

Appendix O Stormwater Pond and Dams Memo

Memorandum

Subject: ARL Project – Stormwater Ponds and Dams Memorandum
Reference No: 1101798
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Date: 29 July 2026

1 Introduction

WM New Zealand (WMNZ) has engaged Tonkin & Taylor Ltd (T+T) to prepare technical memoranda for the proposed new solid waste management and disposal facility in the Wayby Valley, north of Auckland ('ARL' or 'Project').

The Project will involve constructing, operating, closing and providing aftercare for a new 24 Mm³ landfill facility and associated infrastructure at Wayby Valley, Wellsford. Ngāti Manuhiri are Project partners and will work with WMNZ on the proposed management and mitigation measures. Once landfilling ceases, the land will be returned to Ngāti Manuhiri as tāngata whenua.

The new landfill will be a Class 1 landfill, as defined in the Technical Guidelines for Disposal to Land (WasteMINZ Technical Guidelines)¹, accepting municipal solid waste. This includes residential and commercial waste, construction and demolition waste, some industrial wastes that meet acceptance criteria, and contaminated soils. Following waste settlement, the landfill cap surface will have a maximum height of 205 m RL.

WMNZ landholdings in the Wayby Valley area comprise a total area of 1020 ha, with the landfill footprint being approximately 60 ha. The WMNZ landholdings have been divided into five general areas; the Eastern Block, the Western Block, the Southern Block, the Waiwhiu Tributary Block and the Waiteraire Tributary Block. The proposed works will involve the following:

- **Site access and operation:** Construction of site access roads, weighbridges, and a vehicle wheel wash.
- **Landfill development:** Major earthworks and the installation of environmental management systems, including a landfill lining system and collection networks for leachate, stormwater, and landfill gas (LFG).
- **Leachate and landfill gas management:** A dedicated leachate management system and a LFG treatment facility, including a LFG flare and a LFG waste-to-energy plant.
- **Support infrastructure:** Facilities for site staff, plant maintenance, and water supply.
- **Terrestrial, freshwater and wetland biodiversity measures:** This includes native revegetation, and a weed and animal pest management programme to offset or compensate for residual adverse effects on terrestrial, freshwater and wetland ecology.

This memorandum provides an outline of the initial findings of the stormwater ponds and dams assessment and has been prepared for inclusion in an application for Ministerial referral of the Project under the Fast-track Approvals Act 2024 ('FTAA'). Specifically, this memorandum responds to the requirements under section 3.4 of the Fast-track Approvals Referral Application Form and

¹ Technical Guidelines for Disposal to Land, WasteMINZ, September 2023, Revision 3.1.

section 13(4)(h) of the FTAA. A full description of the draft proposal is included in the accompanying information attached to the application form for the referral.

2 Summary of findings

An assessment of potential downstream impacts of the stormwater ponds and dams has been undertaken. In summary:

- In the very unlikely event that one or more of the dams breach, the downstream effects may include some localised sediment deposition and scour, and short-term inundation of low-lying agricultural land and residential accessways. No people or infrastructure are expected to be affected.
- Peak flows in flood events up to the 100-year average recurrence interval (ARI) will be less with the dams in place than they would be with no dams in place, due to the attenuation function of the reservoirs.
- The dams provide for removal of sediment from stormwater runoff.
- The dams provide monitoring points and auto-shut valves so that leachate can be identified, captured and treated appropriately prior to discharge to the downstream environment (in the very unlikely event that leachate escapes from the landfill).
- A range of design features have been included to create resilience in the dam design and specifically address identified potential failure modes and minimise the potential for these to develop.
- A number of recommendations have been provided regarding dam construction, to allow the safe construction of the dams to a high standard in accordance with the New Zealand Society on Large Dams (NZSOLD) Dam Safety Guidelines (DSG).
- Procedures for the ongoing safe management throughout the operational life of the dams will be documented in a dam safety assurance plan (DSAP), to meet the recommendations of the NZSOLD DSG and comply with the Building (Dam Safety) Regulations 2022.

