

RESOURCE MANAGEMENT (UK) LIMITED

Witheyhedge Landfill Site

Leachate Recirculation System

Addendum to the Gas Management Plan

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Prepared for

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INTRODUCTION - EXISTING GAS MANAGEMENT PLAN (GMP)

The existing gas management plan is Withyhedge Landfill Site Gas Management Plan 2014 V2 and includes a general description of the Gas management philosophy at the Withyhedge site. The plan was written by SITA and includes a management structure for the site that quite clearly identifies EnerG working under SITA Power (SITA Power is now replaced by Resource Management (UK) Ltd as they are Permit holders). The management configuration is that the Permit holder is directly and ultimately responsible for gas control at the site.

The application to carry out re-circulation of leachate requires an update of the existing GMP, this is addressed by the development of this addendum. In order to ensure that leachate recirculation does not have any adverse emissions resulting from increased landfill gas generation, low collection rates and outdated management systems it is imperative that the GMP is updated to manage changes. The full Gas Management Plan has been reviewed to identify sections that need to be updated. Adjustments are only required to be made to Sections 4 – 7 as shown in the table below:

Existing GMP Sections	Change Yes/No
4.1	No
4.1.1	Yes
4.1.2	Yes
4.1.3	No
4.1.4	No
4.1.5	Yes
5	No
5.1	No
5.2	No
5.3	No
5.4	No
6	No
6.1	No
6.1.1	No
6.1.2	No
6.1.3	No
7	Yes
7.1	No
7.2	Yes
7.3	Yes
7.4	No
7.4.1	No
7.4.2	No

AMENDMENTS TO THE GAS MANAGEMENT PLAN (GMP)

The following sections have been updated with new management requirements identified under new subsections:

- 4.1.1 Gas Field Balancing
- 4.1.2 Gas Collection System Maintenance
- 7.0 Environmental Emissions
- 7.2 Fugitive Emissions
- 7.3 Procedure for Non-Routine Events

The Gas management plan, “Field balancing document” shows that the existing protocols are robust and the contents of Appendix B to that document are considered to be good industry practice for normal landfill gas management.

To ensure integrated management it is essential that lines of communication are continued between the Permit Holder and EnerG, especially considering that recirculation of leachate may introduce new management issues, as covered in this document, given that landfill gas production rates are expected to increase in an area of leachate re-circulation.

A review of the existing gas collection system by considering the plans and by a site visit, has shown that the existing infrastructure has been decommissioned in the recirculation area. It is also apparent that there is no gas currently measurable in those parts of site where recirculation is planned, this explains why the system has been decommissioned. It is expected that the cell that is dry entombed will not produce much gas, if any at all, which is the current situation, recirculation of leachate is intended to restart gas production. Wells that are currently decommissioned have already been assessed along with manifolds and will be physically investigated for integrity at surface and bentonite seals replaced at the same time as the leachate recirculation system infrastructure is installed and prior to leachate recirculation commencing. The existing wells will be reconnected and additional wells installed, these can be seen in drawing LFS-00104-WH/02 and include the following wells:

- WIPK0019, WIVJ0092, WIVJ0093, WIVJ0094, WIVJ0010, WIVJ0011, WIVJ0012

The re-circulation of leachate is intended to reactivate gas production and gas field balancing will need to be managed to collect additional gas. This means that the existing gas management plan needs to be modified to accommodate extra gas and condensate produced and protect the environment from emissions.

The following text is the current section 4.1.1 of the landfill gas management plan:

4.1.1 Gas Field Balancing

Gas Field Balancing will be undertaken in accordance with the ENPL Field Balancing protocol in Appendix B. A sample of gas balance report and gas well condition survey is included in Appendix B.

Logs will be kept of the monitoring and any adjustments made. During normal operation

the gas quality will be monitored daily at the gas plant and weekly at manifold outlets.

The following text is the replacement section 4.1.1 of the landfill gas management plan and addresses how additional gas from leachate recirculation will be accounted for by balancing. It also addresses the management of additional condensate in the gas carrier system:

4.1.1 Gas Field Balancing

Gas Field Balancing will be undertaken in accordance with the ENPL Field Balancing protocol in Appendix B. A sample of gas balance report and gas well condition survey is included in Appendix B.

Logs will be kept of the monitoring and any adjustments made. During normal operation the gas quality will be monitored daily at the gas plant and weekly at manifold outlets.

