Appendix G – Stormwater and Flood Risk Assessment

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Waimakariri District Council: Rangiora Eastern Road Connection

Technical Assessment – Stormwater and Flood Risk

Project Description & Scope

The Waimakariri District Council (WDC) is preparing a Notice of Requirement (NOR) for a new road designation on the eastern side of Rangiora.

The designation connects Lineside Road and Northbrook Road. The area to which the NOR applies is referred to as 'Rangiora East Road Connection' and is shown in **Figure 1** on the following page.

The proposed designation will form part of a roading link that will ultimately connect Lineside Road through to Coldstream Road (referred to as the 'Rangiora Eastern Link'). Those parts of the Rangiora Eastern Link that do not form part of the proposed designation are:

- MacPhail Avenue, which is an existing road that connects Northbrook Road and Kippenberger Ave; and
- The connection from Kippenberger Ave through to Coldstream Road.

The Rangiora Eastern Link (as well as southern and western routes) were originally proposed in the Rangiora Transport Study, Beca, September 2001 and a subsequent Scheme Assessment Report, Opus, February 2005, developed alignment options for study and provided preliminary details for the selected alignment.

WSP have been commissioned to prepare technical assessments to inform and support the proposed NOR. This Stormwater and Flood Rick Assessment is one of those technical assessments.

These technical assessments and reports are at a high-level and are intended to provide:

- an awareness of the types of effects and their magnitude that may occur as a result of the designation; and
- identify potential measures that would avoid, remedy or mitigate adverse effects.

This document outlines the potential adverse effects relating to stormwater and flood risk for the proposed Rangiora Eastern Road Connections.

