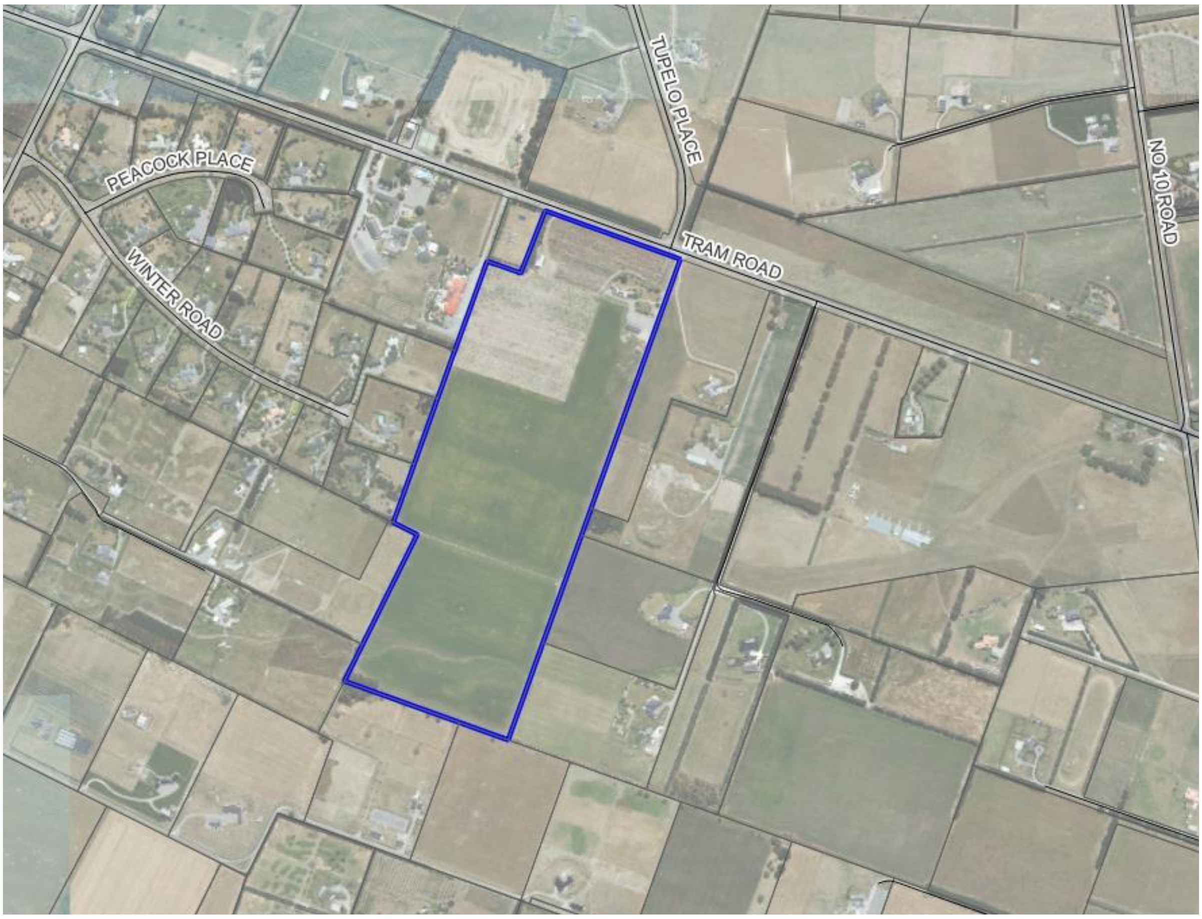
Andrew McAllister

14 December 2023

Tram Road Block B, Swannanoa
Flood Risk Assessment



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ANDREW MCALLISTER

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TRAM ROAD BLOCK B, SWANNANOA FLOOD RISK ASSESSMENT

Quality Control			
Author	*Daniel McMullan*	Client	*Andrew McAllister*
Reviewed by	*Andrew Tisch*	Date Issued	*14 December 2023*
Approved by	*Andrew Tisch*	Revision No.	*2.0*
Doc Name/Location	*rpt 231214 Tram Rd Block B FRA.docx*		

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Project Personnel

Developer:

Owner	Andrew McAllister

Principal Engineers:

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1 Summary

Andrew McAllister is investigating a potential rezoning of a 21.73 ha block of land at 1275 Tram Road in Swannanoa. This block of land includes the property detailed in Table 1, and will be referred to as Block B. The site has been identified through flood modelling by Waimakariri District Council (WDC) as having a significant overland flow path which runs through the site. Figure 1 below shows the site (highlighted in blue), with the peak water depths shown for the 0.5% AEP[1] flood event (equivalent to the 200-year average recurrence interval) including the effects of climate change[2].

Overall, and from a flood risk perspective, Block B has been assessed to be appropriate for development. Recommendations have been provided to manage the on-site flood risk.

Table 1 Properties included in Block B

Site Address	Legal Description	Owner
1275 Tram Road	PT RURAL SEC 8183 BLK XIII RANGIORA SD	Andrew McAllister