4.1.1.1 Gas wells included in the area affected by leachate recirculation will be fitted with monitoring ports and will also be monitored on a weekly frequency to enable assessment for flow and gas balance.

Within areas affected by recirculation increases in methane, and general gas quality including positive pressures will be used as indicators that landfill gas production rates are increasing. Gas wells in those areas will be balanced in accordance with the ENPL Field balancing protocol in Appendix B.

Leachate Recirculation will not commence unless there is sufficient working gas collection infrastructure within the recirculation area.

4.1.1.2 Additional gas production will mean that additional condensate will be produced. The existing gas control system is designed to remove condensate within the range of the volumes of gas suspected to be produced and as a pumped system should not present issues with condensate build up. Any condensate blockages will be intercepted via normal gas field balancing in accordance with the existing Gas Management plan and balancing protocols as per Appendix B

The landfill gas collection system is maintained to ensure gas and condensate are managed. A recirculation program is intended to lead to changes in the gas production rates and these changes need to be assessed on a more regular frequency to manage changes and prevent emissions and ensure all additional gas produced is collected. To manage this the maintenance of the gas collection system needs to be modified.

The following text is the current section 4.1.2 of the landfill gas management plan:

4.1.2 Gas Collection System Maintenance

The general maintenance arrangements for the site are provided in SPOP027 Landfill Gas System Development Procedure and further detailed in SPOP003 Gas Field Balancing and

Gas System Inspection Procedure.

In the event of the failure of a gas well an assessment of the well data and its location within the site will be used to determine the need for replacement.

Whilst undertaking routine balancing, ENPL staff are required to investigate and identify faults.

The location and nature of any damage will be reported to the Landfill Site Manager. ENPL will take prompt and appropriate action in arranging repair of the damage. If possible a temporary fix will be made prior to leaving site, pending permanent repair. A record will be kept in a site log of all remedial actions undertaken.

An annual audit of the gas field will be undertaken to highlight any possible defects and necessary remedial works.

The general arrangement of the Withyhedge Gas Collection System is detailed in drawing SN103-4-WITHY-001 GCS.

The following text is the replacement section 4.1.2 of the landfill gas management plan:

4.1.2 Gas Collection System Maintenance

The general maintenance arrangements for the site are provided in SPOP027 Landfill Gas System Development Procedure and further detailed in SPOP003 Gas Field Balancing and Gas System Inspection Procedure.

In the event of the failure of a gas well an assessment of the well data and its location within the site will be used to determine the need for replacement.

Whilst undertaking routine balancing, ENPL staff are required to investigate and identify faults.

The location and nature of any damage will be reported to the Landfill Site Manager. ENPL will take prompt and appropriate action in arranging repair of the damage. If possible a temporary fix will be made prior to leaving site, pending permanent repair. A record will be kept in a site log of all remedial actions undertaken.

An annual audit of the gas field will be undertaken to highlight any possible defects and necessary remedial works. In addition, monthly assessment of the existing gas collection system's efficacy in treating landfill gas in the locality of the leachate recirculation system will be undertaken by EnerG and reported back to the operator

4.1.2.1 In areas where recirculation of leachate is carried out, re-connected gas wells and manifolds in the recirculation area will be assessed and their condition with any remedial works recorded and presented as a Construction Quality Assurance document. This will include photographic evidence of repairs made.

Assessment of the gas field will include where appropriate and in agreement with Natural Resources Wales:

- Flow checks – to determine any restrictions.
- Well dips – to determine blocked, collapsing or submerged wells from site leachate.
- Gas Field Trending Data – to long term analyse data to assess performance.
- Camera surveys – visual verification within well liners.
- Image maps or similar – to identify areas on the gas field where aerobic activity or other changes are taking place.”

The efficacy of these wells will be fully assessed and where wells are non-functioning they will be replaced by new wells

4.1.2.2 If horizontal collectors or ancient gas collection infrastructure is intercepted it will be further decommissioned by chasing the pipe back one metre and sealing each end with a bentonite plug. (Inc, in CQA procedure). A photographic record will be taken of the decommissioned collector, the location given a unique reference and its location noted on the final CQA report.