3 Assessment methodology

The methodology to inform the assessment to date has been primarily desktop, with site visits undertaken to confirm conditions at each proposed dam location. All assessments and modelling have been undertaken in accordance with the NZSOLD DSG.

The following desktop-based tasks and assessment have been undertaken to inform the assessment:

- Assessment of potential incremental downstream consequences of a hypothetical breach of one or more of the proposed dams. This assessment is a fundamental precursor to inform the dam design process and is not reflective of the actual probability of failure, which is considered highly unlikely due to modern design and dam safety management practices.
- Review of geotechnical conditions at each proposed dam site and available construction materials to inform selection of the most appropriate dam type for this setting.
- Identification of potential failure modes for the proposed dams and defensive design features to minimise the likelihood of failure from each identified potential failure mode.
- Conceptual design of the proposed dams and related structures to establish feasibility of the proposed design features and construction techniques.

Field work to inform the assessment undertaken to date has included:

- Site visits by the dam design engineering team to the proposed dam locations in June 2021 and May 2023.

Modelling that has been undertaken to inform this assessment has included:

- Flows from a hypothetical breach of the stormwater dam(s) down the landfill valley to the confluence of Te Awa o Hōteao.

4 Site and project context

A general description of the site and surrounding locality is included in the accompanying information as part of the referral application. The following elements of the site and Project are key to the Stormwater Ponds and Dams assessment:

- A total catchment area for the final dam in the series (at the downstream end of the site) of approximately 1,069,000 m².
- Steeply inclined valley slopes, with a number of large existing landslide features within the landfill valley (arcuate head scarps and hummocky runout zones).
- Site geology at the proposed dam sites consisting of sandstone and siltstone of the Pakiri Formation. On the west side of the Project area (outside of the landfill valley and away from the dam locations), sheared mudstone of the Northland Allochthon is present.
- Downstream of the proposed dam locations, a relatively confined, forested valley conveys flow into Te Awa o Hōteao, approximately 2.5 km downstream.
- Adjacent to the flow path between the exit from the landfill valley and Te Awa o Hōteao, agricultural land, a number of residential properties, and a small airfield are present.

The initial understanding indicates that there will be a series of stormwater treatment dams constructed downstream of the landfill toe bund, with combined storage volume (to auxiliary spillway level) of approximately 91,000 m³. In addition, a “polishing” wetland will further treat flows up to the 95th percentile before they are discharged to the downstream waterway.

5 Assessment of potential effects

Based on the Project and the information available, an assessment of potential effects on the valley downstream of the proposed dams has been undertaken and is summarised below.

5.1 Dam break assessment

The potential incremental consequences of a hypothetical dam breach were assessed in accordance with the NZSOLD DSG. The potential incremental consequences of a hypothetical dam breach are those that are directly attributable to the dam failure, e.g., for a rainy-day event, the incremental consequences are the total damages incurred by the hypothetical dam-break flood less any damages incurred by the base flood without dam failure.

The assessment considered hypothetical failure of the dams initiated by a “piping” mechanism (“sunny-day” failure) as well as dam failure initiated by overtopping during a large flood event (“rainy-day” failure). Hypothetical breach scenarios of individual dams were assessed, as well as a cascade failure scenario, where all dams fail in succession.

It was found that a hypothetical sunny-day cascade failure of the dams had the highest potential incremental consequences on downstream areas. This is because the dam break flows are very small relative to the flows from a natural flood event at the downstream locations of interest.

In this hypothetical scenario, a flood wave from a sunny-day cascade failure:

- Could potentially cause flooding of low-lying areas at the eastern end of Spindler Road beyond where it exits the downstream valley before joining Te Awa o Hōteao. No dwellings are

expected to be impacted, but part of Spindler Road and some private accessways could be temporarily flooded (for up to 30 minutes).