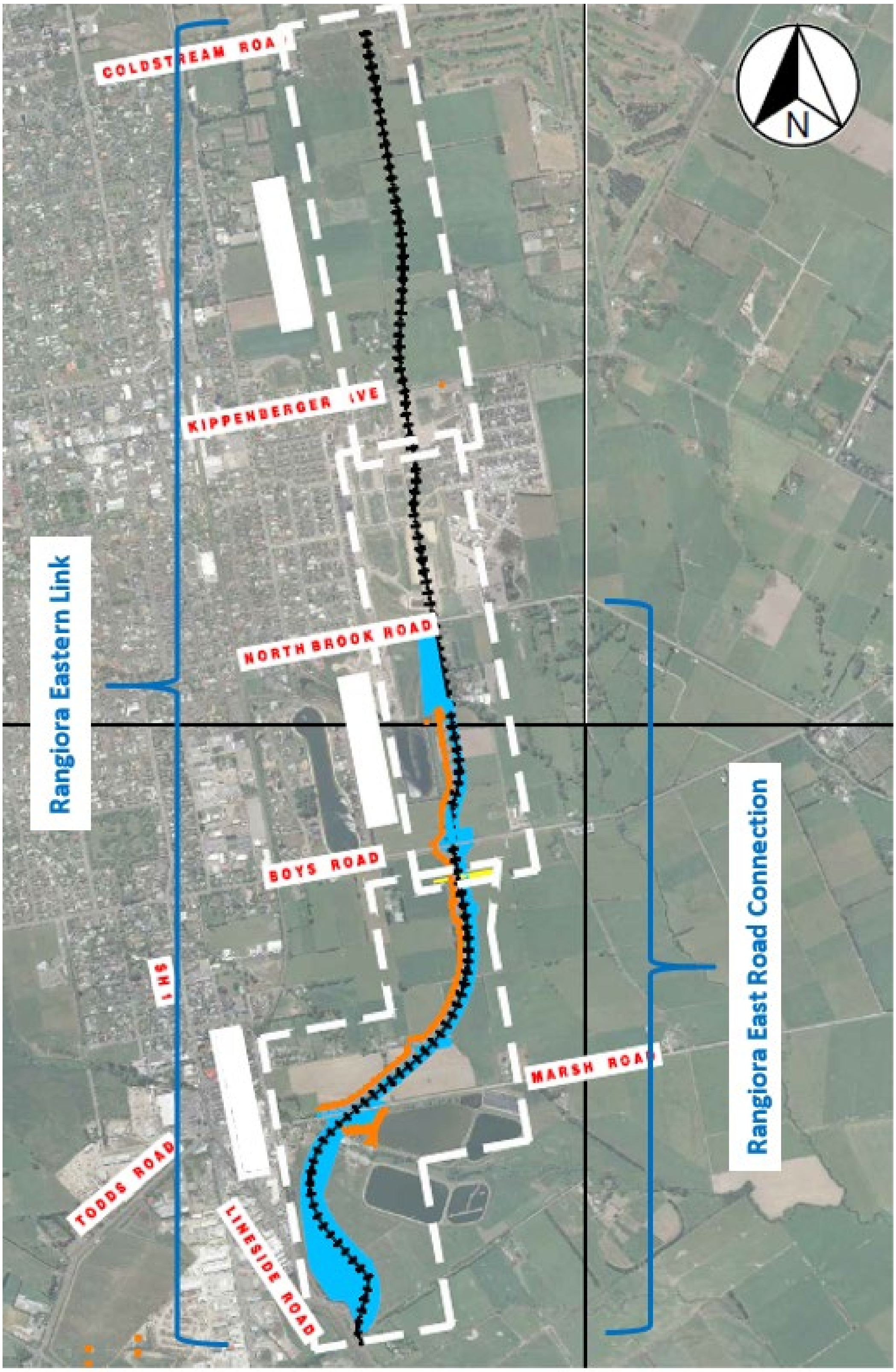


Figure 1: Layout Plan

Design Philosophy

This section of the document outlines our assumptions and the design criteria used to support the proposed designation footprint, in terms of stormwater management and to assess potential affects. The design philosophy broadly follows the Waimakariri District Councils Engineering Code of Practice (2019). The key difference is we have allowed for a 1% AEP event for stormwater management rather than 2% AEP. This is higher than currently required by WDC and is intended to future proof the designation footprint, should WDC's current Level of Service (LoS) be increased in the future.

The philosophy for the management of stormwater for this project is to utilise grassed swales where practical for the conveyance and treatment of stormwater. These shall then drain to attenuation basins which will act to mitigate the increase in run-off. These areas should also include further stormwater treatment where practical either via filtration through soil media, or through provision of wetland areas in the basin invert.

The key design criteria are as follows (excluding an Ashley River breakout event):

- Kerbed sections of the road will be drained via channels and catch-pit discharging to pipes or swales
- Un-kerbed sections of the road will discharge to road-side swales via lateral inflow
- Primary conveyance will be sized to keep the live lanes clear of water in a 10% AEP event and to convey events up to 1% AEP through a combination of primary conveyance and secondary conveyance (overland flow paths).
- No ponded water during the 1% AEP shall exceed 200 mm depth within a live lane or 100 mm depth at the crown.
- Culverts shall be sized to convey a 1% AEP event with minimal head loss.
- All stormwater design shall make consideration of projected climatic changes based on the IPCC's Relative Concentration Pathways or equivalent IPCC scenarios that supersede these.
- All kerbed low points within the pavement shall include a double catch-pit with back entry.
- All culverts shall make allowance for fish passage in general accordance with the NIWA Fish Passage Guidelines through stream simulation with the review of an appropriately experienced ecologist.
- Stormwater treatment shall be provided for rainfall events up to, and including, the 90%ile daily rainfall depth, or events with intensities up to the 90%ile rainfall intensity.
- Flood attenuation systems shall be sized to manage events up to, and including, 1% AEP for rainfall event durations up to, and including, 24 hours duration with the discharge not exceeding the pre-development rate, whilst also making allowance for projected climate change.
- Ensuring that the proposed works do not adversely affect flood risk and do not significantly impact on flood risk during an Ashley River break-out event.

In assessing the proposed road designation, the following assumptions were made:

- 21 m road width throughout for a two-lane road corridor including carriageway, cycle lane, parking, kerb and channel, berm and footpath
- Surface flows for impervious road drainage and adjacent areas have been estimated based on rational method and for events up to, and including, 1% AEP

- 100% impervious for full 21 m road corridor width, including berm
- The swale and ditch width required to convey the maximum flow at outlet points is assumed for the entire swale/ditch length
- Catch-pit design has not been considered at this point as it does not impact the flow in the swales or at the outlet points. It can be assumed that single catch-pits would be required approximately every 40 m and double catch-pits at sag points. Discharge would be a combination of under kerb piping and outlets to the swales behind the kerb
- All curves are assumed to be in super-elevation
- No detailed culvert sizing or cover checks have been undertaken at this point
- All swales are trapezoidal with 1:4 recoverable slopes both sides and 1.0 m wide invert. Assumed minimum 5.5 m width for all swales to account for potential behind kerb discharge for catch-pits. Outlets assumed to be DN225 PVC-U pipe on minimum grade and installed directly under the kerb.
- Basins are sized for treatment of surface water from impervious areas only. The designated area for the basins is estimated as 20% of the total impervious area draining to the basin. Basins assumed to be 1.0 m depth with a flat base and 1:4 side slopes

