Permanent Restoration Capping System to Cell3 and Part of Cell2, AMEC Report ref: 28587rr448i1 dated 12 April 2012; and
- CQA Completion report for the Construction of the Permanent Restoration Capping to Cell 3 and Part of Cell 2, AMEC Report ref: 28587rr670i1 dated 31 January 2013.

The final surface levels were surveyed on completion of capping of cells 2 (north) and 3 with the last survey being carried out in August 2012. Cells 1 and 2 south were last topographically surveyed in May 2011 and are due for resurvey. Future topographical surveys will be carried out annually up to 2018, and then every two years thereafter.

An inspection audit of the cap will be carried out by Gwynedd Council on an annual basis to check for signs of damage or changes which may compromise the performance of the cap. The annual inspection will also include an assessment of the topographical survey with the results compared against the previous survey to identify any areas which may need further investigation. As part of the routine inspection Gwynedd will perform the following checks:

- No large trees or shrubs that may penetrate the cap are present on the cap;
- There is no evidence of soil erosion on the cap or in adjacent areas;
- There are no noticeable depressions or ponded water present;
- There is no noticeable sliding, slope failure or large cracks in the soil cover;
- The geomembrane is not exposed or torn; and
- There are no large areas of bare of vegetation.

Records will be kept of each site visit and all information gathered will be recorded on the audit sheets.

Where remedial work is minor (for example clearing trees and bushes) Gwynedd Council will either complete the required work or employ suitable qualified personnel to make the required repairs as soon as practicably possible.

Where it is determined that there is damage to the cap that requires major remedial work (for example exposed or damaged geomembrane) the following contingency plan will be initiated:

- An assessment of the work required will be made by Gwynedd Council to determine the most suitable means of repair/replacement and set the timescales for the work to be undertaken and completed;
- A Construction Quality Assurance (CQA) Plan will be drawn up for the required work and forwarded to NRW for approval;
- Gwynedd Council will employ suitably qualified personnel to undertake the remedial work in accordance with the CQA Plan. All work will be independently assessed by a qualified CQA Assessor;
- A CQA Completion Report will be submitted to NRW detailing all the activities carried out on site and where appropriate, the materials used including any testing undertaken.

5. Monitoring During the Aftercare Phase

The current leachate, landfill gas, groundwater and surface water monitoring infrastructure at the Llwyn Isaf Landfill Site is shown on Figure 3. The monitoring infrastructure is described in Sections 4.1, 4.3, 4.5 and 4.7 of this report.

The existing and replacement monitoring infrastructure, as described above, is considered adequate in accordance with Annex III of the Landfill Directive², which requires the following:

- Sampling of leachate from representative points;
- Sampling of groundwater with at least one measuring point in the groundwater inflow region and two in the outflow region;
- Sampling of surface water from at least two representative points – one upstream and one downstream of the landfill; and
- Gas monitoring representative of each section of the landfill.

All monitoring for the Aftercare Phase will be carried out in accordance with Annex III to the Landfill Directive.

In determining the monitoring frequencies for leachate, groundwater, surface water and landfill gas for the Aftercare Phase, a review of the results of the previous 12 months monitoring at the site has been carried out to establish long term trends and any seasonal variation. The following Quarterly Monitoring Reports have been referred to:

- AMEC report ref: 28587rr648i2 dated 27 November 2012 covering the period July to September 2012;
- AMEC report ref: 28587rr695i2 dated 13 February 2013 covering the period October to December 2012;
- AMEC report ref: 28587rr6732i2 dated 7 May 2013 covering the period January to March 2013; and
- AMEC report ref: 28587rr780i2 dated 1 August 2013 covering the period April to June 2013.

5.1 Leachate Monitoring

5.1.1 Current Leachate Monitoring Regime

Leachate quality and level monitoring is currently, and will continue to be, undertaken by Gwynedd Council with samples sent to ALS Environmental Ltd for analysis.

As of March 2013, samples of leachate have been collected individually from each of the three cells. Leachate levels are monitored at the monitoring points within each of the cells and leachate samples are collected from the riser pipe within each cell. Leachate head

² Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste.

measurements are currently taken weekly and are in compliance with the requirements of the Environmental Permit. Leachate samples are analysed on a quarterly basis for key determinands, with annual extended analytical suites including additional metals and organic contaminants. These frequencies are more often than the permit requirements which are identified in Table 5.1.

Table 5.1 Leachate Monitoring Regime as per Environmental Permit

Monitoring Location	Frequency	Parameters
All leachate monitoring points	Monthly	Level
All leachate wells/abstraction wells/sumps identified on drawing ESID7 of the permit application documents	Quarterly	Level, EC, Cl, NH ₄ -N, pH, mecoprop, toluene, COD, BOD, Ca, Mg, K, Na, Cd, Alk, TOC, SO ₄ , TON and phenol
	Annually	quarterly plus: Cr, Cu, Fe, Pb, Mn, Ni, Zn and List I suite

Control Levels and Compliance Limits

Control levels and Compliance limits for leachate levels were proposed within the Hydrogeological Risk Assessment (HRA) for the original permit application (AMEC report reference 18846rr095i1 dated October 2007) at 1.0 m and 1.5 m respectively. A limit of 1.5 m leachate head above the base of the cell is specified in Table S4.1 of the current Environmental Permit.

5.1.2 Leachate Monitoring Regime During the Aftercare Phase

Leachate monitoring data for the previous 12 months, reviewed quarterly by AMEC on behalf of Gwynedd Council, shows:

- No significant variability in leachate levels within and across the cells;
- All leachate levels measured during the last 12 months were below the EP compliance limit of 1.5 m above base;
- Leachate quality monitoring of the two key indicators, chloride and ammoniacal nitrogen, shows some variation in concentrations for both parameters over the 12 month period with no apparent link in the increases and decreases to seasonal variation. Overall concentrations of both parameters are higher in Cell 3 as would be expected due to Cell 3 having the most recently deposited waste. For both parameters, there were no spikes in concentration and no overall increase in concentrations was detected;
- The majority of determinands from the annual extended suite were found at concentrations below the laboratory detection limits. Organic determinands above the detection limits in the leachate were not detected at significant concentrations.

Filling and capping of the site is now complete and this in turn will reduce the incidence of leachate generation in the long term. It is therefore expected that leachate levels will continue to remain below the compliance level of 1.5 m. Given that leachate quality monitoring data shows no significant variability over the previous 12 months, groundwater quality monitoring data (see Section 5.3.2) demonstrates no unacceptable impact from Area 3 and the 2009 HRA

predicts no future impact on groundwater quality, it is proposed to reduce leachate level monitoring from monthly to quarterly and reduce the quality monitoring frequency from quarterly to six monthly during the aftercare phase (Table 5.2).

Table 5.2 Leachate Monitoring Regime During the Aftercare Phase

Monitoring Location	Frequency	Parameters
LM1/1, 1/2, 2/1, 3/1 and 3/2	Quarterly	Level
Leachate Riser Pipes within each cell	Six Monthly	EC, Cl, NH ₄ -N, pH, mecoprop, toluene, COD, BOD, Ca, Mg, K, Na, Cd, Alk, TOC, SO ₄ , TON and phenol
	Annually	As monthly/quarterly plus: Cr, Cu, Fe, Pb, Mn, Ni, Zn and List I suite

The leachate monitoring schedule set out in Table 5.2 meets the suggested frequencies set out in Annex III of the Landfill Directive, which requires monitoring of leachate volume and composition every six months during the aftercare phase but only where leachate collection takes place.

5.1.3 Contingency Arrangements

Control and compliance limits for leachate levels were proposed within the Hydrogeological Risk Assessment (HRA) for the original permit application (AMEC report Reference 18846rr095i1 dated October 2007) at 1.0 m and 1.5 m respectively. A limit of 1.5 m leachate head above the base of each cell is specified in Table S4.1 of the current Environmental Permit.

The control limits are set to identify trends and prompt contingency actions prior to compliance limits being exceeded. Data from quarterly and annual reports produced for the site show leachate levels in all Cells 1 and 3 are consistently below the Environmental Permit compliance limit of 1.5 m above base. There have been occasional exceedances in Cell 2.

