



15 May 2025

Te Uri o Hau / Environs Holdings Limited
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WASTE MANAGEMENT LANDFILL: REVIEW OF FURTHER WORK COMPLETED BY TONKIN + TAYLOR AS REQUESTED BY THE ENVIRONMENT COURT

1.0 Background

Pattle Delamore Partners Limited (PDP) were engaged by Magdalene Chambers working on behalf of Environ Holdings Limited (EHL) ('the client') to provide geotechnical review services of further information pertaining to the proposed development of the Waste Management Landfill in Wayby Valley as requested by the Environment Court.

The Environment Court decision set out at [933]b of NZEnvC 277 outlines further work is required to identify the following:

(b) whether the downstream area of landfill and the separation of waters can be improved to deal with:

(i) high rainfall;

(ii) landslip or failure of the landfill;

To address part [933]b the Environment Court requested further information on the following matters:

- ✧ The Factor of Safety of the landfill design and any failure pathways.
- ✧ Whether further work could be undertaken to identify whether the downstream area of landfill and the separation of waters can be improved to deal with: (i) high rainfall; and (ii) landslip or failure of the landfill.
- ✧ The management of leachate from the landfill and monitoring of the same.
- ✧ Details on the proposed contingency and redundancy measures in respect of the potential for discharge of leachate and sediment, and any improvements to the proposed measures.

Tonkin & Taylor Limited (T+T) have provided additional information to answer the request for this further information and provide clarifications in their Technical Memorandum dated 9 February 2024, reports supplied include:

- ✧ Auckland Regional Landfill Stormwater Pond damming: s92 response, December 2019;
- ✧ Stormwater pond dams: s92 response Addendum Report, August 2020; and
- ✧ Stormwater Dams Realignment Report, February 2022.

- ✧ Environment Court Evidence of David Andrew Bouma on behalf of Waste Management (NZ) Limited, for the Design of Stormwater Pond Dams dated 11 February 2022.

This review concentrates on the 2024 T+T memo and associated proposed consent conditions to ascertain the following as requested by EHL:

- ✧ The degree of risk that remains from high rainfall, landslips or climate change/ worst case scenario events.
- ✧ What else can be done to further reduce that risk above and beyond best practice/ i.e. a belts and braces approach.

A Hui was held between EHL, Magdalene Chambers and PDP via video call on the 3rd April 2025 to discuss the draft review comments.

An expert technical conference between PDP and Tonkin & Taylor technical specialists was undertaken via video conferencing on 1st May 2025.. T+T technical experts ran through the design details in more clarity and explained the stormwater pond design intent and allowances to enable the ponds to be maintained easily and the reasoning behind the factor of safety values utilised in their design.

2.0 Tonkin & Taylor Technical Memorandum dated 9 February 2024 Review

The technical memorandum compiled by T+T for Waste Management NZ Limited dated 9 February 2024 has been reviewed by PDP with salient points given below. In addition, and where stated, additional clarification questions were posed to T+T by e-mail on Wednesday 26 March 2025, responses by T+T were provided on Friday 28 March 2025 and are provided in italics.

2.1 Geotechnical design factors of safety (FoS)

The T+T Technical Memo discusses redundancy in design discussing estimated against design FoS. For design conditions, elevated and extreme groundwater conditions noting the estimated FoS is in the order of 1.2 to 1.6 times higher than the design factor of safety, i.e. providing redundancy in design. T+T stated that under seismic conditions ULS (0.19g), the findings were very minor acceptable slope displacement of only 4 mm, with no detrimental effect on waste slopes, capping layer or lining system.

Clarification questions regarding slope instability included:

1. The Tonkin & Taylor memo dated 9 February 2024 utilises the design factor of safety (FoS) as outlined in the now superseded NZGS Slope Stability Geotechnical Guidance Series - Unit 1 General Guidance - Draft for Comment (Part 7 Slope Stability Modelling, Table 7.1). The current December 2024 issue of the aforementioned document and Table 7.1 referred to by T+T has been modified with the design FoS values removed. Please provide evidence that the requirements of the current NZGS Slope Stability Geotechnical Guidance documents (December 2024) have been adopted into the slope stability assessments.

