Pen-Y-Bont Landfill Site

PPC Permit Number GP3830BG

Leachate Management Plan

June 2017

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1.0 Introduction

1.0.1 The objectives of this leachate management plan are;

- To control leachate generation within the landfill;
- To prevent the contamination of ground and surface waters by leachate migration;
- To manage leachate within the landfill in accordance with the requirements of the relevant conditions of the sites PPC Permit, GP3830BG;
- To operate in accordance with relevant EA guidance, specifically LFTGN02 "Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water".
- To achieve a stable biomass as early as possible, so achieving post-settlement contour levels at an early stage.

1.0.2 The control of leachate generation and the control of leachate in compliance with the terms of the Site Permit are integral elements of the risk management measures that will be incorporated into the operation of the site, with the aim of providing protection to the surrounding surface and groundwater environment. This document aims to provide a comprehensive summary of the actions to be undertaken to manage leachate at the site, including criteria to be met and actions required dependent upon the leachate levels and quality actually existing.

1.0.3 Leachate levels will be attempted to be reduced to and then maintained below the currently permitted level of 1m above base of cell or the lowest accessible point within a cell.

1.1 Relevant Documents

1.1.1 The PPC Permit for the site (Ref: GP3830BG) was issued on 9th November 2005.

1.1.2 The following accompanying documents have been produced in support of the Permit and should also be reviewed as they have direct relevance to the issue of leachate management at the site:

- Permit Application Forms (Ref: GP3830BG), November 2004.
- 'Pen-Y-Bont Landfill Site, Schedule 4 Information Requests in relation to Hydrogeological Risk Assessment – July 2005.
- 'Pen-Y-Bont Landfill Site, Site Environmental Setting and Installation Design Report', prepared by Encia Consulting Ltd., Ref: WR4446/ESID, October 2004.
- 'Pen-Y-Bont Landfill Site, Site Management System'. Current version.

2.0 Leachate Management System

2.0.1 Site engineering design provides the main leachate management control at Pen-Y-Bont. The aim is to control leachate generation to levels acceptable to encourage the stabilisation of the waste mass whilst not accumulating excessive excess volumes of leachate. Other facilities supplied by site engineering are the provision and maintenance of suitable leachate collection, abstraction, monitoring and re-circulation infrastructure. In addition the site is provided with leachate pumping, storage and disposal infrastructure.

2.1 Control of Water Ingress

2.1.1 Landfilling operations are phased in order to minimise the generation of leachate using water balance techniques to determine the sequence of waste placement. The water balance is a function of the rate of waste input, the absorptive capacity of the waste and the infiltration rate. Water balance calculations have been included within the PPC Application and supporting documentation.

2.1.2 The phases developed at the site are listed as follows:
Cell 1: 50% permanently hdpe capped
Cell 2: 50% temporary capped
Cell 3: 50% temporary hdpe capped

2.1.3 The site has also been engineered and filled in such a way that surface water is separated from waste and then shed from capped areas into the off-site surface water management systems. Temporarily capped areas should be attempted to be shaped in a way that discourages the infiltration of excessive volumes of surface water and also enables access to existing monitoring and leachate collection infrastructure as well as the installation of temporary gas management infrastructure.

2.2 Engineered Leachate Containment, Collection, Extraction, and Monitoring System Specification

2.2.1 The leachate containment systems that exist at the site are listed in the table below:

Table 2: Pen-Y-Bont Cell Lining and Drainage Details

Cell	**Cell Basal Liner and Drainage**
1	1m thick engineered Ruabon Marl liner placed to a maximum permeability of $5.5x10^{-10}$m/s, with a herringbone pattern plus 160mm diameter piped drainage system.
2	1m thick engineered Ruabon Marl liner placed to a maximum permeability of $5.5x10^{-10}$m/s, with a 300mm thick gravel layer plus 160mm diameter piped drainage blanket.
3	1m thick engineered Ruabon Marl liner placed to a maximum permeability of $5.5x10^{-10}$m/s, overlain by a 2mm HDPE geomembrane and a 300mm thick gravel plus 160mm diameter piped drainage blanket.
Side Slopes	1m thick engineered Ruabon Marl liner placed to a maximum permeability of $5.5x10^{-10}$m/s, overlain by 2mm of mono rough HDPE geomembrane.

2.2.2 The specification of the different elements of the engineered leachate extraction and collection system have been agreed with Natural Resources Wales within CQA Plans submitted prior to construction of the basal lining system of each cell and have been described and assessed elsewhere in the PPC Permit application.

2.2.3 The leachate collection and extraction system in Cell 1 consists of a herring bone drainage pattern of 160mm pipework. The original leachate chamber consisted of a concrete surrounded riser pipe sat on reinforced concrete basal plinth located at the lowest point in the cell, however, this chamber suffered structural failure and has been replaced by a retrodrilled installation, LC1a. The plastic inner casing and steel outer casing of the retrodrill will be extended in 3m sections as waste in-filling progresses.

2.2.4 Cell 2 consists of a 300mm thick gravel drainage blanket within which drainage pipework is placed and surrounded with gravel. The original leachate extraction system consisted of a concrete surrounded riser pipe sat on a reinforced concrete basal plinth located at the lowest point of each cell, however, both extraction chambers and the two monitoring points suffered structural failure and have been replaced by retrodrilled installations, LC4b, LC5b and LM4b and LM5b. The steel casing of the retrodrill will be extended in 3m sections as waste in-filling progresses.