There are also several waterways crossing the road corridor included within NIWA's Flood Frequency tool. These have been queried for their estimated flow rates based on the Rational Method and the Regional Flood Frequency Method. These have been summarised below and highlighted in Figure 2, along with an estimated culvert dimension to accommodate the higher flow rate. Note that these are provisional values only to provide an indication of scale. They are subject to significant uncertainty at this stage and the design stages should undertake a suitable hydrological study to confirm the design parameters. Note there may also be other minor drains not identified here that require suitable design consideration to maintain their functionality.

- For the South Brook stream the 100year flow ranges between 21.37m^3/s to 48.28 m^3/s, which would require one 6m x 2.5m box culvert (or other suitable structure) to accommodate the peak flow.
- For the watercourse at CH1320 the 100year flow ranges between 2.64m^3/s to 8.31 m^3/s, which would require one 1.5m x 1.5m box culver t (or other suitable structure) to accommodate the peak flow.
- For the watercourse at CH1800 the 100year flow ranges between 1.75m^3/s to 6.67 m^3/s, which would require one DN1500 concrete culvert (or other suitable structure) to accommodate the peak flow.
- For the North Brook stream the 100year flow ranges between 7.85m^3/s to 25.10m^3/s, which would require a 3.2m x 2.5m box culvert (or other suitable structure) to accommodate the peak flow.

Note that the lower flow rates are more likely to be accurate, particularly for the larger waterways. Hence the culvert sizes may be optimised through future design work, subject to still meeting fish passage requirements. In some cases, a bridge may be recommended for ecological reasons.

The culvert sizes above do not reflect sizing requirements for fish passage, as no survey or hydraulic analysis has been undertaken at this stage. Cross drainage required to manage break-out flows from the Ashley River has not been considered either at this stage.