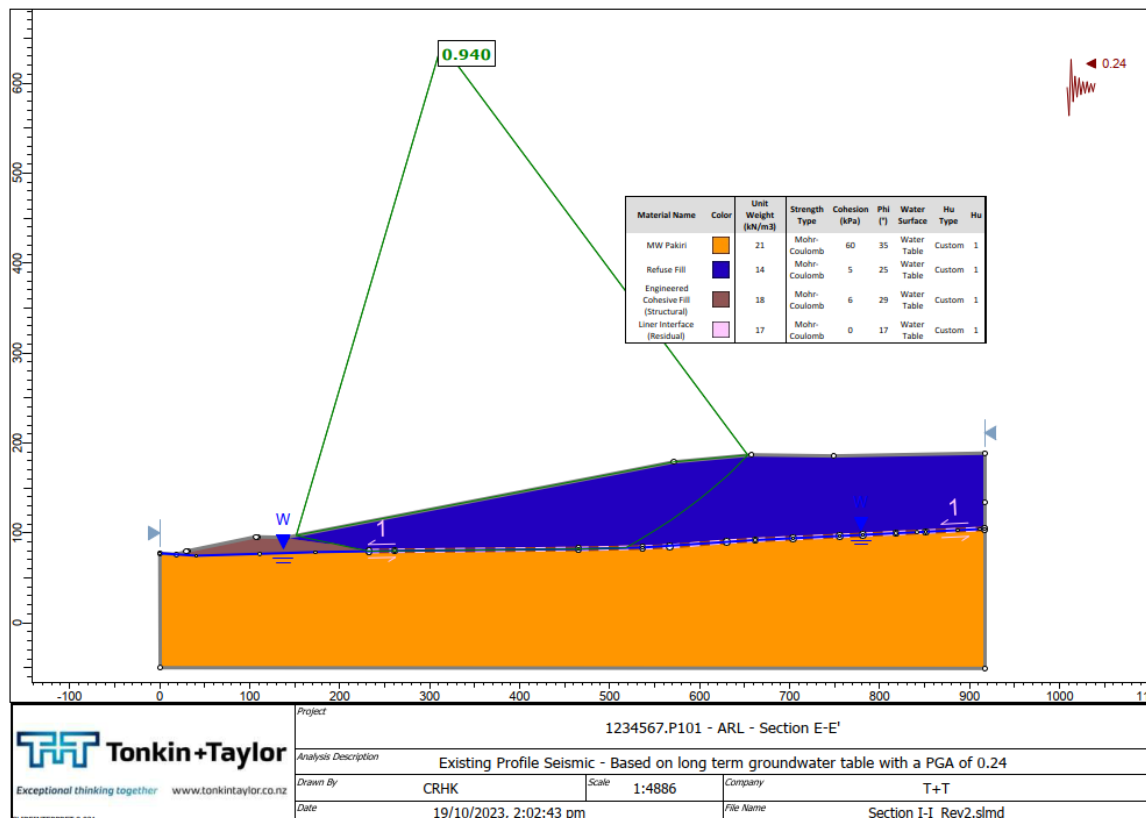
T+T response by Tim Coote (T+T) - *Given there is no waste industry specific guidance for landfill design Factor of Safety thresholds, the minimum design factors of safety thresholds were selected based on general industry accepted criteria (including Part 7 Slope Stability Modelling, Table 7.1 as a typical geotechnical industry guideline that, in turn, refers to other reference sources such as NZTA Bridge Manual 2022, NZ Dam Safety Guidelines, U.S. Army Corps etc.) and to be consistent with those typically adopted at landfills in New Zealand, including Kate Valley Landfill. We maintain these thresholds continue to be relevant today irrespective of the latest version of the reference geotechnical guidelines (which were issued after the memorandum was prepared) having chosen to remove them.*

2. No reference or commentary was given in the T+T memo discussing the origin of the acceptable maximum displacements given in Table 1. Please provide commentary if these are industry standard acceptable displacements or specifically derived for the proposed development.

T+T response - see response to item 1 above. These adopted acceptable maximum displacements for ARL were based on generally accepted industry values including the previously peer reviewed Kate Valley landfill acceptance criteria.

3. The T+T memo notes slope displacement of 4 mm, however no additional information has been provided on which slope stability section this is referring to, the scale of the failure or how the failure transfers into the liner and capping layer if at all. In addition, no methodology of how this displacement has been estimated has been provided in the memo or other supporting geotechnical reports. Please provide clarification on the above.

T+T response - slope stability analyses have been undertaken on valley axis long section through the face of the dam. Liner interface strengths were based on the likely liner construction materials and literature search. These analyses will be updated further to laboratory testing on sourced liner material. The computer stability analyses were undertaken using Slide2 (RocScience) software (figure below shows typical failure scale). The assessment of seismic displacements was undertaken using three industry accepted methods, including Ambraseys & Srbulov (1995), Jibson (2007) and Martin & Qiu (NCHRP report 611).