2.2.5 Within Cell 3, the leachate collection infrastructure consists of 2 side slope risers, LC6 and LC7. These structures are made of 450mm non-perforated HDPE pipe, rising at an angle of 26° from the cell base, against the cell side wall. The risers are protected by surrounding leachate drainage stone lain up to a height of 1500mm above the cell base and are for leachate abstraction only. The original two 450mm diameter HDPE vertical leachate monitoring chambers, which extended from the cell base above the point where the riser meets the drainage layer, have both failed.

These chambers have been replaced by retro-installed monitoring points (LM6b and LM7b) and meet the drainage blanket at the same point as the side slope risers. The plastic inner casing and steel outer casing of the retrodrill will be extended in 3m sections as waste in-filling progresses.

2.3 Chamber Maintenance and Remediation – general guide

2.3.1 It is important that the pre-constructed leachate abstraction and monitoring points are maintained in continuity with the basal collection system. Without them the ability to abstract sufficient volumes and accurately monitor levels of leachate are compromised. In the case of Pen-Y-Bont, all the original concrete structures have failed and have been replaced by retrodrilled installations. It is important to regularly monitor the level of the accessible base of these structures and to compare it to the basal cell levels. Should blockages be noted then remedial action will be taken. This can include several techniques ranging from removal of silts, sludges and rubble blocking bases of chambers, removal of large objects such as abandoned pumps or collapsed re-enforcement rings, reforming of collapsed chamber sleeves using piling techniques or re-lining of partially collapsed chambers.

2.3.2 If chambers, originals or redrills, completely fail and are found to be unrecoverable, options to replace or otherwise compensate for the loss should be risk assessed and the outcome discussed and agreed with Natural Resources Wales.

2.3.3 If it is agreed that the benefits of replacing a lost chamber outweigh the risks associated with drilling close to the base of the site works should be undertaken with extreme caution to ensure that the sites containment is not breached. Ideally, retro-drilling into the sites basal drainage layer should only take place onto pre-constructed and recorded concrete pads, which exist in Cell 2 at Pen-Y-Bont.

2.3.4 Prior to any drilling works the relevant engineering detail should be sought and confirmed to determine the design and elevation of the base of the site. It is very important to undertake these studies prior to any retro-drilling:

1) Internal desk study – to find copies or all relevant documentation that may contain descriptions of or plans showing basal levels and/or construction details of cells. This should include searches of all active and archive data / document stores for Site Licenses, Working Plans, CQA Documents, Site Surveys and Reg. 15 / Hydrogeological Risk Assessments.
2) External desk study – contact should be made with all contractors and consultants who may have worked on relevant jobs at site to find relevant information. Viewing of the Public Register records for the relevant site license should be undertaken and where appropriate copies taken.
3) Site Investigation – all existing structures located within the waste mass should be investigated to discover their as-constructed depth. If this information is not available all such structures should be assessed for their current accessible deepest point. This may entail dipping, drainage-rod / piezo-pipe or camera surveys especially if the intention is to find out if structures can be used to accommodate leachate pumping to below a set level.

2.3.5 Once the required information is obtained maximum drilling depths should be assigned based on the known basal design of the site and an installation proposal and method statement complied in consultation with FCC's internal best practice guidance and agreed with NRW.

2.4 Leachate Chamber Levels

2.4.1 Permit Condition 2.10.12 (see Table 1) requires leachate to be controlled at a level '1m above the base of that cell'. 'The base of the cell shall be taken as the lip or point at which the liner dips into the leachate collection/extraction sump'. This means that for each leachate monitoring and abstraction point a level, in mAOD, needs to be defined that represents the base of the cell above which the relevant head of leachate is calculated.

2.4.2 Presented below is a summary of basal levels for each leachate monitoring and abstraction point currently in existence at the site.

Table 3: Leachate Chamber Monitoring Point IDs and Base Levels at Pen-Y-Bont Landfill Site			
Chamber ID	**Chamber Type**	**Base Level (mAOD**	**Cell Ref**
LC01b	Monitoring and Abstraction	**40.64**	Cell 1
LC03	Monitoring and Abstraction	**64.01**	
LC04b	Monitoring and Abstraction	**40.82**	Cell 2
LM04b	Monitoringand Abstraction	**40.63**	
LC05b	Monitoring and Abstraction	**41.23**	
LM05b	Monitoring and Abstraction	**40.58**	
LM06b	Monitoring and Abstraction	**40.47**	Cell 3
LM07b	Monitoring and Abstraction	**39.60**	
LC06 (Side Riser)	Abstraction	**39.05**	
LC07 (Side Riser)	Abstraction	**39.60**	

3.0 Compliance Levels

3.0.1 The site Permit requirement (condition 2.10.12, see Table 1) is that '…the head of leachate shall not be permitted to exceed 1m above the base of cell'. The Hydrogeological Risk Assessment carried out for the site in support of the PPC Permit Application, however, supports the acceptability of higher permitted leachate levels at the site.

3.0.2 The Hydrogeological Risk Assessment can be summarised as follows:
The installation is not located within any 'source protection zone', but is located within strata that have been classified by the EA as a minor aquifer of variable permeability, however, the site is underlain by significant thicknesses of low permeability mudstones and shales of the Ruabon Marl which is classified as a non-aquifer.

3.0.3 The presence of the landfill would be expected to affect the local pattern of groundwater flow, since the former clay pit has been excavated to depths well below the groundwater table and the elevation of the River Dee. Therefore, in the immediate vicinity at least, groundwater flow towards the site would be expected, especially under a continued regime of permanent leachate management control. As a consequence, Pen-Y-Bont landfill site will remain, as at present, in hydraulic containment.

3.0.4 Diffusive flow of leachate contaminants (passing downward or laterally through the containment barriers) has been assessed within the HRA. The conclusion reached is that as long as the site remains hydraulically contained, diffusion is not considered to be a significant factor of any risk posed to the environment by the presence of the site. This is primarily due to the fact that, in addition to the reworked Ruabon Marl mineral liner, there is significant thickness of in situ Ruabon Marl separating the installation from any potential receptor.

