

Leeston Stormwater Flood Bypass Scheme

Summary of Stormwater Flood Modelling and Assessment



Leeston Stormwater Flood Bypass Scheme – Completed Stage 3 Works

October 2023

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Appendices

Appendix 1	Site Location Map
Appendix 2	Flood Modelling Maps
Appendix 3	Leeston Stormwater Bypass Stages 4 and 5 Detailed Design Report 2020 – Rev C. The General Arrangement Plans (<i>These drawings are subject to some minor amendments but may be further refined through the design/construction process</i>).
Appendix 4	Floor Level Survey and Analysis 2020
Appendix 5	1 in 200 year event effect HEC-RAS modelling check on Howson's property (60 Leeston Dunsandel Road)
Appendix 6	Modelling data of drainage improvements and proposed bank raising
Appendix 7	Photos of completed works to drainage network

1 Overview

Selwyn District Council ('the Applicant') seeks resource consent for works associated with the Leeston Stormwater Flood Bypass scheme. This scheme seeks to alleviate flood risk in Leeston and the surrounding area and involves:

- Establishing a new stormwater bypass channel to divert high flows from Leeston Creek to upgraded drainage channels.
- Upgrading the capacity of Leeston Creek, upstream of the new stormwater bypass channel.
- Localised bank raising adjacent to the drainage network.
- Ongoing maintenance of the Leeston Stormwater Flood Bypass scheme.

The purpose of this document is to summarise the stormwater flood modelling and assessment prepared on behalf of the applicant to date. This document will form an appendix of an updated Land Use Consent Application and assist in consultation with potentially affected persons.

This document collates the relevant information, drawings and appendices from the following documents:

1. Aurecon (12-11-2020), "Leeston Stormwater Bypass – Stage 4 and 5 Assessment of Environmental Effects, Ref 505193-0012-REP-NN-0001 Revision B.
2. Aurecon (18-12-2020), "Leeston Stormwater Bypass – Stages 4 and 5 Detailed Design Report, Ref 505193-0008-REP-CC-0001 Revision C.
3. Aurecon (03-03-2021): "Leeston Stormwater Bypass (Stage 4): 1 in 200-year event effect HEC-RAS modelling check on Howson's property" (memo to SDC).
4. Aurecon (15-06-2021), "Resource Consent Applications CRC212191-194 for the Leeston Stormwater Bypass Project: Response to Requests for Further Information" (letter to ECan).
5. Aurecon (09-11-2021): "Leeston Stormwater Bypass – Stormwater queries" (meeting record).
6. Aurecon (08-12-2021): "Leeston Stormwater Bypass – response to final stormwater queries".
7. Aurecon (26-01-2022): "Leeston Stormwater Bypass - response to final stormwater queries".

Some of this information has been appended in full to this document; the remainder has been incorporated into this summary where it remains relevant.

2 Background

2.1 Scheme Overview

The Leeston Stormwater Flood Bypass scheme responds to previous flooding events of the Leeston township, which have damaged property and put the health and safety of residents at risk (**Figure 1 and 2**). The main source of floodwaters has been identified as Leeston Creek, a waterway that originates on farmland north-west of Leeston.

The scheme is designed to redirect high flows within Leeston Creek, via a new 'bypass' channel to upgraded drains east of the township. The base flow will be retained through the Leeston Creek, protecting its ecological and biodiversity values.



Figure 1: ECAN Aerial Flood Imagery taken 24 August 1986.



Figure 2: ECAN Aerial Flood Imagery taken 23 June 2013.

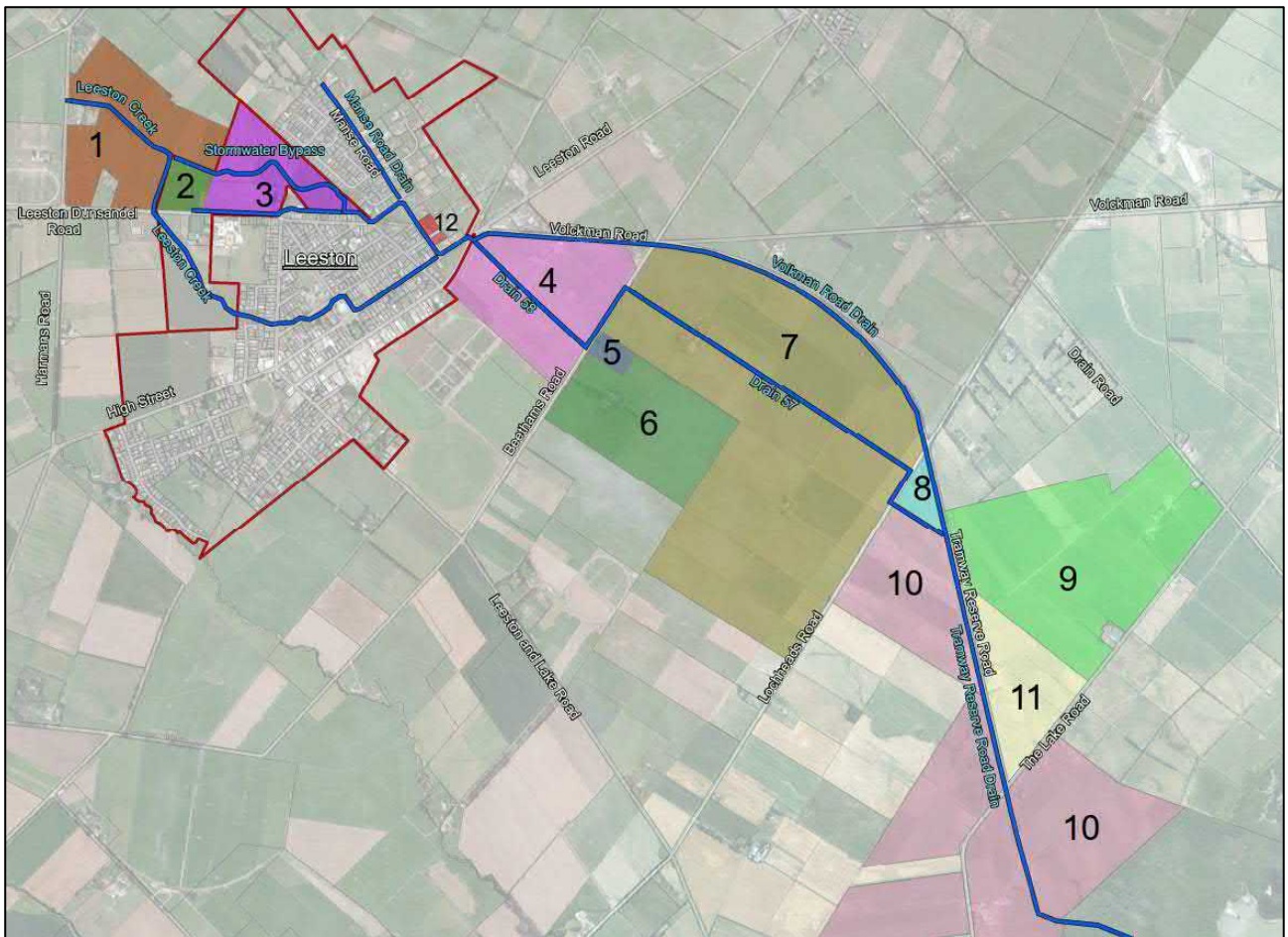


Figure 3: Site Location Map (Appendix 1).

The Leeston Stormwater Flood Bypass scheme is well progressed, with upgrades to the drainage network having occurred under previous construction 'stages'. These completed and proposed 'stages' have arisen out of the design/construction process, summarised below:

- Stage 1 - Connection of the Ellesmere Hospital drain to Manse Road and widening of the High Street Drain (complete).
- Stage 2 – Upgrade of Manse Road Drain and Reids Culvert (complete).
- Stage 3 – Upgrade capacity of drainage channels south of Leeston, including the new High Street culvert (complete).
- Stage 4 – Establish new stormwater bypass channel connecting to previously completed stages and a new diversion structure from Leeston Creek.
- Stage 5 – Upgrade capacity of Leeston Creek upstream of the bypass channel (between Harmans Road and the bypass diversion structure).
- Stage 6 – Extend existing wetland (constructed by the Karumata Oaks subdivision developer at 2 Leeston Dunsandel Road). This stage is primarily to treat stormwater from the new residential subdivision.

Photos of completed Stages 1 to 3 are provided in **Appendix 7**.

This scheme does not yet provide protection to Leeston township from design flooding events; this is contingent on the Leeston Creek upgrade and bypass channel being operational.

2.2 Completed works to drainage network

Works have already been completed to increase the capacity of the drainage network, including:

- Vegetation removal and cleaning out Drain 57.
- Vegetation removal and cleaning out Drain 58.

- Vegetation removal, cleaning out and removal of sections of legacy spoil banks along Volckman Road Drain.
- Replacing the existing Beethams Road culvert with a new box culvert.

These works are shown in **Figure 4** below with photos of the completed Volckman Road works and new box culvert under Beethams Road are provided in **Appendix 7**.

Additional maintenance activities are proposed to provide increased capacity within the network, described in **Sections 3.5 and 3.6** below.



Figure 4: Drainage upgrades.

2.3 Flood Modelling

Hydraulic modelling and design of the Leeston Stormwater Flood Bypass commenced in 2006 and culminated in a preliminary design in 2007. Resource consents were obtained from SDC and the Canterbury Regional Council (CRC) in 2007 and 2008, based on this preliminary design.

The detailed design of the Leeston Stormwater Flood Bypass scheme is informed by flood modelling undertaken by Aurecon which models:

- The existing flood impact on Leeston and its surrounds (referred to as 'pre-project' or 'existing scenario');
- The future flood impact on Leeston and its surrounds based on the chosen design mitigation (referred to as 'post project').

Comparisons between these scenarios allow for a flood impact assessment to be undertaken to understand any changes to flood risk associated with the project.

Flooding effects associated with the pre-project and post-project models are discussed in **Sections 4 and 5** below. The Flood Modelling Maps are included in **Appendix 2** to this summary.

Sources, Assumptions and Limitations

Computer-generated flood models rely on a range of information sources. These inputs and associated assumptions and limitations are set out in various technical reports able to be provided on request.

Information produced by such models is intended to be used as a guide to show anticipated effects during different scenarios to help inform engineering and planning decisions. Physical observations in real life may be different from the modelled results.

The flood model for the Leeston Stormwater Flood Bypass scheme has considered a one-in-100-year return interval (i.e. 1% Annual Exceedance Probability 'AEP'), 6 hour duration rainfall event on the catchments upstream of Leeston.

Since the completion of the original hydraulic modelling in 2006, the criteria for establishing the design rainfall depths has changed, with a net increase in depths. Based on current standards, the design rainfall is now closer to approximately a one-in-80-year ARI event (or 1.3% AEP).

Please note that the documents included in this summary, and forming part of this land use consent application, still refer to the design event as being a '1% AEP'.

3 Proposal

3.1 Overview

The proposed works associated with the Leeston Stormwater Flood Bypass scheme enable the diversion of high flows from Leeston Creek to the more formalised drain network.

The proposed works include:

- Establishing a new stormwater bypass channel to divert high flows from Leeston Creek to upgraded drainage channels.
- Upgrading the capacity of Leeston Creek, upstream of the new stormwater bypass channel.
- Localised bank raising adjacent to the drainage network.
- Ongoing maintenance of the Leeston Stormwater Flood Bypass scheme.

The General Arrangement Plans of 'Stages 4 and 5' are included in the Detailed Design Report (**Appendix 3**). These drawings are potentially subject to minor amendments in discussion with property owners.

3.2 New Stormwater Bypass Channel

A new stormwater bypass channel is proposed to convey the stormwater flows diverted from Leeston Creek (west) to upgraded drainage channels east of the township (**Figure 5**). The new channel traverses the existing properties at 60 Leeston Dunsandel Road and 2 Leeston Dunsandel Road and connects to the drainage network at the corner of Pound Road and Cunningham Street.

The diversion of these higher flows reduces pressure on Leeston Creek and the existing drainage network which runs through the south through the township.



Figure 5: Proposed Bypass Channel and relationship to existing drainage network.

The proposed bypass channel has been designed to convey a flow of 3.8m³ per second, which was a 1% Annual Exceedance Probability (AEP) flood event peak flow at the time of the original modelling (in 2006). As outlined above, based on current standards, the design flow for the bypass is closer to a 1.3% AEP event.

The works associated with the proposed bypass channel include:

- Excavation and formation of the new channel.

The bypass channel is approximately 1,100m in length with typical cross sections of the channel provided in **Figure 6** and **Figure 7** below.

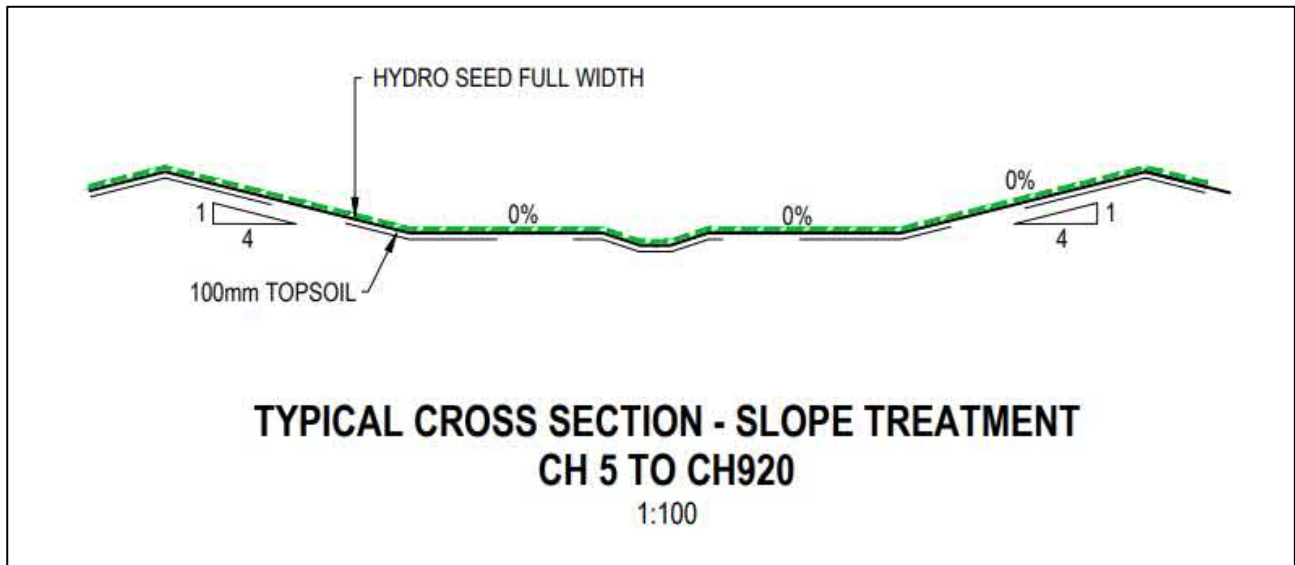


Figure 6: Typical Bypass Cross Section – Main Channel.

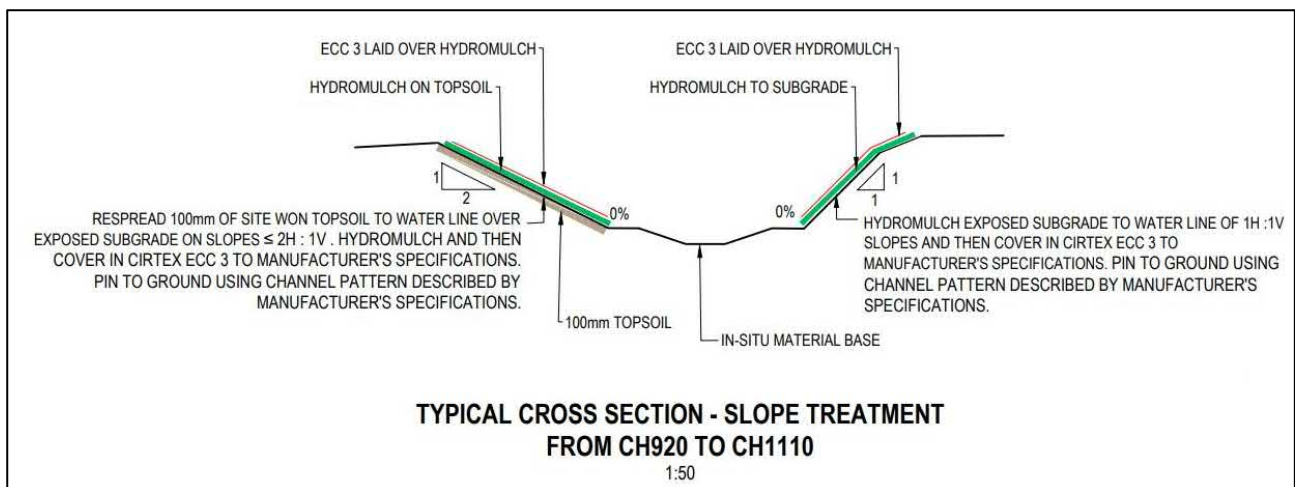


Figure 7: Typical Bypass Cross Section - Downstream Channel.

Minor amendments to the General Arrangement Plans in **Appendix 3** will be made in regard to 60 Leeston Dunsandel Road. These include:

- Removing the northern and southern bunds from the final design plans, and
- Shifting the alignment of the bypass channel by 3m to the north, and
- Reducing the easement width over the bypass channel to 17m.

3.3 Diversion between Leeston Creek and Bypass Channel

The upstream (western) section of the new bypass channel will connect to Leeston Creek (**Figure 8**). The diversion of high flows from Leeston Creek into the bypass channel will be controlled via a new flood control gate.

The flood control gate will allow water to continue to flow downstream, along Leeston Creek, at up to $0.6\text{m}^3/\text{sec}$. When flows in the upstream section of Leeston Creek exceed $0.6\text{m}^3/\text{sec}$, water will build up behind the flood control gate and excess flow will be diverted over a new weir wall and into the bypass channel.

The new weir acts as the transition between the Leeston Creek and bypass channel. The purpose of the weir is to maintain base flows within Leeston Creek while allowing for diverted flows into the bypass channel.

Rock rip rap is proposed to be laid both upstream and downstream of the weir to prevent scouring.

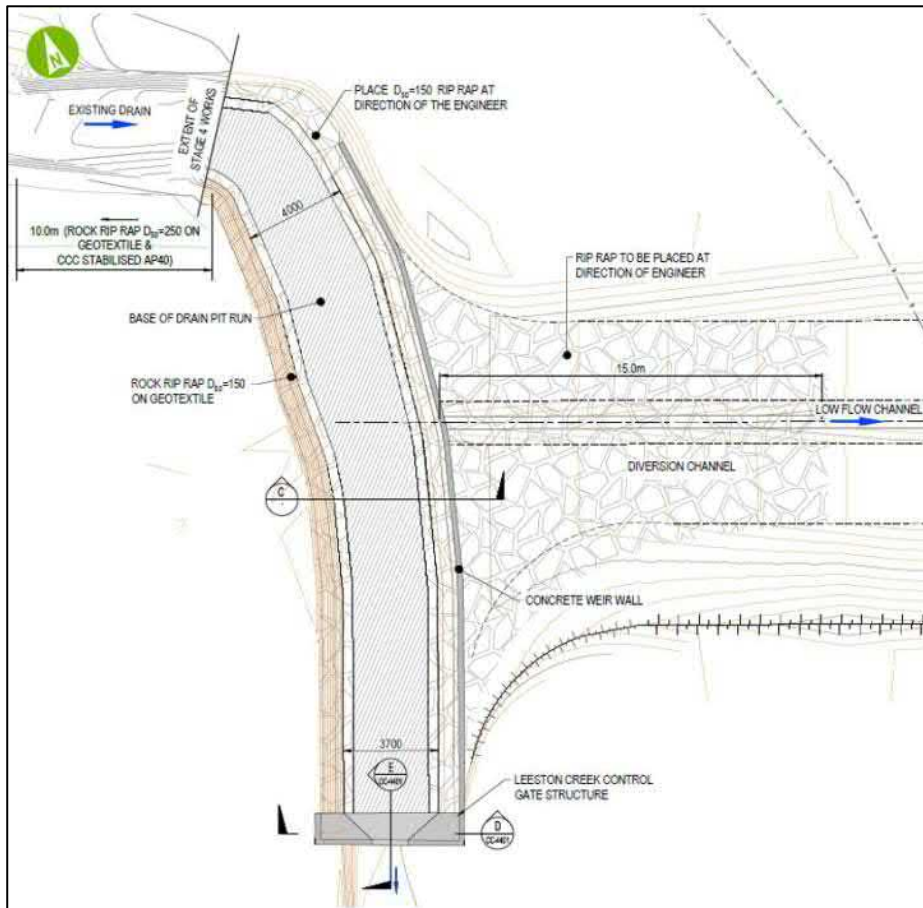


Figure 8: Diversion point of Leeston Creek into the proposed stormwater bypass channel.

3.4 Leeston Creek Upgrade

Leeston Creek, upstream of the proposed bypass channel, will be upgraded to provide additional capacity for high flows. The upgraded section of Leeston Creek, between Harmans Road (west) and 60 Leeston Dunsandel Road (east), is designed to convey the design flow of $3.8\text{m}^3/\text{second}$.

The works associated with the Leeston Creek upgrade include:

- Channel deepening and widening;
- Reforming the batters of banks; and
- Removal and replacement of an existing culvert.

The Leeston Creek upgrade extends over a reach of approximately 600m in length and a typical cross section is provided in **Figure 9** below.

An existing culvert within Leeston Creek will be removed and replaced in the same location with a new box culvert. Rock rip rap will be installed on either end of the culvert to prevent scouring.

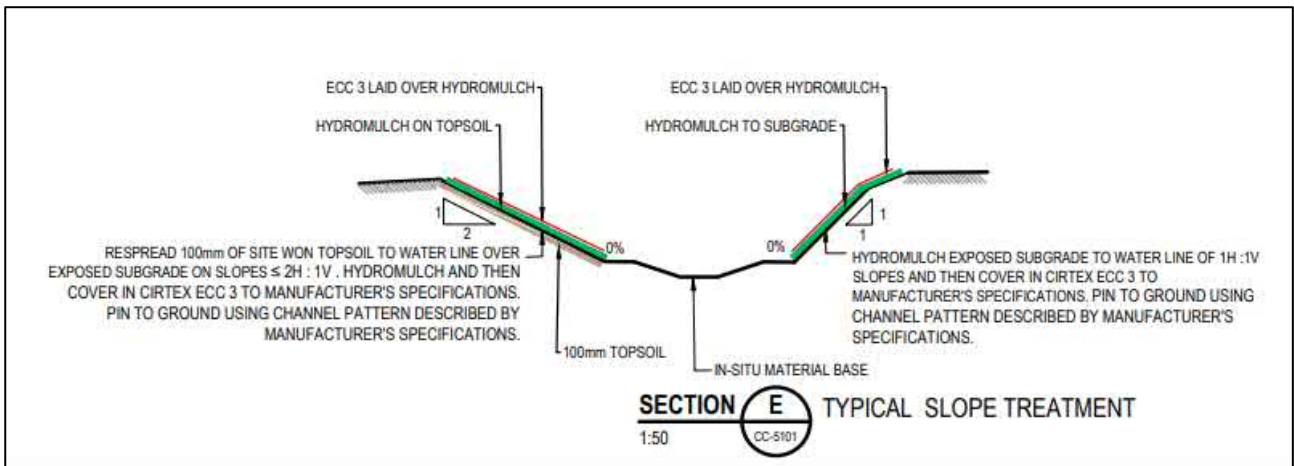


Figure 9: Typical Cross Section – Leeston Creek Upgrade.

3.5 Raising of Bank Heights adjacent to Drainage Network

Localised bank raising to accommodate peak flood levels is proposed at several points within the drainage network south of Leeston (**Figure 10**). Details of the proposed bank increases are included in **Appendix 6**. Increases in bank heights are generally proposed in locations where overland breakouts may occur due to the land falling away from the drains, generally in locations of historic braid paths.

Based on the nature of these bank raising locations, local overland runoff is unlikely to be cut off. However, as bank raising is undertaken, any subdrains that intersect with the main drains will be identified, and non-return valve gate structures installed to accommodate the flow if necessary.

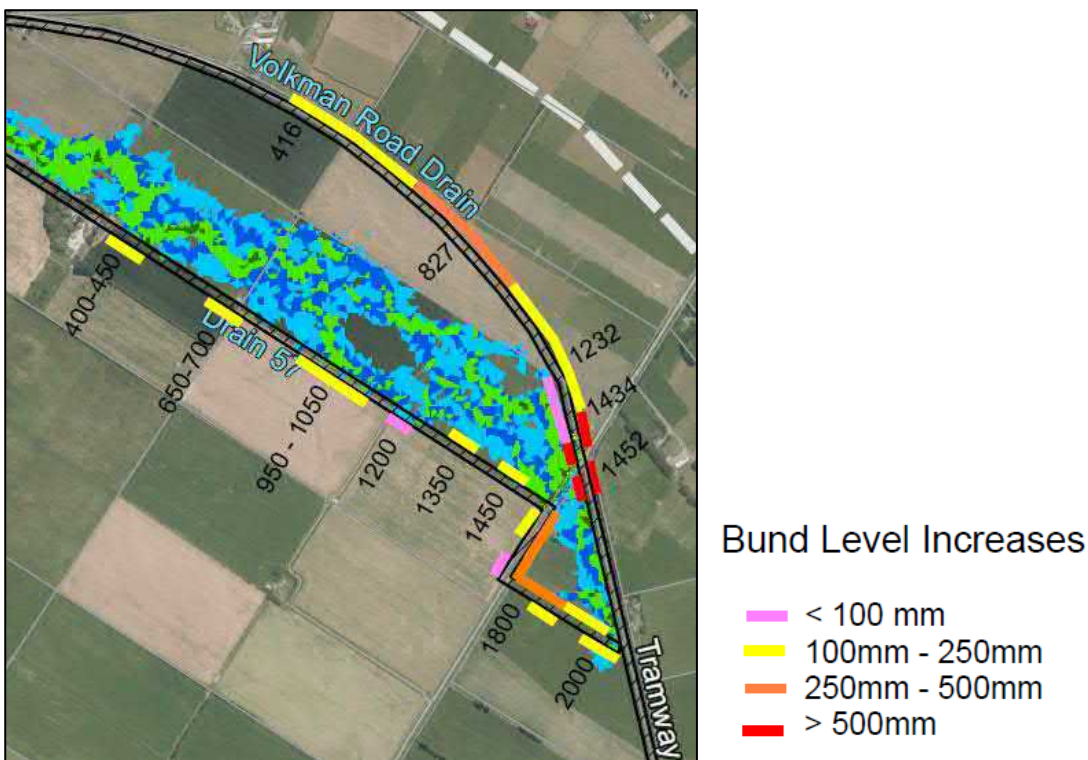


Figure 10: Locations of proposed increases to bank (bund) height

3.6 Ongoing Maintenance of the Drainage Network

Maintenance of the drainage network has a significant influence on carrying capacity and associated flood risk. There has already been a substantial amount of drain clearance and regular inspections and maintenance is required going forward.

The applicant shall, in consultation with relevant land owners, prepare a Maintenance Plan outlining how the drainage network comprising Leeston Creek, the bypass channel, Drain 57, Drain 58, Beethams Road Drain, Volckman Road Drain and Tramway Reserve Road Drain, will be maintained.

The Maintenance Plan shall include:

- a. details of who will hold responsibility for long-term maintenance of the drainage network and the organisational structure which will support this process;
- b. a programme for regular maintenance and inspection of the drainage network, including culverts and vegetation;
- c. a programme for post storm inspection and maintenance; and
- d. general inspection checklists for all aspects of the drainage network based on best practice guidance.

4 Effects - Overview

4.1 Existing Scenario - Flood Impact

The flood model of the existing scenario was produced in 2017, prior to drainage upgrades discussed above.

The peak flood depth and inundation extent associated with the existing scenario (**Figure 11**) indicates that:

- Leeston Creek overtops its banks north of Leeston township and the excess floodwater crosses Leeston Dunsandel Road and flows along roads and overland flow paths through residential properties.
- Within the township, Leeston Creek has insufficient capacity and overtops at multiple locations resulting in significant flooding in properties south of Leeston Creek.
- A significant breakout occurs to the east of Manse Road Drain which inundates multiple residential lots.
- There is significant flooding south of the township which is predominantly through farmland.

Overall, the flood model indicates that approximately 63 hectares of land, spanning 512 individual sections within the Leeston urban area are impacted by flooding under the pre-project condition.

4.2 Post Project – Flood Impact

The 'post project' flood model (**Figure 12**) incorporates the completed and proposed works and indicates that the major breakouts from both Leeston Creek and Manse Road Drain are eliminated.

Flooding within the Leeston urban area is significantly reduced from approximately 63 hectares to 15 hectares in a design event. The number of individual sections impacted by flooding is reduced from 512 to 115 sections.

However, the redirecting of flow via the stormwater bypass channel will increase flow through the High Street culverts to Drain 58, Drain 57 and Volckman Road Drain. This may increase risk of flood breakout in the upper reach of the Volckman Road drain and overtopping of the Beethams Road culvert. In a design event, this could result in increased flooding of adjacent paddocks; up to a 150mm within the existing overland flow paths to east of Drain 58 and up to an 85mm increase within rural properties between Beethams Road and Lake Ellesmere.

The following properties have been identified as potentially experiencing an increase of more than 20mm in flooding in a design event, compared with the pre-project condition:

- 483 Volckman Road
- 143 Lochheads Road
- 159 Beethams Road/206 Lochheads Road
- 1171 The Lake Road/1247 The Lake Road

Potential flooding effects on these properties in a design event are discussed in **Section 5** below.



Figure 11: Existing Scenario - Peak Flood Depth and Inundation Extent.

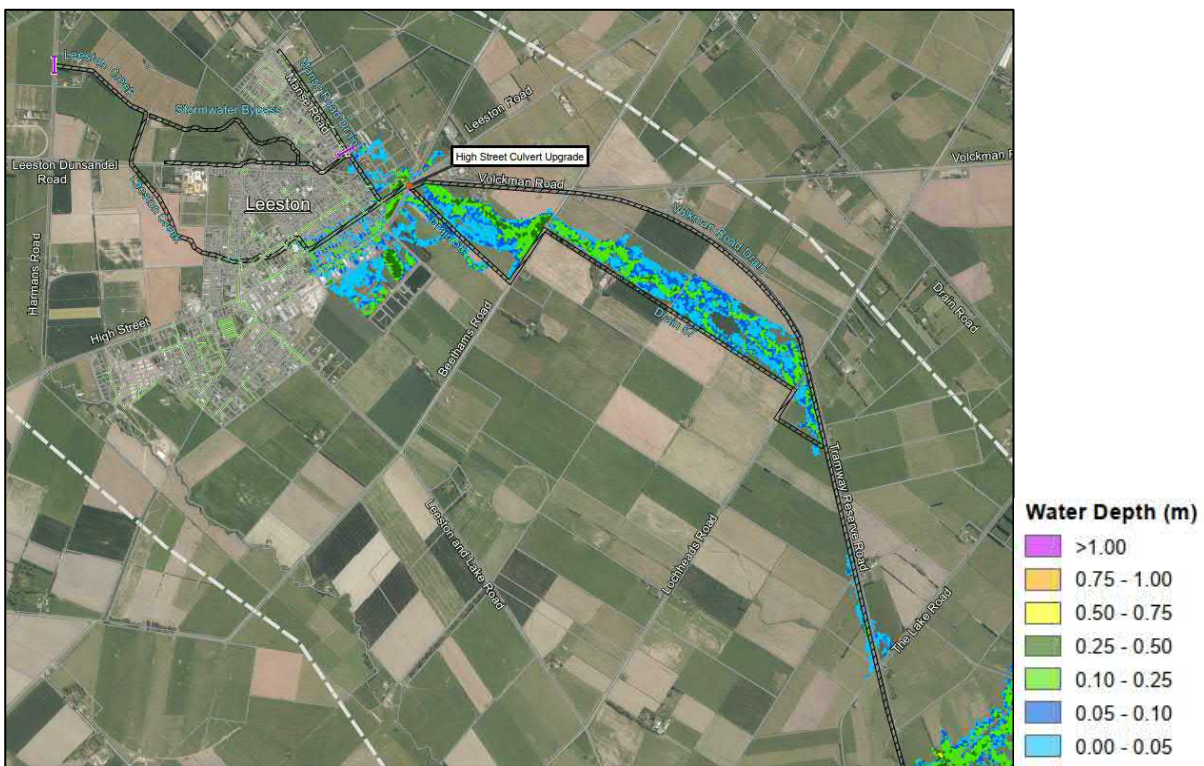


Figure 12: Post Project Scenario - Peak Flood Depth and Inundation Extent.

4.3 Effects on Leeston Creek upstream catchment

The flows into the stormwater bypass channel is controlled by the maximum capacity of the upgraded section of Leeston Creek, which is limited to 4.37 m³/second. Although the design capacity of the stormwater bypass channel is 3.8 m³/second, it can accommodate flows up to the maximum capacity of Leeston Creek of 4.37 m³/second without spilling.

Any flows in excess of 4.37 m³/second will spill from the Leeston Creek channel above the bypass diversion weir and remain within the existing Leeston Creek catchment and overland flow paths through and south of

Leeston. The potential for flooding from those existing overland flow paths will, however, be significantly reduced following completion of the bypass. This is discussed further in **Appendix 5** attached to this summary.

4.4 Effects on residential dwellings

A floor level survey was undertaken in February 2019 to inform a flood impact assessment of existing buildings in the catchment. The surveyed floor levels were then compared against peak flood levels from each of the flood model scenarios considered during the design process for this scheme.

The floor level flood impact assessment for the chosen option ('Mitigation 1B Scenario') is included in **Appendix 4**. This table includes a list of the building (house, garage, shed etc) floor levels, corresponding peak flood levels and freeboard for this modelled scenario.

As outlined above, several properties have been identified as potentially experiencing an increase of more than 20mm in flooding in a design event, compared with the pre-project condition:

- 483 Volckman Road
- 143 Lochheads Road
- 159 Beethams Road/206 Lochheads Road
- 1171 The Lake Road/1247 The Lake Road¹

Potential flooding effects on these properties, and buildings within these, are discussed in **Section 5** below.

4.5 Effects on agricultural land

Due to the alluvial nature of the Canterbury Plains and presence of historic river braid channels, large rain events produce widespread, shallow flooding of agricultural land. Such patterns are visible in **Figure 1** and **Figure 2** above.

For this reason, and in order to assess potential adverse effects of flooding on productive agricultural land, the results of post-project flood modelling have been measured against a "significance test".

The 'significance test' criteria is:

- Flooding extents are increased by less than 10%;
- Flooding depth increases are less than 100mm; and
- Flood water drainage times remains largely unchanged.

Minor changes in flood depth between the pre and post-project condition, that do not significantly affect the extents or duration of the ponded water, are not considered to have an adverse impact on the agricultural use.

Section 5 below discusses potential flooding effects on individual properties in greater detail.

5 Effects – Individual Properties

Potential effects on properties relative to the Leeston Stormwater bypass scheme are discussed below with reference to the Site Location Map in **Appendix 1**. The number attributed to each of these properties on the Site Location Map are also referenced below.

5.1 178 Harmans Road (1)

178 Harmans Road is zoned for rural land use under the existing and proposed Selwyn District Plans, and currently used for this purpose. The widening of Leeston Creek increases the capacity of this waterway, which in turn reduces the likelihood of overflows (flooding) from the existing situation. The flood risk for this property is therefore reduced from the existing scenario.

5.2 60 Leeston Dunsandel Road (2) and 2 Leeston Dunsandel Road (3)

The proposed bypass channel traverses the properties at 2 and 60 Leeston Dunsandel Road, both of which are now zoned for residential use.

60 Leeston Dunsandel Road

¹ These properties are addressed as '177 Lochheads Road' and '1197 The Lake Road' on the Canterbury Maps web application.

60 Leeston Dunsandel Road has recently been rezoned for residential land use under Private Plan Change 62 to the Selwyn District Plan (PC62). The proposed bypass channel is shown as 'Indicative Stormwater Management Area/Local Drainage Reserve to be confirmed at Subdivision' in the 'Outline Development Plan' (ODP) in Appendix 51 in the Township Volume of the Selwyn District Plan (**Figure 13**).

Minor amendments to the General Arrangement Plans in **Appendix 3** will be made in regard to 60 Leeston Dunsandel Road. These include:

A subdivision consent will be required to develop this land for residential use. Stormwater design and construction of the subdivision, and integration with the bypass channel, is likely to be considered as part of this forthcoming process.

Figure 13: Excerpt from Appendix 51 in the Township Volume of the Selwyn District Plan.

2 Leeston Dunsandel Road has obtained land use and subdivision consent for a new residential subdivision 'Karamata Oaks'. The alignment of the proposed bypass channel through 2 Leeston Dunsandel Road is shown in the subdivision consent documents (RC215689) (**Figure 14**).

Maintenance of the proposed bypass channel is important to retain design capacity and is proposed as part of this application.



Figure 14: Approved Subdivision Plan for RC215689 and RC215690.

5.3 483 Volckman Road (4)

The pre-project flood model (**Figure 15**) indicates breakouts from both Volckman Road Drain and Drain 58.

The post-project flood model predicts an increase in flood depth but overall reduction in flooded area.

The modelled change in flood extents is represented by **Figure 16** and calculated by the Design Engineers as:

- The flooded area reduces by 4.8% from 187,904m² to 178,720m².
- The maximum flood depth increases by 57 mm from 468 mm to 525 mm.
- The average flood depth increases by 36 mm from 66 mm to 102 mm.
- Once active flow has ceased, modelling shows no significant differences in drain time.

In terms of effects on dwellings, two are located within this site. The model indicates a 31mm increase in flood depth adjacent to the closest, more centrally located dwelling. This dwelling will maintain more than 400mm of freeboard above the flood level, based on the Floor Level Analysis in **Appendix 4**.

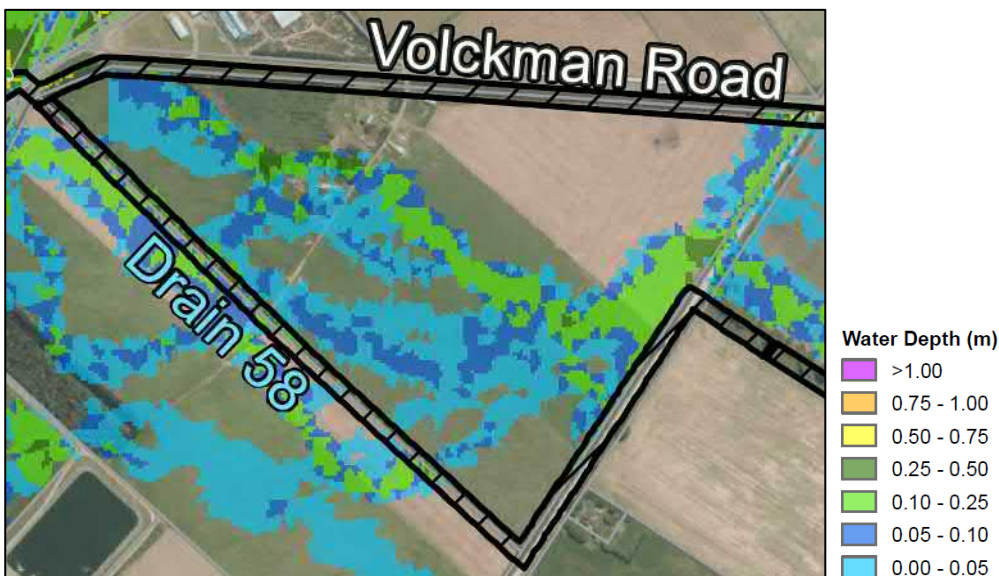


Figure 15: Existing Scenario - Peak Flood Depth and Inundation Extent at 483 Volckman Road.

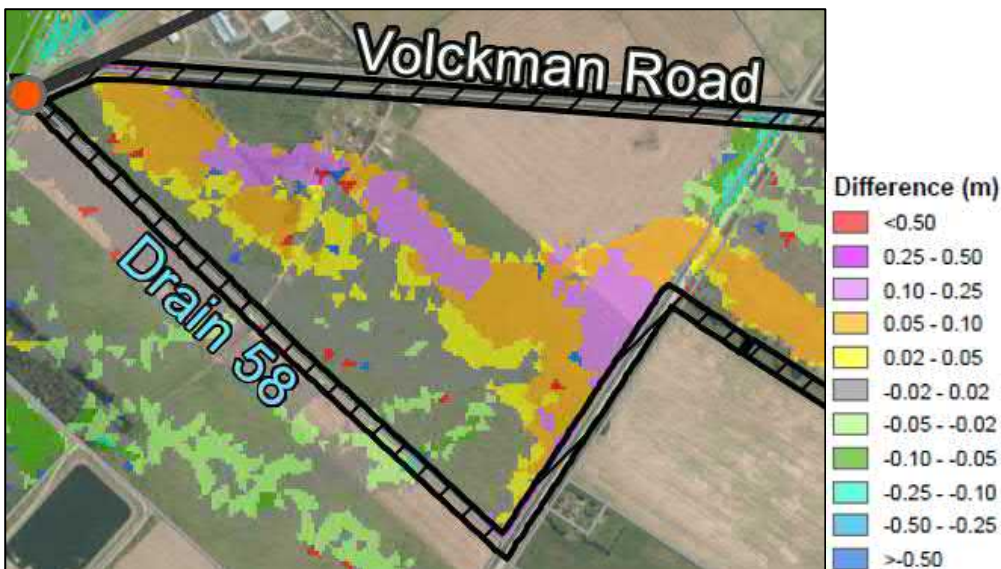


Figure 16: Changes in flood depth (pre-project vs post-project) at 483 Volckman Road.

5.4 159 Beethams Road/206 Lochheads Road (7)

The pre-project flood model (**Figure 17**) indicates that three overland flow paths cross the property from west to east. These three flow paths appear to affect seven paddocks on the property.

The post-project flood model indicates that the two southernmost overland flow paths are eliminated. The spill from the Volckman Road drain (between Drain 57 chainage 1100 and 1400) into this flow path is also eliminated.

However, the flow depths in the overland flow path north of Drain 57 are predicted to increase in a design event. The maximum increase in depth is approximately 85 mm adjacent to Drain 57 chainage 1100 to 1500 on the north-western side of the property. Between Drain 57 chainage 1500 and the eastern property boundary (approximately chainage 2800), the flow depths reduce to generally less than 50 mm as indicated by the yellow coloured portions of the map.

There is a very localised (approximately 1,500m²) depression on the eastern boundary of the section immediately adjacent to Drain 57 (approximate chainage 2700) that experiences depth increases in excess of 100mm due to tailwater in the drain. This area is currently subject to inundation during high water in the drain.

The modelled change in flood extents on this property is represented by **Figure 18** and calculated by the Design Engineers as:

- The flooded area increases by 2.8% from 258,852m² to 266,075m² (+7,223m²).
- The maximum flood depth increases by 85 mm along the overland flow path north of Drain 57 with the majority affected by an increase of less than 50 mm.
- The model indicates that the surface water at 159 Beethams Road/206 Lochheads Road readily flows to Drain 57, and once high levels in the drain recedes, the floodwaters across the land will readily drain. In the modelled (6 hour) flood event, the duration of inundation for this area is approximately 7 hours, after which the majority of the land will not have any ponded water.

The Floor Level analysis (**Appendix 4**) indicates that no inhabited structures are impacted by the predicted flooding in the pre-project or post project scenarios. The water level increase adjacent to the dwelling on the northern side of the site is 59mm, however this dwelling still maintains 470mm of freeboard above the flood level.

Three out of seven paddocks currently affected by flooding are predicted to have no flooding as a result of the project. A fourth paddock in the northern corner of the property will have a significant reduction in area affected by floodwater (shown green on **Figure 18**).

Increases in bank heights are proposed along Drain 57 and Tramway Reserve Road Drain adjacent to this property to reduce the potential for breakouts (see **Section 3.5**).

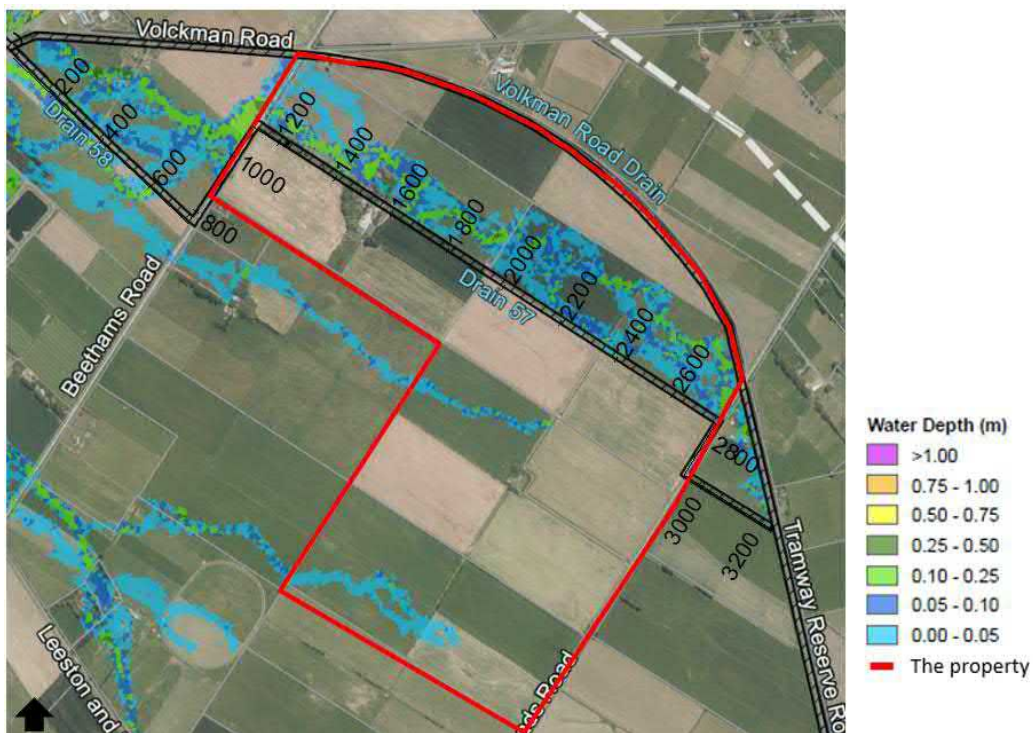


Figure 17: Existing Scenario - Peak Flood Depth and Inundation Extent at 159 Beethams Road

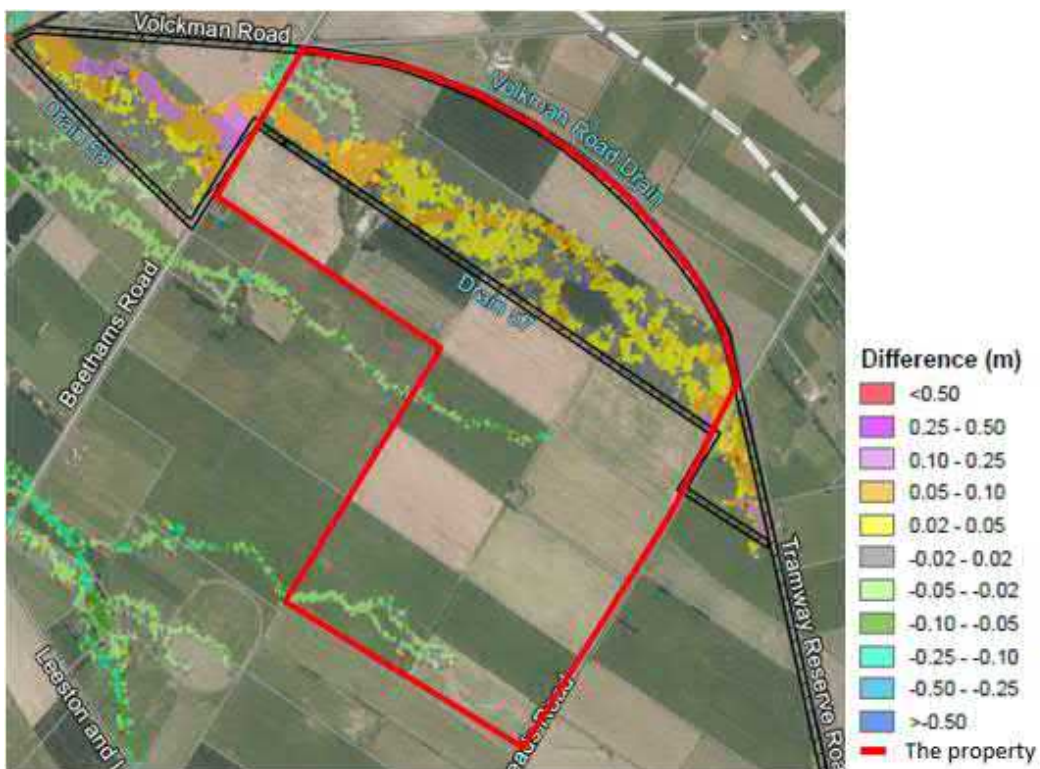


Figure 18: Changes in flood depth (pre-project vs post-project) at 159 Beethams Road.