4.1.2.3 In the event of recirculation of leachate being introduced the area of planned recirculation will be reviewed to consider whether the design needs to be modified:

- The current GasSim model will be considered to assess predicted gas volumes and any changes
- Pipe sizes and capacity will be assessed
- Pressure losses in the system will be calculated back to the GUP from the new design area.
- Additional volumes of condensate to be produced will be calculated
- Well distribution will be considered for potential gaps in collection

Details from the review will be considered and reported to NRW for their agreement before recirculation commences with new wells and carriers installed to ensure full gas field coverage.

The general arrangement of the Withyhedge Gas Collection System is detailed in drawing SN103-4-WITHY-001 GCS.

The current Section on Gas Treatment is seen in Section 4.1.5 of the existing GUP:

4.1.5 Gas Treatment

In line with efforts to improve gas systems on landfill sites, the design of gas extraction systems operated by SITA Power is also subject to continual review. The standard configuration for gas utilisation equipment is detailed in SPOP028 Gas Utilisation and Flaring Systems.

The general arrangement of the Withyhedge Gas Utilisation Plan is detailed in drawing NPL4-03-002.

It is anticipated that landfill gas rates will increase over approximately 12 months of introducing leachate recirculation, the modelled uplifts can be seen in the GasSim Lite models seen below and the existing gas collection system has sufficient capacity to collect additional gas

once it has been reconnected and reinstated prior to leachate recirculation commencing. The intent is to collect the extra gas and divert to the GUP. Uplift on gas production will be seen at the GUP where changes in volume, quality and suction pressures will be monitored.

To manage additional gas produced at the site the updated Section 4.1.5 is as follows:

4.1.5 Gas Treatment

In line with efforts to improve gas systems on landfill sites, the design of gas extraction systems operated by SITA Power is also subject to continual review. The standard configuration for gas utilisation equipment is detailed in SPOP028 Gas Utilisation and Flaring Systems.

The general arrangement of the Withyhedge Gas Utilisation Plan is detailed in drawing NPL4-03-002.

4.1.5.1 If additional gas wells are required a review of gas collector main will be required to demonstrate the existing main has sufficient capacity to accept the maximum quantity of gas anticipated. There is potential to create a ring main from the existing gas collectors and this may be the most cost effective means of collecting additional gas.

4.1.5.2 The gas collection system will have sufficient capacity to collect additional gas generated before leachate recirculation commences with decommissioned wells having been recommissioned and additional wells being installed in areas where there are gaps in gas infrastructure in the area of recirculation. Early detection of uplift is essential so that additional gases can be utilized immediately. This will require increased weekly monitoring of the gas wells and this will be carried out by the permit holder. Early signs of uplift will include the additional delivery of gas to the GUP with a decrease in vacuum. In 5.22 on page 17 of Appendix 2 of Gas Management Plan it confirms that adjustments will be made in load adjustment circumstances, in the case where there is more gas, the same adjustments and notifications will be made to the Permit holder as this is an indicator of higher gas production rates. Load adjustment may be required post balance to control the rate of gas extraction, this will be done by the Permit Holder:

- If site vacuum increases as a direct result of the balance, load reduction is evaluated to prevent over extraction.
- If site vacuum decreases, the gas field will be allowed to stabilise for at least 24hrs before evaluating load adjustment.
- Early signs of uplift will include the additional delivery of gas to the GUP with a decrease in vacuum; in the case where there is more gas, the same adjustments and notifications will be made to the Permit holder as per 5.22 of Appendix 2 (as this is an indicator of higher gas production rates).

In the event of additional gas being generated during recirculation of leachate the need for the installation of additional wells will be reviewed.

The general arrangement of the Withyhedge Gas Utilisation Plan is detailed in drawing

The introduction of leachate recirculation means that more gas production and will introduce a review of procedures. The Environmental Emissions section has been changed to manage this. The following text is the current section 7.0 Environmental Emissions states:

7.0 Environmental Emissions

The Monitoring Management Plan details the methods, frequency and standards required for environmental monitoring at the site. In general, environmental monitoring serves two purposes:

<i>Permitted Emissions</i>	<i>Gas Engines and Flare Systems are monitored to ensure that exhaust and flare gas components are controlled within permitted levels.</i>
<i>Fugitive Emissions</i>	<i>Gas migration boreholes, Surface Emissions Monitoring and odour checks are undertaken to ensure that fugitive emissions do not give rise to hazard or nuisance.</i>