3.0.5 Although the HRA (2004) completed for the site indicates that leachate levels within the site have generally (over the last two years) been maintained below 2m and that the HRA suggests that a 3m compliance level could be set, it is proposed that for the purpose of this leachate management plan that the requirement to reduce leachate heads to 1m at the site is retained as per Condition 2.10.12 of the Permit.

3.0.6 The table below shows Compliance Levels for each cell currently in existence at the site:

Table 4: Pen-Y-Bont Leachate Compliance Levels				
Chamber ID	**Cell Ref.**	**Compliance Levels**		**Basal Levels**
		Head (m)	**Level (mAOD)**	**Base of Chamber (mAOD)**
LC01b	Cell 1	**1**	**42.30**	**41.30**
LC03		**1**	**65.01**	**64.01**
LC04b	Cell 2	**1**	**41.58**	**40.58**
LM04b		**1**	**41.47**	**40.47**
LC05b		**1**	**41.52**	**40.52**
LM05b		**1**	**41.58**	**40.58**
LM06b		**1**	**40.05**	**39.05**

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LM07b	Cell 3	**1**	**40.60**	**39.60**

3.1 Leachate Level Contingency Action Plan

3.1.1 In the event that Compliance levels are exceeded at the designated monitoring locations, the various actions that may be appropriate are detailed below:

i) Advise Site Management.
ii) Confirm by repeat sampling and analysis.
iii) Advise FCC Regional Environment Manager.
iv) Instigate leachate pumping from relevant abstraction points.
v) Turn off any leachate recirculation in to the affected cell.
vi) Follow FCC Escalation Procedure.
vii) Advise Environment Agency verbally within 24 hours of confirmed breach.
viii) Submit Compliance Action Plan (CAR form) within 5 days of breach to propose actions following breach.
ix) Review existing monitoring information.
x) Review site management and operations, implement actions to prevent future breach of compliance levels.
xi) Review the assumptions incorporated into the site conceptual model.
xii) Review existing hydrogeological risk assessments.
xiii) If risks are unacceptable, set in place procedures for implementing corrective measures in consultation with or required by NRW.

3.1.2 In the event of leachate levels being confirmed as exceeding the Compliance level, the likely outcome of any investigations will be to increase the rate of leachate extraction from the site. This will be achieved by actions such as installing pumping to any suitable installations in the waste as necessary. Consideration will be given to the need to install additional leachate extraction pumps and installation of pumps with greater pump rates.

3.1.3 Any downtime of the leachate pumping system which has occurred for any reason, such as ongoing capping or tipping operations shall be kept to a minimum of 48 hours and where possible, pumping will only stop during working hours and recommence overnight on each day of pumping disruption. This will keep leachate head recovery time down to as small a time as is practical.

4.0 Leachate Management Strategy

4.0.1 The compliance with the leachate level limits prescribed in the PPC permit is currently achieved through pumping at all extraction and monitoring locations. It is acknowledged that pumping from monitoring locations is not ideal, although Agency guidance LFTGN02 does facilitate pumping from monitoring points, where it is essential to maintain compliance. Section 9.5.4 of LFTGN02 states that;
"Where measurement of water levels in monitoring points affected by pumping is unavoidable (for example in the vicinity of major groundwater extraction or where leachate levels need to be maintained below compliance levels) a comment should be included in the monitoring records to indicate that pumping is taking place"

4.0.2 The conditions described above, requiring pumping from monitoring wells in order to maintain compliance, are currently prevalent at Pen-Y-Bont, as a consequence of significant perched leachate flows in the site.

4.0.3 It is an objective of this plan to ultimately restore monitoring to the more desirable monitoring from dedicated un-pumped monitoring wells and/or through pump suspension monitoring.

4.0.4 Cells exhibiting excess leachate should have leachate removed until such time as levels can be demonstrated to be controlled within the proposed levels. Leachate should be removed from cells with excess volumes and stored for disposal to suitably licensed treatment facilities. Leachate should be disposed of at a rate that is sufficient to reduce levels to compliance within the time-scale proposed in the Permit Condition 1.4.1.13.

4.0.5 In addition, consideration may be given to re-circulating leachate into both the newly deposited waste and completed cells with compliant leachate levels to encourage degradation and rapid stabilisation. Any proposal for recirculation of leachate will be submitted for approval to NRW.

4.0.6 When leachate levels in excess of those allowed by the Permit are reported (from either monitoring or abstraction wells, under pumping or pump suspended monitoring or from monitoring locations remote from pumped locations) consideration should be given to installation of active pumping from all leachate wells, including monitoring points. Whilst the site is non-compliant with it's permit the abstraction and off site disposal of leachate should be given priority and consideration should be given to installation of additional pumping infrastructure to available gas wells and ultimately to the installation of specific, retro-fitted, leachate abstraction wells into the waste. This action will affect the ability of the site to report representative leachate levels and so the monitoring protocols for the site under these conditions should be amended (see Section 6).

4.0.7 The leachate management strategy for this site will therefore be comprised of the following 2 elements.

1) The site should be engineered in such a way as to control leachate generation, to enable leachate levels to be accurately monitored and to provide sufficient infrastructure to remove excess leachate should it be required.
2) Any excess leachate identified by the 'time to compliance report' or discovered as a result of the suggested leachate monitoring regime for the site should be removed from the base of the site via one of the following two routes;
    i) Tanker to a suitably licensed off site treatment facility.
    ii) Re-circulate to waste with excess spare absorptive capacity once the site is compliant to below 1m.

