24 November 2025
Job No: 1101381.0000

Horowhenua District Council
126 Oxford Street
LEVIN 5540

Attention: Tony Parsons

Dear Tony

Levin Closed Landfill
Leachate Remediation Review

1 Introduction

This letter report presents the results of Tonkin & Taylor Ltd (T+T)'s review of work conducted by Earthtech Ltd on behalf of HDC in relation to the closed Levin Landfill. This work was done in accordance with our Letter of Engagement dated 15 October 2025. Specifically, this letter report provides our review of the technical work completed to date and a suggested pathway forward.

2 Background

T+T has previously provided advice on the Levin Landfill (2008 work by Tony Kortegast for the Parliamentary Commissioner for the Environment (PCE), and 2019 Best Practicable Option advice for Horowhenua District Council (HDC)). Since then, HDC has engaged Earthtech to progress the Best Practicable Option (BPO) for meeting consent conditions requiring the cessation or material reduction of leachate from the old landfill reaching the Hokio Stream. The Earthtech recommendation, which was subsequently endorsed by Council in May 2024 was for a groundwater extraction and discharge of extracted leachate contaminated groundwater to the Levin WWTP.

Investigations since May 2024 have confirmed that the BPO is not currently feasible. The key matters being:

- The recommended extraction location is in a Natural Inland Wetland and wetland offsetting would be required.
- The Levin WWTP is not able to accept the extracted groundwater without putting compliance at risk until after the Master Plan upgrades are completed.

Subsequent review by Council officers, supported by Good Earth Matters has identified that the urgency to act indicated in technical reports was based on consent compliance date and not directly linked to imminent significant environmental effects.

HDC is required to engage with its iwi partners and parties to the consent and landfill agreement (i.e. Neighbour Liaison Group, NLG) in this work. At present, there is not a common understanding between HDC and these parties as to the effects of the leachate discharges, feasibility of reduction of leachate production, nor the need or urgency to undertake remedial works.

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HDC officers will be reporting back to Council in December 2025 on the monitoring framework and options for leachate intervention and capping of the old landfill.

3 Legal Context

The following discussion regarding the legal context was taken from the Earthtech report "Assessment of Groundwater Pollution Plume Mobility and Remediation Plan Rev A, May 2023, Earthtech Consulting Ltd".

The Horizons Regional Council has issued several (a suite of) consents in relation to the operation of the Levin Landfill which are detailed in HDC's Annual Compliance Audit Report for July 2021 to June 2022 (HDC, December 2022). This latter compliance audit rated the Levin Landfill as moderately non-compliant. Consent condition 2A of ATH-2002003983.02 (6010) requires that the selected leachate remediation option (the BPO) is fully implemented by June 2023.

An Environmental Court of New Zealand Consent Order (19 December 2019) was issued following a matter presented between the Hōkio Environmental Kaitiaki Alliance (HEKA) and Horizons Regional Council (HRC) and Horowhenua District Council (HDC), ruling that the Levin Landfill Consent Conditions be amended. Accordingly, the General Consent Conditions on discharge of leachate to ground notes, under Discharge Permit 6010 section 2A, that by the end of April 2021, the Permit Holder must complete an assessment of leachate remediation options (and a BPO) to:

- Cease, or if cessation is not feasible, materially reduce the discharge of leachate to the Tatana Drain and Hōkio Stream.
- If neither of the options in (a) are feasible then options to offset effects within the Hōkio catchment and if that is not feasible or possible options to compensate effects within the Hōkio catchment or outside of it (either option through an ecological package).

The order further states that the Permit Holder (HDC) shall decide on a BPO that is feasible to implement, applying the hierarchy under a) and b) above from the assessment. HDC must notify the Regulatory Manager of Horizons Regional Council (HRC) which BPO it selects and provide a copy of the final assessment. The selected leachate remediation option must be fully implemented by June 2023.

The Court Order further details HDC's consent conditions in Section 3, providing monitoring conditions and trigger values for sampling locations within the Hōkio Stream, namely locations HS1A, HS2 and HS3. Specifically, at the downstream location of HS3, maximum and average ammoniacal-N trigger value concentrations of 2.1 mg/l and 0.4 mg/l respectively, are stated.