It is proposed that the exceedance of the compliance limit on a single occasion will require action. The outline course of action is as follows:

- Site management will be advised immediately;
- NRW will be advised within 48 hours;
- Repeat monitoring at the affected leachate monitoring points within 1 week;
- An inspection of the leachate management and monitoring infrastructure and capping will be undertaken to identify any signs of damage which may lead to the change on levels recorded within one week;
- Any remedial action required will be carried out in accordance with the programme set out in Section 4.2;
- Review monitoring data;
- Re-evaluate the risks;

- Initiate remedial action or re-evaluate assessment criteria (depending on risks) within 6 months.

Any proposed changes to the leachate compliance levels as a result of the revaluation assessment would be discussed with NRW and, if agreed, an application to vary the Environmental Permit would be sought at that time.

5.2 Landfill Gas Monitoring

5.2.1 Current Landfill Gas Monitoring

In-waste landfill gas monitoring is currently and will continue to be undertaken by CH4 Consultants. Perimeter boreholes are monitored by Gwynedd Council. Monitoring in perimeter and in-waste boreholes for Area 3 is currently carried out monthly for peripheral boreholes and twice monthly for in waste boreholes for the parameters set out in the Environmental Permit and in accordance with the EA's 'Guidance on the Management of Landfill Gas' (LFTGN03 2004). Trace gas analysis is carried out annually in accordance with the EA's 'Guidance for monitoring trace components in landfill gas' (LFTGN04 v3 201). The gas monitoring regime required by the Environmental Permit is identified in Table 5.3.

Table 5.3 Gas Monitoring Regime as per Environmental Permit

Monitoring Location	Frequency	Measurement/Determinand
Peripheral gas monitoring boreholes G1A*, G2, G3, G4, G5, G6 and G7.	Monthly	Methane, carbon dioxide, oxygen, atmospheric pressure, differential pressure, temperature and meteorological data.
In-waste monitoring boreholes (at least two monitoring wells within each cell).	Monthly	Methane, carbon dioxide, oxygen, carbon monoxide, atmospheric pressure, differential pressure and meteorological data.
Representative sample taken from the extraction line prior to disposal system.	Annual	Trace Gas Analysis in accordance with Environment Agency Document LFTGN04.

Note: * G1A is a replacement for G1, which was lost to construction work for the new AD plant in July 2012.

Control Levels and Compliance Limits

The control levels and compliance limits for methane and carbon dioxide for the external monitoring boreholes were agreed with the Environment Agency Wales (now NRW) based on the results of fourteen monitoring rounds undertaken between 7 October 2008 and 25 June 2009 (with the exception of G1A where limits were set in June 2013) as set out in Table 5.4.

Table 5.4 Landfill Gas Control and Compliance Levels for External Monitoring Boreholes

Borehole Reference	G1A		G2		G3		G4		G5		G6		G7	
Parameter	CH ⁴	CO ²	CH ⁴	CO ²	CH ⁴	CO ²	CH ⁴	CO ²	CH ⁴	CO ²	CH ⁴	CO ²	CH ⁴	CO ²
Control Limit	0.8	4.7	0.8	1.9	0.8	4.5	0.8	2.0	2.1	5.0	/	/	/	/
Compliance Level	1.0	5.9	1.0	2.3	1.0	5.7	1.0	2.5	2.6	6.2	/	/	/	/

Surface Emissions Monitoring

Surface emissions monitoring will be undertaken in accordance with the EA's 'Guidance on monitoring landfill gas surface emissions' (LFTGN07 v2 2010) and the requirements of the Environmental Permit. The overall process will include a walkover survey with a TDL 500. Should elevated emissions be detected then a schedule of works to investigate the source of the emissions will be drawn up and will be likely to include:

- The removal of overlying restoration soils;
- Inspection of underlying capping works for damage.

Where it is determined damaged infrastructure requires major remedial work the contingency plan in Section 4.9 (Cap Maintenance) will be initiated.

A surface emissions monitoring schedule for the site during the aftercare phase is presented in Table 5.5.

Flare Emission Monitoring

Emissions monitoring of the landfill gas flare will be undertaken in accordance with the EA's 'Guidance for monitoring enclosed landfill gas flares' (LFTGN05 v2 2010) and the requirements of the Environmental Permit.

5.2.2 Landfill Gas Monitoring for the Aftercare Phase

Landfill gas monitoring data for the previous 12 months, reviewed quarterly by AMEC on behalf of Gwynedd Council, shows:

- Methane and carbon dioxide concentrations in the perimeter boreholes during this reporting period were consistent and any exceedances of compliance limits have been isolated occurrences and not significant;
- Methane and carbon dioxide have been detected at elevated concentration in borehole G6 on 8 occasions out of the 13 monitoring rounds undertaken. However this borehole is located between Area 3 and the unlined closed landfill (Area 2) which suggests that methane and carbon dioxide are likely to be derived from Area 2. Monitoring at borehole G7 which is also within this location has detected low concentrations of methane on two occasions (0.1% v/v and 0.5% v/v) and elevated concentrations of carbon dioxide of 8.4% v/v and 4.7% v/v for the same monitoring period. No control levels and compliance limits are set on these boreholes;

- For all other external monitoring boreholes methane and carbon dioxide concentrations remained consistently low with no exceedance of the compliance limits set for methane recorded. For carbon dioxide concentrations, there were four exceedances, however these were not significant and were isolated occurrences with no trend being identified;
- Methane and carbon dioxide concentrations recorded at the in-waste monitoring boreholes have remained consistent across the twelve month period with concentrations of methane around 60% v/v and carbon dioxide concentrations around 30% v/v as would be expected with gas from biodegradable landfills where degradation is occurring.

Filling and capping of the site is now complete and a landfill gas collection system (including extraction wells, collector pipework and condensate knockout pots) is in operation across all cells and connected to the high temperature (HT) ground flare located in the compound to the north of Cell 3. During the aftercare period for Area 3, the gas extraction system will be routinely monitored to ensure extraction and gas utilisation are optimised and landfill gas does not migrate from the site. Given that perimeter borehole landfill gas monitoring data shows no significant variability over the previous 12 months and gas extraction will continue during the aftercare phase, it is proposed to reduce landfill gas monitoring of the external boreholes and the in waste boreholes from monthly to quarterly (Table 5.5).

Table 5.5 Landfill Gas Monitoring Regime During the Aftercare Phase

Monitoring Location	Frequency ¹	Parameter
Landfill surface	Annually as required (see footnote to Table S4.6 of Environmental Permit)	Methane Atmospheric pressure General surface type and condition Meteorological data
Landfill Gas Flare	Annually	Oxides of nitrogen Carbon monoxide Total VOCs Operational Temperature Gas flow rate
Peripheral gas monitoring boreholes G1A*, G2, G3, G4, G5, G6 and G7	Quarterly	Methane Carbon dioxide Oxygen Atmospheric pressure Differential pressure Meteorological data
In-waste monitoring boreholes (at least two monitoring wells within each cell)	Quarterly	Methane Carbon dioxide Oxygen Carbon monoxide Atmospheric pressure Differential pressure Meteorological data
Representative sample taken from the extraction line prior to disposal system	Annually	Trace gas analysis

¹ These frequencies may be reduced over time if agreed with NRW.

The landfill gas monitoring schedule set out in Table 5.5 exceeds the suggested frequencies set out in Annex III of the Landfill Directive, which requires monitoring representative of each section of the landfill for potential gas emissions and atmospheric pressure every six months during the aftercare phase. The Directive also requires the efficiency of the gas extraction system to be checked regularly and this is covered in Section 4.4.

5.2.3 Contingency Arrangements

Compliance levels are set in the Environmental Permit for the flare (Table S4.2), external landfill gas monitoring boreholes (Table S4.5) and for surface emissions (Table S4.6). In the event of a confirmed exceedance of the compliance limits specified in the permit, the appropriate actions (specified below) will be instigated.

Combustion Emissions

In the event that compliance limits set out in Table S4.2 of the Environmental Permit for flare emissions are exceeded the following contingency action plan will be implemented, as follows:

- The results will be notified to NRW within 24 hours of the elevated concentration being detected. The results will be confirmed in writing within 10 working days of the monitoring;
- An assessment of previous data will be undertaken to determine whether the exceedance is consistent with established or predicted trends;
- The gas field will be re-balanced;
- Further sampling and analysis will be undertaken within 2 months of reporting of the initial results;
- If the repeat analysis is compliant no further action will be taken;
- If the repeat analysis is not compliant then further remedial action will be taken, as agreed with NRW;
- Following remediation, repeat sampling will be undertaken to ensure compliance with emission standards.

