Gwynedd Council

Cilgwyn Landfill

Closure Report

18 December 2014

AMEC Environment & Infrastructure UK Limited

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AMEC Environment & Infrastructure
UK Limited

Report for

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Document Revisions

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1	Draft for Client Comment	02/12/14
2	Final Issue to NRW	18/12/14

Purpose of this Report

Gwynedd Council has appointed AMEC Environment & Infrastructure (UK) Ltd (AMEC) to prepare and submit an updated Closure Report for Cilgwyn Landfill (Environmental Permit No EPR/KP3094FZ). This report is produced in accordance with the current Natural Resources Wales/Environment Agency (NRW/EA) regulatory guidance 'Understanding the Landfill Directive' (LFD 1 v2, March 2010) and 'Additional guidance for Landfill (EPR 5.02) How to comply with your environmental permit -Closing your landfill, March 2013'. The Closure Report has been produced so that the site can move towards definitive closure under the Landfill Directive (Council Directive 1999/31/EC) by the 31st March 2015.

Contents

1. Introduction

1.1 Report context and purpose

Gwynedd Council (the Council) commissioned AMEC Environment & Infrastructure UK Ltd (AMEC) to prepare and submit an updated Closure Report for Cilgwyn Landfill Site, near Carmel, Gwynedd.

Cilgwyn Landfill site was operated by Cwmni Gwastraff Mon-Arfon Cyf (CGMAC) under the conditions of Environmental Permit (EP) reference EAWML 37082 (EPR/ KP3094FZ) until it ceased accepting waste for disposal on 31 December 2008. The Environmental Permit was transferred to Gwynedd Council on 5 October 2008 following the dissolution of CGMAC.

1.2 Closures Notices

Separate PPC Permit applications were submitted to Environment Agency Wales (now Natural Resources Wales) for the separate parts of the site known as Faengoch and Gloddfa, however, both were refused. A Closure Notice (37082 CN1) was issued by the Environment Agency on 26 September 2006. In response to this notice, CGMAC submitted a Section B Closure Report (AMEC report reference 02277rr1673i2) to Environment Agency Wales (EAW) in December 2006, setting out the justification for the continued acceptance of waste until 31 December 2008. In response to a final Closure Notice (37082 CN2 issued on 6 February 2007), CGMAC submitted a Section A Closure Report (AMEC report reference 02277rr2002i2) to Environment Agency Wales in September 2008, detailing the proposed management and monitoring of the site during the aftercare phase (post closure).

Since the submission of the Section A Closure Report, Natural Resources Wales (NRW) has been in discussions with the Council regarding the work required to move the site to definitive closure. This has included

- The removal of the waste within Gloddfa into Faengoch;
- The requirement to cap the site;
- The installation of the gas extraction system; and
- The installation of a leachate treatment plant.

This work has now been completed as detailed in Section 4 of this report.

Following a meeting between the Council and NRW on 3 September 2014, NRW requested the Closure Report is updated to include the information on the completed work to accurately reflect actual site conditions and infrastructure; and the report to be submitted by the end of December 2014 to ensure compliance with articles 13 and 14 of the Landfill Directive.

1.3 Site Details

1.3.1 Location and Access

Cilgwyn Landfill is situated on the slopes of Mynydd y Cilgwyn, approximately 1km to the north west of the village of Nantle, near Penygroes, Gwynedd. The site is centred at National Grid Reference (NGR) SH 500 540 and is accessed via an unclassified road.

The site location is shown on Figure 1.

1.3.2 Site Topography and Setting

The landfill, located in a former slate quarry, was operated by Cwmni Gwastraff Mon Arfon Cyf and latterly (since 2008) by the Council's Waste Treatment Service and received non-hazardous waste over a period of approximately 30 years. It was originally divided into two areas:

Faengoch: The Faengoch area is comprised of two interconnected quarries, Faengoch and Hen Cilgwyn, which are referred to singularly as Faengoch. Faengoch is known to have between 60m and 80m depth of waste, making it one of the deepest landfills in the UK.

Gloddfa: The Gloddfa Glytiau quarry also lies within the current permit boundary but is separated from Faengoch by a vertical basaltic dyke.

Landfilling was initially carried out in Faengoch quarry until 1987 when it was temporarily suspended, as Gloddfa quarry became operational. Waste disposal ceased in Gloddfa quarry sometime during 1988, and landfill operations resumed in Faengoch quarry. The deposited wastes within Gloddfa were subsequently relocated into Faengoch with work being completed by May 2009 with a total of approximately 110,334tonnes of waste was extracted from Gloddfa from October 2008 through to April 2009 relocated within the area of Faengoch identified on Drawing 25262/SHR/173 presented at Appendix A.

There are no engineered landfill cells or sidewall (except part of the upper southern sidewall) and basal lining. The site is bound by the former quarry sidewalls. Capping and restoration of the landfill was completed in December 2012. To the west of the site lie the site offices, gas management compound and surface water balancing lagoon which was constructed in association with the capping.

The Site lies within the catchment of the principal watercourse in the area, Afon Llyfni, which drains east to west and is located approximately 1000 m to the south of the landfill. Leachate from within the Cilgwyn landfill is presently drained by an adit, which exits the landfill to the south, at the base of an existing slate waste slope and is pumped to a Leachate Treatment Plant (LTP) 400 m to the south east of the site which was commissioned in September 2013. After treatment the flow combines with clean surface water from the landfill and any excess flow from the adit before being discharged to a tributary of the Afon Llyfni. The Leachate Treatment Plant is operated in accordance with the requirements Environmental Permit EPR/PP3539NV.

The wider landscape comprises a rural landscape of small settlements linked together by a network of minor roads. Within the landscape there are a number of Public Rights of Way (PRoW) former slate workings and water bodies set within the rolling topography of the area.

The closest residential areas are Cilgwyn, approximately 0.4km to the northwest, Talysarn, approximately 1km to the southwest and Nantlle 0.8km to the east-southeast. The immediate

surroundings comprise a steep slope to the north followed by farmland and some small holdings, agricultural land to the east, slate scree and the leachate treatment plant to the south and to the west of the site lie the site offices, gas management compound and surface water balancing lagoon which was constructed in association with the capping. Land uses within 500 m of the whole site are detailed in Table 1.1.

Table 1.1 Land uses within 500 m of the Site

Direction	Land use
North	Rock face, Farm land and small holdings followed by Mynydd y Cilgwyn
East	Agricultural land, Bryntwrog Cottages (around 400m away), Disused slate quarries and scrub heath
South	Slate scree slope, scrub land with pockets of scree, deep water bodies and a PRoW
West	Scheduled Monument (Blaen y Cae Slate Quarry), water bodies, scrub and exposed slate scree followed by agricultural land

The site is within 5 km of three European sites. The nearest European site is Coleg Glynllifon SAC, with areas of the SAC approximately 2.5 km to the west and 3.6 km southeast of the site. The other European sites, Afon Gwyrfai a Llyn Cwellyn SAC and Corsydd Eifionydd SAC, are situated 4.2 km to the northeast and southwest of the site respectively.