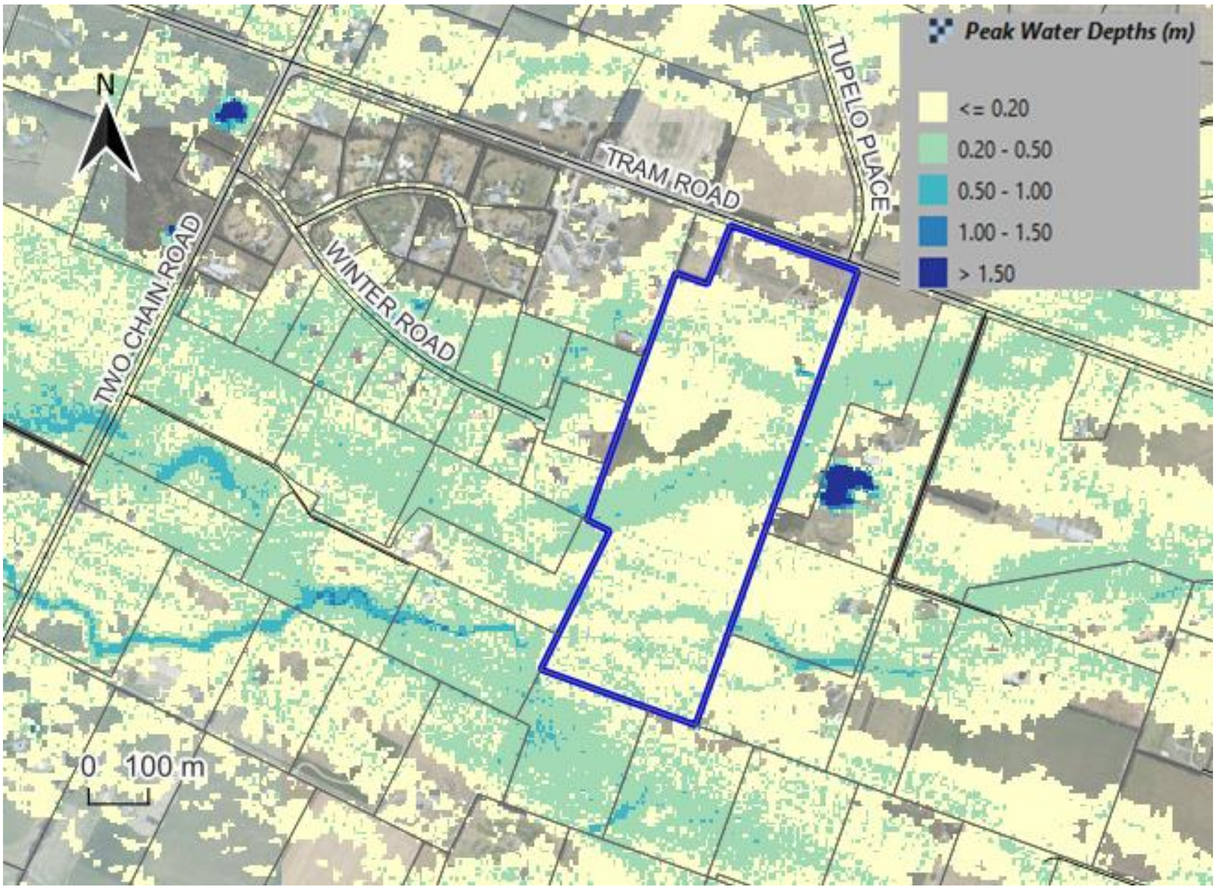


Figure 1 Proposed rezoning of 1275 Tram Road (Block B) in Swannanoa (highlighted in blue) with peak flood depths shown for the 0.5% AEP flood event

[1] Annual exceedance probability.
[2] Note that all flood events discussed in this report include the effects of climate change.

1.1 Scope

The purpose of this report is to:

- Describe and detail our current understanding of flood risk in the existing undeveloped situation, and including the effects of climate change;
- Review requirements by WDC with respect to this flood risk;
- Review any other legislative policy with respect to this flood risk;
- Propose options to mitigate on-site flood risk so that development can safely occur, or if required, determine what land is unsuitable for development;
- Propose options to ensure overland flow paths are not diverted, impeded, or obstructed by any potential future development; and
- Undertake a section 106 assessment of flood hazard.

2 WDC Access Requirements

WDC have the following access requirements for any new lots in semi-rural / rural areas[3]:

- The accessway to the building platform must not be inundated in a 20% AEP flood event;
- Culverts must be designed to the 10% AEP flood event;
- The accessway must be passable in a 2% AEP flood event, with water depths over the waterway to be no more than 300 mm; and
- Culverts across overland flow paths or waterways need to be designed so that if they are blocked, then the accessway is still passable (i.e., have a water depth over it of less than 300 mm), and do not create a flood hazard for neighbouring properties.

3 Overview of the Site's Catchment

3.1 Site Overview

The 21.73 ha site is gently sloping with an approximate grade of 1 in 164 falling in an easterly direction. There is also a water race located approximately 260 m from the south side of Block B (see Figure 2 below), and another along the south boundary of the site (see Figure 3 below). We have categorised the on-site flooding by identifying four overland flow paths, as shown in Figure 4 below for reference.

Aerial, topographical, and flood maps of the site are provided in Appendix A for reference.

[3] Sourced from access requirements for similar developments in the Waimakariri District. These were confirmed with WDC staff for those developments (C. Bacon, personal communication, September 29, 2023).