5.5 143 Lochheads Road (8)

The pre-project flood model (**Figure 19**) indicates flooding along the eastern boundary of this property. This flooding is generally the result of flows spilling from 159 Beethams Road over Lochheads Road.

The post project model predicts an increase in flood depth and in flooded area.

The modelled change in flood extents is represented by **Figure 20** and calculated by the Design Engineers as:

- The flooded area increases by 88% from 12,096m² to 22,832m².
- The maximum flood depth increases by 67 mm from 534 mm to 601 mm.
- The average flood depth increases by 6 mm from 68 mm to 94 mm.
- Once active flow has ceased, modelling shows no significant differences in drain time.

The increases in water depth adjacent to the dwelling and dairy shed are 81mm and 85mm, respectively, however these structures both maintain significant freeboard above the flood levels of 546mm and 946mm.

Increases in bank heights are proposed along the true left bank of Drain 57 and a short section of Tramway Reserve Road Drain to prevent breakout from the drains (see **Section 3.5**).

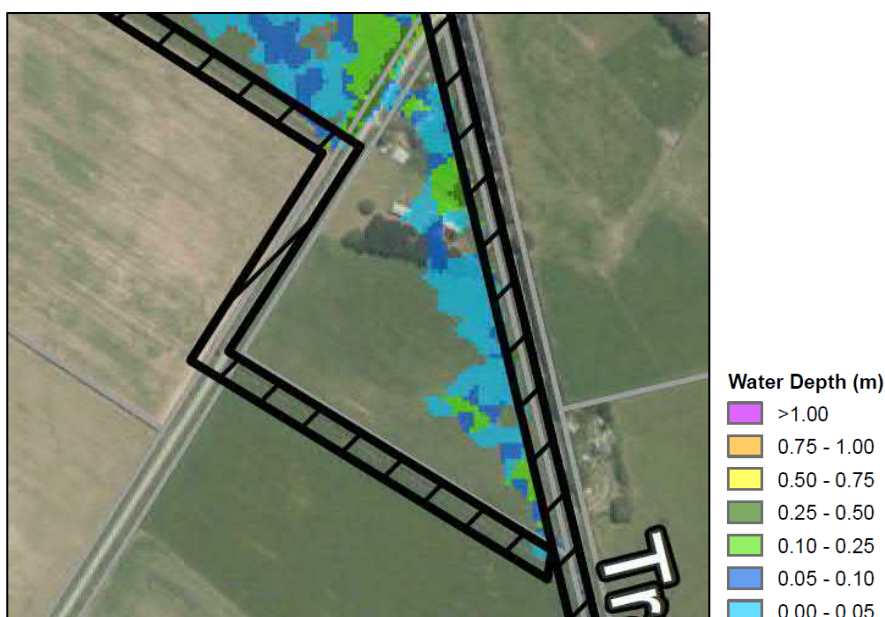


Figure 19: Existing Scenario - Peak Flood Depth and Inundation Extent at 143 Lochheads Road

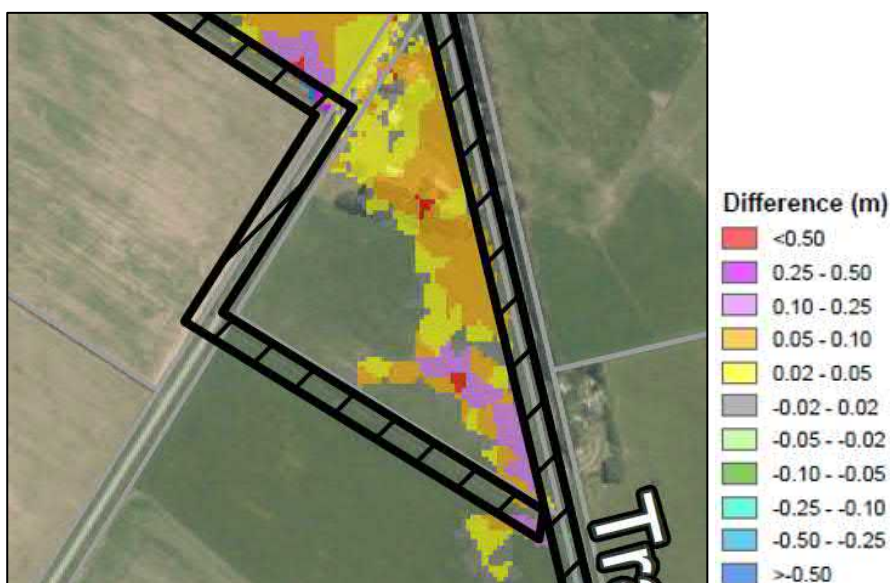


Figure 20: Changes in flood depth (pre-project vs post-project) at 143 Lochheads Road.

Note: 'red' pixels are noise resulting from model mesh overlaps.

5.6 1171 The Lake Road and 1247 The Lake Road (10)

The pre-project flood model (**Figure 19**) indicates an overland flow path through the southern portion of this property.

The post project flood model predicts the removal of this overland flow path, however minor breakouts are shown from Tramway Reserve Road Drain. These breakouts impact small areas of this property and do not occur in the vicinity of any structures.

The modelled change in flood extents is represented by **Figure 22** and calculated by the Design Engineers as:

- The flooding area reduces by 81% from 109,168m² to 20,320m² (this is due to the removal of a large flow path across the southern portion of the site).
- The maximum flood depth reduces by 172 mm from 493 mm to 321 mm.
- The average flood depth increases by 2 mm from 53 mm to 55 mm.
- Once active flow has ceased, modelling shows significantly reduced drain time.

Increases in bank heights are proposed along the true right bank of Drain 57 adjacent to the northernmost boundary of this property to prevent the breakout (**Figure 10**).



Figure 21: Existing Scenario - Peak Flood Depth and Inundation Extent at the Lake Road properties



Figure 22: Changes in flood depth (pre-project vs post-project) at the Lake Road properties

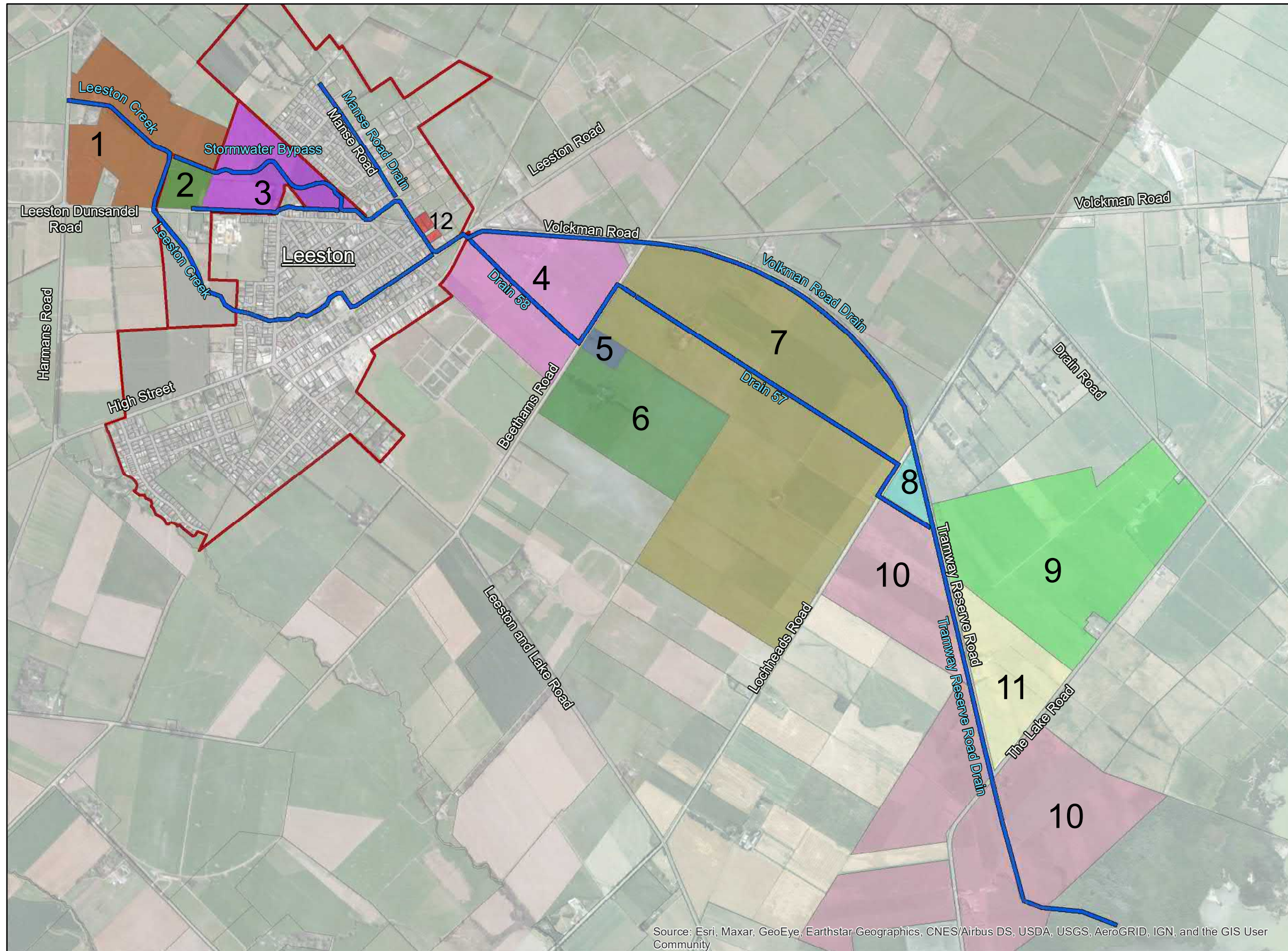
5.7 1-4 Showground Place (12)

The post-project flood model maps indicate a small adverse impact on the properties at 1-4 Showground Place. This is considered an errant result as the sections comprising 1-4 Showground Place have been filled well above the indicated flood level, since the flood model (incorporating former terrain data) was developed.

The flooding indicated at this location on the maps will therefore not occur in a design event and these sections will not be affected by the proposal.

Appendix 1 – Site Location Map





Legend

- Drain Locations
- Leeston Urban Boundary

Properties of Interest

- (1) 178 Harmans Road
- (2) 60 Leeston Dunsadel Road
- (3) 2 Leeston Dunsadel Road
- (4) 483 Volckman Road
- (5) 189 Beethams Road
- (6) 211 Beethams Road
- (7) 159 Beethams / 206 Lochheads
- (8) 143 Lochheads Road
- (9) 141 / 143 Drain Road
- (10) 1171 / 1247 The Lake Road
- (11) 293 Tramway Reserve Road
- (12) 1-4 Showground Place

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Date: 18/01/2022

Version: 2



A3 scale: 1:20,000

Job No: 227110

Projection: NZTM00

0

200

300

400

500m

Appendix 2 – Flood Modelling Maps

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

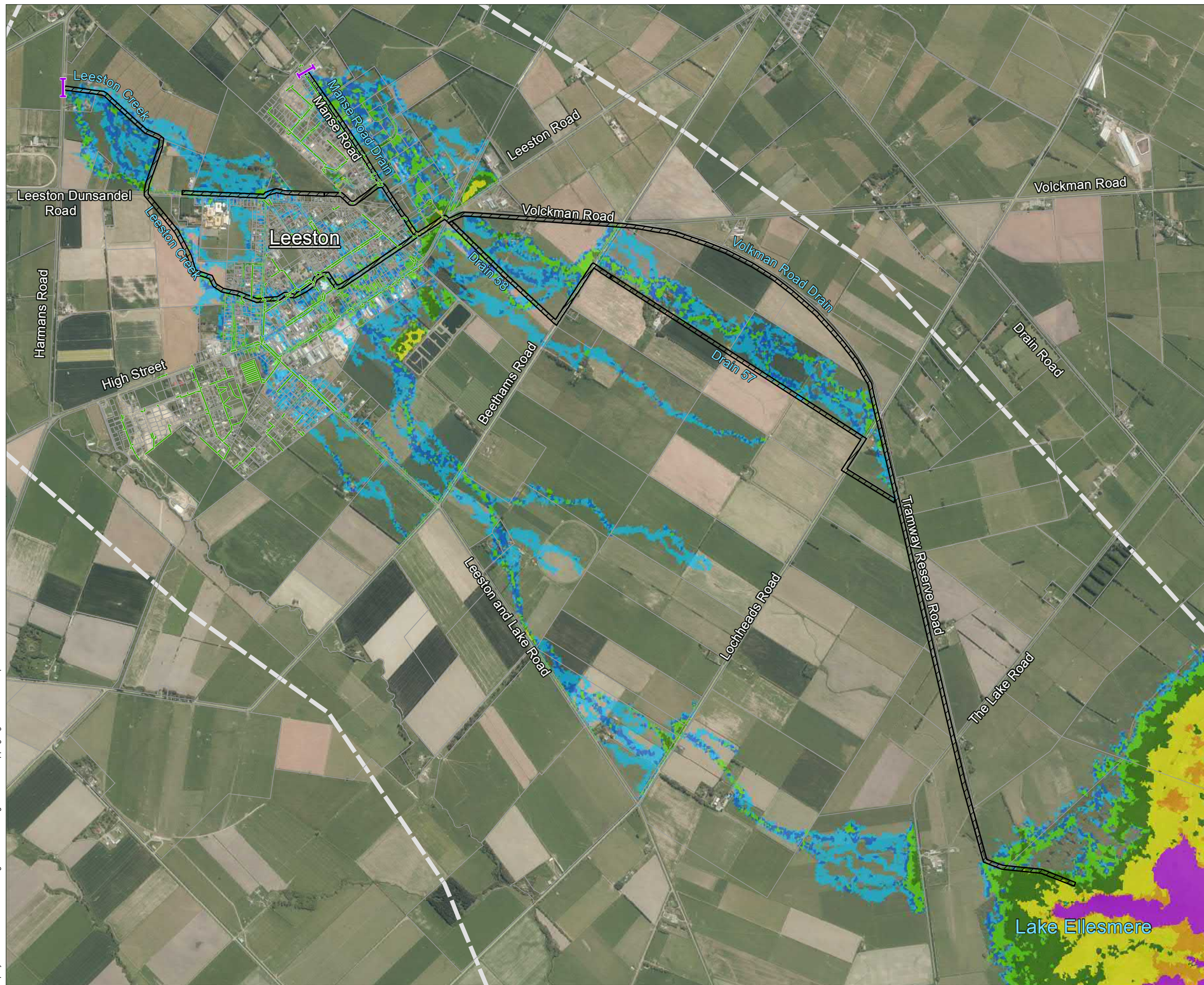
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. Peak flood depth within the MIKE 11 model extent is not shown
3. The flood information represented on this map does not include for freeboard and as such is not recommended building level
4. Aerial photography and stormwater network asset data provided by SDC

Date: 3/10/2017

Version: 2



Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A1: 1% AEP Event - Existing Scenario - Peak Flood Depth and Inundation Extent



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

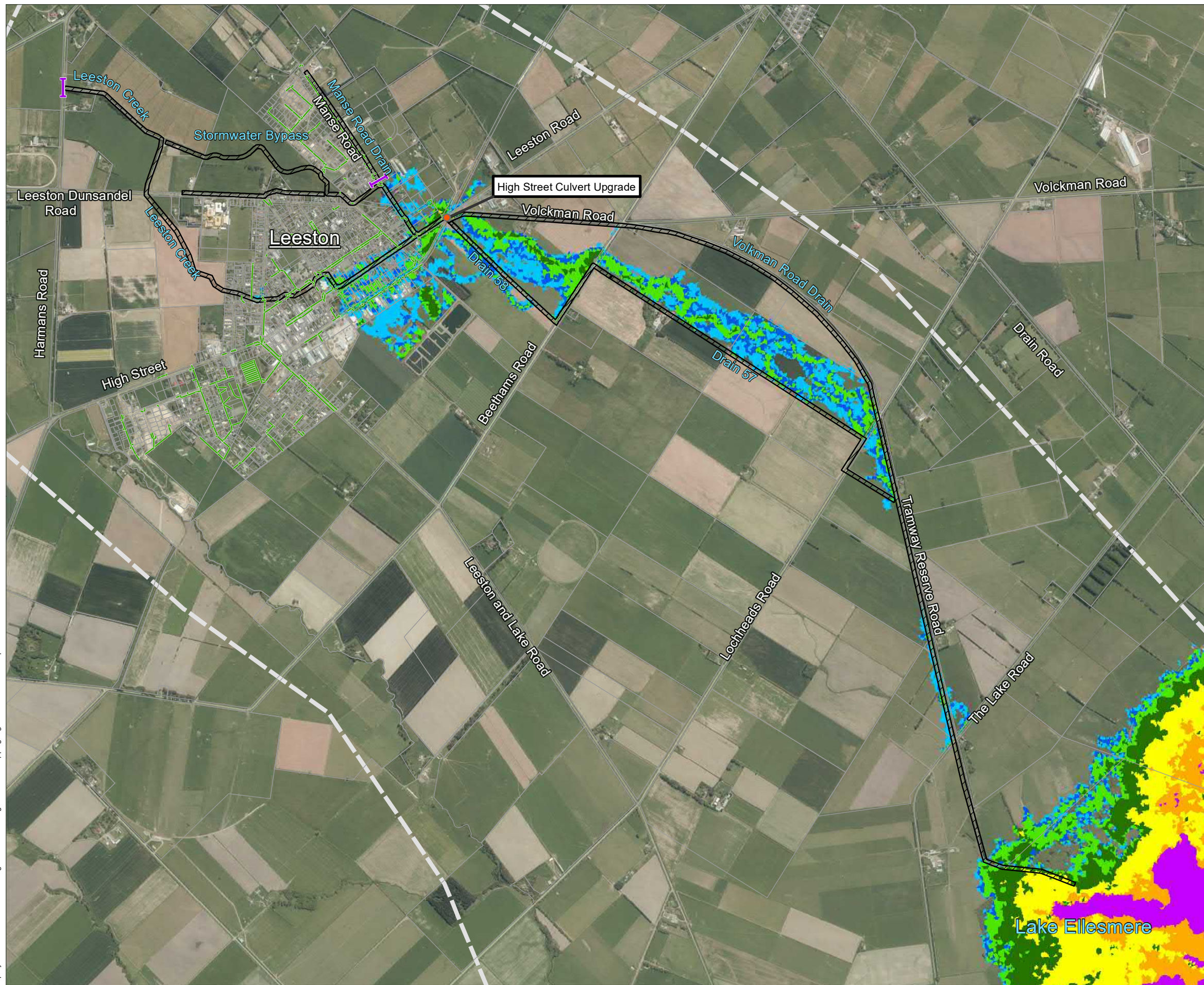
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. Peak flood depth within the MIKE 11 model extent is not shown
3. The flood information represented on this map does not include for freeboard and as such is not recommended building level
4. Aerial photography and stormwater network asset data provided by SDC
5. See design report for a description of the mitigation measures included in this model scenario

Date: 18/01/2022

Version: 2



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A4 LDD MIT OP 1 Depth.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A4: 1% AEP Event - Mitigation Option 1 Scenario with Clean Drains - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

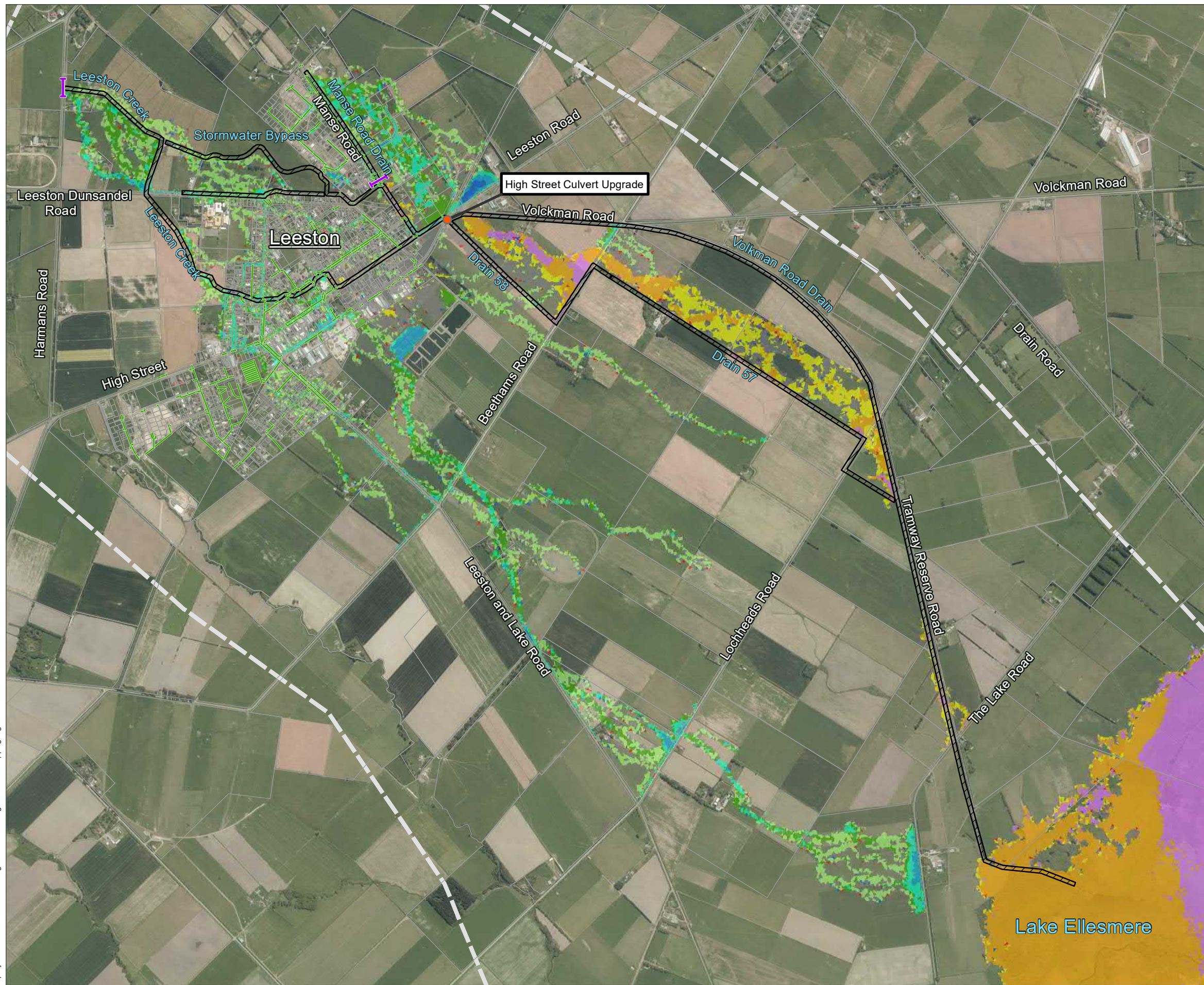
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 18/01/2022

Version: 2



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A6 LDD MIT OP1 Exist Diff.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A6: 1% AEP Event - Mitigation Option 1 Scenario Clean Drains - Existing Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

innun_compare

Description

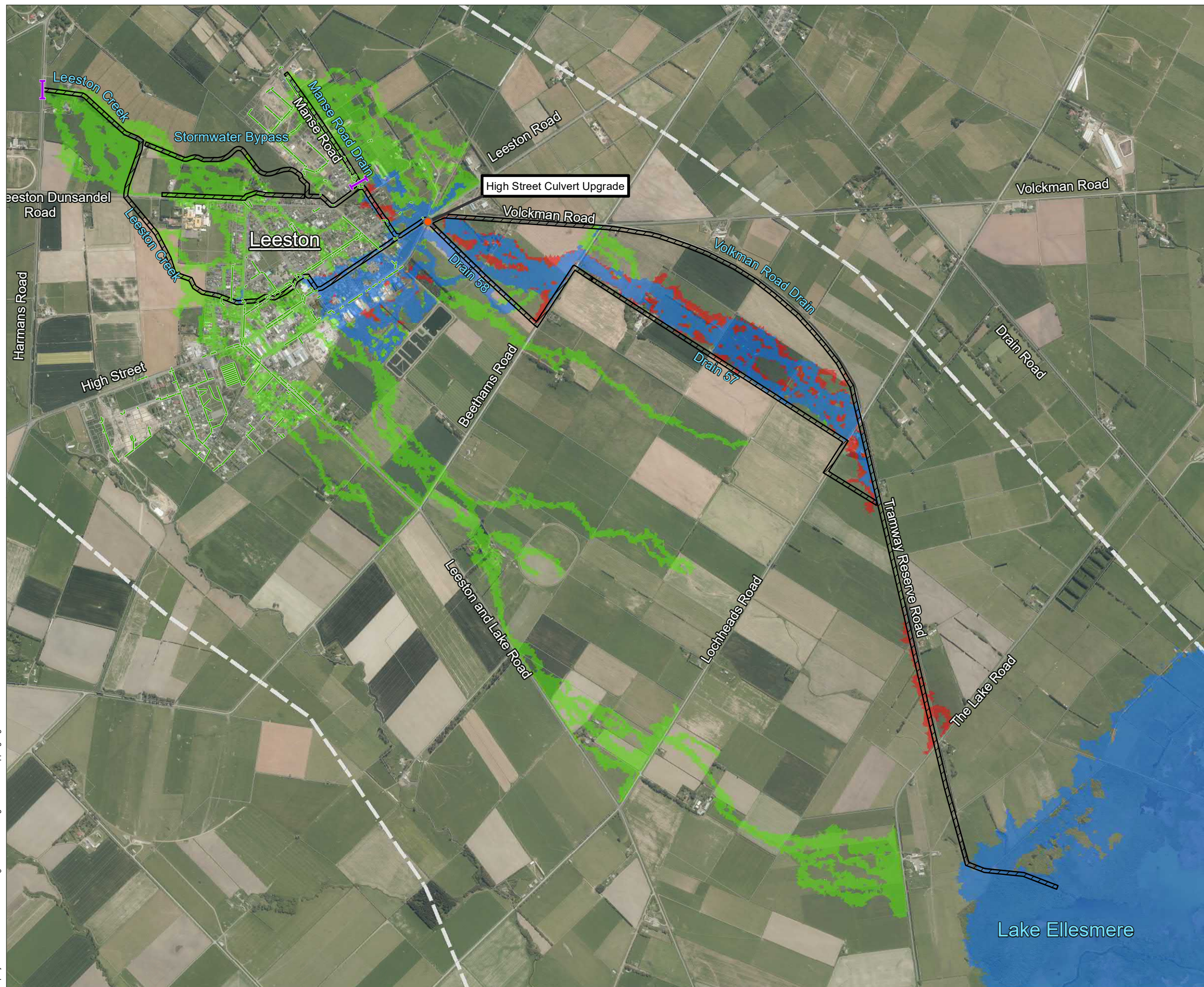
-  Was wet, now wet
-  Was dry, now wet
-  Was wet, now dry

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 18/01/2022

Version: 2



Map by: CB P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A6 LDD MIT OP1 Exist Diff.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A22: 1% AEP Event - Mitigation Option 1 Scenario Extent Comparison

**Appendix 3 – Leeston Stormwater Bypass Stages 4 and 5
Detailed Design Report 2020 – Rev C**

Leeston Stormwater Bypass

Stages 4 and 5 Detailed Design Report

Selwyn District Council

Reference: 505193-0008-REP-CC-0001

Revision: C

2020-12-18

Document control record

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Appendix A

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Appendix B

Safety in Design Register 2020

Appendix C

Leeston Flood Modelling Report 2019

Appendix D

Preliminary Design Consent Conditions 2007

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Flood Modelling Output 2020

Appendix F

SDC Communications

Appendix G

SDC Revision Comments and Responses

Figures

Figure 1 - Stages 4 and 5 of Leeston Stormwater Bypass

Figure 2 - Future Subdivision

Figure 3 – Stages of Leeston Stormwater Bypass Project

Figure 4 - Survey areas

Figure 5 - Excavated burn pit ground profile

Figure 6 – Bore log M36/4896 and Excavation Burn Pit at the confluence

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Figure 8 – Extent of Stage 4 works shown by red lines.

Figure 9 - Kowai Gate control mechanism accessed from the side

Figure 10 - Unknown utility as shown on SDC Service Plan through the confluence.

Figure 11 - Martins Drain (red dashed) and Dunsandel Drains (continuous blue)

Figure 12 - Existing and Future Wetlands

Figure 13 - Stable Bed Velocities table 22-5 from CCC WWDG

1 Introduction

Selwyn District Council have engaged Aurecon New Zealand Ltd to undertake the detailed design for Stages 4 and 5 of the Leeston Stormwater Improvements Project, as set out in our proposal dated 5th May 2020.

The Stages 4 and 5 works are part of the overall Leeston Stormwater Bypass project which aims to create a flood bypass to alleviate flooding within Leeston Township from Leeston Creek.

Stages 4 and 5 of the Leeston Stormwater Bypass project are located on farmland north of the Leeston township. The proposed works for stage 5 start after Leeston Creek crosses Harmans Road and enters private property. No works have been proposed to upgrade the Harmans Road culvert as this has been identified as having sufficient capacity. Problematic spilling of stormwater over the banks of the existing Leeston Creek occurs downstream of the Harmans Road culvert.

The proposed Stage 5 works follow the existing creek alignment until it reaches the Stage 4 and 5 confluence. The confluence structure has been designed to divert the consented capacity of 1% Annual Exceedance Probability (AEP) stormwater flow into the proposed Stage 4 bypass, which runs in a general east-southeast direction (north of Leeston Dunsandel Road), where it then reconnects to the Stage 1 completed drainage widening works, north of the Pound Road and Cunningham St corner. Figure 1 below illustrates the various components and extents of Stages 4 and 5.

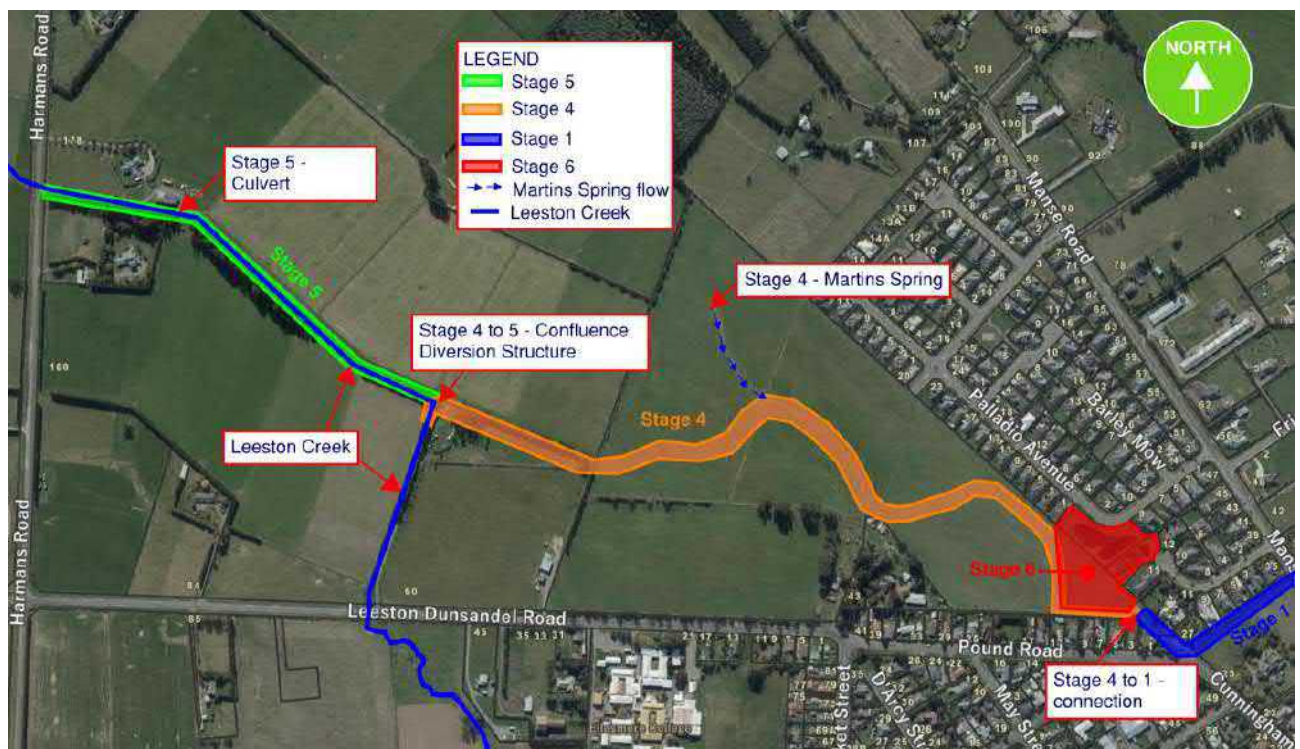


Figure 1 - Stages 4 and 5 of Leeston Stormwater Bypass

With the downstream Stage 1 and 2 works complete and Stage 3 construction underway, this report describes the detailed design considerations of the Stage 4 Stormwater bypass channel and Stage 5 Leeston Creek Upgrade.

2 Background

Hydraulic modelling and design of the proposed Leeston Stormwater Bypass commenced in 2006 and culminated in a preliminary design in 2007, however the physical works were placed on hold due to budgetary constraints. Resource consents were obtained in 2007 from Environment Canterbury (ECan) for the Leeston Stormwater Bypass based on the 2007 preliminary design. These consents are listed in section 5 Resource Consents. These consents required the stormwater bypass to be designed to convey the 1% Annual Exceedance Probability (AEP) flood event peak flows around the Leeston Township. A detailed investigation of potential downstream impacts associated with the proposed stormwater bypass was not completed for these early stages of the project.

A significant flood event in June 2013 resulted in extensive flooding within Leeston Township, and shortly after this SDC engaged Aurecon to further the design of the Leeston Stormwater Bypass.

A one-dimensional (1D) MIKE 11 hydraulic model was developed for the Leeston Stormwater Bypass in 2004 by Stantec (formerly MWH). This hydraulic model was later modified and used by Aurecon to design a number of drain upgrades that form part of the overall Leeston Stormwater Bypass scheme.

The Leeston flood modelling report provided by Aurecon to SDC in 2019 included recommendations for the upgrades of High Street (Stage 3), design drawings for the proposed Leeston Stormwater Bypass (Stage 4) and recommended upgrades for Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass (Stage 5). This report is included in Appendix C.

Flood modelling in the 2019 report was completed for the existing scenario, design scenario (existing layout with the proposed Leeston Stormwater Bypass included) and a number of mitigation option scenarios. Results are included in the Appendix C 2019 report.

The model results validated the need for the Leeston Stormwater Bypass due to the significant flooding which occurs throughout the Leeston Township in the existing scenario, with multiple residential and commercial properties inundated. Leeston Creek overtops north of the township and the excess floodwater then crosses Leeston Dunsandel Road and flows along roads and through residential properties. Within the township, Leeston Creek has insufficient capacity and overtops at multiple locations. Additionally, Manse Road Drain had insufficient capacity to convey its flow and a significant breakout occurred to the east of the drain which inundates residential lots.

The Detailed Design alignment and profile follows the route and profile that was determined and consented in the 2007 preliminary design. The 2019 hydraulic modelling results noted in the Appendix C report indicated Stage 5 is necessary to be completed to enable flows to reach the Stage 4 bypass.

The Stage 5 alignment follows Leeston Creek, whereas for Stage 4 an attempt was made to naturalise its course through a future subdivision development. Figure 2 below illustrates the alignment of the bypass channel through the future subdivision. Detailed Design changes to the profile and alignment of the existing design compared to the 2007 preliminary design are respectively addressed in sections 8.1.5 Channel Cross Section and 8.1.9 Future Wetland Bypass Channel and Connections of this report.



Figure 2 - Future Subdivision

The construction of the Leeston Stormwater Bypass Project is staged as follows:

Stage 1 – High Street Drain and CDHB Drain Upgrade (complete).

Stage 2 – Manse Road Drain and Reids Culvert (complete).

Stage 3 – Leeston Road culvert and downstream drain upgrade (under construction).

Stage 4 – Stormwater bypass channel (detailed design included in this report).

Stage 5 – Leeston Creek Upgrade from Harmans Rd to Stage 4 confluence (detailed design included in this report).

Stage 6 – Future wetland construction (an extension of an existing wetland).

Figure 3 below illustrates the various stages of the overall Leeston Stormwater Bypass Project. The design of these stages has been informed by Aurecon flood modelling investigations.

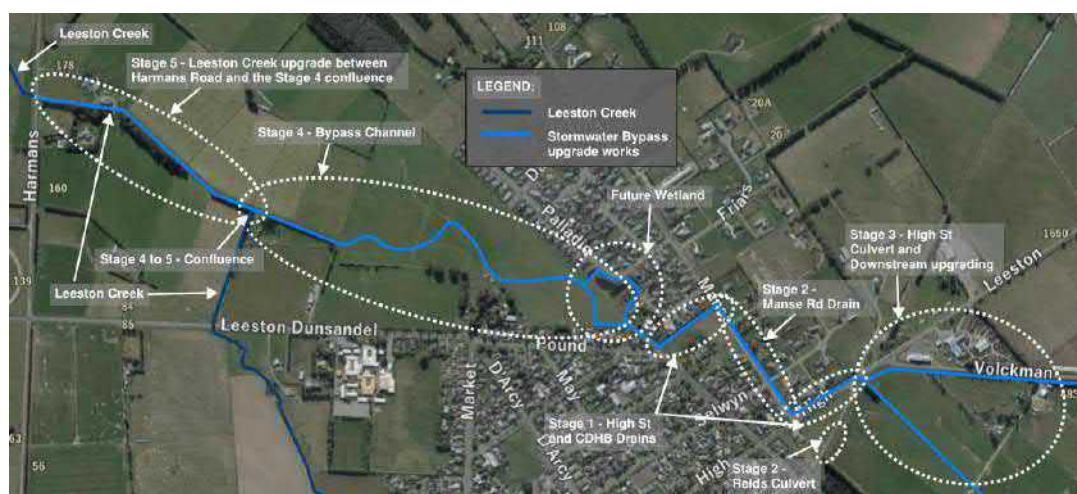


Figure 3 – Stages of Leeston Stormwater Bypass Project

Stages 1 and 2 have already been constructed. These initial stages involved upgrading the drain through the Canterbury District Health Board (CDHB) site, down Manse Road and along High Street.

Stage 3 involves upgrading the twin culverts beneath High St and the downstream section of open channel drain. Construction is underway as of 12th of October 2020.

Stage 4 proposes the construction of a diversion structure at the Leeston Creek confluence and earthworks to shape the stormwater bypass channel. The bypass channel will run in a general east-southeast direction,

through farmland, connecting into the completed Stage 1 High Street Drain and CDHB Drain Upgrade, just north of the Pound Road and Cunningham Street corner.

To enable the proposed bypass to operate effectively, Stage 5 involves widening of the existing Leeston Creek drain from a variable 1.6 m - 2.4 m to a more generally consistent 2.5 m base width (with localised widening to a 3.5 m base width) with a typical depth of 1.1 m, and upgrading the existing single culvert to a proposed 2.5m wide by 1.0m high and 5m long box culvert (providing improved capacity and improved constructability than the twin DN1200 culverts proposed during preliminary design).

3 Scope of Work

The scope of work noted in the proposal for the investigation and detailed design phase is summarised below:

Investigation and Detailed Survey:

- Undertake a detailed topographic survey at the two localised stage 4 interfaces (refer Figure 4 - Survey areas, below in section 7):
 - the Stage 4 to 5 confluence (between the downstream boundary and existing Leeston Creek, where the diversion structure is to be installed), and
 - where the Stage 4 to Stage 1 transition will occur.
- Survey crew will also carry out investigative scale tests of insitu ground conditions around the proposed Stage 5 twin culverts and confluence diversion structure.

Detailed Design and Tender Documentation for Stages 4 and 5:

- Site walkover with SDC staff (contractor and landowner if possible) to confirm concept design alignment and identify any site constraints or construction methodology factors that may influence project.
- SiD and Risk Workshop with SDC
- Detailed design of new Stage 5 twin 1.2m diameter culverts
 - Configuration/alignment
 - Foundations
 - Wingwalls
 - Inlet/outlet protection
 - Hydraulic design
 - ESCP
- Detailed design of Stages 4 & 5 channel upgrade, including confluence and diversion structure.
- Review and Design of channel alignment adjacent to wetland.
- Prepare detailed design documentation:
 - Plans, long sections, details, etc
 - Technical specifications.
 - Update SiD and Risk Register.
 - Prepare detailed design report.
- Prepare schedule of quantities and cost estimate.
- Q/A – review, verification and approvals.
- Issue draft documents to SDC for review and approval.
- Update and issue final Stage 4 and 5 documentation, with deliverables as follows:
 - Detailed design report.
 - Tender Issue plans and specifications.
 - Schedule of quantities/Engineers Estimate.

4 Exclusions, Assumptions and Considerations

As per the proposal for Stages 4 and 5 dated 5 May 2020, some exclusions and assumptions are listed below.

4.1 Exclusions

- Modelling of events greater than 1% Annual Exceedance Probability.
- Adjustment or redesign of the channel alignment.
- Structural design of the control gate.
- Stakeholder engagement.
- No scala ground investigations were carried out; visual inspection of excavated burn pit confirmed ground similar to bore log M36/4896.
- Design of realignments, upgrades or additional structures.

4.2 Assumptions

- The Stage 4 Eliot Sinclair survey from 2007 is not significantly different to the current state of the land. Known accuracy has been provided.
- The in-situ soil is able to sustain a 1:1 slope with hydromulch and ECC3.
- Stage 5 culvert and headwalls will be constructed from prefabricated wingwalls and standard culvert sections.
- Ground conditions are suitable for placement of proposed structures based on visual inspection of excavated pit at confluence only.

4.3 Considerations for SDC

- Taege Engineering will need to provide a visible marker on the side of the gate to show operation gate height to the maintenance crew. This has been noted on the drawings. A 400mm high gap (confirmed with revised hydraulic model) is shown on the drawings and will provide the necessary control to ensure flows greater than 0.6 m³/s are diverted into the bypass channel. If more flow is to be allowed past to help flush debris, then the gate can be further opened.
- As the Stage 4 bypass channel has been designed to convey the full 3.78m³/s one hundred year storm flow, our recommendation is to close the control gate in the event that a significant rainfall event is predicted to cause flooding within the Leeston Township and direct all storm flows into the Stage 4 Bypass. This will free up much needed conveyance capacity with the upstream portion of the Leeston Township stormwater reticulation network.
- The grass seed used across the whole of the proposed work site needs to meet the requirements of the landowner's pasture farming requirements and be in agreement with Selwyn District Council.
- Aurecon's recommendation for the isolated portion of the future wetland is for a post and wire fence along the north side of the bypass to keep wandering stock out. Alternative access could be made by the farmer from Leeston Dunsandel Road, corner of Market St and Pound Rd, which is considered a more cost-effective option than providing a culvert crossing.
- Selwyn District Council to regularly maintain the Stage 5 creek banks to keep grass growth under control. The reach will not perform to design if the drains are not regularly maintained. This is also applicable to the Stage 4 bypass where stock are not accessing the grass and keeping it low.
- Standard 2.5m x 1.0m x 1.55m long box culvert units are proposed for the Stage 5 farm culvert replacement, however if SDC decide that the box culvert is not preferable due to significant construction cost differences, then the use of twin DN1600 RCRRJ Class 4 pipe would meet the National

Environmental Standards (NES) requirements of 1.3 x the base width and can be buried 25%, and can be substituted into the design in place of the box culvert.

- An arborist should be present for excavations near the roots of the existing gum trees identified in the Stage 4 and 5 plans as well as for trimming of tree branches, if required.
- The drawings show the location of fences to be replaced at the points of intersection with the bypass, and how these are to be installed. A note is included on the drawings to indicate their functionality and that an experienced fencing contractor is needed to advise and install. SDC may need to discuss maintenance of these types of fences with the landowner depending on agreements. It is advisable for SDC maintenance to check that debris has not built up around the base of the round support posts proposed to be installed within the area of flow. An experienced fencing contractor will be needed to install the fence and make any amendments in agreement with the Engineer. The aim of the spacing is to avoid too many support posts being installed through the channel, which would reduce the bypass capacity.

5 Resource Consents

The detailed design of Stage 4 and Stage 5 has been guided by the resource consents obtained from Environment Canterbury (ECan) for the Leeston Stormwater Bypass in 2007, and 2014 (refer below). However, these have now lapsed as they were not activated within the required timeframes and as such a new consent application for Stages 4 and 5 has been put together by Aurecon, which is in the process of being lodged with ECan at the time of this report. Aurecon aim to have these Consents approved prior to construction work commencing 1 February, 2021, as requested by Selwyn District Council.

The new consent application put together by Aurecon has been aligned with the design objectives of this report.

The original 2007 and 2014 resource consents are listed as follows, and are included in the Appendices D:

- CRC071839 To divert a watercourse (Bypass)
- CRC071840 Works in a Water Course
- CRC072300 Excavation of soil over a Confined Aquifer
- CRC143914 Discharge contaminants into surface water

Examples of conditions that have guided the design, taken from Resource consent CRC071839, are as follows:

- The stormwater bypass to be designed to convey the 1% Annual Exceedance Probability (AEP) storm event, which equates to 3.78 cubic meters per second without overtopping.
- The diversion of Leeston Creek is to only occur when the flow upstream of the diversion structure reaches 0.6 cubic meters per second or greater.
- The diversion channel is to be grassed, and consideration has been given to not prevent the downstream passage of any fish and avoid the stranding of fish in pools or channels.

6 Site Walkover

On 20 August 2020, two engineers from Aurecon undertook a site walkover with a representative from SDC in order to gain a better understanding of the proposed works areas. The walkover was started with a meeting at the confluence with two of the landowners to discuss the proposed design and answer their queries. From this meeting and subsequent walkover, the following was learned:

- The landowner for the Stage 5 portion identified stormwater can break out of the Leeston Creek along the north side of the upper reach, near the house, upstream of the existing culvert. From there it can travel through farmland to the east, slightly north of the proposed channel in Stage 4. This indicated the importance of removing sections of the proposed northern bunds along the Stage 4 bypass channel to allow stormwater to be collected by the bypass channel. Modelling shows there is localised flooding near the house correlating with what the landowner identified, however it shows that the main breakout is in the southern direction.
- Five eucalyptus trees were requested to be retained if possible. These are located immediately north-east of the proposed location of the Stage 4 and 5 Leeston Creek Diversion Structure confluence. An arborist will be required to provide an assessment and guidance during channel excavation. This has been highlighted within the design documentation.
- The Martins Spring channel (Stage 4) was flowing at the time of walkover. It was later identified by the Stage 4 landowner to SDC that the channel is ephemeral and can dry out in summer. SDC provided information on how this currently connects to Dunsandel drain. Refer 8.1.7 Martins Spring and Dunsandel Drain.
- An existing culvert, connecting the existing wetland located north of Pound Road and Cunningham Street corner (Stage 1 connection), will need to have the outlet lined with rock/riprap to protect it from stormwater flow.

7 Survey

In the Stage 4 and 5 Leeston Stormwater Bypass proposal Aurecon highlighted that a detailed survey of Stage 5 and Stage 1 was available and was suitable for progressing with for the detailed design, however it was also noted that only LiDAR was available for Stage 4. Aurecon noted that the LiDAR was suitable for detailed design of the bypass alignment in the field, but that it wouldn't provide accurate volume estimates of earthworks.

However, on project commencement, the Aurecon survey team identified that the information for Stage 4 was not LiDAR but was survey data which had been carried out by Elliot Sinclair in 2007. We note that this is from before the Canterbury Earthquake Sequence. When compared to the Stage 4 and 5 survey carried out by our survey team, we were able to determine that this data has an accuracy (margin of error) of +/-100mm horizontally and +/-50mm vertically.

The Stage 4 and 5 scope included carrying out a detailed topographic survey of the interfaces of Stage 4; these being Stage 4 to 5 confluence and Stage 4 to 1 transition. These locations are identified by the red areas in the figure below. The estimated accuracy of survey data collected by Aurecon staff at these interfaces is +/- 25 mm horizontally and vertically.



Figure 4 - Survey areas

7.1 Stage 4 Survey Note – 2012 LINZ Control

As noted above and on the engineering drawings, the survey used over the majority of Stage 4 was carried out by Elliot Sinclair in 2007, prior to the Canterbury Earthquake Sequence. As part of the detailed design of the Leeston Stormwater Bypass, Aurecon translated this and the new survey data to align with LINZ controls from 2012. This means that during set out for construction, the contractor and the construction team must use these 2012 controls. The potential margin of error in the Elliot Sinclair 2007 field survey is noted in the section above.

7.2 In situ Ground Profile

The existing in-situ ground profile was not investigated during the survey portion of the detailed design phase. During the site walkover a burn pit at the proposed confluence had been excavated, as shown in the image below Figure 5. Figure 6 shows the location of the burn pit. The excavation piles, made up of two piles of silt

(earth) and sandy gravels, indicated that the ground can be anticipated to be relatively consistent with the M36/4896 bore log, refer Figure 7.

Any soft spots identified during construction can be over-excavated and replaced with engineered backfill.