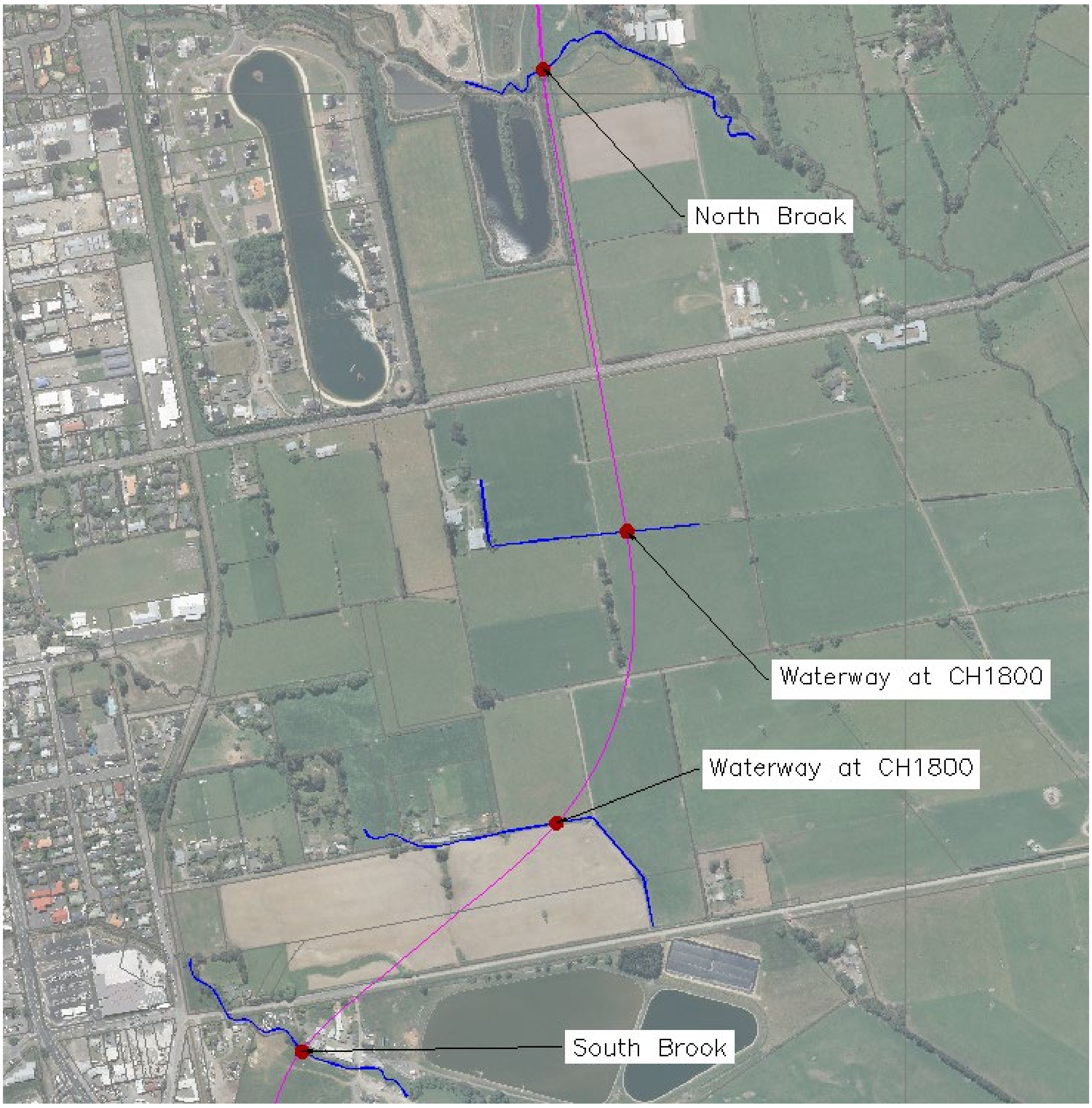


Figure 2: Locations of the four-main waterway crossing through the proposed alignment

Review of risks for future design stages

The review of the risks for future design stages is a summary of the general and site-specific adverse effects as identified from above:

- Break out of the Ashley River.
- Managing the release of sediment/contaminants during construction.
- Stormwater contaminants adversely impacting the existing watercourses.
- Increased imperviousness area.
- Damage to, or loss of, aquatic habitat through construction of the road.
- Managing numerous existing overland flow paths.
- Crossing farmland which may impact on irrigation systems or farm drainage functions.
- Potential to fill areas of existing flood storage.
- Introducing a new source of stormwater contaminants to the area.
- Construction of new culvert structures that may impede fish passage and cause localised stream erosion.

- High groundwater table.
- Impacting on existing road drainage functions at intersections.

The potential construction phase and operational effects are discussed in detail below:

Construction Phase Effects

During construction there is a risk of uncontrolled release of sediment/contaminants associated with construction, into waterways or adjacent wetlands. This could have a significant negative impact on the receiving environment. These risks can be managed during the construction phase through implementation of an Environmental Management Plan which includes an Erosion and Sediment Control Plan.

Site access points will need to be established to enable work. The introduction of plant movement in and out of site may track mud onto adjacent roads. This can be mitigated by installing wheel washing points and shaker ramps / cattle grids at the points of entry, in line with regional plan expectations. This risk can also be managed during the construction phase through implementation of an Environmental Management Plan which includes an Erosion and Sediment Control Plan.

Operational Effects

Potential adverse effects identified are as follows:

- The water run-off from road, may impact on the māna of the watercourses. This includes the mauri of the water (as indicated by its ecological health and water quality), the ability to support mahinga kai and opportunities for contact recreation. This is conventionally mitigated through the provision of stormwater treatment systems that mimic natural processes of uptake, settlement and filtration. From a te mana o te wai and mahinga kai point of views, the systems that give preference to discharge of stormwater to land or through land (e.g. cobbles) are preferred, as these allow the water to be cleansed and restore the mauri of the waters and to allow customary harvest of food in accordance with tikanga Maori.

- The increase in imperviousness area associated with the road's construction will increase the amount of surface water run-off during rainfall events. This increase in run-off rate and volume could exacerbate existing flood risk and surface erosion. This can be mitigated through provision of flood attenuation systems that slow the discharge of the run-off to a pre-development rate and encourage soakage to ground, where ground conditions are suitable, to mimic a more natural flow response. However, the total run-off volume may still be increased regardless of the attenuation provided, though this may not result in any adverse effect so long as flow rates are not increased.