As at May 2023, A BPO was being put into action by the HDC, addressing a series of works aimed at the remediation of environmental areas affected by historical pollution plumes.

The BPO elements addressed in the review contained herein include the remediation of contaminated land in the gully area around BHC2 via a groundwater extraction trench (Element 3) and additional capping to the top and sides of the closed landfill (Element 5).

4 Scope of work

T+T has completed the following scope of work, the results of which are presented herein, to support resolution of the issues noted above.

Review of technical work to date

- Existing monitoring and technical reports have been reviewed, specifically focussing on the estimates of leachate migration and resulting impact on Hokio Stream, including a discussion of uncertainty and likely range of impacts and identification of data gaps.
- The feasibility and efficacy of proposed extraction options have been assessed, and alternatives presented to avoid or minimise the impacts on the natural inland wetland.

Monitoring recommendations

- A high-level overview of the sampling plan and sampling results (focussing on leachate and groundwater) has been conducted to assess if the sampling plan can be improved and/or if the sampling results can be better used to assess the change in quality and rate of leachate migration from the landfill as well as compliance with consent conditions.

Review of recommendation for side slope capping

- Previously provided options for landfill capping and predicted reduction in infiltration estimates have been reviewed in light of further work conducted with comment including any recommendations for revising this estimate.

5 Objectives

HDC has indicated that the results of the reviews conducted will provide input to their Expert Panel. It is understood that the purpose of this group is to:

- Confirm, from existing monitoring and technical reports, the current and likely future effects arising from the leachate plume on the Hokio Stream water quality and ecosystems.
- Identify the level of certainty in these conclusions and identify any critical information gaps.
- Confirm if likely future effects may result in significant adverse effects and / or non-compliance with consent conditions and water quality limits for the Hokio Stream.
- If likely future effects are assessed as being significant and / or leading to non-compliance, confirm the understanding from the technical assessments as to the timing at which intervention is required to be implemented to avoid or minimise those effects.

The group membership will include representation from Council and its advisors, the NLG, Project Management Group for the landfill. Horizons Reginal Council may have some representation on the group as observers, but this is yet to be confirmed.

6 Documents Reviewed

The following documents were reviewed for the assessments included in this letter report.

- Assessment of Groundwater Pollution Plume Mobility and Remediation Plan RevA, May 2023, Earthtech Consulting Ltd.
- Conceptual Groundwater Model Report, Levin Landfill, Hokio Beach Road, Levin, Revision B, Final, February 2024, Earthtech Consulting Ltd.
- Numerical Groundwater Modelling Report and BPO Engineering Design RevB, February 2024, Earthtech Consulting Ltd.
- Hokio Stream Water Quality Predictions for Proposed Best Practical Option 3 – Groundwater Intercept Drain Remedial Works, Levin Landfill, Letter Report dated 11 July 2024, Earthtech Consulting Ltd.
- Analysis of Alternative Groundwater Intercept Drain Located at the Landfill Toe, Levin Landfill, Letter Report dated 13 December 2024, Earthtech Consulting Ltd.
- Levin Landfill Ecological Assessment, Draft v2, 19 May 2025, Ecological Solutions Ltd.
- Levin Landfill July 2025 Quarterly Groundwater, Surface Water and Leachate Monitoring Report, Revision 2 Final, 19 August 2025, Stantec.
- Levin Landfill – Summary of Leachate Options Assessment Letter Report dated 6 December 2019, T+T.
- Levin_LF_tabulated results_July_2025_shallow system monitoring.xlxs.
- Levin Closed Landfill Management Plan, rev02 Draft for Client, 24 November 2024, Stantec New Zealand.
- Critique of Earthtech BPO and suggested refinements, Graeme Lindsay, PhD, Powerpoint presentation, undated.
- Another Perspective on Levin Landfill Area A2 Mitigation: Protecting the Wetland – Cofferdam and Extraction Wells, G. Lindsay, PhD undated.

7 Current Situation

Earthtech used numerical model predictions to estimate future leachate concentrations in groundwater near the stream, and mass flux calculations to estimate resulting concentrations in the stream after accounting for groundwater inputs to streamflow.