4.0.8 Should off-site disposal prove unsustainable due to factors such as lack of off-site disposal outlets, excessive cost or a significant and sustained increase in the volume required to be disposed of off–site, consideration should then be given to the design, construction and operation of an on-site leachate treatment facility.

4.1 Leachate Extraction

4.1.1 Leachate will be removed from the cells by pumping in order to comply with the proposed Leachate Compliance Levels. This will be achieved using electric submersible pumps installed within the leachate collection/extraction wells, side slope risers and if necessary, the leachate monitoring points.

4.1.2 Dependent on the effectiveness of pumping of leachate from the leachate extraction and monitoring points, the possibility of utilising gas extraction boreholes to increase the rate of extraction, and control of leachate to agreed levels, will also be considered.

4.1.3 Leachate pumps and associated collection systems must satisfy a number of basic design criteria for them to be suitable for leachate pumping on a landfill site:

<u>Leachate Pumps:</u>

i) should be permanent installations so that they do not rely on the chamber being accessible or there being sufficient manpower to move and re-install on a regular basis
ii) must be intrinsically safe, even under failure conditions and be atex rated
iii) must be easy to install and remove
iv) must be of robust manufacture, ~ body stainless steel, hoses HDPE / MDPE
v) have minimum moving parts
vi) should be capable of a variable flow rate, as conditions will vary widely throughout the seasonal cycle. A range of from about 60 litres an hour to greater than $1m^3$/hour would be realistic for a pump located within a borehole
vii) should be automatic, turning on when leachate is present and off when not present, ideally capable of running dry with no harm being done to its operation or be fitted with sensors to stop operation of the pump in dry conditions

viii) should be capable of being controlled by a remote signal to turn the pump on and off (for instance a signal from a storage tank level sensor to turn on when tank empty and off when tank full)
ix) pump should be designed for low maintenance
x) should be capable of handling varying quantities of fine material and sludge that often accompanies leachate production, perhaps with additional protection being afforded by filtration
xi) must have sufficient power to lift leachate against a head equivalent to the depth of the site and to overcome frictional losses within the collection system to enable leachate to be delivered to the storage tank
xii) should be able to record flow rates so that the effects of pumping on recharge can be seen

Collection Systems:
i) pipework should be of robust, chemically resistant manufacture, MDPE etc, with a burst pressure in excess of that capable of being delivered by the field pumps pumping against a closed valve
ii) where possible all joints should be welded to avoid leakage
iii) pipelines should be located in such a way as to avoid frequent movement and areas where vehicle movements may crush pipes, where pipelines cross roadways they should be protected from crushing
iv) all pipelines should be clearly labelled or marked out and their locations surveyed and recorded on a site services plan
v) should be fitted with failsafe systems so that field pumping can stopped and started with signals from storage tank level sensors. This should include an activated valve that stops the collection system discharging to the storage tanks at tank high level or emergency shut-off.

4.1.4 At Pen-Y-Bont an electric pumped system is currently being utilised. This may from time to time be assisted by other pump types to help in specific situations. The electric pump system has been designed, supplied and installed by local pumping contractors, Site Electrical.
The pumps are designed to run at an optimum flow rate of 4 cubic metres per hour with some minor frictional loss and deliver leachate to the sites storage tanks.
They are controlled by sensors attached to each pump to prevent them running dry and damaging the pump motors and by timing switches to ensure that the pumps turn back to check for the presence of liquid in the well. The pumps are also turned off and on by high and low level signals in the leachate storage tanks to prevent them overfilling the tanks whilst optimising pump run times.

4.2 Leachate Storage

4.2.1 Leachate is initially delivered to storage tanks 1 and 2, which have a capacity of 80m^3 each, until they reach capacity at which point a level sensing ‘float’ device prevents them from overtopping and leachate diverts to additional storage space within tanks 3 and 4. Once these are filled, the pumping system shuts down until the tanks are emptied (by road going tankers) and the ‘high level’ sensing device deactivates to allow pumping to recommence.

4.2.2 Storage tanks 1 and 2 have been designed and constructed with their own integral bunds to 110% of the capacity of the tank. The bunds also have level sensing ‘floats’ installed within them as an extra safety device which shuts off the leachate pumping system should the level floats in the main tanks be by passed. Storage tanks 3 and 4 are located in a contained, clay bunded, HDPE lined area of 150m^3 capacity.

The tanks are emptied at a rate that encourages maximum field pumping to take place 24 hours per day, 7 days per week. Both the air and electric pumps on site currently deliver leachate to the 4 storage tanks, with levels in the pumped chambers being reduced to below 1m and then recharging until the pumps ‘cut-in’ once again at 1m.

4.3 Leachate Re-circulation

4.3.1 Leachate will only be re-circulated after obtaining agreement from NRW as to the suitability of re-circulation as a management option and after having supplied a suitable strategy for doing so.

4.4 Off-Site Disposal of Leachate

4.4.1 Leachate is disposed of off-site from cells that report a leachate level in excess of the Compliance Level for that cell, if it is not suitable to re-circulate that leachate to unsaturated areas of waste elsewhere on the site.

4.4.2 Off-site leachate disposal takes place via pumping to the leachate storage tanks for bulking up prior to tankering off-site. The leachate storage tanks are set up as described in Section 5.2 and they are located in an area that is easily and safely accessible by road going tankers. During the collection of leachate from the tanks, tanker drivers are issued with the following guidance notes on protocols for safely loading with leachate and safely dealing with spillages.

4.4.3 The leachate tanker loading procedure for the site is as follows:

General Site Behaviour.

