Peka Peka to Ōtaki Expressway – Post Project Hydraulic Model Report

29 October 2018

Revision 5

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NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

New Zealand Government

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REVISION HISTORY

Revision N°	Prepared By	Description	Date
1.	Dewi Knappstein and Kelsey Beckett	First issue	12/09/2017
2.	Dewi Knappstein and Kelsey Beckett	Updated to include Waitohu model	25/10/2017
3.	Dewi Knappstein and Kelsey Beckett	Rev 3 100% Stage Flood Model	29/03/2018
4.	Dewi Knappstein and Kelsey Beckett	Rev 4 Finalised following review comments	11/05/2018
5.	Emma Boon	Rev 5 - No change following review	29/10/2018

DOCUMENT ACCEPTANCE

Action	Name	Signed	Date
Prepared by	Dewi Knappstein and Kelsey Beckett		29/10/2018
Reviewed by	Jon Rix		29/10/2018
Reviewed by	Tom Bassett		29/10/2018
Approved by	Bruce Symmans		29/10/2018
on behalf of	Beca Ltd		

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1. Introduction and Objectives

1.1 The Project

Fletcher Construction Company Limited (Fletcher) has been commissioned by the NZ Transport Agency (NZTA) to provide the Detailed Design and Construction for the Peka Peka to Ōtaki expressway (PP2Ō, the "Project").

PP2Ō forms part of the Wellington Northern Corridor from Levin to Wellington Airport. The Project consists of a 12.5km four lane expressway, approximately 9km of local road, ten bridges, including the 330m Ōtaki River Bridge, and realignment of approximately 1.6km of rail.

1.2 Report Scope

This report summarises the details of the hydraulic models that describe the post-project situation, which is explained further in Section 1.4. The models are for the:

- Ōtaki River and Mangapouri Stream;
- Waitohu Stream; and
- Mangaone Stream.

The report should be read in conjunction with the "Stormwater 80% Design Report Rev 1" (PP2Ō, January 2018), the "Pre Project Hydraulic Model Report Rev 5" (PP2Ō, May 2018) and the "Hydraulic & Hydrological Modelling Schematisation Report" (Fletcher, March 2017).

The purpose of the report is to summarise the post-project model build methodology, assumptions and data sources where there are changes from the pre-project hydraulic models, and to assess the post-project effects and compliance with the Resource Consents and Principal's Requirements.

1.3 Objective of the Hydraulic Modelling

Hydraulic modelling is required to assess compliance with the specified hydraulic performance standards for the Project, which are set out by:

- Resource Consents; and
- Principal's Requirements, as modified by Notices to Tenderers, Notices to Contractor, and Approved Departures.

1.4 Method to Fulfil Objectives

The hydraulic models assess compliance with the performance standards by:

- Modelling a pre-project situation: Quantifying the hydraulic behaviour of floods based on the pre-project arrangement, assuming climate change to 2130 and allowing for future land development;
- Modelling a post-project situation: Quantifying the hydraulic behaviour of floods based on the post-project arrangement, also assuming climate change to 2130 and allowing for future land development;

- Assessing compliance with objectives: The changes in flood patterns, depths, velocities and flows for the post-project arrangement compared with the pre-project arrangement have been identified by comparing the models developed for the two situations listed above.

This report summarises the post-project modelling situation only. The pre-project representation is reported in the “Pre Project Hydraulic Model Report Rev 5” (PP2Ō, May 2018).

Three hydraulic models have been developed (the “post-project models”). The post-project models include the following rivers and streams:

- Ōtaki-Mangapouri Model: Ōtaki River and floodplain, and Mangapouri Stream;
- Waitohu Model: Waitohu Stream and floodplain; and
- Mangaone Model: Mangaone Stream and alluvial fan.

Hydraulic models for other watercourses and streams are covered in separate design reports.

The models are valid for assessing compliance for this project, but may not be valid at other locations and for other purposes.

1.5 Report Revision

1.5.1 Introduction

The subject document is Revision 4 of this report, which was previously issued as Revision 3 on 29 March 2018. Revision 3 presented the model build and compliance checks for the Ōtaki-Mangapouri, Waitohu and Mangaone 100% stage post-project models.

Revision 4 represents the finalisation of the report, and incorporates the following:

- Changes associated with Stakeholder, Peer Review and Principal’s Advisor Check comments (refer Section 1.5.2); and
- Correction to some hydrological inputs for the Ōtaki-Mangapouri model (refer Section 1.5.3).

1.5.2 Review Comments

Records of the Peer Review and Principal’s Advisor Check are included in Appendix D and Appendix E respectively.

Most comments have been closed out except four, which are “parked” or “on hold”, subject to additional information to be provided in separate reports / notices:

Peer Review:

- **Comment 6**: The Peer Reviewer has asked whether drainage arrangements for the borrow area are included in the design. Further detail regarding drainage of the borrow area is to be included in the Stormwater 100% Design Report, scheduled to be issued on 15 June 2018.

Principal's Advisor Check:

- **Comment 38**: This comment relates to water levels upstream of the proposed Ōtaki River Expressway Bridge, which have increased principally due to upgrading Chrystall's Stopbank. To close out Comment 38 and Comment 39 (below), the Principal's Advisor has requested submission of documentation confirming that raising of the Stopbank has been accepted by Greater Wellington Regional Council and that affected stakeholders have been adequately consulted.
- **Comment 39**: Similar to the comment above, Comment 39 relates to water levels in the off-river storage basin on the true right bank of the Ōtaki River, upstream of the proposed Ōtaki River Expressway Bridge.
- **Comment 42**: This comment relates to a 20m section of Expressway between Chainage 280 and 300m (near the existing SH1 / Taylors Road intersection) where the freeboard to the expressway reduces to 420mm in the 1% AEP CC2130 event i.e. up to 80mm short of the 500mm required. The Principal's Advisor has requested that options are presented in a Notice to Engineer.

As per the Notice to Contactor included in Appendix E, the Principal's Advisor has noted:

> *"Although comments 38, 39, and 42 are still outstanding they are relatively minor in scope. Comments 38 and 39 are covered by the separate GWRC and Fletchers agreement to raise the Chrystalls Bend Stopbank and Comment 42 impacts only a localised length of the mainline alignment. It is acceptable to proceed to the IFC stage for the Post Project Hydraulic Model with hold points or clouds for comments 38, 39, and 42."*

1.5.3 Correction to Hydrological Inputs

The Ōtaki-Mangapouri model has been re-run for the events listed in Table 1 to correct a data entry error for hydrological inputs. All discussion, figures, compliance checks etc have been updated for the corrected model results.

The corrected results were discussed and circulated to the Peer Reviewer and Principal's Advisor before finalising the report. The process resulted in an additional iteration of Peer Review comments and design response, which is included in Appendix D.

Table 1: Correction to Hydrological Inputs for Ōtaki-Mangapouri Model

Event	Description of Error
0.2% AEP CC2130 including base case, breach and debris blockage scenarios	Previously modelled flows for "Ōtaki 1" catchment were too high
1% AEP CC2130 (High Range climate change allowance)	Previously modelled flows for "Mangapouri 1", "Mangapouri 2" and "Ōtaki Flood Plain" catchments were too low
1% AEP	Previously modelled flows for "Ōtaki Flood Plain" catchment were slightly too high
2% AEP	Previously modelled flows for "Ōtaki Flood Plain" catchment were slightly too high
5% AEP	Previously modelled flows for "Ōtaki Flood Plain" catchment were slightly too high

In summary:

- **0.2% AEP CC2130**: There is a decrease in flood levels such that Chrystall's Stopbank no longer overtops in this event i.e. corrected flood levels are lower than previously modelled. The breach scenario has been modelled with the breach initiating when the water levels adacent the stopbank are at a maximum, rather than when the stopbank starts overtopping (since the latter no longer occurs). There is no longer any bypass flow around the ends of the Secondary Containment Bund in the 0.2% AEP CC2130 breach scenario.
- **1% AEP CC2130 (High Range)**: There is an increase in flood levels of 30mm in the Mangapouri catchment and 130mm in the Racecourse catchment i.e. corrected flood levels are higher than previously modelled. The increase in flood levels for the corrected 1% AEP CC2130 (High Range) event compared with the 1% AEP CC2130 base case (Mid Range climate change allowance) is still of a similar magnitude to other areas of the project.
- **1% AEP, 2% AEP and 5% AEP**: 70-80mm decrease in flood levels in the local Ōtaki Floodplain catchment i.e. corrected flood levels are lower than previously modelled.

The previously modelled flows were generally too high, and the correction has resulted in an improvement in the assessed performance. The main change is that the 0.2% AEP CC2130 water levels upstream of the Ōtaki River bridge and in the off river storage basin have decreased. These water levels are still non-compliant with the maximum allowable water levels in the Principal's Requirements, but the amount of non-compliance has decreased.

1.6 Coordinate System and Vertical Datum

The coordinate system and vertical datum adopted for the post-project models are consistent with the Principal's Requirements (PRs, Section 7.2.2) and comprise:

- Coordinate system: NZTM 2000; and
- Vertical datum: NZVD 2009.

2. Model Build / Changes from Pre-Project Model

2.1 Hydraulic Modelling Package

The Danish Hydraulics Institute (DHI) MIKE FLOOD modelling package is used for the pre- and post-project models, including one-dimensional (MIKE 11) and two-dimensional (MIKE 21) components. Details of the software used are set out in Table 2.

Table 2: Flood Modelling Software

Software Type	MIKE 11 by DHI	MIKE 21 by DHI
Software Version	Version 2014	Version 2014
Service Pack	Service Pack 3	Service Pack 3

2.2 Post-Project Models and Detailed Design Stages

The model build for the post-project models is generally consistent with the model build for the pre-project situation described in the Pre-Project Hydraulic Model Report Rev 5 (PP2Ō, May 2018). The modifications to represent the post-project situation include the addition of the expressway, realigned local roads, and associated hydraulic structures.

2.3 Ōtaki-Mangapouri Model Changes

2.3.1 MIKE 11 Model

MIKE 11 (open channel) extents are presented in Figures 1, 2.1, 2.2 and 2.3 in Appendix A. These extents are kept the same as the pre-project models, except in areas where realignment is required for the inlets/outlets of the proposed culverts.

Cross sections are kept the same as those in the pre-project model, unless branches have been realigned or structures added in the post-project situation. At these locations, additional cross sections have been added for hydraulic modelling purposes (inlets/outlets to culverts or branch start/end). Cross section data for modified post-project cross sections are based on adjacent cross sections and structure geometry. The data source of each cross section is described in the "Cross Section ID" section of the MIKE 11 cross section file and is summarised in Figures 2.1, 2.2 and 2.3 in Appendix A.

Table 3 summarises the proposed structures that have been added to represent the post-project situation.

Table 3: Proposed Structures for Post-Project Situation for Ōtaki-Mangapouri Hydraulic Model

Structure	Name in Model	Description
Ōtaki River Bridge	"PP2O_OtakiBridge"	Bridge conveying expressway over the Ōtaki River
Culverts 9 and 10	"PP2O_Culv9and10"	Concrete box culverts (in series) conveying the Mangapouri Stream under the proposed expressway and rail realignment respectively
Culvert 7	"PP2O_Culv07"	Concrete box culvert through the approach embankment to the proposed Rahui Road bridge to maintain an existing overland flow path between the Mangapouri and Racecourse catchments
Culvert 12	"PP2O_Culv12"	Concrete circular culvert conveying flow from Remnant Wetland East to a swale that in turn conveys flow to Kennedy Wetland
Culvert 13	"PP2O_Culv13"	Concrete circular culvert conveying flow from Kennedy Wetland to the Mangapouri Stream
Culvert 14	"PP2O_Culv14"	Concrete circular culvert conveying the Racecourse Stream under the proposed expressway and rail realignment
Culverts 15b to 15d	"PP2O_Culv15b" "PP2O_Culv15c" "PP2O_Culv15d"	Concrete circular culverts conveying flows from the local catchment and Ōtaki River flows overtopping / breaching the Chrystall's Stopbank under the proposed expressway
Culvert 15e	"PP2O_Culv15e"	Corrugated steel "underpass" profile culvert providing continuity of access and conveying flows from the local catchment and Ōtaki River flows overtopping / breaching the Chrystall's Stopbank under the proposed expressway

Structure	Name in Model	Description
Culvert 18	"PP2O_Culv18"	Corrugated steel circular culvert providing continuity for flows across the proposed expressway between the Ōtaki River and the off-river storage basin
Culvert 18a	"PP2O_Culv18a"	Concrete box culvert for conveyor belt for Winstone Aggregates operations
Pipe 66 and 69	"PP2O_Pipe66" "PP2O_Pipe69"	Circular concrete culverts in series with vee channels that convey flows from the outlet of Culvert 7 to the Racecourse Stream

The proposed scruffy dome and orifice / slot inlets of Culverts 12 and 13 are not represented in the MIKE FLOOD model, noting that these inlets constrain outflow from wetlands and thus provide attenuation in the Remnant Wetland East and Kennedy Wetland. Instead, the inlets are represented for modelling purposes as simple headwall inlets, allowing flow through the full diameter of the culvert set at the upstream invert of the culvert. This is a conservative approach because it effectively neglects the attenuation provided by the proposed railway wetland system, and omits the associated benefits reducing downstream flooding.

The configurations of the proposed structures are based on:

- Revising the configurations over several iterations of the hydraulic model to achieve the performance standards described in Section 5; and
- Wider design development, including considerations such as fish passage and coordination with other design disciplines.

Figures 2.1, 2.2 and 2.3 in Appendix A present the locations of all structures within the model extents. The method for modelling these structures is as described in the Pre-Project Hydraulic Model Report Rev 5 (PP2Ō, May 2018)

The flow roughness coefficient (Manning's n) has been adopted as 0.012 for concrete, 0.035 for substrate, and 0.033 to 0.034 for corrugated steel depending on diameter. A weighted average was adopted for culverts where multiple materials are present. The Manning's n for corrugated steel was based on empirical data for structural plate (230mm x 65mm corrugations) from Figure B.3 of Hydraulic Design of Highway Culverts 3rd Ed (HIF-12-026, FHWA 2012).

The roughness coefficient has not been increased to account for the spat ropes that are proposed for fish passage within Culverts 12 and 13. This is considered acceptable because neglecting the increased roughness of the spat ropes slightly overestimates discharge downstream of the culverts, which is conservative for assessing downstream flood effects. This is not conservative for flood levels upstream of the culverts and design of the railway wetland system, but design of this system is covered by separate modelling that accounts for the increased roughness (refer Culvert 12 Design Report Rev 2 (PP2Ō March 2018).

Entrance loss coefficients have been selected based on the following inlet configurations in line with guidance in FHWA 2012:

- Concrete box culverts: Square edge (30 to 75 degrees flare) wing wall (Ke = 0.5);
- Concrete circular culverts: Square edge with headwall (Ke = 0.5); and
- Corrugated steel culverts: Mitred to conform to slope (Ke = 0.7, end stiffening ring beams that match the batter slope are proposed).

The dimensions, invert levels, and model types of the proposed structures are detailed in Appendix B.

2.3.2 MIKE 21 Model

The pre-project model 2D topography has been modified for the post-project model to incorporate the proposed expressway and realigned local roads based on the geometric design current on 23 February 2018. Additional topographical changes are described in Table 4 below, and the locations of these changes are presented in Figures 3.1 to 3.5 in Appendix A.

Table 4: Additional topographical changes applied to pre-project model topography

Topographical Feature	Description
Raised Chrystall's Stopbank (Refer Figures 3.1 and 3.2, Appendix A)	Chrystall's Stopbank is proposed to be raised to the east of the expressway to provide 0.8m freeboard to the 1% AEP CC 2130 event. This includes a section alongside the expressway described as the "Eastern Expressway Flood Bund" in previous versions of this report. Furthermore, in previous versions of modelling, the stopbank was assumed to be raised to both the east and west of the expressway, but is currently proposed to be raised to the east only - refer further discussion in Section 5.1.2. The model topography was refined to ensure the raised stopbank is represented as a continuous barrier to flow in the 2D terrain with overtopping level set to provide 0.8m freeboard to the 1% AEP CC 2130 event, noting this required raising the top of the bund from the level in the February 2018 geometric design.
Borrow Area (Refer Figure 3.2, Appendix A)	A borrow area is to be constructed between Chainage 2620 to 3180, which will be bounded by the expressway, the Chrystall's Stopbank and the existing railway. The model topography was revised to reflect a permanent 1.5m average lowering of existing ground levels, which is anticipated at the proposed borrow area.
Secondary Containment Bund (Refer Figures 3.2 and 3.3, Appendix A)	A secondary containment bund is proposed at the northern end of the local Ōtaki flood plain to prevent transfer of flows from the Ōtaki catchment to the Racecourse and Mangapouri catchments. This bund is required to provide 0.3m freeboard to the 0.2% AEP CC 2130 flood. The model topography was refined to ensure the bund is represented as a continuous barrier to flow in the 2D terrain with overtopping level set to the top of the bund at 16.60mRL (as per the February 2018 geometric design). This level provides excess of 0.3m freeboard to the 0.2% AEP CC 2130 Chrystall's Stopbank breach scenario, noting the breach scenario results in higher water levels alongside the bund than the 0.2% AEP CC 2130 Chrystall's Stopbank overtopping scenario. The extent of the secondary containment bund has been limited to the project designation boundary.
Swale between Expressway and Secondary Containment Bund (Refer Figure 3.3, Appendix A)	The model topography was refined to ensure this swale is represented as a continuous channel in the 2D terrain, falling from 15.55mRL at the northeastern end to 14.05mRL at the southwestern end.
Rail Flood Bund / Platform (Refer Figure 3.3, Appendix A)	A flood bund is proposed between the expressway embankment and rail embankment at Chainage 2,400m to prevent water flowing northeast between the realigned rail and expressway, and subsequently overtopping the realigned rail near Racecourse Stream. The top of the flood bund is set at 14.35mRL, approximately 0.5m to 0.6m above existing ground level. In the final design, the bund may become a raised platform rather than linear bund to suit landowner requirements.

Topographical Feature	Description
Racecourse Basin Bund (Refer Figures 3.3 and 3.4, Appendix A)	The model topography was refined to ensure the bund proposed to retain Racecourse Basin is represented as a continuous barrier to flow in the 2D terrain with overtopping level set at the top of the bund at 14.5mRL.
Concrete Road Barriers (Refer Figures 3.2, 3.3, 3.4 and 3.5, Appendix A)	The model topography was refined to ensure the rigid concrete road barriers proposed along the expressway are represented as a continuous barrier to flow in the 2D terrain, with overtopping level set at the top of the barrier. The concrete road barriers have generally been specified for road safety reasons, and their behaviour in holding back flood water is incidental. We have included the concrete road barriers in the flood model as this is conservative with respect to upstream flood effects from the project i.e. estimates higher flood levels.
Vee Channels between Culvert 7, Pipe 66 and Pipe 69 alongside Milk Station link road (Refer Figure 3.4, Appendix A)	The model topography was refined to ensure these vee channels are represented as continuous channels in the 2D terrain.
Rahui Basin Bund (Refer Figures 3.4 and 3.5, Appendix A)	The model topography was refined to ensure the bund proposed to retain Rahui Basin is represented as a continuous barrier to flow in the 2D terrain with overtopping level set at the top of the bund at 14.8mRL, and one 5m cell set lower at 14.4mRL to represent the 5m wide spillway.
Kennedy Wetland Bund (Refer Figures 3.4 and 3.5, Appendix A)	The model topography was refined to ensure the bund proposed to retain Kennedy Wetland is represented as a continuous barrier to flow in the 2D terrain with overtopping level set at the top of the bund at 16.35mRL.
Motel Bund (Refer Figures 3.4 and 3.5, Appendix A)	A flood bund is proposed around the motel property adjacent Pare-o-Matangi Reserve to provide 0.3m freeboard to the 1% AEP CC 2130 event. The model topography was refined to ensure the bund is represented as a continuous barrier to flow in the 2D terrain with overtopping level set to 13.45mRL.
Kennedy Swale (Refer Figure 3.5, Appendix A)	A swale is proposed to convey flows from Culvert 12 to the Kennedy Wetland. The model topography was refined to ensure this swale is represented as a continuous channel in the 2D terrain.
Overland Flow along the Expressway (Refer Figure 3.5, Appendix A)	Overland flow from north to south along the expressway has been blocked at Chainage 1,650m to direct flow from the "Te Manuao 2" catchment into the Remnant Wetland East. Testing in the railway wetland SWMM model (refer Culvert 12 Design Report Rev 2, PP2Ō March 2018) indicates that the proposed wetland system, which is not represented fully in the MIKE FLOOD model, is able to convey flows without this overland escape flow occurring (only minor escape flow less than 70L/s is predicted by the SWMM model in the largest 0.04% AEP CC 2130 event).

Where proposed culverts are located in the floodplain, the surrounding terrain has been altered to match culvert inverts for model stability purposes.

In addition to the above, the 2D topography for the Ōtaki-Mangapouri post-project model incorporates additional survey of the existing rail between Chainages 2,300m and 2,900m and anticipated removal of temporary stockpiles between Chainages 3,300m and 3,500m. These changes have similarly been incorporated in the pre-project topography presented in the Pre-Project Hydraulic Model Report Rev 5 (PP2Ō May 2018).

The rail embankment levels are based on top of ballast in the current version of the post-project model rather than the top of formation (bottom of ballast), noting that the latter was assumed for sections of realigned rail only in previous versions of the model. The approach has changed so that existing and realigned sections of rail are modelled consistently.

2.3.3 Linkage Between Models

Where “links” are found in both pre- and post-project models, settings remain the same for consistency. To help stabilise the standard link, the momentum factor (“Mom Fact”) was set to 0 and the exponential smoothing factor set to 0.2 for the following culverts:

- Culvert 7 (Ōtaki-Mangapouri post-project model);
- Culvert 18 (Ōtaki-Mangapouri post-project model); and
- Culvert 18a (Ōtaki-Mangapouri post-project model).

2.4 Waitohu Model Changes

2.4.1 MIKE 11 Model

MIKE 11 (open channel) extents are presented in Figures 1 and 4 (refer Appendix A). These extents are kept the same as the pre-project models, except in areas where realignment is required for the inlets/outlets of the proposed culverts.

Cross sections are kept the same as those in the pre-project model, unless branches have been realigned or structures added in the post-project situation. At these locations, additional cross sections have been added for hydraulic modelling purposes (inlets/outlets to culverts or branch start/end). Cross section data for modified post-project cross sections are based on adjacent cross sections and structure geometry. The data source of each cross section is described in the “Cross Section ID” section of the MIKE 11 cross section file and is summarised in Figure 4 in Appendix A.

Table 5 summarises the proposed structures that have been added to represent the post-project situation.

Table 5: Proposed Structures for Post-Project Situation for Waitohu Hydraulic Model

Structure	Name in Model	Description
Waitohu Stream bridge (Bridge 1)	“PP2O_WaitohuBridge”	Bridge conveying the expressway over the Waitohu Stream. Taylors Road is also realigned under Bridge 1 and provides additional waterway capacity in floods equal to or larger than the 5% AEP event.
Culvert 1	“PP2O_Culv1”	Corrugated steel pipe arch culvert conveying the Greenwood Stream under the expressway and Taylors Road
Culvert 2b	“PP2O_Culv2b”	Concrete circular culverts conveying Waitohu floodplain flows under the expressway and Taylors Road
Culvert 3	“PP2O_Culv3a”	Concrete circular culvert conveying an ephemeral tributary of the Waitohu Stream across the expressway
Culvert 3a	“PP2O_Culv3b”	Corrugated steel “underpass” profile culvert located beside Culvert 3 but at a higher elevation. Culvert 3a provides continuity of access, and in combination with Culvert 3, contributes to conveying the ephemeral tributary of the Waitohu Stream across the expressway in flood events

The configurations of the proposed structures are based on:

- Revising the configurations over several iterations of the hydraulic model to achieve the performance standards described in Section 5; and
- Wider design development, including considerations such as fish passage and coordination with other design disciplines.

Figure 4 in Appendix A presents the location of all structures within the model extents. The method for modelling the culverts and overtopping is as described in the Pre-Project Hydraulic Model Report Rev 5 (PP2Ō, May 2018).

The flow roughness coefficient (Manning's n) has been adopted as 0.012 for concrete, 0.035 for substrate, and 0.033 to 0.034 for corrugated steel depending on diameter. A weighted average was adopted for culverts where multiple materials are present. The Manning's n for corrugated steel was based on empirical data for structural plate (230mm x 65mm corrugations) from Figure B.3 of Hydraulic Design of Highway Culverts 3rd Ed (HIF-12-026, FHWA 2012). At the abutments of the proposed bridge structure, a Manning's n value of 0.024 has been applied to represent MSE material.

Entrance loss coefficients have been selected based on the following inlet configurations in line with guidance in FHWA 2012:

- Concrete box culverts: Square edge (30 to 75 degrees flare) wing wall (Ke = 0.5);
- Concrete circular culverts: Square edge with headwall (Ke = 0.5); and
- Corrugated steel culverts: Mitred to conform to slope (Ke = 0.7, end stiffening ring beams that match the batter slope are proposed).

The dimensions, invert levels, and model types of the proposed structures are presented in Appendix B.

2.4.2 MIKE 21 Model

The pre-project model 2D topography has been modified for the post-project model to incorporate the proposed expressway and proposed local roads based on the geometric design current on 11 January 2018. Additional topographical changes are described in Table 6 below, and the locations of these changes are presented in Figure 5 in Appendix A.

Table 6: Additional topographical changes applied to pre-project model topography

Topographical Feature	Description
Ground shaping to direct flow into Culvert 2b	This is an area within the Designation, upstream of Culvert 2b, where existing ground levels will be modified to allow overland flow to smoothly enter Culvert 2b and improve hydraulic performance of this culvert
Waitohu south bank stream diversion	A stream diversion is proposed to connect the downstream end of Culvert 3 to the existing stream channel. This has been represented as a 5m wide channel at 23.1mRL
Culvert 3 Flood Bund	A small bund up to 0.8m high is proposed with a crest level of 24.75mRL to direct flows from Culvert 3 into the Waitohu south bank stream diversion described above

Several features included in previous versions of the model are no longer proposed and have been deleted from the current model:

- Waitohu north bank overflow channel: A channel was previously proposed between the inlet to Culvert 2b and the Waitohu Stream to allow flood plain flows (that do not enter Culvert 2b) to return to the Waitohu Stream channel. There is no space for this

channel within the Designation, so it has been deleted from the current design and model, and flow is instead directed through Culvert 2b and over Taylors Road.
- Taylors Road Flood Wall: A 1m high flood wall between the Waitohu Stream and Taylors Road under the bridge was previously proposed to help maintain the existing balance of flows between the Waitohu and Greenwood Stream in large floods. In the current design, the balance of flows is maintained instead by an additional culvert barrel for Culvert 2b and changes to the geometric design.

Where proposed culverts are located in the floodplain, the surrounding terrain has been altered to match culvert inverts for model stability purposes.

2.4.3 Linkage Between Models

Where "links" are found in both pre- and post-project models, settings remain the same for consistency.

2.5 Mangaone Model Changes

2.5.1 MIKE 11 Model

MIKE 11 (open channel) extents are presented in Figures 1 and 6 in Appendix A. These extents are kept the same as the pre-project models, except in areas where realignment is required for the inlets/outlets of the proposed culverts.

Cross sections are kept the same as those in the pre-project model, unless branches have been realigned or structures added in the post-project situation. At these locations, additional cross sections have been added for hydraulic modelling purposes (inlets/outlets to culverts or branch start/end). Cross section data for modified post-project cross sections are based on adjacent cross sections and structure geometry. The data source of each cross section is described in the "Cross Section ID" section of the MIKE 11 cross section file and is summarised in Figure 6 in Appendix A.

Table 7 summarises the proposed structures that have been added to represent the post-project situation.

Table 7: Proposed Structures for Post-Project Situation for Mangaone Hydraulic Model

Structure	Name in Model	Description
Culvert 23	"PP2O_Culv23"	Concrete box culvert conveying Mangaone Stream under School Road
Culvert 23a	"PP2O_Culv23a"	Corrugated steel arch culvert conveying secondary flow path under School Road
Culvert 24	"PP2O_Culv24"	Concrete box culvert conveying Mangaone Stream under expressway
Culvert 27	"PP2O_Culv27"	Corrugated steel arch culvert conveying Mangaone Overflow under School Road
Culvert 28	"PP2O_Culv28"	Corrugated steel "box" profile culvert conveying Mangaone Overflow under expressway
Culvert 34	"PP2O_Culv34"	Concrete box culvert conveying Mangaone Stream under western link road
Lucinsky Overflow	"PP2O_LucinskyOverflow"	Side weir off Mangaone Stream maintaining existing secondary flow path

The configurations of the proposed structures are based on:

- Revising the configurations over several iterations of the hydraulic model to achieve the performance standards described in Section 5; and
- Wider design development, including considerations such as fish passage and coordination with other design disciplines.

Figure 6 in Appendix A presents the location of all structures within the model extents. The method for modelling the culverts and overtopping is as described in the Pre-Project Hydraulic Model Report Rev 5 (PP2Ō, May 2018).

The flow roughness coefficient (Manning's n) has been adopted as 0.012 for concrete, 0.035 for substrate, and 0.033 to 0.034 for corrugated steel depending on diameter. A weighted average was adopted for culverts where multiple materials are present. The Manning's n for corrugated steel was based on empirical data for structural plate (230mm x 65mm corrugations) from Figure B.3 of Hydraulic Design of Highway Culverts 3rd Ed (HIF-12-026, FHWA 2012).

Entrance loss coefficients have been selected based on the following inlet configurations in line with guidance in FHWA 2012:

- Concrete box culverts: Square edge (30 to 75 degrees flare) wing wall (Ke = 0.5);
- Concrete circular culverts: Square edge with headwall (Ke = 0.5); and
- Corrugated steel culverts: Mitred to conform to slope (Ke = 0.7, end stiffening ring beams that match the batter slope are proposed).

The Lucinsky Overflow is modelled as a weir (Honma) structure in MIKE 11, with a weir coefficient of 1.1 applied due to it being a lateral structure.

The dimensions, invert levels, and model types of the proposed structures are detailed in Appendix B.

2.5.2 MIKE 21 Model

The pre-project model 2D topography has been modified for the post-project model to incorporate the proposed expressway and proposed local roads based on the geometric design as current on 25 October 2017. Additional topographical changes are described in Table 8 below, and the locations of these changes are presented in Figures 7.1 to 7.3 in Appendix A.

Table 8: Additional topographical changes applied to pre-project model topography

Topographical Feature	Description
School Road Drain Enlargement (Refer Figure 7.1, Appendix A)	A drain is proposed to be enlarged alongside the realigned section of School Road between the tie in with the existing road at the southern end and inlet to Culvert 27 at the northern end. In line with NTC-385, the extent of drain enlargement works is limited to within Designation, noting this results in some escape flow to the south over School Road near the tie in. The model topography was refined to represent the drain enlargement in the 2D terrain as a 5m wide channel, 424m long, grading at 0.64% from 19.1mRL at the southern end to 16.4mRL at the northern end.
Te Horo Eastern Flood Bund (Refer Figures 7.1, 7.2 and 7.3, Appendix A)	An eastern flood bund has been added along the edge of the expressway with the overtopping level set 0.6m above the 1% AEP CC 2130 flood level, noting this involved modifying the top of the bund from the level in the October 2017 geometric design. The flood bund extends to Chainage 6,500m in the northeast, where it transitions to a landscape bund.

Topographical Feature	Description
Te Horo Western Flood Bund (Refer Figure 7.2, Appendix A)	A western flood bund has been added along the true left bank of the Mangaone Stream between the existing SH1 and Culvert 34 with the overtopping level set at the level of the top of the bund in the October 2017 geometric design (this level provides excess of the 0.3m required freeboard to the 2% AEP CC 2130 flood level). The purpose of the flood bund is to prevent headwater upstream of Culvert 34 spreading across Te Horo Beach Road in the 2% AEP CC 2130 event.
Lucinsky Overflow (Refer Figure 7.2, Appendix A)	A channel is proposed downstream of the proposed Lucinsky Weir. The model topography was modified to represent this as a 17m wide channel grading from the weir sill level of 14.8mRL to tie in with existing ground within the Designation.

Where proposed culverts are located in the floodplain, the surrounding terrain has been altered to match culvert inverts for model stability purposes.

2.5.3 Linkage Between Models

Where "links" are found in both pre- and post-project models, settings remain the same for consistency.

3. Modelled Scenarios

There are a range of scenarios that the hydraulic models are required to assess to meet the performance standards set out in Section 1.3. These consist of "effects assessment" type scenarios which are carried out for pre-project and post-project situations, and the scenarios which are required for post-project representation only to ensure compliance with a particular performance standard.

3.1 Summary of Modelled Scenarios for Post-Project Models

Table 9 summarises the design storm scenarios for post-project models. For the Ōtaki-Mangapouri model, the hydrology and 2D topography vary with the scenario being modelled as summarised in Table 10 in Section 3.2. Further detail is provided regarding specific scenarios for breach of Chrystall's Stopbank in Section 3.3, debris blockage in Section 3.4, culvert blockage in Section 3.5, an Alternative Design without upgrade of Chrystall's Stopbank and the addition of a 70m floodway bridge in Section 3.6, and a High Range climate change scenario for sensitivity testing in Section 3.7.

Table 9: Post-Project Design Storm Scenarios

Scenario	Ōtaki-Mangapouri	Waitohu	Mangaone
0.04% AEP + CC2130	✓	✓	✓
3,000m³/s - No CC	✓ (Ōtaki only)		
0.1% AEP + CC2130			✓
0.2% AEP + CC2130	✓		

Scenario	Ōtaki-Mangapouri	Waitohu	Mangaone
1% AEP + CC2130 (High Range)	✓	✓	✓
1% AEP + CC2130	✓	✓	✓
1% AEP - No CC	✓		
2% AEP + CC2130			✓
2% AEP - No CC	✓		
5% AEP + CC2130			✓
5% AEP – No CC	✓	✓	
10% AEP + CC2130	✓	✓	✓
10% AEP - No CC	✓ (Mangapouri only)	✓	
3,000m³/s - No CC Stopbank Breach	✓ (Ōtaki only)		
0.2% AEP + CC2130 Stopbank Breach	✓		
0.2% AEP + CC2130 Debris Blockage	✓		
1% AEP + CC2130 Debris Blockage	✓	✓	
1% AEP + CC2130 Culvert Blockage	✓		
1% AEP + CC2130 Alternative Design	✓		

3.2 Ōtaki-Mangapouri Model Setup

The following table summarises the hydrology and 2D topography setup for each modelled scenario for the Ōtaki-Mangapouri model.

Table 10: Ōtaki-Mangapouri Model Setup

Scenario	Hydrology	Topography
0.04% AEP + CC2130	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place
3,000m³/s - No CC	3,000m³/s applied upstream of Rail Bridge. No other hydrological inputs applied to model.	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place

Scenario	Hydrology	Topography
0.2% AEP + CC2130	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place
1% AEP + CC2130 (High Range)	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place
1% AEP + CC2130	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place.
1% AEP - No CC	Pre-project schematisation	Gap left in Chrystall's Stopbank; to represent "no stoplogs".
2% AEP - No CC	Pre-project schematisation	Gap left in Chrystall's Stopbank; to represent "no stoplogs".
5% AEP – No CC	Pre-project schematisation	Gap left in Chrystall's Stopbank; to represent "no stoplogs".
10% AEP + CC2130	Pre-project schematisation	Gap left in Chrystall's Stopbank; to represent "no stoplogs".
10% AEP - No CC	Hydrological inputs applied to Mangapouri Catchment only. Ōtaki River not considered in scenario, noting that there is no interaction between the Ōtaki and Mangapouri catchments in this event.	Gap left in Chrystall's Stopbank; to represent "no stoplogs".
3,000m³/s - No CC Stopbank Breach	3,000m³/s applied upstream of Rail Bridge. No other hydrological inputs applied to model.	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place Time varying topography representing stopbank breach
0.2% AEP + CC2130 Stopbank Breach	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place Time varying topography representing stopbank breach
0.2% AEP + CC2130 Debris Blockage	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place
1% AEP + CC2130 Debris Blockage	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place.
1% AEP + CC2130 Culvert Blockage	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place.
1% AEP + CC2130 Alternative Design	Pre-project schematisation	2D levels modified at Chrystall's Stopbank floodgate to simulate "stoplogs" in place. Chrystall's Stopbank crest remains at pre-project levels, i.e. is not raised as per proposed design. Gap 'cut' through expressway to represent 70m wide bridge.

3.3 Stopbank Breach Scenarios

Scenarios incorporating a breach in Chrystall's Stopbank are modelled with both the pre- and post-project Ōtaki-Mangapouri models. Table 10 includes the relevant design storm scenarios and summarises the model setup for the various breach scenarios.

The breach was modelled using a time-varying 2D topography. The breach location is upstream of the expressway in approximately the same location as modelled by Opus in the Specimen Design phase. This location is used for both pre- and post-project breach scenarios. The location is expected to be conservative for assessing flood effects on the expressway since the breach is immediately upstream of the expressway i.e. flood effects on the expressway for the breach location adopted are worse than if a breach occurred further upstream.

The breach starts forming when the stopbank starts to overtop for most events. For the 0.2% AEP CC 2130 storm event, the stopbank does not overtop, so the breach starts forming when the maximum water level occurs at the stopbank for the 0.2% AEP CC 2130 storm event (this is when the stopbank would be most vulnerable to many alternative failure modes, such as internal erosion, and results in the largest breach discharge).

The breach progresses from an initial central breach to a full breach width of 140m over 2 hours and 20 minutes. Final invert levels are based on surrounding existing natural ground and vary between 14.4mRL and 14.8mRL, giving an average beach depth below stopbank crest level of around 2.3m (the upgraded stopbank has a minimum crest level of 16.81mRL to provide the required 0.8m freeboard to the 1% AEP CC2130 flood level).

3.4 Debris Blockage Scenarios

A scenario incorporating debris blockage at the expressway bridges is modelled with the post-project Ōtaki-Mangapouri and Waitohu models. Table 11 summarises the relevant design storm scenarios and the model setup for the debris blockage scenarios.

In previous versions of this report, the methodology to assess increases in flood levels in the main stream channel upstream of bridges due to debris blockage was proposed to be by independent analytical methods, such as Yarnell equation. However, this approach has been revised in this report so debris blockage is assessed within the post-project Ōtaki-Mangapouri and Waitohu models for consistency of comparison with no blockage water levels.

The debris blockage was based on a rectangular debris raft on each bridge pier, with;

- Width (W) = 15m; and
- Height below water surface (T) = Half flow depth.

The shape and dimensions above are based on the New Zealand Transport Agency Bridge Manual (NZTABM) 3rd Edition including amendments issued in September 2014 (Amendment 1).

This was applied to the bridge structures in the 1D model by assigning a pier blockage ratio where every pier is 7.5m wide (this approximates the same area blocked as the debris raft shape described above).

Table 11: Post-Project Debris Blockage Design Storm Scenarios

Scenario	Ōtaki-Mangapouri	Waitohu
0.2% AEP + CC2130	✓ Nine Piers. Pier blockage increases from 0.044 to 0.205	
1% AEP + CC2130	✓ Nine Piers. Pier blockage increases from 0.044 to 0.205	✓ Two piers. Pier blockage increases from 0.043 to 0.200

3.5 Culvert Blockage Scenario

Debris blockage assessments have been completed for proposed project culverts as presented in Section 5.4.9 of the Culvert 80% Design Report Rev 1 (PP2Ō February 2018). In summary, the risk of debris blockage was categorised as Low for the proposed culverts.

However, Culvert 18a is proposed for a conveyor belt culvert for Winstone Aggregates operations. The risk of blockage of Culvert 18a is considered higher than for other project culverts because mechanical equipment will be located within the culvert. Therefore, an additional scenario, incorporating blockage at proposed Culvert 18a, has been modelled with the post-project Ōtaki-Mangapouri model for the 1% AEP CC 2130 storm event.

The culvert blockage is based on a 50% blockage ratio and is applied to the culvert structure in the 1D model by applying an equivalent width and height. The box culvert is reduced from 2.5m x 2.5m (post-project model) to 1.78m x 1.78m (post-project model with culvert blockage).

3.6 Alternative Design (No Upgrade of Chrystall's Stopbank and Addition of Floodway Bridge)

This additional scenario was modelled to compare the proposed approach of upgrading Chrystall's Stopbank with an alternative approach of not upgrading Chrystall's Stopbank as per the earlier Specimen Design. If Chrystall's Stopbank is not upgraded, the Ōtaki River will overtop and/or breach Chrystall's Stopbank upstream of the expressway in the 1% AEP CC 2130 event, and an additional 70m wide floodway bridge would be required to convey these overtopping/breach flows past the expressway with the required freeboard to the expressway. In the Proposed Design, Chrystall's Stopbank is to be upgraded to the east of the expressway to have a minimum 0.8m freeboard to the 1% AEP CC 2130 event i.e. will be designed to avoid overtopping / breaching in this event. Further discussion is provided in Section 5.1.2.

The Alternative Design has been modelled with the Ōtaki-Mangapouri model for the 1% AEP CC 2130 storm event using a configuration that is identical to the post-project models except for the following modifications:

- Chrystall's Stopbank not upgraded, i.e. Stopbank at pre-project levels;
- (Proposed) Culvert 15e removed; and

- 70m wide bridge added through expressway at location of proposed Culvert 15e.

The 70m floodway bridge is applied to the 2D terrain by removing the expressway embankment at this location.

3.7 Climate Change Sensitivity

A High Range Climate Change scenario has been modelled with the post-project Ōtaki-Mangapouri, Waitohu and Mangaone models for the 1% AEP CC2130 event. This is intended to provide a sensitivity evaluation against high range climate change as specified in Consent Condition SW.2. Refer to Section 3.2 of the Stormwater Design Philosophy Report Rev 2 (PP2Ō, August 2017) for the methodology that has been adopted to develop High Range and base case (Mid Range) allowances for climate change.

4. Results

Figures 8 to 79 in Appendix A provide the model results for the design storm scenarios described in Section 3. The full list of figures is provided at the start of Appendix A.

Performance of the design based on the model results is discussed in Section 5 and Appendix C. A summary of model results and the implications for design are provided below for a number of the modelled scenarios.

The Peer Reviewer has noted that the values for the 2D velocities presented in Figures 38 to 60 are in a "good realistic range", which provides greater confidence in the model representation.

4.1 Stopbank Breach Scenario Results

Figures presenting model results in breach scenarios for the Ōtaki-Mangapouri pre and post project models are provided as follows:

Table 12: Ōtaki-Mangapouri Stopbank Breach Scenario Figures

Storm Scenario	Situation	Figures
3,000m³/s - No CC	Pre-project with breach – modelled depths	Figure 17.1 to 17.3 in Appendix B of the Pre Project Hydraulic Model Report Rev 5 (PP2Ō May 2018)
	Post-project with breach – modelled depths	Figure 18.1 to 18.3, Appendix A
	Post-project Breach vs Post-project Base Case (no breach) - water level differences	Figure 63.1 and 63.2, Appendix A
0.2% AEP + CC2130	Pre-project with breach – modelled depths	Figure 18.1 to 18.3 in Appendix B of the Pre Project Hydraulic Model Report Rev 5 (PP2Ō May 2018)

	Post-project with breach – modelled depths	Figure 19.1 to 19.3, Appendix A
	Post-project with breach vs Post-project base case (no breach) – water level differences	Figure 65.1 and 65.2, Appendix A
	Post-project with breach vs Pre-project with breach – water level differences	Figure 66.1 and 66.2, Appendix A

As illustrated in Figures 63.1 to 63.2 and 65.1 to 65.2, compared with the base case (no breach), a breach of the Chrystall's Stopbank immediately upstream of the expressway results in the following:

- A decrease in flood levels on the Ōtaki River and adjacent banks:
  - In the 3,000m³/s event, the decrease is < 130mm and is generally limited to within 0.9km upstream and 1.0km downstream of the expressway bridge.
  - In the 0.2% AEP CC2130 event, the decrease is negligible. This is because the breach has been modelled as initiating at the peak water level from the base case (no breach) i.e. the peak water levels upstream of the stopbank are essentially the same for the breach and base case. (This approach has been adopted because the stopbank does not overtop in the base case, and thus a breach would more likely be initiated by another failure mechanism other than overtopping.)

- An increase in flood levels on the major overland flow path on the north side of Riverbank Road and along the Mangapouri Stream:
  - In the 3,000m³/s event, the increase is generally < 300mm downstream of the expressway with some pockets < 650mm. The increase in water levels upstream of the expressway is generally < 650mm.
  - In the 0.2% AEP CC2130 event, the increase is generally < 300mm downstream of the expressway with some pockets < 650mm similar to the 3,000m³/s event. The increase in flood levels upstream of the expressway ranges up to 1600mm in the 0.2% AEP CC2130 event. There is negligible increase in flood levels upstream of the expressway to the north of the Secondary Containment Bund. The increase in water levels upstream of the expressway is more pronounced for the 0.2% AEP CC2130 event than for the 3,000m³/s event because of a lesser base case level of flooding.

In terms of implications for design, the key outcomes from the breach scenario results are:

- Flood levels from the 0.2% AEP CC2130 with breach scenario have been used (in combination with 0.3m freeboard allowance) to set the level of the top of the Secondary Containment Bund, which was found to result in a higher bund than the 0.2% AEP CC2130 base case (no breach).
- Flood levels, depths, velocities and flows from the 3,000m³/s event with breach scenario will be used for the Ultimate Limit State design of the Ōtaki flood plain crossing. The assessment of performance of project elements in this event will be presented separately in the Stormwater 100% Design Report and Culvert 100% Design Report.

4.2 Debris Blockage Scenario Results

Figures presenting debris blockage scenarios for the Ōtaki-Mangapouri and Waitohu post project models are provided as follows:

Table 13: Debris Blockage Scenario Figures

Storm Scenario	Situation	Figures
0.2% AEP + CC2130	Post-project Ōtaki-Mangapouri model with debris blockage on the bridge piers - modelled depths	Figure 20.1 to 20.3, Appendix A
	Post-project Ōtaki-Mangapouri model with debris blockage vs base case (no debris blockage) - water level differences	Figure 67.1 and 67.2, Appendix A
1% AEP + CC2130	Post-project Ōtaki-Mangapouri model with debris blockage on the bridge piers - modelled depths	Figure 21.1 to 21.3, Appendix A
	Post-project Ōtaki-Mangapouri model with debris blockage vs base case (no debris blockage) - water level differences	Figure 68.1 and 68.2, Appendix A
	Post-project Waitohu model with debris blockage on the bridge piers - modelled depths	Figure 30.1 and 30.2, Appendix A
	Post-project Waitohu model with debris blockage vs base case (no debris blockage) - water level differences	Figure 75, Appendix A

As illustrated in Figures 67.1 to 67.2 and Figures 68.1 to 68.2, the changes in levels due to a debris raft forming on the piers of the Ōtaki River expressway bridge are generally limited to the banks of the Ōtaki River, including the off-river storage basin, over a 0.9km reach upstream of the bridge. Introducing a debris raft increases flood levels in this area by up to 60mm for the 1% AEP CC2130 event, and up to 30mm for the 0.2% AEP CC2130 event.

As illustrated in Figure 75, the changes in water level due to a debris raft forming on the piers of the Waitohu Stream expressway bridge are limited to the local vicinity of the bridge, between the existing SH1 and rail bridges. Introducing a debris raft increases flood levels in this area by < 30mm generally in the 1% AEP CC2130, mostly on the southern bank of the stream both upstream and downstream of the expressway bridge.

In terms of implications for design, the key conclusions are:

- The freeboard provision of 500mm to the expressway and 800mm to the upgraded Chrystall's Stopbank in the 1% AEP CC2130 event (base case, no debris blockage) adopted for the project substantially exceeds the modelled increase in flood levels for a debris blockage scenario for the Ōtaki-Mangapouri model i.e. < 60mm on the banks of the Ōtaki River and in the off-river storage basin. The upgraded Chrystall's

Stopbank is not expected to be overtopped by the 0.2% AEP CC2130 event, even if a debris raft forms.
- The freeboard provided to the expressway in the vicinity of the Waitohu Stream bridge is substantially in excess of the 500mm required. > 500mm of freeboard will still be provided to the expressway even with a < 30mm increase in flood levels due to a debris raft. The increase in flood levels due to a debris raft would increase the depth of flooding on Taylors Road, but the increase < 30mm is considered minor.
- > 1.95m freeboard is provided to the Ōtaki River Bridge soffit in the 1% AEP CC2130 event (base case, no debris blockage), noting that the freeboard at the centre span of the bridge is greater than this because of the vertical profile of the bridge. > 1.89m freeboard will still be provided for the debris blockage scenario (1D model results), which exceeds both the standard 0.6m freeboard (normal circumstances) and 1.2m freeboard (where large trees may be carried down the waterway) recommended in the Bridge Manual (Transport Agency 2010).
- > 5.43m freeboard is provided to the Waitohu Stream Bridge soffit in the 1% AEP CC2130 event (base case, no debris blockage), noting that the freeboard substantially exceeds hydraulic requirements because the level of the bridge soffit is governed by clearance requirements for access. > 5.17m freeboard will still be provided for a debris blockage scenario (1D model results), which still substantially exceeds freeboard requirements for hydraulic considerations.

In summary, based on the above, the freeboard provisions and design are considered to provide an appropriate level of resilience against debris blockage uncertainty.

4.3 Culvert Blockage Scenario Results

Figures presenting results for the culvert blockage scenario for the Ōtaki-Mangapouri post project model are provided as follows:

Table 14: Culvert Blockage Scenario Figures

Storm Scenario	Situation	Figures
1% AEP + CC2130	Post-project Ōtaki-Mangapouri model with culvert blockage - modelled depths	Figure 22.1 to 22.3, Appendix A
	Post-project Ōtaki-Mangapouri model with culvert blockage vs base case (no culvert blockage) - water level differences	Figure 69, Appendix A

In the culvert blockage scenario, 50% blockage of Culvert 18a, the conveyor belt culvert for Winstones Aggregates, has been assumed. The flow through Culvert 18a in the 1% AEP CC2130 event for the base case (no blockage) is 0.67m³/s, and in the blockage scenario is 0.47m³/s. The flows are very small due to the culvert size and the invert level, which is raised at the western end to suit the conveyor belt. The discharge through the culvert and the change in discharge with culvert blockage is relatively small and has negligible impact on flood levels as illustrated in Figure 69 (< 25mm change confined to the immediate vicinity of the culvert).

In terms of implications for design, the key conclusions are:

- Blockage or clear flow through Culvert 18a has negligible impact on flood levels.
- The performance of the Project elements in terms of managing flood effects does not depend on flow through Culvert 18a.

- No specific allowance / contingency is warranted to allow for uncertainty of blockage of Culvert 18a.
- It is not necessary to impose any specific constraints on Winstone Aggregates' operation of Culvert 18a for flood management reasons.

4.4 Alternative Design Scenario Results

A comparison of the Proposed Design (Upgrade Chrystall's Stopbank to East of Expressway) and Alternative Design (No Upgrade to Chrystall's Stopbank and Addition of Floodway Bridge) is discussed in detail in Section 5.2.2.

4.5 Climate Change Sensitivity Results

Figures 72.1 to 72.2, 76 and 79 in Appendix A compare 1% AEP CC 2130 flood levels for the High Range Climate Change scenario and base case (Mid Range Climate Change allowance).

Key results for design of the project are:

Table 15: Climate Change Sensitivity Results

Location	Increase in Flood Levels for High Range Estimate
Ōtaki-Mangapouri	
Upstream of expressway in Mangapouri storage area north of Rahui Road	< 30mm
Upstream of expressway between Rahui Road and the Secondary Containment Bund	< 160mm
Upstream of expressway between the Secondary Containment Bund and Chrystall's Stopbank	< 90mm
Upstream of expressway on the banks of the Ōtaki River, including in off-river storage basin adjacent Chrystall's Stopbank	< 400mm
Right bank of the Ōtaki River 1.5-2.2km upstream of the expressway bridge, adjacent Chrystall's Stopbank	< 160mm
On the Ōtaki River upstream of the expressway bridge	< 380mm
Waitohu	
Upstream of proposed road embankments	< 100mm
On the Waitohu Stream upstream of the expressway bridge	< 140mm
Mangaone	
Upstream of School Road embankment and Te Horo Eastern Flood Bund on eastern side of expressway (Note there is a localised larger increase in flood level at the southern end of the bund – this is where water levels in the base case taper off due to head losses,	< 230 mm

but the high range scenario forms a level pool. The top of the bund is relatively level in this location so still provides a consistent level of freeboard.)	
Upstream of Culvert 34 and the School Road link to Te Horo Beach Road	< 80 mm

In terms of implications for design, the key conclusions are:

- Water levels are most sensitive (< 400mm increase in levels) to the climate change allowance immediately upstream of the expressway bridge on the Ōtaki River and in the adjacent off-river storage basin on the right bank.
- Water levels are moderately sensitive to the climate change allowance upstream of the School Road embankment and Te Horo Eastern Flood Bund (< 230mm increase in levels).
- In other locations upstream of Project elements, the increase in water levels for a high range climate change scenario compared with the base case (mid range climate change allowance) is < 200mm.
- The freeboard provision of 500mm to the expressway in the 1% AEP CC2130 event (base case, mid range climate change adjustment) adopted for the project exceeds the modelled increase in flood levels for a high range climate change scenario by at least 100mm in all locations, and by 300mm in most locations i.e. even if climate change is greater than expected, the design will still have a residual freeboard of > 300mm in most locations.
- The freeboard provision of 800mm to the upgraded Chrystall’s Stopbank in the 1% AEP CC2130 event (base case, mid-range climate change adjustment) adopted for the project exceeds the modelled increase in flood levels for a high range climate change scenario by at least 400mm i.e. even if climate change is greater than expected, the upgraded stopbank will still have a residual freeboard of > 400mm.
- > 1.95m freeboard is provided to the Ōtaki River Bridge soffit in the 1% AEP CC2130 event (base case, mid range climate change adjustment), noting that the freeboard at the centre span of the bridge is greater than this because of the vertical profile of the bridge. > 1.57m freeboard will still be provided for a High Range climate change scenario (based on 1D model results), which exceeds both the standard 0.6m freeboard (normal circumstances) and 1.2m freeboard (where large trees may be carried down the waterway) recommended in the Bridge Manual (Transport Agency 2010).
- > 5.43m freeboard is provided to the Waitohu Stream Bridge soffit in the 1% AEP CC2130 event (base case, mid range climate change adjustment), noting that the freeboard substantially exceeds hydraulic requirements because the level of the bridge soffit is governed by clearance requirements for access. > 5.29m freeboard will be provided for a High Range climate change scenario (based on 1D model results), which still substantially exceeds freeboard requirements for hydraulic considerations.
- > 600mm freeboard is provided to the Te Horo Eastern Flood Bund in the 1% AEP CC2130 event (base case, mid range climate change adjustment). For the High Range scenario, > 360mm freeboard is generally still provided.

In summary, based on the above, the freeboard provisions and design are considered to provide an appropriate level of resilience against climate change uncertainty.

5. Design Development and Performance

5.1 Compliance with Performance Standards

5.1.1 Introduction

The specified hydraulic performance standards for the Project are set out by:

- Resource Consents; and
- Principal's Requirements, as modified by Notices to Tenderers, Notices to Contractor, and Approved Departures.

Compliance of the Project design with the performance standards above is presented in detail as spreadsheets in Appendix C. Particular areas of potential non-compliance (only) for the Ōtaki-Mangapouri catchment are highlighted in Table 16, for the Waitohu catchment in Table 18, and for the Mangaone catchment in Table 19.

The areas of potential non-compliance do not reflect reduced performance of the design in terms of flooding effects, but are due to a more detailed level of assessment appropriate for detailed design, incorporating new flood models and updated input data and methodologies, i.e. new survey data and revised hydrology. This more detailed level of assessment has resulted in an improved level of understanding of the flooding issues and refinement to the baseline flood levels and flows, against which the Project is benchmarked.

Comments from the Peer Reviewer and Principal's Advisor on potential non-compliances are included in Appendix D and E. The Principal's Advisor has advised "*In general, it is accepted that the proposed design is optimised to minimise the impact of flooding following completion if the project*" (refer Notice to Contractor in Appendix E). Most comments on potential non-compliances have been closed out based on clarification or relaxation of the Principal's Requirements as documented in the Notice to Contractor. Two Principal's Advisor comments (38 and 39) and one Peer Review comment (6) for the Ōtaki-Mangapouri model and one Principal's Advisor comment for the Waitohu model (42) are "parked" or "on hold", subject to additional information to be provided in separate reports / notices.

As per the Notice to Contactor included in Appendix E, the Principal's Advisor has noted:

> *"Although comments 38, 39, and 42 are still outstanding they are relatively minor in scope. Comments 38 and 39 are covered by the separate GWRC and Fletchers agreement to raise the Chrystalls Bend Stopbank and Comment 42 impacts only a localised length of the mainline alignment. It is acceptable to proceed to the IFC stage for the Post Project Hydraulic Model with hold points or clouds for comments 38, 39, and 42."*

Overall, we consider that the hydraulic performance of the design meets the intentions of the performance standards for the Project.

5.1.2 Ōtaki-Mangapouri Model

As noted above, the proposed design for the Ōtaki and Mangapouri catchments has been optimised to achieve or exceed the hydraulic performance standards for the project.

The key difference between the Proposed Design and the Specimen Design relates to the treatment of the Chrystall's Stopbank and flood plain on the true right bank of the Ōtaki River. The Specimen Design proposed to retain the current levels of the Chrystall's Stopbank, which would overtop in the 1% AEP CC 2130 flood. The Specimen Design included a 70m long bridge (Bridge 10) to convey the 1% AEP CC 2130 flood flows under the expressway, which included conveyance of flows overtopping the stopbank from the Ōtaki River and flows from the local catchment.

For the Proposed Design, Chrystall's Stopbank will be raised on the eastern side of the expressway to provide a 1% AEP CC 2130 flood standard. This will prevent flows in the Ōtaki River from entering the adjacent flood plain in the 1% AEP CC 2130 event. The flows entering the flood plain in the 1% AEP CC 2130 event will be from the immediate catchment only, which can be conveyed under the expressway by five culverts (Culverts 15b to 15e) with provision of 0.5m freeboard to the road surface i.e. Bridge 10 is no longer required nor proposed.

In the Ultimate Limit State event (3,000m^3/s event on the Ōtaki River), flows from the Ōtaki River will enter the flood plain by overtopping or breaching the Chrystall's Stopbank and will add to the direct catchment flows. The resulting combined flows will be conveyed past the expressway by overtopping the expressway embankment in conjunction with flow through culverts 15b to 15e. Furthermore, in the 0.2% AEP CC 2130 event (both breach scenario and base case), a flood bund at the northern end of the flood plain "Secondary Containment Bund" (also included in the Specimen Design) will prevent flows from transferring north into the Racecourse and Mangapouri catchments.

Further detail on the Proposed Design for the Ōtaki flood plain is provided in Section 5.8.4 of the "Stormwater 80% Design Report Rev 1" (PP2Ō, January 2018).

As noted above, the proposed design meets the intentions of the performance standards for the Project set out in Section 1.3, but discussion with the Principal's Advisor has been required due to technical non-compliance with exact wording and numbers in the Principal's Requirements. Some of the areas of technical non-compliance relate to the Principal's Requirements being developed based on the Specimen Design, which as noted above, differs from the proposed design.

As noted above, the Principal's Advisor has accepted that the design is optimised in general to minimise the impact of flooding following completion if the project. All comments on potential non-compliances for the Ōtaki-Mangapouri model have been closed out based on clarification or relaxation of the Principal's Requirements as documented in the Notice to Contractor in Appendix E, except for the following three comments, which are "parked" or "on hold", subject to additional information to be provided in separate reports / notices:

Peer Review:

- **Comment 6**: The Peer Reviewer has asked whether drainage arrangements for the borrow area are included in the design. Further detail regarding drainage of the borrow area is to be included in the Stormwater 100% Design Report, scheduled to be issued on 15 June 2018.

Principal's Advisor Check:

- **Comment 38**: This comment relates to water levels upstream of the proposed Ōtaki River Expressway Bridge, which have increased largely due to upgrading Chrystall's Stopbank. To close out Comment 38 and Comment 39 (below), the Principal's Advisor has requested submission of documentation confirming that raising of the Stopbank has been accepted by Greater Wellington Regional Council and that affected stakeholders have been adequately consulted.
- **Comment 39**: Similar to the comment above, Comment 39 relates to water levels in the off-river storage basin on the true right bank of the Ōtaki River, upstream of the proposed Ōtaki River Expressway Bridge.

Refer to Appendix C for full details of compliance of the Project design for the Ōtaki-Mangapouri Model. Table 16 following describes areas of potential non-compliance only. Refer to Appendix D and E for Peer Review and Principal's Advisor Check comments on previous revisions of the report and potential non-compliances.

Table 16: Potential Non-compliance Summary for the Otaki-Mangapouri Model

ID	Potential Non-Compliance	Comments
1	Existing Culvert 15 in the 10% AEP event: • The modelled Post-Project upstream water level (11.88mRL) exceeds the maximum allowable water level (11.86mRL) in the PRs	The allowable water level is exceeded by 20mm. The post-project water level is only 6mm higher than the pre-project water level i.e. the allowable water level is 14mm below the modelled pre-project water level; thus the non-compliance reflects a change in methodology and refined input information and not a decrease in performance. The 20mm exceedance is also considered less than minor. Further, the water level cannot be reduced without compromising the current design, which has been optimised to fulfill the wider intents of the performance requirements (further detail below). There are only a few elements of the Project that have the potential to affect discharge through the existing Culvert 15. The relevant elements comprise proposed Culverts 7 and 14. However, despite the non-compliant water level upstream of Culvert 15, the current design of Culverts 7 and 14 is considered optimised to minimise flooding effects. Culvert 7 maintains an existing overland flow path over a low point on Rahui Road, which currently diverts some flow from the Mangapouri Stream to the Racecourse Stream (on which Culvert 15 is located) in very large flood events. The current design of Culvert 7 is optimised to minimise flooding effects across the Mangapouri and Racecourse catchments i.e. minimising flows transferred into the Racecourse catchment while also avoiding substantial increases in flood levels in the Mangapouri catchment. The design of Culvert 14 is similarly optimised to minimise flooding effects upstream and downstream i.e. minimising flood rise upstream of the expressway, while also minimising volumes transferred downstream to the Kāpiti Coast District Council (KCDC) soakage area, which has a limited capacity.

ID	Potential Non-Compliance	Comments
2	Transfer of flow from Mangapouri catchment to Racecourse catchment via combination of flow through Culvert 7 and Rahui Road overtopping (road overtopping only in Pre-Project situation): • Requirement to avoid premature transfer in the Post-Project situation compared with the Pre-Project situation is not achieved. • Requirement to avoid increasing the volume transferred in floods ranging from the 10% AEP No CC to the 1% AEP CC 2130 is not achieved.	As noted above, the inlet level of Culvert 7 has been set at 14.0mRL to minimise flows transferred to the Racecourse Catchment while also avoiding substantial increases in flood levels in the Mangapouri catchment north of Rahui Road and east of the expressway. In the pre-project situation, inter-catchment transfer commences when the low point in Rahui Road at 14.15mRL is overtopped (occurs in an event between the 5% AEP and 2% AEP flood). In the Post-Project situation, inter-catchment transfer commences earlier because the culvert inlet is lower (occurs in an event between the 10% AEP and 5% AEP flood). Ideally, the inlet level of Culvert 7 would be raised to reduce the frequency of events in which inter-catchment transfer occurs as per the first bullet point and reduce volume transferred to the Racecourse catchment in line with the second bullet point. However, the inlet level (14.0mRL) cannot be raised further without causing substantial increases in flood levels in the Mangapouri catchment. As previously noted, the current design and level of Culvert 7 is considered to be optimised to minimise flooding effects across both the Mangapouri and Racecourse catchments on balance. Additional design measures are proposed to mitigate the impacts of increasing the frequency and volume of inter-catchment transfer through Culvert 7: • Drainage is proposed alongside the milk station link road (vee channels and two 0.9m diameter pipes) to convey the 5% AEP flow from the outlet of Culvert 7 to the Racecourse Stream without overland flow through private property i.e. the frequency of activation of the existing overland flow path through 35 Rahui Road will not be increased. The figures in Appendix A still show flow through the property in the 5% AEP event, but this is due to the resolution / scale of the model and is not considered an accurate representation. Calculations will be provided in the Culvert 100% Design Report to demonstrate adequate capacity of the proposed drainage system. • The volumes transferred through Culvert 14 to the soakage area at the end of Jean Hing Place, which has a limited capacity, are not increased (refer further detail below).
3	Proposed Culvert 14 in the 1% AEP CC event: • The modelled Post-Project discharge (3.75m^3/s) exceeds the maximum allowable discharge (2.15m^3/s) in the PRs	The modelled post-project discharge (3.75m^3/s) is less than the modelled pre-project discharge (4.09m^3/s), i.e. the maximum allowable discharge is 1.94m^3/s less than the pre-project discharge. Thus, non-compliance reflects a change in methodology and refined input information and not a decrease in performance. Essentially, more accurate information and detailed modelling has shown the maximum allowable discharge in the PRs to be too low.
4	Proposed Culvert 14 in the 10% AEP event: • The modelled Post-Project upstream water level (12.32mRL) exceeds the	The allowable water level is exceeded by 160mm to 170mm. The size of Culvert 14 could be increased to reduce this water level, but this would be undesirable in that it would increase peak discharge through the culvert (refer Item 3 above) and increase volumes

ID	Potential Non-Compliance	Comments
	maximum allowable water level (12.16mRL) in the PRs	transferred to the KCDC soakage area at the end of Jean Hing Place. Further to this last point, the PRs specify that the soakage area should not be used more frequently than is currently the case, which is only just achieved by the current design (volumes essentially matched to the pre-project situation in the 10% AEP event, decreased slightly in the 10% AEP CC 2130 event, and moderately decreased in the 1% AEP CC 2130 event). The design of Culvert 14 is considered optimised for flooding effects and to meet the intents of several related PRs on balance (as discussed in Items 3 and 4 of this table).
5	Modelled water levels upstream of the Ōtaki River bridge: • 1% AEP CC 2130 water level 15.74mRL compared with maximum allowed 15.56mRL • 0.2% AEP CC 2130 water level 16.43mRL compared with maximum allowed 15.79mRL • 1% AEP CC 2130 with debris raft water level 15.80mRL compared with maximum allowed 15.61mRL • 0.2% AEP CC 2130 with debris raft water level 16.46mRL compared with maximum allowed 15.89mRL	The water level exceedance ranges from 180mm to 650mm depending on the event. Water levels have increased due to the revised input hydrology (increase in volume of storm by 50% due to adopting a more representative hydrograph shape, and conservative allowance for climate change based on 2008 MfE projections) and due to upgrading the Chrystall's Stopbank to a 1% AEP CC 2130 flood standard. There is limited opportunity to reduce these water levels, noting that they are also controlled by throttling at the existing rail and SH1 bridges downstream. However, the Project has been designed to accommodate the higher water levels. For example, the Ōtaki River bridge has been raised to ensure the consented freeboard is provided and Chrystall's Stopbank will be upgraded to maintain freeboard to the flood standard agreed with GWRC. Note, this potential non-compliance is addressed by Principal's Advisor Comment 38, which is "parked" or "on hold", subject to receipt of documentation confirming that raising of the Stopbank has been accepted by Greater Wellington Regional Council and that affected stakeholders have been adequately consulted.
6	Modelled water levels in the off-river storage basin at the junction of the Chrystall's Stopbank and expressway: • 1% AEP CC 2130 water level 16.01mRL compared with maximum allowed 15.21mRL • 0.2% AEP CC 2130 water level 16.74mRL compared with maximum allowed 15.34mRL • 1% AEP CC 2130 with debris raft water level 16.06mRL compared with maximum allowed 15.26mRL • 0.2% AEP CC 2130 with debris raft water level 16.77mRL compared with maximum allowed 15.44mRL	The water level exceedance ranges from 800mm to 1,400mm depending on the event. The comments for the item above regarding the reasons for the increase in water levels and limited opportunity to reduce these are also relevant here. As noted above, the Project has been designed to accommodate the higher water levels i.e. Chrystalls Stopbank will be upgraded to provide the freeboard agreed with GWRC. Note, this potential non-compliance is addressed by Principal's Advisor Comment 39, which is "parked" or "on hold", subject to receipt of documentation confirming that raising of the Stopbank has been accepted by Greater Wellington Regional Council and that affected stakeholders have been adequately consulted.

5.1.3 Waitohu Model

The proposed design for the Waitohu catchment has been optimised to achieve or exceed the hydraulic performance standards for the project, but does so through a different cross-drainage arrangement than the Specimen Design. As for the Ōtaki-Mangapouri and Mangaone models, the proposed design for the Waitohu catchment meets the intentions of the performance standards for the Project, but discussion with the Principal's Advisor has been required due to technical non-compliance with exact wording and numbers in the Principal's Requirements. For the Waitohu catchment, the areas of technical non-compliance generally relate to the Principal's Requirements being developed based on the Specimen Design cross-drainage arrangement, which differs from the Proposed Design.

For reference, the cross drainage arrangements for the Specimen Design and Proposed Design are summarised in Table 17 (refer also Figure 1 and Figure 2 following).

Table 17: Cross-drainage Arrangements for the Specimen Design and Proposed Design

Element	Specimen Design	Proposed Design
Culvert 1	A box culvert conveying the Greenwood Stream under the expressway	Replaced by a corrugated steel culvert with a similar cross sectional area.
Bridge 11	An underpass conveying Taylors Road and floodplain flows under the expressway. The underpass is depressed below existing ground levels, so a flood bund is proposed to the east of the expressway between the Waitohu Stream and Taylors Road to prevent flooding of the underpass in smaller flood events. The design intent is for the flood bund to prevent flooding of the underpass and maintain vehicle access in floods smaller than the 5% AEP, but for the flood bund to overtop and Bridge 11 to convey flows in floods equal to or larger than the 5% AEP event (no vehicle access in these larger events).	Bridge 11 and Culvert 2 are replaced by realigning Taylors Road under Bridge 1 and by providing additional waterway capacity under Bridge 1 and through a new Culvert 2b (refer below).
Culvert 2	A box culvert conveying floodplain flows on the north bank of the Waitohu Stream through the expressway.	
Culvert 2a	A series of circular culverts conveying floodplain flows under the slightly elevated expressway off-ramp (existing SH1).	No longer required as the off-ramp is to be relocated away from the Waitohu flood plain (beyond model extents) so that both the vertical alignment of the existing SH1 and existing flooding situation in this area remain unchanged.
Culvert 2b	Not included.	An additional series of circular culverts at the location of the eliminated Bridge 11.
Bridge 1	An expressway bridge over the Waitohu Stream.	Remains. As noted above, Taylors Road is realigned under the bridge and additional waterway capacity is provided.

Element	Specimen Design	Proposed Design
Culvert 3	A box culvert conveying an ephemeral tributary of the Waitohu Stream through the expressway.	Replaced by two culverts: a circular culvert to convey normal flows, and a corrugated steel culvert at a higher elevation that will typically be dry and used for vehicle access, but will provide additional capacity to convey flood flows in large events.

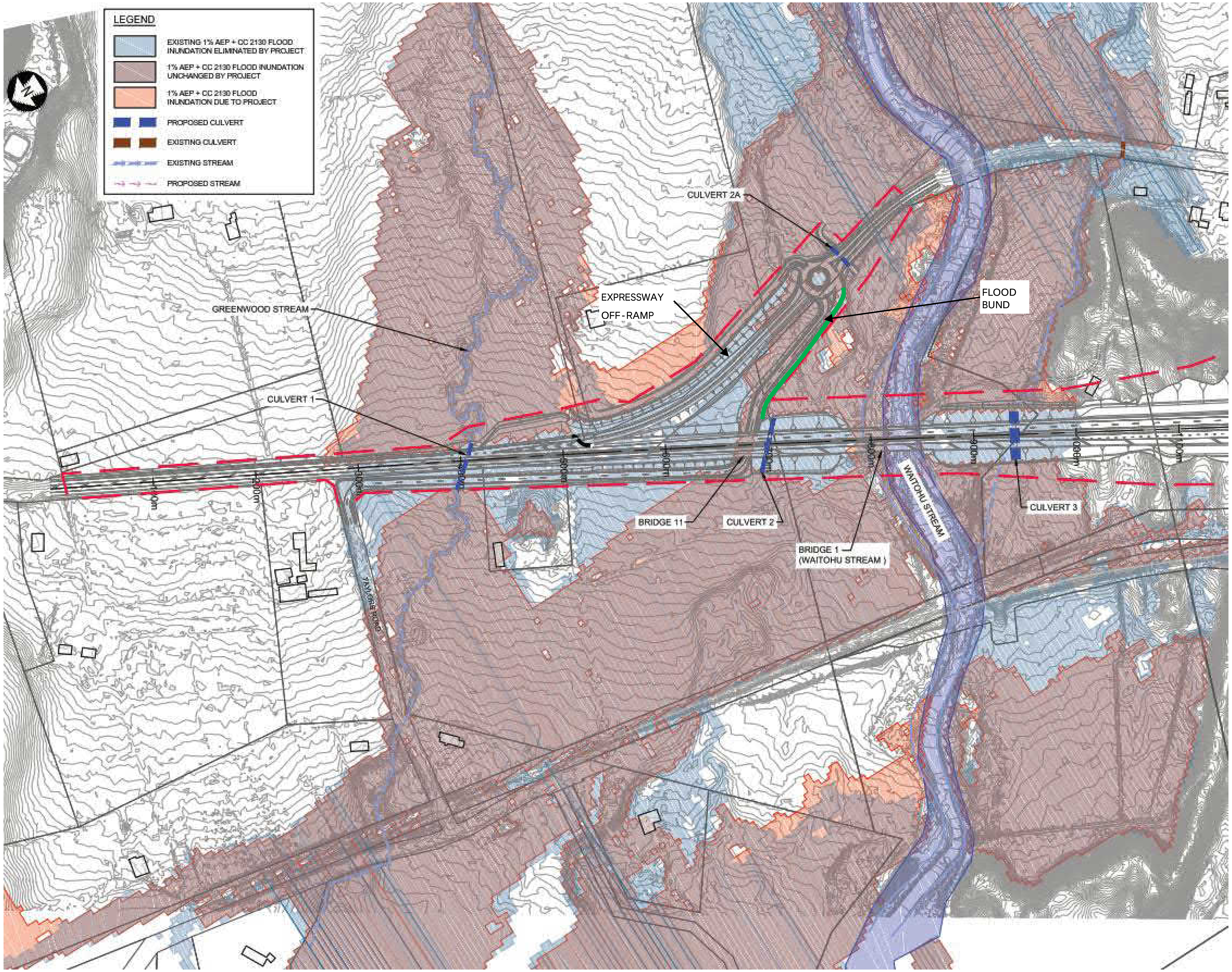

Figure 1: Cross-drainage arrangement for Specimen Design (extracted from DWG 5-C277100 H102 Rev D (Opus 2015), annotation for flood bund added)

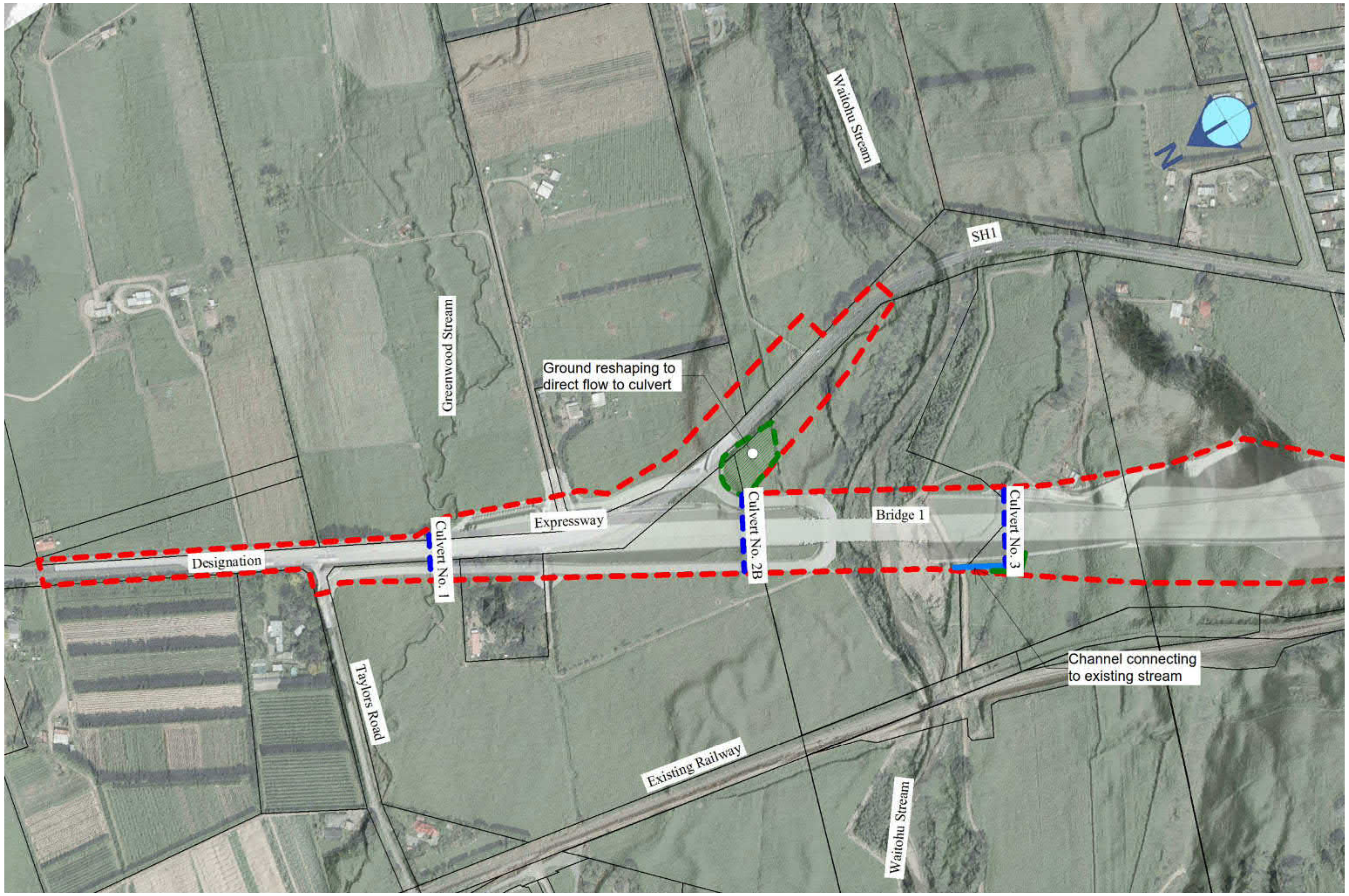

Figure 2: Cross-drainage Arrangement for Proposed Design

As previously discussed, the Proposed Design is considered suitable to meet the hydraulic performance requirements for the Project for the following reasons:

- The Proposed Design will be consistent with the consent conditions.
- The Proposed Design will achieve freeboard to Bridge 1 of at least 1.2m in the 1% AEP CC 2130 flood event in accordance with consent condition WS.6a)ii).
- The abutments of Bridge 1 and realigned Taylors Road will be located outside of the 75m fairway width set aside for potential channel migration of the Waitohu Stream.
- Existing overland flow paths will be maintained.
- Flooding effects will be comparable with the Specimen Design, and improved in some aspects:
    - Changes in the 1% AEP CC 2130 flood level of greater than 100mm due to the Proposed Design compared with the pre-project situation are generally limited to a tight band extending up to 60m upstream of the expressway embankment between existing Taylors Road / SH1 intersection and Culvert 3.
    - The proposed design reduces flooding compared with the pre-project situation for the properties west of the expressway and north of the Waitohu Stream.
    - The increase in flood levels upstream of the expressway embankment due to the proposed design is less extensive than for the Specimen Design. Firstly, the location of the off-ramp across the floodplain for the Specimen Design results in increased flood levels immediately upstream of the elevated off-ramp embankment, which is avoided for the Proposed Design. Secondly, the increase in flood levels greater than 100mm upstream of Culvert 3 is more extensive for the Specimen Design than the proposed design.
- The flood standard to roads is considered appropriate:
    - 0.5m freeboard is provided to the expressway in the 1% AEP CC 2130 flood.
    - The expressway off ramp is to be relocated away from the Waitohu flood plain for the proposed design and will have an improved flood standard in the new location.
    - In the Proposed Design, the vertical alignment of SH1 to the east of the expressway will not be changed from existing, and the existing overland flow path over SH1 will be maintained. SH1 will continue to overtop in the 5% AEP event along with the adjacent section of Taylors Road where it ties into the existing levels of SH1.
    - The realigned section of Taylors Road to the west of the expressway and under Bridge 1 will remain passable for emergency vehicles in the 5% AEP event, noting that this is an improved flood standard compared with the Taylors Road underpass (under Bridge 11) in the Specimen Design, which would become impassable in a flood between the 10% AEP and 5% AEP events.

As noted above, the Principal's Advisor has accepted that the design is optimised in general to minimise the impact of flooding following completion if the project. All comments on potential non-compliances for the Waitohu model have been closed out based on clarification or relaxation of the Principal's Requirements as documented in the Notice to Contractor in Appendix E, except for the following comment, which is "parked" or "on hold", subject to additional information to be provided in separate reports / notices:

Principal's Advisor Check:

- **Comment 42**: This comment relates to a 20m section of Expressway between Chainage 280 and 300m (near the existing SH1 / Taylors Road intersection) where the freeboard to the expressway reduces to 420mm in the 1% AEP CC2130 event i.e. up to 80mm short of the 500mm required. The Principal's Advisor has requested that options are presented in a Notice to Engineer.

Refer to Appendix C for full details of compliance of the Project Design for the Waitohu Model. Table 18 following describes areas of potential non-compliance only. Refer to Appendix D and E for Peer Review and Principal's Advisor Check comments on previous revisions of the report and potential non-compliances.

Table 18: Potential Non-compliance Summary for the Waitohu Model

ID	Potential Non-compliance	Comments
1	Proposed Culvert 2b in the 1% AEP CC event: • The modelled water level (0.27m above the soffit of the culvert) does not provide the freeboard to soffit specified in the PRs (0.6m)	Because Culvert 2b passes under Taylors Road, it is not possible to comply with both of the following PRs in combination: • PR A21.5.2b specifies that the Taylors Road underpass beneath the expressway must provide flood conveyance capacity in the 5% AEP event and larger floods i.e. Taylors Road must be lower than the 5% AEP flood level. • PR A21.4.5b specifies that freeboard to the Taylors Road underpass and Waitohu Stream north bank and south bank flood plain culverts must be at least 0.6m to the bridge/culvert soffit in the 1% AEP CC 2130 event i.e. the soffit of Culvert 2b must be 0.6m higher than the 1% AEP CC flood level (but must also pass under Taylors Road). The modelling indicates that the design complies with the first bullet point above, but not the second. However, the design is considered appropriate since it achieves the outcomes intended by the 0.6m freeboard specified in the second bullet point: • The 0.6m freeboard mitigates against the risk of flood plain conveyance being under capacity. Culvert 2b and Taylors Road underpass (under Bridge 1) convey the north bank flood plain flows in combination. If the capacity of Culvert 2b is exceeded, the Taylors Road underpass has freeboard several metres in excess of 0.6m and can convey additional flow. • The 0.6m freeboard mitigates against risk of blockage. However, the likelihood of blockage is low (culverts are not in the main stream channel, flows are coming from the southeast across grassed fields and over the existing SH1 where there are negligible sources of large debris), and the consequences of blockage are low (the Taylors Road underpass can convey additional flow if there is blockage at Culvert 2b, flood plain flows are occasional (10% AEP event and larger) so any blockage would only need to be cleared very rarely). • The 0.6m freeboard to the culvert soffit is not required for fish passage since Culvert 2b only conveys occasional flood plain flows.
2	0.5m freeboard to expressway in 1% AEP CC event	The freeboard to the expressway is up to 80mm less than the required 500mm freeboard to the white edge line only over a 20m section between Chainage 280 and 300m (near existing SH1/Taylors Road intersection). The exceedance is considered less than minor in magnitude and extent, and is due to tying in to the existing levels of Taylors Road and SH1.

ID	Potential Non-compliance	Comments
		Note, this potential non-compliance is addressed by Principal's Advisor Comment 42, which is "parked" or "on hold", subject to additional information (options to address the potential non-compliance) to be provided in a Notice to Engineer.

5.1.4 Mangaone Model

The proposed design for the Mangaone catchment has been optimised to achieve or exceed the hydraulic performance standards for the project. The cross-drainage arrangement for the proposed design is similar to the Specimen Design. The proposed design meets the intentions of the performance standards for the Project, but discussion with the Principal's Advisor has been required due to technical non-compliance with exact wording and numbers in the Principal's Requirements.

As noted above, the Principal's Advisor has accepted that the design is optimised in general to minimise the impact of flooding following completion if the project. All comments on potential non-compliances for the Mangaone model have been closed out based on clarification or relaxation of the Principal's Requirements as documented in the Notice to Contractor in Appendix E.

Refer to Appendix C for full details of compliance of the Project Design for the Mangaone Model. Table 19 following describes areas of potential non-compliance only. Refer to Appendix D and E for Peer Review and Principal's Advisor Check comments on previous revisions of the report and potential non-compliances.

Table 19: Potential Non-compliance Summary for the Mangaone Model

ID	Non-compliance	Comments
1	The modelled peak discharge over the Lucinsky Overflow is 9.10m^3/s in the 1% AEP CC 2130 event but the maximum allowable discharge is 3.5m^3/s according to PR Table A21-11.	Several other performance requirements relate to the Lucinsky Overflow: • PR A21.5.6t requires that the existing hydraulic capacity of the Lucinsky Overflow is maintained +/-10%. • Consent condition WS.6b requires that the same volume is transferred over the Lucinsky Overflow +/-20% in the 1% AEP CC 2130 event. The sizing of the Lucinsky Overflow achieves the other performance requirements i.e. matches the existing hydraulic capacity +/- 10% and matches the volume transferred in the 1% AEP CC 2130 event +/-20%. Although the modelled post-project discharge (9.10m^3/s) exceeds the maximum allowable discharge (3.5m^3/s) in PR Table A21-11 in the 1% AEP CC 2130 event, the modelled discharge is less than the pre-project discharge (9.31m^3/s) i.e. the maximum allowable discharge is 5.81m^3/s less than the modelled pre-project discharge. Thus, the non-compliance of peak discharge reflects a change in methodology and refined input information and not a decrease in performance. Essentially, more accurate information and detailed modelling has shown the maximum allowable discharge in the PRs to be too low.

5.2 Flooding Effects due to Upgrading Chrystall's Stopbank

5.2.1 Introduction

In the post-project situation, Chrystall's Stopbank is raised to the east of the expressway to provide 0.8m freeboard to the 1% AEP CC 2130 event. As a result, river flows will remain within the Ōtaki River, unlike the existing situation where substantial flows overtop Chrystall's Stopbank and flow through Ōtaki town in the 1% AEP CC 2130 event.

5.2.2 Flooding Effects Represented in the 2D Domain

Pre Project vs Post Project Flood Levels for Proposed Design

Figure 61.1 in Appendix A compares modelled flood levels in the pre- and post-project situations in the 1% AEP CC 2130 event. Pale green shading and dark green shading in Figure 61.1 indicate extensive areas through town where flood levels have decreased more than 100mm or flooding has been eliminated entirely in the post-project situation. Red shading in Figure 61.1 indicates areas with more than a 100mm increase in flood levels, which is predominantly confined to a few areas alongside the Ōtaki River.

Figure 61.1 demonstrates clear, significant benefits in terms of reduced flooding in the 1% AEP CC 2130 event. Consultation with relevant landowners about flooding effects will be required in areas with more than 100mm increase in flood levels (red shading in Figure 61.1) in line with consent condition SW.2 iii)c).

Comparing Proposed Design (Upgrade Chrystall's Stopbank to East of Expressway) and Previous Design (Upgrade Chrystall's Stopbank to both East and West of Expressway)

The areas of both dark green (eliminated flooding) and red shading (increases greater than 100mm) in Figure 61.1 are reduced compared with the previous iteration of this report, which assumed Chrystall's Stopbank would be upgraded to both the east and west of the expressway. The current Proposed Design (upgrade to east only) is preferred because, while it does not reduce flooding to the north of Sue Avenue as much as the previous design, the Proposed Design also does not increase flooding along the north bank of the Ōtaki River downstream of the existing rail bridge to the same extent. The Proposed Design does not preclude later upgrades to the stopbank to the west of the expressway.

Comparing Proposed Design (Upgrade Chrystall's Stopbank to East of Expressway) and Alternative Design (No Upgrade to Chrystall's Stopbank and Addition of Floodway Bridge)

Figures 71.1 and 71.2 in Appendix A compare flood levels and patterns in the 1% AEP CC 2130 event for the Proposed Design versus an Alternative Design with no upgrade to Chrystall's Stopbank. A floodway bridge is also incorporated in the Alternative Design, since if Chrystall's Stopbank is not upgraded a floodway bridge would be required to meet flood standards for the expressway in the 1% AEP CC 2130 event. Specifically, the floodway bridge would convey flows overtopping the stopbank in the 1% AEP CC 2130 flood past the expressway with adequate freeboard to the expressway. The floodway bridge would be approximately 70m long and located to the north of the Chrystall's Stopbank. Refer further discussion in Section 3.6 and 5.1.2 above.

Figures 71.1 and 71.2 in Appendix A indicate:

A. The Proposed Design (upgrading Chrystall's Stopbank) has lower flood levels than the Alternative Design (floodway bridge and no stopbank upgrade) along the Mangapouri Stream.
B. The Proposed Design has lower flood levels than the Alternative Design along the major overland flow path along the north side of Riverbank Road.
C. The Proposed Design has higher flood levels than the Alternative Design alongside the Ōtaki River.
D. On balance, the benefits of lower flood levels along the Mangapouri Stream and lower flood levels along the overland flow path north of Riverbank Road are considered more substantial than the drawbacks of higher flood levels alongside the Ōtaki River. Although the flood levels alongside the Ōtaki River are higher for the Proposed Design, the flood levels are still predominantly within 100mm of pre-project flood levels in these areas.

5.2.3 Flooding Effects Beyond the 2D Domain

We have also examined changes further downstream due to the increased flows retained in the Ōtaki River as a result of the stopbank upgrade.

The 1D component of the model extends all the way to the sea beyond the 2D extents shown in Figure 61.1. The 1D component that is not coupled to the 2D domain comprises the "Otaki3" branch between Chainages 2,000m to 3,900m as shown in Figure 3. The 1D cross sections extend to and include the stop banks that run along both sides of the Ōtaki River.

For the uncoupled (1D only) reach for both the pre-project and post-project situations, the 1% AEP CC 2130 flood levels are contained within the stop banks except for a 900m long section along the true left bank between Chainages 2,000m and 2,900m as shown in Figure 3. The stopbank is represented as a "glass wall" in this location that does not account for stopbank overtopping, so it is likely that flood levels are overestimated by the model in this area.

The increase in post-project 1% AEP CC 2130 water levels compared with the pre-project situation ranges from 14mm at Chainage 2,000m reducing to 6mm at Chainage 3,900m (14mm to 10mm where the stopbank is overtopped between Chainage 2,000m and 2,900m). Figures in Appendix F illustrate the depth and duration of overtopping of the true left stop bank at several locations. The general change in water levels between Chainages 2,000m to 3,900m and the changes in depth and duration of stop bank overtopping between Chainages 2,000m and 2,900m (illustrated in Appendix F) are considered to be less than minor and within the accuracy of the model.

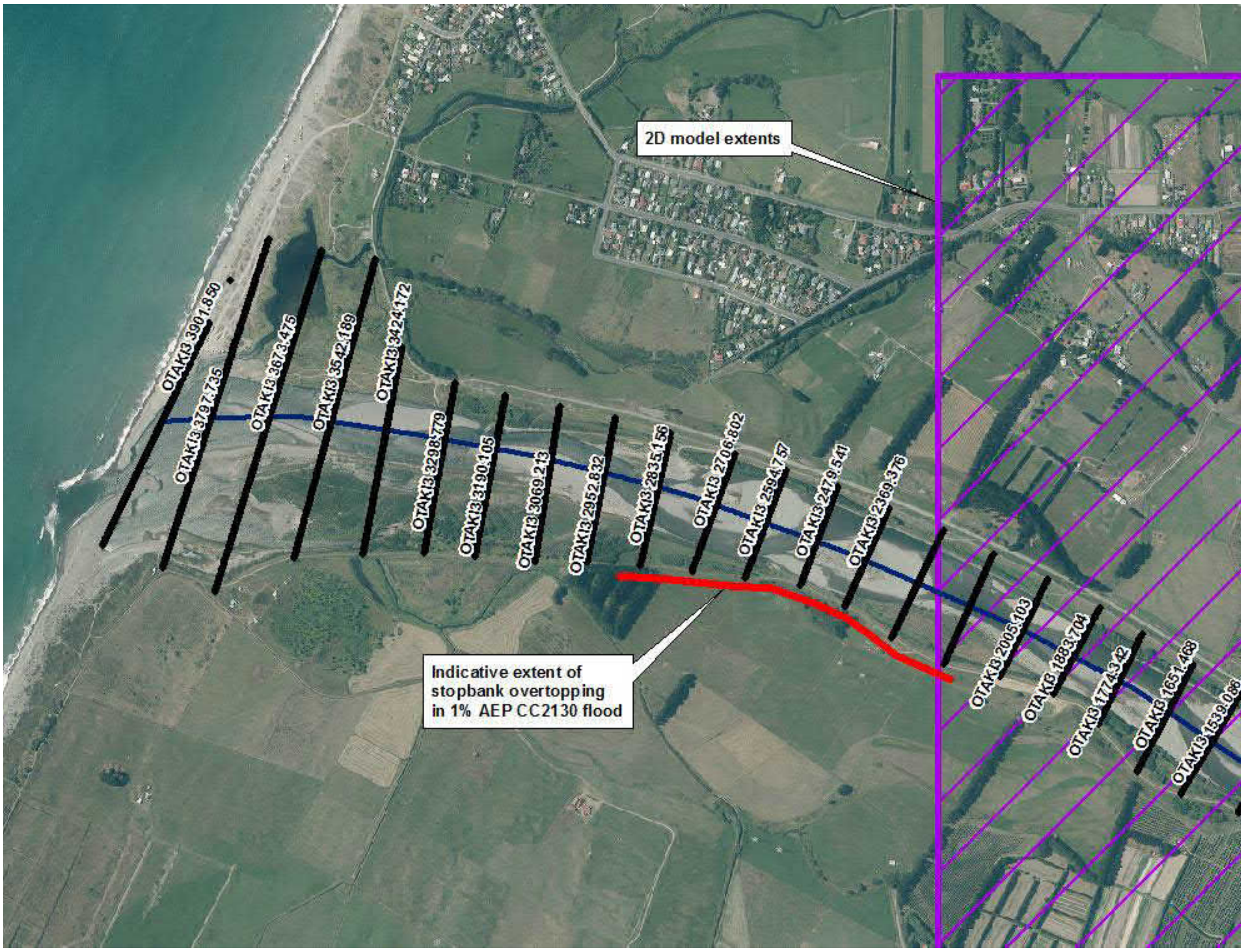

Figure 3: Indicative extent of stopbank overtopping in the 1 % AEP CC 2130 event downstream of 2D model extents

5.3 Flooding Effects in Pare-o-Matangi Reserve

KCDC has requested specific consideration of flooding effects in Pare-o-Matangi Reserve.

Figure 8 through to Figure 23 in Appendix A present flood depths in Pare-o-Matangi Reserve for a range of flood events. If these figures are compared with the pre-project situation presented in "Pre Project Hydraulic Model Report Rev 5" (PP2Ō, May 2018), the following conclusions can be drawn:

- In the 10% AEP (present climate) event, the spatial extent of flooding is reduced and the water levels in areas of residual flooding are lowered by up to 260mm in the post-project situation compared with the pre-project situation, i.e. the post-project situation is improved with respect to flooding effects.
- In the 10% AEP CC 2130 event[1] (refer Figure 62.2 in Appendix A), there is negligible change in the spatial extent of flooding. Flood levels to the north of the Mangapouri Stream are lowered by up to 8mm in the post-project situation compared with the pre-project situation (i.e. marginally improved in the post-project situation), and increased by up to 16mm to the south of the Mangapouri Stream (i.e. slightly worsened in the post-project situation).
- In the 1% AEP CC 2130 event (refer Figure 61.4 in Appendix A), there is negligible change in the spatial extent of flooding. Flood levels are increased in both the north and south of Mangapouri Stream by up to 21mm in the post-project situation compared with the pre-project situation (i.e. slightly worsened in the post-project situation).

KCDC has also asked (meeting on 20 October 2017) whether the project works affect the duration of flooding in the Reserve and how quickly the Reserve will drain. Figure 4, Figure 5 and Figure 6 compare pre-project and post-project flood levels over time at the outlet from the Reserve in the 10% AEP present climate, 10% AEP CC 2130 and 1% AEP CC 2130 events respectively. The figures indicate that the change in the duration of flooding is negligible.

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[1] Note the 10% AEP CC 2130 event is slightly larger than the 5% AEP present climate event.

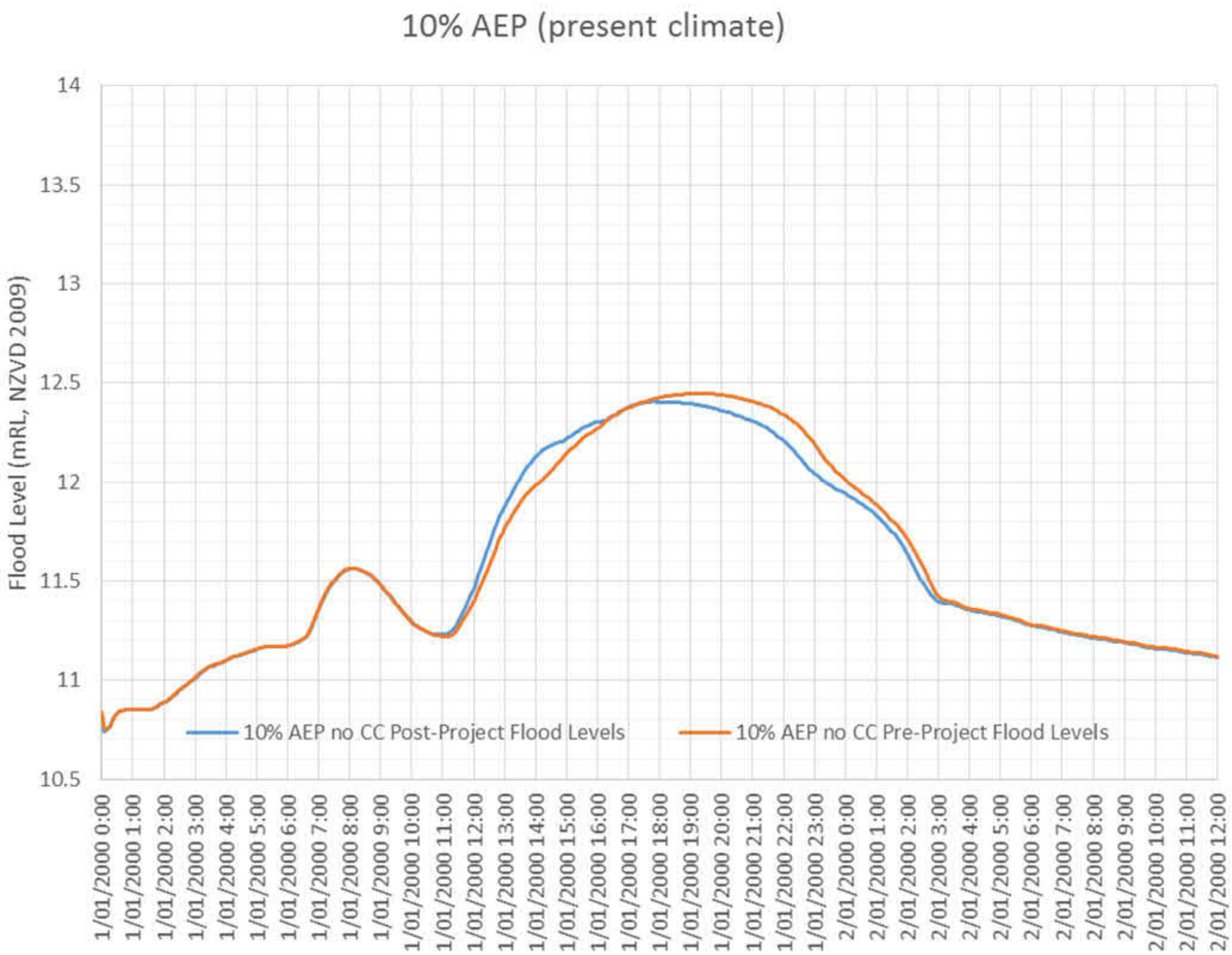

Figure 4: Flood level versus time in 10% AEP present climate event at outlet from Pare-o-Matangi Reserve (upstream end of existing culvert under SH1)

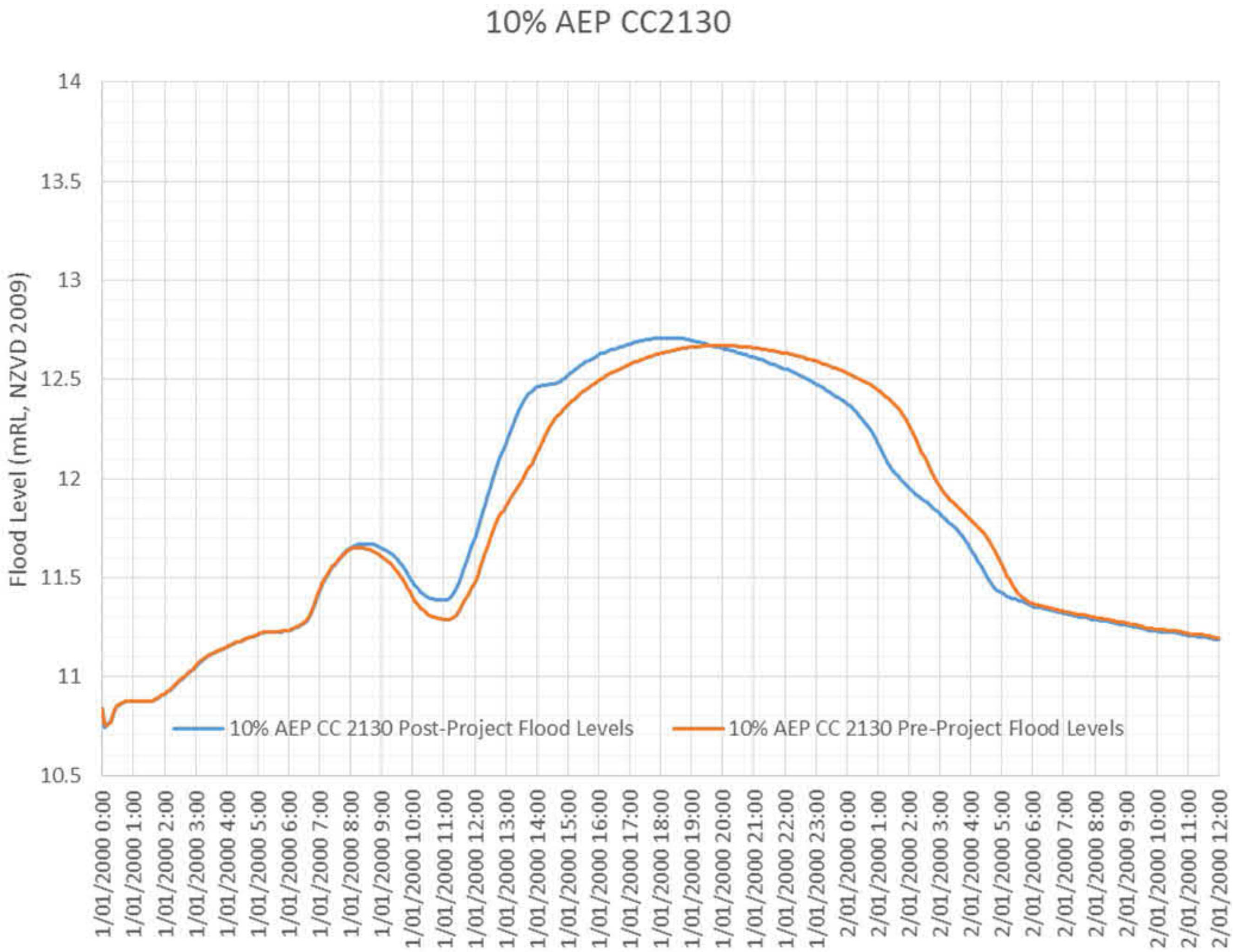

Figure 5: Flood level versus time in 10% AEP CC2130 event at outlet from Pare-o-Matangi Reserve (upstream end of existing culvert under SH1)

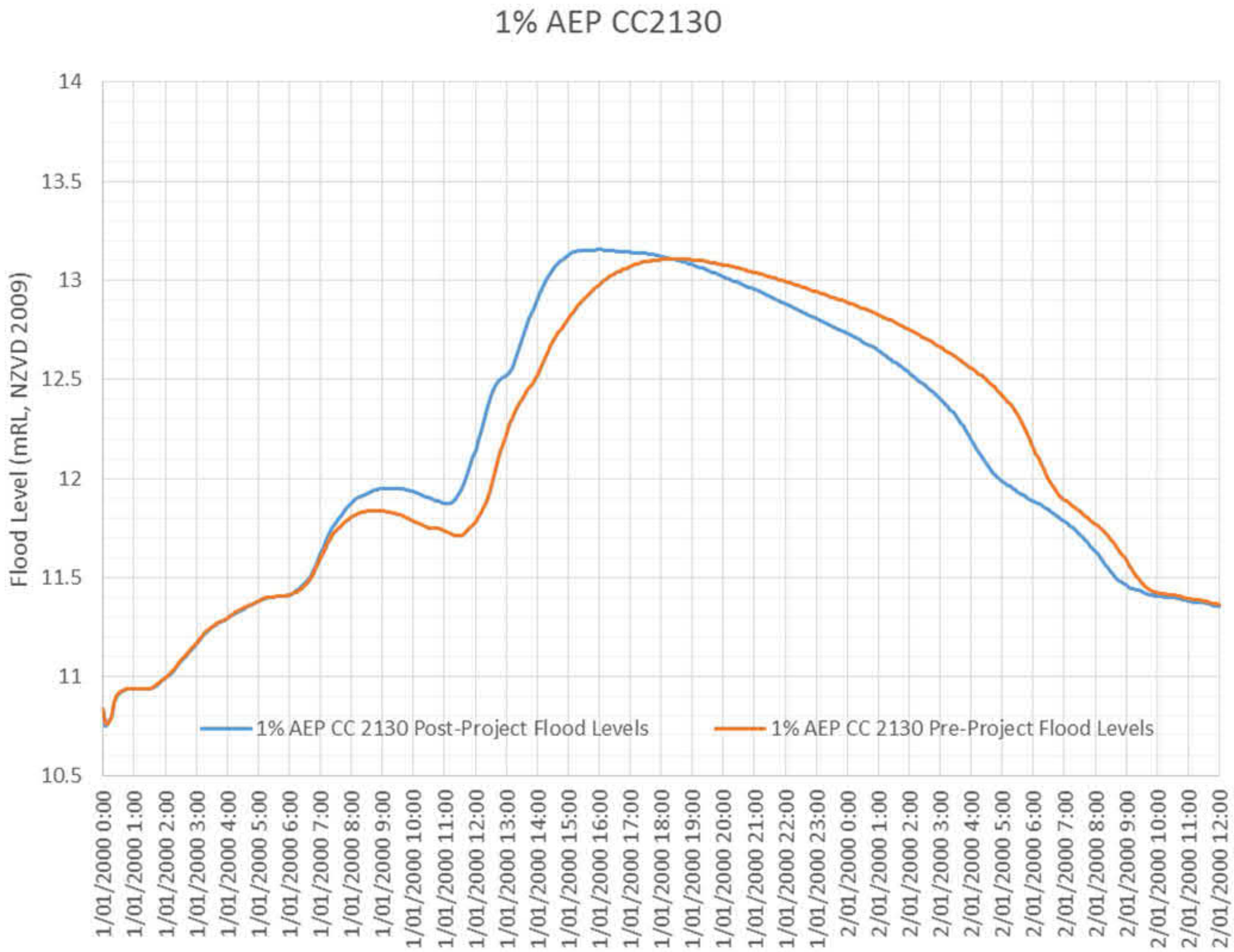

Figure 6: Flood level versus time in 1% AEP CC2130 event at outlet from Pare-o-Matangi Reserve (upstream end of existing culvert under SH1)

5.4 Flows Conveyed South of the Mangaone 2D Model Extents

Some flows are conveyed south of the 2D Mangaone 2D model extents. Hydrographs representing these flows have been extracted (refer Appendix G) and will be used for design and assessment of flood effects for proposed culverts 35 to 42, located to the south of the Mangaone model.

6. Applicability

This report has been prepared for the exclusive use of our client NZ Transport Agency, 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.