Lateral Emission – Action Plan

In the event of a compliance limit for methane or carbon dioxide set out in Table S4.5 of the Environmental Permit being exceeded the following procedures will be implemented:

- The results will be notified to NRW within 24 hours of the elevated concentration being detected. The results will be confirmed in writing within 10 working days of the monitoring;
- An assessment of previous data will be undertaken to determine whether the exceedance is consistent with established or predicted trends;
- Should a compliance level continue to be exceeded, gas samples may be taken from the boreholes and submitted for laboratory analysis to investigate the source of the elevated gas concentrations. The method and frequency will be agreed with NRW on an incident specific basis, as will the appropriate action to be taken.

In response to the above, the following remedial actions may be taken:

- The frequency of monitoring will be increased to determine whether the elevated concentrations are sustained. The increased frequency will be based on an assessment of the risks associated with the elevated concentrations. The risk assessment will include consideration of the location of the borehole, the bulk gas composition, the location of the nearest receptors to the borehole, previous monitoring results for that borehole and other boreholes and by how much the trigger level is exceeded. Monitoring at the increased frequency may include other boreholes in the area. Monitoring at the increased frequency will continue until the gas concentrations recorded in the borehole are consistently below the trigger level, or unless otherwise agreed with NRW;
- If the gas recorded is attributable to landfill gas migration from the site the gas extraction system will be adjusted as appropriate to improve gas control. Monitoring at the increased frequency described above will continue to determine the effectiveness of the system and allow consideration of the action to be taken;
- If necessary, additional gas extraction wells or gas monitoring boreholes will be installed to improve the control or monitoring of landfill gas.

Surface Emission – Action Plan

In the event that the compliance limit for permanently capped areas set out in Table S4.6 of the Environmental Permit are exceeded. The following procedures will be implemented:

- The results will be notified to NRW within 24 hours of the elevated concentration being detected. The results will be confirmed in writing within 10 working days of the monitoring;
- An assessment of previous data will be undertaken to determine whether the exceedance is consistent with established or predicted trends;
- A report on surface emissions flux will form the basis for proposals on remediation through the gas management plan. The operator will identify the most appropriate remedial actions on an incident specific basis and these will be agreed with NRW;
- Remedial actions may consist of:
 - Rectification of fissures and/or defects in the capping system as set out in Section 4.9;
 - Extension of the gas extraction system;
 - Undertaking an improved monitoring procedure for subsequent surveys on areas where the current survey showed variability in the cap and uncertainty in the value for the flux.
- Following remediation, repeat sampling will be undertaken to ensure compliance with emissions standards.

5.3 Groundwater Monitoring

Groundwater quality and level monitoring is currently, and will continue to be, undertaken by Gwynedd Council in accordance with the requirements of the Environmental Permit, with samples sent to ALS Environmental Ltd for analysis.

5.3.1 Current Groundwater Monitoring Regime

Groundwater levels are monitored manually on a quarterly basis (frequency reduced from monthly on the basis that the data showed no significant variability). Groundwater samples are analysed on quarterly basis in Area 3 for key determinands, with an annual extended analytical suite. The groundwater sampling regime is outlined in Table 5.6.

Monitoring boreholes GW2, GW5 and M47 are upgradient of the landfill, borehole DAS lies between Area 2 and Area3 and boreholes GW3, GW4, M17 and M36 lie downgradient of the landfill. Monitoring locations are shown on Figure 3.

Table 5.6 Groundwater Monitoring Regime as per Environmental Permit

Monitoring Location	Frequency	Measurement/ Determinand
M17, M36, M47, DAS, GW2, GW3 and GW4.	Monthly*	Level.
M17, M36, M47, DAS, GW2, GW3, GW4 and GW5.	Quarterly	EC, DO, Cl, NH ₄ -N, Hg, Zn, mecoprop Ca, Mg, K, Na, Cd, Alk, TOC, SO ₄ , TON and phenol.
M17, M36, M47, DAS, GW2, GW3, GW4 and GW5.	Annually	As quarterly plus: Cr, Cu, Fe, Pb, Mn, Ni, Zn, hazardous (List I) suite (as for leachate, or selected parameters) – not required if hazardous (List I) substances are absent in leachate.

Notes: * Monitoring frequency was reduced from monthly to quarterly in April 2009 for M47, in April 2010 for GW2, GW3, GW4, GW5, M17 and M36 and in May 2013 for DAS on the basis that monthly water level for these boreholes showed no significant variability.

Control Levels and Compliance Limits

Control levels and Compliance limits for groundwater quality at boreholes GW3, GW4 and M36 were proposed within the Hydrogeological Risk Assessment (HRA) for the original permit application (AMEC report Reference 18846rr095i1 dated October 2007). Limits were set for Ammoniacal-N, Chloride, Zinc, Mercury and Mecoprop and compliance limits for these parameters at these borehole locations were set in Table S4.4 of the Environmental Permit.

A reappraisal of the conceptual HRA was completed in 2009 using actual site data in response to improvement condition No.6 of Table S1.3 of the Environmental Permit (AMEC Report reference 28587n665i2 dated 21 August 2009). The report concluded the conceptual model for the site produced in the original HRA remains valid and no changes to the compliance limits was proposed. More recently a technical note was produced by AMEC (AMEC Report reference 28587n745i1 dated 20 June 2013) on behalf of Gwynedd Council to review the groundwater compliance limits for mercury specified in the Environmental Permit (0.05 µg/l without specifying if it refers to total or dissolved forms). Review of monitoring data for the period January 2012 to April 2013 showed that total mercury concentrations continued to show variability and occasional exceedances of the compliance limit whilst dissolved mercury

concentrations were consistently below the compliance limit. As dissolved mercury is the most mobile form, and therefore the most relevant for assessing the risks to controlled waters, it was recommended that the compliance limit of 0.05 µg/l refers specifically to the dissolved form of mercury and that future measurements of mercury in groundwater are taken of dissolved form only.

5.3.2 Groundwater Monitoring Regime During the Aftercare Phase

Groundwater levels and quality are currently monitored on a quarterly basis. Groundwater monitoring data, reviewed quarterly by AMEC on behalf of Gwynedd Council, show:

- Seasonal variation in groundwater levels with no discernible long term trends;
- No significant variability in groundwater quality downgradient of Area 3; and
- No unacceptable impact from Area 3 on groundwater quality and no exceedances of the Environmental Permit compliance limits (assuming mercury limit refers to the dissolved form).

Given that filling and capping of the site is complete, monitoring data show no significant variability and no unacceptable impact from Area 3, and the 2009 HRA predicts no future impact on groundwater quality, it is proposed to continue groundwater level monitoring on a quarterly basis and reduce the quality monitoring frequency from quarterly to six monthly during the aftercare phase (Table 5.7). In accordance with the requirements of the Environmental Permit, the HRA for the site will be reviewed every 4 years and this will include an assessment of monitoring data to confirm if the original conceptual model remains valid.

Table 5.7 Groundwater Monitoring Regime during the Aftercare Phase

Monitoring Location	Frequency	Measurement/Determinand
M17, M36, M47, DAS, GW2, GW3 and GW4.	Quarterly	Level.
M17, M36, M47, DAS, GW2, GW3, GW4 and GW5.	Six-monthly	EC, DO, Cl, NH ₄ -N, Hg, Zn, mecoprop Ca, Mg, K, Na, Cd, Alk, TOC, SO ₄ , TON and phenol.
M17, M36, M47, DAS, GW2, GW3, GW4 and GW5.	Annually	As six-monthly plus: Cr, Cu, Fe, Pb, Mn, Ni, Zn, hazardous (List I) suite (as for leachate, or selected parameters) – not required if hazardous (List I) substances are absent in leachate.

No changes are proposed to the current groundwater compliance limits set in Table S4.4 of the Environmental Permit (subject to mercury being read as ‘dissolved’ rather than ‘total’).

5.3.3 Contingency Arrangements

Control levels and compliance limits for downgradient groundwater monitoring boreholes GW3, GW4 and M36 were proposed within the HRA for the original permit application (AMEC report Reference 18846rr095i1 dated October 2007) and with the exception of an amendment to how mercury is reported, they remain valid. Compliance Limits for these boreholes are set in Table S4.4 of the Environmental Permit.

The control levels are set to identify trends and prompt contingency actions prior to compliance limits being exceeded. Data from quarterly reports produced for the site show groundwater quality in the down gradient boreholes to be consistently below the compliance limits set in the Environmental Permit.