The updated version of section 7.0 Environmental Emissions makes the assessment for hydrogen sulphide emissions more robust and states:

7.0 Environmental Emissions

The Monitoring Management Plan details the methods, frequency and standards required for environmental monitoring at the site. In general environmental monitoring serves two purposes:

Permitted Emissions	Gas Engines and Flare Systems are monitored to ensure that exhaust and flare gas components are controlled within permitted levels.
Fugitive Emissions	Gas migration boreholes, Surface Emissions Monitoring and odour checks are undertaken to ensure that fugitive emissions do not give rise to hazard or nuisance
	7.0 (i) In the areas of leachate recirculation malodorous emissions will result in the recirculation system being turned off immediately. The system will only be turned back on when the requirements of Section 7.2 Fugitive Emissions have been met.

The following text is the current section 7.2 of the landfill gas management plan:

7.2 Fugitive Emissions

In the event of gas migration exceeding trigger levels, ENPL will assess and investigate the likely cause of the exceedance and initiate action to eliminate or control the

migration. Such action will include adjustment of flow at specific gas wells, remediation of equipment or proposal to augment or replace gas infrastructure.

Air-borne emissions detected by odour inspections or compliance monitoring (e.g. Surface Emissions Monitoring) will be addressed in the same manner.

Notification of fugitive emissions and proposed actions will be supplied to NRW via the SITA Compliance Manager within 24 hours of receipt (see Table 2).

ENPL shall provide details to the SITA Power Operations Manager of the nature and potential effect of any fugitive emissions and the action proposed to bring the emissions within permitted levels.

7.2.1 *Malodorous emissions in the leachate recirculation areas will lead to recirculation being stopped immediately and gas wells and leachate recirculation infrastructure being investigated using monitors capable of measuring parts per billion (ppb) Hydrogen Sulphide or parts per million (ppm) Methane. The recirculation system will not be turned back on until it is confirmed in writing to NRW that the source of odour is not a result of recirculation and agreement has been made with them to recommence or;*

If the leachate recirculation system is responsible for fugitive emissions that the sources have been remediated and re-monitored to confirm emissions have stopped.

The following text is the new section 7.2 of the landfill gas management plan:

7.2 Fugitive Emissions

In the event of gas migration exceeding trigger levels, ENPL will assess and investigate the likely cause of the exceedance and initiate action to eliminate or control the migration. Such action will include adjustment of flow at specific gas wells, remediation of equipment or proposal to augment or replace gas infrastructure.

Air-borne emissions detected by odour inspections or compliance monitoring (e.g. Surface Emissions Monitoring) will be addressed in the same manner.

ENPL shall provide details to the SITA Power Operations Manager of the nature and potential effect of any fugitive emissions and the action proposed to bring the emissions within permitted levels.

Notification of fugitive emissions and proposed actions will be supplied to NRW via the SITA Compliance Manager within 24 hours of receipt (see Table 2).

The current Procedure for Non-Routine events states:

7.3 Procedure for Non-Routine events

Abnormal conditions may arise in the operation of the gas management system:

- *Abnormal monitoring data*
- *Operational problems*
- *Failure of the gas control system*
- *Reported event*

In the event of any release of gas or odour having a potential impact on the local air quality or human health, this will be investigated to identify the root cause. Prompt action will be taken as necessary to minimise any impact

Gas Control Contingency Measures are included within the relevant section of the Monitoring Management Plan.

This is updated to specifically include re-circulation of leachate and fortifies the need to turn of the leachate recirculation system immediately in the event of odour from the recirculation area:

7.3 Procedure for Non-Routine events

Abnormal conditions may arise in the operation of the gas management system:

- Abnormal monitoring data
- Operational problems
- Failure of the gas control system
- Reported event

In the event of any release of gas or odour having a potential impact on the local air quality or human health, this will be investigated to identify the root cause. Prompt action will be taken as necessary to minimise any impact.

Gas Control Contingency Measures are included within the relevant section of the Monitoring Management Plan.

7.3.1 Malodorous emissions in the leachate re-circulation areas will lead to recirculation being stopped immediately and gas wells and leachate recirculation infrastructure being investigated using monitors capable of measuring Parts Per Billion (ppb) Hydrogen Sulphide or Parts per Million (ppm) Methane. The recirculation system will not be turned back on until it is confirmed in writing to NRW that the source of odour is not a result of recirculation and agreement has been made with them to recommence. (See 7.2.1)

GasSim Assessment

In accordance with the new **Section 4.1.2.3** of the GMP a review of the GasSim and current gas collection infrastructure has been carried out. The model for the site demonstrates that gas production rates should now be in the order of 720m³per hour of landfill gas which is a consequence of waste being “Dry”.

