Caulmert Limited

Engineering, Environmental & Planning
Consultancy Services

Brookhill Landfill Site

Flintshire County Council

Leachate and Landfill Gas Management Review and Audit

Prepared by:

Caulmert Limited
InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Fax: 01248 672601
Email: asastrickland@caulmert.com
Web: www.caulmert.com

Document Reference: 1850.4.FCC.ÅKS.JDM.A0

February 2014

Caulmert
Engineering, Environmental and Planning

APPROVAL RECORD

Site:	**Brookhill Landfill Site**
Client:	**Flintshire CC Waste Management Services**
Document Title:	**Leachate and Landfill Gas Management Review and Audit**
Document Ref:	**1850.4.FCC.ÅKS.JDM**
Report Status:	**A0**
Project Director:	**Åsa Strickland**
Project Managers:	**Åsa Strickland, Jim McClymont**
Caulmert Limited:	**InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG**
Tel:	**01248 672666**

Authors	Åsa Strickland	**Date**	19.02.2014
Reviewer	Jim McClymont	**Date**	21.02.2014
Approved	Mike Caulfield	**Date**	21.02.2014

DISCLAIMER

LEACHATE AND LANDFILL GAS MANAGEMENT REVIEW AND AUDIT

BROOKHILL LANDFILL SITE

TABLE OF CONTENTS

DRAWINGS

1140.EMP.01 Environmental Monitoring Plan

APPENDICES

Appendix 1 Leachate Dip Data from Tankering Period (06.01.2014 – 02.02.2014)
Appendix 2 Photographic Log: Leachate treatment plant
Appendix 3 Photo Log: Landfill Gas Extraction System Audit
Appendix 4 Landfill Gas Extraction System Audit Results

1.0 INTRODUCTION

1.1 Background

1.1.1 Flintshire County Council (FCC) Waste Management Services has appointed Caulmert Ltd to undertake a review of the landfill gas, leachate extraction and leachate treatment infrastructure at Brookhill Landfill Site (Brookhill). The review is required in order to assist the Council in the evaluation of current management practices and to identify improvements and potential cost savings.

The following specific tasks have been undertaken for the review:

- Collation of information relating to the landfill gas and leachate management practices from site personnel;
- Evaluation and review of the maintenance and monitoring regime for both landfill gas and leachate infrastructure;
- A site visit for the visual inspection of leachate treatment plant;
- A site walkover and visual inspection of the landfill gas and leachate extraction systems, including:
  - Inspection of all wellheads;
  - Monitoring of in-well gas using a GA2000 gas analyser;
  - Monitoring of leachate levels and base levels within leachate wells and leachate monitoring points using a dip tape;
  - Inspection of pipework and connections;
  - Observation of ground settlement, where applicable; and
  - A review of the areas highlighted in the Natural Resources Wales Audit on the 23rd of October 2013.

1.1.2 The report has been divided into two sections, a review of the leachate management followed by a review of the landfill gas management. The concluding sections discuss both, and recommendations for improved management have been provided.

1.2 Site History and Location

1.2.1 Brookhill Landfill Site is located approximately 1.5km north of Buckley, Flintshire, North Wales at NGR SJ278656. The site is accessed via the Pinfold Industrial Estate, Pinfold Lane, which is located off the A494 Mold to Ewloe Road.

1.2.2 The site is bound to the east by a wooded, disused railway leading to open grassland. Agricultural land lies to the west of the site. The Pinfold Industrial Estate and a number of residential properties (on the outskirts of Buckley, approximately 400 m away) are situated to the south of the site. A restored refuse tip (Ewloe Barn Landfill) lies to the north of the site. It is currently used for rough grassland leading to open grazing land and some woodland.

1.2.3 Brookhill Landfill Site has been developed in a former quarry, which was worked for Buckley Fireclay and the siltstones and mudstones beneath the Fireclay (known as the Warrant) for use in the manufacturing of bricks and tiles.

1.2.4 In 1997, in preparation for the engineering of the landfill site, further Fireclay was removed together with a quantity of coal in the quarry base under agreement with the Coal Authority. Brookhill landfill site started accepting waste in 1999. The wastes permitted at the site were stipulated within the site permit. The general waste streams which were permitted at the site through its history can be summarised as:

- Domestic food and organic wastes – approximately 60%
- Non-hazardous industrial wastes, (including plastic, paper, cardboard, wood, stone and sand, etc.) – approximately 40%
- Most special wastes (allowed until June 2004).

1.2.5 The special wastes which were tipped at the site were accepted pre-June 2004 (under the WML for the site). This indicates that they would have been deposited predominantly within Cell 1, and the lower parts of Cells 2, 3 and 4. It is likely that none of the waste tipped in Cells 5 and 6 contains any 'special waste' waste streams.

1.2.6 The site ceased accepting waste in late 2007.

1.3 Site Engineering

1.3.1 The site comprises six separate cells. The engineering details and the formation levels of the cells are indicated in Table 1 below.

Table 1: Engineering details of the cells at Brookhill Landfill Site

Cell	Year of construction	Base level mAOD	Base area m^2	Engineering - Base	Engineering – Sides	Leachate Drainage system
1	1999-2001	117	3324	0.6m EML, 2.0mm HDPE	1.0m EML, 2.00mm HDPE up to 7m	300mm thick granular leachate drainage blanket
2	1999-2001	113	3234	1.0m EML	1.0m EML	As in Cell 1
3	2001-2003	112	2160	1.0m EML	1.25m EML	As in Cell 1
4	2002-2004	112	2808	1.0m EML	1.25m EML	As in Cell 1 and a HDPE leachate collection system
5	2002-2004	113	2408	1.0m EML	1.25m EML	As in Cell 4
6	2003-2005	120	2672	2.0m EML	2.0m EML	As in Cell 4

EML - Engineered Mineral Liner

1.3.2 An under-liner drainage system was installed to remove groundwater from below the cell basal and side wall lining and prevent the build-up of hydrostatic head (as detailed in the CQA plans for the site prepared by Symonds in 2001) and allowed construction of the cells below the water table.

1.3.3 The final capping and restoration phases were undertaken during 2010. The capping details of the site are a flexible membrane cap, installed onto a protective geotextile layer and restored with cover soils (specific capping specifications are detailed in capping CQA plans for the site).

2.0 LEACHATE MANAGEMENT REVIEW

2.1 System Overview

2.1.1 Leachate extraction has been undertaken at Brookhill since the early years of its active life. Leachate wells are drilled into the waste mass, and pumps installed in the leachate wells pump the leachate via surface laid pipework to the leachate treatment plant.

2.1.2 In 2001, a leachate treatment plant was constructed on site. The leachate treatment plant is a Sequential Batch Reactor (SBR), which treats the leachate by biological treatment. The leachate treated in the SBR is discharged to sewer for further treatment in a wastewater treatment plant under a discharge consent to Welsh Water. The maximum daily discharge volume is 150 m^3/day.

2.1.3 The leachate treatment plant also treats leachate from nearby Standard Landfill which is delivered to site by tractor and bowser. More recently, the plant has accepted some leachate from Hafod Landfill, near Wrexham, for a trial period.

2.2 Leachate Extraction System and Infrastructure

2.2.1 Leachate extraction wells have been installed into the waste mass, and remote leachate monitoring points are installed in each of the six landfill cells. During the construction of the site, each cell had one leachate extraction point (leachate chamber, LC) and one remote leachate monitoring point (Remote, R). Over the years, some additional chambers and remote monitoring points have been retro drilled, and some of the remote points have also been fitted with pumps to increase the leachate extraction capacity from the site. Table 2 shows the leachate extraction and monitoring pumps on site at present, and also which type of pump is installed. Cells 1, 2, 4 and 6 have remote monitoring points, which remain as dipping points only. The leachate extraction and monitoring points can be seen on the enclosed drawing, 1140.EMP.01.

Table 2: Leachate Extraction and Monitoring Points

Cell	Chamber	Pump
Cell 1	LC1	Air
Cell 1	LC1b	Electric
Cell 1	R1b	Air
Cell 2	LC2b	Electric
Cell 2	R2b	Air
Cell 3	LC3	Air
Cell 3	R3	Air
Cell 4	LC4	Air
Cell 4	LC4b	Electric
Cell 4	R4b	Air
Cell 5	LC5	Electric
Cell 5	R5	Air
Cell 6	LC6	Electric
Cell 6	R6B	Air
Cell 1	R1	dip only
Cell 2	R2	dip only
Cell 4	R4	dip only
Cell 6	R6	dip only

2.2.2 As can be seen in Table 2, the landfill site currently has 14 extraction points, 9 of which are currently fitted with air pumps and 5 are fitted with electrical pumps. The site also has 4 monitoring points dedicated to dipping and sampling.

2.3 Leachate Treatment Plant

2.3.1 The leachate treatment plant is a SBR. It consists of a collection/balancing tank into which the leachate is pumped from site (Plate 2, Appendix 2), and this tank also receive the leachate from Standard Landfill. The leachate is subsequently pumped into the SBR reactor for biological treatment (nitrification) (Plate 3, Appendix 2). Following treatment the leachate is pumped to the effluent tank (Plates 4 and 5, Appendix 2), where it is discharged to sewer following testing of leachate quality.

2.3.2 The SBR is generally treating the leachate efficiently, although in the winter period the nitrification process has suffered from colder temperatures. The reactor tank is not insulated and although it has a roof cover, this is also not insulated (Plate 7, Appendix 2).

2.3.3 A crude heat exchanger was constructed a few years ago, where exhaust heat from the engine is piped across to the SBR reactor (see plates 8, 9 and 10 in Appendix 2). This has improved the treatment efficiency during the winter month, and is a good example of how internal resources can be used. However, this heat source is only available when the landfill gas engine is operational and is therefore not a consistently available.

2.3.4 Occasionally, the sludge age is increasing which results in increasing COD levels and reduced treatment capacity. When this happens, the treatment process is stopped and excess sludge removed. The SBR is either re-started slowly to build up biomass, or occasionally it has been re-seeded with sludge from an external source.

2.4 Leachate Treatment Plant Inspection

2.4.1 Caulmert staff visited the leachate treatment plant (LTP) on the 9th of January 2014 and the leachate extraction system was visited on the 22nd of January 2014. The findings for the leachate extraction systems are covered in section 5.3 of this report.

2.4.2 The LTPs treatment capacity reduced during the latter part of 2013, and the plant throughput was low. More recently the plant was stopped for re-seeding. It is common that the SBR tank capacity is reduced during the winter months, as the nitrifying bacteria are less efficient when the temperature falls below 10 °C. Therefore, during this time the plant requires careful management to sustain its treatment capacity.

2.4.3 During the autumn of 2013, storm winds and rain caused a tear in the existing LTP roof (see plate 7, Appendix 2), which increased the heat losses. FCC will attempt a repair to this damage.

2.4.4 It is considered that the leachate treatment plant would benefit from better insulation. An insulated roof or similar system (e.g. Siemens floating ball system) should be considered to retain heat and retain treatment capacity during the winter period. This is particularly important if leachate from external sources is to be treated at the plant.