It is proposed that control levels lead to action once they have been exceeded for three consecutive monitoring rounds and the exceedance of the compliance limit on a single occasion will require action. The outline course of action is as follows:

- Site management will be advised immediately;
- NRW will be advised within 24 hours of receipt of monitoring results;
- Confirm by repeat sampling and analysis at boreholes where exceedances are recorded within 1 week;
- Review existing monitoring data within 14 days of receipt of results;
- Review site management and operations, and implement actions to prevent future failure of a compliance limit within 21 days of receipt of results;
- Review the assumptions incorporated into the conceptual site model within 1 month of receipt of results;
- Consider reviewing existing control and compliance limits within 1 month of receipt of results;
- If risks are unacceptable, set in place procedures for implementing corrective measures in consultation with NRW within 3 months of receipt of results.

5.4 Surface Water Monitoring

Surface Water quality monitoring is currently, and will continue to be, undertaken by Gwynedd Council in accordance with the requirements of the Environmental Permit, with samples sent to ALS Environmental Ltd for analysis.

5.4.1 Current Surface Water Monitoring Regime

Surface water quality is monitored on a monthly basis in accordance with the requirements of the Environmental Permit as set out in Table 5.8.

Table 5.8 Surface Water Monitoring Regime as per Environmental Permit

Monitoring Location	Frequency	Measurement/Determinand
Infiltration Basin.	Monthly*	EC, pH, Cl, NH ₄ -N, Cd.
SWW and SWY (upstream) SWB, SWC, SWD2 and SWE (downstream) SWD* (discharge from the new attenuation lagoon).	Monthly	EC, pH, Alk, Cl, NH ₄ -N, TOC, BOD, COD, DO. Plus suspended solids for SWD.
SWW and SWY (upstream) SWB, SWC, SWD2 and SWE (downstream) SWD* (discharge from the new attenuation lagoon).	Quarterly	As monthly plus: Ca, Mg, K, Na, SO ₄ , NO ₃ , NO ₂ , TON, Cd, Cu, Fe, Pb, Mn, Ni and Zn.

Notes: SWD is in operation since September 2012 following construction of the attenuation lagoon.

* Subject to there being a flow from this location.

Control Levels and Compliance Limits

Control levels and Compliance limits for point source emissions to surface water were proposed within the Hydrogeological Risk Assessment (HRA) for the original permit application (AMEC report Reference 18846rr095i1 dated October 2007) for Ammoniacal Nitrogen, Dissolved Oxygen, BOD and pH. As part of an application to vary the Environmental Permit to include a new surface water management system (AMEC Report reference 28587rr143i2 dated 27 June 2011), revised limits were proposed for the surface water discharge to the Afon Desach and these were supported assessment of the impact of a future discharge to surface water from Llwyn Isaf Landfill site, in accordance with the Environment Agency Horizontal Guidance note H1 Annex D (Environment Agency, 2010) (Appendix D of AMEC Report reference 28587rr143i2 dated 27 June 2011). Revised limits were proposed for Ammoniacal Nitrogen, Dissolved Oxygen, BOD, Suspended Solids and pH for Discharge point D (discharge point from Surface water attenuation lagoon into the Afon Desach). These revised limits were transposed into Table S4.3 of the Environmental Permit through Variation number EPR/YP3138UJ/V002 dated 12 September 2011.

5.4.2 Surface Water Monitoring Regime During the Aftercare Phase

Surface water quality is currently monitored on a quarterly basis. Surface water monitoring data, reviewed quarterly by AMEC on behalf of Gwynedd Council, show:

- Low ammoniacal nitrogen and chloride concentrations continue to be recorded at most monitored locations and generally show no impact from Area 3;
- The highest chloride concentrations continue to be detected at D2 and combined with detectable concentrations of ammoniacal nitrogen are likely to represent a slight impact from the nearby closed landfill (Area 2);
- No unacceptable impact from Area 3 on surface water quality and no exceedances of the Environmental Permit compliance limits (emission limits set for sample point D) with the exception of suspended solids in April and May 2013. Measures for reducing suspended solids in the attenuation lagoon have been implemented (installation of straw bales to filter inflow and reduce re-suspension of fine particles in May 2013 and removal of silts from the base in June 2013).

Given that filling and capping of the site is complete, monitoring data show no significant variability and no unacceptable impact from Area 3, it is proposed to reduce the monitoring for the point source emission at Sampling Point SWD from monthly to every two months subject to there being a flow from the lagoons to this point and to reduce the quality monitoring frequency from monthly to six monthly and from quarterly to annually during the aftercare phase (Table 5.9).

Table 5.9 Surface Water Monitoring Regime During the Aftercare Phase

Monitoring Location	Frequency	Measurement/Determinand
SWD (discharge from the new attenuation lagoon).	Every two Months*	NH ₄ -N, DO, BOD, Suspended solids, pH.
Infiltration Basin*.	Six Monthly*	EC, pH, Cl, NH ₄ -N, Cd.
SWW and SWY (upstream) SWB, SWC, SWD2 and SWE (downstream) SWD* (discharge from the new attenuation lagoon).	Six Monthly	EC, pH, Alk, Cl, NH ₄ -N, TOC, BOD, COD, DO. (Plus suspended solids for SWD).
SWW and SWY (upstream) SWB, SWC, SWD2 and SWE (downstream) SWD* (discharge from the new attenuation lagoon).	Annually	As six monthly plus: Ca, Mg, K, Na, SO ₄ , NO ₃ , NO ₂ , TON, Cd, Cu, Fe, Pb, Mn, Ni and Zn.

* Subject to there being a flow from this location.

5.4.3 Contingency Arrangements

No changes are proposed to the compliance limits set in Table S4.3 of the Environmental Permit only to the frequency of monitoring as set out in Table 5.9 above.

Control and Compliance limits for point source emissions to surface water were proposed within the Hydrogeological Risk Assessment (HRA) for the original permit application and updated as part of the application to vary the permit when the new surface water management system was installed. The control limits (where identified) are set to identify trends and prompt contingency actions prior to compliance limits being exceeded. Data from quarterly reports produced for the site show for sample point SWD the compliance limits have not been exceeded with the exception of suspended solids in April and May 2013 (AMEC Report reference 28587rr780i2 dated 1 August 2013). Measures for reducing suspended solids in the attenuation lagoon have recently been implemented (installation of straw bales to filter inflow and reduce re-suspension of fine particles in May 2013 and removal of silts from the base in June 2013).

It is proposed that control limits lead to action once they have been exceeded for three consecutive monitoring rounds and the exceedance of the compliance limit on a single occasion will require action. The outline course of action is as follows:

- Site management will be advised immediately;
- NRW will be advised within 48 hours of receipt of monitoring results;
- Confirm by repeat sampling and analysis at locations where exceedances are recorded within 1 week;

- Review existing monitoring data within 14 days of receipt of results;
- Review site management and operations, and implement actions to prevent future failure of a compliance limit within 21 days of receipt of results;
- Review the assumptions incorporated into the conceptual site model within 1 month of receipt of results;
- Consider reviewing existing control and compliance limits within 1 month of receipt of results;
- If risks are unacceptable, set in place procedures for implementing corrective measures in consultation with NRW within 3 months of receipt of results.

5.5 Restored Surface Monitoring

Restored surface monitoring at the site during the aftercare phase will be carried out in accordance with Annex III of the Landfill Directive which requires a yearly recording of the settling behaviour of the level of the landfill body during the aftercare phase.

Regular monitoring of the gas extraction system will be undertaken to ensure that the system is operating as designed and that no gas build up occurs below the cap.

The surface levels of the completed landfill will be surveyed on an (initially) annual basis to monitor progress of the settlement.

6. Reporting

6.1 Significant Environmental Effects

The reporting of 'significant environmental effects' will be required during the aftercare phase for the Llwyn Isaf landfill. For groundwater quality, the compliance limits should be reported in accordance with Annex III of the Landfill Directive, which is used as the basis for reporting significant environmental effects. The Directive states:

'Significant adverse environmental effects, as referred to in Articles 12 and 13 of this Directive, should be considered to have occurred in the case of groundwater, when an analysis of a groundwater sample shows a significant change in water quality. A trigger level must be determined taking account of the specific hydrogeological formations in the location of the landfill and groundwater quality.'

The Landfill Directive makes no reference to what constitutes a significant adverse environmental effect for landfill gas or leachate quality. NRW/EA Guidance *'How to comply with your environmental permit -Closing your landfill'* (Consultation Document March 2013) states for leachate and landfill gas:

'a significant adverse environmental effect will include any increase above an established baseline level.'