Figure 2 Central water race at 1275 Tram Road looking upstream

Figure 3 Water race along south boundary of 1275 Tram Road looking downstream

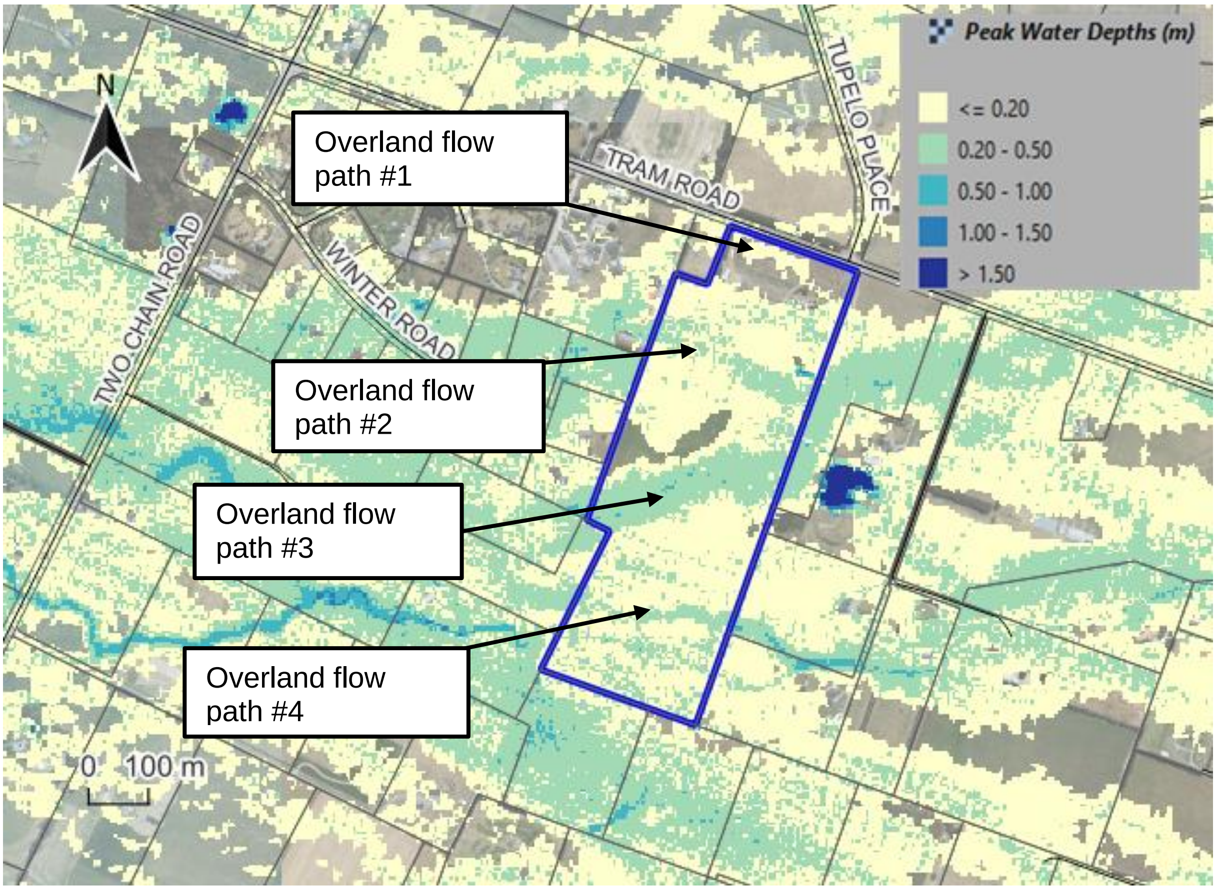


Figure 4 Location of on-site overland flow paths with peak flood depths shown for the 0.5% AEP flood event

3.2 Upstream Catchment Information

Block B has a local catchment upstream of the site estimated to have the following parameters:

- Area = 22.3 km²
- Length = 14.5 km
- Soil drainage = imperfectly to moderately well drained soils
- Catchment slope = 0.6% (1 in 158)
- Estimated time of concentration = 12 hours[4]

3.3 WDC Model Results

WDC has undertaken flood modelling for the 1% AEP, 0.5% AEP and 0.2% AEP flood events including the effects of climate change. Results from WDC flood modelling are available to the public. The peak water depths in the 0.2% AEP flood event are presented in Appendix A. Flow rates at key locations were also requested from WDC (see Table 2 and Figure 5 below).

[4] Calculated using the Friend equation.

Key points from these model results, also shown in Figure 1, include:

- There is a minor overland flow path at the north end of site that enters near Tram Road (overland flow path #1).
- There are three large overland flow paths that spread across the majority of the property and essentially merge together in the 0.5% AEP flood event (overland flow paths #2, #3, and #4).
- The site is therefore predominantly inundated in the 0.5% AEP flood event.
- Water depths in the 0.5% AEP flood event are typically less than 0.2 m, with water depths up to 0.5 m in primary overland flow channels.
- Flow velocities across site in the 0.5% AEP flood event are generally less than 0.6 m/s in overland flow paths #1, #2 and #4, and are up to 0.9 m/s in overland flow path #3.

Table 2 Peak flow rates in the overland flow paths at the upstream end of Block B

Overland flow path	1% AEP	0.5% AEP	0.2% AEP
Overland flow path #1	0.3 m³/s	0.6 m³/s	1.1 m³/s
Overland flow path #2	10.2 m³/s	14.9 m³/s	22.5 m³/s
Overland flow path #3	13.3 m³/s	19.0 m³/s	28.1 m³/s
Overland flow path #4	13.2 m³/s	20.0 m³/s	31.6 m³/s
Total flows:	**37.0 m³/s**	**54.5 m³/s**	**83.2 m³/s**