2.4.5 During our site visit, it was noted that the leachate treatment plant area is messy, with littering across the facility. The control room has not been cleaned or tidied for a long time and paper work is not kept in order. One of the sodium hydroxide pumps had been leaking recently, spilling sodium hydroxide over the panels and floors in the control room. This had not been cleaned up, representing a significant health hazard to personnel (Plates 11, 12, 13 and 14, Appendix 2). In summary, the leachate treatment plant area and especially the control room needs to be cleaned and tidied up. Paperwork and control documents should be updated and kept in order.

2.4.6 Sodium hydroxide is added to the treatment process to provide alkalinity, to balance the biological reactions in the treatment process. It is extremely important for the efficiency of the treatment process that pH control is maintained at all times to avoid stress to the biological system. During a previous site visit in November 2013, the sodium hydroxide had run out, and the pH in the process had dropped to critical level. During the more recent visit, one of the sodium hydroxide pumps had an air lock and had leaked as described above. Not only is this a health hazard to personnel but also stress the biological treatment process.

2.5 Leachate Management

2.5.1 During the site operational years, the leachate pumping system was management by the site operative staff on a daily basis. Since site closure, there are fewer staff on site permanently. There have also been changes to staff and management procedures, during the process of integration of AD Waste to FCC. Currently, the leachate system is part managed by three Flintshire CC staff (Phil Mulhall, Paul Murphy and Andrew Scarfo), although it is not clear who has holds responsibility for each aspect, including the management of the leachate treatment plant.

2.5.2 If managed well and consistently, a leachate treatment plant will provide consistent treatment capacity. Any biological process thrives within a constant environment, and deviations from this environment will stress the process and result in decreased treatment efficiency and in worst case total loss of treatment capacity. A leachate treatment plant should therefore be managed by one or two staff, who know the process and can manage it consistently on a day to day basis, and ensures that parameters such as pH control, temperature control, sludge age and leachate feed is managed in a diligent manner.

2.5.3 From discussions with Flintshire personnel, it is clear that the personnel changes over the last year or so, has had a detrimental impact on the leachate treatment plant. There are no clear lines of responsibility and no one person who takes ownership of the management of the leachate treatment plant. This has had a negative impact on the leachate treatment capacity.

2.5.4 Fundamentally, there are three members of staff who are responsible for the leachate and landfill gas management at Standard and Brookhill Landfill. All three have a lot of historical knowledge of the site, and also technical knowledge. However, they have not got clearly defined roles or areas of responsibility and it is therefore difficult for them to take ownership of the tasks. Those staff have also been delegated other duties which impacts on their ability to manage the landfill gas and leachate as thoroughly as would be desirable.

2.5.5 The leachate treatment plant is fundamentally a robust plant and an asset to the council, however, its maintenance has been neglected. The roof leak and lack of insulation is also affecting the leachate treatment performance plant during the colder winter period. In our opinion, the leachate treatment plant would benefit from the installation of an insulated roof (or similar).

2.5.6 Well managed and with some additional investment, the leachate treatment plant will regain its asset value, and may indeed provide spare treatment capacity from external sources.

2.6 Leachate Tankering, January 2014 – Results and Discussion

2.6.1 The treatment capacity at the leachate treatment plant reduced during the latter part of 2013, and the plant throughput was low. In combination with a period of high rainfall leachate levels rose above consent limits in the landfill site as a consequence.

2.6.2 Due to the above, a decision was made to stop the SBR and to desludge it. During this period the leachate was tankered for off-site treatment.

2.6.3 During the assessment period of 6th January to 2nd of February 2014, two tanker loads were removed from site each day. Leachate removal volumes are presented in Table 3, Appendix 1. During this period, leachate levels at extraction and remote monitoring wells were recorded twice daily. Daily leachate level and pump data is compiled and presented in Appendix 1 in graphs and in Tables 1 and 2.

2.6.4 The dip levels showed an overall decrease in leachate levels during this time, clearly demonstrating that increased leachate extraction efficiently reduce the leachate levels in the site. The pump at LC1b was not operational for much of the first week and also not on the 20th and 21st of January. Therefore, naturally, the leachate levels were not reduced as much in this LC1B. Interestingly, the leachate levels did not reduce significantly even after the pump was operation (after the 22nd of January) but a significant decrease was seen in the remote monitoring point, R1B, in this cell (5.5m) over the period. The conclusion is that the recharge rate to LC1B is high, and extraction from this well has a significant impact on the leachate levels in this part of the site.

2.6.5 Leachate levels in LC2b in Cell 2 also increased temporarily while pumping ceased in Cell 1, though pumping at the well itself had not ceased. Levels stabilised and decreased later in the month. Levels had decreased by 3.22 m from 6th January to 2nd February in LC2b.

2.6.6 Leachate levels in all other monitoring points in Cells 2, 3, 4, 5 and 6 displayed a decreasing trend as frequent pumping extracted leachate at a steady rate. The largest change was observed in Cell 4 at R4b, where levels decreased by 12.44 m from 6th January to 2nd February.

2.6.7 All pumps were off on the 14th January, when a compressor fault on site led to a power outage. As a result, leachate levels increased slightly at all locations, but reduced again as pumping recommenced on the 15th January.

2.6.8 In summary, leachate levels have generally displayed a significant decreasing trend across the leachate extraction points over the period of extraction and tankering.

2.7 5 Year Leachate Level Review

2.6.9 FCC have asked for a summary of the leachate head levels recorded within the leachate wells and monitoring points at Brookhill over the previous 5 years. Leachate head levels recorded at the site between 2008 and 2014 are displayed in Figure 1 below.

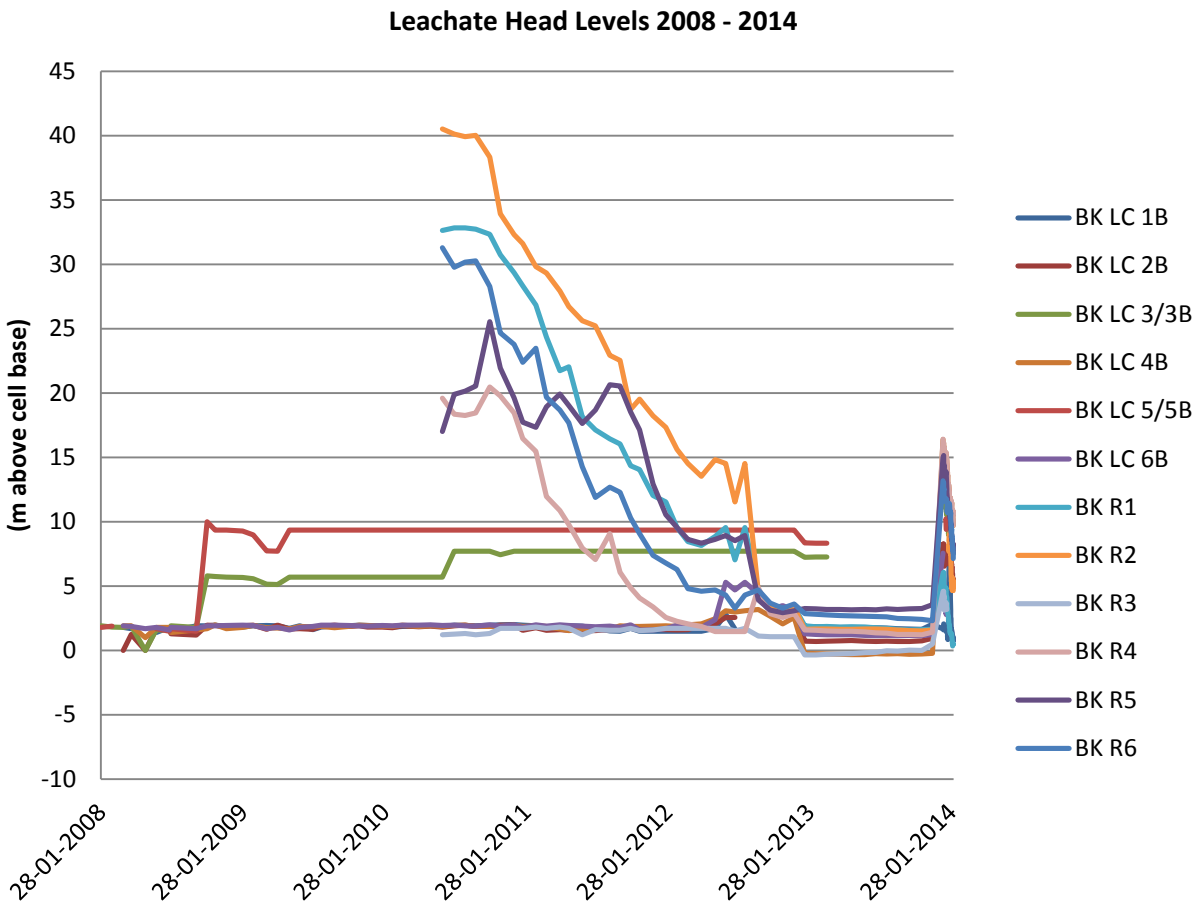


Figure 1: Leachate Head Levels recorded at Brookhill between 2008 and 2014.

2.6.10 Figure 1 displays a generally decreasing trend in leachate head level within the monitoring points between 2008 and the end of 2013, when all but R5 and R6 were recorded as being below their respective trigger limits.

2.6.11 The daily leachate level data, collected throughout January 2014 has also been included within Figure 1. The daily level measurements do not follow the trend of previously monitored levels. The data indicates that leachate head levels at the beginning of January 2014 were considerably higher than those recorded in December 2013 in wells LC2B, R3B, LC4B, LC6B, R1, R2, R3, R4, R5 and R6. For example, the leachate head level recorded on the 10th of December 2013 in R4 was 1.41 m above cell base, on the 6th of January 2014 the leachate head level in R4 was recorded as 16.42 m above cell base. A decreasing trend in leachate head levels is observed during January 2014, over the tankering period.

3.0 LANDFILL GAS MANAGEMENT REVIEW

3.1 System Overview

3.1.1 The landfill gas management system at Brookhill was installed in a phased manner following the infilling of waste and progressive capping of each phase. Control measures have been put in place to provide containment, collection and treatment of landfill gas.

3.2 Landfill Gas Extraction System and Infrastructure

3.2.1 An active gas control system has been installed at the site. This comprises gas extraction wells drilled after the completion of infilling and connected, via transmission pipe-work, to a gas plant consisting of a gas engine (electricity generator) and a back-up flare.

3.2.2 At present Brookhill Landfill has an gas extraction system comprising gas collection wells which are connected to a gas main, running from the north-west corner of the site in a clock-wise direction along the eastern site boundary and connecting to the engine, which is located to the south east of the site, near the leachate treatment plant. The majority of extraction wells have been installed along the side slopes.

3.3 Technical Specification of Landfill Gas Utilisation Unit

3.3.1 The gas utilisation scheme includes an environmental compound that houses the electricity generating engine and a back-up flare to be used in the event of the failure of the engine.