6.1.1 Leachate

Compliance limits have been set for leachate levels within the landfill. A contingency plan for leachate is presented at Section 5.1.3 of this report. It is proposed that exceedance of the compliance limit on a single occasion will require action.

If a compliance limit is exceeded, the results will be notified to the NRW within 48 hours.

6.1.2 Landfill Gas

Contingency action plans for surface, lateral and combustion emissions are presented in Section 5.2.3 of this report. It is proposed that the exceedance of the compliance limit set in the Environmental permit on a single occasion will require action.

If a compliance limit is exceeded the results will be notified to the NRW within 48 hours.

6.1.3 Groundwater

Control levels and compliance limits have been set for groundwater quality on downgradient boreholes. A contingency plan for groundwater is presented in Section 5.3.3 of this report. It is proposed that the exceedance of the compliance limit on a single occasion will require action.

If a compliance limit is exceeded, the results will be notified to the NRW within 48 hours.

6.1.4 Surface Water

Control levels and compliance limits have been set for surface water quality on the discharge point from the attenuation lagoon into the Afon Desach. A contingency plan for groundwater is presented in Section 5.4.3 of this report. It is proposed that the exceedance of the compliance

limit on a single occasion will require action.

If a compliance limit is exceeded, the results will be notified to the NRW within 48 hours.

6.1.5 Stability/Settlement

The final surface levels will be annually surveyed to monitor progress of settlement and to ensure that no adverse stability issues arise. Details on cap maintenance are presented in Section 4.9 of this report. If significant irregularities are noted in the capping system, such as depressions or large cracks in the cap, NRW will be notified within a week.

7. Habitats

7.1 Habitats

A Habitats Risk Assessment (AMEC Report Reference 18846n097i1 dated October 2007) was submitted in support of the original PPC application.

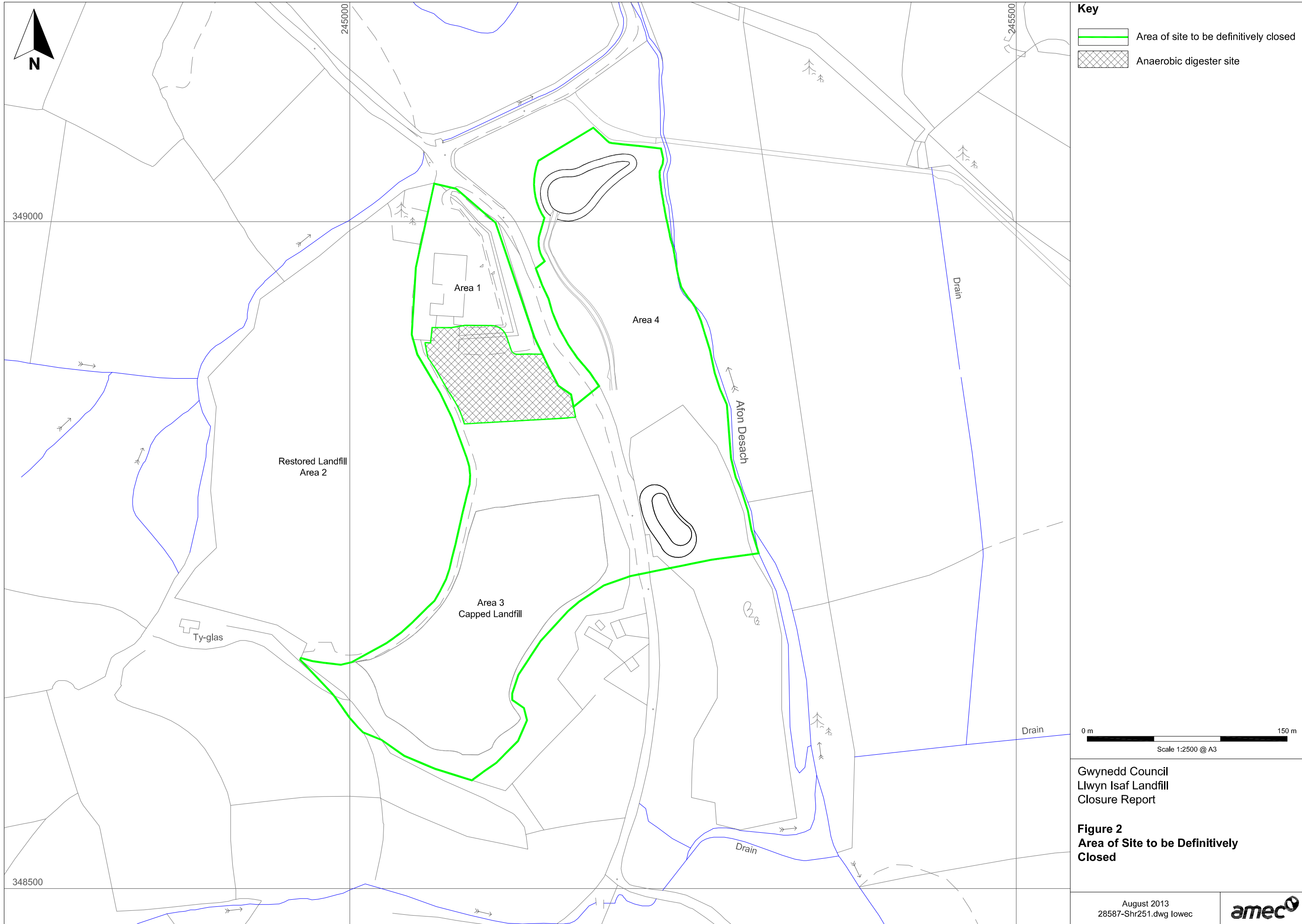
The site is within 5 km of a European Site. A European site is any site that has been designated as a site of international nature conservation importance either as a Special Protection Area (SAC), a Special Area of Conservation (SAC) or a Ramsar Site. The nearest European Site is Corsydd Eifionydd SAC is located approximately 0.02 km to the south east of the installation and covers an area of approximately 144.32 ha. It is designated a SAC due to the presence of transition mires, quaking bogs, slender green feather moss and the marsh fritillary butterfly. Corsydd Eifionydd cSAC comprise 3 Sites of Special Scientific Interest (SSSIs) namely Cors Llanllyfni, Cors Y Wlad and Cors Gyfelog.

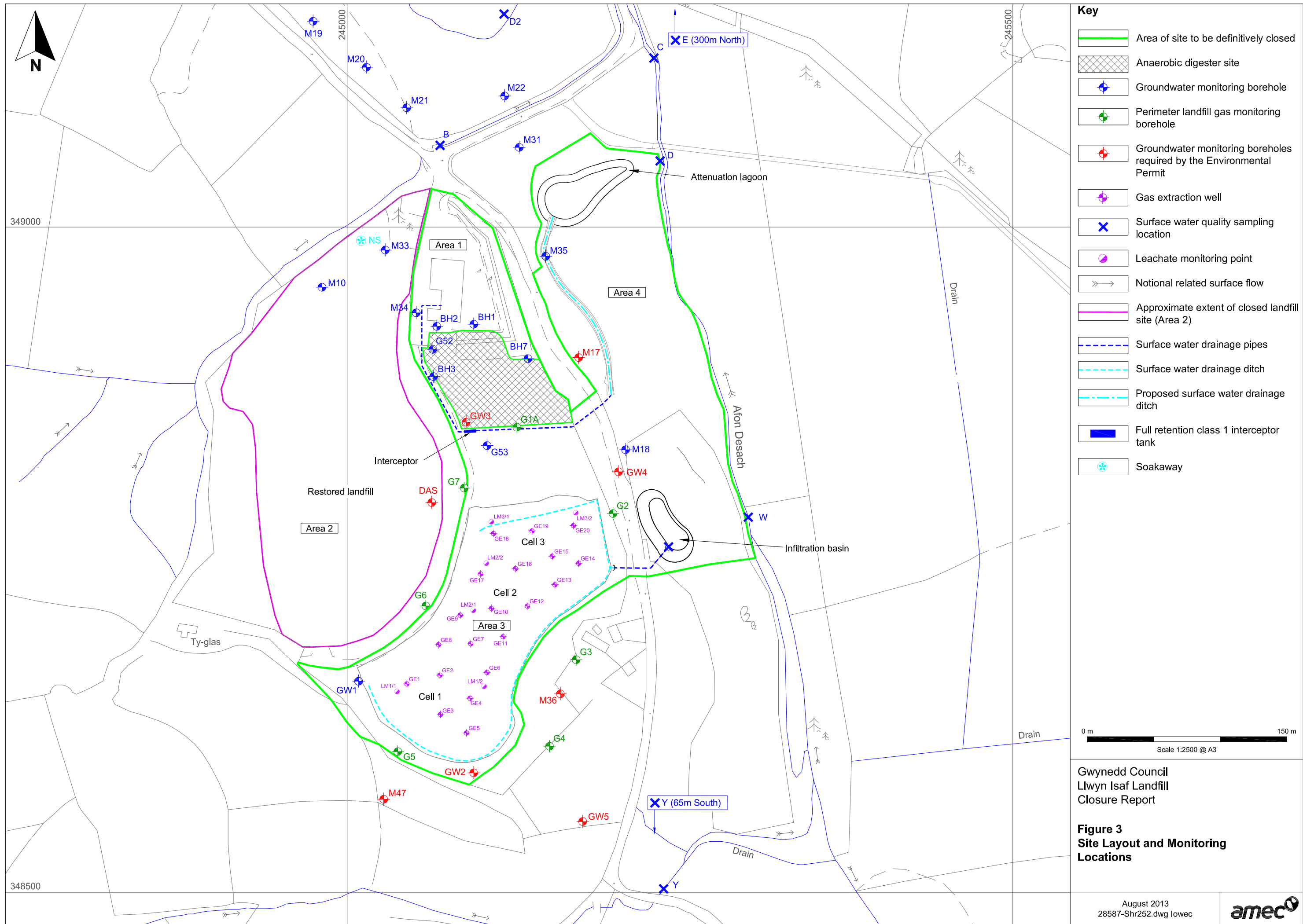
The site is not hydraulically connected to the European site.