- Would result in some deposition of silt in the stream bed and some localised erosion of the stream banks immediately downstream of the dam. These effects would be relatively localised and temporary and meet the description in the NZSOLD DSG of minimal to moderate environmental damage.
- Could flood low lying farmland on the eastern side of the Springhill Airport runway; however, the runway itself would be unlikely to be affected. The flow would likely be contained inside the deeply incised channel of Te Awa o Hōteio at the existing SH1 bridge location crossing Te Awa o Hōteio, so the existing bridge is also unlikely to be affected.
- Downstream of the existing SH1 bridge, it is expected that the dam break flood would have attenuated further and be fully contained in the river channel.

Based on the above, and in order to assign a “Potential Impact Classification” (PIC) to the dams, an overall damage level of “moderate” was assessed, on the basis that no damage is expected to residential houses or infrastructure, with some localised short-term damage to the environment (silt deposition and scour). No permanent Population at Risk (PAR) were identified in the potential inundation zone and only a negligible itinerant PAR (e.g., people driving on accessways, agricultural workers, etc) is expected (less than 1 person at any given time). As a result, overall PAR is estimated to be less than 1 for the purposes of this analysis, and there is no anticipated potential loss of life.

Given an assessed damage level of Moderate and a PAR of less than one with no loss of life, it is anticipated that the proposed dams to be located at site will be assessed as Low PIC. This classification sets the recommended design criteria accordingly.

5.2 Flood attenuation

One of the functions of the proposed stormwater dams is to attenuate the peak flow in the landfill valley stream during flood events. This means that the peak flow rate in the stream after construction of the dams is less than the peak flow rate that would occur from the existing forested catchment.

Typically, the dams established at the site will feature a primary spillway which will control the normal operational level (typically at approximately 30% of the total storage volume) in the pond and will pass flow from normal rainfall. An auxiliary spillway at a higher level on each dam will enable excess flow from very intense rainfall events to safely pass. The auxiliary spillways will only activate after the pond has filled from the lower primary spillway level up to the auxiliary spillway level. This process temporarily stores some of the runoff, thereby reducing the peak flow.

The combination of spillways and storage volume will be designed to ensure that the peak discharge down the valley during rainfall up to (and including) a 100-year ARI rainfall event is no greater with the landfill in place than it was before the landfill development.

5.3 Sediment capture

Stormwater runoff which enters each of the reservoirs is stored for a short period of time prior to being discharged via the primary spillway. The storage time and reduced velocity allow entrained sediment to settle out of the flow, thereby progressively cleaning the stormwater as it moves through the system of treatment ponds. Stormwater from the site will variously be treated by a series of ponds at the site. Flows up to the 95th percentile will also flow through a wetland, which provides a final “polishing” prior to discharge to the downstream valley. The wetland achieves this polishing via a series of shallow and deep marsh zones, with minor deeper areas (including a forebay and outlet area). Accumulated silt will be manually removed from reservoirs and wetland forebay from time to time.

5.4 Leachate capture

Although no leachate is expected to be discharged from the landfill into the downstream dams, monitoring of electrical conductivity will be undertaken on flows at a number of locations as water moves through the stormwater treatment system. These monitoring locations include:

- Overland flows at various appropriate locations.
- Landfill subsoil drainage outlet flows.
- Flow discharged from the wetland.

If any of these monitoring instruments detect conductivity exceeding a predetermined trigger level, auto-shut valves on the respective outlets will be triggered. This will allow time for investigation, isolation, and containment of the source of contamination. Interim flows may also be bypassed around the affected pond so that accumulated contaminated water may be pumped to the leachate treatment system for treatment.

5.5 Resilient design

Preliminary assessment of potential failure modes associated with dams located at the site is shown in Table 5.1. Table 5.1 also outlines the proposed mitigation measures that will be considered during the detailed design process to reduce the risk of dam failure.