3.3.2 The gas utilisation plant (power generator) at the site is a Caterpillar G3516 which was installed by ENER-G Plc. It is designed for 1040 kWe and utilises 550 – 650 m^3 landfill gas per hour. It is designed to meet current emissions standards[1].

3.3.3 A telemetry control system which is managed by ENER-G Plc on behalf of the site operator is used to manage the engine and report failure of the engine. Failures of the engine are reported immediately by ENER-G to the site office or stand-by personnel.

3.3.4 Recently the gas utilisation plant has been de-rated due to high suction pressure and decrease landfill gas quality.

3.4 Landfill Gas Extraction & Leachate Extraction System Audit

3.4.1 An audit of the landfill gas and leachate extraction system was carried out by Caulmert on the 22nd of January 2014.

3.4.2 During the site visit, all gas extraction wells were inspected, connecting pipe work and lines were also inspected and key features were noted. Where possible, a note was made of which manifold each well was connected to. All leachate wells and monitoring points were examined and leachate dip levels were recorded, where possible.

3.4.3 A description of the condition of the individual gas wells, the condition of the above ground pipe work, the valve position (VP) the concentration of gas within each line (where recorded), and any other general observations are included in Appendix 4.

[1] Environment Agency. 2004. LFTGN 08. Guidance for monitoring landfill gas engine emissions.

3.5 Landfill Gas Extraction System Assessment

3.5.1 36 gas extraction wells with the prefix GV were inspected. The approximate location of each gas well is displayed on enclosed drawing 1140.EMP.01.

3.5.2 The wellhead and above ground pipework at GV1, GV4, GV6, GV7, GV9, GV9.1, GV10, GV11, GV13, GV16, GV17, GV18, GV20, GV22, GV24, GV25, GV27, GV30, GV31, GV32, GV33 and GV34 were all in good condition with no visible damage.

3.5.3 The valves at GV2, GV3, GV5, GV19, GV23 and GV26 were rusted, but otherwise these wells were also all in good condition with no visible damage. See Photographic Log in Appendix 3.

3.5.4 GV12, GV14 and GV15 were inaccessible during the site audit as their chambers were locked.

3.5.5 A strong landfill gas odour was noted within the chamber at gas well GV8, indicating a gas leak.

3.5.6 The pipework between the gas well and the manifolds was buried at all locations.

3.5.7 Gas quality was recorded at wells GV2, GV4, GV5, GV8, GV10, GV13, GV16, GV20, GV23, GV24 and GV34. Methane concentrations of >50 % were detected in all locations except GV20 (maximum of 0.2 % methane) and GV34 (maximum of 20.3 % methane).

3.5.8 Of the 36 gas wells, a total of 10 were closed at the manifold valve and 2 wells were closed at the wellhead. A further 5 wells were only very slightly open at either the wellhead valve or the manifold valve. Of the remaining 19 wells a total of 14 wells were greater than 50 % open - GV3, GV5, GV6, GV7, GV8, GV18, GV22, GV23, GV27, GV28, GV30, GV31, GV32 and GV34.

3.5.9 Relative pressure was generally negative across the GV series. Positive relative pressure was detected at GV2 (+4.8 mb), GV4 (+7.8 mb), GV8 (+4.7 mb) and GV24 (+5.0 mb).

3.5.10 Gas wells GV31 and GV32 were dipped using an anti-foam dip tape. GV31 was dry to the base at 30 m. In GV32, which has a recorded base level of 28.50 m, the leachate level was 20.44 m. This represents a potential head of 8.06 m.

3.6 Leachate Extraction System Assessment

3.6.1 All leachate wells and remote monitoring points were visited on the 22nd of January 2014.

3.6.2 Dip to leachate and dip to base levels were recorded at each location, with the results displayed in Table 3.

Table 3: Recorded Leachate and base levels within Leachate Locations (22.01.2014)

Location	Dip to Leachate (m)	Dip to Base (m)	Potential Leachate Head (m)	Notes
LC1b	19.50	21.80	2.30	-
R1	Dry	21.55	-	Dry or blocked?
R1b	31.19	32.00	0.81	-
LC2b	33.00	42.00	9.00	-
R2	Dry	16.59	-	Dry or Blocked?
R2b	22.90	40.50	17.60	-
R3	Dry	44.00	0.00	-
LC4	Dry	27.00	-	-
LC4b	26.11	32.00	5.89	-
R4	Dry	22.50	-	Dry or blocked?
R4b	34.00	37.00	3.00	-
LC5	Dry	-	0.00	-
R5	35.00	42.00	7.00	-
LC6	Dry	-	0.00	-
R6	20.04	22.80	2.76	Blocked?
R6b	21.10	35.45	14.35	-

3.6.3 Locations R1, R2, R4 and R6 appear to be blocked at a higher level than their installation depths. These locations are no longer pumped and have been replaced.

3.6.4 No leachate was recorded in R3, LC5 or LC6.

3.6.5 Recorded leachate head levels ranged significantly across the site. Relatively low levels were recorded in LC1b (2.30 m) and R1b (0.81 m), while significantly elevated levels were recorded within R2b (17.60 m) and R6b (14.35 m). Further assessment regarding leachate levels is included in Section 2.6.

3.6.6 Landfill gas leaks were noted at R5, LC2b, LC4 and LC6. LC6 was determined to be leaking from an aperture created for the pump cable, as displayed in Plate of 8 of the Photographic Log in Appendix 3.

3.7 Review of areas highlighted in the Natural Resources Wales (NRW) Audit

3.7.1 The NRW Audit on the 23rd of October 2013 observed that 27 gas extraction wells were turned off. On the 22nd of January 2014, 12 wells were turned off at the manifold and 2 wells were turned off at the well head, a total of 14. This represents an improvement in the number of wells which are currently being utilised, as compared to the number in October 2013. However, almost 40 % of the 36 wells installed at the site remain unused i.e. are closed at either the wellhead or at the manifold.

3.7.2 On the 23rd of October 2013, positive pressure was detected in two wells, GV4 (+10.7 mb) and GV24 (+3.4 mb). On the 22nd of January 2014, positive pressure was again detected in GV4 (+7.8 mb) and GV24 (+5.0 mb). Positive pressure was also detected at GV2 (+4.8 mb)

and GV8 (+4.7 mb) in January 2014. Positive pressure in gas wells indicate that this area of the site is under-extracted, and increased suction pressure should be exerted in those areas.

3.7.3 The NRW Audit report requests that gas wells be dipped in order to determine the level of "perched" leachate within them. Gas wells GV31 and GV32 were dipped in January 2014. No leachate was recorded in GV31. In GV32 a leachate head of 8.06 m was recorded. GV32 was recorded to be 28.50 m deep, which indicates that an extractable depth of 20.44 m remains within this well.

3.7.4 The NRW Audit report outlines that condensate was detected across the gas field. In January 2014, Caulmert determined that the pipework between the well head and the manifold was buried for the majority of the gas wells. The volume of condensate within these gas lines was therefore difficult to assess. Recommendations for further assessment of condensate blockages in the gas lines are outlined in Section 4.2.

3.7.5 In October 2013, NRW found that leachate sump LC2b had loose fittings on head-works allowing gas to escape. In January 2014, LC2b was again found to have a gas leak, with strong landfill gas odour within the chamber. Gas leaks were also noted at R5, LC4 and LC6. LC6 was leaking from an aperture created for the pump cable.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

Leachate Management

4.1.1 Brookhill closed landfill benefits from having a leachate management plant which treats leachate from Brookhill landfill site and the nearby Standard. The leachate treatment plant is a biological treatment process of SBR type which has and treated leachate efficiently over the years. The leachate treatment plant is a valuable asset for the Council. As any plant, however, it requires regular maintenance and this had been neglected in recent years.

4.1.2 In the winter, the treatment capacity is reduced due to heat losses. This is normal, as nitrifying bacteria operate less efficiently in temperature below 10°C degrees, and stop nitrifying completely at 5°C. A crude but functional heat exchanger was built two years ago, using waste heat from the landfill gas engine. This has improved the winter performance, but it only works when the landfill gas engine is running.

4.1.3 Like any biological process, the leachate treatment plant requires attention and should be monitored on a daily basis. Recently, the leachate management responsibilities at Brookhill have been split between several staff, and this has had a detrimental effect on the leachate treatment efficiency and capacity. At present, no one takes ownership of the treatment plant.

4.1.4 Biological processes require constant conditions in order to operate efficiently, and do not like shocking by changes in operating conditions. Any variation in factors like temperature, dosing of alkalinity (sodium hydroxide), leachate composition/source will impact the treatment system. As the nitrifying bacteria are slow growing, this impact may not be seen for a number of weeks.

4.1.5 The leachate extraction system which also requires regular/daily management suffers from the same lack of responsibility and ownership. The combination of these two factors has led to an increase in leachate levels within the landfill and reduced (loss of) treatment at the most critical time of the year.

4.1.6 Regaining treatment in the winter months, without any/sufficient heating treatment will take a long time, and the plant will most likely not return to full treatment capacity until the outside temperature increases (or the heat exchanger heats continuously).

4.1.7 FCC has staff that are trained in management of the leachate treatment plant, and know the leachate extraction systems. However, they have been given different tasks, and have not been able to manage the system as regularly and diligently as is required for a biological process.

4.1.8 The leachate extraction system has a sufficient number of extraction points, and high extraction rates can be achieved by increased pumping, as has been done during the recent tankering exercise. Improved regular monitoring and management are required to re-gain and retain control of the leachate levels in the landfill.

4.1.9 The leachate treatment plant was taken out of operation recently as it had been overloaded and stressed, and needed de-sludging. Leachate levels in the site increased and exceeded trigger levels. Therefore leachate has been tankered off during a two week period. The recent tankering exercise was beneficial, and has reduced levels in the site. Leachate levels

generally displayed a significant decreasing trend across the leachate monitoring points over the period of extraction and tankering.

4.1.10 Should management improve with the recommendations below implemented, the leachate treatment plant is an asset to FCC. It will continue to treat the leachate from Brookhill and Standard landfill, and will potentially also treat leachate from external sources.

Landfill Gas Management

4.1.11 The current status of the gas extraction system was assessed as part of the site audit carried out by Caulmert in January 2014. Overall, the condition of the gas extraction wells was satisfactory. No gas extraction wells appeared to be under significant stress or strain from the associated pipework.

4.1.12 The pipework between the gas wellheads and the manifolds was buried and therefore could not be examined.

4.1.13 Almost 40 % of the gas extraction wells were turned off during the audit. This is a similar percentage to that recorded by NRW during their audit in October 2013. It appears that the recommendations provided by NRW in their letter dated 12th of November 2013 have not been actioned. Positive pressure was again detected within GV4 and GV24 and LC2b still has loose fittings on head-works allowing gas to escape.

4.2 Recommendations

Leachate Treatment Plant

4.2.1 The leachate treatment plant area and control room should be tidied up from litter. The control room and lab is in a terrible state, and is not a pleasant or safe working environment. The monitoring records should be organised and set up so that there are traceable records in an easily accessible format.