2.2 Stormwater Pond System

The memo only discusses capacity of the proposed ponds and not any geotechnical requirements for the proposed pond system. Noted that the crest heights are proposed to be raised by a further 0.5 m increasing the capacity of Pond 3 from 62,000 m³ to 69,000 m³. The other pond capacities are as follows:

- ✧ Pond 1 – 11,700 m³.
- ✧ Pond 2 – 22,000 m³
- ✧ Pond 3 – 69,000 m³ (increased crest height by 0.5 m)
- ✧ Pond 5 – 76,000 m³

The following are additional questions asked to further quantify the risk from high level rainfall and the design requirements for the proposed embankment dams. As before T+T responses are given in italics.

4. No design information has been provided regarding the proposed dams separating the stormwater ponds such as dam type, batter angles, crest width, dam heights or any slope stability or seepage analysis for varying scenarios (static, seismic, rapid drawdown etc.). Please provide this additional information to quantify the risks of failure of these embankment dams.

T+T response by David Bouma - *Design information for the stormwater pond dams has been provided in the evidence of David Bouma dated 11 February 2022. This evidence refers to three reports: 1) "Auckland Regional Landfill Stormwater Pond damming: s92 response, December 2019 ("SPD Report")*, 2) *Stormwater pond dams: s92 response Addendum Report, August 2020 ("Addendum Report")*, and 3) *"Stormwater Dams Realignment Report, February 2022". This evidence and the referenced reports describe the proposed dams including dam type, batter angles, crest width and dam heights and other information. Slope stability and seepage analysis had not been completed at the time of preparing the evidence as these analyses are completed as part of the detailed design process. However, the evidence and supporting reports confirm that the dams will be designed to meet the design criteria recommended by the NZSOLD Dam Safety Guidelines which are considered accepted practice for dam design in New Zealand.*

5. Please confirm if the proposed dams are considered classifiable under the Building (Dam Safety) Regulations 2022. The proposed storage capacity of Ponds 2, 3 and 5 (as given in the T+T 2024 Memo) exceed the 20,000 m³ given in Regulation 5 of the Act, however, it is unclear what the proposed dam heights are.

T+T response - *The dams that form Ponds 2, 3 and 5 will be Classifiable Dams.*

6. If the dams are considered classifiable, has a Potential Impact Classification (PIC) for the dams been completed? This should consider the effect of dam failure on community, cultural damage, infrastructure and the natural environment (NZSOLD NZ Dam Safety Guidelines 2023). If this has been completed, please provide a copy.

T+T response - *Yes. An initial level PIC assessment is included in the Stormwater Dams Realignment Report, February 2022 attached to the evidence of David Bouma. All three dams are assessed as low PIC.*

7. As the stormwater ponds are in series, has the risk from cascade failure of dam embankments been considered in determining risk to the downstream environment.

T+T response - *Yes – cascade failure was considered as part of the PIC assessment.*

3.0 Discussion

The following section discusses the information supported by T+T in relation to the EHLs requirements.

3.1 Information review key points

- ✧ The factor of safety information provided in the memo and additional clarifications are considered adequate, the onus is placed on slope stabilisation works during construction, there is always an unknown regarding slope stability and is dependent on construction practices and control measures such as adequate testing of the materials during construction – specifically for the pond embankments.
- ✧ The stormwater information provided meets the general requirements of the Building (Dam Safety) Regulations 2022, although this will need to be reassessed on the final design including a detailed slope stability and seepage analysis based on the proposed storage pond dam construction materials and methods.
- ✧ The initial level PIC assessment referenced by T+T in their recent responses meets current industry guidance with reference to further assessment of the detailed design and provisions for a Dam Safety Management Plan (DSMP) for all pond embankment dams (as required under amended consent conditions). For context an initial level PIC assessment should include a dam-break consequence assessments, estimation of damage levels which would involve the preliminary identification of buildings, cultural and heritage sites, critical and major infrastructure and environmental areas. From the perspective of this document, we have only reviewed the proposed PIC from a Population at Risk (PAR) perspective, consequences to the environment and cultural aspects are outside the scope of this geotechnical review. The initial PIC assessment would be the same (Low), if based only on cultural or environmental grounds, as a dam becomes classifiable on its height and storage volume. A low PIC is the default, and then refined up based on further assessment of PAR, cultural, environmental damage levels etc at the next levels of PIC assessment (intermediate / comprehensive), this should be completed at detailed design. In this instance a DSMP has been included into the consent conditions already, this is required for dams with a PIC rating of Medium or High but not always for a Low PIC rated dam. A DSMP places an addition level of operational management and surveillance on the dam owner which reduces risk.
- ✧ The responses given by T+T about leachate monitoring and contingency measures (Sections 4.1, 4.2, 4.3 & 4.4 of the T+T Memo) are acceptable. Amended consent conditions 314B and 326A requiring duplicate instruments in critical locations have been included. Also, a specific new condition (319A) requiring that the access road be designed to provide for a diversion of clean stormwater around Ponds 2 and 3 in the event that there is a blockage, or there is a need to contain contaminated stormwater, this design shall be submitted to the Council for certification prior to Initial Site Construction Works.

