19 July 2016

Horowhenua District Council
Private Bag 4002
LEVIN 4002

Attention: **Paul Gaydon**
Water and Waste Services Manager

Dear Paul

Levin Landfill Biofilter Technical Review

MWH New Zealand Limited (MWH) was engaged by the Horowhenua District Council (HDC) to provide technical comments on its document entitled *'Design Report: Odour Bio-filter for Levin Landfill'* (referred to hereafter as the 'design report') dated July 2016. Our comments are set out below. It is noted that no concept or detailed design drawings of the biofilter were included in the design report.

1 Introduction

Horizon Regional Council's (HRC) document entitled 'Review of Conditions of Discharge Permits 6009, 6010, 6011, 7289 and 102259 for the Levin Landfill—Schedule of Proposed Conditions' (referred to hereafter as the 'Schedule of Proposed Conditions') dated 30 October 2015 contains a number of proposed conditions for activities undertaken at Levin Landfill. Permit number 6011 relates to discharges to air and MWH provided a letter dated 10 June 2016 which suggested some amendments to these conditions.

Conditions 3H, 3I, 3J, 3K and 6E relate to the installation and maintenance of a biofilter at the Levin Landfill to control odour discharges from the leachate collection manhole. This odour emission source has been previously identified by MWH as a significant source of odour and landfill gas at the site (refer to MWH's report entitled *'Levin Landfill Odour Assessment'* dated February 2015). MWH's odour assessment report recommended that HDC should consider extracting the air from the leachate collection manhole for treatment by combustion in a flare, or if that is not possible or practicable, by biofiltration. It was noted that there is sufficient room for a biofilter adjacent to the leachate collection manhole. Providing that the air can be extracted and treated safely and effectively for treatment in a biofilter, the LFG and odour emissions at this source have the potential to be significantly reduced. Refer to the MWH odour assessment report for further details.

Conditions 3H, 3I, 3J, 3K and 6E are as follows:

> *"3H Within six months of the commencement date of the decision of the 2015 review of conditions, the leachate collection chamber must be vented to a bio-filter. The bio-filter must be designed by a suitably qualified and experienced person."*
>
> *"3I The Consent Holder must employ an appropriately qualified person to undertake a comprehensive assessment of the bio-filter performance on an annual basis. The assessment shall include, but not be limited to, an evaluation of the media size distribution and composition and effectiveness in removing contaminants."*

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"3J The Consent Holder shall measure and record the following parameters:

- *Continuous display of differential pressure for the bio-filter;*
- *Weekly recording of pressure across the bio-filter bed;*
- *Weekly general observations of the bio-filter condition, including weed growth, compaction and short circuiting;*
- *Quarterly media moisture content of the upper two thirds layer for the first two years of operation and then six-monthly thereafter;*
- *Quarterly monitoring of the pH of the bio-filter bed media in the upper two thirds layer for the first two years then six monthly thereafter."*

"3K The Consent Holder must ensure that the bio-filter and bed complies with the following limits at all times:

- *The air flow rate shall not exceed 100 cubic metres per hour per metre of bed;*
- *The pH of the filter material shall be between 6 and 8 pH units;*
- *An even distribution of gas flow through the filter bed; and*
- *There shall be no short circuits of untreated air through and filter bed."*

"6E The Consent Holder must carry out a weekly walk-over survey of all the landfill surfaces, including the area around the bio-filter and leachate pond. The purpose of the walk-over survey is to check for odour, cracks in the landfill cap surface and integrity of any gas collection or leachate pipework."

Refer to MWH's letter dated 10 June 2016 which suggested some amendments to these and other conditions.

The term 'biofiltration' is applied to a technology in which vapour phase compounds (generally organic compounds) are passed through a bed of media material ('biofilter') and adsorbed onto the exposed surface where they are degraded by microorganisms within the bed. The bed media is generally soil, bark, compost, scoria or any combination of these materials. The biofilter at Levin Landfill is proposed to comprise principally of bark (with minor components of compost and lime and/or crushed shell; see later) and be of high porosity (60%).

Biofilters are primarily used for odour control and if well designed and operated have good removal efficiencies (at least 95%) for odorous hydrogen sulphide (H_2S), organo-sulphur and organo-nitrogen compounds.

A photo of an example of a biofilter with bark media is shown in Figure 1–1. It is noted that the biofilter media depth at Levin Landfill will be 1 m and is therefore deeper than the example shown in the figure.