Appendix A

FIGURES

Figure		Ōtaki-Mangapouri	Waitohu	Mangaone
Post-Project Model Schematisation		Fig. 1, Fig. 2.1 – 2.3	Fig. 1, Fig. 4	Fig 1, Fig. 6
Post-Project Topography Changes		Fig.3.1 – 3.5	Fig. 5	Fig. 7.1 – 7.3
3,000m³/s - No CC Model Results	Depth	Fig. 8.1 – 8.3	-	-
0.04% AEP + CC2130 Model Results	Depth	Fig. 9.1 – 9.3	Fig. 24.1 – 24.2	Fig. 31.1 – 31.2
0.1% AEP + CC2130 Model Results	Depth	-	-	Fig. 32.1 – 32.2
0.2% AEP + CC2130 Model Results	Depth	Fig. 10.1 – 10.3	-	-
1% AEP + CC2130 (HR) Model Results	Depth	Fig. 11.1 – 11.3	Fig. 25.1 – 25.2	Fig. 33.1 – 33.2
1% AEP + CC2130 Model Results	Depth	Fig. 12.1 – 12.3	Fig. 26.1 – 26.2	Fig. 34.1 – 34.2
1% AEP - No CC Model Results	Depth	Fig. 13.1 – 13.3	-	-
2% AEP + CC2130 Model Results	Depth	-	-	Fig. 35.1 – 35.2
2% AEP - No CC Model Results	Depth	Fig. 14.1 – 14.3	-	-
5% AEP + CC2130 Model Results	Depth	-	-	Fig. 36.1 – 36.2
5% AEP – No CC Model Results	Depth	Fig. 15.1 – 15.3	Fig. 27.1 – 27.2	-
10% AEP + CC2130 Model Results	Depth	Fig. 16.1 – 16.3	Fig. 28.1 – 28.2	Fig. 37.1 – 37.2
10% AEP - No CC Model Results	Depth	Fig. 17.1 – 17.2	Fig. 29.1 – 29.2	-
3,000m³/s - No CC Stopbank Breach Model Results	Depth	Fig. 18.1 – 18.3	-	-
0.2% AEP + CC2130 Stopbank Breach Model Results	Depth	Fig. 19.1 – 19.3	-	-
0.2% AEP + CC2130 Debris Blockage Model Results	Depth	Fig. 20.1 – 20.3	-	-

Figure		Ōtaki-Mangapouri	Waitohu	Mangaone
1% AEP + CC2130 Debris Blockage Model Results	Depth	Fig. 21.1 – 21.3	Fig. 30.1 – 30.2	-
1% AEP + CC2130 Culvert Blockage Model Results	Depth	Fig. 22.1 – 22.3		
1% AEP + CC2130 Alternative Design (No Upgrade to Chrystall's Stopbank + Additional Floodway Bridge) Model Results	Depth	Fig. 23.1 – 23.3		
3,000m³/s - No CC Model Results	Velocity	Fig. 38.1 - 38.2		
0.04% AEP + CC2130 Model Results	Velocity	Fig. 39.1 – 39.2	Fig. 48.1 – 48.2	Fig. 54
0.1% AEP + CC2130 Model Results	Velocity	-	-	Fig. 55
0.2% AEP + CC2130 Model Results	Velocity	Fig. 40	-	-
1% AEP + CC2130 (HR) Model Results	Velocity	Fig. 41	Fig. 49	Fig. 56
1% AEP + CC2130 Model Results	Velocity	Fig. 42.1 – 42.2	Fig 50.1 – 50.2	Fig. 57
1% AEP - No CC Model Results	Velocity	Fig. 43	-	-
2% AEP + CC2130 Model Results	Velocity	-	-	Fig. 58
2% AEP - No CC Model Results	Velocity	Fig. 44	-	-
5% AEP + CC2130 Model Results	Velocity	-	-	Fig. 59
5% AEP – No CC Model Results	Velocity	Fig. 45	Fig. 51	-
10% AEP + CC2130 Model Results	Velocity	Fig. 46	Fig. 52	Fig. 60
10% AEP - No CC Model Results	Velocity	Fig. 47	Fig. 53	-
1% AEP + CC2130 Model Results Comparison (Post- minus Pre-Project)	Water Level	Fig. 61.1 – 61.4	Fig 73.1 – 73.2	Fig. 77.1 - 77.2
2% AEP + CC2130 Model Results Comparison (Post- minus Pre-Project)	Water Level	-	-	Fig. 78
10% AEP + CC2130 Model Results Comparison (Post- minus Pre-Project)	Water Level	Fig. 62.1 – 62.2	-	-
5% AEP – No CC Model Results Comparison (Post- minus Pre-Project)	Water Level	-	Fig 74	-
3,000m³/s - No CC Model Results Stopbank Breach Comparison (Breach minus Base)	Water Level	Fig. 63.1 – 63.2		

Figure		Ōtaki-Mangapouri	Waitohu	Mangaone
3,000m³/s - No CC Model Results Stopbank Breach Comparison (Post- minus Pre-Project)	Water Level	Fig. 64.1 – 64.2		
0.2% AEP + CC2130 Model Results Stopbank Breach Comparison (Breach minus Base)	Water Level	Fig. 65.1 – 65.2		
0.2% AEP + CC2130 Model Results Stopbank Breach Comparison (Post- minus Pre-Project)	Water Level	Fig. 66.1 – 66.2		
0.2% AEP + CC2130 Model Results Debris Blockage Comparison (Post Blockage- minus Post-Project)	Water Level	Fig. 67.1 – 67.2		
1% AEP + CC2130 Model Results Debris Blockage Comparison (Post Blockage- minus Post-Project)	Water Level	Fig. 68.1 – 68.2	Fig. 75	
1% AEP + CC2130 Model Results Culvert Blockage Comparison (Post Blockage- minus Post-Project)	Water Level	Fig. 69		
1% AEP + CC2130 Model Results Alternative Design (No Upgrade to Chrystall's Stopbank + Additional Floodway Bridge) Comparison (Post Alternative Design - minus Pre-Project)	Water Level	Fig. 70.1 – 70.4		
1% AEP + CC2130 Model Results Alternative Design (No Upgrade to Chrystall's Stopbank + Additional Floodway Bridge) Comparison (Post Alternative Design - minus Post-Project)	Water Level	Fig. 71.1 – 71.2		
1% AEP + CC2130 Model Results Climate Change Comparison (High Range Climate Change minus Mid Range Climate Change)	Water Level	Fig. 72.1 – 72.2	Fig. 76	Fig. 79

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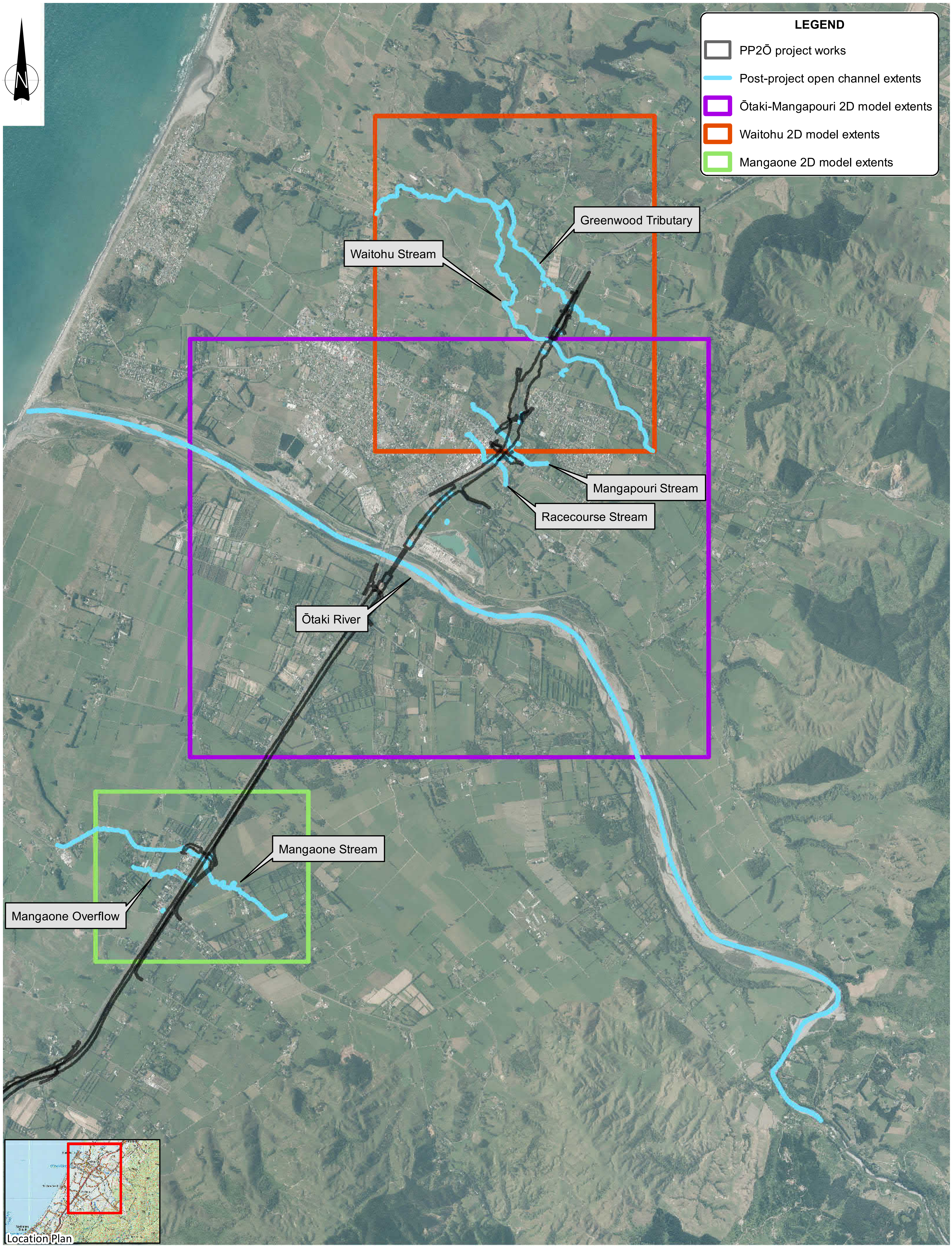

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- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:35,000

0 0.4 0.8 1.2 1.6 2 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18
ARCFILE Fig1_PostProjectModelSchematisation.mxd		
SCALE (AT A3 SIZE) 1:35,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Overview of Models

FIGURE No. Figure 1. Rev. 0

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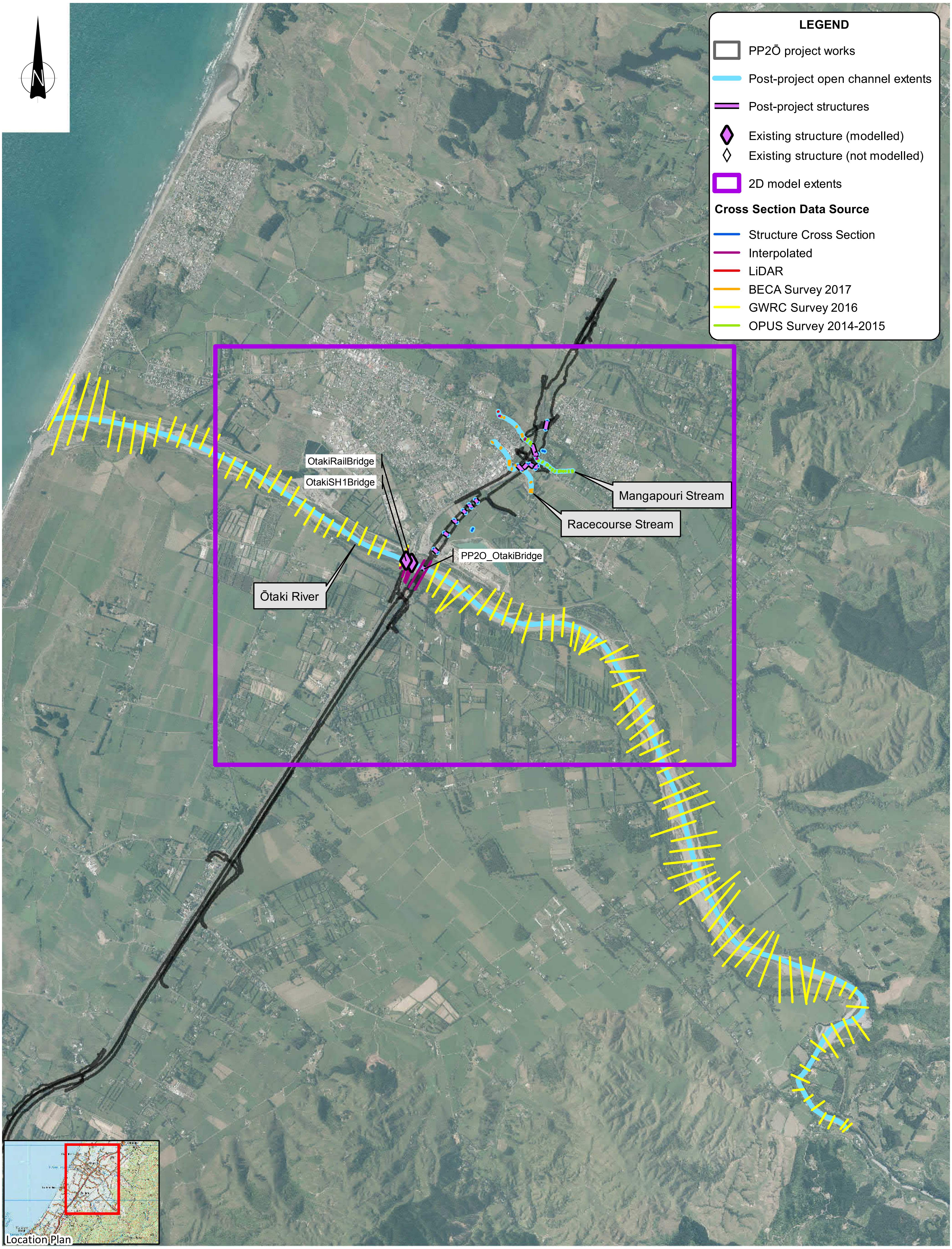

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A3 SCALE 1:35,000

0 0.4 0.8 1.2 1.6 2 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig2_1_OM_PostProjectModelSchem.mxd

SCALE (AT A3 SIZE) 1:35,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model

FIGURE No. Figure 2.1

Rev. 0

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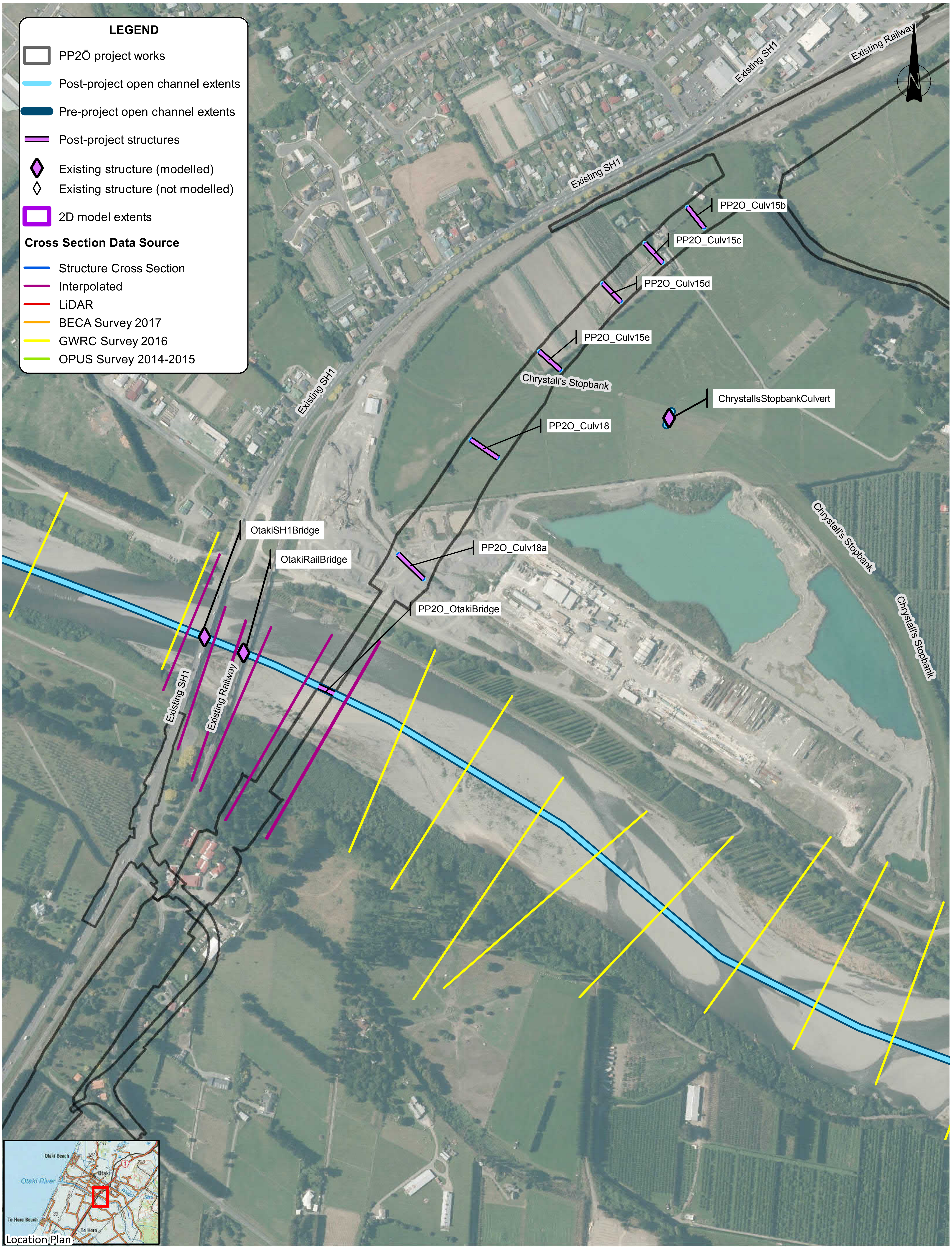

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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

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CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig2_2_OM_PostProjectModelSchem.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

Post-Project Hydraulic Model Schematisation

Ōtaki-Mangapouri Model

FIGURE No. Figure 2.2

Rev. 0

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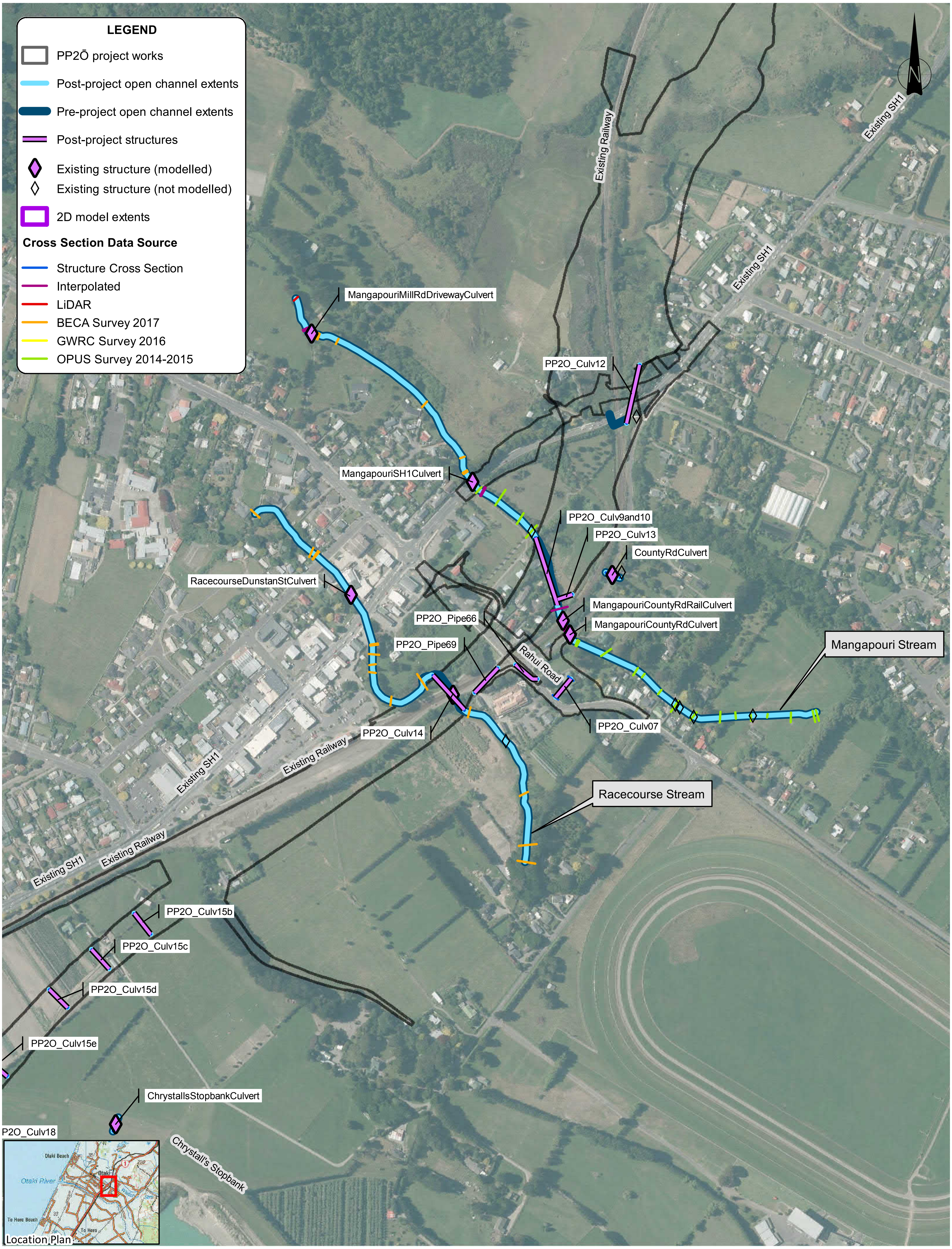

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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

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APPROVED	TSRF	May.18
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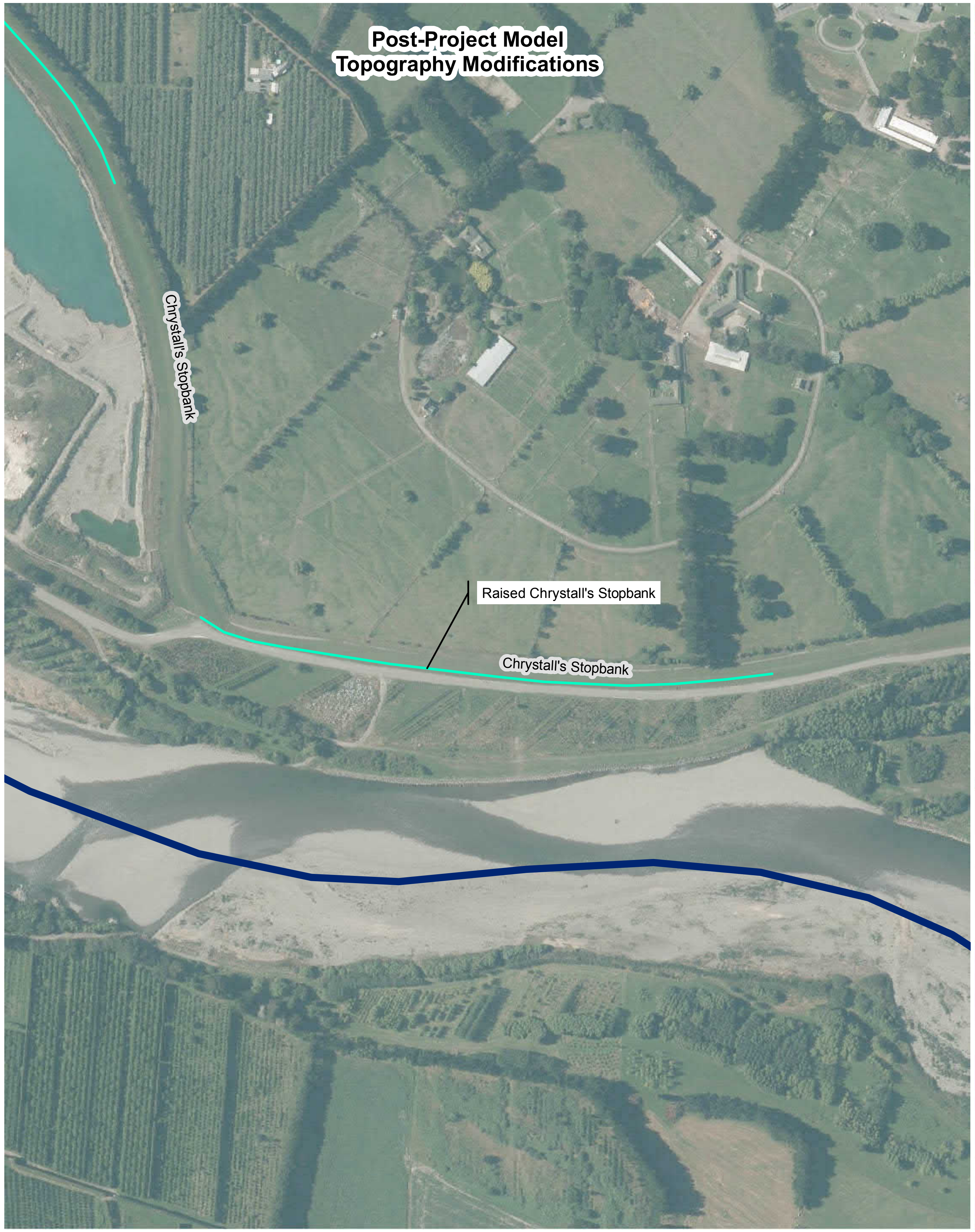
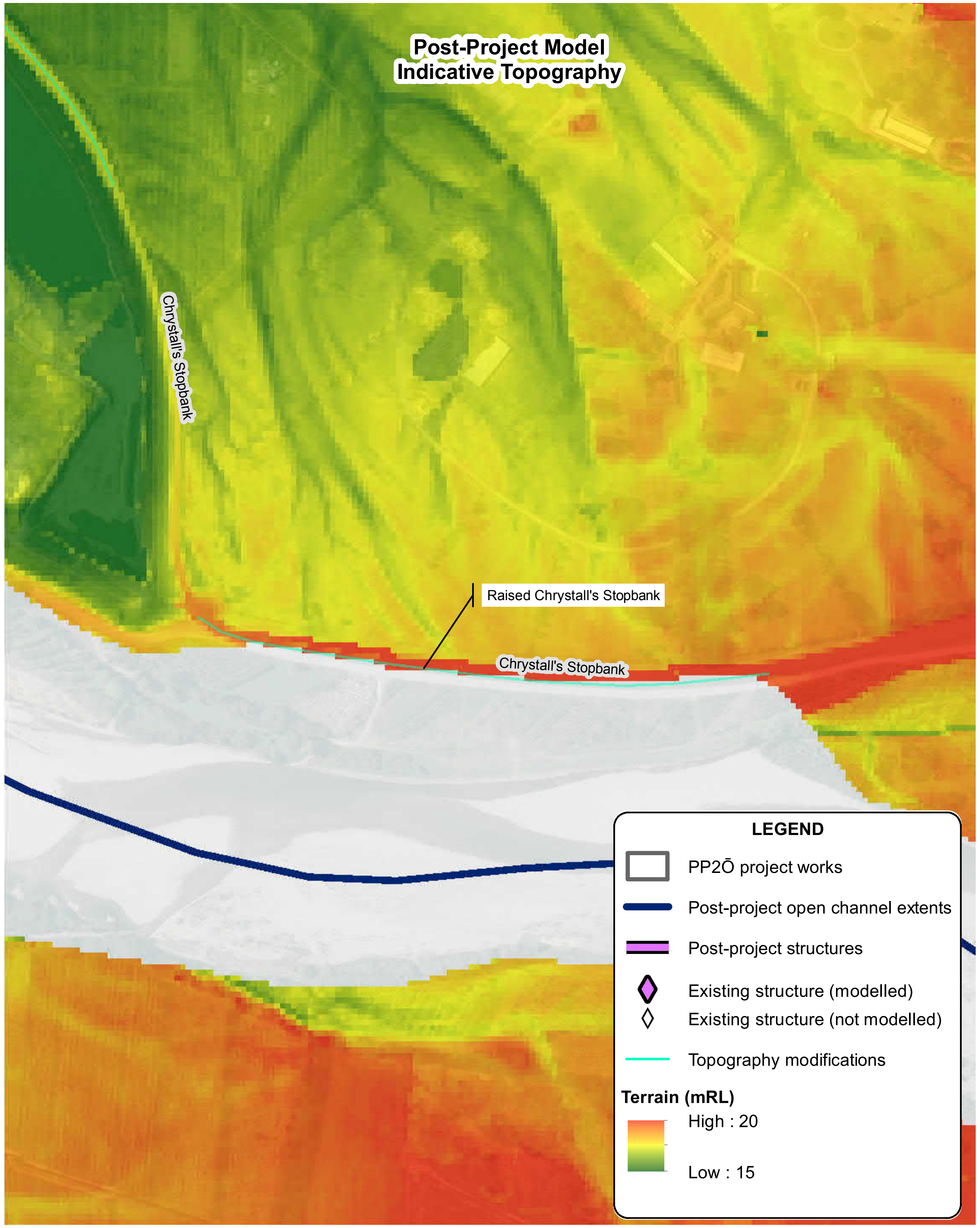
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model

FIGURE No. Figure 2.3

Rev. 0





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- Terrain values set to "land" in bathymetry are shown as white

A3 SCALE 1:4,500
0 40 80 120 160 200 Meters

Location Plan

NZ TRANSPORT AGENCY WAKA KOTAHI
Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

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SCALE (AT A3 SIZE) 1:4,500
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model - Topography Modifications

FIGURE No. Figure 3.1 Rev. 0

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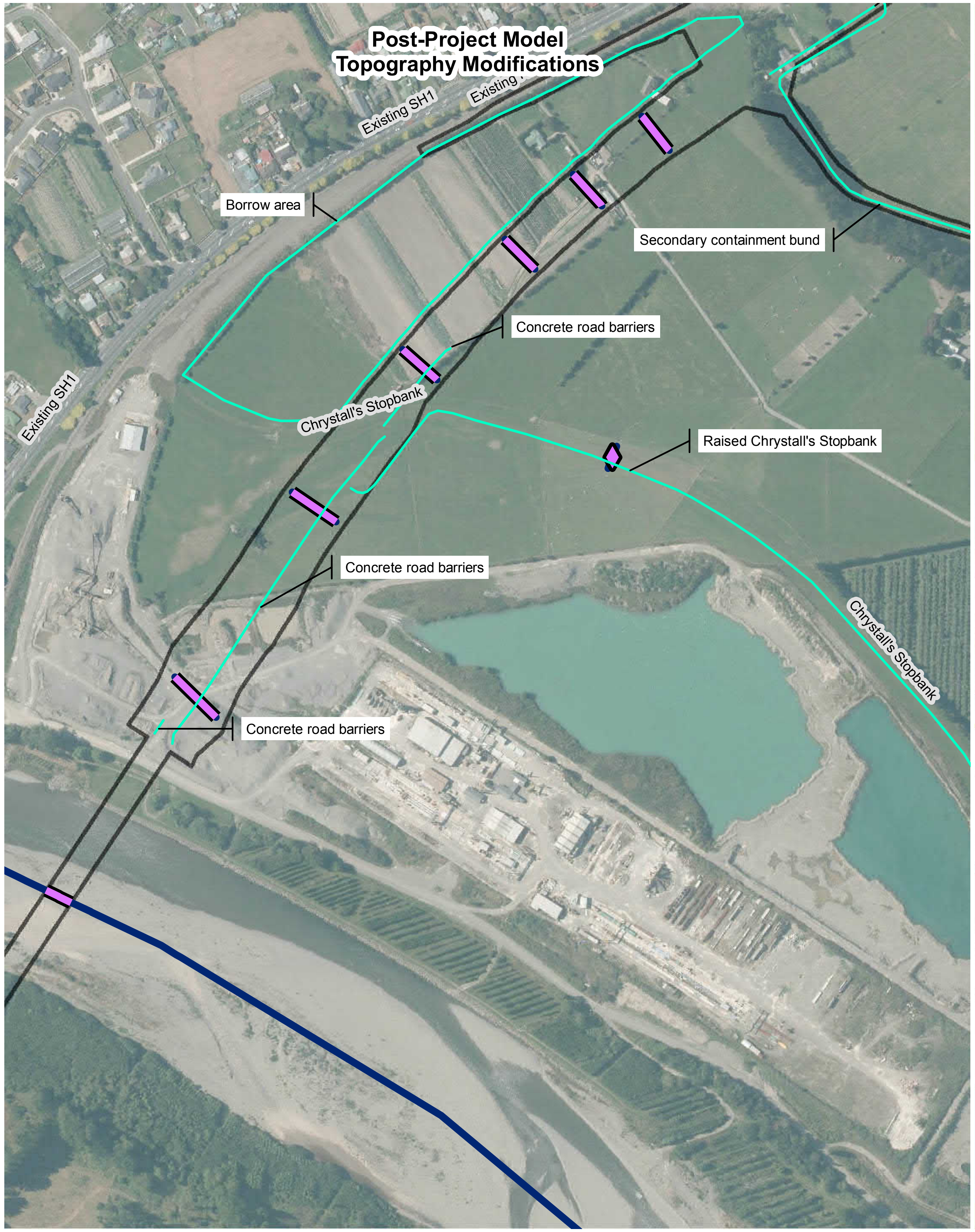

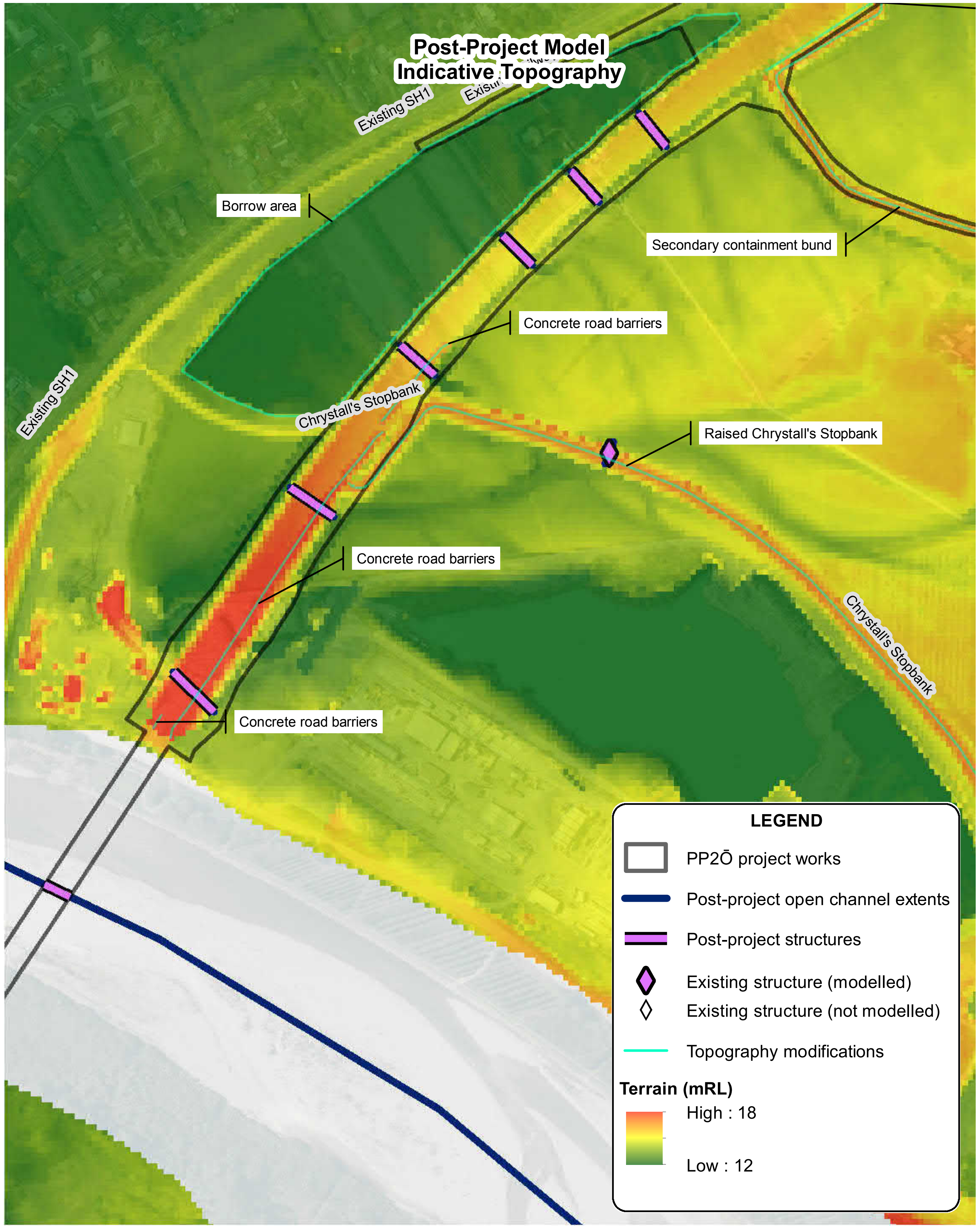

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- Terrain values set to "land" in bathymetry are shown as white

A3 SCALE 1:4,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig3_2_OM_TopographyChanges.mxd		
SCALE (AT A3 SIZE) 1:4,500		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model - Topography Modifications

FIGURE No. Figure 3.2 Rev. 0

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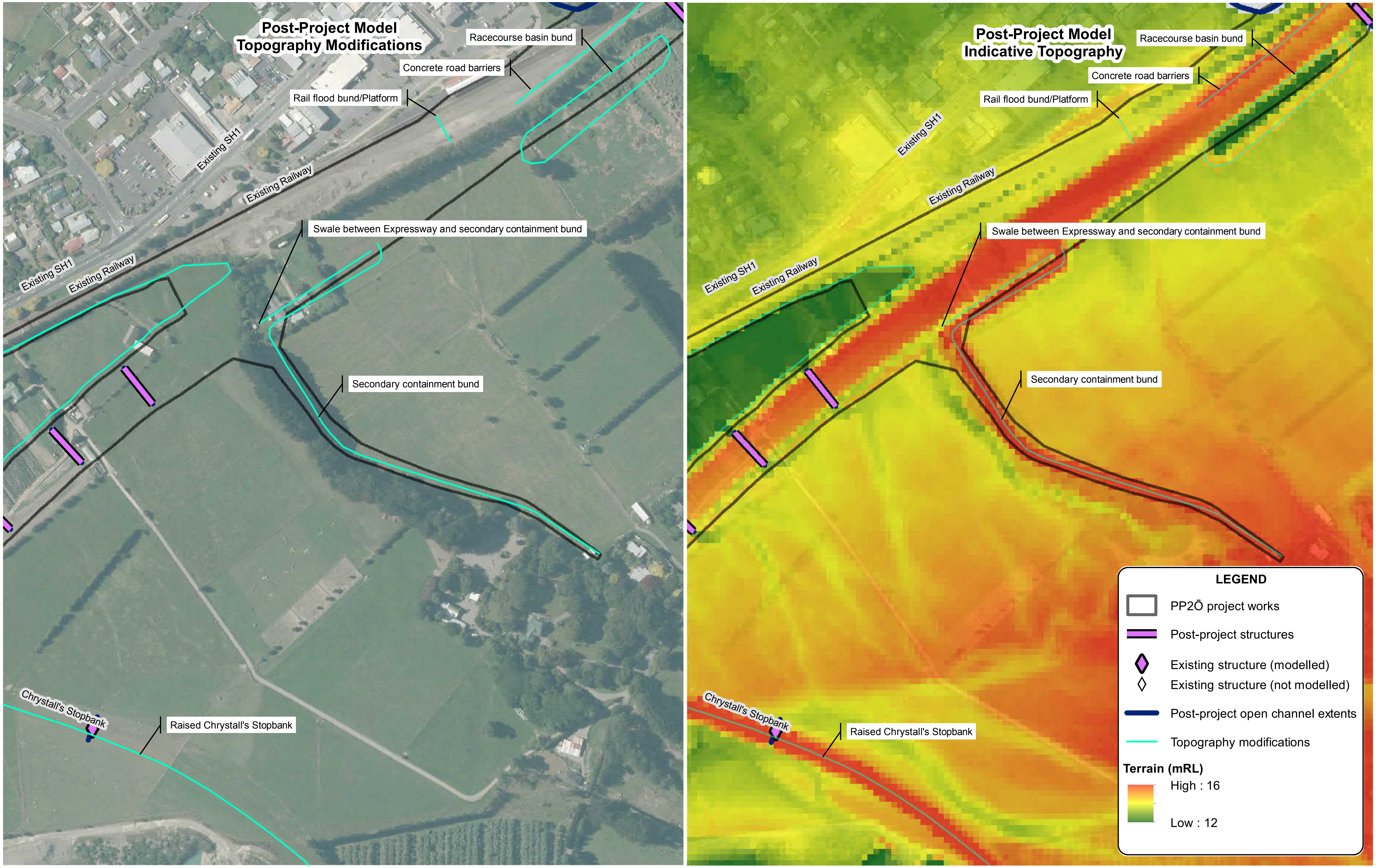

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- Terrain values set to "land" in bathymetry are shown as white

A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

N

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig3_3_OM_TopographyChanges.mxd

SCALE (AT A3 SIZE) 1:3,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model - Topography Modifications

FIGURE No. Figure 3.3

Rev. 0

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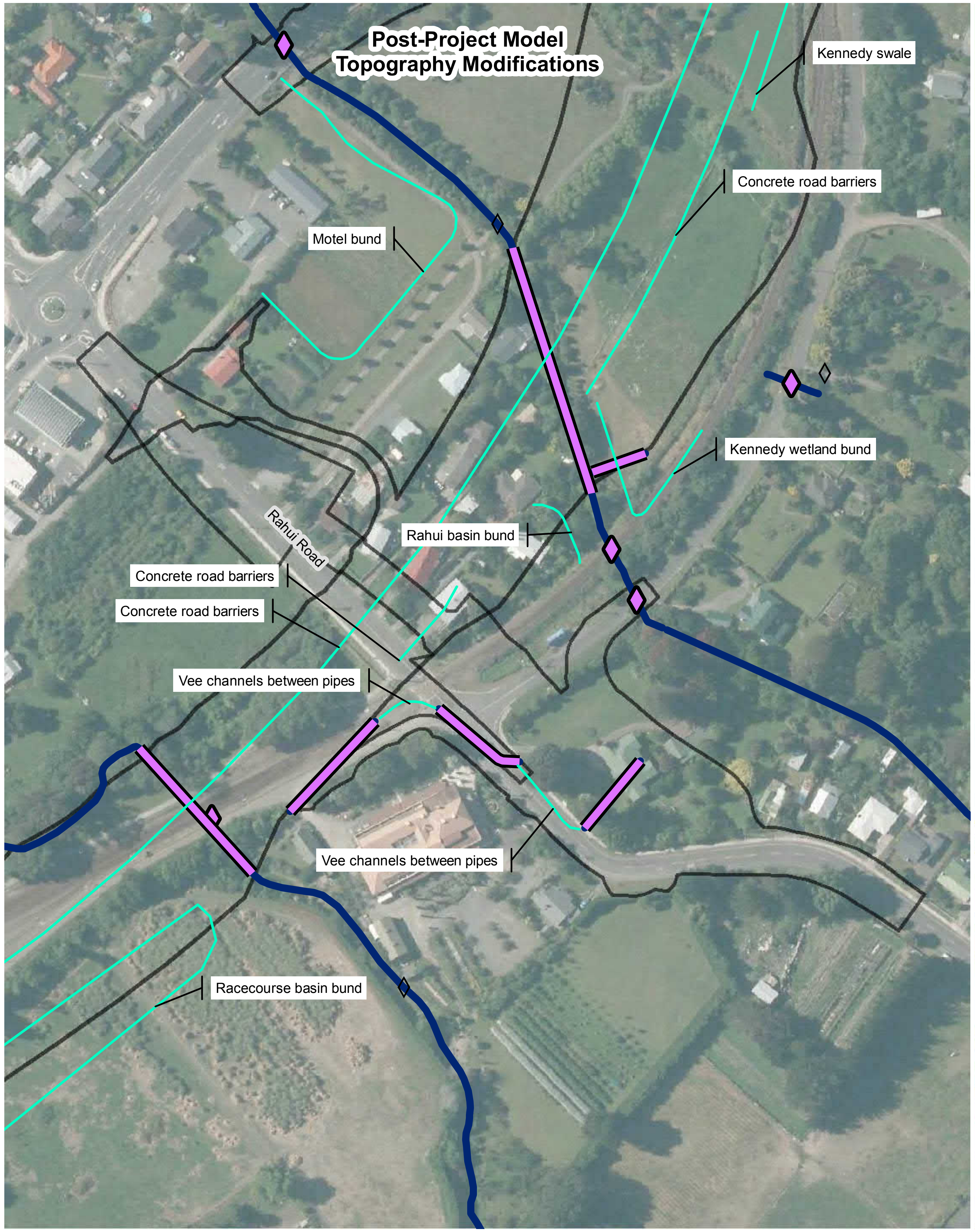

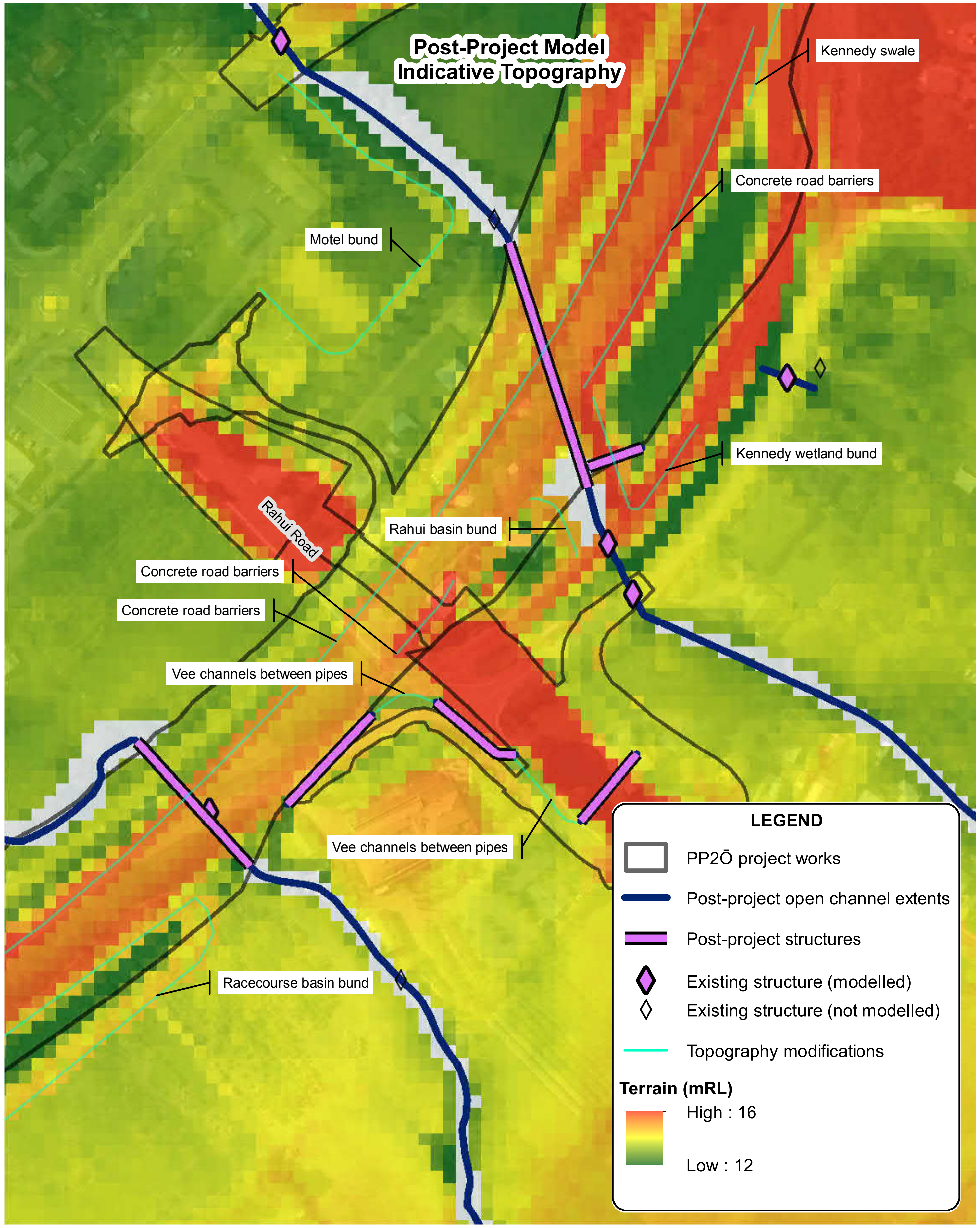

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- Terrain values set to "land" in bathymetry are shown as white

A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

N

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig3_4_OM_TopographyChanges.mxd	
SCALE (AT A3 SIZE)	1:2,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model - Topography Modifications

FIGURE No. Figure 3.4

Rev. 0

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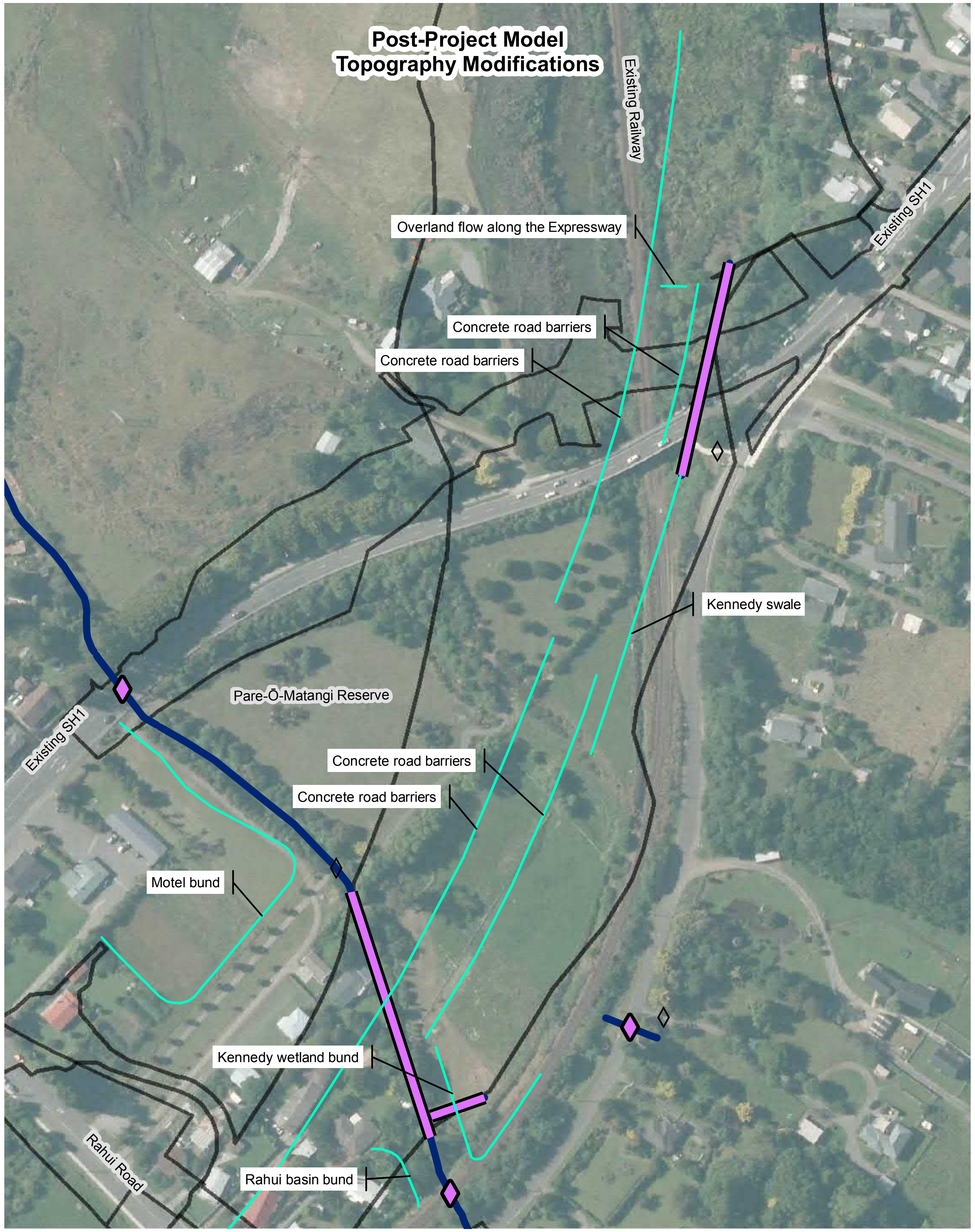

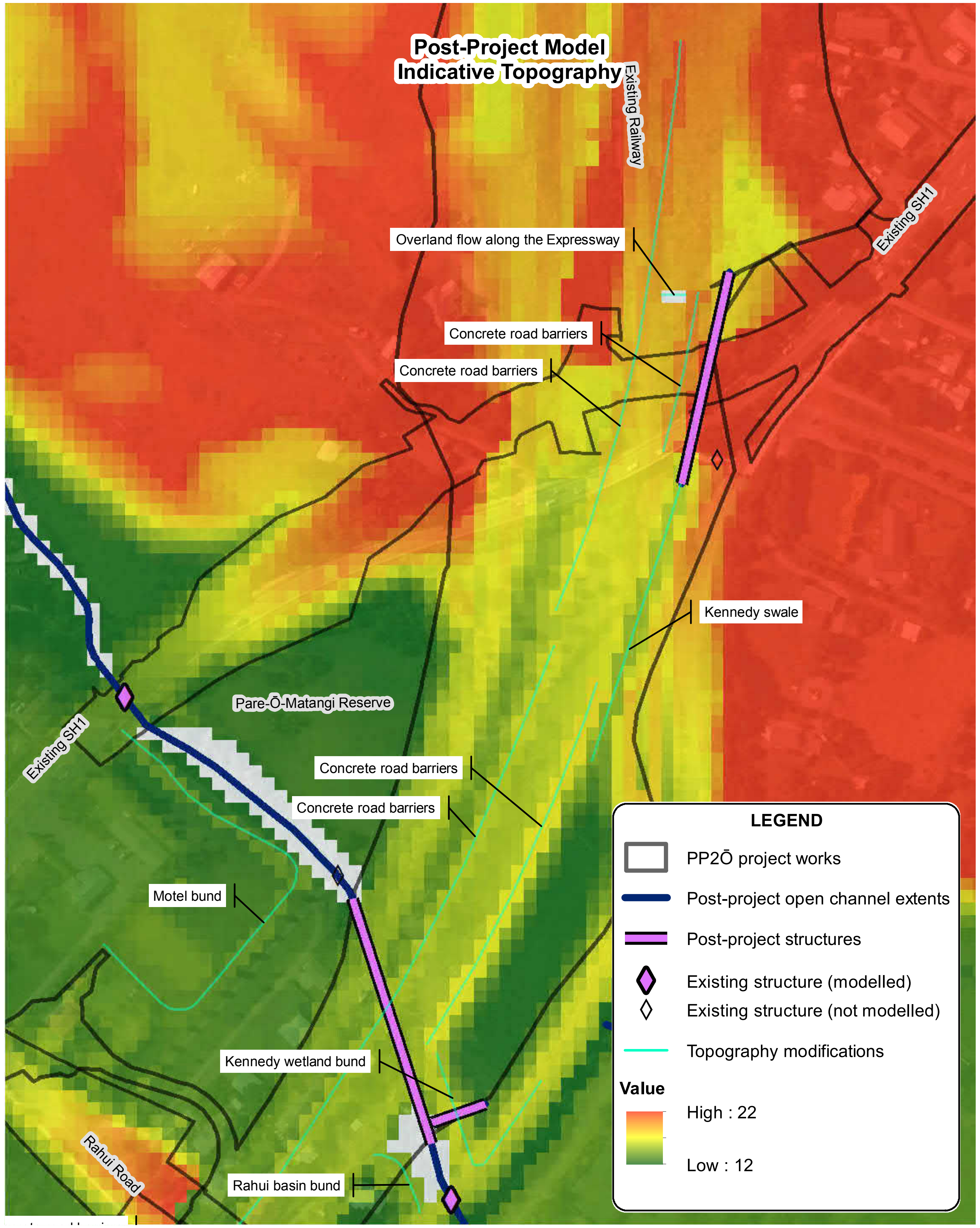

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- Terrain values set to "land" in bathymetry are shown as white

A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

Location Plan

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig3_5_OM_TopographyChanges.mxd

SCALE (AT A3 SIZE) 1:2,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Ōtaki-Mangapouri Model - Topography Modifications

FIGURE No. Figure 3.5

Rev. 0

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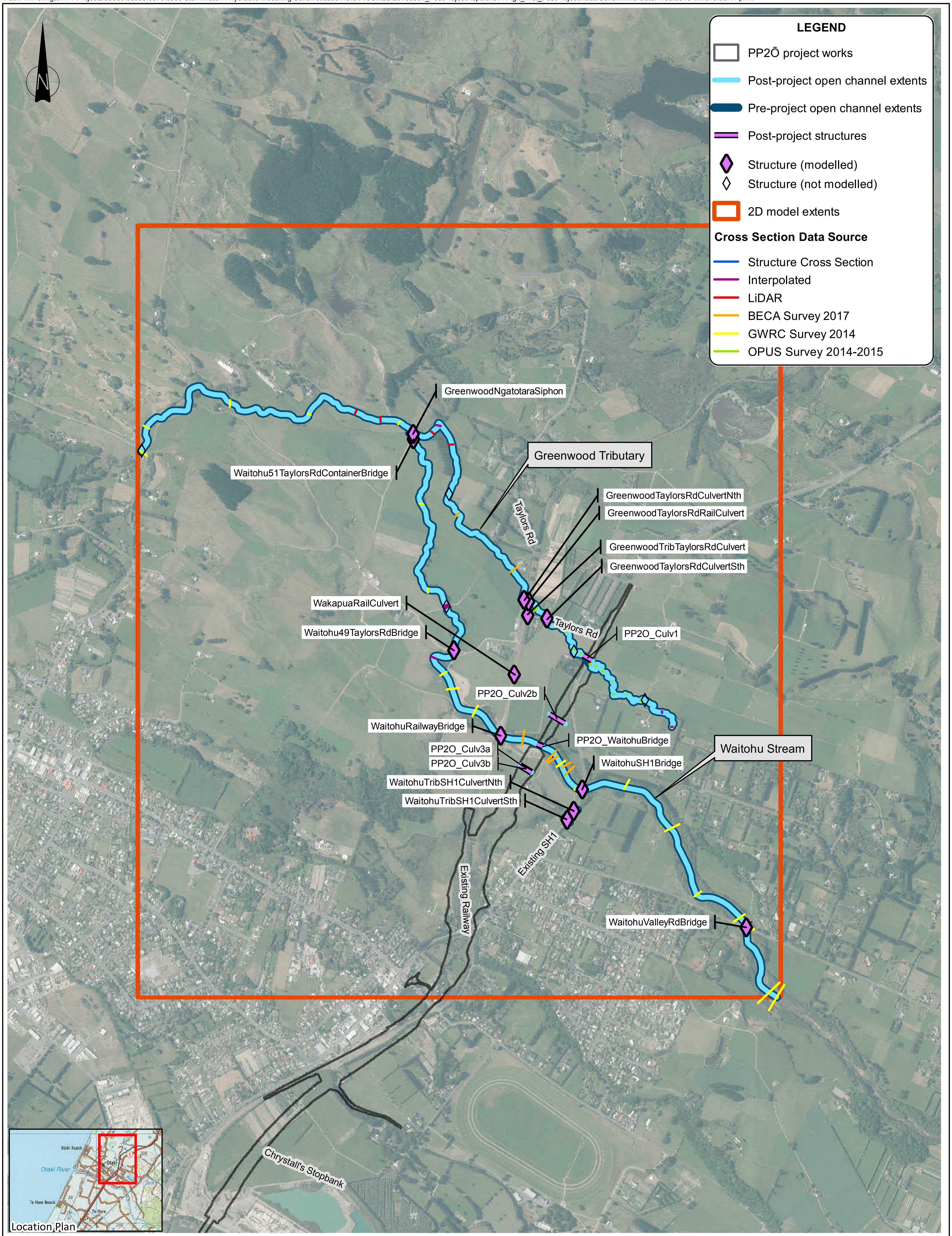

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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig4_Wai_PostProjectModelSchem.mxd

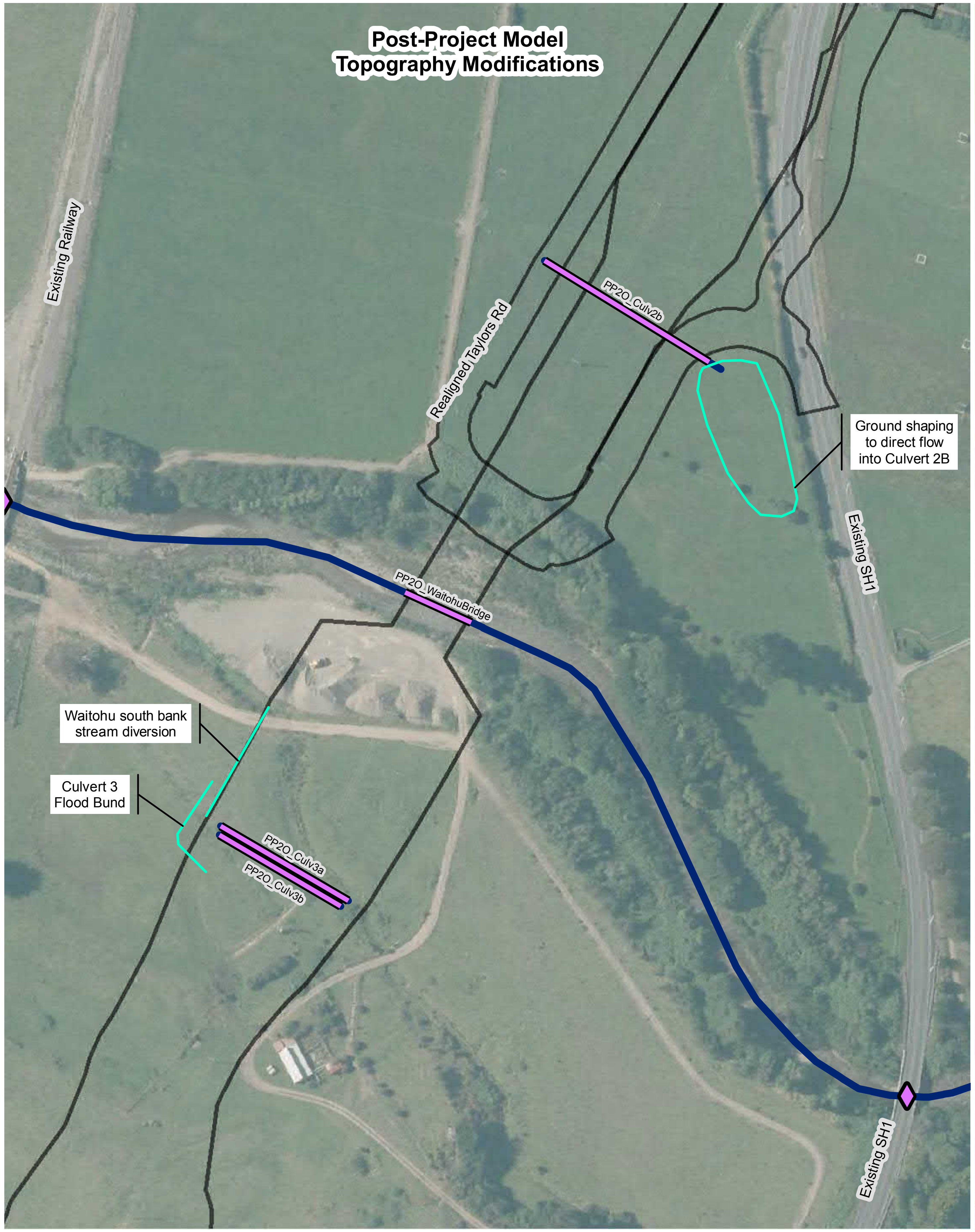
SCALE (AT A3 SIZE)
1:15,000

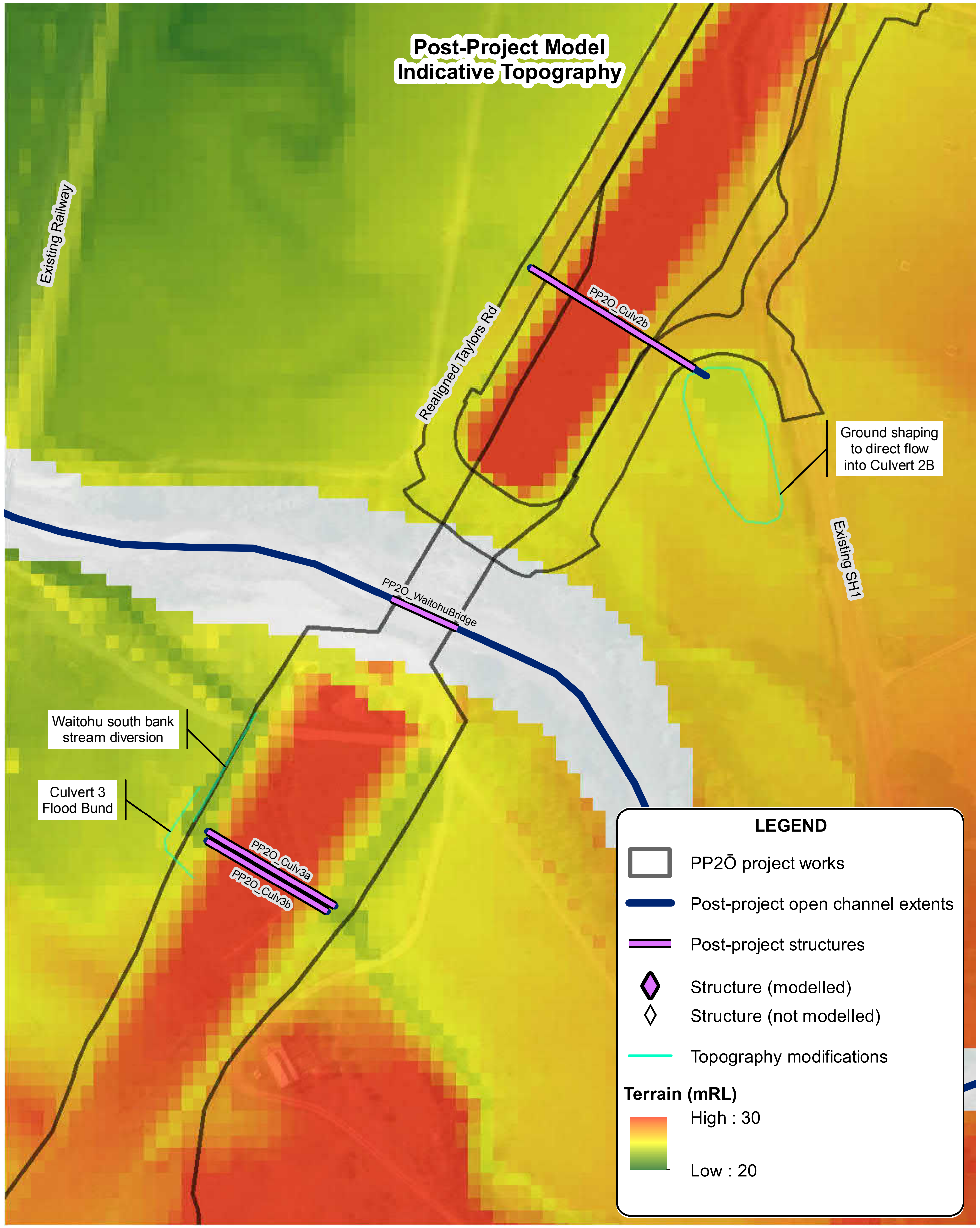
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Waitohu Model

FIGURE No. Figure 4.

Rev. 0





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- Terrain values set to "land" in bathymetry are shown as white

A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

Location Plan

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig5_Wai_TopographyChanges.mxd

SCALE (AT A3 SIZE)
1:2,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Waitohu Model - Topography Modifications

FIGURE No. Figure 5.

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig5_Wai_TopographyChanges.mxd Date: 10/05/2018 Time: 6:47:14 p.m.

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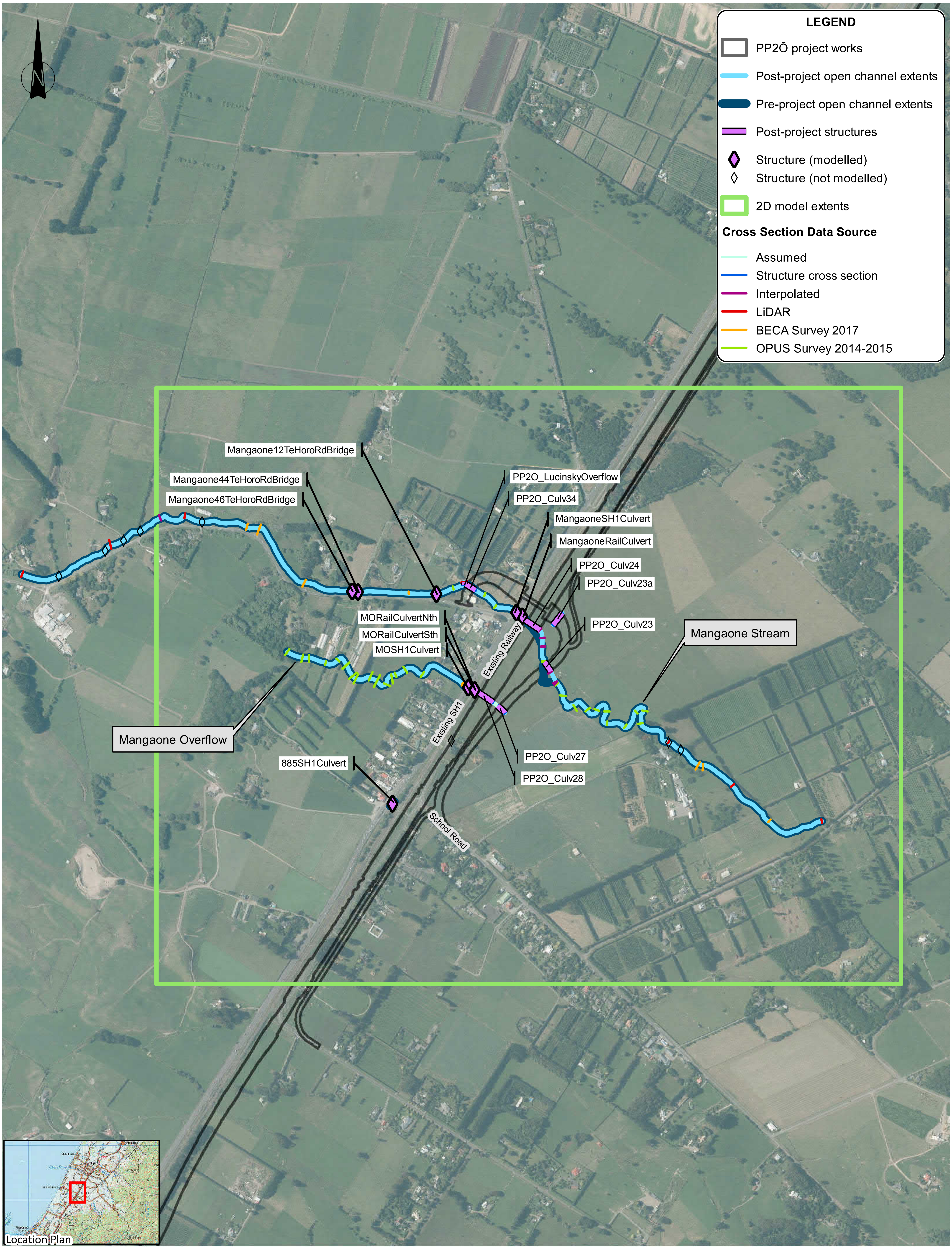

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A3 SCALE 1:10,000

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig6_Mang_PostProjectModelSchem.mxd

SCALE (AT A3 SIZE) 1:10,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

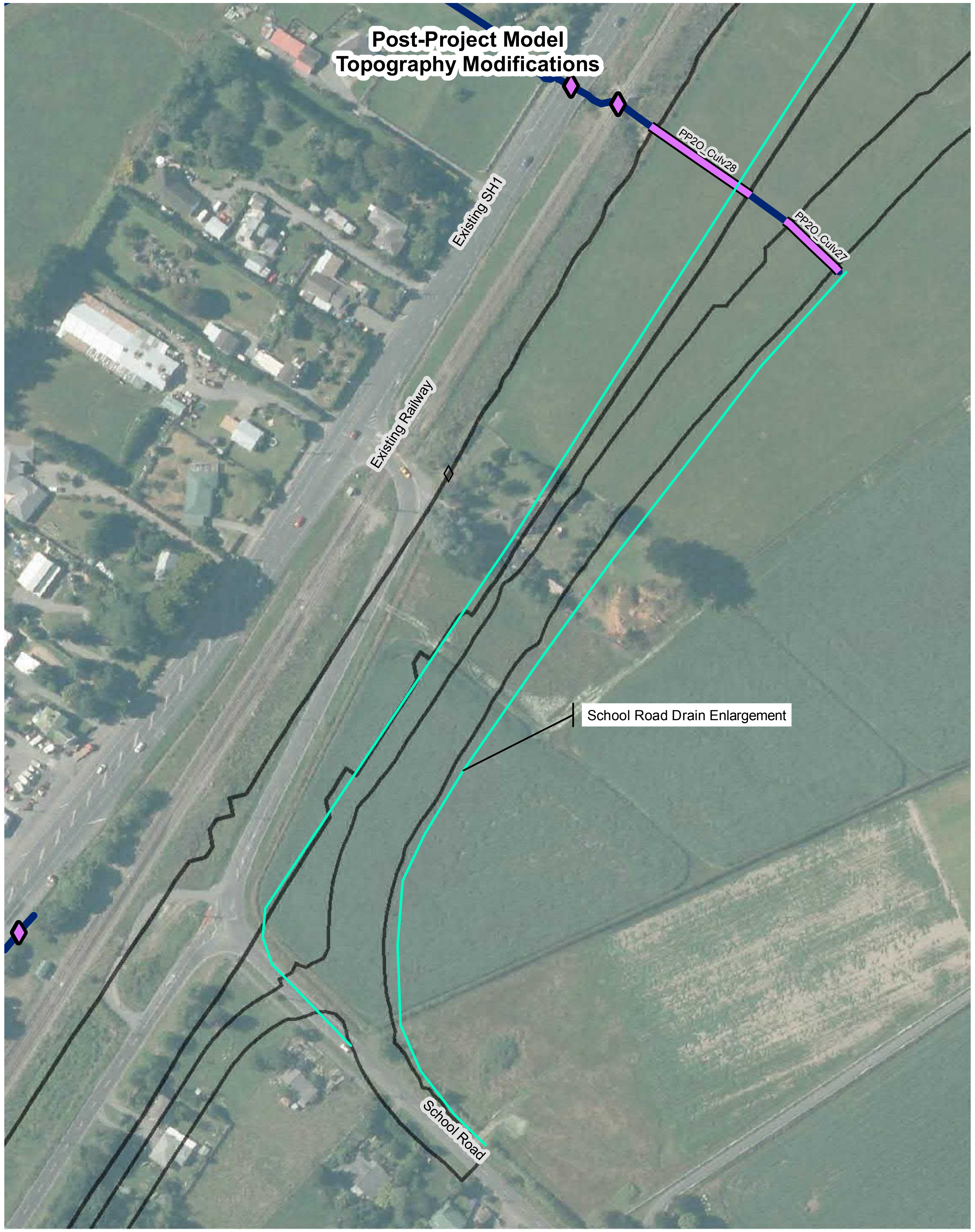
PEKA PEKA TO ŌTAKI EXPRESSWAY

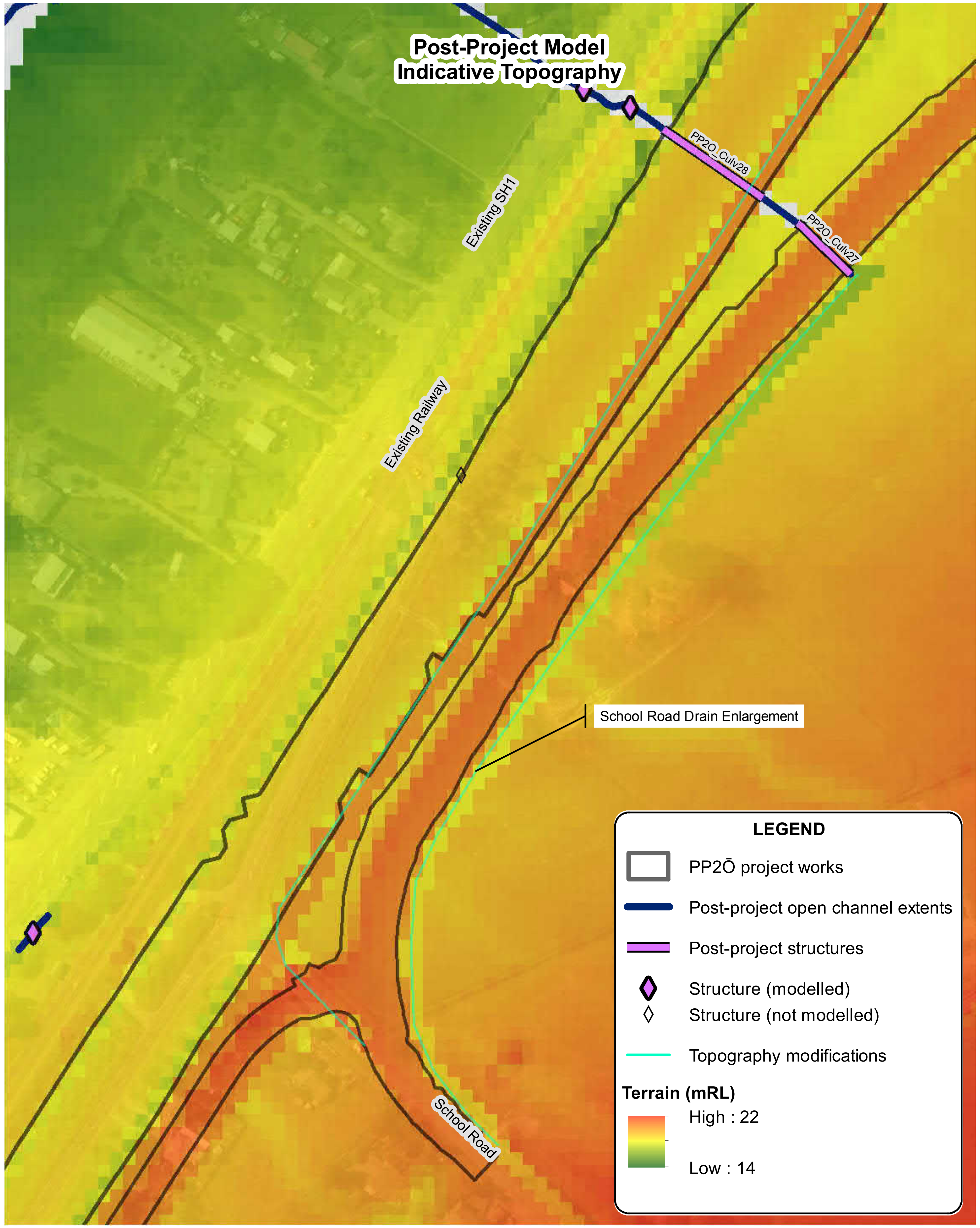
Post-Project Hydraulic Model Schematisation

Mangaone Model

FIGURE No. Figure 6.

Rev. 0





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A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

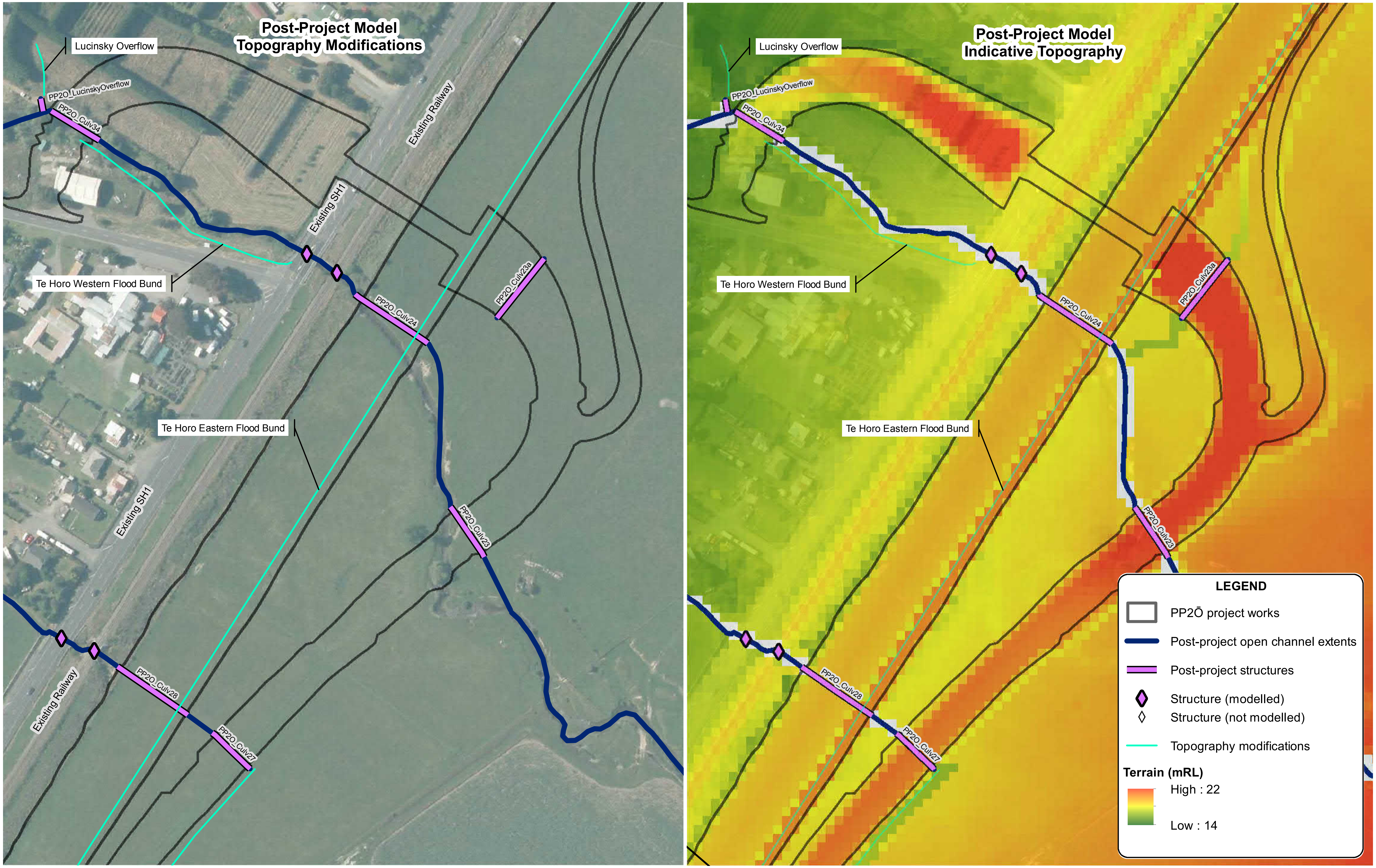
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig7_1_Mang_TopographyChanges.mxd	
SCALE (AT A3 SIZE)	1:2,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Mangaone Model - Topography Modifications

FIGURE No. Figure 7.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig7_1_Mang_TopographyChanges.mxd Date: 7/05/2018 Time: 3:58:53 p.m.



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A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

N

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

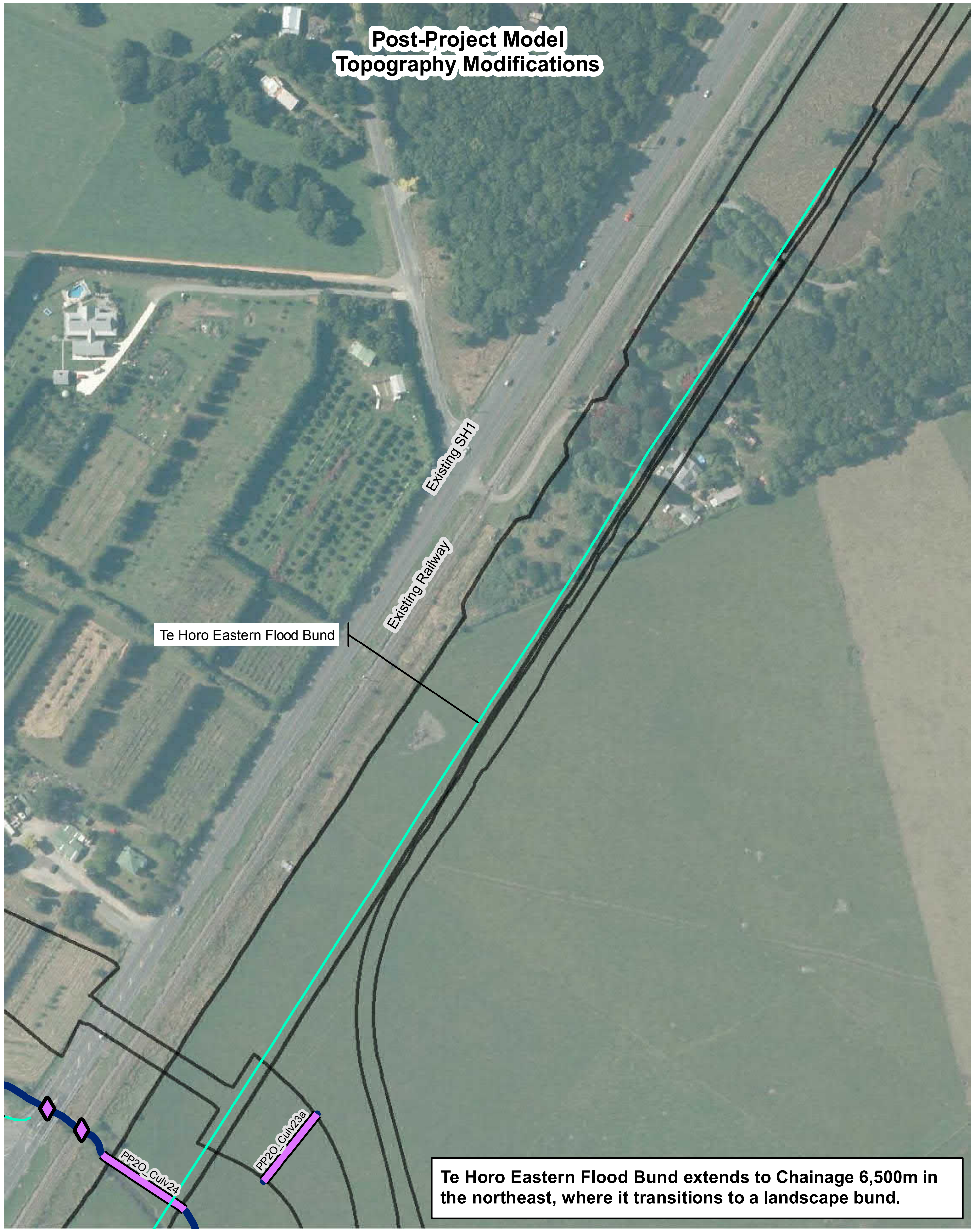
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig7_2_Mang_TopographyChanges.mxd		
SCALE (AT A3 SIZE) 1:2,000		
PROJECT No. 85985.0070		

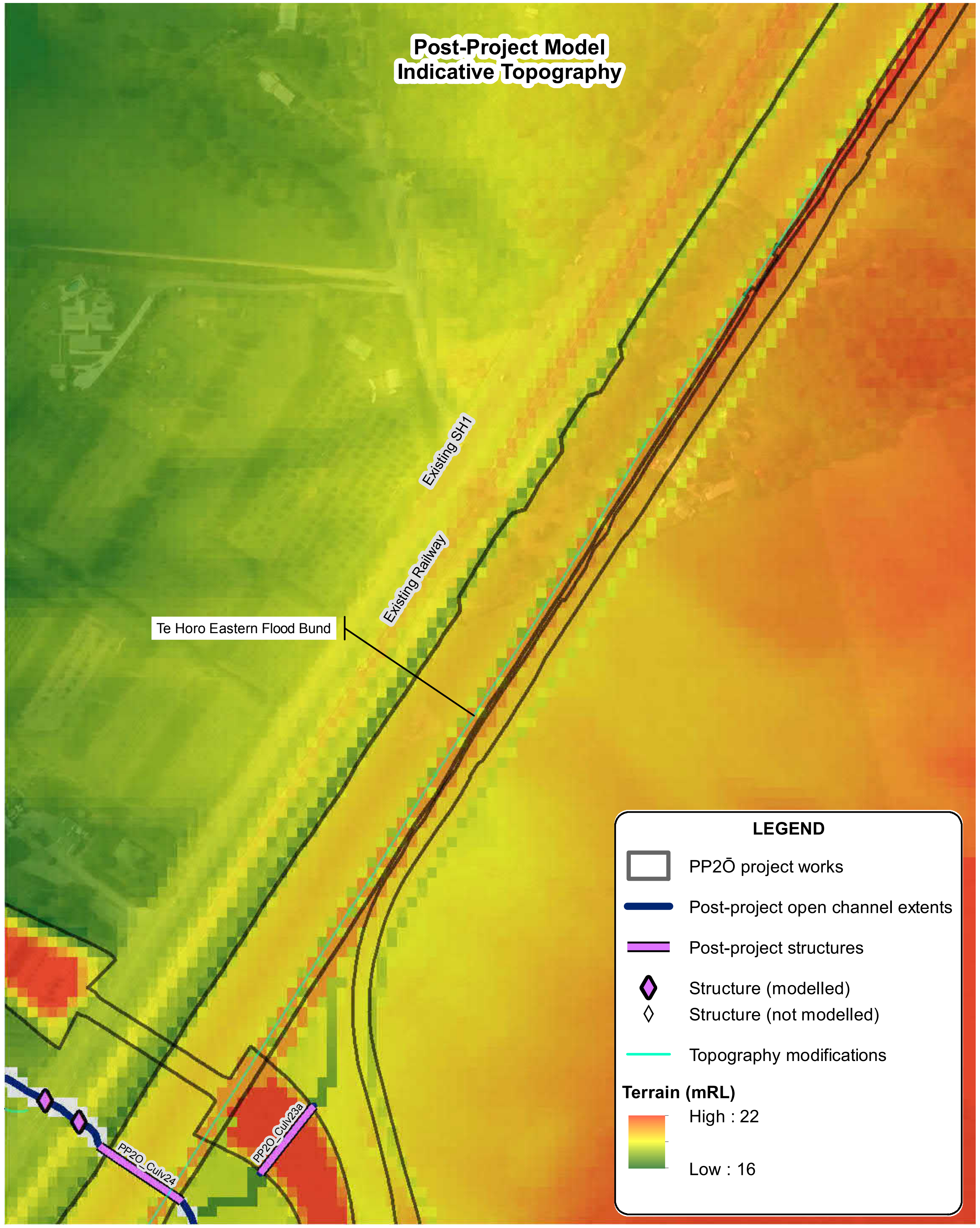
NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Mangaone Model - Topography Modifications

FIGURE No. Figure 7.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig7_2_Mang_TopographyChanges.mxd Date: 10/05/2018 Time: 5:31:59 p.m.





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A3 SCALE 1:2,500

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig7_3_Mang_TopographyChanges.mxd

SCALE (AT A3 SIZE) 1:2,500

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Schematisation
Mangaone Model - Topography Modifications

FIGURE No. Figure 7.3

Rev. 0

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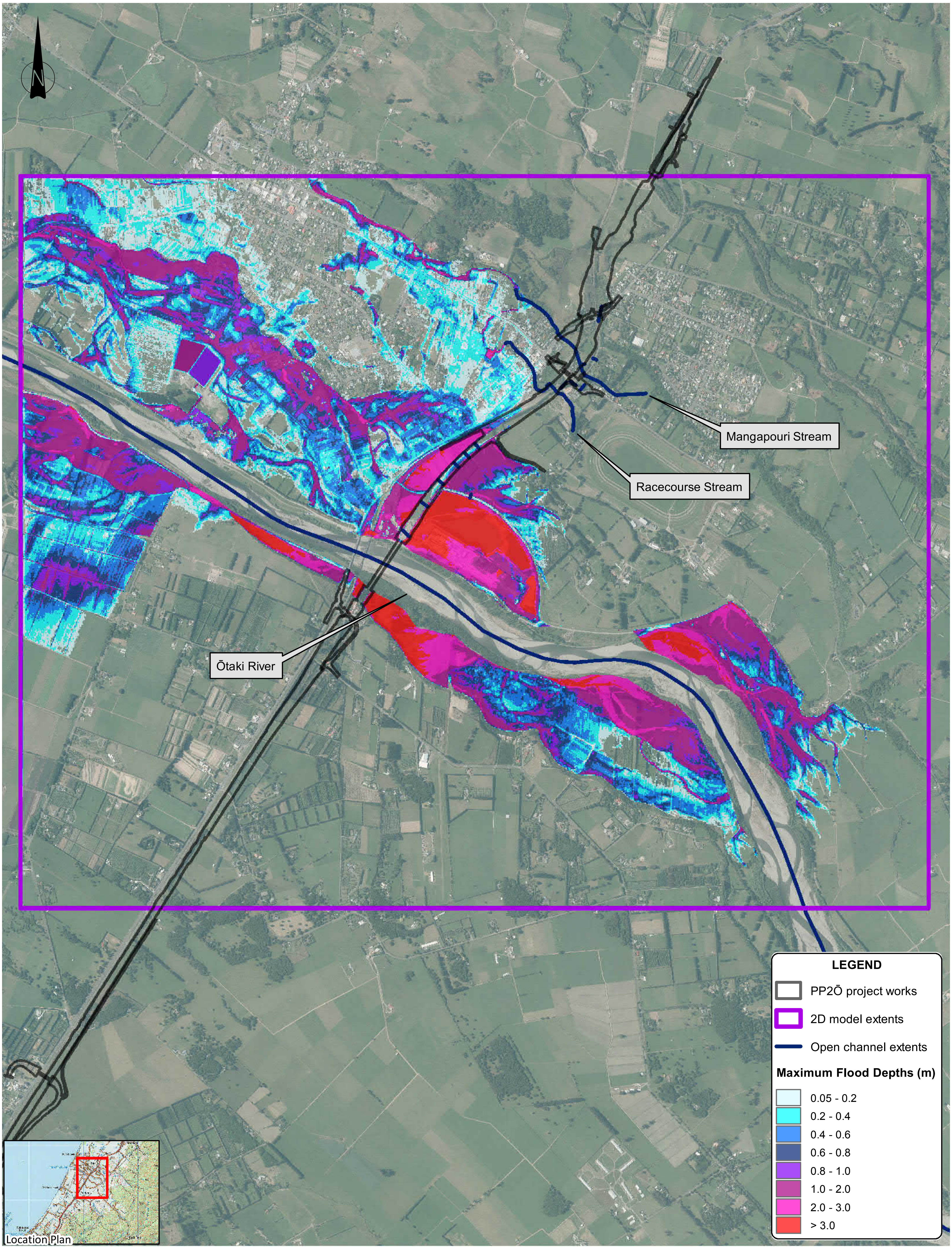

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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig8_1_OM_ModelResultsH_3000Cu.mxd

SCALE (AT A3 SIZE)
1:20,000

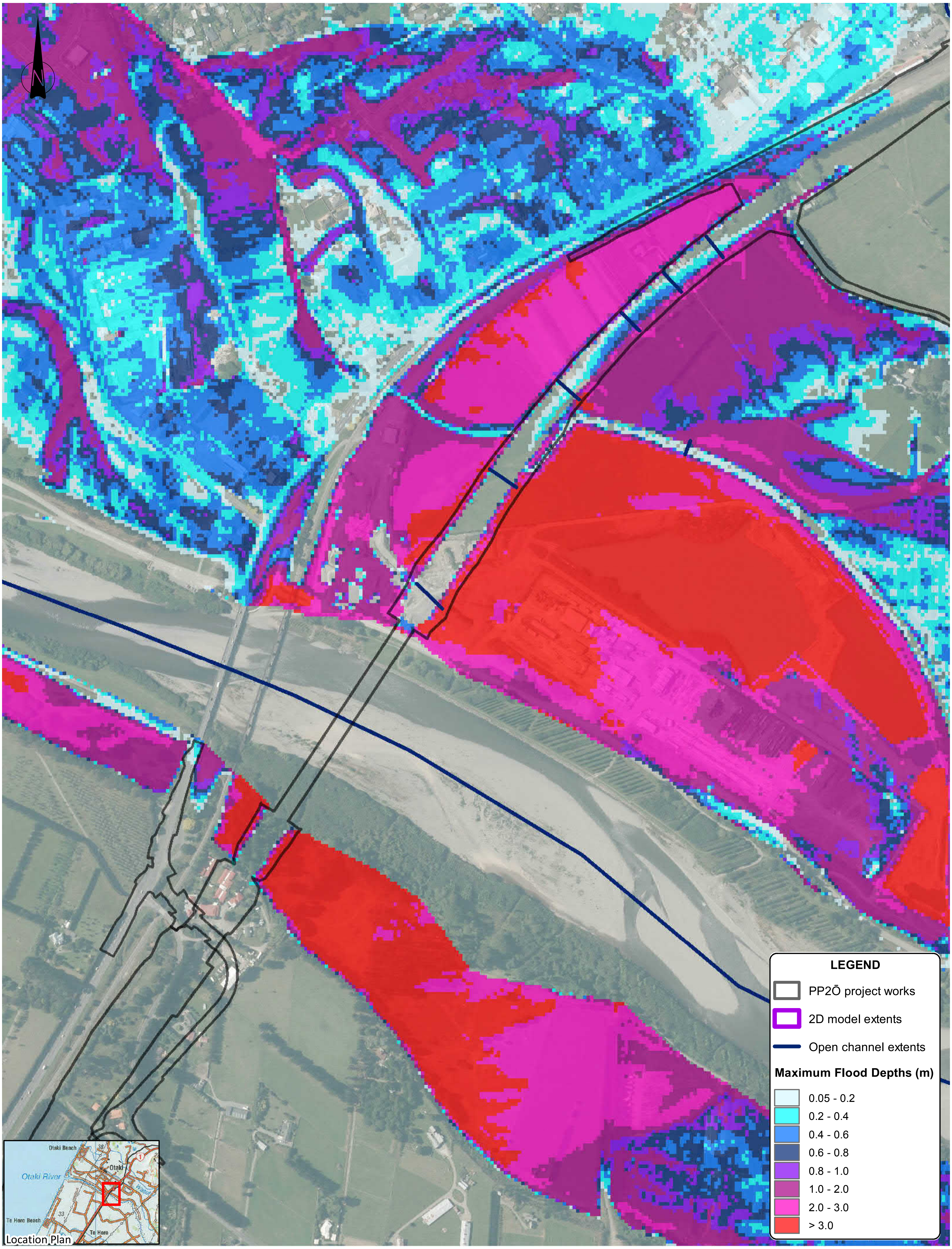
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 8.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig8_2_OM_ModelResultsH_3000Cu.mxd Date: 7/05/2018 Time: 5:00:05 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig8_2_OM_ModelResultsH_3000Cu.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

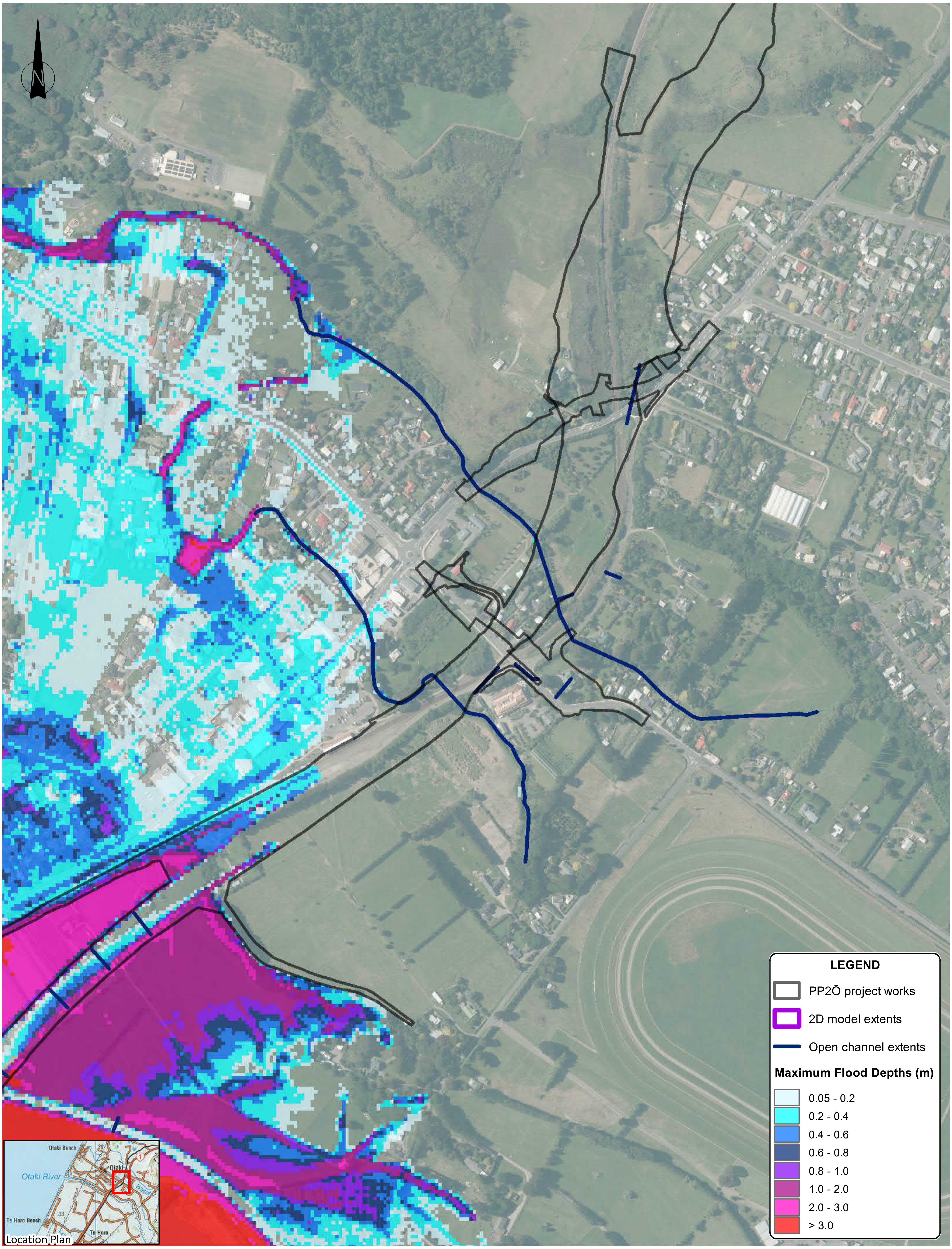
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 8.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig8_3_OM_ModelResultsH_3000Cu.mxd Date: 7/05/2018 Time: 5:02:20 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig8_3_OM_ModelResultsH_3000Cu.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

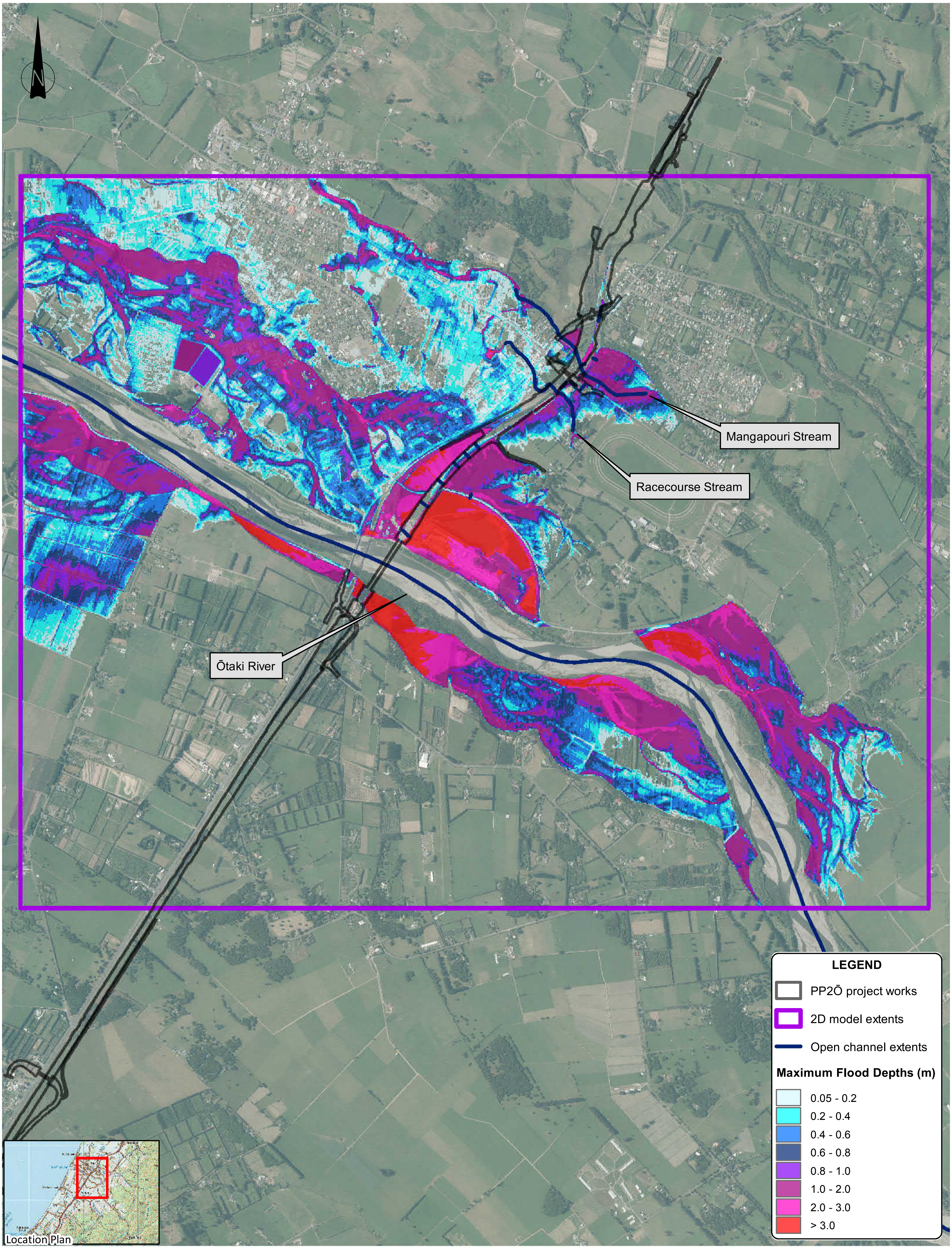
PEKA PEKA TO ŌTAKI EXPRESSWAY

Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 8.3 Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig9_1_OM_ModelResultsH_2500yrCC.mxd Date: 7/05/2018 Time: 5:04:37 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig9_1_OM_ModelResultsH_2500yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

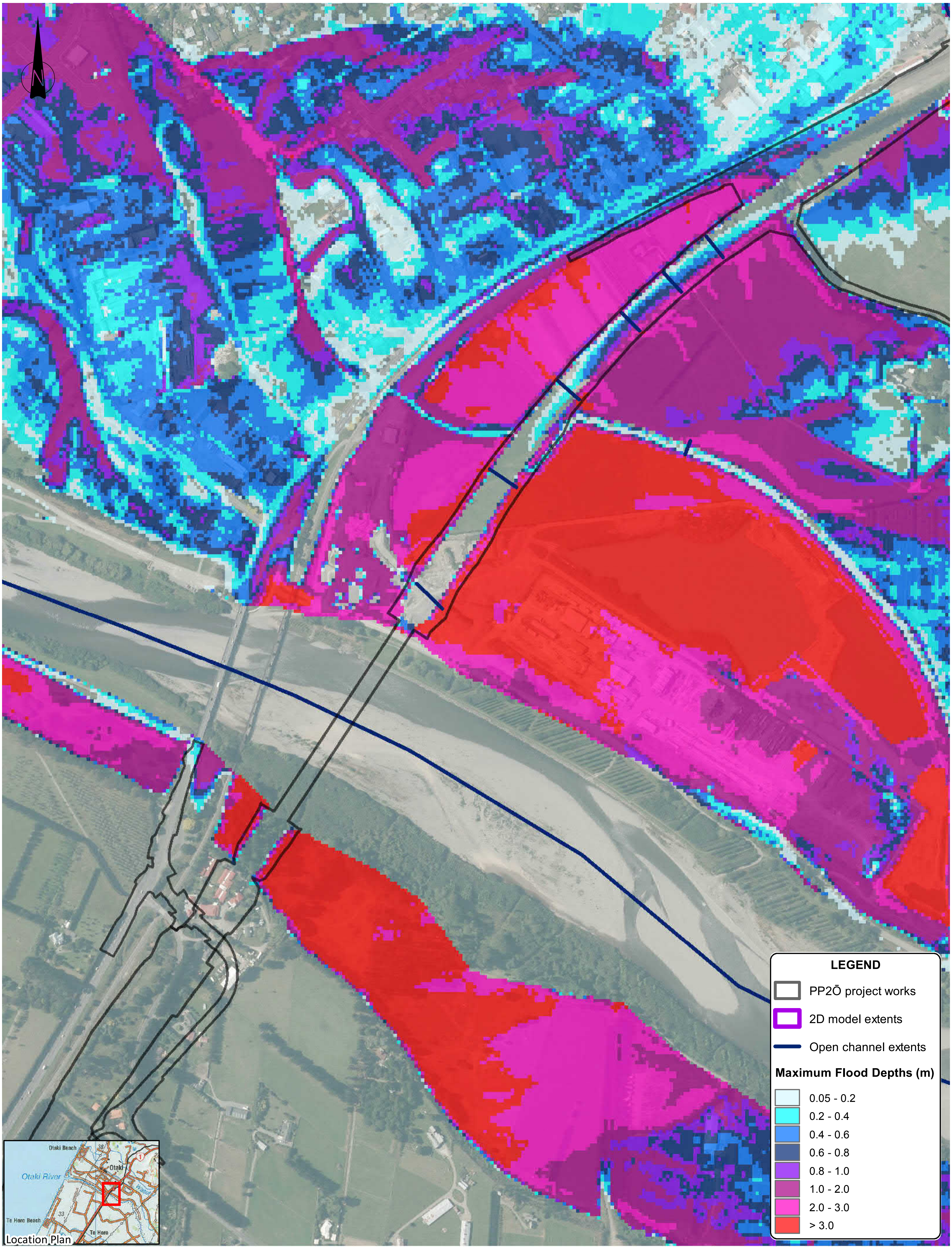
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 0.04% AEP CC2130

FIGURE No. Figure 9.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig9_2_OM_ModelResultsH_2500yrCC.mxd Date: 7/05/2018 Time: 5:07:08 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig9_2_OM_ModelResultsH_2500yrCC.mxd

SCALE (AT A3 SIZE): 1:5,000

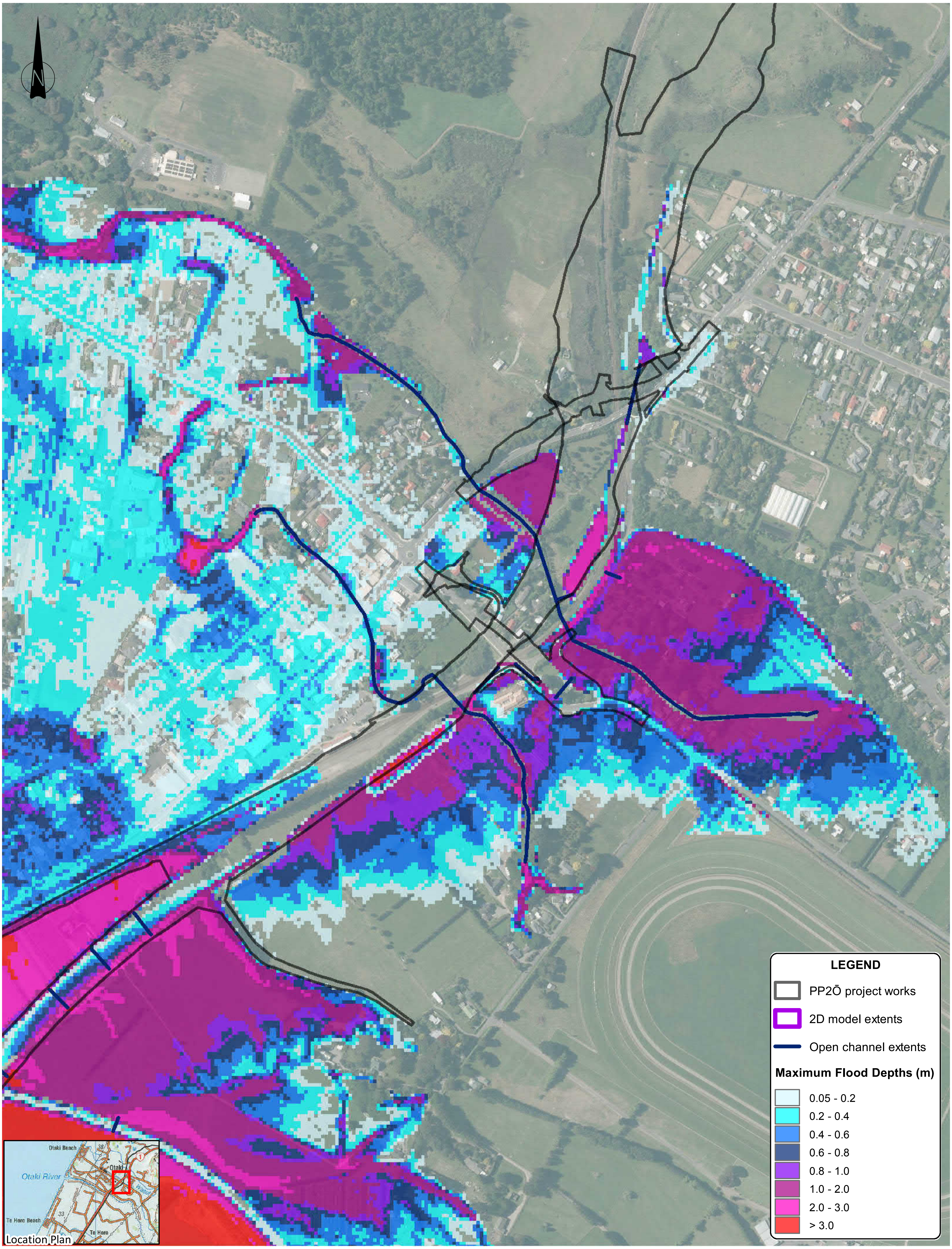
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 0.04% AEP CC2130

FIGURE No. Figure 9.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig9_3_OM_ModelResultsH_2500yrCC.mxd Date: 7/05/2018 Time: 5:08:54 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig9_3_OM_ModelResultsH_2500yrCC.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

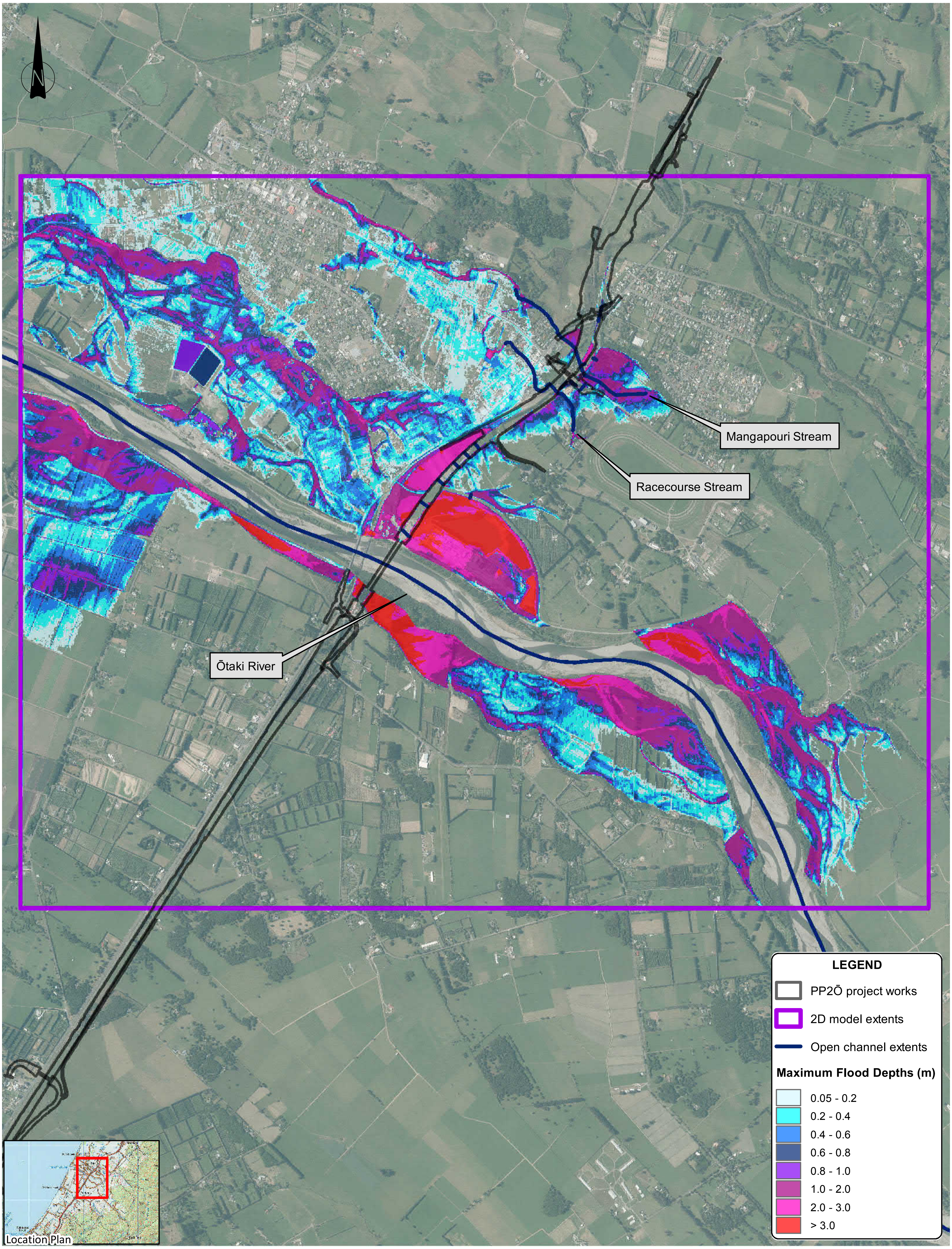
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 0.04% AEP CC2130

FIGURE No. Figure 9.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig10_1_OM_ModelResultsH_500yrCC.mxd Date: 7/05/2018 Time: 5:23:09 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig10_1_OM_ModelResultsH_500yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

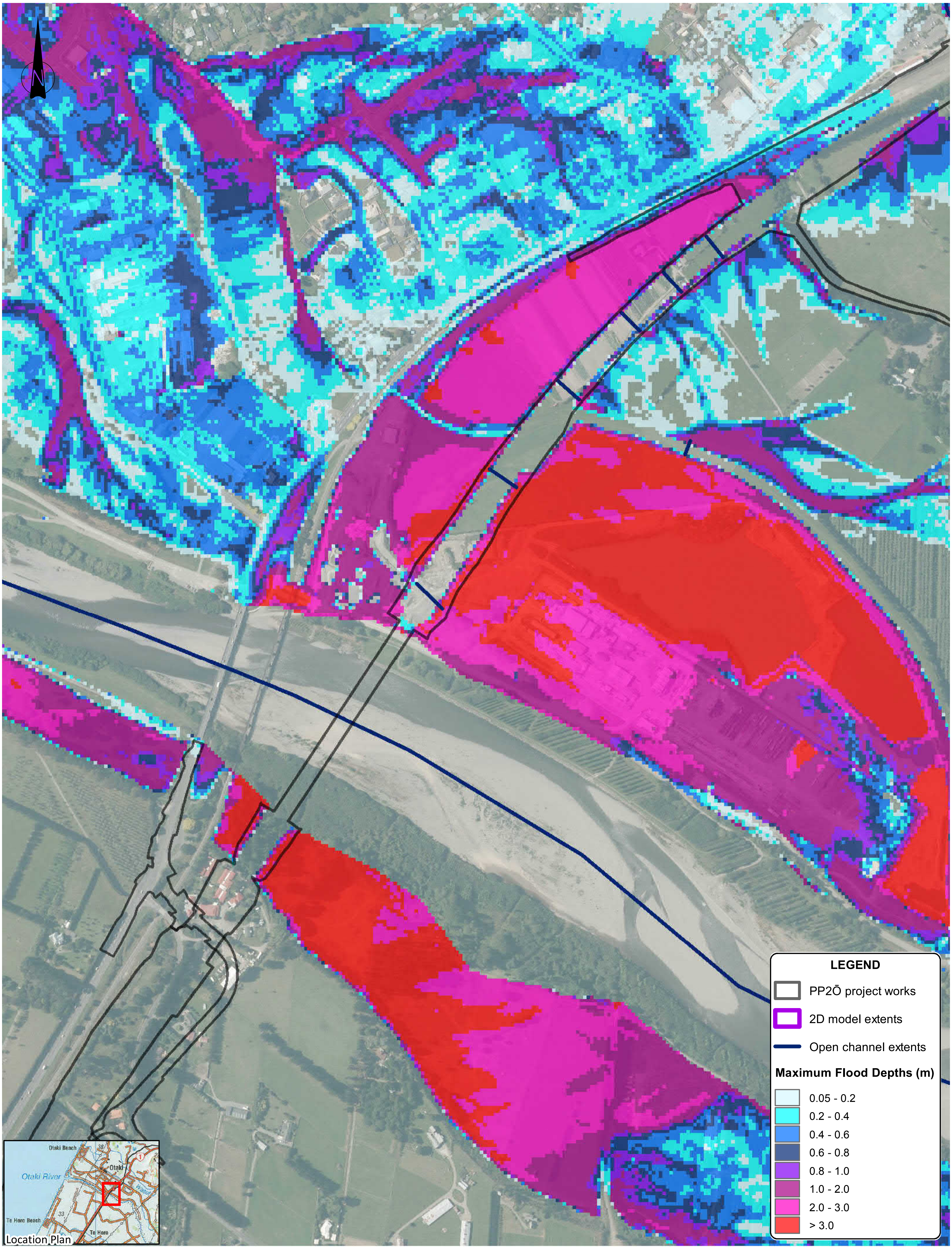
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 0.2% AEP CC2130

FIGURE No. Figure 10.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig10_2_OM_ModelResultsH_500yrCC.mxd Date: 7/05/2018 Time: 5:24:33 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI
Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig10_2_OM_ModelResultsH_500yrCC.mxd

