Technical Memo

To:	Mark Liang, Jennyl Estil	Job No:	1092045
From:	Peter Norfolk, Jade Huffadine	Date:	8 February 2024
cc:			
Subject:	P2B Interchange Flood Modelling		

1 Background

Waka Kotahi is intending to design and construct a new motorway interchange ("P2B Interchange") approximately midway between the existing Drury and Ramarama interchanges on SH1 as part of the P2B project. An eastern road connection will run from that interchange across the Hingaia flood plain to a connection onto Maketu Rd within the Drury South Precinct development. Aurecon has been engaged by Waka Kotahi to carry out the consenting and preliminary design of the interchange and road connection. The Hingaia flood plain is being modified as part of the Drury South precinct development works to manage flood flows to ensure that development land achieves the required flood protection and flood effects outside of the Drury South precinct do not adversely change, relative to pre-development levels, as a result of the development. This is a resource consent requirement for the development. As the proposed P2B interchange road connection will cross the flood plain the design of that crossing must be assessed and developed to ensure that it will also comply with the same requirements.

Tonkin & Taylor Ltd (T+T) has carried out all of the flood assessment and flood plain terrain design for the Drury South precinct works and has developed a detailed terrain and flood assessment (TUFLOW) model for this purpose. That model was developed to provide specific detailed analysis of the Drury South precinct area and was derived from the Council MIKE FLOOD catchment wide model.

Waka Kotahi has engaged T+T to carry out the required flood analyses for the proposed interchange and road connection using that same model, and information on the proposed interchange design has been provided by Aurecon, who are the lead designer for the interchange and road connection.

T+T's role has been to receive the proposed interchange and road/bridge design(s) from Aurecon and input it/them into the verified Drury South precinct flood model to derive the resulting flood effects. Results from those analyses have then been provided back to Aurecon to allow them to review, interpret and finetune their design to ensure that flood effects are appropriately managed and that they can use that information to support the consent application they are preparing on behalf of Waka Kotahi.

The following Technical Memo details the flood model setup and flood modelling that has been undertaken by T+T and provided to Aurecon for this purpose.

2 Flood model

The DHI MIKE FLOOD Hingaia catchment flood model provided by AC was originally used for the flood modelling of the Drury South Area DSA (previously referred to as the Drury South Precinct –

DSP). However, for the purposes of detailed design along the Hingaia Stream within the DSA area, a more fit-for-purpose TUFLOW 1D/2D linked model has been compiled by Tonkin + Taylor. This model is better suited for detailed design purposes as it has a much smaller extent, rather than modelling the full catchment. The DHI model was set up to model the Hingaia catchment, refer Figure 2.1 below. The difference in the two models is indicative of the difference in the catchment areas whereby the DHI model is a similar extent to the Hingaia Catchment and the TUFLOW model is a similar extent to the precinct catchment.

The TUFLOW model also better simulates the flow between the main stream channel and adjacent flood plain areas. Specifically, it better simulates the spill levels and velocities from the Hingaia Stream into the adjacent flood plains, aiding the design of specific parts of the floodplain. It was therefore considered more appropriate for detailed design of the development area.

The focused TUFLOW model utilizes hydraulic parameters from the calibrated full catchment flood results, being run version v210 of the Hingaia catchment model which included some minor updates of the v203 model. Results of v210 model compared to the Council verified v203 model showed minimal difference in flood levels and extents. These results were previously reviewed by Council following submission in the T+T technical memo of March 2019.

The P2B Interchange is located within the DSA model extent.