Figure 1–1: Photograph of a Biofilter with Bark Media

2 Determination of the Design Flow

The design volumetric flow rate (incoming gas flow through the inlet duct to the biofilter) is 199 cubic metres per hour (m^3/hr) and is based on a leachate chamber volume of 6.62 m^3 and 30 air changes per hour (or one air change every two minutes). A suitably sized fan (blower) is required to overcome pressure drop in the system. It will also be important to ensure that there is a 100% (or close) gas seal at the leachate chamber to ensure that there is negative pressure within the chamber and that fugitive odour and landfill gas emissions from the chamber do not occur (i.e. the odorous gases within the chamber are directed for treatment in the biofilter by mechanical ventilation).

A blower will be selected by HDC and in order to maintain the correct flow it is expected that a control valve will be required. As pressure drop is expected to increase over time as the filter media decomposes and settles, causing blockages in the holes in the pipes situated within the plenum (empty cavity situated below the biofilter media), or after heavy rainfall, HDC may wish to select a fan with a variable speed drive to have the ability to control the airflow to the biofilter.

The design volumetric flow rate of 199 m^3/hr (at actual conditions) equates to a flow rate of 0.06 m^3/s. For an inlet duct with an internal diameter of 100 mm (0.1 m), the air velocity within the duct will be 7.02 m/s.

3 Biofilter Volume

There are two main criteria for determining the volume of a biofilter to ensure there is sufficient media to treat the process gases. The first is the empty bed residence time (which is a measure of how long the gas will be present in the media), and the second is the media loading rate in cubic metres per hour per square metre of bed (e.g. 50 $m^3/m^2/hr$). The latter is also referred to as the ratio of total gas volume to bed cross-sectional area. It is noted that the maximum loading rate (air flow rate) specified in Condition 3K is 100 $m^3/m/hr$, however this is a typographical error and should be 100 $m^3/m^2/hr$.

The initial design residence time is conservatively assumed to be a minimum of 120 seconds (2 minutes), while the filter media depth is assumed to be 1 m. For a bark biofilter with a design residence time of 120 seconds, MWH recommends that the maximum loading rate should be 50 $m^3/m^2/hr$ (i.e. more conservative than Condition 3K).[1]

Based on the above information and assumptions, the required biofilter media area was calculated to be 6.62 m^2. Therefore, assuming that the length of each side of the biofilter media bed is 3 m (i.e. it is square), the design biofilter media area is 9 m^2. Given that the filter media depth is assumed to be 1 m, the design biofilter media volume is 9 m^3.

The actual residence time was estimated to be 163 seconds (approximately 3 minutes) and, therefore, in excess of the minimum design residence time of 120 seconds (2 minutes) and is acceptable.

The actual loading rate was estimated to be 22.1 $m^3/m^2/hr$ and, therefore, well below the maximum loading rate of 50 $m^3/m^2/hr$ (or 100 $m^3/m^2/hr$ specified in Condtion 3K) and is acceptable.

The required filter media area and volume was estimated to be 3.97 m^2 and 3.97 m^3.

Therefore, the information provided in HDC's design report indicates that the proposed bark biofilter media bed dimensions of 3 m by 3 m by 1 m (depth) will be suitable for a design volumetric flow rate of 199 m^3/hr. Furthermore, two cells will be installed of the same dimensions to allow for maintenance and repair work to be undertaken on one of the cells without compromising odour control which will continue to be provided by the other (identical) cell (i.e. the biofilter will be capable of running with parts of the bed isolated from the incoming gas flow).

[1] This is consistent with the Auckland Council's Technical Publication Number 152: Assessing Discharges of Contaminants into Air, Auckland Regional Council, April, 2002 (Draft).

4 Biofilter Design

A schematic plan view of the biofilter is shown in Figure 4–1. This figure is for illustrative purposes only (not for construction).