SCALE (AT A3 SIZE): 1:5,000

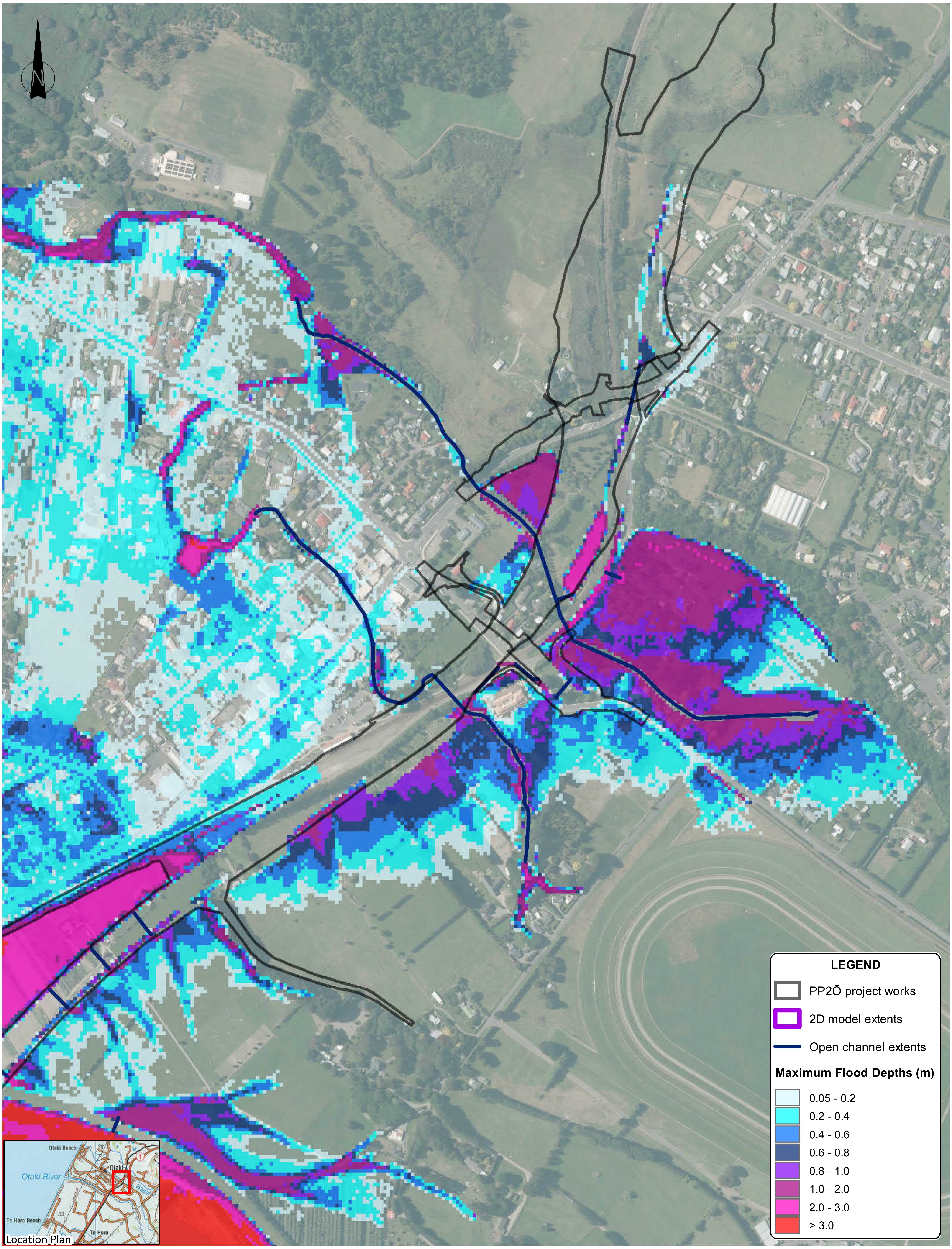
PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 0.2% AEP CC2130

FIGURE No. Figure 10.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig10_3_OM_ModelResultsH_500yrCC.mxd Date: 7/05/2018 Time: 5:27:07 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig10_3_OM_ModelResultsH_500yrCC.mxd

SCALE (AT A3 SIZE)
1:5,000

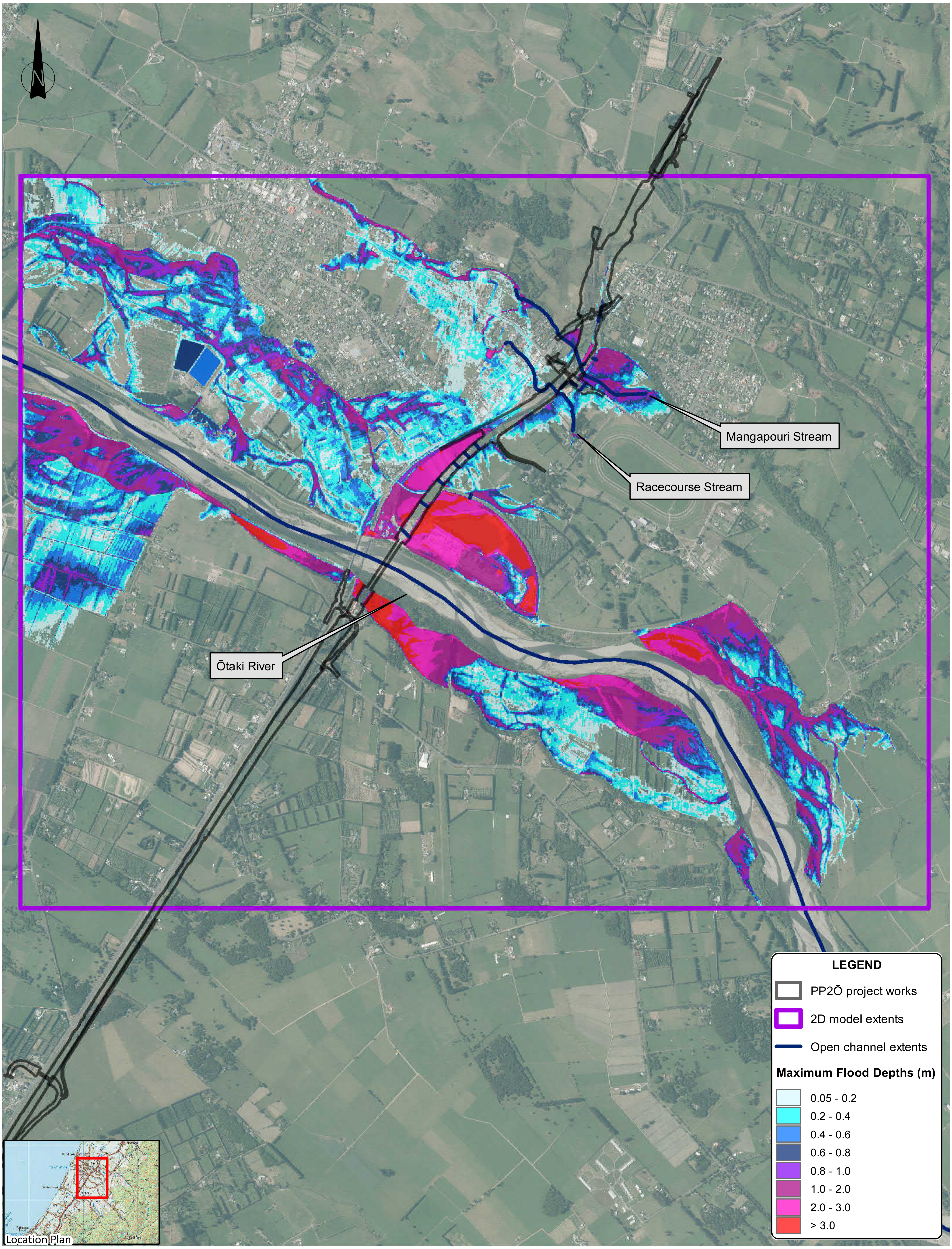
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 0.2% AEP CC2130

FIGURE No. Figure 10.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig11_1_OM_ModelResultsH_100yrCCHR.mxd Date: 7/05/2018 Time: 5:28:28 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig11_1_OM_ModelResultsH_100yrCCHR.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

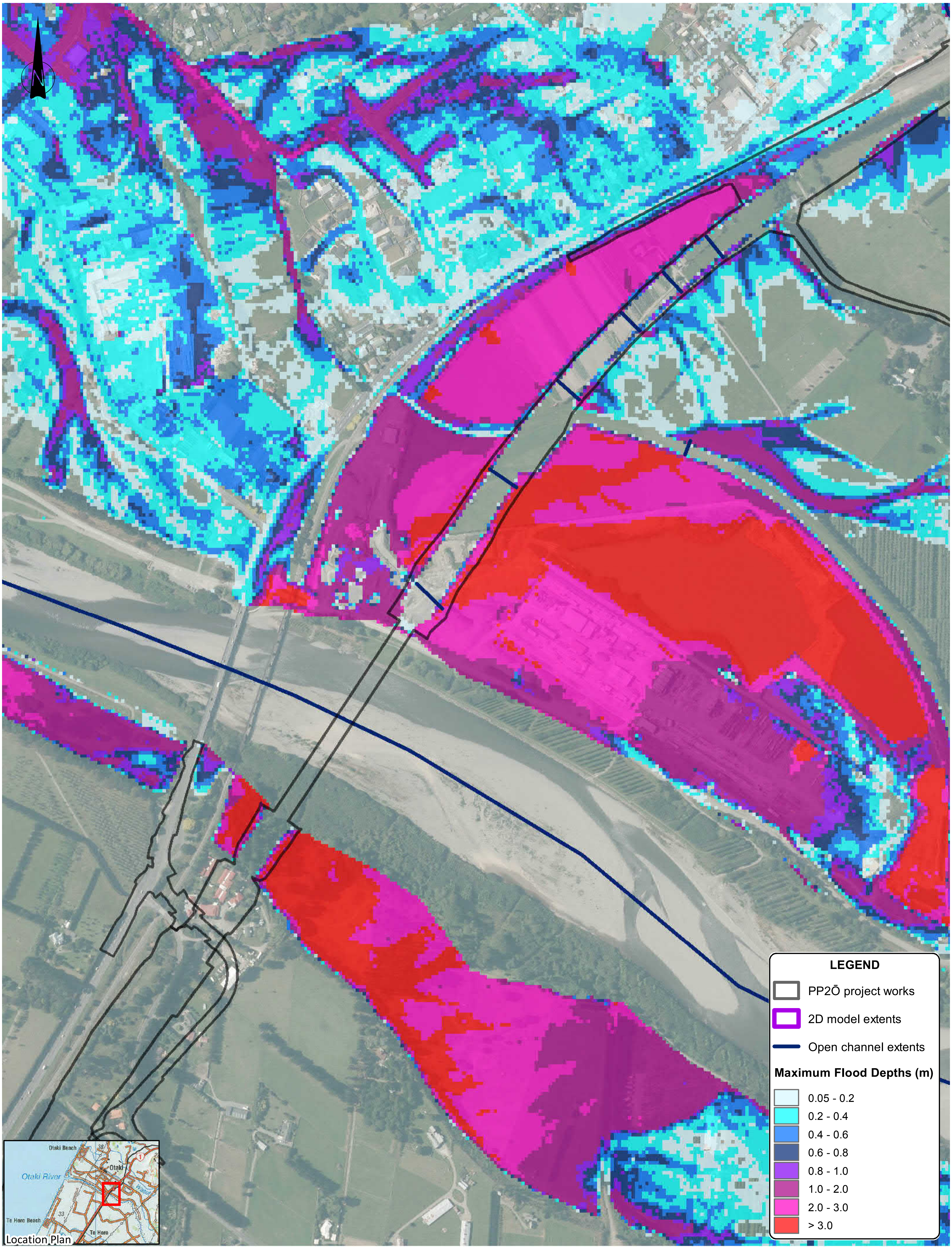
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 11.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig11_2_OM_ModelResultsH_100yrCCHR.mxd Date: 7/05/2018 Time: 5:35:51 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig11_2_OM_ModelResultsH_100yrCCHR.mxd

SCALE (AT A3 SIZE)
1:5,000

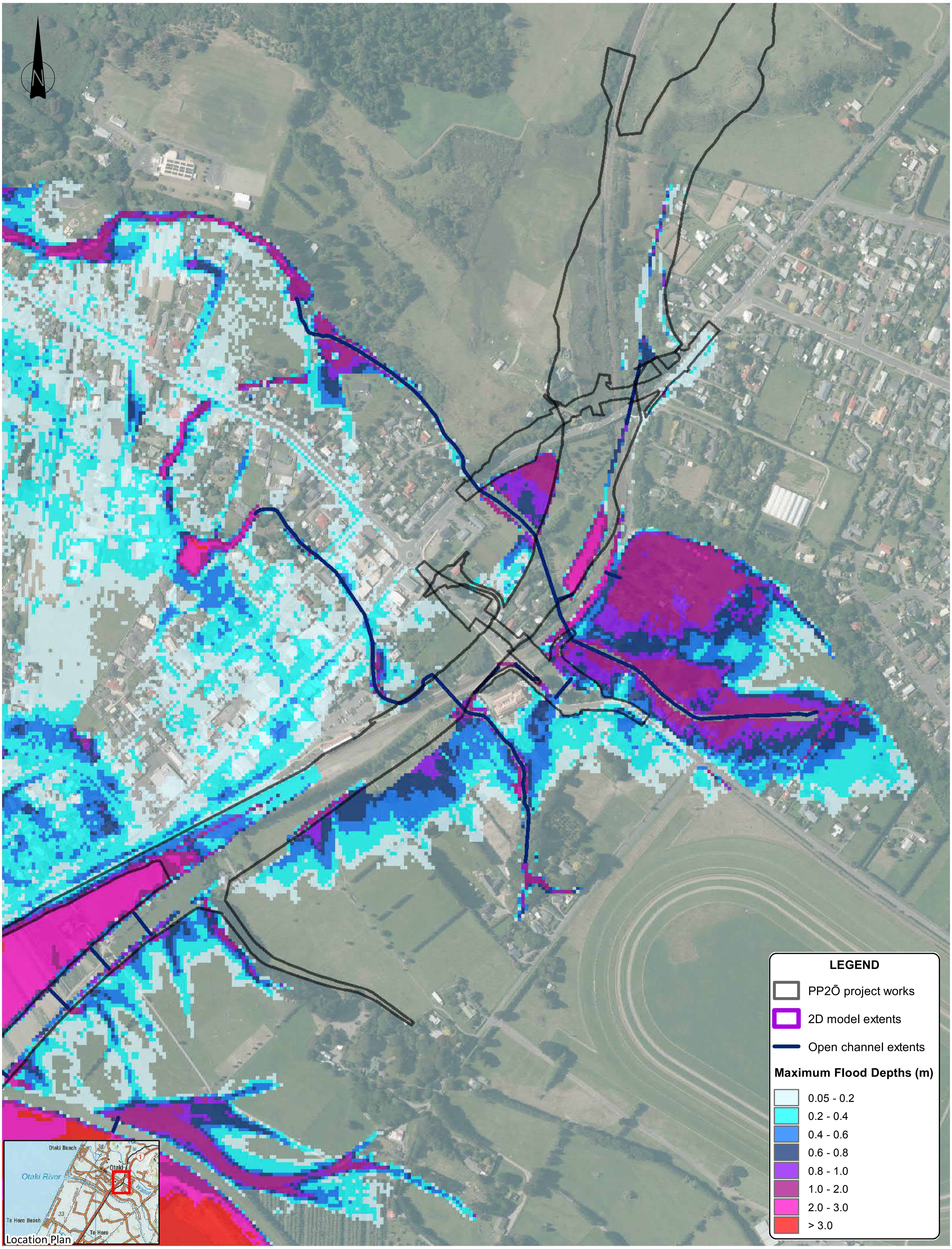
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 11.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig11_3_OM_ModelResultsH_100yrCCHR.mxd Date: 7/05/2018 Time: 5:39:40 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

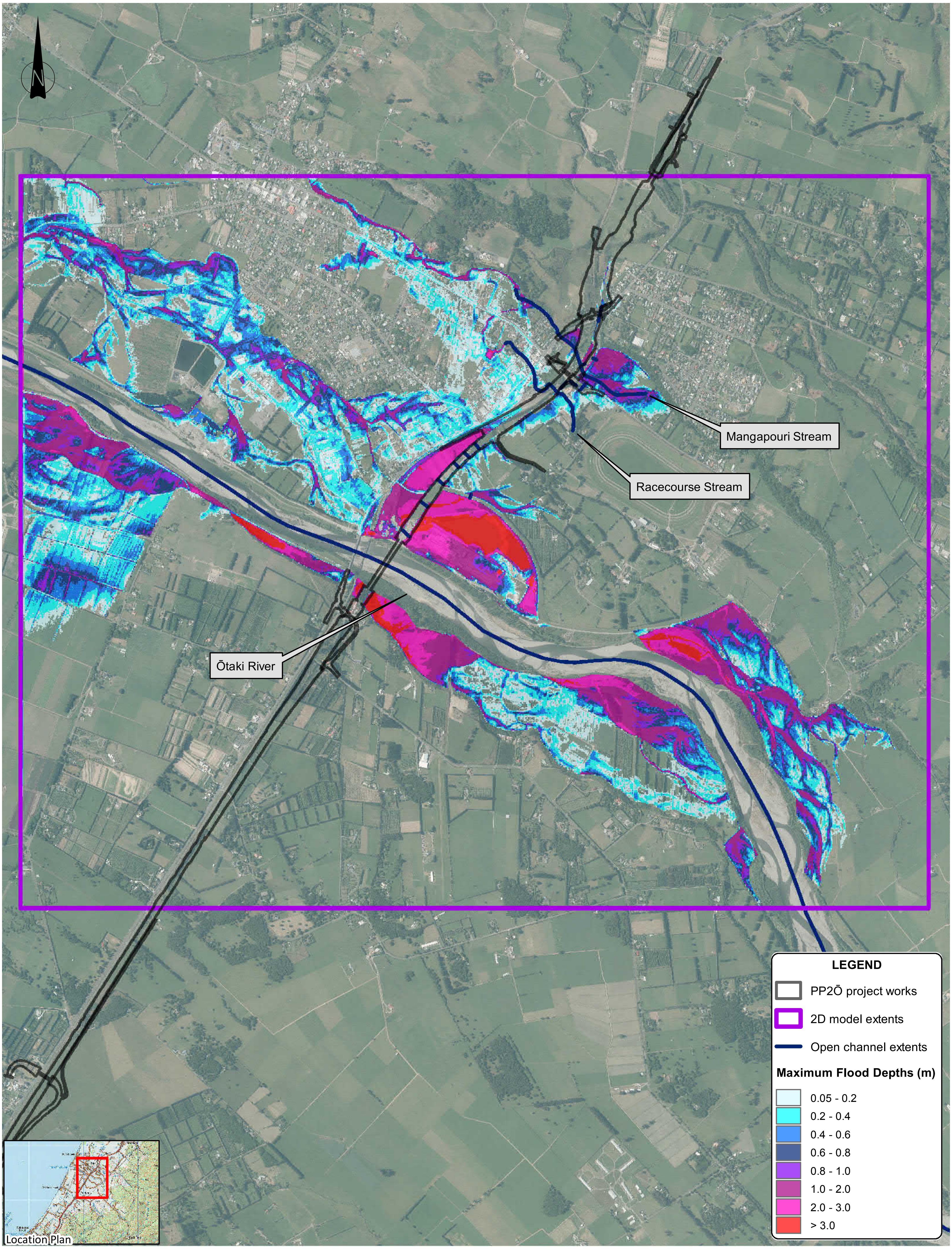
Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig11_3_OM_ModelResultsH_100yrCCHR.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 11.3 Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig12_1_OM_ModelResultsH_100yrCC.mxd Date: 7/05/2018 Time: 5:42:08 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig12_1_OM_ModelResultsH_100yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

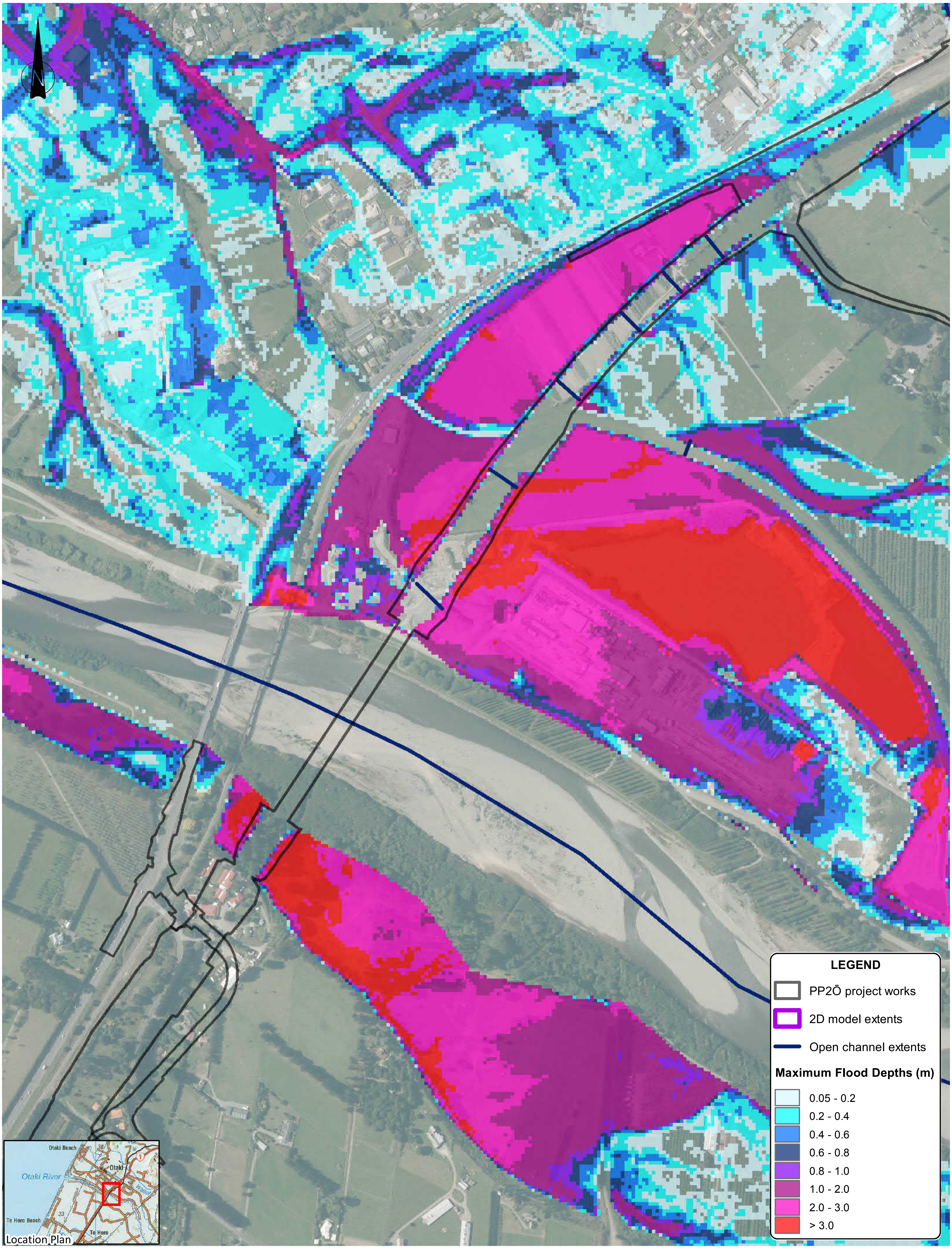
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP CC2130

FIGURE No. Figure 12.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig12_2_OM_ModelResultsH_100yrCC.mxd Date: 7/05/2018 Time: 5:43:33 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig12_2_OM_ModelResultsH_100yrCC.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

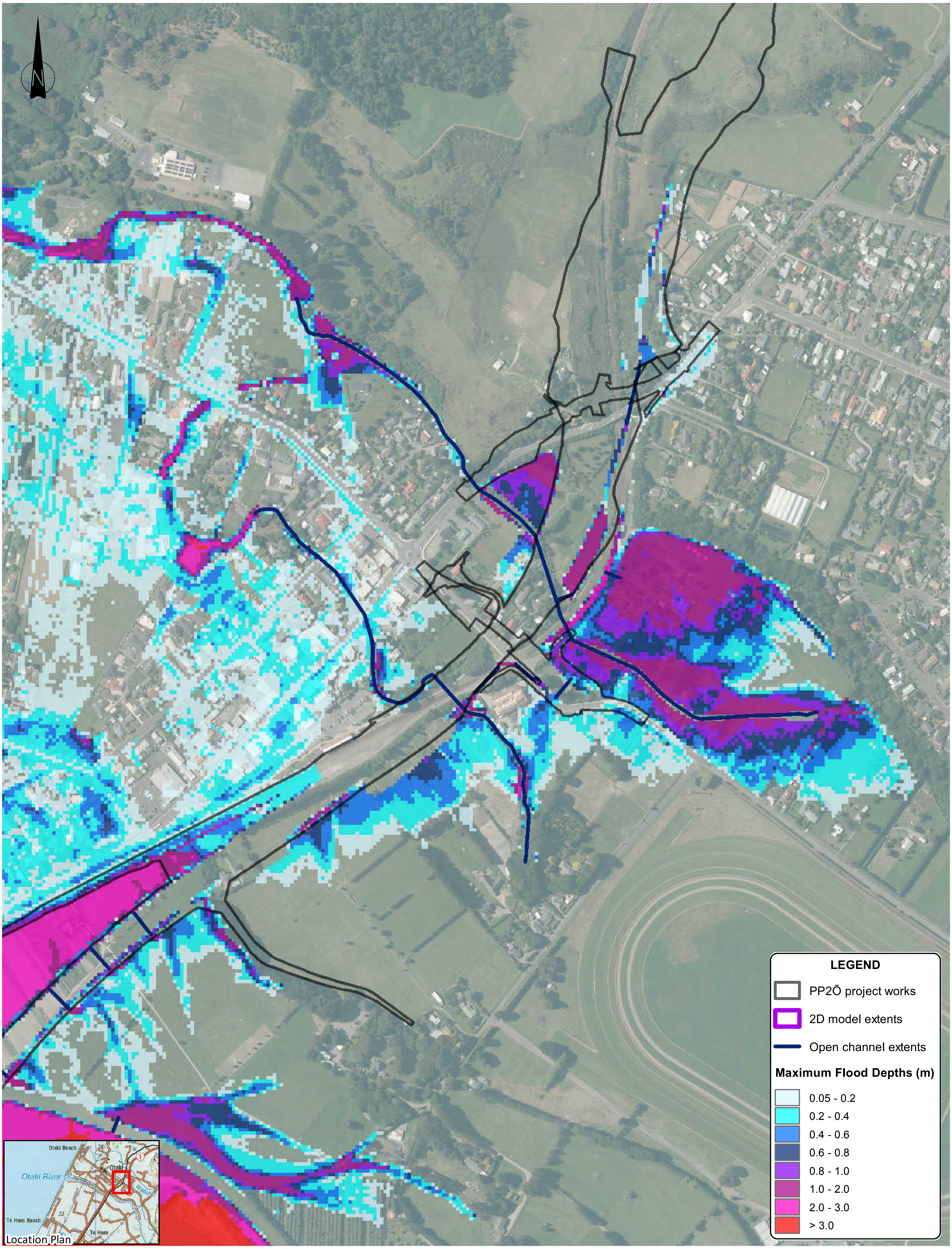
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 1% AEP CC2130

FIGURE No. Figure 12.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig12_3_OM_ModelResultsH_100yrCC.mxd Date: 7/05/2018 Time: 5:45:28 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig12_3_OM_ModelResultsH_100yrCC.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

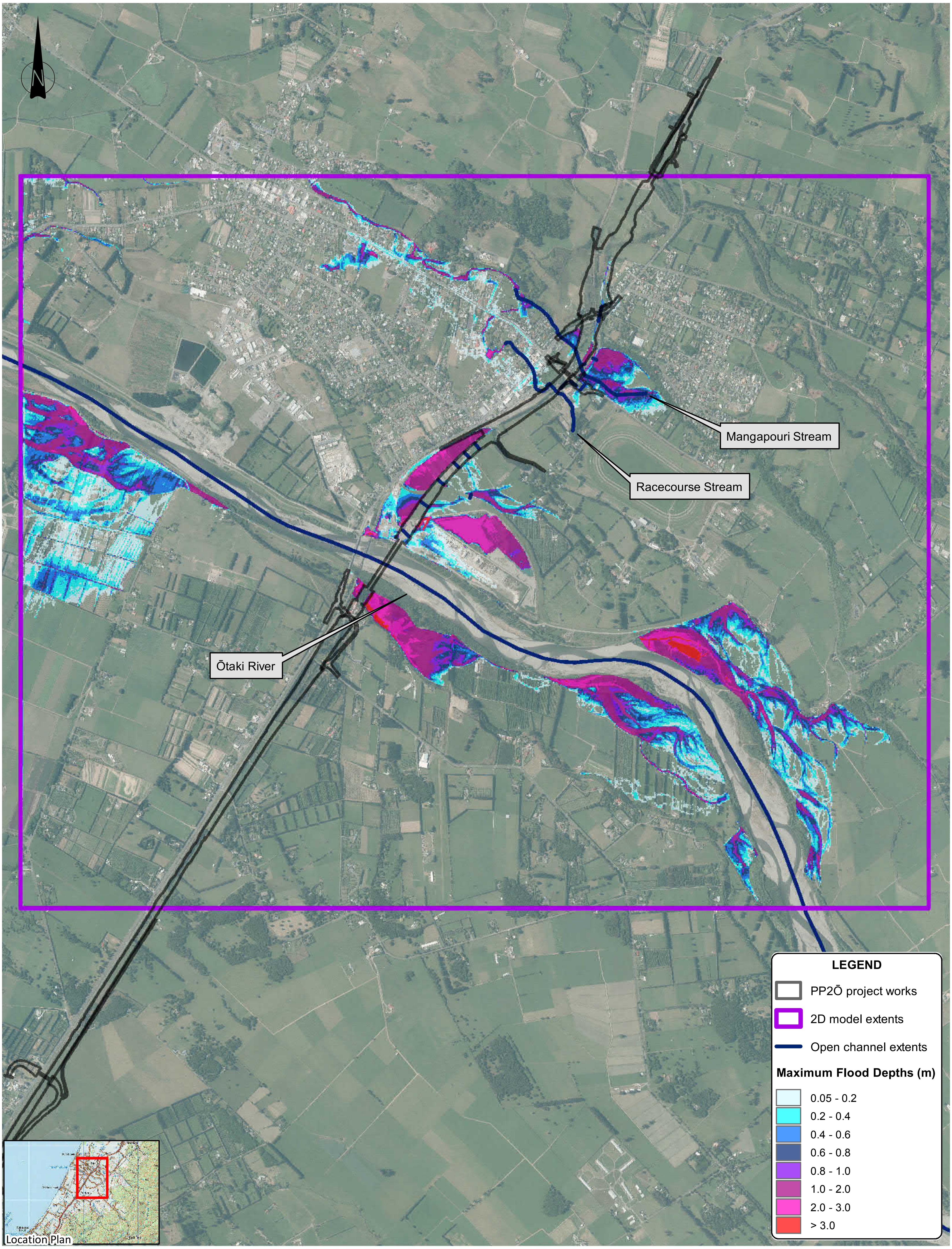
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 1% AEP CC2130

FIGURE No. Figure 12.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig13_1_OM_ModelResultsH_100yr.mxd Date: 7/05/2018 Time: 5:47:56 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig13_1_OM_ModelResultsH_100yr.mxd

SCALE (AT A3 SIZE) 1:20,000

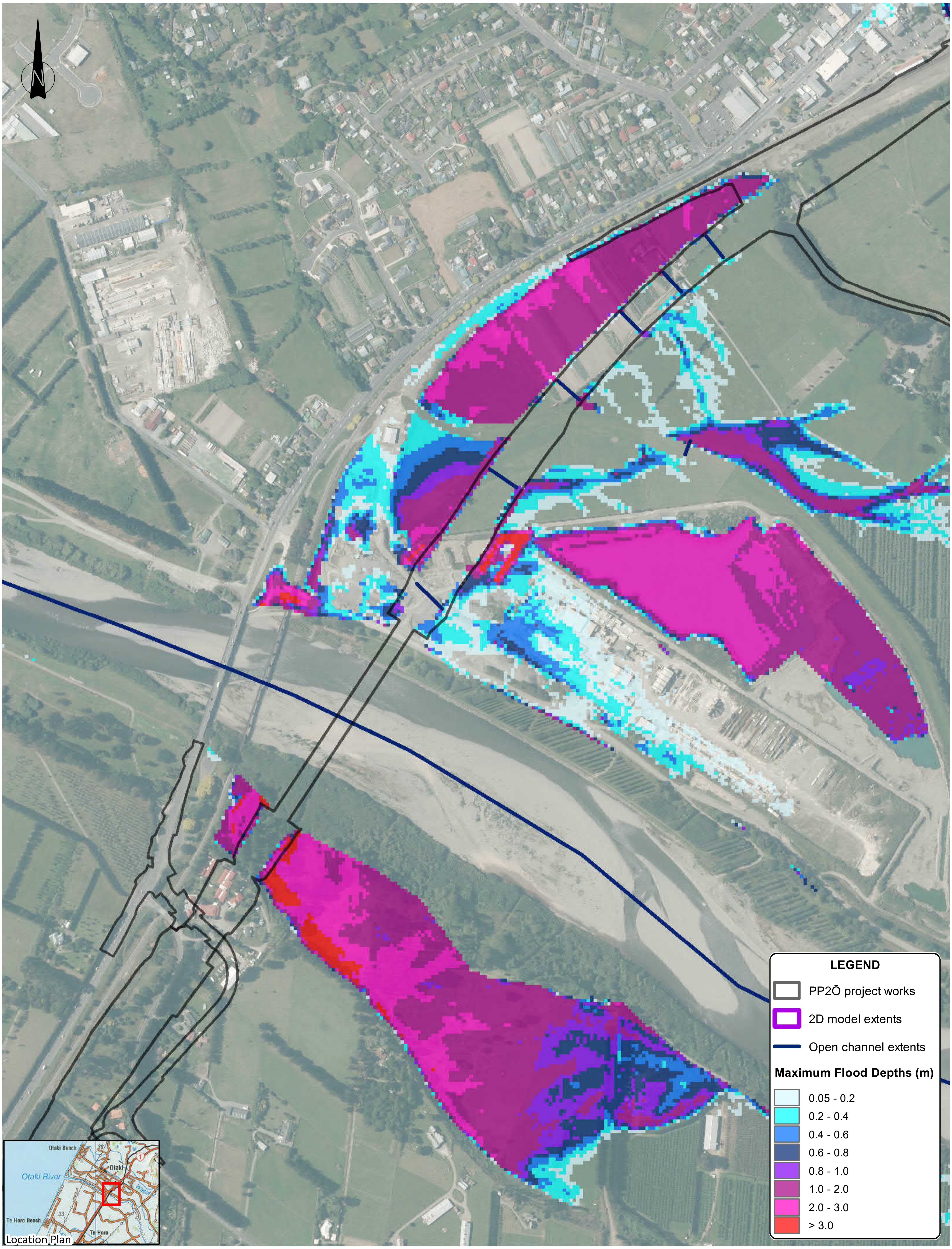
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP

FIGURE No. Figure 13.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig13_2_OM_ModelResultsH_100yr.mxd Date: 7/05/2018 Time: 5:49:05 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig13_2_OM_ModelResultsH_100yr.mxd

SCALE (AT A3 SIZE): 1:5,000

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

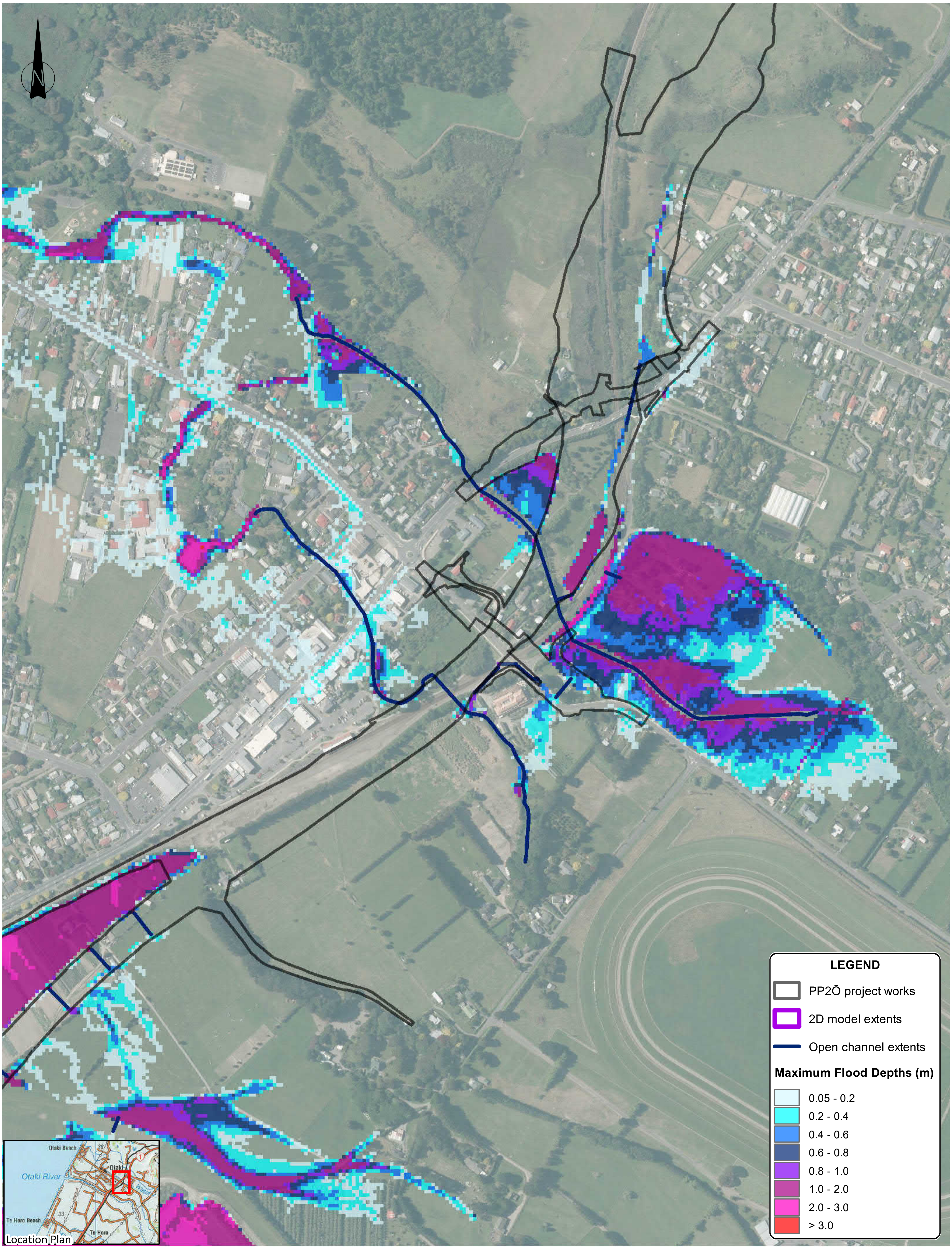
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 1% AEP

FIGURE No. Figure 13.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig13_3_OM_ModelResultsH_100yr.mxd Date: 7/05/2018 Time: 5:50:26 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig13_3_OM_ModelResultsH_100yr.mxd

SCALE (AT A3 SIZE): 1:5,000

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

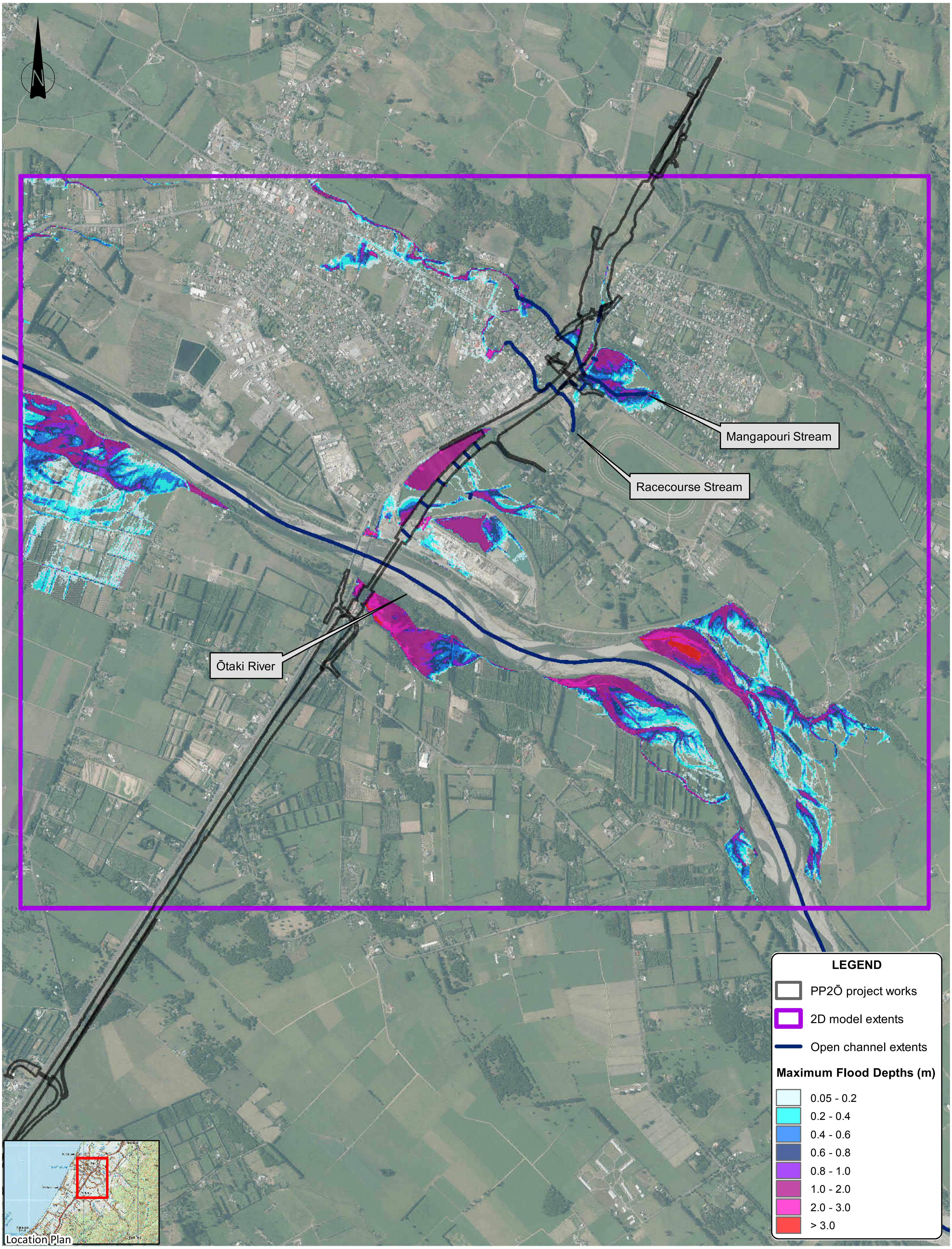
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 1% AEP

FIGURE No. Figure 13.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig14_1_OM_ModelResultsH_50yr.mxd Date: 7/05/2018 Time: 5:52:04 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig14_1_OM_ModelResultsH_50yr.mxd

SCALE (AT A3 SIZE) 1:20,000

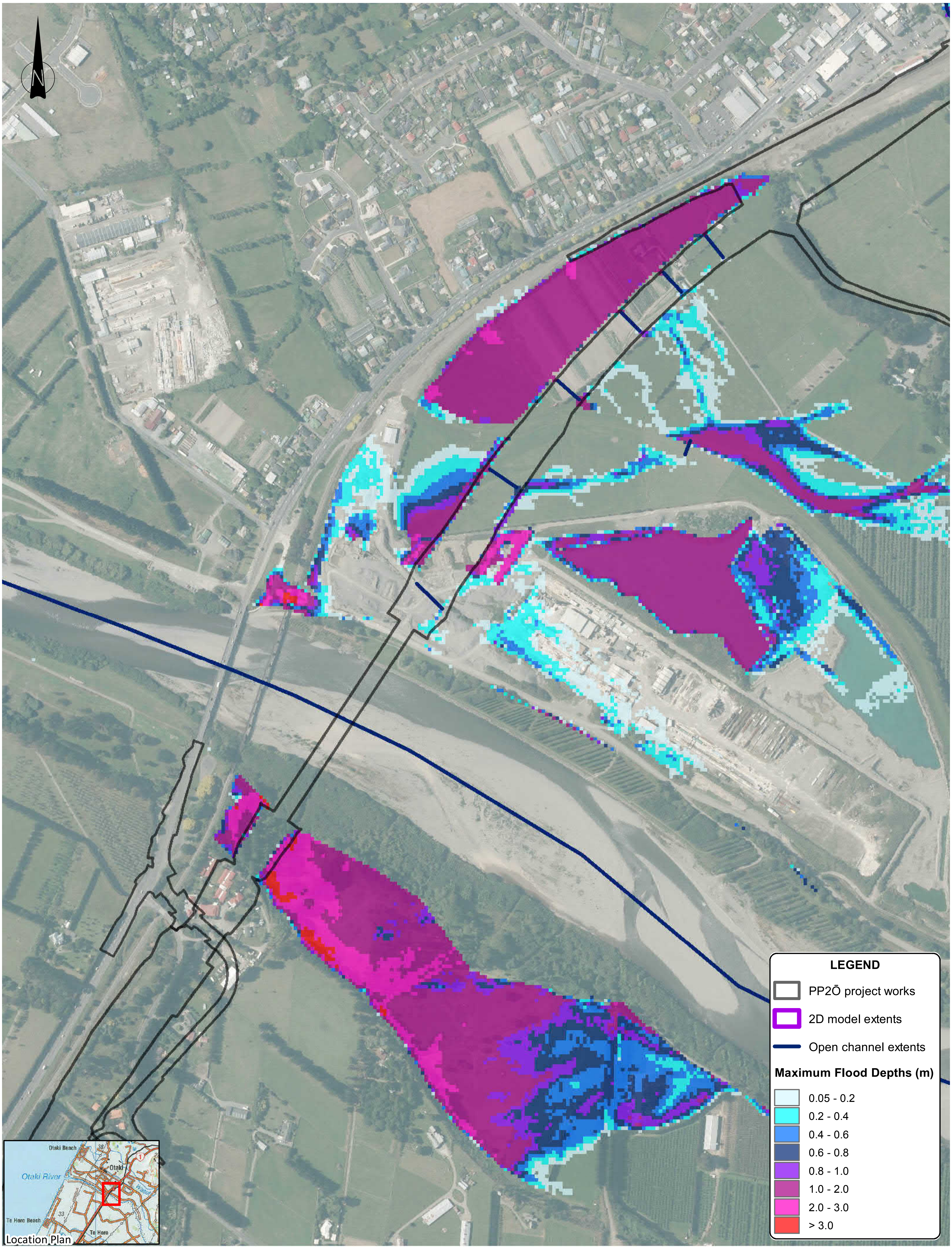
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 2% AEP

FIGURE No. Figure 14.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig14_2_OM_ModelResultsH_50yr.mxd Date: 7/05/2018 Time: 5:56:02 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig14_2_OM_ModelResultsH_50yr.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

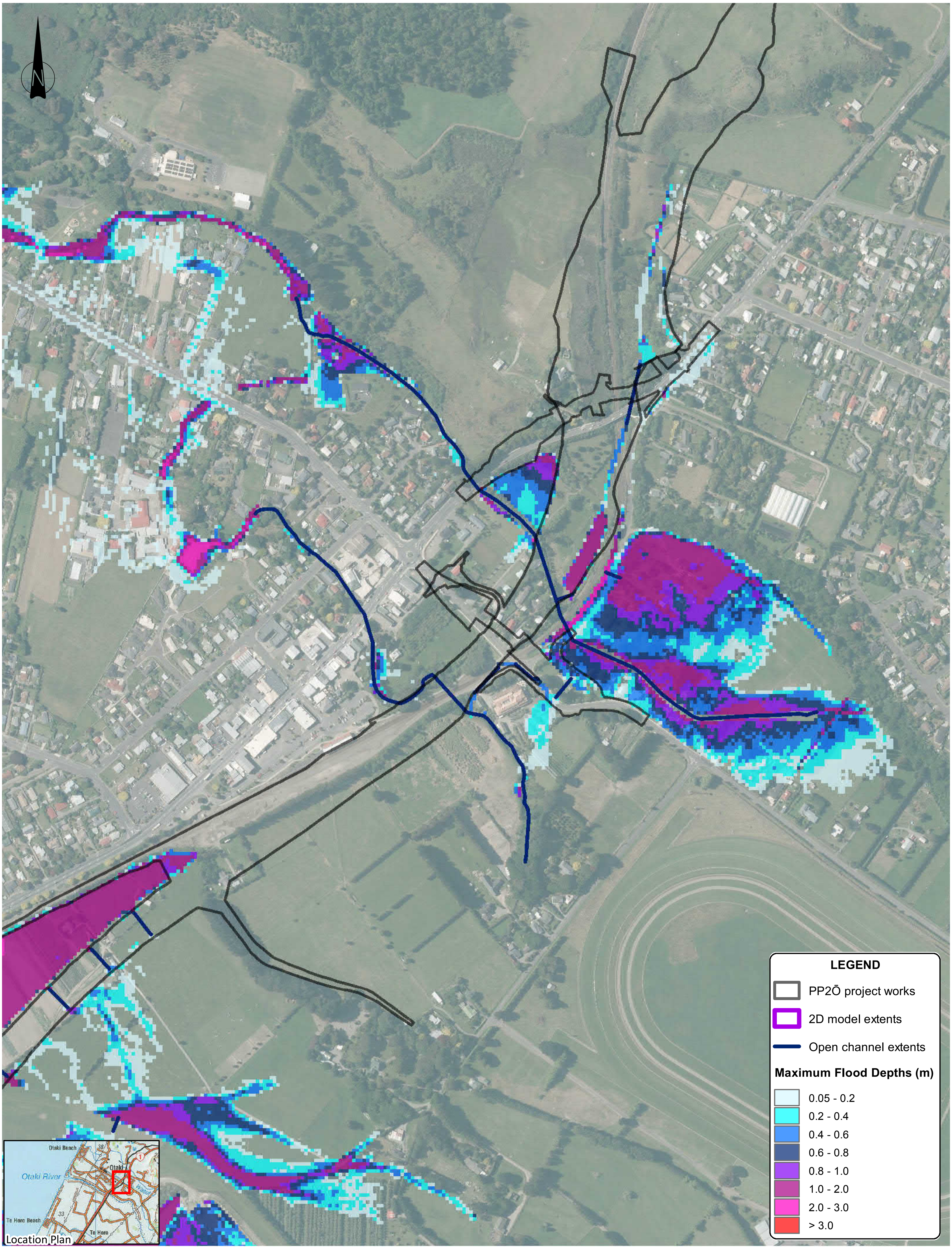
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 2% AEP

FIGURE No. Figure 14.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig14_3_OM_ModelResultsH_50yr.mxd Date: 7/05/2018 Time: 6:01:29 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig14_3_OM_ModelResultsH_50yr.mxd

SCALE (AT A3 SIZE) 1:5,000

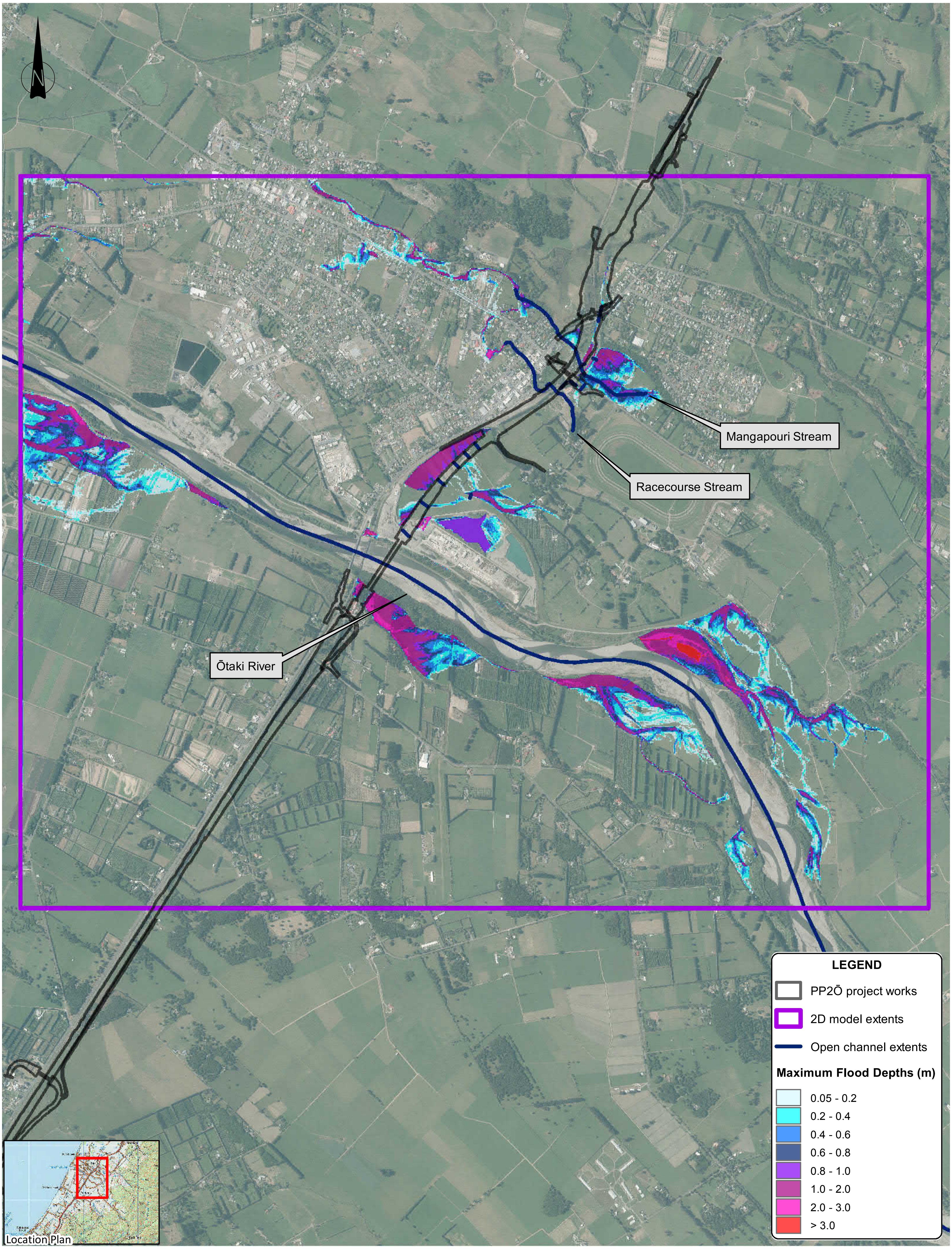
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 2% AEP

FIGURE No. Figure 14.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig15_1_OM_ModelResultsH_20yr.mxd Date: 7/05/2018 Time: 6:03:03 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig15_1_OM_ModelResultsH_20yr.mxd

SCALE (AT A3 SIZE) 1:20,000

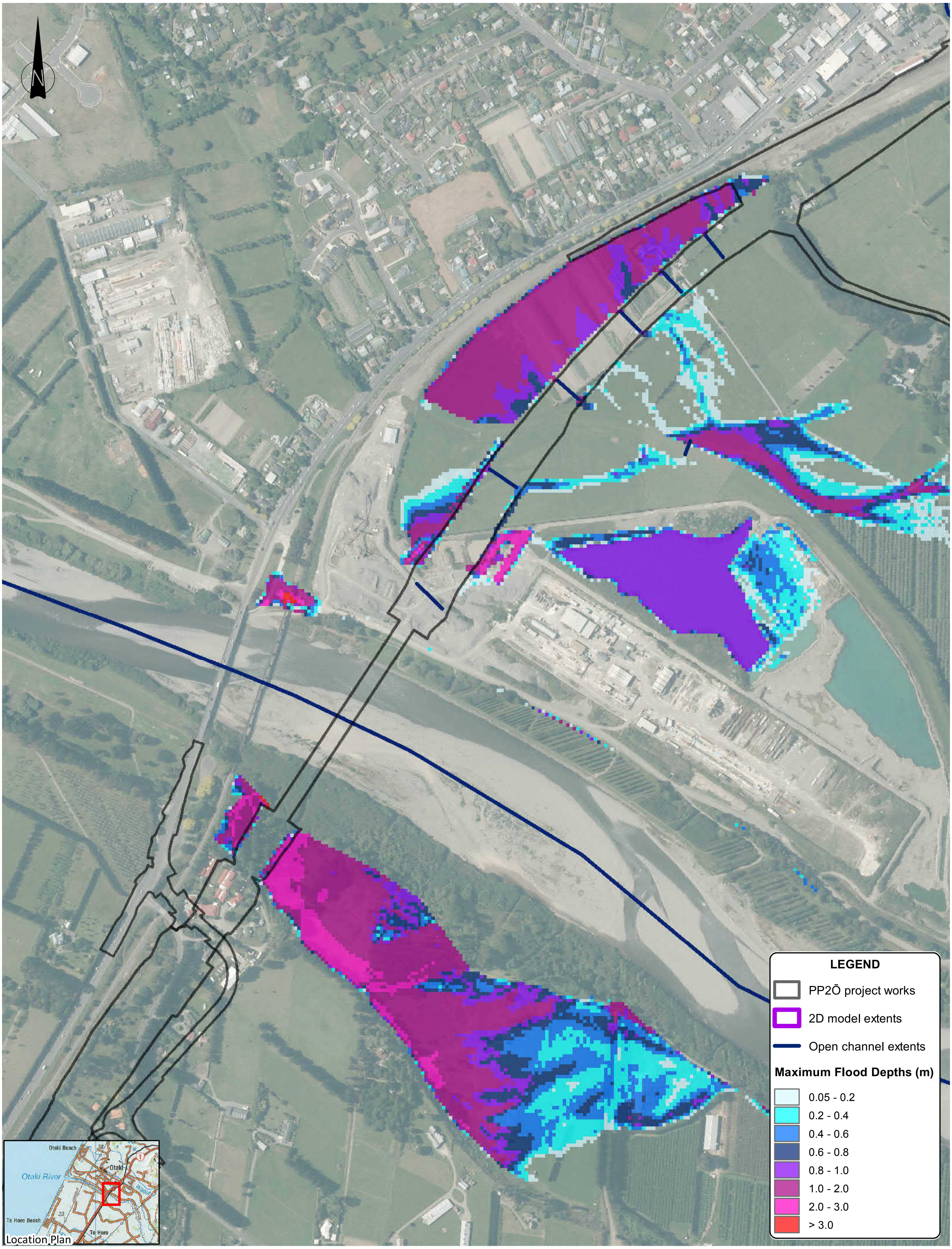
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 5% AEP

FIGURE No. Figure 15.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig15_2_OM_ModelResultsH_20yr.mxd Date: 7/05/2018 Time: 6:04:25 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig15_2_OM_ModelResultsH_20yr.mxd

SCALE (AT A3 SIZE)
1:5,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

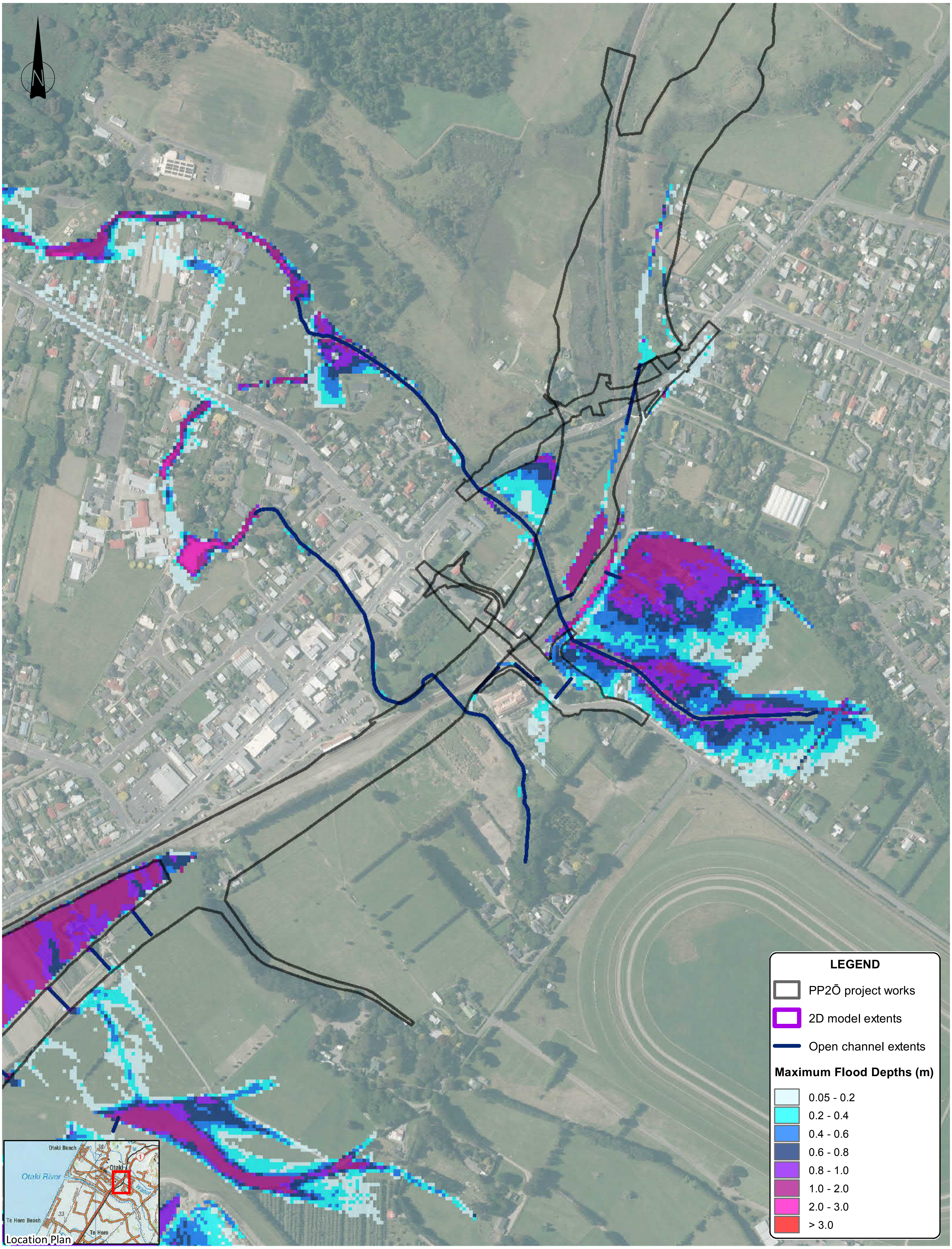
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 5% AEP

FIGURE No. Figure 15.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig15_3_OM_ModelResultsH_20yr.mxd Date: 7/05/2018 Time: 6:05:37 p.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig15_3_OM_ModelResultsH_20yr.mxd

SCALE (AT A3 SIZE)
1:5,000

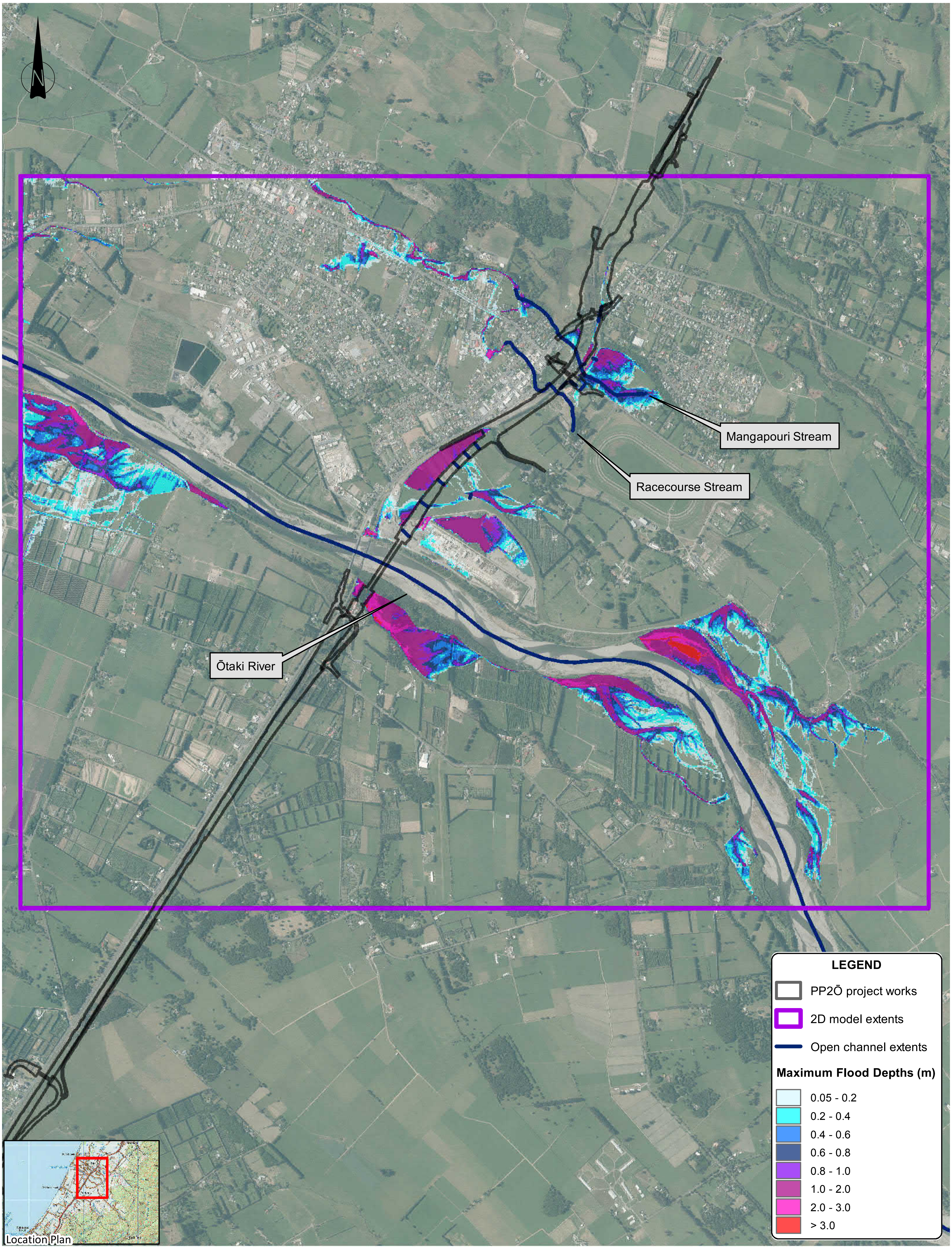
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 5% AEP

FIGURE No. Figure 15.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig16_1_OM_ModelResultsH_10yrCC.mxd Date: 8/05/2018 Time: 6:38:29 a.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig16_1_OM_ModelResultsH_10yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

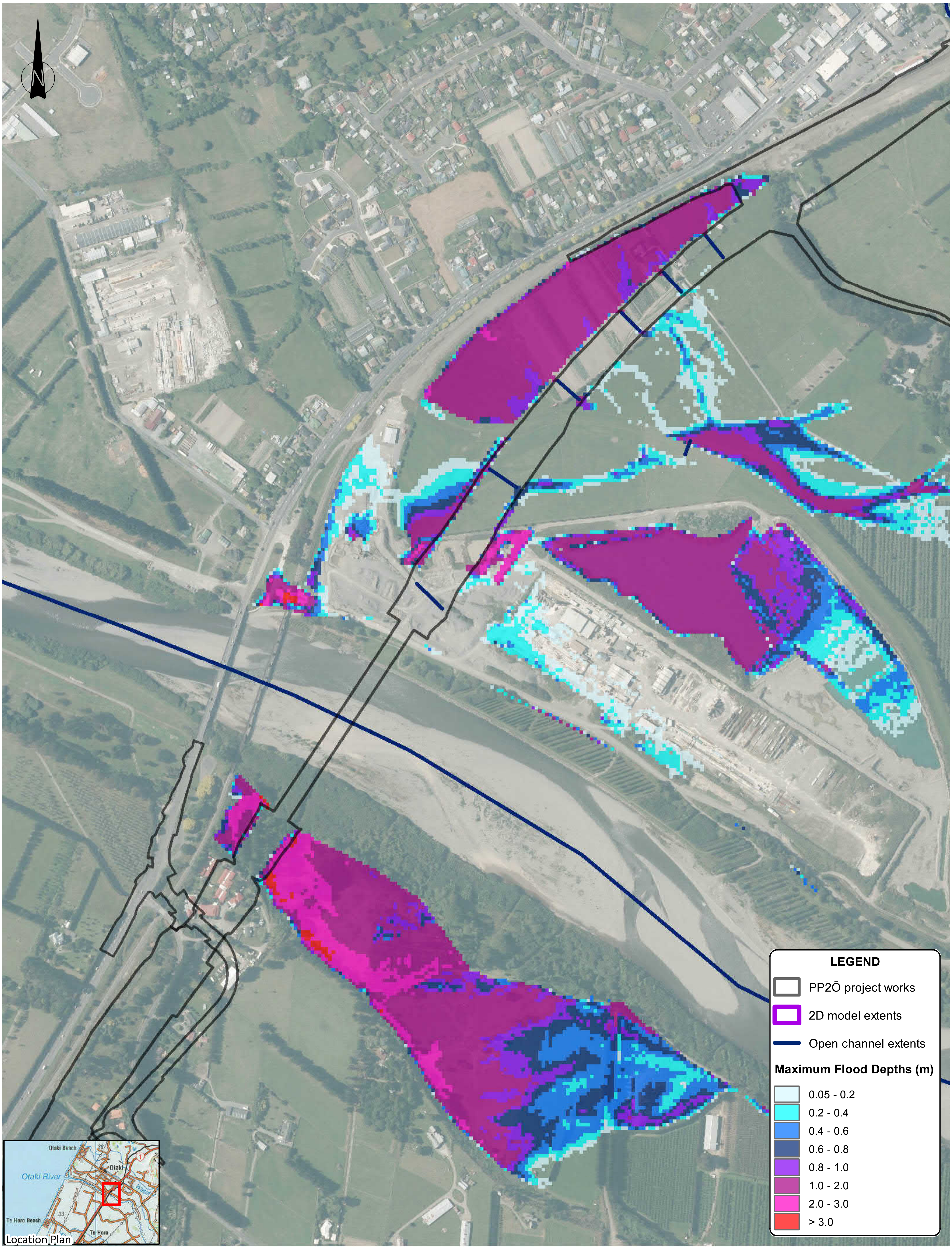
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 10% AEP CC2130

FIGURE No. Figure 16.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig16_2_OM_ModelResultsH_10yrCC.mxd Date: 8/05/2018 Time: 6:42:21 a.m.



Notes: - Aerial photograph sourced from Greater Wellington Regional Council and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand licence.
- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

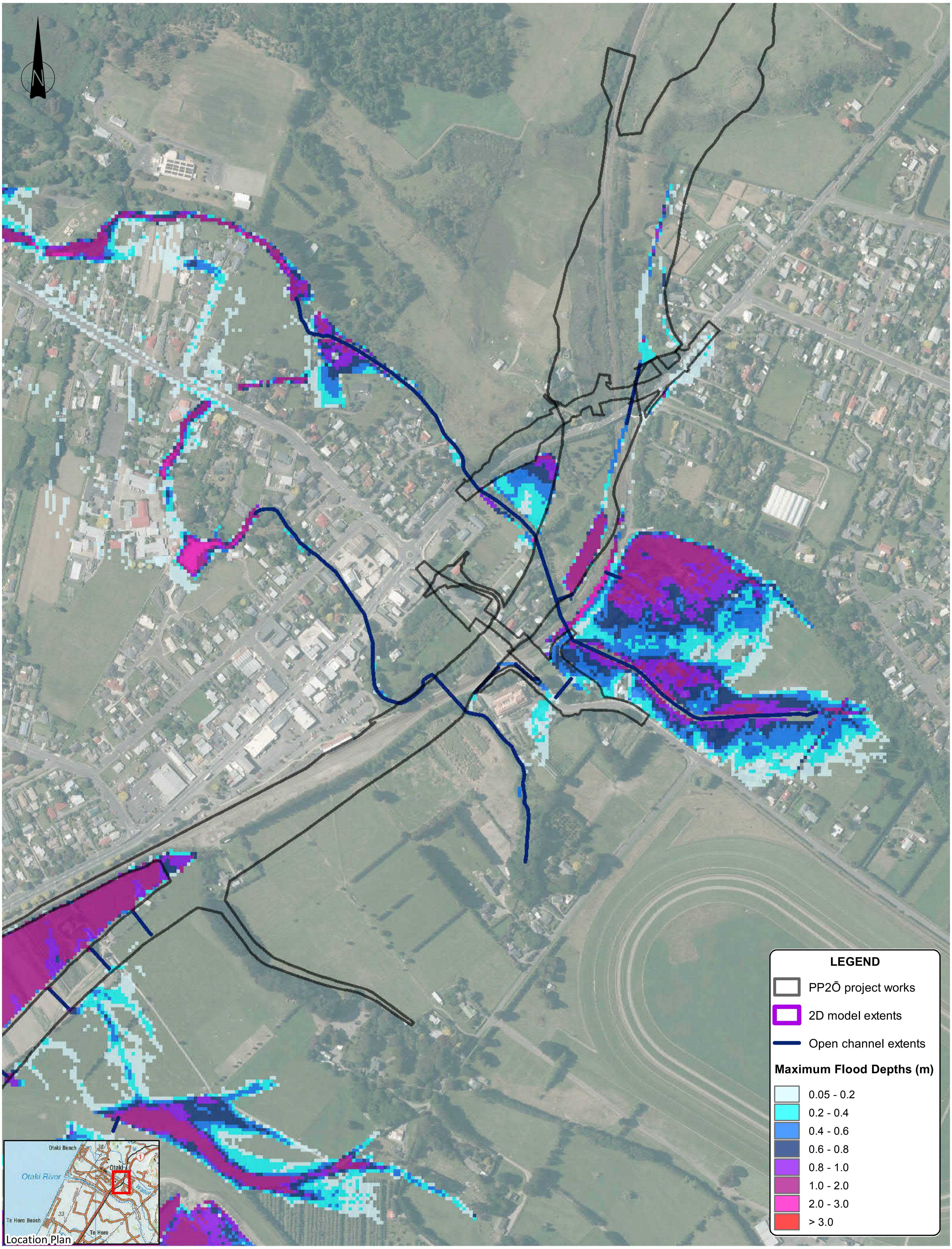
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig16_2_OM_ModelResultsH_10yrCC.mxd	
SCALE (AT A3 SIZE)	1:5,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 10% AEP CC2130

FIGURE No. Figure 16.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig16_3_OM_ModelResultsH_10yrCC.mxd Date: 8/05/2018 Time: 6:43:18 a.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig16_3_OM_ModelResultsH_10yrCC.mxd	
SCALE (AT A3 SIZE)	1:5,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

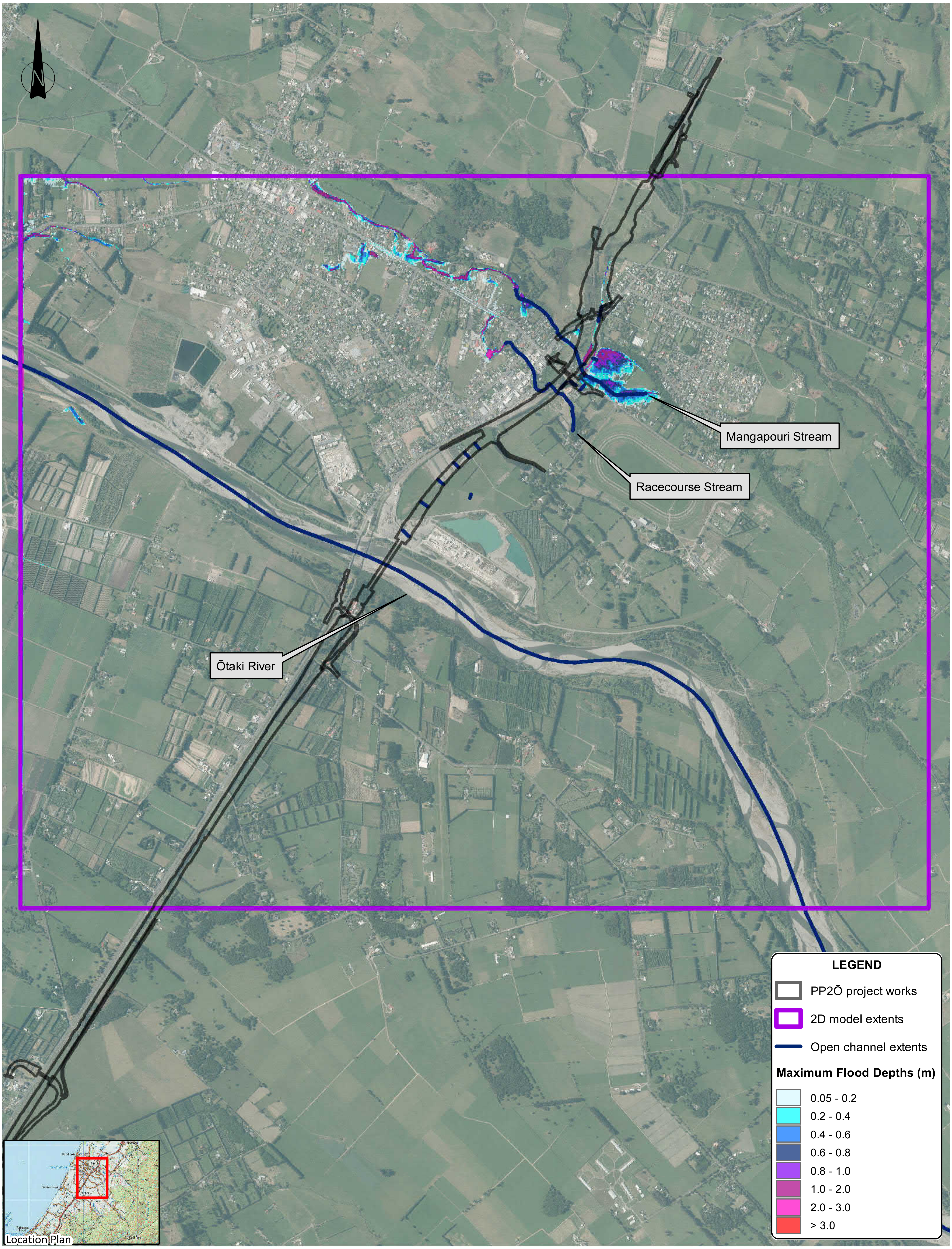
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 10% AEP CC2130

FIGURE No. Figure 16.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig17_1_OM_ModelResultsH_10yr.mxd Date: 8/05/2018 Time: 6:44:26 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig17_1_OM_ModelResultsH_10yr.mxd

SCALE (AT A3 SIZE)
1:20,000

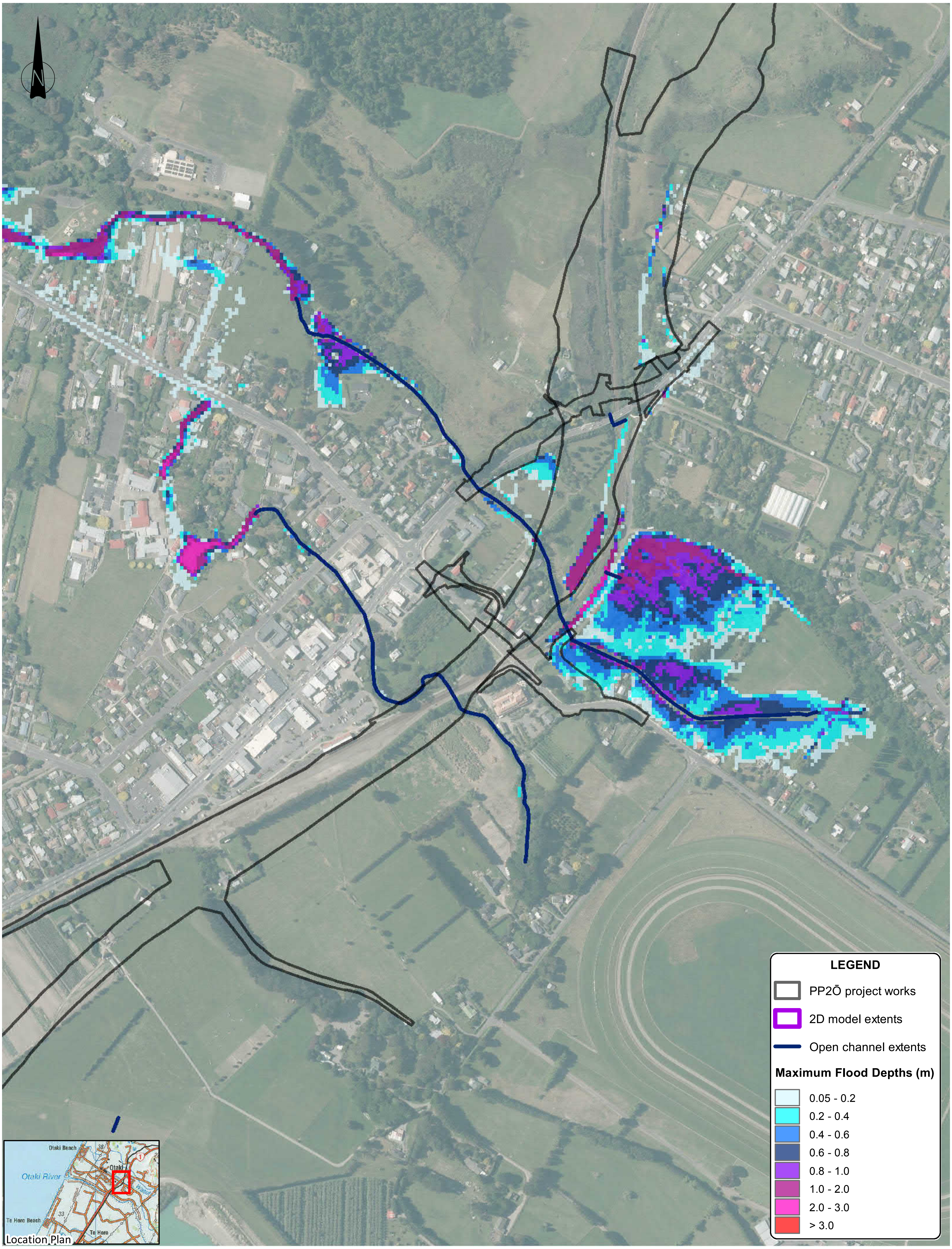
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 10% AEP (Mangapouri only)

FIGURE No. Figure 17.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig17_2_OM_ModelResultsH_10yr.mxd Date: 8/05/2018 Time: 6:45:34 a.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig17_2_OM_ModelResultsH_10yr.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

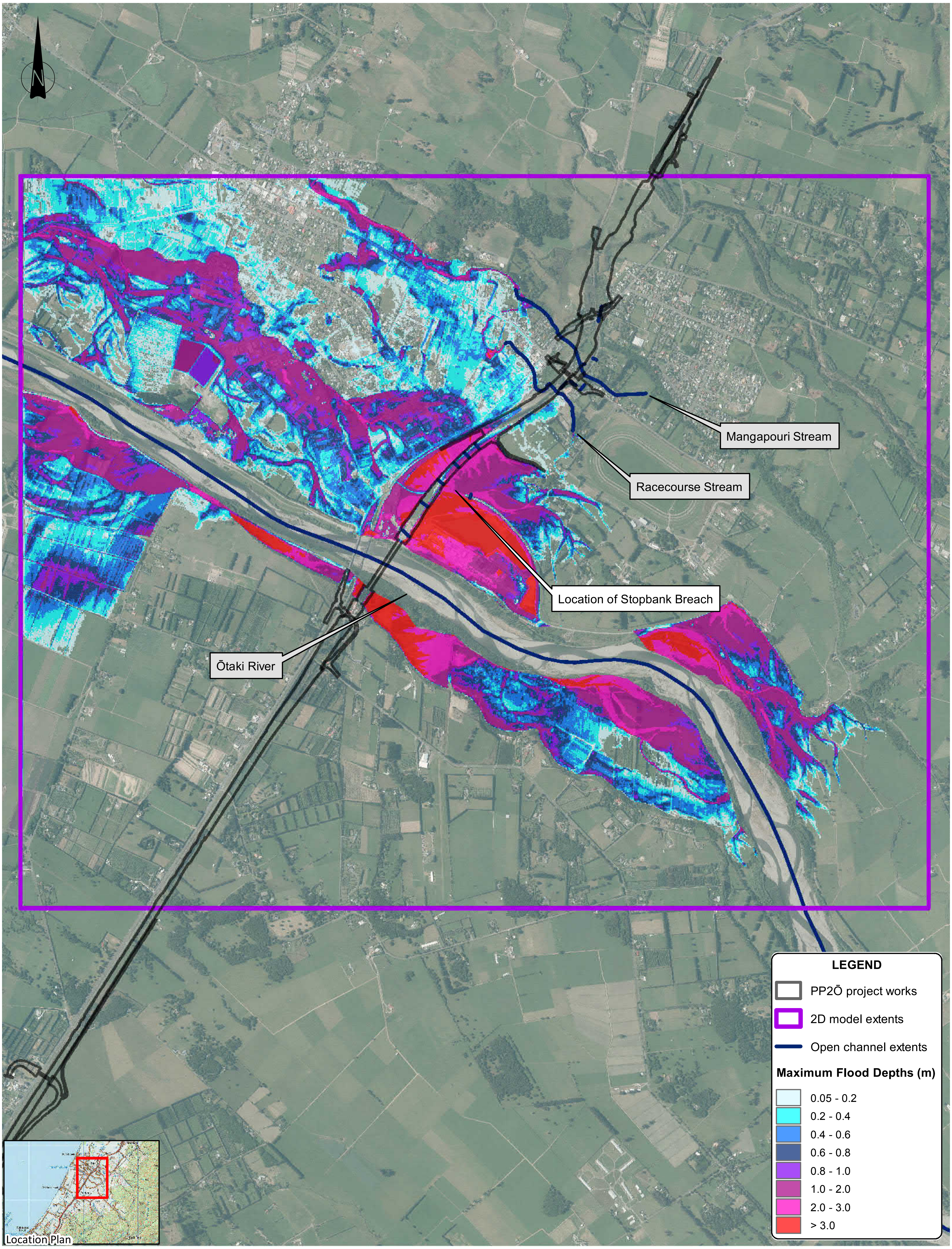
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 10% AEP (Mangapouri only)

FIGURE No. Figure 17.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig18_1_OM_ModelResultsH_3000Cu_Br.mxd Date: 8/05/2018 Time: 6:51:57 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig18_1_OM_ModelResultsH_3000Cu_Br.mxd

SCALE (AT A3 SIZE) 1:20,000

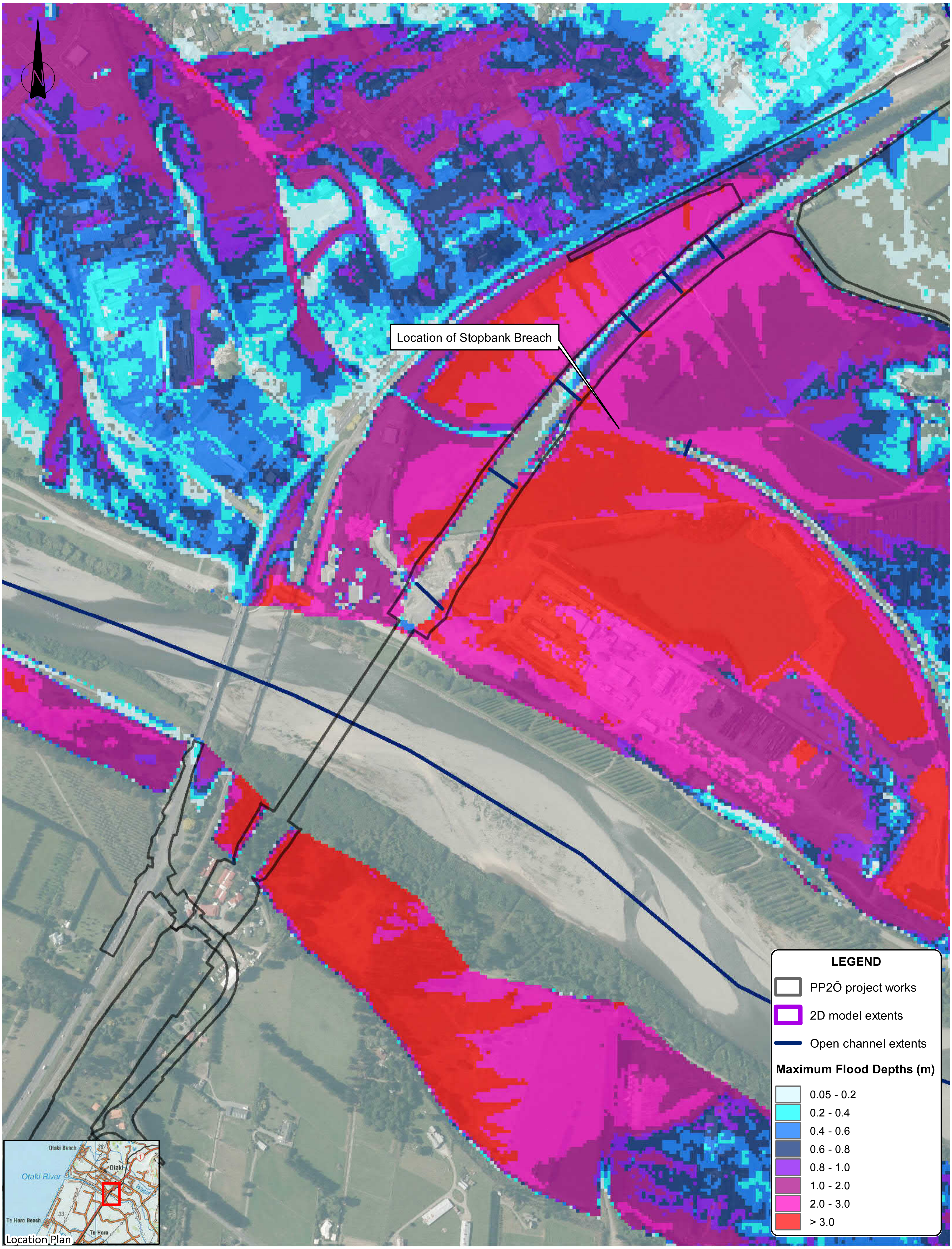
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Stopbank Breach - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 18.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig18_2_OM_ModelResultsH_3000Cu_Br.mxd Date: 8/05/2018 Time: 6:54:55 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig18_2_OM_ModelResultsH_3000Cu_Br.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

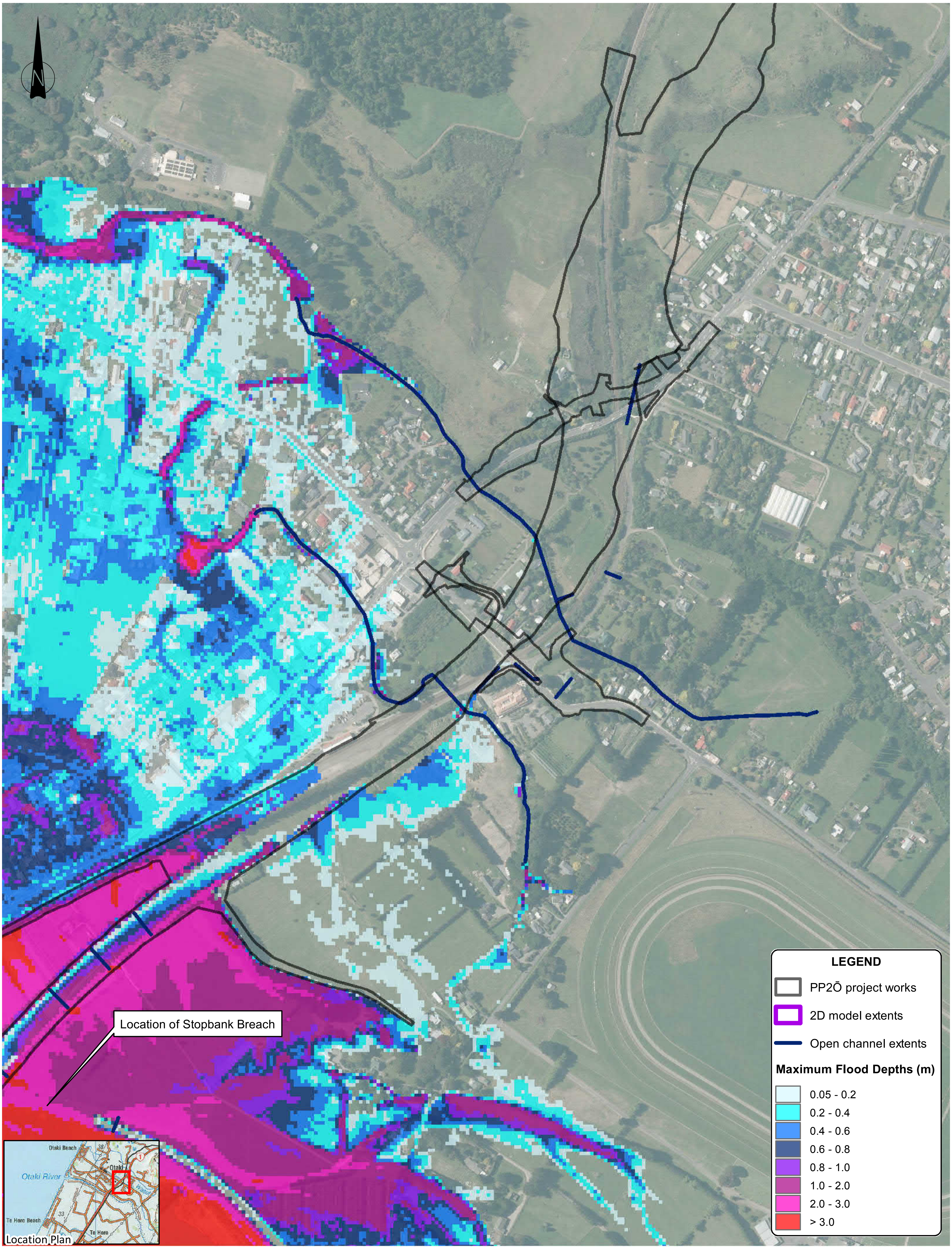
PEKA PEKA TO ŌTAKI EXPRESSWAY

Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Stopbank Breach - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 18.2 Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig18_3_OM_ModelResultsH_3000Cu_Br.mxd Date: 8/05/2018 Time: 6:57:30 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	May.18

ARCFILE Fig18_3_OM_ModelResultsH_3000Cu_Br.mxd

SCALE (AT A3 SIZE) 1:5,000

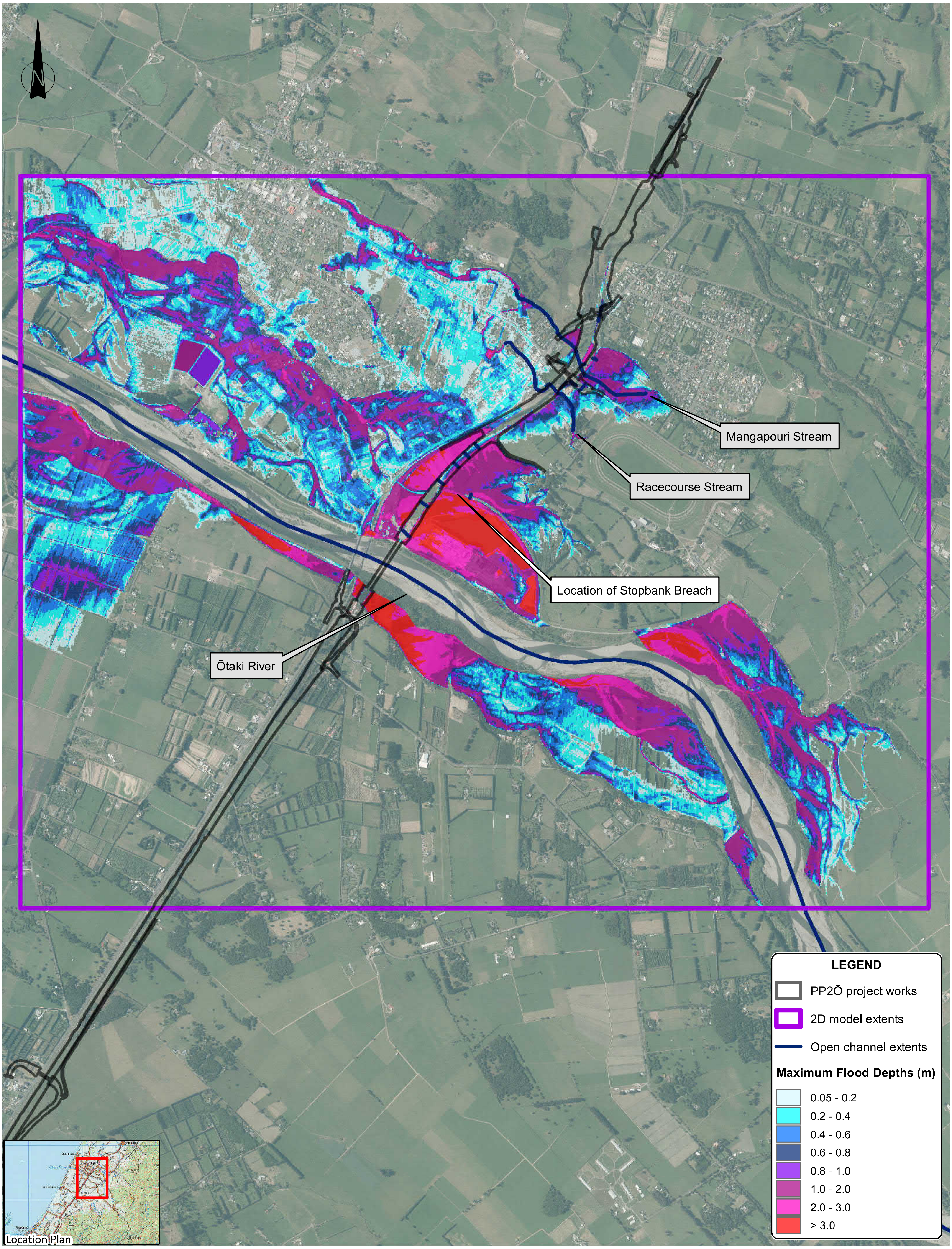
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Stopbank Breach - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 18.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig19_1_OM_ModelResultsH_500yrCC_Br.mxd Date: 8/05/2018 Time: 6:59:44 a.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig19_1_OM_ModelResultsH_500yrCC_Br.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

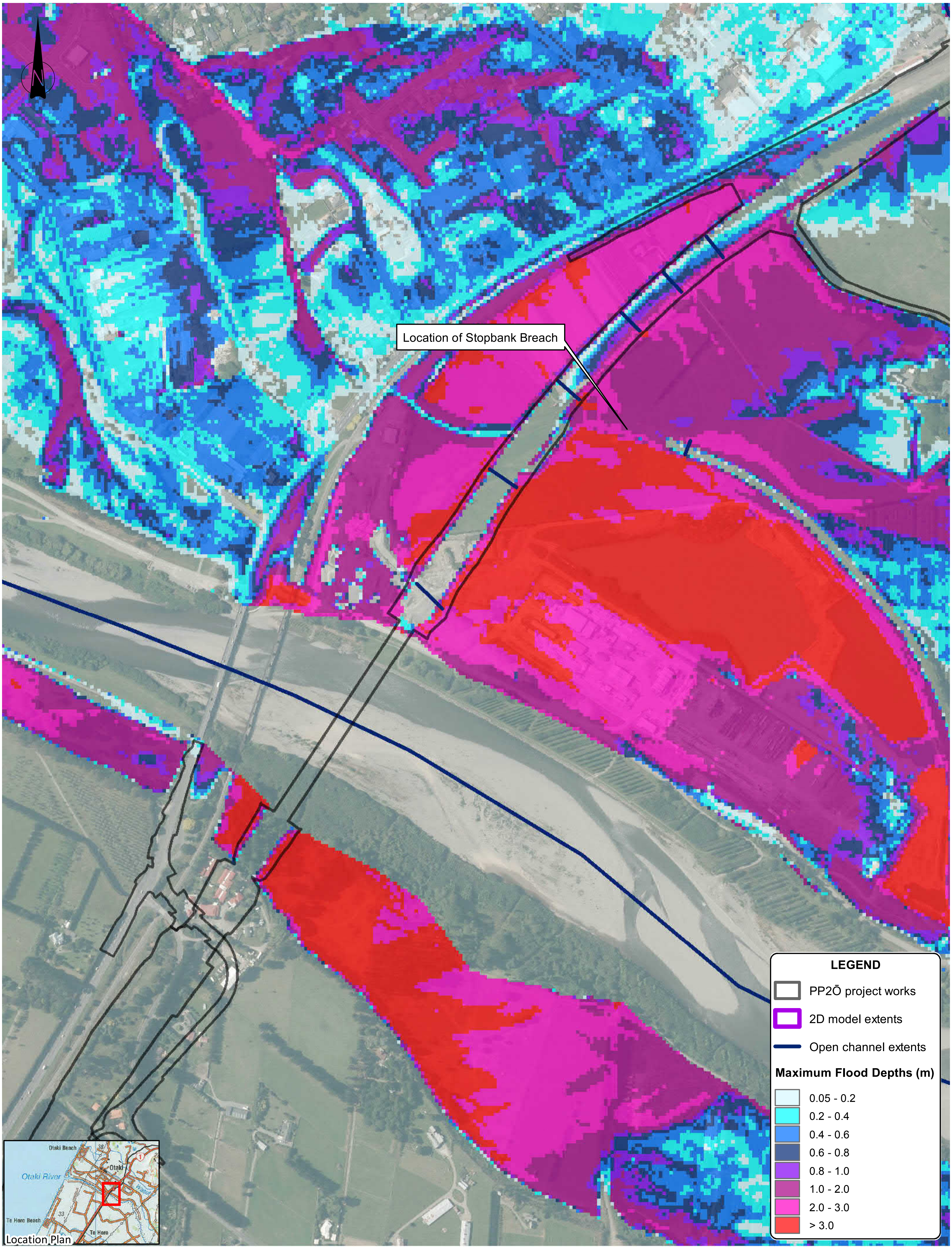
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Stopbank Breach - 0.2% AEP CC2130

FIGURE No. Figure 19.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig19_2_OM_ModelResultsH_500yrCC_Br.mxd Date: 8/05/2018 Time: 7:02:12 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

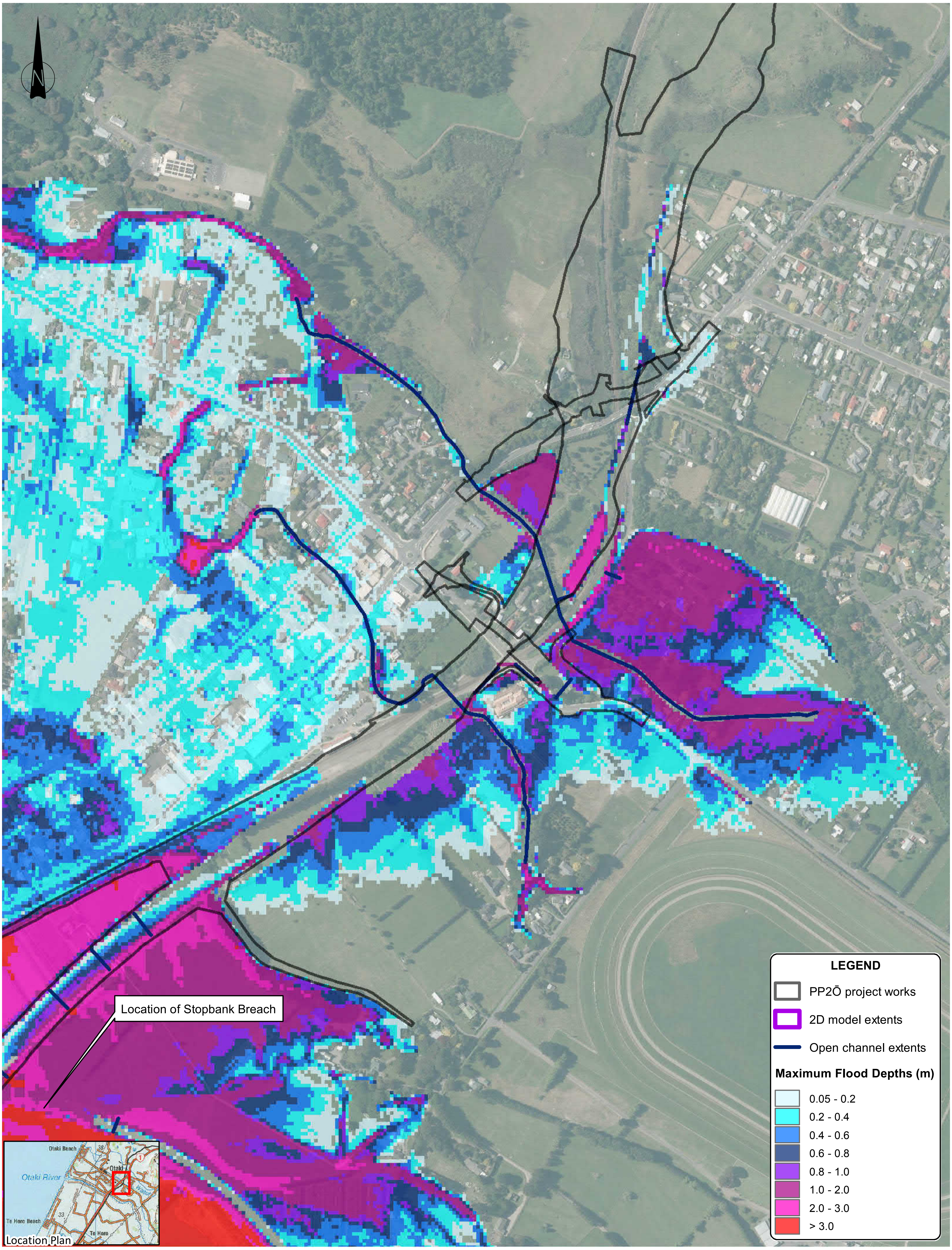
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig19_2_OM_ModelResultsH_500yrCC_Br.mxd	
SCALE (AT A3 SIZE)	1:5,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Stopbank Breach - 0.2% AEP CC2130

FIGURE No. Figure 19.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig19_3_OM_ModelResultsH_500yrCC_Br.mxd Date: 8/05/2018 Time: 7:04:27 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig19_3_OM_ModelResultsH_500yrCC_Br.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

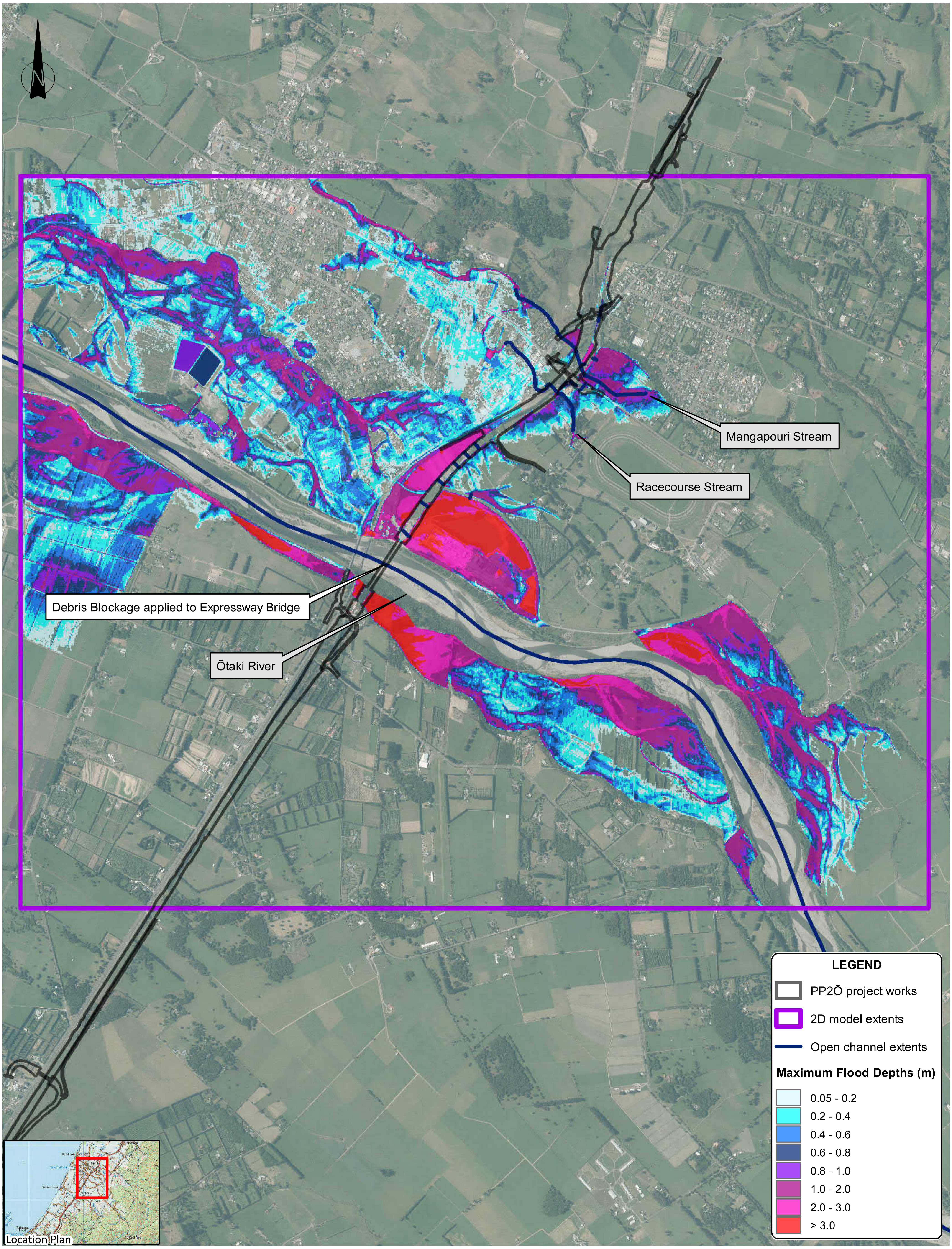
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Stopbank Breach - 0.2% AEP CC2130

FIGURE No. Figure 19.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig20_1_OM_ModelResultsH_500yrCCDB.mxd Date: 8/05/2018 Time: 7:07:23 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig20_1_OM_ModelResultsH_500yrCCDB.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

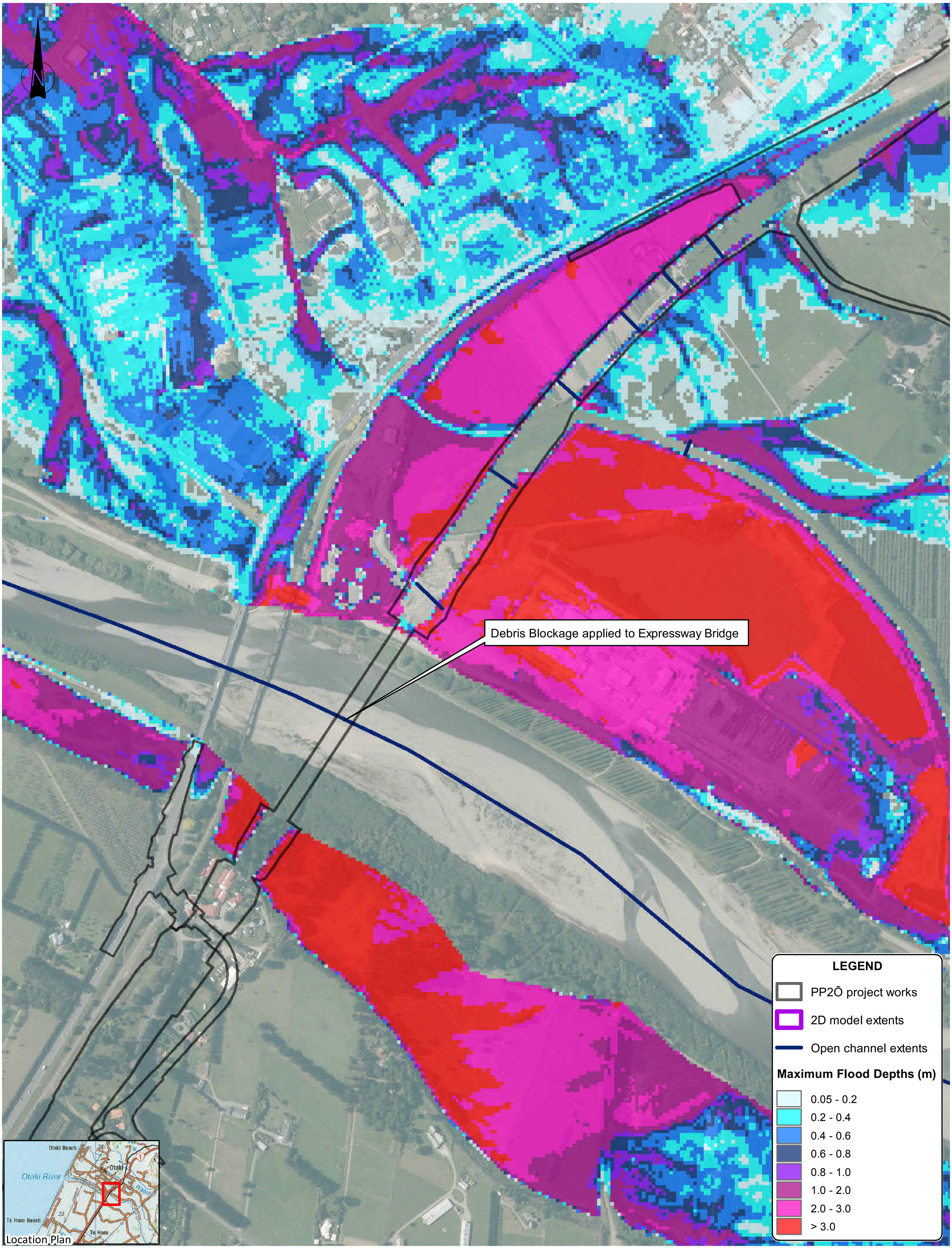
NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Debris Blockage - 0.2% AEP CC2130

FIGURE No. Figure 20.1 | Rev. 0



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig20_2_OM_ModelResultsH_500yrCCDB.mxd