Figure 5 - Excavated burn pit ground profile



Figure 6 – Bore log M36/4896 and Excavation Burn Pit at the confluence



Figure 7 – Bore log M36/4896 is within 90m of the proposed twin culvert upgrade

8 Stormwater Design

8.1 Stage 4 – Bypass Channel Design

The list of consents that the Preliminary Design was based on, and in turn what the Detailed Design is based on, are noted in Section 5 Resource . The 1% Annual Exceedance Probability (AEP) flow condition is noted in CRC071839 To divert a watercourse (Bypass):

- The stormwater bypass to be designed to convey the 1% AEP storm event, which equates to 3.78 cubic meters per second without overtopping.

Stage 4 of the stormwater bypass channel will involve soil disturbance along a length of 1.1km, up to a width of 20m (when including bund footprint) with excavations through this wide portion down to 0.94 m below the current ground level, and through the narrow portion of the bypass channel (near the existing wetlands) down to 1.4m below the current ground level. The Stage 4 extent of works is illustrated with red lines in the figure below and is shown in the drawings.



Figure 8 – Extent of Stage 4 works shown by red lines.

8.1.1 Earthworks and Flood Modelling

The earthworks of the creek and bypass drain profiles and alignments have been modelled using 12d Version 14, and the revised 2019 flood model was updated and rerun for this Detailed Design phase using a steady-state HEC-RAS hydraulic model, to help inform the updated changes made throughout.

Aurecon determined that the preliminary design flood model required updating for the following reasons:

- The preliminary model included a concrete weir within the wetland section of the bypass channel, which needed to be removed from the model to provide an accurate representation of freeboard at the narrowing section of the bypass.
- Design alterations were needed to the wetland bypass channel profile in order to provide continuous fish passage to meet consent requirements.
- Design alterations were needed to be made to the channel in order to include a connection to Martins Spring.
- Refinement of the confluence diversion structure was made which required a confirmation of the preliminary design determined weir spillway height.
- The confluence control gate with orifice had not been modelled.

8.1.2 Control Gate Structure

The requirement for a control gate is noted in the 2007 consent CRC071839 To divert a watercourse (Bypass), listed in Section 5 Resource :

- The diversion of Leeston Creek is to only occur when the flow upstream of the diversion structure reaches 0.6 cubic meters per second or greater.

The control gate is proposed to be located in Leeston Creek, immediately downstream of the proposed confluence weir spillway structure. The updated flood modelling has indicated that the orifice through the control gate structure will be sufficient to convey up to the 0.6 m³/s flow prescribed, however the gate will need to be kept open to 400mm from the invert to meet this. Taege Engineering will need to provide a visible marker on the side of the gate to show operation gate height to the maintenance crew. This has been noted on the drawings. A 400mm high gap will provide the necessary control to allow flows greater than 0.6 m³/s to be diverted down the bypass channel. If more flow is to be allowed past, then the gate can be further opened.

The top height of the concrete control gate will match the surrounding bank heights of RL23.95m to provide 250mm freeboard. This has been assessed as part of the revised 2019 flood hydraulic modelling carried out for this detailed design phase. The 1% AEP high water level over the weir is shown in the revised model to be 23.70 m RL.

Health and safety considerations were raised by SDC during the detailed design phase to make the winding mechanism accessible from the side. SDC provided the Kowai Control Gate example, shown in below figure 6. Refer also SDC Communications, Appendix F, email From: Daniel Meehan, Sent: Friday, 25 September 2020 4:14 PM, Subject: FW: Kowai Control Gate. This is to avoid maintenance staff having to access the gate mechanism from the top of the diversion structure during a storm event. This has been included in the SiD assessment sheet. The design drawings have been modified to take these considerations into account. Design and fabrication will be carried out by Taege Engineering, as requested by SDC. The modelling indicates that the orifice will need to remain as indicated on the drawings to meet the 0.6m³/s consent requirement.

SDC have requested a hardstand area located beside the control gate to assist with providing service vehicles or an excavator with a solid base. A 5m x 5m hardstand area of compacted AP65 has been indicated on the drawings for this purpose.



Figure 9 - Kowai Gate control mechanism accessed from the side

When the existing trees on the banks of Leeston Creek are trimmed upstream of the control gate, this could lead to debris blockages of the control gate. It is recommended that SDC have maintenance staff check the gate structure prior to storm events in order to prevent unnecessary blockages.

8.1.3 Confluence Diversion Structure (concrete weir spillway)

The preliminary 2007 design of the confluence diversion structure located between Stages 4 and 5 was reviewed as part of this design phase. There were a number of changes made which include:

- Removal of gabion baskets from the design. It was determined that the wall of gabion baskets were not beneficial because they introduced the opportunity for footing erosion and debris blockage. During the walkover we noted that the yearly maintenance works of trimming the farm boundary hedging and trees, located upstream of the diversion structure, left branches in the stream which could then potentially clog

the gabion baskets, effectively increasing the height of the weir spillway. This would in turn increase the flow threshold required to overtop the weir spillway. If this occurred, it would result in floodwater spilling over the Leeston Creek control gate and embankments and continue down Leeston Creek rather than through the bypass channel.

- The design proposes constructing the diversion weir spillway as a rip rap lined concrete wall, instead of gabion baskets, to better control the flow and reduce the occurrence of erosion under the toe and side of the spillway. The top level of the concrete diversion weir spillway will be set at the reduced level of 23.40m. This is being addressed in the new consent application.

8.1.4 Existing Unknown Service

Review of requested Before-U-Dig asset information along the Stormwater Bypass alignment identified only one unknown service, as shown on the SDC supplied service plan, that crosses approximately 15m downstream of the Leeston Creek and Stormwater Bypass channel confluence, refer figure 7 below. There is no easement that follows this unknown service and it is not identified on Chorus plans and there are no overhead power lines or Transpower assets that cross this location. The likelihood that this is a buried power utility is low, and therefore we identified this service on the detailed design plans as an unknown service, which is to be confirmed by the contractor.

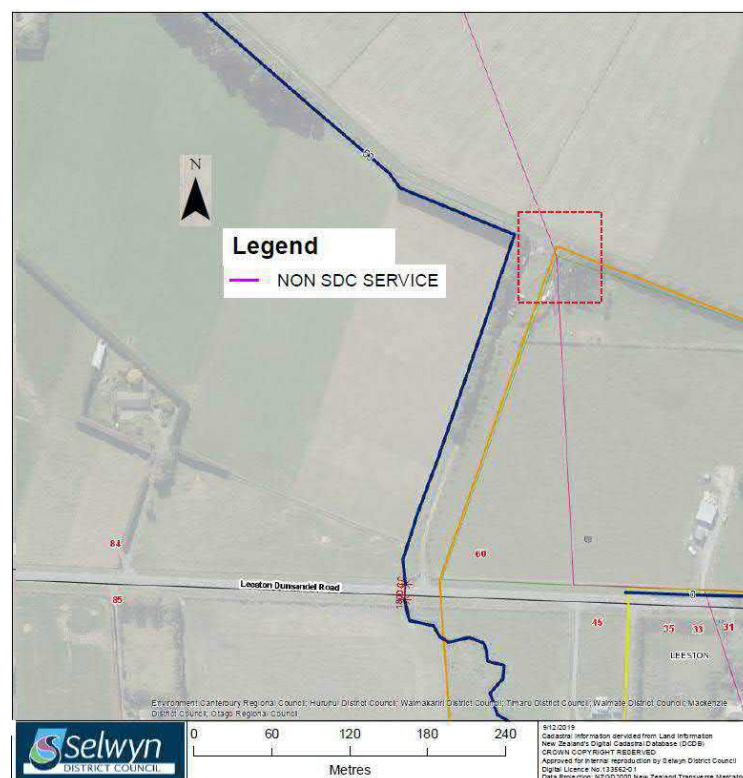


Figure 10 - Unknown utility as shown on SDC Service Plan through the confluence.

8.1.5 Channel Cross Section

The cross section of the channel is up to 20m wide (when including the bund footprint) in Stage 4. During the site meeting with the landowners, concern was raised by one landowner surrounding the width of land required for the channel through his portion of land (Stage 4). As a result of this concern, SDC requested Aurecon identify considerations and risks involved in narrowing the profile of the Stage 4 bypass section. Aurecon noted from the concept design report that the profile had been originally kept wide and shallow due to an anticipated high groundwater table in this area.

The following considerations were given in the email included in the SDC communications in Appendix F, email Sent: Monday, 31 August 2020 4:55 PM, To: Daniel Meehan, Subject: RE: Leeston Stage 4 - Walkover follow up:

1. **Earthworks cost benefit likely neutral:** Logically to narrow the drain profile, it still needs to have the same cross-sectional area to contain the consented flow with freeboard, therefore the same amount of earth volume would need shifting. This would likely indicate that there would be no noticeable savings for SDC in regards to earthworks.
2. **Consent Variation processing cost:** Making changes to the design will require change variation requests to be submitted for the existing consents, of which to my knowledge there are currently four. On the ECan website applications to "Change or cancel the conditions of a resource consent for groundwater or surface water" is \$2,150 or "Change or cancel the conditions of any other resource consent" is \$1,200. I would need to discuss with our Planners to determine how much effort would be required to put this application together and how many applications (\$) would be needed. I haven't proceeded with the Planners for this as I wanted to see what your thoughts were with regards to all of the considerations.
3. **Easement Boundary cost benefit:** As discussed on site with the landowner John Howson, a narrower profile provides John with more land with which to develop his lots, and in turn requires less land for SDC to purchase. Is Geoff Martin also pushing to narrow the proposed bypass drain width? The consented plans show the lot design for the subdivision allow for the wider profile through Geoff Martin's land, and given the cost benefit of earthworks is likely neutral for council, it may therefore make sense to only look at the section through John's land, approximately 250m. This would also reduce the amount of redesign time necessary and any other SDC agreements currently in place.
4. **Time delay:** We would also need to consider that there will be a delay in time in getting the design ready for this summer while waiting on the revised consents to be approved. This would push work out to either winter (unwanted by owners) or next summer.
5. **Design change and Modelling:** We would need to model the modified profile, including draughting (assuming this is for the first 250m only through John's land with a transition into wider current profile through Geoff's land) this would be in the vicinity of \$9,300 (excluding planning input). Working along with this we would need to carry out stormwater modelling of the modified profile which would take approximately two days of the modellers time, approximately \$3,000.

Verbal direction from Daniel Meehan of SDC was to proceed with the design layout as per 2007 preliminary design alignment and profile, with only gaps in the northern bunding to allow stormwater flow from the paddocks to join with the bypass flow. This is discussed further in section 8.1.6 Channel Bund below.

Based on the earthworks model, the earthworks will generate cut soil requiring disposal of up to approximately 7,323m³ for Stage 4, which is the volume of spoil remaining after forming the bunds either side of the bypass channel.

8.1.6 Channel Bund

The Stage 4 bypass profile has shallow grades with the bunds and will be easy to traverse in a farm vehicle or by stock, once grass has established.

It had been identified in the Leeston Flood Modelling 2019 Report (refer Appendix C) that a continuous bund along the northern side of the channel could block overland flow from the paddocks. Referring to section 3.2 Design Scenario (pg 13) of the Leeston Flood Modelling 2019 Report "The proposed Stormwater Bypass has adequate freeboard without constructing raised bunds along both banks. As these bunds will prevent overland flow upstream of the stormwater bypass from entering the waterway it is recommended that consideration is given to not constructing these bunds as part of the proposed Leeston Stormwater Bypass. The need for these bunds or land raising can be assessed during design of the adjacent subdivision."

The revised 2019 flood modelling investigations also identified that even without the bunds, the proposed Stage 4 Stormwater Bypass has adequate freeboard (a minimum of 190mm of available freeboard where bunding is removed) when operating at the design event, to convey 1% Annual Exceedance Probability (AEP) storm event, which is equivalent to 3.78m³/s flow.

As such, the bund design along the northern side only of the channel has been amended from the preliminary design, as approved with SDC, refer section above. The design now excludes portions of the bund on the north side of the channel. The gaps created are intended to coincide with the low points of the existing surface topography, to allow surface flow from surrounding paddocks to drain into the bypass channel. The accuracy

of the survey data (refer section 7 Survey) in this area means that the contractor will need to confirm the identified low points on site. This requirement has been reflected in the design drawings.

We also note that the bunding along the north side of the Stage 4 bypass channel immediately after the confluence spillway and up to chainage 226 has also been removed from the design to allow arborist service vehicles to access the large gum trees when required for branch trimming.

It has been previously recommended to SDC that the bund on the south side could be extended south as an efficient method to dispose of cut material; however due to the volume of spoil, the ability to do so relies on approval from the landowners. As per discussions with SDC, the overall extent of the stated volume needing disposal off site can be reduced if an agreement can be reached with the landowners to utilise the spoil on site. Keeping soil on site may also be of benefit to the future proposed subdivision development of the site to help shape lots. Note that utilisation of spoil on site would have to be kept solely on the southside of the channel to avoid disrupting surface water flow through the northside paddocks, as noted above.

8.1.7 Martins Spring and Dunsandel Drain

The proposed alignment of the channel joins with the existing Martins Spring drain. A 450 mm concrete RCRRJ culvert has been included in the proposed bund design to allow the flow to continue to follow its original path, through the north side of the proposed channel bunding. The inlet and outlet of this culvert will be protected with riprap to prevent scouring. The downstream portion of the existing Martins Spring Drain, south of the new bypass channel and bund, will be disconnected as part of these works. The Martins Spring flow will instead be directed down the low flow channel of the new bypass.

There is an existing channel drain, identified in Figure 11 below as Dunsandel Drain, which Martins Drain currently joins up with. Dunsandel drain runs along the north side of Leeston Dunsandel Road, diverts through number 43 Leeston Dunsandel Road, joins up with Martins Spring and then continues along the north side (backend) of the properties along Pound Road. The Stage 4 channel will connect with this drain at the back of number 9 Pound Road. Dunsandel Drain will be widened from 9 Pound Road along the Stage 4 portion to match the Stage 1 profile, this is discussed further in 8.1.9 Future Wetland Bypass Channel and Connections.

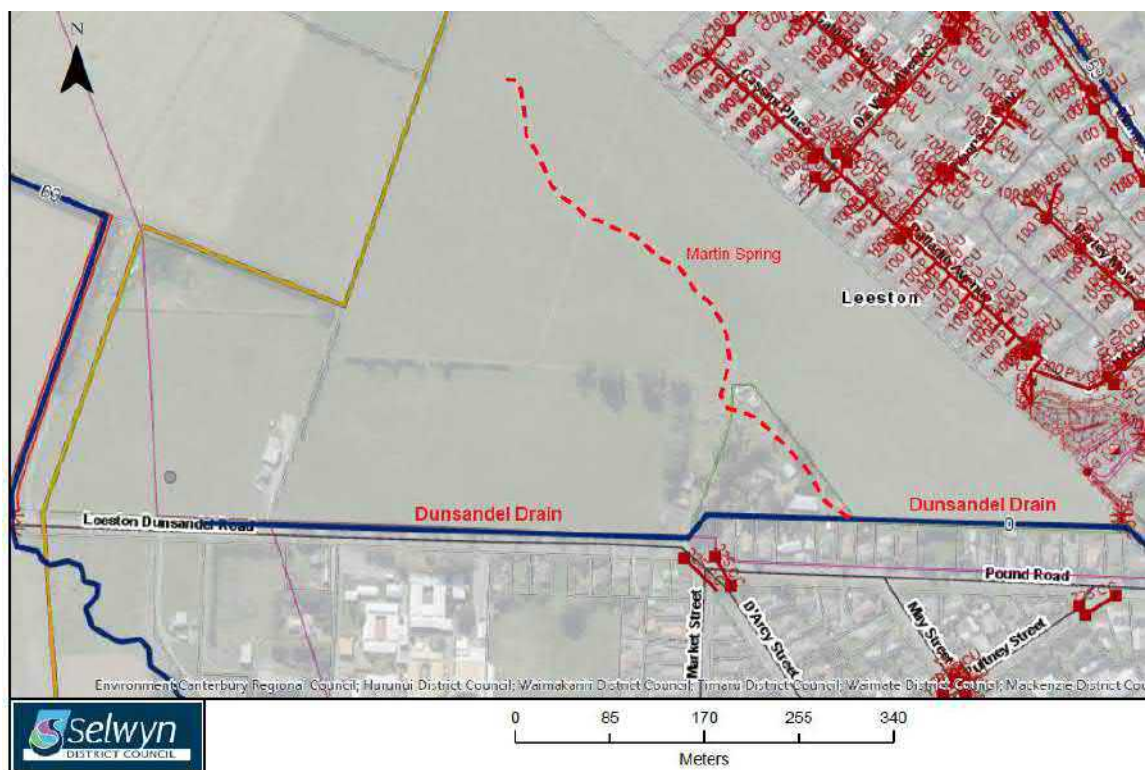


Figure 11 - Martins Drain (red dashed) and Dunsandel Drains (continuous blue)

8.1.8 Fish Passage Consideration

The landowner has identified that Martins Spring is ephemeral and dries up during summer, however during winter it has a steady flow and as part of the resource consent requirements, consideration has been given for fish passage through the proposed bypass channel, providing an uninterrupted passage from the source of Martins Spring through to the Stage 4 to 1 connection.

The NIWA Fish Passage Guidelines document (pg 11) indicates that culverts should be embedded by 25 – 50% of their diameter and that no vertical drops should be placed within the alignment. The Resource Management (National Environmental Standards for Freshwater, referred to as NES) Regulations implemented 3rd September 2020, Section 70 (2) (e)-(g) state the following:

- (e) the culvert must be open-bottomed, or its invert must be placed so that at least 25% of the culvert's diameter is below the level of the bed.
- (f) the bed substrate must be present over the full length of the culvert and stable at the flow rate at or below which the water flows for 80% of the time; and
- (g) the culvert provides for continuity of geomorphic processes (such as the movement of sediment and debris).

Burying the Stage 4 Martins Spring drain culvert pipe by 25% would reduce its capacity. Because of this requirement, Aurecon have shown in the drawings that the culvert is to be buried 25%. The pipe size has been increased from 375mm to 450 mm to account for this.

Similarly, burying the proposed Stage 5 twin DN1200 farm culvert replacements effectively reduces their capacity. The pipe size would need to be increased from DN1200 to DN1600 to account for this.

The drawings proposed to install a box culvert for reasons given in section 8.2.1 Farm Culvert Design. The proposed box culvert of Stage 5 is not shown to be buried 25% due to the cross-sectional restrictions, which is consistent with what was approved by ECan for the box culvert in Stage 3 of the Leeston Bypass. This has been accounted for in the new consent application as a discretionary activity.

If there is difficulty with supply and installation of a box culvert versus twin DN1600 pipes, the installation of DN1600 pipes could be shown as not degrading fish passage and therefore wouldn't require much to approve.

With regards to the confluence structure, the NIWA Fish Passage Guidelines recommend the use of natural substrate at the base of any new structures in order to maintain "hydraulically diverse" flow environments. This means that the fish have areas where they can rest, hide, and lay eggs. SDC revision comments expressed concern for the amount of rip rap used at the confluence (refer Appendix G, item 12) and identified there should be a low flow (refer Appendix G, item 17). A low flow was not previously proposed through this section due to the available inverts and grades and had been designed to allow flow through that met the original channel flat base profile.

To meet these revision comments, it is proposed to use uncompacted pit run at the base of the confluence between Stages 4 and 5. Void fill has also been added to the drawings and specification for the proposed rip rap, which will help shape a low flow base and keep to the inverts.

As part of the NES considerations of fish, allowance should be made for fish salvage in Martins Spring (if it is still flowing at time of construction), and Leeston Creek (depending on the method of flow diversion used by the contractor). In order to satisfy this, we recommend an SDC ecologist consult on the process, which we anticipate would include the following processes:

- Install precautionary fish screens upstream and downstream of the new channel alignment in Martins Spring, or confluence works of Leeston Creek.
- Allow SDC ecologist to attend site to catch and clear fish from the works portions of the drains and transfer all caught fish downstream of the works.
- While screens are in place, they are to be cleaned out after any significant rainfall event

8.1.9 Future Wetland Bypass Channel and Connections

There is currently an existing wetland that is located at the corner of Palladio Avenue and Wheatsheaf Drive and neighbouring the farmland where the proposed bypass is indicated to go. Stage 6 of the Leeston Stormwater Bypass project is to extend the existing wetlands and connect the bypass to it. This is to be done as part of the future subdivision development, by the developer. This calculation will need to account for additional surface flows from roads and properties and are outside the scope of this design.



Figure 12 - Existing and Future Wetlands

To avoid these future proposed wetlands at the downstream portion of Stage 4, the channel profile narrows from wide and shallow, and subsequently deepens, and the alignment runs along the outer perimeter of the proposed wetlands. Discussion was had with SDC about a straighter alignment through the future wetlands, however the overall alignment as shown in the drawings has been kept as per SDC's direction, as "Changing the alignment significantly could be problematic due to the challenges we are facing with land acquisition etc." (refer SDC Communications, Appendix F, response email From: Daniel Meehan, Sent: Wednesday, 12 August 2020 3:35 PM, Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents). It is understood that this narrowed portion will be appropriately modified in the future when the wetlands design is progressed.

During this design phase, it was identified that the reduction in cross-sectional flow area was a risk for overtopping, as the previous model showed there was no freeboard at this location. We found that this lack of freeboard was due to a weir that was included in the preliminary design hydraulic model at the wetlands location, which was intended to represent a spillway into the future wetlands. As noted above, the future subdivision will need to factor additional surface flows from roads and properties, which are outside the scope of this design. The revised detailed design hydraulic flood model removed this wetland weir and determined that the freeboard was about 210mm at the narrowing portion of the bypass. Even so, bunding had been added to give some additional freeboard as well as to provide a means to keep some of the spoil on site.

The SDC revision comments of the detailed design (refer Appendix G SDC Comments, item 6 and 50) indicated that there was concern the bund would restrict the access for the farmer, and suggested a culvert be installed across the narrow portion of the bypass due to the steep sides. Due to the 5m width of this narrow portion of the bypass, a large box culvert would be needed to ensure there was no disruption to the design flows. This would add cost to the construction and would also require Aurecon to review the effect in the model to ensure no throttling and overtopping occurred as a result of installing a box culvert. Due to time constraints, this was not possible for Aurecon to assess in a timely manner. Hence the northern side of the bund closest to the wetland boundary has been removed, and a compacted AP65 hardstand area has been proposed, if

vehicle access is absolutely necessary. Grades will be fine for a 4x4 vehicle, across the rip rap sides and onto the AP65 base, however this may disrupt the shape of the rip rap needed for the 1% Annual Exceedance Probability (AEP) design flows. Because the land is being sold to a developer, as verbally indicated by SDC, Aurecon's preferred recommendation is for a post and wire fence along the north side of the narrow portion of the bypass to keep wandering stock out of the isolated portion of future wetland, and for alternative access to be made from Leeston Dunsandel Road, corner of Market St and Pound Rd, which is considered a more cost effective option than providing a culvert crossing.

The flow around the 90deg bend where the bypass connects with Dunsandel drain, and the proximity of the alignment to residential properties was also viewed as a risk, and was reviewed in the updated hydraulic model to find there was also no overtopping for the 1% AEP design flows at this location. Currently there is a lack of space for a bund to provide additional protection between the channel and the properties, however, the model determined that the freeboard was about 270mm at this location. We expect that the Dunsandel Drain connection will be providing a "cushioning" effect and additional storage capacity.

There are two connections for the bypass with existing drains along this downstream portion. The first of these is the Stage 4 connection to the existing Dunsandel Drain, immediately north of 9 Pound Road. The invert of Dunsandel Drain appears to sit approximately 400 mm above the proposed invert of the modified drain. The outlet of this drain into the proposed channel will be protected with riprap in order to minimise scouring.

There is also a culvert connecting to the proposed channel alignment stemming from the existing wetland north of the proposed Stage 4 to 1 connection. The design proposes that the outlet of this culvert will be lined with rock/riprap to protect it from stormwater flow.

8.2 Stage 5 - Leeston Creek Upgrade Design

The preliminary 2019 flood modelling identified that the existing Stage 5 Leeston Creek reach, between Harmans Road and the Stage 4 Bypass confluence (CH0 to CH575), has insufficient capacity to convey the design flow to the confluence spillway structure. The landowner of the adjacent property identified during the walkover that the breakout of flow also occurred on the northside, upstream of the culvert. The flood modelling investigations (refer Appendix C Leeston Flood Modelling 2019) indicated that in a significant event, stormwater would break out on the north side creating localised flooding confirming what the landowner identified, however once this initial floodplain storage is overwhelmed further, flow will break out over the southern bank of the creek upstream of the proposed Stage 4 confluence. The Leeston flood model indicates that once this flow exits the waterway it does not re-enter prior to the Stage 4 confluence instead the model predicts the flow to follow existing overland flow paths south until it re-joins the creek slightly upstream of Leeston Dunsandel Rd. Stormwater would then travel into the township and cause widespread flooding as shown in past rainfall events.

Stage 5 of the stormwater bypass channel will involve 575 lineal metres of soil disturbance, with excavations proposed to widen the existing drain to a base width that varies from 2.5 m to 3.5 m base with a typical depth of 1.1 m. The existing single DN1200 farm culvert servicing the field access within the property is proposed to be upgraded to a 2.5 m wide by 1.0 m high and 4.65 m long box culvert.

Based on the latest volumes from the earthworks model, Stage 5 works will generate cut soil requiring disposal of up to 1,250m³. Revised detail design Stage 5 does have a 200m bund proposed along the northern bank (CH330 to CH530) which uses 27.8m³ of spoil, the volume of 1,250m³ is the total spoil needing disposal.

Due to the concerns raised by landowners regarding the creek breaking its banks on the north side, it was suggested that some of the excavated material may be left beside the river and grassed in order to make a bund for extra security.

As part of the detailed design process a one-dimensional hydraulic model was constructed (refer Section 9), to test and verify the proposed cross-sectional profile and grade of the Stage 5 channel. Alongside an appropriate maintenance program, the proposed Stage 5 channel upgrades will ensure that this portion of Leeston Creek has sufficient capacity to convey the 3.78m³/s one-hundred-year design flow into the Stage 4 Bypass.

8.2.1 Farm Culvert Design

Preliminary design flood modelling had indicated that replacing the single farm 1200 mm diameter (DN1200) culvert with twin DN1200 culverts (or similar) would be sufficient to convey the 1% Annual Exceedance Probability (AEP) storm event flow ($3.78\text{m}^3/\text{s}$) defined in the consent.

The original scope was for twin DN1200, however the newly imposed 2020 National Environmental Standards (NES) for Freshwater Fish Passage Section 71 condition require culverts to be buried 25%. Refer 8.1.8 Fish Passage Consideration. As a result, the twin DN1200 would need to be increased to twin DN1600 and therefore an increase in construction cost.

To provide improved constructability, with slightly improved capacity than the twin DN1200 culverts due to the slightly larger cross-sectional area, we proposed in the updated design a 2.5m wide by 1.0m high, and using the standard 1.55m long box culvert units with wingwalls for the inlet and outlet (therefore not requiring special mould). Three of these are needed, making it 4.65 m long. Note though that the proposed unit sizes are standard length and will not require specialty moulds as was specified in the construction of Stage 3.

The proposed box culvert of Stage 5 will not be buried by 25% for fish passage due to the cross-sectional restrictions. This is accounted for in the consent as a discretionary activity, which is consistent with what was approved for the box culvert in Stage 3. Fish passage considerations are noted in section 8.1.8 Fish Passage Consideration.

If SDC decide that the box culvert is not preferable due to significant construction cost differences, then the use of twin DN1600 RCRRJ Class 4 pipe would meet the NES requirements of 1.3 x the base width and can be buried 25%, and can be substituted into the design in place of the box culvert.

8.3 Rip Rap

The locations and extents determined for the rip rap, as shown on the drawings, were determined using the Hydraulic Model of the bypass to check for potential scour. As identified on the drawings (refer Appendix A), these locations are typically where the profile, direction and gradient of the drain changes, leading to increases in velocity.

Both the channels and the associated structures have been designed to convey a one in one hundred year design storm flow of 3.78m³/s, with the exception of the control gate structure at Stage 4 and 5 confluence, which is designed to convey a 0.6m³/s flow as per the resource consent conditions. The Hydraulic Modelling carried out for this project is described in the section 9 Hydraulic Modelling, below.

Sizing of the rip rap was based on Christchurch City Council's Waterways, Wetlands and Drainage Guide (WWDG) Part B, Section 22 – Hydraulics. The assessment was carried out using Equation 22-16, which is based on the Ibash formula:

$$d_{50} = K \frac{v^2}{2g} \quad \text{Eqn (22-16)}$$

K incorporates an allowance for the degree of turbulence and stone angle of internal friction. The angular characteristic of the rock, to ensure a good level of interlocking, has been defined in the drawings and specification, and mean the K value can be taken as 0.42. The velocity (v) was taken as the highest value found in the hydraulic modelling, which was determined as 1.51 m/s. The size required for the median diameter of rip rap was determined as 49mm.

The use of equation 22-16 requires that the bed slope is less than 5%, and assumes high turbulence, which is the case for this bypass throughout. Checked against Figure 13 - Stable Bed Velocities table 22-5 from CCC WWDG, below, we can see the value correlates.

Table 22-5: Stable bed velocities

Ibash		Eqn(22-13)	y/d = 5
d ₅₀ (m)	vel (m/s)	d ₇₅ (m)	V _{max} (m/s)
		0.003	0.40
		0.006	0.60
		0.010	0.75
0.020	1.0	0.020	1.1
0.030	1.2	0.030	1.3
0.040	1.4	0.040	1.6
0.060	1.7	0.060	1.9
0.080	1.9	0.080	2.2
0.100	2.2	0.100	2.5
0.120	2.4	0.120	2.7
0.150	2.6	0.150	3.0
0.200	3.1	0.200	3.3

Figure 13 - Stable Bed Velocities table 22-5 from CCC WWDG

This determined value is too small for rip rap realistically, so we decided to proceed with a reasonably small standard rip rap median diameter of 150mm. d_{max} is taken as double the median, equating to 300mm. D_{min} was then determined to be 100mm.

9 Hydraulic Modelling

To hydraulically verify the proposed Stage 4 and 5 channel geometry, the alignments were modelled using the United States Army Corps of Engineer's Hydrologic Engineering Centre's River Analysis System (HEC-RAS) modelling software. Both the channels and the associated structures have been designed to convey a one in one hundred year design storm flow of $3.78\text{m}^3/\text{s}$, with the exception of the control gate structure at Stage 4 / 5 confluence, which is designed to convey a $0.6\text{m}^3/\text{s}$ flow as per the resource consent conditions. The Flood Model output for this is shown in Appendix E. Note that the chainages shown in the output are in reverse to the chainages shown in the drawing. This is due to HEC-RAS being an American based modelling tool, where the method is to start from the downstream limit.

The HEC-RAS model is a one-dimensional, steady state model which utilises the boundary conditions extracted directly from the two-dimensional Leeston Stormwater Flood Model (based in the Danish Hydraulic Institute's MIKE FLOOD modelling software programme). For further information regarding the hydrological basis of the model and the wider Leeston floodplain model please consult Aurecon's associated Leeston Stormwater Bypass: Flood Modelling Report (revision 4 dated 17 May 2019).

9.1 Stage 4: Leeston Bypass Channel

The Stage 4 reach of the HEC-RAS model is bounded by the Stage 4 / 5 confluence at the upstream end and the Stage 4 / 1 confluence at the downstream end. The reach comprises of two main cross-sectional profiles;

- A wider upstream profile with a base width of eight metres, one to four batters and additional bunding on either bank
- A narrower parabolic downstream profile with one to one batters and bunds

The reach has been modelled with a Manning's n value of 0.035 which represents a fairly uniform well-maintained grass lined channel (Christchurch City Council Waterways, Wetlands and Drainage Guide). The general topography falls gradually from the north to the south whilst the Bypass runs West to East, hence northern bund has been cutdown at a number of locations to allow overland flow to enter into the bypass. The true right (right bank when looking downstream) side of the channel has an average freeboard of 570mm and a minimum freeboard of 220mm. The true left bank has an average freeboard of 450mm and a minimum freeboard of 100mm which occurs at a bank cutdown.

Note whilst two minor waterways intersect the Stage 4 alignment, namely Martin's Spring and Dunsandel Drain, no additional inflow has been allowed for at each of these junctions. This is in line with hydrological parameters modelled in the larger Leeston floodplain model (refer Leeston Stormwater Bypass: Flood Modelling Report May 2019).

9.2 Stage 5: Upgraded portion of Leeston Creek

The Stage 5 reach of the HEC-RAS model is bounded by the Harmans Road culvert at upstream end and the Stage 4 / 5 confluence at the downstream end.

The channel has a fairly consistent cross-sectional profile, reflecting that of the Stage One profile, with a base width of 2.5m to 3.25m a left bank batter of one to two and right bank batter profile of one to one. The steeper right bank profile is to cater to the existing trees adjacent to the waterway whilst ensuring bulk earthworks are minimised where possible.

Consistent with other reaches in the Bypass scheme and the downstream Stage 4 reach, Stage 5 has been modelled with a Manning's n value of 0.035. It was noted during the initial site inspection / survey (mid 2019) that the portion of Leeston Creek which forms Stage 5 of the bypass was severely overgrown with a number of large established plants within the waterway. The reach will not perform to design if the drains are not regularly maintained. If Council would like to have a reduced maintenance program on this portion of the Bypass, the cross-sectional area of the drain should be increased, and HEC-RAS model rerun with an increased Manning's n value.

There are severe consequences if the right bank of Stage 5 channel overtops as flow that breaks out in this portion of the Bypass does not re-enter the scheme and instead flows into the Leeston Township along existing overland flow routes.

The true right (right bank when looking downstream) side of the channel has an average freeboard of 260 mm and a minimum freeboard of 120mm. The true left bank has an average freeboard of 190mm and a minimum freeboard of 100mm.

9.3 Hydraulic Structures

Four hydraulic structures are present within the HEC-RAS model, they are as follows:

- Stage 5 farm culvert: Modelled as an inline 2.5m wide by 1m high box culvert.
- Control gate: Modelled as a lateral structure with an 800mm wide control gate at the Stage 4 / 5 confluence.
- Concrete spillway weir: Modelled as 17m wide low-profile weir at the Stage 4 / 5 confluence.
- Downstream Stage One culvert: Modelled as a 3.5m wide by 900mm high box culvert to ensure the model reflected an appropriate tailwater condition.

The Stage 5 Farm culvert, whilst inlet controlled, has sufficient capacity to convey the 3.78m³/s design flow without creating adverse tailwater effects on the upstream portion of the Stage 5 reach.

The Control gate at the Stage 4 / 5 confluence has been designed to ensure that up to a maximum of 0.6m³/s flow can continue down the existing Leeston Creek alignment in a one-hundred-year storm event. To limit the flow to 0.6m³/s the gate should be restricted to a maximum opening of 800mm wide by 400mm high. As the Stage 4 bypass channel has been designed to convey the full 3.78m³/s one hundred year storm flow, our recommendation is to close this control gate in the event that a significant rainfall event is predicted to cause flooding within the Leeston Township and direct all storm flows into the Stage 4 Bypass. This will free up much needed conveyance capacity with the upstream portion of the Leeston Township stormwater reticulation network.

10 SiD and Risk Workshop

The purpose of Safety in Design is to identify potential hazards and then eliminate or minimise the potential risks of injury throughout the life of the infrastructure. This includes the design, construction, operation, maintenance and decommissioning of the infrastructure.

A Safety in Design risk register has been developed for this detailed design phase and can be found in Appendix B. This assessment has identified the risk sources (i.e. hazards) associated with the design, assessed the risks and, where the risks cannot be eliminated, established control measures as well as the parties best placed to implement the control measures. The Safety in Design assessment is a live document that will be updated as the design progresses.

Any residual risks in the safety in design assessment that are more than moderate will be identified for approval and ownership by SDC.

A Safety in Design workshop was undertaken at the commencement of the detailed design stage with Aurecon designers and a representative from SDC. All items in the Safety in Design register were discussed and any additional Safety in Design considerations identified at this workshop were documented in the register. This has allowed safety improvements to be integrated into the specific elements in the detailed design of the proposed bypass works. Refer to the Appendix B for the Safety in Design documentation. Points of note include the following:

- Ongoing uncertainty due to the COVID-19 pandemic.
- Much of the work is taking place in and around existing waterways.
- The existing farmland nature of the land (livestock and potential contamination).
- Construction of concrete structures.

11 Slope Stability Treatment (Grassing versus Planting)

The majority of the Stage 4 bypass channel is shallow and wide, and the intent is to grass on completion, reinstating the surface to its existing condition. This is addressed in the new consent application.

The grass seed used across the whole of the proposed work site needs to meet the requirements of the landowner's pasture farming requirements and in agreement with Selwyn District Council.

Maintenance of the grass levels will be required during Spring and Autumn to reduce height of overgrown grasses in the Stage 5 drain, it is especially important for this to be checked before a large event. This is also applicable to the Stage 4 bypass where stock are not accessing the grass and keeping it low.

The preliminary design indicated that the 1:1 and 1:2 slopes are planted with Carex, however planting requires long term maintenance for weed management, and also leads to gaps between plants that are still subject to erosion, the extent of such erosion is typically hidden under coir matting. The growth height and size of mature plants tend to also reduce the capacity of the drain.

To provide batter stabilisation for slopes that are steeper than 2H:1V, the design proposes to use Cirtex EEC3 high performance turf matting over top of a hydro mulched surface, as per the drawings. Once vegetated, ECC3 can handle flow velocities up to 7.62 m/s which make it an attractive alternative to traditional hard armour scour protection methods such as concrete and gabions.

12 Fencing

During the walkover it was identified that the proposed bypass alignment crosses through a number of existing stock management fences and bisects the existing paddocks into smaller portions. The landowners will expect to be able to still manage their stock by allowing movement into each portion and avoid having their stock wander into neighbouring land.

Reinstating wire and waratah fence perpendicular across the channel, as would sometimes be required, needs to consider the following points:

- from the stormwater design perspective, the potential of debris build-up in the wire fence caused by a fence for a large storm event; and
- from the farmers perspective the ability to restrain stock during normal day-to-day farm operation.

The majority of the bypass channel is shallow and wide and will be grassed on completion, and because of this will be safe for stock to pass through. The gradients are shallow enough for traversing in a farm vehicle also.

For the sections where the bypass crosses boundaries or through existing fencing, SDC have proposed to install a fence that gives way when under load from storm flow. The drawings show the location of fences to be replaced at the points of intersection with the bypass, and how these are to be installed. A note is included on the drawings to indicate their functionality and that an experienced fencing contractor is needed to advise and install. SDC may need to discuss maintenance of these types of fences with the landowner depending on agreements. It is advisable for SDC maintenance to check that debris has not built up around the base of the round support posts proposed to be installed within the area of flow. An experienced fencing contractor will be needed to install the fence and make any amendments in agreement with the Engineer. The aim of the spacing is to avoid too many support posts being installed through the channel, which would reduce the bypass capacity.

The one issue identified with letting stock into the bypass channel is the waste material generated by the stock will be washed downstream during each storm event. However, stock have been accessing Martins Spring without restriction to date, so Aurecon have worded the consent application to avoid fencing off the full alignment. Fencing off the bypass will also require gates and increase SDC maintenance requirements and is likely a large cost for SDC for a short term (until the development of the land).

13 Contaminated Land Investigations

Stages 4 and 5 of the stormwater bypass channel will involve 1.7km of soil disturbance, with excavations down to 0.94 m below the current ground level through the wide portion of the bypass channel, and down to 1.39m below the current ground level through the narrow portion of the bypass channel (near the existing wetlands). Based on the latest volumes from the earthworks model, these works will generate cut soil requiring disposal of up to approximately 7,323m³ for Stage 4, and 1,250m³ for Stage 5. The extent of both stated volumes depends on how much of this spoil can be utilised on site, as discussed in 8.1.6 Channel Bund. The Stage 4 volume of 7,323m³ is the spoil remaining after forming the bunds either side of the bypass channel. Because Stage 5 does not yet have a bund in the design, the volume of 1,250m³ is the total spoil needing disposal.

If the spoil cannot remain on site as discussed in 8.1.6 Channel Bund, in order to dispose of this material off site at a clean fill, an assessment of the soil for contaminants will be required in order to meet the clean fill site requirements. A proposal was provided to SDC which relates to soil sampling investigation and subsequent contamination assessment, to determine options for soil management and disposal.

A cursory review of aerial photography suggests the land the proposed alignment of the stormwater bypass crosses through has been used as pastoral land for at least the last 65 years. The last 20 years have seen some minor farm buildings and houses erected at the western end of the Stage 4 Confluence, but otherwise the land along the alignment has seen little development. The geological map of the Christchurch area indicates the alignment to lie within grey river alluvium comprising gravel, sand and silt. Based on our knowledge of the Leeston area surface geology, we anticipate topsoil and sandy silts to be between 0.5 m and 1.0 m below ground level, overlying very dense gravel.

A search of Environment Canterbury Regional Council's (ECan) Listed Land Use Register (LLUR) did not return any known HAIL sites within a 50 m buffer of the proposed alignment.

Our proposal was tailored to assess the potential for contamination to be present within the soil that will be disturbed, and to provide recommendations for disposal of surplus soil in the form of a letter report. This will identify key contamination issues associated with the project and will be appropriate for inclusion in consent applications for the work.

SDC requested that the proposal was revised to focus on Stage 4 only, this was due to budgeting restrictions and because Stage 5 may likely be built at a later stage to Stage 4. This revised proposal for Stage 4 only is currently with SDC as of the time of this report. Refer SDC Communications, Appendix F, email From: Ben Henry, Sent: Friday, 9 October 2020 4:51 PM, Subject: RE: 505193 Leeston Stage 4&5 Contaminated land investigation.

To manage the potential budget risk of encountering contaminated land, a high-level estimate of quantities needed to go to Kate Valley has been allowed for in the Engineers Estimate as provisional items. We note that Burwood closes at the end of the year (before construction begins).

14 Erosion and Sediment Control

Erosion and Sediment Control Plan (ESCP) is not within Aurecon's scope for this design. SDC will need to ensure the contractor provides an ESCP which is stamped approved by ECan. Considerations should include, but not be limited to:

- Working in a live waterway – measures to protect the existing waterway flora and fauna.
- Bulk earthmoving for Stages 4 and 5.
- Exposed earth due to excavation.
- Stockpiling of material.
- Removal/installation/adjustment of culverts.
- Inspection/maintenance of ESCP measures.