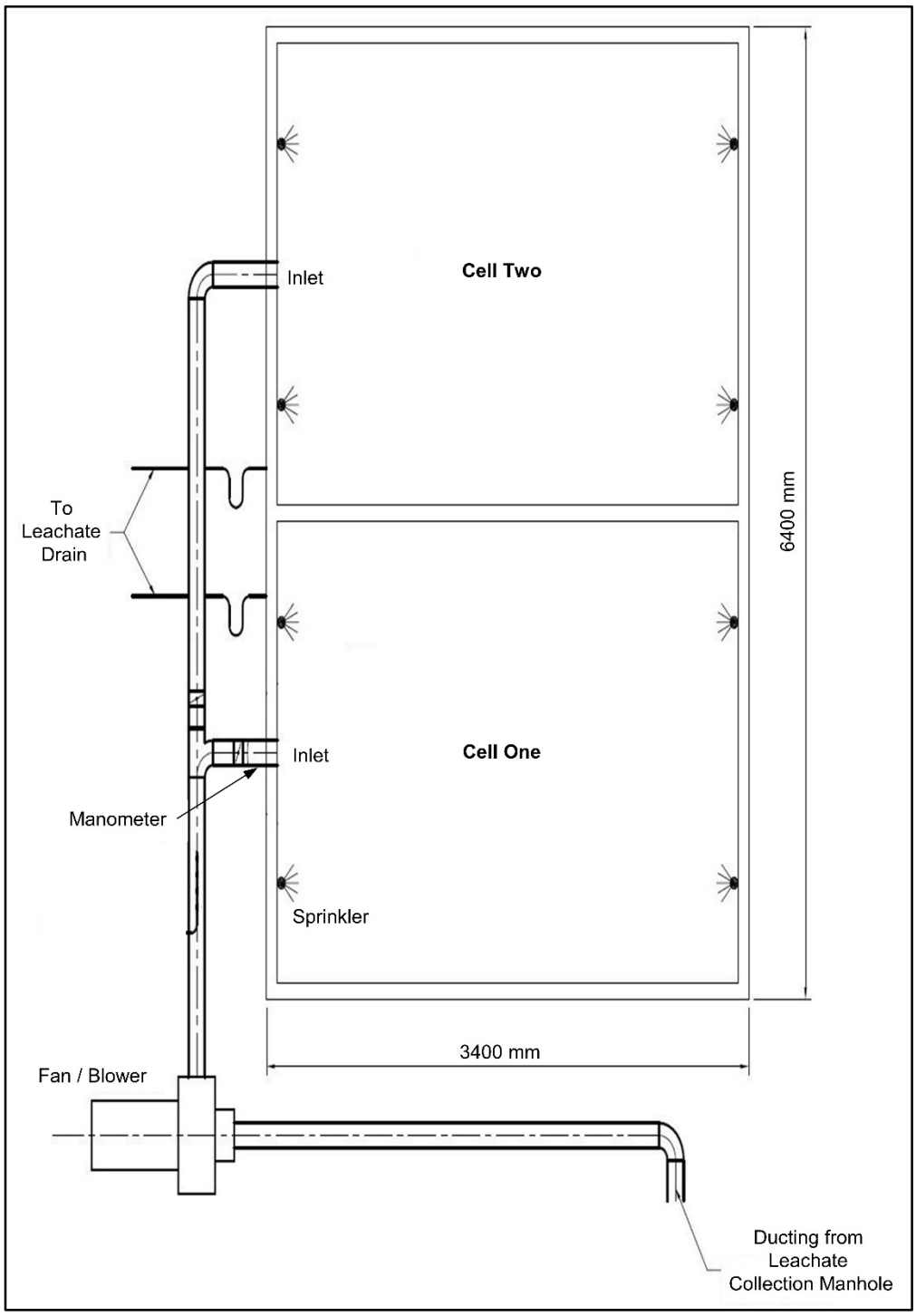

Figure 4–1: Schematic Plan View of the Biofilter at Levin Landfill

The proposed biofilter structure should comprise of a concrete slab with concrete block walls (200 mm width) and under-drainage to remove biofilter-derived leachate (see later note).

There should be an open plenum of a depth of at least 200 mm under the media and an internal polypropylene geo-membrane liner should be placed around the side walls and base of the structure to protect the concrete and to collect leachate. The purpose of the plenum is to distribute the incoming odorous air evenly beneath the biofilter media via pipework. Concrete blocks or open plastic box structures (e.g. Atlantis matrix mini modules) could be considered to be placed within the plenum, rather than stone pebbles or limestone chips (to provide greater porosity) and a 6 mm (1/4 inch) polypropylene 'oyster drainage mesh' should be placed above the liner (overlap) and drainage cells to provide adequate support to the media, rather than a 100 mm mesh stated in the design report (to ensure that the bark chips do not fall into the plenum where they could block the pipework).

