Technical Memorandum

To:	Rebecca Jackson	**From:**	Anna Lukey
Company:	Otago Regional Council	**SLR Consulting NZ**	
cc:	Samantha Iles (SLR)	**Date:**	10 November 2023
		Project No.	13556

RE: RM23.185 - Green Island Landfill Groundwater Quality Technical Review

1.0 Introduction

SLR Consulting NZ (SLR) has been engaged by Otago Regional Council (ORC) to conduct a technical review of the resource consent application (including subsequent attachments and request for information (RFI) responses submitted by Dunedin City Council (the applicant) for the operation, expansion and closure of the Green Island Landfill.

Dunedin City Council is proposing to continue to extend the life of the Green Island Landfill to allow acceptance of waste until between December 2029 and March 2031, following which closure operations and landfill aftercare will commence.

2.0 Scope of Review

This technical review relates to information primarily presented in Waste Futures – Green Island Landfill Closure – Groundwater Technical Assessment, GHD, 9 March 2023 (the Report), and some groundwater technical information is included in Surface Water Report, GHD, 7 March 2023 and Development and Management Plan, Stantec, February 2023 in addition to the Assessment of Environmental Effects. Six piezometers were installed to gauge water levels reported in the Geotechnical Investigation Factual Report, GHD, 20 February 2023.

I have completed my review of the Report and other available information in order to answer specific questions from ORC.

The Landfill Development and Management Plan (Stantec 2023) sets out proposed environmental monitoring. This is based on the consents for operation, due to expire in October 2023, and does include some discussion regarding closure monitoring proposals and has been reviewed in the context of this review.

This review considers the principles of Te Mana o te Wai in that the well being and health should be prioritised, the groundwater should be considered a receptor of importance, and on the understanding that there is a direct connection between ground and surface water.

This review considered the Waste Management Institute New Zealand (WasteMINZ) Technical Guidelines for Disposal to Land, September 2023 regarding the proposed monitoring programme.

The following is based on my understanding of the Conceptual Site Model (CSM) as generally presented in the GHD documentation. In summary:

- The landfill is unlined on the upper and lower Kaikorai Estuary members and beneath that the Abbotsford Mudstone which operates as a natural confining layer.

- The waste was deposited historically on the estuary sediments below groundwater level.
- Discharge of leachate to groundwater is controlled through the leachate interception trench, which also extracts some surface waters.
- Groundwater monitoring is completed through wells which are connected to the trench system and there is reliance on the surface water quality to determine the effectiveness of the trench performance.
- There are no downgradient wells to monitor the underlying groundwater quality outside of the trench system.
- There are also potential preferential flow paths from prior channels of the Kaikorai Stream which have not been investigated through installation of downgradient groundwater monitoring wells.

3.0 Response

ORC posed the following questions which we respond to in turn:

Is the technical information provided in support of the application robust, including being clear about uncertainties and any assumptions? Yes, or no. If not, what are the flaws?

Yes - the technical information provided in the application documents is generally robust. The data that has been presented is clear and discussed. However, there are numerous assumptions made and assumptions of note are highlighted below:

- The historical data from the groundwater monitoring wells is not comprehensive and some assumptions are required based on well construction.
- The introduction section sets out a number of assumptions about the landfill life expectancy, which is based on filling volumes and the establishment of Smooth Hill landfill.
- Appendix D (Section 1.3) sets out assumptions which includes the Site being commercial/industrial land use until closure, and thereafter will be used for recreational purposes.
- The Report notes (Section 1.1): *"When the landfill closes completely, there will be opportunities for environmental enhancements and public recreational use around the edge of the site. Examples could be planting restoration projects and new walking and biking tracks beside the Kaikorai Estuary. Long term use and public access to the landfill site post closure will be determined in consultation with Te Runanga o Otakou, the local community and key stakeholders."*

There is no discussion presented regarding what impact groundwater quality will have on the expected recreational land use. The proposed recreational use does not include water use, however it would be expected that this should be discussed in the context of potential future receptors.

Are there any other matters that appear relevant to you that have not been included? Or is additional information needed? Please specify what additional info you require and why [please explain]

The level of detail regarding historic well construction, including screen details are not available through the reports. This would assist in understanding the CSM further.

A limited contaminated soil investigation was conducted based on opportunistic geotechnical investigation and it does not seem that there was a dedicated contaminated soils/groundwater investigation. The geotechnical works included the installation of six piezometers which bore logs included indicate submerged screens. It is understood these wells are used for water level gauging, not groundwater quality. Further discussion should be provided with respect to applicants plans for these wells, and if they will form any part of the future groundwater quality monitoring.

The Surface Water report notes in Section 3.4: the Kaikorai Stream historically ran through where the Landfill is now. However, the stream was diverted along the western boundary of the Landfill to run in a southwest and southerly direction, towards the Kaikorai Estuary and ultimately the sea. The potential for the former drainage channel(s) to be acting as a preferential pathway has not been addressed. Furthermore, there is the potential that the leachate interception trench is located above the former channel(s). In addition, there is also a gap in the leachate trench to the southern side of the landfill, which may result in leachate not being captured and ultimately discharging through the former drainage channel(s). As such, there needs to be further investigation into the previous drainage channels and how these relate to the landfill CSM.

Installation of downgradient of monitoring wells screened in the Upper Kaikorai Estuary Member (UKEM) and the Lower Kaikorai Estuary Member (LKEM) will assist in determining impact on groundwater quality. It would also be expected that deeper groundwater, in the Abbotford formation would also be monitored to confirm understanding of the aquitard function as stated in the application. At least three well locations (sets of wells in each unit should be considered to understand impact on underlying units) should be installed to cover off the former drainage channels and the impact of the landfill as a whole. These wells are to be installed outside of the leachate interception trench well system in a downgradient position before the estuary. There are limited locations based on surface water locations, however these can be installed in the southern to south western area of the landfill.