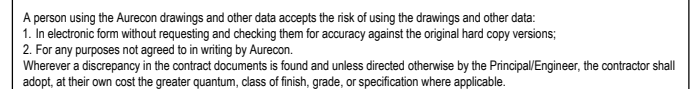
Appendix A

Design Drawings

Doc File: laureum.infobases\NCHC\Projects\555-193 - SDC Loretto SN Biosas Stage 3 & 45 Deliverables\555-193-DRC-CC-000-C00-00\lwa
Name: Jordan Wilsch-Kade Xref: 555-193-CANTERBURY-03n-RURAL-AERIAL-PHOTOS-2015-2016_555193-VR-BASE
Images: Aurecon Logo www.SDC.LO



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APPROVED  DATE 12/11/2020		TITLE SAFETY IN DESIGN SHEET 1	
A. LINDGREN		DRAWING No. PROJECT No. AREA TYPE DISC NUMBER REV A. LINDGREN 505193 - 0000 - DRG - CC - 4001 - B	



CLIENT

 **Selwyn**
DISTRICT COUNCIL

[illegible]

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER
NOT FOR CONSTRUCTION

APPROVED

DATE
12/11/2020

A. LINDGREN

A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4						
TITLE	SAFETY IN DESIGN SHEET 1						
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IDENTIFY HAZARD					ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Applicable Phases	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
Construction and Commissioning Phase																	
1.12	A high ground water level is encountered throughout the full alignment.	Contractor excavations encounter a higher than anticipated ground water level throughout the alignment springs which cause delays to construction due to requirements to manage	Contractor	ALL	3 - Likely	D - Significant	Moderate	Contractor to provide methodology on how to manage high ground water levels. Options include managing by a) sump pump or b) spear use for GWL reduction. Option a) is preferable as a less costly option and has been used successfully at Stage 3 culvert installation. Spear install to draw water down is much more costly. We have put both as Provisional Items in cost estimate. Contractor to assess how they would address this in their methodology.	3 - Likely	D - Significant	Moderate	Contractor	Yes	Methodology to be ready for implementation	Contractor	Construction Phase	Open
1.13	Livestock on operational farm	Interaction with livestock leads to injury of workers or damage to livestock	Contractor / Landowner	ALL	3 - Likely	C - Serious	High	Fencing to be constructed/installed on site to minimise or avoid interaction between waterway (maintenance), workers and livestock. Communicate with landowner around programme to aid movement of livestock. Understand consent conditions.	2 - Unlikely	C - Serious	Moderate	Contractor / SDC / Construction observer	Yes	Communicate with landowner	Contractor / SDC / Construction observer	Construction Phase	Open
1.14	Laying of larger rock rip rap at the confluence results in injury	Contractor has accident while laying the large rip rap	Contractor	ALL	3 - Likely	C - Serious	High	Contractor to ensure methodology is in place to ensure the safety of the crew. Appropriate PPE to be worn at all times. Protection of eyes and hands and feet.	2 - Unlikely	C - Serious	Moderate	Contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
1.15	Installation of structures (eg culverts, confluence) results in injury	Contractor has accident while installing structures	Contractor	ALL	3 - Likely	C - Serious	High	Contractor to ensure methodology is in place to ensure the safety of the crew. Appropriate PPE to be worn at all times. Protection of eyes and hands and feet.	2 - Unlikely	C - Serious	Moderate	Contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
1.16	Erosion of 1H:1V slopes	1H:1V slopes have difficulty establishing grass and continue to erode	SDC	ALL	3 - Likely	D - Significant	Moderate	Contractor to ensure methodology is in place to ensure the safety of the crew. Appropriate PPE to be worn at all times. Protection of eyes and hands and feet.	2 - Unlikely	D - Significant	Low	Contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
Maintenance and Operation Phase																	
2.01	Water Drain	Open water drain creates drowning and injury risk.	Maintenance contractor	ALL	1 - Very unlikely	A - Disastrous	High	Contractor to ensure a safe working environment for all employed on site - stated in Specifications. SDC to specify installing necessary fencing to isolate the hazard.	1 - Very unlikely	A - Disastrous	High	Maintenance contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.			Open
2.02	Set height of Control Gate	Works or Maintenance Contractor (SDC) leave the gate closed or set higher than the consented operation height as they are not aware of the consent requirement. A continually closed gate would lead to drying up of the downstream portion of Leeston Creek, blocking fish passage. Leaving wide open would let more water past than the consented 0.6m ³ /s and lead to flooding downstream in Leeston township during a 1% AEP storm event.	Works contractor / Maintenance Contractor (SDC)	ALL	5 - Very likely	D - Significant	High	Design drawings have been updated by Aurecon to require Taage Engineering to provide a clear height marker on both sides of the engineered gate. Gate needs to have a 400mm opening during normal operation (non storm events), however it is recommended that during a 1% AEP (or close) event it is closed for the duration of the storm, and then reopened for normal operation. Contractor to ensure gate height is set to 400mm open when works are completed. Lock to be placed on winch making only accessible to SDC maintenance team. SDC to update maintenance team to understand the requirements indicated in the Detailed Design Report.	2 - Unlikely	D - Significant	Low	Aurecon / Works contractor / Maintenance Contractor (SDC)	Yes	Ensure all described measures are carried out appropriately and correctly.			Open
2.03	Signage	Public entering property	Maintenance contractor / community	ALL	2 - Unlikely	D - Significant	Low	Appropriate signage, private property signage in place	1 - Very unlikely	D - Significant	Low	Maintenance contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.			Open
2.04	Poor maintenance of stage 5 drain and confluence diversion structure leads to reduced drain capacity during storm events	Lack of maintenance of upgraded drainage leading to blockages or otherwise reduced flow capacity and design flows breaking out of Leeston Creek before reaching the confluence diversion structure and stage 4 bypass	Maintenance contractor / SDC	ALL	4 - Good chance	D - Significant	High	Regular maintenance requirements of grass on banks and weeds in drain to be clearly laid out in maintenance contract. Maintenance to keep the gate free of debris. Requirements indicated in Detailed Design Report. SDC to check stage 5 drain prior to storm events	2 - Unlikely	D - Significant	Low	Maintenance contractor	Yes	Ensure all described measures are carried out appropriately and correctly.			Open
2.05	Unsafe mowing of surfaces	Wet/boggy ground conditions, gradients too steep for mowers	Maintenance contractor	ALL	4 - Good chance	E - Minor	Moderate	Grassed areas of waterway designed to be clear of low flow water level and at suitable gradient. Where banks are not at gradient suitable for mower, string trimmers are expected to be used to reduce overgrowth. Stage 4 paddock is anticipated to be accessible to stock (which will keep growth down) until subdivision works get underway.	2 - Unlikely	E - Minor	Low	Aurecon / SDC	Yes	Ensure all described measures are carried out appropriately and correctly.			Open

Likelihood of occurrence					
Most Likely Consequence	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low



REV	DATE	REVISION DETAILS	APPROVED
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B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

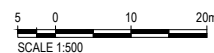
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DESIGNED	N CATTO
REVIEWED	R. DAVIES

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APPROVED	TITLE
DATE 12/11/2020	SAFETY IN DESIGN SHEET 2
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A. LINDGREN	PROJECT No. 505193

AREA	TYPE	DISC	NUMBER	REV
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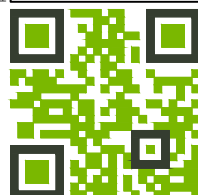
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- MAJOR CONTOUR (0.5m)
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- EXTENT OF WORKS

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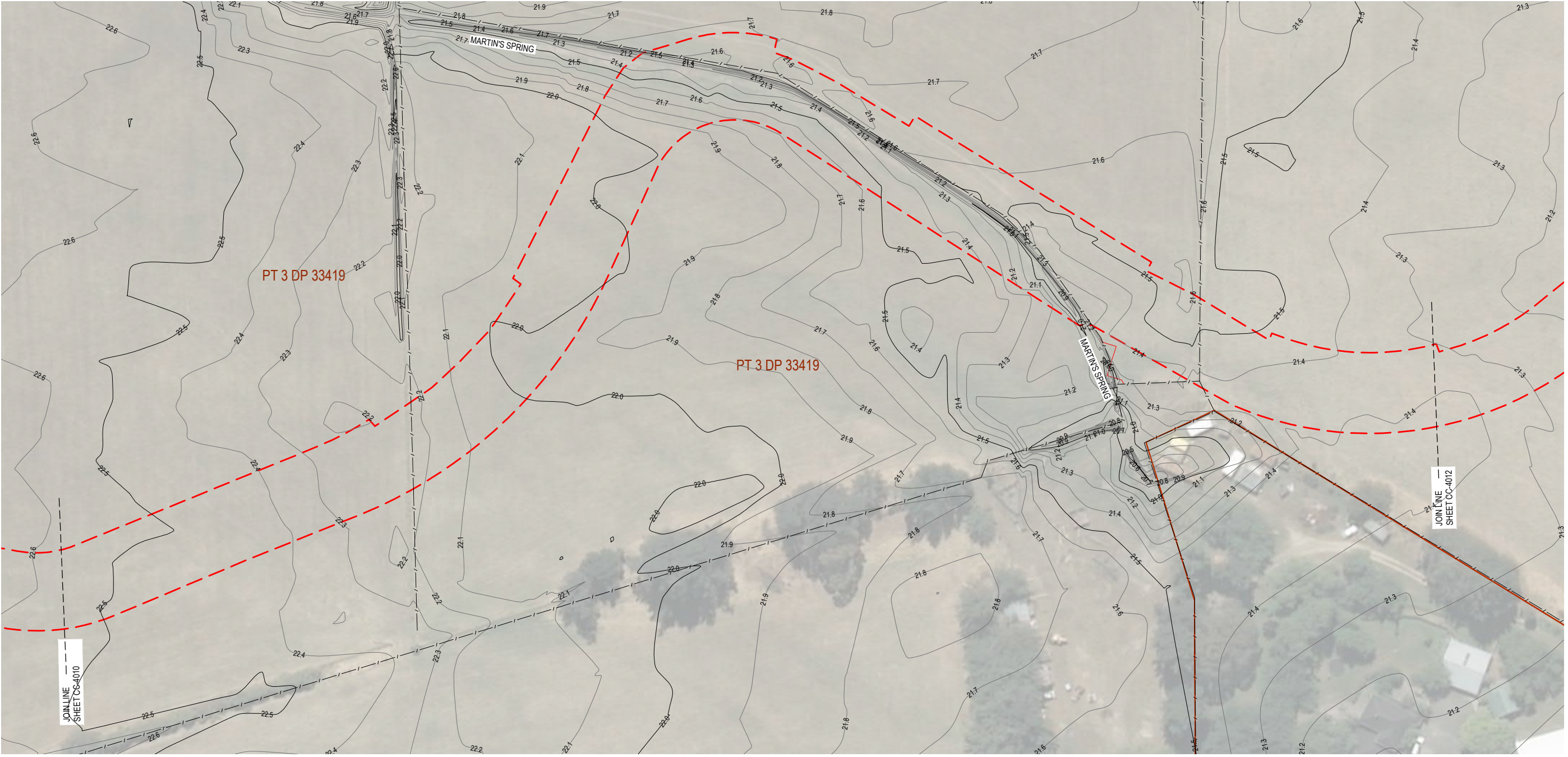


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B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

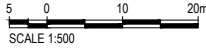
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DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER
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A. LINDGREN
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PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	EXISTING CONTOURS SHEET 1
DRAWING No.	505193
PROJECT No.	0000
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TYPE	CC
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PLAN VIEW
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- EXISTING FENCE
- EXTENT OF WORKS

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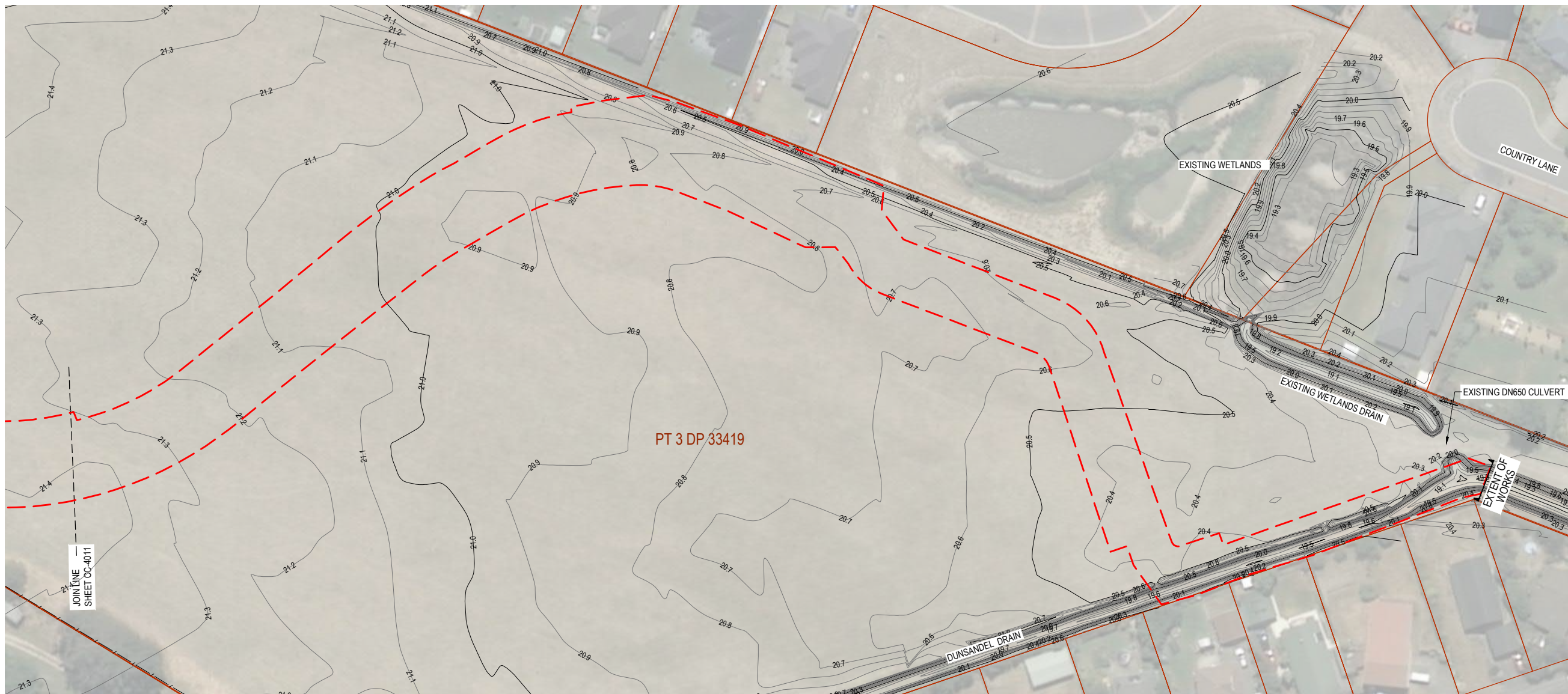


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B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

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REVIEWED	
R. DAVIES	

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APPROVED
A. LINDGREN
DATE
16/10/20

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	EXISTING CONTOURS SHEET 2
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
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NUMBER	B
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PLAN VIEW
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- EXISTING FENCE
- EXTENT OF WORKS

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B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

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R. DAVIES	

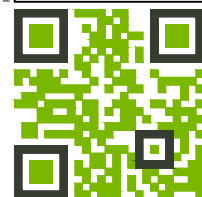
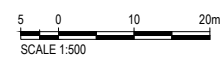
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PLAN VIEW
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— FILL CONTOUR (0.1m INTERVALS)
— CUT CONTOUR (0.1m INTERVALS)
--- EXTENT OF WORKS

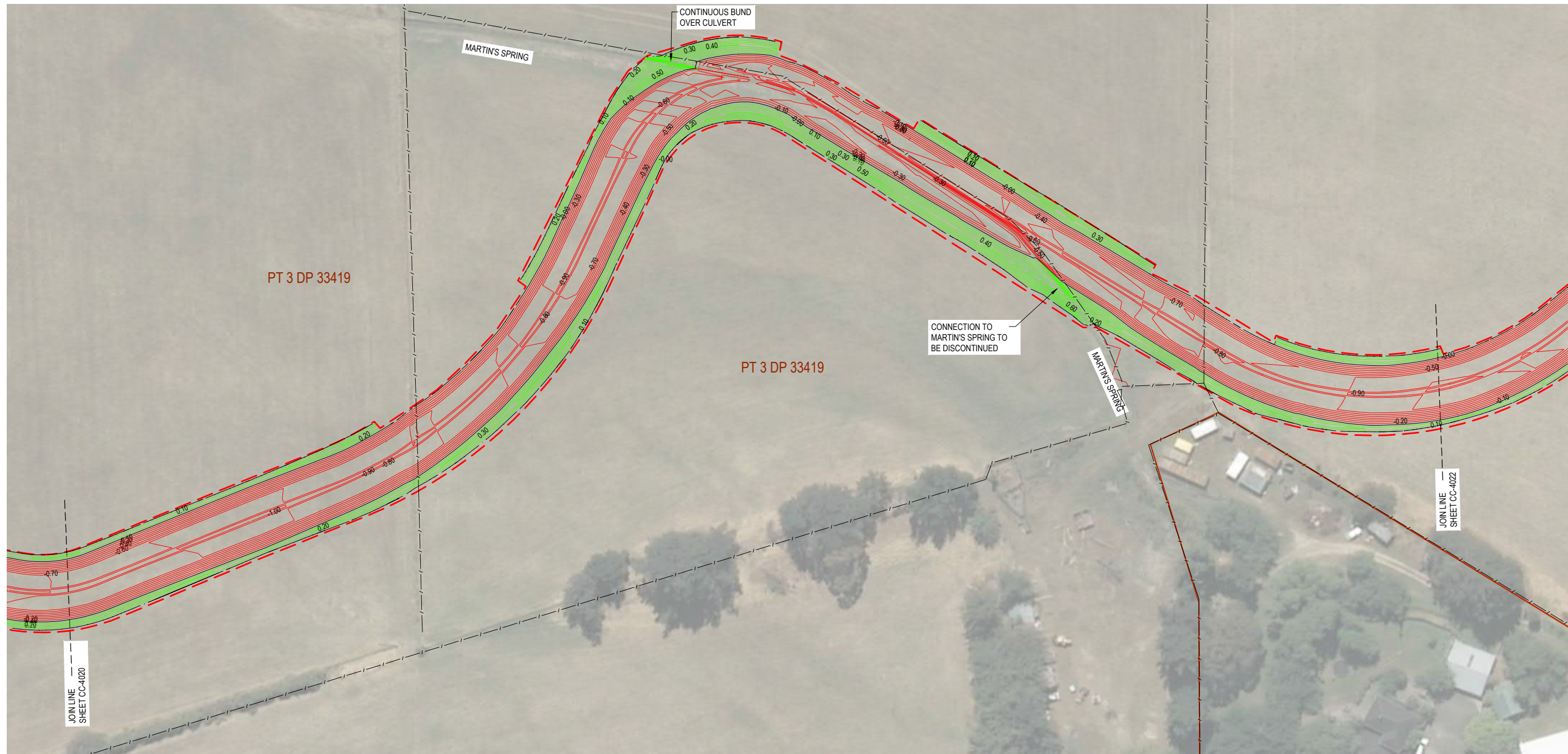


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B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

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DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

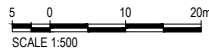
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DATE
16/10/20

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PLAN VIEW
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- EXTENT OF WORKS



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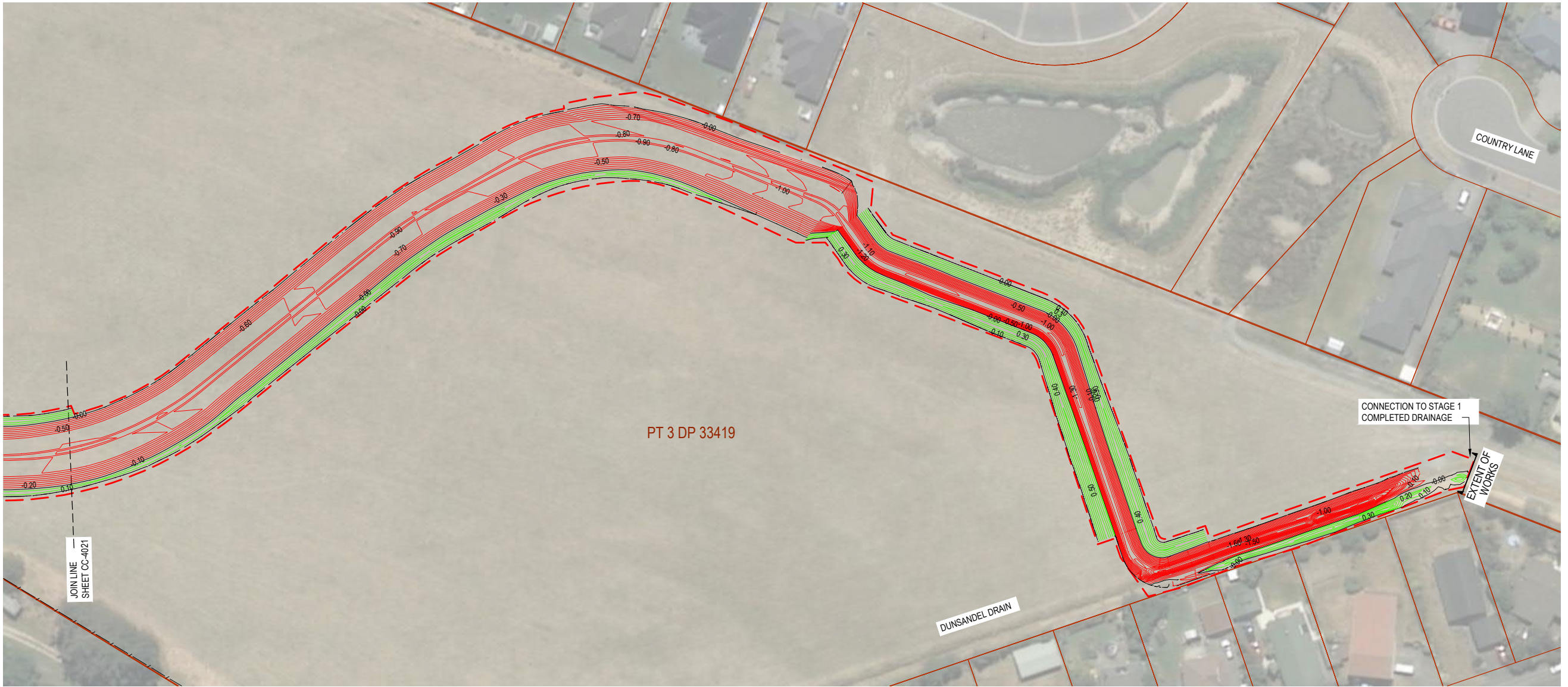
CLIENT

REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

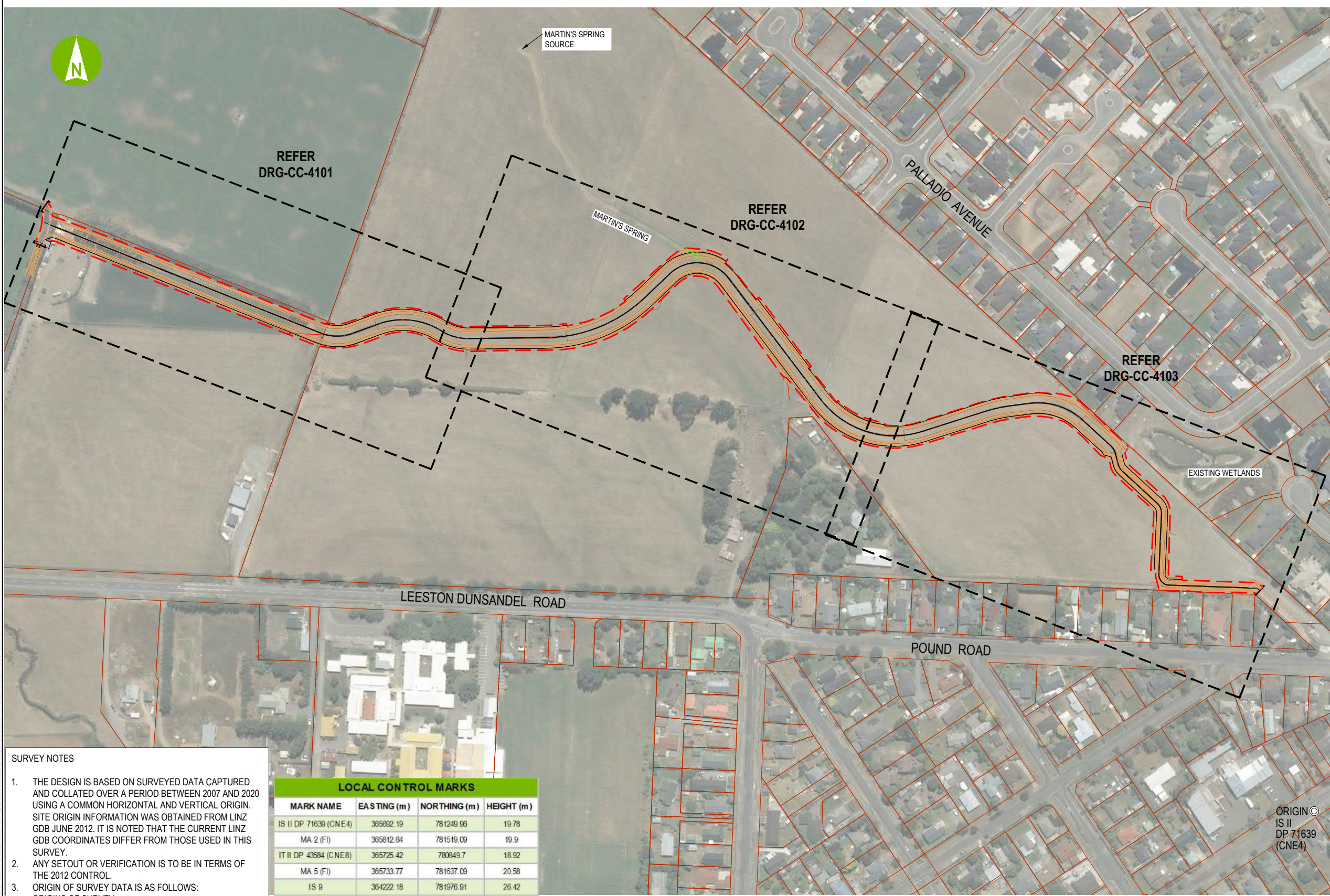
TENDER
NOT FOR CONSTRUCTION
APPROVED
A. LINDGREN
DATE
16/10/20

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4										
TITLE	CUT FILL CONTOURS SHEET 2										
DRAWING No.	505193	-	0000	-	DRG	-	CC	-	4021	-	B



— 0.0m (NO CUT FILL) CONTOUR
 — FILL CONTOUR (0.1m INTERVALS)
 — CUT CONTOUR (0.1m INTERVALS)
 - - - - - EXTENT OF WORKS

[illegible]



NOTES:

- WHILST EVERY EFFORT HAS BEEN MADE TO SHOW ALL KNOWN SERVICES, THE LOCATION AND EXISTENCE OF UTILITIES SHOWN IS TO BE TREATED AS INDICATIVE ONLY. THE CONTRACTOR IS TO CONFIRM THE LOCATION OF SERVICES ONSITE.
 - CONTRACTOR TO LIAISE WITH LAND OWNER TO CONFIRM IF KNOWN SERVICES EXIST ON SITE. EXISTING SERVICES THAT ARE TO BE RETAINED ARE TO BE ADEQUATELY SUPPORTED TO PREVENT DAMAGE FOR THE DURATION OF WORKS.
 - PLAN IS TO BE READ IN CONJUNCTION WITH ALL OTHER ENGINEERING DOCUMENTS.
 - PROPOSED WORK IS WITHIN EXISTING WATERWAY, THE CONTRACTOR IS TO HAVE A ROBUST TEMPORARY WORKS PLAN TO DEAL WITH FLOWS GENERATED FROM SIGNIFICANT RAINFALL EVENTS.
 - REFER SHEET 4100 FOR SURVEY HEIGHT & CONTROL DETAILS.
- GENERAL NOTES:**
- ROCK PROTECTION TO BE PROVIDED IN ACCORDANCE WITH PROJECT SPECIFICATION AND DRAWINGS.
 - ALL WORKS ARE TO COMPLY WITH THESE DRAWINGS AND THE SELWYN DISTRICT COUNCIL (SDC) CODE OF PRACTICE (COP). WHERE THERE IS CONFLICT BETWEEN THE TWO THE DRAWINGS HAVE PRECEDENCE.
 - SITE PREPARATION AND RESTORATION SHALL BE AS PER THE PROJECT SPECIFICATION.
 - SETOUT CO-ORDINATES / DIMENSIONS ARE TO BE CONFIRMED ON SITE BY THE CONTRACTOR PRIOR TO COMMENCING WORK. DRAWINGS SHALL NOT BE SCALED.
 - ANY DISCREPANCY SHALL BE REFERRED TO THE ENGINEER BEFORE PROCEEDING WITH ANY WORK. NO SUBSTITUTE MATERIALS SHALL BE USED WITHOUT PRIOR APPROVAL OF THE ENGINEER.
 - MAKE SMOOTH CONNECTION TO EXISTING WORK.
 - SURFACES WHICH LIE OUTSIDE THE GENERAL LIMIT OF WORKS WHICH ARE DISTURBED DURING THE CONSTRUCTION OF THE WORKS SHALL BE RESTORED BY THE CONTRACTOR TO AT LEAST THE PRE-CONSTRUCTION CONDITION.
 - PRIOR TO ANY EXCAVATION OR CONSTRUCTION ON SITE, THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL UNDERGROUND SERVICES ON THE SITE.
 - IMAGE SOURCED FROM LINZ. IMAGE IS INDICATIVE ONLY, NOT BE USED FOR CONSTRUCTION PURPOSES.

EARTHWORKS NOTES

EW1. CLEARING AND GRUBBING

CLEARING, STRIPPING AND GRUBBING SHALL BE CARRIED OUT IN AREAS SUBJECT TO EARTHWORKS. ALL SOIL CONTAINING ORGANIC MATTER SHALL BE STRIPPED FROM THE CONSTRUCTION AREA AND STOCKPILED FOR FUTURE SITE REHABILITATION OR USED AS TOPSOIL.

EW2. MATERIAL SPECIFICATION.

- 2.1 ALL MATERIALS USED AS FILL SHALL BE FREE FROM DELETERIOUS MATTER.
- 2.2 NO MATERIAL CONTAINING THE FOLLOWING MAY BE USED AS FILL
- VEGETABLE MATTER
 - MATERIALS CONTAMINATED THROUGH PAST SITE USE
 - ORGANIC CLAYS OR SILTS
 - ASHES, COAL OR THE LIKE
 - ANY MATERIALS WHICH IN THE OPINION OF THE ENGINEER WILL SCOUR BADLY OR ANY DISPERSIVE SOIL.
- 2.3 RIPRAP SHOULD MEET THE FOLLOWING SPECIFICATIONS
- ROCKS SHOULD BE ANGULAR IN SHAPE, NOT ROUNDED AND EACH PIECE SHOULD HAVE ITS GREATEST DIMENSION NOT GREATER THAN THREE TIMES ITS LEAST DIMENSION.
 - THE SPECIFIC GRAVITY SHOULD NOT BE LESS THAN 2.5
 - THE RIPRAP SHOULD MEET THE FOLLOWING SCREENING CRITERIA:

DIAMETER	PERCENT OF MATERIAL SMALLER
300mm	100
200mm	60-80
150mm	30-50
100mm	0

- 2.4 WHERE POSSIBLE, BUNDING IS TO BE COMPOSED OF COMPACTED SPOIL.

SURVEY NOTES

- THE DESIGN IS BASED ON SURVEYED DATA CAPTURED AND COLLATED OVER A PERIOD BETWEEN 2007 AND 2020 USING A COMMON HORIZONTAL AND VERTICAL ORIGIN. SITE ORIGIN INFORMATION WAS OBTAINED FROM LINZ GDB JUNE 2012. IT IS NOTED THAT THE CURRENT LINZ GDB COORDINATES DIFFER FROM THOSE USED IN THIS SURVEY.
- ANY SETOUT OR VERIFICATION IS TO BE IN TERMS OF THE 2012 CONTROL.
- ORIGIN OF SURVEY DATA IS AS FOLLOWS:
ORIGINS OF SURVEY:
NZ GEODETIC DATUM 2000, MOUNT PLEASANT CIRCUIT IS II DP 71639 (CNE4)
781249.964mN 365692.185mE
SOURCED FROM LINZ GEODETIC DATABASE JUNE 2012
ORIGIN OF LEVELS:
LYTTTELTON VERTICAL DATUM: V61 NO 2 (AF4R)
RL 32.2759M
SOURCED FROM LINZ GEODETIC DATABASE JUNE 2012

LOCAL CONTROL MARKS			
MARK NAME	EASTING (m)	NORTHING (m)	HEIGHT (m)
IS II DP 71639 (CNE4)	365692.19	781249.96	19.78
MA 2 (FI)	365812.64	781519.09	19.9
IT II DP 43584 (CNE8)	365725.42	780949.7	18.92
MA 5 (FI)	365733.77	781637.09	20.58
IS 9	364222.18	781976.91	26.42
IS 10	364324.8	781961.19	25.76
IS 11	364419.69	781950.57	25.49
IS 12	364439.29	781946.32	25.34
IS 13	364524.25	781866.38	24.87
IS 14	364611.3	781787.74	24.38
IS 15	364707.44	781726.37	23.93
IS 16	364736.51	781712.52	23.78

OVERALL LAYOUT PLAN
1:1500
SCALE 1:1500

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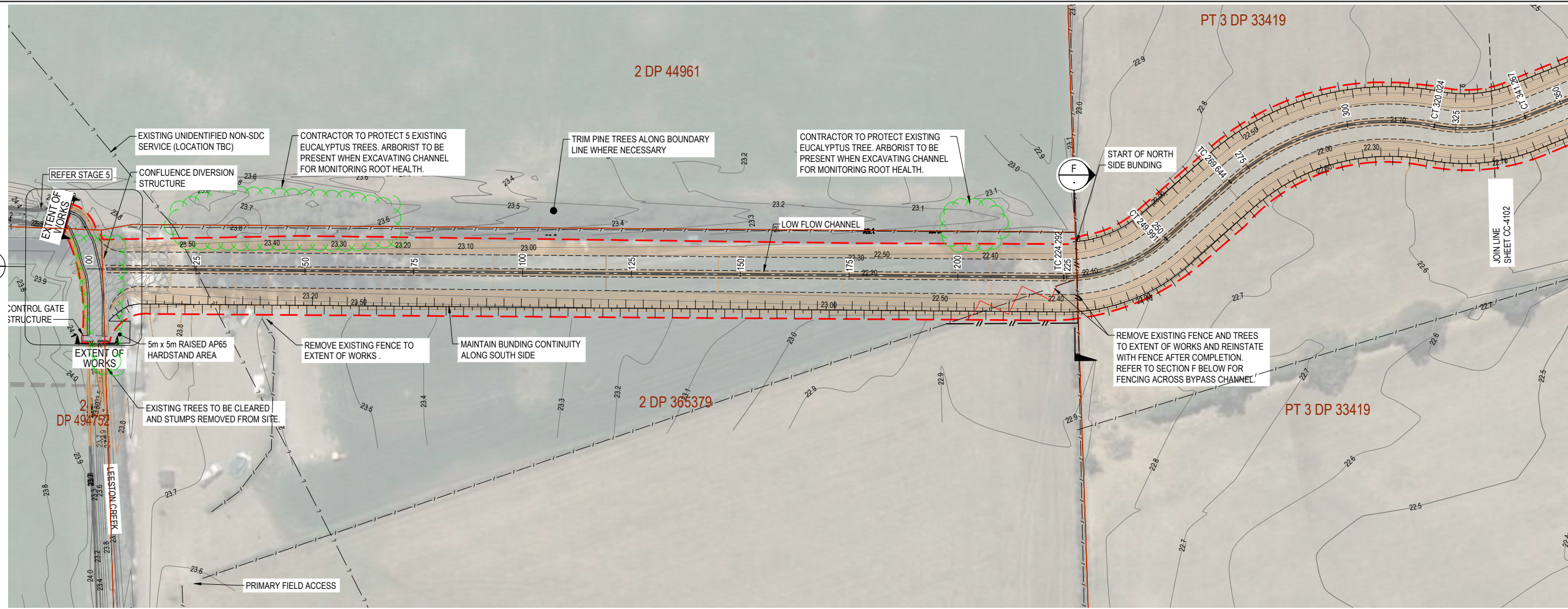
REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED
A. LINDGREN
A. LINDGREN

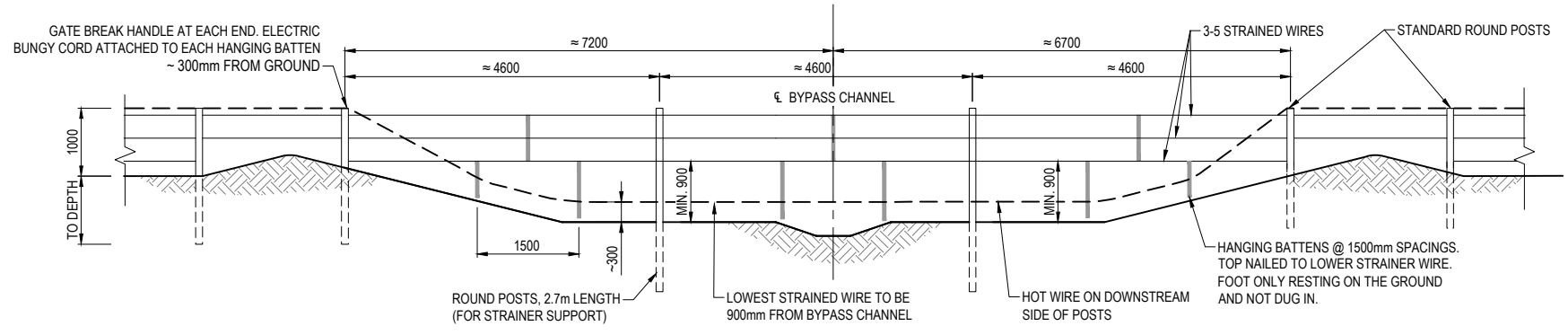
SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER
NOT FOR CONSTRUCTION
APPROVED
DATE
12/11/2020
A. LINDGREN
A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	OVERALL LAYOUT PLAN
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	4100
NUMBER	B
REV	

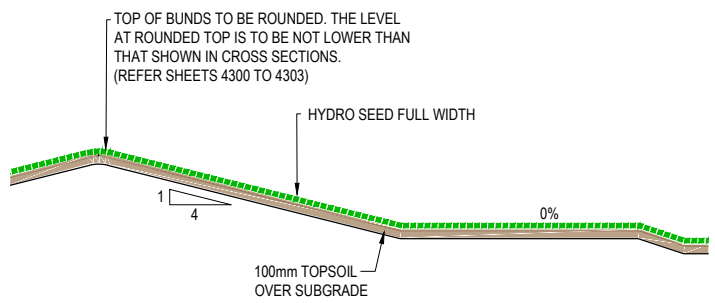


PLAN VIEW
1:500

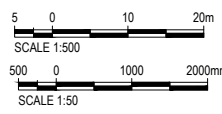


SECTION F FENCE CROSSING BYPASS CHANNEL ≈ CH226 (WITH HOT WIRE)
1:50

- NOTES:
1. EXPERIENCED FENCING CONTRACTOR TO INSTALL ALL FENCING, MEETING STANDARD FARMING REQUIREMENTS.
 2. PROPOSED BYPASS FENCE CROSSINGS TO BE CONFIRMED IN LIAISON WITH AN EXPERIENCED FENCING CONTRACTOR.
 3. WHERE HOT WIRE IS NOT ACCESSIBLE, USE WIRE & BATTEN FENCE SPANNING THE BYPASS AS PER SECTION F BUT INSTEAD OF HANGING BATTENS USE HORIZONTAL BOARDS HUNG BY WIRE FROM THE LOWER STRAINER, AS PER THE PHOTO SHOWN ON DRAWING 4102



TYPICAL CROSS SECTION - SLOPE TREATMENT (BOTH SIDES)
CH 5 TO CH920
1:50



LEGEND	
	DESIGN MINOR CONTOUR (0.1m)
	DESIGN MAJOR CONTOUR (0.5m)
	EXISTING CONTOUR
	TOP OF BUND
	BOTTOM OF BANK
	DRAIN CENTRELINE
	EXISTING FENCE
	PROPOSED FENCE
	FENCE TO BE REMOVED
	EXISTING PIPE
	PROPOSED PIPE
	EXISTING PROPERTY BOUNDARY
	EXTENT OF WORKS

NOTE
REFER SHEET 4100 FOR ALL NOTES AND SURVEY CONTROL

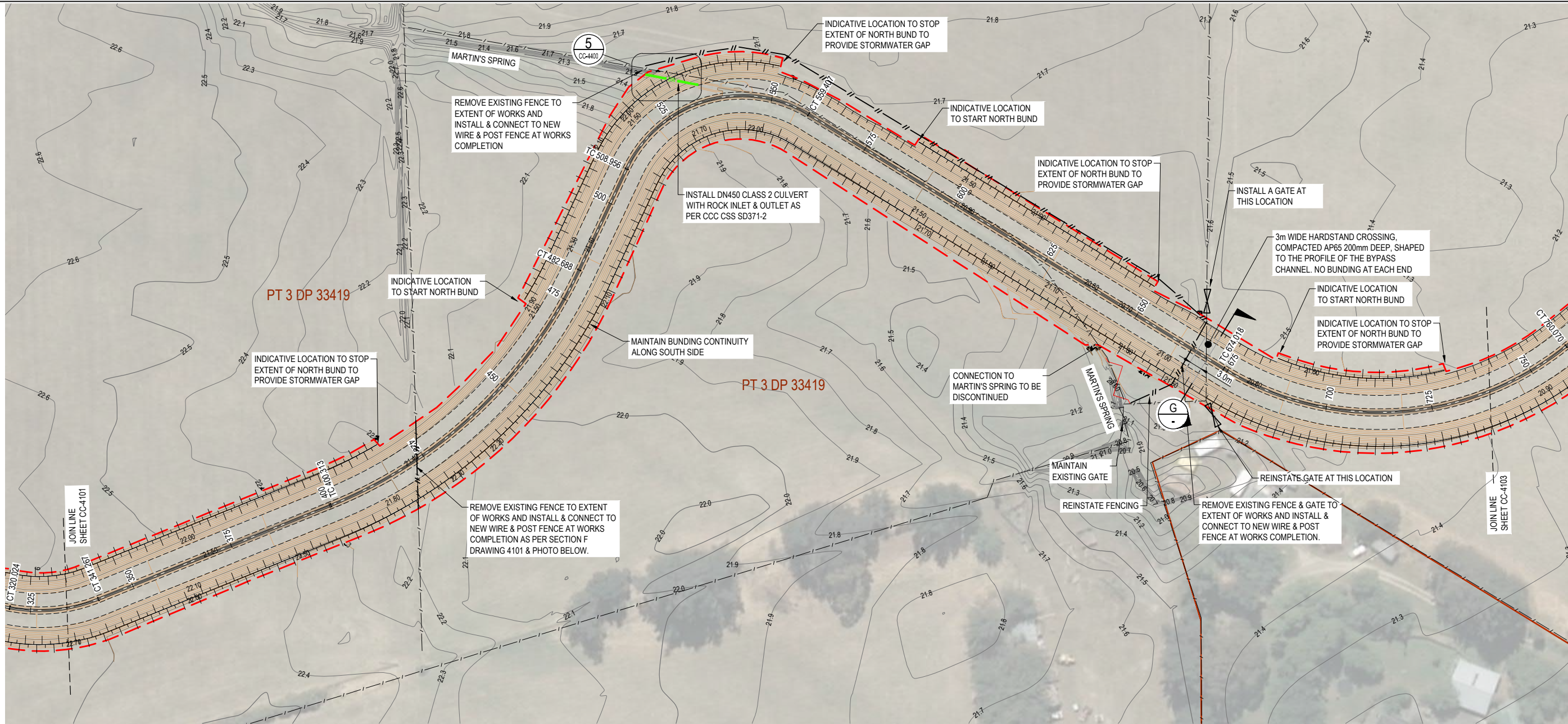
Proj Date: 12/11/2021 13:41:41, Client: NZDC, Filename: P:\09193_SDC LEESTON SW BYPASS STAGE 4\46 DELIVER DESIGN\WG CAD\DRAWINGS\SDS\18.000.DWG, CC-4101.DWG

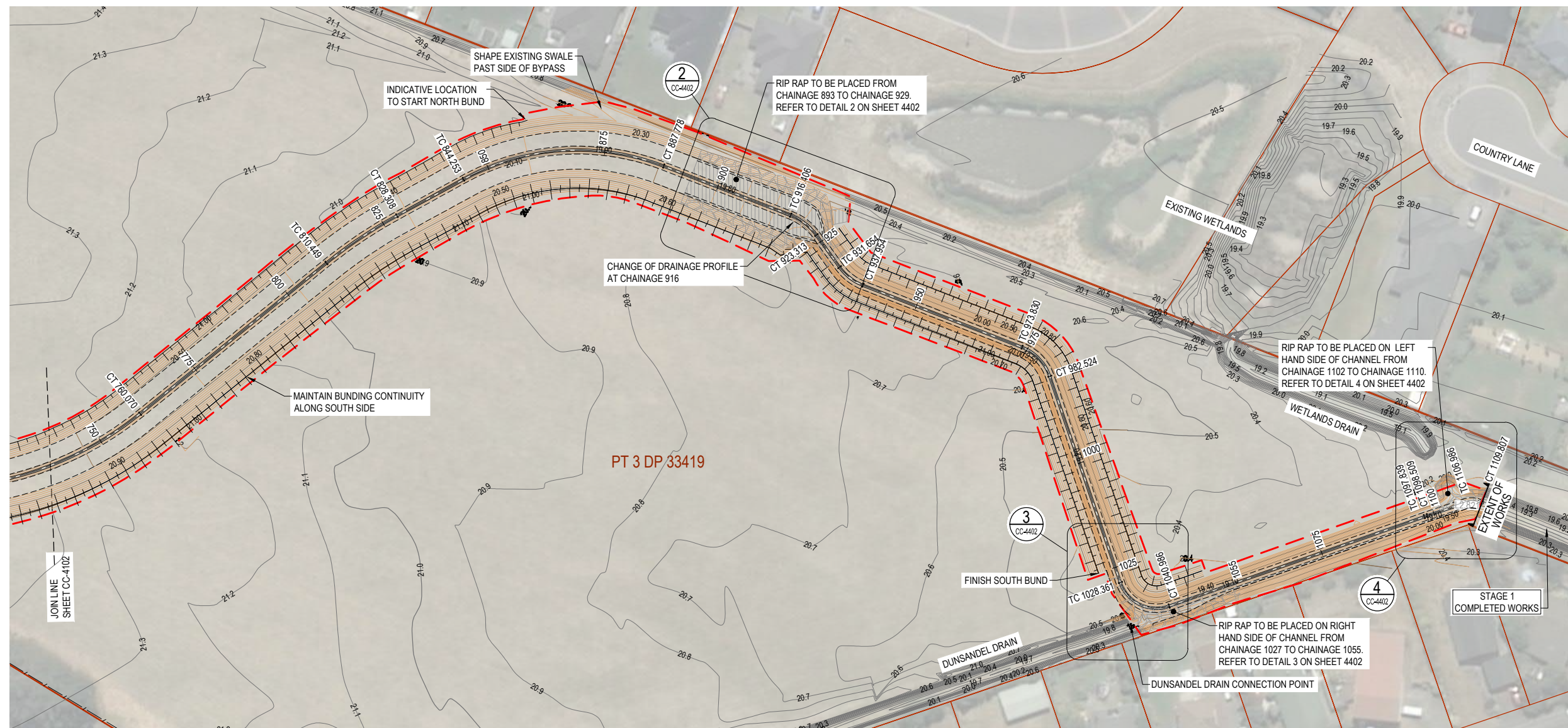


REV	DATE	REVISION DETAILS	APPROVED	SCALE	SIZE	TENDER	PROJECT
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN	AS SHOWN	A1	NOT FOR CONSTRUCTION	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN				

DRAWN	DESIGNED	REVIEWED	APPROVED	DATE	TITLE
R DAWSON	N CATTO	R. DAVIES	A. LINDGREN	18/10/20	LAYOUT PLAN SHEET 1

DRAWING No.	PROJECT No.	AREA	TYPE	DISC	NUMBER	REV
505193	0000	DRG	CC	4101	B	

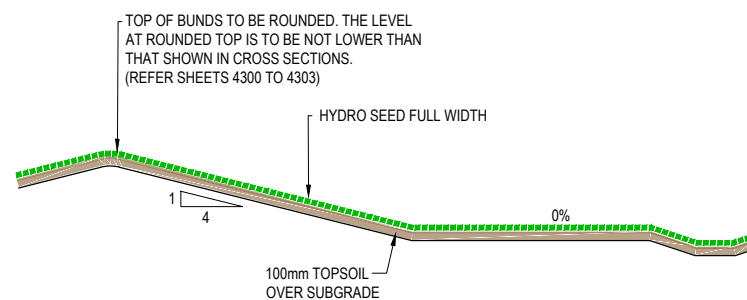




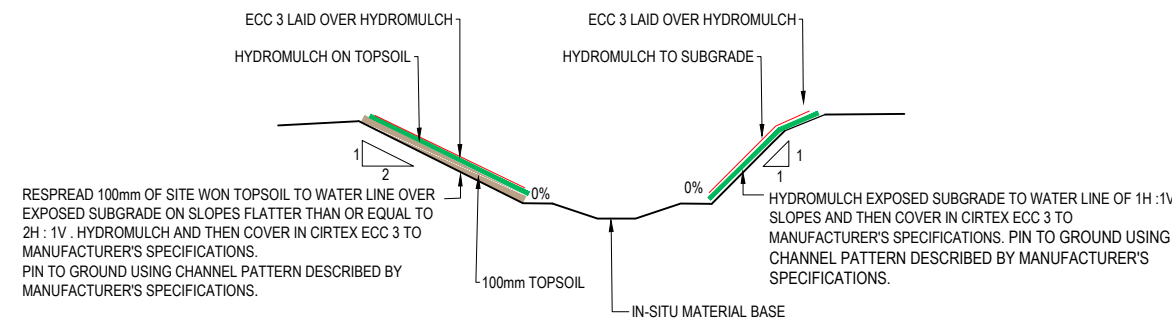
PLAN VIEW
1:500

LEGEND

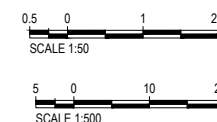
- DESIGN MINOR CONTOUR (0.1m)
- DESIGN MAJOR CONTOUR (0.5m)
- EXISTING CONTOUR
- TOP OF BUND
- BOTTOM OF BANK
- DRAIN CENTRELINE
- EXISTING FENCE
- PROPOSED FENCE
- FENCE TO BE REMOVED
- EXISTING PIPE
- PROPOSED PIPE
- EXISTING PROPERTY BOUNDARY
- EXTENT OF WORKS



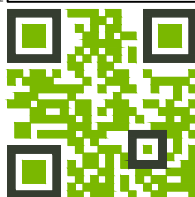
TYPICAL CROSS SECTION - SLOPE TREATMENT (BOTH SIDES)
CH 15 TO CH893
1:50



TYPICAL CROSS SECTION - SLOPE TREATMENT
FROM CH929 TO CH1110
1:50



NOTE
REFER SHEET 4100 FOR ALL NOTES AND SURVEY CONTROL



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REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER	DATE
NOT FOR CONSTRUCTION	12/11/2020
APPROVED	
A. LINDGREN	
A. LINDGREN	

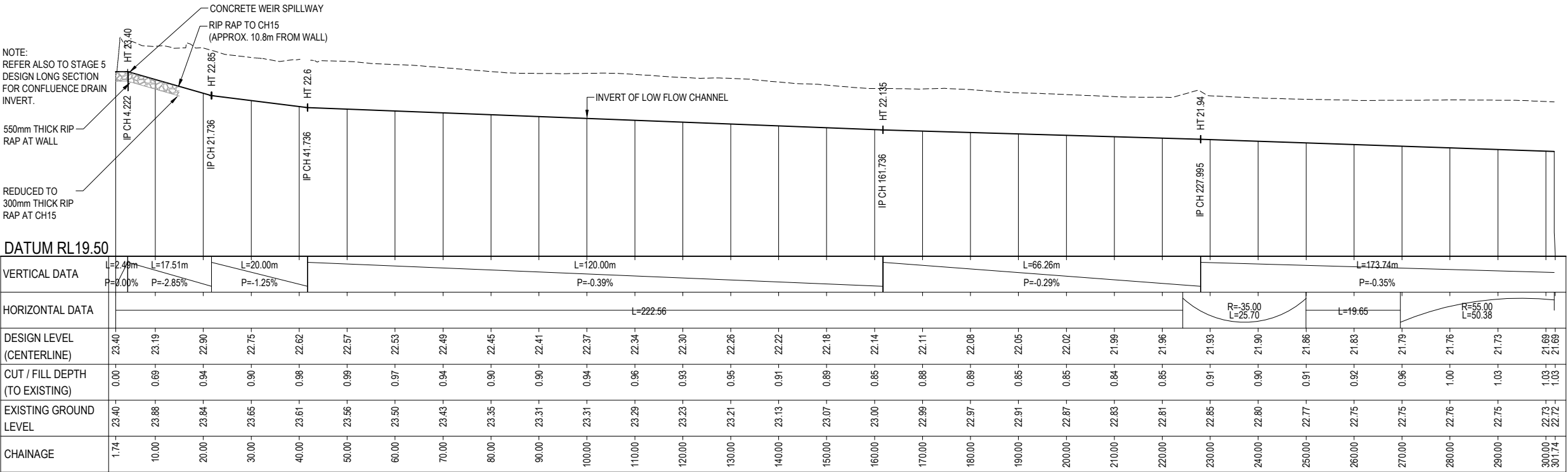
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TITLE	LAYOUT PLAN SHEET 3
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	4103
NUMBER	B
REV	

NOTE:
VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTTELTON VERTICAL DATUM (1937)