SCALE (AT A3 SIZE)
1:5,000

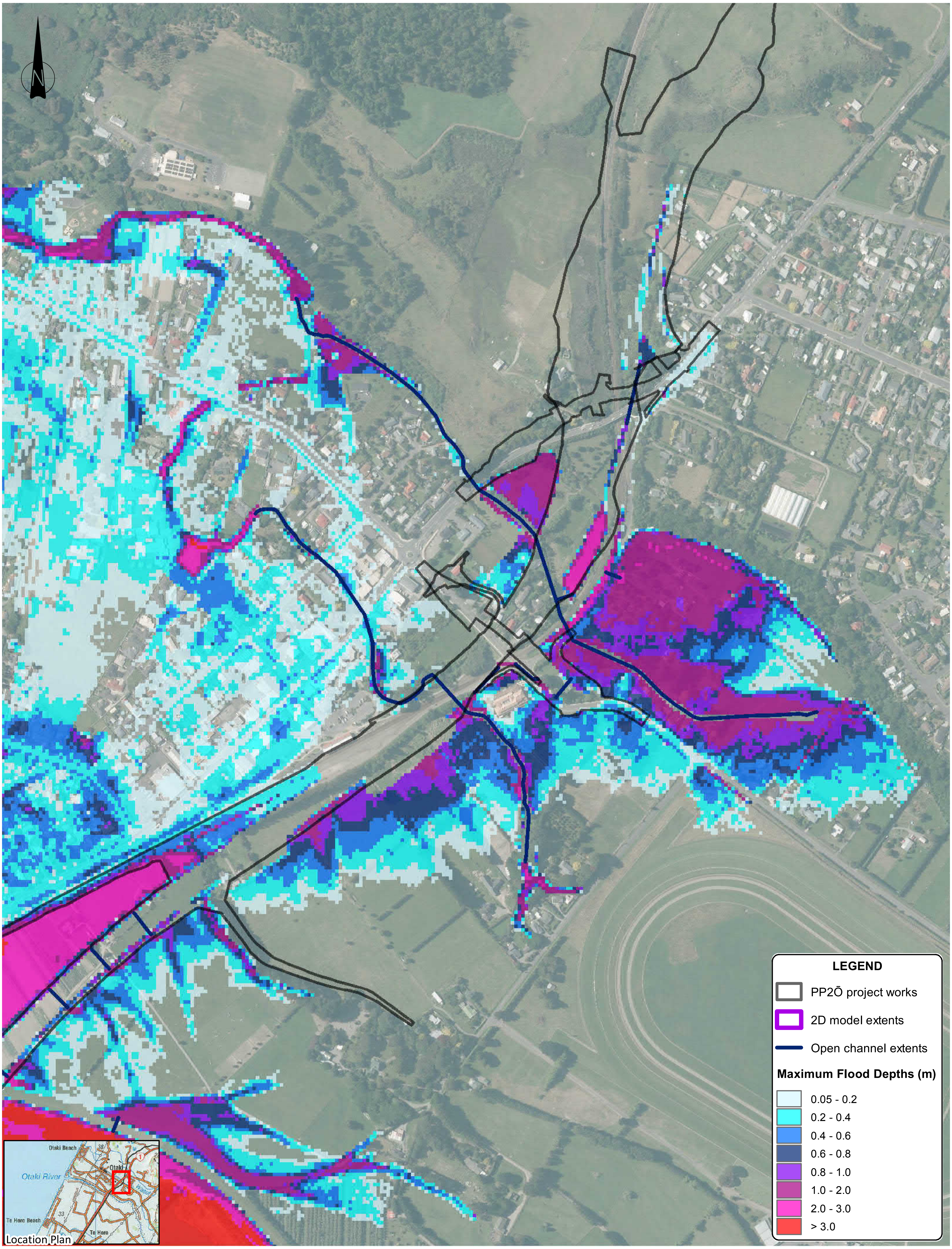
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Debris Blockage - 0.2% AEP CC2130

FIGURE No. Figure 20.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig20_3_OM_ModelResultsH_500yrCCDB.mxd Date: 8/05/2018 Time: 7:10:59 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig20_3_OM_ModelResultsH_500yrCCDB.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

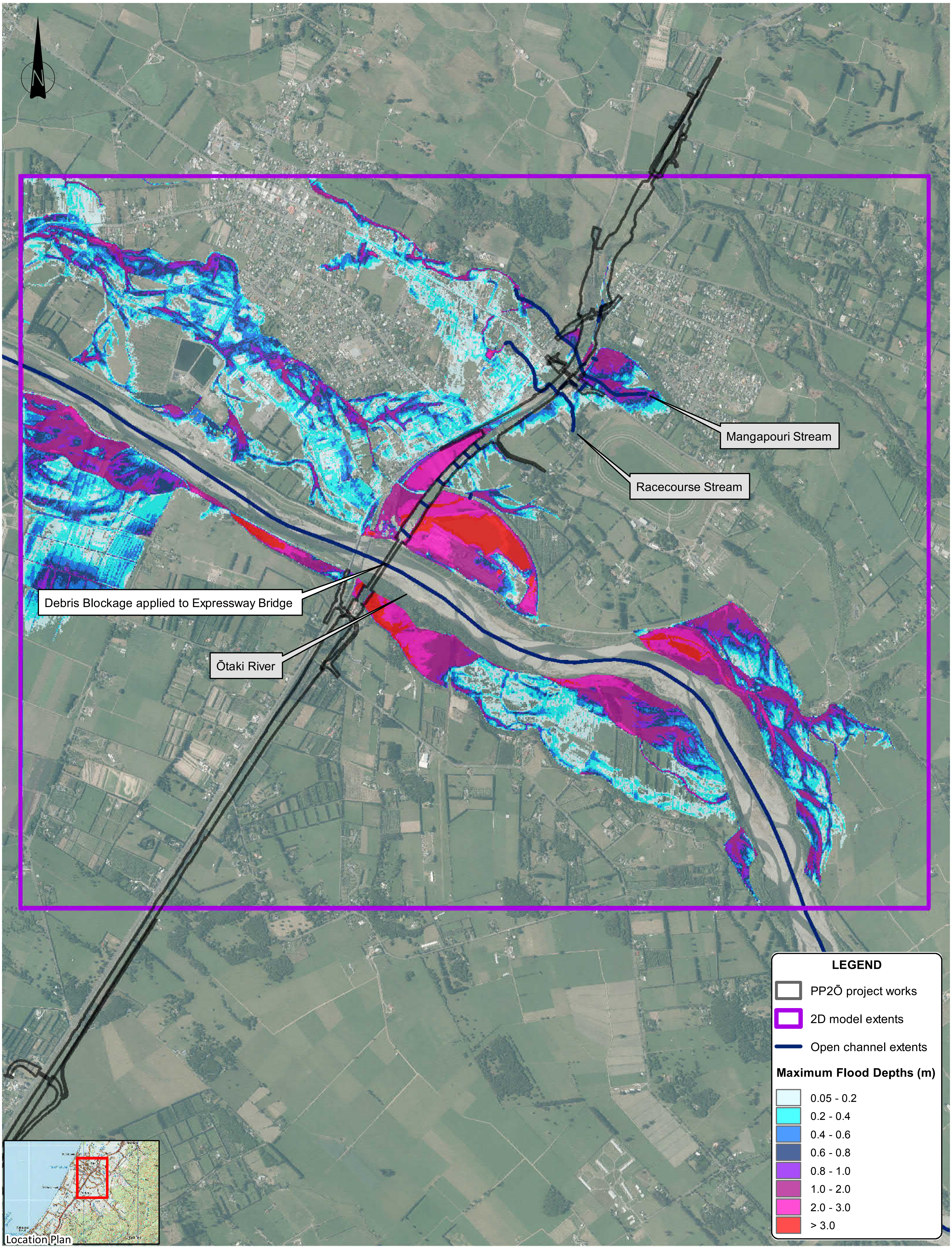
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Debris Blockage - 0.2% AEP CC2130

FIGURE No. Figure 20.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig21_1_OM_ModelResultsH_100yrCC_DB.mxd Date: 8/05/2018 Time: 7:13:29 a.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig21_1_OM_ModelResultsH_100yrCC_DB.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

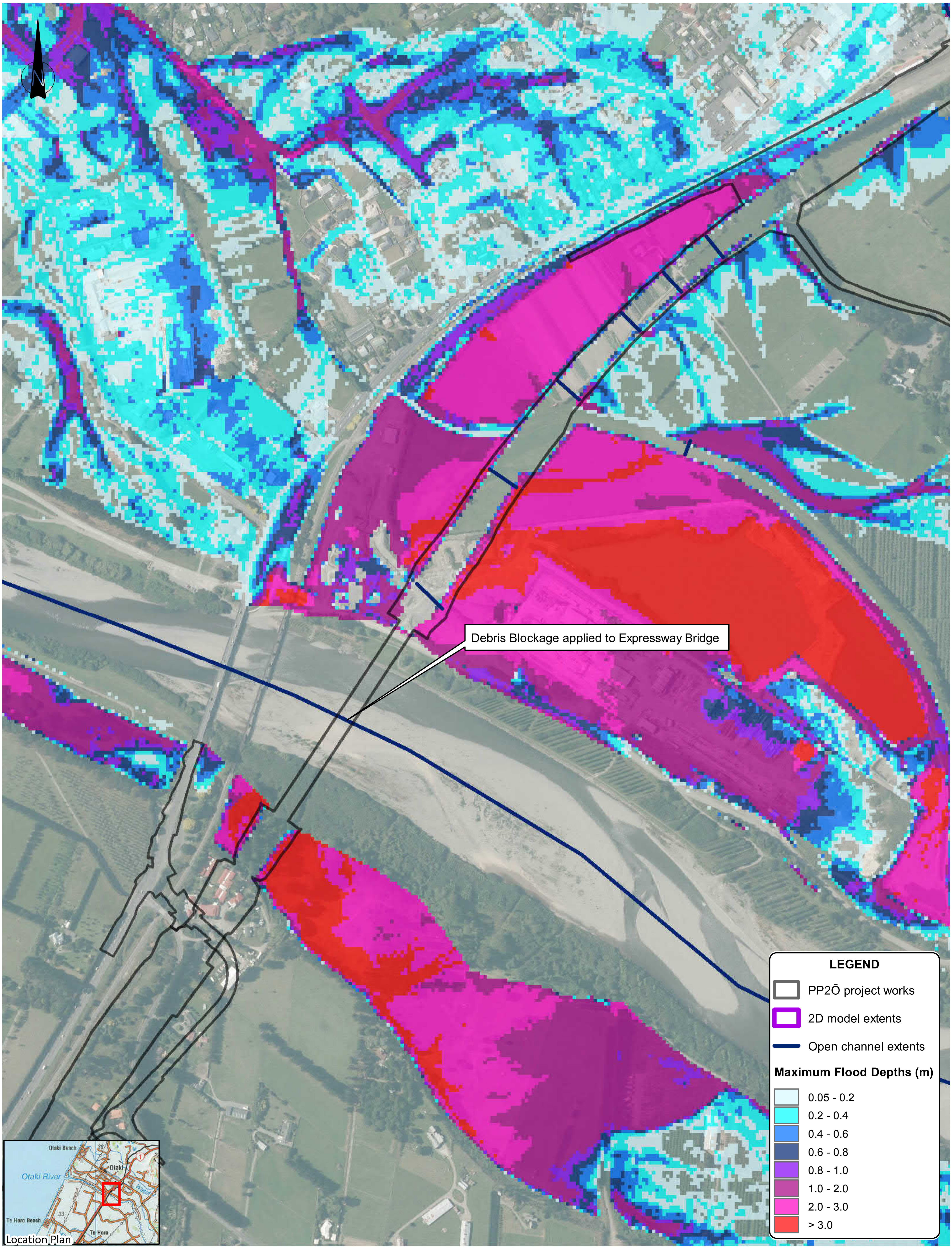
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Debris Blockage - 1% AEP CC2130

FIGURE No. Figure 21.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig21_2_OM_ModelResultsH_100yrCC_DB.mxd Date: 8/05/2018 Time: 7:16:10 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig21_2_OM_ModelResultsH_100yrCC_DB.mxd

SCALE (AT A3 SIZE): 1:5,000

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

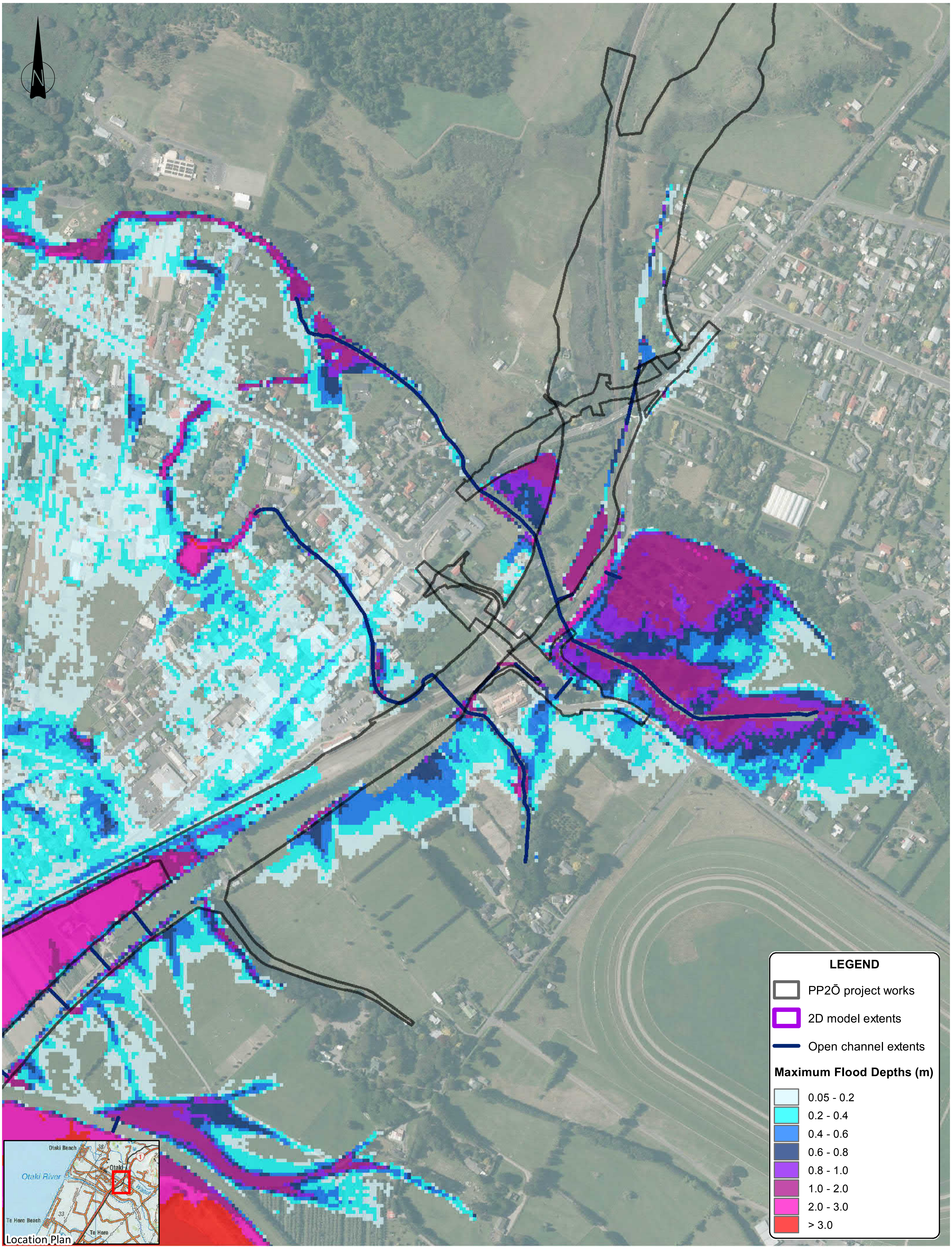
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Debris Blockage - 1% AEP CC2130

FIGURE No. Figure 21.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig21_3_OM_ModelResultsH_100yrCC_DB.mxd Date: 8/05/2018 Time: 7:17:48 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig21_3_OM_ModelResultsH_100yrCC_DB.mxd

SCALE (AT A3 SIZE)
1:5,000

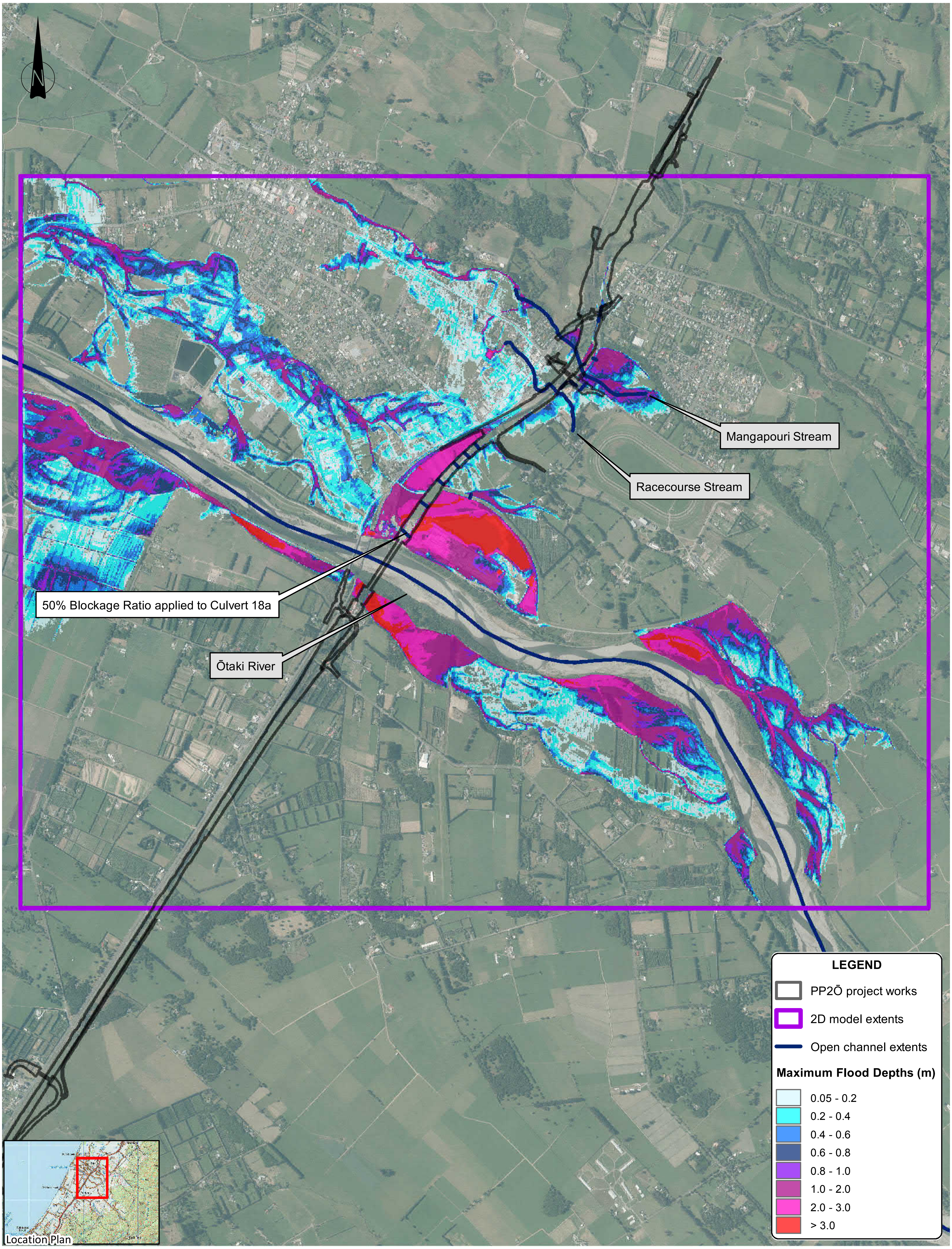
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Debris Blockage - 1% AEP CC2130

FIGURE No. Figure 21.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig22_1_OM_ModelResultsH_100yrCC_CB.mxd Date: 9/05/2018 Time: 10:29:07 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

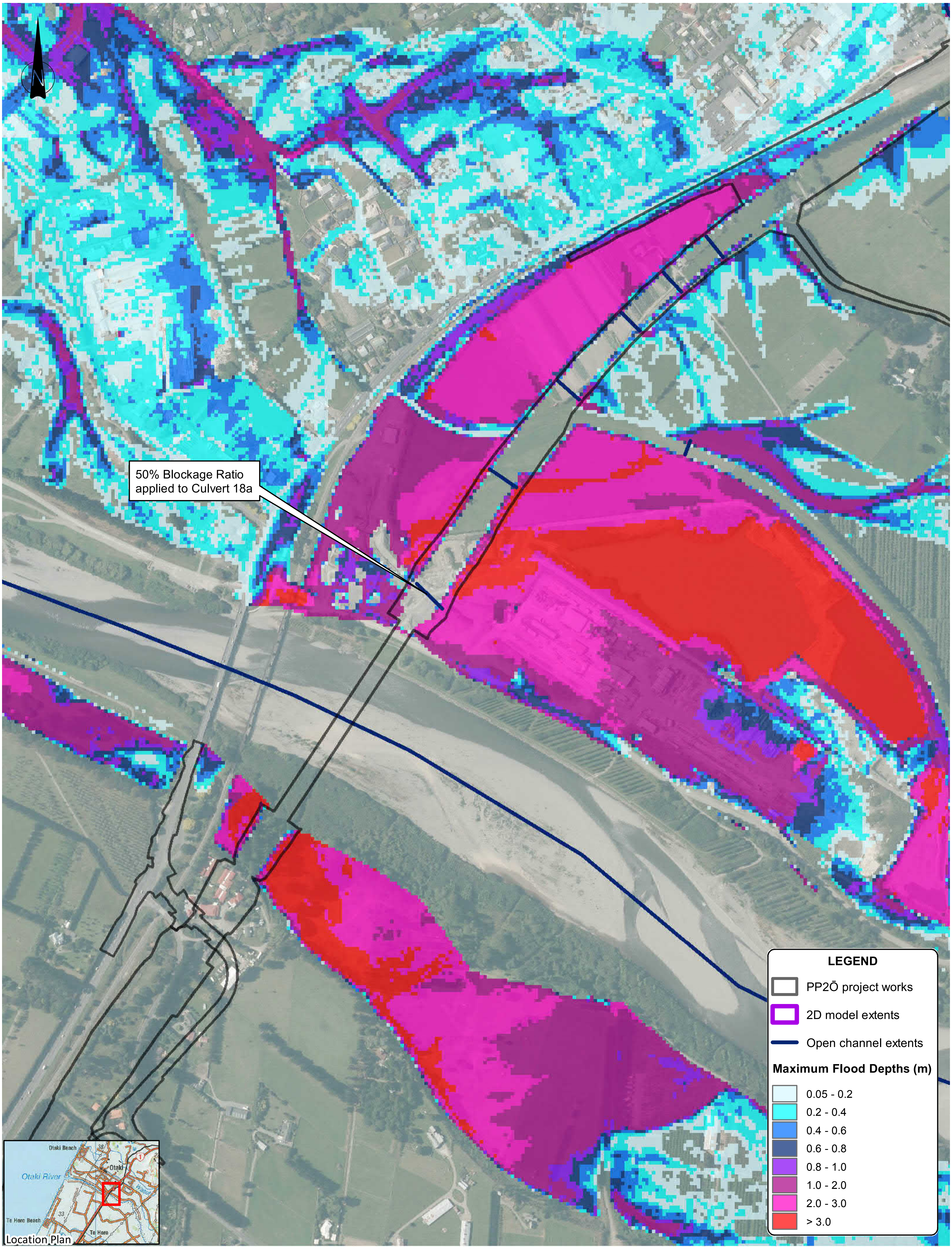
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig22_1_OM_ModelResultsH_100yrCC_CB.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Culvert Blockage - 1% AEP CC2130

FIGURE No. Figure 22.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig22_2_OM_ModelResultsH_100yrCC_CB.mxd Date: 8/05/2018 Time: 7:23:44 a.m.



Notes: - Aerial photograph sourced from Greater Wellington Regional Council and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand licence.
- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig22_2_OM_ModelResultsH_100yrCC_CB.mxd

SCALE (AT A3 SIZE)
1:5,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

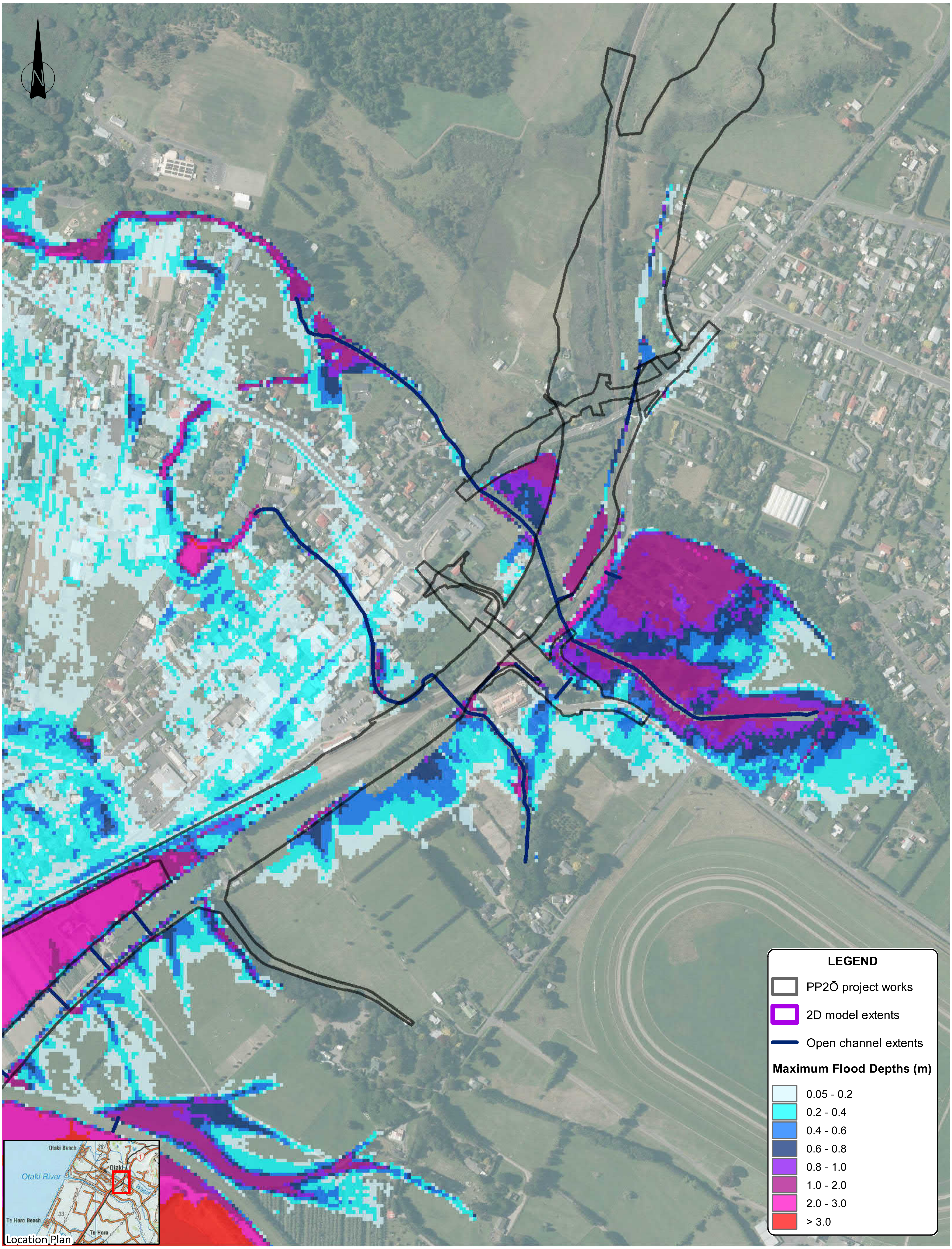
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Culvert Blockage - 1% AEP CC2130

FIGURE No. Figure 22.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig22_3_OM_ModelResultsH_100yrCC_CB.mxd Date: 8/05/2018 Time: 7:25:30 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

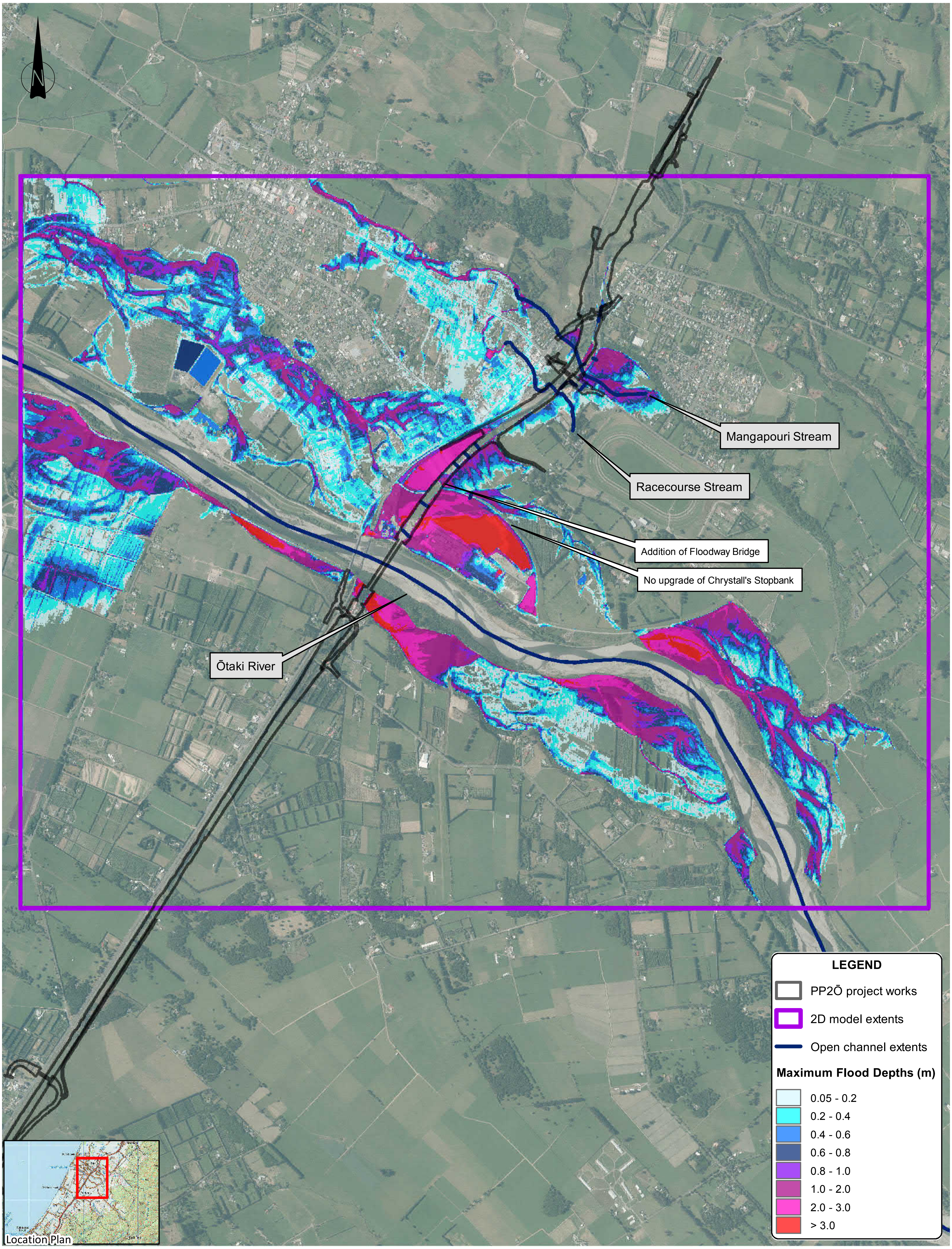
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig22_3_OM_ModelResultsH_100yrCC_CB.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Culvert Blockage - 1% AEP CC2130

FIGURE No. Figure 22.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig23_1_OM_ModelResultsH_AltDesign.mxd Date: 8/05/2018 Time: 8:49:44 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig23_1_OM_ModelResultsH_AltDesign.mxd

SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

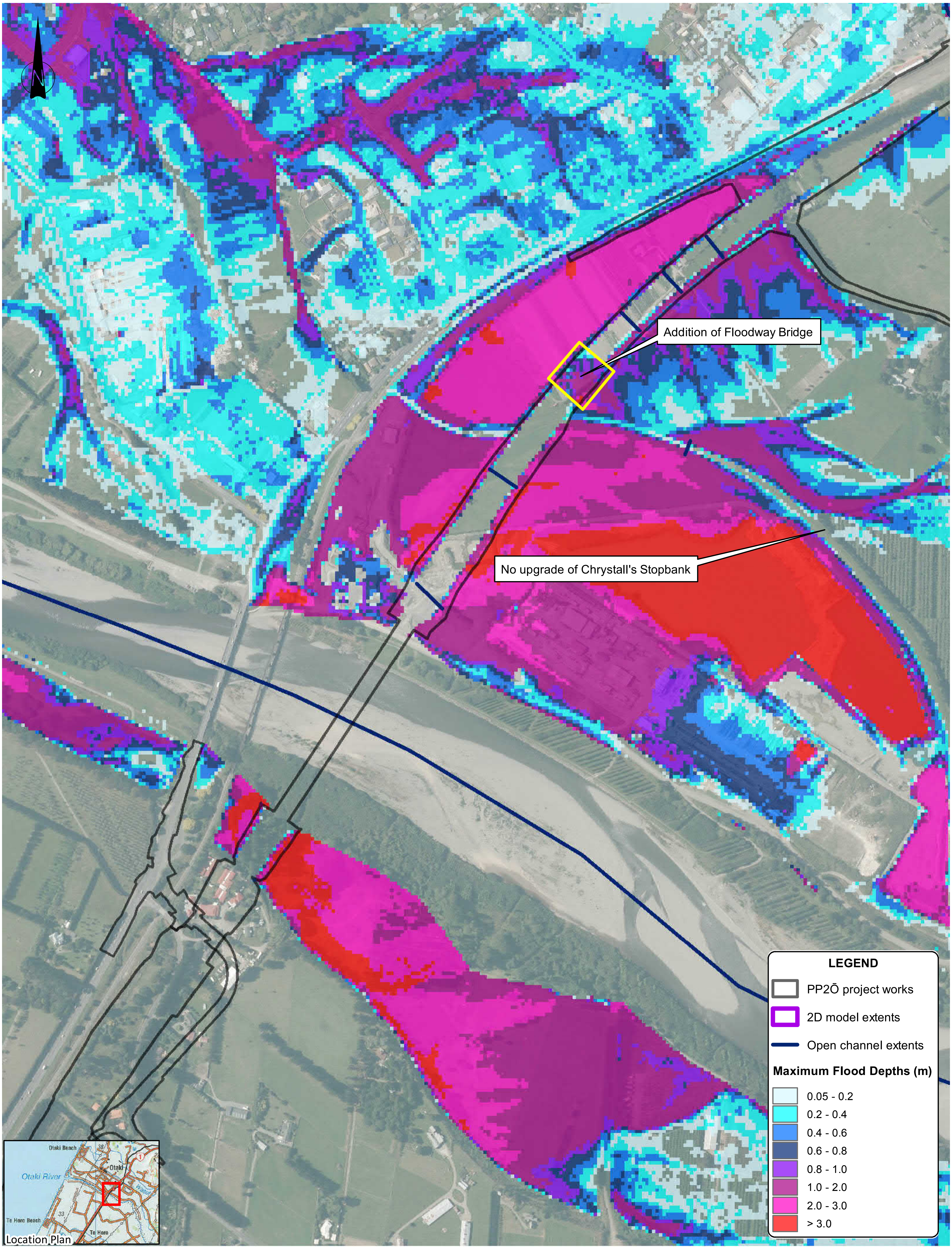
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Alternative Design - 1% AEP CC2130

FIGURE No. Figure 23.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig23_2_OM_ModelResultsH_AltDesign.mxd Date: 8/05/2018 Time: 9:19:51 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig23_2_OM_ModelResultsH_AltDesign.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

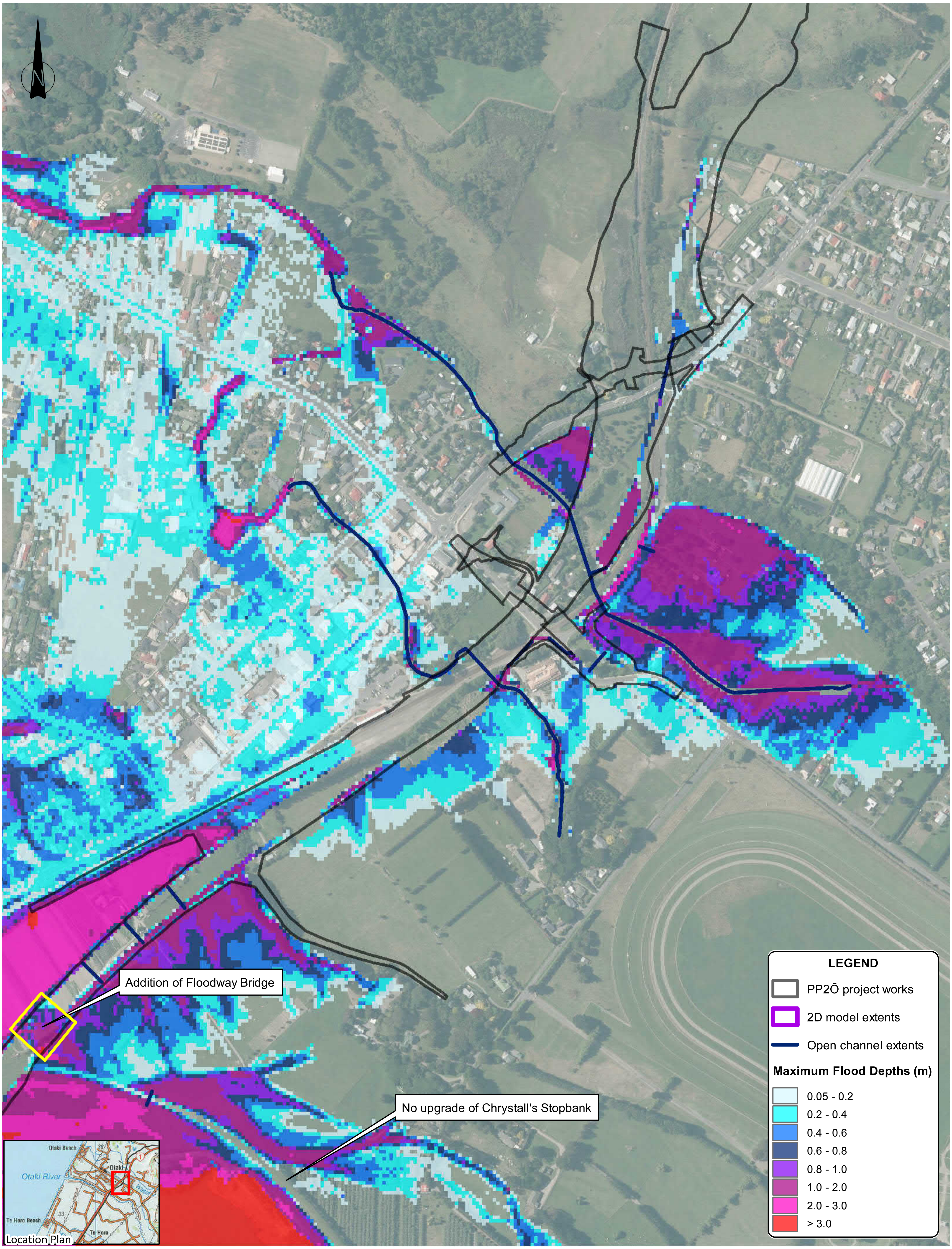
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model with Alternative Design - 1% AEP CC2130

FIGURE No. Figure 23.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig23_3_OM_ModelResultsH_AltDesign.mxd Date: 8/05/2018 Time: 9:32:07 a.m.



Notes:
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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig23_3_OM_ModelResultsH_AltDesign.mxd

SCALE (AT A3 SIZE)
1:5,000

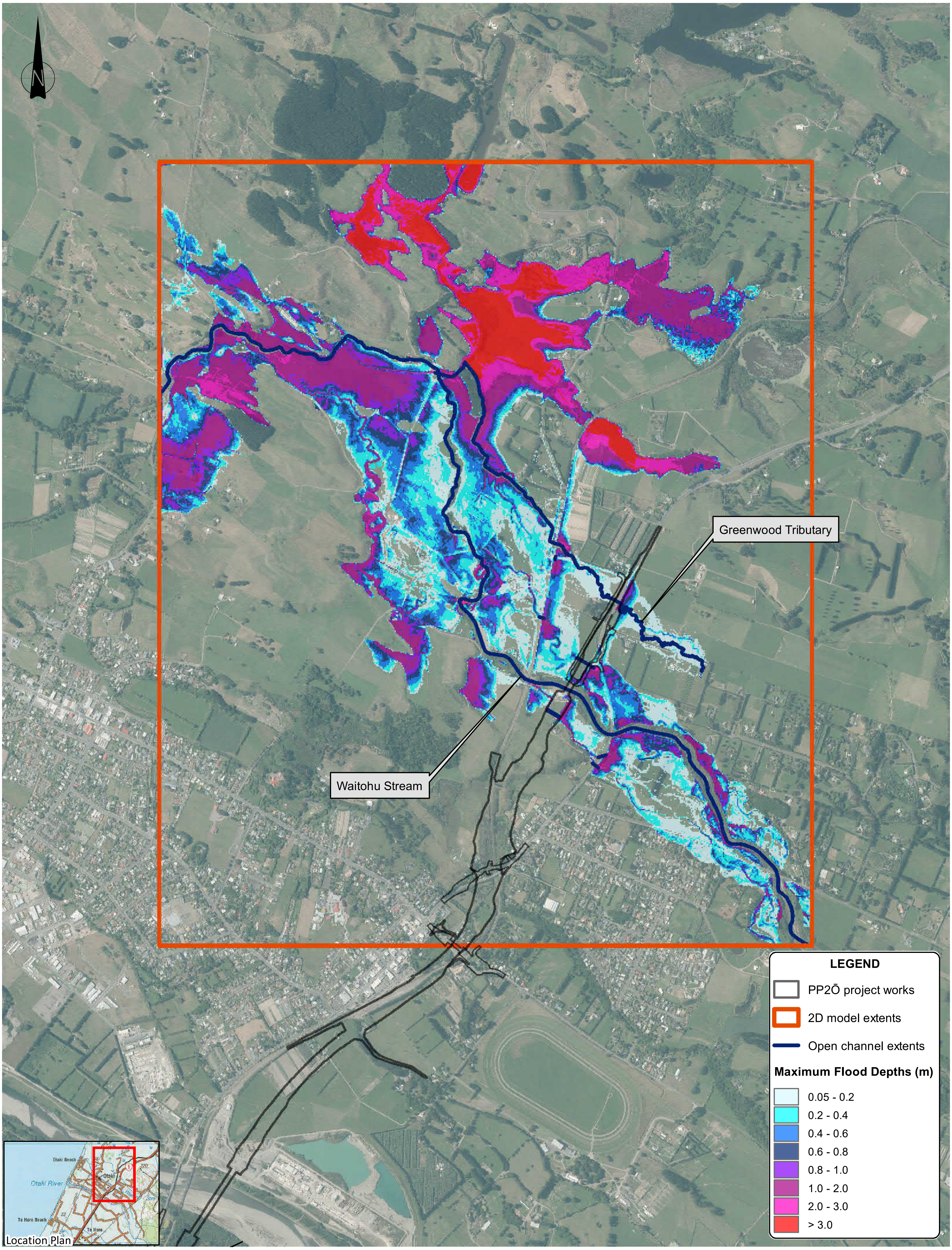
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model with Alternative Design - 1% AEP CC2130

FIGURE No. Figure 23.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig24_1_Wai_ModelResultsH_2500yrCC.mxd Date: 23/03/2018 Time: 3:33:59 PM



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig24_1_Wai_ModelResultsH_2500yrCC.mxd

SCALE (AT A3 SIZE) 1:15,000

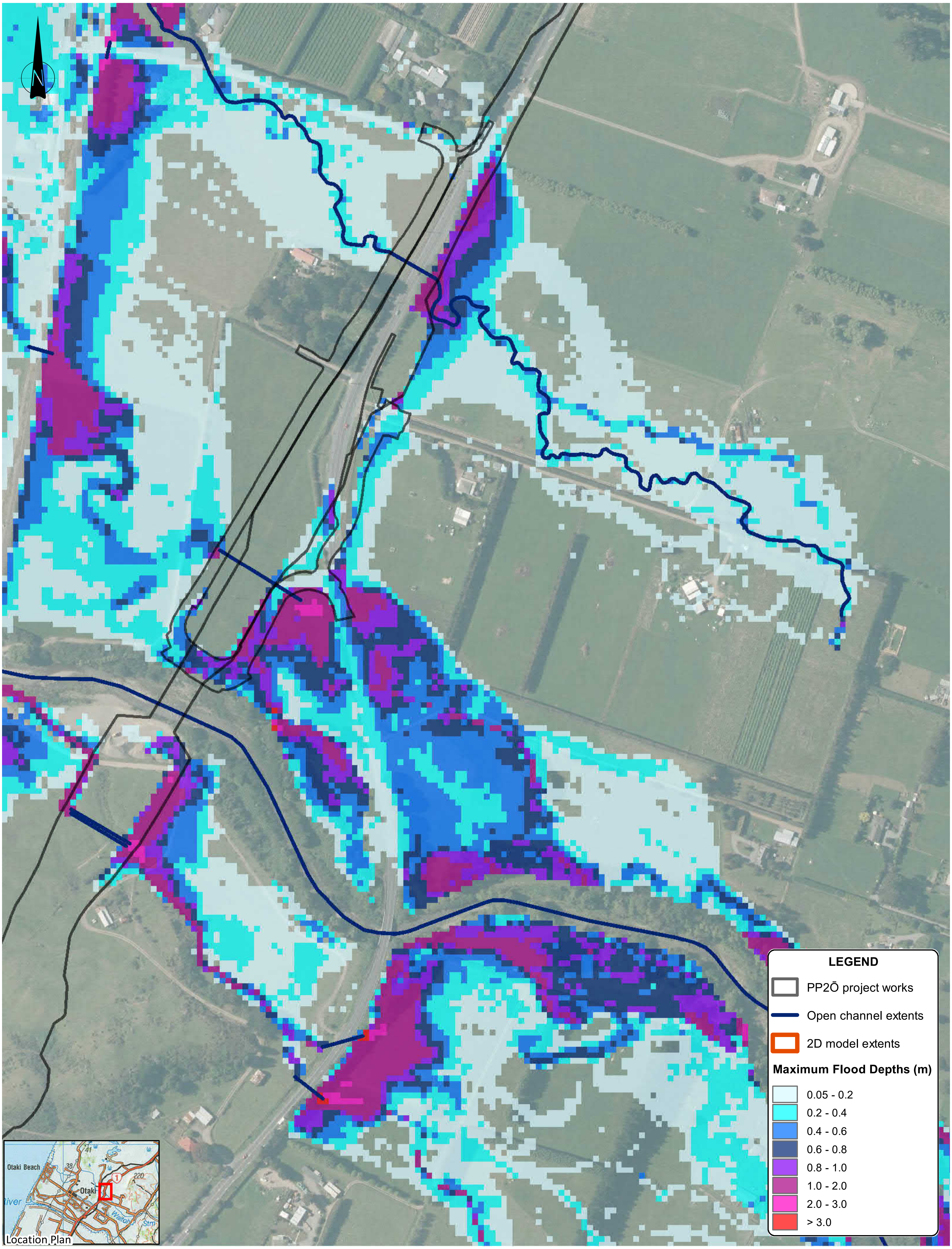
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 0.04% AEP CC2130

FIGURE No. Figure 24.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig24_2_Wai_ModelResultsH_2500yrCC.mxd Date: 23/03/2018 Time: 3:38:03 PM



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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE
Fig24_2_Wai_ModelResultsH_2500yrCC.mxd

SCALE (AT A3 SIZE)
1:3,000

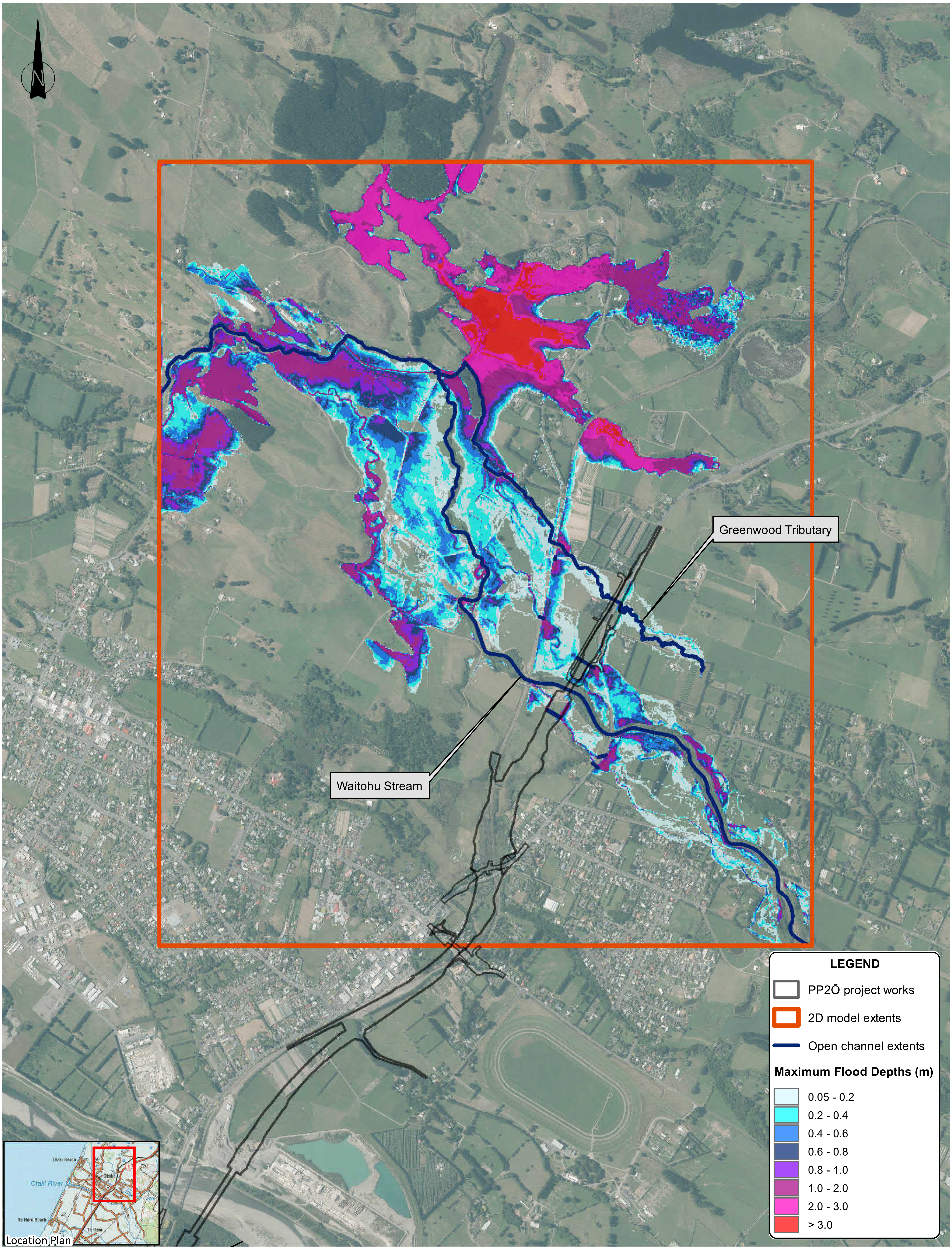
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 0.04% AEP CC2130

FIGURE No. Figure 24.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig25_1_Wai_ModelResultsH_100yrCCHR.mxd Date: 23/03/2018 Time: 3:40:28 PM



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A3 SCALE 1:15,000

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig25_1_Wai_ModelResultsH_100yrCCHR.mxd

SCALE (AT A3 SIZE) 1:15,000

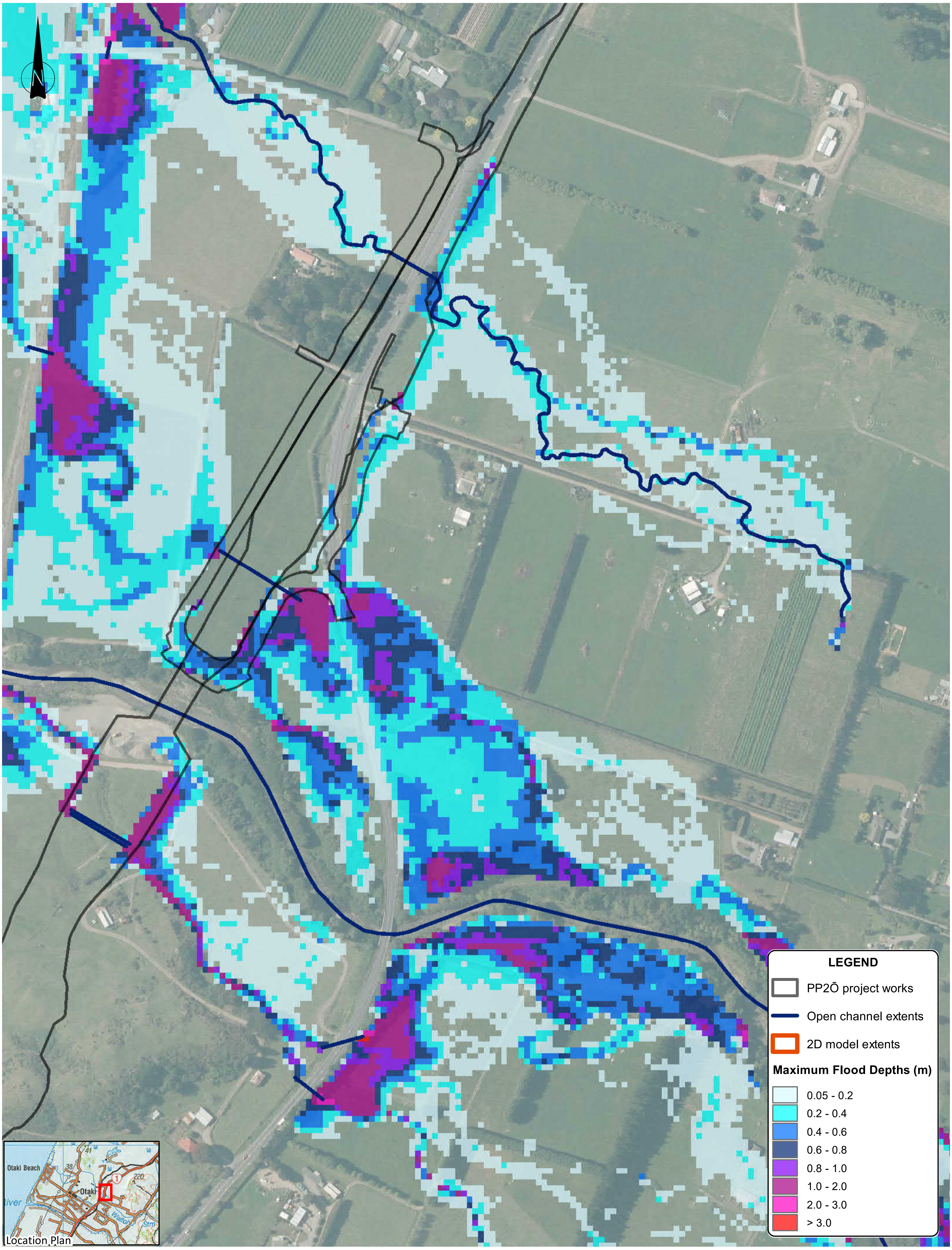
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 25.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig25_2_Wai_ModelResultsH_100yrCCHR.mxd Date: 23/03/2018 Time: 3:41:56 PM



Notes:
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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE
Fig25_2_Wai_ModelResultsH_100yrCCHR.mxd

SCALE (AT A3 SIZE)
1:3,000

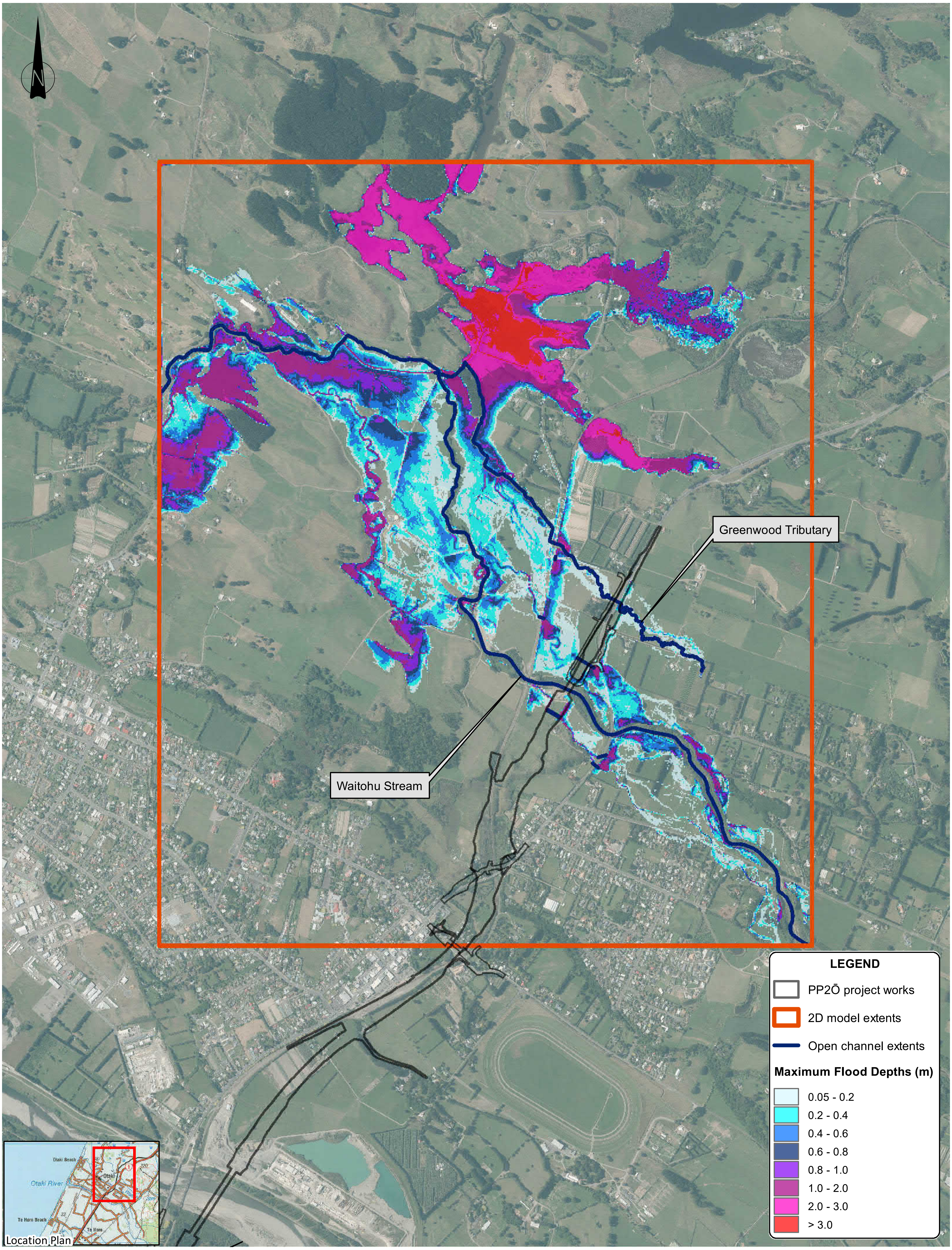
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 25.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig26_1_Wai_ModelResultsH_100yrCC.mxd Date: 23/03/2018 Time: 3:44:11 PM



Notes:
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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

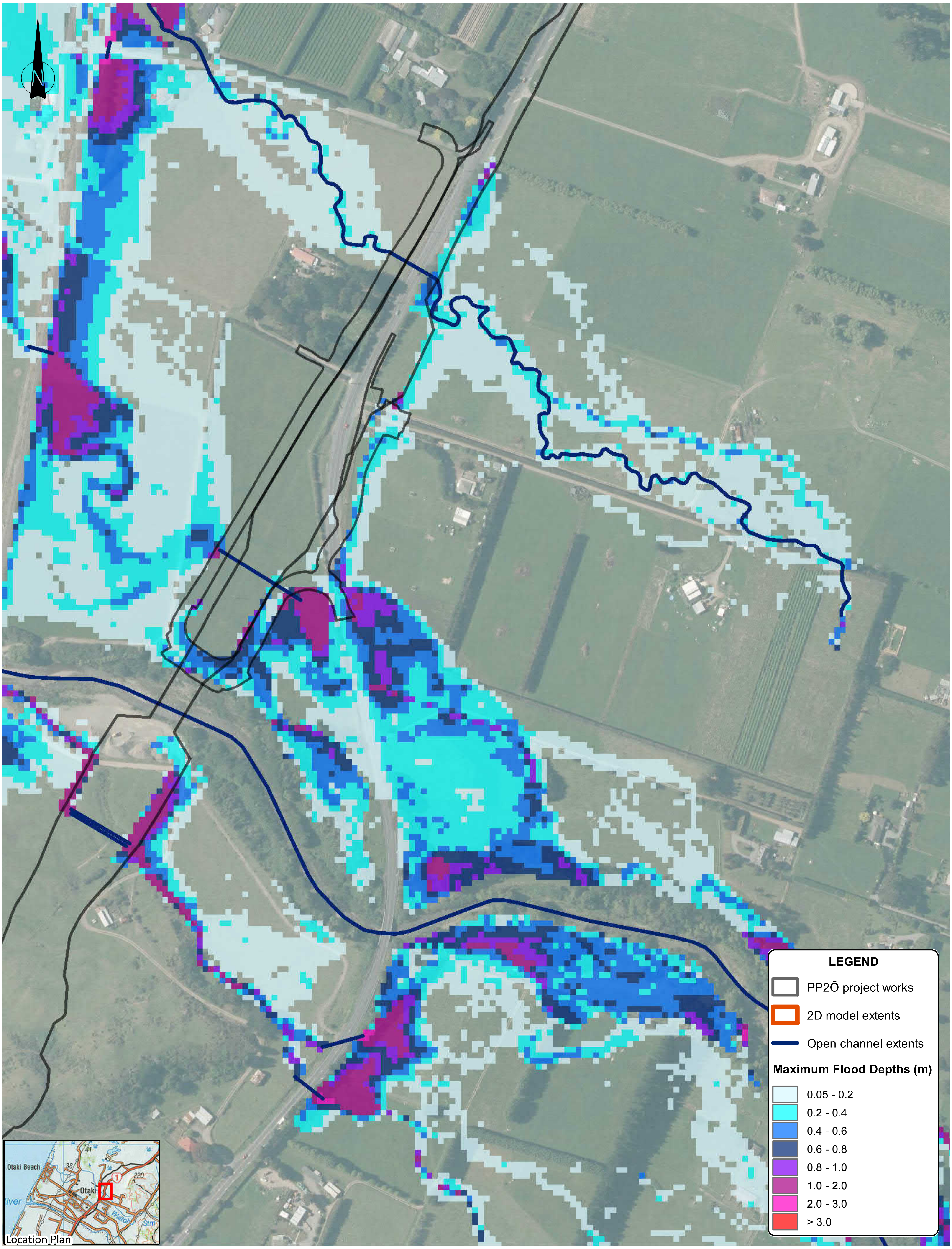
DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18
ARCFILE Fig26_1_Wai_ModelResultsH_100yrCC.mxd		
SCALE (AT A3 SIZE) 1:15,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 1% AEP CC2130

FIGURE No. Figure 26.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig26_2_Wai_ModelResultsH_100yrCC.mxd Date: 8/05/2018 Time: 10:01:30 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig26_2_Wai_ModelResultsH_100yrCC.mxd

SCALE (AT A3 SIZE)
1:3,000

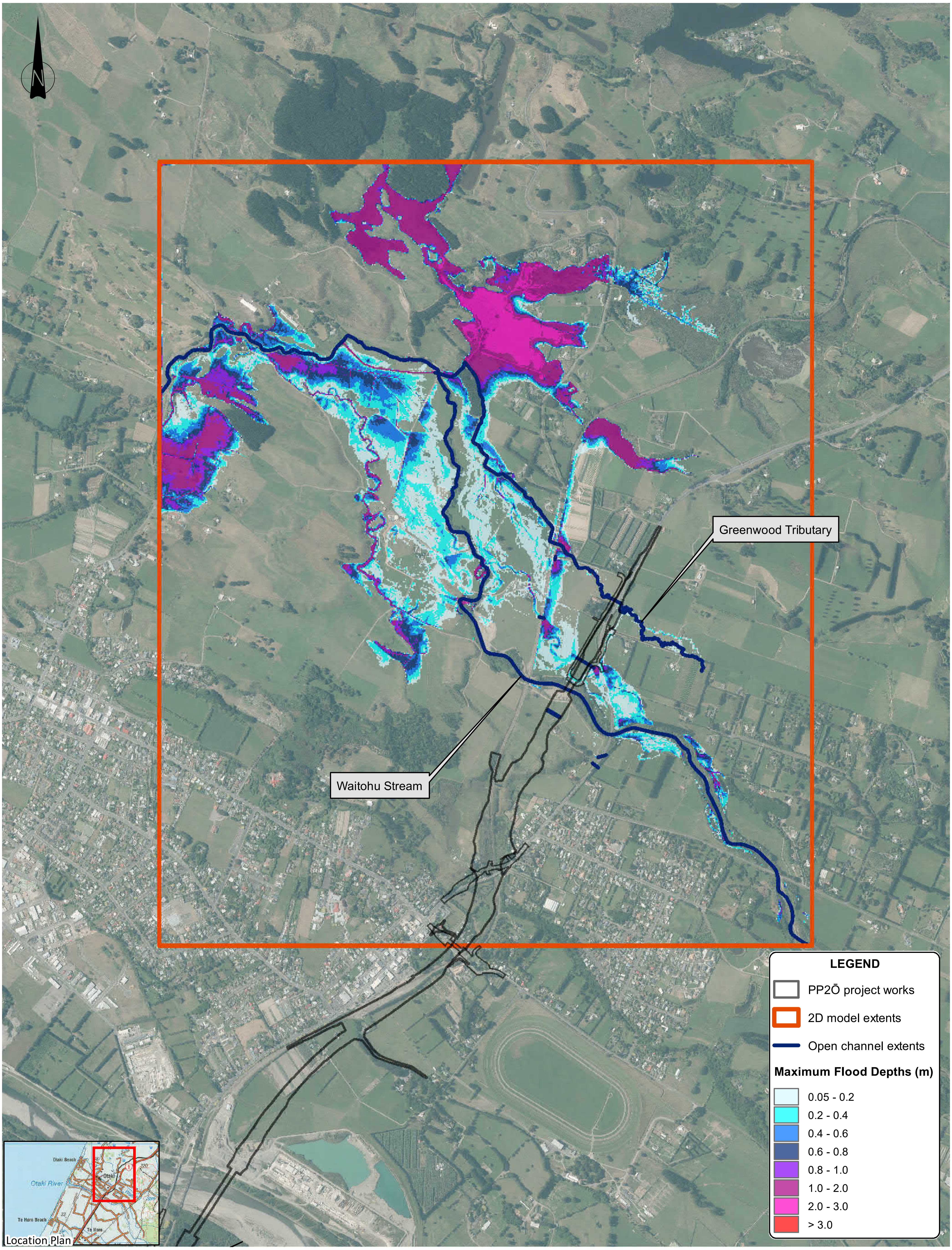
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 1% AEP CC2130

FIGURE No. Figure 26.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig27_1_Wai_ModelResultsH_20yr.mxd Date: 23/03/2018 Time: 3:46:56 PM



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:15,000

0 | 0.2 | 0.4 | 0.6 | 0.8 | 1 (km)

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

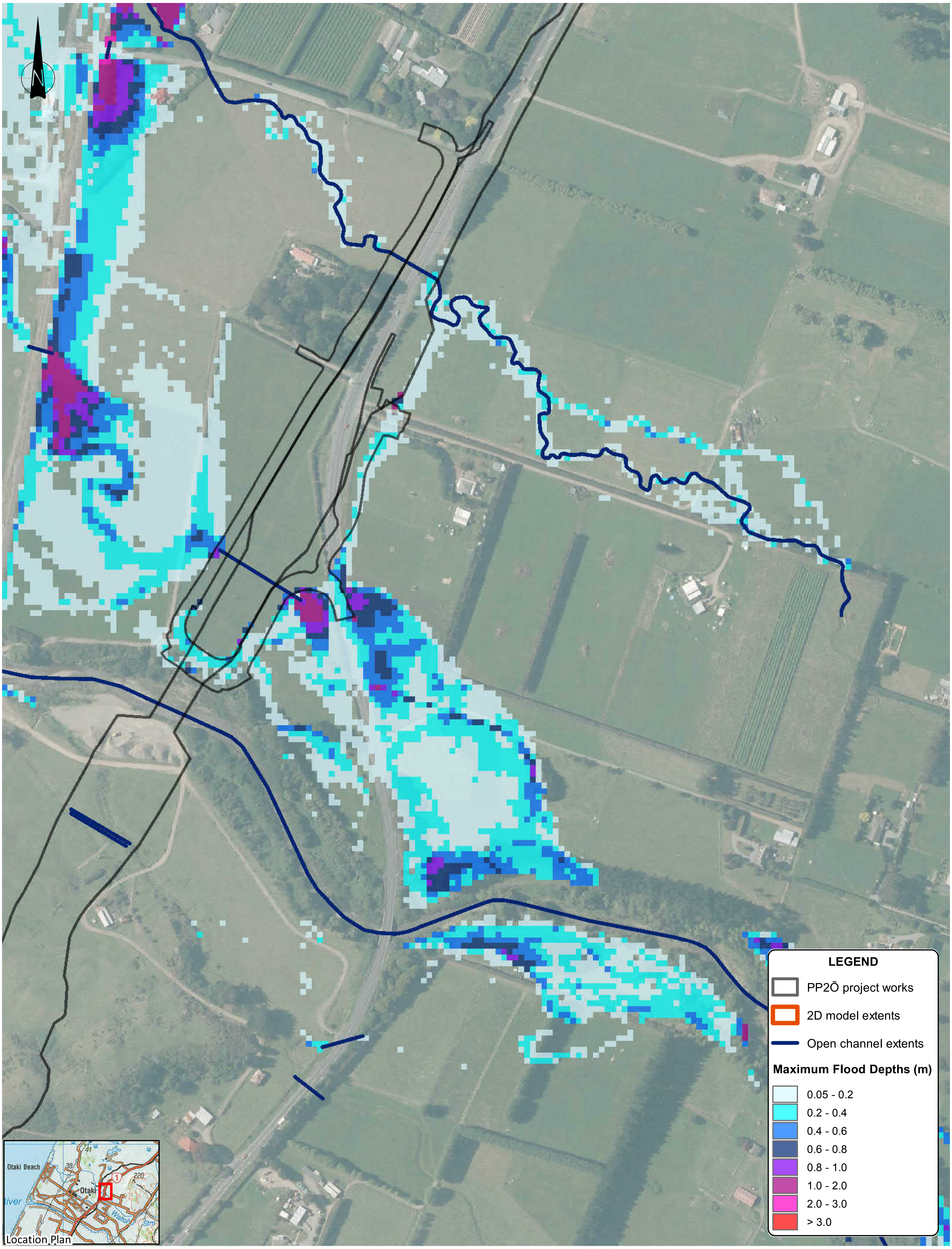
DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18
ARCFILE Fig27_1_Wai_ModelResultsH_20yr.mxd		
SCALE (AT A3 SIZE) 1:15,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 5% AEP

FIGURE No. Figure 27.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig27_2_Wai_ModelResultsH_20yr.mxd Date: 8/05/2018 Time: 10:32:24 a.m.



Notes:
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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig27_2_Wai_ModelResultsH_20yr.mxd

SCALE (AT A3 SIZE) 1:3,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

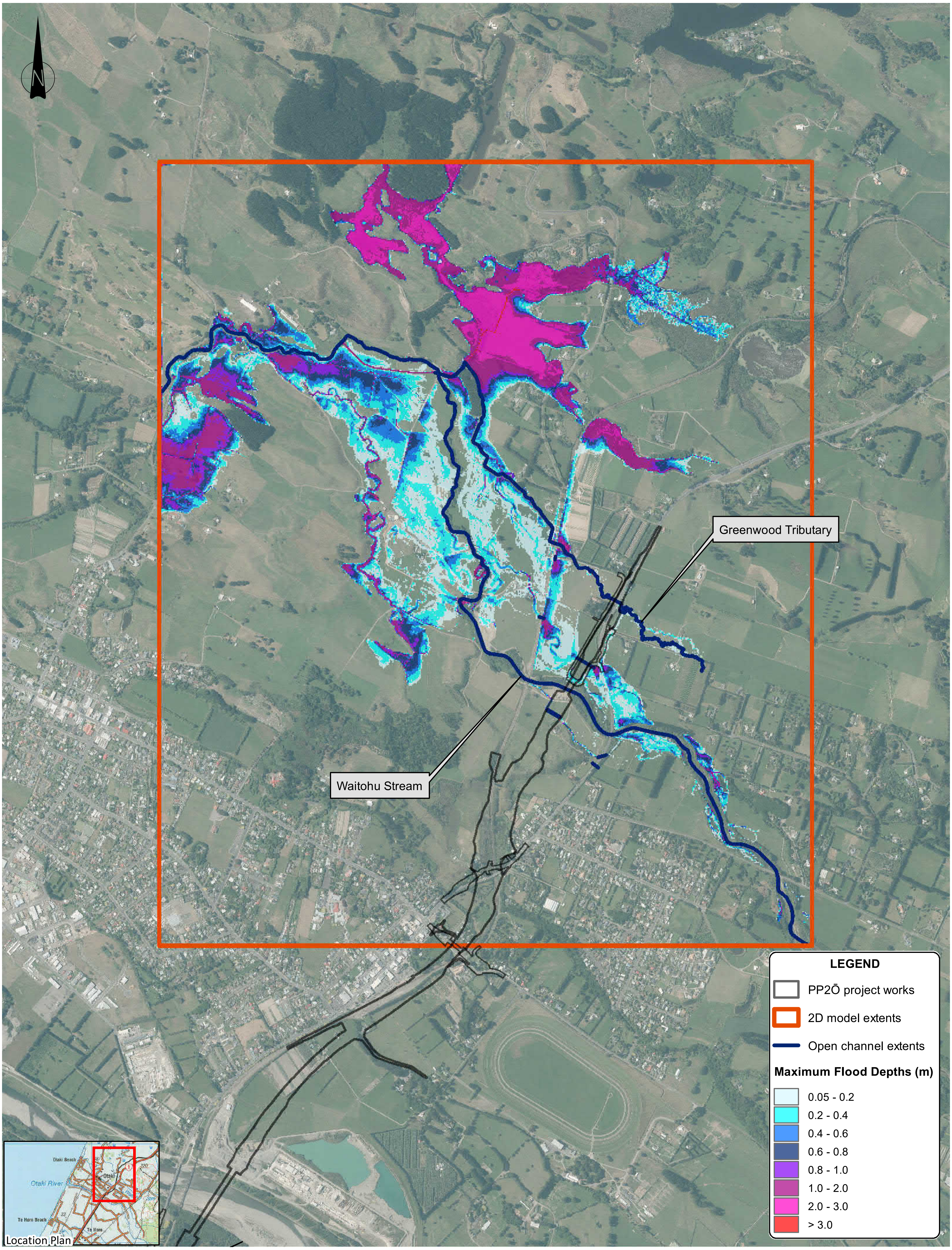
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 5% AEP

FIGURE No. Figure 27.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig28_1_Wai_ModelResultsH_10yrCC.mxd Date: 23/03/2018 Time: 3:49:47 PM



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig28_1_Wai_ModelResultsH_10yrCC.mxd

SCALE (AT A3 SIZE) 1:15,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

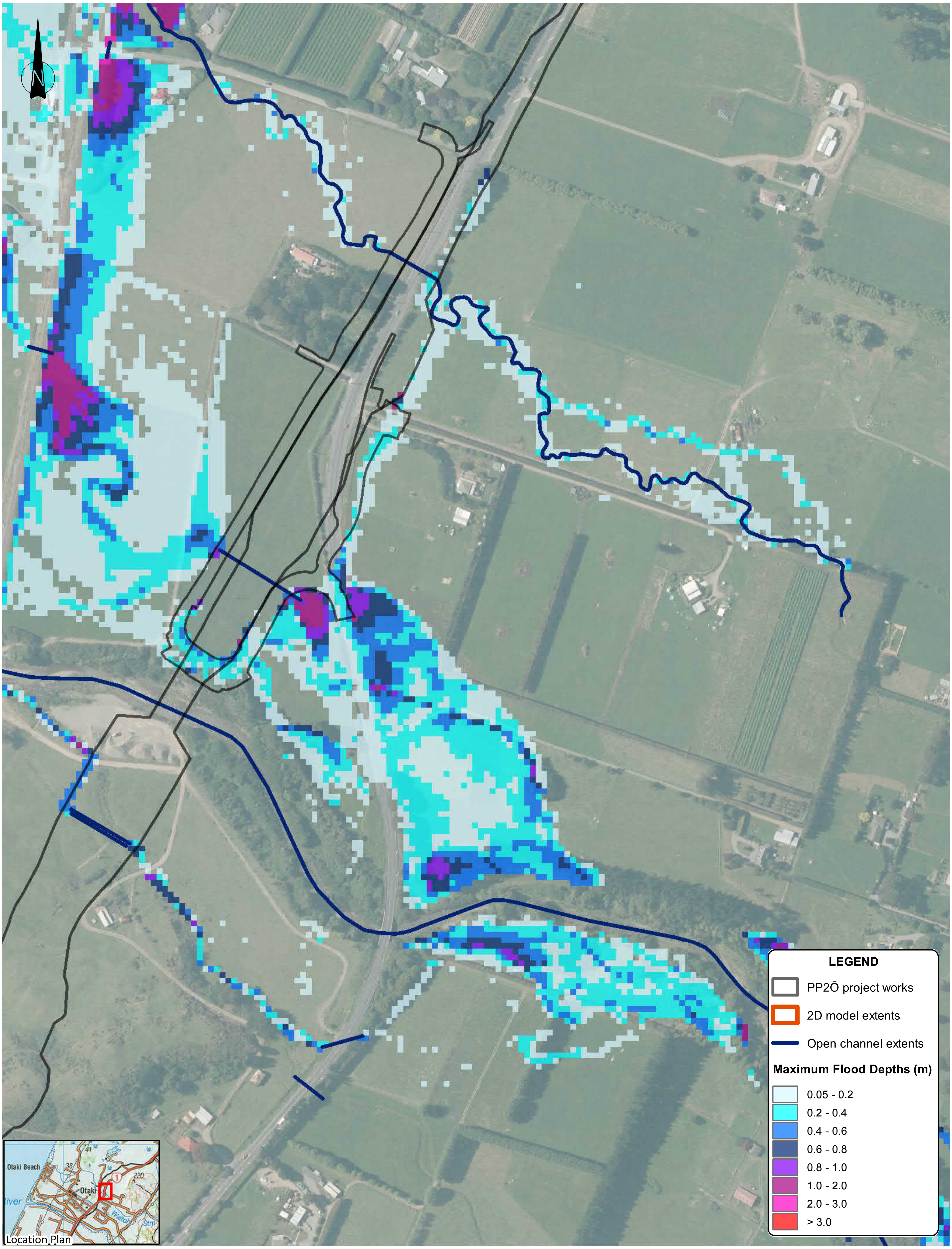
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 10% AEP CC2130

FIGURE No. Figure 28.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig28_2_Wai_ModelResultsH_10yrCC.mxd Date: 8/05/2018 Time: 10:34:11 a.m.



Notes:
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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI
Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig28_2_Wai_ModelResultsH_10yrCC.mxd

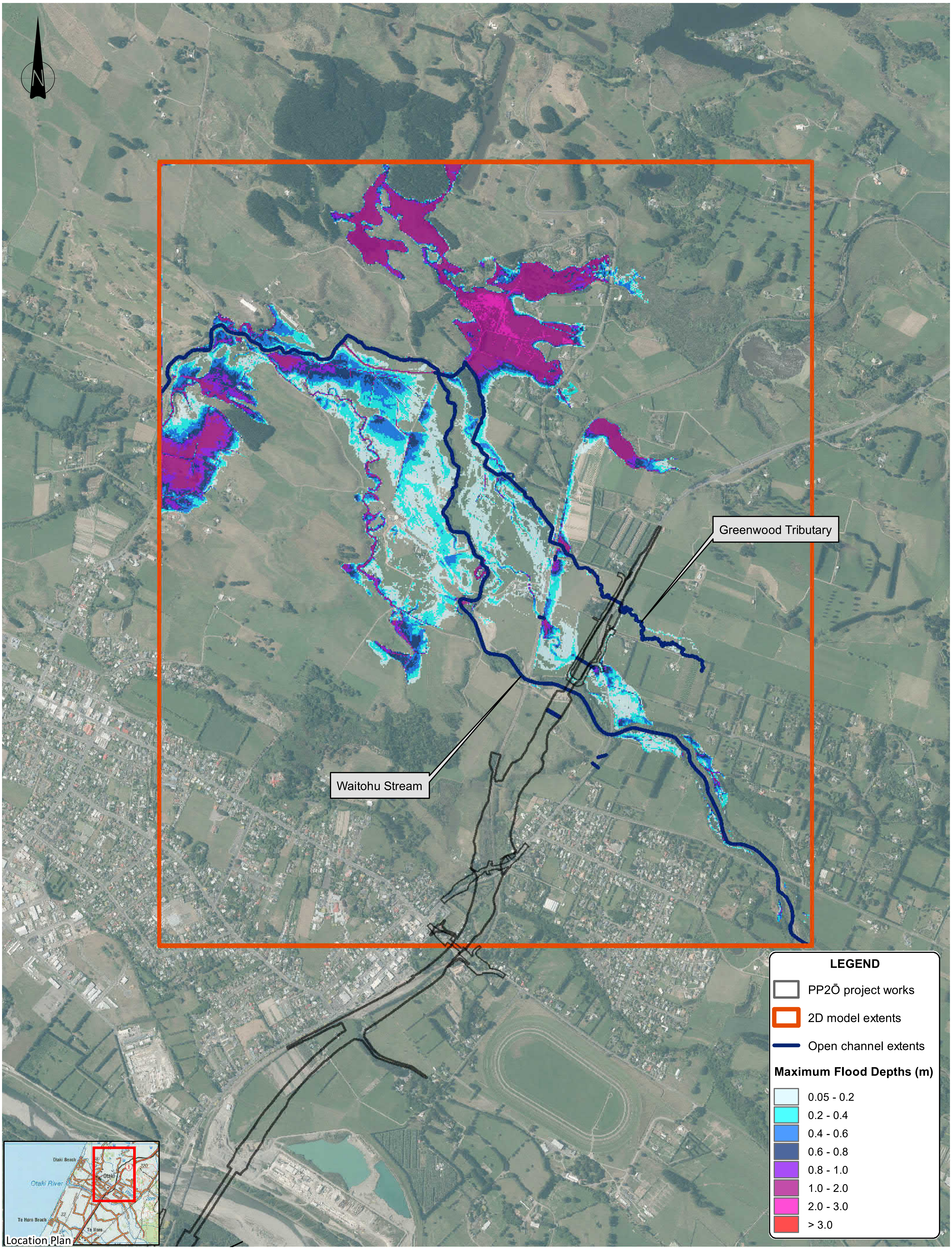
SCALE (AT A3 SIZE) 1:3,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 10% AEP CC2130

FIGURE No. Figure 28.2

Rev. 0



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig29_1_Wai_ModelResultsH_10yr.mxd

SCALE (AT A3 SIZE) 1:15,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

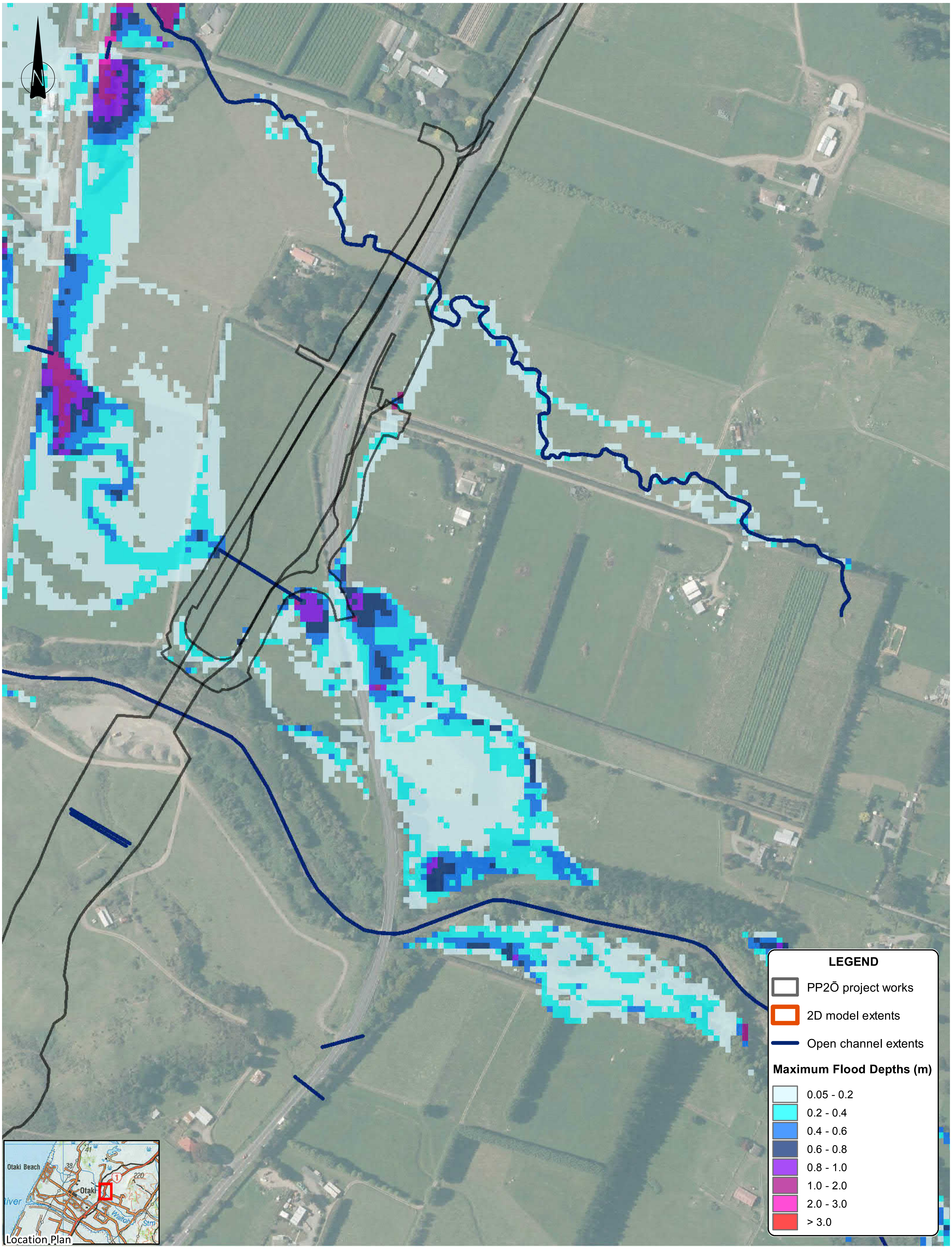
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 10% AEP

FIGURE No. Figure 29.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig29_2_Wai_ModelResultsH_10yr.mxd Date: 8/05/2018 Time: 10:36:01 a.m.



Notes:
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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig29_2_Wai_ModelResultsH_10yr.mxd

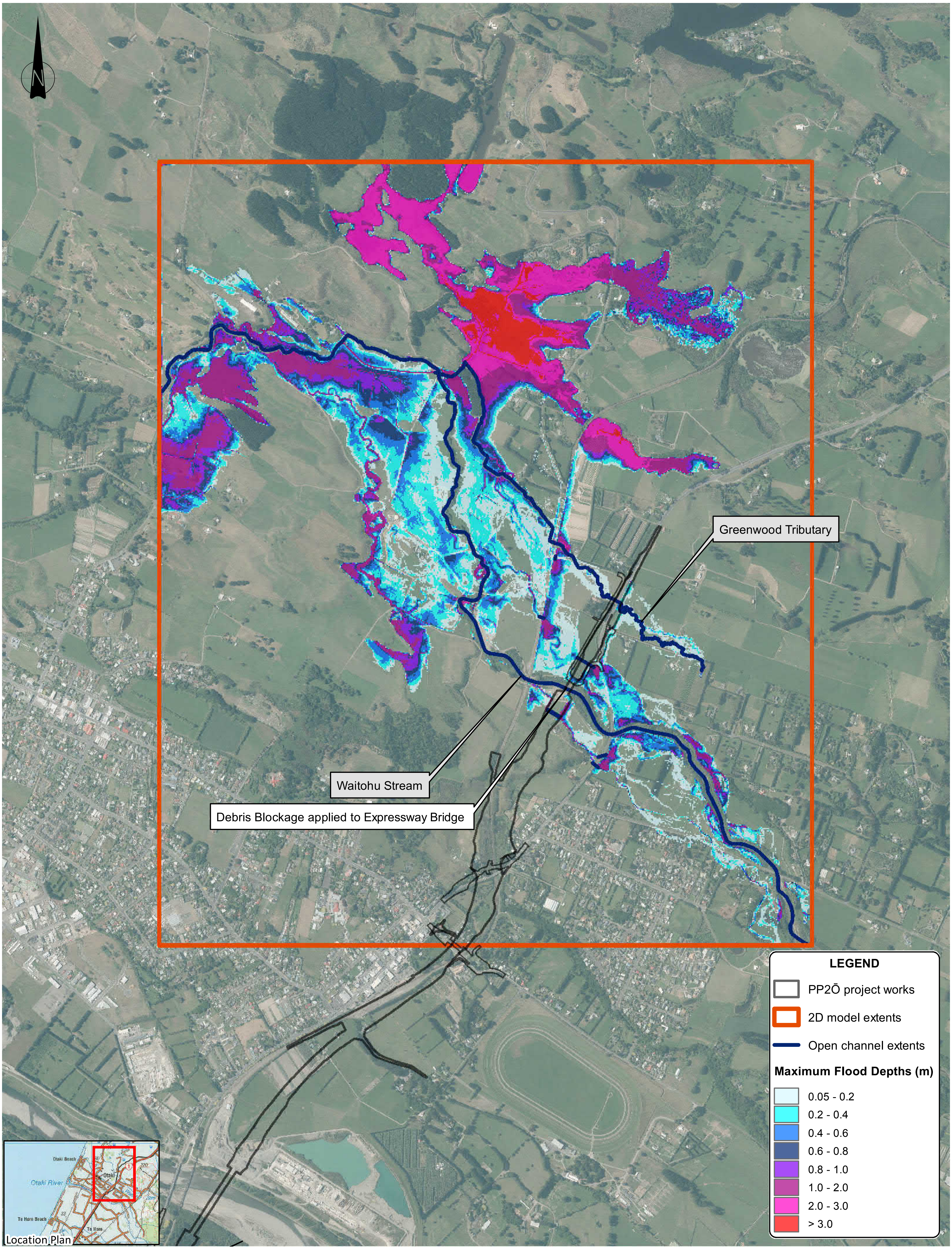
SCALE (AT A3 SIZE)
1:3,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 10% AEP

FIGURE No. Figure 29.2

Rev. 0



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

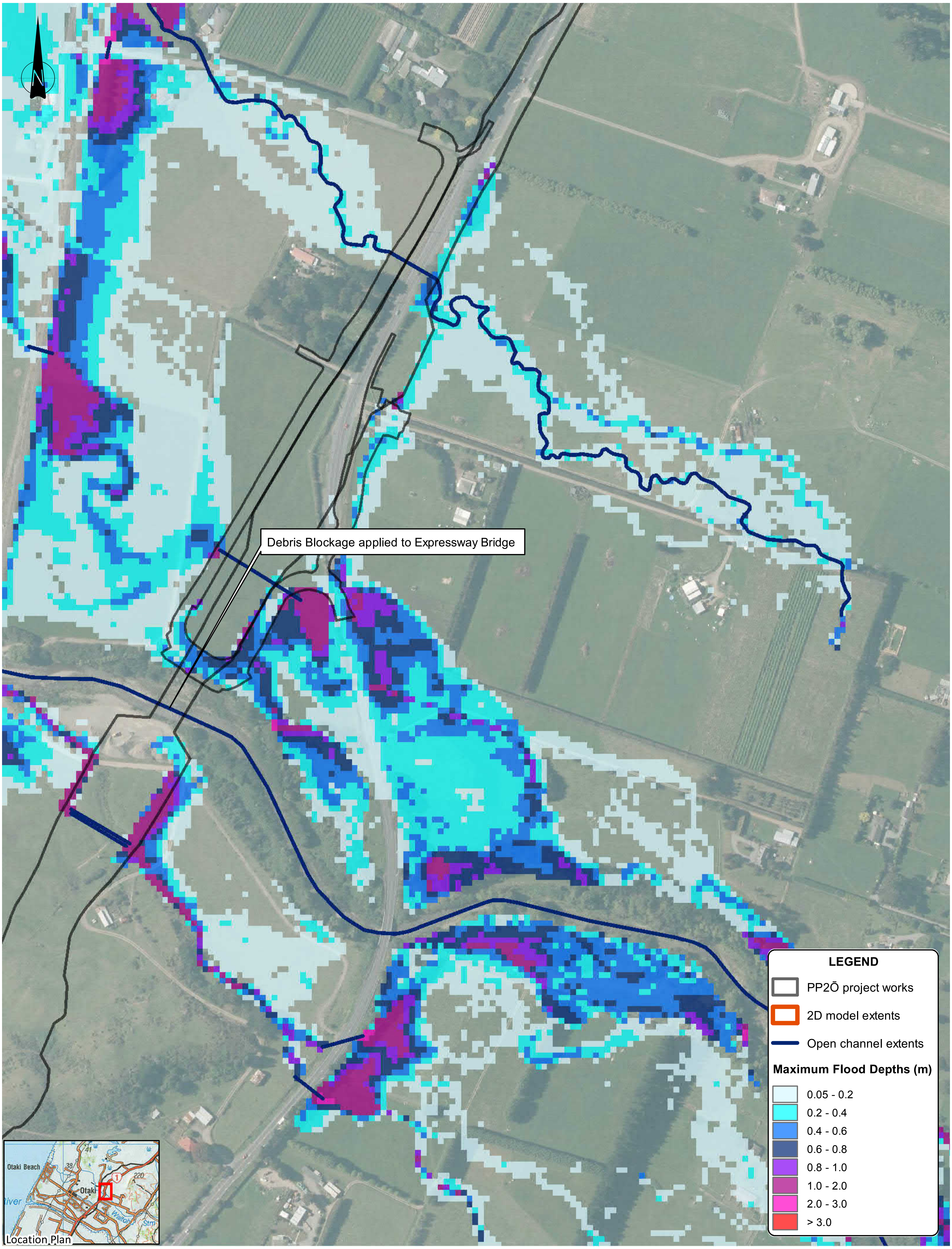
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig30_1_Wai_ModelResultsH_100yrCC_DB.mxd		
SCALE (AT A3 SIZE) 1:15,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model with Debris Blockage - 1% AEP CC2130

FIGURE No. Figure 30.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig30_2_Wai_ModelResultsH_100yrCC_DB.mxd Date: 8/05/2018 Time: 10:45:47 a.m.



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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

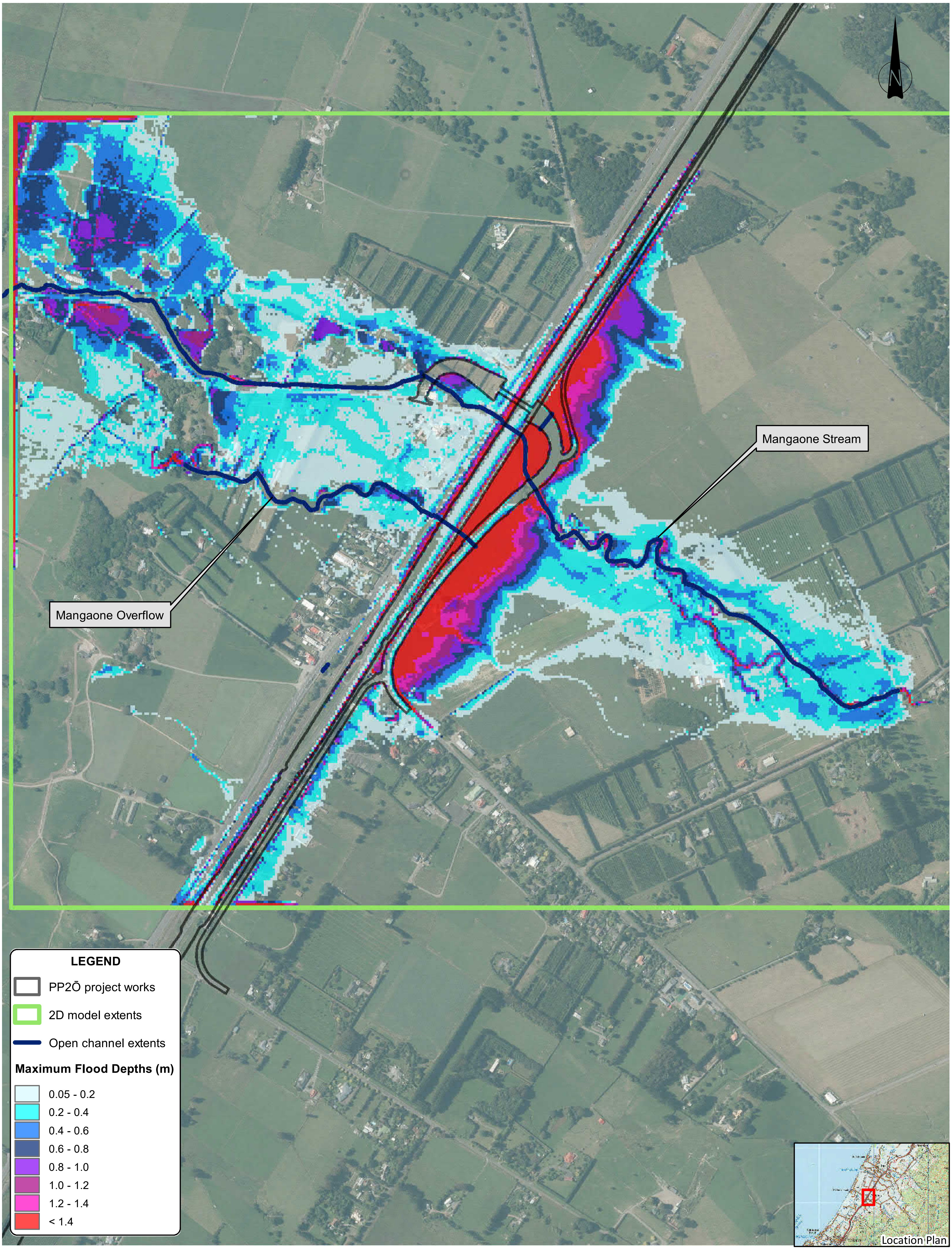
Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig30_2_Wai_ModelResultsH_100yrCC_DB.mxd		
SCALE (AT A3 SIZE) 1:3,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model with Debris Blockage - 1% AEP CC2130

FIGURE No. Figure 30.2 | Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig31_1_Mang_ModelResultsH_2500yrCC.mxd Date: 23/03/2018 Time: 4:02:46 PM



Notes:
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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE: Fig31_1_Mang_ModelResultsH_2500yrCC.mxd

SCALE (AT A3 SIZE): 1:7,500

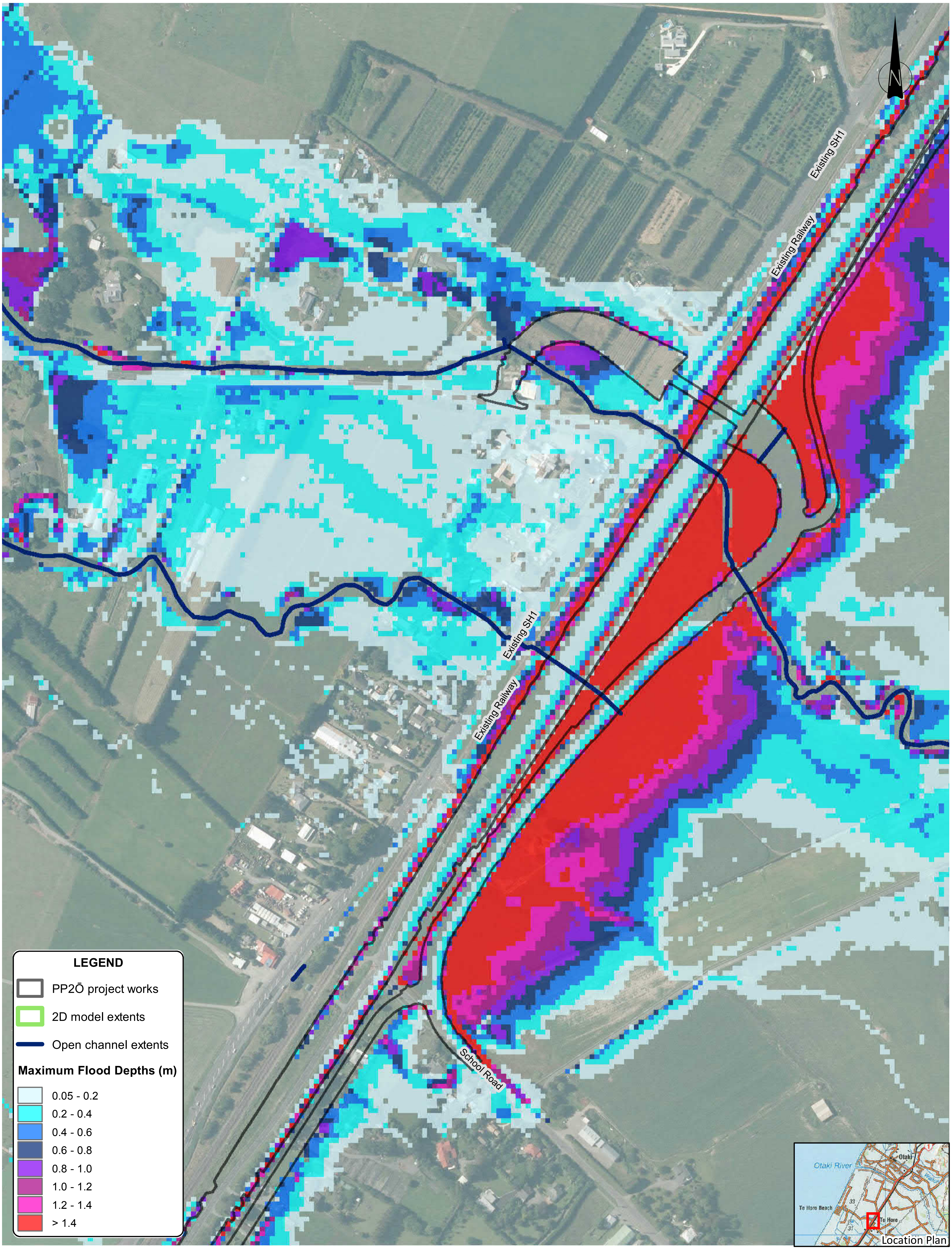
PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 0.04% AEP CC2130

FIGURE No. Figure 31.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig31_2_Mang_ModelResultsH_2500yrCC.mxd Date: 8/05/2018 Time: 10:58:43 a.m.



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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig31_2_Mang_ModelResultsH_2500yrCC.mxd

SCALE (AT A3 SIZE): 1:3,500

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

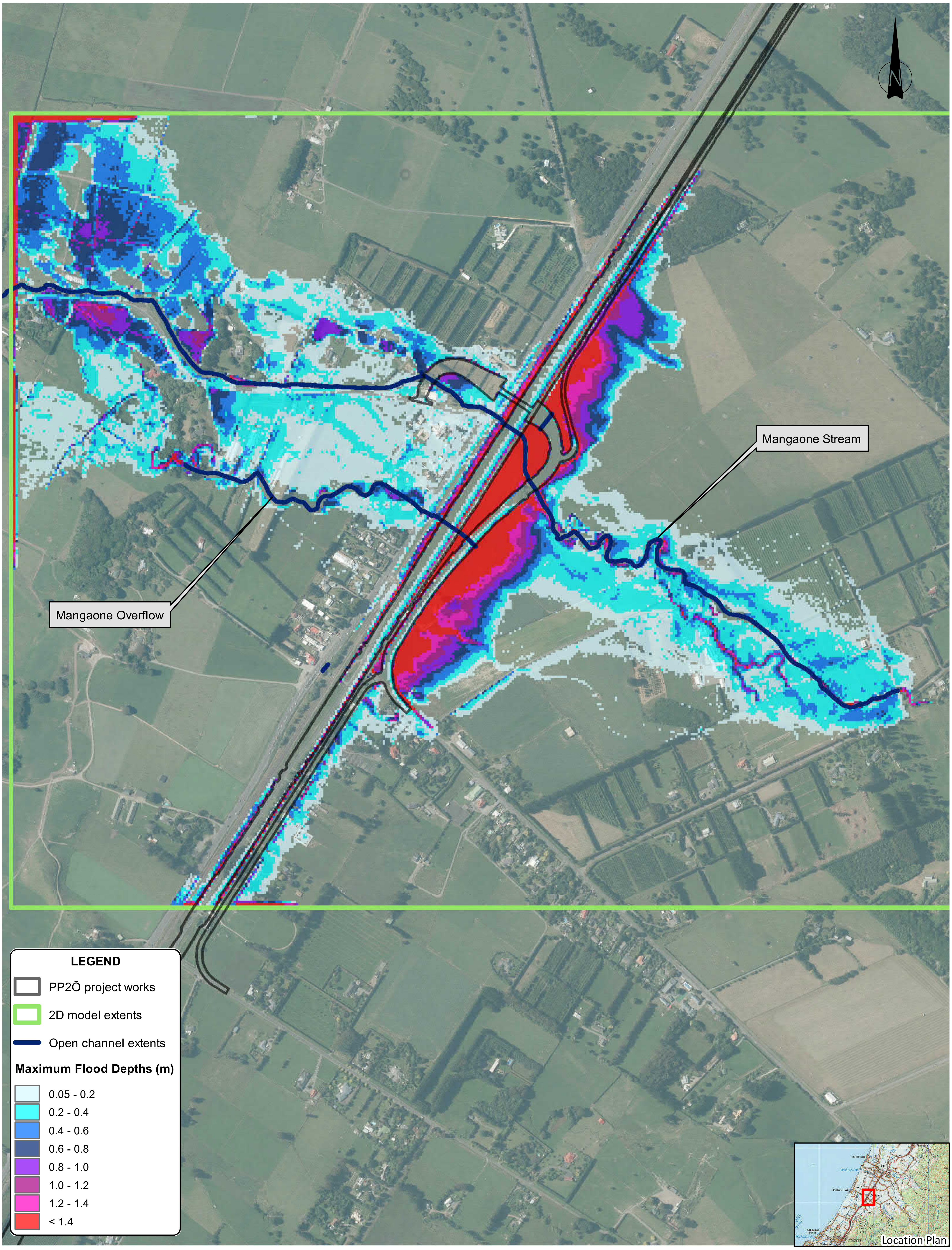
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 0.04% AEP CC2130

FIGURE No.: Figure 31.2

Rev.: 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig32_1_Mang_ModelResultsH_1000yrCC.mxd Date: 23/03/2018 Time: 4:10:13 PM



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE: Fig32_1_Mang_ModelResultsH_1000yrCC.mxd

SCALE (AT A3 SIZE): 1:7,500

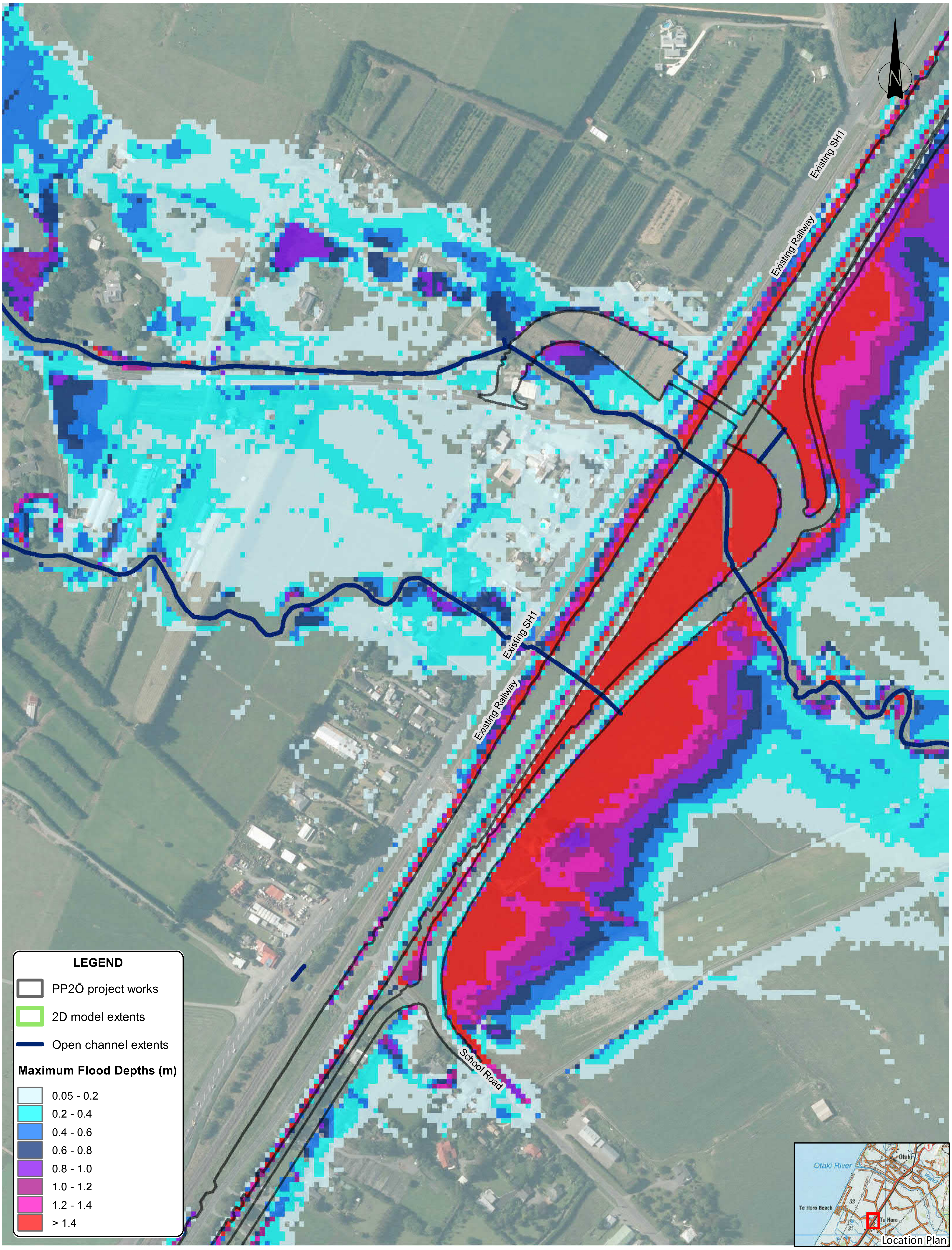
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 0.1% AEP CC2130

FIGURE No. Figure 32.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig32_2_Mang_ModelResultsH_1000yrCC.mxd Date: 8/05/2018 Time: 10:59:58 a.m.



Notes:
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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig32_2_Mang_ModelResultsH_1000yrCC.mxd

SCALE (AT A3 SIZE)
1:3,500

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

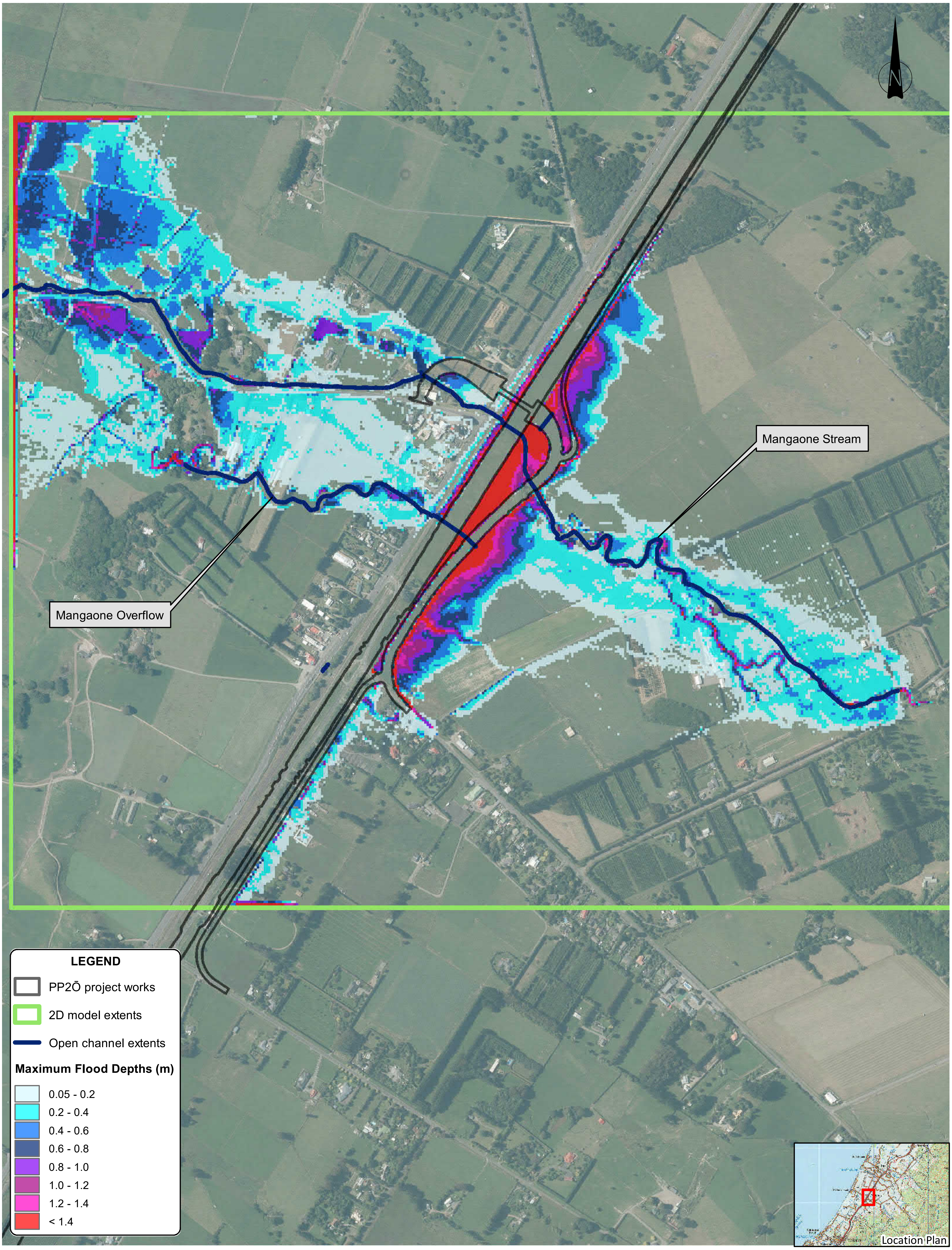
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 0.1% AEP CC2130

FIGURE No. Figure 32.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig33_1_Mang_ModelResultsH_100yrCCHR.mxd Date: 23/03/2018 Time: 4:14:58 PM



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig33_1_Mang_ModelResultsH_100yrCCHR.mxd

SCALE (AT A3 SIZE) 1:7,500

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

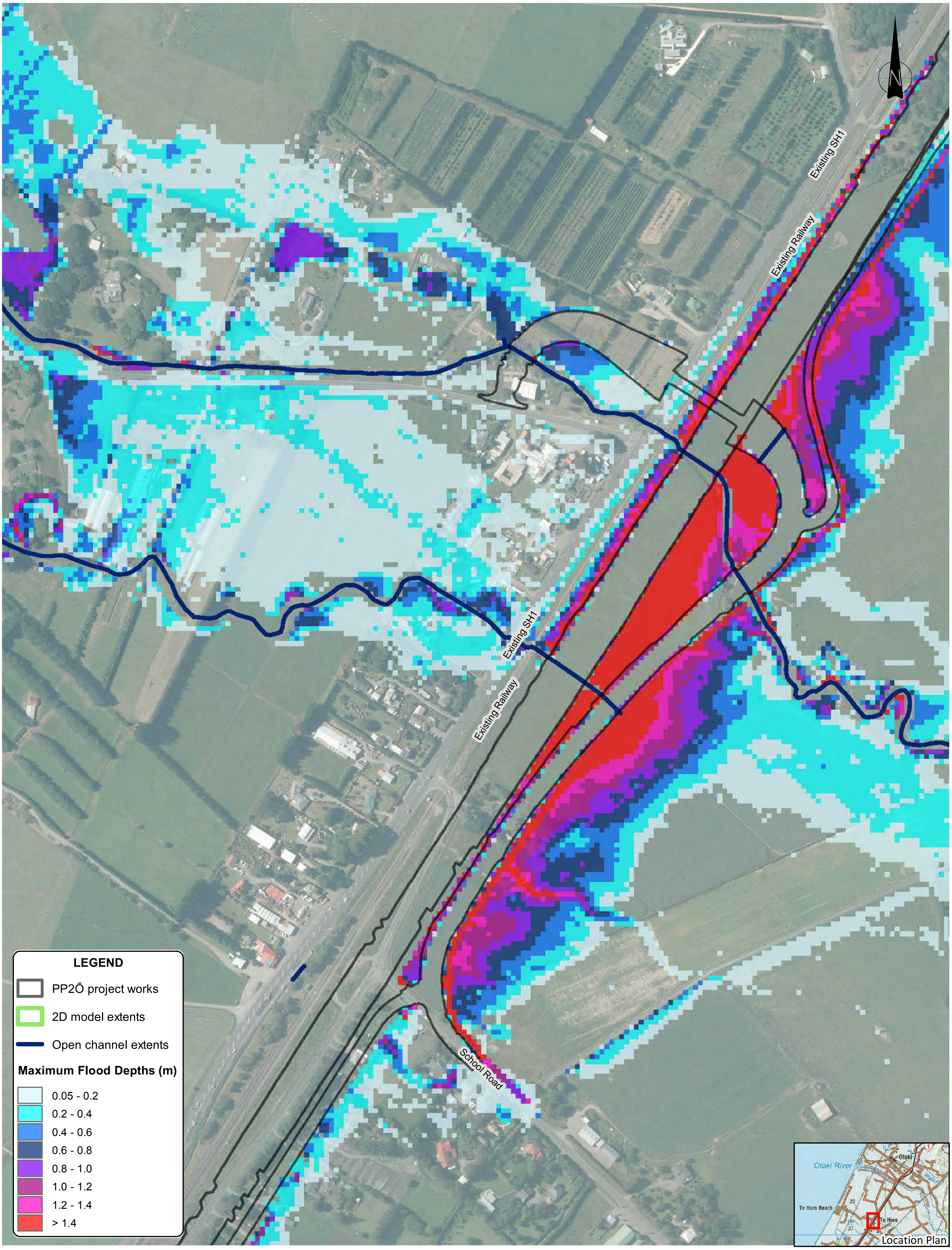
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 33.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig33_2_Mang_ModelResultsH_100yrCCHR.mxd Date: 8/05/2018 Time: 11:01:10 a.m.