In addition, additional consent condition (53B) requires background sampling and analysis of endocrine disruptors and microplastics, and Condition 376 (J) includes monitoring of endocrine disruptors and microplastics on a biennial basis.

3.2 The degree of risk that remains from high rainfall, landslips or climate change/ worst case scenario events

Regarding high rainfall, the volume of water which could potentially be stored within the stormwater ponds is significant and would have a detrimental impact on the downstream environment if there is a failure of the embankments. The storage pond dams are given as classifiable and a low PIC which means there will be annual inspections in relation to dam safety and intermediate and comprehensive dam safety

reviews at 5 and 10-year intervals respectively. The onus on safety is placed on regular monitoring and maintenance of the dams (and timely repairs of remediation) not additional engineered protection measures. This is covered by the DSMP which would generally include additional inspections required following weather events outside the norm.

In addition, the proposed redundancy for higher rainfalls from climate change appears to be based on increasing capacity. There is a reasonable emphasis on drawing down before a rain event, this comes with the assumption that high intensity rainfall events are well forecasted, and the ponds can be drawn down easily with sediment removed in time to achieve the design maximum capacity of the storage ponds. If this is not undertaken, then the loss of capacity could contribute to a failure of one or more storage pond dams (worst case). It would be challenging to manage stacked events where the first rainfall event hasn't been managed (i.e. pumped down / de-silted) before the second occurs. At the technical conference T+T highlighted that the pond design intent was to fit to the available space with the spillway designed to safely pass the 1,000-year flood event (i.e. the 1 in a 1,000-year event) with adequate freeboard.

Landslides could increase the sediment load into the ponds which will reduce capacity further as discussed above. T+T noted in the expert conference that significant slope stabilisation works are proposed and required under amended conditions 139 to 143. It is possible that, in the unlikely event of a landslide triggered due to extreme rainfall, increased sediment loading could occur whilst the stormwater ponds are at or close to capacity. T+T noted that ponds are designed with ramps to facilitate access for desilting the ponds when required, maintenance of the ponds will be included into the Dam Safety Management Plan as covered in amended Conditions 181 to 184 inclusive.

3.3 What else can be done to further reduce that risk above and beyond best practice/ i.e a belts and braces approach.

Another control measure that can be utilised is that a risk assessment of the entire system be carried out to quantitatively determine risks, probability and frequency to identify critical system components. This would include any engineering measures included in the detailed design and all the proposed management and monitoring systems including operational responses after heavy rainfall events. This type of analysis develops a fault/event tree for the system that covers all the faults or events that can contribute to failure and then analyses the system in a probabilistic way to determine the probability of a failure occurring.

This requirement was discussed in the expert conference with T+T. It was apparent that each probable event had been individually assessed and control measures implemented into the concept design or given as a condition of consent notably the requirement for a Dam Safety Management Plan which is more than what is required for a low PIC dam under the NZSOLD Dam Safety Guidelines.

4.0 Concluding Statement

We have completed a review of the T+T 2024 memo and other supporting documents supplied including responses by T+T to further information requests. The proposed design amendments given in the T+T.

The amended design increases capacity of the ponds, whilst the inclusion of access ramps enables the capacity to be maintained through desilting when required, a DSMP as required by consent conditions will govern the maintenance requirements of the ponds into the future.

It should be noted that the proposed embankment dams for the stormwater storage ponds are considered robust and exceed current industry standard practice.

Subsequently, a review of the amended consent conditions given in the Joint Memorandum of Council dated 25 February 2025, and a technical expert conference between T+T and PDP has provided additional confidence that there are sufficient control measures in place to ensure additional resilience and

assurance during landfill operation for the stormwater ponds to operate safely with landslides and multiple rainfall events.

5.0 Limitations

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Te Uri o Hau / Environs Holdings Limited and Tonkin and Taylor Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Yours faithfully

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