4.2.2 The sodium hydroxide spill in the control should be cleaned up immediately and damaged floor panels removed. The sodium hydroxide pumping system should be repaired, and the air lock in the system removed. It is not only a health hazard, but also detrimental to the leachate treatment if the sodium hydroxide dosing cannot be relied upon.

4.2.3 It would be beneficial for the leachate treatment plant at Brookhill to either have an insulated roof or for example a Siemens floating ball system for improved temperature control. This is a necessity if the treatment plant is going to operate to a high efficiency, and potentially treat leachate from external sources.

Landfill Gas Management

4.2.4 It is recommended that a more structured approach is taken towards balancing of the gas extraction system. At present 40 % of the system is not in use. It appears that gas wells are being 'balanced' at the wellhead, by recording landfill gas concentrations and relative pressures and turning on or off where necessary. However, during the audit several wells were found to be open at the wellhead but closed at the manifold, and vice versa. A well balanced landfill gas extraction system will maximise the volume of gas available for energy generation at the utilisation plant. This is particularly pertinent at Brookhill, where the

utilisation plant has recently been underperforming, leading to a decrease in potential income.

4.2.5 Balancing of the landfill gas system has to include monitoring of and regulating on relative pressures, and at present this is not measured or considered when the system is regulated. This is also the means to measure any blockages or larger leaks in the system.

4.2.6 It is recommended that the Landfill Gas Management Plan for the site be updated, to include structured procedures for gas balancing.

4.2.7 It is further recommended that the Gas Extraction System Layout Drawing for the site be updated, to accurately display all gas well locations and the location of the manifolds to which they are connected.

4.2.8 The conditions of the gas extraction system should be checked on a regular basis. Regular checks should include visual checks of the condition of the manifolds, wellheads and pipework as well as making general observations of smell of landfill gas or the sound of condensate within the pipes. Furthermore, the areas surrounding the gas wells should be checked for ground settlement in order to avoid undue stress on the wellheads and surface emissions from areas of settlement. Leachate wells should also be assessed to identify gas leaks.

4.2.9 Individual point sources, for example at GV8 and at leachate wells R5, LC2b, LC4 and LC6 should be repaired immediately, to limit oxygen ingress and maximise gas extraction.

4.2.10 The majority of the connecting pipes between gas wellheads and the manifold are of relatively small diameter (63 mm) and have been buried below the capping material. Smaller diameter pipework is prone to distortion, which can allow for condensate build up. Relative pressure should be recorded across the system, at wellheads and at the manifolds during regular gas balancing visits. This will allow for the identification of blockages within the buried pipework, which cannot be assessed visually or otherwise.

4.2.11 Where necessary, gas extraction wells that are no longer required should be retired and sealed adequately.

Management Responsibilities

4.2.12 Leachate management responsibilities must be made clear, and one person should be give main responsibility for leachate extraction and treatment (and discharge), with one or two other trained persons also involved and serving as back-up. Clearly it is important that those persons are trained to look after the plant and understand the treatment process.

4.2.13 A dedicated employee should also be nominated for gas balancing. This person should be provided with additional training, if required. The same nominated employee should also be responsible for repair, or organising the repair, of faults on the system detected during gas balancing visits.

4.2.14 The management of the landfill gas extraction system, the leachate extraction system and leachate treatment plant at Brookhill (and Standard) and can be effective provided that the management roles are clear, and staff are given sufficient resources to manage them effectively.

4.2.15 There are other management options to consider, which are to outsource all or parts of the leachate and landfill gas management. There are companies who undertake routine monitoring and other companies who manage landfill gas extraction systems. It would be possible to tender those tasks and evaluate the cost efficiency.

4.2.16 The council has internal resources who know both landfills and their management systems history. They are dedicated staff, and to utilise them in an efficient manner (i.e. give them clear responsibilities and the resources and training required) could be the most cost efficient option going forward.

4.3 Summary to Specific Questions asked by FCC

4.3.1 Several specific questions were to be addressed as part of this review. These are outlined below, along with a summary answers formulated for the conclusions and recommendations included above.

Are the current leachate management arrangements effective?

4.3.2 FCC has staff that are trained in management of the leachate treatment plant, and know the leachate extraction systems. However, they have been given different tasks, and have not been able to manage the system as regularly and diligently as is required for a biological process.

4.3.3 The leachate extraction system has a sufficient number of extraction points, and high extraction rates can be achieved by increased pumping, as has been done during the recent tankering exercise. Improved regular monitoring and management are required to re-gain and retain control of the leachate levels in the landfill.

Is the gas management system effective?

4.3.4 The current status of the gas extraction system was assessed as part of the site audit carried out by Caulmert in January 2014. Overall, the condition of the gas extraction wells was satisfactory. No gas extraction wells appeared to be under significant stress or strain from the associated pipework.

4.3.5 During the site audit it was determined that almost 40 % of the gas extraction wells were turned off. This is a similar percentage to that recorded by NRW during their audit in October 2013. Evidently, gas wells which are turned off are not effective in terms of the extraction of landfill gas. The reasoning behind this number of wells being turned off is unclear; however; it is clear that regular balancing of the gas extraction system is required. Balancing of the landfill gas system has to include monitoring of and regulating on relative pressures, and at present this is not measured or considered when the system is regulated. This is also the means to measure any blockages or larger leaks in the system.

What would be the optimum solution for leachate and landfill gas management at the site?

4.3.6 There are other management options to consider, which are to outsource all or parts of the leachate and landfill gas management. There are companies who undertake routine monitoring and other companies who manage landfill gas extraction systems. It would be possible to tender those tasks and evaluate the cost efficiency.

4.3.7 The council has internal resources who know Brookhill Landfill well and the history of its management. They are dedicated staff, and to utilise them in an efficient manner (i.e. give them clear responsibilities and the resources and training required) could be the most cost efficient option going forward.

What investment is required to achieve the optimum level?

4.3.8 The leachate treatment plant area and control room should be cleared and tidied. The control room and lab is in a terrible state, and is not a pleasant or safe working environment. The monitoring records should be organised and set up so that there are traceable records in an easily accessible format.

4.3.9 The sodium hydroxide spill in the control should be cleaned up immediately and damaged floor panels removed. The sodium hydroxide pumping system should be repaired, and the air lock in the system removed. It is not only a health hazard, but also detrimental to the leachate treatment if the sodium hydroxide dosing cannot be relied upon.

4.3.10 It would be beneficial for the leachate treatment plant to either have an insulated roof or for example a Siemens floating ball system for improved temperature control. This is a necessity if the treatment plant is going to operate to a high efficiency, and potentially treat leachate from external sources.

DRAWINGS

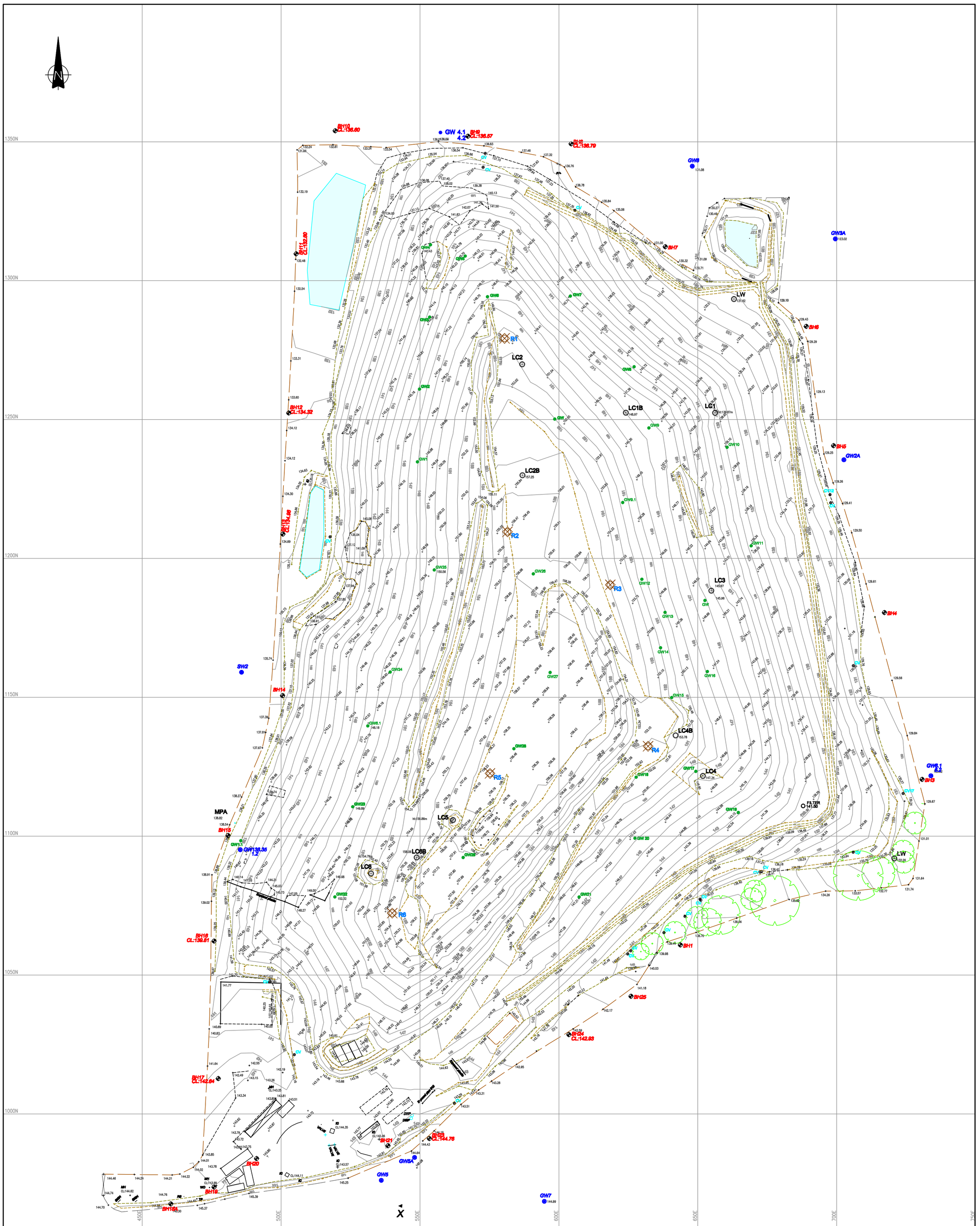
1140.EMP.01 Environmental Monitoring Plan

NOTES

1. SURVEY INFORMATION PROVIDED BY SOUTH STAFFS SURVEYS, TITLE: UPDATE SURVEY, REF: 4839a.dwg. DATE: 08.02.2008.

LEGEND

BH14	GAS BOREHOLE
GW	GAS EXTRACTION WELL
GW5	GROUND WATER MONITORING BOREHOLE
LC5	LEACHATE WELL
SW2	SURFACE WATER MONITORING POINT
CV	COAL VENT
	LEACHATE MONITORING POINT