The inlet duct should be made of galvanised mild steel (as opposed to PVC, as indicated in the design report) as it will be necessary to attach sampling ports and fittings, and the leachate/condensate drain will be made of PVC.

Based on our experience, the composition of the media should comprise of a blended mixture of aged and washed bark chips of 20 mm minimum particle size (90%), compost (5%) and crushed shell (5%). The bark will provide the porosity (approximately 60%) and structure, while the compost will provide microorganisms, nutrients, and moisture holding capacity. It is noted that the composition shown in the design report is different to this recommendation. To ensure the biofiltration performance is optimal, the media should be raked and loosened on a minimum 3 monthly basis, as discussed below. Periodic smoke testing should be carried out to identify any short-circuiting that may be occurring. This testing should be carried out a three-monthly intervals, or more frequently if odorous gases are suspected to be bypassing the biofilter bed.

A sprinkler system should be provided with a mains powered automatic timer for daily irrigation of the media. The timer configuration can be manually adjusted for seasonal variation if required. Operations staff should check the moisture levels in the media periodically using a manual moisture probe to ensure the watering regime is maintaining the media in a visibly damp state and at between 40-60% moisture content (not over-watered or under-watered). Irrigation should be provided on the top lip of the biofilter (on opposite sides) to provide adequate coverage.

It is noted that too little moisture could cause cracking and decreased microbial activity within the media, while too much moisture could cause clogging, preventing adsorption, increasing the pressure drop and leading to undesirable anaerobic activity. It is not necessary to cover the biofilter[2] with a roof, provided that there is adequate drainage available within the biofilter, and it is important to be able to have access to the top of the filter for undertaking maintenance (including raking/loosening of the media and checking the moisture content and pH).

Leachate generated from the biofilter will drain through a PVC water trap to the landfill's leachate collection system. Pressure flushing of the water trap could be undertaken, if surcharging of the trap is observed, by inserting a pressure hose using a plastic screw cap connection with an attachment that closely matches the internal diameter of the pipe. The pressure hose would need to reach past the leachate drain pipe connection from the biofilter. The attachment to the pipe should be used to reduce backflow to the biofilter. The plastic screw cap connection would also allow for a smoke injection point for any smoke testing required.

[2] The media in an open-bed biofilter should be uncovered and exposed to the weather conditions, including rain.

5 Biofilter Monitoring

There is a potential for the biofilter to fail if the media becomes compacted and low in porosity, causing short-circuiting (when the media is bypassed) and the consequent break-out of untreated odorous gases (often along the biofilter walls but it can also occur in 'vents' across the biofilter bed due to uneven settlement over time). Air channelling (uneven airflow through the biofilter) will reduce the contact time (residence time) between untreated odorous air and filter media, therefore, negatively affecting odorous gas removal efficiency. Furthermore, an increase in back-pressure can cause excessive wear and tear on the mechanical ventilation equipment (blower). In order to avoid these issues, the biofilter media should be periodically raked/loosened (e.g. on a quarterly basis) and it is likely that the media will need to be replaced every five to seven years as it will gradually degrade over time.

An inclined manometer should be fitted to the inlet duct to the biofilter as shown in Figure 4–1 to allow the pressure drop over the biofilter media (the difference between the inlet pressure and the ambient pressure) to be determined on a weekly basis, or as required. The manometer could be fitted to a 5-6 mm barbed pipe attached to the inlet duct.

It is noted that Condition 3J specifies continuous monitoring of differential pressure. Whilst continuous differential pressure (DP) sensors could be fitted, MWH suggests that it would be appropriate for operations staff to check and record the pressure readings on a weekly basis. Based on MWH's experience, many of the continuous instruments (e.g. Dwyer Instruments) require a minimum gas flow rate and pressure to be reached in order to make good (accurate) measurements and there are some units that have a digital interface. An appropriate manometer / pressure sensor should be selected based on the actual volumetric flow rate (incoming gas flow) and pressure achieved at the biofilter.

If the pressure drop increases to around 100 mm water gauge, then the porosity of the biofilter media needs to be inspected and remedial action taken, if required. A sampling port should be added to the inlet duct to allow for checks on the incoming gas flow to the biofilter, as flow adjustments could be made with a control valve.

Also on a weekly basis (at the same time that the pressure drop is checked), the biofilter media's moisture content should be measured to ensure that it is between 40-60% moisture content.