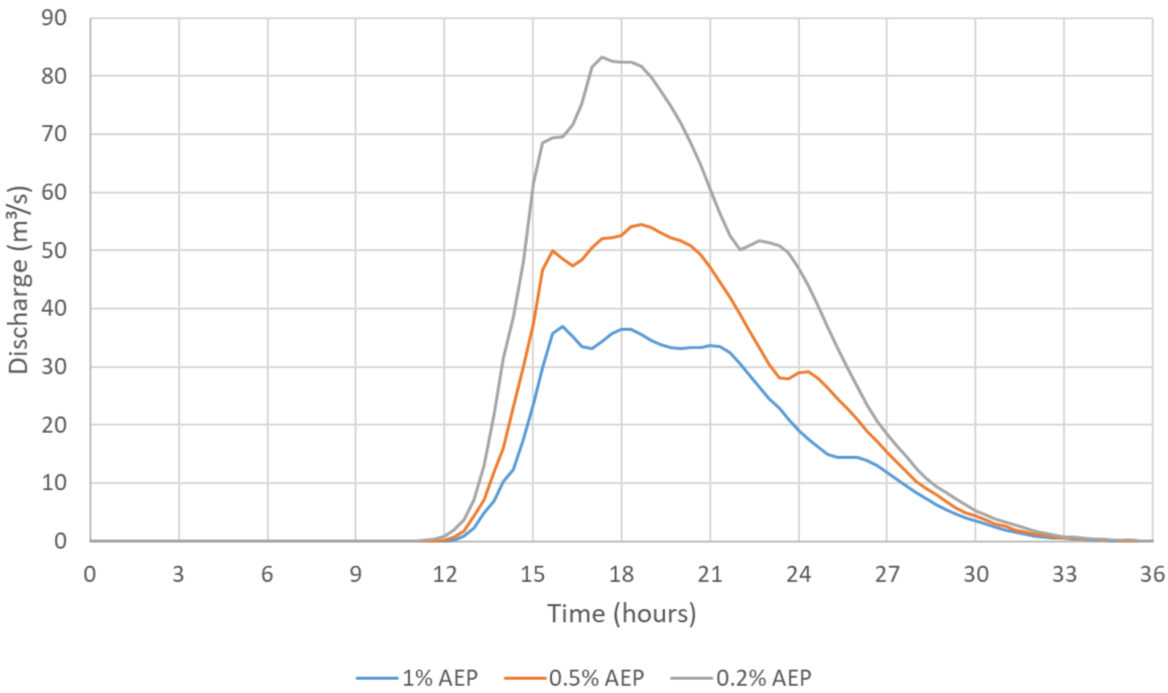


Figure 5 Total catchment runoff onto Block B in large flood events, as modelled by WDC

3.4 Catchment Hydrology

As the WDC flood model has not been simulated for flood events less than the 1% AEP flood event (i.e., the 20% and 10% AEP flood events), peak flow rates have been calculated for the local catchment upstream of Block B with a rainfall runoff model using Horton's equation for the 20% and 10% AEP flood events. These flow rates are for a critical 24-hour duration rainfall event with rainfall intensities sourced from HIRDS V4, and assumed infiltration rates based off soil drainage types[5] and WDC infiltration parameters. The 1% AEP flow detailed below has been extracted from the WDC model results and will be used in place of the 2% AEP flood event. This is due to the uncertainty of the runoff volumes and the capacity of the upstream drainage network to divert flows away from our site.

We note that the estimated peak flow rate for the 1% AEP flood event is much greater than the 20% and 10% AEP flood events. This is because the local drainage network becomes overwhelmed in the 1% AEP flood event, and so upstream catchment runoff spills over local drains (that would have conveyed runoff away from site) and into the catchment of Block B.

Estimated peak flow rates from the upstream catchment onto the entirety of Block B:

- 20% AEP flood event including the effects of climate change = 1.8 m^3/s
- 10% AEP flood event including the effects of climate change = 3.6 m^3/s
- 1% AEP flood event including the effects of climate change = 37.0 m^3/s

3.5 On-Site Stormwater Management

On-site stormwater management will be required to manage flows coming off the proposed development. Dependent upon site specific groundwater levels, these could be managed through either soak holes or rainwater roof tanks. We understand that the existing gravelled yard at the northern end of site currently discharges to ground through a soak hole, and anecdotally that this performs well. Overall, we consider that it will be possible to effectively manage the post-development stormwater runoff so that flood risk either on, or off-site, is not increased.

4 Policy Review

The Canterbury Regional Policy Statement (CRPS) policy 11.3.1 describes the requirements in relation to new subdivision, use and development of land in high hazard areas unless key conditions can be met. "High hazard areas", in this context, are flood hazard areas subject to inundation events where the water depth (metres) x velocity (metres per second) is greater than or equal to 1, or where depths are greater than 1 metre, in a 0.2% AEP flood event.

A review of the WDC model results indicates that there is only 100 m^2 of the site which has been modelled to have water depths greater than 1 metre in the 0.2% AEP flood event. Flow velocities on site are less than 1 m/s in the 0.2% AEP flood event. Minor earthworks would be able to reduce the maximum water depth on site to less than 1 metre, and so we consider that there are no high hazard areas that would prevent development from occurring.

Overall, we consider that any development on Block B will be able to meet the requirements of CRPS policies on high hazard areas.

[5] Soil drainage types sourced from Canterbury Maps

5 Overview of Predicted Flood Risk

Based on the site's flood risk described above in section 3, the predicted flood risk can be summarised as:

- Generally having slow moving floodwaters across the property, with some higher velocities (still less than 1 m/s) in the overland flow paths;
- Having areas of shallow inundation (less than 200 mm water depth), with areas of moderate inundation (200 mm to 500 mm water depth) in the overland flow paths; and
- Having some areas where development will need to consider flood risk during future design stages.

In summary, it is our view that Block B is suitable for development.

6 Recommendations to Manage On-Site Flood Risk

6.1 Site Access

Accessway Design

Accessway road levels are proposed to be set no more than 300 mm below the 1% AEP flood level. This will ensure that there is less than 300 mm of water depth above the accessway in a 2% AEP flood event, and so the accessway would remain passable. Any raised accessways should not be located against the upstream property boundary so that they do not increase flood hazard on neighbouring properties. They should instead be located at least 50 – 60 m downstream of the upstream boundary. Later design stages will need to quantitatively assess that the conveyance capacity over accessways does not increase flood hazard on upstream due to the raising of the overland flow path invert.

Flow velocities over the accessway are expected to be much less than 3 m/s based on modelled flow velocities in the area.