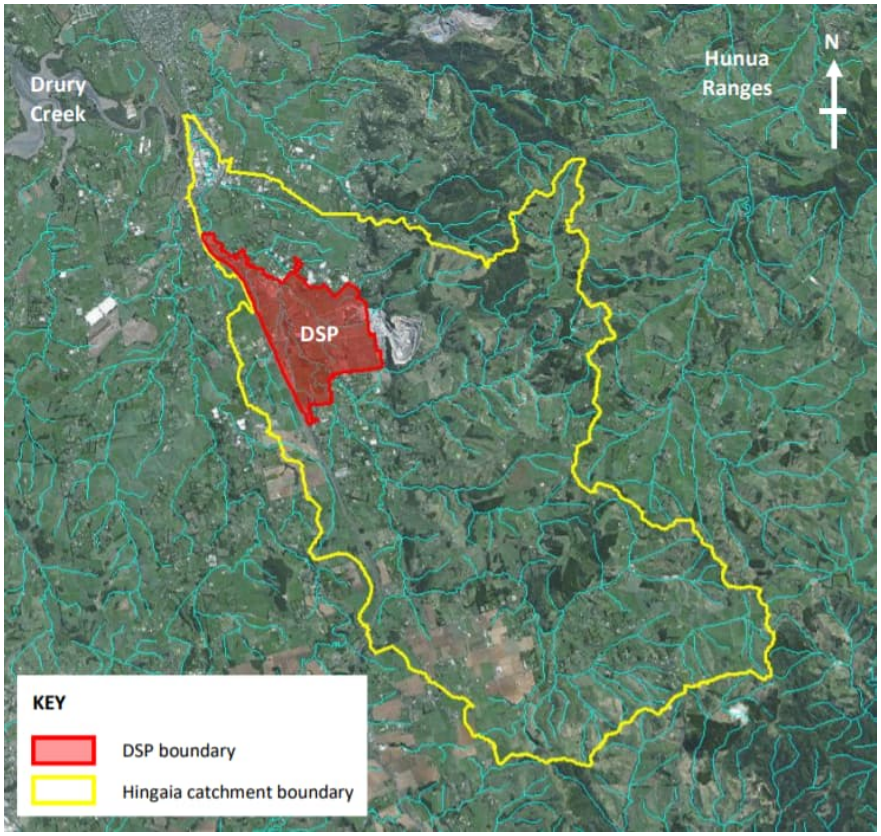

Figure 2.1: Hingaia Catchment

2.1 Hydrological assessment

The boundary conditions for the TUFLOW model were taken from the existing AC DHI model. These were inflow hydrographs (flow versus time relationships) at the upstream end of the model extent, and water level hydrographs (water level versus time relationships) at the downstream end. Climate change was included in these hydrological inputs as per the AC Code of Practice for Land Development and Subdivision (temperature increase of 2.1 degrees by 2090).

In addition, flows from internal catchments within the DSA have been included. These were inflow hydrographs taken from the AC DHI model and were input into the TUFLOW model as source areas.

2.2 Hydraulic model

This section summarises the details of the hydraulic model used for the assessment including describing the terrain and hydraulic structures that have been represented in the model.

2.2.1 Hydraulic structures

2.2.1.1 Bridge hydraulic structure

Spine Road Bridge, the proposed P2B interchange bridge, "Hingaia Bridge" and the First Gas bridge are represented by open channels with 2D bridge piers, rather than 1d elements, because the water levels for the 100-year ARI event are designed to be below soffit level of all bridge decks.

Ramarama Bridge, Ararimu Road Bridge and McEldownie Bridge are modelled as 1d to 2d elements.

2.2.2 Modified culverts

There are two existing culverts which cross beneath SH1 in the vicinity of the proposed interchange, refer Figure 2.2 below. The embankment of the proposed interchange currently fills the upstream and downstream ends of two culverts. These culverts have been extended to allow for the fill batters of the new interchange. The existing culvert size and gradient has been maintained.