1.4 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;
- • Section5: Monitoring;
- • Section 6: Reporting;
- • Section 7: Habitats.

2. Area of Closure

2.1 Area of the Site Progressing to Definitive Closure

The area Gwynedd Council wish to progress to definitive closure is shown in Figure 2 of this Closure Report. It includes both Faengoch and Gloddfa as both are within the existing waste management licence boundary but no waste remains within Gloddfa and therefore this document covers the Closure Report for Faengoch.

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

3. Waste Stability

3.1 Basal Subgrade and Side Slopes

The British Geological Survey map (BGS Sheet SH 55 SW, 1991 (1:10 000 series) shows that the Site is located almost entirely within the Cambrian Llanberis Formation, which consists of blue, grey and purple striped mudstones and siltstones interbedded with medium to coarse grained sandstones. The site is situated in an area of varied and complex geological character.

Faengoch comprises a large single cell dilute and disperse landfill with no engineered containment excepting a geosynthetic clay liner (GCL) on the upper part of the southern sidewall. The steep sidewalls form the original walls of the quarry.

A Stability Risk Assessment was prepared in support of the Section A Closure Report to demonstrate the revised landform and capping arrangements will remain stable during the aftercare period. The stability of the proposed capping system was assessed in detail prior to construction, see below.

3.2 Capping System

The limits of the permanent capping area were defined by the edges of the quarry sidewalls on the western, eastern, and northern southern. On the southern side the capping terminated against a bund of slate waste, below which is a buried GCL.

The capping system comprises a 100 mm minimum thickness regulating layer, a 1 mm Linear Low Density Polyethylene (LLDPE) double textured geomembrane, a geotextile protector and 300 mm depth of restoration slate material, with roadways of thicker slate to 600 mm depth to allow maintenance access to gas wells. The finished profiles of the site are shown on drawings within the CQA completion report.

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

- Technical Note - Capping Design Philosophy, AMEC Report ref 25262n331i1 dated 15 March 2012;
- Design Report, Specification and Construction Quality Assurance Plan for the Construction of the Permanent Restoration Capping and Associated Surface Water Management System; AMEC Report ref: 25262rr343i1 dated 12 June 2012.

A CQA validation report and subsequent Addendum Report were also completed for the work as follows:

- Construction Quality Assurance Completion Report for the Construction of the Permanent Restoration Capping and Associated Surface Water Management System, AMEC Report ref: 25262rr501i2 dated 17 October 2013; and
- Capping CQA Completion Report Addendum, AMEC Technical Note ref: 2562n595i2 dated 14 May 2013.

A capping CQA Report Addendum AMEC Reference 25262N595i2 dated May 2014 details some further works completed in January 2014 to provide some edge sealing of the capping system at Hen Cilgwyn.

The October 2014 site survey (Appendix A) identifies the capping slopes are typically 1:3.

3.3 Rock Face Stability

The rock face on the northern margin of Faengoch is prone to instability and a substantial rock fall occurred in 2013. As a consequence there is no working permitted adjacent to the rock face. Rock falls do not have the potential to significantly impact the capping system or gas collection system. Some of the older pin wells adjacent to the rock face have been abandoned because of rock fall safety concerns.

3.4 Stability Monitoring

The site (Faengoch) will continue to be monitored for evidence of instability when topographical surveys are carried out to assess the settlement of the waste mass. The site was last surveyed in October 2014 and indicates maximum settlements of up to 0.8m since the previous survey in March 2013. The October 2014 topographical survey of the site is included as Appendix A to this Closure Report. A site walkover in November 2014 identified no areas of instability within the waste mass.

4. Site Infrastructure

4.1 Leachate Infrastructure

Cilgwyn Landfill was developed as a dilute and disperse landfill facility and as a result no containment engineering works have been carried out, apart from a geosynthetic clay lining system to part of the sidewall on the south of the site. This lining system was installed to prevent the lateral migration of leachate through the slate waste forming the upper part of the sidewall direct it through the underlying waste and base of the site.

Leachate Treatment Plant

The leachate management system for Faengoch comprises non-engineered leachate drainage under gravity from the wastes into an adit which exits south of the landfill at the base of an existing slate waste slope which is the only known leachate discharge from the site. Within the adit there is a V notch weir which allows the base flow of 800 m3/day to be pumped directly to the Leachate Treatment Plant (LTP) located at the base of the slope. All leachate flow above 800 m3/day will over top the V notch weir and exit the adit over ground as a stream, where combined with treated leachate and clean surface water it then flows overland before disappearing into the ground and reappearing further down the valley as a diffuse spring line before ultimately discharging into the Afon Llyfni.

Leachate treatment of the base flow is through the biological removal of ammoniacal nitrogen through nitrification in a biological treatment process where naturally occurring bacteria (known as nitrifiers) convert ammoniacal nitrogen into nitrites then nitrates. The whole process is automated and designed to operate for 24 hours/day, 365 days/year and is operated in accordance with Environmental Permit EPR/PP3539NV issued on 12 September 2013. Details of the system are described in the application report and supporting documents (AMEC Report Reference 25262rr462i2 dated 22 March 2013).

The treated effluent from the LTP combines with any surface water from the landfill (surface water runoff is rainfall dependant) and is removed via underground pipe to a point west of the adit then overland to join the existing watercourse. The overland channel is formed using gabion baskets approximately 1 m wide by 0.3 m depth crossing land between the base of the slate waste slope and the stream. A cascade channel has been built down to the discharge point it is joined by the adit overflow leachate at the current discharge consent point at the base of the cascade channel.

In-Waste Monitoring Infrastructure

There are four wells (LMB02, LMB03 LMB04 and LB8) originally completed for the purpose of leachate monitoring within the waste as shown on Figure 3. Leachate levels and quality were monitored from these wells only between August 2009 and March 2011. These wells have now been connected to the gas extraction system and since June 2012 leachate dips and quality have been undertaken in these wells and a number of the gas wells. Monitoring is described further in Section 5.1 of this report.

A Construction Quality Assurance Plan for the installation of the LMB leachate wells was provided by CLP Envirogas and previously submitted to Natural Resources Wales (Report ref: DJ 9/09 June 2009 dated 27 July 2009).

Leachate Recirculation Infrastructure

Some leachate has been pumped on occasion from selected gas wells and recirculated to a soakaway within the wastes on the north west margin of the site (to the north of the lined surface water lagoon). Leachate is extracted by pneumatic pumps and is passes through a Siltbuster™ unit to remove suspended solids prior to recirculation.