The most recent assessments regarding impact of leachate (NH_4-N) on Hokio Stream are as follows:

- Hokio Stream Water Quality Predictions for Proposed Best Practical Option 3 – Groundwater Intercept Drain Remedial Works, Levin Landfill, Letter Report dated 11 July 2024, Earthtech Consulting Ltd.
- Levin Landfill Ecological Assessment, Draft v2, 19 May 2025, Ecological Solutions Ltd.
- Levin Landfill July 2025 Quarterly Groundwater, Surface Water and Leachate Monitoring Report, Revision 2 Final, 19 August 2025, Stantec.

Our review has highlighted that there is significant uncertainty associated with each of the information sources that have contributed to a conclusion that landfill leachate will cause exceedances of trigger levels in the future, including:

- Although collected over a relatively long time-period, site data is low-frequency and robust statistical analysis has not been completed. Site data may not be accurately representing short-term pulses of contamination or how the wetland / existing drain are interacting.

- The numerical modelling work has inherent uncertainties and limitations due to how the model has been constructed and the input parameters used.
- Leachate concentrations in groundwater and streamflow conditions used to complete the mass flux calculations may not be representative of actual site conditions (and thus not reasonable).

Each of these are described in more detail over the following sections.

Earthtech's 11 July 2024 letter report documents their use of a mass flux approach to estimate maximum predicted future NH_4-N concentration in Hokio Stream. The stream flow monitoring conducted by NIWA was utilised for these predictions. Specifically, the results of the modelling indicated a maximum NH_4-N concentration of 9.2 mg/l over the width of the plume approaching Hokio Stream in the year 2045 (20 years in the future). With the proposed intercept drain operating, Earthtech estimate a maximum NH_4-N concentration of 4.1 mg/l over the width of the plume.

In terms of predicted concentrations within Hokio Stream, Earthtech have applied extremely conservative assumptions based on the highest concentrations reported at monitoring location HS3 (the compliance point). All predictions are based on low flow stream conditions. Even with conservative assumptions, Earthtech estimate a future average NH_4-N concentration at HS3 of 0.38 mg/l, below the consented average concentration limit of 0.4 mg/l.

In estimating the predicted future maximum concentration at HS3, Earthtech use a single data point from February 1994 to increase the 2024 low flow NH_4-N concentration by a factor of 20. Even with this extremely conservative approach, they estimate a maximum concentration of 2.6 mg/l at HS3, minimally above the consented maximum of 2.1 mg/l.

There are a number of uncertainties associated with Earthtech's predictions (beyond the uncertainties associated with the modelling, as noted below). These include, but are not limited to, the following:

- The influence of the Northern Farm Drain and the wetlands.
- The groundwater / surface water interaction in terms of both changes to state of NH4-N (through nitrification / denitrification), NH4-N attenuation through the stream bed, and the actual flux in and out of the stream from / to groundwater over time.

The ecological assessment undertaken in May 2025 notes the following:

- "surveys found no evidence of current (May 2025) ecological effects of the leachate plume, with the high abundance of ammoniacal- nitrogen sensitive snails[1] indicating leachate is not likely to be currently altering the Hokio Stream's capacity to support aquatic fauna".

The most recent stream sampling conducted by Stantec as noted in the July 2025 Quarterly Report did not show any exceedances of Ammoniacal-N in Hokio surface water and no significant change in Nitrate-N between upstream and downstream. The recently received data from October and November 2025 confirm the NH_4-N results.

Based on the most recent groundwater sampling event, the highest leachate concentrations appear to be associated with the area around C2 and the wetlands; rather than located nearer to the landfill toe. Subject to further statistical interrogation, this suggests:

- Leachate concentrations discharging from the landfill are likely reducing. This would be consistent with the age of the landfill.
- Relatively high dilution / attenuation is likely occurring over relatively short distances within the wetlands.