- Drivers are expected to wear all relevant PPE as stated in the current Conditions of Site Use and with reference to the relevant FCC COSHH assessment for Leachate (available on FCC Intranet).
- Drivers are expected to be familiar with the Conditions of Site Use and adhere to them at all times.
- Drivers must report to the Weighbridgeman present at the site to arrange for the lockable valve on the tank outlet to be released and then locked after loading.

Loading Points.

- Only the nominated tanker loading point, fitted with lockable valve and Bauer fitting, shall be used to load leachate from the tank to the tanker.

Loading Procedure.

- Reverse tanker close to Loading Point.
- Connect pipework to tanker Loading Point and check that Tanker Inlet Valve is closed.
- Connect pipework to Leachate Tank outlet Bauer coupling ensuring that the lockable Outlet Valve is closed and the 'Bleed Valve' is closed.
- Ensure all Bauer connections are firmly secured and tightly closed to prevent any leaks. Ensure that the Bauer connection and pipework at the Leachate Tank is positioned over the drip tray provided.
- Before loading commences the Technician must record the value on the flow metre provided.
- Open lockable Outlet Valve to flood tanker loading pipework and ensure there are no leaks (should a leak be detected close Leachate Tank Outlet Valve, empty pipework into tanker and refer to spills procedure). Once satisfied the pipework is not leaking open Inlet Valve on tanker and allow tanker to load.
- Once the tanker has completed loading close the Leachate Tank Outlet Valve. With the tanker still providing suction the Bleed Valve should be opened and the tanker loading pipework emptied of all traces of leachate. Once satisfied that the tanker loading pipework is clear of leachate, close the tanker Inlet Valve.
- Disconnect all pipework. The driver should now check all Valves are suitably locked or secured. The tanker can now be allowed to leave. NOTE: Any spills noted should be dealt with as per the Spills Procedure.
- The time of the tanker removal, number of loads and volumes removed should be reported on a daily log at the weighbridge.

4.4.4 **The leachate tanker spills procedure for the site is as follows:**

Responsibilities.

- It is the responsibility of the tanker driver to inform site management of any spills that occur during loading.

Drip Tray Spills.

- Most minor spills and leaks from fittings should be contained within the drip tray. Should any liquid be present within the drip tray then the tanker should be directed to empty the drip tray both before and after loading from the Leachate Tank. The drip tray should be empty before loading the tanker commences.

Spills on Concrete Hardstanding.

- The Leachate Tank is located within an area of hardstanding, such that any spills or leaks that occur will be onto the concrete. The concrete hardstanding will prevent any spills having an immediate effect on the environment whilst they are contained on the concreted area.
- Should any spills occur priority should be given to containing the spill within the concreted area, with absorbent granules or sand and removing the spill as quickly as possible to prevent seepage over time through the concrete.
- If possible any liquid spilt should be lifted and removed by the tanker by employing its suction hose immediately it has occurred.
- Should a spill occur the following procedure should be followed:

Immediate action will include –

1. If any spillage occurs it should be immediately contained if possible and reported to the Site Supervisor or Site Manager. They will then asses the situation and decided on an appropriate course of action.
2. If possible stop the leak or if it is safe to do so isolate the cause of the spill or leak.
3. If the spillage is small then use absorbent granules immediately to prevent the spill spreading, clean up and send contaminated material to an appropriately licensed site for disposal.
4. If the spill is larger use inert materials (i.e. clay or sand) to make a containment bund and seek specialist help to clean up.
5. If some of the spillage has entered a flowing watercourse immediately contact the EA and use an appropriate approach to dam the flow and remove the contaminated waters.
6. If the spillage is major and cannot be contained using approved materials, then the EA and Senior Management should be contacted immediately and specialist help obtained.
7. If a tanker does start leaking and it can be safely approached and started then it should either discharge its load back into the Leachate Storage Tank (if sufficient room is available) or it should be moved to a position where any spill can be more easily contained (i.e. quarantine area, concreted area) or to an area where any contamination can be more easily remediated (i.e. away from Surface Water bodies, particularly those that are flowing).

In all instances Natural Resources Wales should be informed of all spills as soon as is reasonably practical.

4.4.5 The leachate is then disposed of to a suitably licensed treatment facility and records are kept of quantities disposed. Currently leachate is disposed of at the Castle Environmental disposal facility located in Stoke. Should this outlet for any reason not be able or willing to accept leachate from Pen-Y-Bont Landfill for a period of time alternative disposal outlets will be made available at other locations to ensure disposal from the landfill continues.

4.4.6 Leachate disposal will continue from the required areas of the site until such time as leachate levels are proven to be controlled to below Compliance Levels.

4.5 System Inspection and Maintenance Procedures

4.5.1 The responsibility for system maintenance lies with the Site Manager, aided by the Regional Leachate Manager.

4.5.2 Maintenance of the pre-engineered leachate containment, collection and monitoring systems should be a priority at the site. The most valuable asset at a site for the control of leachate is a fully functioning engineered leachate management infrastructure. At Pen-Y-Bont this currently consists of the following elements;

- Basal and side-wall leachate containment system.
- Basal leachate drainage and collection layers.
- Retrodrilled leachate pumping and monitoring wells.

4.5.3 Full CQA documentation of these elements should be maintained on-site along with copies of all as-built drawings. Further records should be maintained of the construction details of all leachate pumping and monitoring structures to include as a minimum the following information;

- Chamber identification number, location co-ordinates and relevant as-built drawing number reference.
- Chamber construction details (cross-section).
- Basal Level referenced to mAOD (either Basal Drainage Invert Level and/or Base of Chamber).
- Top Datum (from where monitoring levels are taken) referenced to mAOD and to a date. This should be compiled into the form of a Top Datum history detailing every change in elevation of the point from which monitoring takes place. Typically the Top Datum for each monitoring point will be determined by surveying. However, in an active area of the site, monitoring points may need to be raised between surveys. If this is done the height by which the monitoring point has been raised (or lowered) should be recorded and the Top Datum elevation amended accordingly.