Leachate recirculation proposals were detailed in AMEC Technical Note 25262N302i2 dated December 2011 and subsequently approved by NRW.

4.2 Leachate Infrastructure Maintenance

Leachate Treatment Plant

The maintenance of the leachate treatment plant (LTP) is undertaken by the Operator (Gwynedd Council) with support from FLI Water who designed and constructed the plant. The maintenance is undertaken in accordance with the plant operation and maintenance manual, a copy of which is held onsite.

The plant is designed to operate through automated control. Each component part of the plant is connected to control panels, each housing a programmable logic controller (PLC) and human machine interface (HMI) for monitoring and control of the plant. In the event of any part of the LTP failing, an alarm is triggered on the HMI panel identifying where the failure is and sending the information via the SCADA system and telemetry to instigate corrective action. Therefore, the identification of any failure on any part of the LTP is identified at an early stage and corrective action can be taken quickly thereby reducing the risk of a failure in the normal operation of the LTP having a negative environmental impact.

Although the LTP is designed to work on automated control, a fortnightly inspection of the site including the kiosk, adit, the Feed Pumping Station, the LTP, control panels and all associated pipework, surfacing and bunds is made as part of a routine visit to the site. Any signs of damage or failure of the LTP is reported to the Operator for corrective action to be taken. All work carried out as part of the maintenance programme is recorded and held by the Operator.

In-Waste Monitoring Infrastructure

Leachate monitoring well and leachate recirculation 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 infrastructure to ensure it does 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 monitoring points remain safe and clear to access and are clearly identified;
- All leachate 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 monitoring record sheets.

Where remedial work is minor Gwynedd Council will either complete the required work or employ suitably 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 a 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 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

Details on the development of the landfill gas infrastructure can be found in the following documents:

- Landfill Gas Extraction and Utilisation Technical Note (AMEC Report ref 02277n311i2 dated 1 April 2003);
- Faengoch Landfill Gas Risk Assessment (AMEC Report Ref 02277r436i2 dated 7 October 2003);
- Updated Landfill Gas Utilisation Plan (AMEC Report ref 02277N621i2 dated 21 November 2003);
- Landfill Gas Control System (AMEC Report ref 02277n805i1 dated 19 March 2004);

- Design Report and Specification for the Construction of the Landfill Gas Management System (AMEC Report ref 02277rr96612 dated November 2004);
- Landfill Gas Management Plan, Appendix B – Tender for Monitoring Boreholes (AMEC Report ref 02277rr995i1 dated 15 November 2004;
- Quality Assurance Plan for the Installation of the Gas Collection System at Faengoch (AMEC Report ref 022771190ai1 dated 13 May 2005);
- Gas Control System Construction Quality Assurance Completion Report (AMEC Report ref: 02277rr1253i1 dated 31 May 2005);
- Drilling and Completion of Monitoring Boreholes - Factual Report (AMEC Report ref: 1322i2 dated 18 July 2005)
- Technical Note - Sealing to Highwall to Landfill (AMEC Report ref 02277N1390i3 dated 8 December 2005);
- Quality Assurance Plan for the Installation of Landfill Gas Extraction Wells Faengoch (AMEC Report Ref 022771449i1 dated 28 November 2005);
- Faengoch Gas Management Plan (Rev 3) (AMEC Report ref: 02277rr1190i3 dated 16 January 2006);
- CQA Completion Report for Gas Extraction Wells and Passive Landfill Gas Vent Sealing Works (AMEC Report ref: 02277rr1567i1 dated 22 March 2006);
- Landfill Gas Audit Technical Note (AMEC Report ref: 25262N253i1 dated 9 June 2011);
- Technical Note - Landfill Gas Emission Action Plan (AMEC Report ref: 25262N553i1 dated 5 September 2013);
- Project Quality Assurance Drilling and Installation Report (D&J Drilling Consultants Report ref: DJ 31/13 November 2013); and
- Technical Note - Landfill Gas Management Update (AMEC Report ref: 25262N605i1 dated August 2014).

In-waste Gas Extraction System

In waste gas monitoring infrastructure is shown on Figure 3.

There are currently 43 existing gas wells (plus a further 3 wells recently completed in November 2014) retained for the purpose of extracting landfill gas from the capped area. In addition there are 4 leachate monitoring wells which are also used for gas abstraction. As part of the capping works undertaken on 2012, 23 gas relief pipes and valves were installed to provide a means of monitoring and relieving any landfill gas pressure that may have built up below the geomembrane during deployment of the capping system.

In addition there were a number of pin wells on the northern margin of the site but these are no longer in operation. There are a number of condensate knock-out pots within and outside the capped area as shown on Figure 3.

Details of the construction of the in waste gas monitoring infrastructure was previously provided in the Section A Closure Report which states ‘Well pipework is typically plain High

Density Polyethylene (HDPE) pipe to 5 m below ground level and slotted below with a gravel surround. Backfill to the upper 3 to 5 m is bentonite to seal the annulus.'

As part of the capping works the existing gas wells and leachate monitoring wells infrastructure were tied into the permanent capping using an HDPE oversleeve pipe with a factory fitted LLDPE 'skirt' which was then welded to the capping geomembrane in the field. The annulus between the existing well pipe and oversleeve pipe was closed with a flexiseal fitting. The gas relief pipes and valves were also factory fabricated with an LLDPE skirt and welded to the capping geomembrane in the field.

In August 2014 a Landfill Gas Management Update Technical Note (AMEC report Ref 25262n605i) was provided to NRW. The Technical Note and its recommendations were discussed at a meeting with NRW on 3 September. One of the agreed actions was to provide a drilling and monitoring plan for some combined gas and leachate wells to investigate Zone 2 waste (leachate zone waste as described in Landfill Gas Management Update Report (AMEC Report ref 25262N605i1 dated August 2014)).

Three deep combined gas and leachate wells (701, 702 and 703) have recently been installed as shown on Figure 3 (approximate location). These have been drilled to a depth of at least 8m below the first encountered leachate level. Proposed details are provided in AMEC Technical Note: Gas Well Drilling and Monitoring Plan (AMEC Report Ref 25262N607i1 dated October 2014). A CQA report describing the completion of these wells is currently in preparation.

Landfill Gas Engine and Flare

The gas extraction system is connected via a series of pipework to the landfill gas management compound to the west of the landfill. The compound contains the following equipment:

- Gas booster;
- Gas flare (1500 m3/hr rated);
- Jenbacher JGC 312 GS-LL gas engine generator set (625 kW output rated);
- Transformer;
- Substation; and
- Office cabin.

The permanent flare was commissioned during April 2005. The landfill gas engine was installed and commissioned in October 2006.