[1] *Potamopyrgus*

Although there is a degree of uncertainty in the predictions (which could either overestimate or underestimate effects) and although field data does suggest that a plume may be migrating from the landfill to the stream, there is nothing presented in the Earthtech reports to support that immediate physical intervention is required. Furthermore, although relatively quick to implement, the installation of a 200m trench may not be a pragmatic option. Particularly given that the trench itself presents another set of environmental challenges associated with impacts to the existing wetland, and off-site management of the waste stream generated but the interception.

In summary, there is currently little justification, based on work conducted to date, for assuming adverse impact to Hokio Stream from NH_4-N concentrations in groundwater migrating from the closed landfill now or in the future. The proposal for a 200m trench is not supported by the technical work conducted to date.

8 Review of technical work relating to leachate migration and remedial design

The predictions of leachate migration and assessment of the proposed remedial design were based on development of a Hydrogeologic Conceptual Site Model (HCSM) and subsequent development and use of a numerical model by Earthtech Consulting Ltd (Earthtech). A review of the model has been conducted with reference to the Australian Groundwater Modelling Guidelines, Barnett et al. (2012), National Water Commission, Canberra. The pertinent results of the review are presented below.

The stated modelling objectives were to assess the ammoniacal nitrogen (NH_4-N) plume within the groundwater system and to assess the effectiveness of the proposed groundwater intercept drain to provide the Best Practical Option remedial works design.

The HCSM is well presented and includes discussion of the relevant components (source, pathway, receptors) required for a numerical model to assess contaminant migration in groundwater. A FEFLOW finite element groundwater model was then set up to simulate both groundwater flow and contaminant transport. In addition, the model was used to assess the effectiveness of a groundwater intercept drain (BPO3) to meet consent conditions as noted above. Based on the modelling results, a 200m long drain was recommended.

The assumed model input parameters are well documented in the report. However, because of limited site data, a number of the key input parameters to the model such as hydraulic conductivity, infiltration and contaminant source concentrations are not well supported.

In terms of model boundary conditions, it is noted that both the Hokio Stream and the Northern Farm Drain are set as a constant head boundaries. For Hokio Stream, this means the stream is always a gaining stream but never a losing stream. For the Northern Farm Drain, this means that the drain always contains water and always flows into Hokio Stream. These assumptions are not supported by the stream gauging conducted by NIWA. In terms of assessing the performance of a proposed intercept drain, it should be noted that no site specific pumping tests have been conducted. The assessed performance of the trench was based on slug tests (where no, or minimal, volumes of groundwater are removed) from two locations (3 test results). This is not adequate for the assessment of long term pumping from a trench.

The model was calibrated to both groundwater levels and NH_4-N concentrations. While the calibration to groundwater levels showed a good correlation (not surprising given the use of constant head boundary conditions), the calibration to NH_4-N concentrations was not ideal, also not surprising given the lack of site specific source concentrations as well as other parameters. The model results both under-predicted and over-predicted concentrations but did generally match the observed plume configuration, just not exact concentration levels.

The model was not calibrated to groundwater flow rate (as in a comparison to groundwater pumping rates or groundwater discharge to the stream). This, combined with a lack of adequate site specific hydraulic conductivity or infiltration data, is a serious omission, particularly in terms of evaluating the proposed trench performance or estimating groundwater flow into Hokio Stream.

There is always a degree of uncertainty with any numerical model predictions. As discussed above, the primary sources of uncertainty in Earthtech's modelling relates to the model set up, the assumed input parameters, and the lack of calibration to groundwater flow rate. Earthtech's modelling report does not include a discussion of model uncertainty.

In summary, the numerical model used by Earthtech incorporates a significant level of uncertainty and is not an appropriate tool for evaluating remedial solutions (particularly in regard to groundwater pumping scenarios).

9 Review of recommendation for side slope capping

In 2019 T+T carried out a review of options to reduce the impacts of leachate from the old unlined area of the Levin Landfill (Area 1). The landfill has an estimated area of about 4.8 Ha of which the relatively flat top area is about 2.5 Ha. The side slopes, with typical gradients of between 1V:4H and 1V:3H, occupy about 2.3 Ha. The top area has a clay cap over the waste whilst the side slopes are capped with dune sand. One of the options considered was improving the capping of the landfill and, in particular adding a clay cap to the landfill side slopes. This study estimated the likely effectiveness of the various options. With respect to capping the side slopes with a clay cap, it was estimated that doing so would reduce the total infiltration of rainwater to groundwater (volume of leachate generated) by about 45%. HDC have requested that this assessment is reviewed in the light of additional information now available and a differing opinion expressed by HDC's consultant Earthtech.