By recirculating leachate waste will become wetter and increased gas production rates are anticipated as a consequence of design to increase. They are not expected to increase beyond the maximum gas production rates set in the current GasSim. The emissions section of the GasSim model and plant requirements are unlikely to change as numbers and type of engines and flares will remain as per maximum gas generation rates in the existing GasSim. This means that 3.2 of the GMP does not currently alter.

In addition to this the assessment of the system has identified some gaps in numbers of wells, but full gas well coverage will be in place before leachate recirculation commences. This is in accordance with 4.1.2.2, 4.1.2.4, 4.1.5.1 and 4.1.5.2 of the GMP.

The GasSim model for the whole site suggests that the maximum volumes of gas being produced for the whole site would be 1400m³/hr. Page 13 of the Gas Management Plan states that the 50 percentile plot indicates gas production rate of approximately 720m³/hour in 2014.

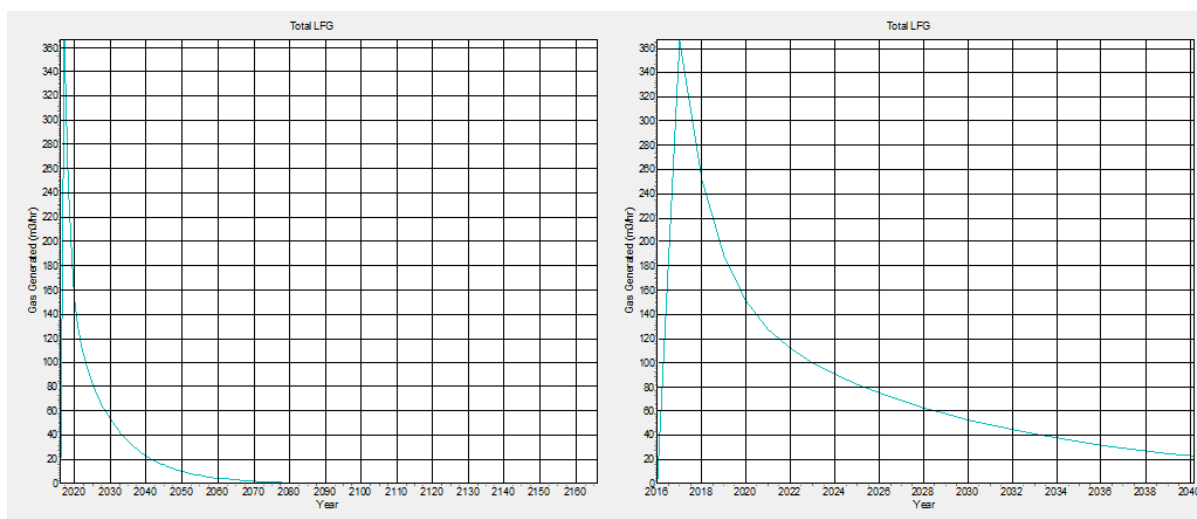
Gas Collection Infrastructure Review

In accordance with 4.1.2.2, 4.1.2.4, 4.1.5.1 and 4.1.5.2 of the GMP. A physical inspection of gas wells at site and review of the gas collection infrastructure plan *LFS-00104-WH/02* has been carried out for the area where leachate recirculation is proposed at Withyhedge landfill. The cell has been considered for:

- Whether gas wells and carriers have been de-commissioned
- Gas well seals and integrity of the collector pipework
- Density of gas wells
- Carrier pipe sizes; and
- Maximum volumes of gas collectable via each pipe diameter