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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig33_2_Mang_ModelResultsH_100yrCCHR.mxd

SCALE (AT A3 SIZE) 1:3,500

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

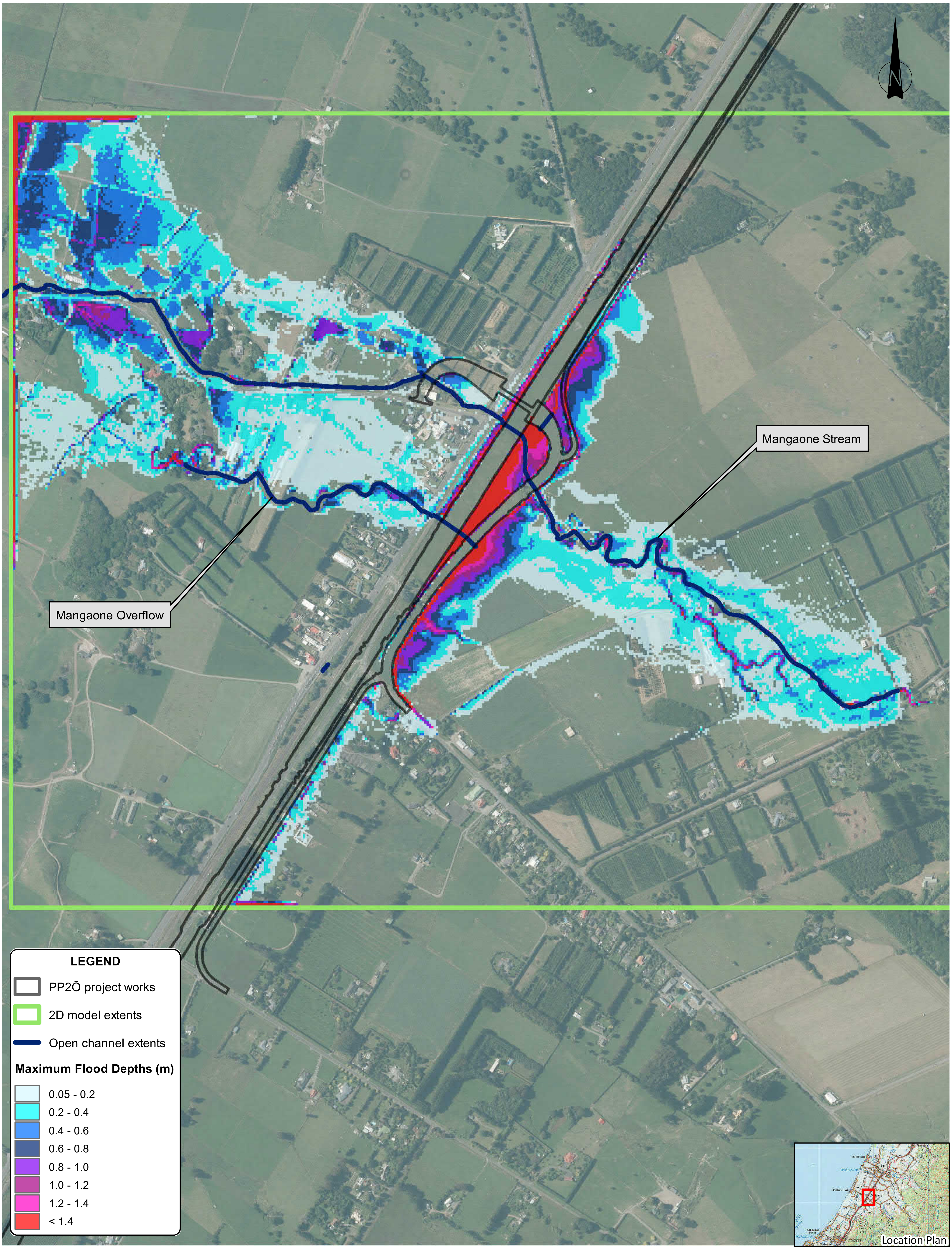
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 33.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig34_1_Mang_ModelResultsH_100yrCC.mxd Date: 23/03/2018 Time: 4:17:44 PM



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

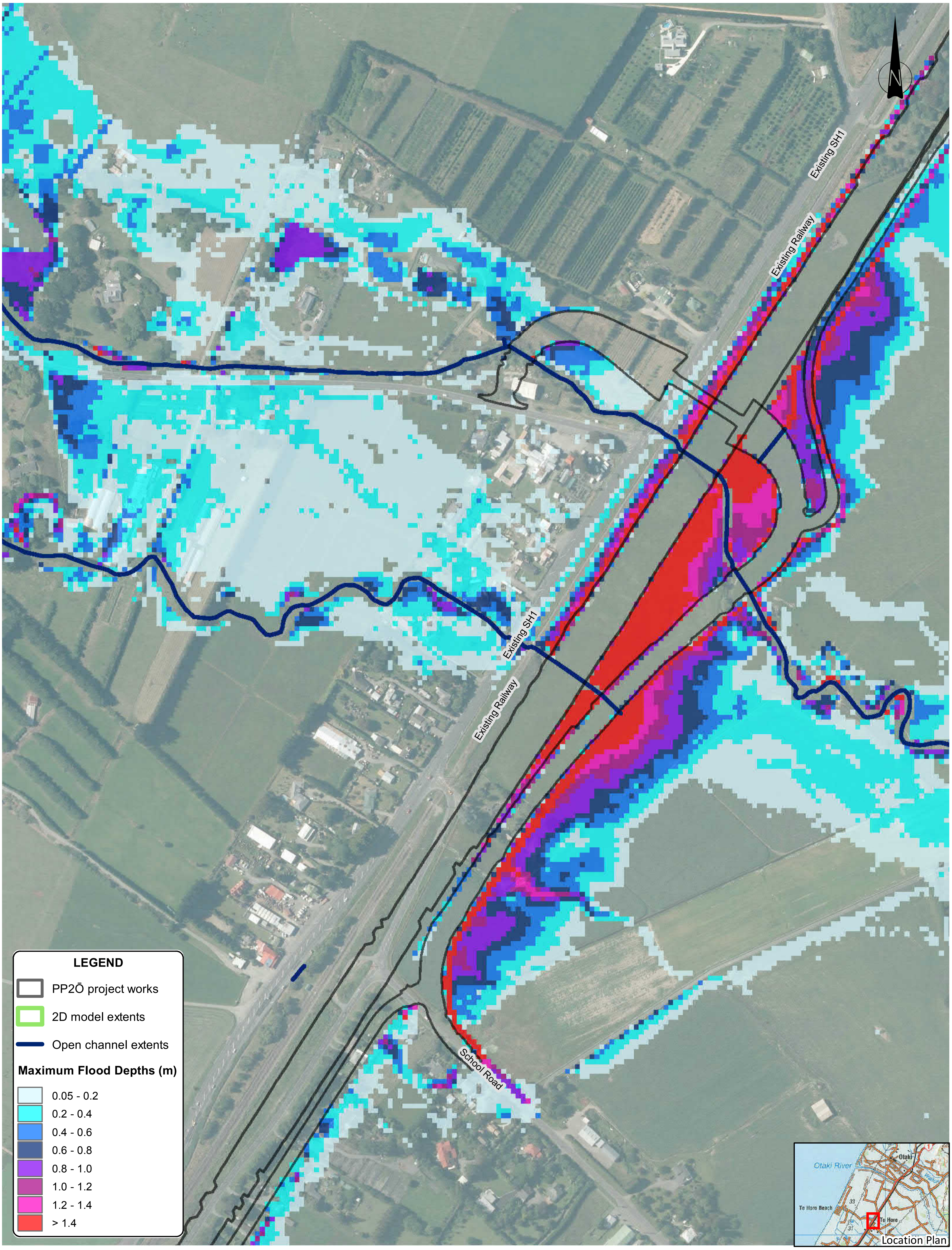
DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18
ARCFILE Fig34_1_Mang_ModelResultsH_100yrCC.mxd		
SCALE (AT A3 SIZE) 1:7,500		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 1% AEP CC2130

FIGURE No. Figure 34.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig34_2_Mang_ModelResultsH_100yrCC.mxd Date: 8/05/2018 Time: 11:02:23 a.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig34_2_Mang_ModelResultsH_100yrCC.mxd

SCALE (AT A3 SIZE)
1:3,500

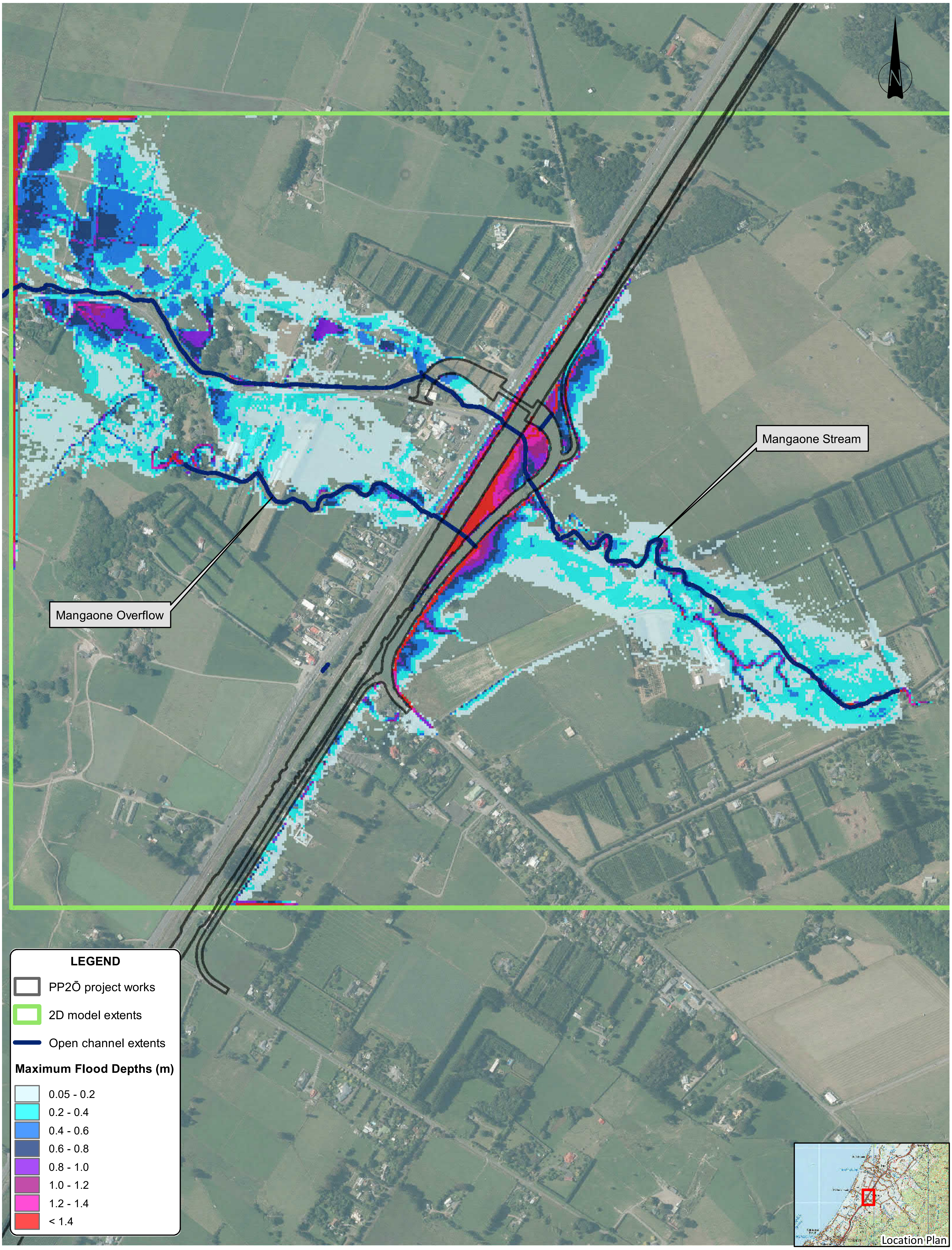
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 1% AEP CC2130

FIGURE No.
Figure 34.2

Rev.
0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig35_1_Mang_ModelResultsH_50yrCC.mxd Date: 23/03/2018 Time: 4:20:31 PM



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE: Fig35_1_Mang_ModelResultsH_50yrCC.mxd

SCALE (AT A3 SIZE): 1:7,500

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

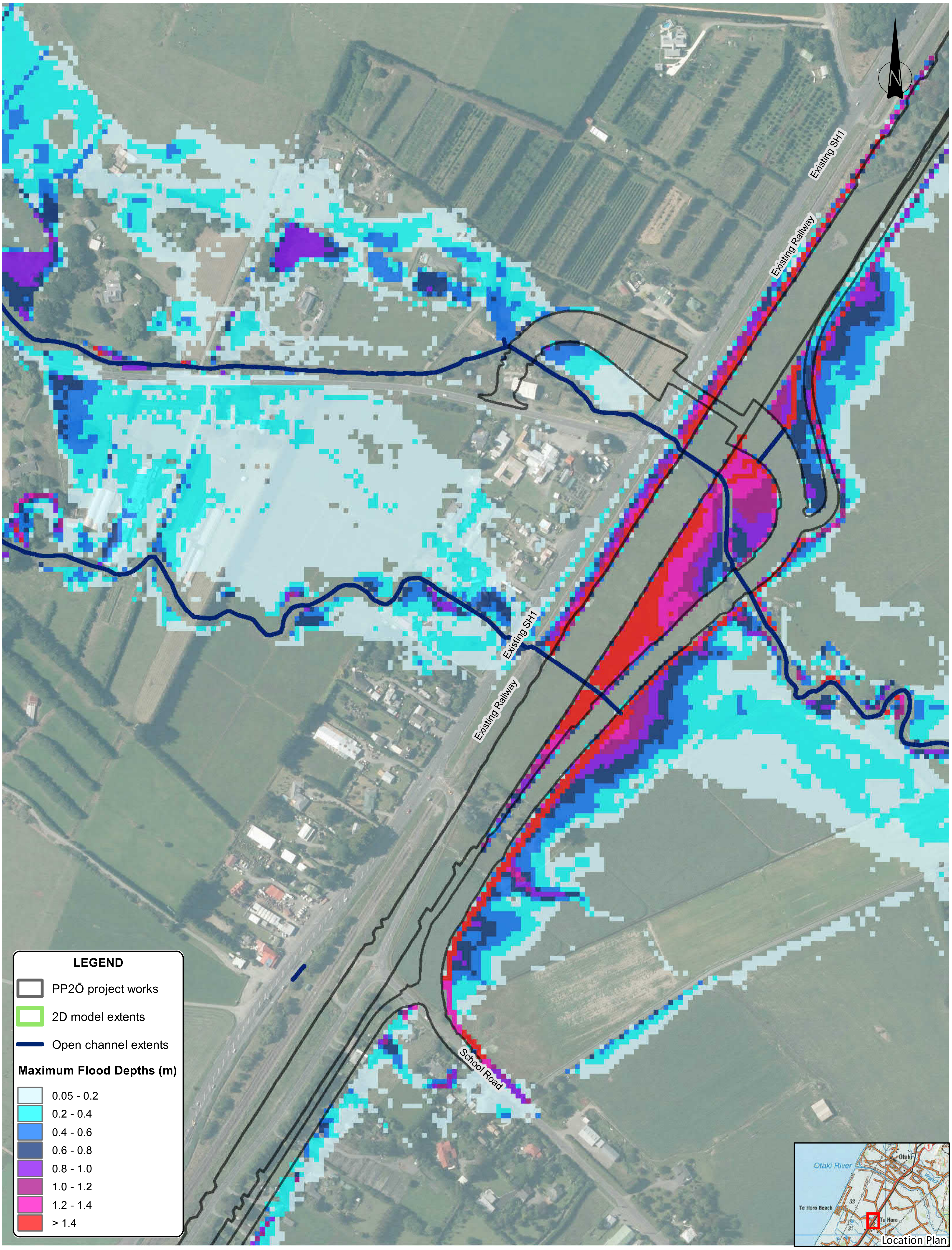
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 2% AEP CC2130

FIGURE No.: Figure 35.1

Rev.: 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig35_2_Mang_ModelResultsH_50yrCC.mxd Date: 8/05/2018 Time: 11:04:01 a.m.



Notes:
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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig35_2_Mang_ModelResultsH_50yrCC.mxd

SCALE (AT A3 SIZE): 1:3,500

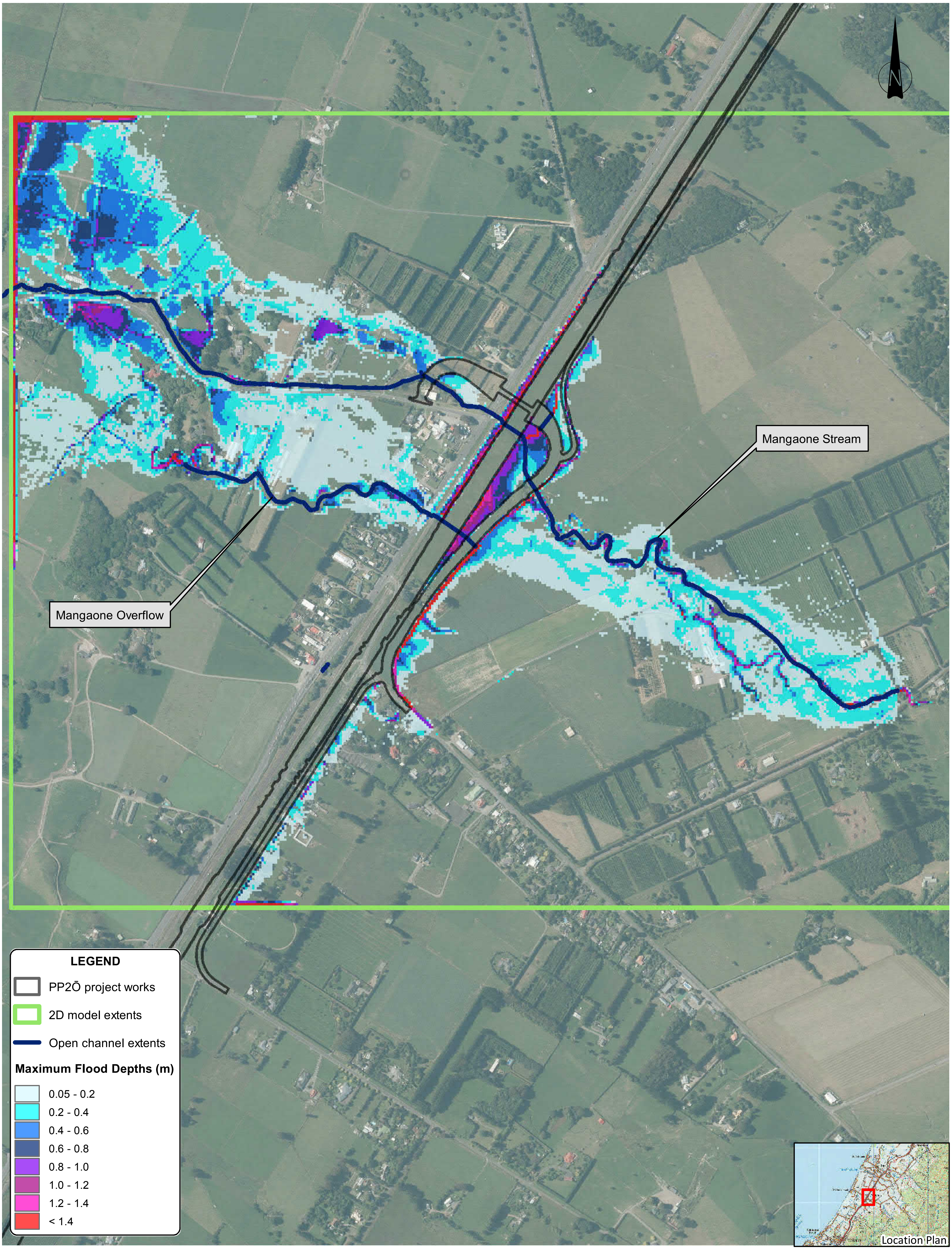
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 2% AEP CC2130

FIGURE No. Figure 35.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig36_1_Mang_ModelResultsH_20yrCC.mxd Date: 25/03/2018 Time: 9:25:06 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig36_1_Mang_ModelResultsH_20yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

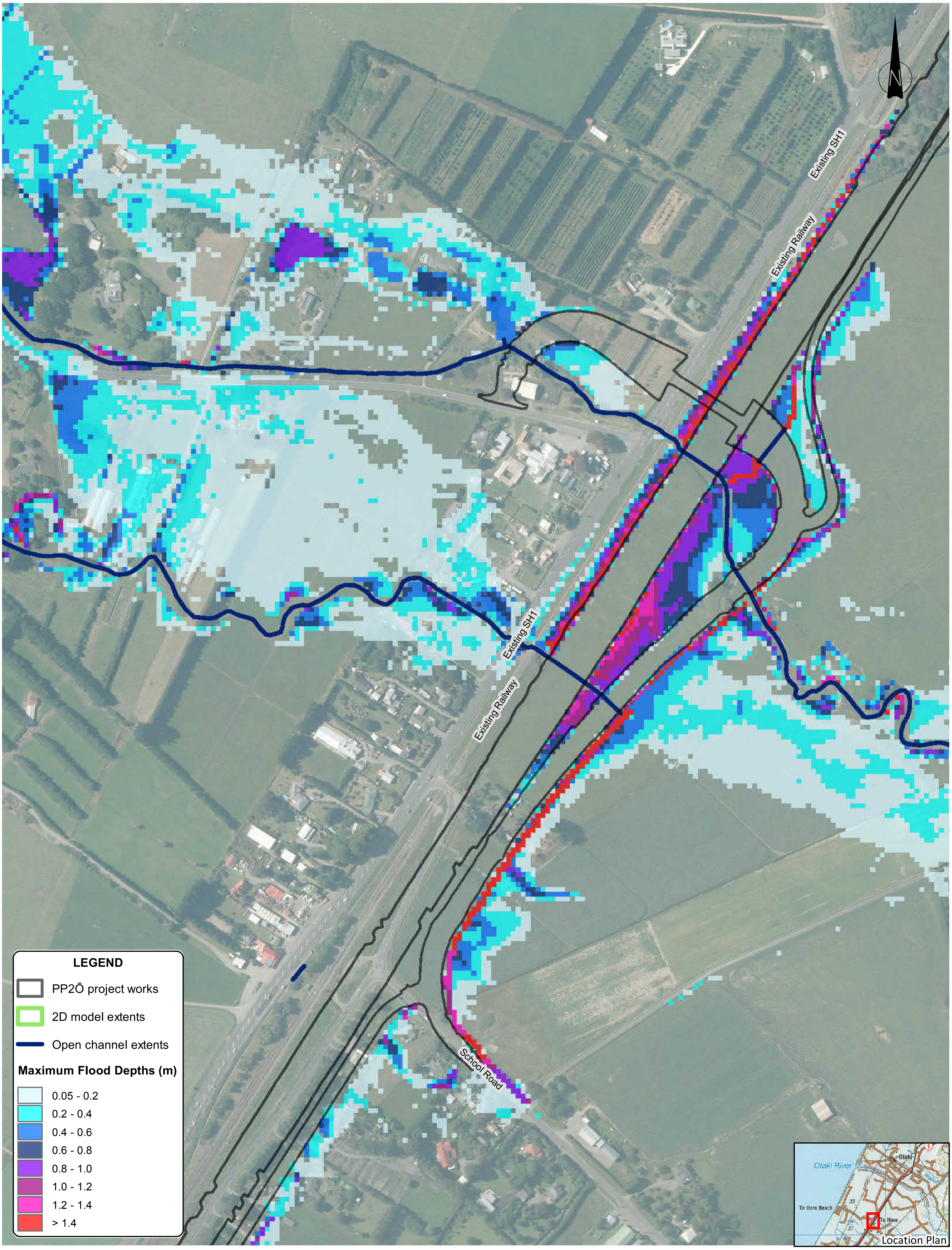
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 5% AEP CC2130

FIGURE No. Figure 36.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig36_2_Mang_ModelResultsH_20yrCC.mxd Date: 8/05/2018 Time: 11:08:12 a.m.



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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

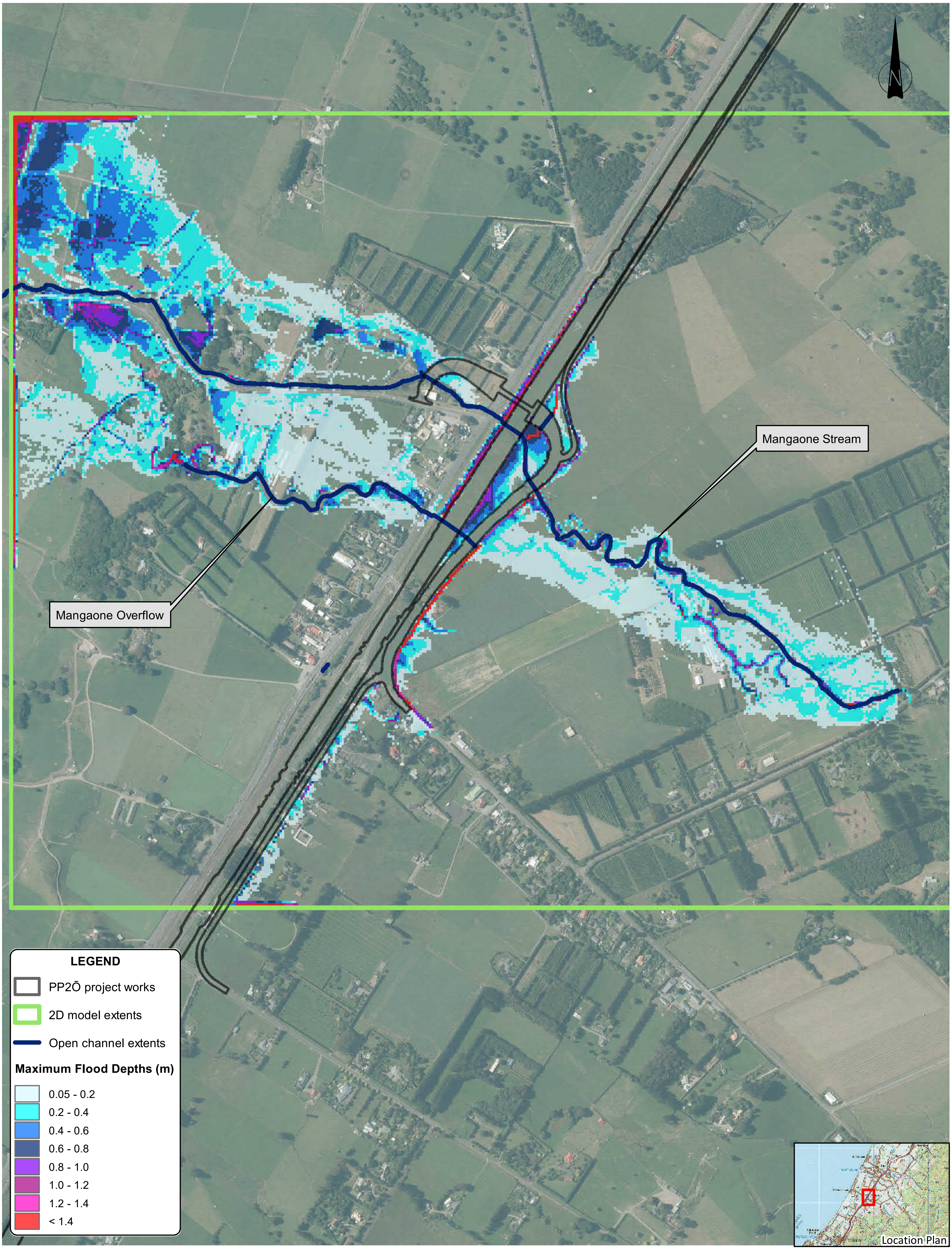
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig36_2_Mang_ModelResultsH_20yrCC.mxd	
SCALE (AT A3 SIZE)	1:3,500	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 5% AEP CC2130

FIGURE No. Figure 36.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180323_PostProjectReportRev3\Fig37_1_Mang_ModelResultsH_10yrCC.mxd Date: 23/03/2018 Time: 4:38:16 PM



Notes:
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- All levels are New Zealand Vertical Datum 2009.
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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	JOPA	Mar.18
CHECKED	DMK	Mar.18
APPROVED	TSRF	Mar.18

ARCFILE Fig37_1_Mang_ModelResultsH_10yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

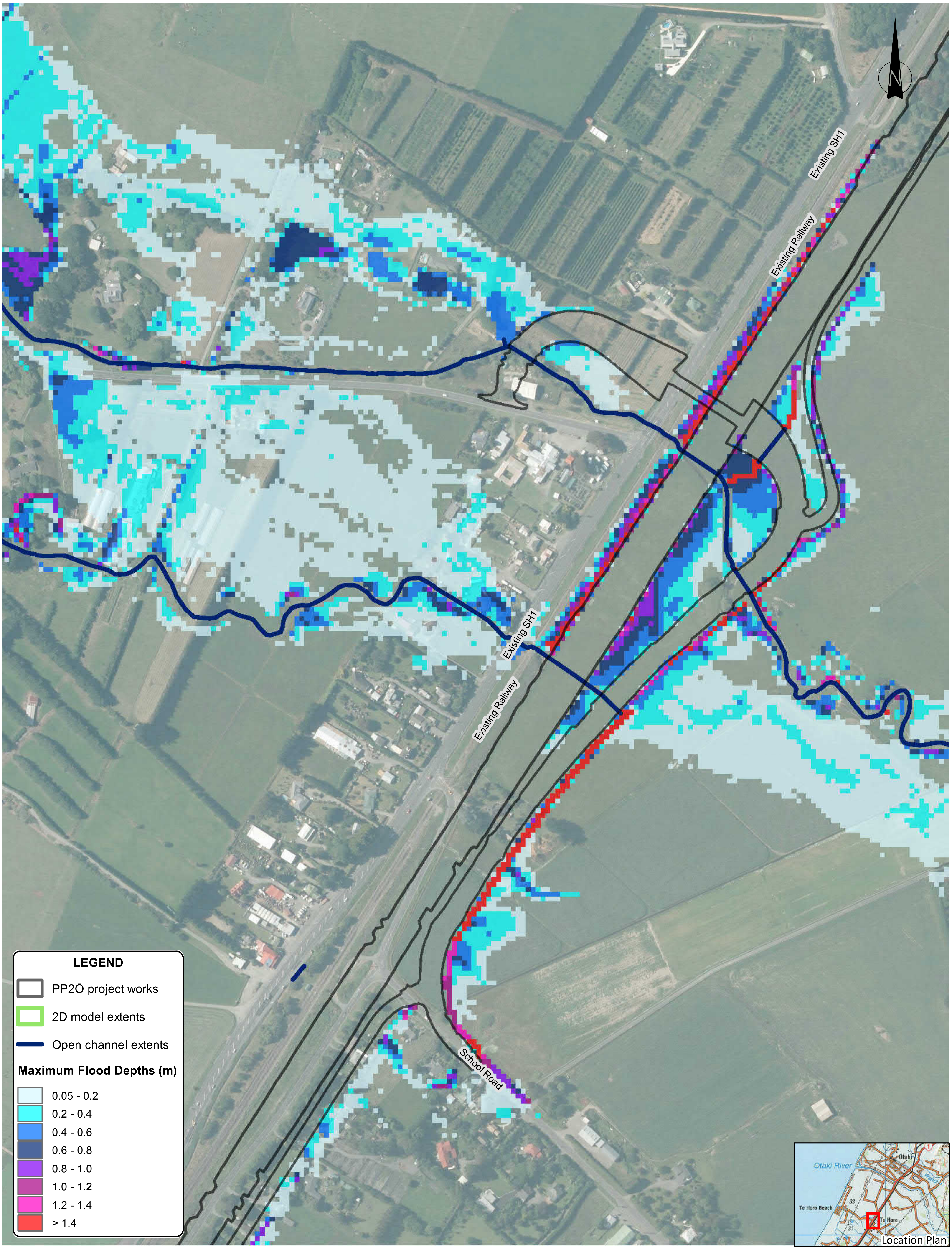
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 10% AEP CC2130

FIGURE No. Figure 37.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig37_2_Mang_ModelResultsH_10yrCC.mxd Date: 8/05/2018 Time: 11:10:02 a.m.



Notes:
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A3 SCALE 1:3,500

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig37_2_Mang_ModelResultsH_10yrCC.mxd		
SCALE (AT A3 SIZE) 1:3,500		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

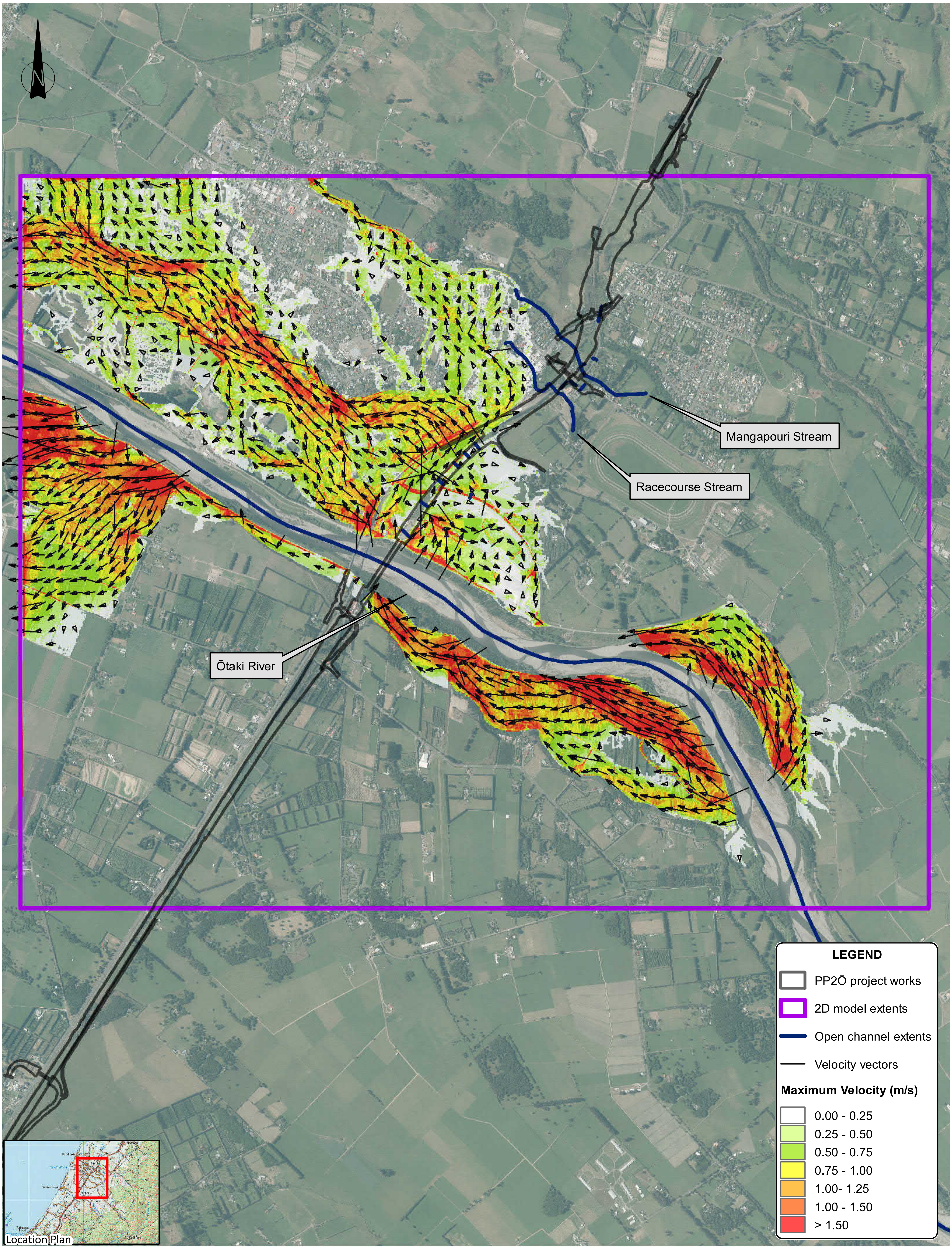
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 10% AEP CC2130

FIGURE No. Figure 37.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig38_1_OM_ModelResultsV_3000cu.mxd Date: 8/05/2018 Time: 2:50:21 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig38_1_OM_ModelResultsV_3000cu.mxd

SCALE (AT A3 SIZE)
1:20,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

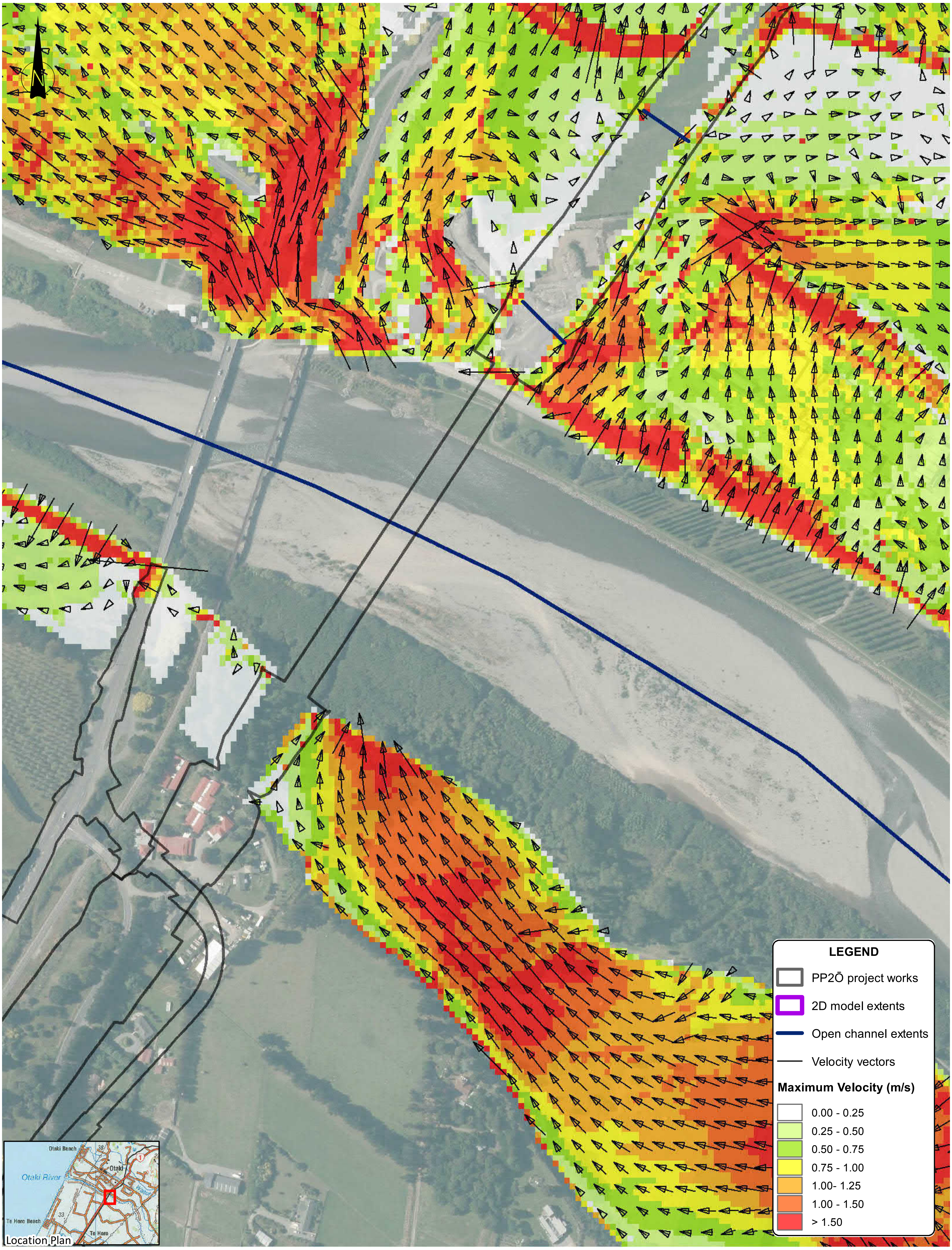
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 38.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig38_2_OM_ModelResultsV_3000CuZmd.mxd Date: 8/05/2018 Time: 2:51:08 p.m.



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A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig38_2_OM_ModelResultsV_3000CuZmd.mxd

SCALE (AT A3 SIZE) 1:3,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

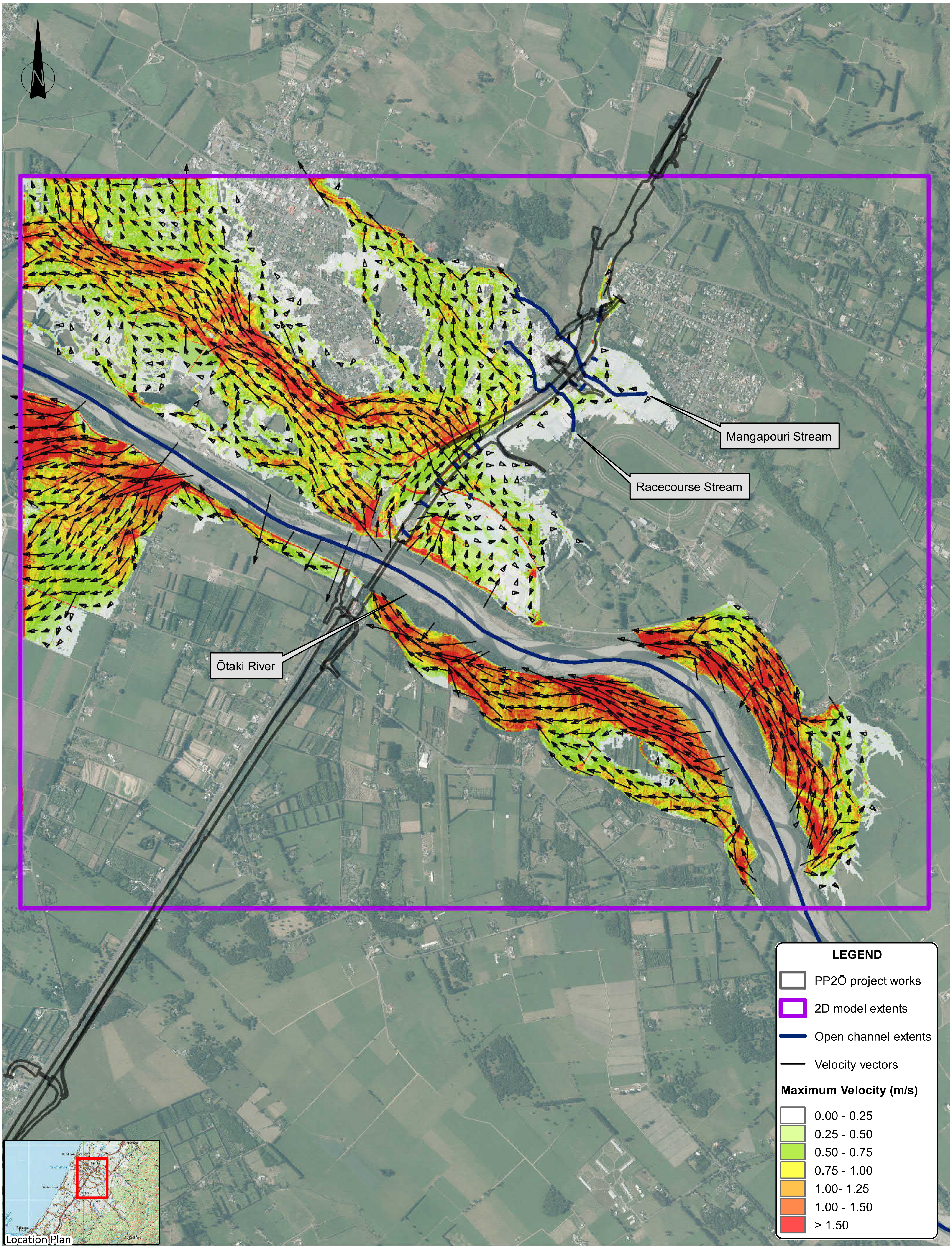
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 3000 m^3/s (Ōtaki only)

FIGURE No. Figure 38.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig39_1_OM_ModelResultsV_2500yrCC.mxd Date: 10/05/2018 Time: 6:43:55 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig39_1_OM_ModelResultsV_2500yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

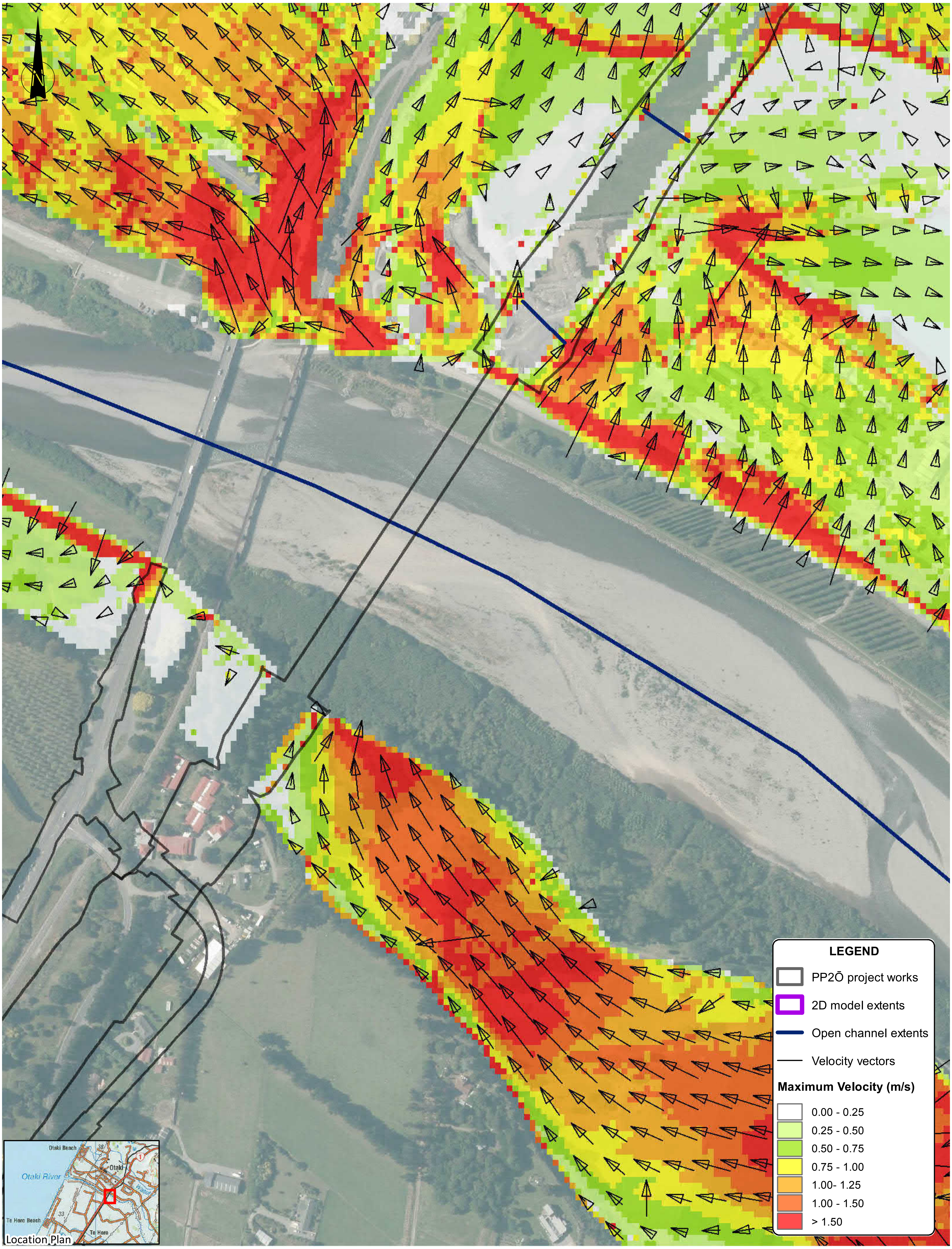
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 0.04% AEP CC2130

FIGURE No. Figure 39.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig39_2_OM_ModelResultsV_2500yrCCZmd.mxd Date: 10/05/2018 Time: 6:09:54 p.m.



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- All levels are New Zealand Vertical Datum 2009.
- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig39_2_OM_ModelResultsV_2500yrCCZmd.mxd

SCALE (AT A3 SIZE) 1:3,000

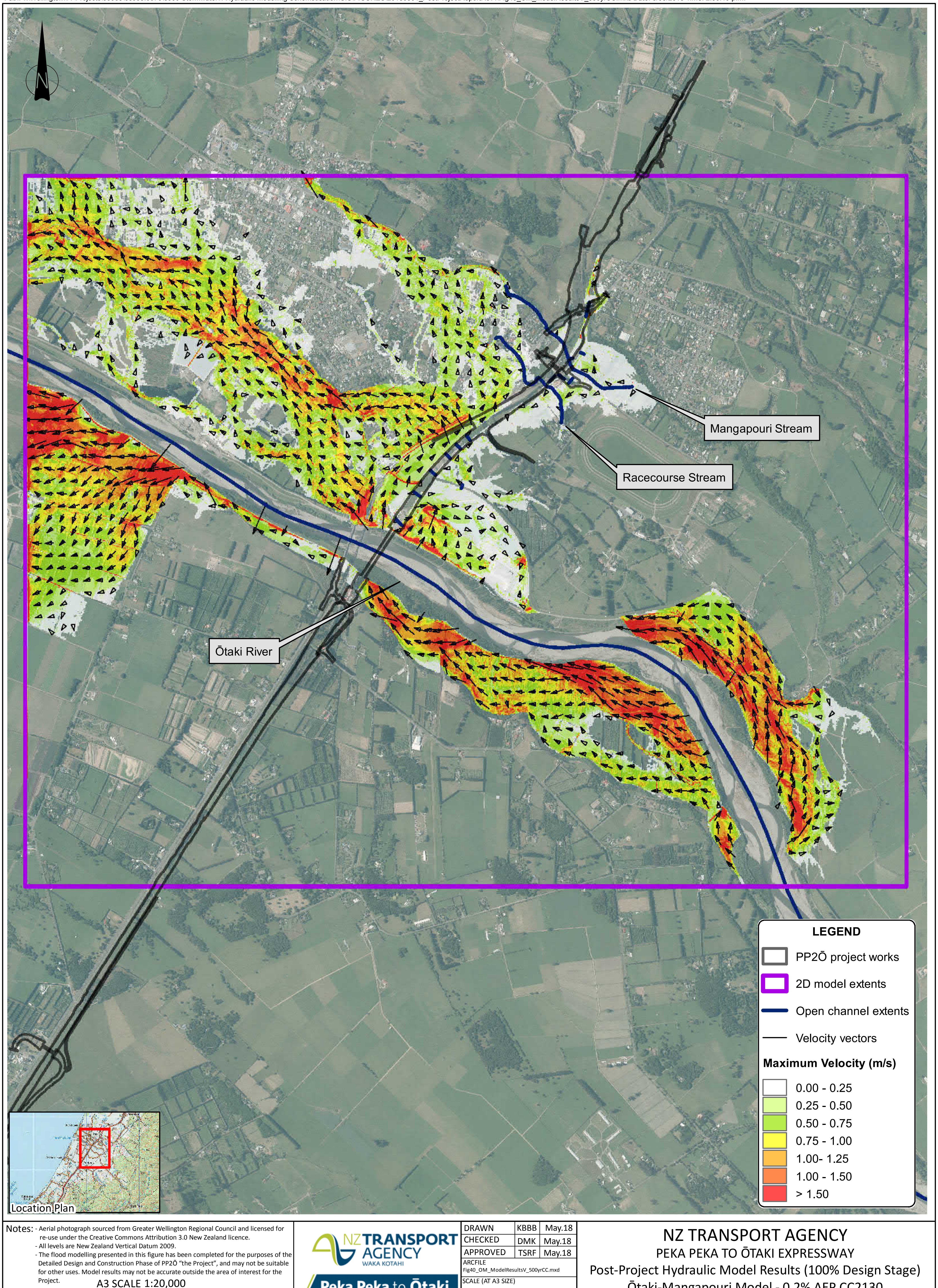
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 0.04% AEP CC2130

FIGURE No. Figure 39.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig40_OM_ModelResultsV_500yrCC.mxd Date: 8/05/2018 Time: 2:53:19 p.m.



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- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig40_OM_ModelResultsV_500yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

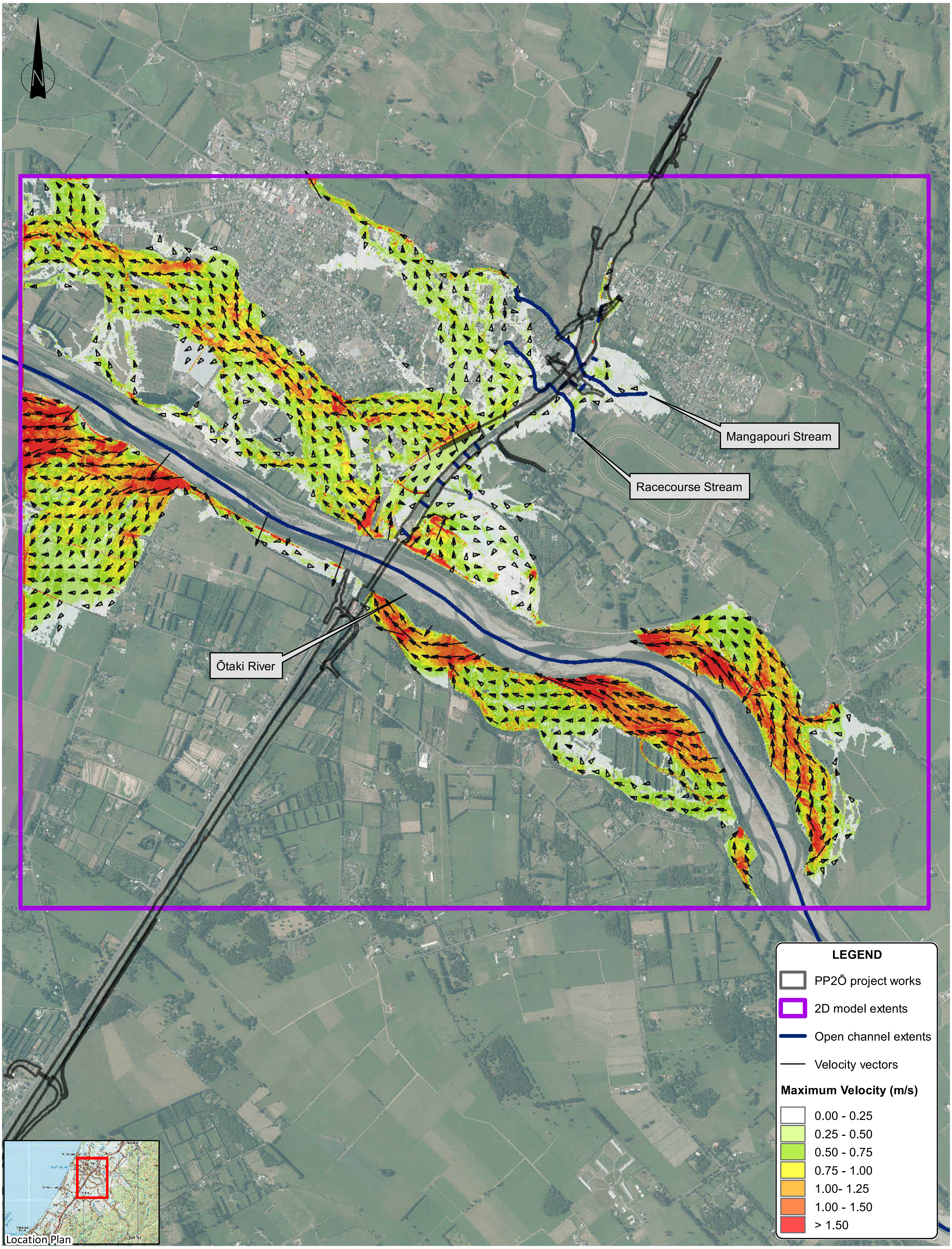
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 0.2% AEP CC2130

FIGURE No. Figure 40

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig41_OM_ModelResultsV_100yrCCHR.mxd Date: 8/05/2018 Time: 2:54:01 p.m.



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- All levels are New Zealand Vertical Datum 2009.
- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig41_OM_ModelResultsV_100yrCCHR.mxd

SCALE (AT A3 SIZE)
1:20,000

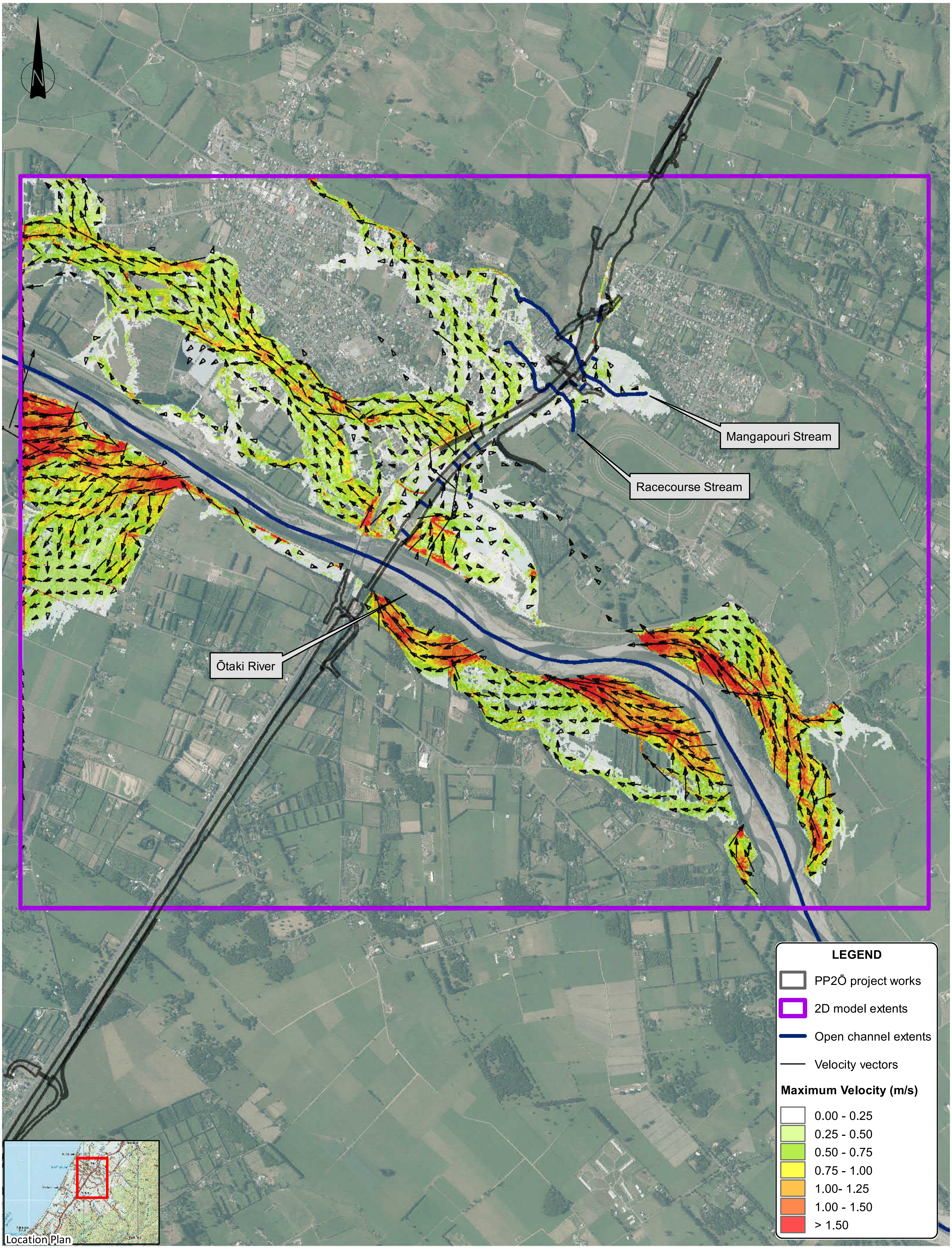
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP CC2130 (High Range)

FIGURE No.
Figure 41

Rev.
0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig42_1_OM_ModelResultsV_100yrCC.mxd Date: 8/05/2018 Time: 2:54:38 p.m.



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- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig42_1_OM_ModelResultsV_100yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

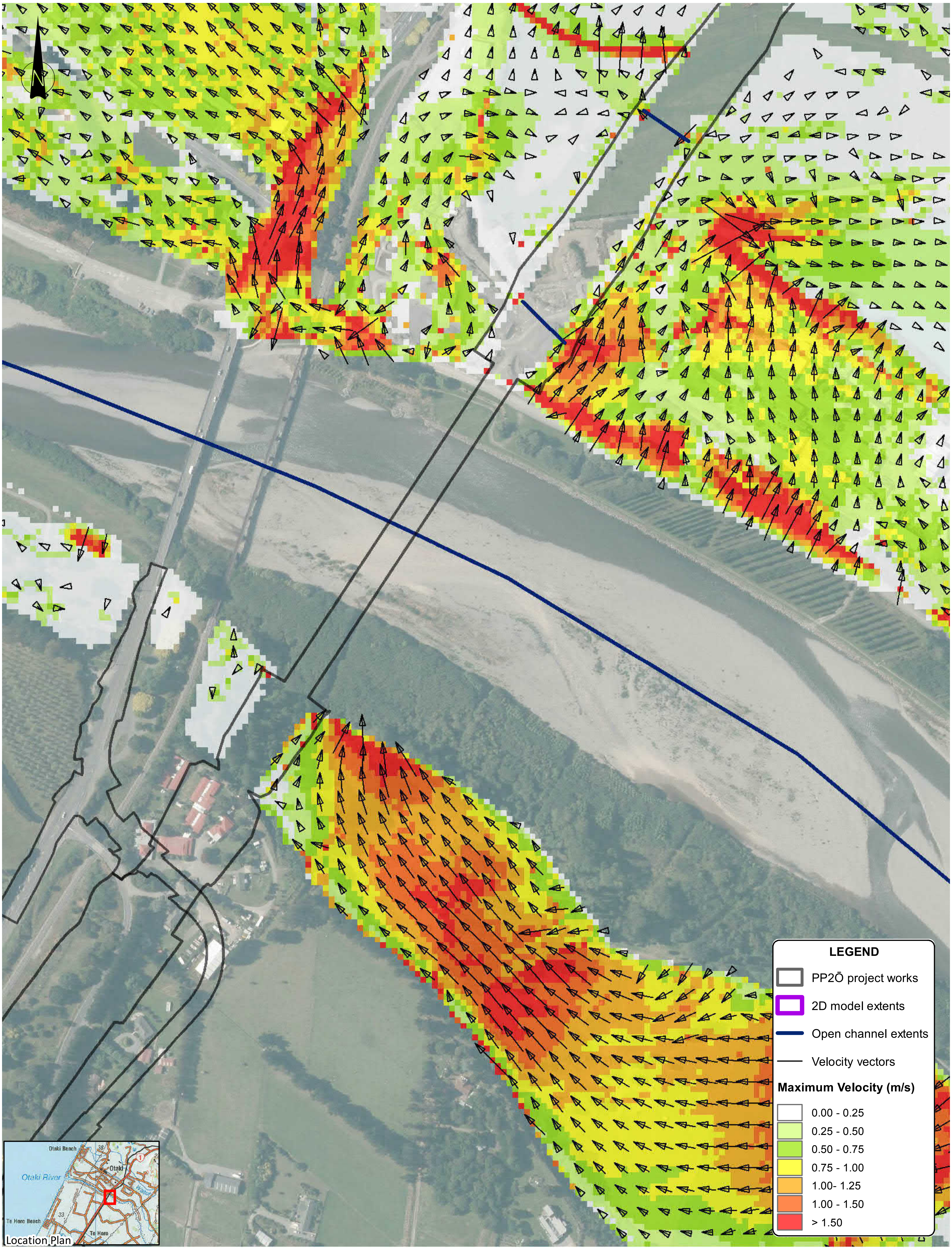
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP CC2130

FIGURE No. Figure 42.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig42_2_OM_ModelResultsV_100yrCCZmd.mxd Date: 8/05/2018 Time: 2:55:10 p.m.



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- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:3,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig42_2_OM_ModelResultsV_100yrCCZmd.mxd

SCALE (AT A3 SIZE) 1:3,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

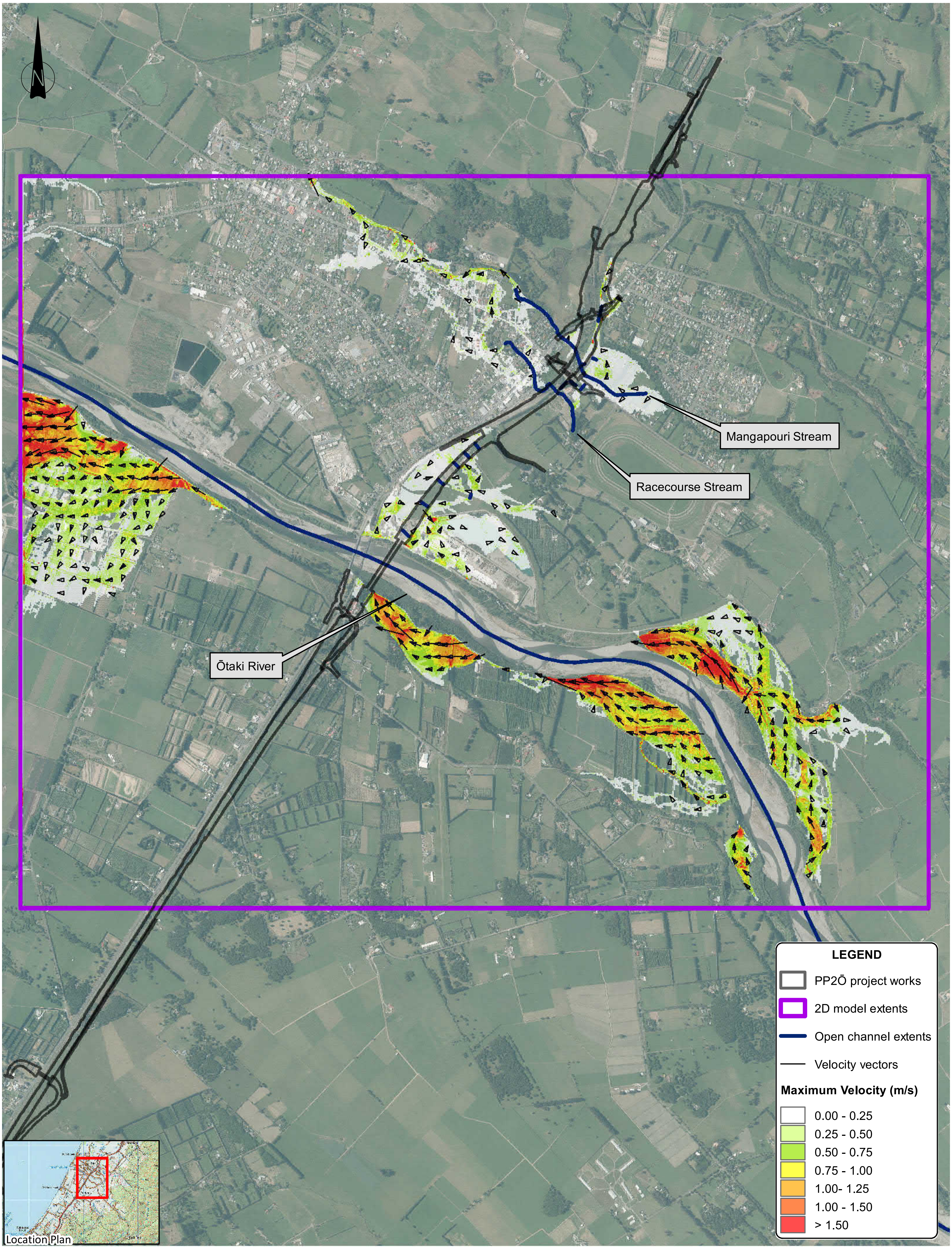
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 1% AEP CC2130

FIGURE No. Figure 42.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig43_OM_ModelResultsV_100yr.mxd Date: 8/05/2018 Time: 2:55:54 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig43_OM_ModelResultsV_100yr.mxd

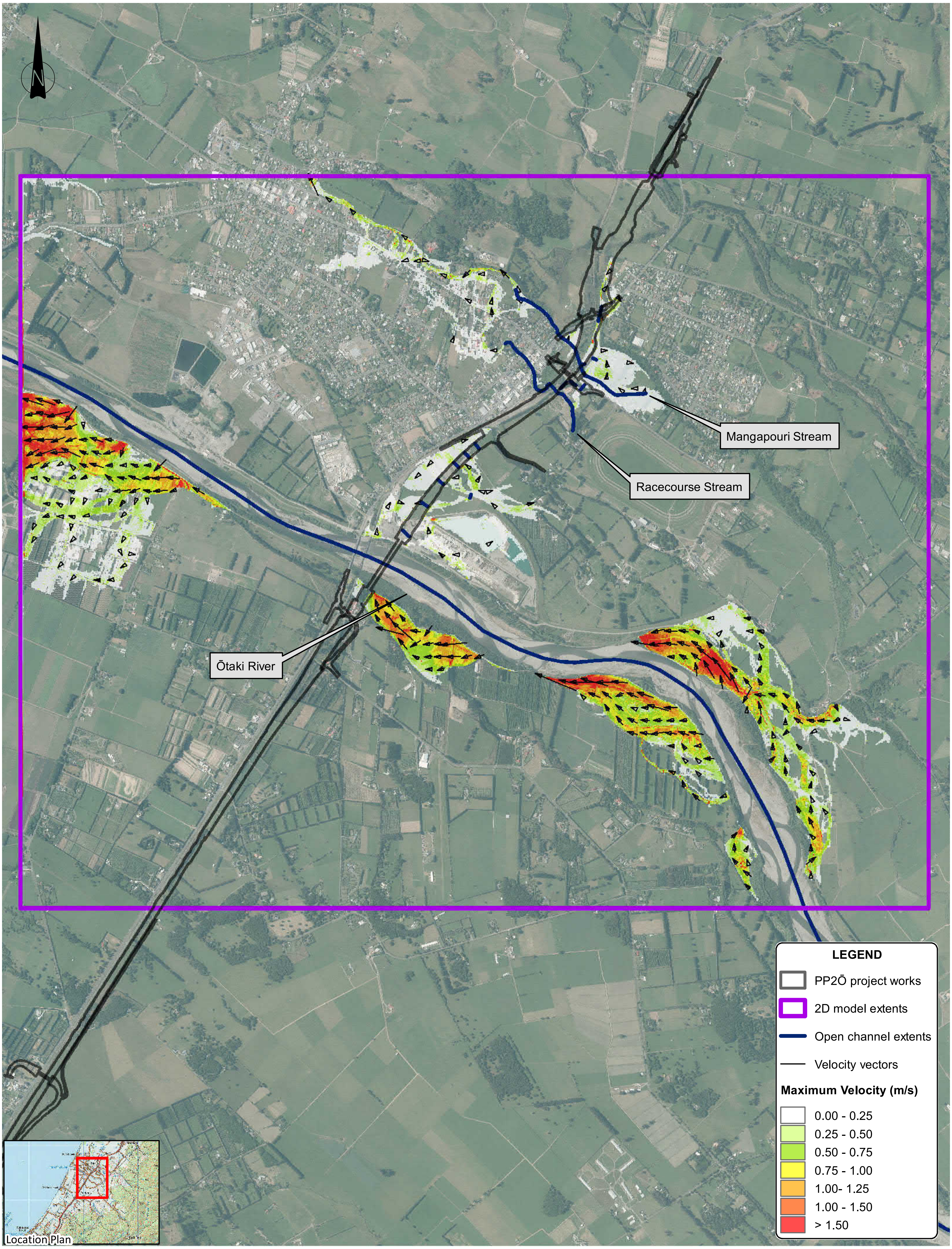
SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 1% AEP

FIGURE No. Figure 43

Rev. 0



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig44_OM_ModelResultsV_50yr.mxd

SCALE (AT A3 SIZE)
1:20,000

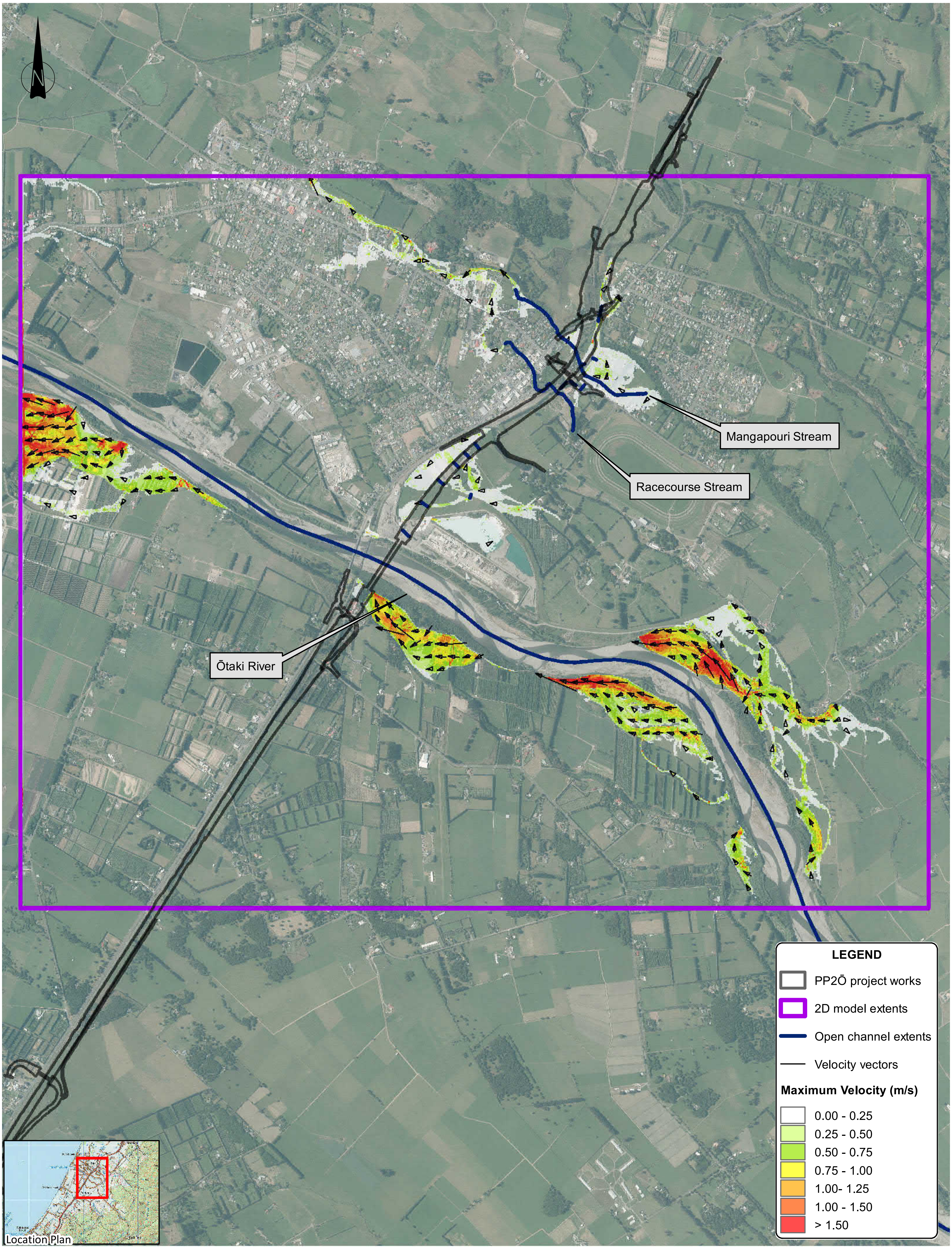
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 2% AEP

FIGURE No. Figure 44

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig45_OM_ModelResultsV_20yr.mxd Date: 8/05/2018 Time: 2:57:33 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig45_OM_ModelResultsV_20yr.mxd

SCALE (AT A3 SIZE)
1:20,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

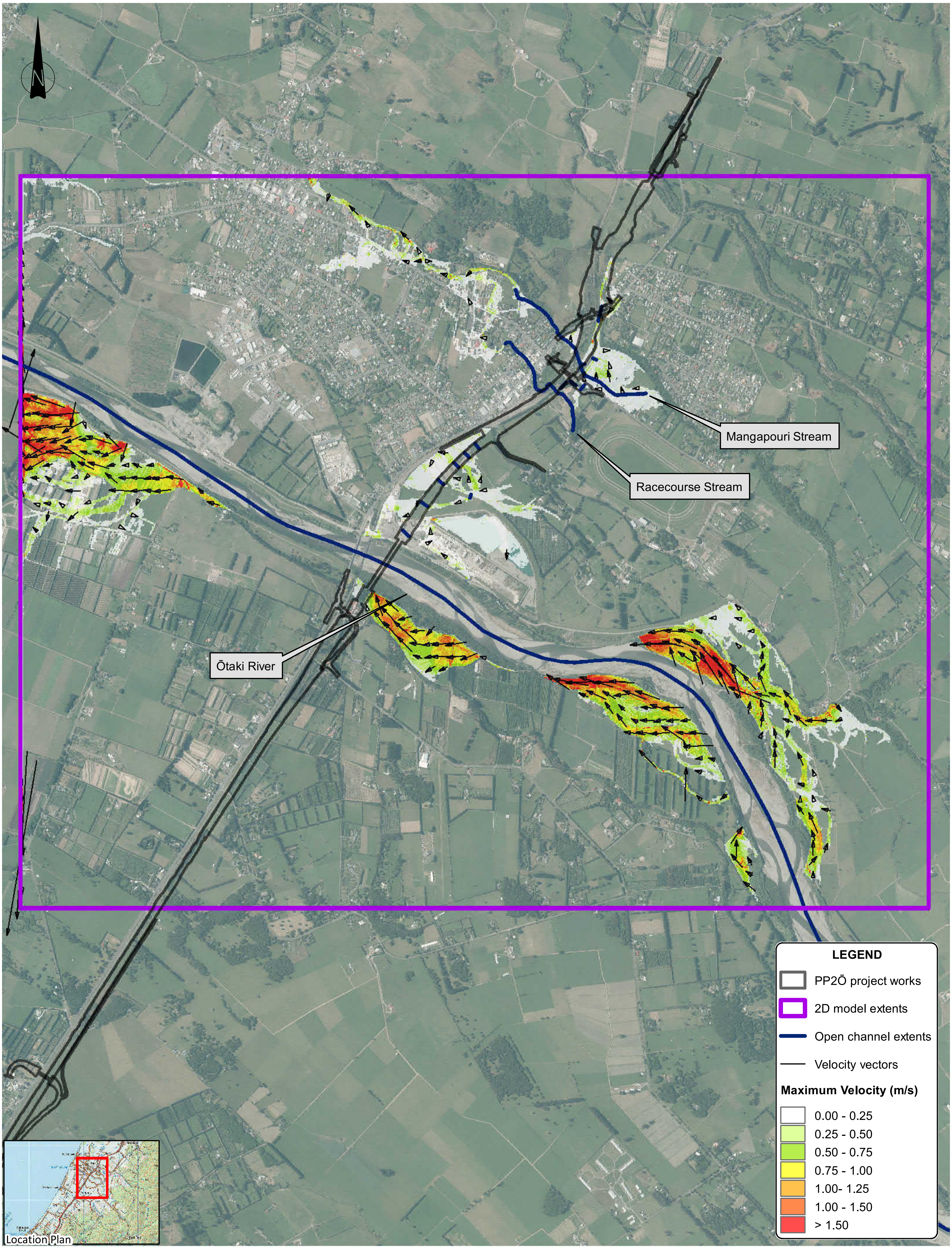
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 5% AEP

FIGURE No. Figure 45

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig46_OM_ModelResultsV_10yrCC.mxd Date: 8/05/2018 Time: 2:58:03 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig46_OM_ModelResultsV_10yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

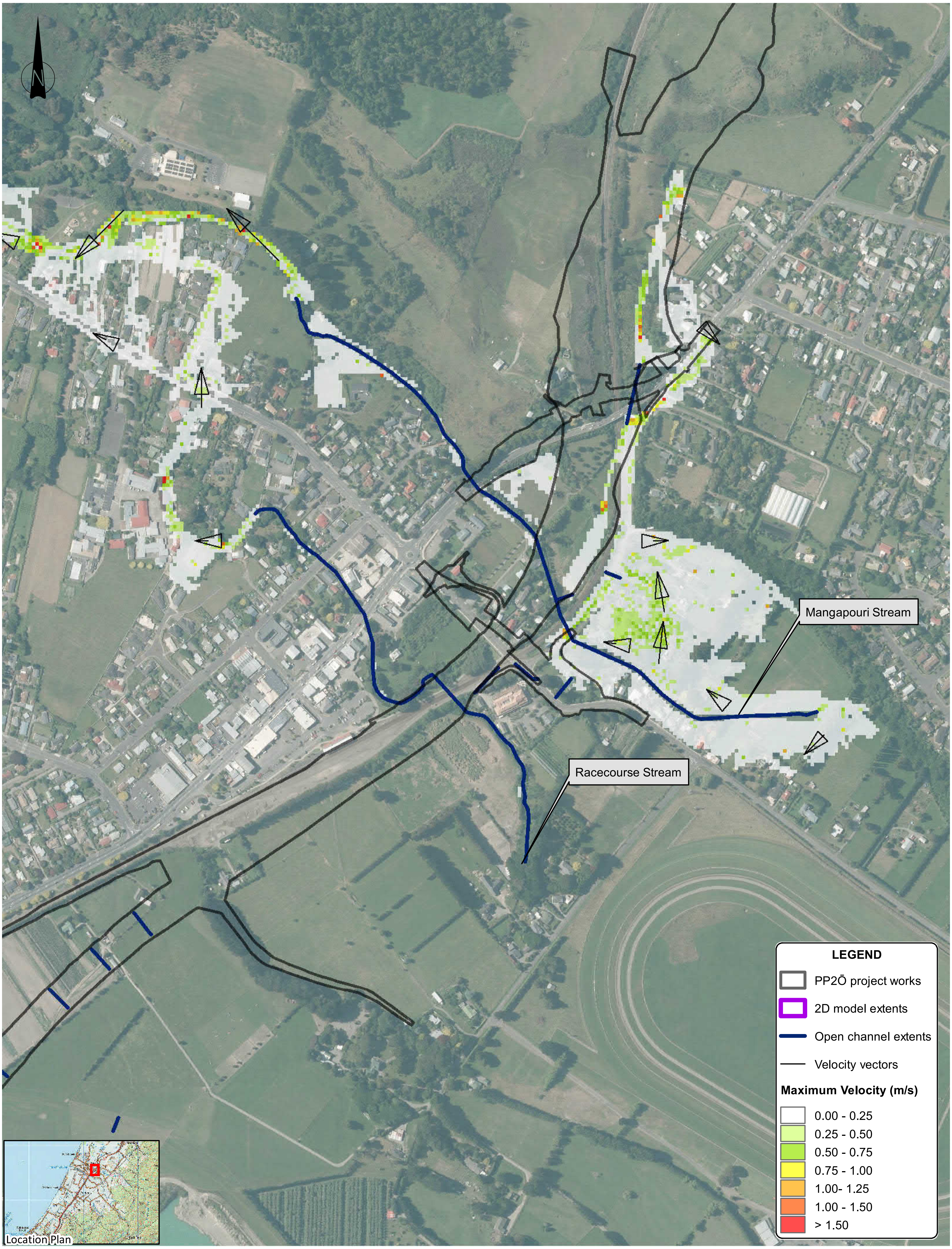
Post-Project Hydraulic Model Results (100% Design Stage)

Ōtaki-Mangapouri Model - 10% AEP CC2130

FIGURE No. Figure 46

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig47_OM_ModelResultsV_10yr.mxd Date: 8/05/2018 Time: 2:58:47 p.m.



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- All levels are New Zealand Vertical Datum 2009.
- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:5,000

0 50 100 150 200 250 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig47_OM_ModelResultsV_10yr.mxd

SCALE (AT A3 SIZE)
1:5,000

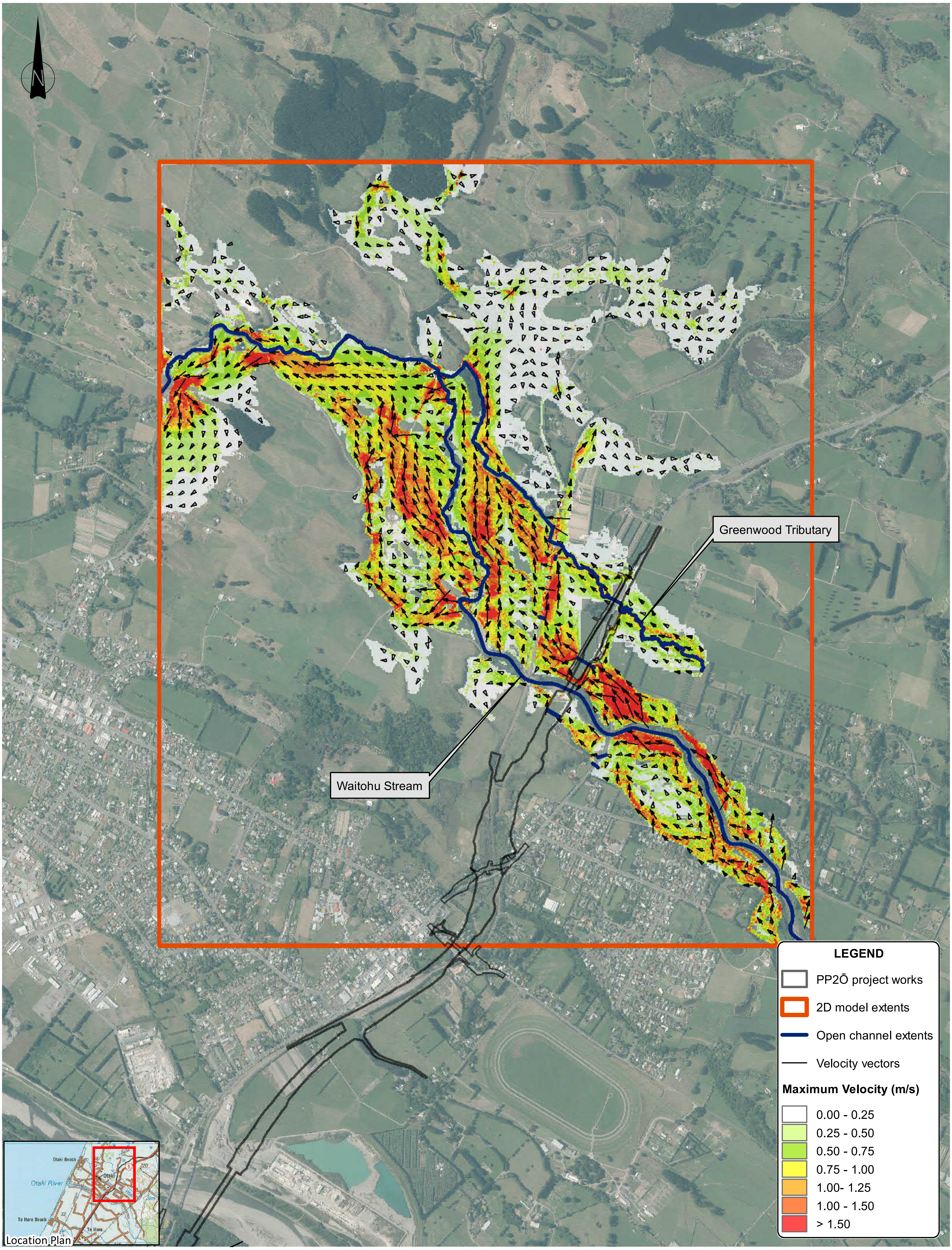
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Ōtaki-Mangapouri Model - 10% AEP (Mangapouri only)

FIGURE No. Figure 47

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig48_1_Wai_ModelResultsV_2500yrCC.mxd Date: 8/05/2018 Time: 3:01:43 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig48_1_Wai_ModelResultsV_2500yrCC.mxd

SCALE (AT A3 SIZE) 1:15,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

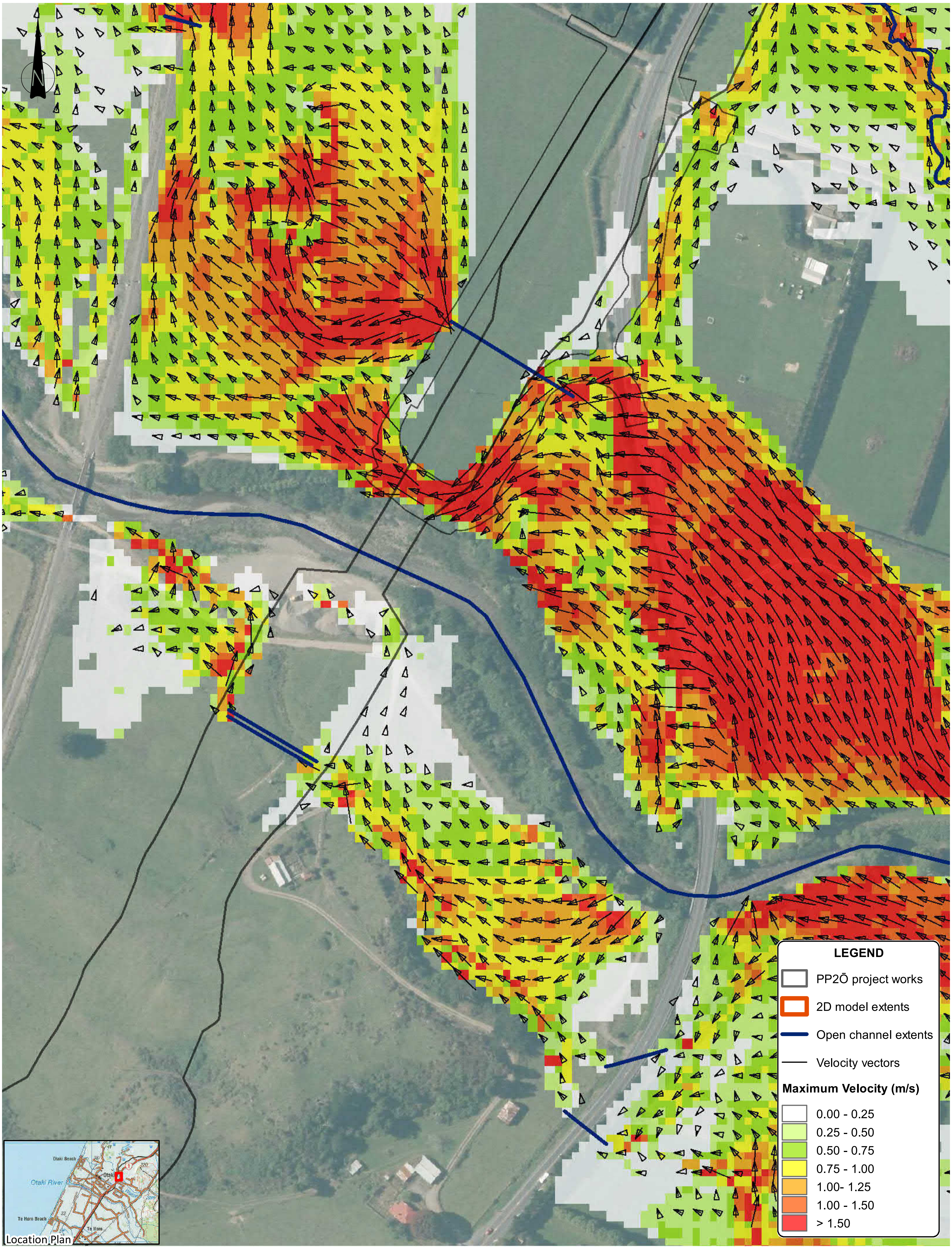
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 0.04% AEP CC2130

FIGURE No. Figure 48.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig48_2_Wai_ModelResultsV_2500yrCCZmd.mxd Date: 8/05/2018 Time: 3:15:09 p.m.



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A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig48_2_Wai_ModelResultsV_2500yrCCZmd.mxd

SCALE (AT A3 SIZE) 1:2,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

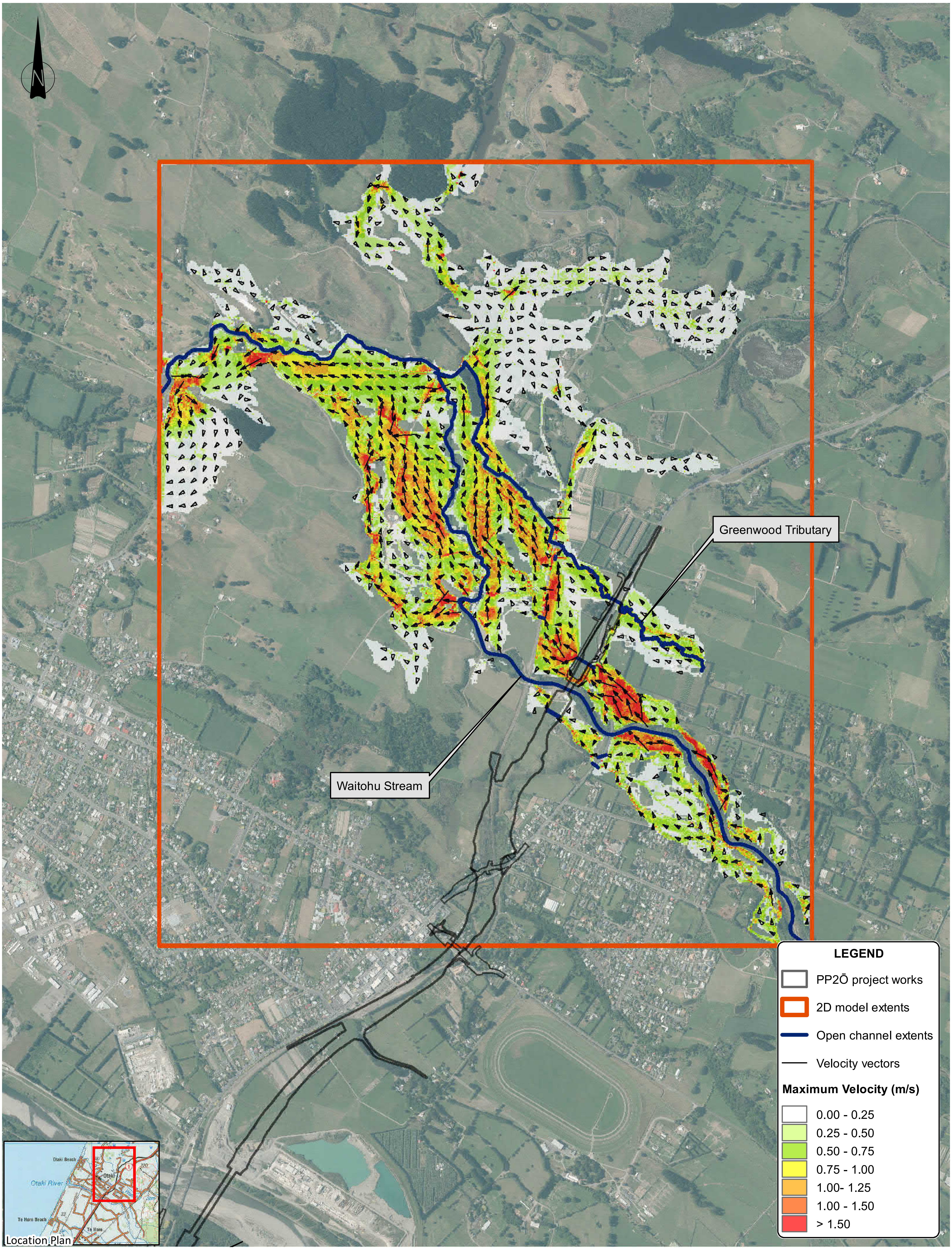
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 0.04% AEP CC2130

FIGURE No. Figure 48.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig49_Wai_ModelResultsV_100yrCCHR.mxd Date: 8/05/2018 Time: 3:07:02 p.m.



Notes:
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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig49_Wai_ModelResultsV_100yrCCHR.mxd

SCALE (AT A3 SIZE) 1:15,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

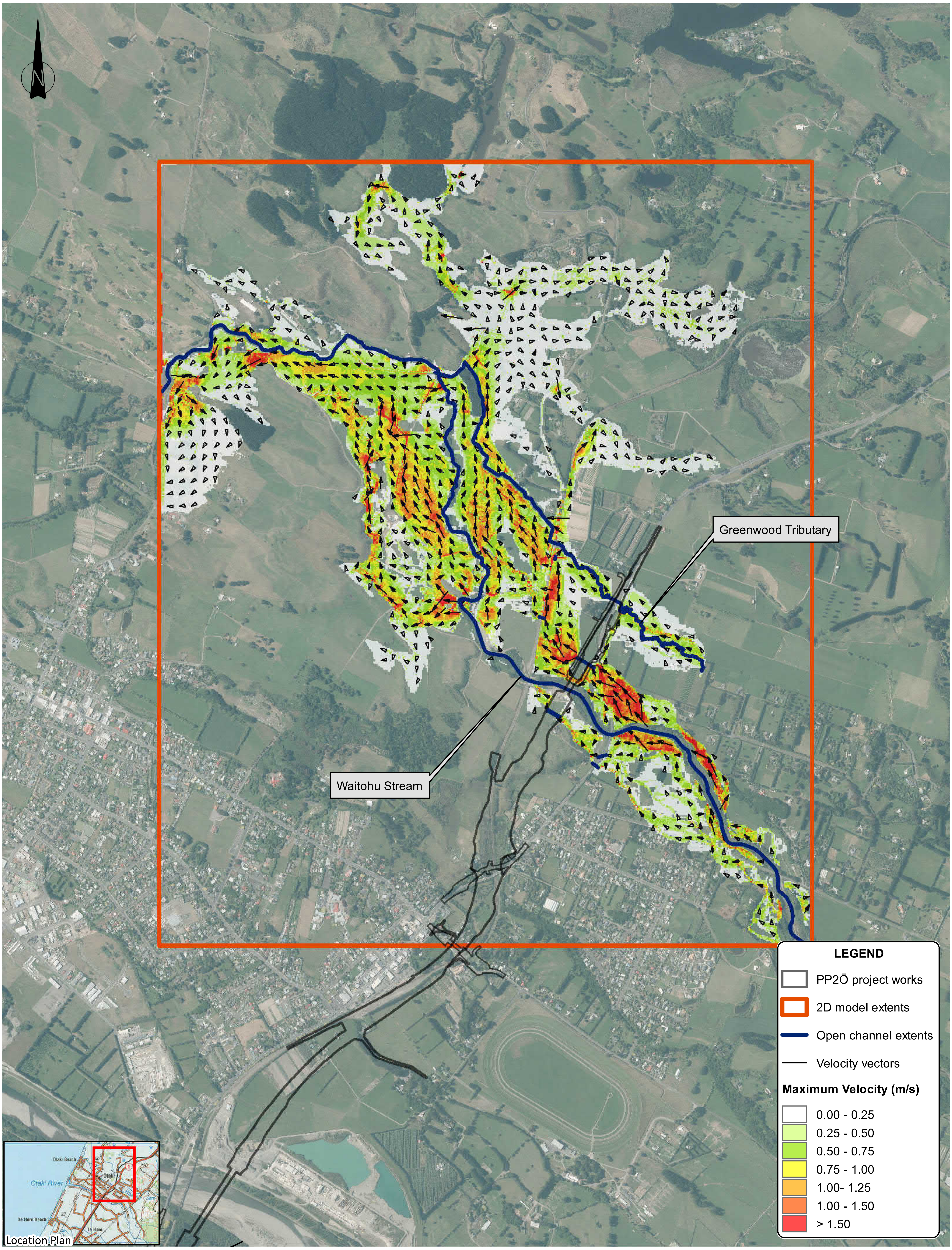
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 49

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig50_1_Wai_ModelResultsV_100yrCC.mxd Date: 8/05/2018 Time: 3:09:16 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig50_1_Wai_ModelResultsV_100yrCC.mxd

SCALE (AT A3 SIZE) 1:15,000

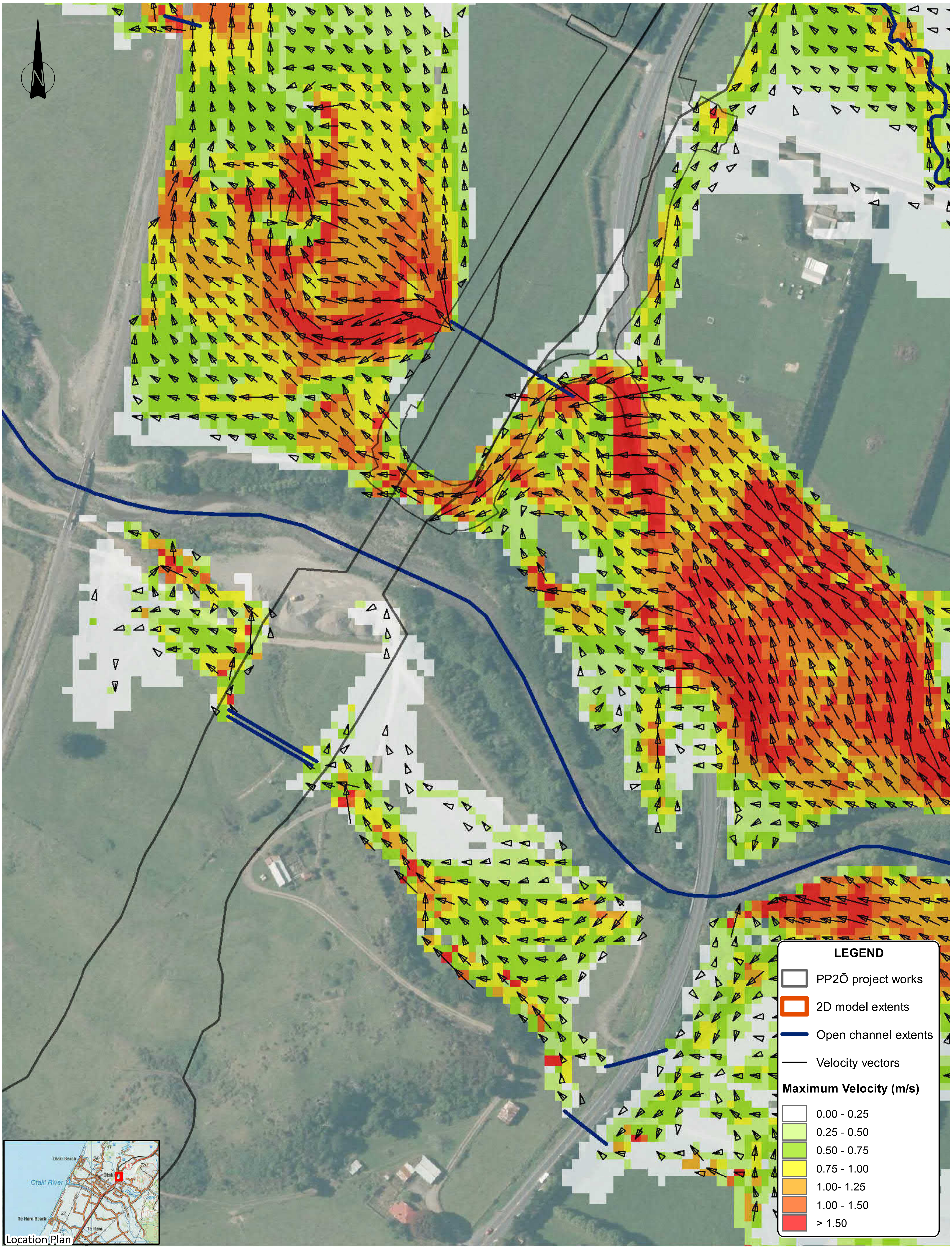
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 1% AEP CC2130

FIGURE No. Figure 50.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig50_2_Wai_ModelResultsV_100yrCCZmd.mxd Date: 8/05/2018 Time: 3:14:23 p.m.