The risk assessment concluded that the landfill would have no adverse effects on the integrity of the SAC. It is considered the conclusions drawn in the original assessment remain valid and the closure of the site and the aftercare phase will not have any adverse effect on the integrity of the SAC.

Figures







- Key**
- Area of site to be definitively closed
 - Anaerobic digester site
 - Groundwater monitoring borehole
 - Perimeter landfill gas monitoring borehole
 - Groundwater monitoring boreholes required by the Environmental Permit
 - Gas extraction well
 - Surface water quality sampling location
 - Leachate monitoring point
 - Notional related surface flow
 - Approximate extent of closed landfill site (Area 2)
 - Surface water drainage pipes
 - Surface water drainage ditch
 - Proposed surface water drainage ditch
 - Full retention class 1 interceptor tank
 - Soakaway

0 m 150 m
Scale 1:2500 @ A3

Gwynedd Council
Llwyn Isaf Landfill
Closure Report

Figure 3
Site Layout and Monitoring Locations

Based upon the Ordnance Survey Map with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright. 100001776.

Appendix A

Post Construction Capping Stability

Calculation

1 Page

STABILITY ASSESSMENT FOR SLOPES AND FINAL COVER

Slope with uniform cover thickness

Input cells coloured yellow			Textured	Movement of Plant	
				Upslope	Downslope
Cover Soil	γ_d	Dry unit weight of Soil (kN/m ³)	18.00	18.00	18.00
	γ_{sat}	Saturated unit weight of Soil (kN/m ³)	21.00	21.00	21.00
	γ_w	Unit weight of water (kN/m ³)	10.00	10.00	10.00
	Φ	Friction angle of the Soil (°)	28.00	28.00	28.00
	c	Cohesion of the Soil	0.00	0.00	0.00
	h	Thickness of the Soil (perpendicular to slope) (m)	0.83	0.83	0.83
Slope	h_w	Vertical height of water surface measured perpendicular to slope (m)	0.10	0.10	0.10
	H	Slope height (vertical) (m)	8.00	8.00	8.00
	β	Slope angle (°)	22.60	22.60	22.60
Geosynthetics		Number of geosynthetic units in system	2	2.00	2.00
	δ_1	Interface friction angle between Soil and GDL (°)	28.00	28.00	28.00
	α_1	Adhesion between Soil and GDL	4.00	4.00	4.00
	δ_2	Interface friction angle between GDL and Geomembrane (°)	21.00	21.00	21.00
	α_2	Adhesion between GDL and Geomembrane (°)	8.00	8.00	8.00
	δ_3	Interface friction angle between Geomembrane and Soil (°)	27.00	27.00	27.00
	α_3	Adhesion between Geomembrane and Soil (°)	4.00	4.00	4.00
	δ_4	NOT USED		0.00	0.00
	α_4	NOT USED		0.00	0.00
	σ_1	Shear strength/yield stress of GDL (kN/m)	19.00	19.00	19.00
	σ_2	Shear strength/yield stress of Geomembrane(kN/m)	11.00	11.00	11.00
	σ_3	NOT USED		0.00	0.00
	L	Length of the slope (m)	20.82	20.82	20.82
	C_a	Adhesive force between Soil of the active wedge and the GDL	74.68	74.68	74.68
	C	Cohesive force along the failure plane of the passive wedge	0.00	0.00	0.00
	W_A	Total weight of active wedge	298.07	410.07	410.07
	W_P	Total weight of passive wedge	17.31	17.31	17.31
	N_A	Effective force normal to the failure plane of the active wedge	256.14	359.41	359.41
	Un	Pore pressures acting perpendicular to slope	19.09	19.22	19.22
	Uh	Pore pressures acting on the interwedge surfaces	0.05	0.05	0.05
	Uv	Vertical pore pressures acting on passive wedge	0.12	0.12	0.12
		Parallel Saturation Ratio	0.12	0.12	0.12
		GDL not under tension (mobilised tension negative kN)	-160.14	-147.05	-132.16
		Geomembrane not under tension (mobilised tension negative kN)	-116.13	-92.77	-78.25
		NOT USED			
	FS	Factor of Safety against Soil sliding on GDL	2.01	1.81	1.63
	FS	Factor of Safety against sliding on Geomembrane	2.41	2.00	1.81
	FS	Factor of Safety against sliding on Soil	1.97	1.76	1.60
	FS	Factor of Safety against rupture of GDL	INFINITE	INFINITE	INFINITE
	FS	Factor of Safety against rupture of Geomembrane	INFINITE	INFINITE	INFINITE

Slope angle calculator	
Vertical	1
Horizontal	2.4
Slope	22.62

		Description of Layers
Cover		Soil
Geo-syn-thetics	1	GDL Geomembrane
	2	
	3	
Underlying		Soil

 = actual values from site specific testing

Gas Pressure

U _g	Allowable gas pressure beneath geomembrane (kPa)	4.50	4.50	4.50
FS	Factor of Safety against gas uplift effects	1.52	1.52	1.52