4.5.4 When any failures in the sites leachate collection infrastructure are found these should be remediated as quickly as possible. The most common form of failure is blockage or collapse of leachate pumping or monitoring structures. Failure of chambers can be identified by comparison of the accessible chamber depth (from ‘Dip to Base’ that should be regularly monitored) with the as-constructed depth (‘Top Datum’ in mAOD minus ‘Basal Level’ in mAOD). Advice on the remediation of blocked and collapsed chambers and the recovery of ‘lost’ chambers can then be obtained from the Leachate Management Team.

4.5.5 The above procedures are important for both the correct reporting of leachate levels and also for the control of risks associated with the management of leachate at landfill sites.

- Knowledge of the elevation and construction of the base of the site is critically important for calculation of the head of leachate present above the site containment systems. For sites where compliance is regulated on this, data records of Basal Levels are essential. It is not possible to correctly monitor leachate levels without the survey information detailed above. For instance, if a leachate chamber is raised by 10m but the ‘Top Datum’ is not increased, leachate levels referred to mAOD will appear to be 10m below actual levels. This can lead to problems with compliance (i.e. not being able to prove correct leachate levels), problems with permitting (i.e. Hydrogeological Risk Assessments depend on comparison of leachate levels to surrounding groundwater levels) and problems with leachate management (i.e. leachate levels may be closer to breaching containment than expected).

- Knowledge of which chambers control leachate in which areas of the site and also an understanding of which chambers re-charge at high rates is also helpful in deciding which areas are critical to leachate level control. If details of construction and design philosophy of particular features of the leachate management infrastructure are lost then important control measures may be neglected. This can lead to breaches in leachate containment. For instance, if leachate drains fall to a particular sump to enable effective pumping and the location of the sump is subsequently 'lost', saturation of specific areas of waste with leachate can occur.

4.5.6 For sites that have lost existing leachate collection and monitoring chambers, retro-drilling of replacement chambers is often used. Should retro-drilling of leachate chambers close to the base of the site be required, it should be undertaken with extreme caution. Knowledge of the depth to base of the site at the point where retro-drilling is to take place is important for 2 main reasons;

1. To avoid breaching site containment by puncturing the base of the site with over deep installations.
2. To avoid setting compliance levels for retro-installed leachate monitoring and collection infrastructure that is not achievable due to a lack of site depth in that area.

4.5.7 If the relevant engineering detail is not available to determine the design and elevation of the base of the site the following steps should be taken. It is very important to undertake this work prior to any retro-drilling. The intention is to discover if any existing site infrastructure is still connected to the drainage systems and/or to discover if any existing infrastructure extends to below compliance levels, thus being useful for monitoring or achieving compliance. Failing this, the presence of waste to below compliance levels needs to be confidently predicted to enable safe installation of retro-drilled wells:

1) Internal desk study – to find copies of all relevant documentation that may contain descriptions of or plans showing basal levels and/or construction details of cells. This should include searches of all active and archive data / document stores for Site Licenses, Working Plans, CQA Documents, Site Surveys and Reg. 15 / Hydrogeological Risk Assessments.
2) External desk study – contact should be made with all contractors and consultants who may have worked on relevant jobs at site to find relevant information. Viewing of the Environment Agency's Public Register records for the relevant site license should be undertaken and where appropriate copies taken.

4.5.8 If the required information is still not available from desk studies site investigations should then be considered. Site investigations should also be undertaken if leachate pumping and monitoring structures have been lost. All existing structures located within the waste mass should be investigated to discover their as-constructed depth. If this information is not available all such structures should be assessed for their current accessible deepest point. This may entail dipping, drainage-rod / piezo-pipe or camera surveys especially if the intention is to find out if structures can be used to accommodate leachate pumping to below a set level.

4.5.9 As a last resort retro-drilling of leachate monitoring and pumping chambers may be necessary without the benefit of as-built cell information. If this is the case maximum drilling depths should be assigned based on the maximum known or provable depth of waste. Stand-offs from external waste flanks should also be left by assuming a minimum of a 1:3 slope on batters. This must be done to avoid installation of over deep wells that would risk breaching site containment. However, whenever retro-drilling in areas where as-built cell details are not available it must always be considered that basal cell topography may not be simple and that structures such as inter-cell bunds or geological features that have been engineered around may locally elevate the site base.

4.5.10 All of the equipment used within the leachate management system is regularly inspected, where possible, and maintained and repaired as necessary. Inspection and maintenance activities include the following actions:-

- Inspection of drainage blanket and collection pipework during placement of the initial lift of waste in the base of each cell, to ensure that any damage is identified and remedial action taken (all works now completed);
- Weekly inspection of leachate chambers for evidence of damage and the repair of damaged items to ensure that the integrity of the system is maintained;
- Review and assessment of leachate extraction and monitoring riser pipes to assess suitability for use, and retro-drilling of pipes where excessive deflections or blockages occur;

- Removal of leachate abstraction pumps at intervals recommended by supplier, for cleaning inspection, maintenance and repair;
- Inspection of leachate carrier pipework for evidence of damage and leaks;
- Inspection and remedial measures (e.g. jetting or use of a 'guzzler') to extraction pipework, when necessary, to maintain the ability to reduce leachate levels.

4.5.11 In addition to the regular routine of maintenance, further assessment and additional measures, if required, would be triggered by the leachate level contingency action plan, which is described within Section 3.1.