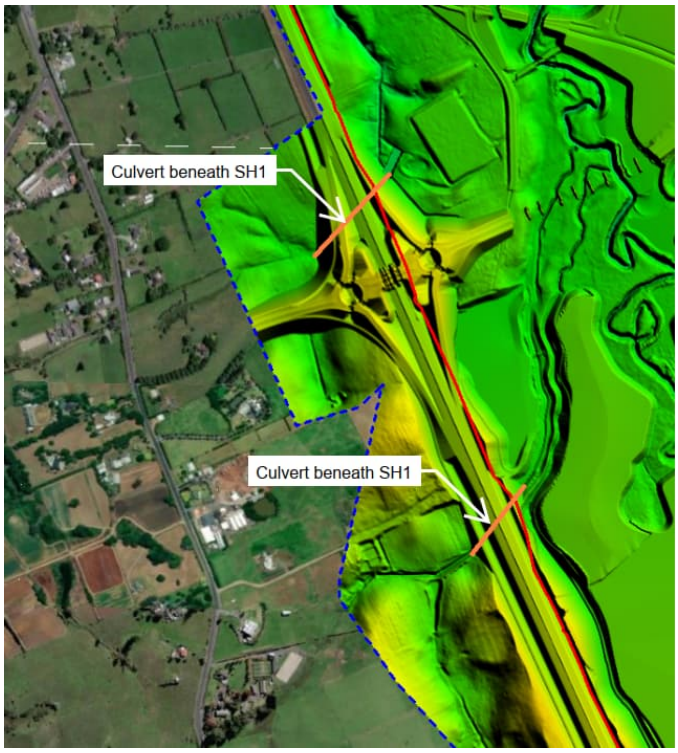

Figure 2.2: SH1 Culvert locations

2.2.3 Terrain

Four scenarios have been modelled comprising:

1 The Baseline scenario ("base-baseline"): This is prior to any works commencing in the Drury South Area.

2 Post-DSL Construction Baseline scenario: Assumes all works within the DSL precinct have been completed.

3 Post-Interchange scenario: Construction of the P2B interchange has been completed (as well as all of the DSL precinct works).

4 Modified post-interchange scenario: Modifications to the motorway cross drainage culverts and a storage area to the west of SH1 has been added as part of optioneering to provide some understanding of the influence of the culverts on flood levels.

The T+T 1D/2D linked hydraulic model (with 1D structures), uses TUFLOW software. The existing land levels in the TUFLOW model were derived from the 2013 LiDAR[1] data provided by AC. The design levels are a combination of as-built data and design surface levels (where the site is not yet complete) derived from a 12D model. This information was used to produce the model bathymetry with a two-metre grid.

For the developed terrain a combination of LiDAR data was supplemented within the DSA boundary using as-built terrain survey information (for the phases of earthworks already completed in both the DSIP and residential areas) and 3D modelled terrain, created utilising 12D software, for the proposed levels of areas still to be developed.

The P2B interchange has been modelled using 12D software.

Figure 2.3, Figure 2.4, Figure 2.5 and Figure 2.6 show the terrain used for the four models.

[1] LiDAR stands for Light Detection and Ranging, it is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to earth. LiDAR surveys are used to collect ground level data for large areas.