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A3 SCALE 1:2,000

0 20 40 60 80 100 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig50_2_Wai_ModelResultsV_100yrCCZmd.mxd

SCALE (AT A3 SIZE) 1:2,000

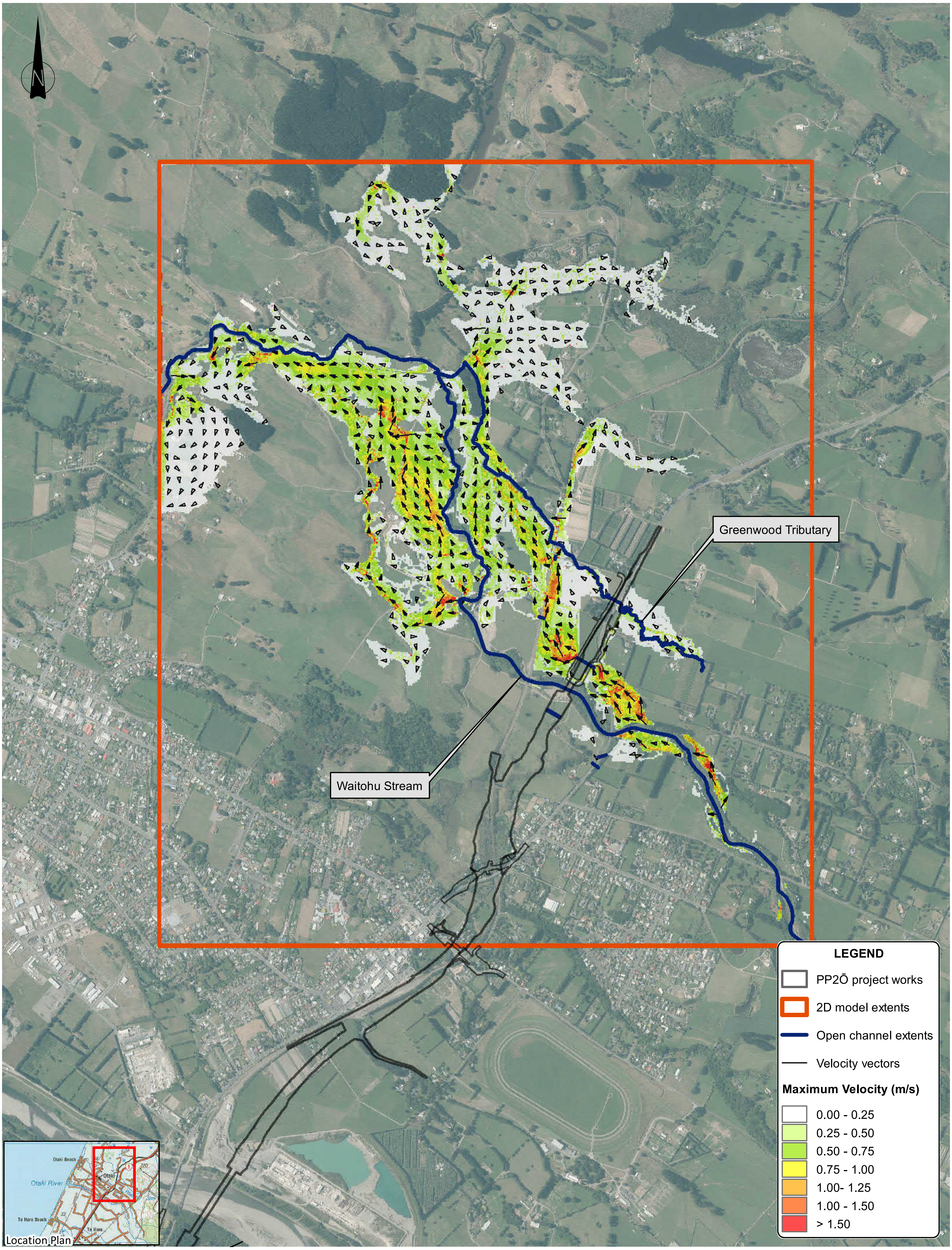
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 1% AEP CC2130

FIGURE No. Figure 50.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig51_Wai_ModelResultsV_20yr.mxd Date: 8/05/2018 Time: 3:16:52 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig51_Wai_ModelResultsV_20yr.mxd

SCALE (AT A3 SIZE) 1:15,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

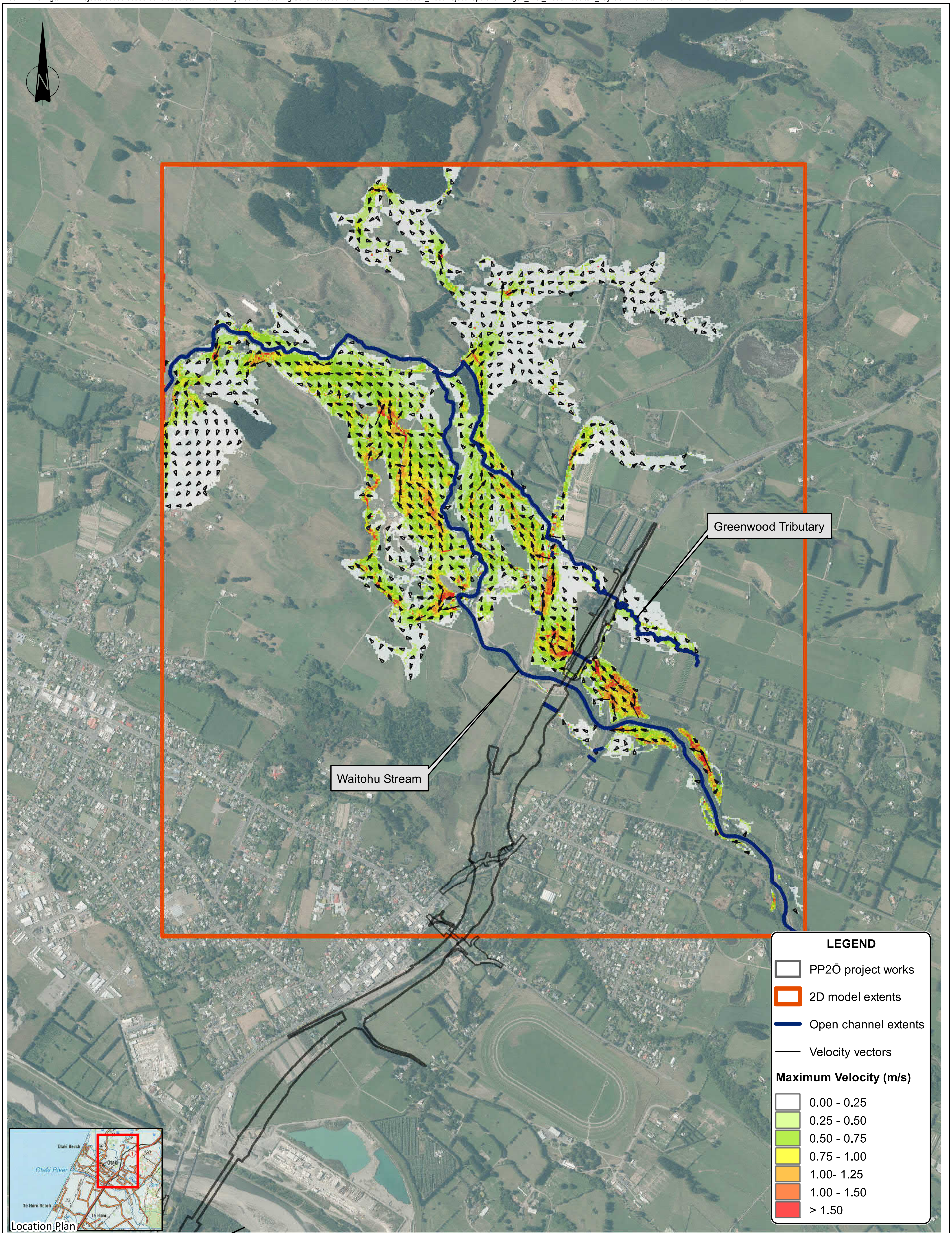
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 5% AEP

FIGURE No. Figure 51

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig52_Wai_ModelResultsV_10yrCC.mxd Date: 8/05/2018 Time: 3:18:22 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig52_Wai_ModelResultsV_10yrCC.mxd

SCALE (AT A3 SIZE)
1:15,000

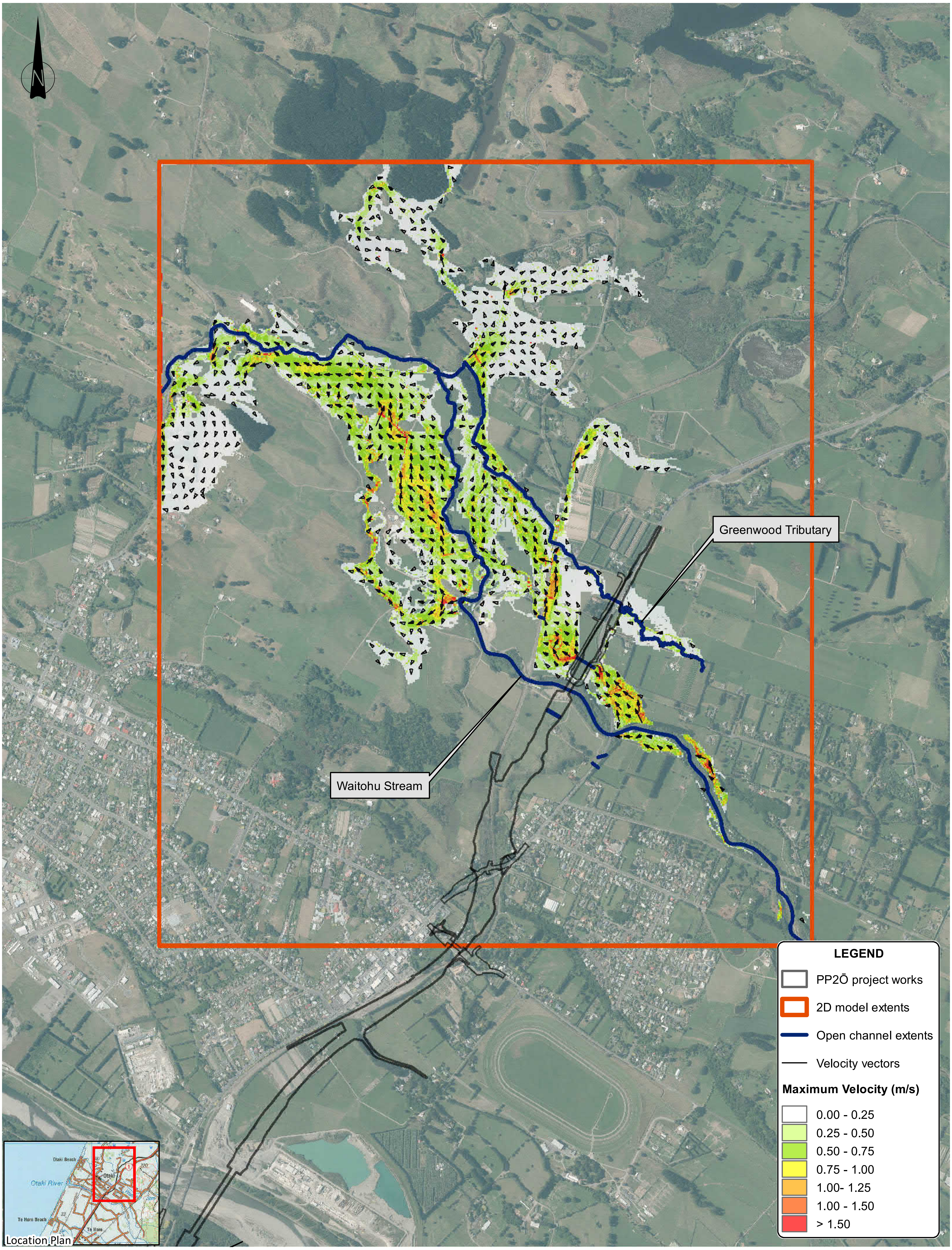
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Waitohu Model - 10% AEP CC2130

FIGURE No. Figure 52

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig53_Wai_ModelResultsV_10yr.mxd Date: 8/05/2018 Time: 3:20:15 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig53_Wai_ModelResultsV_10yr.mxd

SCALE (AT A3 SIZE)
1:15,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

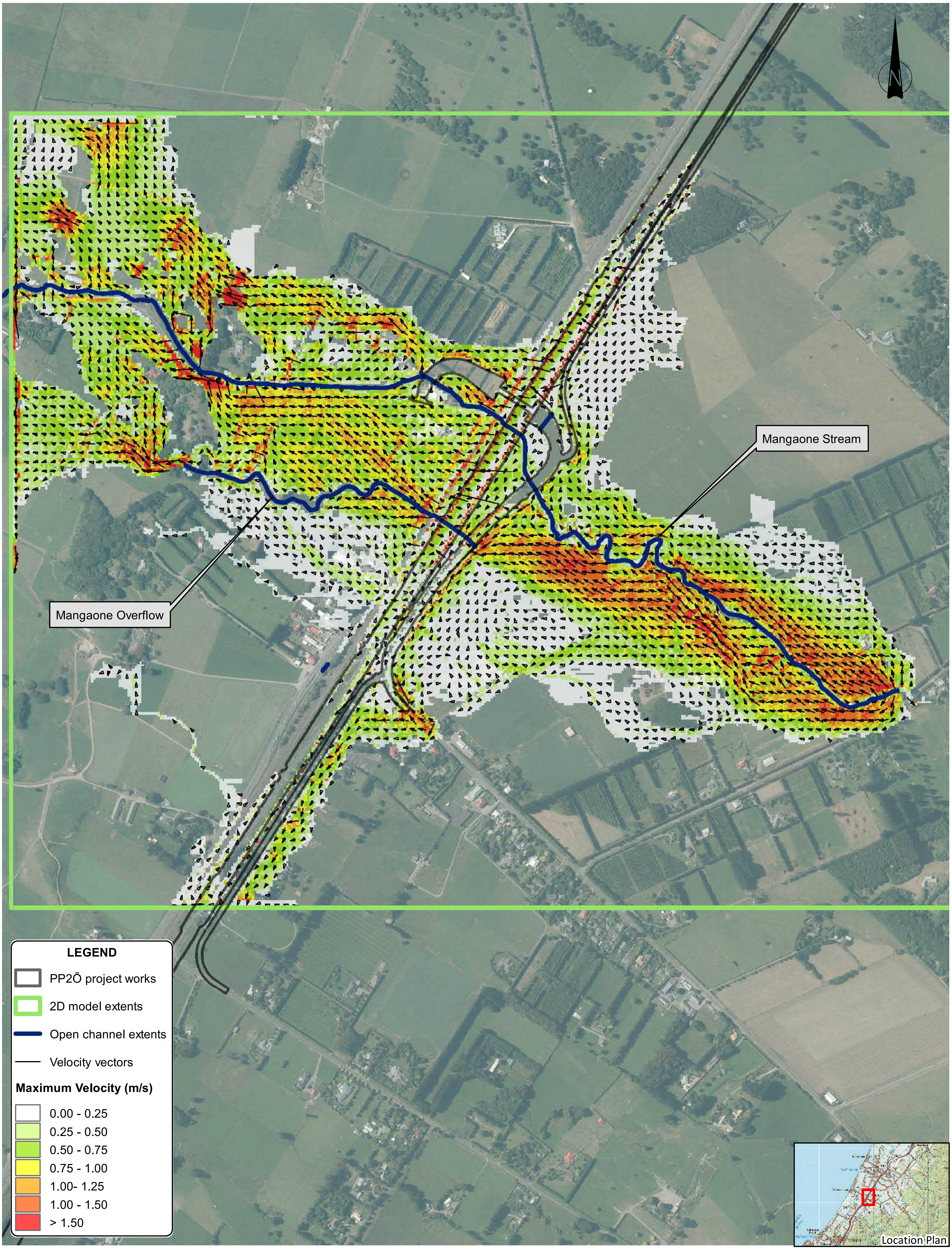
Post-Project Hydraulic Model Results (100% Design Stage)

Waitohu Model - 10% AEP

FIGURE No. Figure 53

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig54_Mang_ModelResultsV_2500yrCC.mxd Date: 8/05/2018 Time: 3:23:28 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig54_Mang_ModelResultsV_2500yrCC.mxd

SCALE (AT A3 SIZE)
1:7,500

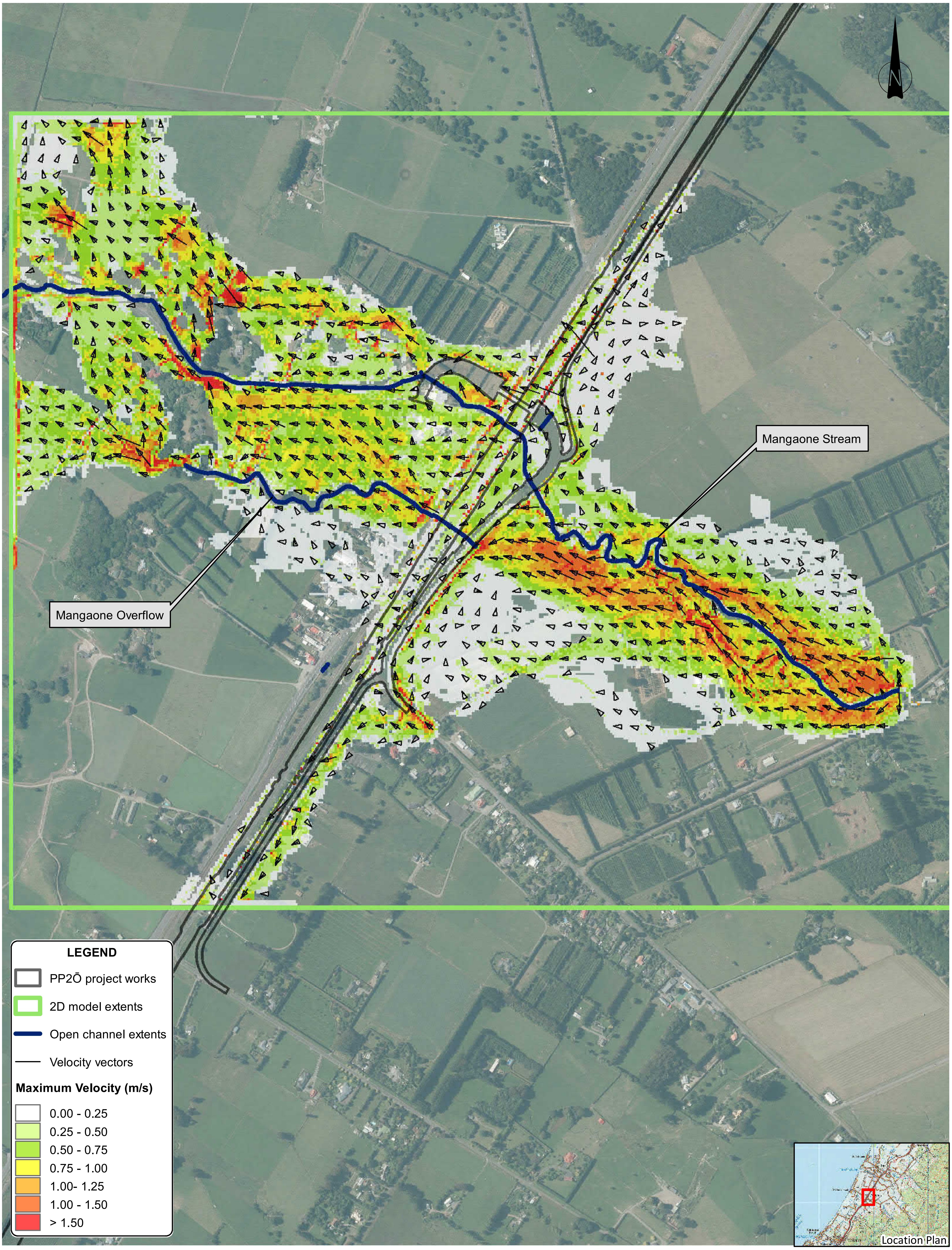
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 0.04% AEP CC2130

FIGURE No. Figure 54

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig55_Mang_ModelResultsV_1000yrCC.mxd Date: 8/05/2018 Time: 3:24:39 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig55_Mang_ModelResultsV_1000yrCC.mxd

SCALE (AT A3 SIZE): 1:7,500

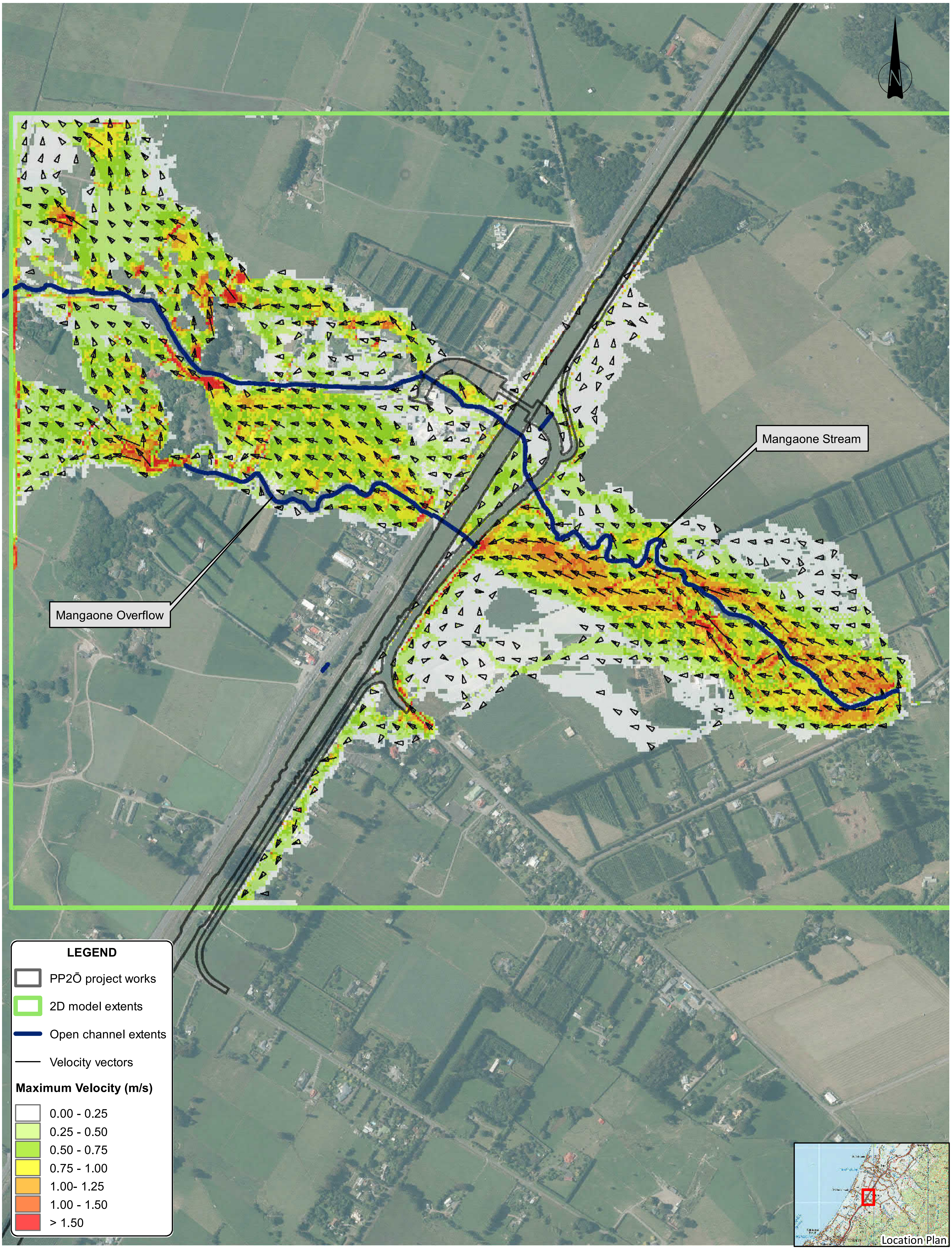
PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 0.1% AEP CC2130

FIGURE No. Figure 55

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig56_Mang_ModelResultsV_100yrCCHR.mxd Date: 8/05/2018 Time: 3:25:55 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig56_Mang_ModelResultsV_100yrCCHR.mxd

SCALE (AT A3 SIZE)
1:7,500

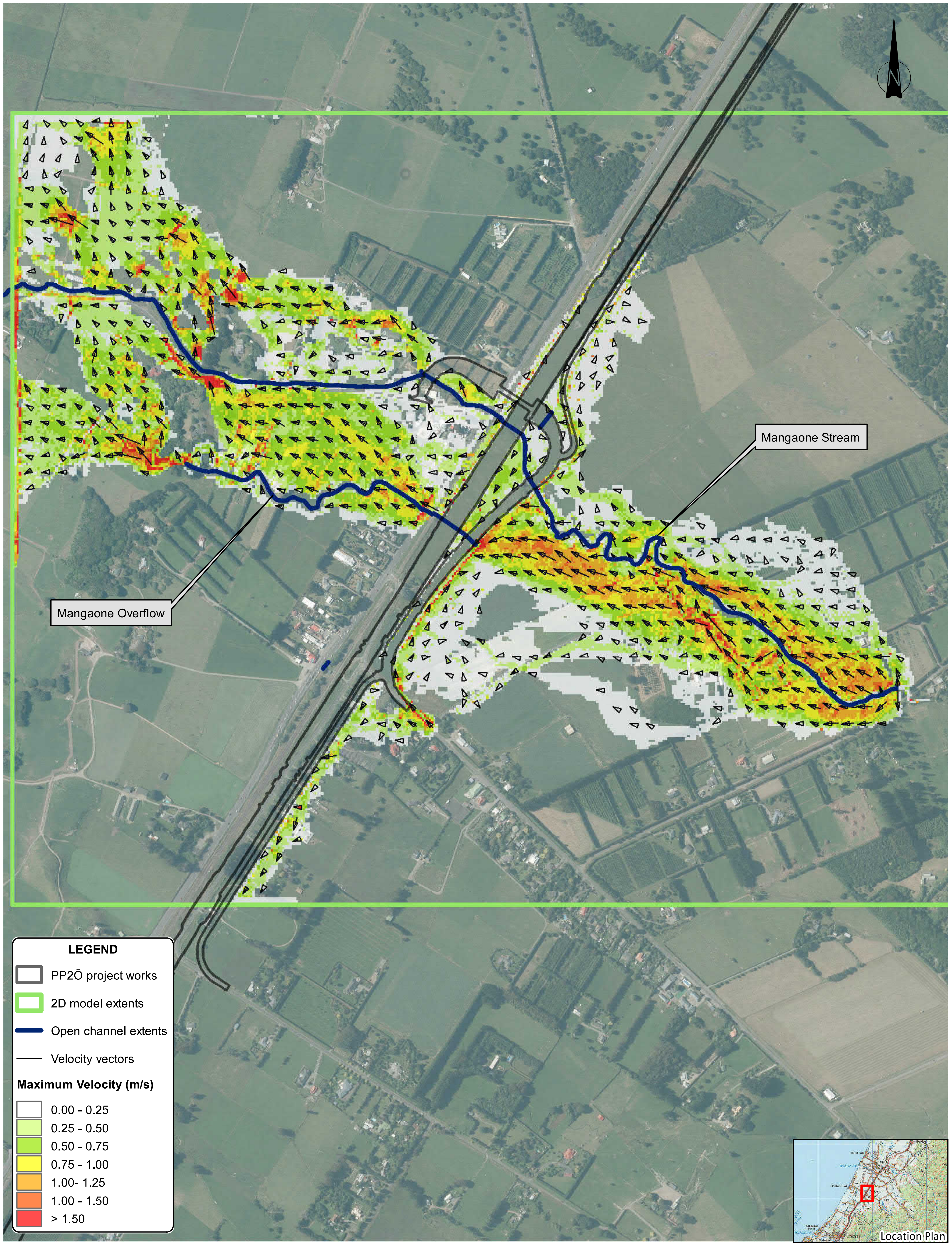
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 1% AEP CC2130 (High Range)

FIGURE No. Figure 56

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig57_Mang_ModelResultsV_100yrCC.mxd Date: 8/05/2018 Time: 3:27:15 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig57_Mang_ModelResultsV_100yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

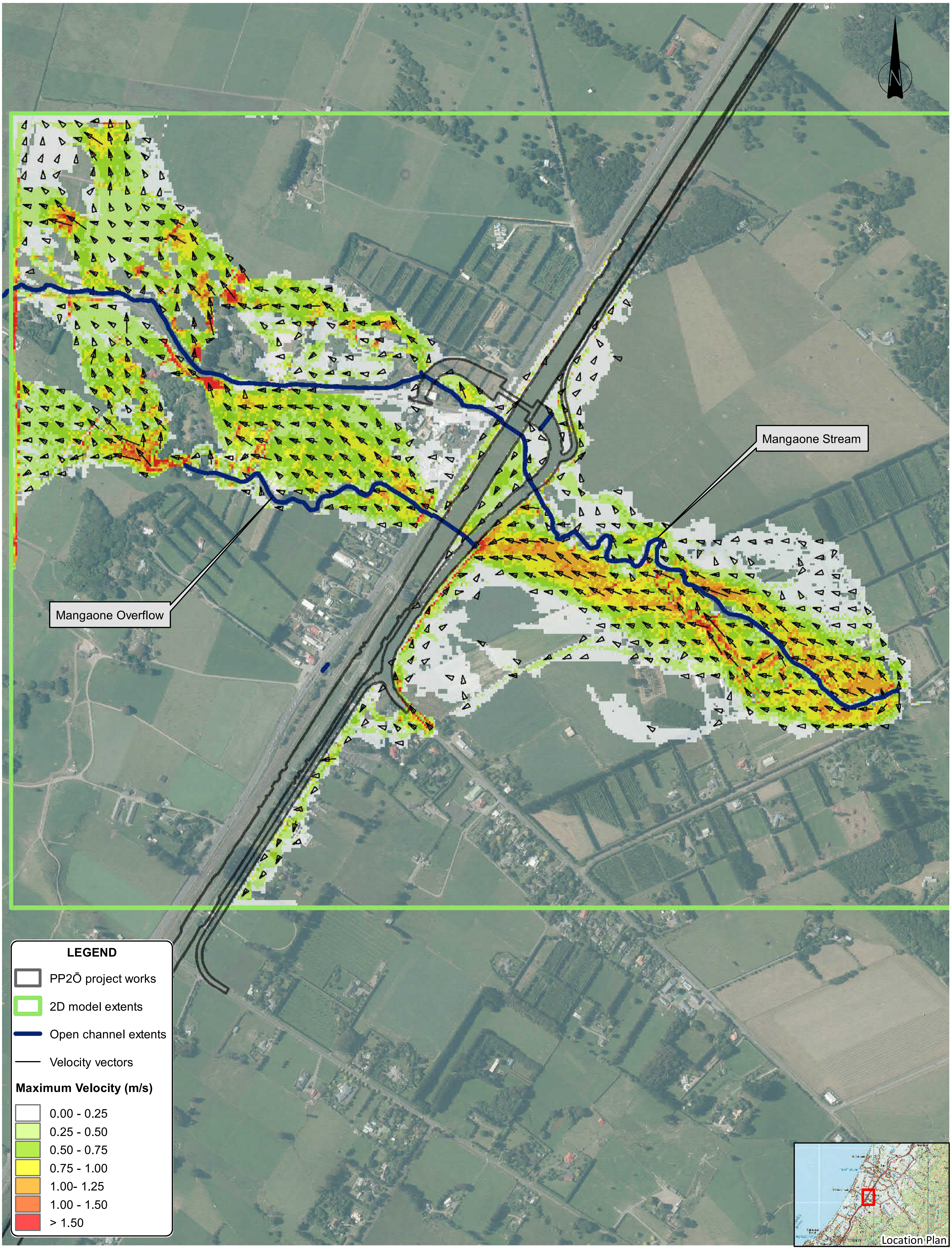
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 1% AEP CC2130

FIGURE No. Figure 57

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig58_Mang_ModelResultsV_50yrCC.mxd Date: 8/05/2018 Time: 3:28:21 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig58_Mang_ModelResultsV_50yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

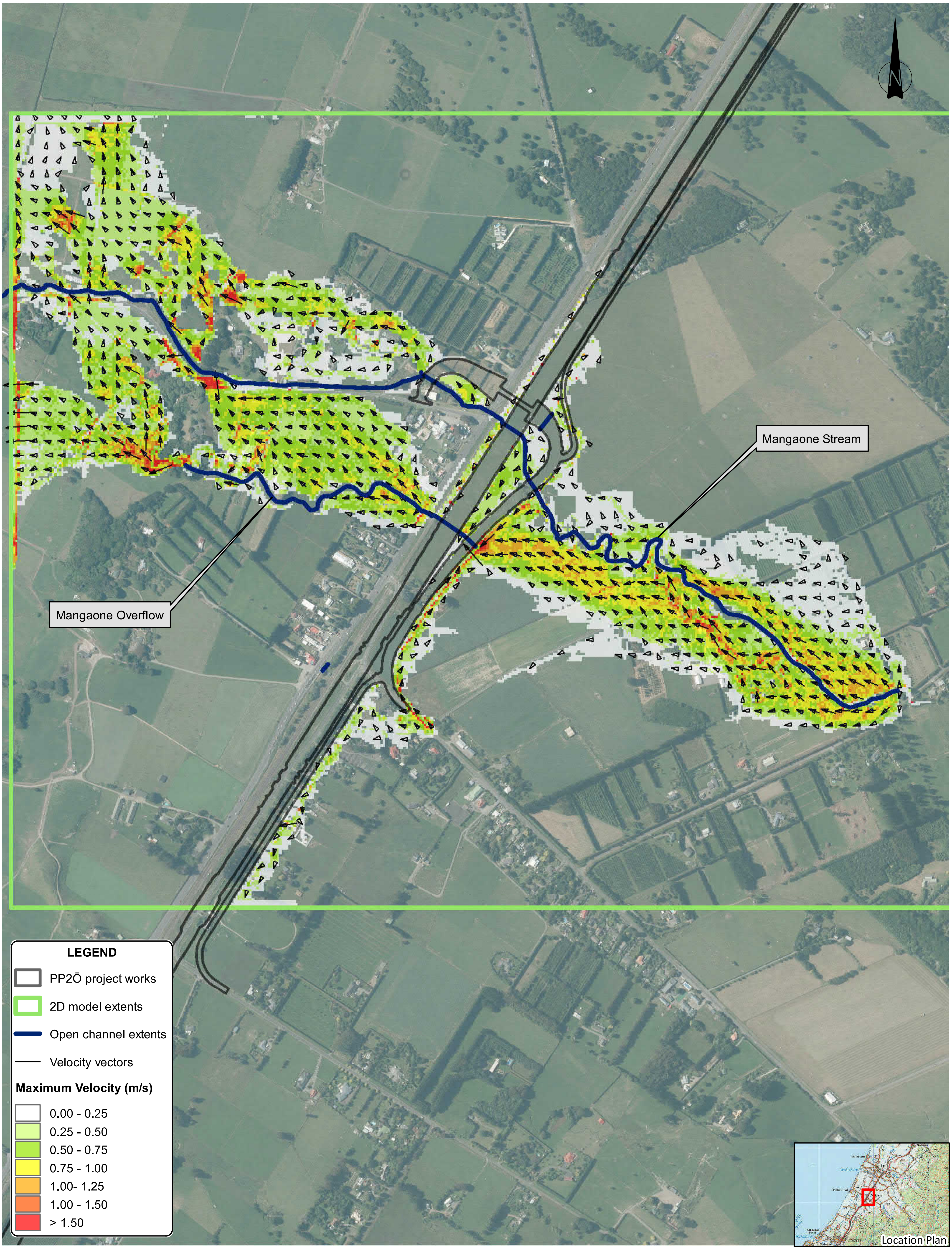
Post-Project Hydraulic Model Results (100% Design Stage)

Mangaone Model - 2% AEP CC2130

FIGURE No. Figure 58

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig59_Mang_ModelResultsV_20yrCC.mxd Date: 8/05/2018 Time: 3:29:50 p.m.



Notes:
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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig59_Mang_ModelResultsV_20yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

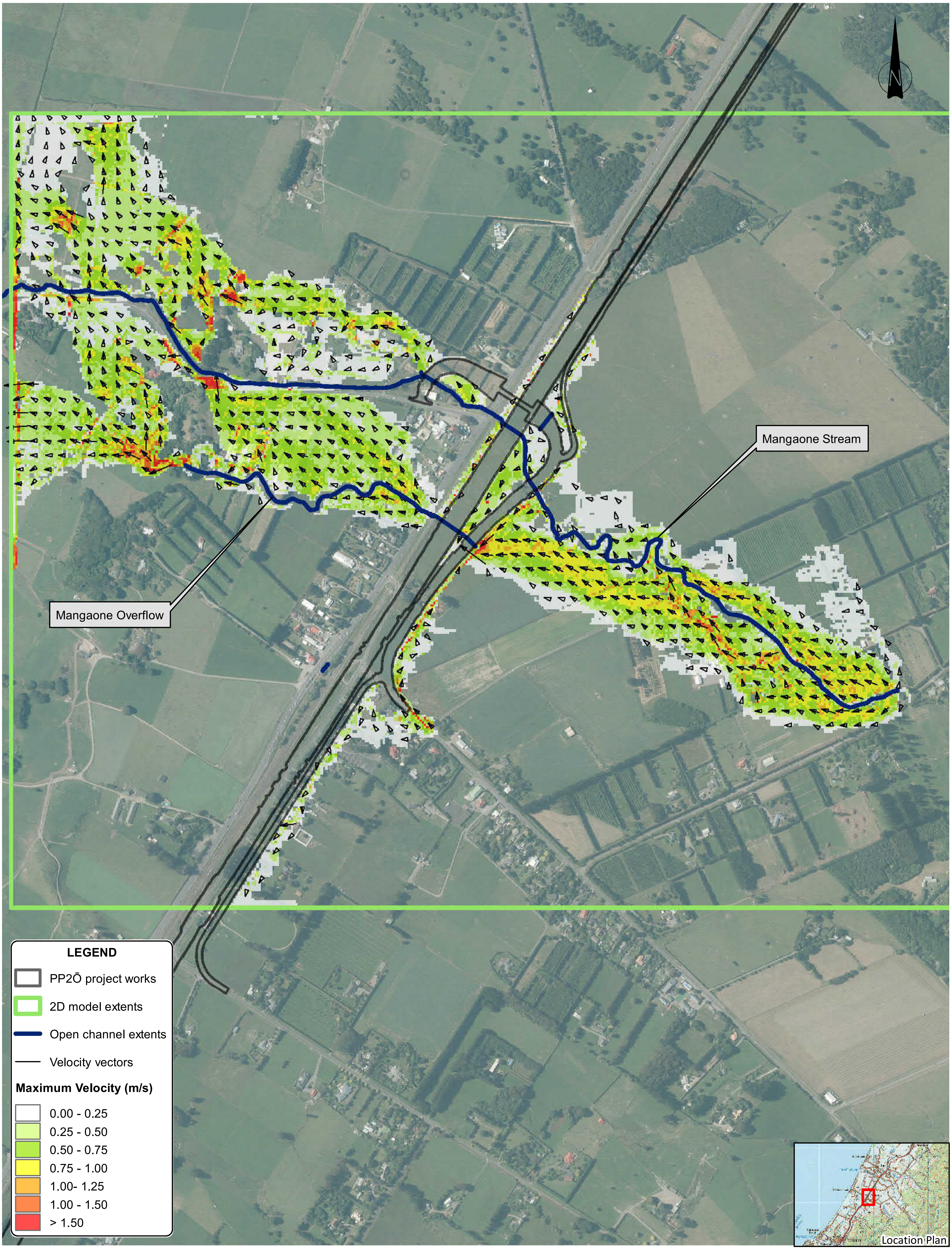
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 5% AEP CC2130

FIGURE No. Figure 59

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig60_Mang_ModelResultsV_10yrCC.mxd Date: 8/05/2018 Time: 3:48:30 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig60_Mang_ModelResultsV_10yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

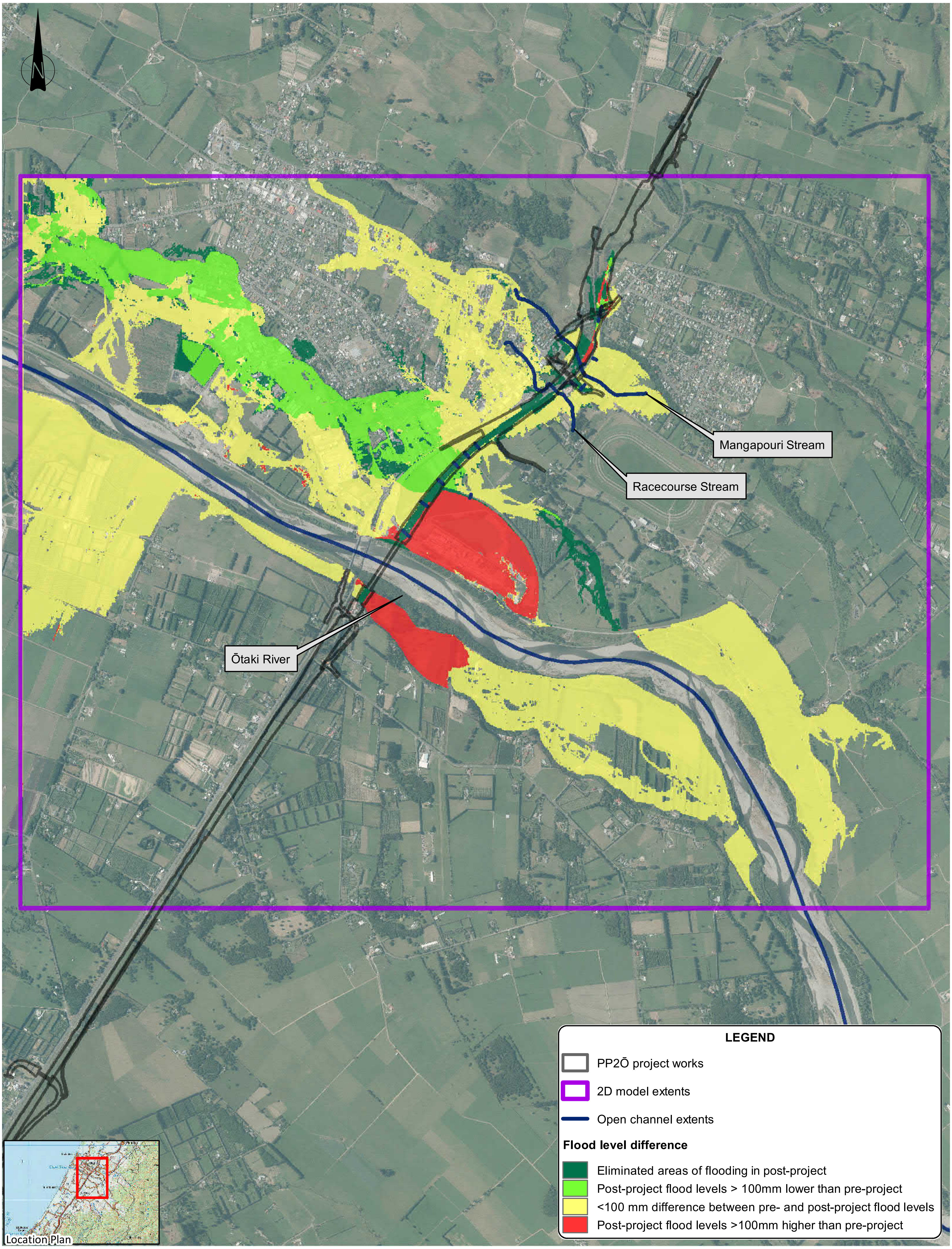
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Post-Project Hydraulic Model Results (100% Design Stage)
Mangaone Model - 10% AEP CC2130

FIGURE No. Figure 60

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig61_1_OM_DiffPlotPostvsPre100mm_100yrCC.mxd Date: 8/05/2018 Time: 3:58:26 p.m.



Notes:
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- All levels are New Zealand Vertical Datum 2009.
- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō “the Project”, and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

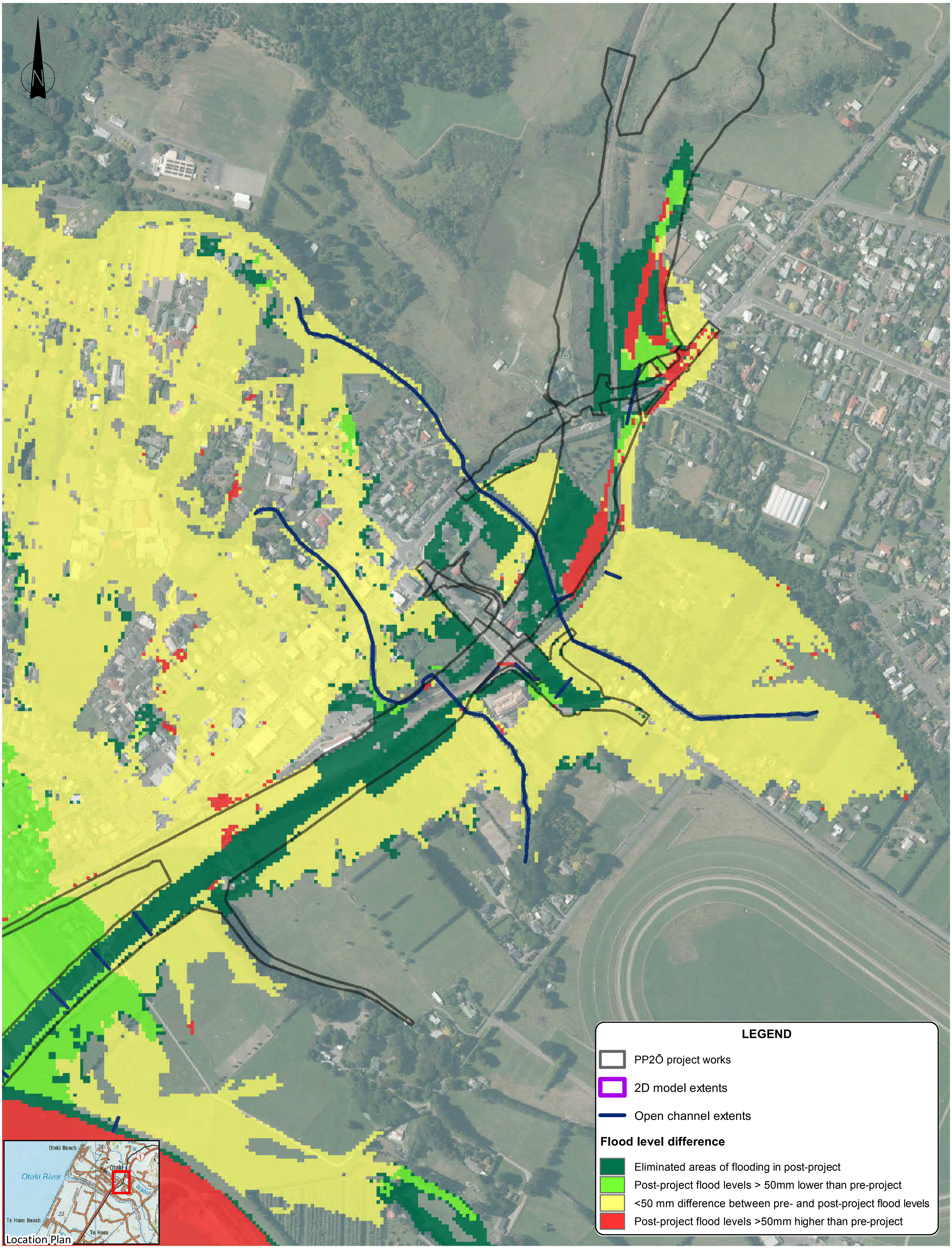
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig61_1_OM_DiffPlotPostvsPre100mm_100yrCC.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 61.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig61_2_OM_DiffPlotPostvsPre50mm_100yrCC.mxd Date: 9/05/2018 Time: 1:34:33 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig61_2_OM_DiffPlotPostvsPre50mm_100yrCC.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

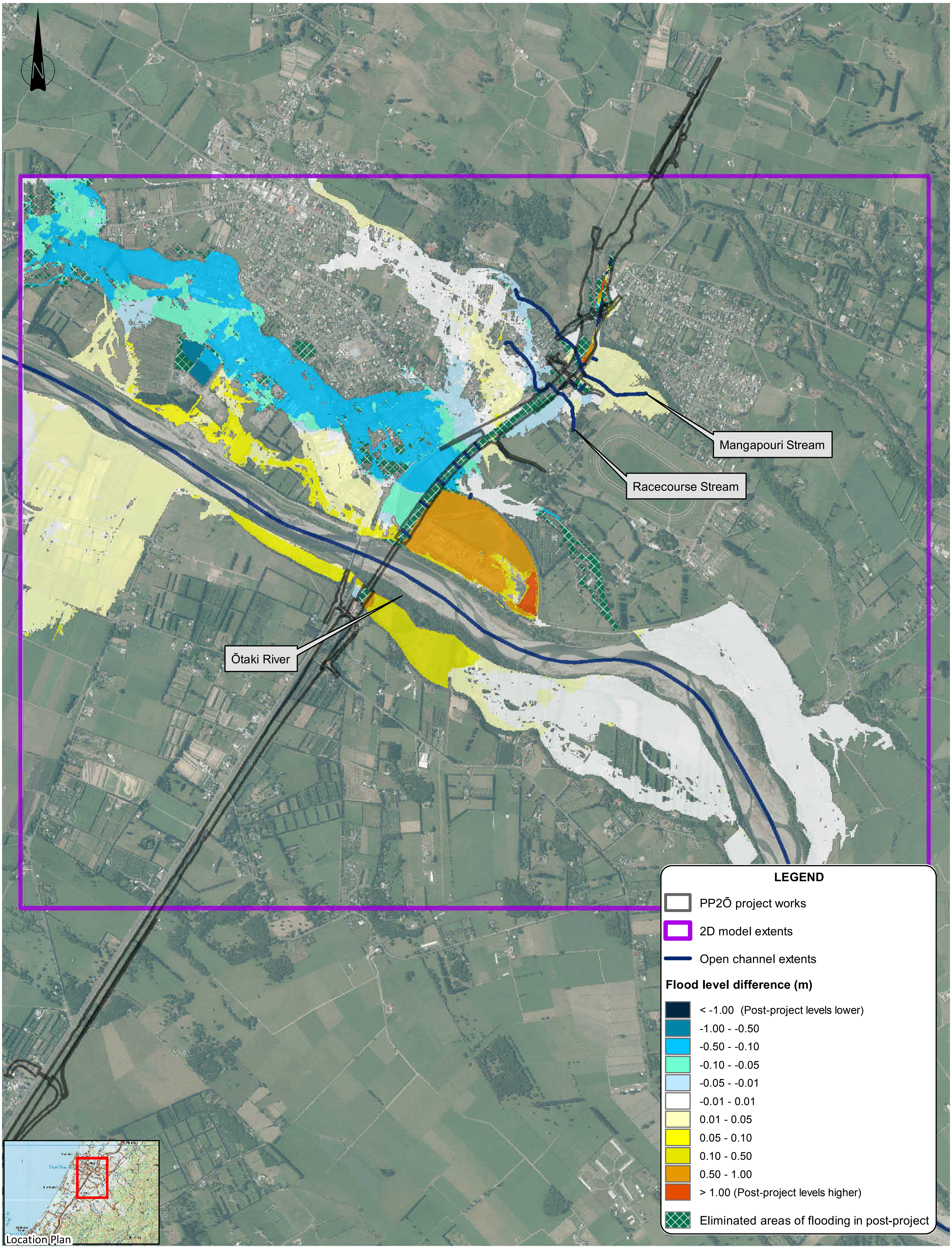
Ōtaki-Mangapouri Model Results Comparison

Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 61.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig61_3_OM_DiffPlotPostvsPre_100yrCC.mxd Date: 8/05/2018 Time: 4:04:16 p.m.



Notes:
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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig61_3_OM_DiffPlotPostvsPre_100yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

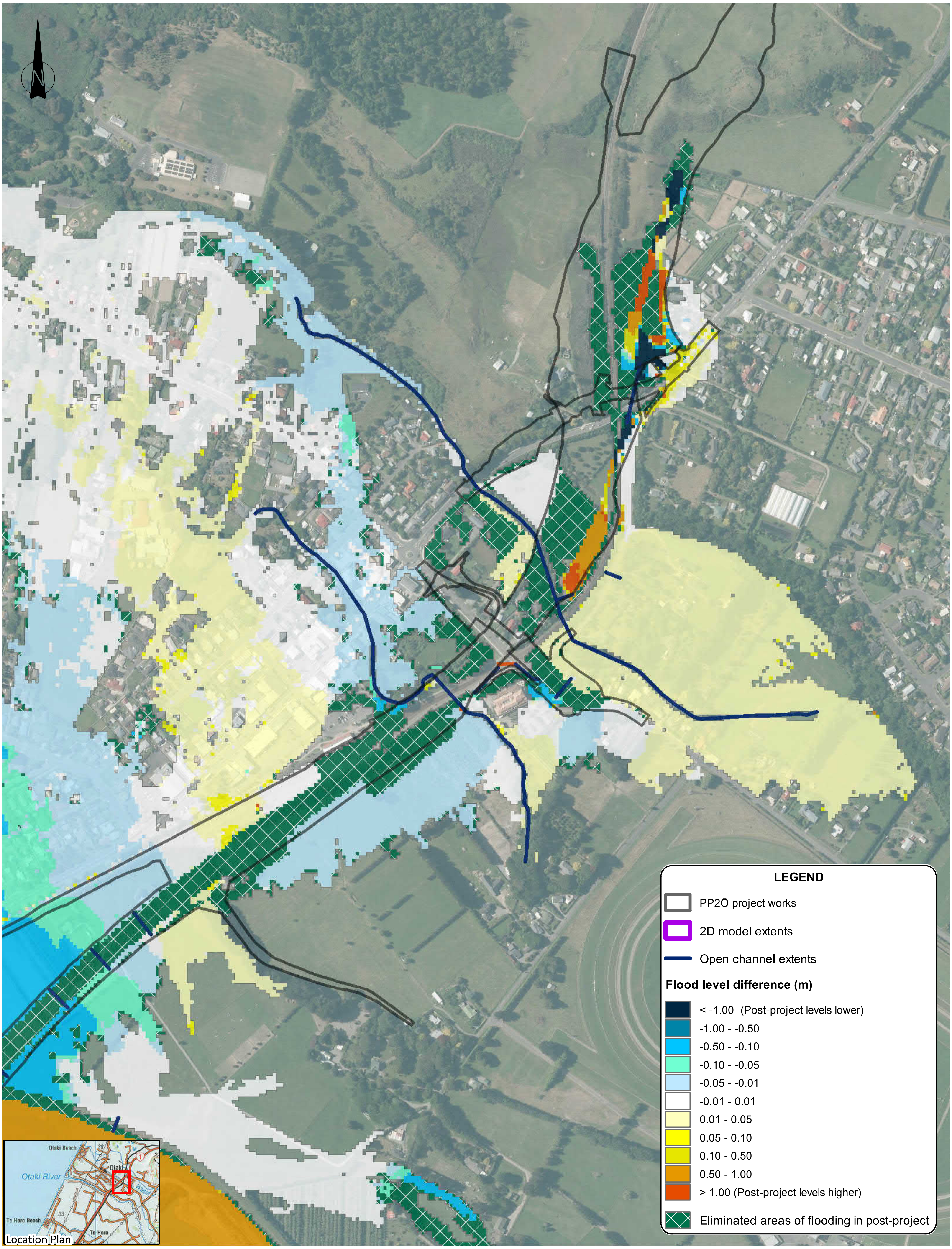
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 61.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig61_4_OM_DiffPlotPostvsPre_100yrCC.mxd Date: 8/05/2018 Time: 4:23:42 p.m.



Notes:
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- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig61_4_OM_DiffPlotPostvsPre_100yrCC.mxd

SCALE (AT A3 SIZE)
1:5,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

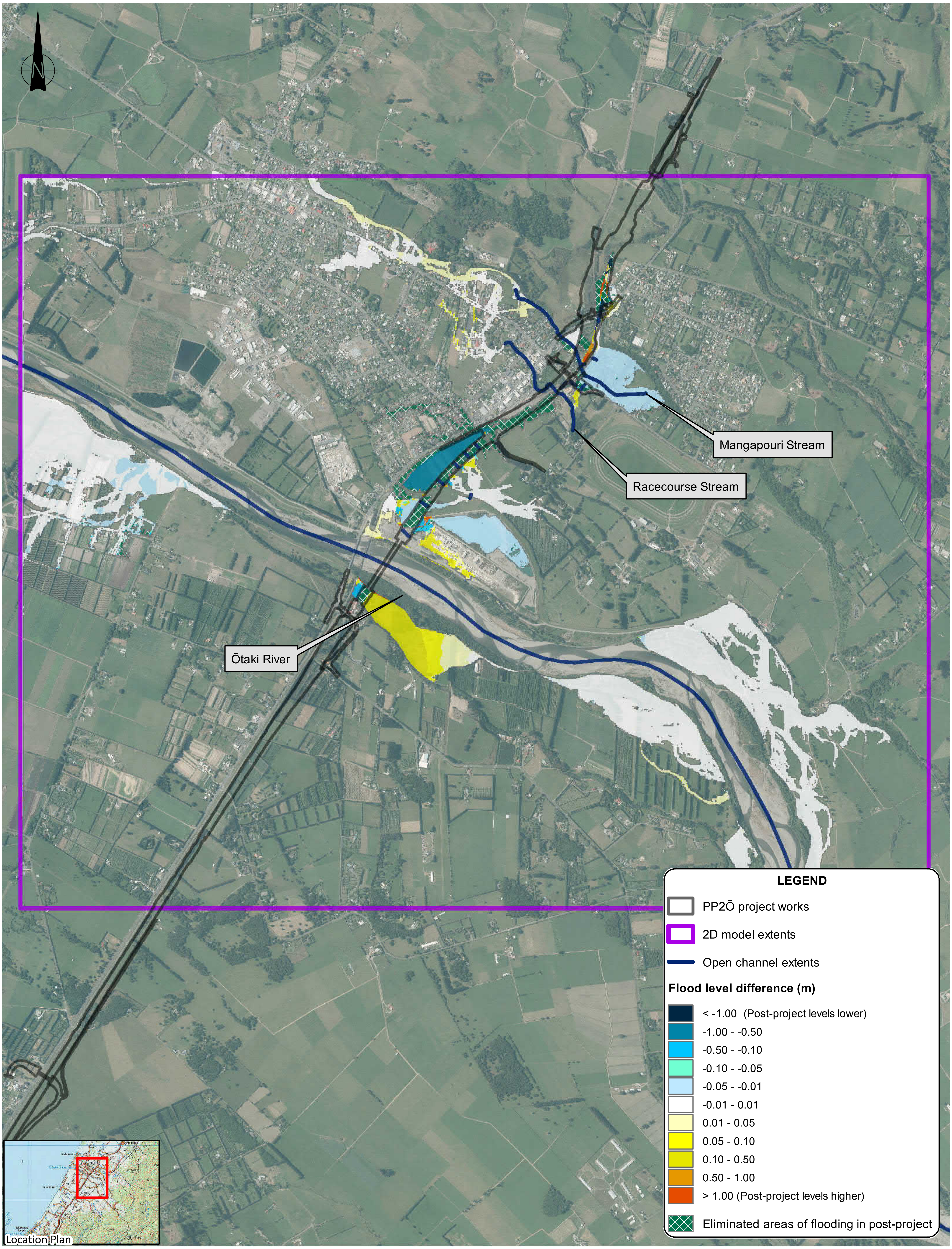
Ōtaki-Mangapouri Model Results Comparison

Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 61.4

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig62_1_OM_DiffPlotPostvsPre_010yrCC.mxd Date: 8/05/2018 Time: 4:30:00 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig62_1_OM_DiffPlotPostvsPre_010yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

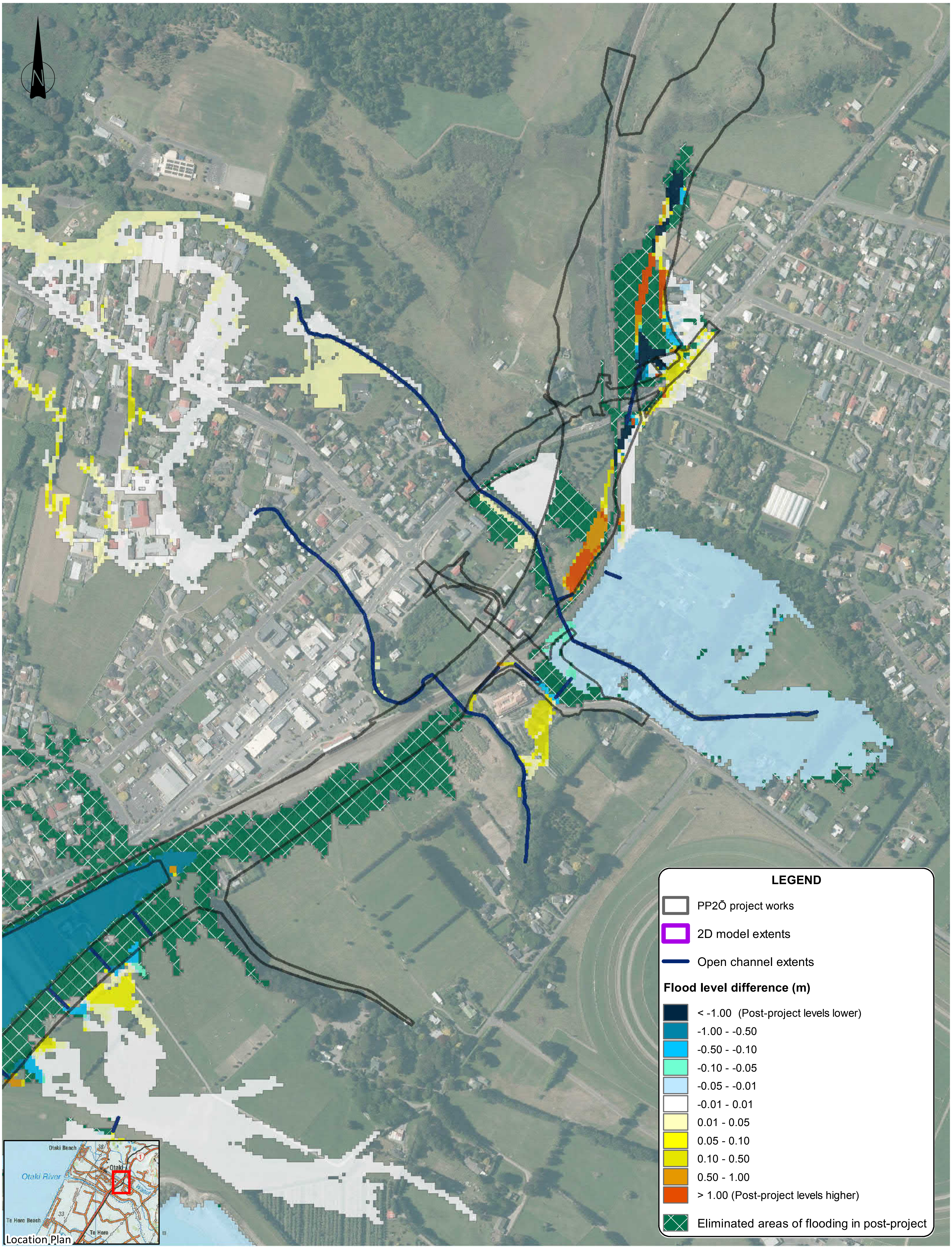
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project minus Pre-Project Water Levels - 10% AEP CC2130

FIGURE No.
Figure 62.1

Rev.
0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig62_2_OM_DiffPlotPostvsPre_010yrCC.mxd Date: 8/05/2018 Time: 4:34:53 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig62_2_OM_DiffPlotPostvsPre_010yrCC.mxd

SCALE (AT A3 SIZE) 1:5,000

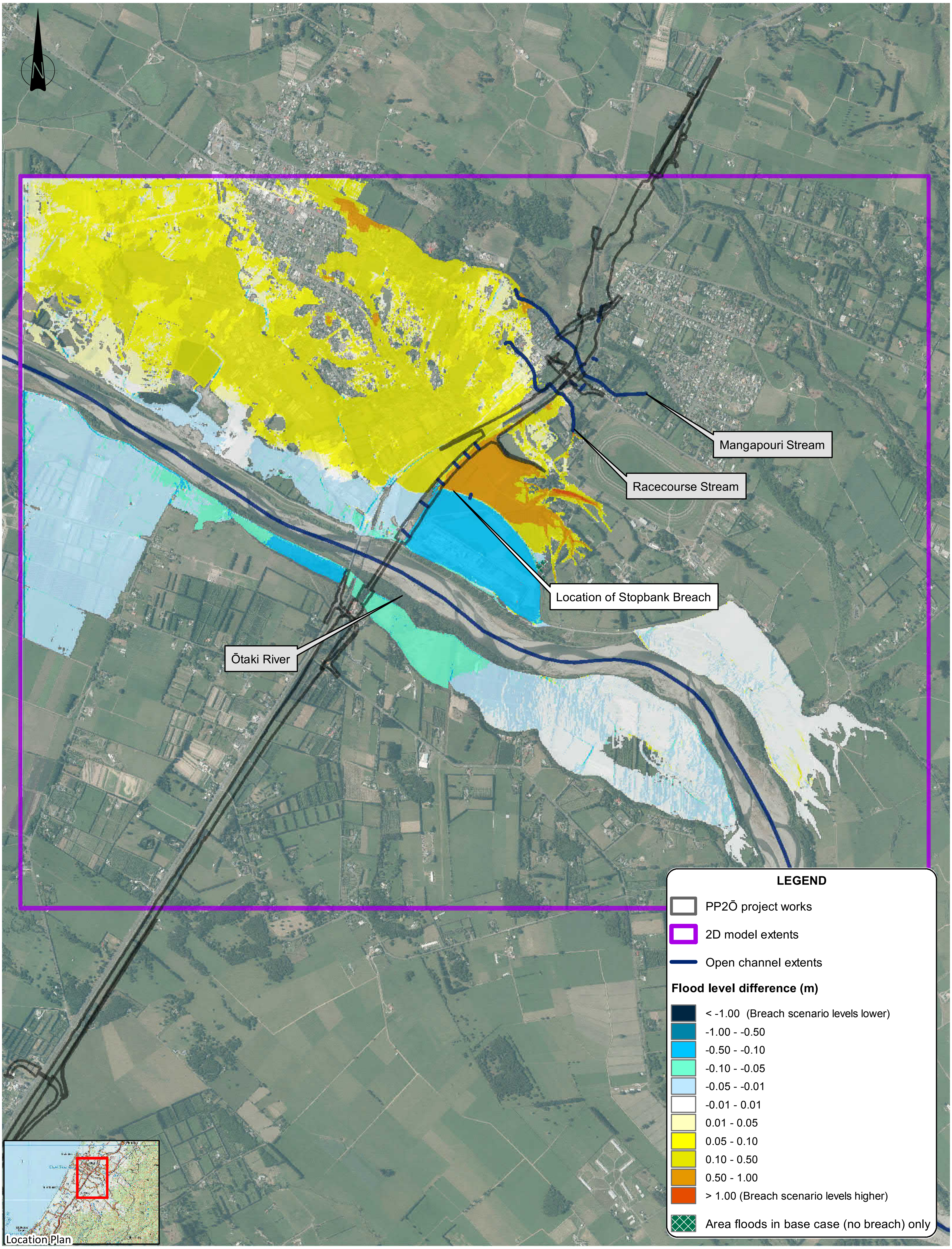
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project minus Pre-Project Water Levels - 10% AEP CC2130

FIGURE No. Figure 62.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig63_1_OM_DiffPlotPostBreachvsPostBase_3000cmc.mxd Date: 9/05/2018 Time: 7:07:19 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig63_1_OM_DiffPlotPostBreachvsPostBase_3000cmc.mxd

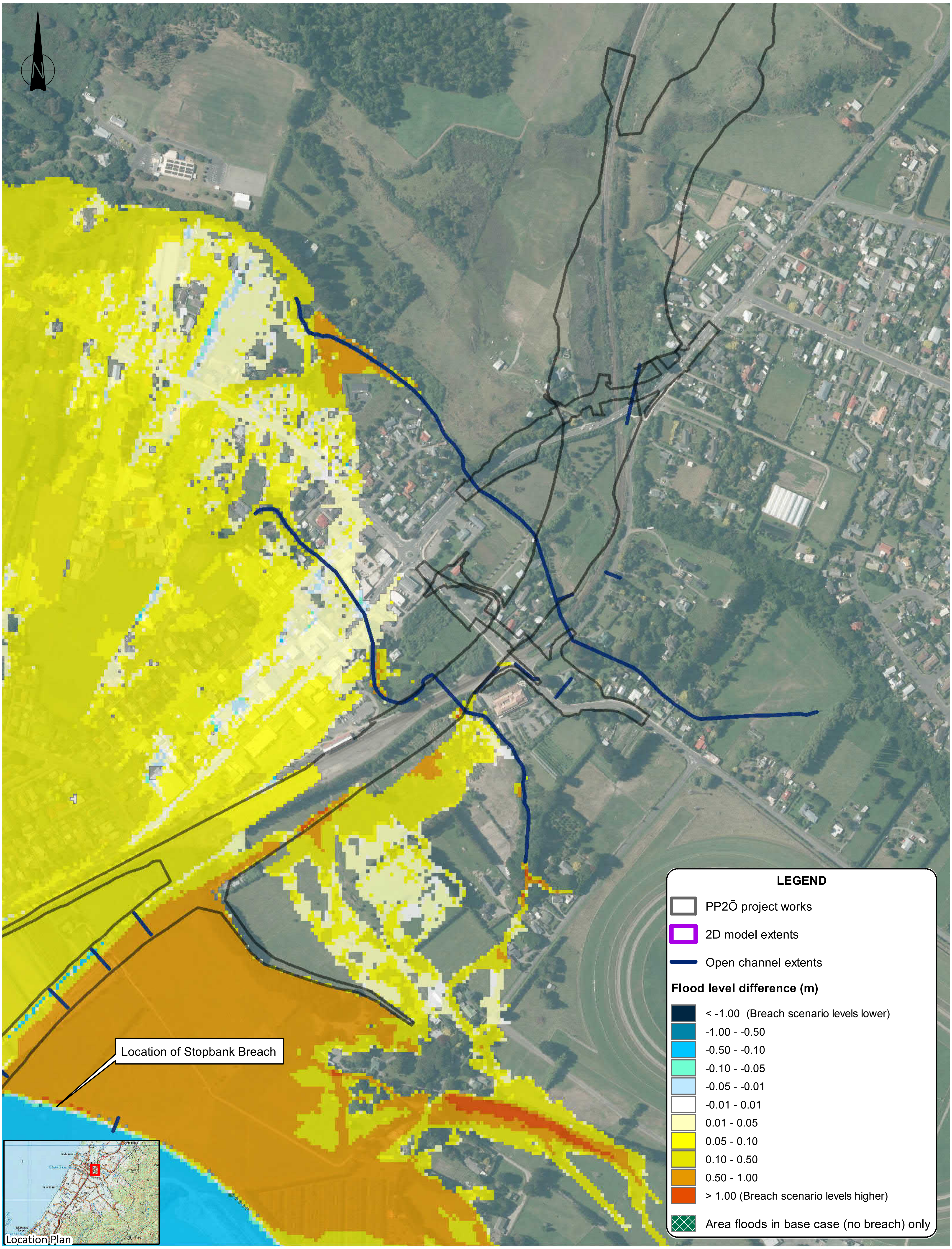
SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Breach Scenario minus Post-Project Base Scenario Water Levels - 3,000 m^3/s (Ōtaki only)

FIGURE No. Figure 63.1

Rev. 0



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig63_2_OM_DiffPlotPostBreachvsPostBase_3000cmc.mxd

SCALE (AT A3 SIZE)
1:5,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

Ōtaki-Mangapouri Model Results Comparison

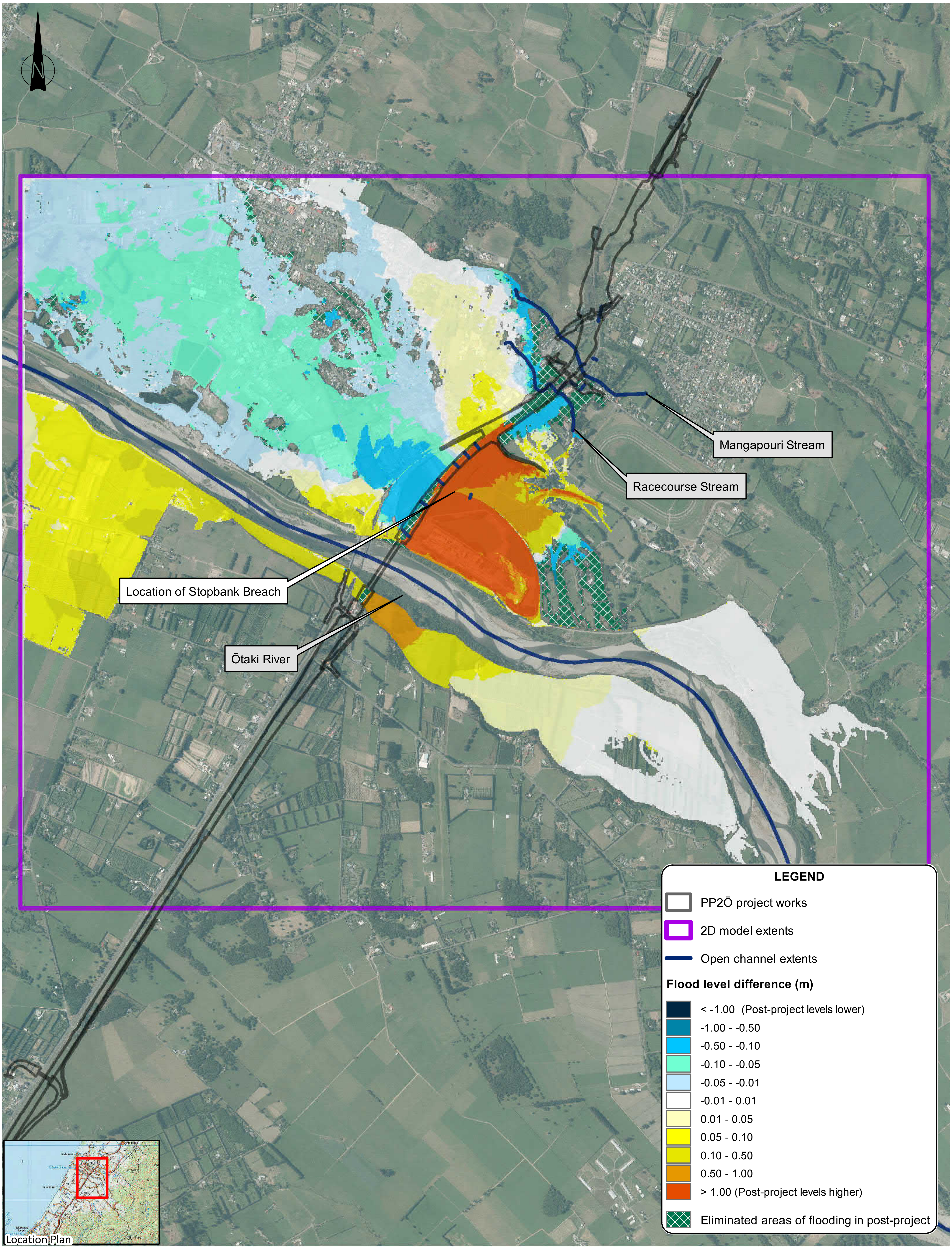
Post-Project Breach Scenario minus Post-Project Base Scenario

Water Levels - 3,000 m³/s (Ōtaki only)

FIGURE No. Figure 63.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig64_1_OM_DiffPlotPostBreachvsPreBreach_3000cmc.mxd Date: 9/05/2018 Time: 8:25:37 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig64_1_OM_DiffPlotPostBreachvsPreBreach_3000cmc.mxd

SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

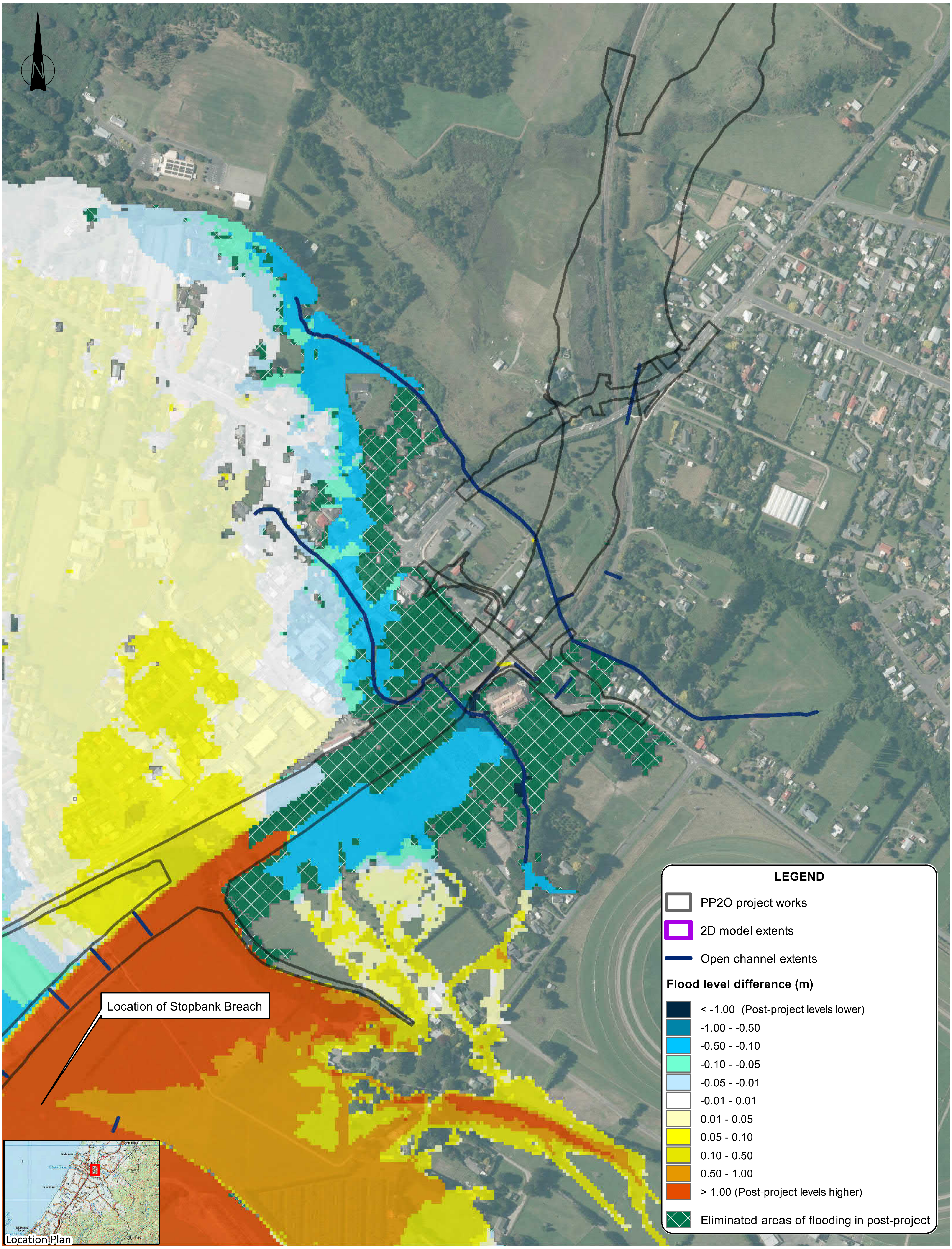
Ōtaki-Mangapouri Model Results Comparison

Post-Project Breach Scenario minus Pre-Project Breach Scenario
Water Levels - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 64.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig64_2_OM_DiffPlotPostBreachvsPreBreach_3000cmc.mxd Date: 9/05/2018 Time: 1:08:19 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig64_2_OM_DiffPlotPostBreachvsPreBreach_3000cmc.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

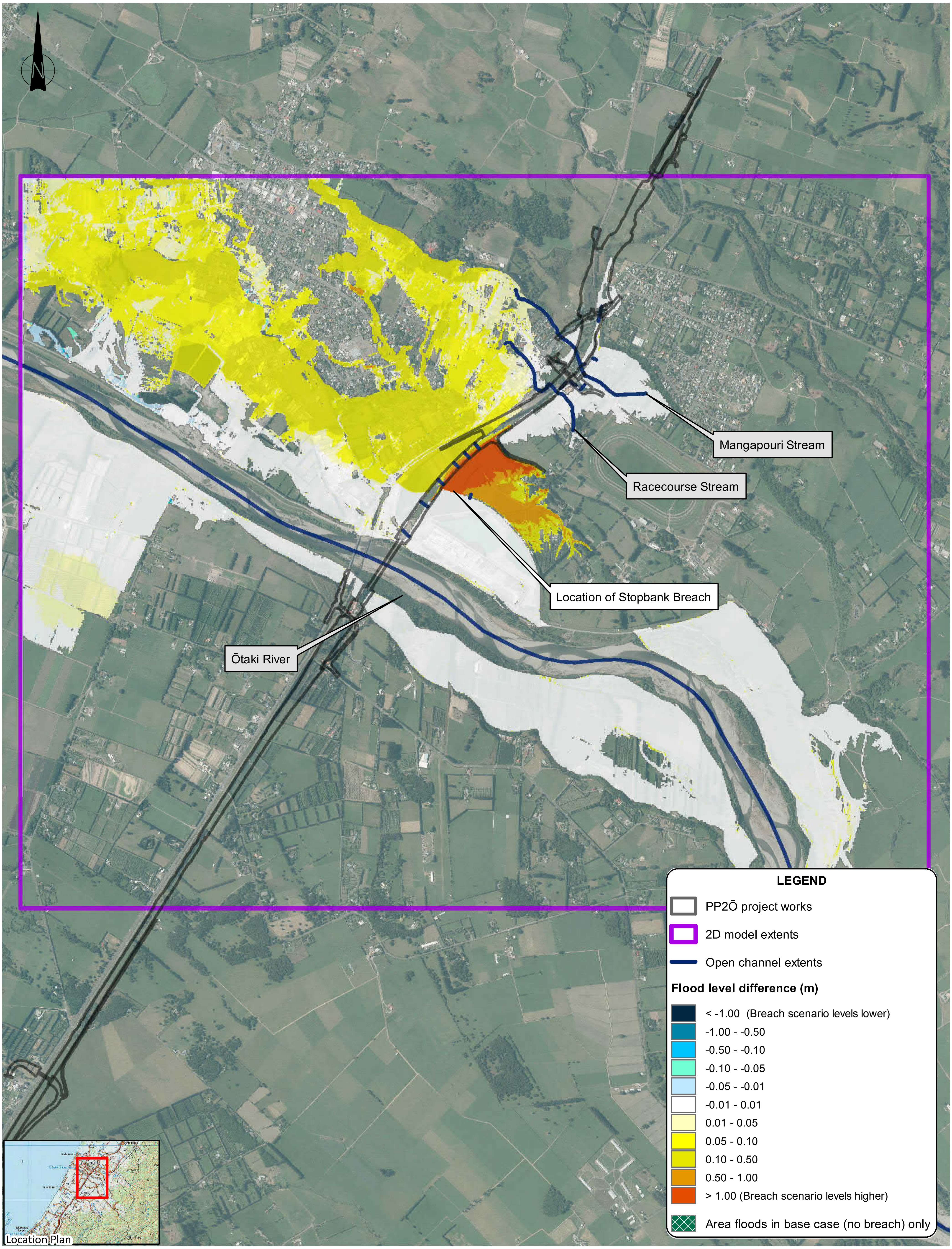
NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison

Post-Project Breach Scenario minus Pre-Project Breach Scenario
Water Levels - 3000 m³/s (Ōtaki only)

FIGURE No. Figure 64.2 Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig65_1_OM_DiffPlotPostBreachvsPostBase_500yrCC.mxd Date: 9/05/2018 Time: 8:17:15 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig65_1_OM_DiffPlotPostBreachvsPostBase_500yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

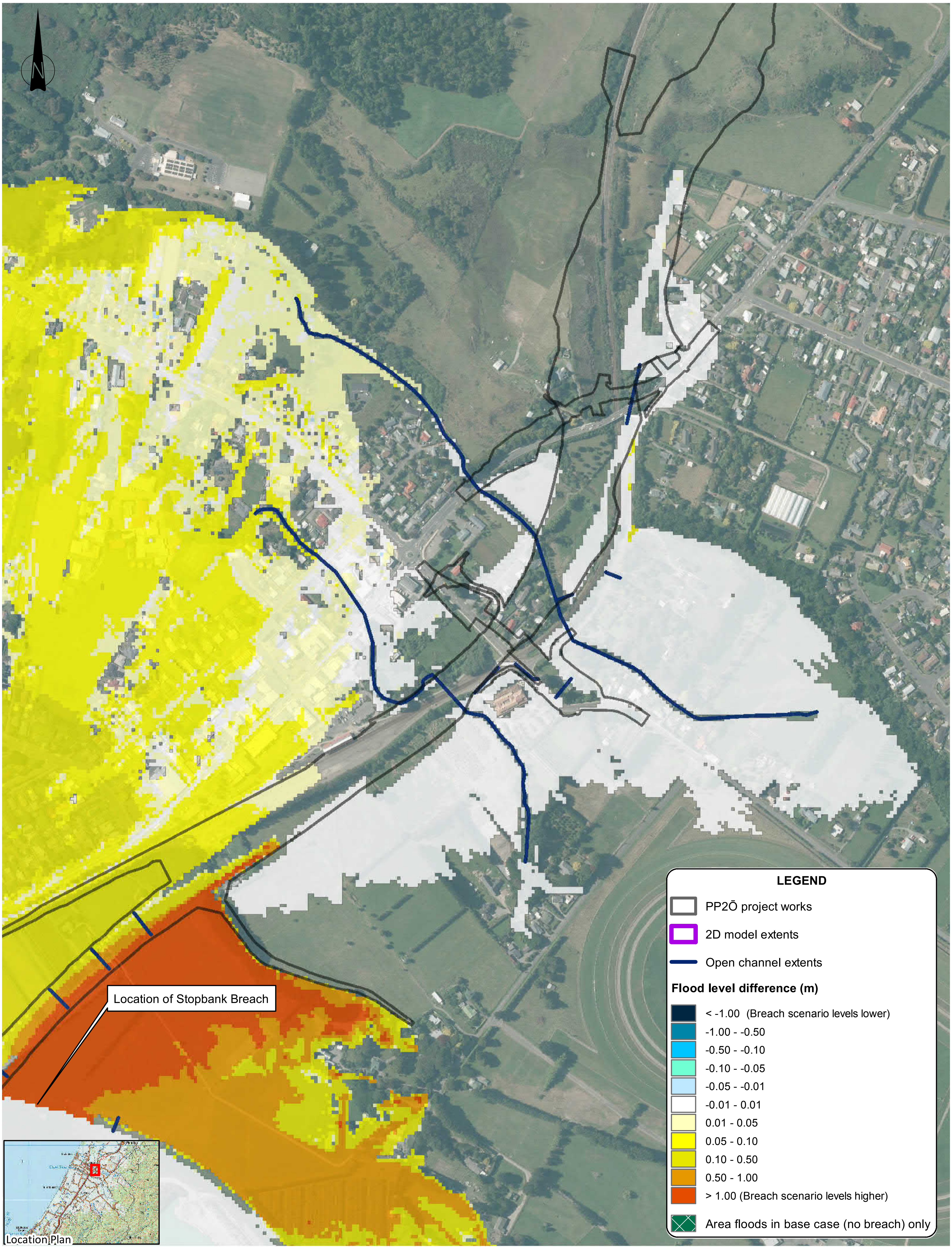
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Breach Scenario minus Post-Project Base Scenario
Water Levels - 0.2% AEP CC2130

FIGURE No. Figure 65.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig65_2_OM_DiffPlotPostBreachvsPostBase_500yrCC.mxd Date: 9/05/2018 Time: 8:20:40 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig65_2_OM_DiffPlotPostBreachvsPostBase_500yrCC.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

Ōtaki-Mangapouri Model Results Comparison

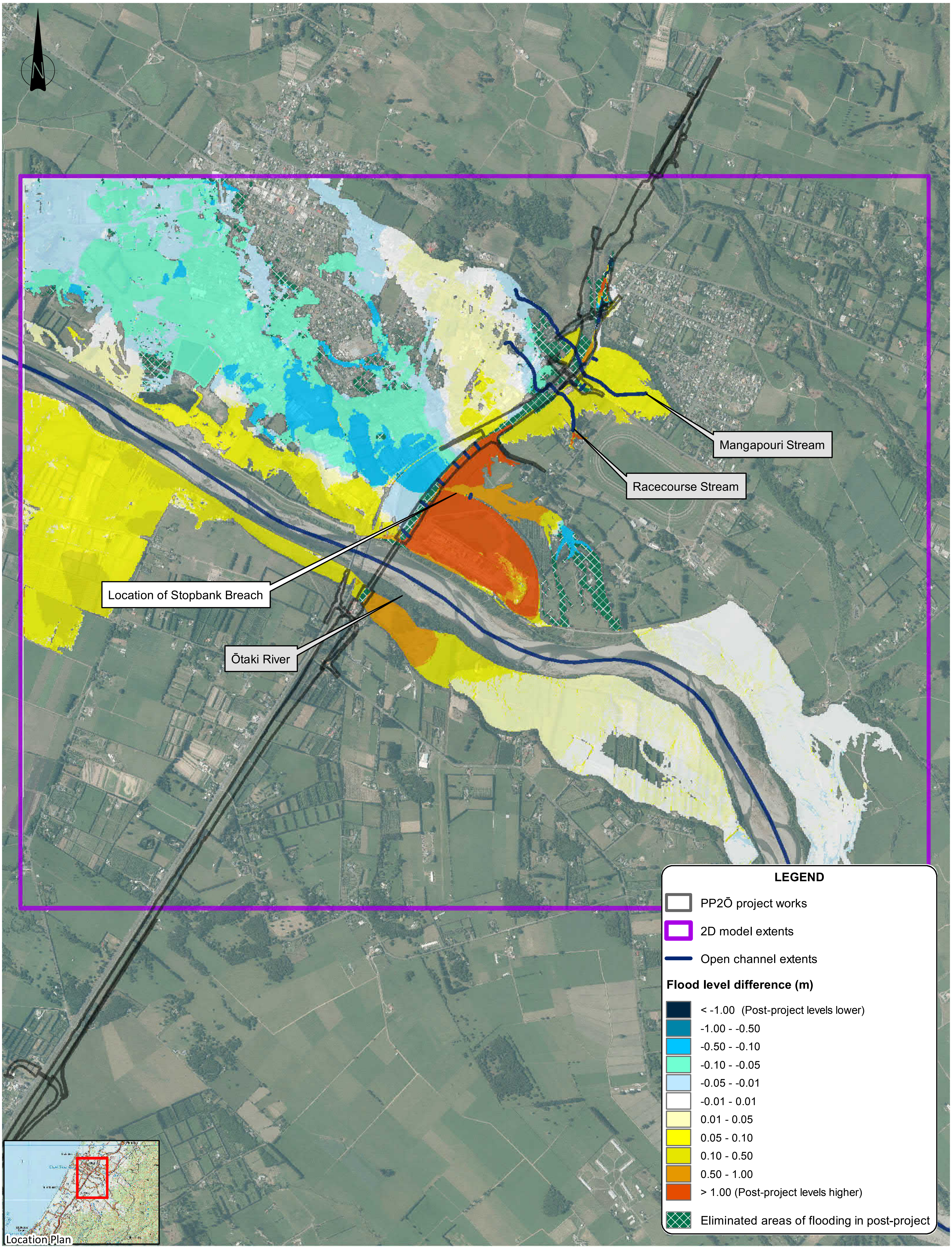
Post-Project Breach Scenario minus Post-Project Base Scenario

Water Levels - 0.2% AEP CC2130

FIGURE No. Figure 65.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig66_1_OM_DiffPlotPostBreachvsPreBreach_500yrCC.mxd Date: 9/05/2018 Time: 1:09:24 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig66_1_OM_DiffPlotPostBreachvsPreBreach_500yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

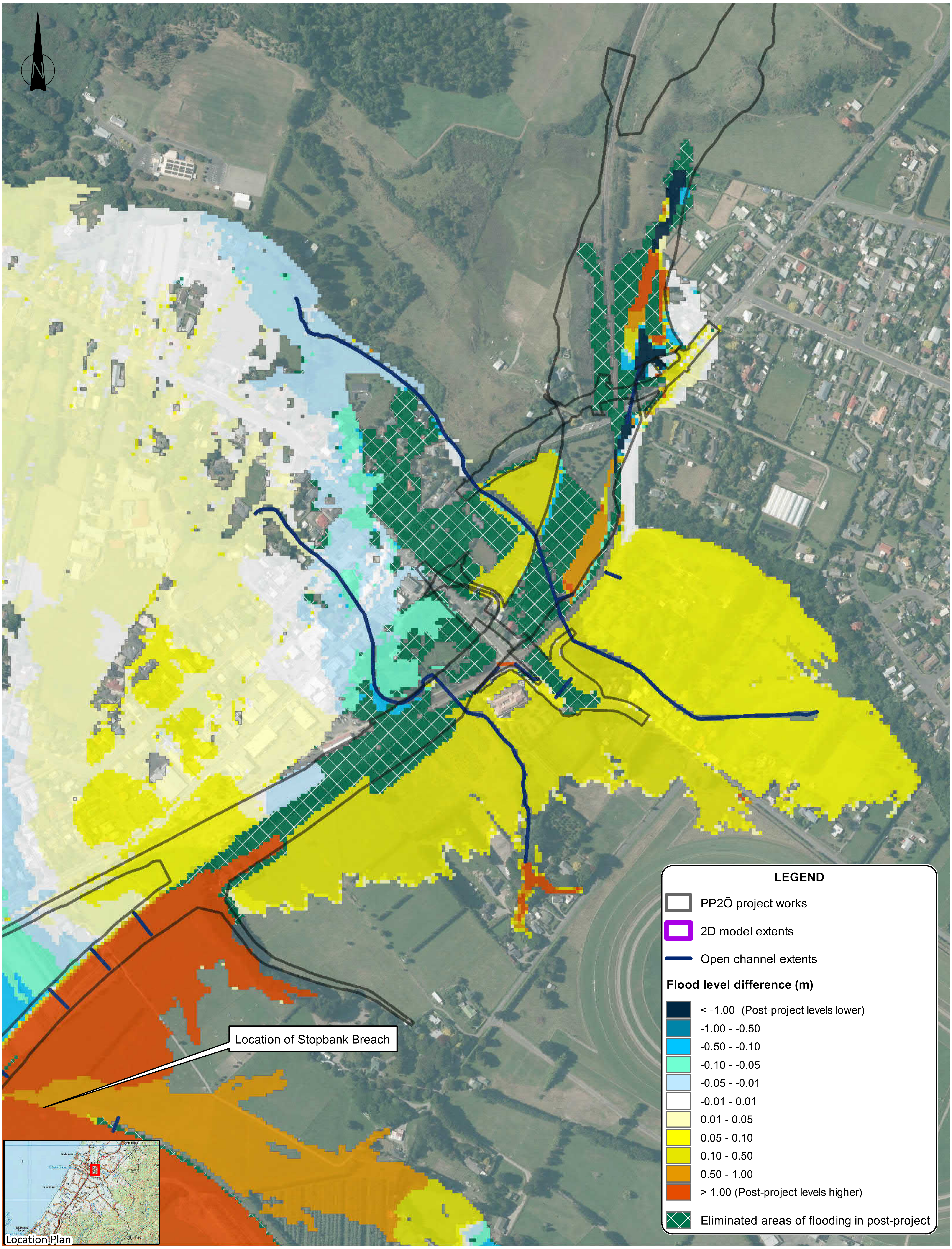
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Breach Scenario minus Pre-Project Breach Scenario
Water Levels - 0.2% AEP CC2130

FIGURE No. Figure 66.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig66_2_OM_DiffPlotPostBreachvsPreBreach_500yrCC.mxd Date: 9/05/2018 Time: 1:10:23 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig66_2_OM_DiffPlotPostBreachvsPreBreach_500yrCC.mxd

SCALE (AT A3 SIZE) 1:5,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

Ōtaki-Mangapouri Model Results Comparison

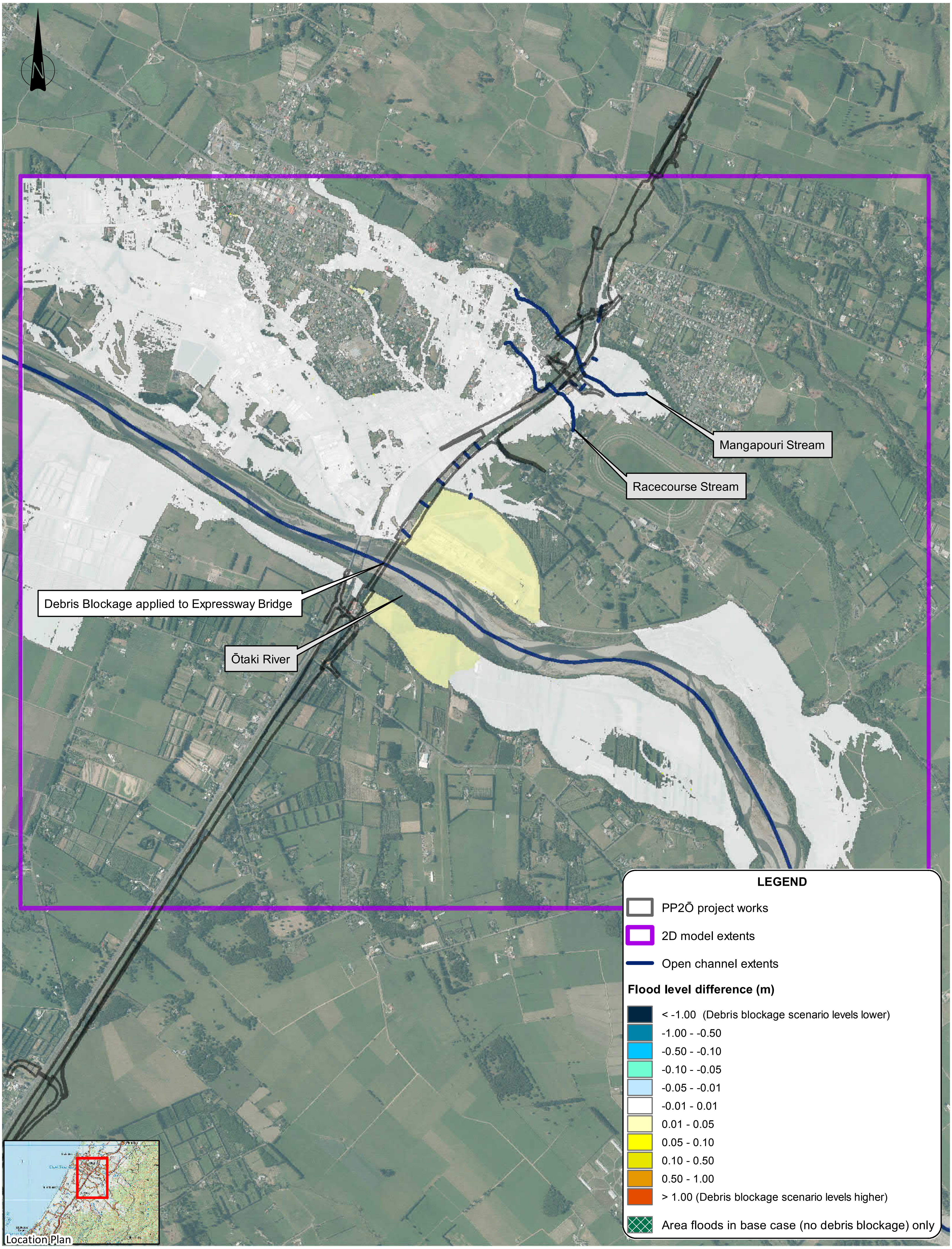
Post-Project Breach Scenario minus Pre-Project Breach Scenario

Water Levels - 0.2% AEP CC2130

FIGURE No. Figure 66.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig67_1_OM_DiffPlotPostDBvsPostBase_500yrCC.mxd Date: 9/05/2018 Time: 9:51:29 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig67_1_OM_DiffPlotPostDBvsPostBase_500yrCC.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

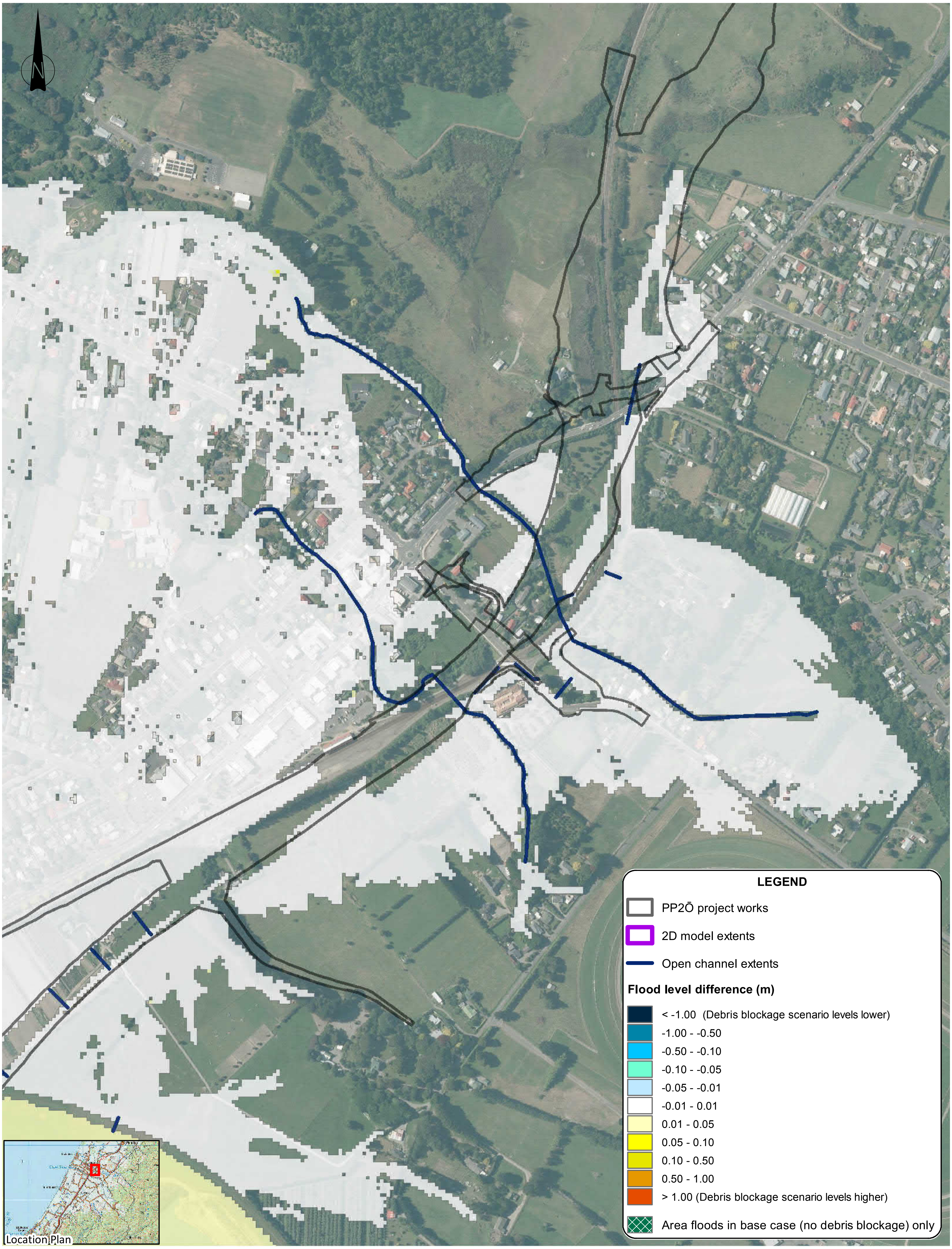
Ōtaki-Mangapouri Model Results Comparison

Post-Project Debris Blockage Scenario minus Post-Project Base Scenario Water Levels - 0.2% AEP CC2130

FIGURE No. Figure 67.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig67_2_OM_DiffPlotPostDBvsPostBase_500yrCC.mxd Date: 9/05/2018 Time: 9:53:29 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig67_2_OM_DiffPlotPostDBvsPostBase_500yrCC.mxd

SCALE (AT A3 SIZE)
1:5,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

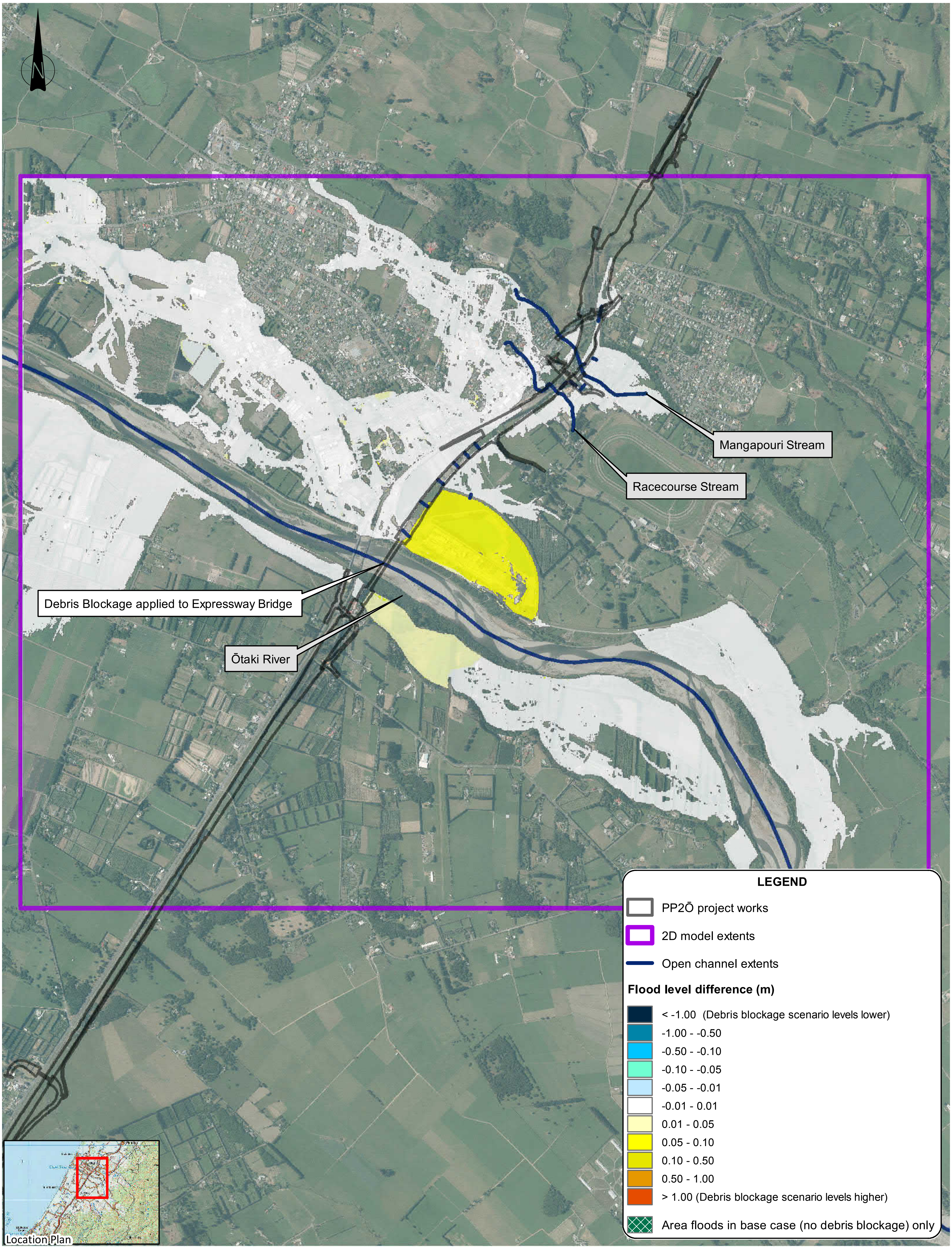
Ōtaki-Mangapouri Model Results Comparison

Post-Project Debris Blockage Scenario minus Post-Project Base Scenario
Water Levels - 0.2% AEP CC2130

FIGURE No. Figure 67.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig68_1_OM_DiffPlotPostDBvsPostBase_100yrCC.mxd Date: 9/05/2018 Time: 10:10:22 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig68_1_OM_DiffPlotPostDBvsPostBase_100yrCC.mxd

SCALE (AT A3 SIZE)
1:20,000

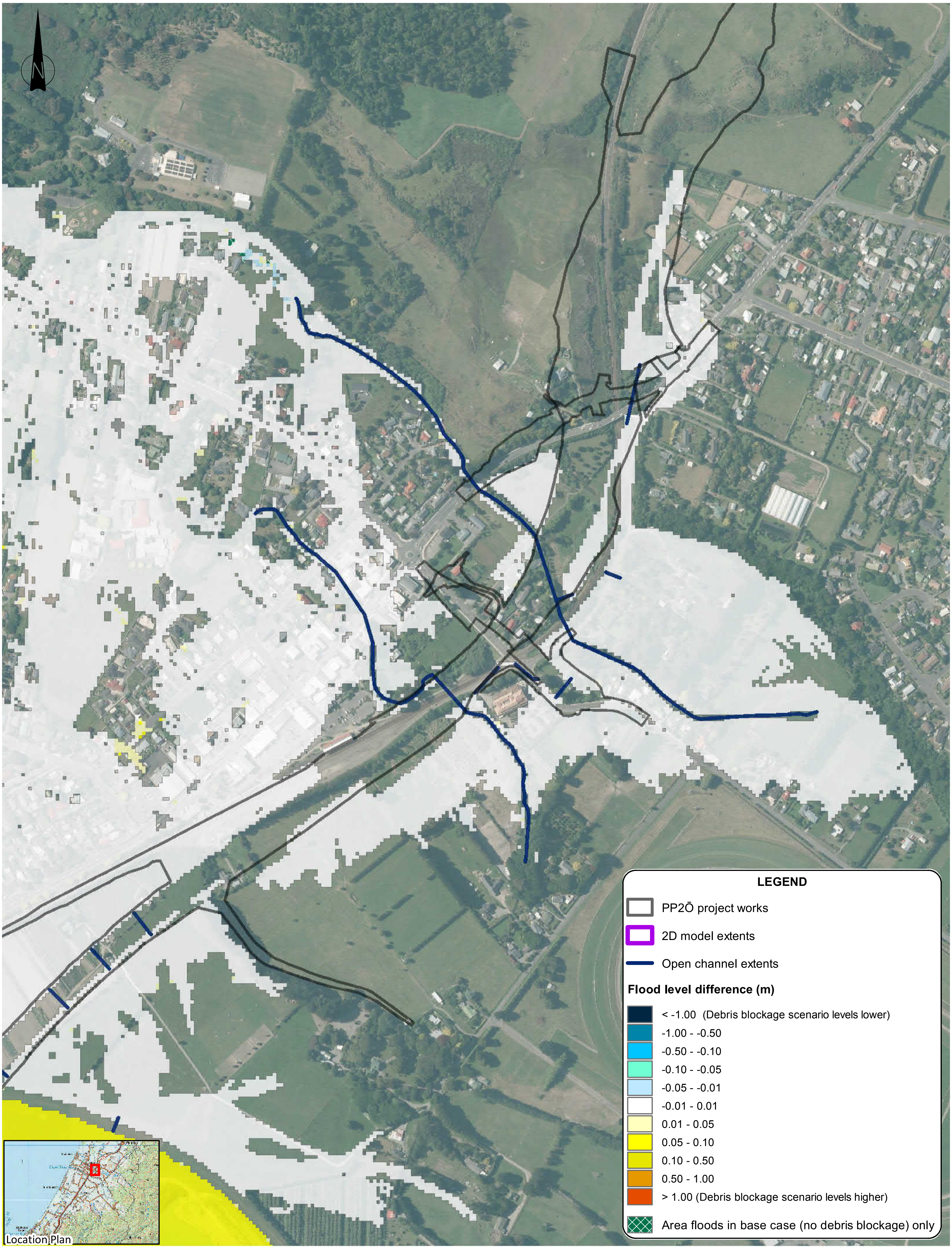
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Debris Blockage Scenario minus Post-Project Base Scenario
Water Levels - 1% AEP CC2130

FIGURE No. Figure 68.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig68_2_OM_DiffPlotPostDBvsPostBase_100yrCC.mxd Date: 9/05/2018 Time: 10:12:00 a.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

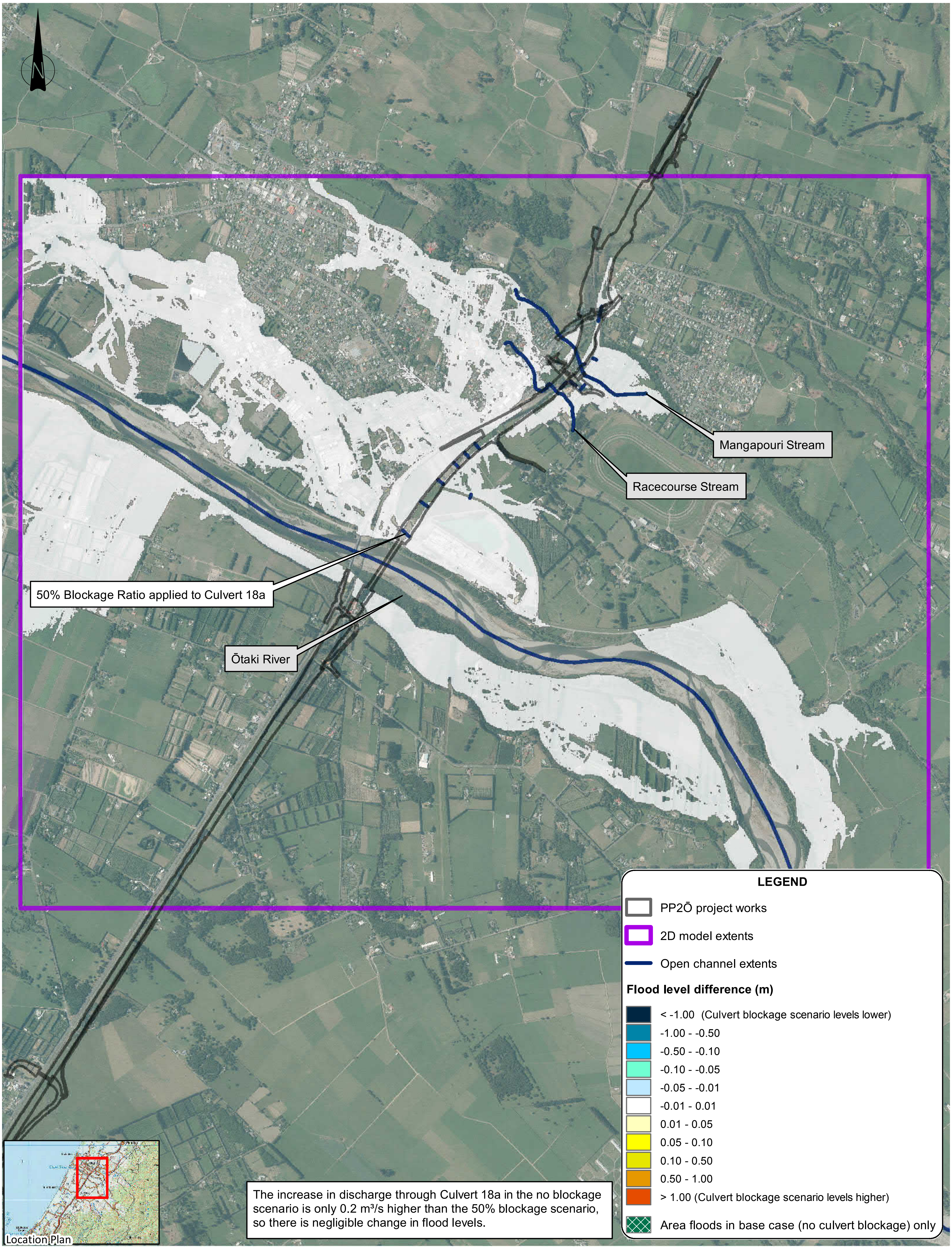
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig68_2_OM_DiffPlotPostDBvsPostBase_100yrCC.mxd	
SCALE (AT A3 SIZE)	1:5,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Debris Blockage Scenario minus Post-Project Base Scenario
Water Levels - 1% AEP CC2130

FIGURE No. Figure 68.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig69_OM_DiffPlotPostCBvsPostBase_100yrCC.mxd Date: 9/05/2018 Time: 10:27:49 a.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig69_OM_DiffPlotPostCBvsPostBase_100yrCC.mxd

SCALE (AT A3 SIZE) 1:20,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

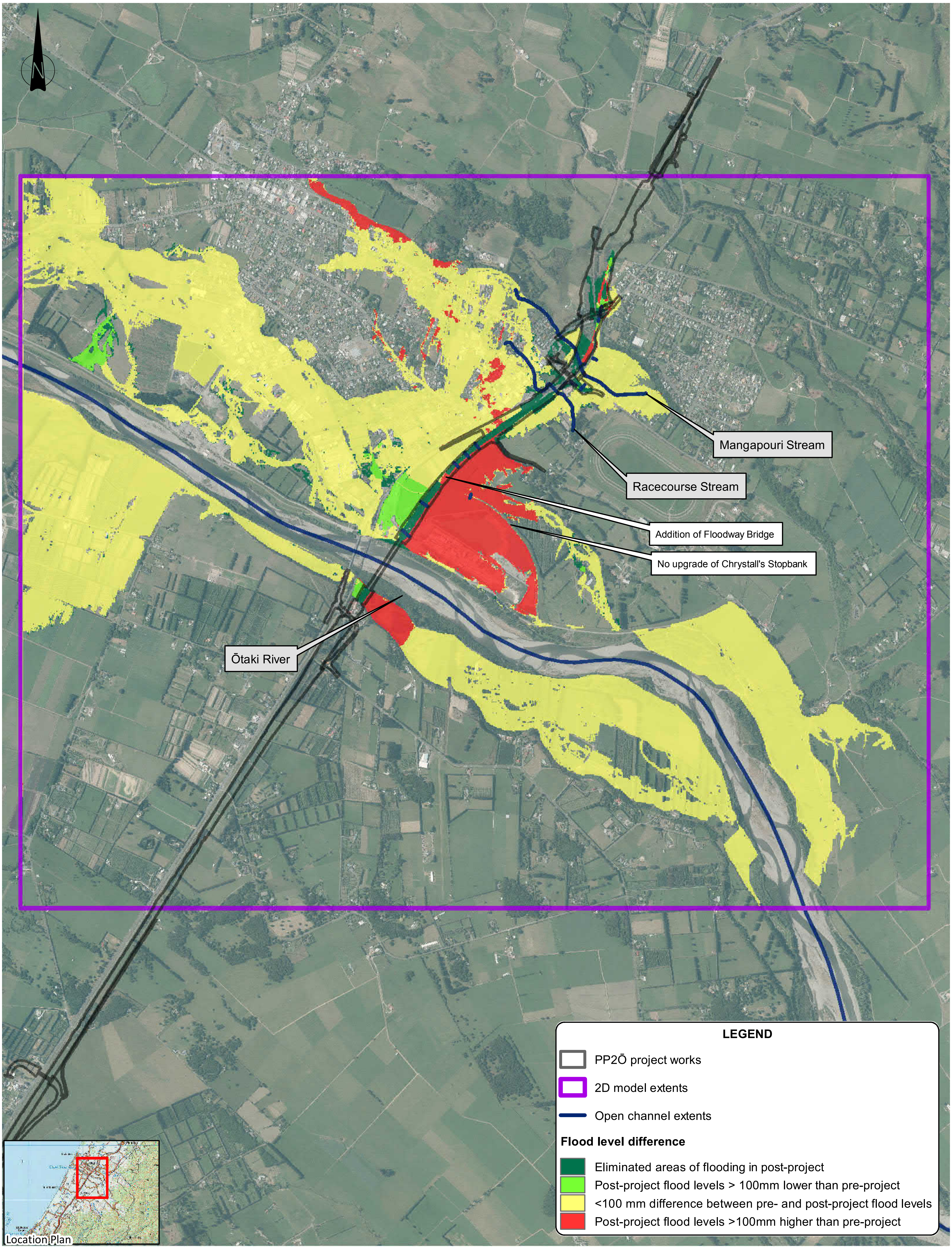
Ōtaki-Mangapouri Model Results Comparison

Post-Project Culvert Blockage Scenario minus Post-Project Base Scenario
Water Levels - 1% AEP CC2130

FIGURE No. Figure 69

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig70_1_OM_DiffPlotPostAltDesignvsPreBase100mm.mxd Date: 9/05/2018 Time: 12:24:27 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig70_1_OM_DiffPlotPostAltDesignvsPreBase100mm.mxd		
SCALE (AT A3 SIZE) 1:20,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

Ōtaki-Mangapouri Model Results Comparison

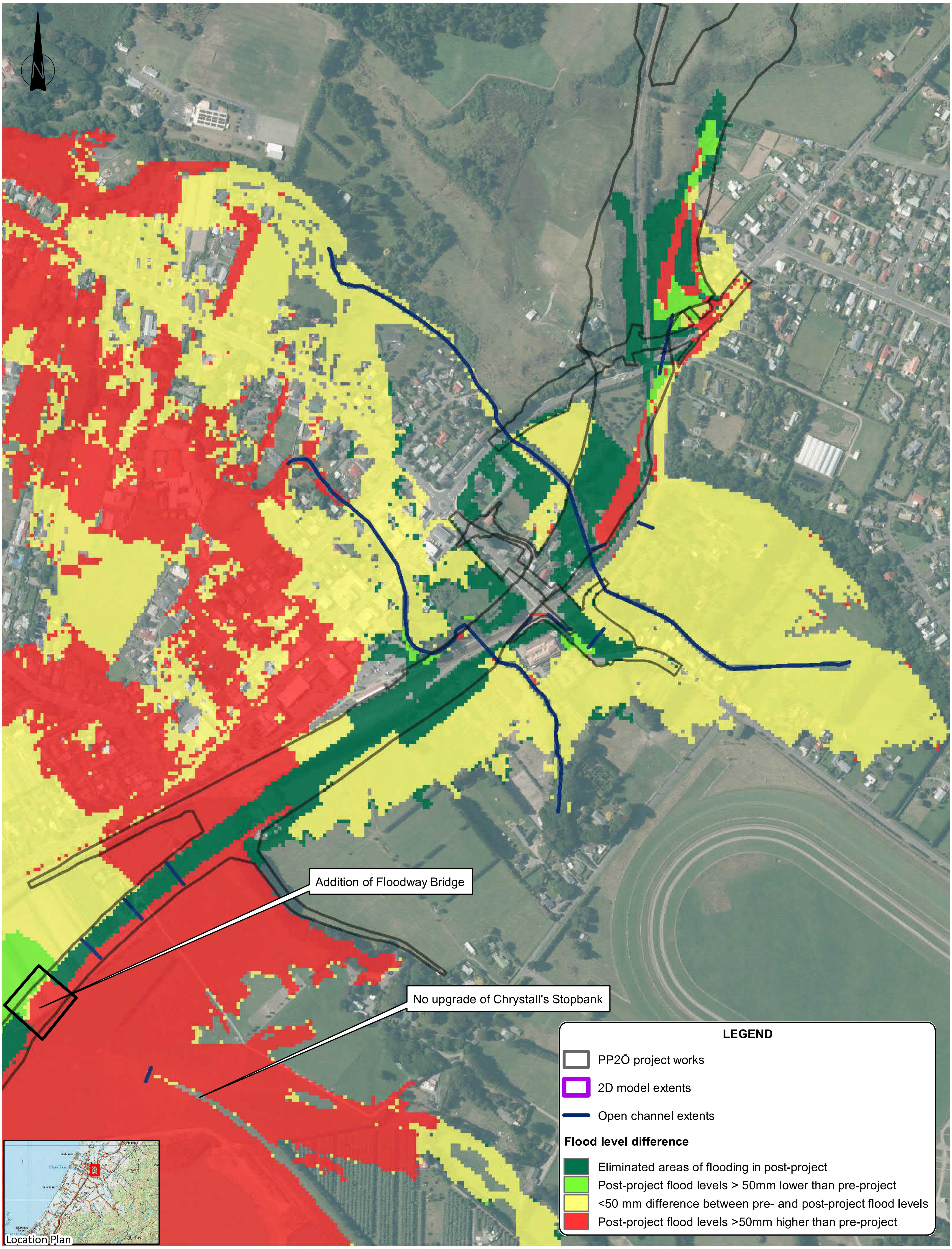
Post-Project Alternative Design minus Pre-Project

Water Levels - 1% AEP CC2130

FIGURE No. Figure 70.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig70_2_OM_DiffPlotPostAltDesignvsPreBase50mm.mxd Date: 9/05/2018 Time: 1:36:36 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig70_2_OM_DiffPlotPostAltDesignvsPreBase50mm.mxd

SCALE (AT A3 SIZE) 1:5,000

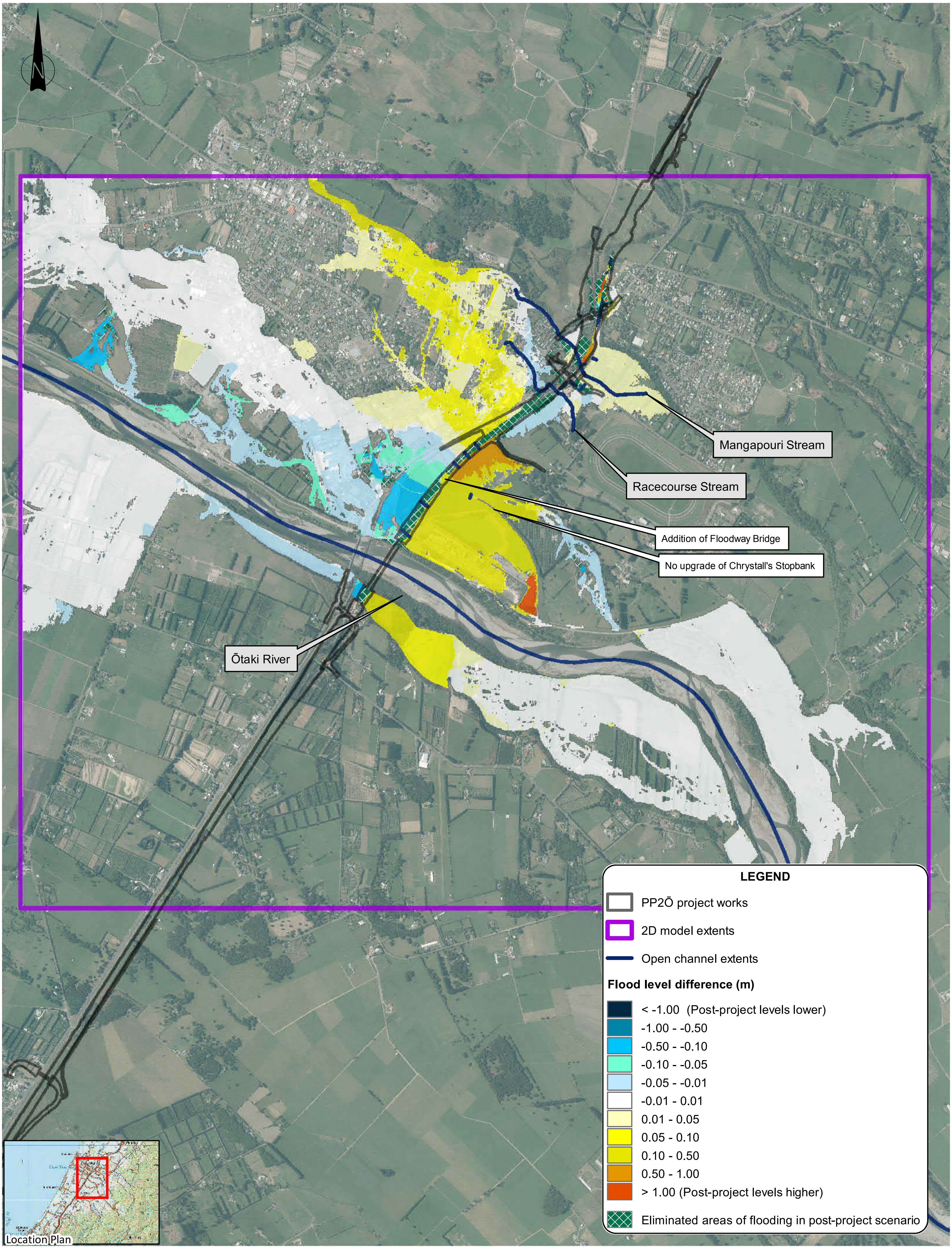
PROJECT No. 85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Alternative Design minus Pre-Project
Water Levels 1% AEP CC2130

FIGURE No. Figure 70.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig70_3_OM_DiffPlotPostAltDesignvsPreBase.mxd Date: 9/05/2018 Time: 12:46:19 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig70_3_OM_DiffPlotPostAltDesignvsPreBase.mxd

SCALE (AT A3 SIZE): 1:20,000

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

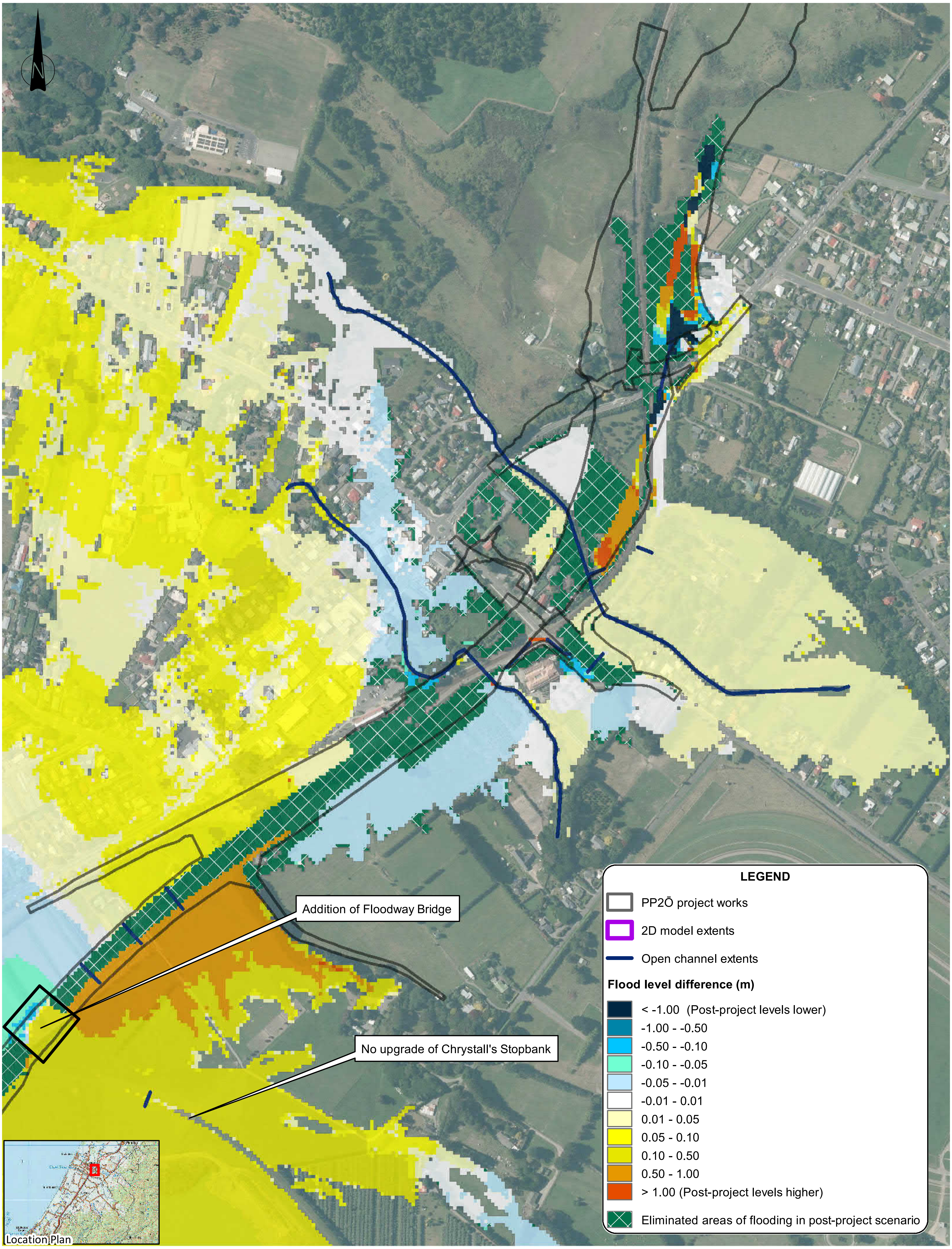
Ōtaki-Mangapouri Model Results Comparison

Post-Project Alternative Design minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 70.3

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig70_4_OM_DiffPlotPostAltDesignvsPreBase.mxd Date: 9/05/2018 Time: 12:47:45 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE: Fig70_4_OM_DiffPlotPostAltDesignvsPreBase.mxd

SCALE (AT A3 SIZE): 1:5,000

PROJECT No.: 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

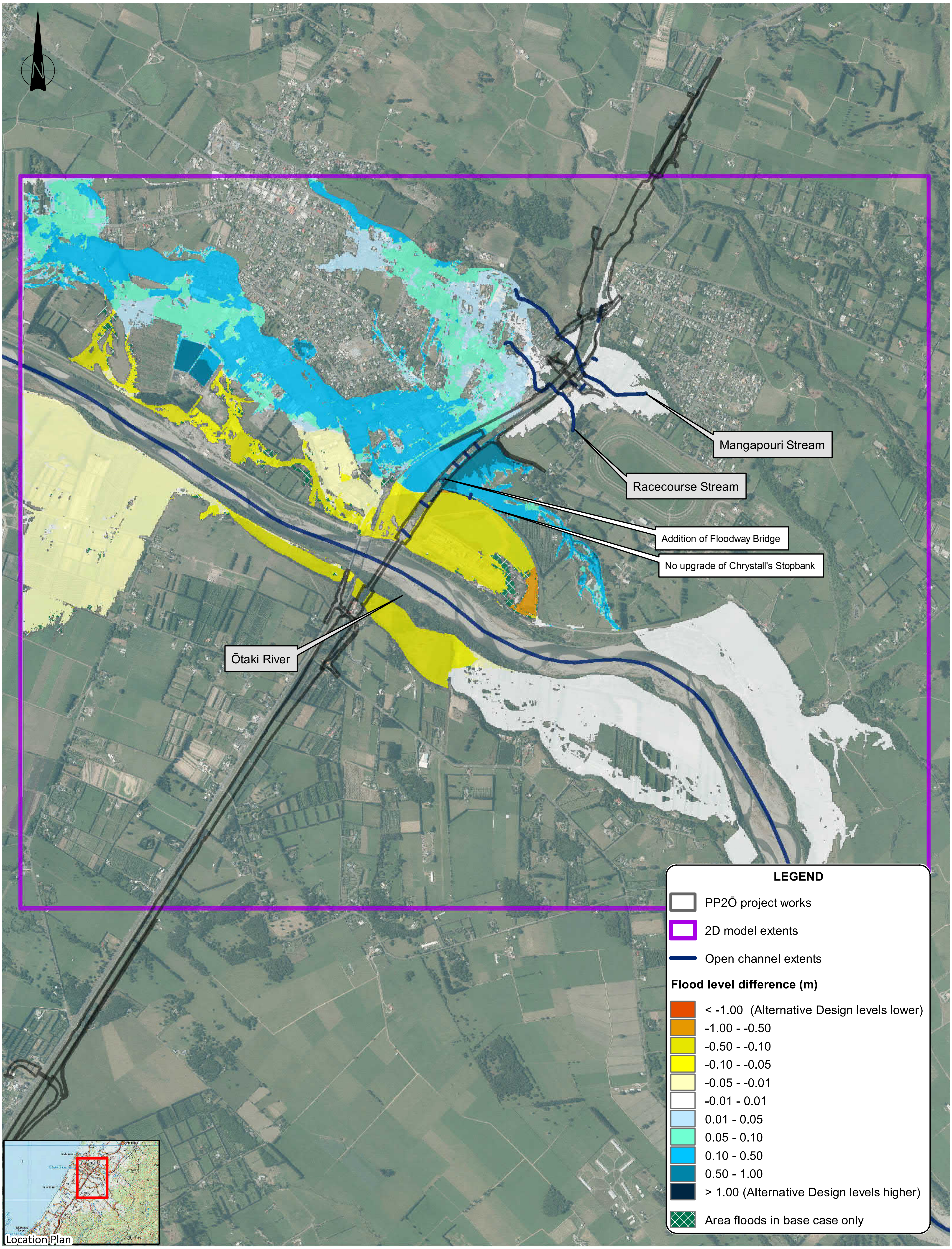
Ōtaki-Mangapouri Model Results Comparison

Post-Project Alternative Design minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 70.4

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig71_1_OM_DiffPlotPostAltDesignvsPostBase.mxd Date: 9/05/2018 Time: 12:51:29 p.m.