REV	MODIFICATIONS	BY	CH	AP	DATE

BROOKHILL LANDFILL SITE

ENVIRONMENTAL MONITORING PLAN

DRAWN BY: AS	DATE: 23.07.2010	
CHECKED BY: JM	SCALE @ A1: 1:750	
APPROVED BY: XX	ISSUE: Dr	REVISION: -

DRAWING NUMBER: 1140.EMP.01

Caulmert
Engineering, Environmental and Planning

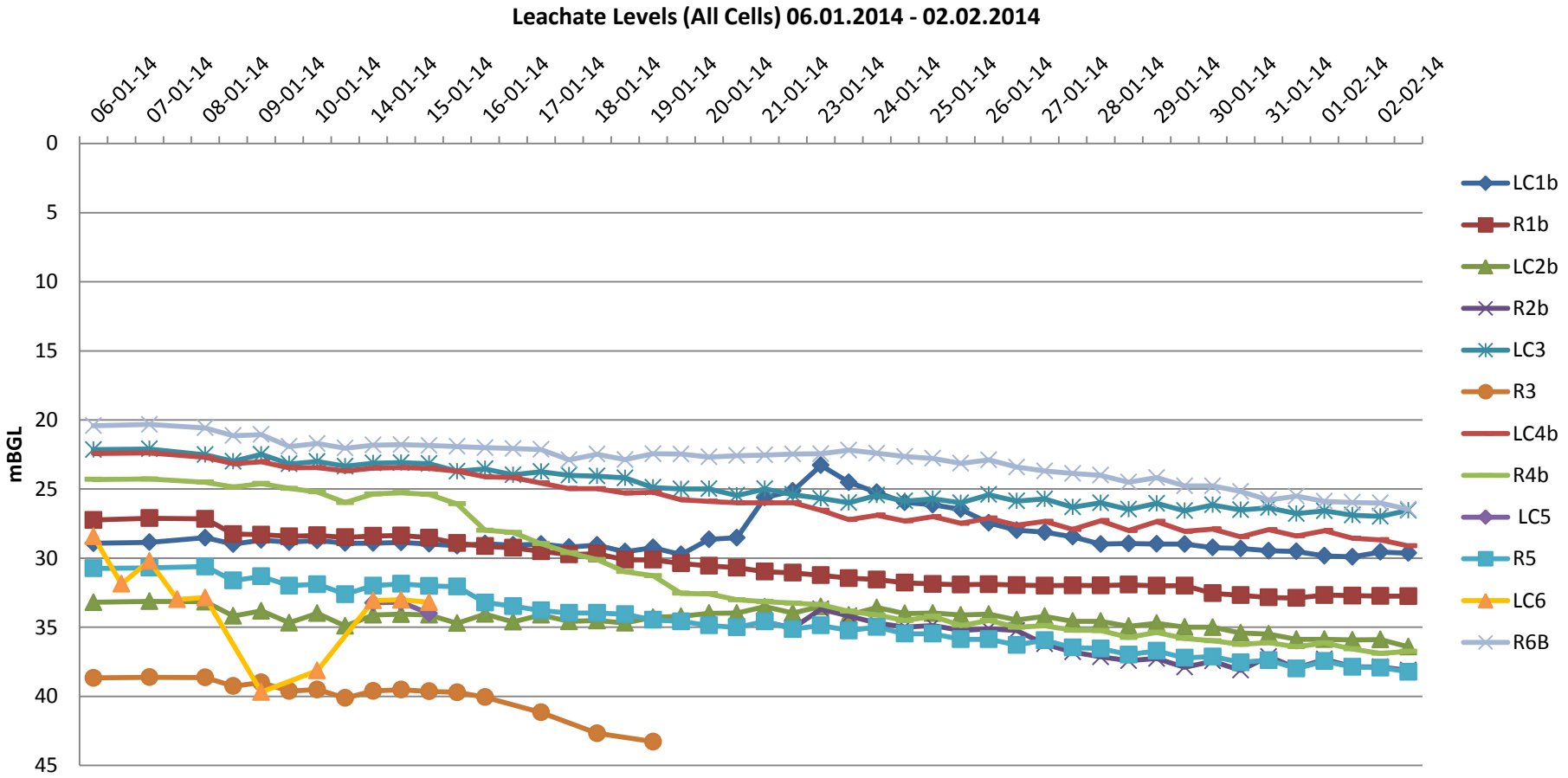
CAD FILE REF: M:\Cad Projects\1140 Brookhill\1140.EMP.01.dwg

WWW.CAULMERT.COM

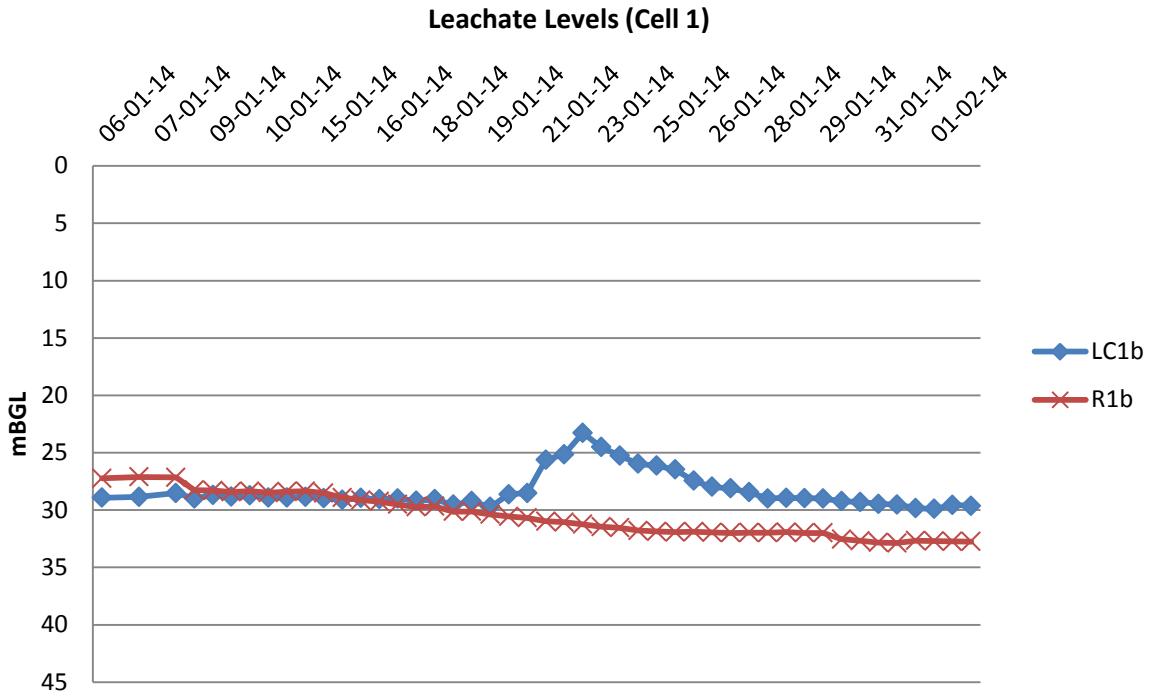
APPENDIX 1

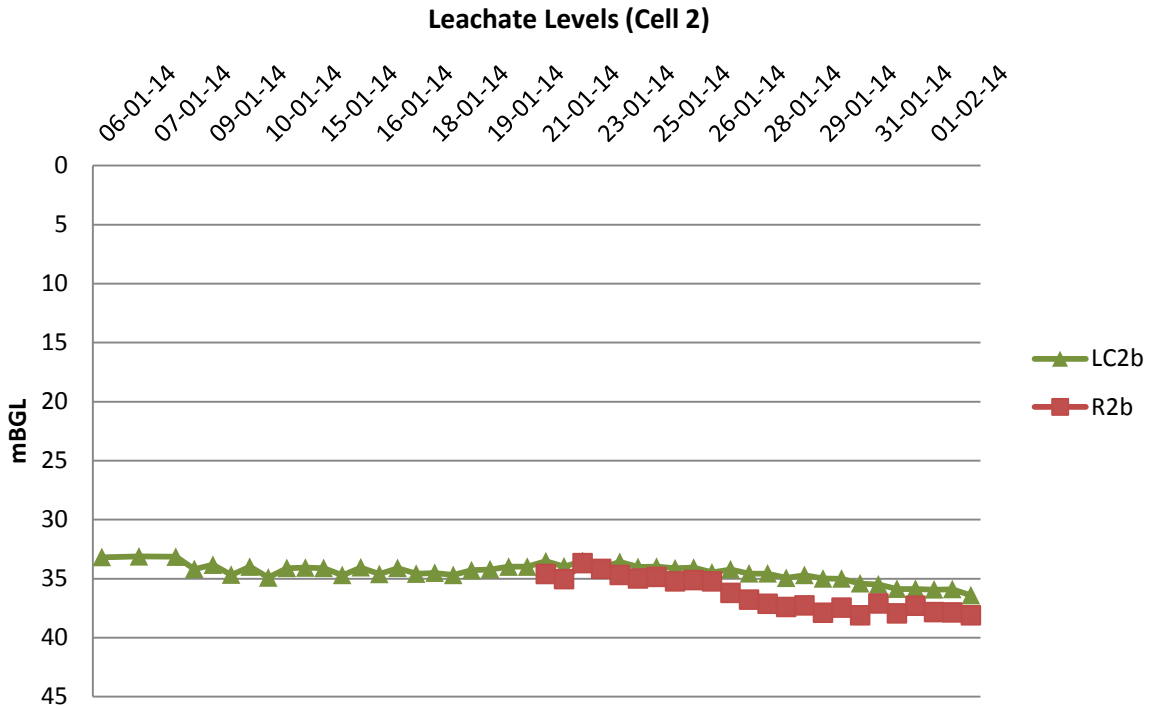
Leachate Dip Data from Tankering Period (06.01.2014 – 02.02.2014)