- Loss of aquatic habitat [*Refer to Rangiora Eastern Connections: Ecology Assessment, Boffa Miskell 2021*] through construction of the road corridor over existing waterways, farm drains or springs can adversely impact on ecology. To mitigate the adverse effect, compensatory habitat can be provided, and streams can be realigned and bridged or culverted following NIWA's fish passage guidance to maintain fish passage.

- The new alignment will intercept numerous existing overland flow paths. This has the potential to cause increased flooding upstream or the modification of flow paths downstream. This can be mitigated using a combination of:
  - Increased upstream flood storage
  - Installing cross culverts under the new road alignment to preserve existing and predicted flow paths
  - Consideration of flood risk as part of the roads geometric design e.g. aligning low points to existing flow paths
  - Detailed hydraulic modelling to ensure the adverse effects have been managed through the wider stormwater management system proposed.
- The new alignment may fill areas of existing flood storage. Displacement of flood storage can exacerbate flood risk for adjacent landowners. This can be mitigated through the provision of compensatory flood storage, or through employment of detailed hydraulic modelling to ensure the adverse effects have been managed through the wider stormwater management system proposed.
- The new alignment is proposed to cross multiple paddocks and depending on the function of each paddock, has the potential to affect the irrigation systems and farm drainage functions. This could adversely affect the farm's productivity. In terms of reducing this risk, it vital for early stakeholder engagement to agree on any mitigation required to minimise impact as far as practicable.
- The new road alignment intercepts Marsh Rd, Boys Rd and Spark Lane. Marsh Rd, Boys Rd and Spark Lane all have existing stormwater running along them in the form of swales/drains. If the road blocked these systems, it could result in localised flooding. To mitigate these risks, the SW design should make allowance for these flows where intercepted, and ideally incorporate them within the stormwater management systems, or provide cross drainage to maintain their flow regime.
- The road will introduce a new source of stormwater contaminants into the area. This could contaminate downstream water pathways and adversely affect the ecology of the waterways. This is conventionally mitigated through the provision of stormwater treatment systems that target high frequency rainfall events typically up to the 90%ile daily rainfall depth.
- As the new road alignment will cross the South Brook & North Brook streams, there is a potential to cut off migration routes for freshwater fish and other aquatic life. To mitigate the risk, bridges should be given consideration over culverts, and where culverts are provided, they must broadly follow the NIWA Fish Passage Guidelines, or be approved by an Ecologist as being acceptable.
  - Due to new structures being installed across the streams, there is a potential risk of changing the downstream flow of the streams locally, which may scour banks/ change the direction of the streams. To reduce the risk the SW design should consider flow direction, momentum and provide downstream scour protection if required.

- Cross drainage structures (culverts) may become blocked post construction after heavy rain or lack of maintenance. This may lead to upstream flooding that previously would not have occurred. This can be mitigated through provision of dedicated overtopping points or designing the structures to minimise the potential for blockage (including maintenance and access). For this project the risk of blockage is generally considered low due to there being limited debris potential within the catchment upstream.

- Through excavation, groundwater may be intercepted, as it is close to surface along the proposed alignment. Intercepting groundwater could alter flows produced by springs or flows intercepted by nearby streams. It could also modify the level of the water table or impact on downstream consumptive takes. This is normally managed through geotechnical investigations to better define the water table surface and by minimising excavation within these areas.

- The disposal of stormwater to ground may result in the water table being locally raised, due to more concentrated points of disposal. This can be mitigated using linear disposal systems such as swales, or periodic disposal points to break the road down into a series of small catchment areas.

- The disposal of stormwater to ground may result in the contamination of nearby shallow wells if present. A review should be undertaken to identify any at risk wells of this nature with a view to decommissioning them and switching to a mains supply if feasible.

- The disposal of stormwater to ground in areas of historic contamination may mobilise certain contaminants due to the concentration of discharge, if any occur along the alignment. This can be mitigated either through avoidance, or remediation and would be addressed as part of the wider project.

- A potential consequence of constructing next to the existing treatment wetland and flood attenuation system is decreasing the system's overall capacity through earthworks (filling) and thus increasing the potential for the system to overflow during heavy rainfall events. To mitigate the potential risk, the scope of works should ensure that the basin's flood attenuation volume and wetland area are preserved, or compensated, as part of the works where any filling occurs.