External Landfill Gas Boreholes

A total of 11 landfill gas/groundwater boreholes external to the wastes have been installed around the periphery of the site as shown on Figure 3. Boreholes A, B, C, D, E (1&2), F, G were installed between February and June 2005 and Boreholes 5a, 6a, 9 and 10 earlier. An audit of the gas infrastructure undertaken by CPL Envirogas in 2011 found borehole BH9 is full of water and consideration is to be given to decommissioning and replacement and borehole BH10 is redundant and replaced by BH E1 and E2.

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. Monitoring data is provided in Section 5 of this report.

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 this is considered to be sufficient given the relatively isolated location and distance to sensitive receptors, the nearest residential property is Bryn Glas approximately 100 m north of the quarry highwall and is equipped with a flammable gas alarms services which are calibrated on a six month frequency.

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 CLP Envirogas (CLP) as the current landfill gas management contractors.

Planned maintenance, and that which has been identified during inspections, will continue to be carried out by suitably experienced CLP personnel. An experienced CLP engineer is available on standby should the need arise for maintenance outside the site's normal operational hours. For such emergency call outs, CLP operate a rota by which an engineer is on call out of working hours. Unless there are extreme circumstances, the CLP engineer will not visit the site after dark to attend to gas fieldwork, due to health and safety considerations. Instead a visit will be scheduled for early the following day.

In the event of a major incident, e.g. a fire or explosion, the visiting CLP engineer will notify Gwynedd Council and the local emergency services. In the event of a non-significant event the CLP engineer will follow agreed remedial actions and report progress and findings to Gwynedd Council. All call outs will be documented and the record kept in the CLP office on site.

The following sections detail maintenance procedures specific to the individual components of the site landfill gas management infrastructure.

Gas Extraction Field Maintenance

The gas pipelines, wellheads, manifolds and condensate knockout systems shall be checked by CLP monitoring technicians weekly for the following:

- Wellhead damage;
- Settlement, which may affect wellhead connections and pipework falls;
- Condensate, which may block pipelines or restrict flow;
- Integrity of couplings and connections;
- Pipework damage and leaks; and
- Functioning of condensate pumping systems.

Any faults encountered will be repaired, and/or components will be replaced as necessary. Records of inspections and maintenance will be kept in the site office, either as paper records or stored electronically.

Landfill Gas Management Compound Maintenance

Maintenance of the flare will be carried out in accordance with the manufacturer's recommendations to ensure that the flare on site runs efficiently at all times.

The flare, when in operation, will be inspected weekly by the CLP engineer. 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 CLP engineer. If the CLP 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 CLP office on site.

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 otherwise 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, e.g. if the failure occurs outside of normal office hours. In such cases NRW will be notified as soon as is practicable.

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 plant, when in operation, will be assessed regularly by the monitoring and logging of the following parameters:

1. Field vacuum (mb);

2. Stability of vacuum readings;
3. Delivery pressure (mb);
4. Stability of gas pressure readings;
5. Gas quality CH_4, CO_2, O_2;
6. Differential pressure across fine filter (mb);
7. Differential pressure across flame arrestor (mb);
8. Flow rate through entire plant;
9. Temperature of combustion;
10. Booster hours run;
11. Booster starts; and
12. Valve positions.

Interim maintenance will be carried out following the identification of a problem from this data.

At the designated service interval, prior to commencement, the Gwynedd Council site Operations Manager will be informed.

Prior to servicing the flare, it will be checked that the gas engine will remain in operation such that in the event of an extended period of servicing, gas control can be maintained. During servicing, the flare is shut down for a period of half an hour to allow time for cooling. The power is isolated prior to any work taking place. Upon completion of the service, the flare will be restarted and Gwynedd Council notified.

All personnel undertaking maintenance on the flare and gas field will be suitably trained, qualified and competent to undertake the work. Table 4.1 details the maintenance schedule for the landfill gas flare.

Table 4.1 Flare Stack Maintenance Schedule

Flare Plant Maintenance Schedule	Quarterly 1	Annually
Ensure power is isolated for these checks and earth leads		
Check ignition electrodes for wear or misalignment	X	
Grease securing screws	X	
Check Transformer condition	X	
Clean UV sensor	X	
Remove and clean flame traps		X
Check cable condition and security	X	
Open and inspect terminal boxes	X	

Table 4.1 (continued) Flare Stack Maintenance Schedule

Flare Plant Maintenance Schedule	Quarterly 1	Annually
Test temperature sensor function	X	
Check Isolating valve condition/operation		X
Booster		
Check bearing operating temperature	X	
Check for noise/vibration	X	
Isolate power to booster		
Inspect shaft seal	X	
Grease bearings (use lithium based)	X	
Check belt tension (if fitted) and condition	X	
Ensure guards are secure	X	
De-watering		
Check de-watering lance is not drawing air	X	
Turn off Booster and shut gas valves		
Check de watering pot is clear	X	
Check tank and clean out if required	X	
Check float switch operation, remove and clean if required	X	
Check operation of trace heating and frost protection	X	
Check sample points are secure and clear	X	
Turn off Booster and shut gas valves		

1 When in operation

The out of hours breakdowns and emergency shut downs on the gas flare will be covered by an automated dial out unit, which calls out the CLP duty engineer.

In the event that the flare cannot be repaired within 12 hours, unless otherwise agreed in writing with NRW, a temporary replacement flare will be installed until such time the permanent flare is repaired and back in operation. NRW will be notified immediately in the event of failure of the flare. There may be some circumstances where it is not possible to inform NRW immediately, e.g. if the failure occurs outside of normal office hours. In such cases NRW will be notified as soon as is practicable.

Landfill Gas Engine

A regular maintenance scheme has been designed for the engine, based on manufacturer's guidelines and site specific factors, such as gas quality and the age of the engine. The maintenance schedule will include preventative maintenance, which is designed to avoid unscheduled down-time and maintain an efficient level of operation between overhaul services. Regular maintenance will ensure that the engine runs at maximum energy efficiency and maintains engine exhaust emissions at below emission benchmarks. The engine will be run using best practice methods to ensure that emissions from the crankcase are minimised.

The power plant will be inspected visually by the CLP engineer on a weekly basis. The CLP engineer will rectify any faults immediately or, where necessary, contact a specialist contractor. All operation and maintenance manuals will be located at the CLP site office.

Any faults will be recorded in the site diary. The diary is available for inspection on request.

In the event of a failure of the engine or of damage to any of its components which disables the generator set - e.g. electrical connection fault, NRW will be informed immediately, where practicable or unless otherwise agreed with them. There may be some circumstances where it is not possible to inform the NRW immediately, e.g. if the failure occurs outside of normal office hours. In such cases the NRW will be notified as soon as is practicable.

Maintenance will be undertaken by the CLP engineer according to the manufacturer's recommendations as detailed in Table 4.2.