Culvert Design

Depending on the proposed subdivision layout, culverts may be required on accessways to prevent minor overland flow path(s) from being blocked, and to ensure that no overtopping occurs in the 20% AEP rainfall event. If culvert(s) are required, they will need to be shallow to accommodate the wide and shallow flows. For instance, Hynds DriftDeck units could be used, or multiple Ø300 circular culverts. However, this would need to be confirmed during subdivision design once the subdivision layout is known.

We also recommend that on-site water races are crossed with well-designed culvert structures that have greater capacity than the water races so that those structures do not become a constraint on flows. To assist with this, we recommend they have proper headwall structures to minimise entry and exit headlosses. These could be in the form of pre-cast concrete headwall structures, or a naturalised headwall with rock faces to prevent plants from blocking flows (see Figure 6 below for an example). Culverts in water races should also be buried to allow for any fish passage.

Figure 6 Example of Mitred Pipe Inlet/Outlet with Rock Facing (WWDG Chapter 14)

6.2 Building Platforms

Building Platform Locations

In general, building platforms should not be located within any overland flow paths. However, provided floodwaters can flow around the building platform (potentially with large wide swales), they can be located in areas with depths up to 200 mm in the 0.5% AEP flood event. We also recommend that building platforms are offset from water races by at least 10 m to allow for maintenance of water races, and to convey overflows from water races. A plan showing example building platform locations (assuming 20 m x 20 m building platforms) is provided in Appendix B. This plan is provided as proof-of-concept only, and is subject to further assessment and design.

Overland flow path #3 provides key conveyance for floodwaters across site. Any building platforms located within this flow path create the possibility for floodwaters to be redirected (potentially increasing flood hazard on neighbouring properties), and would be more challenging to maintain access to in a 2% AEP flood event without blocking the flow path. We therefore recommend the following:

- Lot sizes that intersect with this overland flow path are made as large as possible to create space between building platforms for floodwaters to flow.
- Building platforms are situated out of, or only on the edge of, the overland flow path (i.e., not in the centre of the overland flow path).
- Building platforms are also located in a series aligned with the flow direction of the overland flow path.
- Building platforms for lots next to overland flow path #3 are pre-determined by the developer to ensure there is minimal impact on the overland flow paths conveyance capacity.

The extent and depth of overland flow path #3 should be confirmed by survey during subdivision design; and for the purpose of this matter, the extent of the overland flow path is defined by estimated water depths being greater than 200 mm in the 0.5% AEP flood event. There may be the opportunity in future subdivision design to optimise the conveyance of the overland flow path, and so reduce its width in order to maximise the space for building platforms.

More specific building platform location advice can be given if required.

Building platform level requirements are discussed further below.

The above advice does not take into account any planning requirements, such as building platform sizes and setbacks, which will also need to be taken into account.

Building Platform & Finished Floor Levels

Building platform levels and their associated building finished floor levels should be based upon the chosen location of the building platform and the highest modelled 0.5% AEP flood level intersecting the building platform. Building platform levels are recommended to be set at least as equivalent to the 0.5% AEP flood level, or ideally 225 mm below the finished floor level.

At minimum, the floor levels will need to be 400 mm above the highest ground level intersecting the building footprint where water depths are expected to be less than 100 mm in a 0.5% AEP flood event. However, where water depths are expected to be greater than 100 mm in a 0.5% AEP flood event, finished floor levels are required to be 500 mm above the highest 0.5% AEP flood level intersecting the building footprint.

We recommend selected floor levels are confirmed by WDC at the appropriate stage of development.

6.3 Water Races

In regards to on-site water races, we recommend the following:

- Water races are naturalised for amenity value, with hydraulic capacity and bank stability maintained. Any necessary engineering standards / bylaws to be achieved.
- Water race culverts are well-designed (as discussed above).
- Building platforms are set back from water races by at least 10 m (as discussed above).
- Management of water races are aligned with upstream and neighbouring properties as much as possible to minimise blockage, maintain conveyance capacity, and prevent misdirection of overflows.

7 Section 106 Assessment of Flood Hazard

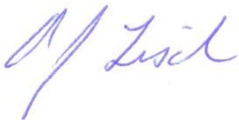
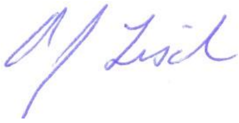
See Table 3 below for a Section 106 assessment of flood hazard for the site of the proposed rezoning. The result of this assessment confirms that Block A is suitable for development with appropriate flood hazard mitigations.