- *Oliver, Wild and Canterbury (N.Z.). Science Group, 2016* identified <0.1m water depth during a 100-year ARI (1% AEP) and 0.1m to 0.3m water depth during a 200-year ARI (0.5% AEP) event could occur through sections of the corridor if the banks of the Ashley River were breached. The road, if constructed in fill, could act as a low height dam, further impounding water during such an event increasing flood risk. The impact of this is likely to be low where the predicted flood depth is high, as the road would be submerged. Where the flow is shallower, the road may have more influence, intercepting and redirecting flows. The rail embankment to the west ensures that the road does not have an adverse effect beyond this point. Once a 3-dimensional model for the road is available, the effect can be quantified and mitigation developed, where needed. This may include intentionally lowering some sections of the road or adding additional cross drainage to maintain key flow paths. (Refer to attached REL long section drawings, Appendix A, showing potential vertical road alignment. NB: these long sections were developed as part of the 2005 scheme assessment and are indicative only).

Proposed designation conditions for stormwater management

Stormwater management will be covered by WDC's Engineering Code of Practice, or its future replacement. This will ensure the design will manage the conveyance, treatment and disposal of stormwater.

Further to this, the discharge will either need to comply with a global WDC stormwater disposal consent (if the works are covered by one) or obtain resource consents from the regional Council. Fish passage will also require consent under the Freshwater National Environmental Standard (NES).

Hence specific stormwater conditions are not required as part of the designation. However, the following general conditions could be included:

- The design of the road shall comply with the current version of Waimakariri District Councils Engineering Code of Practice (or equivalent document if superseded).
- A report shall be prepared prior to construction to assess the potential impact of the road corridor on flood risk, including an Ashley River break-out event (if still considered feasible). The report shall identify any potential adverse effects and proposed mitigation measures that are incorporated into the road design.

References

Boyle, T., Surman, M.R., Canterbury (N.Z.). Investigations and Monitoring Group and Canterbury (N.Z.). Environment Canterbury (2009). Ashley Riverbed level investigation. Christchurch N.Z.: Environment Canterbury.

Oliver, T., Wild, M. and Canterbury (N.Z.). Science Group (2016). Ashley River floodplain investigation: 2016 update. Christchurch: Environment Canterbury Regional Council.

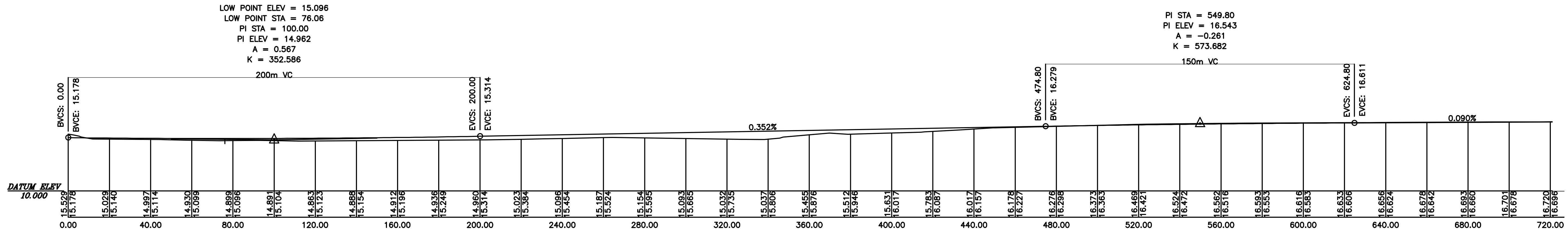
Document History and Status

Rev	Date	Author	Reviewed by	Approved by	Status
1	19/01/21	M. Groves – Principal Engineer: Water & Environment	L. Foster – Technical Principal – Water	G Larcombe – Senior Engineer	Draft issue for review
2	26/02/21	M. Groves	L. Foster	G. Larcombe	Final
3	12/03/21	M Groves	L. Foster	G. Larcombe	Final
4	16/04/21	M Groves	L. Foster	G. Larcombe	Final

Revision Details

Revision	Details
2	Review comments update, alignment amended between Boys & Northbrook Roads, and additional area of designation north of Kippenberger Ave
3	Changes to document made to reflect additional review comments.
4	Removal of stub of land north of Kippenberger Ave