If granted, are there any specific conditions that you recommend should be included in the consent?

Further downgradient groundwater monitoring network is required in order to assess any impact on groundwater outside of the leachate inception trench system.

There are no deep wells through the lines in the southern “half” of the landfill, which is within the area which is expected to be downgradient. There is no groundwater flow direction presented in the Report, however the Kaikorai Stream ran in a southwest and southern direction, prior to diversion, it is expected that this is the regional groundwater flow direction, towards the estuary and ultimately the coast.

Long term monitoring post closure needs to be established in detail at this stage.

Does the application appropriately identify sensitive areas including affected water bodies (surface, ground and coastal water), wetlands, bores, drinking water supplies? Yes/no.

The application notes the following:

- Kaikorai Stream and estuary to N and W are identified as Regionally Significant Wetland in the Regional Plan and an Area of Significant Biodiversity Value and a Wahi Tupuna of cultural significance to mana whenua in the 2GP.
- The Site is not within a Groundwater Protection Zone or Seawater Intrusion Risk Zone. However, it is adjacent to a Regionally Significant Wetland as defined in the ORC Regional Plan (ORC, 2018).

Appendix D Landfilling History and Targeted Contaminated Land Assessment Report notes that Kaikorai Stream originally went through landfill footprint area but was diverted. The former Kaikorai Stream channel is potentially a sensitive area.

Through the Section 92 process, 49 bores were identified within the area of interest. Drinking water bores in the site vicinity were not specifically identified in the application. There was reference to no groundwater use in the vicinity throughout the application, however further discussion is required based on the identified bores.

Is the description of the sensitive areas attributes potentially affected by the activity accurate?

Water bodies are identified however very limited discussion regarding attributes (refer to ecology technical memo). The underlying groundwater requires further review and investigation; with appropriate attention given to the principles of to Te Mana o te Wai.

Has the Applicant adequately assessed the adverse effects on groundwater quality of the discharge of waste and leachate to land?

Section 4 of the Report and section 8.3.5 of the AEE discuss the effects.

In my view the applicant has not provided sufficient detail regarding the assessment of adverse effects, other than reiterating the performance and reliance on the leachate interception trench noting surface water is not indicating adverse effects from groundwater impacts.

Has the applicant proposed appropriate methods to limit contaminants, particularly leachate, entering groundwater?

The application is based on the successful operation of the leachate interception trench. The groundwater results indicate that leachate is in the wells outside of the trench, however the hydraulic gradient is pulling impacted groundwater towards the trench and away from surface waters through continuous pumping.

The trench is currently not present along the Southern side of the landfill and is planned to be extended with this work. The landfill engineer memorandum will comment on the expected performance following extension.

The application notes the trench is not tied to the Abbotsford Formation mudstone which is inferred to be an aquitard due to the very low permeability of the mudstone and effectively an impermeable barrier for any downward seepage.

It is also expected the improved landfill capping will result in less leachate being generated and requiring treatment, following closure.

Is the SEEP/W 2D groundwater model appropriate for use in this context? Has it been applied appropriately?

Refer to the groundwater quantity and flood risk memorandum.

Have the cumulative effects of the activity been appropriately assessed?

Cumulative effects have not been specifically assessed in the AEE for groundwater quality.

Do you consider that the proposed improvements to the leachate system will be effective in improving groundwater quality?

Refer to the landfill engineering memorandum.

Has the Applicant proposed appropriate groundwater monitoring for the duration of the consent?

Section 5.1 of the Report recommends that groundwater monitoring is continued in line with the current consent conditions, (with some exceptions). The exceptions are valid. The monitoring parameters have been compared with Table 8-2 of the Wasteminz Technical Guidelines for Disposal to Land and it is noted that parameters are generally consistent with recommended parameters with the exception of copper, which should be included.

There is also note that PFAS is to be included in future monitoring.

The AEE, Section 8.3.6 sets out the proposed groundwater monitoring, which is an extension of the existing monitoring regime with some reduction of frequency for quarterly parameter monitoring.

The Stantec Management Plan recommends that the monitoring programme is reviewed and updated to reflect the changes to the landfill post closure.

As this consent includes the post closure management, it would be expected that groundwater monitoring is set out at this stage and this includes installing new downgradient wells in both upper and lower Kaikorai formations and the Abbotsford mudstone, included in this monitoring to determine discharge and impact to groundwater.

Do you agree with the Applicant's conclusions as to the level of adverse effects on groundwater?

The applicant has based their conclusions on the performance and reliability of the leachate trench and the low permeability of the Abbotsford mudstone and the surface water quality. In my view there is not enough site specific downgradient groundwater data to determine the level of adverse effects on groundwater.

In my view further data is required in the form of downgradient groundwater monitoring wells which are screened within the 3 units to assess impact to groundwater at these different depths. These wells need to be located outside of the leachate interception trench.

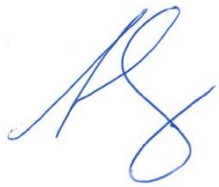
4.0 Closure

In summary, the application requires the following further detail:

- Surrounding groundwater use description and assessment;
- The assessment of effects needs address the potential preferential flow pathway presented by the former channels of Kaikorai Stream;
- The advancement of additional groundwater monitoring wells outside of the leachate interception trench system in order to assess groundwater impact;
- Reference to Appendix K of the WasteMINZ guidelines for the closure monitoring well network requirements; and
- Details of the proposed monitoring post closure schedule.

Regards,

SLR Consulting NZ



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