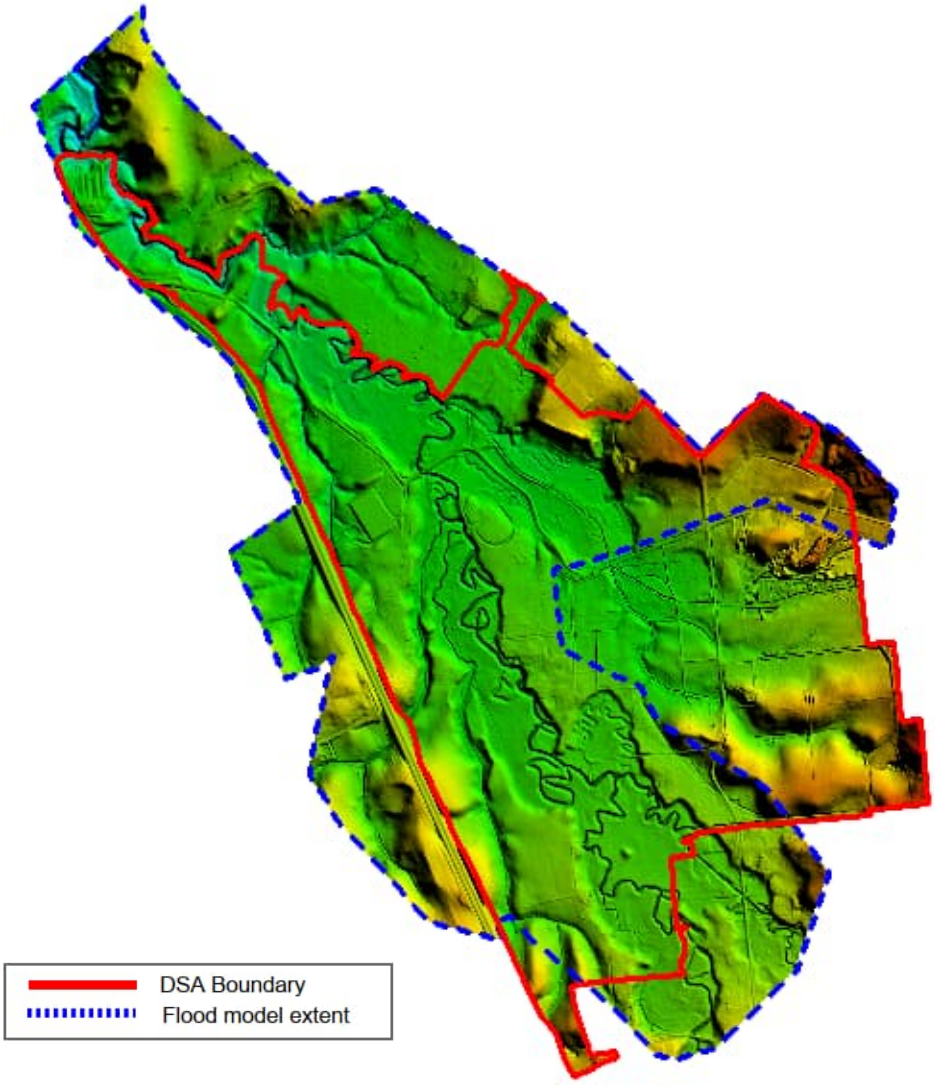

Figure 2.3: Baseline Terrain (pre any development)