Table 3 Section 106 assessment of flood hazard

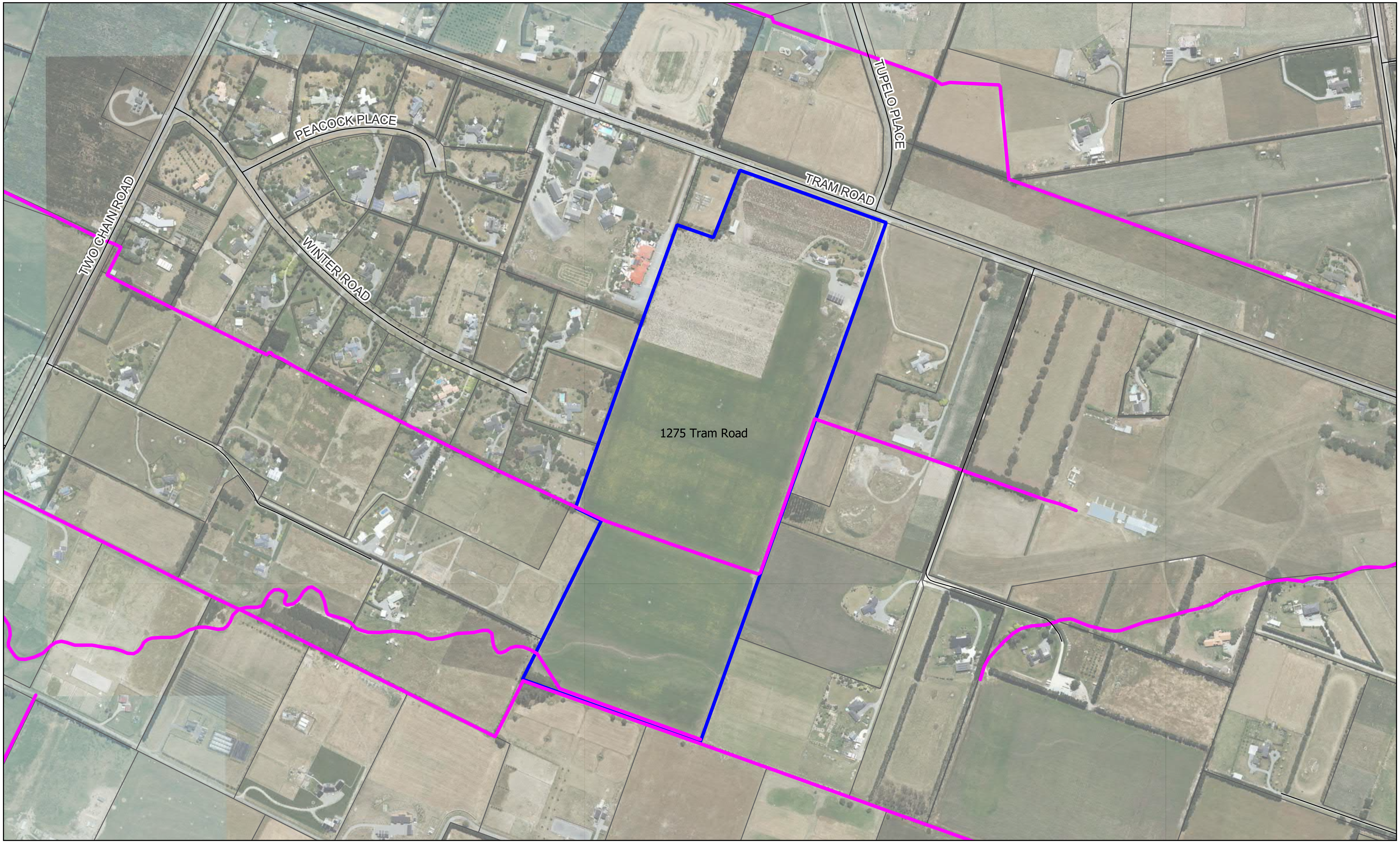
106 Consent authority may refuse subdivision consent in certain circumstances		
Clause	**Assessment**	**Complies (yes/no)**
A consent authority may refuse to grant a subdivision consent, or may grant a subdivision consent subject to conditions, if it considers that— (a) there is a significant risk from natural hazards; or (b) *[Repealed]* (c) sufficient provision has not been made for legal and physical access to each allotment to be created by the subdivision.	We have assessed that future residents will be able to have access to their lots and building platforms, and that these can be designed and constructed in a way that there is not significant risk to people or property from natural flood hazard.	Yes
(1A) For the purpose of subsection (1)(a), an assessment of the risk from natural hazards requires a combined assessment of— (a) the likelihood of natural hazards occurring (whether individually or in combination); and (b) the material damage to land in respect of which the consent is sought, other land, or structures that would result from natural hazards; and (c) any likely subsequent use of the land in respect of which the consent is sought that would accelerate, worsen, or result in material damage of the kind referred to in paragraph (b).	The likelihood of flood hazard occurring at this site has been assessed. The material damage to land or structures at this site from flood hazard has been assessed. The use of land for the proposed development would not accelerate, worsen, or result in material damage.	Yes
(2) Conditions under subsection (1) must be— (a) for the purposes of avoiding, remedying, or mitigating the effects referred to in subsection (1); and (b) of a type that could be imposed under section 108.	Conditions could be placed on the proposed development in regards to the design of the accessway to each proposed lot, and / or to the location of the building platforms on each proposed lot.	Yes

8 Report Approvals

This report has been:

Task	Initial	Signature	Date
Prepared by:	Daniel McMullan, e2		14 December, 2023
Reviewed by:	Andrew Tisch, e2		14 December, 2023
Approved by:	Andrew Tisch, e2		14 December, 2023

Appendix A – Site Plans



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Legend
- Block B Extent
- Drainage channels & water races

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Andrew McAllister
Tram Road Block B Plan Change Application