Since 2019 remedial works have been carried out to the capping on the top, relatively flat, area of the landfill. It is understood that this work consisted of stripping off topsoil and adding approximately 3,800 m^3 of compacted clayey soil material to remove depressions, after which topsoil was reapplied and the cap grassed. The objective of this work was to ensure that a minimum thickness of clay cap of 700 mm was achieved to comply with the requirements of the resource consent and to prevent ponding of water, to reduce infiltration of rainwater. No additional work has been carried out to the side slopes which remain capped with approximately 0.7 m of fine dune sand with a covering of well vegetated topsoil.

Earthtech were engaged by HDC to develop remedial solutions to mitigate the adverse effects of leachate generated within the landfill on the Hokio stream. Earthtech developed a hydrogeological model for the landfill and surrounding area and made a number of assumptions concerning the amount of water infiltrating through the landfill cap to groundwater. Notably, an average infiltration rate to groundwater of 10% of annual rainfall has been assumed for the landfill. This relatively low infiltration rate is based on an assumption that there is little infiltration through the sand capped side slopes and that there would be no benefit in capping the side slopes with clay. We understand that this assumption is based on the following:

- Measured leachate generation rates in the newer lined part of the Levin Landfill, which has a clay cap, are reported by Earthtech in their 'Numerical Groundwater Modelling report and BPO Engineering Design, Levin landfill, Hokio Beach road, Levin, 21 February 2024' as being between 6% and 13% of annual rainfall that infiltrates through the cap to generate leachate.
- In response to PMG points raised in an email from PMG dated 19 March 2024, Earthtech respond in a document titled 'Responses to Dr. Graham Lindsay' dated 17 April 2024 as below:
  - Query 3 – Effective capping:

- Detailed walk-overs across the northern face of the landfill slope during wetter weather showed 'less than minor to negligible evidence of water ingress' with no notable evidence of rilling or scour.
- No evidence to support clay capping. There is a stronger case to leave 'as-is' noting that clay soils are subject to shrinkage and cracking until cover soils and vegetation has established.
- 'Whilst there may be the likelihood of some recharge of rainwater into the existing waste body, this would largely be from the flatter top surface - but unlikely following the recent land forming and clay capping works'.

- In response to 'Red Flags' raised by Dr G Lindsay, Earthtech respond in a document titled 'LD LEVIN LANDFILL SITE – RESPONSES TO DR. GRAHAM LINDSAY'S POINTS TITLED: "IMPROVING EARTHTECH'S BPO LEACHATE MITIGATION PROPOSAL, RECEIVED 14 OCTOBER 2024' dated 15 November 2024 as below:
  - Red Flag 6:
    - Soil inspections were carried out using a spade and hand auger to up to 1m depth and soil conditions were found to be 'moist' not 'wet/saturated'
    - No high flow paths such as cracks were identified. A good soil and vegetation cover was noted.
  - Red Flag 7:
    - In response to an experiment carried out by Dr Lindsay in which he poured water quickly onto the sand capped slopes and observed only minimal runoff Earthtech responded that pouring water onto the slope is not an effective test to determine potential runoff under rainfall conditions. Infiltration should be tested under saturated conditions.
    - The 'crust-nature' of the soil cap held together by established vegetation is of significance.
    - Evapotranspiration losses must be considered.