On a monthly basis, the pH of the biofilter media needs to be checked using a manual probe and recorded to ensure the pH has not become too low (Condition 3K requires the pH of the media to be maintained at between 6 pH and 8 pH). A by-product of treating sulphides is the production of sulphuric acid. Lime or crushed shell can be added to the biofilter media to increase the pH if required.

HDC will be required under Condition 3I to undertake a *"comprehensive assessment"* of the performance of the biofilter on an annual basis. However, the performance criteria should actually be determined by HDC on a more regular basis, to ensure that it is effective in controlling odour and landfill gas emissions. MWH suggests that the annual report should summarise the following monitoring and inspection data:

- Daily visual inspection and recording of the state of the biofilter bed, particularly for signs of any short-circuiting, clogging of the bed, compaction and weed growth. This should also be coincide with a weekly "check for odour" at the biofilter (and at other locations across the landfill site), which would involve undertaking a sniff test and scoring the odour intensity in accordance with MfE (2003),[3] as required by Condition 6E. The inlet gas fan and ductwork should be inspected daily and any maintenance undertaken should be recorded;
- Weekly monitoring and recording of the pressure drop across the biofilter media to ensure that it is less than 100 mm water gauge;

[3] MfE, 2003. Good Practice Guide for Assessing and Managing Odour in New Zealand, Ministry for the Environment, June 2003.

- Weekly monitoring and recording of the biofilter media moisture content to ensure that it is between 40-60% moisture content. It is noted that Condition 3J specifies checking the media moisture content of the filter bed on a quarterly basis for the first two years of operation and then six-monthly thereafter, however, MWH does not agree with this and suggests that weekly monitoring and recording of the media moisture content is required to ensure that optimal conditions for the microorganisms are maintained;
- Monthly monitoring and recording of the pH of the media to ensure that it is between 6 pH and 8 pH. It is noted that Condition 3J specifies checking the pH of the filter bed on a quarterly basis for the first two years of operation and then six-monthly thereafter, however, MWH does not agree with this and suggests that monthly monitoring and recording of the media pH is required to ensure that optimal conditions for the microorganisms are maintained; and,
- Quarterly raking and loosening of the biofilter media, or as otherwise required, to reduce the potential for short-circuiting, clogging of the bed, compaction and weed growth.

In accordance with proposed Condition 6F, HDC is required to "maintain a log of all inspections, investigations and actions taken in accordance with all monitoring and odour inspection conditions" of consent number 6011. The condition also requires HDC to make the log available to the HRC on request, and a summary of all results and assessments should be presented in the annual report (as specified in Condition 3I).

6 Summary

HDC plans to install a biofilter at the Levin Landfill to treat odour and landfill gas emissions at the leachate collection manhole via mechanical ventilation. MWH has reviewed the information and data provided in HDC's design report for the biofilter. Based on this review, MWH considers that the proposed biofilter will be of a suitable size to control odour at this emission source, providing that there is a 100% (or close) gas seal at the leachate chamber to ensure that there is negative pressure within the chamber and that fugitive odour and landfill gas emissions from the chamber do not occur.

The main structure will incorporate two cells, each comprising a biofilter media area of 9 m^2. The structure will comprise of a concrete block wall on a concrete pad, with the odorous gas entering into an open plenum at the base of the biofilter media. A separate leachate drainage pipe via a water trap will allow for removal of any excess water.

The biofilter media will mainly be a mixture of graded, aged and screened pine bark chips of 20 mm minimum size, with a small amount of compost and some lime or crushed shell material added to reduce acidity. The process gas being treated will enter an empty cavity (plenum) as the media will be supported by concrete blocks or open plastic box structures which are covered by a 6 mm mesh. A manometer will be fitted to the cavity to measure the back-pressure of the media so that periodic checks can be made to ensure that the pressure is less than 100 mm water gauge.

As the biofilter needs to be maintained at between 40-60% moisture content, irrigation will be provided on the top lip of the biofilter on opposite sides to provide adequate coverage.

Providing that the biofilter is designed and operated in accordance with the recommendations stated in this letter, MWH considers that the biofilter will be effective in controlling odour and landfill gas emissions such that the odour emissions from the leachate collection manhole will be significantly reduced.

I trust that this meets your requirements. Should you require any additional information or clarification, please do not hesitate to contact me on (09) 580 4575 or 021 766 576.

Yours sincerely

Dr Doug Boddy
Senior Air Quality Consultant
MWH New Zealand Limited

Reviewed By: 
Dr Paul Heveldt (18/7/2016)

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