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- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig71_1_OM_DiffPlotPostAltDesignvsPostBase.mxd

SCALE (AT A3 SIZE)
1:20,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

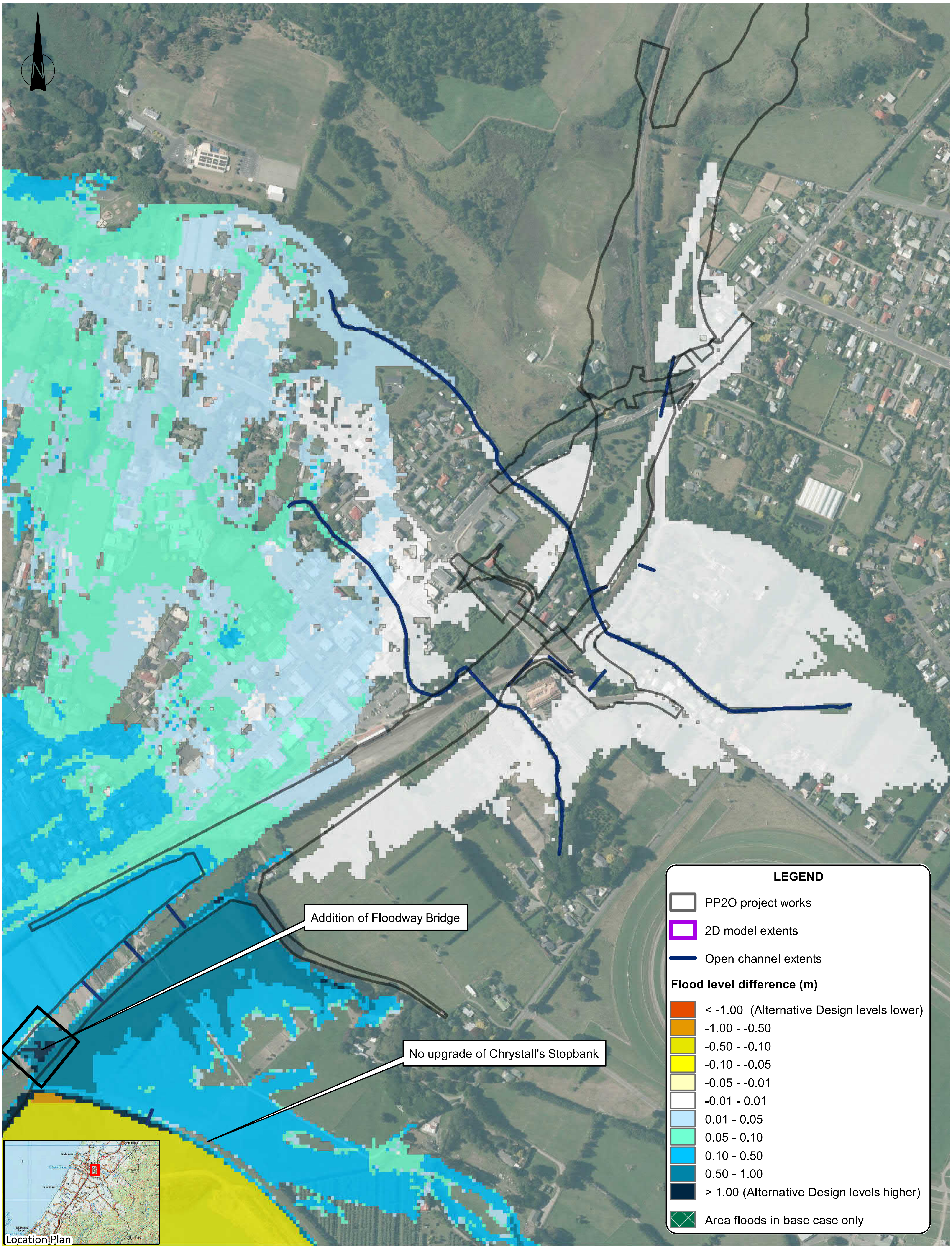
Ōtaki-Mangapouri Model Results Comparison

Post-Project Alternative Design minus Post-Project Base Scenario
Water Levels - 1% AEP CC2130

FIGURE No. Figure 71.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig71_2_OM_DiffPlotPostAltDesignvsPostBase.mxd Date: 9/05/2018 Time: 12:56:07 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig71_2_OM_DiffPlotPostAltDesignvsPostBase.mxd

SCALE (AT A3 SIZE)
1:5,000

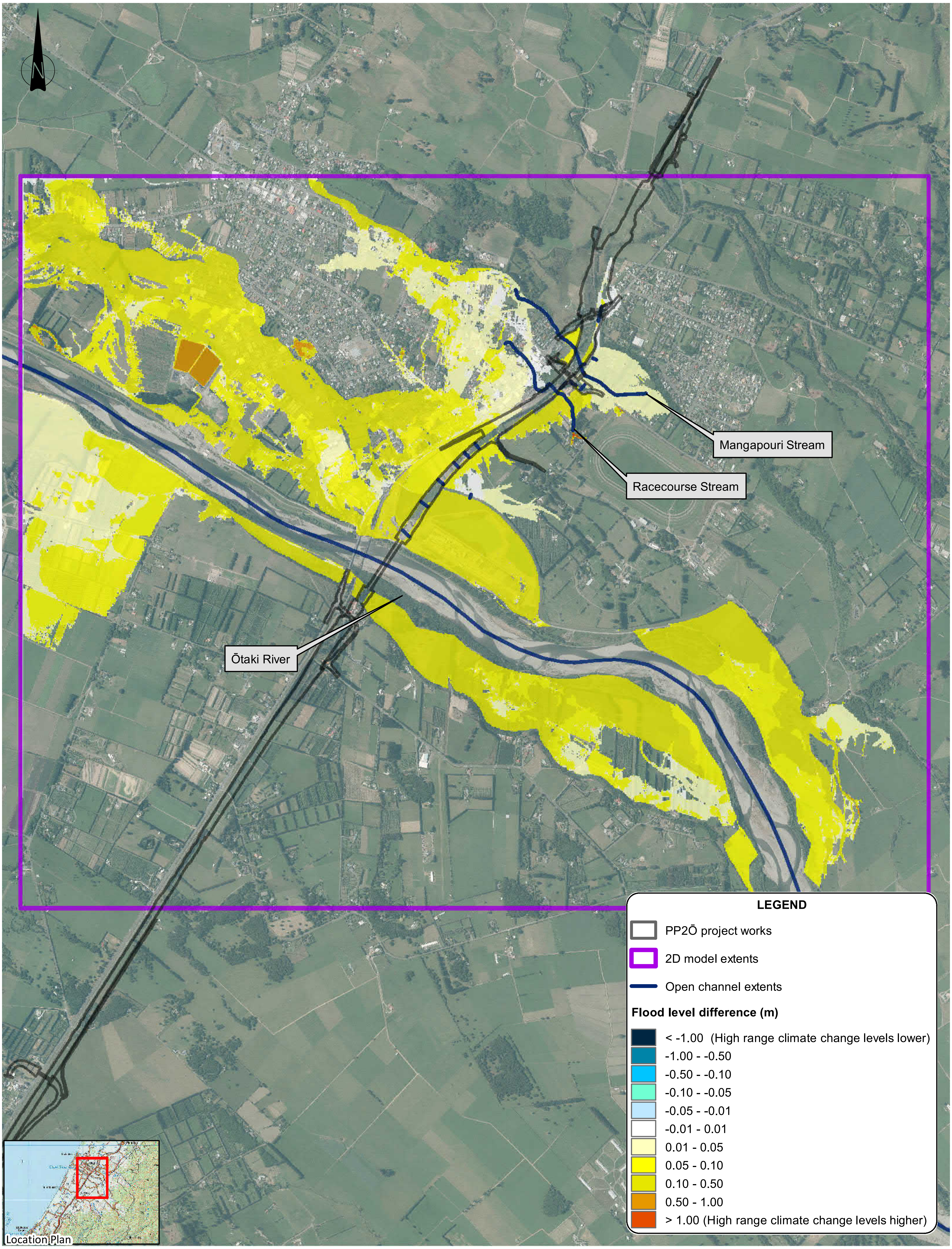
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project Alternative Design minus Post-Project Base Scenario
Water Levels - 1% AEP CC2130

FIGURE No.
Figure 71.2

Rev.
0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig72_1_OM_DiffPlotPostHRCCvsPostCCMR_100yr.mxd Date: 9/05/2018 Time: 12:18:21 p.m.



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A3 SCALE 1:20,000

0 200 400 600 800 1,000 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig72_1_OM_DiffPlotPostHRCCvsPostCCMR_100yr.mxd	
SCALE (AT A3 SIZE)	1:20,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

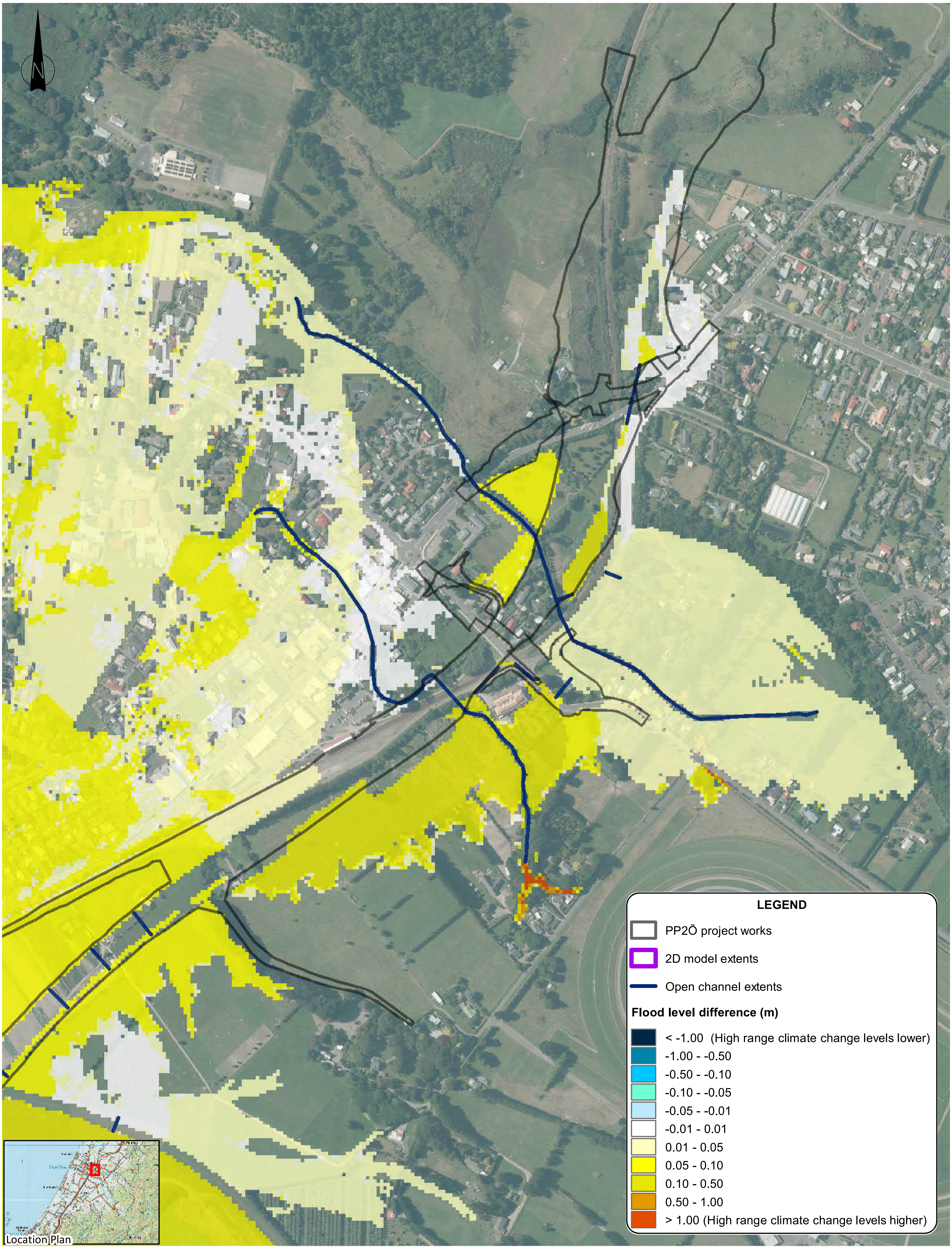
Ōtaki-Mangapouri Model Results Comparison

Post-Project High Range Climate Change minus Post-Project Base Scenario (Mid Range Climate Change) Water Levels - 1% AEP CC2130

FIGURE No. Figure 72.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig72_2_OM_DiffPlotPostHRCCvsPostCCMR_100yr.mxd Date: 9/05/2018 Time: 12:22:53 p.m.



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A3 SCALE 1:5,000

0 40 80 120 160 200 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

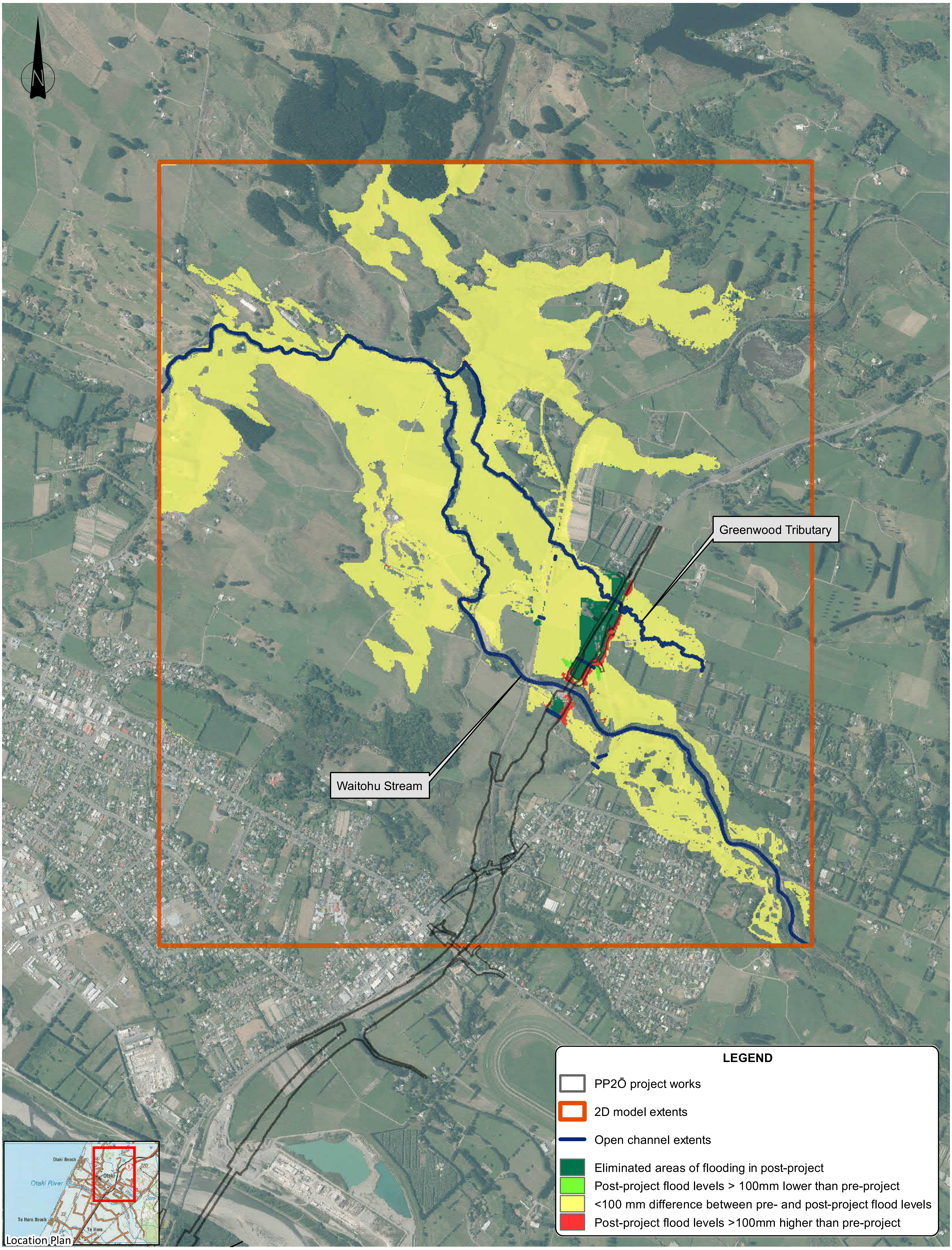
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig72_2_OM_DiffPlotPostHRCCvsPostCCMR_100yr.mxd		
SCALE (AT A3 SIZE) 1:5,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Ōtaki-Mangapouri Model Results Comparison
Post-Project High Range Climate Change minus Post-Project Base Scenario (Mid Range Climate Change) Water Levels - 1% AEP CC2130

FIGURE No. Figure 72.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig73_1_Wai_DiffPlotPostvsPre100mm_100yrCC.mxd Date: 9/05/2018 Time: 1:01:11 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

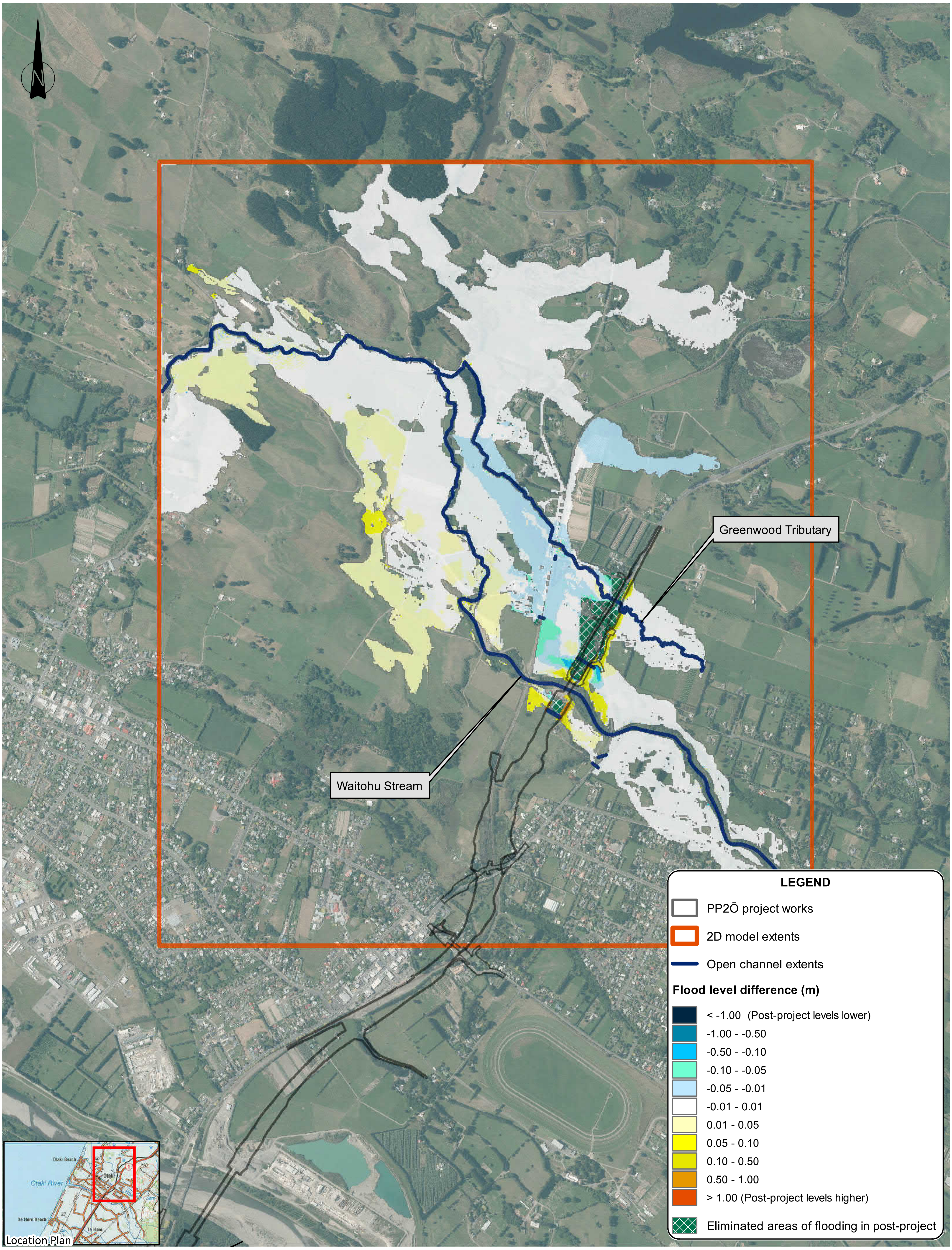
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE	Fig73_1_Wai_DiffPlotPostvsPre100mm_100yrCC.mxd	
SCALE (AT A3 SIZE)	1:15,000	
PROJECT No.	85985.0070	

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Waitohu Model Results Comparison
Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 73.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig73_2_Wai_DiffPlotPostvsPre_100yrCC.mxd Date: 9/05/2018 Time: 1:03:11 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig73_2_Wai_DiffPlotPostvsPre_100yrCC.mxd

SCALE (AT A3 SIZE)
1:15,000

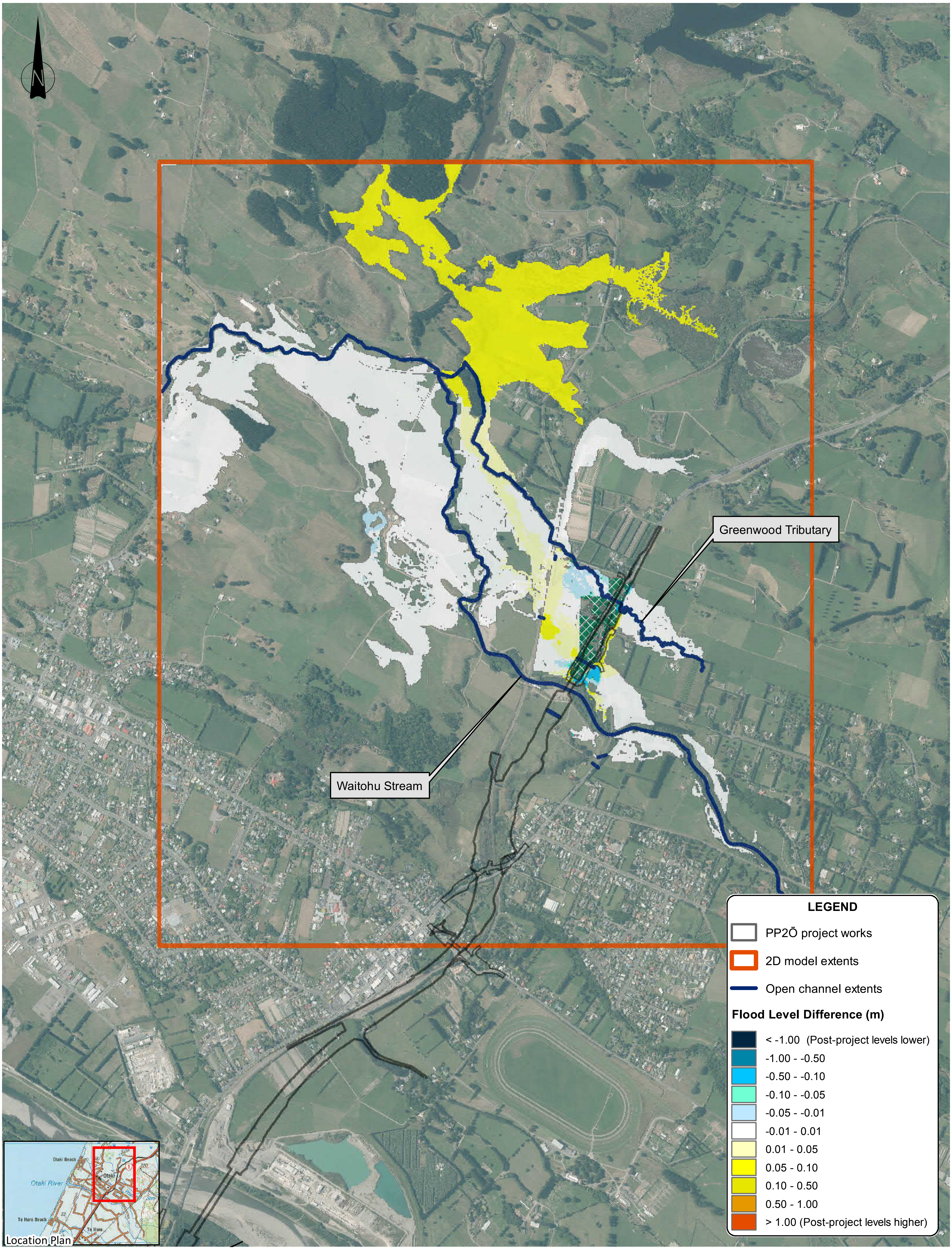
PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Waitohu Model Results Comparison
Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 73.2

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig74_Wai_DiffPlotPostvsPre_20yrCC.mxd Date: 9/05/2018 Time: 1:05:52 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig74_Wai_DiffPlotPostvsPre_20yrCC.mxd

SCALE (AT A3 SIZE) 1:15,000

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

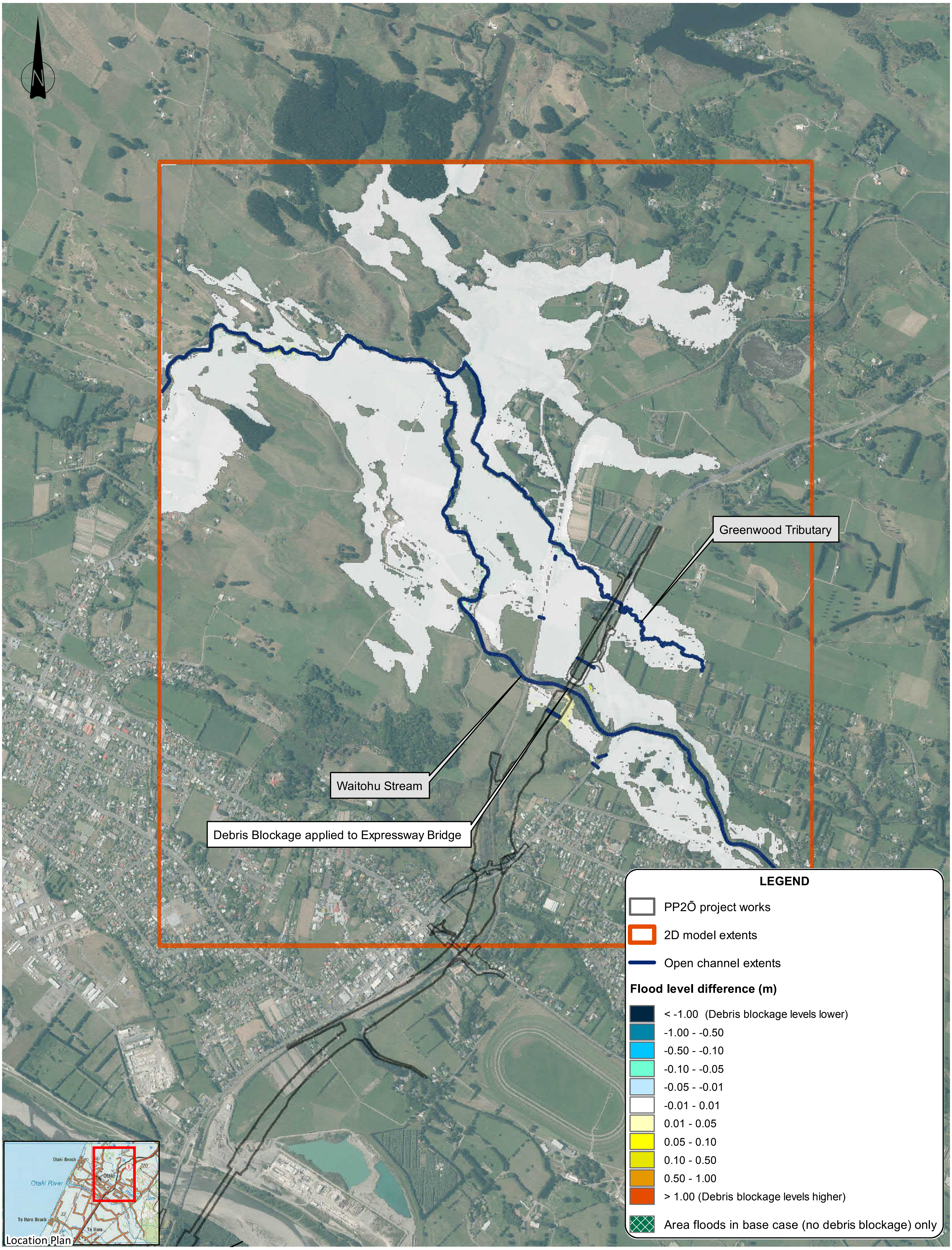
Waitohu Model Results Comparison

Post-Project minus Pre-Project Water Levels - 5% AEP

FIGURE No. Figure 74

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig75_Wai_DiffPlotPostDBvsPostBase_100yrCC.mxd Date: 9/05/2018 Time: 1:20:40 p.m.



LEGEND

- PP2Ō project works
- 2D model extents
- Open channel extents

Flood level difference (m)

- < -1.00 (Debris blockage levels lower)
- -1.00 - -0.50
- -0.50 - -0.10
- -0.10 - -0.05
- -0.05 - -0.01
- -0.01 - 0.01
- 0.01 - 0.05
- 0.05 - 0.10
- 0.10 - 0.50
- 0.50 - 1.00
- > 1.00 (Debris blockage levels higher)
- Area floods in base case (no debris blockage) only

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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig75_Wai_DiffPlotPostDBvsPostBase_100yrCC.mxd		
SCALE (AT A3 SIZE) 1:15,000		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY

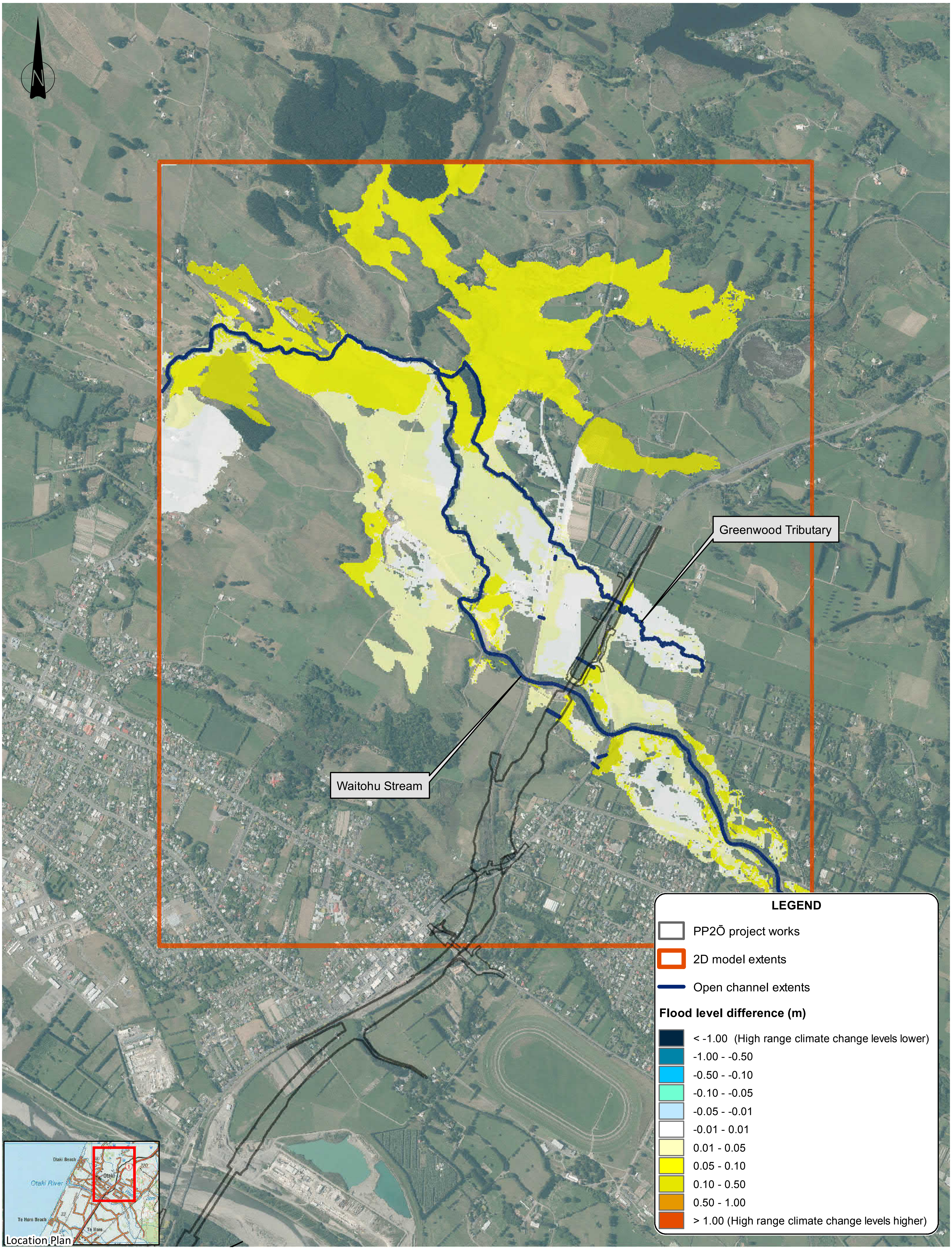
PEKA PEKA TO ŌTAKI EXPRESSWAY
Waitohu Model Results Comparison

Post-Project Debris Blockage Scenario minus Post-Project Base Scenario
Water Levels - 1% AEP CC2130

FIGURE No. Figure 75

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig76_Wai_DiffPlotPostHRCCvsPostMRCC_100yrCC.mxd Date: 9/05/2018 Time: 1:28:04 p.m.



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A3 SCALE 1:15,000

0 0.2 0.4 0.6 0.8 1 (km)

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig76_Wai_DiffPlotPostHRCCvsPostMRCC_100yrCC.mxd

SCALE (AT A3 SIZE)
1:15,000

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

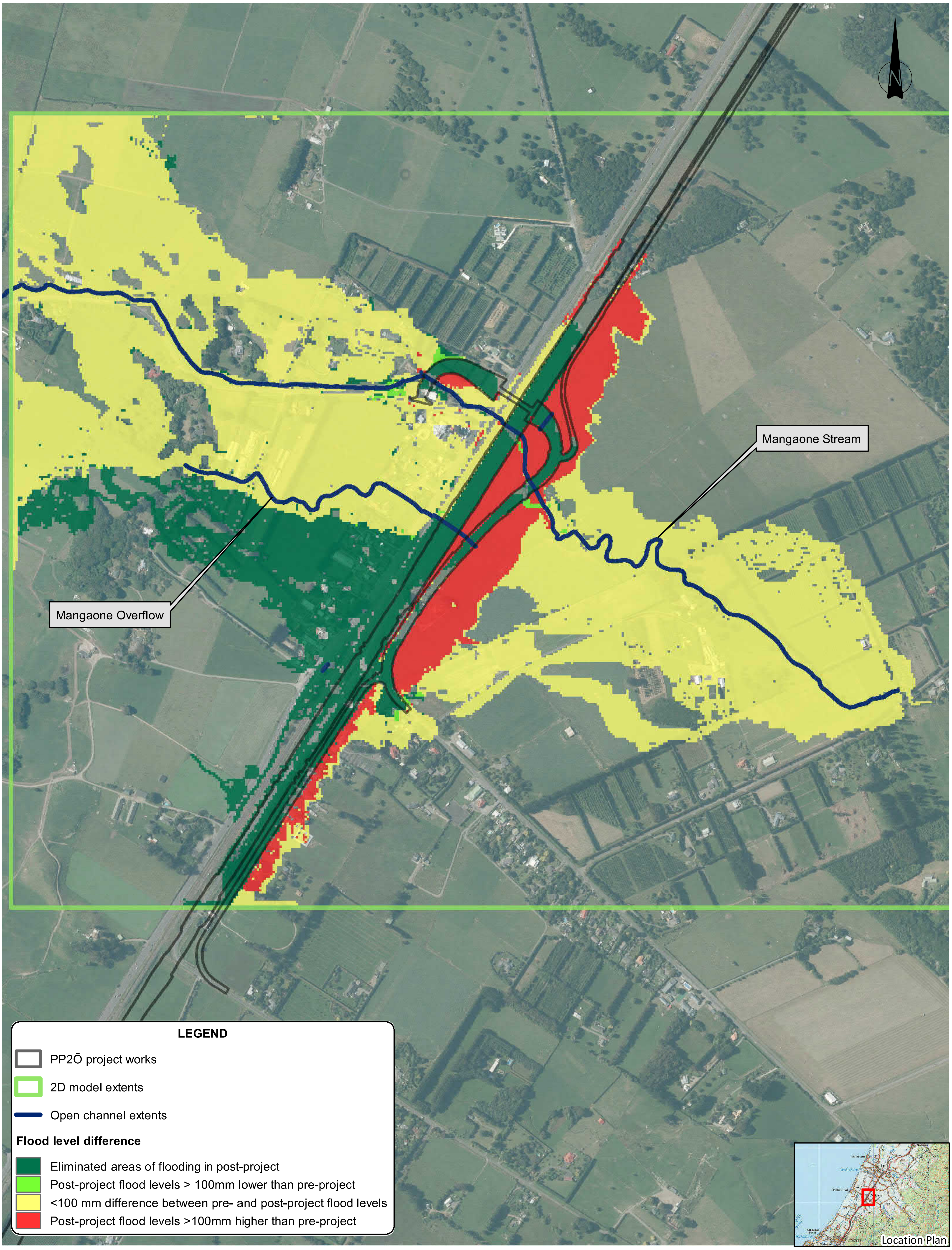
Waitohu Model Results Comparison

Post-Project High Range Climate Change minus Post-Project Base Scenario (Mid Range Climate Change) Water Levels - 1% AEP CC2130

FIGURE No. Figure 76

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig77_1_Mang_DiffPlotPostvsPre100mm_100yrCC.mxd Date: 9/05/2018 Time: 1:39:01 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE Fig77_1_Mang_DiffPlotPostvsPre100mm_100yrCC.mxd

SCALE (AT A3 SIZE) 1:7,500

PROJECT No. 85985.0070

NZ TRANSPORT AGENCY

PEKA PEKA TO ŌTAKI EXPRESSWAY

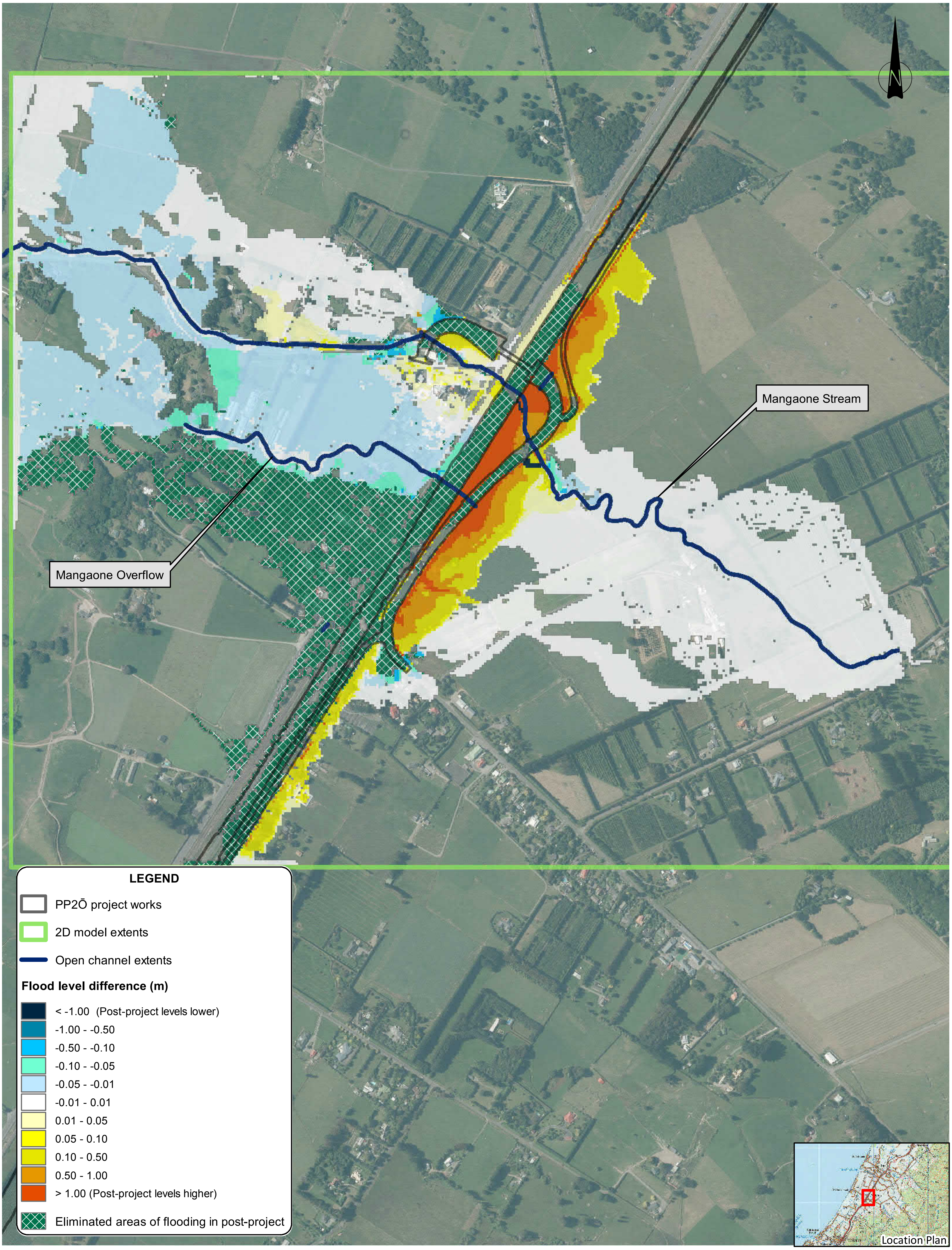
Mangaone Model Results Comparison

Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 77.1

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig77_2_Mang_DiffPlotPostvsPre_100yrCC.mxd Date: 9/05/2018 Time: 1:41:23 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

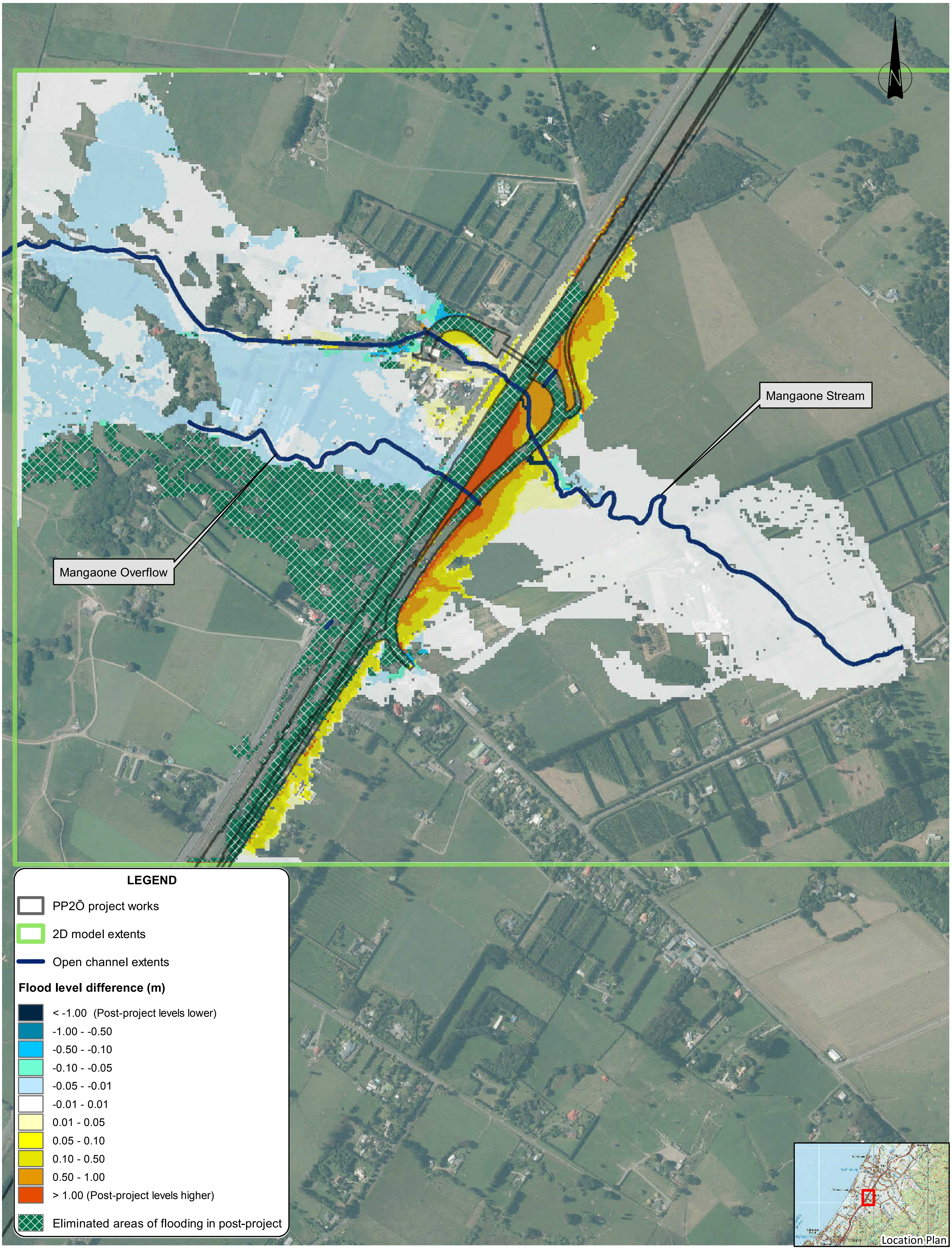
Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig77_2_Mang_DiffPlotPostvsPre_100yrCC.mxd		
SCALE (AT A3 SIZE) 1:7,500		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Mangaone Model Results Comparison
Post-Project minus Pre-Project Water Levels - 1% AEP CC2130

FIGURE No. Figure 77.2 Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig78_Mang_DiffPlotPostvsPre_50yrCC.mxd Date: 9/05/2018 Time: 1:43:29 p.m.



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A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY WAKA KOTAHI

Peka Peka to Ōtaki Expressway

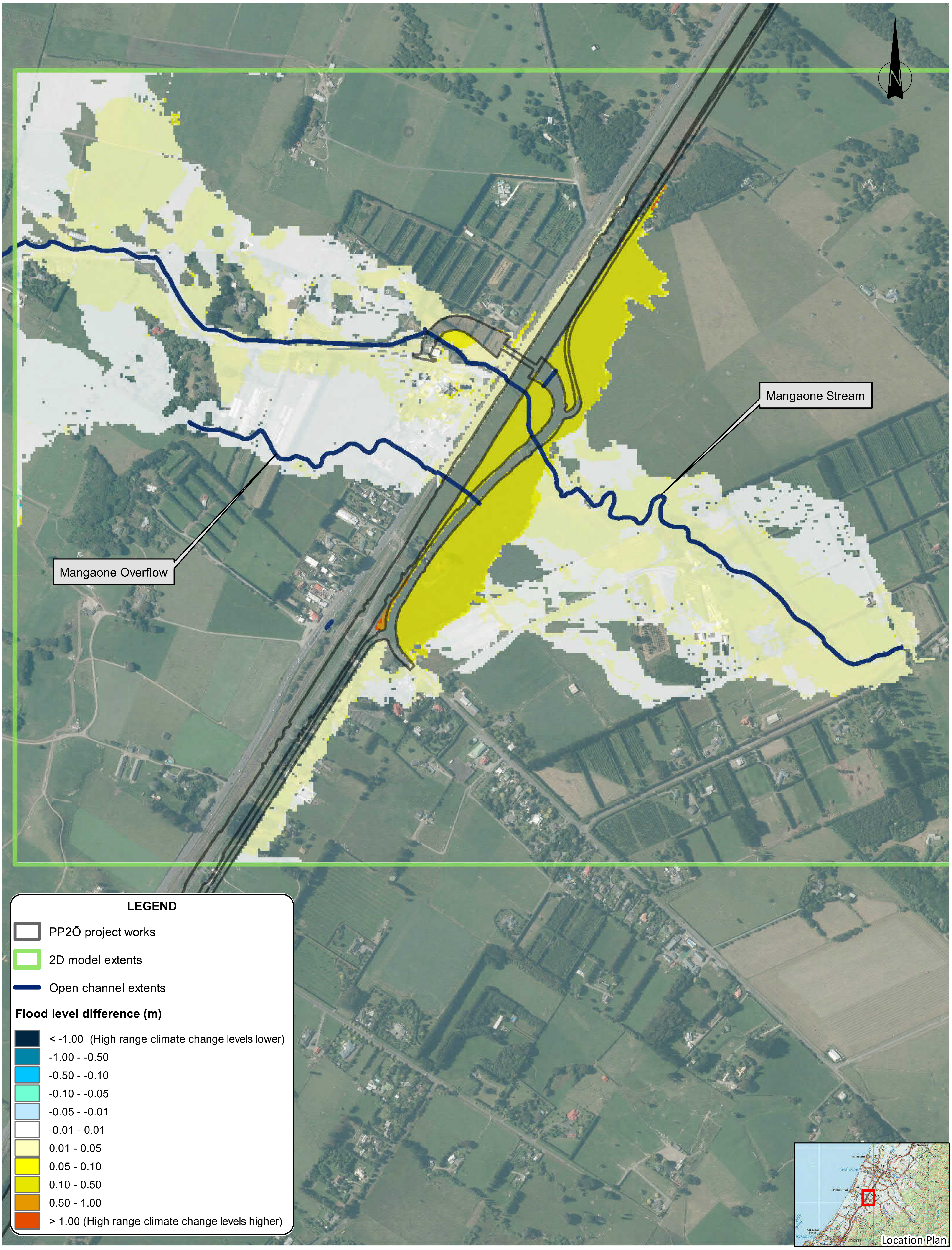
DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18
ARCFILE Fig78_Mang_DiffPlotPostvsPre_50yrCC.mxd		
SCALE (AT A3 SIZE) 1:7,500		
PROJECT No. 85985.0070		

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Mangaone Model Results Comparison
Post-Project minus Pre-Project Water Levels - 2% AEP CC2130

FIGURE No. Figure 78

Rev. 0

Path: T:\Wellington\TT Projects\85985\85985.0070\5000 Stormwater\4 Hydraulic Modelling Schemetisation\GIS\FIGURES\20180501_PostProjectReportRev4\Fig79_Mang_DiffPlotPostHRCCvsPostMRCC_100yrCC.mxd Date: 9/05/2018 Time: 1:53:12 p.m.



Notes:
- Aerial photograph sourced from Greater Wellington Regional Council and licensed for re-use under the Creative Commons Attribution 3.0 New Zealand licence.
- All levels are New Zealand Vertical Datum 2009.
- The flood modelling presented in this figure has been completed for the purposes of the Detailed Design and Construction Phase of PP2Ō "the Project", and may not be suitable for other uses. Model results may not be accurate outside the area of interest for the Project.

A3 SCALE 1:7,500

0 100 200 300 400 500 Meters

NZ TRANSPORT AGENCY
WAKA KOTAHI

Peka Peka to Ōtaki Expressway

DRAWN	KBBB	May.18
CHECKED	DMK	May.18
APPROVED	TSRF	May.18

ARCFILE
Fig79_Mang_DiffPlotPostHRCCvsPostMRCC_100yrCC.mxd

SCALE (AT A3 SIZE)
1:7,500

PROJECT No.
85985.0070

NZ TRANSPORT AGENCY
PEKA PEKA TO ŌTAKI EXPRESSWAY
Mangaone Model Results Comparison
Post-Project High Range Climate Change minus Post-Project Base Scenario (Mid Range Climate Change) Water Levels - 1% AEP CC2130

FIGURE No. Figure 79

Rev. 0

Appendix B:

PROPOSED STRUCTURES – MODELLING NOTES

Ōtaki-Mangapouri Modelled Structures

Proposed Culverts

Culvert No.	Type	Culvert Use	No. of Barrels	Size (m)			Invert Level		Length (m)	Slope (%)	Fish Passage		Model Notes								
				Width	Depth	Embedment	u/s	d/s			Requirement	Type	Model Name	Modelled Type	Substrate Depth	Modelled Width	Modelled Height	Modelled Diam.	Modelled US IL	Modelled DS IL	Weighted n
9 10	Box	Stream Conveyence	1	2.5	3.5	0.5	10.4	10	101	0.40	Yes	500mm Substrate	PP2O_Culv9and10	M11 Culvert	0.5	2.50	3.00		10.90	10.50	0.019
7	Box	Flood Event	2	5	1	0	14	13.85	33	0.45	No		PP2O_Culv07	M11 Bridge Energy Equation		5.00	1.00		14.00	13.85	
14	Circular	Stream Conveyence	1	1.2		0	11.85	11	64	1.33	No		PP2O_Culv14	M11 Culvert				1.2	11.85	11.00	
15b	Circular	Flood Event	1	1.05		0	13.3	12.2	37	2.97	No		PP2O_Culv15b	M11 Culvert				1.05	13.30	12.20	
15c	Circular	Flood Event	1	1.05		0	13	12.2	36	2.22	No		PP2O_Culv15c	M11 Culvert				1.05	13.00	12.20	
15d	Circular	Flood Event	2	1.05		0	12.9	12.2	36	1.94	No		PP2O_Culv15d	M11 Culvert				1.05	12.90	12.20	
15e	CM "Underpass"	Flood Event	1	3.801	2.95	0	11.85	11.65	39	0.51	No		PP2O_Culv15e	M11 Culvert		3.801	2.95		11.85	11.65	0.027
18	CM "Pipe"	Flood Event	1	3.8	3.71	0	12.5	12.2	48	0.63	No		PP2O_Culv18	M11 Culvert		3.800	3.71		12.50	12.20	0.0279
18a	Box	Conveyor Belt	1	2.5	2.5	0	13.6	15.7	52	-4.06	No		PP2O_Culv18a	M11 Culvert		2.50	2.50		13.60	15.70	
12	Circular	Flood Event	1	1.2		0	16.60	15.90	87	0.81	Yes	Spat rope	PP2O_Culv12	M11 Culvert				1.2	16.60	15.90	
13	Circular	Flood Event	1	1.05		0	12.35	12.10	23	1.11	Yes	Spat rope	PP2O_Culv13	M11 Culvert				1.05	12.35	12.10	
66	Circular	Flood Event	1	0.9		0	13.15	13.00	38	0.40	No		PP2O_Pipe66	M11 Culvert				0.9	13.15	13.00	
69	Circular	Flood Event	1	0.9		0	12.80	12.60	49	0.40	No		PP2O_Pipe69	M11 Culvert				0.9	12.80	12.60	

Proposed Bridges

Model Name	Modelled Type	Model Notes
PP2O_OtakiBridge	M11 Bridge FHWA WSPRO	- Submergence, overflow and piers modelled - Bridge level top = 20.993 mRL - Bridge Level Bottom = 17.687 mRL - Width = 330 m - Waterway Length = 24 m - Pier Blockage Ratio = 0.044 - Resistance Value (n) = 0.012

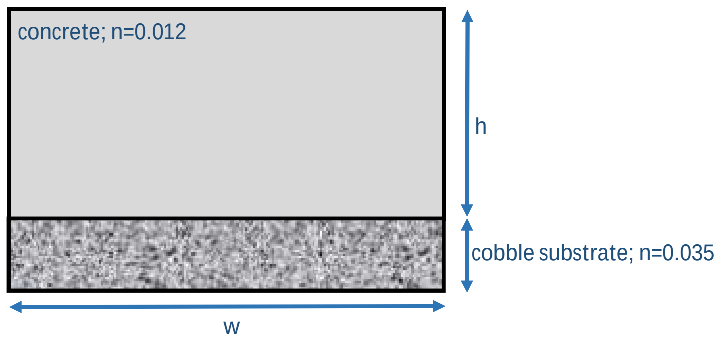
Note 1: Weighted manning's n is calculated using:

Cobble substrate n = 0.035

Concrete n = 0.012

$$\text{Weighted n of culvert} = \frac{(0.012 \times 2 \times \text{modelled culvert height}) + (0.035 \times \text{culvert width})}{(2 \times \text{modelled culvert height} + \text{culvert width})}$$

$$= \frac{(0.012h) + (0.012h) + (0.035w)}{(h + h + w)}$$



Note 2: The resistance value set for the bridge structure is only applied at the 'abutments' of the bridge.
The adjacent cross sections' resistance is applied at the low flow channel by the software.

Note 3: Culverts are modelled as MIKE11 culvert structures for consistency wherever possible, and as bridge structures where required because of model instabilities.
Sensitivity tests have been carried out to confirm that modelling culverts as MIKE 11 bridge structures is appropriate. The testing showed that the bridge representation can match the culvert representation well, depending on the parameter settings.
The testing informed the selection of the following parameter settings where culverts are modelled as MIKE 11 bridge structures:

- Submergence level is set at soffit level in centre of culvert
- A weighted manning's n is applied to structure and immediately adjacent cross sections
- Contraction and expansion losses remain as default values

Waitohu Modelled Structures

Proposed Culverts

Culvert No.	Type	Culvert Use	No. of Barrels	Size (m)			Invert Level		Length (m)	Slope (%)	Fish Passage		Model Notes								
				Width	Depth	Embedment	u/s	d/s			Requirement	Type	Model Name	Modelled Type	Substrate Depth	Modelled Width	Modelled Height	Modelled Diam.	Modelled US IL	Modelled DS IL	Weighted n
1	CM "Pipe arch"	Stream Conveyence	1	3.718	2.425	0.45	22.40	22.05	46	0.76	Yes	450mm Substrate	PP2O_Culv1	M11 Culvert	0.45	3.718	1.98		22.85	22.50	0.0321
2b	Circular	Flood Event	11	1.2		0	24.5	24.2	83	0.36	No		PP2O_Culv2b	M11 Culvert				1.2	24.50	24.20	
3	Circular	Flood Event / Stream Conveyence	1	0.75		0.15	23.4	23.1	59	0.51	Yes	150mm Substrate	PP2O_Culv3a	M11 Culvert	0.15	Modelled as irregular section to represent substrate in base of culvert*			23.55	23.25	0.0181
3a	CM "Underpass"	Flood Event / Stream Conveyence	1	3.802	3.164	0	24.05	23.75	56	0.54	No		PP2O_Culv3b	M11 Culvert		3.802	3.16		24.05	23.75	0.026

Proposed Bridges

Model Name	Modelled Type	Model Notes
PP2O_WaitohuBridge	M11 Bridge FHWA WSPRO	- Submergence, overflow and piers modelled - Bridge level top = 31.9 mRL - Bridge Level Bottom = 30.4 mRL - Width = 75 m - Waterway Length = 25 m - Pier Blockage Ratio = 0.043 - Resistance Value (n) = 0.024

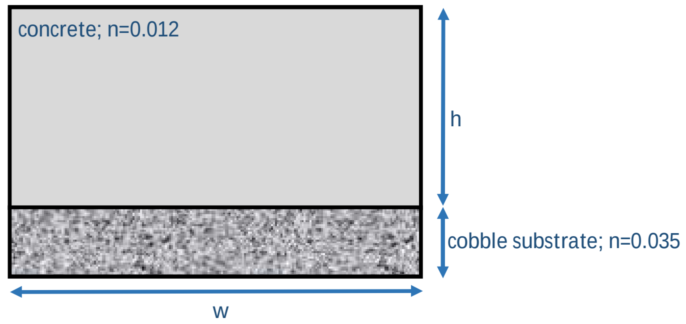
Note 1: Weighted manning's n is calculated using:

Cobble substrate n = 0.035

Concrete n = 0.012

Weighted n of culvert = $\frac{(0.012 \times 2 \times \text{modelled culvert height}) + (0.035 \times \text{culvert width})}{(2 \times \text{modelled culvert height} + \text{culvert width})}$

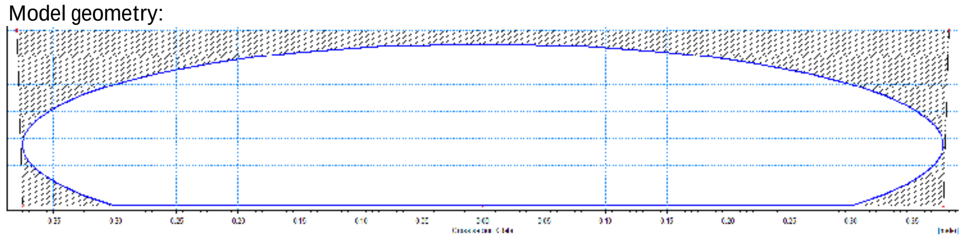
$= \frac{(0.012h) + (0.012h) + (0.035w)}{(h + h + w)}$



Note 2: The resistance value set for the bridge structure is only applied at the 'abutments' of the bridge.
The adjacent cross sections' resistance is applied at the low flow channel by the software.

*Piped culvert 3 ("PP2O_Culv3a") is modelled as an irregular section to represent the substrate in the base of the culvert.

Model geometry:



Mangaone Modelled Structures

Proposed Culverts

Culvert No.	Type	Culvert Use	No. of Barrels	Size (m)			Invert Level		Length (m)	Slope (%)	Fish Passage		Model Notes								
				Width	Depth	Embedment	u/s	d/s			Requirement	Type	Model Name	Modelled Type	Substrate Depth	Modelled Width	Modelled Height	Modelled Diam.	Modelled US IL	Modelled DS IL	Weighted n
24	Box	Stream Conveyence	1	5	2	0.15	16.25	15.85	47	0.86	Yes	150mm "Glued" Substrate	PP2O_Culv24	M11 Culvert	0.15	5.00	1.85		16.40	16.00	0.025
23	Box	Stream Conveyence	1	5.5	3.5	0.5	17.5	17.1	29	1.36	Yes	500mm Substrate	PP2O_Culv23	M11 Culvert	0.5	5.50	3.00		18.00	17.60	0.023
23a	CM "Arch"	Flood Event	1	5.996	2.885	-0.3	17.40	16.95	37	1.21	No		PP2O_Culv23a	M11 Bridge Energy Equation		5.996	3.19		17.10	16.65	0.034
27	CM "Arch"	Stream Conveyence	1	6.15	2.918	0	16.4	16.2	28	0.72	No		PP2O_Culv27	M11 Bridge Energy Equation		6.15	2.92		16.40	16.20	0.034
28	CM "Box"	Stream Conveyence	1	5.665	2.123	0	16.10	15.60	51	0.98	No		PP2O_Culv28	M11 Bridge Energy Equation		5.665	2.12		16.10	15.60	0.034
34	Box	Stream Conveyence	1	4	3.6	0.5	12.9	12.5	29	1.38	Yes	500mm Substrate	PP2O_Culv34	M11 Culvert	0.5	4.00	3.10		13.40	13.00	0.021

Proposed Weirs

Model Name	Modelled Type	Model Notes
PP2O_LucisnkyOverflow	M11 Weir Weir Formula 2 (Honma)	- Weir coefficient (C1) = 1.1 m½/s - Weir width = 17 m - Weir crest level = 14.8 m

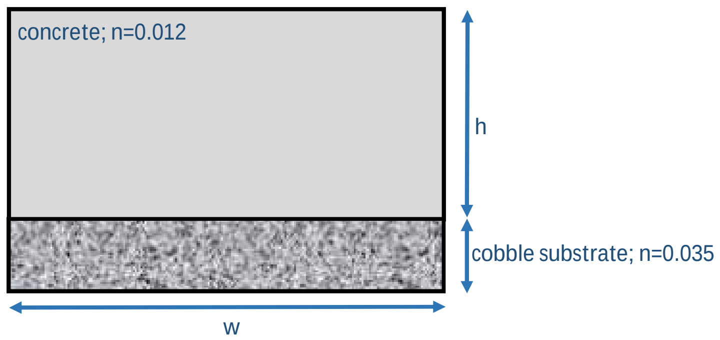
Note 1: Weighted manning's n is calculated using:

Cobble substrate n = 0.035

Concrete n = 0.012

$$\text{Weighted n of culvert} = \frac{(0.012 \times 2 \times \text{modelled culvert height}) + (0.035 \times \text{culvert width})}{(2 \times \text{modelled culvert height} + \text{culvert width})}$$

$$= \frac{(0.012h) + (0.012h) + (0.035w)}{(h + h + w)}$$



Note 2: The resistance value set for the bridge structure is only applied at the 'abutments' of the bridge.
The adjacent cross sections' resistance is applied at the low flow channel by the software.

Note 3: Culverts are modelled as MIKE11 culvert structures for consistency wherever possible, and as bridge structures where required because of model instabilities.
Sensitivity tests have been carried out to confirm that modelling culverts as MIKE 11 bridge structures is appropriate. The testing showed that the bridge representation can match the culvert representation well, depending on the parameter settings.
The testing informed the selection of the following parameter settings where culverts are modelled as MIKE 11 bridge structures:

- Submergence level is set at soffit level in centre of culvert
- A weighted manning's n is applied to structure and immediately adjacent cross sections
- Contraction and expansion losses remain as default values

Appendix C:

COMPLIANCE WITH PERFORMANCE STANDARDS

Element	Chainage	Description	Reference	Comment		Compliance
Culvert 6 (existing rail culvert on Mangapouri Stream) "MANGAPOURICOUNTYRDCULVERT 28/38"	2000	Maximum WL of 14.53mRL in 100 yr CC	PR Table A21-3	14.39mRL in 2D	14.229mRL in 1D	<14.53mRL OK
		Maximum flow of 4.3m3/s in 100 yr CC	PR Table A21-4	4.224	m3/s	<4.3 OK (4.32m^3/s in Pre-Project)
		Maximum WL of 14.01mRL in 10 yr (no CC)	PR Table A21-5	13.91mRL in 2D	13.675mRL in 1D	<14.01 mRL OK
		Maximum WL of 14.28mRL in 50 yr (no CC)	PR Table A21-6	14.20mRL in 2D	13.990mRL in 1D	<14.28 mRL OK
		Maximum WL of 14.36mRL in 100 yr (no CC) upstream of culvert	PR Table A21-7	14.27mRL in 2D	14.067mRL in 1D	<14.36 mRL OK
Culvert 11 (existing SH1 culvert on Mangapouri Stream) "MANGAPOURISH1CULVERT 0/18.5"	1900	Maximum WL of 13.33mRL in 100 yr CC	PR Table A21-3	13.14mRL in 2D	13.153mRL in 1D	<13.33mRL OK
		Maximum flow of 6.3m3/s in 100 yr CC	PR Table A21-4	5.209	m3/s	<6.3 OK, but note a slight increase on 5.14m^3/s in the Pre-Project
		Maximum WL of 12.96mRL in 10 yr (no CC)	PR Table A21-5	12.36mRL in 2D	12.406mRL in 1D	<12.96 mRL OK
		Maximum WL of 13.21mRL in 50 yr (no CC)	PR Table A21-6	12.81mRL in 2D	12.822mRL in 1D	<13.21 mRL OK
		Maximum WL of 13.29mRL in 100 yr (no CC)	PR Table A21-7	12.93mRL in 2D	12.939mRL in 1D	<13.29 mRL OK
Culvert 15 (existing SH1 culvert on Racecourse Stream) "RACECOURSEDUNSTANSTCULVERT 0/78"	2200	Maximum WL of 14.18mRL in 100 yr CC	PR Table A21-3	13.18mRL in 2D	13.228mRL in 1D	<14.18mRL OK
		Maximum flow of 1.8m3/s in 100 yr CC	PR Table A21-4	1.495	m3/s	<1.8 OK, not including overtopping in the 2D domain
		Maximum WL of 11.86mRL in 10 yr (no CC) upstream of culvert	PR Table A21-5	No 2D flow	11.882mRL in 1D	>11.86 mRL Not OK, marginal exceedance of 0.02m (note only a 6mm increase on 11.876mRL in Pre-Project)
		Maximum WL of 13.38mRL in 50 yr (no CC)	PR Table A21-6	12.94mRL in 2D	12.949mRL in 1D	<13.38 mRL OK
		Maximum WL of 13.74mRL in 100 yr (no CC)	PR Table A21-7	13.12mRL in 2D	13.162mRL in 1D	<13.74 mRL OK
Culverts 12 and 70. Note assessed in separate hydraulic model. Refer Culvert 12 Design Report Rev 2 (PP2Ō March 2018)	1650 and 1580	Maximum WL of 18.83mRL in 100 yr CC in remnant railway wetland / west wetland	PR Table A21-3	18.0	mRL Remnant Wetland West	<18.83 mRL OK
				18.7	mRL Railway Wetland	<18.83 mRL OK
		Maximum flow of 2.6m3/s in 100 yr CC	PR Table A21-4	0.382	m3/s Culvert 70	<2.6m3/s OK
				0.653	m3/s Culvert 12	<2.6m3/s OK
		Maximum WL of 18.15mRL in 10 yr (no CC) upstream of culvert	PR Table A21-5	Not modelled		OK, 10 yr with CC flood levels all < 18.15mRL (Culvert 70 = 17.6 mRL, Culvert 12 =17.03 mRL in 10yr CC)
		Maximum WL of 18.42mRL in 50 yr (no CC) upstream of culvert	PR Table A21-6	Not modelled		OK, 100 yr with CC flood levels all < 18.42mRL (see below)
		Maximum WL of 18.53mRL in 100 yr (no CC) upstream of culvert	PR Table A21-7	Not modelled		OK, 100 yr with CC flood levels all < 18.53mRL (Culvert 70 = 18.22 mRL, Culvert 12 =17.24 mRL in 100yr CC)
PP2O_Culv9and10	2000	Cover to culvert 9 under Expressway		0.440	m cover based on modelled culvert rise with 0.4m deck thickness	<0.6m. To be addressed by a combination of reducing culvert rise by 100mm (increases cover to 0.54m) and specific design of pavement for reduced cover.
		Cover to culvert 10 under rail (top of rail to top of culvert)		1.250	m cover from top of rail, with 0.4m thick deck	Subject to separate design by structural design team
		Separate structures (to let light in as described in Section 18.5.4 of Specimen Design Report	PR A21.5.3f	Light entry provided via scruffy dome in top of culvert deck		OK, light entry provided
		0.3m freeboard to soffit in 100 yr CC	PR A21.4.5c and WS.6a)iii)	0.695	m to soffit (u/s end)	As noted above, the intent is to reduce the culvert rise by 100mm, which will reduce the freeboard to soffit to 595mm at the upstream end and 259mm at the downstream end. The culvert is still considered compliant because > 300mm freeboard to soffit is provided at the upstream end, the reduced freeboard to soffit at the downstream end is due to high tailwater levels because of downstream constraints rather than due to capacity of the culvert, and sensitivity testing indicates that water levels are relatively insensitive i.e. even in much larger floods freeboard is maintained to the soffit of the culvert including at the downstream end (> 180mm in the 100yr CC High Range and > 30mm in the 500yr CC with the reduced culvert rise) .
				0.359	m to soffit (d/s end)	
		No collapse in 2500 yr CC (ULS)		HW = 13.594 mRL ; TW = 13.483 mRL. Peak flow = 6.490 m3/s		Embankment batter slope and scour protection design will include ULS requirements.
PP2O_Culv07	2080	Cover to culvert		2.650	m cover	>0.6m OK. Refer PP2Ō-DR-SW-1025.
		Must not operate prematurely compared with the existing situation	PR A21.5.3c	Culvert inlet level (14.0mRL) is lower than existing low point in road (14.15mRL) so operates prematurely - between a 10yr no CC and 20yr no CC event. In the pre-project situation, the overland flow path through 35 Rahui Road activates between a 20yr no CC and 50yr no CC event (Pre Project Hydraulic Model Report Rev 3 PP2Ō October 2017).		Not OK, but if raise inlet results in worsened flooding effects for residential area north of culvert. Mitigated by providing drainage alongside milk station link road (open channels and 0.9m dia pipes) to convey the 20yr present climate discharge from Culvert 7 to Racecourse Stream without activating overland flow path through private property. (Note the MIKE FLOOD model results still show overland flow in the 20 yr no CC event but this is due to the resolution / scale of the model i.e. is not real.)
		Transfer less flood volume than occurs in the existing situation in the 10 yr no CC up to the 100 yr CC event	PR A21.5.3c	Total Rahui Rd Flows: 10 yr PreProj = 0 m3 PostProj = 0 m3 10 yr CC PreProj = 0 m3 (Overland Flow Only) Post Proj = 8,100 m3 (Culvert 7 Flow, Overland Flow zero) 100 yr CC PreProj = 77,100 m3 (Overland Flow Only) PostProj = 89,200 m3 (73,700 m3 Culvert 7, 15,500 m3 Overland Flow)		Not OK - volume transferred across Rahui Road (overtopping road and through Culvert 7) is increased. Mitigated by providing drainage alongside milk station link road to avoid increasing frequency that the overland flow path through private property is activated (see above). Also, there is no increase in the volume transferred through Culvert 14 to the existing soakage area on Racecourse Stream (see below).
		0.5m freeboard to road in 100 yr CC		4.115	m freeboard upstream	>0.5m OK
				4.573	m freeboard downstream	>0.5m OK
		No collapse in 2500 yr CC (ULS)		HW = 14.686 mRL ; TW = 14.685 mRL. Peak flow = 4.752 m3/s		Embankment batter slope and scour protection design will include ULS requirements.

Element	Chainage	Description	Reference	Comment		Compliance
PP2O_Culv14	2200	Cover to culvert under Expressway		1.150	m cover	>0.6m OK. Refer PP2Ō-DR-SW-1027.
		Cover to culvert 10 under rail (0.75m absolute min from top of rail to top of pipe, 1.2m from	KiwiRail standards	1.223	m cover (0.1875m thick collars)	>1.2m OK for proposed Class 4 pipe
		Match existing culvert capacity	PR A21.5.3e	Peak discharge through Culvert 14: 10 yr no CC PreProj = 0.415 m3/s Post Proj = 0.421 m3/s 10 yr CC PreProj = 0.570 m3/s Post Proj = 0.840 m3/s 100 yr CC PreProj = 4.085 m3/s PostProj = 3.754 m3/s		OK considering both peak discharge and volume transferred (see below for latter) across events
		0m freeboard to soffit in 10 yr CC		0.533	m freeboard upstream	>0m OK
				-0.002	m freeboard downstream	<0m but exceedance marginal, essentially compliant within 2 decimal places
		0.5m freeboard to road in 100 yr CC		1.444	m freeboard	>0.5m OK
		Maximum WL of 14.51mRL in 100 yr CC	PR Table A21-3	14.076	mRL	<14.51mRL OK
		Maximum flow of 2.15m3/s in 100 yr CC	PR Table A21-4	3.754	m3/s	>2.15 not OK, but note <4.09m^3/s in Pre-Project
		Maximum WL of 12.16mRL in 10 yr (no CC) upstream of culvert	PR Table A21-5	12.323	mRL	>12.16 mRL Not OK, but configuration optimised to match peak discharge and volumes through culvert to the pre project situation
		Maximum WL of 13.60mRL in 50 yr (no CC)	PR Table A21-6	13.009	mRL	<13.60 mRL OK
		Maximum WL of 13.99mRL in 100 yr (no CC)	PR Table A21-7	13.436	mRL	<13.99 mRL OK
		The KCDC soakage area at the end of Jean Hing Place should not be used more frequently than is currently the case	PR A21.5.3d	Volumes through Culvert 14: 10 yr no CC PreProj = 8,500 m3 Post Proj = 8,600 m3 10 yr CC PreProj = 22,500 m3 Post Proj = 19,700 m3 100 yr CC PreProj = 159,400 m3 PostProj = 109,400 m3		OK - volume essentially the same in the 10yr no CC event, slightly decreased in 10 yr CC, and moderately decreased in 100 yr CC
		No collapse in 2500 yr CC (ULS)		HW = 14.614 mRL; TW = 13.262 mRL. Peak flow = 4.570 m3/s		Embankment batter slope and scour protection design will include ULS requirements.
PP2O_Culv15b	2750	Cover to culvert		0.800	m cover	>0.6m OK. Refer PP2Ō-DR-SW-1030.
		0m freeboard to soffit in 10 yr CC		0.850	m freeboard upstream	OK
				0.016	m freeboard downstream	OK
		0.5m freeboard to road in 100 yr CC		1.064	m freeboard	>0.5m OK
		Maximum WL of 15.19mRL in 100 yr CC	PR Table A21-8	14.316	mRL	<15.19mRL OK
		Maximum WL of 16.07mRL upstream of culvert in 500 yr CC with Chrystall's Bend stopbank overtopping	PR Table A21-8	14.469	mRL	<16.07 mRL OK for stopbank overtopping scenario. Note higher with stopbank breach scenario 16.033mRL (still < 16.07mRL).
		Maximum WL of 16.36mRL in 3000m3/s flood with Chrystall's Bend stopbank overtopping	PR Table A21-8	15.698	mRL	<16.36 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.274mRL (still < 16.36mRL)
		No collapse in 3000m3/s flood (ULS) (case with breach of Chrystall's Stopbank assumed since results in higher water levels and discharge than overtopping (no breach) case)		HW = 16.274 mRL ; TW = 14.712 mRL. Peak flow = 4.187 m3/s		Embankment batter slope and scour protection design will include ULS requirements
PP2O_Culv15c	2830	Cover to culvert		0.800	m cover	>0.6m OK. Refer PP2Ō-DR-SW-1031.
		0m freeboard to soffit in 10 yr CC		0.584	m freeboard upstream	OK
				0.016	m freeboard downstream	OK
		0.5m freeboard to road in 100 yr CC		0.811	m freeboard	>0.5m OK
		Maximum WL of 15.19mRL in 100 yr CC	PR Table A21-8	14.329	mRL	<15.19mRL OK
		Maximum WL of 16.07mRL upstream of culvert in 500 yr CC with Chrystall's Bend stopbank overtopping	PR Table A21-8	14.476	mRL	<16.07 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.033mRL (still < 16.07mRL).
		Maximum WL of 16.36mRL in 3000m3/s flood with Chrystall's Bend stopbank overtopping	PR Table A21-8	15.700	mRL	<16.36 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.276mRL (still < 16.36mRL)
		No collapse in 3000m3/s flood (ULS) (case with breach of Chrystall's Stopbank assumed since results in higher water levels and discharge than overtopping (no breach) case)		HW = 16.276 mRL ; TW = 14.821 mRL. Peak flow = 4.408 m3/s		Embankment batter slope and scour protection design will include ULS requirements
PP2O_Culv15d	2920	Cover to culvert		0.700	m cover	>0.6m OK. Refer PP2Ō-DR-SW-1032.
		0m freeboard to soffit in 10 yr CC		0.205	m freeboard upstream	OK
				0.016	m freeboard downstream	OK
		0.5m freeboard to road in 100 yr CC		0.618	m freeboard	>0.5m OK
		Maximum WL of 15.19mRL in 100 yr CC	PR Table A21-8	14.322	mRL	<15.19mRL OK
		Maximum WL of 16.07mRL upstream of culvert in 500 yr CC with Chrystall's Bend stopbank overtopping	PR Table A21-8	14.471	mRL	<16.07 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.033mRL (still < 16.07mRL).
		Maximum WL of 16.36mRL in 3000m3/s flood with Chrystall's Bend stopbank overtopping	PR Table A21-8	15.687	mRL	<16.36 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.285mRL (still < 16.36mRL)
		No collapse in 3000m3/s flood (ULS) (case with breach of Chrystall's Stopbank assumed since results in higher water levels and discharge than overtopping (no breach) case)		HW = 16.285 mRL ; TW = 14.851 mRL. Peak flow = 8.420 m3/s		Embankment batter slope and scour protection design will include ULS requirements

Element	Chainage	Description	Reference	Comment		Compliance
PP2O_Culv15e	3040	Cover to culvert		0.700	m cover	>0.643m OK. Refer PP2Ō-DR-SW-1033 and 1034.
		Vehicle access	PR A21.5.4l	Sized to provide for access		OK
		0m freeboard to soffit in 10 yr CC		1.562	m freeboard upstream	OK
				1.362	m freeboard downstream	OK
		0.5m freeboard to road in 100 yr CC		1.356	m freeboard	>0.5m OK
		Maximum WL of 15.19mRL in 100 yr CC	PR Table A21-8	14.314	mRL	<15.19mRL OK
		Maximum WL of 16.07mRL upstream of culvert in 500 yr CC with Chrystall's Bend stopbank overtopping	PR Table A21-8	14.475	mRL	<16.07 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 15.986 mRL (still < 16.07mRL)
		Maximum WL of 16.36mRL in 3000m3/s flood with Chrystall's Bend stopbank overtopping	PR Table A21-8	15.625	mRL	<16.36 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.326mRL (still < 16.36mRL)
		No collapse in 3000m3/s flood (ULS) (case with breach of Chrystall's Stopbank assumed since results in higher water levels and discharge than overtopping (no breach) case)		HW = 16.326 mRL ; TW = 15.139 mRL. Peak flow = 40.096 m3/s		Embankment batter slope and scour protection design will include ULS requirements
PP2O_Culv18	3340	Cover to culvert		0.850	m cover	>0.643m OK. Refer PP2Ō-DR-SW-1035 and 1036.
		No premature flooding to eastern part of flood basin	PR A21.5.5i	Controlled by surrounding ground levels rather than culvert levels		OK
		0.5m freeboard to road in 100 yr CC		1.302	m freeboard	>0.5m OK
		No collapse in 3000m3/s flood (ULS) (case with overtopping only (no breach) of Chrystall's Stopbank assumed since results in higher water levels and discharge than with breach case)		HW = 16.884 mRL ; TW = 15.688 mRL. Peak flow = 48.701 m3/s		Embankment batter slope and scour protection design will include ULS requirements.
PP2O_OtakiBridge	3500 - 3800	1.7m freeboard to soffit in 100 yr CC	WS.6i and PR A21.4.5e	1.95m provided. 100yr CC flood level 15.74mRL. Bridge soffit 17.687mRL min (at abutments and higher at centre span).		>1.7m OK
		Length between faces of the abutments greater than 330m (without subtraction of pier width)	PR A21.5.6.2 and PR A21.5.5a	330	m between vertical abutment faces	>330m OK
		Upper and lower access track under the northern abutment of the bridge to have 4.2m and 6.0m clearance respectively to the soffit of the bridge		Refer PP2Ō-DR-SB-5011		OK
		Provision for draining lower level access to the Ōtaki River with backflow prevention	PR I5.4.2.13	N/A		Not applicable, now open channel for free drainage
		Minimum level of service of at least the 20 yr flood (no CC) to the upper and lower access tracks. Principal's Advisor has verbally	PR A21.5.5j	14.242	mRL	OK - Will be provided by existing ground left in place between the upper public access and lower overdimension track
		Maximum WL of 15.56mRL in 100 yr CC upstream of bridge	PR Table A21-9	15.98 in 2D domain on right abutment, 16.12 on left abutment	15.740mRL in 1D	>15.56mRL not OK, but increased water level due to upgrading Chrystall's Stopbank
		Maximum WL of 15.79mRL upstream of bridge in 500 yr CC	PR Table A21-9	16.433	mRL with Chrystall's stopbank overtopping	>15.79 mRL Not OK, but increased water level due to upgrading Chrystall's Stopbank
				16.432	mRL with breach of Chrystall's stopbank	>15.79 mRL Not OK, but increased water level due to upgrading Chrystall's Stopbank
		Maximum WL of 15.61mRL (= 15.56mRL + 0.05m) in 100 yr CC upstream of bridge with debris raft formation	PR Table A21-9	16.05 in 2D domain on right abutment, 16.18 on left abutment	15.798mRL in 1D	>15.61mRL not OK, but increased water level due to upgrading Chrystall's Stopbank
		Maximum WL of 15.89mRL (= 15.79mRL + 0.10m) upstream of bridge in 500 yr CC with debris raft formation	PR Table A21-9	16.464	mRL	>15.89 mRL Not OK, but increased water level due to upgrading Chrystall's Stopbank
Primary flood storage area on Mangapouri Stream upstream of the existing rail embankment / County Road	1750-2070	0.3m freeboard in 100 yr CC	PR A21.4.5c	In 100yr CC, water is spilling from this storage area through exiting rail Culvert 6, through Rahui Road Culvert 7, and overland over Rahui Road to the east of County Road - refer figure showing flood extents. All other locations have greater than 0.3m freeboard to the 100yr CC flood level.		OK
Expressway near Racecourse Stream	2070-2200	0.5m freeboard to road in 100 yr CC between Rahui Road Bridge and Racecourse Stream	PR A21.4.5d	Small areas of flooding alongside expressway in this area. >0.5m freeboard provided in all locations		ok
Freeboard to Expressway		0.5m freeboard to road in 100 yr CC		Greater than 0.5m at all locations to white edge line		OK, note flood bund / barrier allowed for between Chainage 3070-3180m on eastern side
Junction of secondary containment bund and Expressway (Ch2650 on eastern side of Expressway)	2500	Maximum WL of 15.19mRL in 100 yr CC	PR Table A21-8	14.323	mRL	<15.19 mRL OK
		Maximum WL of 16.07mRL in 500 yr CC with Chrystall's Bend stopbank overtopping	PR Table A21-8	14.479	mRL	<16.07 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.049 mRL (still < 16.07mRL)
		Maximum WL of 16.36mRL in 3000m3/s flood with Chrystall's Bend stopbank overtopping	PR Table A21-8	15.713	mRL	<16.36 mRL OK for stopbank overtopping scenario, but note higher with stopbank breach scenario 16.282mRL (still < 16.36mRL)

Element	Chainage	Description	Reference	Comment		Compliance
Junction of Chrystall's Bend stopbank and Expressway in off river storage basin	3100	Maximum WL of 15.21mRL in 100 yr CC	PR Table A21-9	16.006	mRL	>15.21mRL not OK, but increased water level due to upgrading Chrystall's Stopbank
		Maximum WL of 15.34mRL in 500 yr CC	PR Table A21-9	16.740	mRL with Chrystall's stopbank overtopping	>15.34mRL not OK, but increased water level due to upgrading Chrystall's Stopbank
				16.740	mRL with breach of Chrystall's stopbank	>15.34mRL not OK, but increased water level due to upgrading Chrystall's Stopbank. Note stopbank does not overtop so breach has been modelled at peak water level, which is the same as the peak water level in the non-breach case.
		Maximum WL of 15.26mRL (= 15.21mRL + 0.05m) in 100 yr CC with debris raft formation	PR Table A21-9	16.058	mRL	>15.26mRL not OK, but increased water level due to upgrading Chrystall's Stopbank
		Maximum WL of 15.44mRL (= 15.34mRL + 0.10m) in 500 yr CC with debris raft formation	PR Table A21-9	16.768	mRL	>15.44mRL not OK, but increased water level due to upgrading Chrystall's Stopbank
Chrystall's bend stopbank	3100	0.6m freeboard to stopbank in all locations in 100 yr (present climate)	PR A21.5.5g	>0.6m provided to the 100yr water level		OK, note this requirement is less critical than 0.8m freeboard criteria for 100yr CC event (see below)
		0.8m freeboard to stopbank in off-channel storage basin in 100 yr (present climate)	PR A21.4.5f	>0.8m provided to the 100yr water level		OK, note this requirement is less critical than 0.8m freeboard criteria for 100yr CC event (see below)
		0.8m freeboard to upgraded section of stopbank in 100 yr CC	Discussions with GWRC and Principal's Advisor	>0.8m provided to the 100yr CC water level		OK - provided by upgrading stopbank to the east of the expressway
Secondary containment bund	2500 to 2650	0.3m freeboard for the overland flow resulting from stopbank overtopping by the 500 yr CC flood in the Ōtaki River	PR A21.4.5g and PR A21.5.4c	In the 500yr CC overtopping scenario, the secondary containment bund has freeboard well in excess of 0.3m, and there is no transfer of flow from the Ōtaki to Mangapouri catchments to the east of the expressway - refer figure showing flood extents.		OK based on the overtopping event specified in PR A21.4.5g and PR A21.5.4c. A scenario with a 140m long breach of Chrystall's stopbank has also been considered. Flood levels in the breach scenario are 1.57m higher than the overtopping (no breach) scenario, and have conservatively been used to set the top of the secondary containment bund. In this breach scenario, the 0.3m freeboard is not achieved where the secondary containment bund connects to the expressway embankment because of the level of the shoulder and is also not achieved by the natural higher ground at the eastern end of the bund (extent of bund constrained by designation), nevertheless no bypass flow is predicted at either location.
Motel bund		0.3m freeboard to 100yr CC		13.16	mRL max WL adjacent motel bund	OK - motel bund to be raised to 13.46mRL (currently represented in flood model at 13.45mRL, but will be revised slightly)

Waitohu model - 100% stage

Element	Chainage	Description	Reference	Comment		Compliance
Culvert 1	390	Cover to culvert		0.705	m cover	> 0.683m OK, refer PP2Ō-SW-DR-1011 and 1012
		Max WL 24.43mRL in 20 yr no CC event	PR Table A21-2 and NTT-105	23.70	mRL	< 24.43mRL OK
		0.5m freeboard to white edge line of expressway in 100 yr CC		2.176	m freeboard	> 0.5m OK
		Max WL 25.15mRL in 100yr CC	PR Table A21-1 and NTT-105	24.38	mRL	< 25.15mRL OK
		No collapse in 2500 yr CC (ULS)		HW 25.201 mRL ; TW 23.890 mRL. Peak Flow = 17.13 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 2b	700	Cover to culvert		0.3	m cover	< 0.6m, specific design proposed to provide for reduced cover
		>0m freeboard to pipe soffit in 10 yr CC event	PR A21.8.2a	0.09	m freeboard	> 0m OK
		Max WL 25.70mRL in 20 yr no CC event upstream of "Culvert 2" (slightly different location and intent than Culvert 2b)	PR Table A21-2	25.52	mRL	< 25.70mRL OK
		0.5m freeboard to white edge line of expressway in 100 yr CC	PR A21.8.2b	5.31	m freeboard	> 0.5m OK
		0.6m freeboard to soffit in 100 yr CC	PR A21.4.5b	-0.273	m freeboard	Not achieved since culverts must pass under Taylors Road, and Taylors Road underpass is required by PRs to be lower than the 20 yr flood.
		Max WL 25.98mRL in 100yr CC upstream of "Culvert 2" (slightly different location and intent than Culvert 2b)	PR Table A21-1 and NTT-105	25.97	mRL	< 25.98 mRL OK
		Max WL 25.98mRL in 100yr CC in 100 yr CC event with debris raft formation upstream of "Culvert 2" (slightly different location and intent than Culvert 2b)	PR A21.12.2	25.97	mRL	< 25.98 mRL OK
		No collapse in 2500 yr CC (ULS)		HW 26.376 mRL ; TW 25.176 mRL. Peak Flow = 38.74 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 3/3a	950	Cover to culvert		3.35	m cover	> 0.643m OK, refer PP2Ō-SW-DR-1015 and 1016
		>0m freeboard to pipe soffit in 10 yr CC event	PR A21.8.2a	0.14	m freeboard	> 0m at upstream end, OK
		Max WL 25.99mRL in 20 yr no CC event	PR Table A21-2 and NTT-105	no flow	mRL	<25.99mRL OK
		0.5m freeboard to white edge line of expressway in 100 yr CC	PR A21.8.2b	5.27	m freeboard	>0.5m OK
		0.6m freeboard to soffit in 100 yr CC	PR A21.4.5b	1.915	m freeboard	>0.6m upper barrel, ok
		Max WL 26.36mRL in 100yr CC	PR Table A21-1 and NTT-105	25.30	mRL	<26.36mRL OK
		Max WL 26.36mRL in 100yr CC in 100 yr CC event with debris raft formation	PR Table A21-1 and NTT-105	25.33	mRL	<26.36mRL OK
		No collapse in 2500 yr CC (ULS)		HW 25.784 mRL ; TW 24.594 mRL. Peak Flow = 12.85 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Waitohu Bridge	800	Minimum freeboard of 1.2m to the bridge soffit in the 100 yr CC flood	WS.6ii, PR A21.4.5a	5.43	m freeboard	>1.2m OK
		Max WL upstream of bridge 25.10mRL in 20 yr no CC event	PR Table A21-2	24.48	mRL	<25.10mRL OK
		Max WL upstream of bridge 25.36mRL in 100 yr CC event	PR Table A21-1	24.96	mRL	<25.36mRL OK
		Max WL upstream of bridge 25.61mRL (25.36mRL + 0.25m) in 100 yr CC event with	PR A21.12.2	25.22	mRL	<25.61mRL OK
		Minimum 4.0m clearance from stream bed	PR A5.6.2a iv	> 4.0	m	> 4.0m OK, refer PP2Ō-DR-SB-1011
		Minimum 4.9m clearance to the bridge soffit from Taylors Road	PR Table A2.5	> 4.9	m	> 4.9m OK, refer PP2Ō-DR-SB-1011
		Fairway width of 75m	PR A21.5.2d, PR A5.6.2ii	75.2	m	Provided between vertical face of southern abutment and streamside edge of Taylors Road i.e. not including Taylors Road within the 75m. Refer PP2Ō-DR-SB-1011

Element	Chainage	Description	Reference	Comment		Compliance
		Taylors Road (including the underpass) within the Designation must remain passable in all floods smaller than a 20 yr no CC event	PR A21.12.2	< 350	mm	OK - passable depth for emergency vehicles < 350mm, less than flow depth over existing SH1
		Taylors Road underpass shall provide additional flood conveyance capacity for floods larger than or equal to a 20 yr no CC event	PR A21.5.2b			OK - conveying flow in the 20 yr no CC and larger events
Freeboard to Expressway		0.5m freeboard to expressway in 100 yr CC		up to 80mm short of freeboard between CH 280m and 300m		Modest reduction in freeboard to 100yr CC event (420mm provided rather than 500mm) due to tying in with existing levels of SH1 and Taylors Road at northern end of project

Mangaone model - 100% stage

Element	Description	Reference	Comment		Compliance
Culvert 24	Cover to culvert		> 0.6	m cover	> 0.6m OK
	0.6m freeboard to flood bund in 100 yr CC		0.59	m freeboard	< 0.6m based on current design, but flood bund will be raised to comply
	Max WL 20.42mRL in 100yr CC	PR Table A21-10	19.98	mRL	< 20.42 OK
	No collapse in 2500 yr CC (ULS)		HW 20.665 mRL ; TW 19.092 mRL. Peak Flow = 37.587 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 23	Cover to culvert		> 0.6	m cover	> 0.6m OK
	0.6m freeboard to soffit in 50 yr CC	PR A21.4.5h	0.67	m freeboard	> 0.6m OK
	0.6m freeboard to soffit in 100 yr CC	PR A21.5.6e	0.58	m freeboard	< 0.6m but exceedance marginal and within order of accuracy of modelling, also noting compliance with PR A21.4.5h above achieved. To be discussed with Principal's Advisor.
	Max WL 20.43mRL in 100yr CC	PR Table A21-10	20.42	mRL	< 20.43 OK
	No collapse in 1000 yr CC (ULS)		HW 20.950 mRL ; TW 20.629 mRL. Peak Flow = 41.753 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 23a	Cover to culvert		4.55	m cover	> 1.01m ok, refer PP2Ō-SW-DR-1037 and 1038
	Min width of 5m	PR A21.5.6s	6.00	m span	> 5m OK
	0.3m freeboard to road in 50 yr CC		5.54	m freeboard	> 0.3m OK
	No collapse in 1000 yr CC (ULS)		HW 20.655 mRL ; TW 20.647 mRL. Peak Flow = 7.92 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 27	Cover to culvert		1.35	m cover	> 0.92m ok, refer PP2Ō-SW-DR-1045 and 1046
	0.3m freeboard to road in 50 yr CC	PR A21.5.6g	0.89	m freeboard	> 0.3m OK
	Max WL 20.35mRL in 100yr CC	PR Table A21-10	20.19	mRL	< 20.35mRL OK
	No collapse in 1000 yr CC (ULS)		HW 20.973 mRL ; TW 20.535 mRL. Peak Flow = 39.61 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 28	Cover to culvert		0.80	m cover	> 0.60m ok, refer PP2Ō-SW-DR-1045 and 1046
	0.6m freeboard to flood bund in 100 yr CC		0.53	m freeboard	< 0.6m based on current design, but flood bund will be raised to comply
	Max WL 20.42mRL in 100yr CC (Culv27-28 46.7)	PR Table A21-10	19.871	mRL	<20.42 OK
	No collapse in 2500 yr CC (ULS)		HW 20.541 mRL ; TW 18.521 mRL. Peak Flow = 40.86 m^3/s		Embankment batter slope and scour protection design will include ULS requirements
Culvert 34	Cover to culvert		0.41	m cover	< 0.6m, but expected to be addressed by a combination of structural design to minimise culvert deck thickness, geometric options while tying in with Te Horo Beach Road, and specific pavement design for reduced cover.
	0.6m freeboard to soffit in 50 yr CC	A21.4.5h & WS.6iv	0.59	m freeboard	< 0.6m based on current design, culvert rise to be increased 50mm to provide compliance. Proposed increase in culvert rise will not affect flood modelling results since current soffit level is above even the 2500yr CC flood level
	0.6m freeboard to soffit in 100 yr CC	PR A21.5.6e	0.56	m freeboard	< 0.6m based on current design, culvert rise to be increased 50mm to provide compliance. Proposed increase in culvert rise will not affect flood modelling results since current soffit level is above even the 2500yr CC flood level
	Max WL 16.68mRL in 100yr CC	PR Table A21-	15.59	mRL	< 16.68 OK
	Prevent flooding down Te Horo Beach Road from upstream of the crossing in 50 yr CC.	A21.5.6u	No flow down Te Horo Beach Road from headwaters of Culvert 34 in the 50 yr CC event		OK, but note shallow flooding down Te Horo Beach Road from overtopping of SH1 by headwaters of existing Culvert 26
	No collapse in 1000 yr CC (ULS)		HW 15.795 mRL ; TW 15.683 mRL. Peak Flow = 32.20 m^3/s		Embankment batter slope and scour protection design will include ULS requirements

Element	Description	Reference	Comment		Compliance
Mangaone Stream and Mangaone Overflow culvert systems	Capacity of culverts to match existing in floods up to 100 year CC to maintain flood patterns to west Culv 26 "MangaoneSH1Culvert" "MANGAONESH1CULVERT 24.7" Culv 29 "MangaoneOverflowRailCulvert" "MANGAONEOVERFLOWSH1CULVERT 9.2" Culv 30 "MangaoneOverflowSH1Culvert" "MANGAONEOVERFLOWSH1CULVERT 30.2"	PR A21.5.6m	Culvert 26 (D/S - Mangaone Stream) peak flows 10 yr CC PreProj = 18.70 m3/s 10 yr CC PostProj = 19.21 m3/s 20 yr CC PreProj = 19.22 m3/s 20 yr CC PostProj = 20.56 m3/s 50 yr CC PreProj = 20.68 m3/s 50 yr CC PostProj = 22.482 m3/s 100 yr CC PreProj = 21.41 m3/s 100 yr CC PostProj = 24.23m3/s Culvert 29 (rail - Mangaone Overflow)peak flows 10 yr CC PreProj = 28.60 m3/s 10 yr CC PostProj = 28.80 m3/s 20 yr CC PreProj = 35.34 m3/s 20 yr CC PostProj = 34.37 m3/s 50 yr CC PreProj = 42.26 m3/s 50 yr CC PostProj = 39.36 m3/s 100 yr CC PreProj = 44.15 m3/s 100 yr CC PostProj = 41.36 m3/s Culvert 30 (D/S - existing SH1 - Mangaone Overflow) peak flows 10 yr CC PreProj = 28.02 m3/s 10 yr CC PostProj = 28.15 m3/s 20 yr CC PreProj = 31.60 m3/s 20 yr CC PostProj = 31.19 m3/s 50 yr CC PreProj = 34.18 m3/s 50 yr CC PostProj = 33.09 m3/s 100 yr CC PreProj = 35.02 m3/s 100 yr CC PostProj = 33.77 m3/s		3-13% increase in flows on Mangaone Stream through Culvert 26. 0.1% increase in flows in 10yr CC to 6% decrease in flows in 100yr CC on Mangaone Overflow through Culvert 29. Considered sufficiently matched to existing capacity, also taking into account flood level difference plots - OK.
Lucinsky Overflow	Existing hydraulic capacity to be maintained +/-10%	PR A21.5.6t	100 yr CC PreProj = 9.34 m3/s 100 yr CC PostProj = 9.10 m3/s		Within 10%, ok
	Shall pass the same volume as the existing overflow +/-20% in the 100yr CC event	WS.6b	In 100yr CC, 349,700 m^3 in PreProj and 321,100 m^3 in PostProj.		Within 20%, ok
	Max flow 3.5m^3/s in 100yr CC	PR Table A21-11	9.10	m^3/s	> 3.5m^3/s, but consistent with pre project peak discharge and volume as per other PRs for Lucinsky Overflow
Mangaone Stream downstream of Lucinsky overflow	Max flow 19.5m^3/s in 100yr CC	PR Table A21-11	15.35	m^3/s	< 19.5 m3/s OK
Existing culvert 29 (rail)	Max flow 42.5m^3/s in 100yr CC "MangaoneOverflowRailCulvert" "MANGAONEOVERFLOWSH1CULVERT 9.2"	PR Table A21-11	41.36	m^3/s	< 42.5m3/s ok
Existing culvert 30 (SH1)	Max flow 42.5m^3/s in 100yr CC including road overflow "MangaoneOverflowSH1Culvert" "MANGAONEOVERFLOWSH1CULVERT 30.2"	PR Table A21-11	33.77	m^3/s	not including road overflow, but expect compliance based on Culvert 29 flows
Te Horo flood bund	The flood bund is to have a minimum freeboard of 0.6m in the 1% AEP CC2130 event.	PR A21.5.6a, PR A21.5.6q, and PR A21.4.5i	< 200mm short of required freeboard in some locations		< 0.6m based on current design, but flood bund will be raised to comply
	Expressway must not be inundated by floodwaters from downstream in a 1% AEP CC2130 in the vicinity of the proposed flood bund.		No flooding of expressway from downstream water levels in 100yr CC		OK
	The flood bund in conjunction with the enlarged School Road drain is also required to prevent the spread of floodwaters south across School Road and Gear Road in the 1% AEP CC flood.		No overtopping of School Road in the 100yr CC except beyond designation and locally at the tie in with existing levels of School Road		OK. NTC-385 clarified that the hydraulic model should only includes works for the School Road drain within designation.
	Max WL 21.17mRL in 100yr CC at chainage 6600m	PR Table A21-10	No flooding here		OK
	Max WL 20.48mRL in 100yr CC at chainage 6900m	PR Table A21-10	20.02	mRL	< 20.48 OK
	Max WL 20.46mRL in 100yr CC at local link road bridge (culvert 23a)	PR Table A21-10	20.02	mRL	< 20.46 OK
	Max WL 20.43mRL in 100yr CC at Mangaone Stream	PR Table A21-10	19.98	mRL	< 20.43 OK, note 2d model results to either side marginally higher but still compliant
	Max WL 20.43mRL in 100yr CC at Mangaone Overflow	PR Table A21-10	19.87	mRL	< 20.43 OK, note 2d model results to either side slightly higher but still compliant
	Max WL 20.43mRL in 100yr CC at chainage 7700m	PR Table A21-10	19.83	mRL	< 20.43 OK
	Max WL 20.25mRL in 100yr CC at School Road / Gear Road intersection	PR Table A21-10	19.06	mRL	< 20.25 OK
New local road near Te Horo	New local road embankment at Te Horo have a minimum freeboard to road shoulder level of 0.3m (assumed to the white edge line) in the 2% AEP CC2130 flood.	PR A21.5.6g	> 0.3m freeboard provided except over the last 40m of new section of School Road where ties into existing levels		OK

Appendix D:

PEER REVIEW

DESIGN REVIEW RECORD SHEET

Project Name	*PP2O*
Title of Document Reviewed:	*Post-Project Hydraulic Model Build Report*
Reference No. of Document Reviewed:	*Rev 3*
Date of Document Reviewed:	*29/03/2018*
Comments:	

External Reviewer Name:	*Hugh MacMurray*		
Reviewer Discipline:	*Flood Modelling and Cross Drainage*		
Review Revision No.	A	Review Date	*7-Nov-17*
	B		*27-Feb-18*
	C		

Category Level	Status Level
C1: Critical Issue (to be resolved)	**S1: Resolve before proceeding with next stage of design**
C2: Important Issue (Request change)	**S2: Update during next stage of design**
C3: Discussion Item (Potential change needed)	**S3: Consider during next stage of design**
C4: Note (for consideration - no change needed)	**S4: Closed**