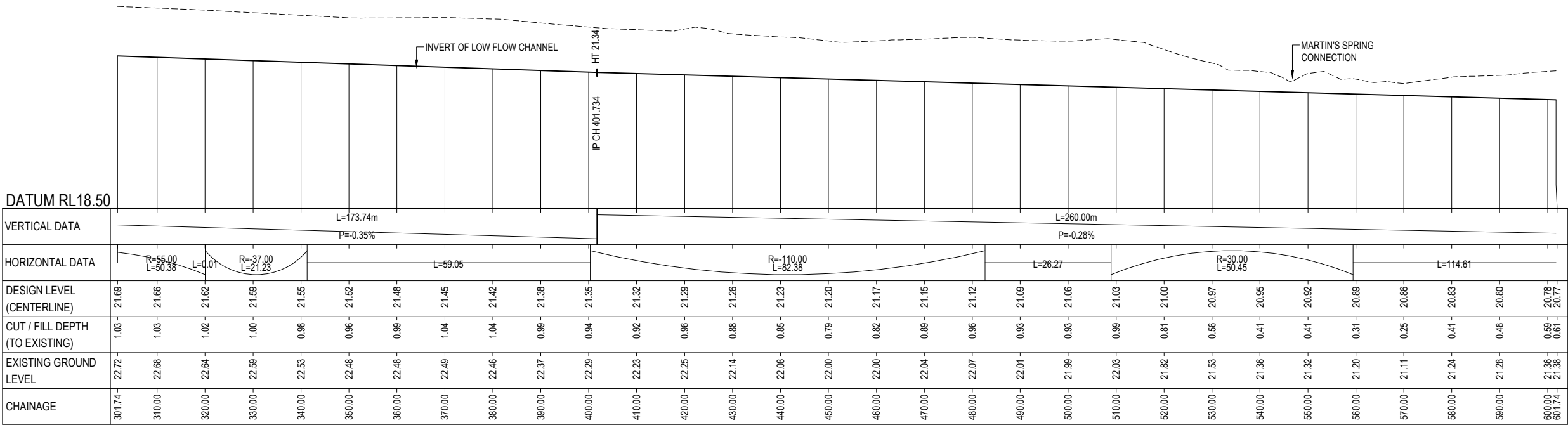
LEGEND

———— DESIGN SURFACE

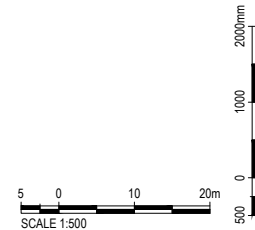
- - - - - EXISTING SURFACE



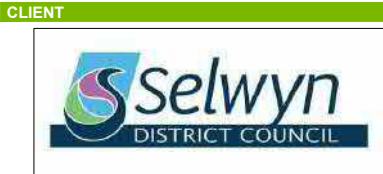
LONGITUDINAL SECTION STAGE 4 PART 1
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:50



LONGITUDINAL SECTION STAGE 4 PART 2
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:50



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REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

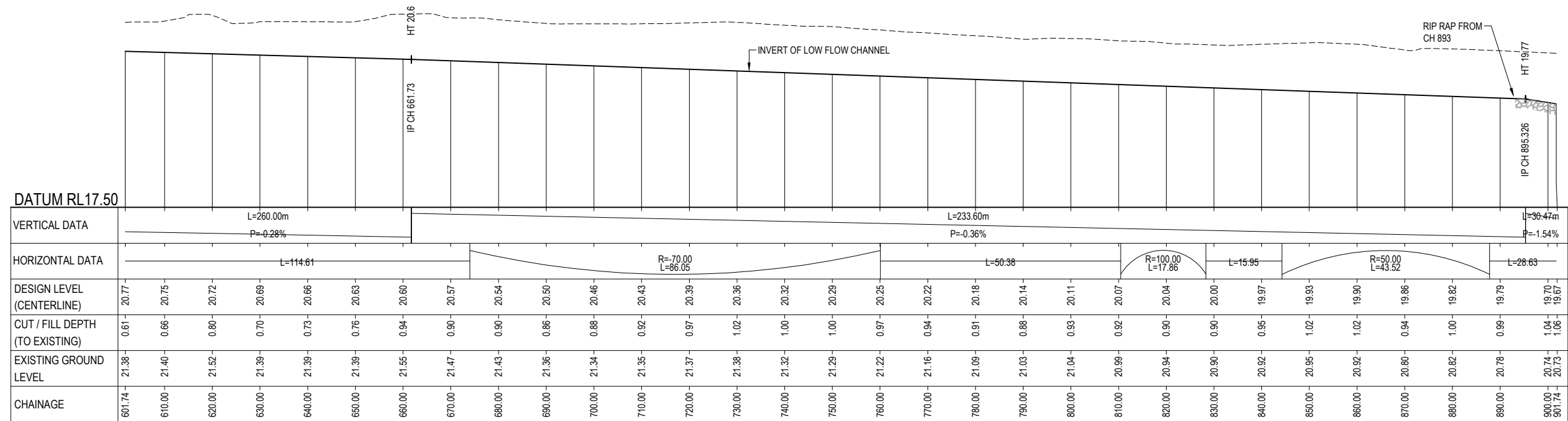
APPROVED	SCALE	SIZE
A. LINDGREN	AS SHOWN	A1
A. LINDGREN		
	DRAWN	
	R DAWSON	
	DESIGNED	
	N CATTO	
	REVIEWED	
	R. DAVIES	

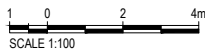
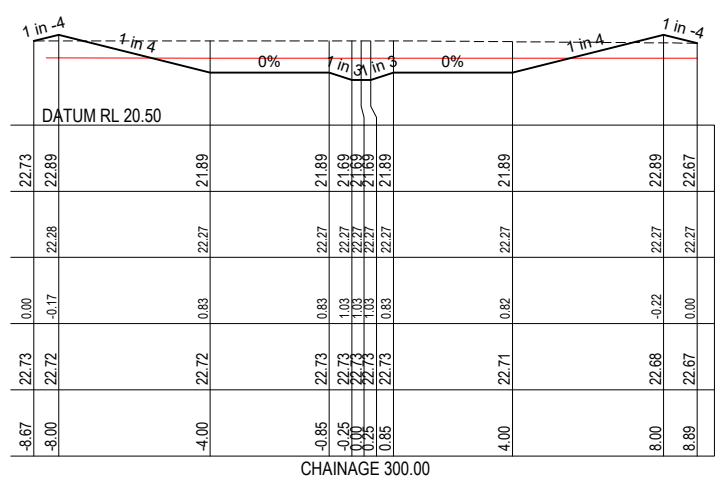
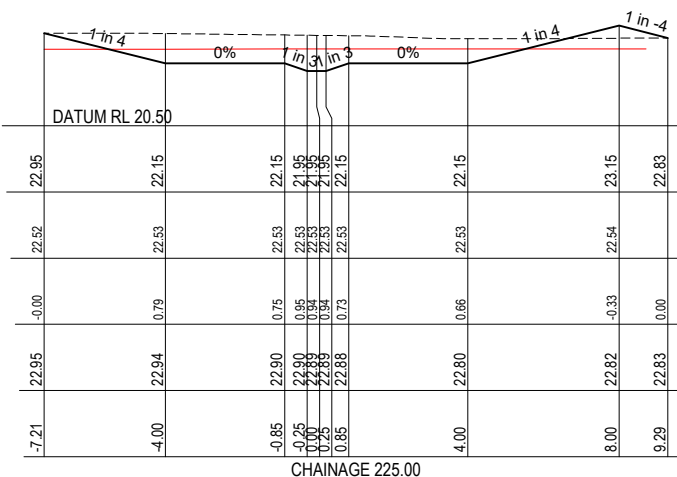
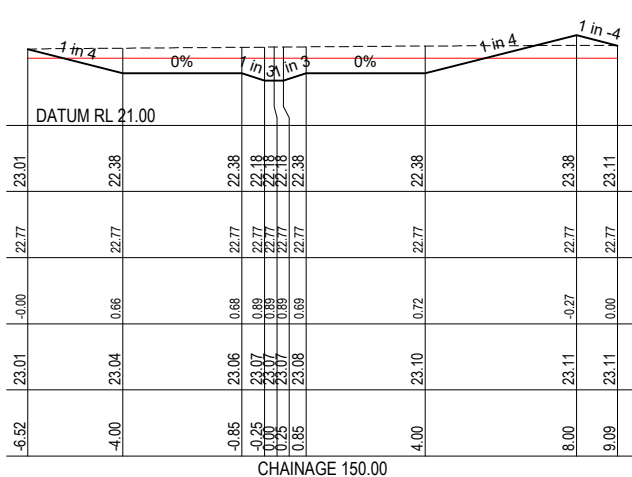
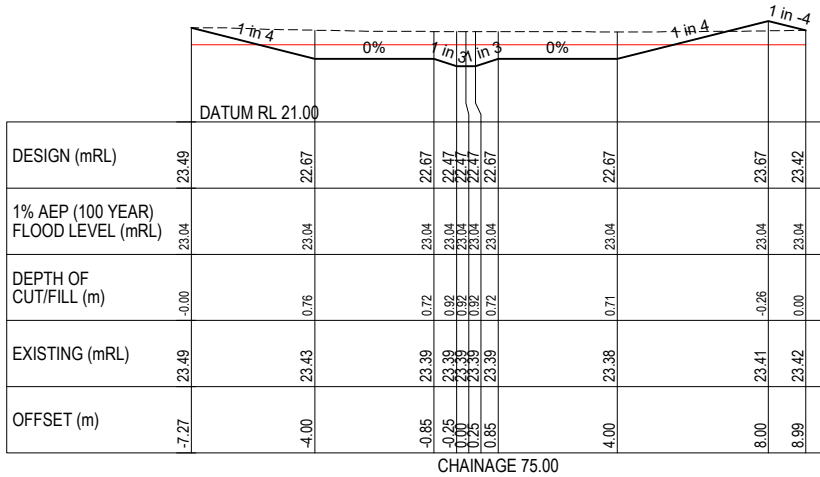
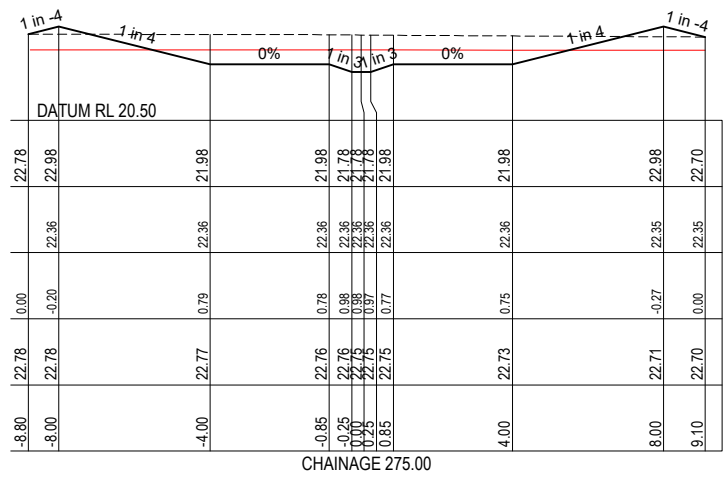
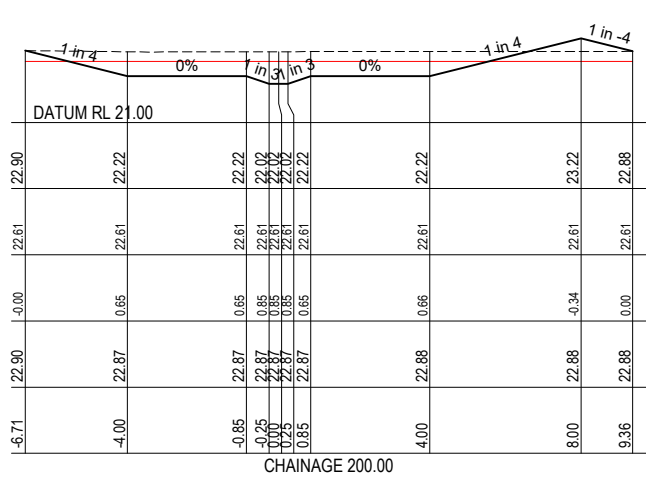
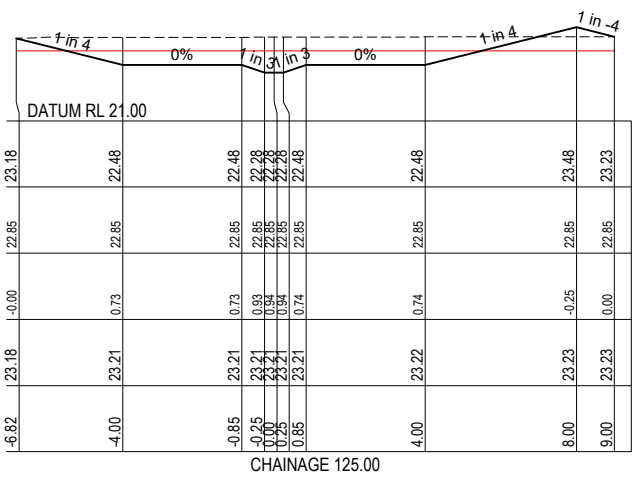
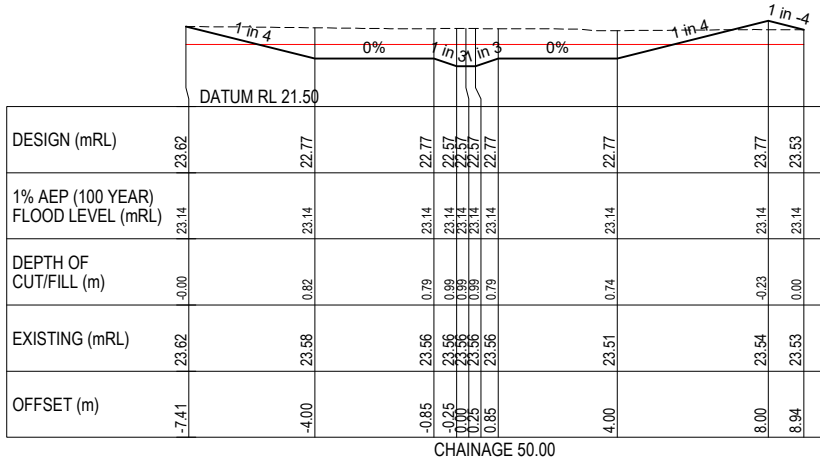
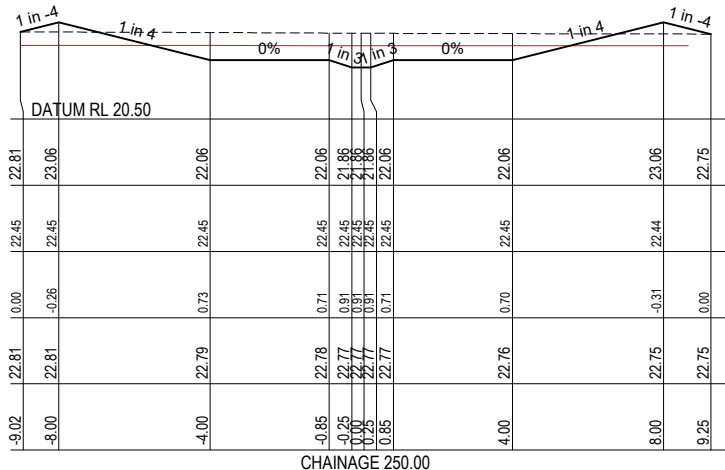
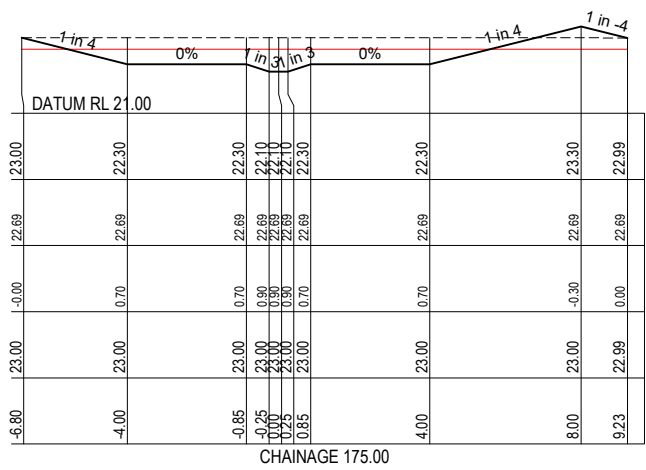
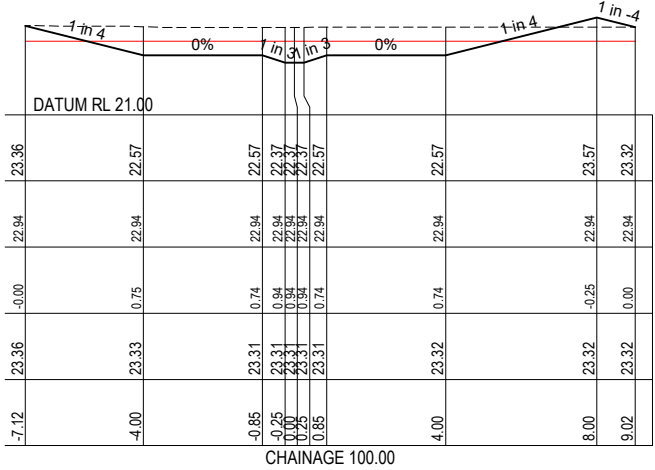
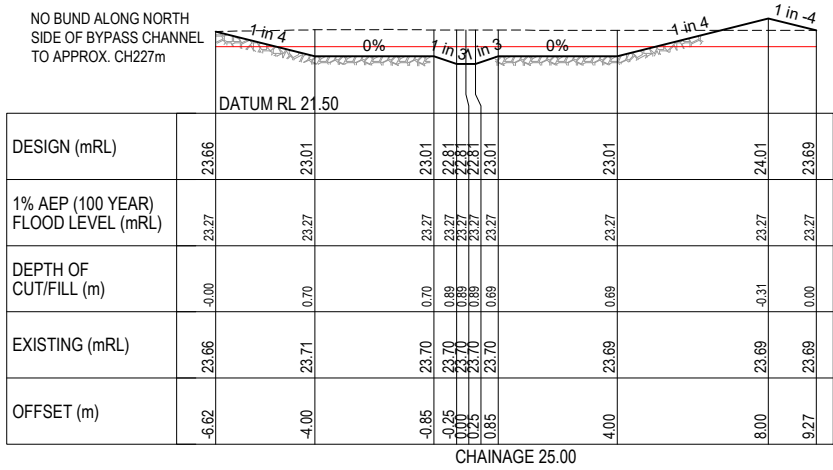
TENDER	APPROVED
NOT FOR CONSTRUCTION	
	DATE
A. LINDGREN	16/10/20
A. LINDGREN	

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	LONG SECTION SHEET 1
DRAWING No.	505193
PROJECT No.	505193
AREA	0000
TYPE	DRG
DISC	CC
NUMBER	4200
REV	B

NOTE:
VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTTELTON VERTICAL DATUM (1937)

LEGEND
—— DESIGN SURFACE
- - - - EXISTING SURFACE





LEGEND

— DESIGN SURFACE

— 100 YEAR STORM EVENT HIGH WATER LEVEL

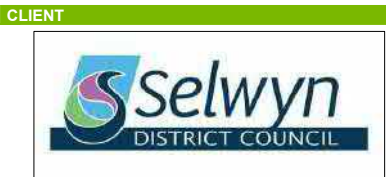
- - - EXISTING SURFACE

RIP RAP

NOTE:

1. TOP OF BUNDS TO BE ROUNDED. HEIGHT TO MATCH THAT SHOWN ON CROSS SECTIONS.

2. VERTICAL ELEVATIONS ARE IN TERMS OF LYTTELTON VERTICAL DATUM (1937)

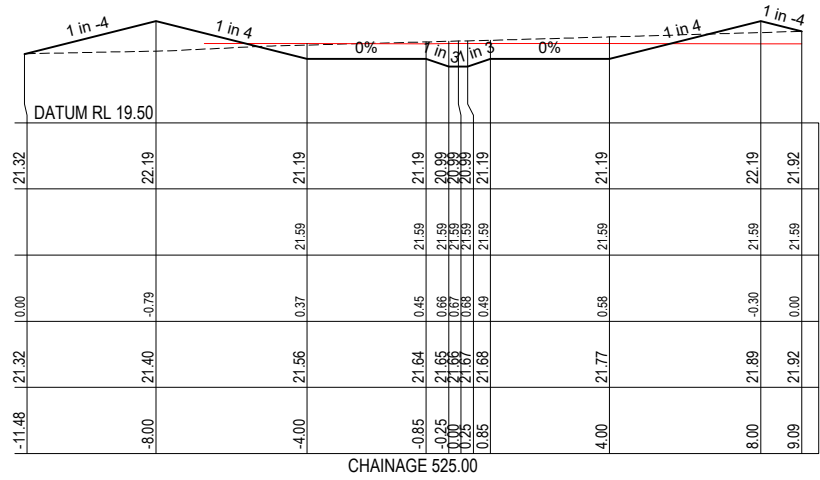
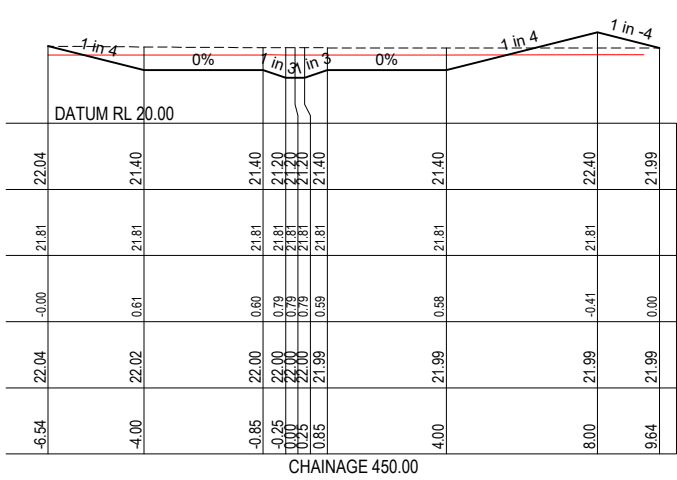
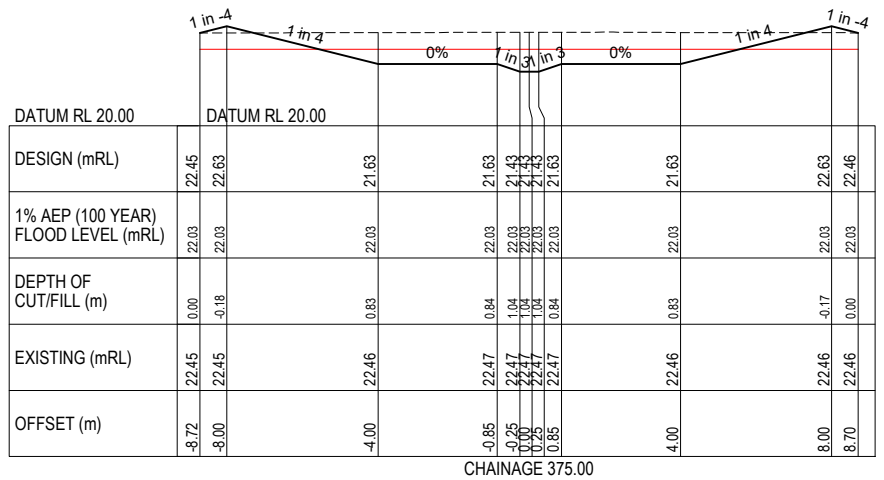
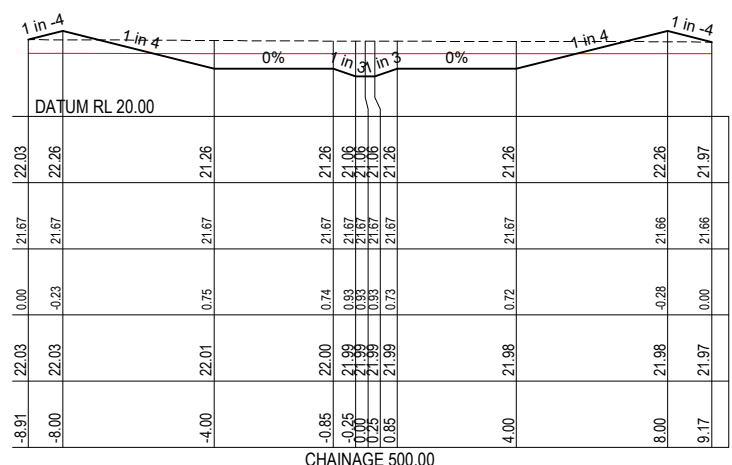
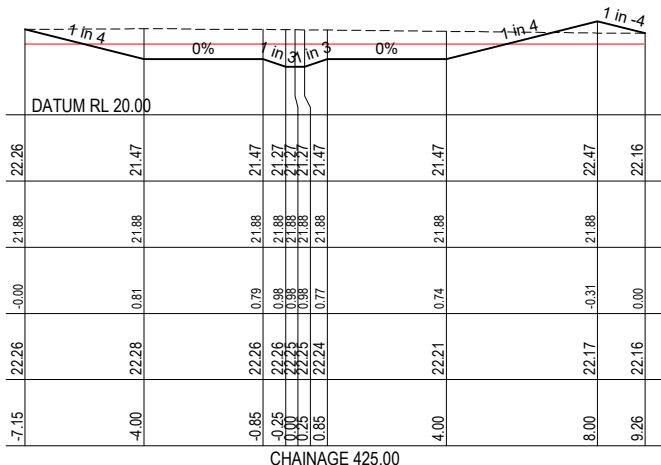
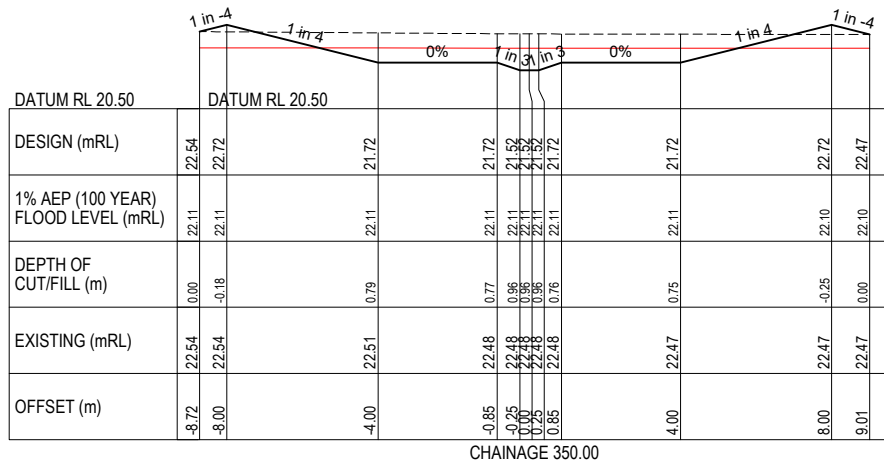
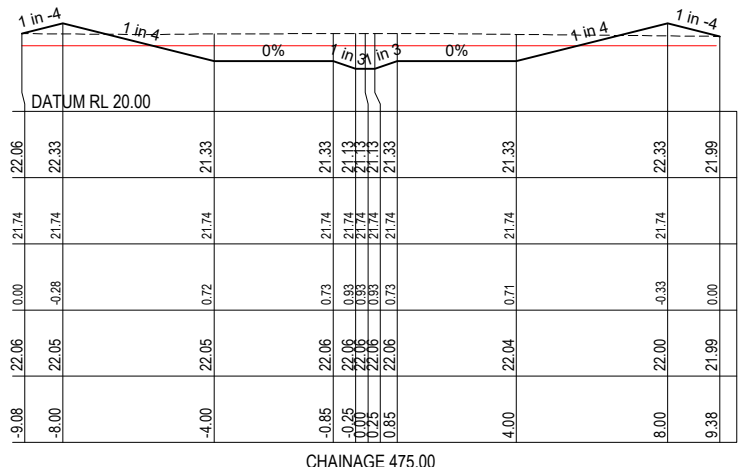
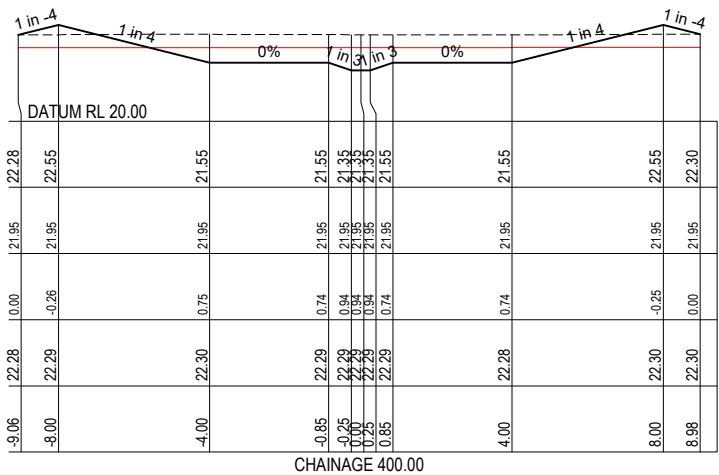
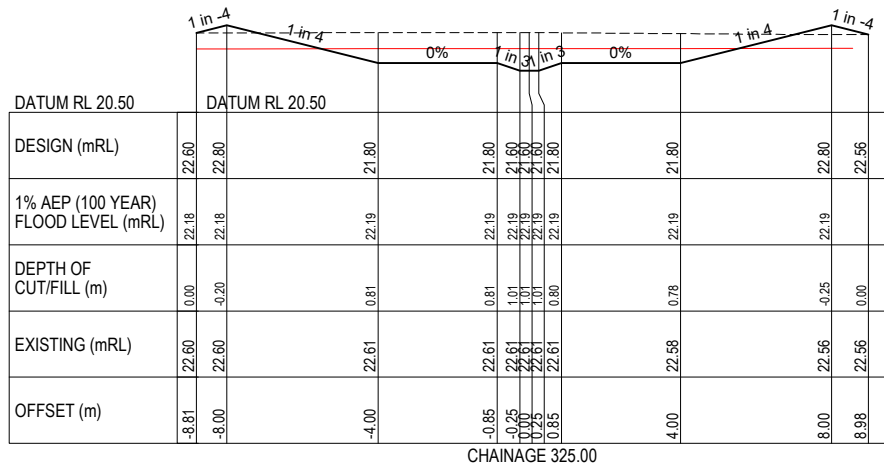


REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED	SCALE	SIZE
A. LINDGREN	AS SHOWN	A1

TENDER	APPROVED
NOT FOR CONSTRUCTION	

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	CROSS SECTIONS SHEET 1
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	4300
NUMBER	
REV	B



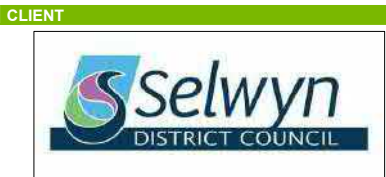
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LEGEND
— DESIGN SURFACE
— 100 YEAR STORM EVENT HIGH WATER LEVEL
--- EXISTING SURFACE
RIP RAP

NOTE:
1. TOP OF BUNDS TO BE ROUNDED.
HEIGHT TO MATCH THAT SHOWN ON
CROSS SECTIONS.
2. VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTELTON VERTICAL DATUM (1937)



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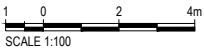
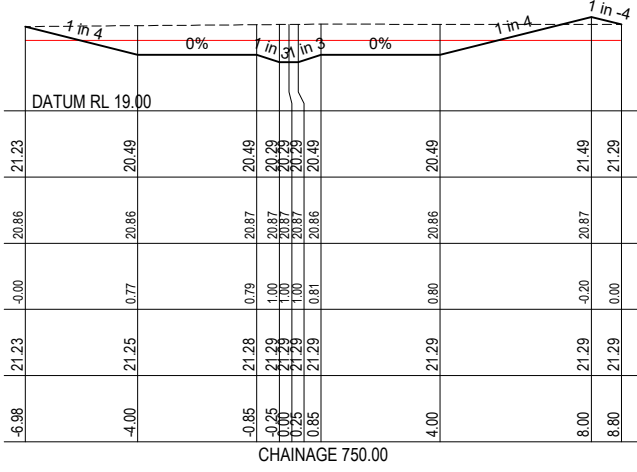
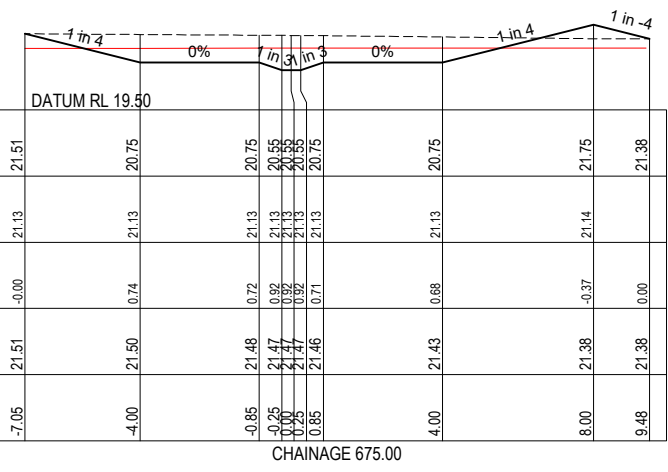
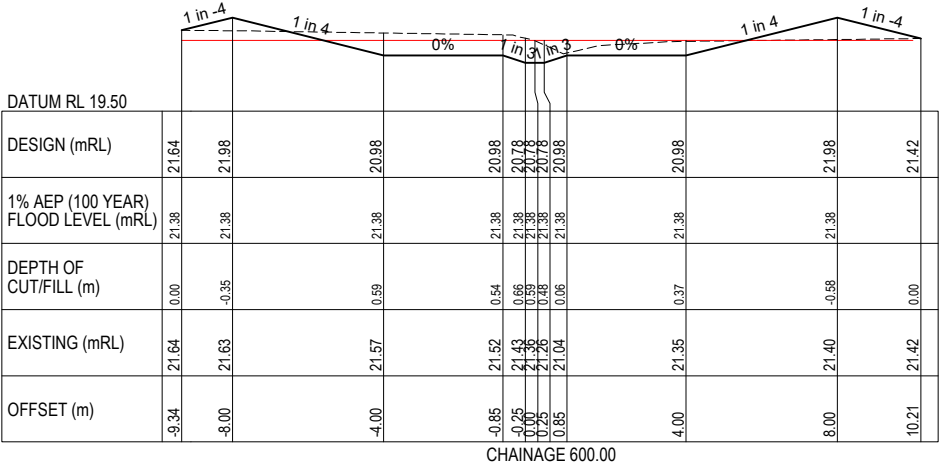
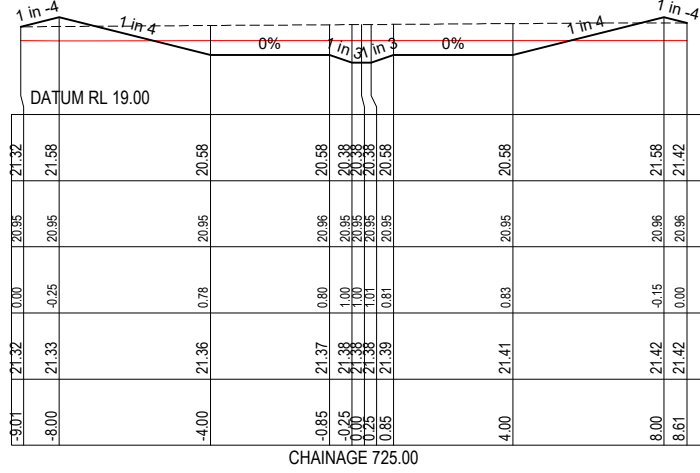
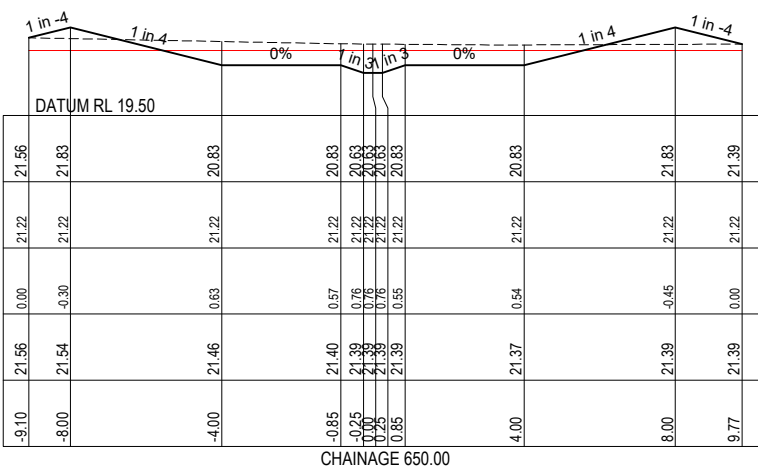
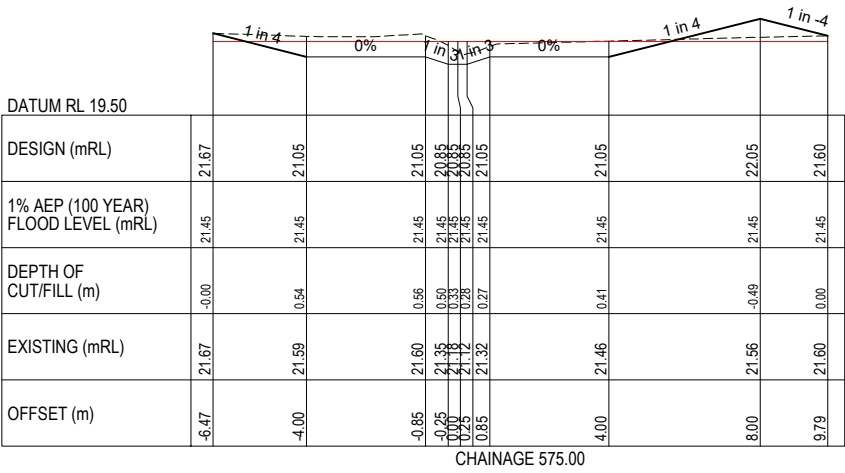
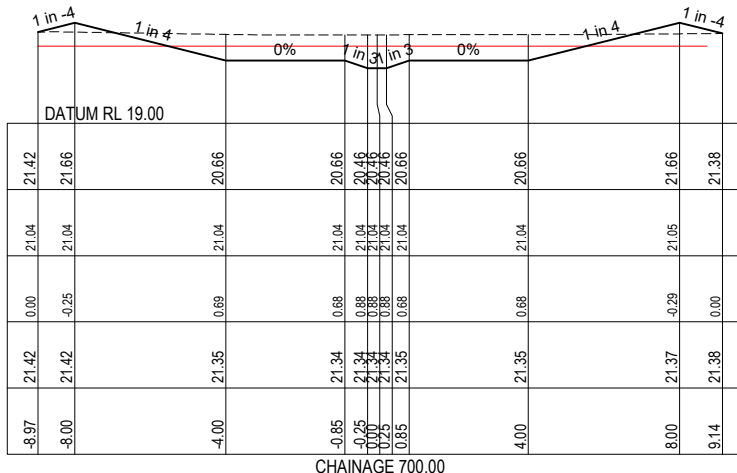
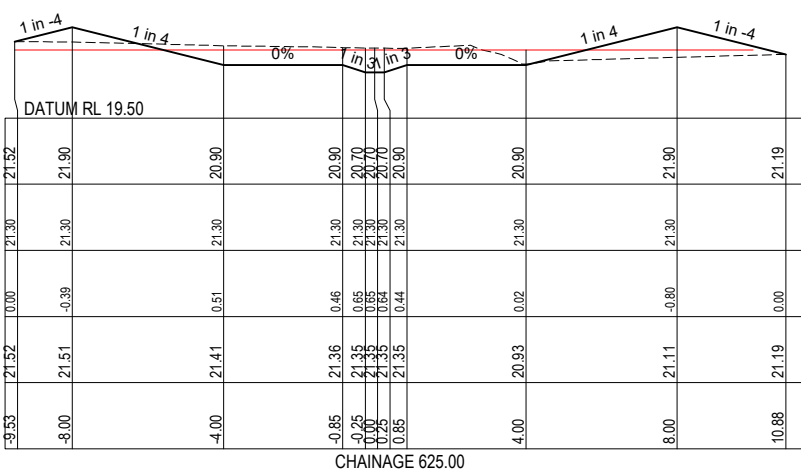
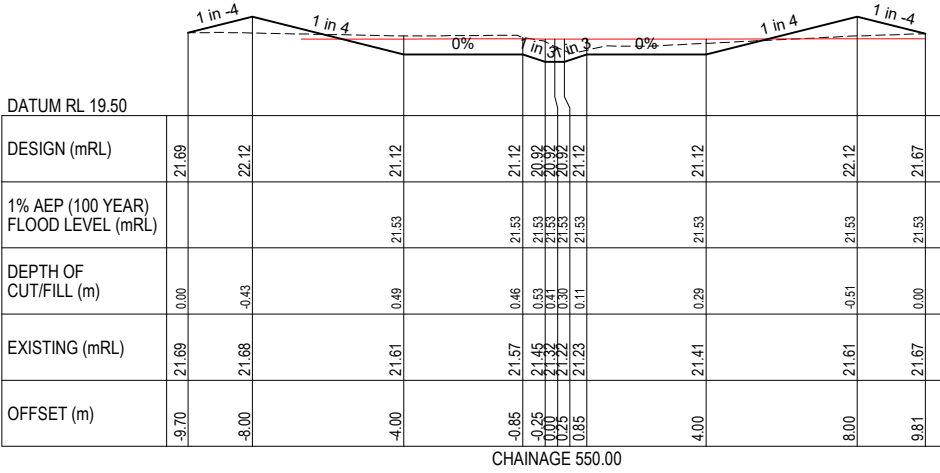


REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER	DATE
NOT FOR CONSTRUCTION	18/10/20
APPROVED	A. LINDGREN

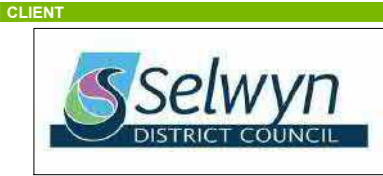
PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	CROSS SECTIONS SHEET 2
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	4301
NUMBER	B



LEGEND

	DESIGN SURFACE
	100 YEAR STORM EVENT HIGH WATER LEVEL
	EXISTING SURFACE
	RIP RAP

NOTE:
1. TOP OF BUNDS TO BE ROUNDED.
HEIGHT TO MATCH THAT SHOWN ON CROSS SECTIONS.
2. VERTICAL ELEVATIONS ARE IN TERMS OF LYTTELTON VERTICAL DATUM (1937)

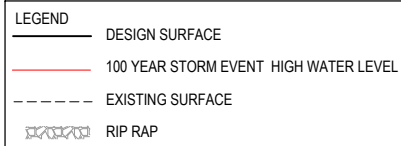
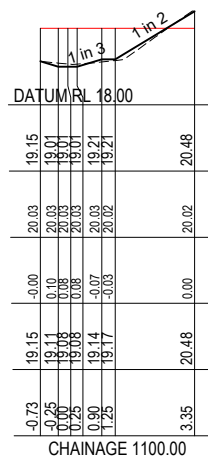
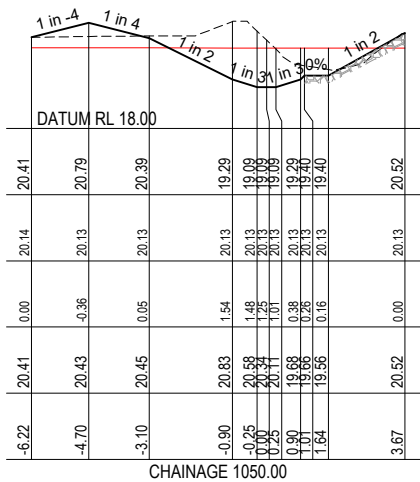
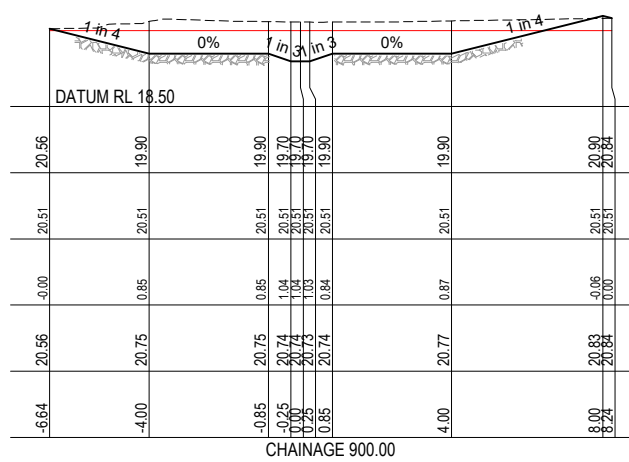
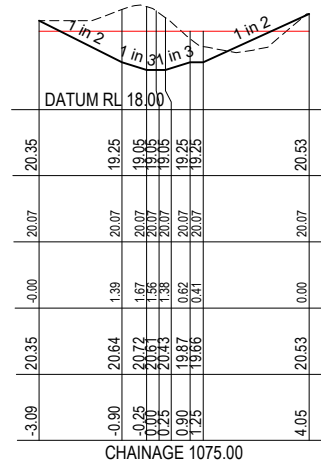
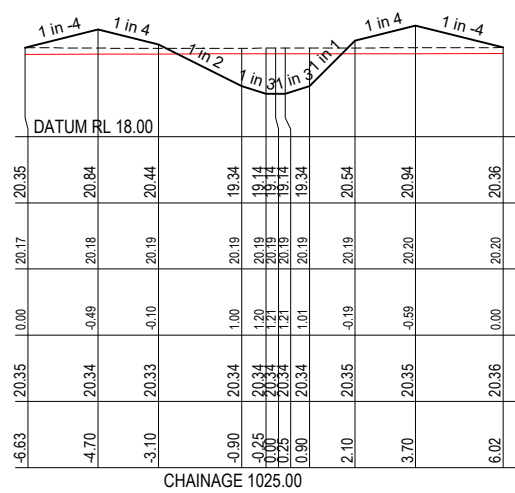
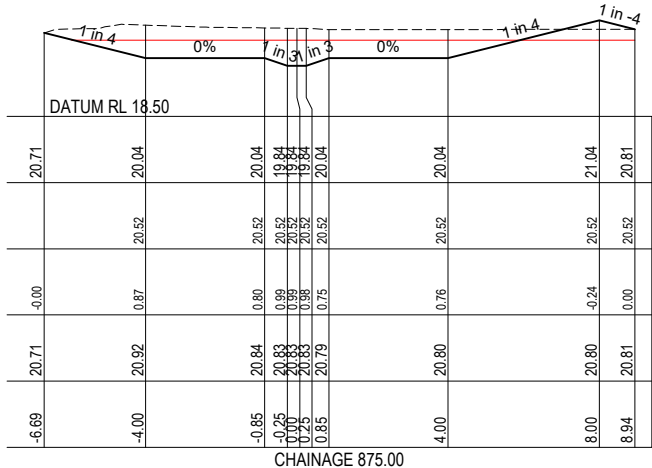
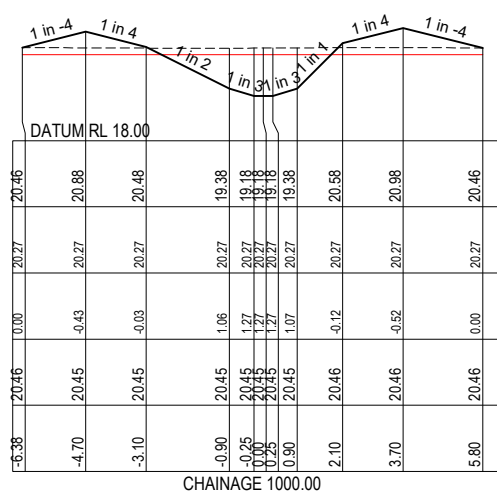
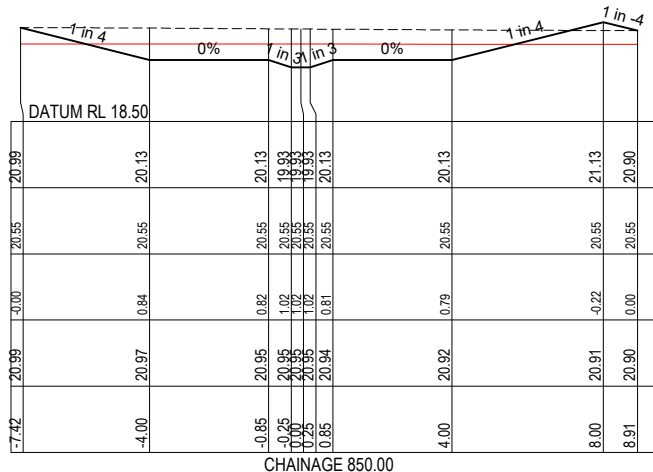


REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER	DATE
NOT FOR CONSTRUCTION	16/10/20
APPROVED	A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4
TITLE	CROSS SECTIONS SHEET 3
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	4302
NUMBER	B



NOTE:

1. TOP OF BUNDS TO BE ROUNDED.
HEIGHT TO MATCH THAT SHOWN ON
CROSS SECTIONS.
2. VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTTELTON VERTICAL DATUM (1937)



REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER
NOT FOR CONSTRUCTION

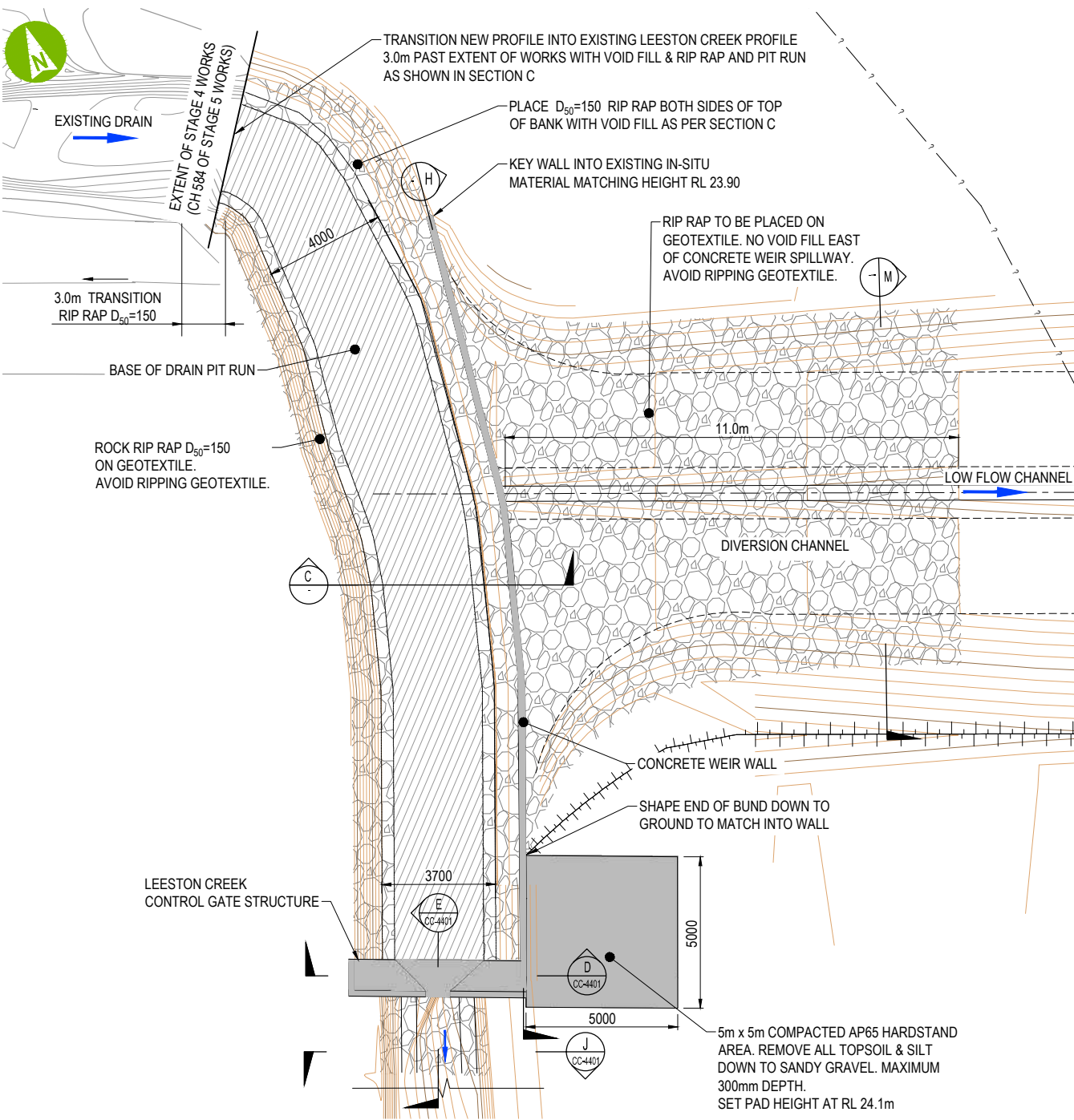
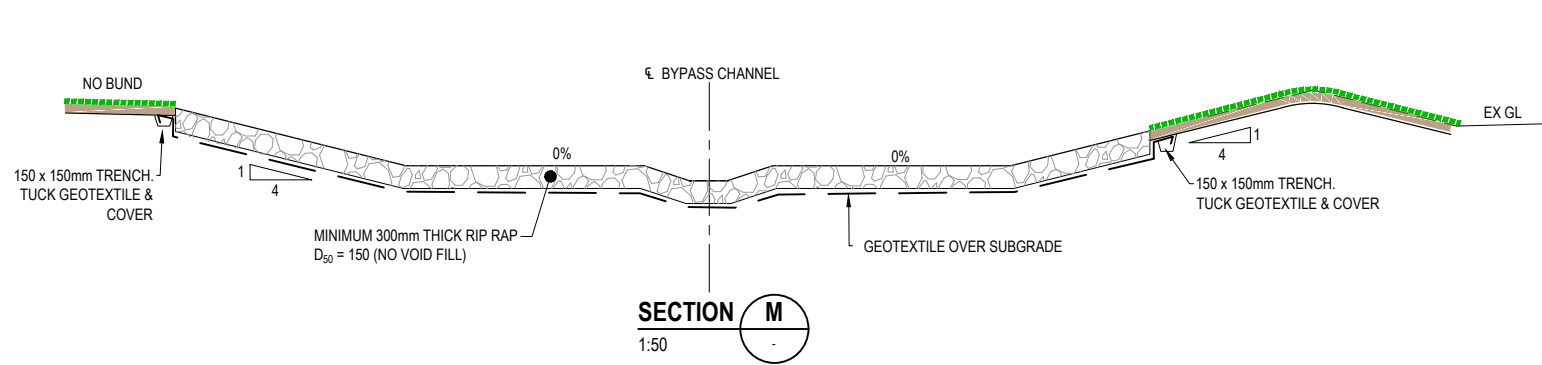
APPROVED

DATE
16/10/20

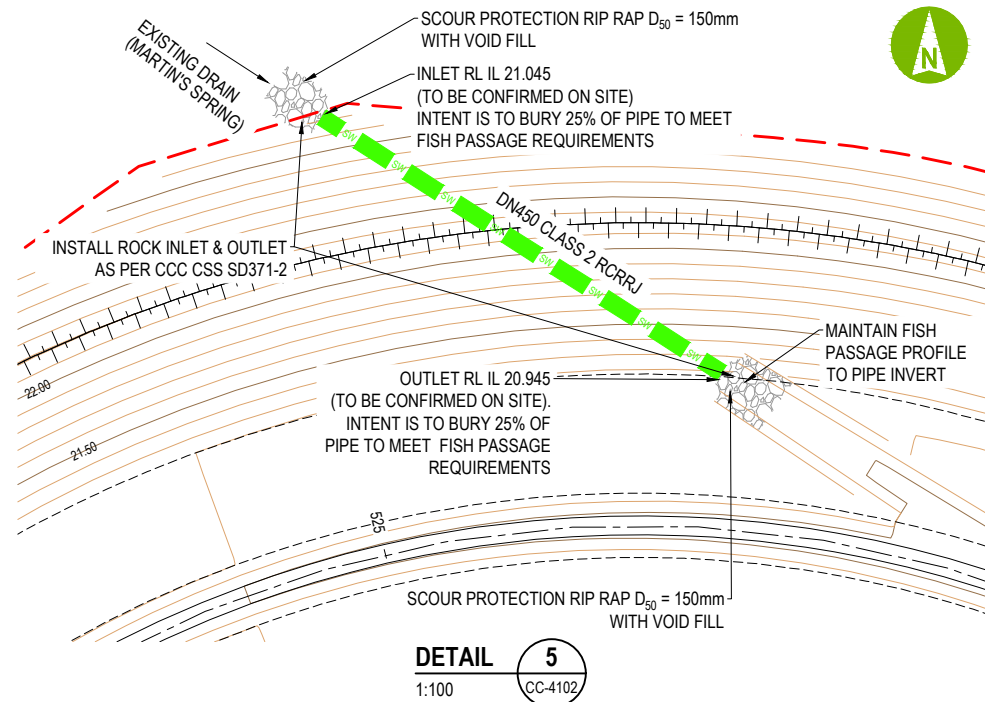
A. LINDGREN

A. LINDGREN

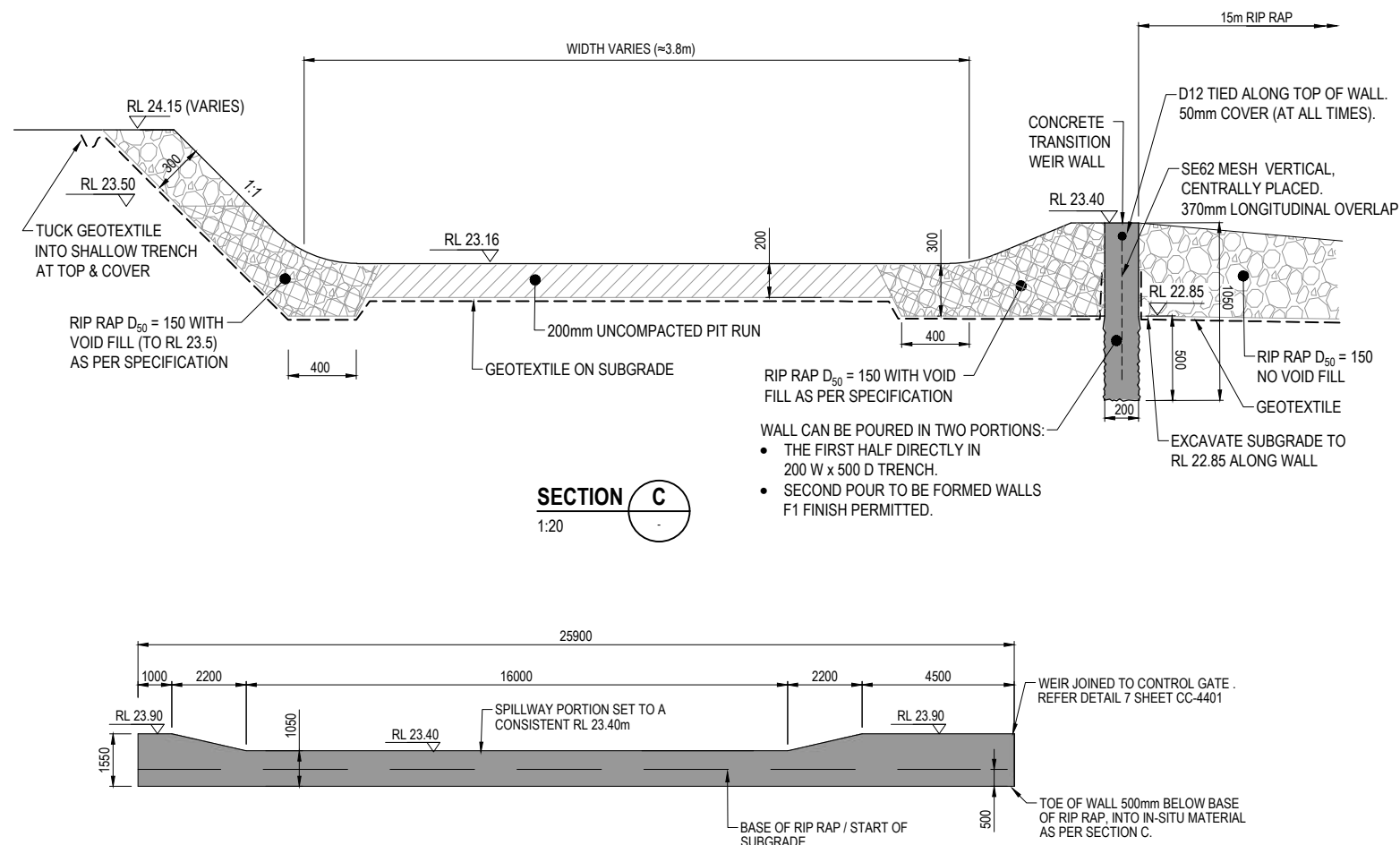
PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4						
TITLE	CROSS SECTIONS SHEET 4						
DRAWING No.	PROJECT No.	AREA	TYPE	DISC	NUMBER	REV	
	505193	- 0000	- DRG	- CC	- 4303	- B	



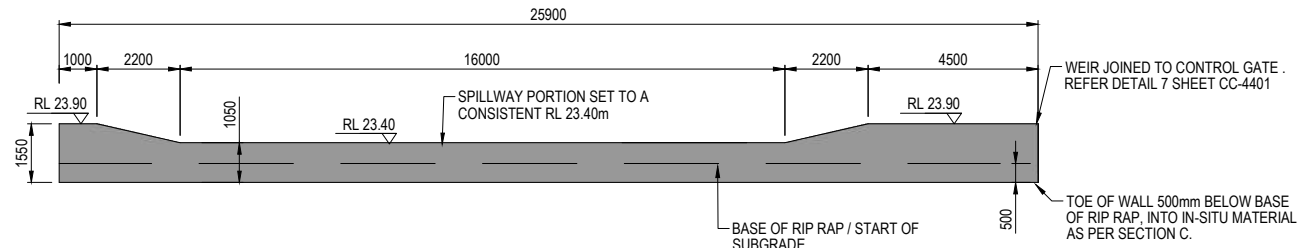
DETAIL 1
1:100
CC-4101



DETAIL 5
1:100
CC-4102



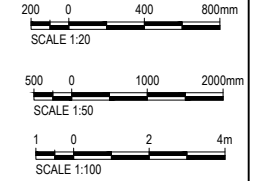
SECTION C
1:20



SECTION H
1:100

**CONFLUENCE DIVERSION
CONCRETE WEIR SPILLWAY**

- NOTE:**
- CONTROL JOINTS EVERY 4.3m TO BE STOPPED WITH FILLER STRIP AND SEALANT
 - CONTROL JOINTS WITH HR12 LAPPING BARS 800mm LONG, EMBEDDED 400mm EACH END, 300mm CRS.
 - MESH TO STOP BEFORE JOINT TO HAVE 50mm COVER.



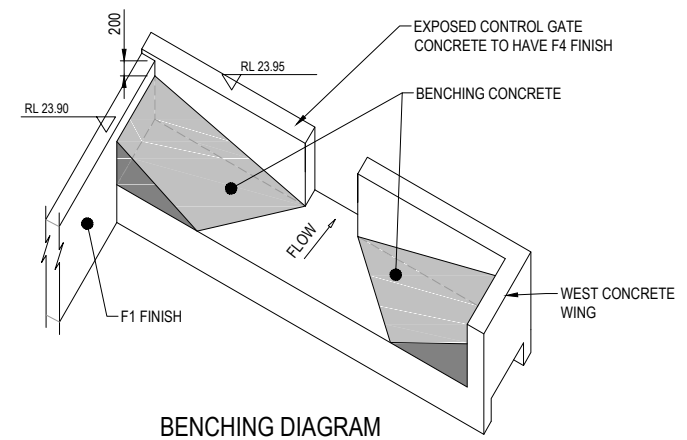
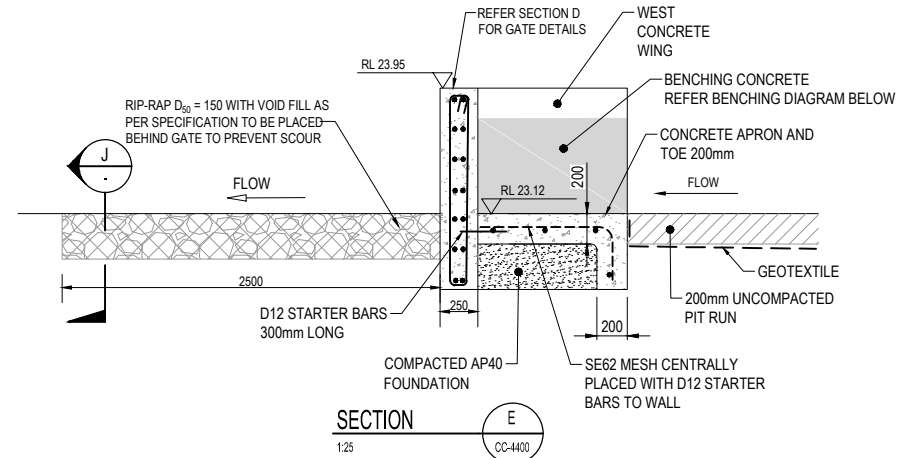
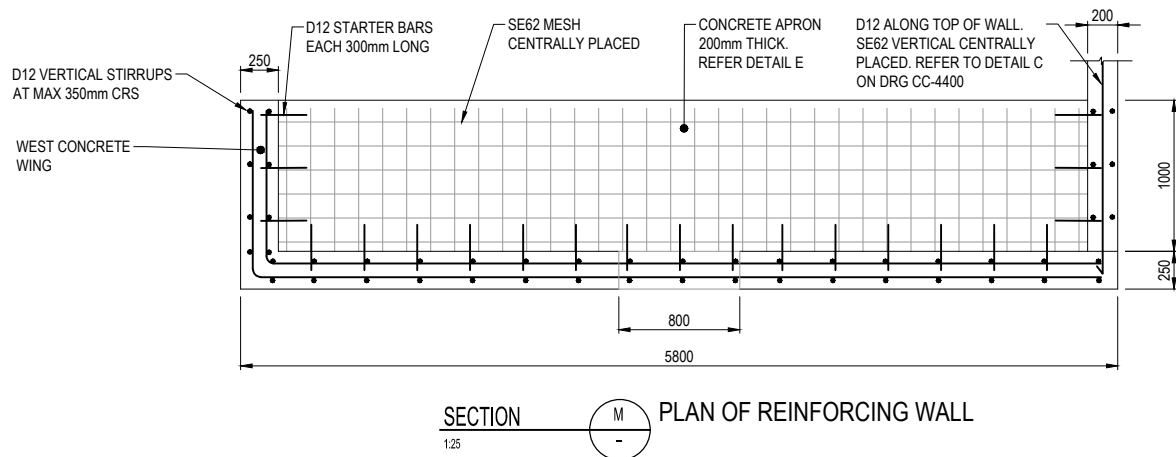
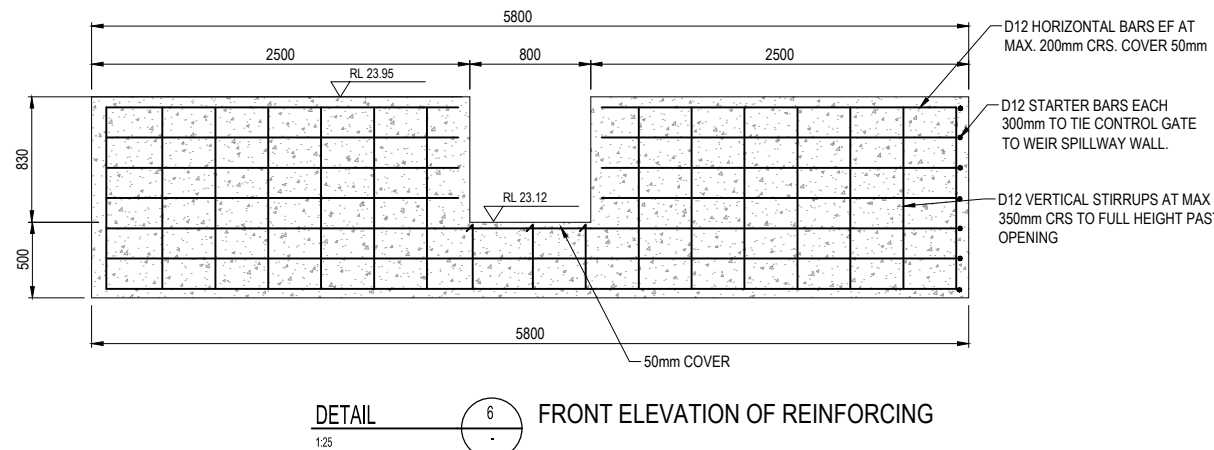
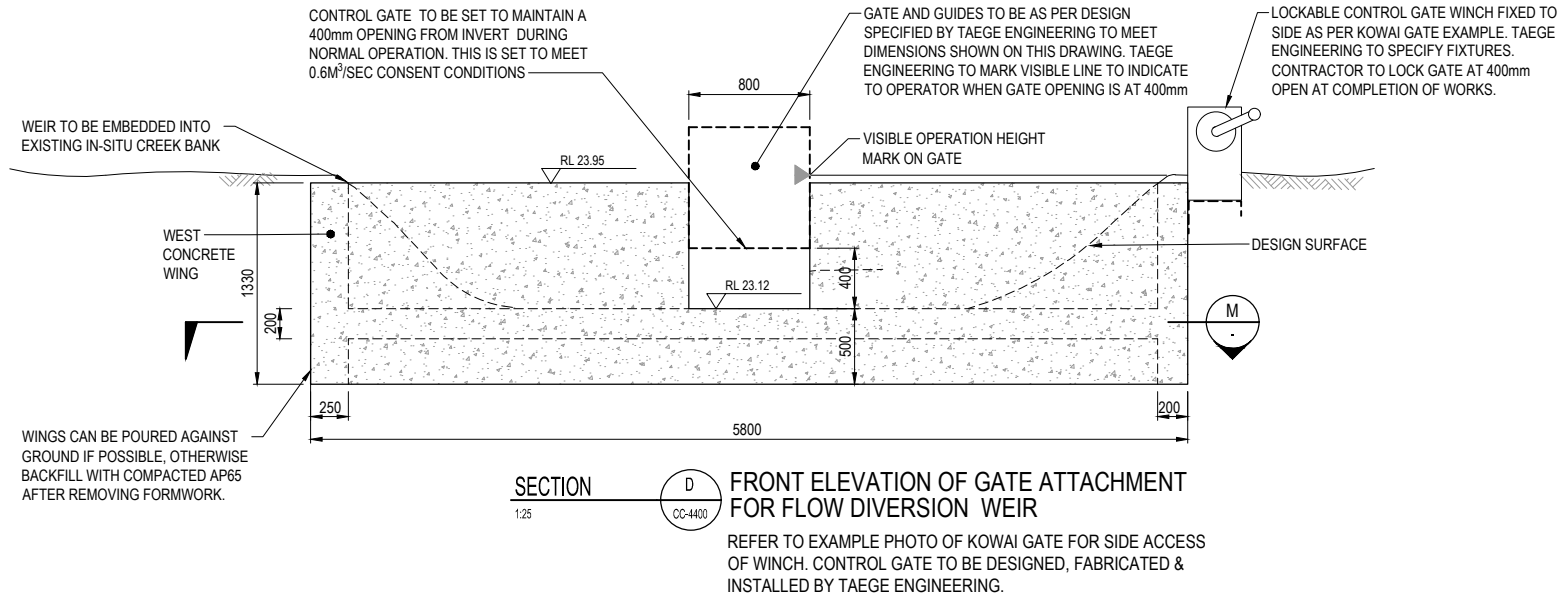
- NOTES:**
- REFER GENERAL NOTES ON SHEET 4100
 - ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN
 - CONCRETE TO 40MPa AFTER 28 DAYS
 - RIP RAP GRADING TABLE AS PER SHEET 4100
 - GEOTEXTILE AS PER SPECIFICATION

REV	DATE	REVISION DETAILS
A	16/10/20	FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED	SCALE	SIZE
A. LINDGREN	AS SHOWN	A1
	DRAWN	
	R DAWSON	
	DESIGNED	
	N CATTO	
	REVIEWED	
	R DAVIES	

TENDER	PROJECT
NOT FOR CONSTRUCTION	SDC - LEESTON NORTH
APPROVED	STORMWATER BYPASS - STAGE 4
A. LINDGREN	
DATE	
18/10/20	

TITLE	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
DETAILS SHEET 1	505193	0000	DRG	CC	4400	B



KOWAI GATE EXAMPLE

- NOTES:**
1. REFER GENERAL NOTES ON SHEET 4100
 2. 6.REFER TO GENERAL REINFORCING NOTES ON DRAWING CC-4403.
 3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN
 4. CONCRETE TO 40MPa AFTER 28 DAYS
 5. RIP RAP GRADING TABLE AS PER SHEET 4100
 6. GEOTEXTILE AS PER SPECIFICATION
 7. DEFORMED REINFORCING BAR TO BE 300E GRADE DUCTILE STEEL.

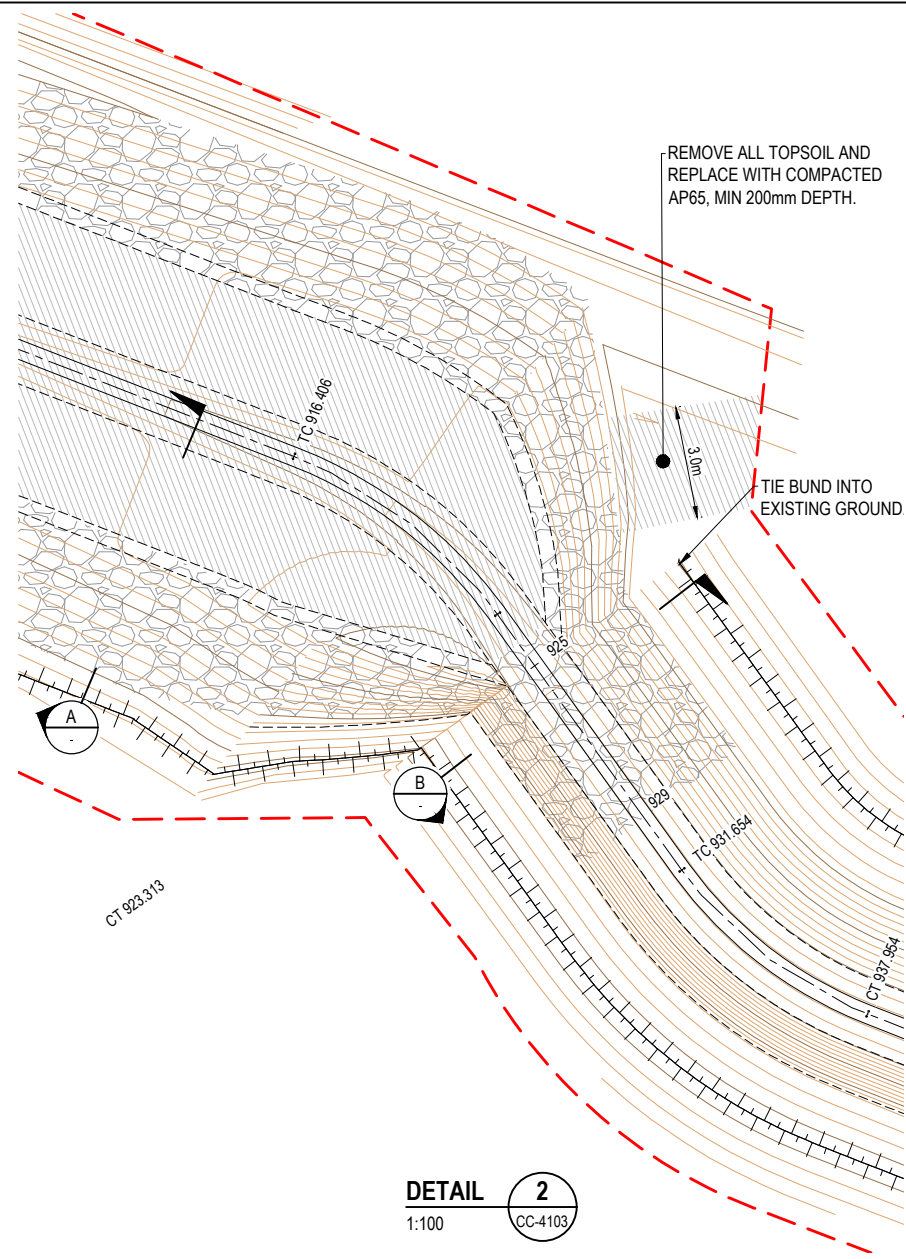
REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED
A. LINDGREN
A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R.DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R DAVIES	

TENDER	
NOT FOR CONSTRUCTION	
APPROVED	
	DATE
A. LINDGREN	16/10/20
A. LINDGREN	

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4																
TITLE	DETAILS SHEET 2																
DRAWING No.	PROJECT No.	505193	-	WBS	0000	-	TYPE	DRG	-	DISC	CC	-	NUMBER	4401	-	REV	B



SHAPE BYPASS INTO EXISTING DUNSANDEL DRAIN.
CONFIRM ON SITE WITH ENGINEER.

EXISTING DN600
CULVERT OUTLET ONLY
TO CCC CSS SD371-2

20.2

20.0

19.50

19.10

100

TC 1098.508

CT 1098.508

TC 1100.807

CT 1100.807

EXTENT OF WORKS

DETAIL 4

EX GL

150 x 150mm TRENCH. TUCK GEOTEXTILE & COVER

300mm THICK RIP RAP $D_{50} = 150$

RIP RAP $D_{50} = 150$ WITH VOID FILL AS PER SPECIFICATIONS TO 200mm ABOVE INVERT

200mm UNCOMPACTED PITRUN

GEOTEXTILE OVER SUBGRADE

0%

LOW FLOW CHANNEL

SECTION A

1:50

ROUNDED BUND

EX GL

1:4

150x 150mm TRENCH. TUCK GEOTEXTILE & COVER

300mm THICK RIP RAP $D_{50} = 150$ (NO VOID FILL)

RIP RAP $D_{50} = 150$ WITH VOID FILL AS PER SPECIFICATIONS TO 200mm ABOVE INVERT

1:2

200

LOW FLOW CHANNEL

1:1

1:4

150x 150mm TRENCH. TUCK GEOTEXTILE & COVER

GEOTEXTILE OVER SUBGRADE

SECTION B

1:50

LOW FLOW CHANNEL

200

1:6

1:1

150x 150mm TRENCH. TUCK GEOTEXTILE & COVER

GEOTEXTILE OVER SUBGRADE

300mm THICK RIP RAP $D_{50} = 150$ (NO VOID FILL)

RIP RAP $D_{50} = 150$ WITH VOID FILL AS PER SPECIFICATIONS TO 200mm ABOVE INVERT

SECTION K

1:50

EX GL

EX GL

150x150mm TRENCH, TUCK GEOTEXTILE & COVER

200

GEOTEXTILE OVER SUBGRADE

RIP RAP $D_{30} = 150$ WITH VOID FILL AS PER SPECIFICATIONS TO 200mm ABOVE INVERT

300mm THICK RIP RAP $D_{30} = 150$

EX GL

150x150mm TRENCH, TUCK GEOTEXTILE & COVER

SECTION L

1:50

REV	DATE	REVISION DETAILS	APPROVED	SCALE	SIZE	TENDER	PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4						
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN	AS SHOWN	A1	NOT FOR CONSTRUCTION	APPROVED DATE 16/10/20 A. LINDGREN	TITLE 						

GENERAL NOTES

1. DRAWINGS SHALL BE READ IN CONJUNCTION WITH THE SPECIFICATION.
2. UNLESS NOTED OTHERWISE, ALL REDUCED LEVELS (RLs) ARE IN METRES, AND ALL DIMENSIONS ARE IN MILLIMETRES
3. DIMENSIONS SHALL NOT BE OBTAINED BY SCALING FROM DRAWINGS.
4. ANY DISCREPANCIES ON THE DRAWINGS SHALL BE REFERRED TO THE ENGINEER FOR RESOLUTION BEFORE PROCEEDING WITH THE WORK.
5. THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION, INCLUDING TEMPORARY WORKS DESIGN, IS THE RESPONSIBILITY OF THE CONTRACTOR.
6. THE METHOD OF EXCAVATION AND TEMPORARY SUPPORT OF ALL CUT FACES IS THE RESPONSIBILITY OF THE CONTRACTOR
7. ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE CURRENT CODES OF PRACTICE EXCEPT WHERE VARIED BY SPECIFICATION OR THE DRAWINGS
8. WHERE PROPRIETARY PRODUCTS ARE SPECIFIED IN THE DOCUMENTS THE CONTRACTOR MAY SUBMIT AN ALTERNATIVE PRODUCT FOR APPROVAL. ALL MATERIALS AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION.
9. ALL NON-LOAD BEARING WALLS SHALL BE KEPT CLEAR OF THE UNDERSIDE OF SLABS AND BEAMS BY 20mm UNLESS OTHERWISE SHOWN.
10. THE ENGINEER SHALL INSPECT STRUCTURAL DETAILS TO CM3 AS DEFINED IN THE ACENZ/IPENZ MODEL CONDITIONS. TYPICALLY INSPECT PRIOR TO:

- MAJOR CONCRETE TOURS
- STRUCTURAL STEEL BEING CONCEALED
- LININGS BEING PLACED OVER TIMBER BRACING DETAILS

CONTACT THE ENGINEER AT LEAST 48 HOURS PRIOR TO ARRANGE INSPECTION WHEN REQUIRED

STANDARD ABBREVIATIONS

1. GENERAL ABBREVIATIONS AS FOLLOWS:

 - ALT - ALTERNATING
 - ARCH - ARCHITECT(S)
 - BOS - BOTTOM OF STEEL
 - BLG - BUILDING
 - C/C - CENTRE TO CENTRE
 - CJ - CONSTRUCTION JOINT
 - COS - CHECK ON SITE
 - CONC - CONCRETE
 - COV - COVER TO REINFORCEMENT
 - CVR - COVER TO REINFORCEMENT
 - CL - CENTRE LINE
 - CRS - CENTRES
 - C/W - COMPLETE WITH
 - DFT - DRY FILM THICKNESS
 - DPM - DAMP-PROOF MEMBRANE
 - DIA - DIAMETER
 - FFL - FINISHED FLOOR LEVEL
 - FPBW - FULL PENETRATION BUTT WELD
 - FWAR - FILLET WELD ALL ROUND
 - GALV - GALVANISED
 - GL - GROUND LEVEL
 - HD - HOLDING DOWN (BOLT)
 - ID - INSIDE DIAMETER
 - IL - INVERT LEVEL
 - LG - LONG
 - MAX - MAXIMUM
 - MIN - MINIMUM
 - MS - MILD STEEL
 - NOM - NOMINAL
 - NTS - NOT TO SCALE
 - O/A - OVERALL
 - OD - OUTSIDE DIAMETER
 - PC - PRECAST CONCRETE
 - RAD - RADIUS
 - REQ'D - REQUIRED
 - RL - REDUCED LEVEL
 - SED - SMALL END DIAMETER
 - STGD - STAGGERED
 - STD - STANDARD
 - STP - STIRRUPS
 - STR - STARTERS
 - COG - STANDARD COG
 - SPEC - SPECIFICATION
 - SQ - SQUARE
 - SS - STAINLESS STEEL
 - TOS - TOP OF STEEL
 - THRU - THROUGH
 - TYP - TYPICAL
 - U/S - UNDERSIDE
 - UNO - UNLESS NOTED OTHERWISE
 - WP - WELD PLATE
 - ø - DRILL DIAMETER
2. ABBREVIATIONS FOR REINFORCED CONCRETE

 - B - BOTTOM
 - Bb - BOTTOM BARS, BOTTOM LAYER
 - Bt - BOTTOM BARS, TOP LAYER
 - T - TOP
 - Tb - TOP BARS, BOTTOM LAYER
 - Tt - TOP BARS, TOP LAYER
 - EW - EACH WAY
 - EF - EACH FACE
 - FF - FAR FACE
 - NF - NEAR FACE
 - LAR - LAP AT RANDOM LOCATIONS
 - REBAR - REINFORCING BARS
 - REINF - REINFORCEMENT
 - STR(S) - STIRRUP(S)
 - STR(S) - STARTER(S)
 - R - PLAIN ROUND REBAR GRADE 300
 - eg. R20 REFERS TO GRADE 300 PLAIN ROUND REBAR 20mm DIA.
 - HR - PLAIN ROUND REBAR GRADE 500
 - eg. HR20 REFERS TO GRADE 500 PLAIN ROUND REBAR 20mm DIA.
 - D - DEFORMED REBAR GRADE 300
 - eg. D20 REFERS TO GRADE 300 DEFORMED REBAR 20mm DIA.
 - H - DEFORMED REBAR GRADE 500
 - eg. H20 REFERS TO GRADE 500 DEFORMED REBAR 20mm DIA.
 - RB - DEFORMED REID BAR (GRADE 500)
 - eg. RB20 REFERS TO DEFORMED REID BAR 20mm DIA,
 - M - MESH eg. SE 62

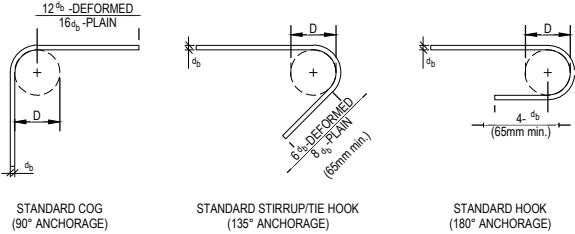
GRADE 500 REFERS TO GRADE 500E MA

NOTES ON REINFORCED CONCRETE

1. MINIMUM CONCRETE STRENGTHS SHALL BE AS FOLLOWS UNLESS NOTED ON DRAWINGS:
- FOUNDATION CONCRETE - 40MPa
 - SLAB ON GRADE - 30MPa
 - PRECAST CONCRETE - 40MPa
 - GROUT INFILL TO BLOCK WALLS - 17.5MPa
 - TIDY SLABS OR ANY OTHER NON-STRUCTURAL CONCRETE - 30MPa
2. SHRINKAGE CONTROL
- CONCRETE STRUCTURES THAT REQUIRE CONSTRUCTION OR SHRINKAGE CONTROL JOINTS HAVE REQUIREMENTS GOVERNED BY THE SIZE OF THE POUR, SIZE OF THE SLAB, THICKNESS OF SLAB, SITE CONDITIONS AND MIX DESIGN. THESE JOINTS MAY BE A SIMPLE KEYED CONSTRUCTION JOINT. THE FINAL SOLUTION SHALL BE DETERMINED BY THE ENGINEER AFTER CONSULTATION WITH THE CONTRACTOR AND ANY NECESSARY SUB-CONTRACTORS.
3. NO PENETRATIONS, CHASES OR EMBEDMENT OF PIPES SHALL BE MADE IN CONCRETE ELEMENTS WITHOUT THE PRIOR APPROVAL OF THE ENGINEER.
4. SURFACE FINISHES TO THE CONCRETE SHALL BE AS STATED IN THE SPECIFICATION OR ON THE DRAWINGS.
5. THE CONTRACTOR IS TO SUBMIT SHOP DRAWINGS OF ALL PRECAST ELEMENTS FOR REVIEW PRIOR TO MANUFACTURE.
6. PROPRIETARY PRECAST ELEMENTS REFERRED TO IN THE DRAWINGS (IF ANY) SHALL BE DESIGNED AND DETAILED BY SUPPLIER AND A COPY OF THE DOCUMENTATION SUBMITTED TO THE ENGINEER FOR REVIEW PRIOR TO MANUFACTURE.
7. CONCRETE PLACING AND MOULDING TOLERANCES ARE TO BE AS STATED IN THE SPECIFICATION.
8. ALL PENETRATIONS THROUGH CONCRETE SLABS SHALL BE TRIMMED BY 2-H12 BARS TO EACH EDGE OF THE PENETRATION UNLESS OTHERWISE NOTED. TRIMMER BARS ARE TO EXTEND 750mm BEYOND THE EDGE OF THE PENETRATIONS.
9. WELDING OF REINFORCEMENT IS NOT PERMITTED UNLESS SHOWN ON THE DRAWINGS OR APPROVED BY THE ENGINEER. IN PILES AND CIRCULAR COLUMNS, SPIRAL TIES MAY BE SUBSTITUTED BY WELDED HOOPS. REFER TO LAP WELDING DETAIL FOR REQUIREMENTS
10. TOP AND BOTTOM REINFORCEMENT IN SLABS SHALL BE ADEQUATELY SUPPORTED TO ENSURE ALL REINFORCING STAYS IN PLACE DURING CONCRETE POURING, BY HIGH CHAIRS OR OTHER APPROVED METHODS, PRECAST BLOCKS ARE NOT TO BE USED.
11. HOOKS AND BENDS TO REBAR ARE TO BE IN ACCORDANCE WITH NZS3109 UNLESS NOTED OTHERWISE ON THE DRAWINGS.
12. BARS PARTIALLY EMBEDDED IN CONCRETE SHALL NOT BE SITE BENT UNLESS SHOWN ON THE DRAWINGS OR SPECIFICALLY APPROVED BY THE ENGINEER.
13. REINFORCEMENT SHALL BE GRADE 300E UNLESS NOTED OTHERWISE
14. NO REINFORCEMENT SPLICES SHALL BE MADE, OTHER THAN THOSE SHOWN ON THE DRAWINGS, WITHOUT THE PRIOR APPROVAL OF THE ENGINEER. UNLESS NOTED OTHERWISE ON THE DRAWINGS, ALL REINFORCEMENT LAPS IN CONCRETE TO COMPLY WITH THE TABLE ON THIS SHEET.
15. SPLICING OF REINFORCEMENT WHETHER BY LAPPING, WELDING OR MECHANICAL SPLICE, SHALL BE CARRIED OUT AS SHOWN ON THE DRAWINGS OR AS SPECIFICALLY APPROVED BY THE ENGINEER, EXCEPT AS NOTED BELOW:
- WELDED WIRE MESH SHALL BE SPLICED AS REQUIRED, BUT NOT THROUGH SLAB JOINTS.
 - REINFORCEMENT IN SLABS ON GRADE AND IN TOPPINGS SHALL BE SPLICED AS REQUIRED, BUT NOT THROUGH SLAB JOINTS.
16. ALL HOOKS ON STIRRUPS AND TIES MUST FIT CLOSELY AROUND MAIN BARS UNLESS NOTED OTHERWISE. FIRST STIRRUP NOT TO BE PLACED FURTHER THAN THE LESSER OF ½ STIRRUP SPACING OR 50mm FROM SUPPORT FACE.
17. ALL EXPOSED ANCHORS SHALL BE HILTI HIT RE 500 SD (UNO)

BAR SIZE	MAIN STEEL	STIRRUPS AND TIES
6	30	22
10	50	32
12	60	40
16	80	60
20	100	70
25	150	
32	195	
40	240	

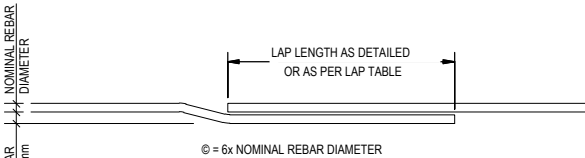
MINIMUM FORMER PIN DIAMETERS "D" FOR BENDING REINFORCING BARS



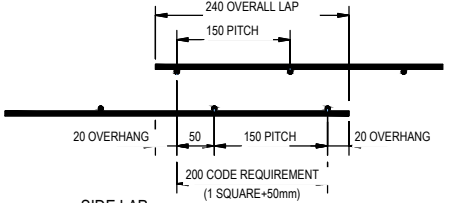
REINFORCING BENDING DETAILS

CONCRETE COVERS			
ENVIRONMENT	CONCRETE COMPRESSIVE STRENGTH f _c (MPa)		
	25	30	40
SURFACES CAST AGAINST AND EXPOSED TO EARTH	75	75	75
SURFACES CAST AGAINST DPM ON EARTH	50	50	50
EXTERIOR ENVIRONMENT WITHIN 500m OF HIGH TIDE MARK	50	45	40
OTHER EXTERIOR ENVIRONMENT	40	35	30
SURFACES EXPOSED TO EARTH (NON-AGRESSIVE OR PROTECTED BY D.P.M.)	40	35	30
INTERIOR ENVIRONMENT NOT SUBJECTED TO REPEATED WETTING OR DRYING	25	20	20

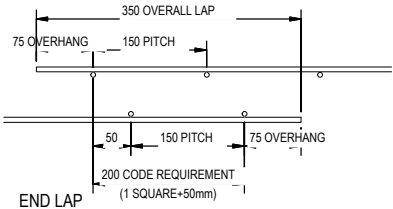
NOTE: CONCRETE COVERS ARE THE MINIMUM DISTANCE TO ANY REINFORCING STEEL, INCLUDING STIRRUPS AND TIES



REBAR CRANKED SPLICE DETAIL

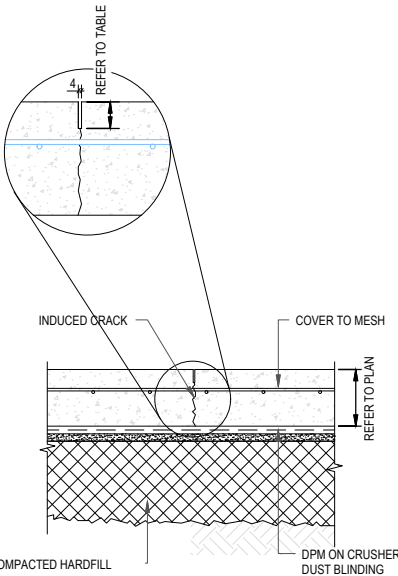


SIDE LAP



END LAP

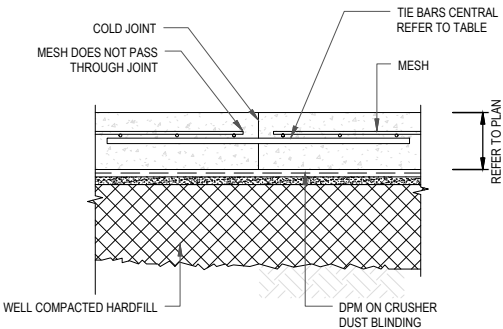
REINFORCING MESH LAPPING DETAILS



EMBEDMENT DEPTHS

ANCHOR SIZE d _f	DEPTH OF ANCHOR h (mm)
M10	100
M12	110
M16	190
M20	170
M24	210

BAR SIZE d _f	EMBEDMENT DEPTH h (mm)
H12	250
H16	350



SLAB DEPTH	BAR SIZE	BAR LENGTH	BAR SPACING
100mm	H10	800mm	300mm
125mm	H10	800mm	300mm
150mm	H12	800mm	300mm
175mm	H12	800mm	300mm
200mm	H16	1000mm	350mm

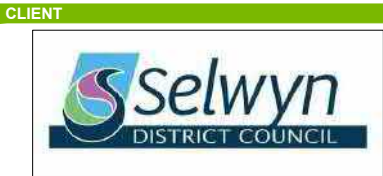
DOWELLED JOINT

TIED INDUCED JOINT - SAW CUT

SLAB DEPTH	SAWCUT DEPTH	MESH COVER
100mm	25mm	35mm
125mm	30mm	40mm
150mm	35mm	50mm
175mm	45mm	60mm
200mm	50mm	65mm



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REV	DATE	REVISION DETAILS
A	12/11/20	ISSUE FOR TENDER

APPROVED	SCALE	SIZE
A. LINDGREN	NA	A1

TENDER	APPROVED
NOT FOR CONSTRUCTION	DATE 12/11/2020

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 4											
TITLE	GENERAL REINFORCING NOTES											
DRAWING No.	PROJECT No.	AREA	TYPE	DISC	NUMBER	REV						
	505193	- 0000	- DRG	- CC	- 4403	- A						

File: \aurecon\in\shaham\NCHC\Projects\505\505_13C_Section\SW\Bypass Stage 3 & 4\5 Deliver\Design\505_13C CAD\Drawing\505 13C DRG-CC-000-000-00.dwg Plot Date: 29/03/2019 11:18:17 PM Name: Jordan Wairlich-Kode Xref: 505 13C-CANTERBURY-03m-RURAL-ALERTAL-PHOTOS-2016-2016 505193XRR-Base Images: Aurecon Logo www.SDC.Logo

File: \aurecon\in\shaham\NCHC\Projects\505\505_13C_Section\SW\Bypass Stage 3 & 4\5 Deliver\Design\505_13C CAD\Drawing\505 13C DRG-CC-000-000-00.dwg Plot Date: 29/03/2019 11:18:17 PM Name: Jordan Wairlich-Kode Xref: 505 13C-CANTERBURY-03m-RURAL-ALERTAL-PHOTOS-2016-2016 505193XRR-Base Images: Aurecon Logo www.SDC.Logo



File: \aurecon\in\shaham\NCHC\Projects\505\505_13C_Section\SW\Bypass Stage 3 & 4\5 Deliver\Design\505_13C CAD\Drawing\505 13C DRG-CC-000-000-00.dwg Plot Date: 29/03/2019 11:18:17 PM Name: Jordan Wairlich-Kode Xref: 505 13C-CANTERBURY-03m-RURAL-ALERTAL-PHOTOS-2016-2016 505193XRR-Base Images: Aurecon Logo www.SDC.Logo



File: \aurecon\in\shaham\NCHC\Projects\505\505_13C_Section\SW\Bypass Stage 3 & 4\5 Deliver\Design\505_13C CAD\Drawing\505 13C DRG-CC-000-000-00.dwg Plot Date: 29/03/2019 11:18:17 PM Name: Jordan Wairlich-Kode Xref: 505 13C-CANTERBURY-03m-RURAL-ALERTAL-PHOTOS-2016-2016 505193XRR-Base Images: Aurecon Logo www.SDC.Logo

File: \aurecon\in\shaham\NCHC\Projects\505\505_13C_Section\SW\Bypass Stage 3 & 4\5 Deliver\Design\505_13C CAD\Drawing\505 13C DRG-CC-000-000-00.dwg Plot Date: 29/03/2019 11:18:17 PM Name: Jordan Wairlich-Kode Xref: 505 13C-CANTERBURY-03m-RURAL-ALERTAL-PHOTOS-2016-2016 505193XRR-Base Images: Aurecon Logo www.SDC.Logo

File: \aurecon\in\shaham\NCHC\Projects\505\505_13C_Section\SW\Bypass Stage 3 & 4\5 Deliver\Design\505_13C CAD\Drawing\505 13C DRG-CC-000-000-00.dwg Plot Date: 29/03/2019 11:18:17 PM Name: Jordan Wairlich-Kode Xref: 505 13C-CANTERBURY-03m-RURAL-ALERTAL-PHOTOS-2016-2016 505193XRR-Base Images: Aurecon Logo www.SDC.Logo

	Likelihood of occurrence				
Most Likely Consequence	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

Print Date: 12/11/2020 1:50:02 PM Office: NZCHC Filename: P:\50193 - SDC LEESTON SW BYPASS STAGE 3 & 4\5 DELIVER DESIGN\503 CAD\DRAWINGS\505 193-0000-DRG-CC-5001.DWG

	Likelihood of occurrence				
Most Likely Consequence	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
B - Critical	Extreme	Extreme	Extreme	High	High
C - Serious	Extreme	High	High	Moderate	Moderate
D - Significant	High	High	Moderate	Low	Low
E - Minor	Moderate	Moderate	Low	Low	Low

[illegible]

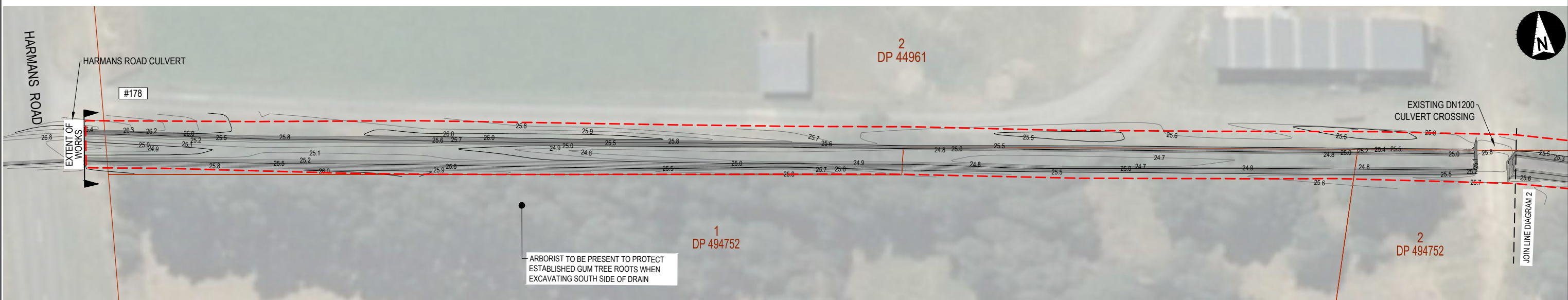


DIAGRAM 1
1:250

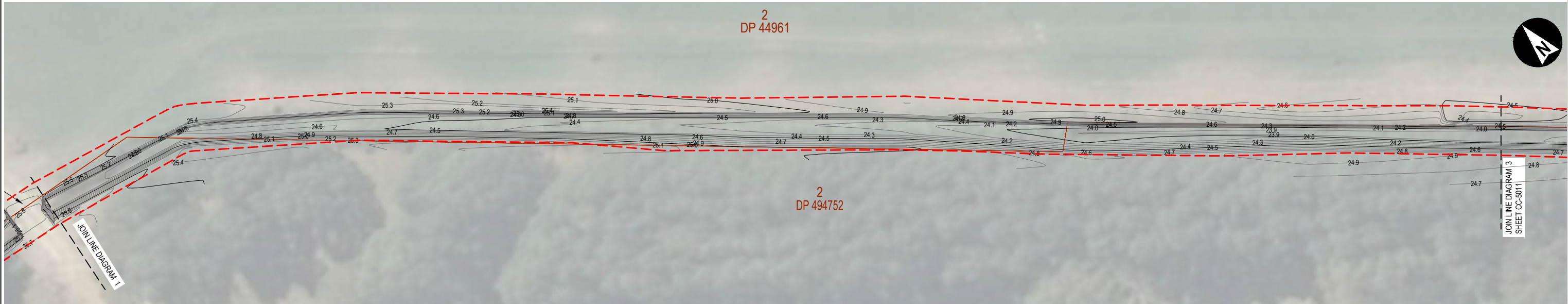


DIAGRAM 2
1:250

Proj Date: 12/11/2020 10:13 PM, Client: NZDC, Filename: P090193, SDC LEESTON SW BYPASS STAGE 3, 4.6 DELIVER DESIGN W/0 CAD/DRAWINGS/05/18/0000/DRG/CC-001.DWG

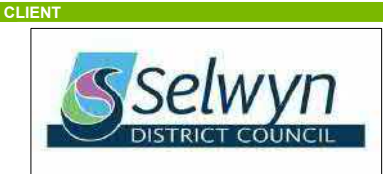
2.5 0 5 10m
SCALE 1:250

- MINOR CONTOUR (0.1m)
- MAJOR CONTOUR (0.5m)
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- EXTENT OF WORKS

VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
AERIAL IMAGERY FROM LINZ DATA SERVICE BY A
CREATIVE COMMONS LICENCE.