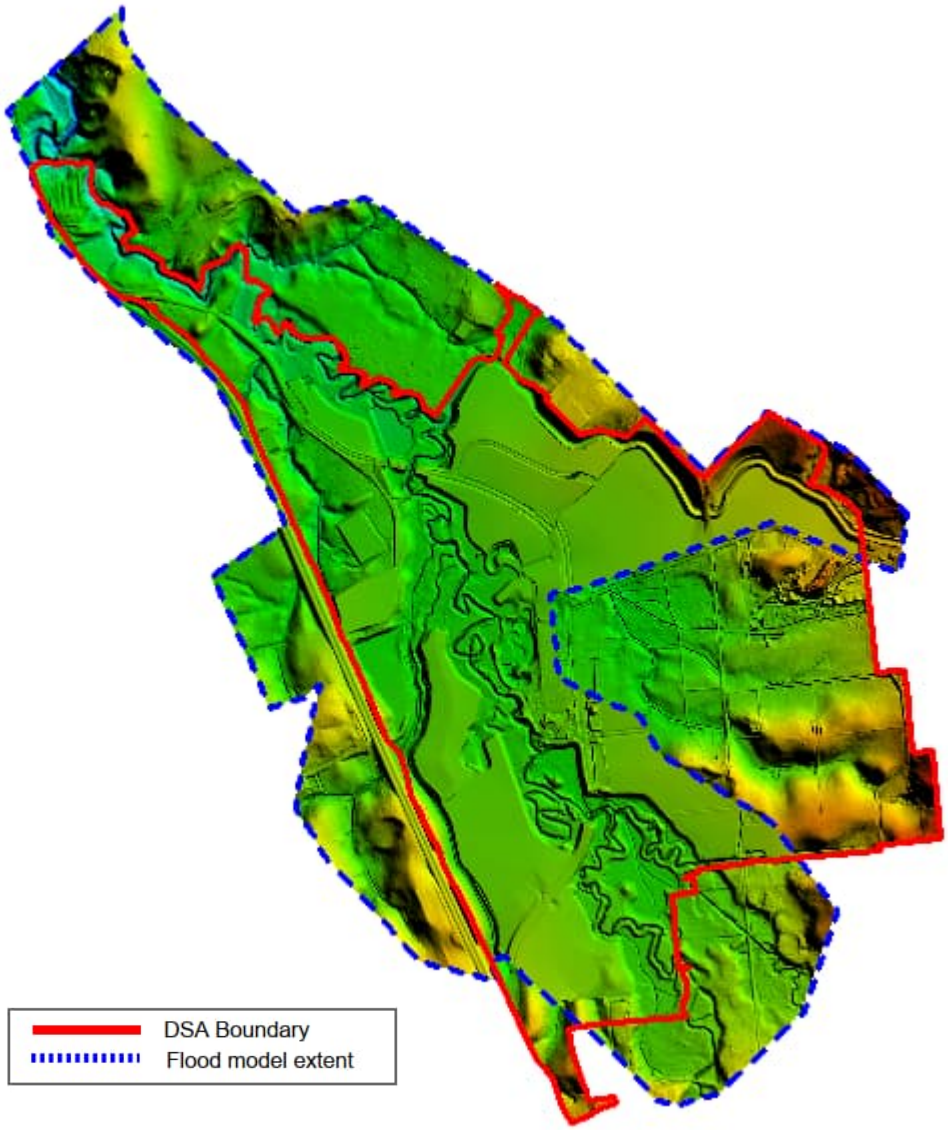

Figure 2.4: Post-DSL Construction Baseline Terrain (all of the precinct development works completed)