5.0 Monitoring

5.0.1 The leachate monitoring system is designed to:

- Determine the head of leachate above the agreed base in each cell;
- Determine the quality of leachate generated in each cell;
- Help determine the stage of waste decomposition;
- Determine appropriate leachate management measures;
- Ensure that the trigger levels specified in schedule 4 of the site permit are not exceeded; and
- Identify when relevant completion criteria are satisfied.

5.1 Leachate Level and Quality Monitoring

5.1.1 Monitoring of leachate levels is required on a regular basis to determine if the site is being maintained in accordance with the specified Trigger Levels. The leachate level compliance points and frequency of monitoring are in accordance Tables S4.1 and S4.8 of the site permit variation (Ref PP3032LN). Should any levels be reported in excess of the proposed Trigger or Control Level then the Leachate Level Contingency Action Plan presented in Section 3.1 will be enacted.

Leachate Level monitoring information includes the following parameters on a monthly basis from all monitoring and extraction points under active pumping:

- Dip to Leachate (DtLm)
- Dip to Base (DtBm)
- Field Leachate Head (m) = DtB – DtL
- Pulse Count/Hours Run/Flow

From this information it is then possible to calculate an estimate of the net liquid balance within any cell (i.e: Infiltration minus Leachate Removed) which can then be correlated against the leachate level. In this way it will be possible to assess if the installed leachate pumping capacity within the cell is sufficient to enable all newly generated leachate to be removed.

5.1.2 The above information is then imported into FCCs environmental monitoring database 'Monitor Pro' where calculated levels are automatically generated, utilising the original CQA'd basal level of the chamber being monitored (mAOD) and the most recently surveyed, dipping port level (Also in mAOD). Calculated levels are generated as follows:-

- Water Level (mAOD) = Surveyed Dipping Point (mAOD) – DtL (m)
- Depth of Liquid from Base (m) = Water Level (mAOD) – Basal Level (mAOD)

Calculations carried out in the monitoring database occur instantaneously, and once generated, will be reviewed, then communicated to the site manager from the relevant area Environment Officer/Technician within 24 hours.

5.1.3 As discussed in Section 5.0.5, if leachate levels are persistently reported as being above that permitted for the site, it may be considered necessary to pump all available leachate infrastructures at the site as the priority for the site will be the removal of leachate at as fast a rate as possible.

Leachate infrastructure such as monitoring points should be used for pumping as they will be likely to be installed into the base of the site, thus enabling leachate to be removed from levels of the site

that will reduce the head acting on the lining systems. In addition, gas wells should be considered for the installation of pumps, particularly if the wells are installed to a significant depth and located within cells where excess volumes are high.

Where pumps have been installed to leachate monitoring wells the following procedure must be followed to ensure that the most accurate leachate level monitoring data is obtained whilst at the same time maximising leachate pumping from the site. Once 'compliant' leachate levels are again recorded from the monitoring wells pumps should be removed and re-located and the monitoring wells will then revert to 'normal' operation.

a) If non-compliant leachate levels are consistently reported from a cell and they have not been able to be reduced by increased pumping rates from the abstraction chamber (i.e. re-charge to the abstraction point is lower than new leachate generation rate in the cell) then a pump should be installed to the monitoring well (after obtaining NRW approval).
b) A 'Recovery Test' should be completed for the pumped monitoring point as follows:
    i) Measure and record the level of leachate in the chamber.
    ii) Switch off the pump and allow leachate to recharge back into the well until no increase in leachate level is observed over a 2 hour period, up to a maximum of 48 hours) such that a 'recovery curve' can be established and graphed as leachate level versus time.
    iii) Switch the pump back on and monitor/record the volume removed and rate at which the leachate head in the well is reduced back to the level prior to the trial commencing.
    iv) Compile all data and produce a report of the findings to be issued to NRW detailing the 'Recovery Period' for the chamber.
c) Once per month, leachate levels should be monitored for the chamber after suspending pumping for the required 'Recovery Period'. At all other monitoring visits the pumps should be left running. Data submissions to NRW must report which results are obtained under pumping and which are from 'Recovered' visits.
d) Once 3 consecutive compliant 'Recovered Head' levels have been reported, pumping from the chamber should be stopped and the chamber should revert to being un-pumped.
e) A formal 'Recovery Test' should be completed annually for all pumped monitoring wells.

5.1.4 All leachate chamber dipping ports are to be resurveyed on a quarterly basis, to ensure accuracy of calculated levels. Any chambers that are raised or lowered during the period between these surveys, will be notified to FFC's Regional Environment Manager, who will arrange for these chambers to be resurveyed independently, to ensure accuracy of calculated results.

5.1.5 Maintaining accurate top and base datum records for leachate monitoring infrastructure is important so that an accurate picture of leachate heads held above the base of the site can be calculated. It is therefore important that when leachate chambers are constructed, the elevation of their base, in mAOD, is recorded and forwarded to NRW. In addition, every time the top level of a chamber is adjusted (i.e. the chamber is raised or lowered) this adjustment should be recorded and amendments made to the database containing the sites monitoring information. FCC have an internal 'Best Practice' procedure for recording such changes, this is presented in Appendix III.

5.1.6 Leachate quality will be monitored in accordance with the requirements of Table S4.8 of the site permit variation.

5.1.7 In addition to the monitoring required by NRW it is recommended that additional leachate monitoring takes place at the site, especially when leachate is being pumped for off-site disposal or re-circulated. Should leachate re-circulation take place on the site the additional monitoring should be considered.

<u>Draw Down Monitoring:</u>
Structures in cells fitted with leachate pumps from which leachate is being removed need to be monitored weekly as follows:

- Weekly Dip to Leachate, Dip to Base and Field Leachate Head (all Leachate Collection Points in cells where leachate is extracted).