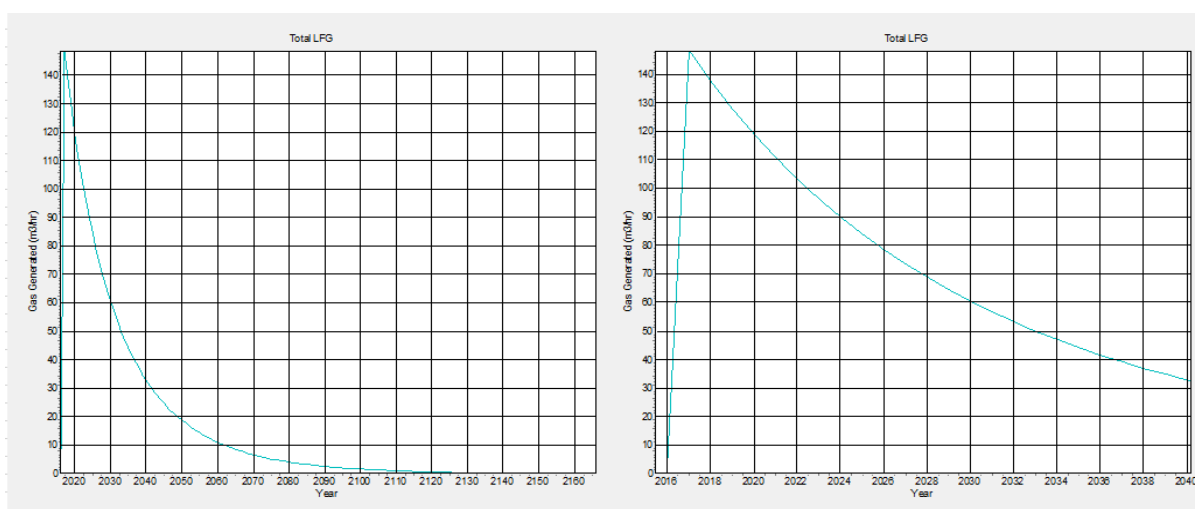
A review of the gas management system plan shows that the existing gas collector is capable of collecting 567m³ gas per hour (velocity of 10m sec⁻¹) being collectable via the northern 160mm 17.6 SDR collector and 720m³ per hour via the Southern 180mm 17.6 SDR pipe. The Northern section of the cell has 24 gas wells, the southern section has 10 wells. The initial phase of leachate recirculation is expected to affect the area with 10 wells in it. We know that waste in the cell is dry from the resistivity survey already carried out but the degree of degradation is impossible to accurately predict. The existing gas collector is capable of collecting 85% of 1400m³ gas per hour which equates to 1190m³, which is the volume of gas predicted to be produced at peak production in full GasSim for the site. This assessment of capacity of the larger carriers indicates the system has sufficient capacity to collect gas across the whole site

To assess that the gas collection system is able to collect all of the gas that **might** be produced in the recirculation cell, a simple GasSim Lite model has been developed. The model assumes the waste has already decayed to a degree before waste dried out. It has also been assumed that 50% of the waste in the cell still has gas production potential. The impact of recirculation assumes in the first scenario that the waste will become “wet” in the model 216,000 cubic metres (the model uses 259,000 tonnes based on a compaction ratio 1.2 t/m³) of waste are in the cell that is to be recirculated into. The Gassim Lite production curve (50 percentile) can be seen under these conditions. The maximum gas production rate is predicted in 2017 and is 370m³/hour. This is considered to be conservative estimate of potential uplift. At 85% collection rate we would expect to see 314m³/hour landfill gas collected.



Gassim Lite – “Wet” Conditions – Recirculation Cell

To give a range of modelled outputs a model with “Average” moisture conditions has also been considered and the GasSim Lite production curve (50 percentile) can be seen under these conditions. The maximum volume of gas predicted in that model is 150m³/hour and this is in 2017.



Gassim Lite – “Average” Conditions – Recirculation Cell

In either scenario there will be sufficient gas wells installed that are functioning and these can be seen in drawing LFS-00104-WH/02

The GasSim Lite models add to the existing GasSim that can be seen on page 13 of the Withy hedge Landfill Site Gas Management Plan January 2014 V2. This GasSim Lite modelling applies to the recirculation areas of waste only. This is an addendum to the 2014 document and is present to estimate what levels of gas increase might be seen.

As installers of the LRS we are aware that there is a buried sacrificial horizontal collector that

needs to be accommodated in the cell when recirculation commences. We have been informed by the Permit Holder that this horizontal collector is immediately below the capping layer and is currently dis-connected from the gas collection system and decommissioned permanently.

The impacts of the horizontal collector by potential leachate introduction will be prevented by only introducing leachate at a depth greater than 1m below the level of this horizontal system.

Drawing LFS-00104-WH/02