Site plan

Job Number	23036
Revision	1
Date	2/10/2023

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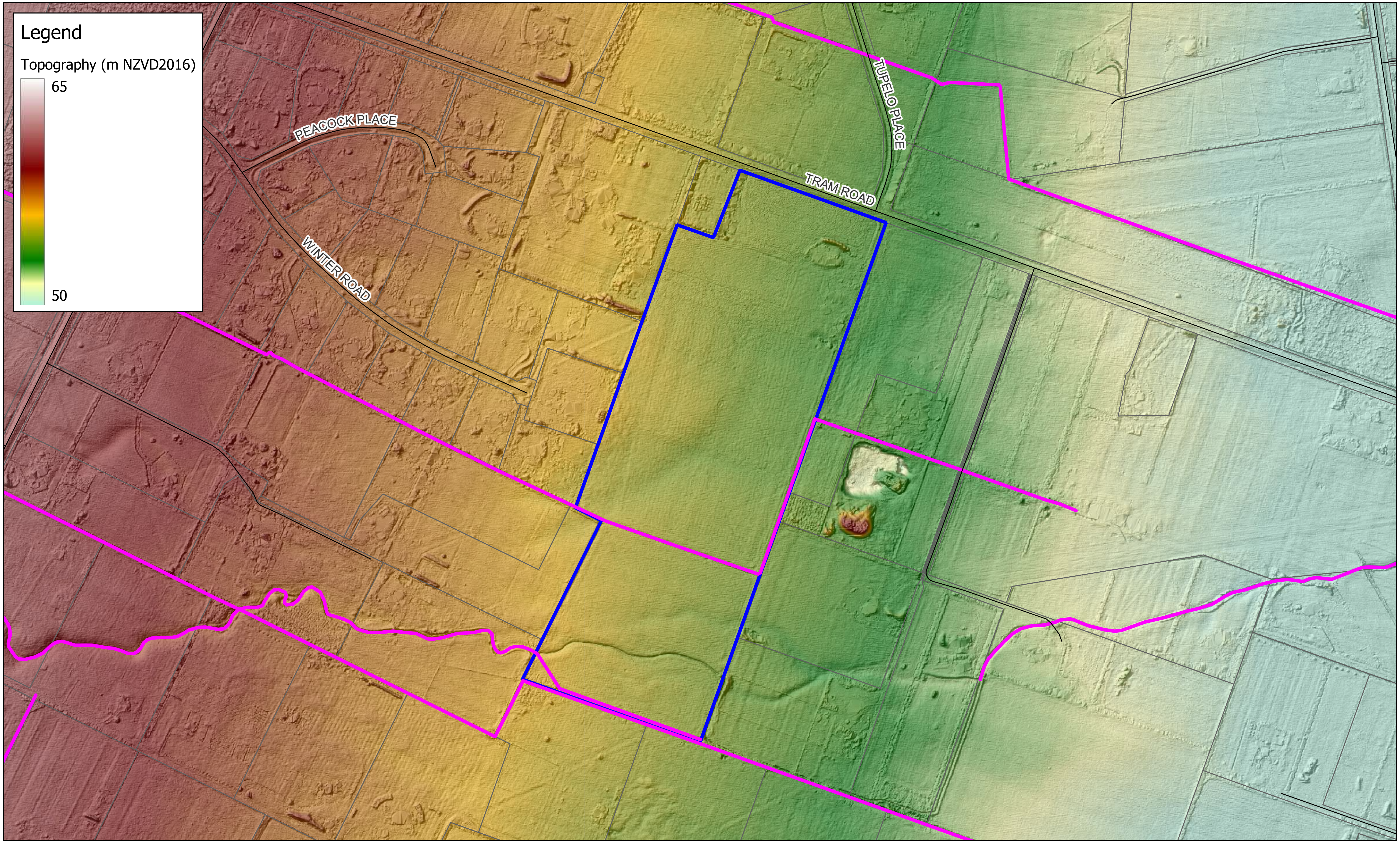

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Grid: NZGD 2000 New Zealand Transverse Mercator

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Legend

Block B Extent

Drainage channels & water races

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Tram Road Block B Plan Change Application

Site Topography (based on LiDAR flown in 2020)

Job Number	23036
Revision	1
Date	2/10/2023

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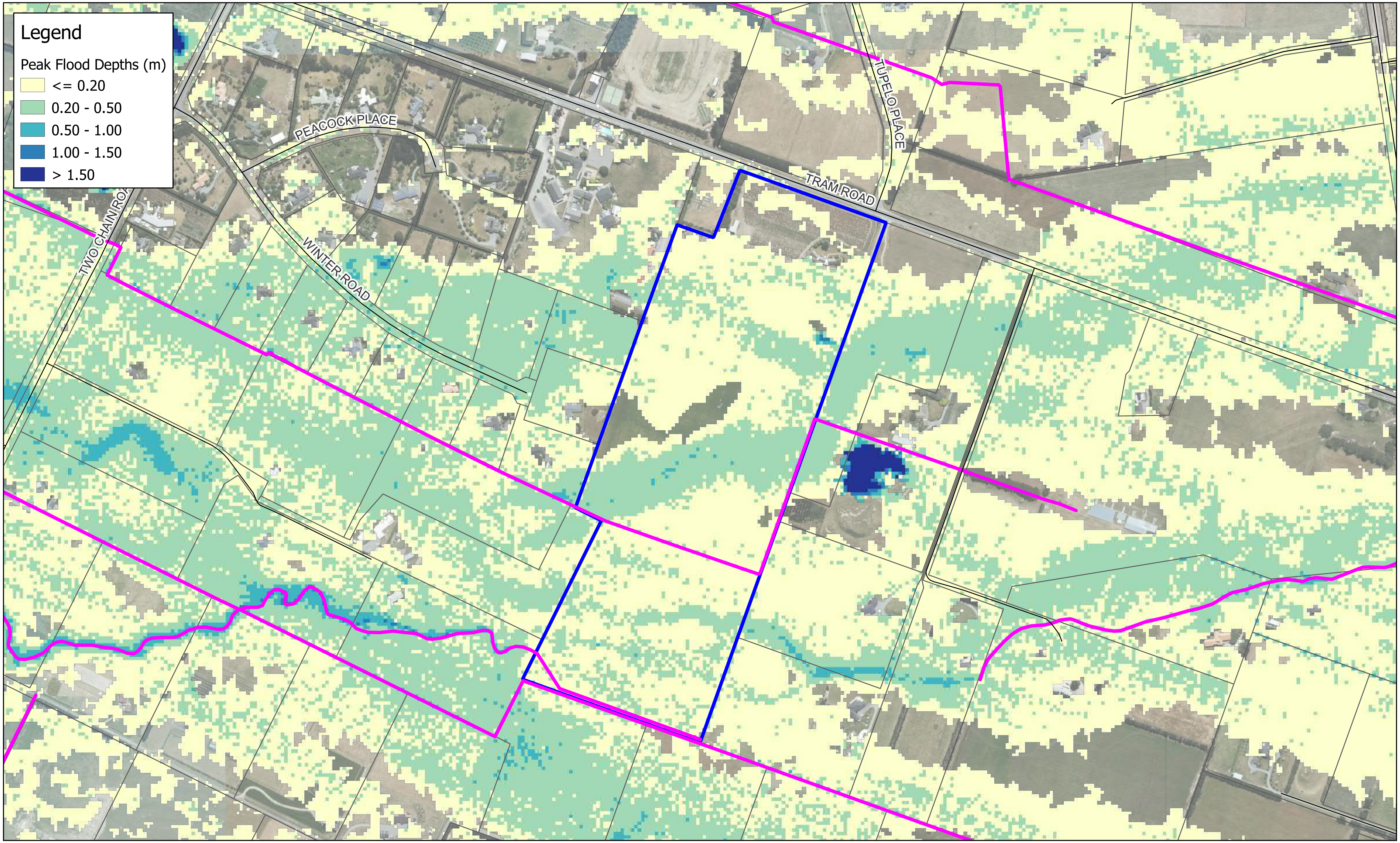