Table 5.1: Preliminary assessment of potential failure modes and proposed mitigation measures

Potential failure mode	Load cases	Proposed mitigation measures	Likelihood of failure post mitigation
Overtopping of the dam embankment during a large flood due to insufficient spillway capacity and freeboard	Flood	Carry out hydrology assessment and flood routing to size the spillways and determine dam crest level with adequate freeboard	Very unlikely
Overtopping of partially completed dam during construction	Flood	Carry out hydrology assessment and flood routing to size the construction diversion and determine cofferdam crest level with adequate freeboard	Very unlikely
Internal erosion / piping failure through the dam embankment	Normal Flood Earthquake	Inclusion of filter compatible chimney and drainage	Very unlikely
Internal erosion of embankment materials into foundation materials	Normal Flood Earthquake	Geotechnical investigation and assessment of each dam site Appropriate foundation treatment (e.g., slush grout and dental concrete treatment of open joints) to be deployed during construction	Very unlikely
Internal erosion / piping failure along the outlet conduit	Normal Flood Earthquake	Appropriate detailing of seepage control, filter design and drainage requirements around outlet conduit Use of suitable materials and appropriate compaction standard along conduit	Very unlikely

Instability of upstream and downstream shoulder	Normal Flood Earthquake Rapid drawdown	Carry out stability assessment to ensure adequate factor of safety for adopted shoulder batters	Very unlikely
Internal erosion of foundation materials	Normal Flood Earthquake	Geotechnical investigation and assessment of each dam site Appropriate design and detailing of filter, drainage, and foundation cut-off	Very unlikely
Overtopping failure due to embankment deformation / settlement / liquefaction of the embankment / foundation under seismic loading causing loss of freeboard	Earthquake	Carry out liquefaction, stability, and settlement assessments to quantify the impact of potential strength loss and/or settlement under design earthquake loading	Very unlikely
Concentrated leak erosion along an earthquake-induced transverse defect	Post-earthquake	Carry out stability analysis to estimate magnitude of potential earthquake deformations Filter compatible full height chimney filter, with adequate width	Very unlikely

The potential failure modes assessment will be updated as detailed design progresses, and appropriate mitigation measures will be incorporated in the design.

5.6 Dam construction

A range of measures are proposed to maintain construction quality so that the dams are built in accordance with the detailed design drawings and technical specification. These include:

- Engaging appropriately experienced contractor(s) for the dam construction works.
- Close observation of the dam construction by an experienced dam engineer.
- Quality control testing requirements.
- Implementation of appropriate quality assurance processes.
- Recording all details in a construction completion report.

If these recommendations are followed, the dams located at the site will be constructed safely and to a high standard in accordance with the design and specification, and in accordance with the NZSOLD DSG.

In addition, for any 'large dam' at the site, building consent will be required. This process will provide an additional level of oversight for the design and construction of the dam(s).

5.7 Ongoing dam safety management

Good practice for ongoing dam safety management is the implementation of a Dam Safety Management Plan (DSMP) that incorporates documentation of procedures for operation, maintenance and surveillance, emergency preparedness, periodic formal dam safety reviews, and identifying and managing dam safety issues. WMNZ will develop a DSMP specifically for the proposed dams to formalise ongoing dam safety management procedures in accordance with the NZSOLD DSG and in compliance with the Building (Dam Safety) Regulations 2022.

6 Conclusions

The proposed design arrangements for the stormwater treatment dams (including the wetland) is technically robust and is consistent with or exceeds the recommendations set out in the NZSOLD DSG.

Potential downstream effects of a hypothetical sunny-day cascade failure of the dams indicate that a PIC of Low is appropriate for the proposed dams. The proposed dams incorporate a range of design features to reduce the risk of potential failure modes developing (consistent with good industry practice). The dams provide benefits to the downstream environment, including peak flood flow attenuation, sediment removal, and early identification and storage of leachate, in the very unlikely event that leachate escapes from the landfill.

7 Applicability

This technical memorandum has been prepared for the exclusive use of our client WMNZ, 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.

We understand and agree that WMNZ will submit this technical memorandum to the Environmental Protection Authority in support of a referral application under the Fast-track Approvals Act 2024 for the works described herein, and that the Environmental Protection Authority will rely on this technical memorandum for the purpose of assessing that application.

Tonkin & Taylor Ltd

Lead Author:

A handwritten signature in blue ink, appearing to read 'John Harris', written over a horizontal dotted line.

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Authorised for Tonkin & Taylor Ltd by:

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