APPENDIX 1 – Leachate Levels

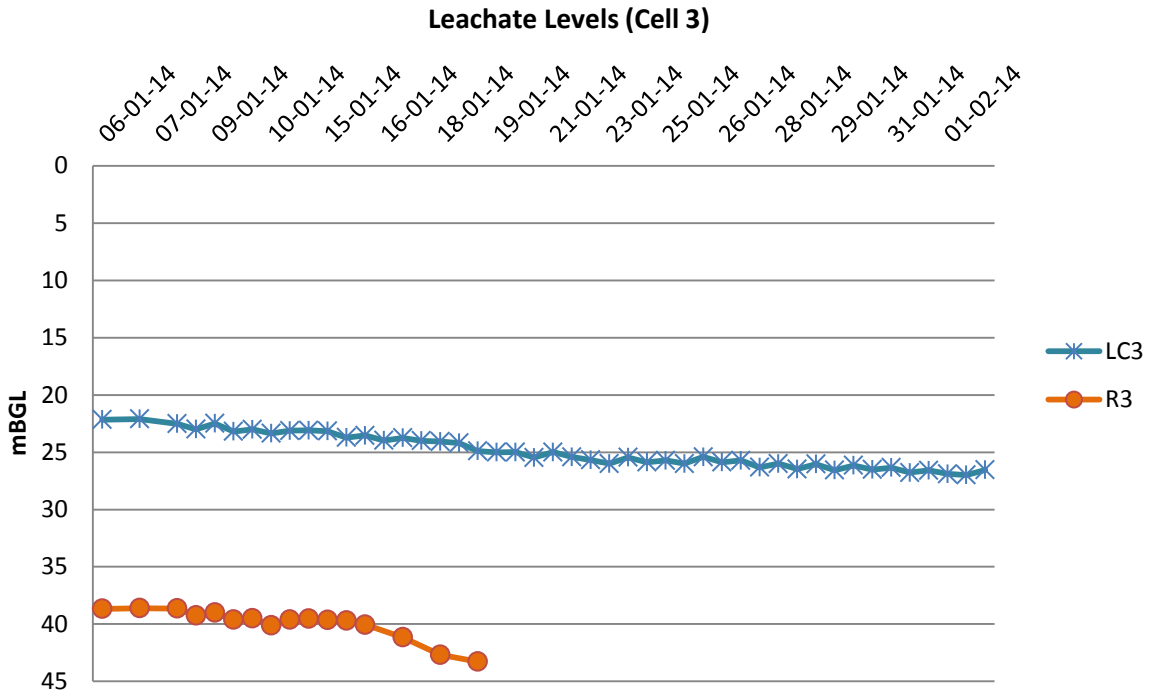


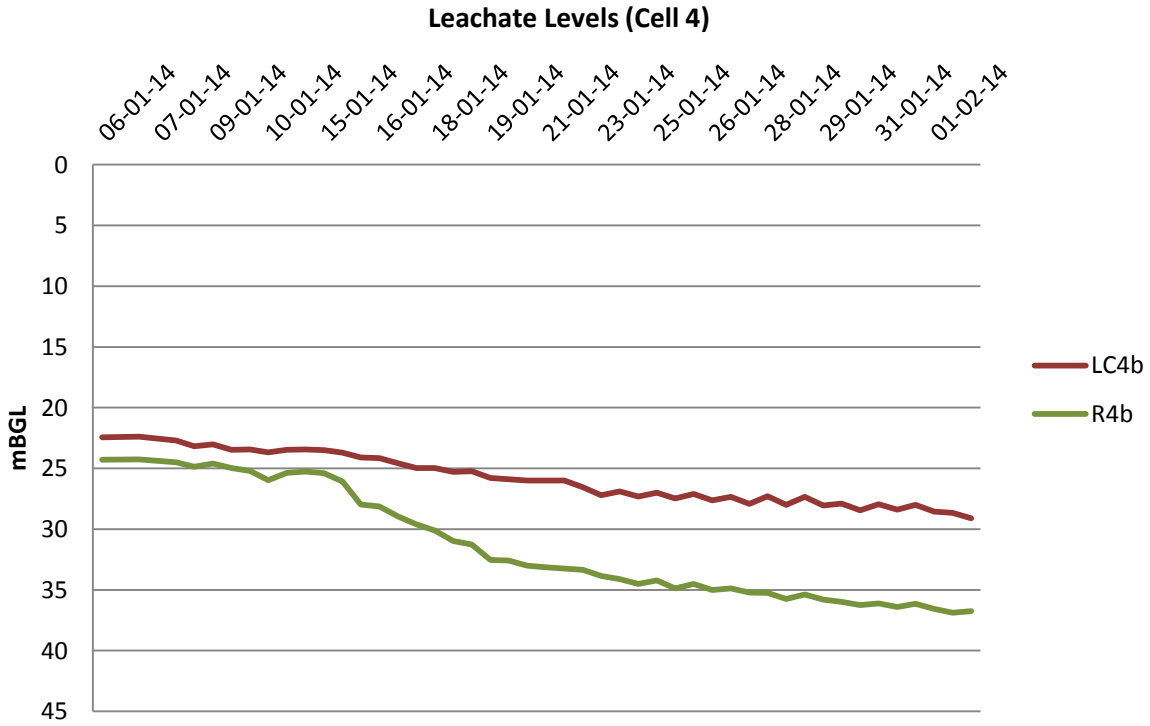
APPENDIX 1 – Leachate Levels



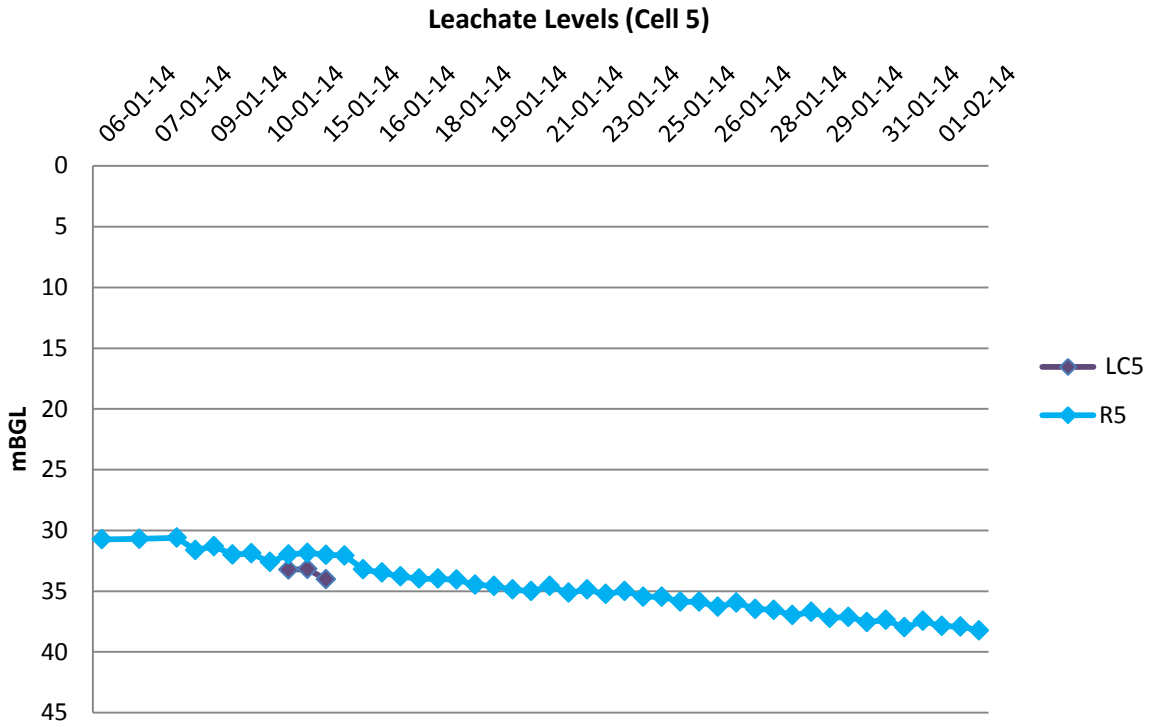


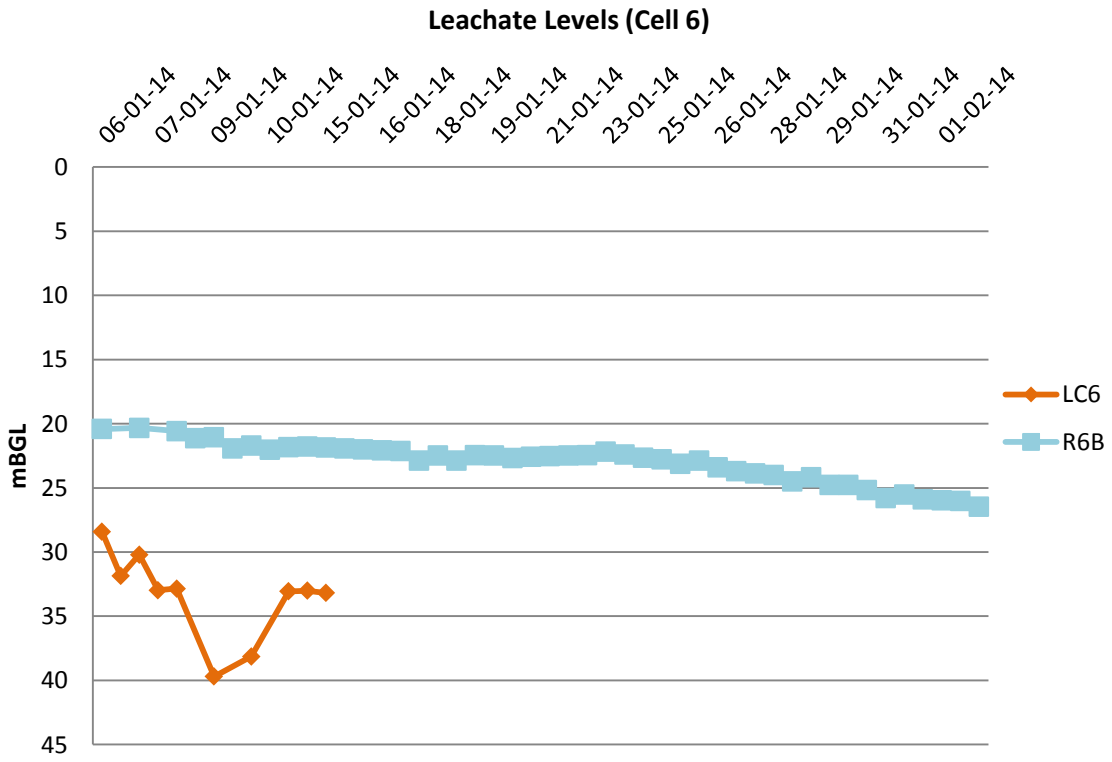
APPENDIX 1 – Leachate Levels





APPENDIX 1 – Leachate Levels





APPENDIX 1 – Leachate Levels

Table 1: Leachate Levels in mBGL Daily Values

Cell Location of Chambers	Cell 1	Cell 1	Cell 2	Cell 2	Cell 3	Cell 3	Cell 4	Cell 4	Cell 5	Cell 5	Cell 6	Cell 6
Chamber Identification Number	LC1b	R1b	LC2b	R2b	LC3	R3	LC4b	R4b	LC5	R5	LC6	R6B
06/01/2014 09:00	28.92	27.24	33.19	-	22.15	38.67	22.43	24.3	-	30.74	28.42	20.42
06/01/2014 18:00	-	-	-	-	-	-	-	-	-		31.86	
07/01/2014 09:00	28.85	27.11	33.12	-	22.1	38.62	22.39	24.27	-	30.7	30.21	20.33
07/01/2014 18:00	-	-	-	-	-	-	-	-	-		32.98	
08/01/2014 09:00	28.52	27.16	33.15	-	22.52	38.64	22.71	24.51	-	30.61	32.85	20.58
08/01/2014 18:00	28.99	28.26	34.19	-	22.99	39.26	23.17	24.86	-	31.62	-	21.14
09/01/2014 09:00	28.69	28.3	33.82	-	22.49	39	23.02	24.61	-	31.32	39.69	21.06
09/01/2014 18:00	28.84	28.42	34.68	-	23.18	39.62	23.46	24.96	-	31.99	-	21.92
10/01/2014 09:00	28.72	28.35	33.99	-	23.01	39.51	23.45	25.21	-	31.89	38.14	21.71
10/01/2014 18:00	28.91	28.49	34.91	-	23.35	40.12	23.68	25.98	-	32.61	-	22.04
14/01/2014 09:00	28.91	28.39	34.11	-	23.12	39.61	23.48	25.36	33.23	31.99	33.06	21.82
14/01/2014 18:00	28.86	28.36	34.06	-	23.09	39.52	23.45	25.27	33.19	31.86	33.01	21.79
15/01/2014 09:00	28.97	28.52	34.11	-	23.16	39.64	23.5	25.39	34.01	32.01	33.19	21.85
15/01/2014 18:00	29.11	28.91	34.71	-	23.71	39.71	23.71	26.07	-	32.06	-	21.92
16/01/2014 09:00	28.95	29.14	34.05	-	23.54	40.06	24.11	27.98	-	33.21	-	22.01
16/01/2014 18:00	29.06	29.26	34.61	-	23.97	-	24.16	28.14	-	33.47	-	22.07
17/01/2014 09:00	28.99	29.51	34.11	-	23.74	41.16	24.57	28.95	-	33.79	-	22.14
17/01/2014 18:00	29.21	29.74	34.58	-	24	-	24.97	29.61	-	33.97	-	22.89
18/01/2014 09:00	29.06	29.68	34.52	-	24.06	42.68	24.98	30.11	-	33.97	-	22.48
18/01/2014 18:00	29.54	30.12	34.69	-	24.19	-	25.29	30.98	-	34.06	-	22.87
19/01/2014 09:00	29.24	30.12	34.28	-	24.89	43.28	25.24	31.27	-	34.47	-	22.45
19/01/2014 18:00	29.74	30.38	34.22	-	25		25.78	32.54	-	34.58	-	22.47
20/01/2014 09:00	28.64	30.56	33.99	-	24.99	-	25.89	32.58	-	34.87	-	22.68
20/01/2014 18:00	28.52	30.69	33.98	-	25.47	-	26	33.01	-	35.01	-	22.58
21/01/2014 09:00	25.62	30.98	33.52	34.61	24.99	-	25.99	33.14	-	34.58	-	22.54
21/01/2014 18:00	25.14	31.06	33.97	35.06	25.41	-	26	33.25	-	35.14	-	22.47
23/01/2014 09:00	23.28	31.24	33.49	33.69	25.68	-	26.54	33.36	-	34.87	-	22.45
23/01/2014 18:00	24.52	31.45	34.12	34.19	25.99	-	27.21	33.85	-	35.24	-	22.19
24/01/2014 09:00	25.25	31.55	33.58	34.7	25.45	-	26.89	34.12	-	34.99	-	22.41
24/01/2014 18:00	25.97	31.78	34.01	34.99	25.87	-	27.31	34.52	-	35.47	-	22.65
25/01/2014 09:00	26.14	31.87	33.98	34.87	25.71	-	27	34.21	-	35.47	-	22.78
25/01/2014 18:00	26.47	31.92	34.12	35.24	26	-	27.48	34.87	-	35.87	-	23.14
26/01/2014 09:00	27.45	31.89	34.06	35.12	25.41	-	27.11	34.52	-	35.87	-	22.89
26/01/2014 18:00	27.98	31.95	34.47	35.24	25.87	-	27.62	35	-	36.28	-	23.41
27/01/2014 09:00	28.12	31.99	34.21	36.21	25.72	-	27.34	34.89	-	35.94	-	23.69
27/01/2014 18:00	28.45	31.97	34.57	36.79	26.31	-	27.92	35.22	-	36.47	-	23.87
28/01/2014 09:00	28.99	31.98	34.57	37.14	26	-	27.29	35.24	-	36.54	-	24
28/01/2014 18:00	28.94	31.92	34.93	37.42	26.47	-	28	35.74	-	36.98	-	24.51
29/01/2014 09:00	28.97	32	34.71	37.26	26.04	-	27.35	35.37	-	36.71	-	24.17
29/01/2014 18:00	28.99	31.99	34.99	37.89	26.57	-	28.06	35.81	-	37.21	-	24.78
30/01/2014 09:00	29.24	32.54	35	37.45	26.15	-	27.89	35.98	-	37.12	-	24.78
30/01/2014 18:00	29.31	32.68	35.41	38.12	26.51	-	28.45	36.24	-	37.54	-	25.18
31/01/2014 09:00	29.47	32.84	35.49	37.12	26.35	-	27.94	36.12	-	37.38	-	25.79
31/01/2014 18:00	29.52	32.88	35.87	37.95	26.78	-	28.39	36.41	-	37.98	-	25.52
01/02/2014 09:00	29.84	32.67	35.87	37.31	26.58	-	28.01	36.14	-	37.45	-	25.89
01/02/2014 18:00	29.91	32.71	35.92	37.85	26.89	-	28.56	36.57	-	37.87	-	25.97
02/02/2014 09:00	29.56	32.74	35.89	37.87	26.98	-	28.67	36.89	-	37.92	-	26.01
02/02/2014 18:00	29.64	32.75	36.41	38.12	26.54	-	29.12	36.74	-	38.23	-	26.47