We have the following comments:

- The measured leachate generation rates in the newer lined landfill, are consistent with typical leachate generation rates in a landfill with a clay cap meeting normal New Zealand practice (typically 600mm thickness of clay with a permeability of 1 x 10-7 m/s and 150 mm of vegetated topsoil). 10 % infiltration of rainfall to groundwater is a reasonable assumption for a landfill with a clay cap.
- A cap of fine dune sand is likely to have a permeability of about of about 1 x 10-5 m/s and does not conform to NZ best practice and would be expected to allow greater infiltration that a clay cap. Given that approximately half of the old landfill has a sand cap, adoption of an infiltration rate to groundwater of 10% for the whole landfill seems likely to underestimate infiltration.
- A 'vegetated crust' is not likely to act as an effective barrier to infiltration. In fact, vegetation roots provide high permeability pathways for water to pass through a topsoil layer preventing the formation of a low permeability 'crust'. The amount of infiltration through a landfill cap is generally controlled by the underlying barrier material. Vegetation also slows down any potential runoff, even on the relatively steep slopes at the landfill, providing opportunity for infiltration.
- Earthtech's observation that the sand cap material was moist but not wet or saturated does not support the assumption of minimal infiltration. The relatively high permeability of the

sand will allow water to drain away quickly following a rain event so saturated ground would not be expected.

- With regard to Dr Lindsay's experiment pouring water onto the sand cap, it is correct to state that this does not prove a high infiltration rate through the cap. It does however demonstrate rapid infiltration into the topsoil layer. As noted by Earthtech, infiltration is measured under saturated conditions, (normally using a double ring infiltrometer). However, it should be noted that under normal environmental conditions, prior to a rain event the ground is unlikely to be saturated and under these conditions infiltration is initially higher as indicated by Dr Lindsay's experiment.

Infiltration rate may be estimated from the soil permeability. A review of available information indicates the following table below:

Soil type	**Typical permeability m/s**	**Typical infiltration rate mm/hour**	**References**
Clayey soils	1×10^{-7} or less (1×10^{-7} is the maximum value required for the clay cap)	1 - 5	Hillel (1998)
Sand	1×10^{-5} reasonable for fine dune sand	>20	

Whilst there has been no testing on the side slopes at the landfill there is no evidence or reason to believe that the typical infiltration rates in Table above are not representative of the two types of landfill cap. Therefore, the following conclusions can be drawn:

- Based on the above information, for a clay cap such as on the top of the landfill it would be expected that the rate of infiltration of rainwater into and through the capping material will be less than that through the topsoil. The typical infiltration rate expected through the clay cap is less than typical heavy rainfall intensities and therefore for any intense / heavy rainfall event, the topsoil is likely to become saturated promoting runoff of surface water and minimising infiltration.
- For a sand cap the potential rate of infiltration through the sand layer is much greater and is greater than typical rainfall intensities. Consequently, unless the rain is very intense the sand layer is likely to drain the topsoil layer resulting in minimal runoff. i.e. most of the rainfall, except in very heavy rain events, is likely to infiltrate into the cap.

The proportion of rainfall likely to runoff can be estimated using the USDA NRCS Curve Number method (USDA, NRCS National Engineering Handbook, Part 630 Hydrology, Chapter 10 (2004)). Conservatively assuming dune sand to be Hydrologic Soil Group B (assuming that the sand is well compacted to minimise its permeability) and allowing for good grass cover a Curve Number of 60 is appropriate. This indicates that runoff in a 50 mm or greater storm is likely to be up to about 15%. For a storm of less than 30 mm there is likely to be little or no runoff. Storms of up to 30mm include a significant proportion of rainfall events. For the purposes of this assessment, it is assumed that the average runoff is about 10% of the annual rainfall.

Earthtech note that evapotranspiration must be taken into account. Not all of the water that infiltrates into the cap will move through the cap to become leachate. A considerable proportion is removed through evapotranspiration. The magnitude of evapotranspiration depends upon the climate, soil type and vegetation cover. Soils with high water storage capacity and with good vegetation growth will achieve higher rates of evapotranspiration. Sandy soil has poor water storage capacity (well drained) resulting in actual evapotranspiration falling below the potential for the area.

