Memo

To	Evan Keating
From	Eugene Vodjansky
Date	14 January 2026
Job No.	149300
Job name	Takitimu North Link Stage 2
Subject	**Response to FTAA-2507-1085 Stormwater RFI, Description of flood delineation procedures, using 1D model output**

This memo is provided to respond to the following query from RFI4:

> It is understood that the analysis was conducted largely using the SWMM model. The Panel's technical advisor has advised that this is a 1D model that does not readily produce flood extent maps. Please explain the procedure for mapping the 1D model results to give 2D flood maps, as shown in Figures 2.8, 2.9, 2.10 and, most specifically in Figure 5.11. This is to enable the technical advisor and Panel to understand the accuracy associated with these mapped extents.

When determining the appropriate method for assessing the flooding effects downstream of the Takitimu North Link Stage 2, we considered the hydraulic conditions and the terrain data available within the Project area:

- From a hydraulic standpoint, flood levels within Oturu Creek and tributaries, downstream of the Project, are controlled by backwater conditions resulting from culverts under Armstrong Road, KiwiRail ECMT, and Borell Road. The hydraulic grade in between these crossings is relatively flat, due to the backwater conditions.
- The available terrain information consisted of LiDAR that was highly influenced by tree cover.

Taking the above into consideration, we considered a 1D modelling approach was the most appropriate choice for assessing flood effects. 1D modelling allowed us to avoid significant volume issues that would have affected the results of a 2D model. The large proportion of the existing LiDAR terrain model that was affected by tree canopy would have required significant terrain model adjustments based on limited topographic survey information, LiDAR in clear areas, and judgement. Therefore, we decided to apply a 1D model, which is better suited for complex culvert and overflow analysis.

There are multiple 1D models that can be effectively applied for flood analysis, and for the Project we selected the EPA SWMM, as it:

1. Effectively handles unsteady flow,
2. Integrates the hydrological routing,
3. Effectively accounts for in-channel storage, and
4. Reliably models complex hydraulic structures, that have multiple hydraulic functions (e.g. bypass channels, pipe/culvert, orifices, and weirs, including overflows).

While 2D models effectively handle unsteady flow and account for in-channel storage, they do not integrate the hydraulic routing, or model complex hydraulic structures as well as the EPA SWMM. As the

most significant influence on Oturu Creek flood levels are the road and rail crossings, we consider the EPA SWMM provides the most reliable results for a study of this kind.

The procedures, or methodology for delineating flood limits for mapping, using 1D models, are well documented and standardised. Prior to the development of good 2D modelling, 1D models were used exclusively, because that was all that existed and implementing the methodology by hand was not practical. 1D models are still used where 2D models do not apply appropriate calculations for the flow conditions. Using 1D models for floodplain delineation requires a lot of experience when the river or stream flows through a floodplain that is very wide in relation to the width of the main channel, which requires the determination of ineffective flow areas. The procedure for using 1D model output to delineate flood limits for mapping is standard and has been applied to the Project (eg to produce the 2D flood maps as shown in Figures 2.8-2.10 and Figure 5.11 of the Stormwater Assessment) as follows:

1. The 1D model was set up with sufficient cross-sections, located appropriately, to capture changes in hydraulic grade. Irregularity in longitudinal grade, variations in channel shape, large variations in floodplain width, and hydraulic features, like road crossings, required additional cross-sections. Where the stream and floodplain are relatively consistent, cross-section intervals were close enough to allow a reasonable frequency of modelled water surface elevations or flood levels.
2. At each cross-section, the modelled water surface elevation, or flood level, was located where the ground level matches.
3. These points are then connected, following the contours of the terrain.

The following text from Section 3 of the U.S. Federal Emergency Management Agency (FEMA) *Guidance for Flood Risk Analysis and Mapping, Riverine Mapping and Floodplain Boundaries Guidance* (December 2020) provides an additional summary of flood delineation, using 1D models:

> *The flood boundaries are delineated by finding the intersection of the ground surface defined by the underlying digital terrain model and the flood surface. Floodplain boundaries are delineated on the best available topographic mapping using the water-surface elevations determined at cross sections. Between cross sections, WSELs are interpolated. The interpolation is linear along smooth lines following the general direction of the flow close to the boundary.*

There are many publications available on the application of 1D modelling for floodplain delineation. While 2D flood modelling has advantages over the use of 1D modelling in many circumstances, it also requires better terrain data to realise those advantages. The procedures applied for assessing the Oturu Creek flood effects, downstream of the Takitimu North Link Stage 2, were not unique, but followed a long-established methodology.

For the above reasons, in the case of Oturu Creek, the hydraulic conditions and quality of available Lidar made the use of a 1D model the most reliable option. The Peer Reviewer, Graham Macky, has extensive experience in the use of 2D and 1D flood modelling, and made the following statement in his letter of 22 March 2024 (provided with NZTA's response to RFI4): "I consider SWMM to be a particularly suitable choice of software".

Yours sincerely

Bloxam Burnett & Olliver

[redacted]

Eugene Vodjansky

Principal Water Resource Engineer

[redacted]