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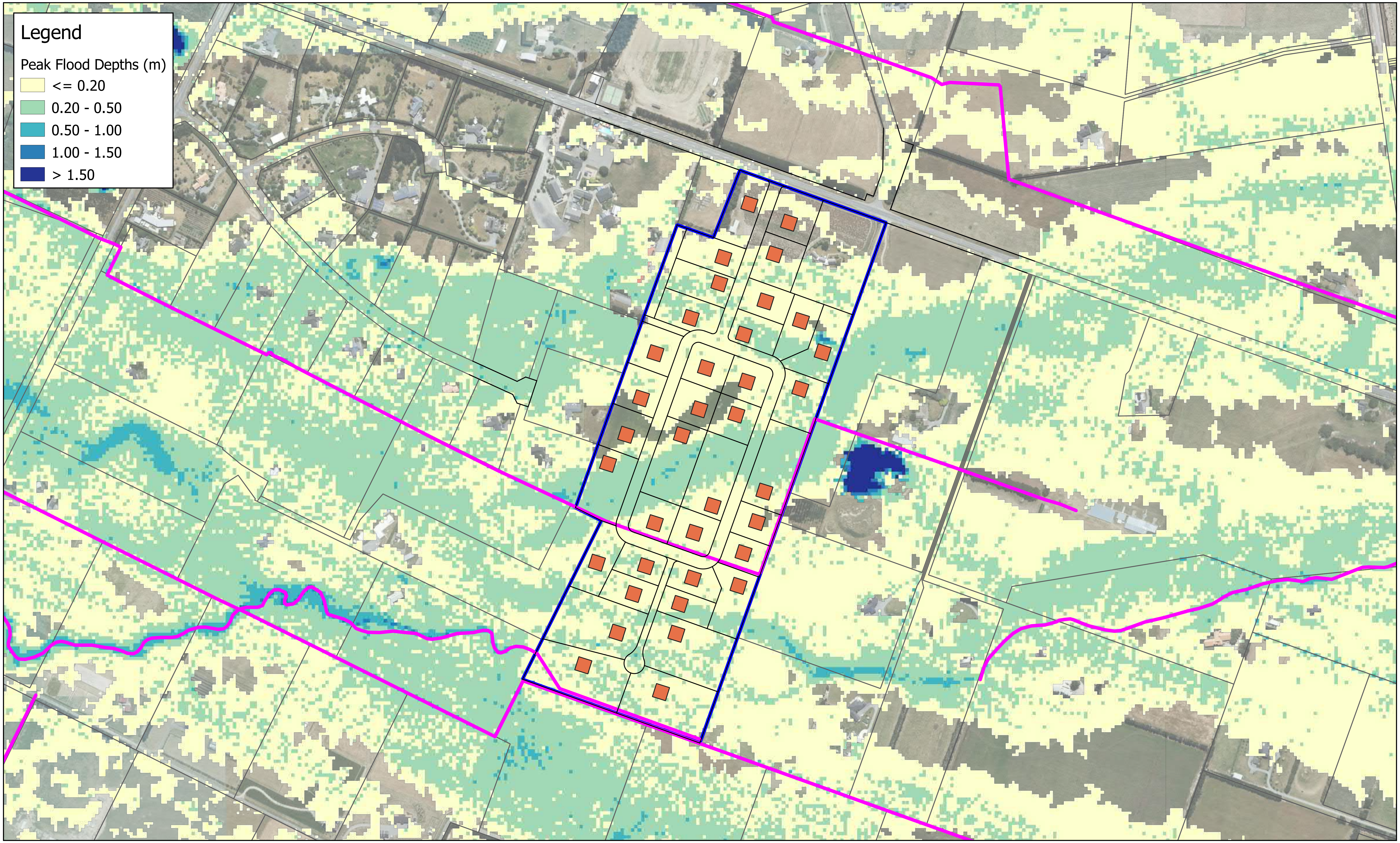
Tram Road Block B Plan Change Application

Job Number	23036
Revision	1
Date	2/10/2023

Peak flood depths in a 0.5% AEP flood event including the effects of climate change (WDC model results)

Appendix B – Example Building Platform Locations



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Legend

- Block B Extent
- Drainage channels & water races
- Example Building Platform Locations

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Tram Road Block B Plan Change Application

Example building platform locations and possible subdivision layout and with peak flood depths in a 0.5% AEP flood event including the effects of climate change (WDC model results)

Job Number	23036
Revision	1
Date	12/12/2023

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