This monitoring will enable an assessment of the rate at which leachate levels are falling to be made.

Re-circulation Monitoring:
Chambers and selected structures in cells into which leachate is being re-circulated need to be regularly monitored to ensure that perched levels are not forming adjacent to waste batters and cell perimeters. Gas wells and other such non-pumped structures should be selected so that all external waste batters / cell perimeters adjacent to the site boundary have at lest 1 monitoring point. In addition, waste batters and perimeters of cells should be inspected for signs of leachate breakout.

5.1.8 Should rapid increases in leachate levels be noted, leachate levels close to the surface or evidence of leachate seepage at cell perimeters be observed, all re-circulation of leachate should cease and the situation be re-assessed before recommencing re-circulation. In addition, the flow of leachate into each of the chosen re-circulation points (whether that be via flow meters fitted to pipelines or by recording number of bowser loads for direct application to freshly tipped waste) needs recording on a daily basis. Leachate levels within re-circulation points also needs daily monitoring and the inflows adjusting accordingly should they be found to be filling too rapidly (turn down input rate) or remaining dry (turn up input rate).

- Daily visual inspection of all batters and perimeters (all perimeters and batters).
- Daily records made of volumes re-circulated (either in bowsers or through sub surface systems).
- Daily inspection / dipping of all re-circulation points and adjustments to inflow rates made and recorded.
- Weekly Dip to Leachate, Dip to Base, Field Head (all Leachate Collection Points and selected gas wells in cells where leachate is re-circulated).

5.1.9 The information collected should be used to make operational decisions regarding the need to increase or decrease the rate of re-circulation of leachate. On an annual basis the information collected should be reviewed to ensure that the rate of reduction of leachate levels is occurring and that areas into which it is being re-circulated are not flooding. Leachate chemistry data should also be assessed to ensure that no detrimental effects are being reported to leachate strength and that the methanogenic / acetogenic nature of the waste is not being affected. This information should form part of the site annual environmental report.

5.1.10 If leachate is being tankered from site the daily number of tankers and their volumes also needs to be recorded and basic leachate quality sampled on a regular basis from the disposal tanks.

Sampling frequencies and determinands may be modified and adjusted as appropriate as part of an on-going and regular review of the Leachate Management Plan or as part of the regular environmental monitoring review. Additional determinands may be considered dependent upon the results of the current monitoring regime and any changes to the waste types deposited. The frequency of testing and/or number of determinands may be reduced in consultation with the Environment Agency.

The leachate monitoring schedule for the site is presented in Appendix II.

6.0 Leachate Pumping Infrastructure Review

6.0.1 The following pumping infrastructure exists at the site:

Table 5: Installed leachate pumps at Pen-y-Bont Landfill.

Cell	Location ID	Designation	Pump Type	Theoretical Max Pump Rate	Installed Pump Capacity to Cell
1	LC01b	Monitoring and Abstraction	Electric	5m³/hr	11m³/hr
	LC03	Monitoring and Abstraction	Air	1m³/hr	
	GW12R	Gas Well	Air	1m³/hr	
	GW25	Gas Well	Air	1m³/hr	
	GW28	Gas Well	Air	1m³/hr	
	GW29	Gas Well	Air	1m³/hr	
	GW40	Gas Well	Air	1m³/hr	
2	LC04b	Monitoring and Abstraction	Electric	5m³/hr	20m³/hr
	LC05b	Monitoring and Abstraction	Electric	5m³/hr	
	LM04b	Monitoring with Abstraction	Electric	5m³/hr	
	LM05b	Monitoring with Abstraction	Electric	5m³/hr	
3	LC06	Abstraction (SSR)	Air	2m³/hr	14m³/hr
	LC07	Abstraction (SSR)	Air	2m³/hr	
	LM06b	Monitoring with Abstraction	Electric	5m³/hr	
	LM07b	Monitoring with Abstraction	Electric	5m³/hr	

Total installed pumping capacity is therefore 45m³/hr or 1,080m³/day. Of which 24% is installed in Cell 1, 44% in Cell 2 and 32% in Cell 3.

6.0.2 The pump rates quoted in Table 5 (above) are theoretical pump rates under ideal conditions for the pump type installed to the well. Whilst this is a good indicator of the maximum possible pump rate at the site it is unlikely that this will be capable of being practically achieved.

6.0.3 Pump rates will be constrained by the re-charge of leachate to the pumped location and this is likely to be several times lower that the maximum theoretical capacity.

6.0.4 Flow metering was installed in 2009 to all pump installations as was leachate storage tank level sensing in both tanks. The level sensors indicate the available storage capacity in the tanks and whether the tank is full or not. This data is continuously logged and presented graphically on a Web based control screen. This information is used by FCC and it's tankering contractors to ensure that off site disposal is arranged in such a way as to encourage continuous field pumping wherever possible, including automated dial out to a designated mobile phone when the tank is full. This data will also be used to show how often field pumping is interrupted because of a tank full signal being sent to the field pumps.

7.0 Conclusions

7.0.1 Leachate levels will continue to be managed and controlled at the site using a combination of engineering methods and off-site disposal. Should reviews of the excess volume show that no progress is being made options for increasing off site disposal will be presented to NRW for approval. This may include installation of pumps to existing gas wells and / or the further retro-drilling of abstraction wells.

7.0.2 Should it become apparent that new leachate generation at the site is much higher than modelled (i.e. assumptions on Effective Rainfall prove to be incorrect) then the site should begin to be considered for on-site treatment options. If this becomes the case NRW will be kept informed from an early stage in discussions over treatment options.

Appendix I

Environmental Monitoring Plan

Appendix II

Leachate Monitoring Schedule

Appendix III

Leachate Disposal Volumes