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REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER	APPROVED
NOT FOR CONSTRUCTION	
	DATE 12/11/2020
A. LINDGREN	A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	EXISTING CONTOURS SHEET 1
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	5010
NUMBER	B
REV	

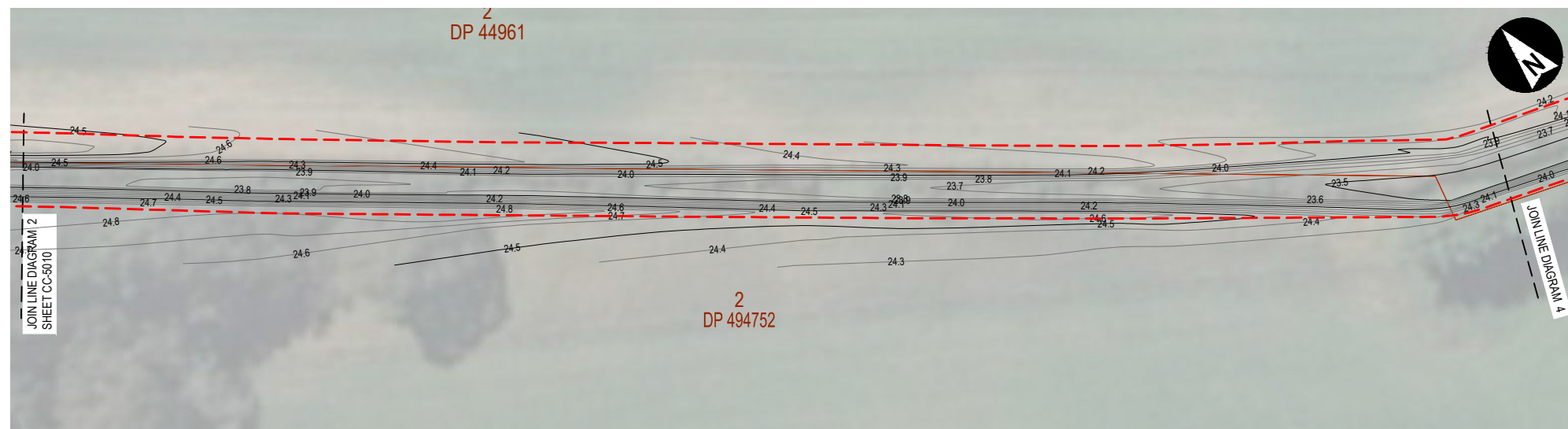


DIAGRAM 3
1:250

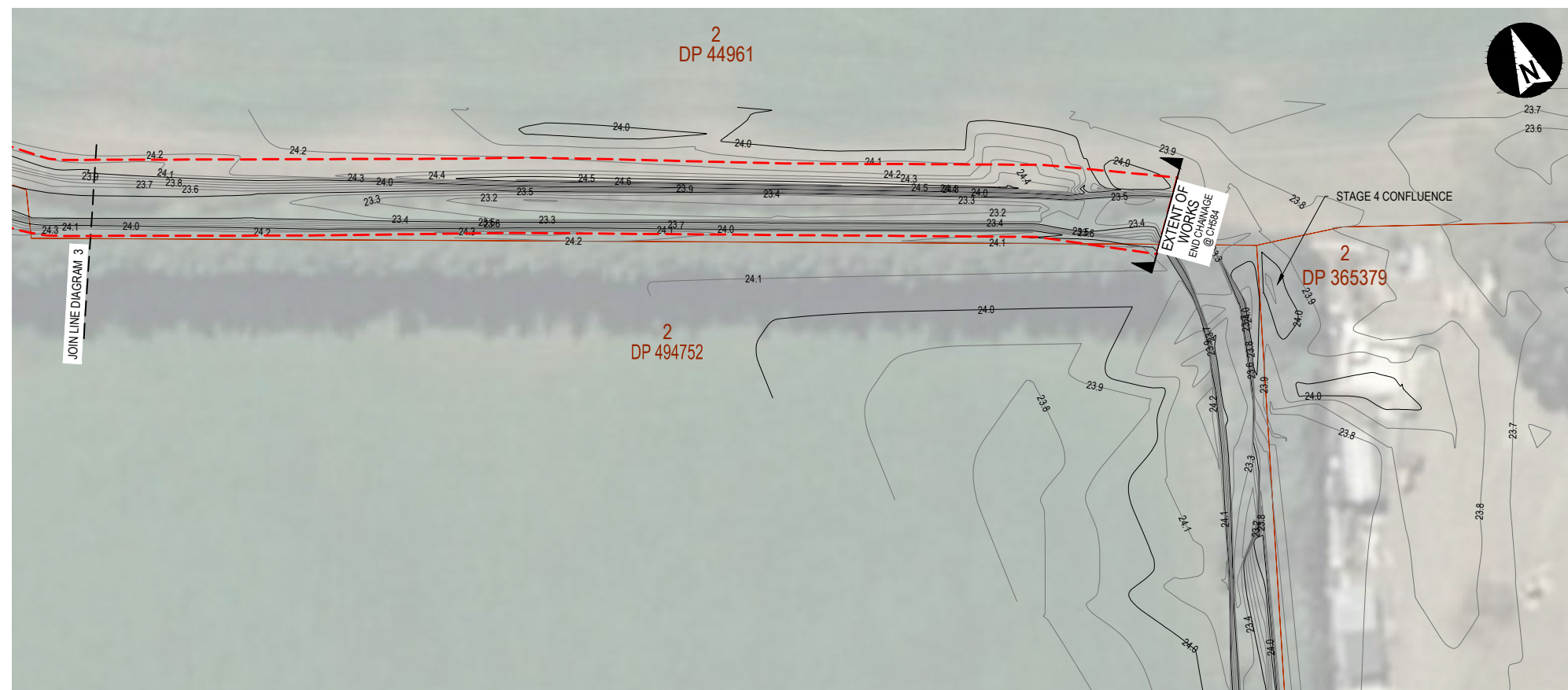


DIAGRAM 4
1:250

- MINOR CONTOUR (0.1m)
- MAJOR CONTOUR (0.5m)
- EXISTING PROPERTY BOUNDARY
- EXISTING FENCE
- EXTENT OF WORKS

VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
AERIAL IMAGERY FROM LINZ DATA SERVICE BY A
CREATIVE COMMONS LICENCE.

2.5 0 5 10m
SCALE 1:250

Plot Date: 12/11/2020 10:13 PM. Client: NZDC. Filename: P:\09193_SDC LEESTON SW BYPASS STAGE 3\1.46 DELIVER DESIGN\DWG CAD\DRAWINGS\05193\000.DWG\CC-011.DWG



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REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER
NOT FOR CONSTRUCTION
APPROVED
A. LINDGREN
A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	EXISTING CONTOURS SHEET 2
DRAWING No.	505193
PROJECT No.	505193
AREA	0000
TYPE	DRG
DISC	CC
NUMBER	5011
REV	B



DIAGRAM 1
1:250

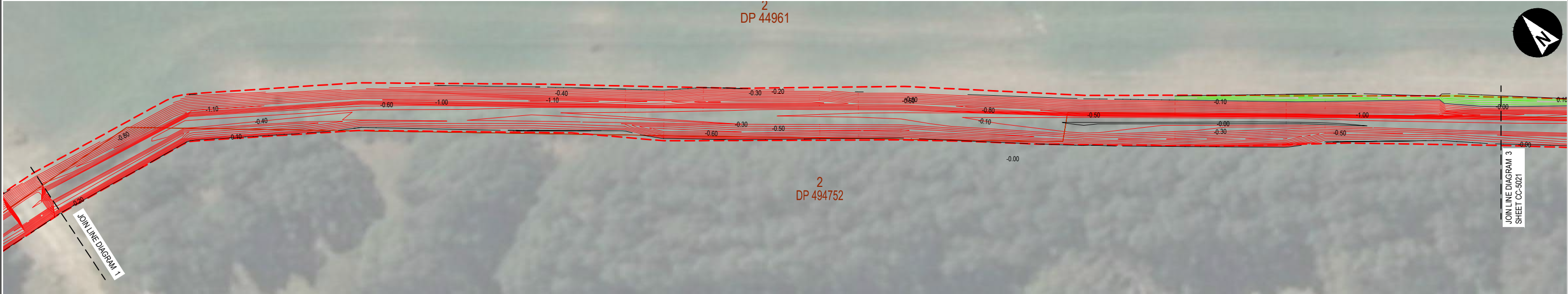


DIAGRAM 2
1:250




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CLIENT



REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED	SCALE	SIZE
A. LINDGREN	AS SHOWN	A1

DRAWN
R DAWSON
DESIGNED
N CATTO
REVIEWED
R. DAVIES

TENDER
NOT FOR CONSTRUCTION
APPROVED
A. LINDGREN

DATE
12/11/2020

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	CUT FILL CONTOURS SHEET 1
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	5020
NUMBER	B
REV	

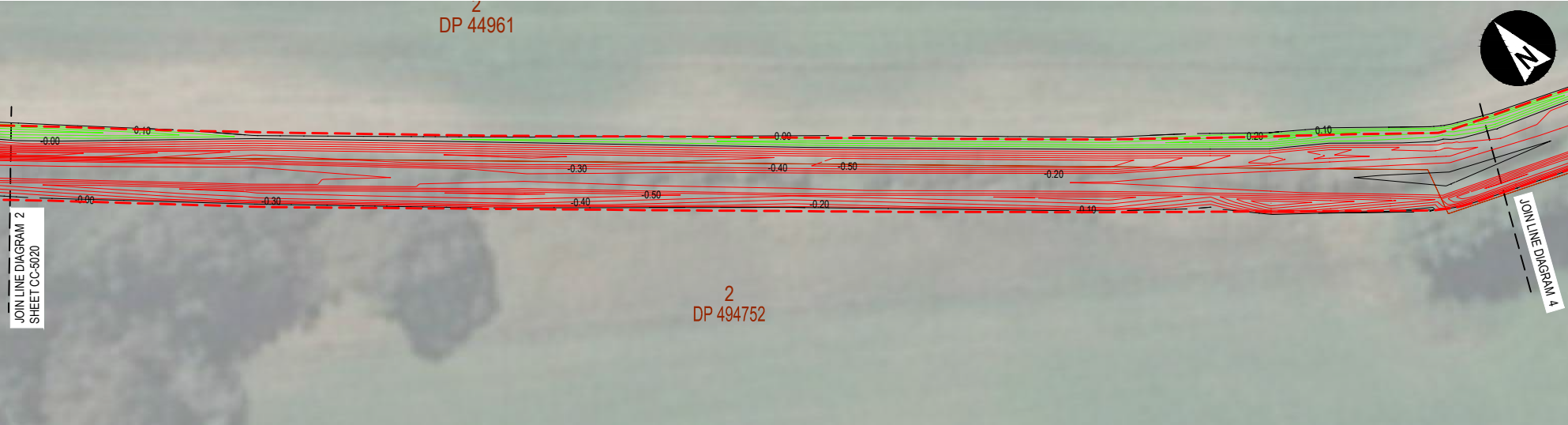


DIAGRAM 3
1:250

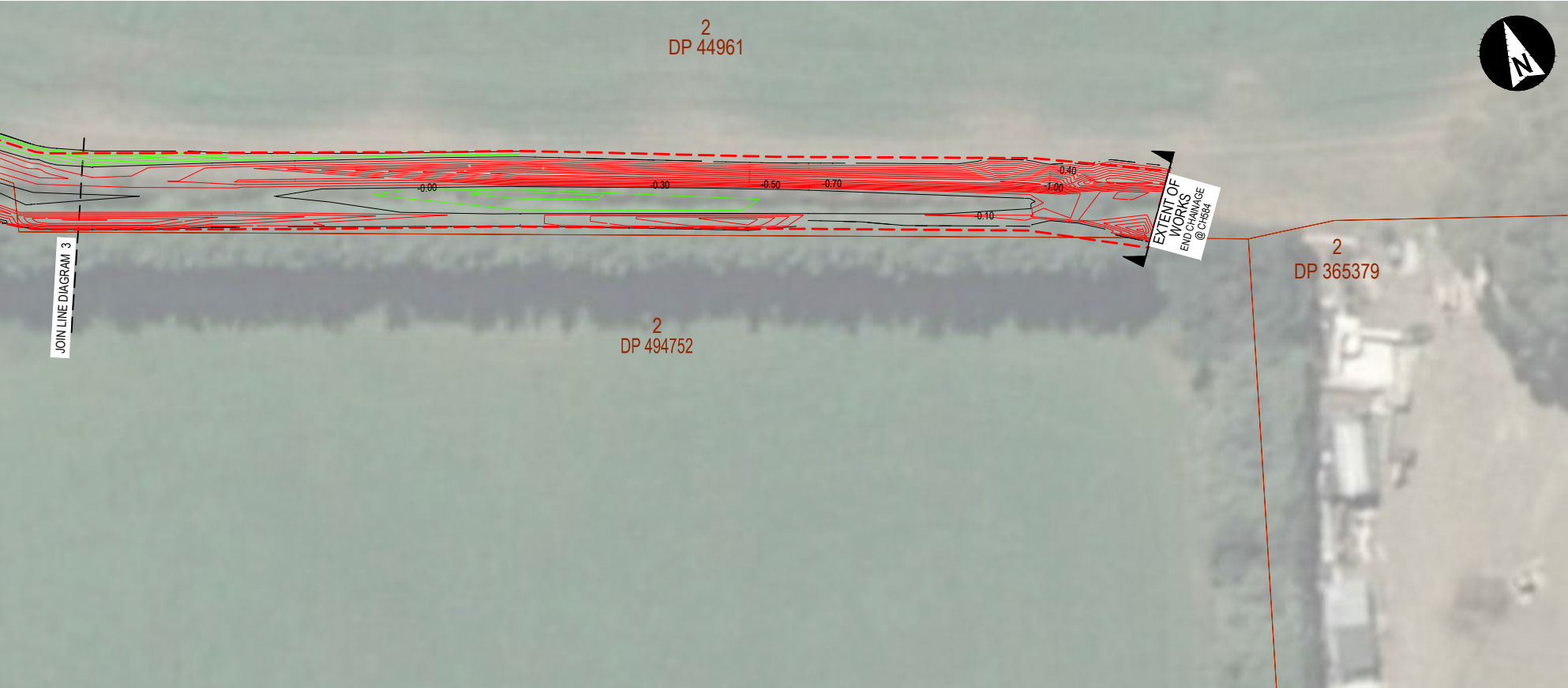
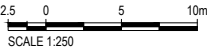


DIAGRAM 4
1:250

- 0.0m (NO CUT FILL) CONTOUR
- FILL CONTOUR (0.1m INTERVALS)
- CUT CONTOUR (0.1m INTERVALS)
- EXTENT OF WORKS



Proj Date: 12/11/2020 10:11 PM, Client: NZDC, Filename: P505193_SDC LEESTON SW BYPASS STAGE 5 1:46 DELIVER DESIGN WDG CAD DRAWINGS 05193.000.DWG, CC-001.DWG

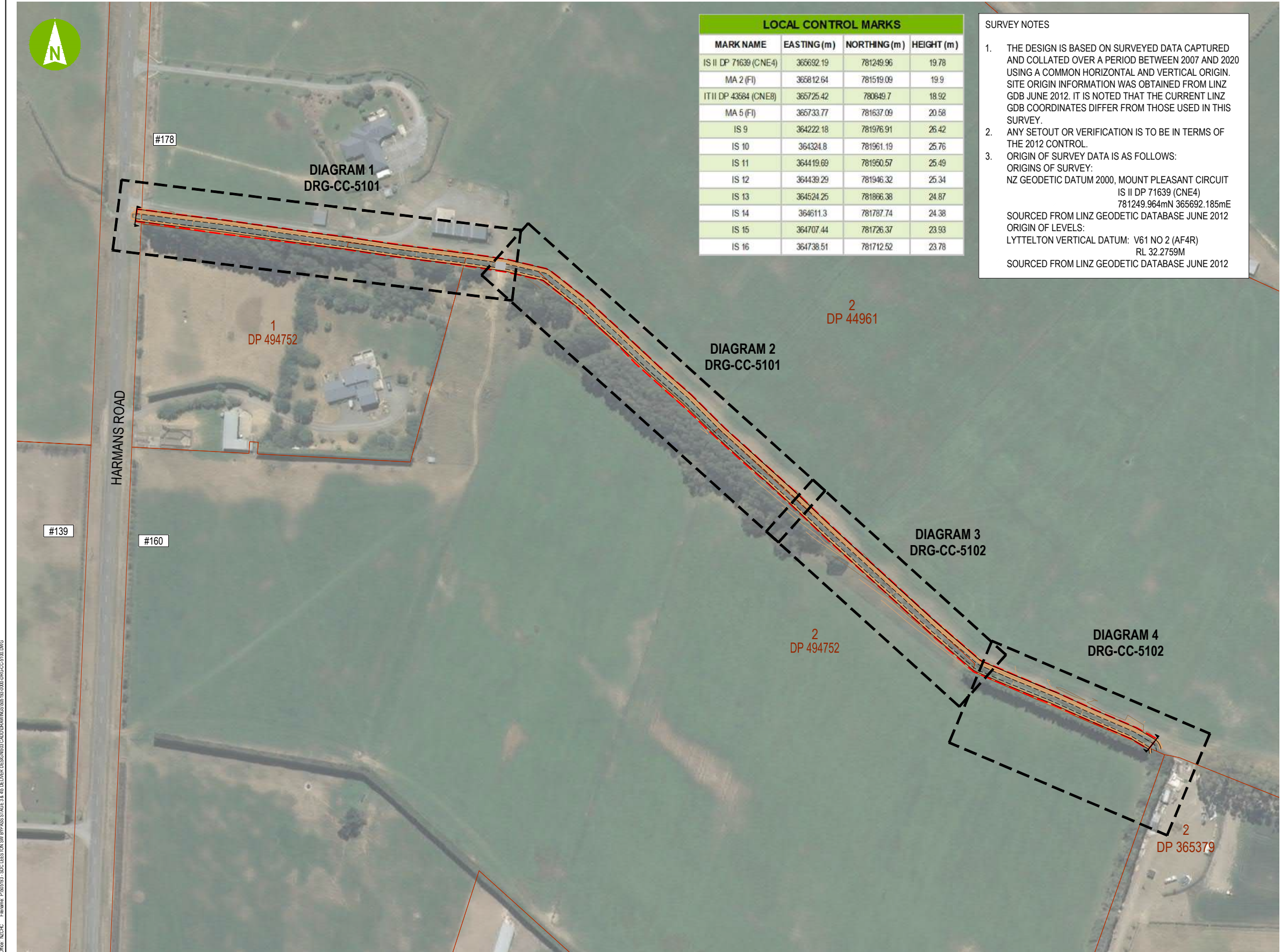


REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER	APPROVED
NOT FOR CONSTRUCTION	DATE 12/11/2020
A. LINDGREN	A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5																
TITLE	CUT FILL CONTOURS SHEET 2																
DRAWING No.	PROJECT No.	505193	-	AREA	0000	-	TYPE	DRG	-	DISC	CC	-	NUMBER	5021	-	REV	B



LOCAL CONTROL MARKS			
MARK NAME	EASTING (m)	NORTHING (m)	HEIGHT (m)
IS II DP 71639 (CNE4)	365692.19	781249.96	19.78
MA 2 (FI)	365812.64	781519.09	19.9
ITII DP 43584 (CNE8)	365725.42	780849.7	18.92
MA 5 (FI)	365733.77	781637.09	20.58
IS 9	364222.18	781976.91	26.42
IS 10	364324.8	781961.19	25.76
IS 11	364419.69	781950.57	25.49
IS 12	364439.29	781946.32	25.34
IS 13	364524.25	781866.38	24.87
IS 14	364611.3	781787.74	24.38
IS 15	364707.44	781726.37	23.93
IS 16	364738.51	781712.52	23.78

SURVEY NOTES

1. THE DESIGN IS BASED ON SURVEYED DATA CAPTURED AND COLLATED OVER A PERIOD BETWEEN 2007 AND 2020 USING A COMMON HORIZONTAL AND VERTICAL ORIGIN. SITE ORIGIN INFORMATION WAS OBTAINED FROM LINZ GDB JUNE 2012. IT IS NOTED THAT THE CURRENT LINZ GDB COORDINATES DIFFER FROM THOSE USED IN THIS SURVEY.

2. ANY SETOUT OR VERIFICATION IS TO BE IN TERMS OF THE 2012 CONTROL.

3. ORIGIN OF SURVEY DATA IS AS FOLLOWS:
ORIGINS OF SURVEY:
NZ GEODETIC DATUM 2000, MOUNT PLEASANT CIRCUIT
IS II DP 71639 (CNE4)
781249.964mN 365692.185mE
SOURCED FROM LINZ GEODETIC DATABASE JUNE 2012
ORIGIN OF LEVELS:
LYTTELTON VERTICAL DATUM: V61 NO 2 (AF4R)
RL 32.2759M
SOURCED FROM LINZ GEODETIC DATABASE JUNE 2012

- NOTES:
- WHILST EVERY EFFORT HAS BEEN MADE TO SHOW ALL KNOWN SERVICES, THE LOCATIONS AND EXISTENCE OF UTILITIES SHOWN IS TO BE TREATED AS INDICATIVE ONLY. THE CONTRACTOR IS TO CONFIRM THE LOCATION OF SERVICE ON SITE.
 - CONTRACTOR TO LIAISE WITH LAND OWNER TO CONFIRM IF KNOWN SERVICES EXIST ON SITE. EXISTING SERVICES THAT ARE TO BE RETAINED ARE TO BE ADEQUATELY SUPPORTED TO PREVENT DAMAGE FOR THE DURATION WORKS.
 - PLAN IS TO BE READ IN CONJUNCTION WITH ALL OTHER ENGINEERING DOCUMENTS.
 - PROPOSED WORK IS WITHIN EXISTING WATERWAY, THE CONTRACTOR IS TO HAVE A ROBUST TEMPORARY WORKS PLAN TO DEAL WITH FLOWS GENERATED FROM SIGNIFICANT RAINFALL EVENTS.
- GENERAL NOTES:
- ROCK PROTECTION TO BE PROVIDED IN ACCORDANCE WITH PROJECT SPECIFICATION AND DRAWINGS.
 - ALL WORKS ARE TO COMPLY WITH THESE DRAWINGS AND THE SELWYN DISTRICT COUNCIL (SDC) CODE OF PRACTICE (COP). WHERE THERE IS CONFLICT BETWEEN THE TWO THE DRAWINGS HAVE PRECEDENCE.
 - SITE PREPARATION AND RESTORATION SHALL BE AS PER THE PROJECT SPECIFICATION.
 - SETOUT CO-ORDINATES / DIMENSIONS ARE TO BE CONFIRMED ON SITE BY THE CONTRACTOR PRIOR TO COMMENCING WORK. DRAWINGS SHALL NOT BE SCALED.
 - ANY DISCREPANCY SHALL BE REFERRED TO THE ENGINEER BEFORE PROCEEDING WITH ANY WORK. NO SUBSTITUTE MATERIALS SHALL BE USED WITHOUT PRIOR APPROVAL OF THE ENGINEER.
 - MAKE SMOOTH CONNECTION TO EXISTING WORK.
 - SURFACES WHICH LIE OUTSIDE THE GENERAL LIMIT OF WORKS WHICH ARE DISTURBED DURING THE CONSTRUCTION OF THE WORKS SHALL BE RESTORED BY THE CONTRACTOR TO AT LEAST THE PRE-CONSTRUCTION CONDITION.
 - PRIOR TO ANY EXCAVATION OR CONSTRUCTION ON SITE, THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL UNDERGROUND SERVICES ON THE SITE.
 - IMAGE SOURCED FROM LINZ. IMAGE IS INDICATIVE ONLY, NOT BE USED FOR CONSTRUCTION PURPOSES.

EARTHWORKS NOTES

EW1. CLEARING AND GRUBBING

CLEARING, STRIPPING AND GRUBBING SHALL BE CARRIED OUT IN AREAS SUBJECT TO EARTHWORKS. ALL SOIL CONTAINING ORGANIC MATTER SHALL BE STRIPPED FROM THE CONSTRUCTION AREA AND STOCKPILED FOR FUTURE SITE REHABILITATION OR USED AS TOPSOIL.

EW2. MATERIAL SPECIFICATION.

2.1 ALL MATERIALS USED AS FILL SHALL BE FREE FROM DELETERIOUS MATTER.

2.2 NO MATERIAL CONTAINING THE FOLLOWING MAY BE USED AS FILL

- VEGETABLE MATTER
- MATERIALS CONTAMINATED THROUGH PAST SITE USE
- ORGANIC CLAYS OR SILTS
- ASHES, COAL OR THE LIKE
- ANY MATERIALS WHICH IN THE OPINION OF THE ENGINEER WILL SCOUR BADLY OR ANY DISPERSIVE SOIL.

2.3 RIPRAP SHOULD MEET THE FOLLOWING SPECIFICATIONS

- ROCKS SHOULD BE ANGULAR IN SHAPE, NOT ROUNDED AND EACH PIECE SHOULD HAVE ITS GREATEST DIMENSION NOT GREATER THAN THREE TIMES ITS LEAST DIMENSION.
- THE SPECIFIC GRAVITY SHOULD NOT BE LESS THAN 2.5
- THE RIPRAP SHOULD MEET THE FOLLOWING SCREENING CRITERIA:

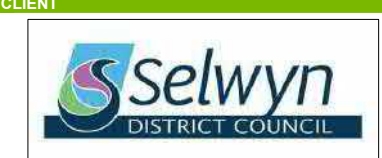
DIAMETER	PERCENT OF MATERIAL SMALLER
300mm	100
200mm	60-80
150mm	30-50
100mm	0

2.4 WHERE POSSIBLE, BUNDING IS TO BE COMPOSED OF COMPACTED SPOIL.

OVERALL LAYOUT PLAN
1:1000

10 0 20 40m
SCALE 1:1000





REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER	DATE
NOT FOR CONSTRUCTION	12/11/2020
APPROVED	A. LINDGREN
	A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	OVERALL LAYOUT PLAN
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	5100
NUMBER	B
REV	

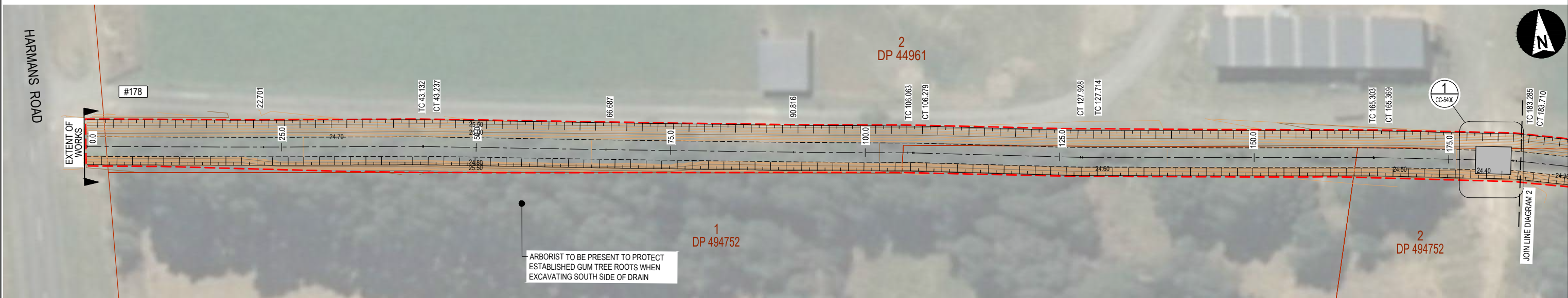


DIAGRAM 1
1:250

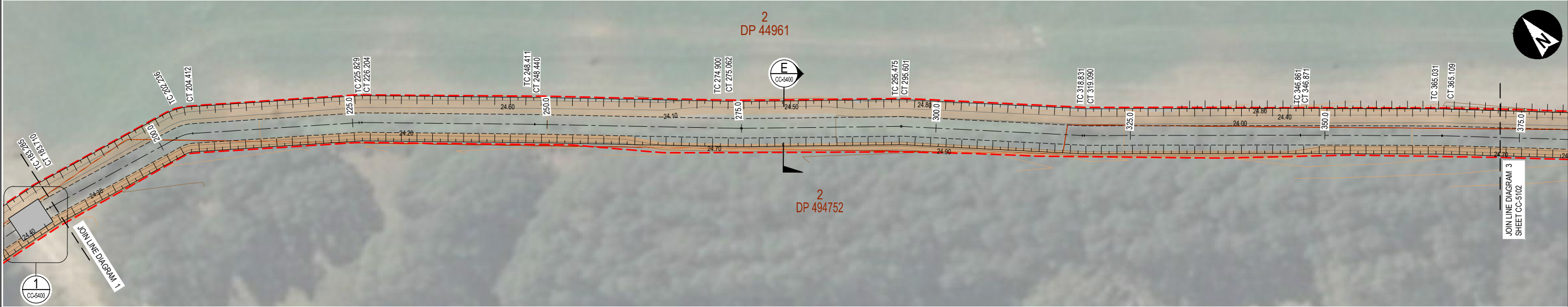
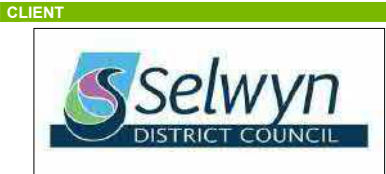


DIAGRAM 2
1:250

LEGEND	
	MINOR CONTOUR (0.1m)
	MAJOR CONTOUR (0.5m)
	TOP OF BANK
	BOTTOM OF BANK
	DRAIN CENTRELINE
	CULVERT
	EXISTING PROPERTY BOUNDARY
	EXTENT OF WORKS

NOTE
REFER SHEET 5100 FOR ALL NOTES AND SURVEY CONTROL



REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER
NOT FOR CONSTRUCTION
APPROVED
A. LINDGREN
DATE
12/11/2020

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	LAYOUT PLAN SHEET 1
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	5101
NUMBER	B
REV	

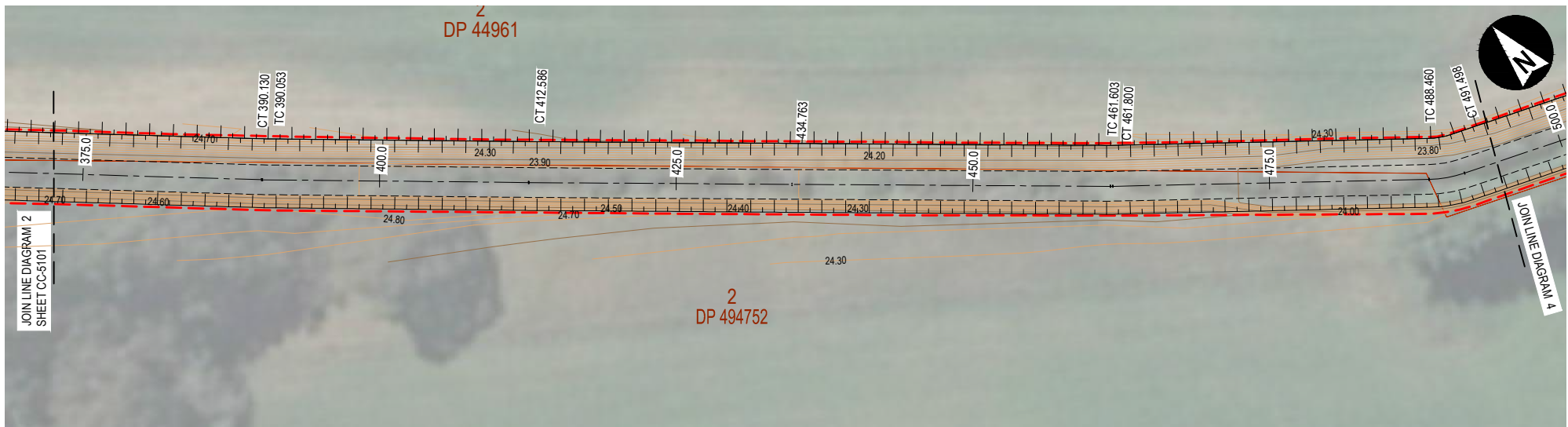


DIAGRAM 3
1:250

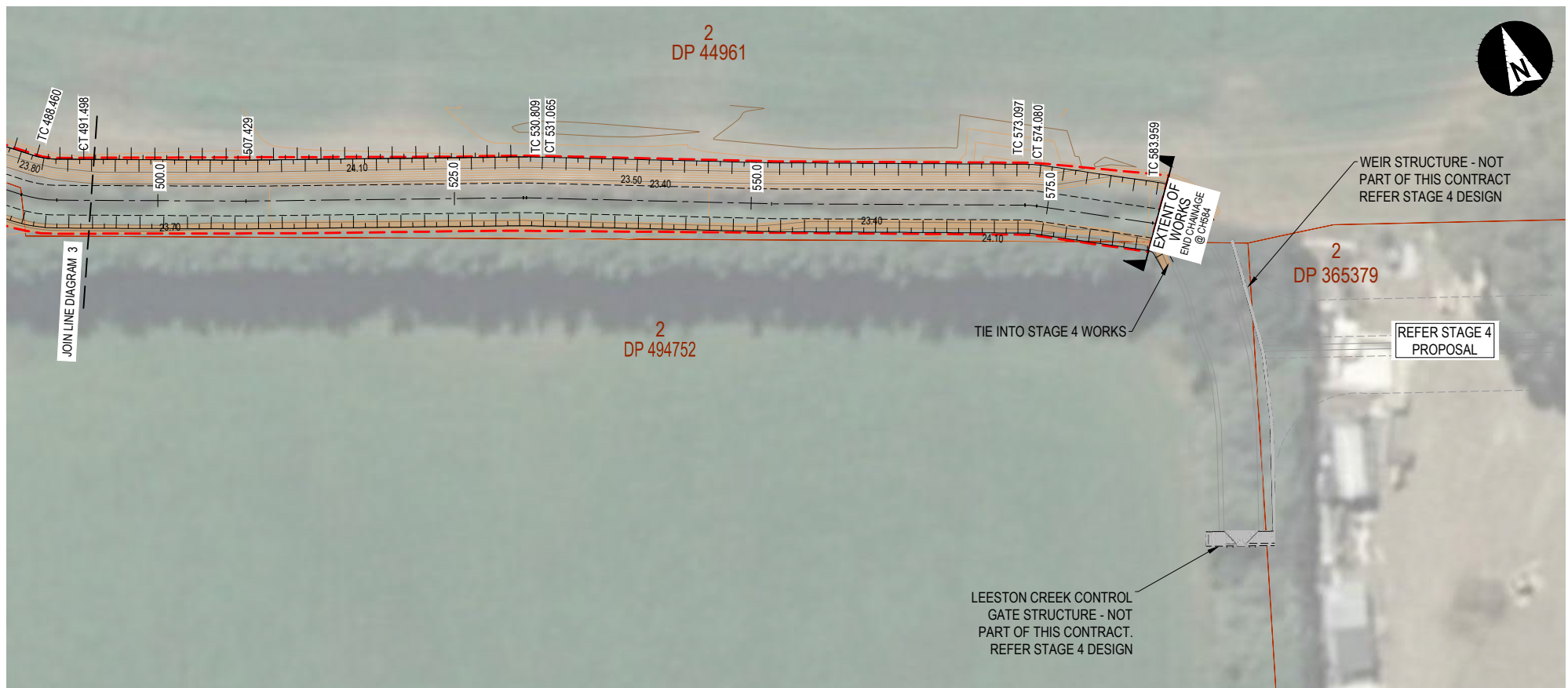


DIAGRAM 4
1:250

NOTE
REFER SHEET 5100 FOR ALL NOTES AND SURVEY CONTROL

LEGEND

- MINOR CONTOUR (0.1m)
- MAJOR CONTOUR (0.5m)
- TOP OF BANK
- BOTTOM OF BANK
- DRAIN CENTRELINE
- CULVERT
- EXISTING PROPERTY BOUNDARY
- EXTENT OF WORKS

Proj Date: 12/11/2021 10:04 PM, Client: NDCH, Filename: P:\09193_SDC LEESTON SW BYPASS STAGE 3\1.46 DELIVER DESIGN\WG CAD\DRAWINGS\05100.DWG, CC-5102.DWG



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REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	N CATTO
REVIEWED	R. DAVIES

TENDER
NOT FOR CONSTRUCTION
APPROVED
A. LINDGREN
DATE 12/11/2020

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	LAYOUT PLAN SHEET 2
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	5102
NUMBER	B
REV	

NOTE:
VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTTELTON VERTICAL DATUM (1937)

LEGEND

———— DESIGN SURFACE
----- EXISTING SURFACE

PROPOSED FARM
CULVERT UPGRADE
RIP RAP

DATUM RL21.50

VERTICAL DATA	L=613.16m P=-0.27%																																																												
HORIZONTAL DATA	L=22.67		R=10.07 L=10.00		L=20.40		R=10.10 L=10.00		L=23.45		L=24.11		R=10.04 L=10.00		L=15.23		R=10.22 L=10.00		L=21.43		R=10.21 L=10.00		L=37.38		R=10.07 L=10.00		L=17.92		R=10.43 L=10.00		L=18.53		R=10.18 L=10.00		L=21.42		R=10.38 L=10.00		L=22.21		R=10.03 L=10.00		L=26.46		R=10.16 L=10.00		L=20.32		R=10.32 L=10.00		L=23.14										
DESIGN LEVEL (CENTERLINE)	24.77		24.75		24.72		24.69		24.67		24.64		24.61		24.59		24.56		24.53		24.51		24.48		24.45		24.42		24.40		24.37		24.34		24.32		24.29		24.26		24.24		24.21		24.18		24.15		24.13		24.10		24.07		24.05		24.02		23.99		23.97
CUT / FILL DEPTH (TO EXISTING)	0.00		0.16		0.32		0.37		0.39		0.32		0.21		0.15		0.19		0.23		0.24		0.24		0.21		0.20		0.27		0.34		0.41		0.46		1.59		0.45		0.39		0.37		0.38		0.37		0.34		0.31		0.27		0.23		0.20		0.17		0.13
EXISTING GROUND LEVEL	24.77		24.91		25.04		25.07		25.05		24.96		24.82		24.73		24.75		24.76		24.75		24.72		24.66		24.62		24.66		24.71		24.75		24.77		25.88		24.72		24.63		24.58		24.56		24.53		24.47		24.41		24.34		24.28		24.22		24.17		24.09
CHAINAGE	0.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00	110.00	120.00	130.00	140.00	150.00	160.00	170.00	180.00	190.00	200.00	210.00	220.00	230.00	240.00	250.00	260.00	270.00	280.00	290.00	300.00																														

LONGITUDINAL SECTION STAGE 5 - PART 1
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:50

DATUM RL21.00

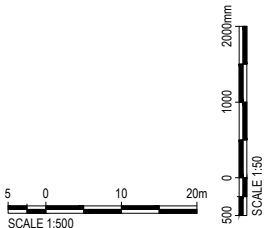
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DESIGN LEVEL (CENTERLINE)	23.97	23.94	23.91	23.88	23.86	23.83	23.80	23.78	23.75	23.72	23.70	23.67	23.64	23.61	23.59	23.56	23.53	23.51	23.48	23.45	23.43	23.40	23.37	23.34	23.32	23.29	23.26	23.24	23.21	23.18	23.16
CUT / FILL DEPTH (TO EXISTING)	0.13	0.05	-0.02	-0.02	-0.03	-0.01	0.04	0.06	0.05	0.03	0.09	0.15	0.16	0.15	0.14	0.12	0.10	0.06	0.01	-0.02	0.00	-0.12	-0.24	-0.18	-0.11	-0.08	-0.06	0.14	0.07	0.26	
EXISTING GROUND LEVEL	24.09	23.99	23.89	23.86	23.83	23.82	23.85	23.84	23.80	23.75	23.79	23.82	23.80	23.76	23.72	23.68	23.63	23.56	23.49	23.43	23.40	23.25	23.10	23.13	23.18	23.17	23.35	23.26	23.42	23.16	
CHAINAGE	300.00	310.00	320.00	330.00	340.00	350.00	360.00	370.00	380.00	390.00	400.00	410.00	420.00	430.00	440.00	450.00	460.00	470.00	480.00	490.00	500.00	510.00	520.00	530.00	540.00	550.00	560.00	570.00	580.00	590.00	600.00

LONGITUDINAL SECTION STAGE 5 - PART 2
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:50