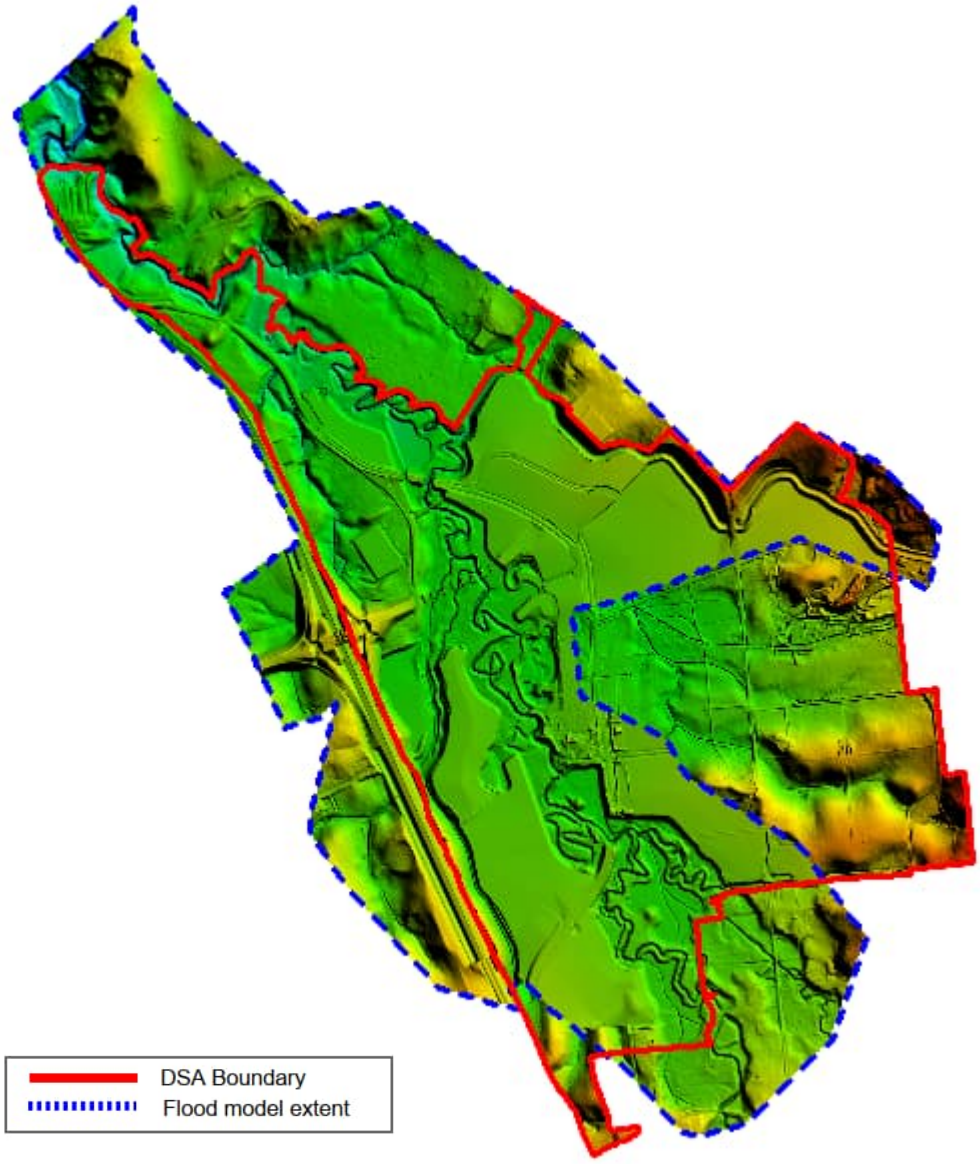

Figure 2.5: Post-Interchange Construction Terrain (Interchange plus all precinct works completed)

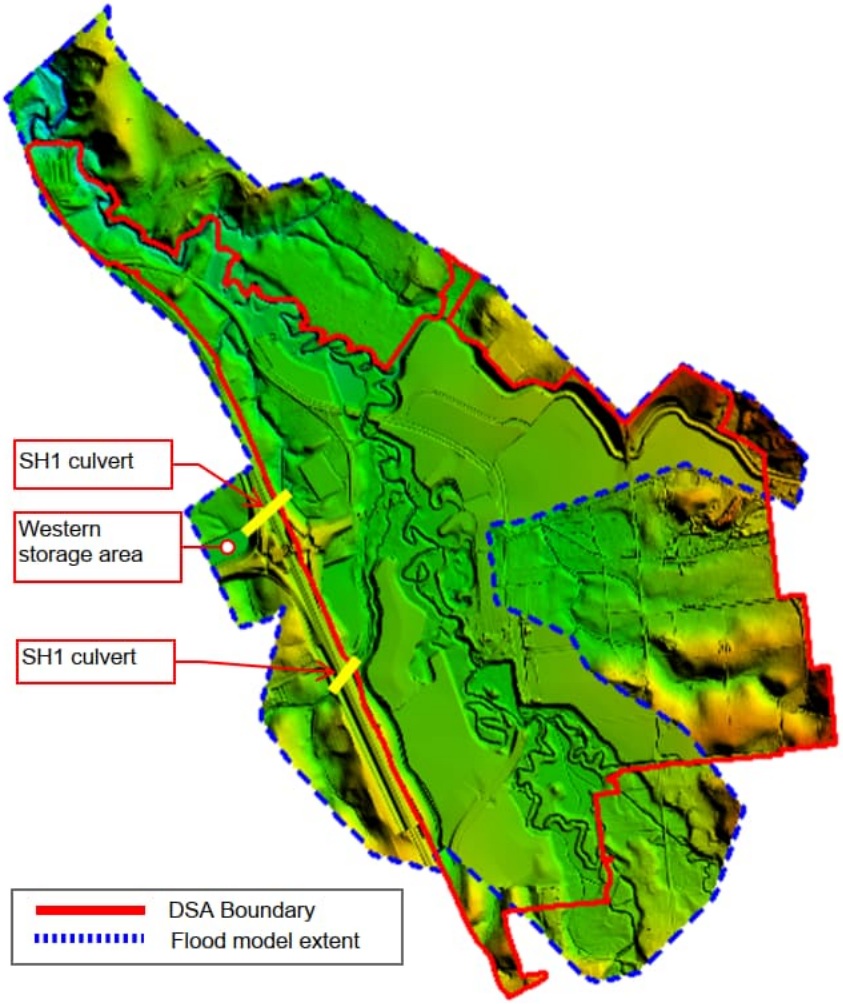

Figure 2.6: Modified Post Interchange Terrain (modified cross-drainage culverts and additional storage)

2.2.4 Terrain Roughness

The roughness was represented by a roughness map based on the AC DHI model. Table 2.1 summarises the materials and roughness values used in the TUFLOW model.