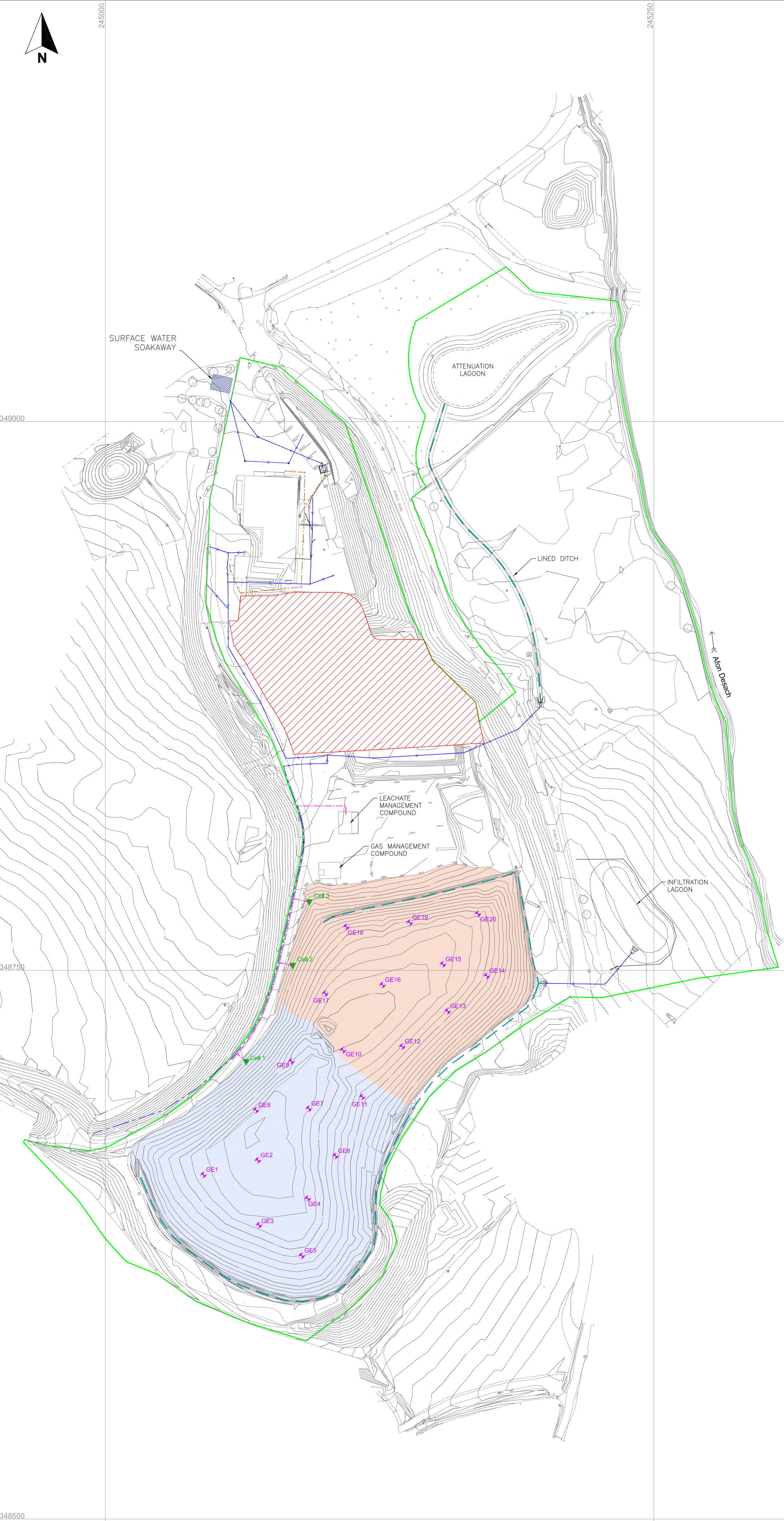
ASSUMED PLANT DETAILS (D6 Dozer)

W_b	Assumed weight of equipment (kN)	160.0
w	Length of equipment track (m)	2.5
b	Width of equipment track (m)	0.3
I	Influence factor at the geosynthetic interface	0.42
a	Acceleration of the bulldozer (assumes max speed 20km/h in 3 sec)	1.86

Appendix B

Site Survey

1 Drawing



DESCRIPTION							
REV A	DATE 13/08 2013	FIRST ISSUE		DWN AB	CHK JB	APP JB	
REVISIONS							
REV	DATE				DWN	CHK	APP

NOTES:

1. Location of Attenuation Lagoon & associated surface water ditch taken from design drawings.

2. Locations of surface water pipes & chambers taken from as built information.

- LEGEND:
- Are of site to be definitively closed
 - Area occupied by AD Plant
 - Existing surface water drain
 - Existing surface water drainage ditch
 - Existing land drain
 - Existing foul/leachate pipe
 - Existing leachate main
 - Existing leachate upslope riser
 - Existing gas well
 - Approximate extent of capping to landfill – completed June 2011
 - Approximate extent of capping to landfill – completed August 2012



SCALES: 1:1250 @ A2

PROJECT TITLE:
LLWYN ISAF LANDFILL

DRAWING TITLE:
DRAWING 1
GENERAL ARRANGEMENT

CLIENT:
GWYNEDD COUNCIL
WASTE TREATMENT SERVICE
SIAMBRAU BANC BARCLAYS
5-7 STRYD BANGOR
CAERNARFON
GWYNEDD LL55 1AT

REF:

CANON COURT, ABBEY LAWN, ABBEY FOREGATE,
SHREWSBURY SY2 5DE.
TEL: (01743) 342000 FAX: (01743) 342010

DRAWING No.
28587/SHR/253

Appendix C

Gas Flare and Maintenance Details

7 Pages

SERVICE SHEET Page No 1	JOB NO 1832	Automatic Flare Systems Ltd Unit 8, Ensign Business Centre Coventry CV4 8JA United Kingdom Tel: +44 (0)24 7647 4877 Fax: +44 (0)24 7647 4834 www.afs-group.co.uk										
SITE: LLwyn Isaf Landfill, Wales		DATE: 4.6.13										
HEALTH AND SAFETY NOTICE WEAR A HEAD HAT AND REFLECTIVE VEST OR JACKET ON OPERATIVE SITES WEAR A PROTECTIVE FACE MASK WHEN WORKING IN AN AREA WHERE THERE IS ANY POSSIBILITY OF BREATHING IN CERAMIC INSULATING DUST												
TO BE COMPLETED FOR ALL HIRE INSTALLATION, SERVICE AND REPAIR VISITS 1. RECORD ALL INSTRUMENT READINGS AND VALVE SETTINGS ON ARRIVAL 2. RECORD ALL CHANGES AND REPAIRS MADE 3. RECORD ALL PARTS, MATERIALS & COMPONENTS FITTED OR USED 4. CHECK THAT PRESSURE AND VACUUM GAUGES ARE ZEROED 5. RECORD ALL INSTRUMENT READINGS AND VALVE SETTINGS ON DEPARTURE 6. LEAVE SITE CLEAN AND TIDY 7. NOTE FUTURE REMEDIAL ACTION NEEDED AND SEE THAT IT IS CARRIED OUT												
ENGINEERS NAME	Steve Willacy											
ARRIVAL RECORD												
HOURS RUN	BOOSTER 1 6439 BOOSTER 2 N/A	CH4 36 O2 0.7 CO2 31.3 PRESSURE 18										
INLET VALVE SETTING % OPEN												
NO 1	F/O	NO 2	F/O	NO 3	N/A	NO 4	N/A	NO 5	N/A	NO 6	N/A	
MAIN CONTROL VALVE SETTING % OPEN												
INLET VACUUM GAUGE READINGS STARING SIDE NEAREST KNOCKOUT POT										(mbarg)		
NO 1	-28	NO 2	N/A	NO 3	N/A	NO 4	N/A	NO 5	N/A	NO 6	N/A	
INLET TEMP	32°C		INLET VACUUM PRIOR TO KO POT FILTER						-28			
VACUUM AFTER KO POT FILTER	N/A		VACUUM AFTER INLET FLAME ARRESTER						N/A			
OUTLET PRESSURE AFTER GAS BOOSTER	80MBAR		OUTLET GAS TEMP						46 °C			
PRESSURE AFTER SLAM SHUT	N/A		PRESSURE AFTER OUTLET FLAME ARRESTER						N/A			
OTHER			BLOWER SPEED						95%			
FLOW RATE	124M³/hr		MEASURING INSTRUMENT						128 OPFM			
FLAME TEMP	1030		MOTOR TEMP						OK			
FLAME QUALITY	OK		AMBIENT TEMP						20 °C			
MANOMETER LIQUID LEVEL WITH RIG SHUT DOWN					AMBIENT PRESSURE TOTAL FLOW 878,916 M³/hr							
TYPE OF LIQUID: PERFLOW												
RED SG - 0.8	N/A		EMISSIONS ANALYSER CO CELL				N/A		EMISSIONS ANALYSER NOX CELL		N/A	

SHEET		1832				United Kingdom Tel: +44 (0)24 7647 4877 Fax: +44 (0)24 7647 4834		
Page No 2								
CHECK FOR LEAKS WITH GAS DETECTOR				OK				
CONDENSATE DRAIN SYSTEM CHECK				Yes				
DRAINS CORRECTLY		Yes		KNOCKOUT POT FILTER CLEAN		N/A		
COMMENTS								
BOOSTER MODEL AND SERIAL NO - GX 34-3 BH 675/2								
MOTOR & FAN SEAL GREASED		Yes		BOOSTER CORRECT ROTATION		Yes		
NOTE: USE SHELL ALVANIA 3, GREASE EVERY SERVICE <u>IMPORTANT DO NOT OVERGREASE</u>								
BOOSTER OIL CHANGED (EVERY 5000 HOURS, USE 20W50 ENGINE OIL IN DONKIN V50						N/A		
BOOSTER FLEXIBLE CONNECTORS		OK		MOUNTINGS		OK		
BEARING NOISE		OK						
BOLTS TIGHT		OK		SLAMSHUT SPRING		OK		
FLAME ARRESTER INLET		OK		OUTLET		OK		
PILOT LIGHT FUNCTION		OK		UV SENSOR FUNCTION		OK		
EXTERIOR LIGHT		N/A						
INTERIOR LIGHT		N/A		ELECTRICAL CONNECTIONS CHECKED FOR TIGHTNESS				YES
ALL INDICATOR BULBS FUNCTION		YES						
HINGES & VALVES LUBRICATED		YES						
PRESSURE SWITCH FUNCTION								
SUCTION		OK		SETTING		1 MBAR		
VENT		N/A		SETTING		N/A		
BOOSTER		OK		SETTING		120 MBAR		
OTHER (specify)		N/A		SETTING		N/A		
BURNER		N/A		SETTING		N/A		
COMMENTS								