Table 4.2 Gas Engine Generator Set Maintenance Schedule

Frequency	Operations
Weekly	Check ignition voltages re-gap spark plugs with reading>25kV Sample oil & send for condition monitoring
As necessary	Change oil depending on analysis results Change container air filters, as determined by pressure measurement Change gas filters, as determined by pressure measurement Overhaul charge air cooler, as determined by pressure measurement
1000 hours	Carry out maintenance as specified in the Jenbacher manual(1)
4000 hours	Grease alternator bearings Grease gas pump bearings Carry out borescopic inspection Check emissions & adjust mixture as necessary
15 000 hours	Carry out top end overhaul and turbocharger change, includes fitting service exchange cylinder heads & de-coking combustion space
20 000 hours	Change crank shaft vibration dampers
30 000 hours	Carry out bottom end and overhaul, includes replacement of pistons, liners and big end shells
60 000 hours	Replace crankshaft main bearings

Notes:
(1) Maintenance manual to be located in the CLP site office.

The hours of overhauls may change dependant on the condition of the engine. This will be determined by borescopic inspection.

The out of hours breakdowns and emergency shut downs on the gas engine will be covered by an automated dial out unit, which will call out the CLP duty engineer.

4.5 Groundwater Infrastructure

There is no groundwater management at the site.

The positions of all groundwater/gas monitoring boreholes at the site are shown on Figure 3.

Boreholes B, C and E2 are considered to represent groundwater quality upgradient of the landfill, whilst boreholes 5A 6A G are located on the southern margins of the quarry and are therefore suitably located to monitor any leachate migration from the landfill (downgradient borehole F is dry).

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 2015.

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 restoration cap has been profiled so that surface water is shed to the perimeter where two surface water drains were constructed on the northern-western flanks, and on the northern-eastern-southern flanks of the capped area. The discharge point for the surface water drains is to a lined collection lagoon located within the south west corner of the landfill capping area. From there it is pumped to a balancing pond located approximately 90 m east of the collection lagoon and landfill capping. The balancing pond discharges off-site via a surface water gravity drain, to the south and east of the site towards the outfall and into the stream below the adit discharge point.

Details of the surface water management system are provided in 'Construction Quality Assurance Completion Report for the Construction of the Permanent Restoration Capping and Associated Surface Water Management System' (AMEC Report Ref 25262rr501i2 dated 17 October 2013). The dedicated sampling point for surface water is the stream below the adit outfall as defined in the permit for the LTP.

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 drains and the collection lagoon and balancing pond to ensure they do not fall into disrepair and to identify if any maintenance, such as de-silting is required.

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

- All surface water drains and the collection lagoon and balancing pond 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 drain 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) 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:

- Design Report, Specification and Construction Quality Assurance Plan for the Construction of the Permanent Restoration Capping and Associated Surface Water Management System Construction Quality Assurance Completion Report for the Construction of the Permanent Restoration Capping and Associated Surface Water Management System, AMEC Report Ref 25262rr343i1dated 12 June 2012;
- Construction Quality Assurance Plan for the Construction of the Permanent Restoration Capping and associated Surface Water Management System, AMEC Report Ref 25262rr344i1 dated 11 June 2012; and
- Construction Quality Assurance Completion Report for the Construction of the Permanent Restoration Capping and Associated Surface Water Management System, AMEC Report Ref 25262rr501i2 dated 17 October 2013.

The site was last surveyed in October 2014 some 22 months following cap completion. Future topographical surveys will be carried out at least once every two years.

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:

- There are no noticeable depressions or ponded water present;
- There is no noticeable sliding, slope failure or large cracks in the slate cover; and
- The geomembrane is not exposed or torn.

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

Where remedial work is minor 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 Aftercare Phase

The current leachate, landfill gas, groundwater and surface water monitoring infrastructure at the Cilgwyn 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 Directive[1] 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; (one point downstream of the landfill which is carried out under the LTP permit, there is no up-gradient water course); 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.

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.

Leachate levels have been monitored within various wells within the landfill since 2009. Originally four wells with a LMB suffix were monitored in the period August 2009 to March 2011. Since June 2012 leachate dips have been undertaken in several gas and leachate wells (GW101, GW103, GW203, GW208, GW210, GW211, LMB02, LMB03, LMB04 and LB08). Leachate head measurements are currently taken weekly.

Leachate quality has been sampled as follows:

- On a monthly basis during 2010 to 2012 at LB8.
- During 2013/4 samples were taken from Siltbuster™ on the leachate recirculation system on 10 occasions;
- GW05 was sampled on 2 occasions in 2014; and

[1] Council Directive 1999/3/EC of 26 April 1999 on the landfill of waste

- Samples were taken from 6 wells (LMB02, LMB03, LB08, GW203, GW210, GW211) in June 2014.

Leachate samples are analysed for key determinands as identified in Table 5.1 which sets out the current leachate monitoring requirements set out in the Environmental Permit.

Table 5.1 Leachate Monitoring Regime as per Environmental Permit

Monitoring Location	Frequency	Parameters
Landfill gas vents within Faengoch	Weekly	Level, pH, Temperature, EC, DO, NH4-N, Cl
	Quarterly	As monthly plus Sulphates, Total alkalinity (as $CaCO_3$ at pH 4.5), TON, TOC, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn

5.1.2 Control and Compliance Limits

No control and compliance levels have been set.

5.1.3 Leachate Monitoring during the Aftercare Phase

Leachate level monitoring data collected between 2009 and 2014, reviewed by AMEC (Report ref. S25262N605i1 dated August 2014) on behalf of Gwynedd Council, shows:

- Some variance in leachate level data collected across the site but leachate is typically encountered at 20m to 30m below capping level;
- There is some variance of levels within individual of up to approximately 2m but no overall trend, with the exception of LMB2 which indicated a rising trend during 2010.
- The data shows that leachate levels are more or less static and that levels pre and post capping are similar.

In terms of leachate quality, data collected in 2014 indicates a relatively high strength leachate. It is noted that samples would have been taken from the top of the leachate column as most wells do not penetrate far below the leachate level. Prior to the recent sampling, leachate analysis had been intermittent and mainly confined to well LB8. Analysis data for well LB8 for both pre capping and post capping suggests that the leachate strength has increased significantly post capping (for example Ammoniacal Nitrogen concentrations pre capping were in the region of 100-300mg/l whereas post capping they were 1000 mg/l). This is, perhaps, not surprising as in the uncapped state the waste in the unsaturated zone was subject to significant flushing through surface infiltration (annual rainfall at Cilgwyn is around 2000mm/year).

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 stable. Given that groundwater quality monitoring data (see Section 5.3.2 below) demonstrates no unacceptable impact from the site, it is proposed to reduce leachate level monitoring from weekly to quarterly and reduce the quality monitoring frequency from weekly/quarterly to six monthly/annual during the aftercare phase (Table 5.2).