Table 2.1: Manning's roughness values

Material	Manning's n	Description
1	0.07	In channel roughness taken from MIKE11
2	0.08	In channel roughness taken from MIKE11
3	0.055	In channel roughness taken from MIKE11
4	0.035	In channel roughness taken from MIKE11
5	0.05	DEM floodplain roughness
6	0.02	DEM Road roughness
7	0.3448	DEM building roughness
8	0.06	In channel roughness taken from MIKE11
9	0.065	In channel roughness taken from MIKE11
200	0.02	DEM Mat Value

Material	Manning's n	Description
270	0.027	DEM Mat Value
349	0.035	DEM Mat Value
429	0.0429	DEM Mat Value
500	0.05	DEM Mat Value
529	0.0529	DEM Mat Value
1000	0.1	DEM Mat Value
1098	0.1098	DEM Mat Value
1492	0.1492	DEM Mat Value
3448	0.3448	DEM Mat Value
99	0.013	Default Roughness
1200	0.12	DEM Mat Value

There is one minor change to the material values compared to the DHI model and that is the increase of roughness through the SEA area to allow for the proposed mitigation planting. The original and previous DHI models of this area assumed all of the weed species had been cleared but had not factored back in the mitigation planting. We have now allowed for that.

2.3 Model verification

The hydraulic parameters of the TUFLOW model were based on an already calibrated AC DHI model. The modelled flood levels were then compared to the AC DHI model flood levels and were found to provide a good correlation.

3 Flood assessment

Four scenarios have been modelled, comprising:

1 The baseline scenario: This is prior to any works commencing in the Drury South Area

2 Post DSL Construction Baseline scenario: All works within the DSL precinct have been completed.

3 Post Interchange Construction scenario: Construction of the P2B interchange has been completed (in addition to the fully completed precinct works).

4 Modified Post Interchange Construction scenario: Construction of the P2B interchange has been completed with some modifications of the cross-drainage culverts and associated storage areas to understand their influence on flood levels.

The scenarios were assessed for the 100-year ARI flood event. Outputs between scenarios 3 and 4 were then compared back to scenarios 1 and 2 to determine the effects and changes resulting from the proposed interchange construction. Modifications to the proposed interchange design were then made by Aurecon and the models updated and re-run until the results were considered acceptable.

T+T carried out internal QA reviews of all of the models and results to confirm they had performed as expected before providing the models and results to Aurecon for their review and interpretation.

4 Conclusions

- Flood modelling has been undertaken to provide Aurecon with results such that they can confirm flood levels to assess the effects of the construction of the proposed P2B Interchange

within the floodplain of the Drury South Precinct area. That information will then be used to support the associated resource consent application.

- The flood assessment modelling was carried out by T+T using the T+T TUFLOW model developed for the Drury South precinct design and based on inputs from AC's DHI model.
- Four scenarios have been modelled for the 100-year ARI event, comprising:
  - The Baseline scenario ("base-baseline"): This is prior to any works commencing in the Drury South Area
  - Post DSL Construction Baseline scenario: All works within the DSL precinct have been completed (in addition to the fully completed precinct works).
  - Post Interchange scenario: Construction of the P2B interchange has been completed.
  - Modified post interchange scenario: Modifications to the motorway cross drainage culverts and a storage area to the west of SH1 has been added to understand their influence on flood levels.
- Copies of the verified models and output files have been provided by T+T to Aurecon for their review, interpretation and use in supporting the associated resource consent application.
- Flood levels and differences in water level between the various scenarios can be assessed by Aurecon at any location in the modelled area from the modelling information provided.

5 Applicability

This report has been prepared for the exclusive use of our client Waka Kotahi, 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 our client will submit this report as part of demonstration of compliance with resource consent and that Auckland Council, as the consenting authority, will use this report for the purpose of assessing that application.

We understand and agree that this report will be used by Auckland Council in undertaking its regulatory functions in connection with Waka Kotahi.

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
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