Total Variation in Levels	**0.72**	**5.51**	**3.22**	**3.51**	**4.39**	**4.61**	**6.69**	**12.44**	**0**	**7.49**	**4.77**	**6.05**

APPENDIX 1 – Leachate Levels

Table 2: Leachate Well Pump Status

Location of Chambers	Cell 1	Cell 1	Cell 2	Cell 2	Cell 3	Cell 3	Cell 4	Cell 4	Cell 5	Cell 5	Cell 6	Cell 6
Chamber Identification Number	LC1b	R1b	LC2b	R2b	LC3	R3	LC4b	R4b	LC5	R5	LC6	R6B
Pump (am) 06/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 06/01/2014 18:00:00	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Pump (am) 07/01/2014 09:00:00	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	On	OFF	On	OFF
Pump (pm) 07/01/2014 18:00:00												
Pump (am) 08/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 08/01/2014 18:00:00	OFF		OFF				OFF		OFF		OFF	
Pump (am) 09/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 09/01/2014 18:00:00	OFF		OFF				OFF		OFF		OFF	
Pump (am) 10/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 10/01/2014 18:00:00	OFF		OFF				OFF					
Pump (am) 14/01/2014 09:00:00	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Pump (pm) 14/01/2014 18:00:00												
Pump (am) 15/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 15/01/2014 18:00:00	OFF		OFF				OFF					
Pump (am) 16/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 16/01/2014 18:00:00	OFF		OFF				OFF					
Pump (am) 17/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 17/01/2014 18:00:00												
Pump (am) 18/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 18/01/2014 18:00:00												
Pump (am) 19/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 19/01/2014 18:00:00												
Pump (am) 20/01/2014 09:00:00	OFF	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 20/01/2014 18:00:00												
Pump (am) 21/01/2014 09:00:00	OFF	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 21/01/2014 18:00:00												
Pump (am) 23/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 23/01/2014 18:00:00												
Pump (am) 24/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 24/01/2014 18:00:00												
Pump (am) 25/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 25/01/2014 18:00:00												
Pump (am) 26/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 26/01/2014 18:00:00												
Pump (am) 27/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 27/01/2014 18:00:00												
Pump (am) 28/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 28/01/2014 18:00:00												
Pump (am) 29/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 29/01/2014 18:00:00												
Pump (am) 30/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 30/01/2014 18:00:00												
Pump (am) 31/01/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 31/01/2014 18:00:00												
Pump (am) 01/02/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 01/02/2014 18:00:00												
Pump (am) 02/02/2014 09:00:00	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Pump (pm) 02/02/2014 18:00:00												

APPENDIX 1 – Leachate Levels

Table 3: Leachate Tankering Operations

Leachate Movements	Total Leachate Tankered Off Site
Date	**Net weight kg / day**
06-01-14	74640
07-01-14	49760
08-01-14	50440
09-01-14	50880
10-01-14	49220
14-01-14	27440
15-01-14	24920
16-01-14	50040
17-01-14	22620
18-01-14	0
19-01-14	0
20-01-14	0
21-01-14	79960
22-01-14	83720
23-01-14	48780
24-01-14	49780
25-01-14	0
26-01-14	0
27-01-14	0
28-01-14	26980
29-01-14	0
30-01-14	45220
31-01-14	0
01-02-14	0
02-02-14	0

APPENDIX 2

Photographic Log: Leachate treatment plant

APPENDIX 2 – Photo Log: Leachate Treatment Plant

PHOTOGRAPHIC LOG

Plate No.	Description
1	Leachate Collection Tanks
2	Collection Balancing Tank
3	Sequential Batch Reactor (SBR)
4	Transfer from SBR to Effluent Tank
5	Effluent Tank
6	Leachate Discharge and Tankering Area
7	Sequential Batch Reactor with Damaged Roof
8	Engine Exhaust Heat Transfer System
9	Engine Exhaust Heat Transfer Infrastructure
10	Engine Exhaust Heat Transfer System Connection to Engine
11	Sodium Hydroxide Pump Leak
12	Sodium Hydroxide Leaking onto Control Panel
13	Sodium Hydroxide build up on work surfaces
14	Sodium Hydroxide build up on pipes and hoses