Table 5.2 Leachate Monitoring Regime during the Aftercare Phase

Monitoring Location	Frequency	Parameters
LB08, GW05 GW701,GW702, GW703	Quarterly	Level
	Six Monthly	pH, Temperature, EC, DO, NH4-N, Cl Total alkalinity (as $CaCO_3$ at pH 4.5), TON, TOC, Na, K, Ca, Mg, and Cd
	Annually	As six monthly 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.

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 CLP Envirogas. Perimeter boreholes are monitored by Gwynedd Council.

Monitoring in perimeter and in-waste boreholes is currently carried out weekly 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 requirements as per Environmental Permit

Monitoring Location	Frequency	Measurement/Determinand
Peripheral gas monitoring boreholes CILGBH06, CILG000F, CILG000G, CILGBH05, CILG000H, CILG000I, CILGBH04, CILG000J, CILG00E1, CILG00E2, CILGBH12, CILG000K, CILG000A, CILG000B, CILGBHB1, CILG000C, CILG000D	Weekly	Methane, carbon dioxide, oxygen, atmospheric pressure, differential pressure.
In-waste monitoring boreholes	Fortnightly	Methane, carbon dioxide, oxygen, nitrogen, flow rate or suction, openness of valve aperture.
Representative sample taken from the extraction line prior to disposal system.	Annual	Trace Gas Analysis in accordance with Environment Agency Document LFTGN04.

Control Levels and Compliance Limits

The compliance limits across all external monitoring boreholes are set at >1%v/v for methane, >1.5%v/v for carbon dioxide and <18% for oxygen as specified in the Environmental Permit.

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. 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 slate;
- • 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 5.4.

Flare/ Gas Engine Emission Monitoring

The flare is not used and will only be tested in the vent that it is brought into operation. Emissions monitoring of the landfill gas engine 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, collected by Gwynedd Council, shows:

- Methane and carbon dioxide concentrations in the perimeter boreholes during this reporting period were consistent and no gas has been recorded above the compliance limit set in the Environmental Permit.
- 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 30% v/v to 40%v/v in the majority of wells. Only one well (GW008) consistently recorded methane at 60%v/v on the 4 reporting occasions during 2014. Carbon dioxide concentrations ranged around 20% V/v to 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 and connected to the gas engine located in the compound to the west of the landfill.

The Landfill Gas Management Plan Update (AMEC Report ref 25262N605i1 dated August 2014) also includes a number of actions to ensure fugitive emissions of landfill gas previously detected on the northern flank of the site are brought under control by implementing the following actions:

- Installation of 3 No gas wells to investigate Zone 2 waste (recently completed).
- Fit pumps for leachate pumping tests (ongoing).
- Record gas quality and flows throughout.
- Increase frequency of sealing of perimeter fugitive emissions to twice a year rather than annually.

- Review field balancing to prevent over-extraction from some wells and reduction in 'free nitrogen'.

Given that perimeter borehole landfill gas monitoring data shows no evidence of any significant gas migration 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 to quarterly (Table 5.4).

Table 5.4 Landfill Gas Monitoring Regime during the Aftercare Phase

Monitoring Location	Frequency	Parameter
Landfill surface at perimeter of site	Six monthly	Methane Atmospheric pressure General surface type and condition Meteorological data
Landfill Gas Flare	Annually[1]	Oxides of nitrogen Carbon monoxide Total VOCs Operational Temperature Gas flow rate
Peripheral gas monitoring boreholes	Quarterly	Methane Carbon dioxide Oxygen Atmospheric pressure Differential pressure Meteorological data
In-waste monitoring boreholes	Monthly	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

Notes:
[1] Flare is not currently in use and will only be monitored in the event it is brought into operation

The landfill gas monitoring schedule set out in Table 5.4 meets 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 gas extraction system, the flare and external landfill gas monitoring boreholes. 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 for the gas extraction system 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 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

The particular characteristics of this site means that there will always be potential for fugitive emissions around the high wall. The site has no sidewall lining system and the waste mass is settling against a very irregular rock face which is inherently unstable. The geomembrane capping system has been extended to the rock face but due to the irregularity it is impossible to form a gas tight seal. Obvious cracks and fissures around the highwall were sealed in early 2014 and proposals have been made to increase the frequency of sealing of these features to twice a year. Full details of proposed actions for dealing with surface emissions were covered in the Landfill Gas Management Plan Update (AMEC Report Ref 25262N605i1 dated August 2014).

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 monthly basis. Groundwater samples are analysed on monthly basis key determinands, with a quarterly extended analytical suite. The groundwater sampling regime is outlined in Table 5.5.

Monitoring boreholes B, C E are upgradient of the landfill, and boreholes F, G, 5A and 6A lie downgradient of the landfill (Note: F is dry and 6A has been dry since 2010). Monitoring locations are shown on Figure 3.

Table 5.5 Groundwater Monitoring Regime as per Environmental Permit

Monitoring Location	Frequency	Measurement/ Determinand
BH4, BH5A, BH6A, BHA, BHB, BHC, BHD, BHE1, BHE2, BHF, BHG, BHH, BHI, BHJ, BHK.	Monthly*	Level.
	Monthly	pH, Temperature, EC, DO, NH_4-N, Cl,
	Quarterly	As quarterly plus: SO_4, $CaCO_3$, TON, TOC, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn

Notes: * Monitoring frequency was reduced from weekly to monthly to quarterly in 2010 On the basis that monthly water level for these boreholes showed no significant variability.

Control and Compliance Limits

Groundwater control and compliance limits were proposed within the Hydrogeological Risk Assessment (HRA) for Site Closure (AMEC Report ref: 0277n1687i2) submitted with the Section B Closure Report in December 2006. Limits were set for Ammoniacal N and Chloride boreholes 4, 5A, 6A, G, H and I. These were reviewed in the Section A Closure Report (AMEC Report ref 02277rr2002i2 dated 25 September 2008) taking account of further data collated since the previous report and concluded the proposed control and compliance levels remained valid and no changes were proposed.

Review of monitoring data for the period January 2010 to May 2014 for Boreholes G and 5A indicates no contamination of groundwater by landfill leachate. Ammoniacal nitrogen concentrations are <0.1mg/l with the exception of a few spikes to <0.7mg/l in BHG1. Chloride concentrations are <20mg/l and similar to up-gradient concentrations. Therefore no changes are proposed to the control and compliance levels from the previous reports and these are presented in Table 5.6.