NIWA data, (The climate and weather of Wellington, P.R.Chappell, 2nd edition, (2014), NIWA Science and Technology Series No. 65) indicates that the annual potential evapotranspiration for the west

coast of the North island (Paraparaumu) averages about 900mm. NIWAs drought indicator chart for the Manawatu / Wellington region (https://niwa.co.nz/climate-and-weather/nz-drought-indicator-products-and-information/drought-indicator-charts) indicates that the Potential Evapotranspiration Deficit, (the difference between potential and actual evapotranspiration), averages about 200mm per year. This value is an average over the whole of the region and is likely to be an underestimate for the specific conditions at the landfill (low storage capacity sand soil). However, this indicates a conservative (likely upper bound) average value of actual evapotranspiration of about 700 mm/year. The average annual rainfall at the landfill is about 1050mm and hence actual evapotranspiration is estimated to be no more than 65 % of the annual rainfall.

Accounting for 10% of rainfall running off and 65% lost through evapotranspiration, leaves approximately 25% of rainfall infiltrating through the cap to generate leachate. Based upon the conservative values adopted this is likely to be an underestimate.

If the sand slopes were capped with clay this should reduce infiltration to groundwater from 25% to the same 10% value assumed for the clay cap on the top of the landfill. Based upon the areas of clay cap and sand cap stated previously, the reduction in volume of leachate generated is estimated to be about 42%.

Based upon this assessment it may be concluded that a 45% reduction in leachate generation, if the sides slopes of the landfill were to be capped with clay, is still a reasonable expectation. This is however an approximate estimate, and the true value could be higher or lower. However, even if the infiltration through the side slopes is only twice that through the clay cap (i.e. 20%), a reduction of 30% should be achieved.

It should also be noted that run-off from the clay capped top area of the landfill will flow onto and down the side slopes. Other than in heavy rain events, it is likely that much of this runoff will infiltrate into the sand capped side slopes nullifying a lot of the benefit of the better standard of cap that has been installed on the top area of the landfill. Capping the side slopes with a similar clay cap would therefore maximise the benefit of the cap over the top area of the landfill.

It is therefore concluded that capping the landfill side slopes with a clay cap would be likely to result in a significant reduction in leachate generation. However, if leachate concentrations discharging from the landfill are now reducing; and the peak leachate plume appears to have migrated to the wetland. As such, capping the side slopes is unlikely to address a future risk of breaching trigger levels within the Hokio Stream.

10 Summary and Conclusions

There is currently little justification to support a conclusion that leachate migrating from the landfill may adversely impact the Hokio Stream now, or in the future. Alongside this, the groundwater model developed is not considered to be suitable to assess the efficacy of remedial options.

Our review of potential infiltration rates through the landfill sides indicates that capping these with clay would significantly reduce leachate generation from the landfill. However, based on the landfill age (and supported by site data) leachate concentrations are expected to be reducing, so capping the landfill sides is unlikely to address the risk of breaching consent trigger limits.

Instead, leachate concentrations observed within the wetland and surrounds likely represent the peak of the plume, with the drain likely allowing a “short-circuit” discharge directly into the Hokio Stream. This presents a higher risk to the Hokio Stream than the current/future discharges from the landfill.

So further technical work could focus on closely observing the plume and associated discharges (current view), whilst refining mass flux analysis (future view) and further assessment of an intervention to manage contamination migration from the wetland/drain.

This may include:

- Upgrades to the existing site monitoring network to collect better quality data at higher frequencies, and to provide an opportunity to respond to environmental changes quickly, including:
  - A period of streamflow, rainfall and groundwater levels at various critical locations.
  - Telemetered water quality data (such as electrical conductivity) within selected groundwater and surface water locations.
- Maintain regular (5-yearly) ecological surveys of the Hokio Stream to validate water quality monitoring.
- Complete further site investigations to determine hydraulic conductivity, particularly between the wetland(s) and the Hokio Stream.
- Based on new and existing data, complete robust trend and multi-variate analysis to further understand how various factors may be interacting (such as groundwater level, streamflow and water quality).
- Based on streamflow, hydraulic conductivity, and water quality data revise the mass flux assessment to estimate potential leachate concentrations within the Hokio Stream.
- Revisit potential remedial options, such as managing flows from the drain and wetland enhancement.

11 Applicability

This report has been prepared for the exclusive use of our client Horowhenua District Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

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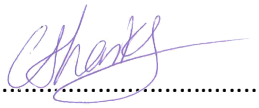

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Chris Shanks
Project Director

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