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 1

Plate 2

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 3

Plate 4

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 5

Plate 6

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 7

Plate 8

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 9

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 10

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 11

APPENDIX 2 – Photo Log: Leachate Treatment Plant

Plate 12

Plate 13

APPENDIX 2 – Photo Log: Leachate Treatment Plant

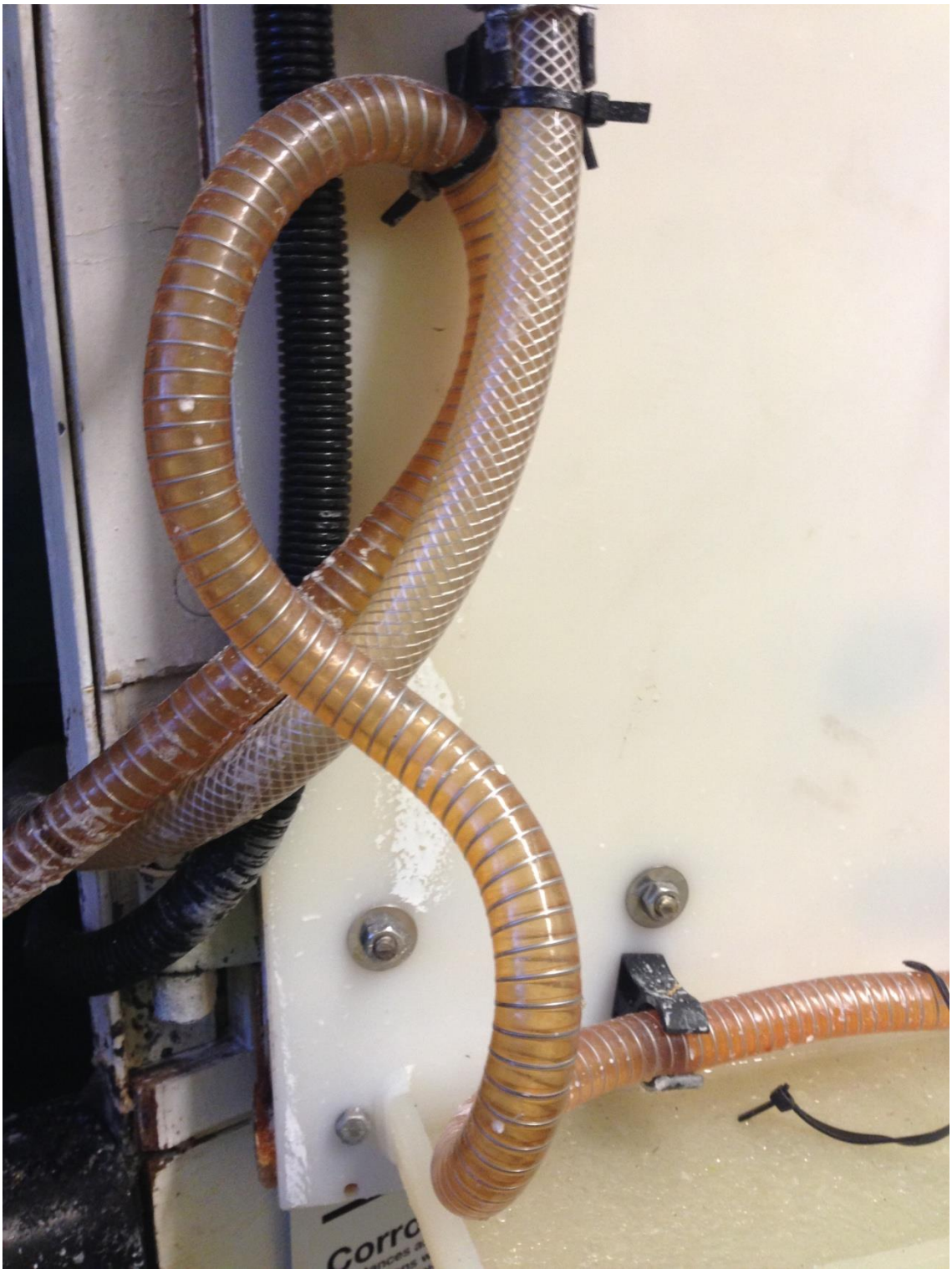


Plate 14

Caulmert
Engineering, Environmental and Planning

Registered Office: InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Fax: 01248 672601
Email: contact@caulmert.com
Web: www.caulmert.com

APPENDIX 3

Photo Log: Landfill Gas Extraction System Audit

APPENDIX 3 – Photographic Log: Landfill Gas Audit

PHOTOGRAPHIC LOG

Plate No.	Description
1	GV2
2	GV2
3	GV3
4	GV5
5	GV7
6	GV19
7	GV23
8	LC6
9	GV26

APPENDIX 3 – Photographic Log: Landfill Gas Audit

Plate 1

Plate 2

APPENDIX 3 – Photographic Log: Landfill Gas Audit

Plate 3

Plate 4

APPENDIX 3 – Photographic Log: Landfill Gas Audit

Plate 5

Plate 6

APPENDIX 3 – Photographic Log: Landfill Gas Audit

Plate 7

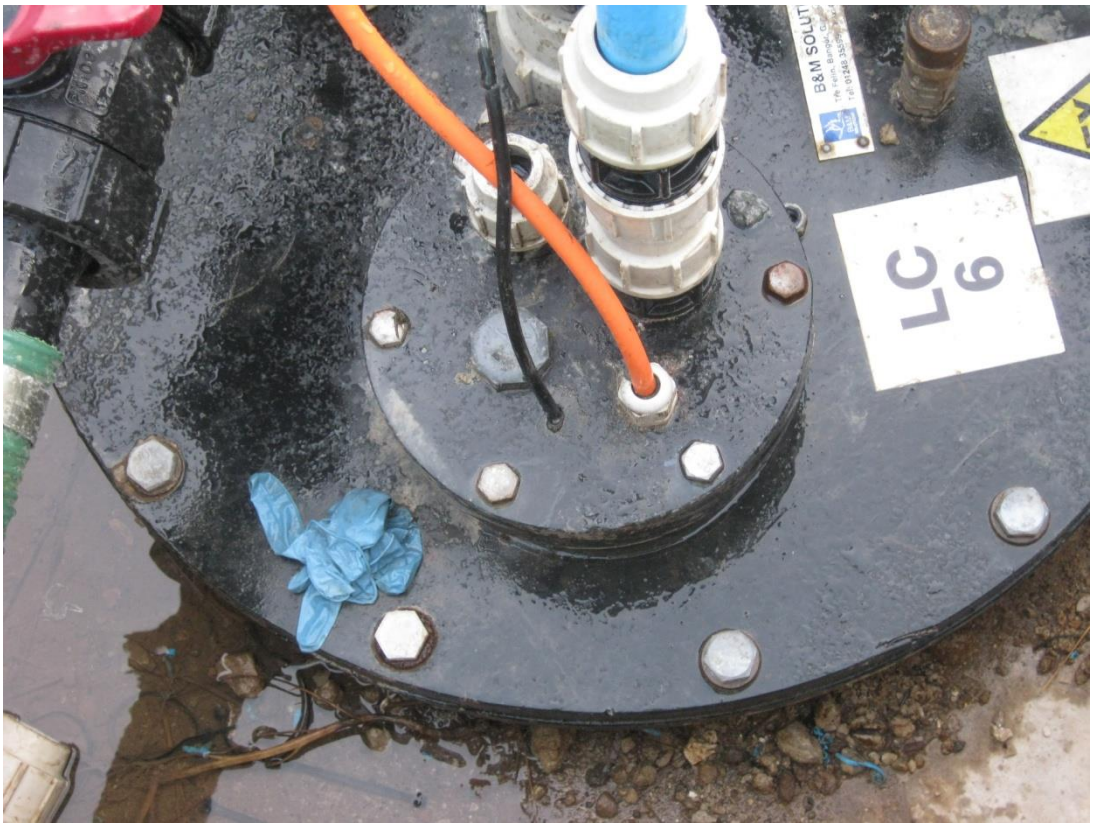


Plate 8

APPENDIX 3 – Photographic Log: Landfill Gas Audit

Plate 9

APPENDIX 4

Landfill Gas Extraction System Audit Results

GEX Well	Condition of Wellhead	Pipe Circ. (cm)	Condition of Pipework	VP at Wellhead (%)	VP (%) at Manifold	Seconds	CH4	CO2	O2	Bal	H2S	CO	RP
GV1	Good	63	Good	95	0	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV2	Ok. Dirty. Photo 1&2.	63	Good	N/A	0	***30***	63.2	38.2	1.2	0.0	46	3	4.79
						60	63.3	38.3	0.3	0.0	56	5	
						90	63.5	38.3	0.0	0.0	52	6	
GV3	Ok. Rusted Valve. Photo 3.	63	Good	100	100	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV4	Good. VP 0% open at manifold	63	Good	N/A	0	***30***	64.7	37.7	0.0	0.0	106	5	7.81
						60	64.7	37.2	0.0	0.0	108	6	
						90	64.8	37.3	0.0	0.0	110	6	
GV5+R1	GV5 Good. Rusted valve. Photo 4. R1 Good. Tefen valve sticks.	63	Good	100	50	***30***	60.6	39.9	0.2	0.0	70	4	R1: -14.23
						60	61.3	39.4	0.0	0.0	72	5	
						90	61.6	39.5	0.0	0.0	71	3	
GV6	Good.	63	Good	100	100	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV7	OK	63	Good	50. photo 5	100	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV8	OK. Strong LFG odour.	63	Good	100	100	***30***	62.9	38.5	0.5	0.0	87	5	4.68
						60	63.3	38.6	1.0	0.0	91	6	
						90	63.5	38.6	0.0	0.0	92	7	
GV9	OK	63	Good	50	0	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV9.1	Good	63	Good	50	0	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV10	Good	63	Good. Unprotected well	Cracked	-	***30***	65.1	34.2	0.3	0.4	13	4	-6.31
						60	65.3	34.1	0.0	0.8	12	5	
						90	65.3	34.1	0.0	0.7	13	6	
GV11	Good	63	Good. Unprotected well	Cracked	-	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV12+R3	Locked chamber, no access	-	-	-	Cracked	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV13	Good	63	Good	100	0	***30***	49.8	34.2	3.0	12.8	2	6	-6.6
						60	49.8	34.2	3.1	13.0	3	6	
						90	50.0	34.2	3.1	12.6	3	7	
GV14	Locked chamber, no access	-	-	-	Cracked	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV15	Locked chamber, no access	-	-	-	Cracked	***30***	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV16	Good	63	Good	20	Cracked	***30***	52.9	35.4	0.1	11.6	19	4	-32.74
						60	52.9	35.3	0.0	11.8	21	5	
						90	52.9	35.5	0.0	11.6	22	5	
GV17+LC4	Good	63	Good	20	0	***30***	30.0	58.2	42.1	0.1	145	6	-38.09
						60	60.0	58.5	42.1	0.0	154	6	
						90	70.0	58.9	42.1	0.0	159	7	

GEX Well	Condition of Wellhead	Pipe Circ. (cm)	Condition of Pipework	VP at Wellhead (%)	VP (%) at Manifold	Seconds	CH4	CO2	O2	Bal	H2S	CO	RP
GV18+21	Good	63	Good	80	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV19	Good	63	Good	100	0	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV20	Good	63	Good	80	0	30	0.2	0.2	20.4	79.1	1	1	-5.95
						60	0.2	0.2	20.4	79.0	1	0	
						90	0.2	0.7	20.4	78.9	0	0	
GV22+CVs	Good	63	Good	100	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV23	Ok. Rusted valve. Photo 7.	63	Good	100	-	30	58.8	42.3	1.4	0.0	127	8	-15.93
						60	59.0	42.3	0.1	0.0	138	11	
						90	59.1	42.3	0.0	0.0	146	12	
GV24	Good	63	Good	N/A	-	30	59.8	41.4	0.4	0.0	49	9	5.02
						60	59.8	41.3	0.0	0.0	52	9	
						90	59.9	41.4	0.0	0.0	55	9	
GV25	Good	63	Good	N/A	-	30	-	-	-	-	-	-	-15.24
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV26/A	Ok. Rusted valve. Photo 9.	63	Good	0	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV27+28/B+C	Good	63	Good	50	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV30	Good	63	Good	50	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV31	Good	63	Good	100	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV32	Good	63	Good	100	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV33	Good	63	Good	0	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV34	Good	63	Good	100	-	30	20.3	27.5	1.3	55.8	1	0	-35.45
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
RP6.1	Good	63	Good	0	-	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV2.1	-	-	-	-	50	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV2.2+LC2B	-	-	-	-	0	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	
GV/LC3.1+LC3	GV 3.1 Good.	125	Good	100	0	30	-	-	-	-	-	-	-
						60	-	-	-	-	-	-	
						90	-	-	-	-	-	-	

Caulmert
Engineering, Environmental and Planning

Registered Office: InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG
Tel: 01248 672666
Fax: 01248 672601
Email: contact@caulmert.com
Web: www.caulmert.com