Item No	Drawing No./ Document Reference	Principal's Requirements Reference	Category Level	Disciplines affected	Review Revision	Review Comment	Design Response	Status
Comments for Revision 2 - issued 25/10/17								
1	Sec 2.3.1, Fig 5.2, Fig 6.5		C3		A	No details are given about how the Te Manuao 2 catchment runoff is split between the SWMM model and the Mike model. Figure 1 says that the Te Manuao 1 split is determined by Mike21 model results. But Fig 6.5 shows the hydrology blocking elements overlaid on the existing road layout, and it is not clear how they work to spilt or redirect the flows. Figure 1 in the text says "flows overtopping SH1 and County / rail", but post project the rail will be on the other side of the expressway, and the blocking element appears to prevent flow over County. Please clarify the treatment of this area.	The split in flow was estimated for Rev 2 in an additional MIKE model run that did not include these blocking elements. However, we note that in the current Rev 3 model, the railway wetland schematisation and hydrology described in this section is no longer used.	S4
					B			
					C			
2	Sec 2.3.1		C3		A	The pre project modelling did not use a separate SWMM model for the wetlands, instead that area was part of the Mike model. Is there any inconsistency in comparing pre project (Mike) results with post project (partly SWMM) results?	As noted in Item 1, in Rev 3, the SWMM results are no longer used as an input to any elements / events of the MIKE FLOOD model.	S4
					B			
					C			
3	Sec 2.3.2, Fig 6.2		C3		A	Not clear why the eastern expressway flood bund is required. Chrystalls bank has 0.8m freeboard in the 1%AEP CC event, and the expressway passes over the top of it, so why is the bund required to give 0.5m freeboard to the expressway?	The expressway is lower than the upgraded level of the top of Chrystall's Stopbank over the length where the flood bund / barrier is required.	S4
					B			
					C			

HOLD

4	Sec 2.3.2, Fig 6.2		C3		A	The motel bund covers a larger area than shown on previous drawings - what is the reason for the change?	The location of the bund is based on a drawing supplied by the Principal's Advisor that reflects their discussions with the landowner and extent of the bund to be included in the landowner agreement	S4
					B			
					C			
5	Sec 2.3.2, Fig 20.5		C3		A	There appears to be some flow around the end of the secondary containment bund in Fig 20.5. Noted that additional model runs are planned to be undertaken to assess whether the effects are worse than they would be in case of a pre project breach.	Discussion and quantum of bypass flows is provided in the detailed compliance checking in Appendix C of the Rev 3 report.	S4
					B			
					C			
6	Sec 2.3.2		C3		A	Are drainage arrangements for the borrow area included in the design?	Further detail regarding cross drainage and longitudinal drainage in the borrow area will be included in the Stormwater 100% Design Report, still to be issued.	S3
					B			
					C			
7	Table 3		C4		A	Report typo. Culvert 3 should be Culvert 3a according to Fig 3.2	Noted. Consistency of labelling has been checked in Rev 3 noting there is now two culverts proposed at this location, Culvert 3 and Culvert 3a.	S4
					B			
					C			
8	Sec 2.4.2		C3		A	What is approximate height of Culvert 3 flood bund above ground level?	The bund is up to 0.8m high with a crest at 24.75mRL.	S4
					B			
					C			
9	Table 4		C4		A	Report error - Culvert 34 conveys Mangaone Stream not Overflow	Corrected in Post Project Hydraulic Model Report Rev 3	S4
					B			
					C			
10	Sec 3.3		C3		A	The debris raft described is consistent with Sec 2.3.5 of the bridge manual. In calculating the blockage ratio, it seems from the report text that there was assumed to be no scour as a consequence of the debris raft. That should make the blockage ratio greater, and the results more conservative.	Noted.	S4
					B			
					C			
11	Fig 44.2, Fig 40.2		C3		A	In spite of the substantial increase in blockage ratio at the Waitohu bridge, from 0.048 to 0.2, the maximum flood levels upstream of the bridge in the 1%AEP CC2130 event are almost unaffected. Please check.	Results have been checked. Water levels increase in the 1D upstream of the bridge, however there is still freeboard to the underside of the expressway bridge and little overtopping from the 1D channel into the 2D.	S4
					B			

					C				
12	Table 7		C3		A	What is the reason for not using the SWMM model of the wetlands for the 0.2%, 0.1%, and 0.04%AEP CC2130 flood modelling?	The previous thinking at the Rev 2 stage was that in these larger events, hydraulic behaviour would likely be dominated by overland flow rather than piped flow between wetlands, the latter being more specifically represented in the SWMM model. However, testing using the SWMM model discussed in the Culvert 12 Design Report Rev 2 (PP2O March 2018) has proven that the pond/piped system represented in SWMM can actually accommodate all of the events with only minor flow (< 70 L/s) lost to the model in the largest (2,500yr CC) event. Nevertheless, in Rev 3, the interaction and dependency between the MIKE FLOOD and SWMM models has been removed.	S4	
					B				
					C				
13	Table 7, Fig 10.1		C3		A	Figure 10.1 indicates flooding north of the containment bund, but Table 7 says no flow was applied other than the 3000m3/s in the Otaki River. Please clarify.	The containment bund overtops in this event, as shown in the figures at smaller scales.	S4	
					B				
					C				
14	Table 8, Item 8		C3		A	Reasons for higher flood levels noted. Also noted that the expressway will be designed for those higher flood levels. Please provide water surface profiles to confirm the effect of the existing bridges of controlling waterlevels at the expressway bridge.	Please refer plot included below, which illustrates the constriction imposed by the existing rail and SH1 bridges and general narrowing of the channel in the vicinity of these bridges (supported by stopbanks), which results in increased water levels upstream of these existing bridges.	S4	
					B				
					C				

15	Table 8, Item 9		C3		A	Do the higher flood levels than allowed in the PRs require any further action regarding the present use of the site by Winstone Aggregates? How is the level of service of the access roads under the expressway bridge affected?	The most substantial changes in flood depths in the Winstone Aggregates area are for events larger than the 100yr No CC flood and due to upgrading the stopbank for a 100yr CC flood standard rather than 100yr No CC. We understand this upgrade was already planned by GWRC for the future and has only been brought forward for PP2O. In the 100yr CC flood, the Winstone's area is already inundated by substantial depths in the pre project situation (1.3-4.0m), and the post project modifications result in changes in depth (60mm decrease in water levels downstream of the expressway, 840mm increase in water levels upstream of the expressway) rather than new areas of flooding. Re level of service to access roads under the bridge, the in situ ground left in place between the upper and lower access tracks will still provide the 5% AEP flood standard to the upper track as per PRs and discussions with Principal's Advisor.	S4
					B			
					C			
16	Table 9, Culvert 2a		C4		A	The new re located off ramp does not appear in Figure 3. Where is it?	The relocated off ramp is located adjacent Ōtaki Main Road North and the Remnant Wetland East between chainages 1400 to 1650m, beyond the extents of the Waitohu model	S4
					B			
					C			
17	Table 10, Item 4		C3		A	Why does the Waitohu Stream bridge have freeboard sever metres in excess of the 1.2m required?	The bridge soffit levels are governed by clearance requirements from the river bed and Taylors Road.	S4
					B			
					C			

18	Table 11, Item 2		C3		A	The 10-40% increase in flow through Culvert 26 would presumably equally apply to Culvert 25? Comparing Fig 32.2 of the pre project hydraulic model report with Fig 58.2 of this report (both for 1%AEP CC2130 event), the maximum water levels upstream of Culvert 25 are 18.7m pre project and 18.8 post project. That seems a small increase in level to produce a relatively large increase in discharge. For 5%AEP+CC2130 event, the maximum level upstream of Culvert 25 is 18.3m post project and 18.5m pre project (comparing Figs 34.2 pre project and 60.2 post project), which suggests a decrease in peak flow through Culvert 25. However 2d domain levels may not be relevant to a flow which is mainly in the 1d domain, and peak level does not necessarily drive peak flow. To be further peer reviewed in model results.	Noted. There is not the same increase in flows on the Mangaone Stream in the Rev 3 model, likely related to changes to resolve instabilities and changes in design.	S4
					B			
					C			
19	Fig 8.2		C3		A	The northern limit of the Te Horo eastern flood bund is not shown. To be clarified in next revision of the report.	The Te Horo Eastern Flood Bund will extend north to Chainage 6,500m as per the Specimen Design. A note has been added to Fig 7.2.	S4
					B			
					C			
20	Fig 12.5, Fig 13.5		C3		A	1%AEP CC HR and 1%AEP CC floods give practically identical peak levels upstream of County Rd, but the smaller flood has higher levels in Pare-o-Matangi reserve (13.3m compared with 13.0m) - seems anomalous, please check.	This is due to the railway wetland schematisation and hydrology adopted for Rev 2 as described in Section 2.3.1 of Rev 2 (this section flagged that water levels for the 1% AEP CC HR event would likely increase in future iterations due to a proposed change in approach). Regardless, the railway wetland schematisation and hydrology is now consistent across events for Rev 3 of the report, and flood levels in the reserve change with events is as would be expected.	S4
					B			
					C			
21	Appendix C culverts 9 and 10		C3		A	Would expect the freeboard to be measured at the upstream end of the culvert, so raising the downstream invert to achieve the freeboard at that end does not seem to be a solution.	We have conservatively assumed the freeboard to soffit requirement applies throughout the culvert barrel. The freeboard to soffit is greater at the upstream end than the downstream end because of backwater from ponding in Pare-o-Matangi Reserve. However, cover is still an issue for Culvert 9 so culvert rise could potentially be revised to provide the 0.3m freeboard at the upstream end only.	S4
					B			

					C			
22	Table 11, Item 2, Fig 58.2	Table A21-10	C3		A	Change in peak water level over Culvert 27 is 0.9m, and that over Culvert 23 is 0.6m. So it seems more likely that the upstream water levels are due to culvert flow resistance than tailwater levels. In case of culvert 27 it suggests it may be possible to comply with the PR. The water surface profile in the 1%AEP CC2130 1d result file shows a fairly steep grade through culvert 27.	The balance of flows between the Mangaone Stream and Mangaone Overflow, as well as compliance with PRs relating to maximum allowable levels upstream of culverts on these streams, has changed significantly in Rev 3 of the model through a combination of factors (including adjustments to project culverts and work to resolve instabilities). The current design is considered optimised to address performance requirements in the PRs and consent conditions.	S4
					B			
					C			
23	Fig 58.2		C3		A	The flooding northwards along the expressway is understood to be entirely due to backwater from the main flow paths. The Specimen design simulated a discharge on a northern flow path, thus providing an increase in water surface level northwards. Please check that the level of the flood bund is not underestimated using the Specimen design northern flow path discharge.	The flood bund will rise to the north to provide freeboard to this northern flow path. This will be demonstrated in a longsection of the bund that will be provided in the Stormwater 100% Design Report, still to be issued.	S4
					B			
					C			
24	Fig 11.5, Fig 21.5		C3		A	Both figures are for 0.2%AEP CC2130, but the second figure also has a Chrystalls stopbank breach. Water levels on the Mangapouri upstream of County Rd probably ought to be the same in both cases. But in the breach case they are 0.1m lower - please check.	Agreed. The difference is caused by the way the breach scenarios have been modelled (using a hotstart file) and then subsequently post-processed. The peak water levels in the Mangapouri area occur before the hotstart file begins. Post-processing will be adjusted to address this in Revision 3 of the report.	S4
					B			
					C			
Comments for Revision 3 issue of Waitohu and Mangaone 100% models only - issued 22/02/18								
25	Mangaone post project		C3		A			
					B	The culverts on the two main flow paths - stream and overflow are now almost entirely consistently modelled as culverts. The exception is Mangaone Overflow SH1 culvert which is still an energy equation bridge. Were any investigations done to confirm that the bridge representation is consistent with the culvert? The possible concern is that the bridge representation might mean the flow split between stream and overflow is not accurately modelled.	A number of sensitivity model runs were carried out and analysed to confirm the validity of this represenation. These are provided in a separate bundle to the peer reviewer with the 100% Design Phase models.	S4
					C			

26	Mangaone post project		C3		A			
					B	Culverts 27 and 28 have inflow head loss factors of 0.7, which is fairly high and indicates unfavourable inflow conditions. Is that consistent with the actual conditions expected? How much influence does that inflow head loss factor have on the flow division between the stream and overflow?	The corrugated steel culverts have been modelled with an entrance loss coefficient, Ke, of 0.7, to reflect the proposed "mitred to conform to fill slope" configuration (refer Culvert 80% Design Report, PP2Ō February 2018) as per guidance for entrance loss coefficients for corrugated steel culverts in Table C.2 of Hydraulic Design of Highway Culverts, 3rd Ed, FHWA-HIF-12-026, FHWA April 2012.	S4
					C			
27	Mangaone post project	A21.5.6	C4		A			
					B	100 year ARI CC2130 maximum flow in overflow SH1 culvert now complies with PR - less than 42.5m3/s	Noted.	S4
					C			
28	Mangaone Post project Rev2 report Table		C4		A			
					B	Maximum water level upstream of Culvert 27 in 100 year ARI CC2130 event now complies with PR.	Noted.	S4
					C			
29	Mangaone post project	Table A21-11	C1		A			
					B	Lucinsky overflow maximum flow is about 9m3/s in 100 year ARI CC2130 event - maximum allowable is 3.5m3/s	This non-compliance is unavoidable to meet other performance requirements for the project, specifically: - PR A21.5.6t requires that the existing hydraulic capacity of the Lucinsky Overflow is maintained +/- 10%. - Consent condition WS.6b requires that the same volume is transferred over the Lucinsky Overflow +/- 20% in the 1% AEP CC event. It will be discussed with the Principal's Advisor.	S4
					C			
30	Mangaone post project		C3		A			
					B	Lateral inflow M21 is unstable in 100 year ARI CC2130 event at Mangaone 1 chainage 1145. There seems to be no significant effect in the 1d branch.	Noted.	S4
					C			
31	Mangaone		C2		A			
					B	ASCII grids of maximum water level for the upper limit model have not been supplied.	Provided to the peer reviewer in a separate bundle 27/02/2018.	S4
					C			

32	Waitohu		C3		A			
					B	Greenwood3 discharge time series are still not stable. However there seems to be negligible effect on the water surface profile. The instability appears to be generated in the area of backwater caused by the Greenwood Taylors Rd railway culvert. The cross section processed data does not extend up to the maximum water level of about 19m. Adding glass walls might possibly fix the instability.	The instability remains when this change is implemented. The results of this model update are provided in a separate bundle to the peer reviewer with the 100% Design Phase models. The model update to the processed cross section data is not carried through the Waitohu models. We agree that there is negligible effect on water surface profile, and are comfortable that model results are representative.	S4
					C			
33	Waitohu		C3		A			
					B	The bridge blockage ratio applied in the debris blockage version of the model appears conservative at 0.2. The scour calculations indicated a*d would be about 4m, which with 2 piers would lead to a smaller ratio than 0.2	Noted.	S4
					C			
34	Waitohu		C3		A			
					B	What is the difference between upper limit models 1 and 2? Noted that in the areas of most interest around the expressway, the differences between the base model and the upper limit model are relatively small. UL2 has a large non flooded area, but not in the area of interest.	Upper Limit model 1 has only Greenwood Stream represented in 2D, while Upper Limit model 2 has both Greenwood Stream and Waitohu represented in 2D.	S4
					C			
35	Waitohu		C3		A			
					B	The downstream boundary condition on Waitohu is a constant level which causes a steep gradient at the flood peak in the 100 year ARI CC2130 event. However it is unlikely to have any effect in the area of interest.	Noted.	S4
					C			
Comments for Revision 3 - issued 29/3/2018								
36	Table 2		C2		A			
					B			
					C	PP2O_Culv15a is no longer in the design but appears in the table.	Noted. The modelling names will be corrected in the final version of the report	S4

37	Sec 3.4	SW.2 (a)	C2		A			
					B			
					C	The report Section 3 includes scenarios addressing the matters referred to in SW.2 (a) except for the high range climate change sensitivity test (aggradation and geomorphological change are addressed in another of the cross drainage reports). The 1%AEP+CC2130(HR) simulation has been done, and the results are mapped in Appendix A, but there is no indication that the results have been used to inform the design. Please include some analysis of the effect of the High Range compared with the standard case (for example by maximum water level difference maps). Corresponding with Section 3.4, there should be a description of the High Range sensitivity tests.	Figures of water level difference will be added to Appendix A comparing the High Range and standard case (Mid Range). Discussion will be added to Section 3 regarding the High Range scenarios, and analysis of the effects will be added in Section 4. We will provide a draft of these figures and text for your review before finalising the report.	S4
38	Sec 4	SW.2 (a)	C2		A			
					B			
					C	The reader is referred to Appendix A which has the figures presenting the results. This section should also refer to Appendix C which details performance against the relevant PRs, as this is an important part of the results of the investigation. Somewhere, probably in Section 4, there should be some discussion or analysis of the matters referred to in Sections 3.3 to 3.6, and also of the high range climate change sensitivity test.	A reference to Section 5 and Appendix C, which addresses performance against performance criteria will be added. Analysis of the stopbank breach scenarios, debris blockage scenarios, culvert blockage scenarios and alternative design will be added to Section 4 along with the High Range sensitivity case for climate change. Draft text for the addtional analysis will be provided for your review before finalising the report.	S4
39	Fig 2.2		C3		A			
					B			
					C	Some of the GWRC and interpolated sections shown do not cover the whole river bed. Are they plotted in the correct place? Do they in fact represent the whole river channel?	The cross sections do represent the whole river channel. The 'shift' that is observed left or right along the stream centreline is caused by DHI placing the lowest invert of the cross section at the stream centreline. The stream centreline generally does not follow the low flow channel due to the large storm events modelled.	S4

40	Fig 5.4		C3		A			
					B			
					C	Understand that there should be a v-channel upstream of Pipe 66, but it is not shown.	The v-channel is represented in the 2D terrain. We will revise the description of the 2D terrain changes in Section 2.3.2 and represented in Figure 5.4 to make it clearer that this channel has been "burned in" upstream of Pipe 66 as well as between Pipe 66 and 69	S4
41	Fig 7.2	A21.5.6a	C3		A			
					B			
					C	The PRs require the flood containment bund (Te Horo East flood bund) to extend from about SH1 / Te Waka Rd intersection to the School Rd / Gear Rd intersection. For clarity it would be good to show or note that north extent of the flood bund, and that it ties into a landscape bund at the north end.	We will expand on the description of the bund in Section 2.5.2 to describe the spatial extent and the transition to a landscape bund in the north. There is already a note in Figure 7.2 regarding the extent of the flood containment bund, but we will add an inset with a wider view to make this clearer.	S4
42	Fig 24.1		C3		A			
					B			
					C	Water is ponded up to the model north boundary in 2 places. Would there be a significant flow out of the model? Does the model allow outflow?	This is a closed boundary and does not allow flow in or out of the model. Velocities are very low and flows are approximately 0.3 cumecs (western ponding) and 2-3 cumecs (eastern ponding). This approach is considered conservative (overestimates flood levels) and given the current 2D extents it is not expected that ponding here should signficantly influence the area of interest.	S4
43	Fig 38.1		C3		A			
					B			
					C	(Applies to other velocity figures also): >1.5m/s could include some large velocities indicating areas of bad model behaviour. The ASCII velocity maps supplied show that in fact the velocities are generally in a good realistic range. Maybe worth noting in the report text that this is the case.	We will add this note in Section 4.	S4

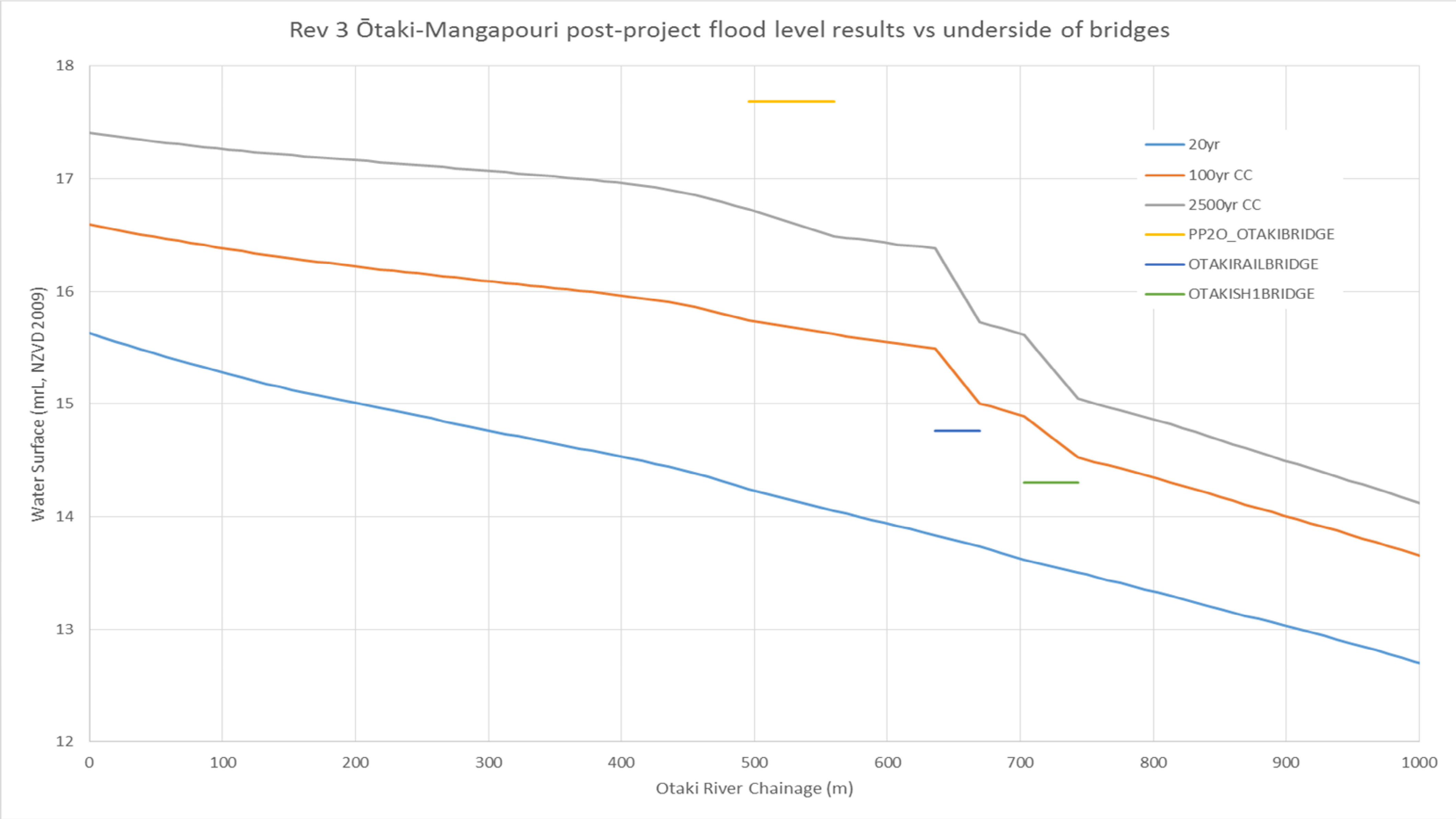
44	Fig 41.4		C2		A			
					B			
					C	Flow hydrograph over School Rd should be included in the report, particularly in cases where this is relevant to the culvert design for Culverts 35-42.	We will add this hydrograph in Section 5.	S4
45	Fig 45.1		C3		A			
					B			
					C	What is the maximum difference? 100mm seems a rather small difference between post project (alternative) and pre project.	Figure 45.1 represents the same data set as Figure 45.3 i.e. Post Project "Floodway Bridge" arrangement vs Pre Project water levels. However, Figure 45.1 partitions the data differently from Figure 45.3 to illustrate the areas that exceed the 100mm threshold for consulation with landowners in consent condition SW.2c)ii) (50mm with respect to Mangapouri Stream as per Fig 45.2). The red areas are where the water level difference exceeds 100mm. Conversely, the data in Figure 45.3 is partitioned to represent trends in water level differences rather than areas exceeding the SW.2c)ii) thresholds.	S4
46	Fig 45.3		C3		A			
					B			
					C	Labelled the same as Fig 45.1, but is quite different. This one looks more realistic in comparison with Fig 42.3.	As above	S4
47	Fig 46.3		C3		A			
					B			
					C	Higher water levels post project in the northern ponding area seem anomalous - that doesn't occur in the 1%AEP+CC2130 event (Fig 46.2)	This is because of shift in flows towards the Greenwood in smaller events, and a shift towards the Waitohu in larger events. The flows just get over the lip of the Greenwood right bank and then get trapped in the sand dune area.	S4
48	Appendix B - bridges		C3		A			
					B			
					C	Suggest add a note that the low Manning n values do not apply to the whole bridge cross section.	We will add this note in the appendix.	S4

49	Appendix C PP2O culvert 07		C3		A			
					B			
					C	From the note it is not clear why the M21 domain flows can be considered unrealistic - please supply more detail.	The 5m pixels representing the 2D terrain do not capture the vee channels nor the lip at the southern edge of the road opposite the Culvert 7 outlet that controls activation of the overland flow path. More specific modelling of the vee channels and pipes is proposed outside the catchment models and will be presented in the Stormwater 100% Design Report.	S4
50	Appendix C culverts 9 and 10		C3		A			
					B			
					C	Has it been confirmed with appropriate experts that the scruffy dome will let in enough light to facilitate fish passage?	The scruffy dome inlet has been maximised (1.8m dia) for the structural design of the culvert (2.5m wide). The arrangement has been discussed with our fish passage specialist and ecologist.	S4
51	Appendix C Chrystalls stopbank	A21.4.5f	C2		A			
					B			
					C	The PR requires 0.8m freeboard in current climate conditions, not future climate.	Agreed. We will separate into two lines. The first line will cover the PR and 100yr present climate freeboard, and the second will cover compliance with expectations for 100yr CC2130 freeboard with the proposed stopbank upgrade based on discussions with GWRC and the PA.	S4
52	Appendix B - culverts 12 and 13		C3		A			
					B			
					C	Manning n for the spat roped culverts is not given.	These culverts have been modelled with a Manning's n of 0.012. This is considered conservative (i.e. overestimates increases in peak water levels and discharge in the post project situation) because the lower Manning's n increases simulated discharge through these culverts and thus underestimates the throttling / attenuation provided upstream of these culverts by the proposed railway wetland system. We will add a description of this in Section 2.3.1. We note that the impact of the lower Manning's n is less signficant in increasing simulated discharge than the omission of the scruffy dome and orifice / slot inlets of Culverts 12 and 13 as also discussed in Section 2.3.1.	S4

53	T+T internal checks: "InternalCheck2_ValidityOfCulvertsRepresentedAsBridges.xlsx"		C3		A			
					B			
					C	The results of the investigation reported in the spreadsheet show that the bridge representation can match the culvert representation well, depending on the parameter settings. Please confirm that the results of the tests reported were used to inform the parameter settings for the culverts represented as bridges, and include a note in the report to that effect (probably in Appendix B).	Note will be added in Appendix B.	S4
Comments for Correction to Otaki Mangapouri hydrology - issued 8 May 18								
54	Fig 1b		C3		B			
					C			
					D	Why is there a localised fairly large increase in water level east of the existing rail embankment north of the Mangapouri in the wetlands area? That area would seem to be far enough removed from Otaki river flows, and the breach flow, to be unaffected.	To generate the peak water levels for the Stopbank breach scenarios, the pre-breach and post-breach peak water levels are processed and combined. This processing was done incorrectly for the previous model results that were then used as a baseline for comparing the corrected results. An updated version of Fig 1b can be found in the PDF attached (email D Knappstein to H MacMurray 10 May 2018). The anomalous increase in water level is eliminated in the updated Fig 1b.	S4
55	Fig 1b		C3		B			
					C			
					D	Generally water levels on the Otaki River floodplain are lower, as expected with the lower Otaki1 flow, but there are a few areas as such along the SH1 alignment near the river, and on the left bank of the river downstream of the existing SH1 bridge, where levels are higher with the corrected hydrology. What is the reason for those higher water levels?	As per comment 55	S4
56	Fig 5		C3		B			
					C			
					D	Why does reducing the Otaki floodplain flow also slightly reduce the water level on the river side of Chrystalls stopbank?	The decrease in water levels is small (11mm) and originates from flows from the Ōtaki floodplain passing through an existing culvert in the stopbank and into the pond. The decrease in water levels in the pond is greater than on the overland flow path because the pond has no outlet.	S4

57	Compliance table				B			
					C			
					D	For Culverts 15 b, c, d, e: the breach scenario levels noted in the Compliance column appear not to have been updated for the 500 yr CC case.	We did not add a revision cloud, but the levels for the breach scenario in the Compliance column have been updated.	S4
58	Compliance table		C3		B			
					C			
					D	For the junction of the secondary containment bund and the expressway, the breach scenario level in the Compliance column appears not to have been updated for the 500 yr CC case.	We did not add a revision cloud, but the levels for the breach scenario in the Compliance column have been updated.	S4
Comments for Additions for Post Project hydraulic model report Rev 2 - issued 8 May 18								
59	Sec 4.5 third bullet point				B			
					C			
					D	The assessment "generally less than 100mm" is perhaps a little optimistic. Two of the changes referred to are greater than 100mm, and three are smaller.	Agreed. We will delete this part of the sentence in the final version of the report.	S4
60	Sec 3.3		C2		B			
					C			
					D	This section should be modified to describe the new stopbank breach start criterion.	Agreed. We have updated to the report accordingly.	S4
					B			
					C			
					D			
					B			
					C			
					D			

Re Item 14:


Rev 3 Ōtaki-Mangapouri post-project flood level results vs underside of bridges
Water Surface (mrL, NZVD 2009)
Otaki River Chainage (m)
18
17
16
15
14
13
12
0
100
200
300
400
500
600
700
800
900
1000
20yr
100yr CC
2500yr CC
PP2O_OTAKIBRIDGE
OTAKIRAILBRIDGE
OTAKISH1BRIDGE

Appendix E:

PRINCIPAL'S ADVISOR CHECK

DESIGN REVIEW RECORD SHEET

Project Name	*PP2O*
Title of Document Reviewed:	*Post-Project Hydraulic Model Build Report*
Reference No. of Document Reviewed:	*Rev 3*
Date of Document Reviewed:	*29/03/2018*
Comments:	

External Reviewer Name:	*Daniel McMullan*		
Reviewer Discipline:	*Flood Management*		
Review Revision No.	A	Review Date	*28-Sep-17*
	B		*6-Nov-17*
	C		

Category Level	Status Level
C1: Critical Issue (to be resolved)	**S1: Resolve before proceeding with next stage of design**
C2: Important Issue (Request change)	**S2: Update during next stage of design**
C3: Discussion Item (Potential change needed)	**S3: Consider during next stage of design**
C4: Note (for consideration - no change needed)	**S4: Closed**

Item No	Drawing No./ Document Reference	Principal's Requirements Reference	Category Level	Disciplines affected	Review Revision	Review Comment	Design Response	Status
1	Section 2.3.3	A21.5.4c	C4	Flood Management	A	Setting secondary containment bund levels based on the 0.2% AEP +CC2130 flood event including a breaching as proposed is considered appropriate.	Noted.	S4
					B			
					C			
2	Table 7 item 2 - Culvert 11	PR Table A21-3	C3	Flood Management	A	Departure on increased flood level upstream of Culverts 11 will be dependent on there being negligible change to flood levels downstream - particularly that they don't cross the 100mm threshold. Flood levels in Pare-o-Matangi reserve have already crossed 100mm threshold, so further 20mm increase is considered relatively negligible.	Noted. Modelled water level now compliant with this PR.	S4
					B			
					C			
3	Table 7 item 3 - Culvert 15	PR Table A21-3	C4	Flood Management	A	Departure probable.	Noted. This non-compliance is still relevant for the latest modelling.	S4
					B			
					C			
4	Table 7 item 4 - Culvert 7	PR Table A21-3	C3	Flood Management	A	Given hydraulic constraints, PR departure possible if other design options have been explored and presented. Have options to divert water that was prematurely transferred from culvert 7 to culvert 14 been considered?	As described in Rev 3 of the report, drainage is proposed alongside the milk station link road (open channels and two 0.9m dia pipes) to convey the 5% AEP flow from the outlet of Culvert 7 to the Racecourse Stream without overland flow through private property	
					B	Noted. See item 35		S4
					C			
5	Table 7 item 5 - Culvert 14	PR Table A21-4	C3	Flood Management	A	Post-project has decreased flow from pre-project so departure is likely.	Noted. This non-compliance is still relevant for the latest modelling.	
					B	Noted. Item covered below under rev3 section		S4
					C			
6	Table 7 items 6 & 7 - Culvert 15 + KCDC soakage area	PR Table A21-5	C3	Flood Management	A	PR departure likely. Item 7 will require consultation with KCDC.	Noted. The non-compliance under Item 6 is still relevant for the latest modelling, but the non-compliance under Item 7 is eliminated.	
					B	Noted. Item covered below under rev3 section		S4
					C			
7	Table 7 items 8 & 9 - Otaki River levels	PR Table A21-9	C3	Flood Management	A	PR departure likely. The effects of raising the stopbank will need to be agreed with GWRC.	Noted. This non-compliance is still relevant for the latest modelling.	
					B	Noted, now discussed in item 38 and 39.		S4
					C			

8	Table 8 item 1 - Culvert 27	PR Table A21-10	C3	Flood Management	A	Departure possible provided extents upstream don't increase property risk to Agency and hydraulic neutrality is still achieved downstream.	Noted. Modelled water level now compliant with this PR.	S4
					B			
					C			
9	Table 8 item 2 - balance of flows between Mangaone Stream and Overflow	PR A21.5.6m	C3	Flood Management	A	PR departure possible assuming GWRC/KCDC approve of post-project effects.	Noted. Modelled balance of flows now compliant with this PR.	S4
					B			
					C			
10	Table 8 item 3 - Lucinsky Overflow	Consent condition WS.6b & PRA21-11	C3	Flood Management	A	PR departure possible. Will need to see results from the width reduced to 10m and how that effects the discharge in the 1% AEP CC event.	Noted.	S4
					B			
					C			
11	Figure 11.5 & Figure 12.5		C4	Flood Management	A	Peak water level in 0.2% AEP +CC2130 in the Pare-o-Matangi reserve appears to be 13.2mRL, lower than the level in the 1% AEP +CC2130 detailed in Table 7 item 2. Similar for 1% AEP +CC2130 (high range).	This is due to the railway wetland schematisation and hydrology adopted for Rev 1 as described in Section 2.3.1 of Rev 1 (this section flagged that water levels for the 1% AEP CC HR event would likely increase in future iterations due to a proposed change in approach). Regardless, the railway wetland schematisation and hydrology is now consistent across events for Rev 3 of the report, and flood levels in the reserve change with events is as would be expected.	
					B	Noted		S4
					C			
12	Appendix C - Culvert 9	WS.6a iii	C1	Flood Management	A	Freeboard of 0.3m required by the consents is expected to be measured at the upstream end of the culvert. Need confirmation from GWRC in writing that anything less than 300mm would be acceptable.	Noted. Cover is still an issue for Culvert 9 so culvert rise could potentially be revised to provide the 0.3m freeboard at the upstream end only.	
					B	Noted. It is understood from Appendix C in rev 3 that Culvert 9 is now compliant with the 300mm freeboard requirement.		S4
					C			
13	Appendix C - Otaki River Bridge	A21.4.5e	C3	Flood Management	A	Comment mentions that raising the bridge as required may increase flood levels on floodplain north of the Chrystalls Bend stopbank. If increase is unacceptable for large flood events (i.e. 0.2% AEP +CC2130 floods into Racecourse catchment), additional culverts through Expressway near culverts 15b, 15c and 15d will need to be investigated to mitigate loss of flow area over Expressway.	The current road geometry (following modification to provide freeboard under the bridge) has been assessed in Rev 3 of the report. The configuration of Culverts 15b, 15c, 15d and 15e has been reviewed and confirmed as part of this assessment.	
					B	Noted		S4
					C			
14	Appendix C - Culvert 34	A21.3.4h	C3	Flood Management	A	On review, it is considered that PR A21.4.5h and consent condition WS.6iv takes priority overt PRA21.5.6e - 600mm freeboard should only need to be provided in 2% AEP+CC2130 flood event. A departure could be sought from PR A21.5.6e. So could culvert 34 then be dropped 220mm to help provide additional cover?	Noted.	S4
					B			
					C			

15	Appendix D - Culvert 15	PR Table A21-3	C4	Flood Management	A	Please provide any comments from Designer/Peer Reviewer why water levels is ~1m lower than Specimen Design	We have not reviewed the accuracy of the Specimen Design models to a detailed design level and would need further information to do so. There are numerous differences in input information (hydrology, survey of existing structures, proposed design) and methodology that could potentially account for differences. Consistency checks with previous models have been completed for the pre project model, and the modelling approach for the post project model is consistent with the pre project model. Please refer also to the review record tracker comments for the peer review of the pre project and post project models.	
					B	Noted.		$4
					C			
16	Appendix D - Culvert 14	PR Table A21-3	C4	Flood Management	A	Please provide any comments from Designer/Peer Reviewer why water levels is ~0.55m lower than Specimen Design. Need to ensure water levels are not underestimated.	As per Item 15	
					B	Noted.		$4
					C			
17	Appendix D - Culvert 24 and 28	PR Table A21-10	C4	Flood Management	A	Please provide any comments by the Designer/Peer Reviewer to understand the differences. Specimen Design water levels upstream of culverts 23 and 24 were typically within 200mm of each other. FCC levels are approx 900mm difference.	As per Item 15	
					B	Noted.		$4
					C			
18	Appendix D - Culvert 34	PR Table A21-10	C4	Flood Management	A	Water levels in MIKE21 around 16.25m. Levels approx 550mm lower than Specimen Design. May be related to levels u/s of culvert 24 that are also much lower. Please provide explanation to ensure water levels are not underestimated.	As per Item 15	
					B	Noted.		$4
					C			
19	Appendix D - Te Horo Flood Bund	PR Table A21-10	C4	Flood Management	A	Lower flood levels likely due to northern overland flow path that hasn't been modelled. Expect flood containment bund will still be provided at appropriate level to accommodate for flows likely in reality. For reference, Specimen Design flood containment bund terminated at chainage 6500m.	Noted. The Te Horo Eastern Flood Bund will extend north to Chainage 6,500m as per the Specimen Design.	
					B	Noted.		S4
					C			
20	Table 7 item 1	PR Table A21-3	C3	Flood Management	A	PR departure possible. Will need to await confirmation of design of Culvert 7. PR departures related to maximum discharges that are exceeded ultimately depend on changes to flood levels.	Noted. Modelled discharge now compliant with this PR.	
					B	Noted		S4
					C			
21	Table 8 item 4	PR A21.5.6q	C4	Flood Management	A	Noted that achieving PR is dependent on external parties.	Noted. Also noted that NTC-385 has subsequently clarified that the hydraulic model should only includes works for the School Road drain within designation.	
					B	Noted.		S4
					C			

Comments for Revision 2 - issued 25/10/17								
22	Section 5.1.3, page 21	PR A21.12.2	C1	Flood Management	A	Revision 2 of the report states that the vertical alignment of SH1 to the east of the Expressway will not be changed from the existing, and the existing overland flow path over SH1 will be maintained. It is expected that Taylors Road within the Project Designation shall remain passable in all Waitohu Stream and Greenwood sub-catchment floods smaller than a 5% AEP flood.	Modelling for Rev 3 indicates that the flood depth on new sections of Taylors Road is less than < 0.35m deep, which is less than on existing SH1, considered passable for emergency vehicles, and is consistent with discussions with KCDC and the Notice of Requirement.	
					B	Noted.		S4
					C			
23	Table 10 - Item 1	PR A21.4.5b	C3	Flood Management	A	Departure for requirement to have 600mm freeboard to Culvert 2b soffit is possible given current design of culvert.	Noted. This non-compliance is still relevant for the latest design and modelling.	
					B	Noted, now discussed in item 41.		S4
					C			
24	Table 10 - item 2	PR A21.12	C3	Flood Management	A	PR departure possible following confirmation of peak water levels.	Noted. Modelled water level now compliant with this PR.	
					B	Noted.		S4
					C			
25	Table 10 - item 3	PR A21.12	C3	Flood Management	A	PR departure possible following confirmation of peak water levels.	Noted. Modelled water level now compliant with this PR.	
					B	Noted.		S4
					C			
26	Table 10 - item 4	PR A21.12	C3	Flood Management	A	Noted the culvert is now a 3x2m culvert. Change in size assumed to be due to updated hydrology. The 600mm freeboard requirement is based off the NZTA Bridge Manual (3rd edition) requirements, so a PR departure for a reduction in freeboard will be dependent upon a departure from the Bridge Manual. Have alternative culvert sizes been considered to provide that freeboard?	This culvert has been changed to a corrugated steel option that provides 600mm freeboard to soffit.	
					B	Noted.		S4
					C			
27	Figure 40.2		C1	Flood Management	A	Switching between Figure 25.2 in the Pre-Project Hydraulic Model Report (Rev 3) and Figure 40.2 of the Post-Project Hydraulic Model Report (Rev 2) suggests there are some differences in the model that are not a result of the project work. See the flood extents next to Greenwood Stream approximately 100m and 200m upstream of the Expressway. The flood extents have been reduced, potentially due to a reduction in the Greenwood inflows. Post-Project model results need to ensure they come from the same base model to ensure that the water level difference maps are reflective of the changes due to the Project not modelling inconsistencies.	Model instabilities were noted along Greenwood Stream and addressed in the latest model iteration. Flood extents have now altered in the Greenwood area.	
					B	Noted		S4
					C			
28	Figure 41.2		C1	Flood Management	A	Same as item 27, but for 5% AEP flood event.	As per Item 27	
					B	Noted		S4
					C			

29	Figure 42.2		C1	Flood Management	A	Same as items 27 and 28, but for 10% AEP +CC2130 flood event.	As per Item 27	
					B	Noted		S4
					C			
30	Figure 43.2		C1	Flood Management	A	Same as items 27, 28, and 29 but for 10% AEP flood event.	As per Item 27	
					B	Noted		S4
					C			
31	Figures for water levels differences		C1	Flood Management	A	Water level differences will be reviewed following clarification of potential model errors between the pre and post-project model results.	Water level differences provided in Post-Project Hydraulic Model Report Rev 3 using updated models.	
					B	Noted.		S4
					C			
32	Figure 3 - Bridge / culvert arrangement		C2	Flood Management	A	Noted that the access track on the southern side of the river is now located underneath Bridge 1 instead of through Culvert 3. Please provide an explanation as to the rationale behind moving the location of the access track.	This culvert has been changed to a corrugated steel option that provides access for the landowner.	
					B	Noted		S4
					C			
Comments for Revision 3 - issued 29/3/2018								
33	Table 7	A21.12	C1	Flood Management	A	Table 7 lists the scenarios for which debris blockage was considered. The Waitohu Stream catchment only considers the 1% AEP +CC2130 flood event (using 15m wide rectangular debris), not the ULS flood event which is now the critical scenario for the protection of the bridge against scour. Inspection of the 80% Stormwater report (section 5.7.4) indicates debris was accounted for through the scour calculations using triangular and rectangular debris rafts of 10m and 7m width respectively. Can you please comment on how these two relate and why different assumptions have been made for each set of debris rafts.	The scenarios listed in Table 7 have been modelled to assess compliance with PRs re maximum allowable flood levels with debris rafts for specific events set out in the PRs. The scour calculations have been based on the ULS flood (0.04% AEP CC2130) to assess scour extents and inform design of piers and scour protection. The debris raft shape has been considered in more detail for the scour assessment than the maximum flood level check. The approach adopted for the maximum flood level check is considered to be on the conservative side. Following more detailed consideration for the scour assessment, 10m and 7m wide debris rafts were adopted as a reasonable scenario for the Waitohu because the upstream existing SH1 bridge is significantly more constrictive (refer cross section below) with a clear central span < 8.5m perpendicular to stream flow (note, bridge is on a skew). We request that any comments on the scour assessment are added to the review record sheet for our Stormwater 80% Design Report, which presents this aspect.	S3
					B	Noted. Any further comments on the scour will be added to the Stormwater Design Report.		S4
					C			
34	Table 8, item 1	A21.12.3	C3	Flood Management	A	Minor exceedance of maximum allowable water level at culvert 15 in the 10% AEP flood event is considered acceptable given change in methodology and input information. Departure would be granted	Noted. Please advise whether we should apply for a departure or request a clarification.	S3
					B	Refer OPUS-NTC-680 Note 1. Is agreed that the design is optimised for flooding effects. Allowable flood level for 10% AEP event is amended to 11.88mRL		S4
					C			

35	Table 8, item 2	A21.5.3 c	C2	Flood Management	A	Difficulty of balancing the flows and volumes is understood. Focus and demonstration must be towards minimising the impacts of increased flows through Culvert 7. Similar to the HEC-RAS model used to understand the split of flows for the Mangapouri wetlands (described in the Culvert 12 report), a refined model of this area would be useful to demonstrate an accurate representation of the impact on 35 Rahui Road.	The capacity of Pipes 66 and 69 and connecting vee channels has been assessed in HY-8 and using Manning's equation - refer PDF attached. The design of these elements will be presented in the Culvert 100% Design Report, and will be covered by Hugh MacMurray's peer review of that report.	S1
					B	Noted, comment transfrred to Culvert 100% Design Report. Hugh MacMurray's review of this element will be critical to ensuring flow dynamics are occurring as described in this report. Confirmation that the assessment of the capacity of the pipes and connecting vee channels have been reviewed and accepted by the Peer Reviewer to be provided to Engineer		S4
					C			
36	Table 8, item 3	A21.12.3	C4	Flood Management	A	No issue with flow through culvert 14 based on it being less than the pre-project discharge. Depature would be granted.	Noted. Please advise whether we should apply for a departure or request a clarification.	S3
					B	Refer note 2 of OPUS-NTC-680. Increase in flow is accepted to be due to refined input data and change in modelling methodology. Is noted that post project flow is less than pre project flow. Design solution is considered acceptable. Comment Closed.		S4
					C			
37	Table 8, item 4	A21.12.3	C3	Flood Management	A	Culvert size agreed to be optimised based on balance of flows/volumes as discussed in the comment section. Departure would be granted.	Noted. Please advise whether we should apply for a departure or request a clarification.	S3
					B	Refer note of OPUS -NTC-680. It is agreed that the design of Culvert 14 is optimised for flooding effects. Therefore, PRs A21.5.3 c and d take precedence over the maximum allowable water level for Culvert 14 detailed in PR A21.12.3 Table A21-5. Comment closed.		S4
					C			
HOLD 38	Table 8, item 5	A21.12.5	C3	Flood Management	A	Water level exceedances agreed to be primarily a result of the change to Chrystall's Stopbank. With respect to the PP2O project, these higher water levels are considered acceptable due to the benefit of reduced flows on the floodplain. Are GWRC currently aware of the type of effect that will occur due to raising the stopbank?	The Post Project Hydraulic Model Build Report Rev 1 to Rev 3 has been provided to GWRC via Aconex, and we have had regular meetings and teleconferences with GWRC throughout the detailed design period at which flood effects of the stopbank upgrade have been discussed. In particular, we met with KCDC, GWRC and their consultant advisor for the stopbank upgrade (Jacobs) on 12 April following issue of Rev 3 of the Post Project Hydraulic Model Build Report, met again with KCDC and GWRC on 18 April, received email comments on the Pre and Post Project reports from one of GWRC's flood modelling specialists on 20 April, and met with that specialist to discuss their comments on 26 April. Based on this correspondence, we consider that they are aware of the effect of raising the stopbank.	S3

HOLD

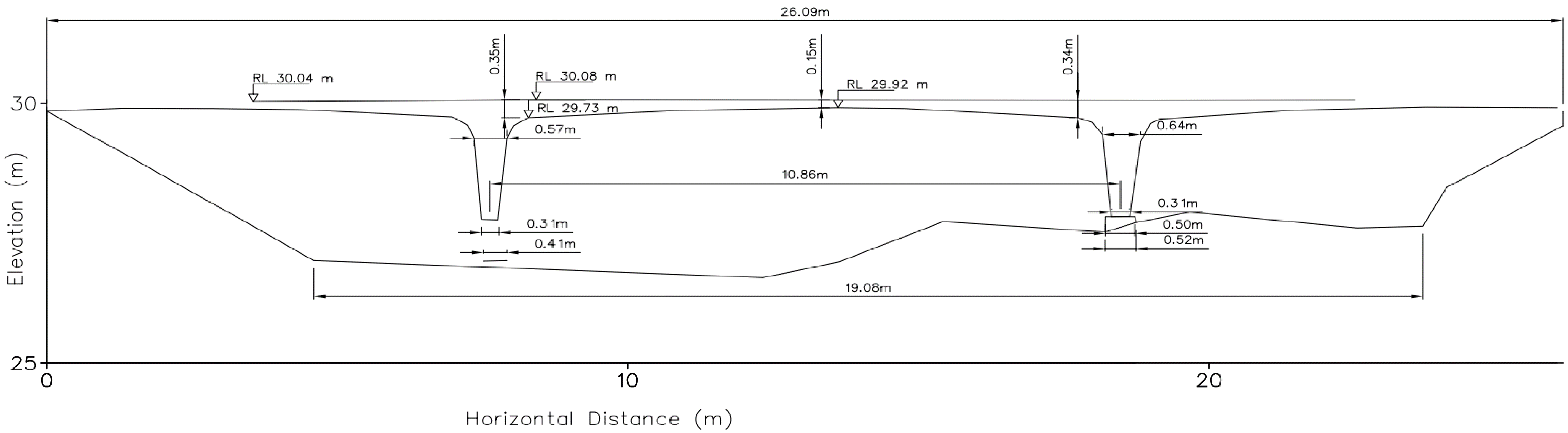
					B	Refer note 4 of OPUS-NTC-680. Documentation will need to be submitted to the Engineer via XXXX that raising of stopbank has been accepted by GWRC and that affected stakeholders have been adequately consulted. Comment Parked		S3
					C			
39	Table 8, item 9	A21.12.5	C3	Flood Management	A	Water level exceedances agreed to be primarily a result of the change to Chrystall's Stopbank. With respect to the PP2O project, these higher water levels are considered acceptable due to the benefit of reduced flows on the floodplain. Are GWRC and affected stakeholders currently aware of the type of effect that will occur due to raising the stopbank?	As per response to Item 38 above.	S3
					B	Refer note 4 of OPUS-NTC-680. Documentation will need to be submitted to the Engineer via XXXX that raising of stopbank has been accepted by GWRC and that affected stakeholders have been adequately consulted. Comment Parked		S3
					C			
40	Figure 1	N/A	C3	Flood Management	A	The references to the expressway off-ramp and flood bund appear to be offset from their actual location.	Noted. Will be fixed in the final version of the report.	S3
					B	Noted, to be addressed in final report.		S4
					C			
41	Table 10, item 1	A21.4.5 b	C3	Flood Management	A	Considering the proposed design would not allow for the 0.6m freeboard for Culvert 2b, the non-compliance is accceptable.	Noted.	S3
					B	Refer note 5 of OPUS-NTC-680. Design of Taylors Rd now goes under the Waitohu Stream Bridge not Culvert 2. Consequently is considered that PR 21.4.5b) no longer applies to Culvert 2b. Comment Closed		S4
					C			
42	Table 10, item 2	A21.4.5 d	C2	Flood Management	A	The reduced freeboard over the 20m section is considered unacceptable and the design must be changed to meet the freeboard requirement.	We will provide an NTE with options as per your request at the meeting on 30 April 2018	S1
					B	Awaiting options to design out the reduced freeboard along the 20m section of mainline alignment.		S2
					C			

HOLD

43	Table 11, item 1	A21.5.6t, Table A21-1	C3	Flood Management	A	Provided A21.5.6t and consent condition WS.6b are met, the discharge over the Lucinsky Overflow is considered acceptable. A departure would be granted. However the change from the Specimen Design is significant. Can you please comment on the exact cause of the change in flow over the Lucinsky Overflow?	The change in flow over the Lucinsky Overflow is due to sizing the proposed overflow weir to match the pre-project Lucinsky discharge and volume. There is a significant difference between the existing Lucinsky discharge estimated in the previous Opus model and the current pre-project model. There are many potential reasons for this (inflow hydrographs are different, existing culverts have been re-surveyed, 2D terrain is different, schematisation is different, the modelled distribution of flows between the Mangaone Stream and Overflow is different, methods for extracting peak flow could be different, software changes). We have not completed a detailed review of the previous Opus model. Nevertheless, we suspect the difference in pre-project Lucinsky discharge is largely due to the 1D-2D exchange of flows over the right bank of the Mangaone Stream. In the latest pre project model, a large proportion of the Lucinsky discharge derives from overtopping of the right bank of the stream over a 160m long section downstream of the existing SH1 culvert, which we suspect does not occur to the same extent in the previous Opus model. In the previous Opus model, 1D-2D exchange was set to occur when the higher of the 1D cross section bank level and the 2D terrain bank level is exceeded, whereas in the latest model, 1D-2D exchange is based on the 2D terrain levels only, which is considered more accurate since the surveyed cross sections over the reach of interest are spread relatively far apart. Refer screenshots below from the previous Opus model.	S3
					B	Refer note 7 of OPUS-NTC-680 PR 21.5.6t and consent condition WS.6b take precedence. Modelled flows of the Lucinsky Overflow are considered acceptable. Comment closed.		S4
					C			
44	Figure 18 - 19		C4	Flood Management	A	For the stopbank breach scenarios, I assume Figures 18.1 - 18.3 are the Otaki River only, but Figure 19.1 - 19.3 include the Mangapouri Stream. Labels for Figures 18.1 - 18.3 would be useful for easy clarification. Similarly, was there a reason the 0.2% AEP +CC2130 flood event with stopbank breach also included the Mangapouri Stream but the 3,000 m3/s flood did not?	As suggested, we will also add "(Ōtaki only)" to the figure labels for the 3,000m3/s event. The 3000m3/s flood is relevant to ULS design of the cross drainage of the Ōtaki River floodplain and the 0.2% AEP CC2130 flood is relevant to design of the secondary containment bund. Inflows on the Mangapouri Stream are not considered to have a signficant impact on hydraulic behaviour in the area of interest for the 3,000m3/s flood (i.e. in the vicinity of the cross drainage of the Ōtaki River floodplain), noting that intercatchment transfer (to the degree that it occurs) is from the Ōtaki towards the Mangapouri and is not dependent on backwater effects from the Mangapouri. The Secondary Containment Bund is intended to prevent intercatchment transfer from the Ōtaki to the Mangapouri and Racecourse catchments in the 0.2% AEP CC2130 event, thus hydraulic behaviour in the Mangapouri and Racecourse catchments is of potential interest for the 0.2% AEP CC2130 event, and inflows on those catchments are included in the 0.2% AEP CC modelling.	S3
					B	Noted, comment closed.		S4
					C			
45	Figure 40.1		C2	Flood Management	A	Could you please provide a zoomed in maximum velocity map around the Bridge for the 0.04% AEP +CC2130 flood event? As this is the critical ULS scenario, more detail in this area would be helpful to inform discussions around the scour protection.	Figure will be added to the report as requested.	S1
					B	Noted to be added to final report		S4
					C			

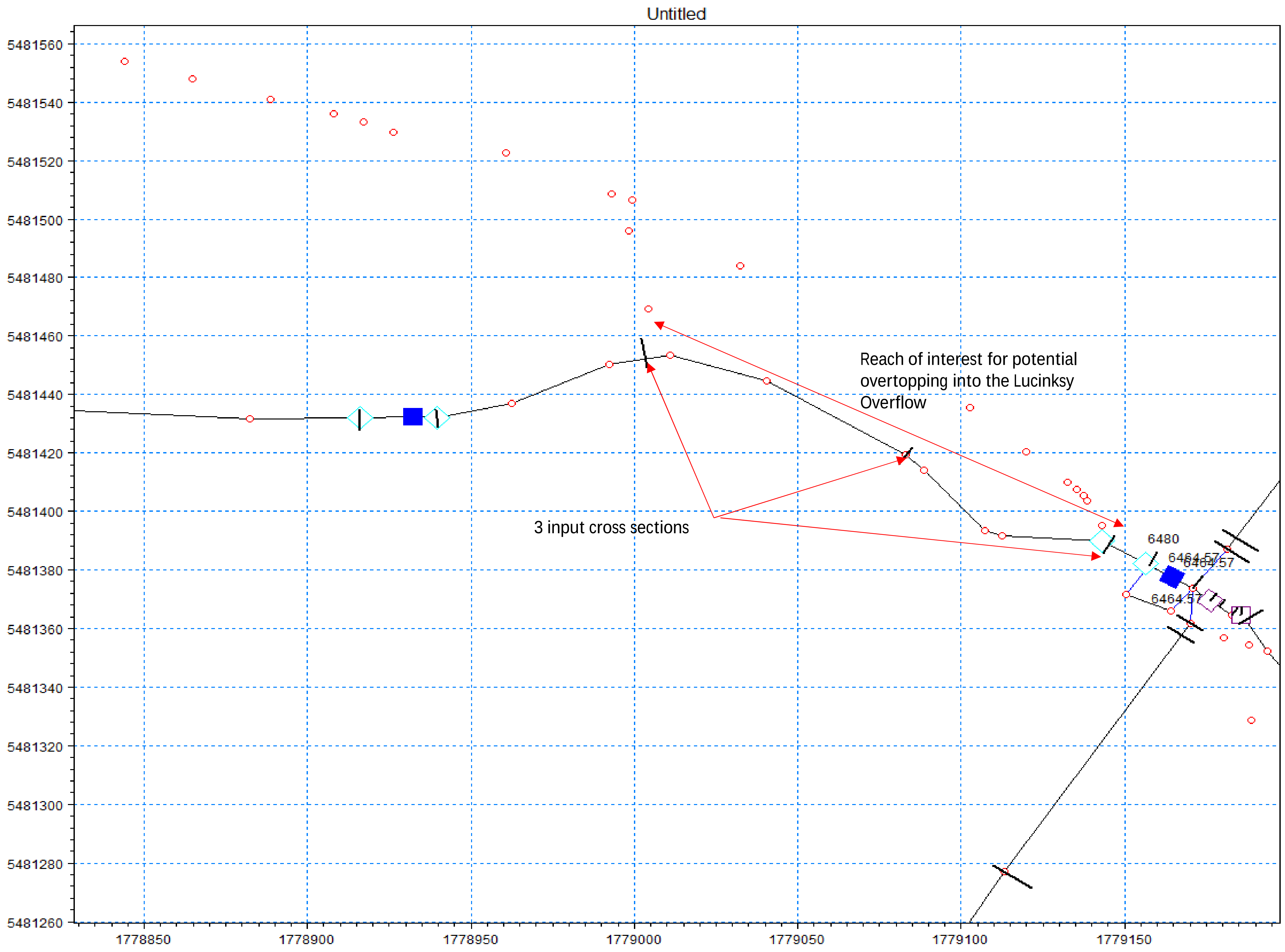
46	Figure 38.5		C2	Flood Management		Could you please provide a zoomed in maximum velocity map around Bridge 5 and its abutments? This will help inform the design and review of the scour protection.	Figure will be added to the report as requested.	S3
						Noted to be added to final report		S4
47	Figure 44.1 & Figure 44.2		C4	Flood Management	A	Post-project debris blockacge minus post-project water levels for the 0.2% AEP +Cc2130 shows a surprising increase in water levels on the Otaki River floodplain north of Chrystalls Bend stopbank upstream of the expressway. Is there a step change where the water level overtops the stopbank and flows into this area?	In the event shown in these figures (0.2% AEP CC2130 event with debris on piers), Chrystall's stopbank is overtopped. The long length of overtopping allows relatively large flows with only a small flood rise to the south of the stopbank. After overtopping the stopbank, flood flows are then confined by the Secondary Containment Bund and the expressway embankment, and outflow is limited by flow through Culverts 15b to 15e - thus resulting in the observed flood rise to the north of the stopbank.	S3
					B	Noted, comment closed.		S4
					C			

<u>Relevant to Item 33:</u>
Existing SH1 Waitohu Bridge Cross section:

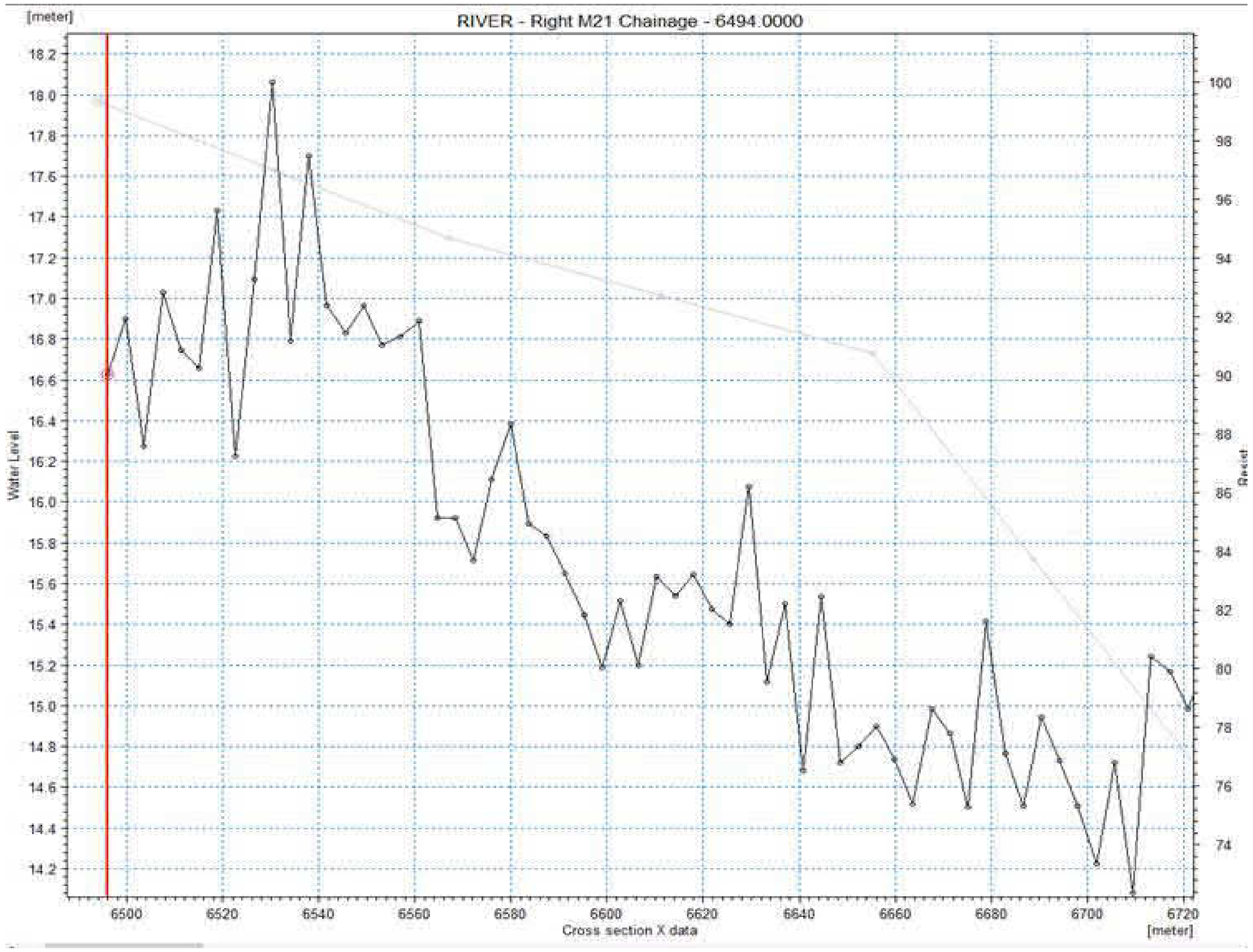


Relevant to Item 43:

Screenshot below from previous Opus pre project model - 3 input cross sections shown over the reach of interest where flows overtop into the Mangaone Overflow



Screenshot below from previous Opus pre project model showing right bank levels based on 1D cross sections (grey line) and 2D terrain (black line).
The lateral links for the previous model are set so that overtopping from the 1D to the 2D occurs only when the higher of the bank levels based on 1D and 2D is exceeded.
As shown by the screenshot, this is typically governed by the 1D levels, which are based on relatively widely spaced 1D cross sections.
The 1D cross sections are interpolated at 50m spacing from the 3 cross sections shown in the plan above.


RIVER - Right M21 Chainage - 6494.0000
[meter]
Water Level
Cross section X data
[meter]
Resist

Dewi Knappstein

From:	David Cross <auto-reply-mel@aconex.com>
Sent:	Monday, 7 May 2018 4:55 p.m.
To:	Dewi Knappstein
Subject:	OPUS-NTC-000680: Re: NTE notifying of design response to PA comments on Post Project Hydraulic Model Report ACNXREF<uBWd9AIzG7s8tpS0LhoY4>
Attachments:	Post Project Hydraulic Model Report.xlsx; REVIEW RECORD - PP2O Culvert 80pc Design Report PA Review Rev 2.xlsx

You have received a new **Notice to Contractor: OPUS-NTC-000680**

Project:	Peka Peka to Otaki
Type:	Notice to Contractor
Mail Number:	OPUS-NTC-000680
To:	Andrew Goldie, Fletcher Construction
Cc:	Stuart Waters, Beca Carter Hollings & Ferner Ltd.
	Mr Ron McFadyen, Opus International Consultants Limited
	Ms Dewi Knappstein, Tonkin and Taylor
From:	D Cross, Opus International Consultants Limited
Sent:	07/05/2018 4:55:21 PM NZST (GMT +12:00)
Attribute 1:	30 - DESIGN
Attribute 2:	Drainage
Status:	N/A
Subject:	**Re: NTE notifying of design response to PA comments on Post Project Hydraulic Model Report**
NTC Type:	Document Review

Andrew,

Please find the attached comments for the Post-Project Hydraulic Model Report.
The following comments required clarification or relaxation of the Principals Requirements in order to close out the comments. In general it is accepted that the proposed design is optimised to minimise the impact of flooding following completion of the project. The clarifications/relaxations are:
1) Comment 34 - It is agreed that the design solution is optimised for flooding effects. The modelled flood levels exceeding the levels allowed by PRA21.12.3 by 20mm are considered acceptable. The Maximum Flood Level specified for Culvert 15 in PRA12.12.3 Table A21-5 is relaxed to 11.88mRL (NZ Vertical Datum).
2**) Comment 35 -** To be transferred to 100% Culvert Design Report , confirmation that the relevant items to be included in the 100% Culvert Design Report Peer Review to be provided to the Engineer. An updated Review Record for the previous 80% Culvert Design Report has been attached with the transferred comment.
2) Comment 36 - It is noted that the post project discharge from Culvert 14 is less than the pre project discharge (3.75m3/s vs 4.09m3/s), although discharge is greater than the volume allowed in PR21.12.3 of 2.15m3/s. It is agreed that the increase in volume is due to refined input data and change in modelling methodology. Based on the detail provided in Table 8, item 3 it is clarified that PR21.12.3 Table 21-4 does not apply to Culvert 14 and that the modelled flows are acceptable.
3) Comment 37 - It is agreed with the statement in Table 8, item 4 that the design of Culvert 14 is optimised for flooding effects. Therefore, PRs A21.5.3 c and d take precedence over the maximum allowable water level for Culvert 14 detailed in PR A21.12.3 Table A21-5. Based on the detail provided in Table 8, item 4 it is clarified that PR21.12.3 Table 21-5 does not apply to Culvert 14 and that the modelled flows are acceptable.
4) Comments 38 and 39 - These two comments are results of the raising of the Chrystalls Bend Stopbank. It is noted that the stopbank is being raised through a separate agreement between Fletcher and GWRC. However, to close off the technical non-

compliance of PR21.12.5 documentation will need to be submitted to the Engineer, via an NTE, showing that GWRC are in agreement with the proposed stopbank raising and that affected parties have appropriately consulted.

5) Comment 41 - The 100% design has Taylors Road being redirected under Bridge 01 and not through Culvert 2 as originally included in the Specimen Design. Consequently Taylors Road flow path now no longer relates to Culvert 2 and PR A21.4.5 b does not apply to Culvert 2b.

6) Comment 42 - The reduced freeboard along the mainline alignment, although only along a length of 20m, is considered non-complying. Options to resolve the reduced freeboard to be submitted to the Engineer.

7) Comment 43 - PR A21.5.6t and consent condition WS.6b take precedence over Table A21-11 for the Luncinsky Overflow. Due to the change in methodology and the use of refined input information the intent of the PRs are considered to be met. Table A21-11 does not apply to the Luncinsky Overflow and confirm that the modelled flows are acceptable.

Although comments 38, 39, and 42 are still outstanding they are relatively minor in scope. Comments 38 and 39 are covered by the sperate GWRC and Fletchers agreement to raise the Chrystalls Bend Stopbank and Comment 42 impacts only a localised length of the mainline alignment. It is acceptable to proceed to the IFC stage for the Post Project Hydraulic Model with hold points or clouds for comments 38, 39, and 42.

Regards

David Cross

Project Manager

Opus International Consultants Ltd, L10 Majestic Centre, 100 Willis St, Wellington, New Zealand

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From: S Findlay
Sent: 02/05/2018 12:47:58 PM NZST (GMT +12:00)
To: Ron McFadyen
Cc: Stuart Waters, David Cross, Dewi Knappstein
Mail Number: FCCL-NE-000928
Subject: NTE notifying of design response to PA comments on Post Project Hydraulic Model Report

NTE Type:	Document Review Request

Ron,

Please find attached the design response to the latest comments by the Principal's Advisor on the Post Project Hydraulic Model Report, as well as supporting information as a PDF. This response has been informed by the meeting between Daniel McMullan, David Cross and Dewi Knappstein on 30 April 2018.

Please close out all comments by Friday 4 May 2018.

Regards

Emma Boon

Design Coordination | Infrastructure

The Fletcher Construction Company Ltd

Level 7 Ranchhod Tower, 39 The Terrace, Wellington

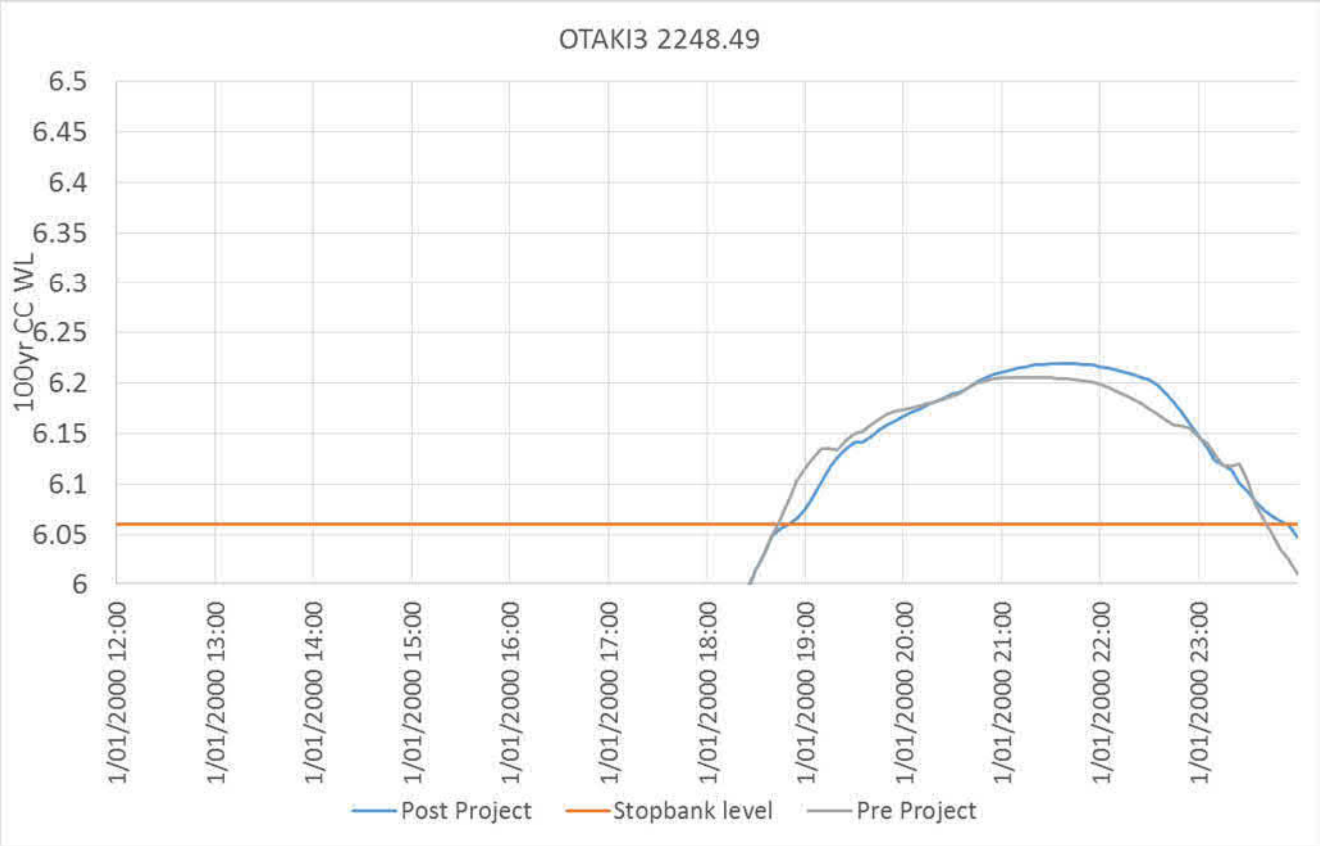
Mob: +64 27 539 9917 **Email**: emmab@fcc.co.nz

From: D Knappstein
Sent: 02/05/2018 12:39:39 PM NZST (GMT +12:00)
To: Andrew Goldie
Cc: Emma Boon
Mail Number: T&T-CADV-000133
Subject: DRAFT NTE notifying of design response to PA comments on Post Project Hydraulic Model Report

This mail was prepared by E Boon

Appendix F:

PRE VS POST-PROJECT DEPTH AND DURATION OF STOP BANK OVERTOPPING IN THE 1% AEP CC EVENT (DOWNSTREAM ŌTAKI RIVER)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6.05
6
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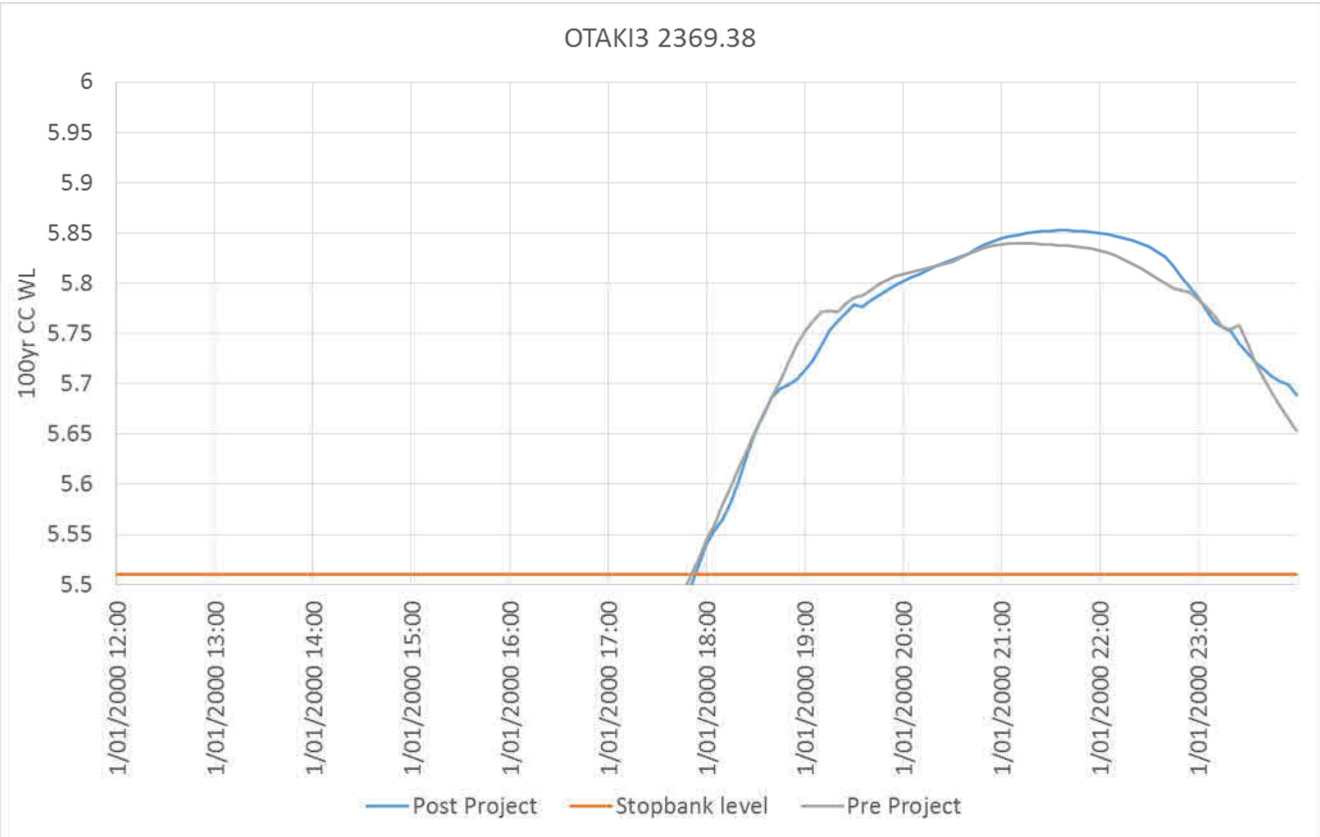
Post Project
Stopbank level
Pre Project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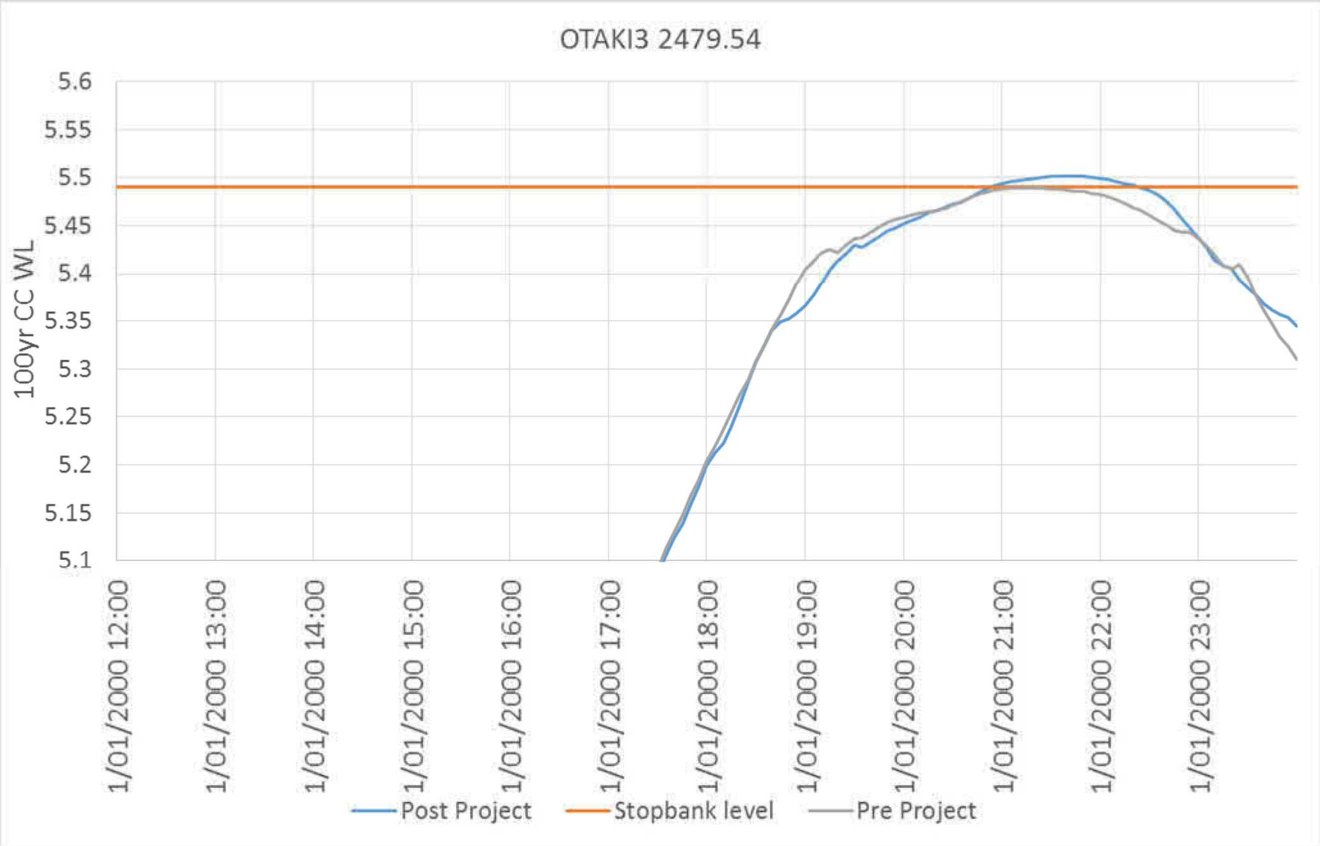
Post Project
Stopbank level
Pre Project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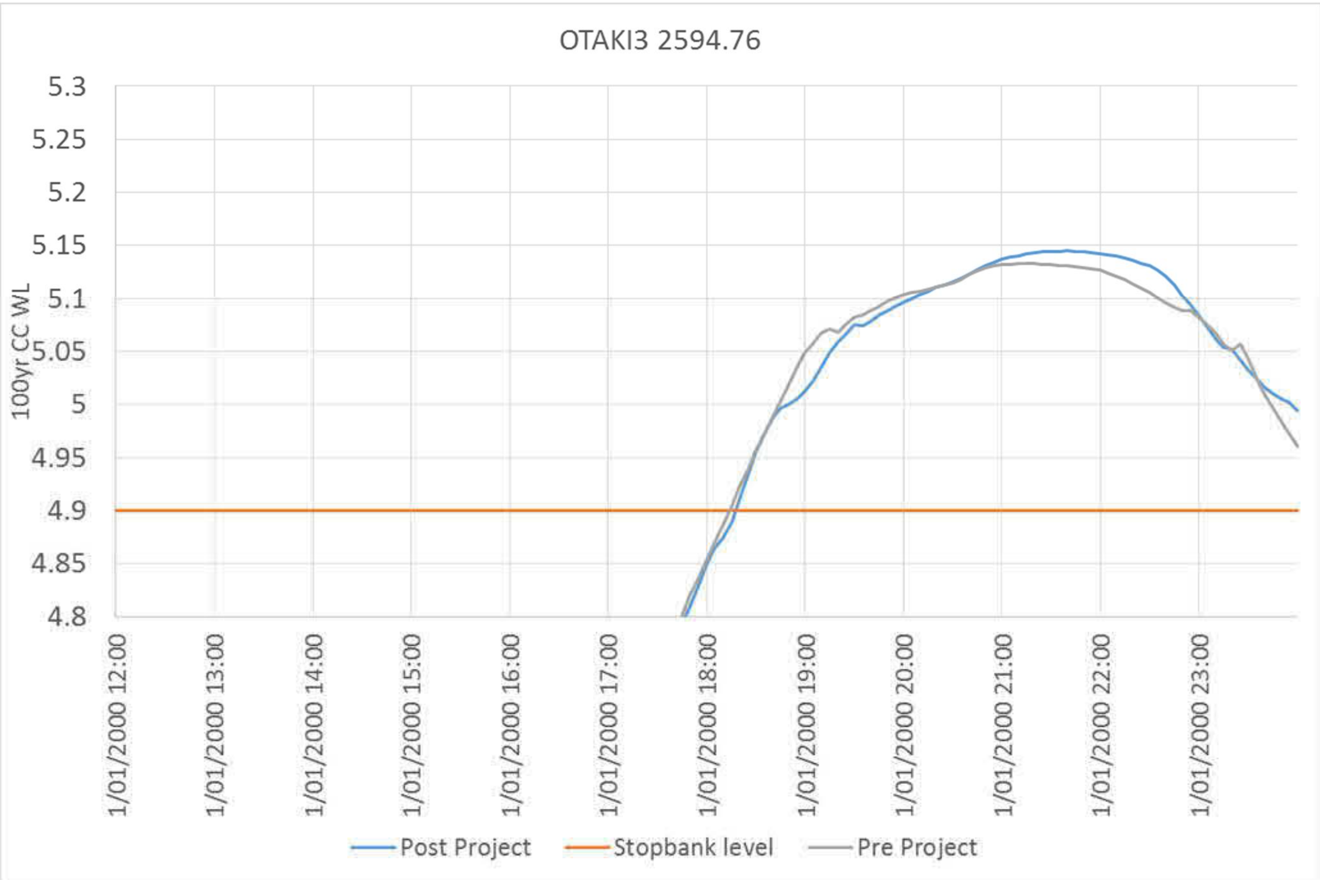
Post Project
Stopbank level
Pre Project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1/01/2000 18:00
1/01/2000 19:00
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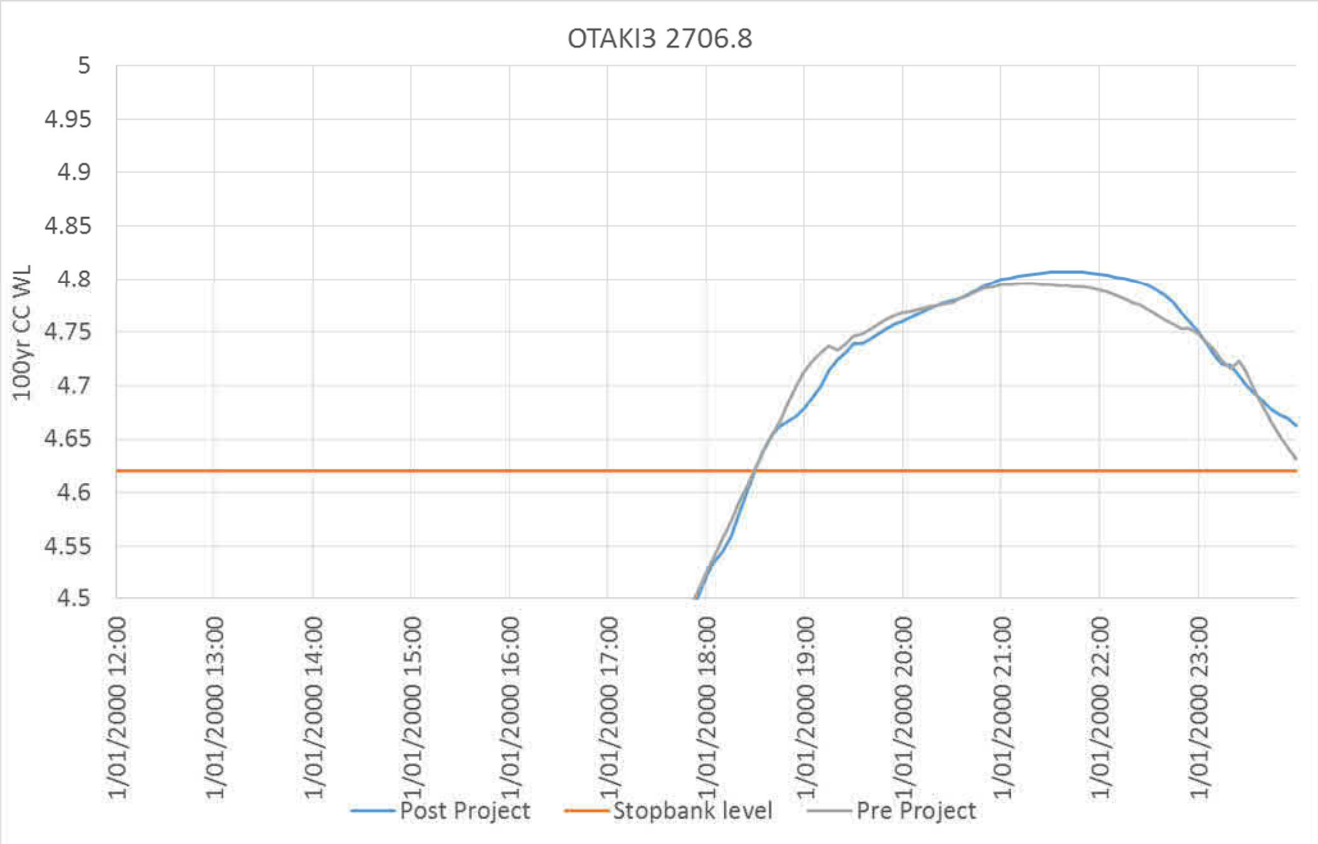
1/01/2000 21:00
1/01/2000 22:00
1/01/2000 23:00
Post Project
Stopbank level
Pre Project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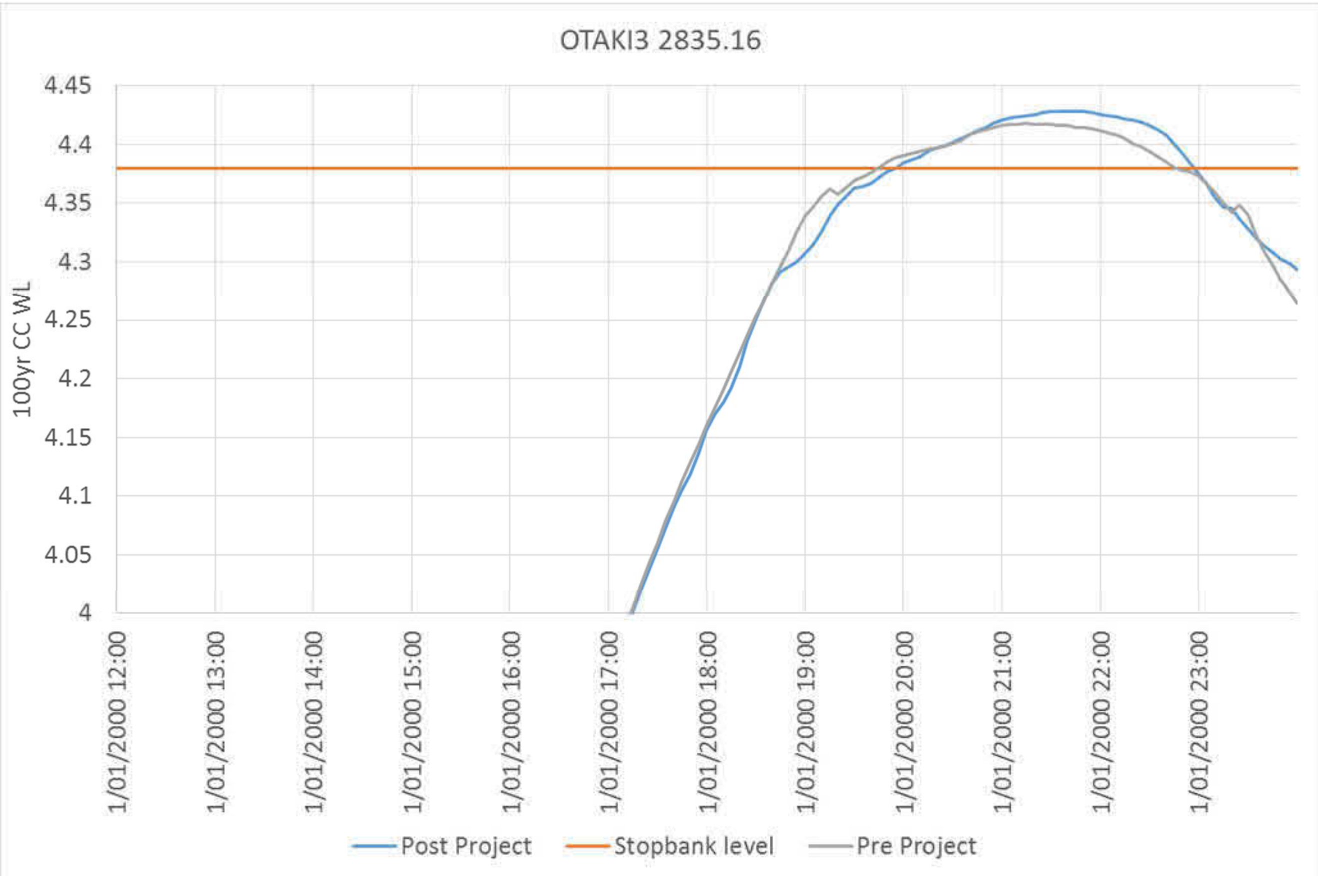
Post Project
Stopbank level
Pre Project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1/01/2000 19:00
1/01/2000 20:00
1/01/2000 21:00
1/01/2000 22:00
1/01/2000 23:00
Post Project
Stopbank level
Pre Project

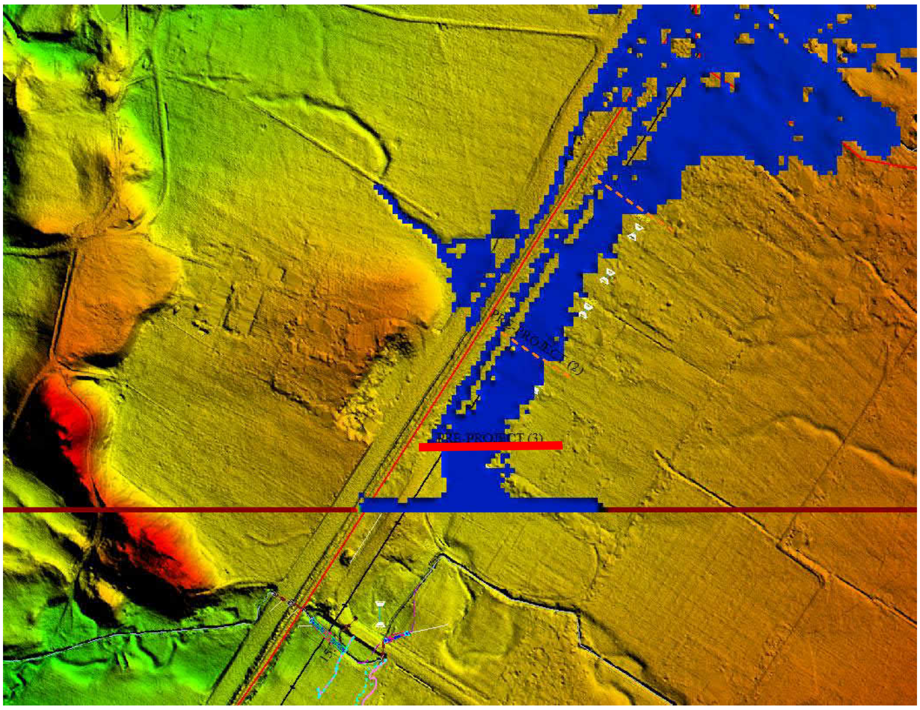
Appendix G:

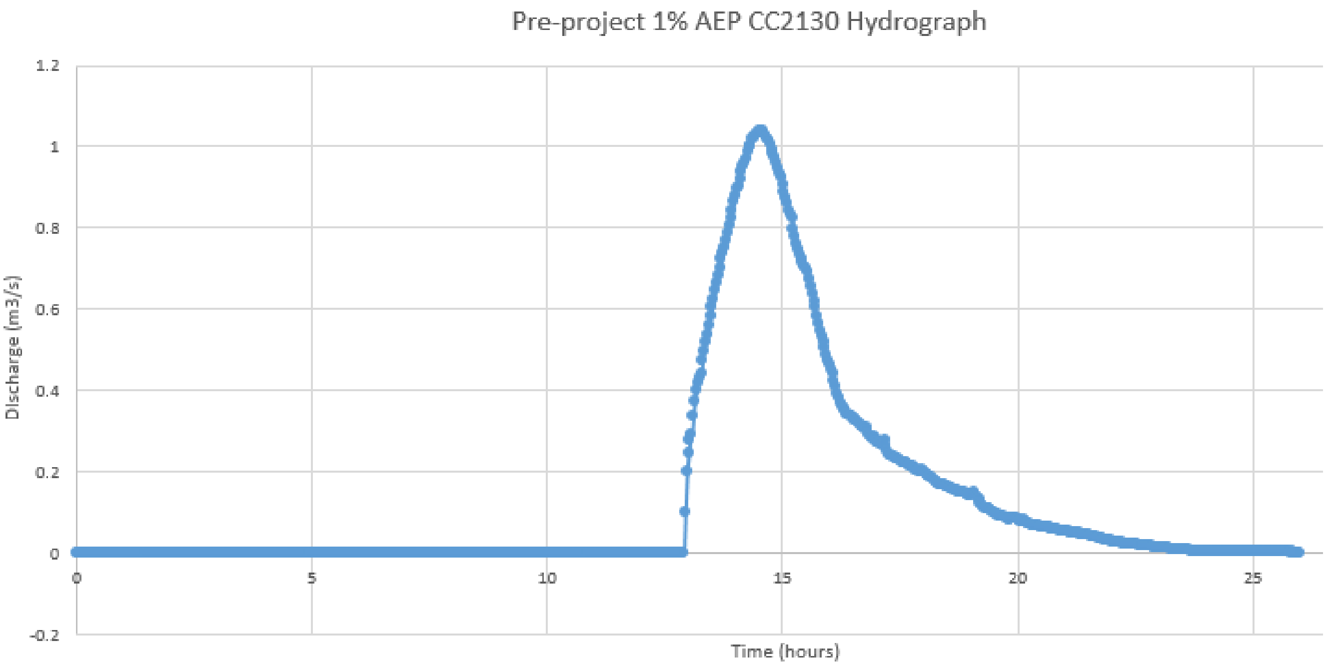
FLOWS CONVEYED SOUTH OF THE MANGAONE 2D MODEL EXTENTS

Used for design and assessment of flood effects for proposed culverts 35 to 42, located to the south of the Mangaone 2D model extents.

PRE PROJECT

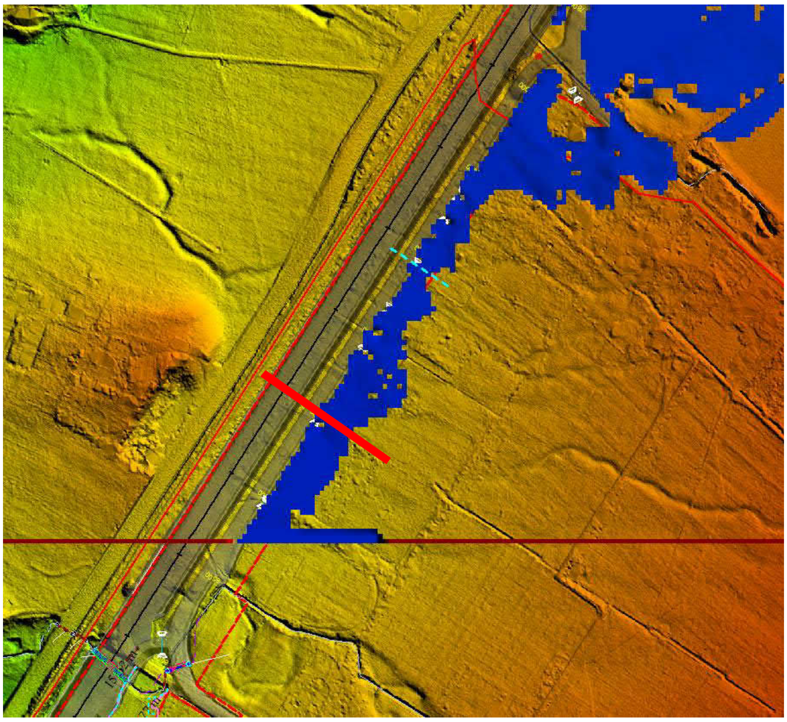
Location of section for extraction of flows from pre project model:

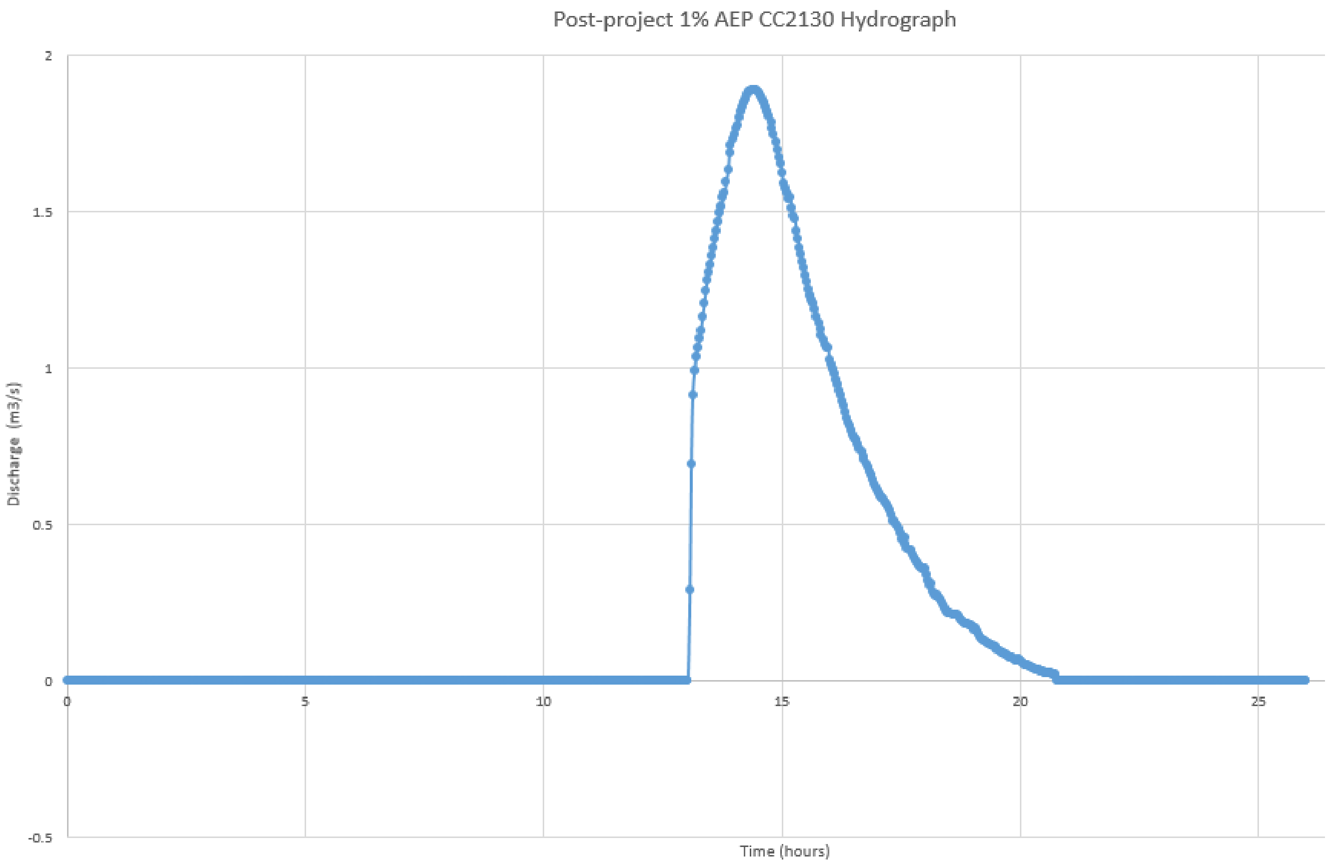


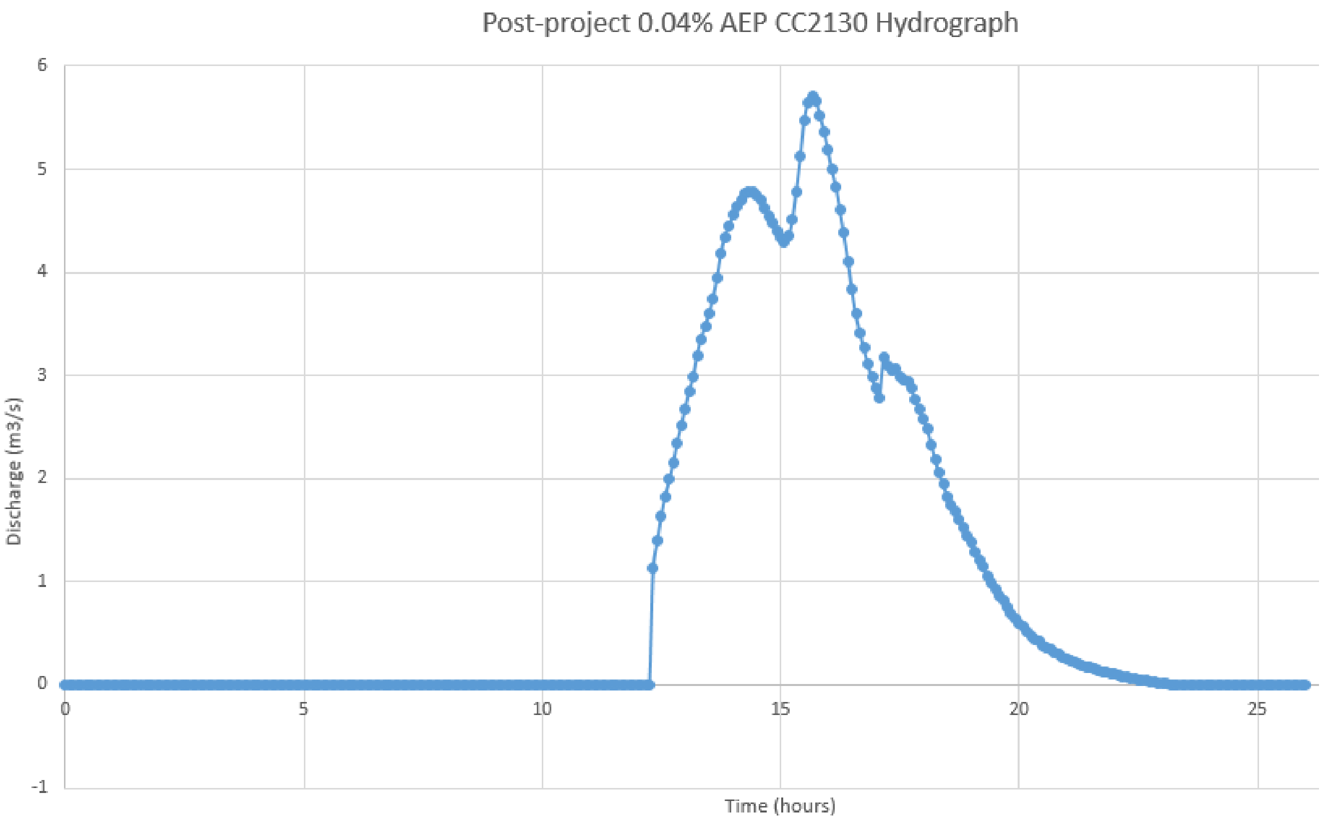


POST PROJECT

Location of section for extraction of flows from post project model:






Post-project 0.04% AEP CC2130 Hydrograph
Discharge (m3/s)
Time (hours)
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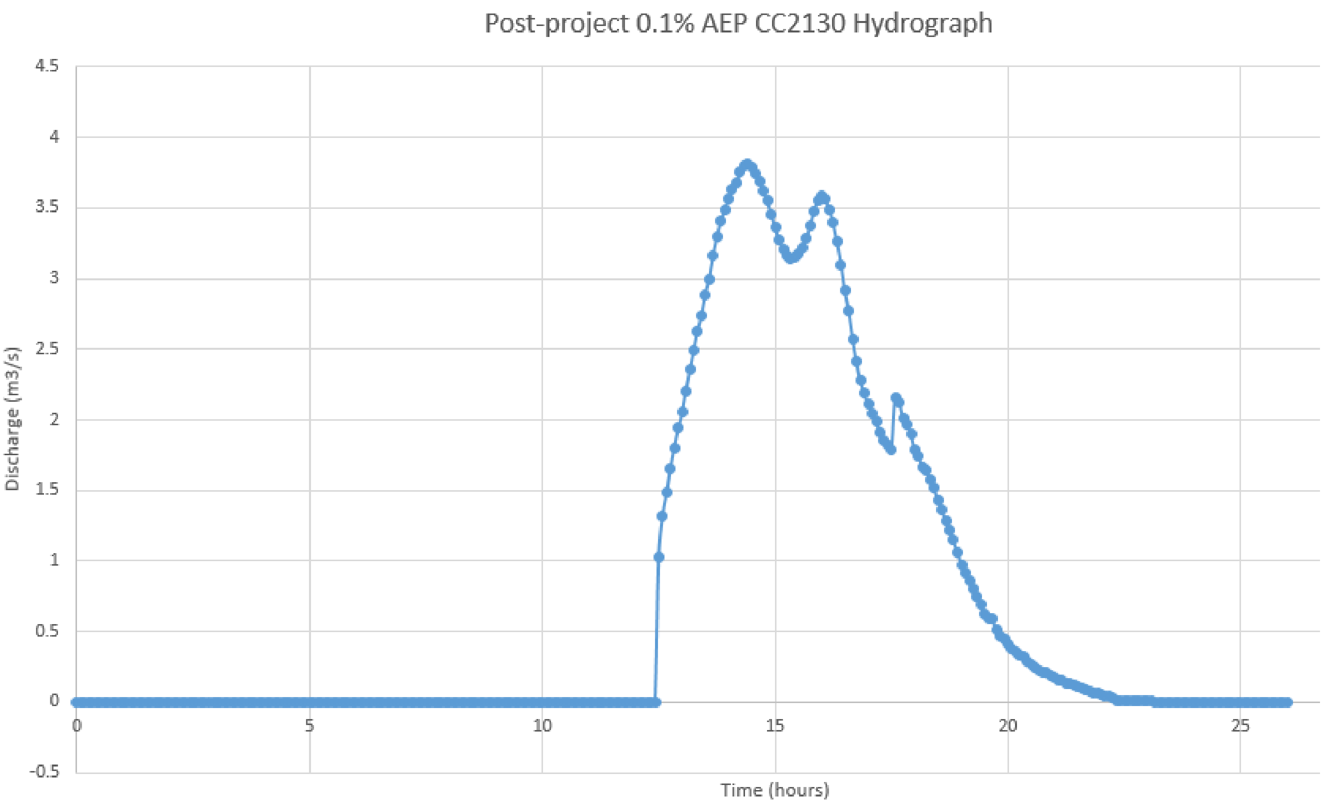
5
4
3
2
1
0
-1
0
5
10
15
20
25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Time (hours)
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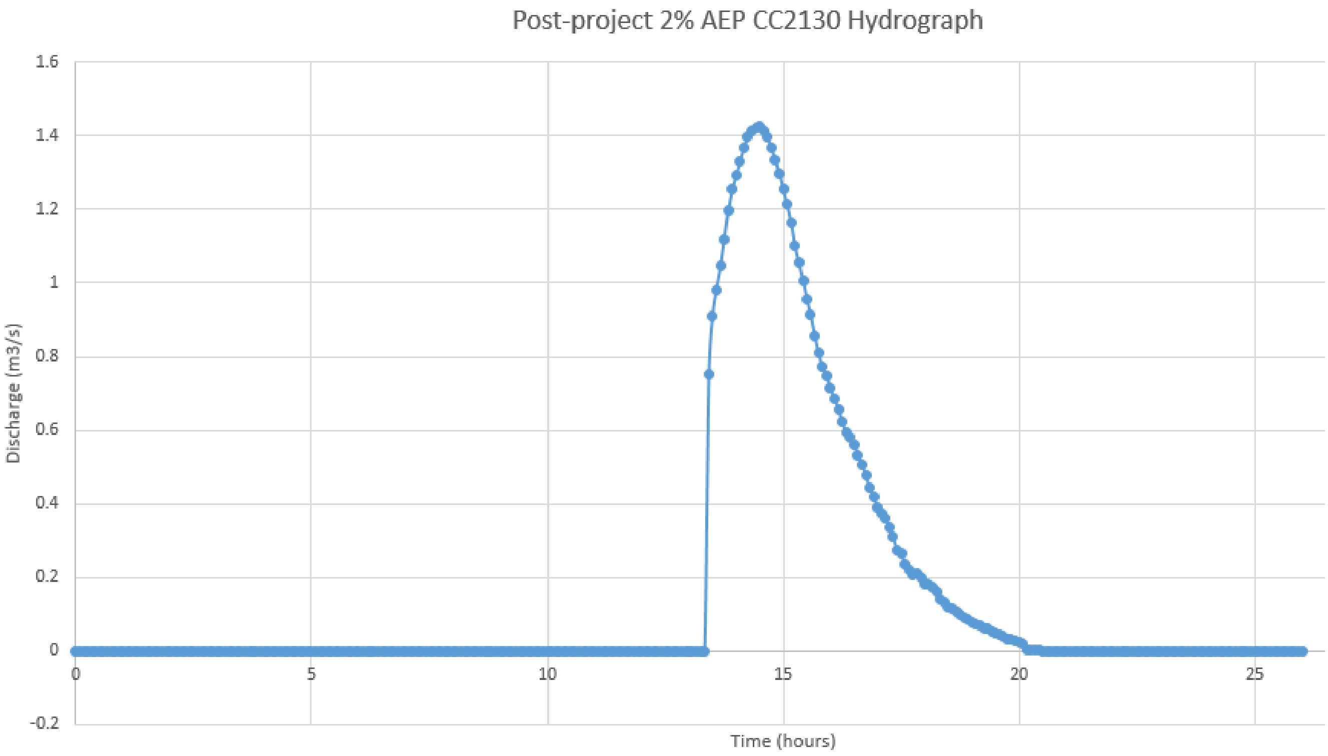
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
0
5
10
15
20
25


Post-project 2% AEP CC2130 Hydrograph
Discharge (m3/s)
Time (hours)
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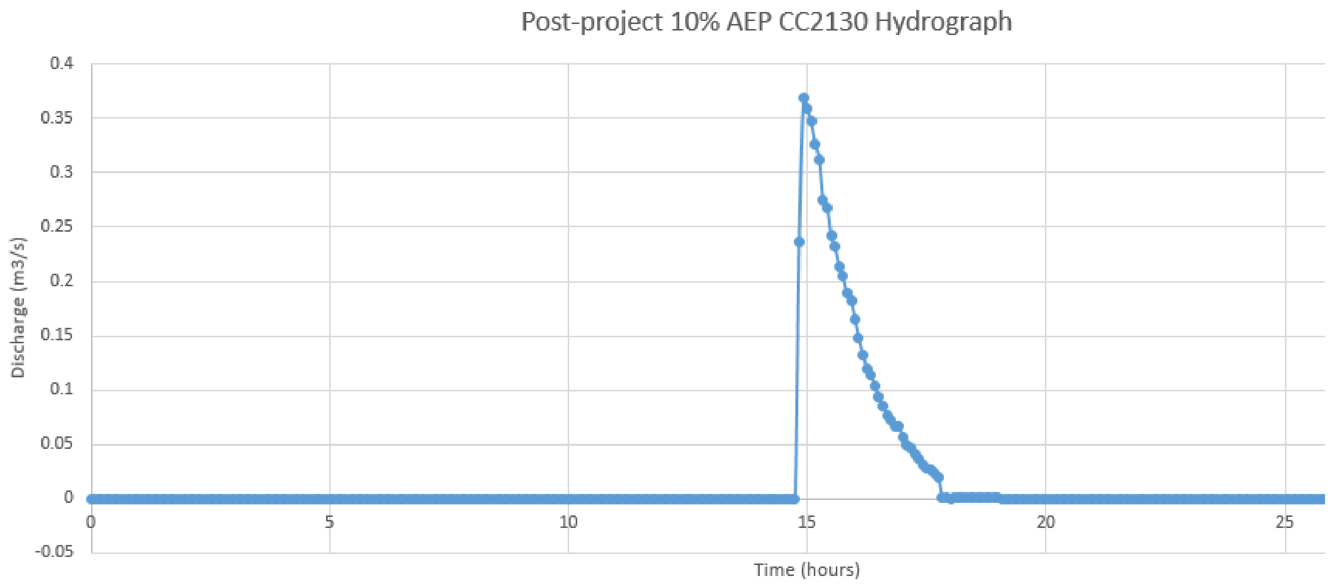
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
0
5
10
15
20
25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Discharge (m3/s)
Time (hours)
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0.25
0.2
0.15
0.1
0.05
0
-0.05
0
5
10
15
20
25