Table 5.6 Proposed Groundwater Control and Compliance Levels

Monitoring Location	Determinant	Control Level (mg/l)	Compliance Level (mg/l)
BH5A	Ammoniacal Nitrogen	0.4	0.5
	Chloride	70	100
BHG	Ammoniacal Nitrogen	0.5	1.0
	Chloride	70	100

5.3.2 Groundwater Monitoring Regime during the Aftercare Phase

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

- Groundwater levels in perimeter boreholes indicate significant seasonal fluctuation but otherwise remain constant. There is a steep groundwater gradient across the site which reflects the topography. Groundwater levels in upgradient borehole are close to those of the top of the waste.
- There is no evidence of any leachate contamination in down-gradient groundwater monitoring boreholes.
- Leachate contaminated groundwater discharging from the Cilgwyn adit has shown a considerable post-capping decline in ammoniacal nitrogen concentrations.

Therefore it is proposed to reduce the frequency of ground water level monitoring and quality for the aftercare phase. Groundwater level monitoring will reduce from monthly to quarterly and groundwater quality monitoring from monthly/quarterly to quarterly/six monthly as shown in Table 5.7.

Table 5.7 Groundwater Monitoring Regime during the Aftercare Phase

Monitoring Location	Frequency	Measurement/ Determinand
BH5A, BH6A, BHA, BHB, BHC, BHD, BHE1, BHE2, BHF, BHG	Quarterly	Level.
	Quarterly	pH, Temperature, EC, DO, NH_4-N, Cl
	Six Monthly	As quarterly plus: SO_4, $CaCO_3$, TON, TOC, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn

5.3.3 Contingency Arrangements

Control levels and compliance limits for downgradient groundwater monitoring boreholes BH5A and BHG are set in Table 5.6.

The control levels are set to identify trends and prompt contingency actions prior to compliance limits being exceeded. Data from period January 2010 to May 2014 indicates no contamination of groundwater by landfill leachate and sampling results are consistently below the compliance limits set out in Table 5.6.

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 exceedences 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 carried out at one point downstream of the landfill under the requirements of the Environmental Permit for the Leachate Treatment Plant (PP3539NV), there is no up-gradient water course.

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 Cilgwyn 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

No control and compliance levels have been set for leachate.

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 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 (Entec reference 02277N462i1) was submitted with the PPC Permit Application.

The site is within 5 km of three European sites. A European Site is any site that has been designated as a site of international nature conservation importance either as a Special Protection Area (SPA), a Special Area of Conservation (SAC) or a Ramsar Site. The nearest European site is Coleg Glynllifon SAC, with areas of the SAC approximately 2.5 km to the west and 3.6 km southeast of the site. The other European sites, Afon Gwyrfai a Llyn Cwellyn SAC and Corsydd Eifionydd SAC, are situated 4.2 km to the northeast and southwest of the site respectively.

The site is not hydraulically connected to any of the European sites.

The risk assessment concluded that the landfill would have no adverse effects on the integrity of the European sites. Closure of the site and the aftercare phase will not have any adverse effect on the integrity of the European sites.

Figures

Gwynedd Council
Cilgwyn Landfill Site
Closure Report

Figure 1
Site Location Plan

December 2014
25262-Shr-170.dwg banna


N
Sheepfold
1829
Shafts (disused)
Pond
Drain
3537
Spreads
Shaft (disused)
2025
0017
Track
9213
0217
0015
Plas-cilgwyn
Track
9712
9209
6805
Bryn-glas
7500
Track
Path (um)
8703
Samaria
8200
8900
7500
Path (um)
Spring
7191
Leachate Recirculation Point
Former civic amenity
LTP Kiosk
Tip (disused)
Gas Management Compound
Slate slope
Slate slope
Shaft (disused)
Pen-y-bryn Slate Quarries (disused)
2678
Levels (disused)
Level (disused)
Issues
7768
Pond
Blaen-y-Cae Slate Quarry (disused)
Pond
Quarry (disused)
Path (um)

Key

Area to definitively closed

0 m — 150 m

Scale 1:2500 @ A3

Gwynedd Council
Cilgwyn Landfill Site
Closure Plan

Figure 2
Area Subject to Definitive Closure

December 2014
25262-Shr-171.dwg banna

amec

Key

- Perimeter gas monitoring borehole
- Combined gas & groundwater monitoring borehole
- Leachate monitoring well
- Gas well
- Gas relief valve
- Knock out pot
- Existing valve to horizontal pipework
- Existing landfill gas carrier main (dashed where position is approximate)
- Existing landfill gas pipe (connection between gas well & carrier main)
- Sub cap horizontal collection pipework
- Capped area of Hen Cilgwyn
- Area fenced off due to rock fall
- Approximate new gas well location (701, 702, 703, 704)
- Well containing leachate pump

0 m 50 m

Scale 1:1250 @ A3

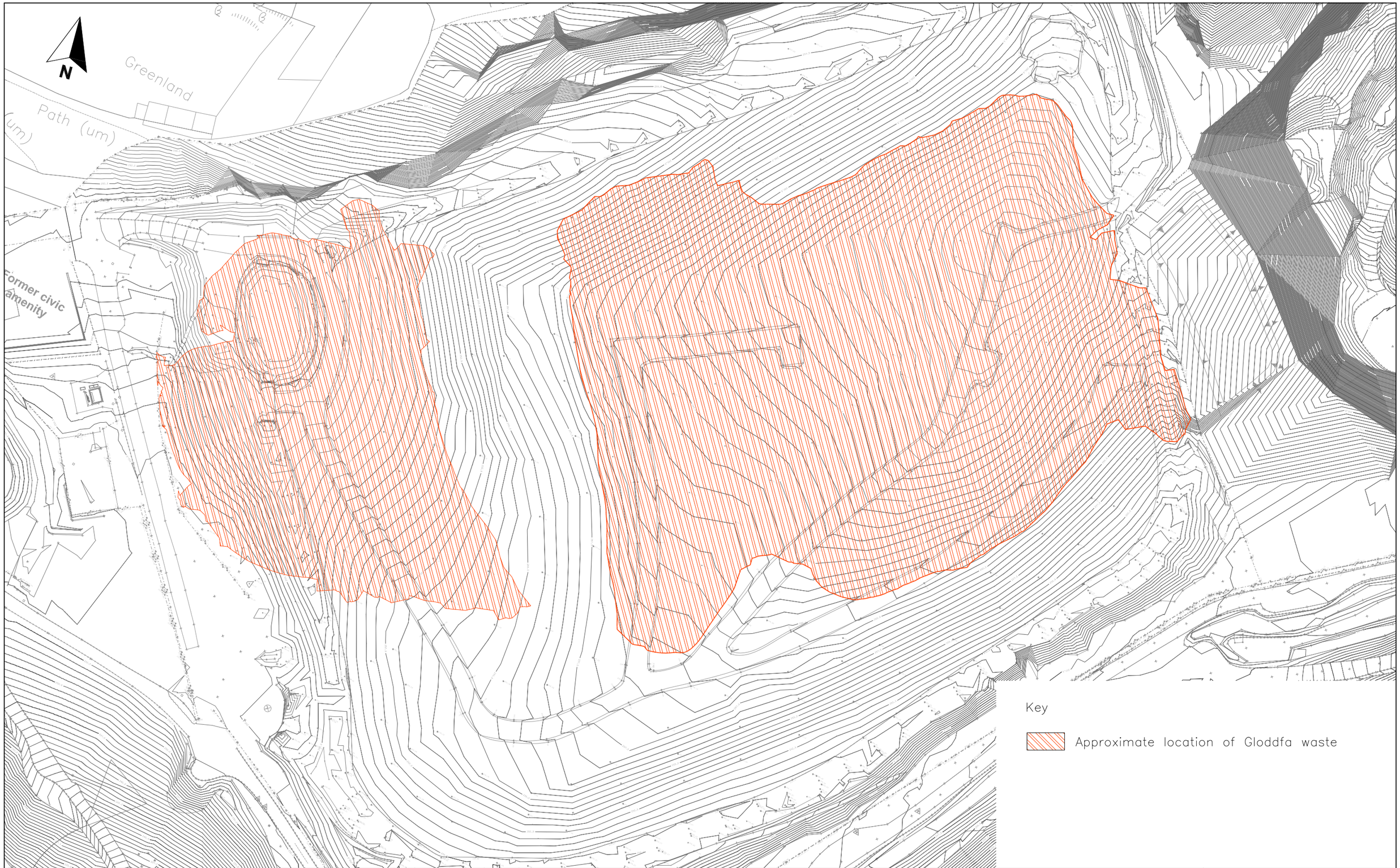
Gwynedd Council
Cilgwyn Landfill Site
Closure Plan