Page No 3

1832



Unit 8, Ensign Business Centre
Coventry CV4 8JA
United Kingdom
Tel: +44 (0)24 7647 4877
Fax: +44 (0)24 7647 4834

[illegible]

SERVICE SHEET Page No 4		Job No 1832			Automatic Flare Systems Ltd Unit 8, Ensign Business Centre Coventry CV4 8JA United Kingdom Tel: +44 (0)24 7647 4877 Fax: +44 (0)24 7647 4834	
REPORT ANY FURTHER REPAIRS OR ACTION NEEDED:						
Checked Txt messaging system on Hi Temp, texts received						
Checked auto re-start mains failure – on power up, not enough time for inverter to start up – goes off on blower failure. Need to add 45 seconds time delay for ABB to boot up						
Need UPS – to keep 24V live on mains failure.						
DEPARTURE REPORT:						
HOURS RUN:		RUN RIG FOR 30 MINUTES BEFORE TAKING READINGS				
CH4	51	CO2	33	O2	N/A	0.8
		H2S 19ppm				
INLET VALVE SETTING % OPEN						
NO 1	F/O	NO 2	F/O	NO 3	N/A	NO 4
				NO 5	N/A	NO 6
				N/A		
MAIN CONTROL VALVE SETTING % OPEN						
INLET VACUUM GAUGE READINGS STARTING SIDE NEAREST KNOCKOUT POT						
NO 1	-20	NO 2	N/A	NO 3	N/A	NO 4
				NO 5	N/A	NO 6
				(mbarg)		
				N/A		
INLET TEMP		35		INLET VACUUM PRIOR TO KO POT FILTER		-20
VACUUM AFTER KO POT FILTER		N/A		VACUUM AFTER INLET FLAME ARRESTER		N/A
OUTLET PRESSURE AFTER GAS BOOSTER		80		OUTLET GAS TEMP		41
80		N/A		PRESSURE AFTER OUTLET FLAME ARRESTER		79
OTHER		BLOWER SPEED % 95				
		MANOMETER READING: 0				
FLOW RATE		136		FLAME QUALITY		OK
FLAME TEMP		1025		HAS RIG & COMPOUND BEEN LEFT CLEAN		Yes
NAMES OF ALL AFS & SUB CONTRACTOR STAFF CARRYING OUT WORK						
REPORT WRITER						
STEVE WILLACY						
SIGNATURE						
						
DATE						
4.6.13						



SPECIFICATION FOR A 200M3/HR HT FLARE

Date: 25 May 2012

Our ref: 1832

HIGH TEMPERATURE (HT) LOW EMISSIONS GROUND FLARE UNIT FOR LANDFILL GAS RATED AT 200 CUBIC METRES PER HOUR

EQUIPMENT SUPPLY DETAILS

The scope of supply includes a skid-mounted package of equipment with a connected HT Range ground flare stack. This will assist with the installation of the unit and will provide a tidier solution to the construction of the equipment involved. By skid mounting the unit and carrying out final assembly on site it is possible to carry out pre-delivery tests in our factory. The HT Range offers good control over combustion air to facilitate elevated temperatures, whilst ensuring complete combustion. Such units will meet current EPA and European Standards for emissions. The equipment supply briefly comprises:

- Item 1 A condensate knockout pot, located prior to the entry of the gas booster with an attached 6" DN150 PN16 single entry from the gas field. It contains a polypropylene dewatering filter which ensures that no airborne liquids can pass into the gas booster. The condensate pot will be manufactured from stainless steel.
- Item 2 A 7.5kW ExN ATEX electric motor, with a direct-drive arrangement to the gas booster, capable of delivering 250 cubic metres per hour with a total head of approximately 150 mbar (60" WG). The booster will be fitted with a stainless steel impeller and will be ATEX rated inside and out.
- Item 3 A pressure switch on the gas booster outlet to detect no flow situations.
- Item 4 The booster motor will be fitted with a star delta starter.
- Item 5 A 3" DN80 PN16 manual trim valve for flow rate adjustment on feed to flare.
- Item 6 A 3" DN80 PN16 ATEX flame arrester with a stainless steel element on the gas booster outlet. The outlet flame arrester will be fitted with a flashback sensor.
- Item 7 A HT Range ground flare with automatic flame temperature control rated at 200 cubic metres per hour. This will burn with a combustion chamber temperature of 1000°C minimum when the methane concentration is above 28%. It will burn cooler than this temperature with a lower methane concentration, down to 22% methane. Minimum residence time will be 0.3 seconds. The turn down ration will be 5:1, ie the minimum flow rate will be approximately 40 cubic metres per hour.



It is important to note that this flare is in accord with current thinking in terms of the technology required to meet present emissions standards. The height from ground level to the top of the shroud will be 6m.

- Item 8 Flame temperature readout.
- Item 9 Automatic flame temperature control, including a PID controller, a combustion air louvre and an 80 second actuator.
- Item 10 An ATEX LFG pilot line complete with a pilot solenoid valve, a flame arrester and a gate valve.
- Item 11 Electric ignition, automatic upon start up. The flare sequence is controlled by a PLC and the ignition sequencing can be adjusted to suit local requirements. It should be noted that it is not simply a question of a spark. Items of equipment involved in the start sequence involve the igniters, a UV sensor to detect the flame and a secondary air damper. The location of the secondary air damper is mechanically set during start up and then reverts to PID control to maintain the correct flame temperatures.
- Item 12 Suction and pressure gauges.
- Item 13 A 3" DN80 PN16 Orifice plate flow meter with a manometer.
- Item 14 Stainless steel 2" dial vacuum gauges on the inlet line with isolation valves.
- Item 15 Temperature gauges on the inlet and outlet to the gas booster.
- Item 16 The design of the flare stack will:
 - satisfy structural wind loading codes of practice
 - the fixing of the flare stack to the concrete base will comply with relevant British Standards
 - the radiation levels at ground level will be within acceptable levels
- Item 17 Four lifting eyes.
- Item 18 Sample points and drainage cocks will be located in the normal places in the pipework.
- Item 19 Operator selection of continue running on flame out or shut down on flame out.



- Item 20 All pipework will be manufactured from 304 stainless steel.
- Item 21 Control panel weather proofed to IP66.
- Item 22 A 21/2" DN65 PN16 ATEX electric slam-shut valve controlling flow to the burner.
- Item 23 UV sensor for flame detection.
- Item 24 Flame temperature readout with an S type ceramic thermocouple.
- Item 25 Built on an integral skid assembly. The skid will be galvanised to BS729.
- Item 26 The chimney will be galvanised to BS729 with a stainless steel top section.
- Item 27 The chimney will be lined with 5" thick pyro-bloc modules and pinned to the inside of the chimney. This system is the best available on the market.
- Item 28 The supply includes a copy of the instruction manual and one year's parts warranty (excludes consumable items).
- Item 29 Delivery, installation and commissioning.

PRICE : [REDACTED]

- Item 30 The Allen Bradley PLC will be fitted with a telemetry unit for automatic dial out on alarm status via SMS text messaging.
E/O: [REDACTED]

- Item 31 A data logger for all monitoring parameters including ambient air pressure and temperature, CH₄, CO₂, O₂, CO, flow, line pressure and flame temperature.
E/O: [REDACTED]

- Item 32 A fully enclosed weather proof walk-in canopy over the control panel.
E/O: [REDACTED]

- Item 33 ABB Inverter drive for flow control and energy saving.
E/O: [REDACTED]

- Item 34 3 year all inclusive maintenance contract
E/O: [REDACTED]

TOTAL PRICE : [REDACTED]

DELIVERY : 8 WEEKS FROM RECEIPT OF ORDER
Standard terms and conditions of trading will apply.