Appendix A – 2005 Scheme Assessment Long Section Drawings



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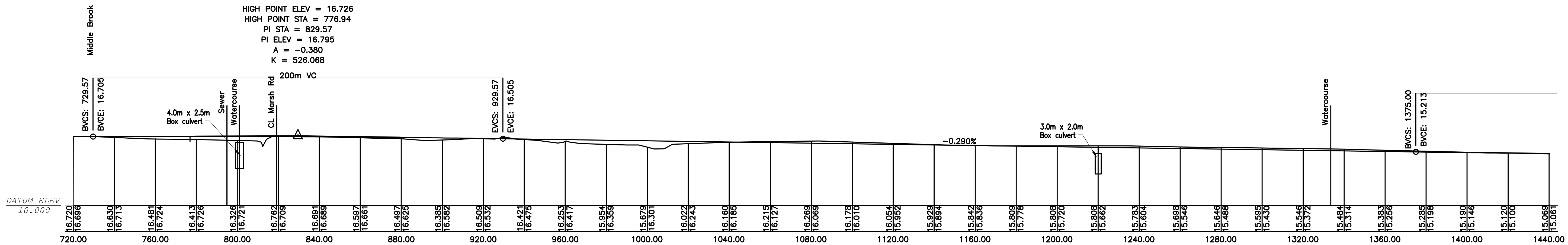

LONGITUDINAL SECTION

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AMENDMENT	APP'D	DATE

	BY	CHECKED	DATE
DESIGN	B Rice	TT	10/04
DRAWN	R Hopgood	TT	10/04
APPROVED	S ROBERTSON		02/05

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TITLE WAIMAKARIRI DISTRICT COUNCIL
RANGIORA LINK ROADS
EASTERN LINK

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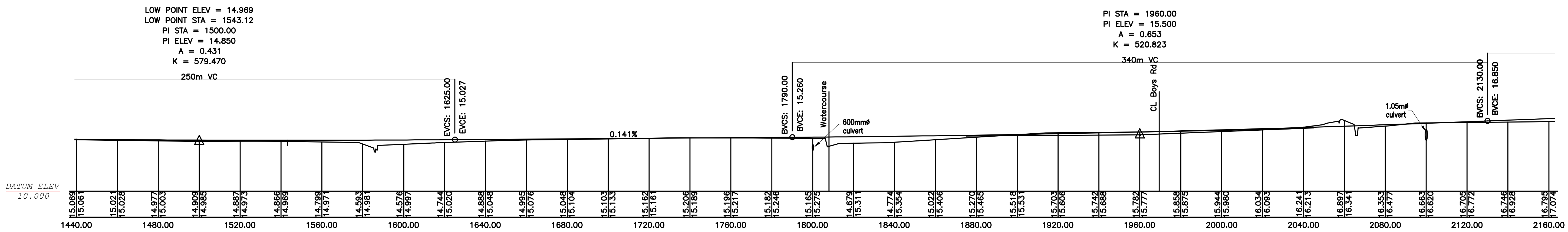

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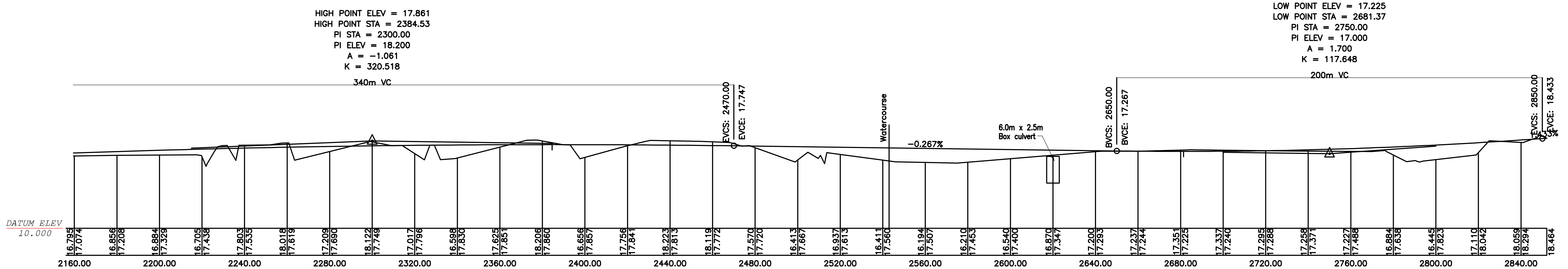

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Existing GL
Finished GL
STATION

LEGEND

	BY	CHECKED	DATE
DESIGN	B Rice	TT	10/04
DRAWN	R Hopgood	TT	10/04
APPROVED	S ROBERTSON		02/05

AMENDMENT | APP'D | DATE

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RANGIORA LINK ROADS
EASTERN LINK
ALTERNATIVE P: LONGITUDINAL SECTION
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