Figure 3
Location of Monitoring Infrastructure

December 2014
25262-Shr-172.dwg banna

amec

Appendix A
Drawings



REV	DATE		DWN	CHK	APP
A	17/12/14	FIRST ISSUE	AB	CP	JB
REVISIONS					
REV	DATE		DWN	CHK	APP

PROJECT TITLE: Cilgwyn Landfill Site Closure Plan

DRAWING TITLE: Drawing 1 Location of Gloddfa Waste

SCALES : 1:2000 @ A3 Original Drawing Size – A3

CLIENT:
Gwynedd Council
Waste Treatment Service
Siambrau Banc Barclays
5–7 Stryd Bangor
Caernarfon
Gwynedd LL55 1AT

REF:

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CANON COURT, ABBEY LAWN, ABBEY FOREGATE, SHREWSBURY SY2 5DE.
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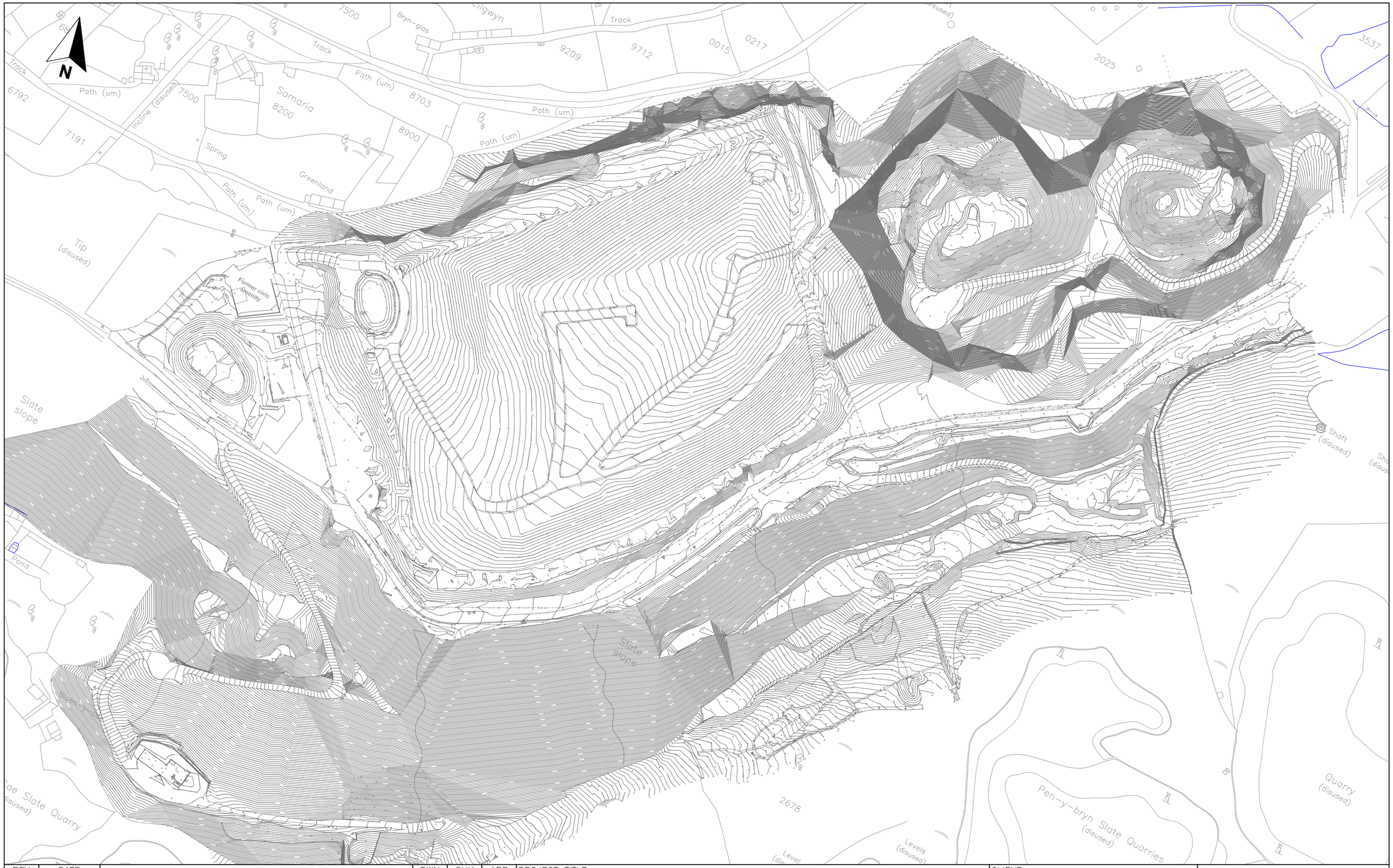
DRAWING No. 25262/SHR/173



REV	DATE		DWN	CHK	APP
A	17/12/14	FIRST ISSUE	AB	CP	JB

REVISIONS

REV	DATE		DWN	CHK	APP

PROJECT TITLE: Cilgwyn Landfill Site
Closure Plan

DRAWING TITLE: Drawing 2
Current Site Topography

SCALES : 1:2000 @ A3 Original Drawing Size – A3

CLIENT:
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25262/SHR/174