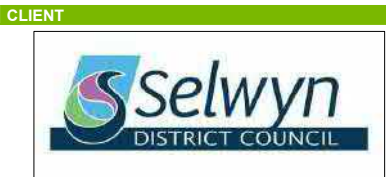
DRAINAGE INVERTS TO BE
CONFIRMED WITH ENGINEER PRIOR
TO EXCAVATION

STAGE 4 WORKS

EXTENT OF STAGE 5
WORKS CH 584



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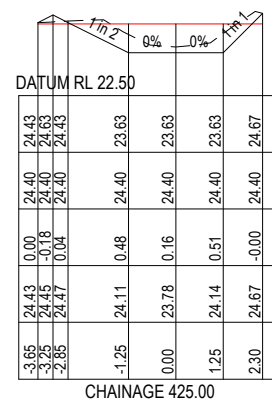
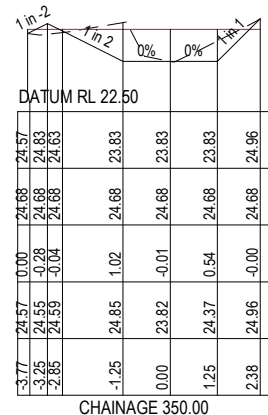
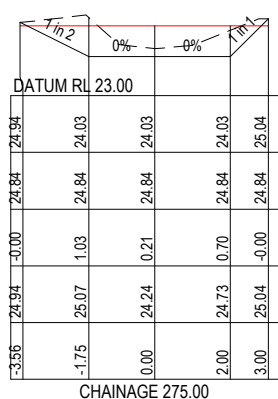
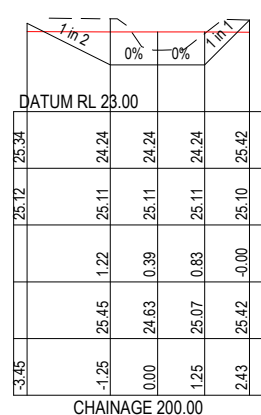
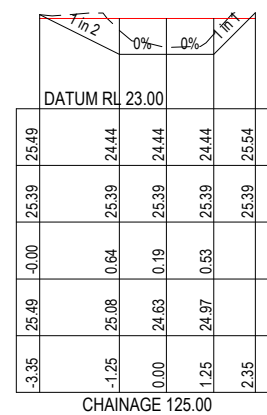
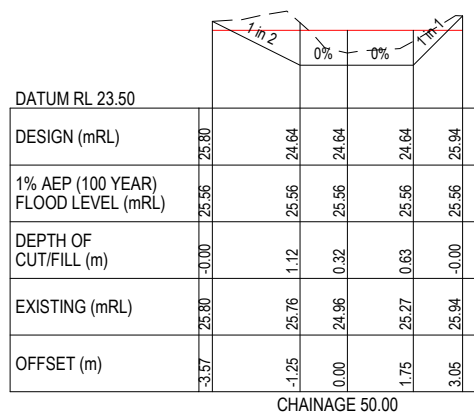
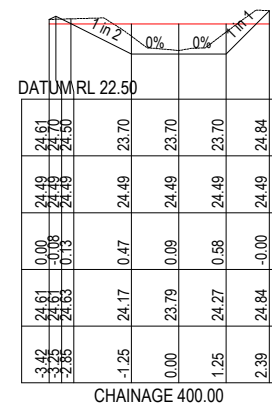
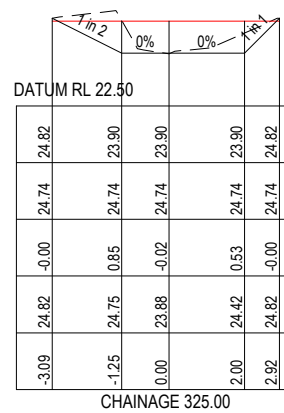
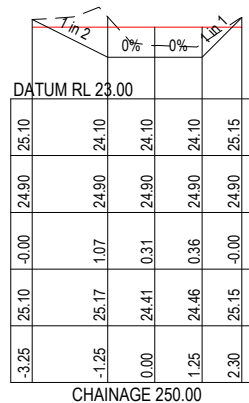
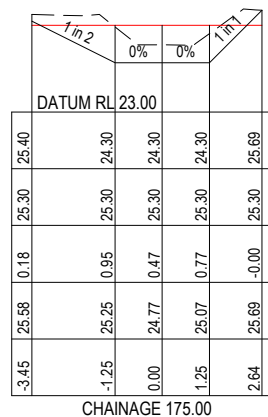
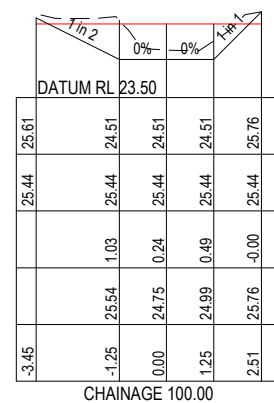
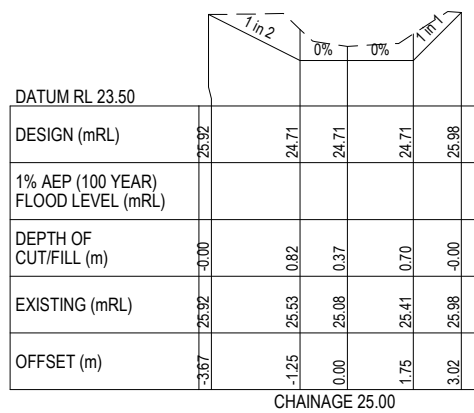
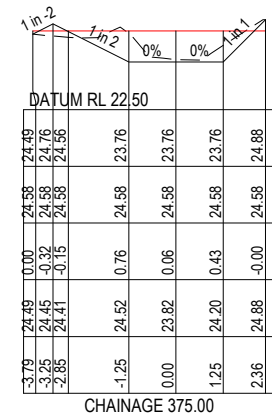
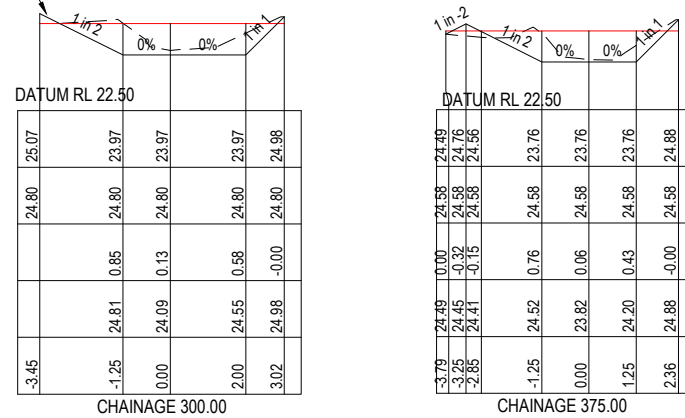
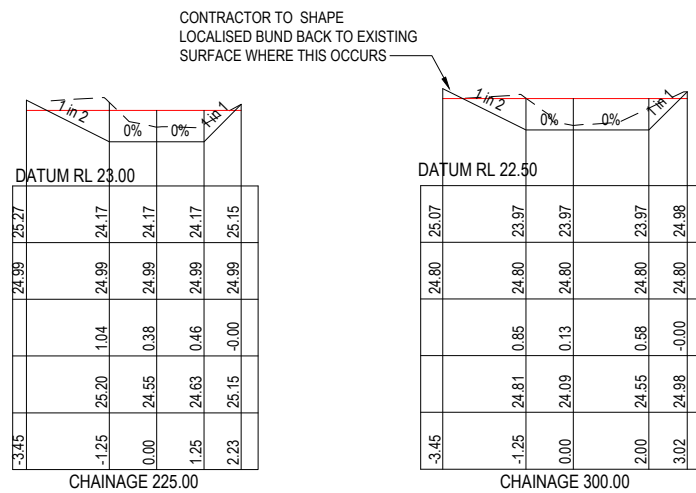
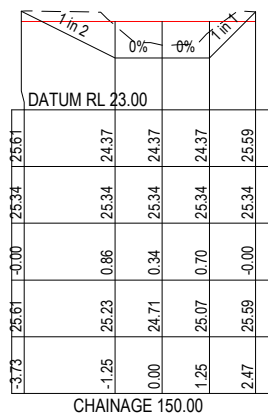
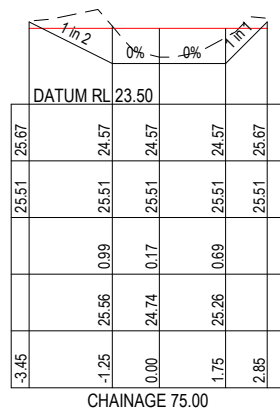
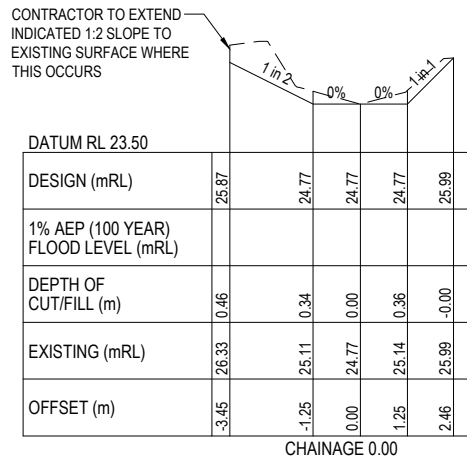


REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED	SCALE	SIZE
A. LINDGREN	AS SHOWN	A1

TENDER	APPROVED
NOT FOR CONSTRUCTION	DATE 12/11/2020

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5				
TITLE	LONG SECTION				
DRAWING No.	505193	AREA	0000	TYPE	DRG
PROJECT No.	505193	DISC	CC	NUMBER	5200
REV	B				



NOTE:
VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTELTON VERTICAL DATUM (1937)

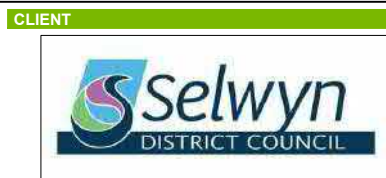
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— DESIGN SURFACE

- - - EXISTING SURFACE

— 100 YEAR STORM EVENT
HIGH WATER LEVEL

1 0 2 4m
SCALE 1:100



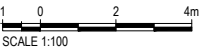
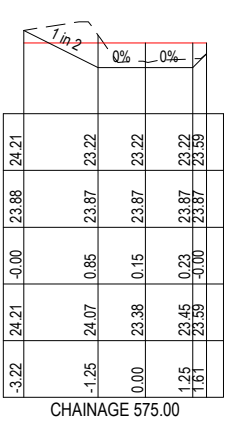
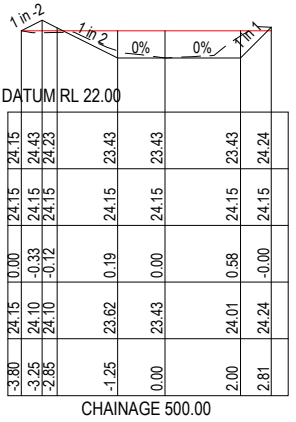
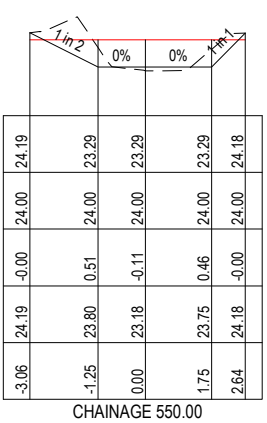
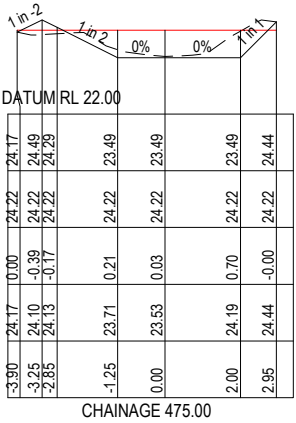
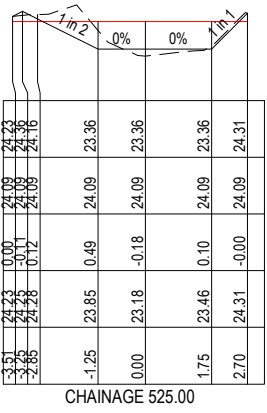
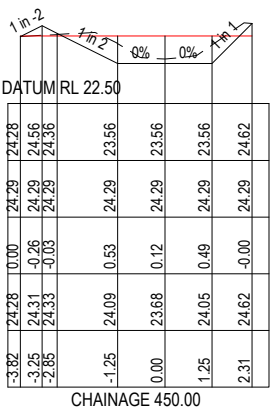
REV	DATE	REVISION DETAILS
A	16/10/20	ISSUE FOR APPROVAL
B	12/11/20	ISSUE FOR TENDER

APPROVED
A. LINDGREN
A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER
NOT FOR CONSTRUCTION
APPROVED
A. LINDGREN
DATE
12/11/2020
A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	CROSS SECTIONS SHEET 1
DRAWING No.	505193
PROJECT No.	0000
AREA	DRG
TYPE	CC
DISC	5300
NUMBER	B
REV	



NOTE:
VERTICAL ELEVATIONS ARE IN TERMS
OF LYTTELTON VERTICAL DATUM (1937)

LEGEND

— DESIGN SURFACE

--- EXISTING SURFACE

— 100 YEAR STORM EVENT
HIGH WATER LEVEL

CLIENT

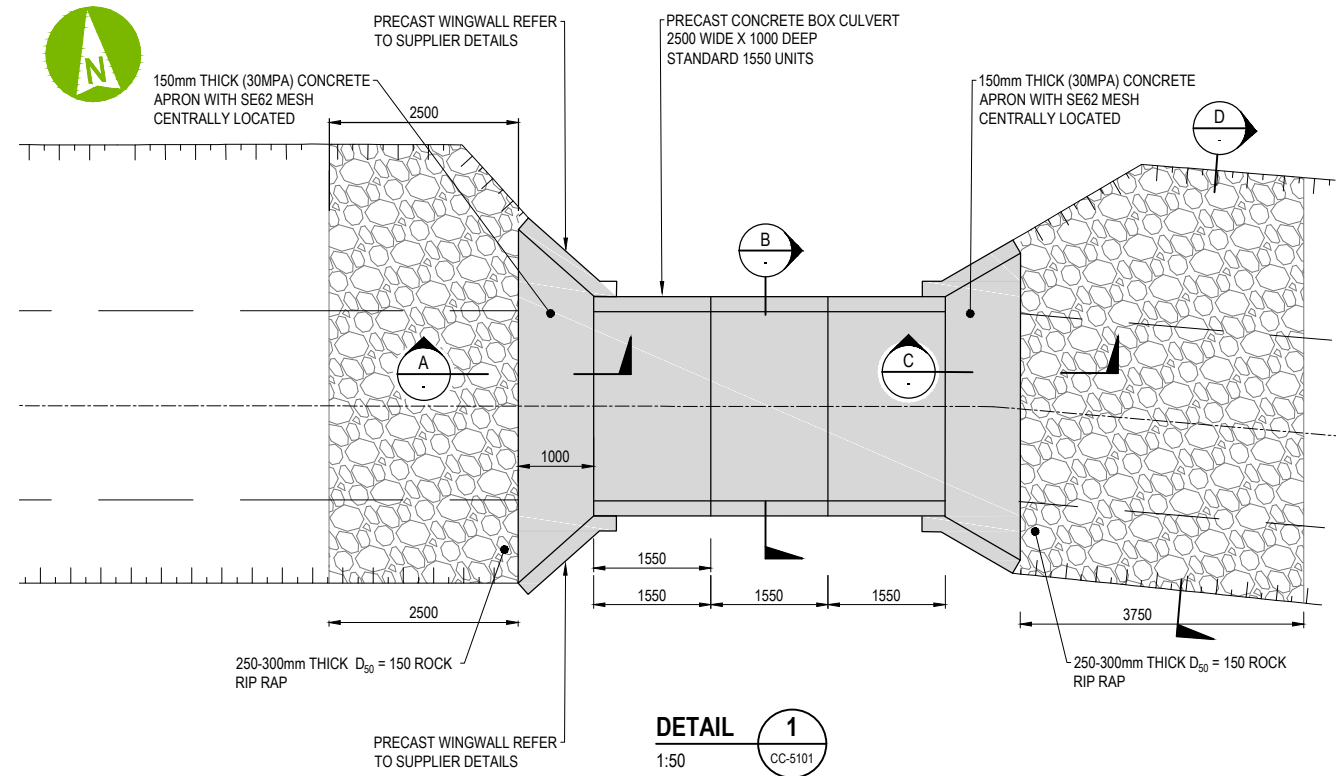


REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	ISSUE FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO	
REVIEWED	
R. DAVIES	

TENDER
NOT FOR CONSTRUCTION
APPROVED
DATE 12/11/2020
A. LINDGREN

PROJECT	SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5
TITLE	CROSS SECTIONS SHEET 2
DRAWING No.	PROJECT No. 505193
AREA 0000	TYPE DRG
DISC CC	NUMBER 5301
REV B	



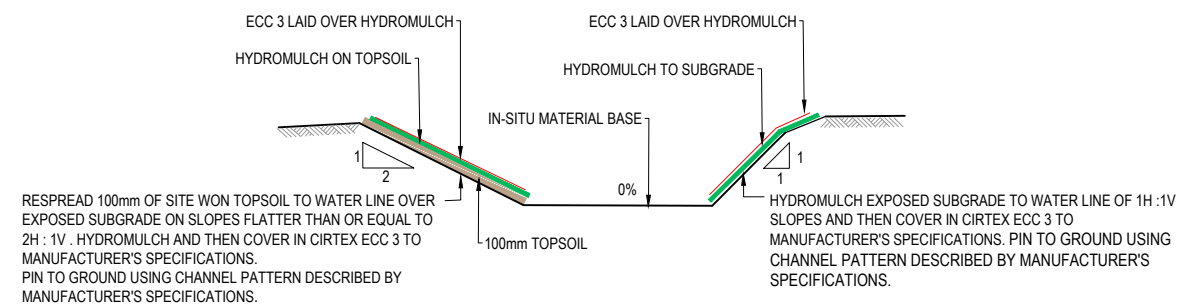
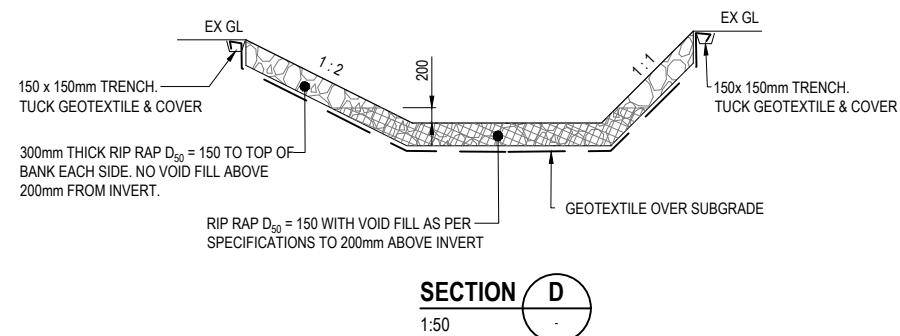
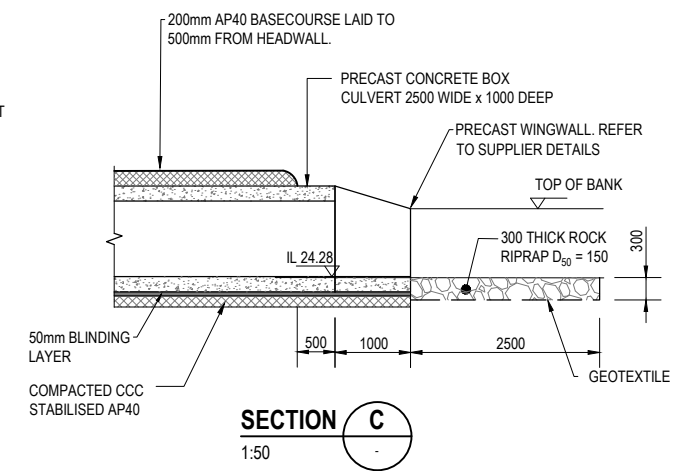
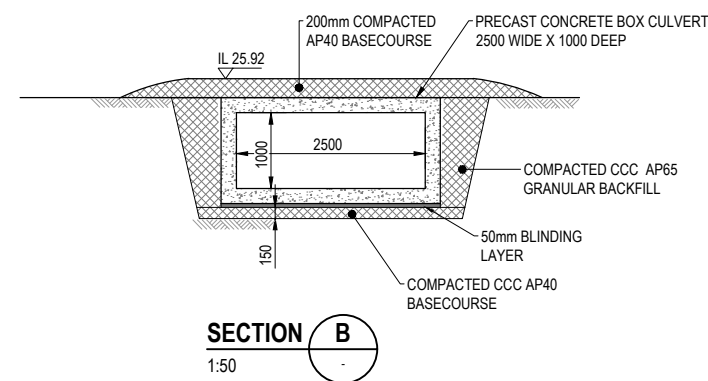
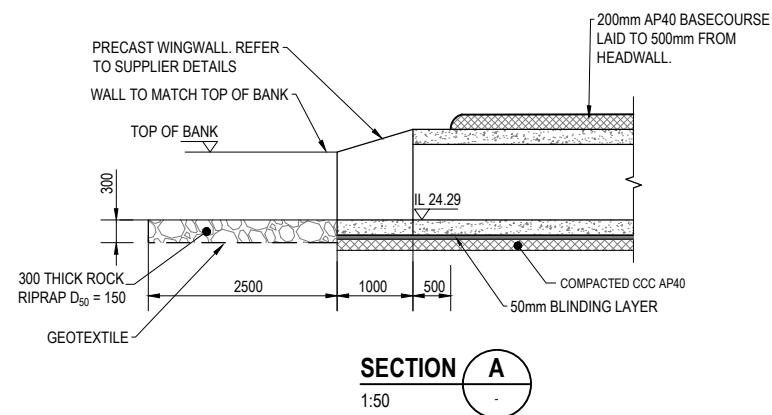
NOTES:

EXCAVATION

1. CONTRACTOR TO CONFIRM WITH LAND OWNER IF ANY EXISTING UTILITIES CROSS AT THE EXISTING CULVERT.
2. EXCAVATION SIDES AND BASES TO BE INSPECTED BY ENGINEER PRIOR TO PLACEMENT OF WALL AND FILL.
3. BASE OF EXCAVATION TO BE DRY DURING FILLING. CONTRACTOR TO CARRY OUT DE-WATERING AS REQUIRED.

BACKFILL:

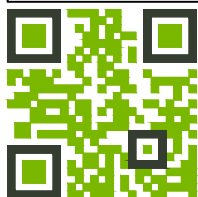
4. FILL MATERIAL BEHIND WALL SHALL BE CRUSHED CCC AP65 WITH MINIMUM TWO BROKEN FACES. (PIT RUN OR RIVER RUN WITH ROUND STONE IS NOT PERMITTED). FILL MATERIAL TO BE APPROVED BY ENGINEER PRIOR TO PLACEMENT. FILL TO BE COMPACTED TO 95% MAX DRY DENSITY (MDD).
5. CONCRETE BOX CULVERT DESIGN USING STANDARD DIMENSIONS TO MANUFACTURER'S REQUIREMENTS & TO BE SUBMITTED TO ENGINEER FOR APPROVAL PRIOR TO CONSTRUCTION.



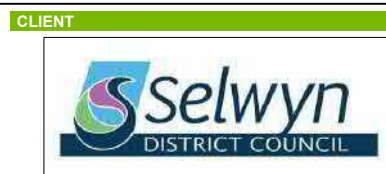
TYPICAL SLOPE TREATMENT

0.5 0 1 2m
SCALE 1:50

VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTLETON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)



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REV	DATE	REVISION DETAILS	APPROVED
A	16/10/20	FOR APPROVAL	A. LINDGREN
B	12/11/20	ISSUE FOR TENDER	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	
R DAWSON	
DESIGNED	
N CATTO / B HENRY	
REVIEWED	
R. DAVIES	

TENDER	DATE
NOT FOR CONSTRUCTION	12/11/2020
APPROVED	
A. LINDGREN	
A. LINDGREN	

PROJECT	TITLE	PROJECT No.	AREA	TYPE	DISC	NUMBER	REV
SDC - LEESTON NORTH STORMWATER BYPASS - STAGE 5	TYPICAL SECTION AND CULVERT DETAILS	505193	0000	DRG	CC	5400	B

Appendix B

Safety in Design Register 2020

Safe Design Risk Register - 504856 - Selwyn District Council Leeston Bypass Project Stages 4 & 5																									
Client	Selwyn District Council (SDC)						Workshop Date	15-Sep-20			Risk Rating Matrix	Likelihood of occurrence													
Stakeholders	Landowners						Revision No.	4				Most Likely Consequence	5 - Very likely					4 - Good chance		3 - Likely		2 - Unlikely		1 - Very unlikely	
Meeting Attendees	SDC Representative Daniel Meehan						Project No.	505193				A - Disastrous	Extreme		Extreme		Extreme		Extreme		High		High		
	Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)						Project Leader	Anna Lindgren				B - Critical	Extreme		Extreme		Extreme		High		High				
							Project Director	Regan Smith				C - Serious	High		High		High		Low		Low				
											D - Significant	High		High		Low		Low		Low					
										E - Minor	Moderate		Moderate		Low		Low		Low		Low				

- Notes:
- This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
 - The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
 - The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
 - Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
 - This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD					ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Applicable Phases	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
Design Phase (Pre-construction)																	
1.01	Site walkover	Injury as a result of accident during site walkover.	Aurecon / SDC	Investigations	2 - Unlikely	C - Serious	Moderate	Follow Aurecon H&S procedures to assist in identifying and managing hazards prior and during site visits including SWMS form and Take 5	1 - Very unlikely	C - Serious	Moderate	Aurecon / SDC	Yes	Ensure all described safety measures are carried out appropriately and correctly.	Designer / SDC		Closed
1.02	events greater than 1% Annual Exceedance Probability	events greater than the 1% Annual Exceedance Probability causing flooding in neighbouring properties.	Aurecon / SDC / Leeston township	Design	1 - Very unlikely	B - Critical	High	The stated design scope and consent requirements were only for an event up to 1% Annual Exceedance Probability (AEP). The bypass has been designed to manage the resulting flow from 1% AEP with a minimum freeboard of 100mm throughout. The bypass bunds along the northern side were identified as blocking the overland flowpath from the paddocks, and were therefore designed to allow surface flow to enter into the bypass. The freeboard gives some additional capacity, however there will be extensive flooding across the whole area and the effect greater than 1% AEP has not been modelled.	1 - Very unlikely	B - Critical	High	SDC	Yes	In consideration of the topography of the land and the probability of an event greater than 1% AEP occurring, SDC and Ecan have decided the design scope is to manage up to 1% AEP event, and not beyond.	SDC		Closed
1.03	Maintenance access to trimming Gum trees at confluence	Five eucalyptus trees were requested to be retained if possible. These are located immediately north-east of the proposed location of the Stage 4 and 5 Leeston Creek Diversion Structure confluence. Difficulties in accessing the gum trees with bypass in place leads to maintenance not being able to happen and branches falling and hurting someone.	Maintenance / SDC / Landowner	Design	3 - Likely	A - Disastrous	Extreme	The design specifically removed the northern bund to enable arborist machinery to access under the tree drip line on a flat surface. The bund is not needed to contain stormwater flow through the bypass. Positioning of a 3m wide hardstand vehicle crossing can be located anywhere after the rip rap and this is to be decided during the construction.	1 - Very unlikely	A - Disastrous	High	SDC	Yes	Northern bund shown as not to be started until Ch227. Hardstand crossing for vehicle access is to be determined during construction.	Works contractor / Maintenance Contractor (SDC) / Landowner		Closed
1.04	Stock and flood proof fencing	Fencing for keeping stock is required at the points where the bypass crosses boundary or existing paddock fencing. Replacement fencing isn't designed properly and lets stock out, or doesn't give way in a storm clogging up with debris and causing localised spilling and flooding as well as danger to staff trying to unblock during high flows.	Aurecon / SDC	Design	3 - Likely	D - Significant	Moderate	Design of floatable fencing and locations have been identified on the drawings.	1 - Very unlikely	D - Significant	Low	SDC	Yes	The drawings show the location of fences to be replaced at the points of intersection with the bypass, and how these are to be installed. A note is included on the drawings to indicate their functionality and that an experienced fencing contractor is needed to advise and install. SDC may need to discuss maintenance of these types of fences with the landowner depending on agreements. It is advisable for SDC maintenance to check that debris has not built up around the base of the round support posts proposed to be installed within the area of flow. An experienced fencing contractor will be needed to install the fence and make any amendments in agreement with the Engineer. The aim of the spacing is to avoid too many support posts being installed through the channel, which would reduce the bypass capacity.	Works contractor / Maintenance Contractor (SDC)		Closed
1.05	Access to Control gate	Health and safety considerations (staff falling off the control gate while trying to open or shut it) were raised by SDC during the detailed design phase to make the winding mechanism accessible from the side, reducing the difficulty of accessing from the top.	Designer / Works contractor / Maintenance Contractor (SDC)	ALL	4 - Good chance	C - Serious	High	Design has been changed to require the winch to be easily accessed from the side.	1 - Very unlikely	C - Serious	Moderate	SDC	Yes	Ensure all described measures are carried out appropriately and correctly.	SDC / Contractor		Closed

Safe Design Risk Register - 504856 - Selwyn District Council Leeston Bypass Project Stages 4 & 5																	
Client	Selwyn District Council (SDC)						Workshop Date	15-Sep-20			Risk Rating Matrix	Likelihood of occurrence					
Stakeholders	Landowners						Revision No.	4				Most Likely Consequence	5 - Very likely	4 - good chance	3 - Likely	2 - Unlikely	1 - Very unlikely
Meeting Attendees	SDC Representative Daniel Meehan						Project No.	505193				A - Disastrous	Extreme	Extreme	Extreme	Extreme	High
	Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)						Project Leader	Anna Lindgren				B - Critical	Extreme	Extreme	Extreme	High	High
							Project Director	Regan Smith				C - Serious	Extreme	High	High	Moderate	Moderate
												D - Significant	High	High	Moderate	Low	Low
										E - Minor	Moderate	Moderate	Low	Low	Low		

- Notes:
- This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
 - The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
 - The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
 - Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
 - This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD					ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Applicable Phases	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
1.06	Set height of Control Gate	Works or Maintenance Contractor (SDC) leave the gate closed or set higher than the consented operation height as they are not aware of the consent requirement. A continually closed gate would lead to drying up of the downstream portion of Leeston Creek, blocking fish passage. Leaving wide open would let more water past than the consented 0.6m3/s and lead to flooding downstream in Leeston township during a 1% AEP storm event.	Designer / Works contractor / Maintenance Contractor (SDC)	ALL	5 - Very likely	D - Significant	High	Design drawings have been updated by Aurecon to require Taege Engineering to provide a clear height marker on both sides of the engineered gate. Gate needs to have a 400mm opening during normal operation (non storm events), however it is recommended that during a 1% AEP (or close) event it is closed for the duration of the storm, and then reopened for normal operation. Contractor to ensure gate height is set to 400mm open when works are completed. Lock to be placed on winch making only accessible to SDC maintenance team. SDC to update maintenance team to understand the requirements indicated in the Detailed Design Report.	2 - Unlikely	D - Significant	Low	Aurecon / Works contractor / Maintenance Contractor (SDC)	Yes	Ensure all described measures are carried out appropriately and correctly.	Works contractor / Maintenance Contractor (SDC)		Closed
1.07	Gabion baskets	Debris gets caught in the baskets causing localised spilling and flooding and danger to staff trying to unblock.	Aurecon / Maintenance Contractor (SDC)	ALL	4 - Good chance	D - Significant	High	It was determined that the wall of gabion baskets were not beneficial because they introduced the opportunity for footing erosion and debris blockage. During the walkover we noted that the yearly maintenance works of trimming the farm boundary hedging and trees, located upstream of the diversion structure, left branches in the stream which could then potentially clog the gabion baskets, effectively increasing the height of the weir spillway. This would in turn increase the flow threshold required to overtop the weir spillway. If this occurred, it would result in floodwater spilling over the Leeston Creek control gate and embankments and continue down Leeston Creek rather than through the bypass channel.	2 - Unlikely	D - Significant	Low	Aurecon / Works contractor / Maintenance Contractor (SDC)	Yes	Design proposes concrete spillway with rip rap. Ensure all described measures are carried out appropriately and correctly.	Works contractor / Maintenance Contractor (SDC)		Closed
1.08	Existing unknown Service	Contractor strikes unknown service because it wasn't identified in the drawings.	Aurecon	ALL	2 - Unlikely	D - Significant	Low	Review of requested Before-U-Dig asset information along the Stormwater Bypass alignment identified only one unknown service, as shown on the SDC supplied service plan, that crosses approximately 15m downstream of the Leeston Creek and Stormwater Bypass channel confluence, refer report and drawings.	1 - Very unlikely	D - Significant	Low	SDC / Works contractor	Yes	Ensure all described measures are carried out appropriately and correctly. There is no easement that follows this unknown service and it is not identified on Chorus plans and there are no overhead power lines or Transpower assets that cross this location. The likelihood that this is a buried power utility is low, and therefore we identified this service on the detailed design plans as an unknown service, which is to be confirmed by the contractor.	Works contractor		Closed

Safe Design Risk Register - 504856 - Selwyn District Council Leeston Bypass Project Stages 4 & 5																								
Client	Selwyn District Council (SDC)						Workshop Date	15-Sep-20			Risk Rating Matrix	Likelihood of occurrence												
Stakeholders	Landowners						Revision No.	4				Most Likely Consequence	5 - Very likely		4 - good chance		3 - Likely		2 - Unlikely		1 - Very unlikely			
Meeting Attendees	SDC Representative Daniel Meehan						Project No.	505193				A - Disastrous	Extreme	Extreme	Extreme	Extreme	High	High	High	High	High			
	Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)						Project Leader	Anna Lindgren				B - Critical	Extreme	Extreme	Extreme	Extreme	High	High	High	High	High			
							Project Director	Regan Smith				C - Serious	Extreme	High	High	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
										D - Significant		High	High	High	High	High	Low	Low	Low	Low	Low	Low	Low	Low
									E - Minor	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low					

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1.09	Bypass's northern Bund blocks overland flow causing flooding	bunding along northern banks of bypass blocks overland flow through paddocks from being able to drain away through the bypass, causing flooding of the neighbouring properties.	Aurecon	ALL	2 - Unlikely	D - Significant	Low	Leeston Flood Modelling 2019 Report (refer Appendix C) identifies that a continuous bund along the northern side of the channel could block overland flow from the paddocks. Referring to section 3.2 Design Scenario (pg 13) of the Leeston Flood Modelling 2019 Report "The proposed Stormwater Bypass has adequate freeboard without constructing raised bunds along both banks. As these bunds will prevent overland flow upstream of the stormwater bypass from entering the waterway it is recommended that consideration is given to not constructing these bunds as part of the proposed Leeston Stormwater Bypass. The need for these bunds or land raising can be assessed during design of the adjacent subdivision."	1 - Very unlikely	D - Significant	Low	Aurecon / SDC	Yes	Design provides gaps in the bunding at the low spots. Ensure all described measures are carried out appropriately and correctly.	Works contractor / SDC		Closed
1.10	Reduction in cross sectional flow area results in flooding	During this design phase, it was identified that the reduction in cross-sectional flow area near the future wetlands was a risk for overtopping, as the previous model showed there was no freeboard at this location.	Aurecon	ALL	3 - Likely	D - Significant	Moderate	We found that this lack of freeboard was due to a weir that was included in the preliminary design hydraulic model at the wetlands location, which was intended to represent a spillway into the future wetlands. The future subdivision will need to factor additional surface flows from roads and properties, which are outside the scope of this design. The revised detailed design hydraulic flood model removed this wetland weir and determined that the freeboard was about 210mm at the narrowing portion of the bypass. Even so, bunding had been added to give some additional freeboard as well as to provide a means to keep some of the spoil on site.	1 - Very unlikely	D - Significant	Low	Aurecon / SDC	Yes	Ensure all described measures are carried out appropriately and correctly.	SDC		Closed
1.11	Stormflow spills out of the drain at connection to Dunsandel Drain	High flow volume around 90deg bend where the bypass connects with Dunsandel Drain results in spilling into the back section of properties, or tailwater backs up the Dunsandel Drain causing flooding upstream.	Aurecon	ALL	2 - Unlikely	D - Significant	Low	The proximity of the alignment to residential properties and tailwater backflow was also viewed as a risk, and was reviewed in the updated hydraulic model. This found there was no overtopping for the 1% AEP design flows at this location, or significant tailwater backflow. Currently there is a lack of space for a bund to provide additional protection between the channel and the properties, however, the model determined that the freeboard was about 270mm at this location.	1 - Very unlikely	D - Significant	Low	SDC	Yes	Ensure bypass is excavated as per design, appropriately and correctly.	Works contractor / SDC		Closed
1.12	Flood water not getting to the confluence	Stage 5 is not completed in time or maintained before the next large storm event; resulting in storm flows breaching the banks of Stage 5 and flood the Leeston township.	Aurecon / SDC / Leeston township	ALL	5 - Very likely	A - Disastrous	Extreme	The preliminary 2019 flood modelling identified that the existing Stage 5 Leeston Creek reach, between Harmans Road and the Stage 4 Bypass confluence (CH0 to CH575), has insufficient capacity to convey the design flow to the confluence spillway structure. Completing the Stage 5 portion as soon as possible would avoid this occurring.	1 - Very unlikely	A - Disastrous	High	SDC	Yes	Ensure stage 5 is completed and is excavated as per design, appropriately and correctly.	SDC		Open

Safe Design Risk Register - 504856 - Selwyn District Council Leeston Bypass Project Stages 4 & 5																						
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Meeting Attendees	SDC Representative Daniel Meehan						Project No.	505193				A - Disastrous	Extreme	Extreme	Extreme	Extreme	High	High	High	High	High	
	Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)						Project Leader	Anna Lindgren				B - Critical	Extreme	Extreme	Extreme	Extreme	High	High	High	High	High	
							Project Director	Regan Smith				C - Serious	Extreme	High	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	
											D - Significant	High	High	High	High	Low	Low	Low	Low	Low		
											E - Minor	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low		

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1.13	Rip Rap	Rip rap not sized appropriately for the flow through the bypass leading to scouring and wash out of the existing rock, requiring repair works that require re-handling of rocks	Aurecon	Investigations	2 - Unlikely	D - Significant	Low	Rip rap to be sized and installed appropriately to avoid scour etc	1 - Very unlikely	D - Significant	Low	Aurecon	Yes	Design of rip rap has been assessed according to WWDG section 22 Hydraulics. Size and characteristics of the rip rap have been stated in the drawings and specification. Ensure rip rap is installed as per design, appropriately and correctly.	Works contractor / Maintenance Contractor (SDC)		Closed
1.14	Plants	Plants flourish in the bypass and stage 5 resulting in choking and blockage of the channels and causing flooding of Leeston.	Aurecon / SDC / Leeston township	Investigations	2 - Unlikely	C - Serious	Moderate	planting (if required) has been suggested to be planted on the bunds outside of the high water level during 1% AEP event, and only grass is to be used in the bypass and Stage 5 banks. Grass will stabilise the soil more thoroughly and give way under stormflow.	5 - Very unlikely	C - Serious	#N/A	Aurecon	Yes	Ensure all described safety measures are carried out appropriately and correctly. Ensure regular maintenance of grass.	Works contractor / Maintenance Contractor (SDC)		Closed
Construction and Commissioning Phase																	
General Site Risks																	
2.01	COVID 19 Level 4 lockdown	Outbreak of Covid-19 in South Island results in shutting down the site and delaying construction further into autumn/winter weather	Contractor	ALL	4 - Good chance	D - Significant	High	Make sure Covid-19 measures and protocols are in place and Contract covers this eventuality	4 - Good chance	D - Significant	High	Contractor	Yes	Ensure all described safety measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
2.02	Failure of ESC measures	Rain events overwhelm the ESC measures in place causing significant silt runoff from site leading to Ecan notices or court action.	Contractor / SDC / Aurecon	ALL	3 - Likely	D - Significant	Moderate	SDC and Aurecon to make sure ESCP is properly thought through and implemented. All measures are in place and are checked by the contractor and Engineer especially before rain events and after. Also important for stormwater runoff into existing waterways. Dust pollution also a problem during extended dry spells. Take appropriate measures depending on season.	1 - Very unlikely	D - Significant	Low	Contractor	Yes	Ensure all described ESC measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
2.03	Running past completion date	The contractor runs over completion date due to lack of resources or weather events.	Contractor / SDC / Construction observation	ALL	3 - Likely	D - Significant	Moderate	Clear statement of expectation of timeframe and consequence of missing deadline (eg. Liquidated damages to be compensated by contractor) to be set out in contract. Up to date programme provided by contractor and monitored by Engineer and SDC.	1 - Very unlikely	D - Significant	Low	Contractor	Yes	Up to date programme provided by contractor and monitored by Engineer or SDC.	Contractor	Construction Phase	Open
2.04	Flooding while working in a live waterway	Works in waterway get overwhelmed in large storm event washing out the construction works, potentially endangering crew. Temporary diversion structures or interim earthworks increasing flooding on adjacent property or downstream due to failure.	Contractor	ALL	3 - Likely	C - Serious	High	Contractor to ensure methodology is in place to be able to safely clear out and secure the worksite in a serious storm event to include management of any temporary diversion structures. No stockpiling of material within the channel, limit earthworks at any given time.	3 - Likely	C - Serious	High	Contractor	Yes	Methodology to be ready for implementation	Contractor	Construction Phase	Open
2.05	Trees	Injury from falling trees.	Contractor / Community	ALL	3 - Likely	A - Disastrous	Extreme	Professional Arborist to be contacted to provide advice and services if required. Providing a service lane for tree trimming on northern side up to chainage ~200m of Stage 4 and the south side of the channel also up to chainage ~200m.	1 - Very unlikely	A - Disastrous	High	Contractor	Yes	Arbortist to be present	Contractor	Construction Phase	Open
2.06	Pedestrian/cyclists and residential access at Pound Rd Stage 4 wastewater pump station service access	Earthworks trucks crossing footpath creates risks and hazards for pedestrians, council services and residential property at the Pound Rd corner access.	Contractor / Community / SDC	ALL	3 - Likely	A - Disastrous	Extreme	The contractor to provide and install necessary fencing and signage to prevent pedestrian and public vehicle site access. Speed limit to be decreased to 30km/hr. Contractor to identify services required, contact numbers from contractor to be provided to SDC. Communicate requirements for access to nearby residents through letter drop. Site inspections to check on these.	1 - Very unlikely	A - Disastrous	High	Contractor / SDC	Yes	Ensure all described H&S and TMP measures are carried out appropriately and correctly.	Contractor / SDC	Construction Phase	Open

Safe Design Risk Register - 504856 - Selwyn District Council Leeston Bypass Project Stages 4 & 5																						
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Meeting Attendees	SDC Representative Daniel Meehan						Project No.	505193				A - Disastrous	Extreme	Extreme	Extreme	Extreme	Extreme	High				
	Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)						Project Leader	Anna Lindgren				B - Critical	Extreme	Extreme	Extreme	Extreme	High	High				
							Project Director	Regan Smith				C - Serious	Extreme	High	High	High	Moderate	Moderate				
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IDENTIFY HAZARD					ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Applicable Phases	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
2.07	Pedestrian/cyclists and residential access at Harmans Rd Stage 5	Earthworks trucks crossing road creates risks and hazards for pedestrians/cyclists and residential property at the Harmen Rd access.	Contractor / Community / SDC	ALL	3 - Likely	A - Disastrous	Extreme	The contractor to provide and install necessary fencing and signage to prevent pedestrian and vehicle site access. Agree with owner best access point for works to enable them to access their house. Speed limit to be decreased to 30km/hr. Site inspections to check on these.	1 - Very unlikely	A - Disastrous	High	Contractor / SDC	Yes	Ensure all described ESC measures are carried out appropriately and correctly.	Contractor / SDC	Construction Phase	Open
2.08	Continuous heavy rainfall that causes earthmoving plant to get bogged in	Torn up pastoral fields that owners wanted to avoid. Plant stuck and unable to be recovered until fields dry out.	Contractor / Property owner	ALL	3 - Likely	D - Significant	Moderate	Contractor to ensure methodology is in place to minimise the ground disturbance at worksite in a serious storm event. Haul road (geotextile and AP65) can be utilised. Ensure appropriate equipment is used.	3 - Likely	D - Significant	Moderate	Contractor	Yes	Methodology to be ready for implementation	Contractor	Construction Phase	Open
2.09	Failing consent conditions for work in a waterway and/or in general	Contractor doesn't meet the consent conditions at any point during works	Contractor / SDC	ALL	3 - Likely	C - Serious	High	SDC to provide summary of consent conditions. Contractor to ensure they are aware of consent conditions and keep necessary consents on site. Site inspections to check on these.	1 - Very unlikely	C - Serious	Moderate	Contractor / SDC / Construction observer	Yes	Ensure all described consent condition measures are carried out appropriately and correctly.	Contractor / SDC / Construction observer	Construction Phase	Open
2.10	Safe access for use of manual control gate at confluence	Preliminary design of manual control gate does not provide the maintenance contractor with a safe access. During a storm they fall off while trying to open/close the gate leading to drowning and / or injury.	SDC / Maintenance Contractor / Aurecon	ALL	3 - Likely	A - Disastrous	Extreme	SDC to provide design intent examples to Aurecon to make amendments to the design to make the operation of the control gate safe for the user.	1 - Very unlikely	A - Disastrous	High	SDC / Aurecon	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	SDC / Aurecon	Construction Phase	Open
2.11	More springs like Martins Spring are encountered	Contractor excavations encounter unknown springs which cause delays to construction due to requirements to manage	Contractor	ALL	3 - Likely	D - Significant	Moderate	Contractor to provide methodology on accidental discovery/exposure of underground springs	3 - Likely	D - Significant	Moderate	Contractor	Yes	Methodology to be ready for implementation	Contractor	Construction Phase	Open
2.12	A high ground water level is encountered throughout the full alignment.	Contractor excavations encounter a higher than anticipated ground water level throughout the alignment springs which cause delays to construction due to requirements to manage	Contractor	ALL	3 - Likely	D - Significant	Moderate	Contractor to provide methodology on how to manage high ground water levels. Options include managing by a) sump pump or b) spear use for GWL reduction. Option a) is preferable as a less costly option and has been used successfully at Stage 3 culvert installation. Spear install to draw water down is much more costly. We have put both as Provisional Items in cost estimate. Contractor to assess how they would address this in their methodology.	3 - Likely	D - Significant	Moderate	Contractor	Yes	Methodology to be ready for implementation	Contractor	Construction Phase	Open
2.13	Livestock on operational farm	Interaction with livestock leads to injury of workers or damage to livestock	Contractor / Landowner	ALL	3 - Likely	C - Serious	High	Fencing to be constructed/installed on site to minimise or avoid interaction between waterway (maintenance), workers and livestock. Communicate with landowner around programme to aid movement of livestock. Understand consent conditions.	2 - Unlikely	C - Serious	Moderate	Contractor / SDC / Construction observer	Yes	Communicate with landowner	Contractor / SDC / Construction observer	Construction Phase	Open
2.14	Laying of larger rock rip rap at the confluence results in injury	Contractor has accident while laying the large rip rap	Contractor	ALL	3 - Likely	C - Serious	High	Contractor to ensure methodology is in place to ensure the safety of the crew. Appropriate PPE to be worn at all times. Protection of eyes and hands and feet.	2 - Unlikely	C - Serious	Moderate	Contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open

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Stakeholders	Landowners				Revision No.		4			Most Likely Consequence						
Meeting Attendees	SDC Representative Daniel Meehan				Project No.		505193			5 - Very likely						
	Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)				Project Leader		Anna Lindgren			4 - Good chance						
					Project Director		Regan Smith			3 - Likely						
										2 - Unlikely						
								1 - Very unlikely								

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2.15	Installation of structures (eg culverts, confluence) results in injury	Contractor has accident while installing structures	Contractor	ALL	3 - Likely	C - Serious	High	Contractor to ensure methodology is in place to ensure the safety of the crew. Appropriate PPE to be worn at all times. Protection of eyes and hands and feet.	2 - Unlikely	C - Serious	Moderate	Contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
2.16	Erosion of 1H:1V slopes	1H:1V slopes have difficulty establishing grass and continue to erode	SDC	ALL	3 - Likely	D - Significant	Moderate	Contractor to ensure methodology is in place to ensure the safety of the crew. Appropriate PPE to be worn at all times. Protection of eyes and hands and feet.	2 - Unlikely	D - Significant	Low	Contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.	Contractor	Construction Phase	Open
Maintenance and Operation Phase																	
3.01	Water Drain	Open water drain creates drowning and injury risk.	Maintenance contractor	ALL	1 - Very unlikely	A - Disastrous	High	Contractor to ensure a safe working environment for all employed on site - stated in Specifications. SDC to specify installing necessary fencing to isolate the hazard.	1 - Very unlikely	A - Disastrous	High	Maintenance contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.			Open
3.02	Set height of Control Gate	Works or Maintenance Contractor (SDC) leave the gate closed or set higher than the consented operation height as they are not aware of the consent requirement. A continually closed gate would lead to drying up of the downstream portion of Leeston Creek, blocking fish passage. Leaving wide open would let more water past than the consented 0.6m3/s and lead to flooding downstream in Leeston township during a 1% AEP storm event.	Works contractor / Maintenance Contractor (SDC)	ALL	5 - Very likely	D - Significant	High	Design drawings have been updated by Aurecon to require Taege Engineering to provide a clear height marker on both sides of the engineered gate. Gate needs to have a 400mm opening during normal operation (non storm events), however it is recommended that during a 1% AEP (or close) event it is closed for the duration of the storm, and then reopened for normal operation. Contractor to ensure gate height is set to 400mm open when works are completed. Lock to be placed on winch making only accessible to SDC maintenance team. SDC to update maintenance team to understand the requirements indicated in the Detailed Design Report.	2 - Unlikely	D - Significant	Low	Aurecon / Works contractor / Maintenance Contractor (SDC)	Yes	Ensure all described measures are carried out appropriately and correctly.			Open
3.03	Signage	Public entering property	Maintenance contractor / community	ALL	2 - Unlikely	D - Significant	Low	Appropriate signage, private property signage in place	1 - Very unlikely	D - Significant	Low	Maintenance contractor	Yes	Ensure all described H&S measures are carried out appropriately and correctly.			Open
3.04	Poor maintenance of stage 5 drain and confluence diversion structure leads to reduced drain capacity during storm events	Lack of maintenance of upgraded drainage leading to blockages or otherwise reduced flow capacity and design flows breaking out of Leeston Creek before reaching the onfluence diversion structure and stage 4 bypass	Maintenance contractor / SDC	ALL	4 - Good chance	D - Significant	High	Regular maintenance requirements of grass on banks and weeds in drain to be clearly laid out in maintenance contract. Maintenance to keep the gate free of debris. Requirements indicated in Detailed Design Report. SDC to check stage 5 drain prior to storm events	2 - Unlikely	D - Significant	Low	Maintenance contractor	Yes	Ensure all described measures are carried out appropriately and correctly.			Open
3.05	Unsafe mowing of surfaces	Wet/boggy ground conditions, gradients too steep for mowers	Maintenance contractor	ALL	4 - Good chance	E - Minor	Moderate	Grassed areas of waterway designed to be clear of low flow water level and at suitable gradient. Where banks are not at gradient suitable for mower, string trimmers are expected to be used to reduce overgrowth. Stage 4 paddock is anticipated to be accessible to stock (which will keep growth down) until subdivision works get underway.	2 - Unlikely	E - Minor	Low	Aurecon / SDC	Yes	Ensure all described measures are carried out appropriately and correctly.			Open
Modification, Demolition and Dismantling Phases																	

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Meeting Attendees	SDC Representative Daniel Meehan Aurecon Team (Ben Henry, Anna Lindgren, Nic Catto)					Project No.	505193					A - Disastrous	Extreme	Extreme	Extreme	Extreme	High	High			
						C - Serious	Extreme	Extreme	Extreme	High		High									
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						E - Minor	Moderate	Moderate	Low	Low											

- Notes:
1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
 2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
 3. The risk register is focussed on hazards resulting from atypical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
 4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
 5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD					ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Applicable Phases	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
4.01	N/A	N/A	Maintenance or demolition Contractor		1 - Very unlikely	E - Minor	Low		1 - Very unlikely	E - Minor	Low	Client					Open

Appendix C

Leeston Flood Modelling Report 2019



**Leeston Stormwater Bypass
Flood Modelling Report
Selwyn District Council**

**17 May 2019
Revision: 4
Reference: 505193**

*Bringing ideas
to life*

Document control record

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Executive Summary

Introduction

Hydraulic modelling and design of the proposed Leeston Stormwater Bypass commenced in 2006 but the physical works were placed on hold due to budgetary constraints. Resource consents were obtained from Environment Canterbury (ECan) for the Leeston Stormwater Bypass. These consents required the stormwater bypass to be designed to convey the 1% Annual Exceedance Probability (AEP) flood event peak flows around the Leeston Township. A detailed investigation of potential downstream impacts associated with the proposed stormwater bypass was not completed for these early stages of the project.

A significant flood event in June 2013 resulted in extensive flooding within Leeston Township and shortly after this further design of the Leeston Stormwater Bypass commenced.

A one-dimensional (1D) MIKE 11 hydraulic model was developed for the Leeston Stormwater Bypass in 2004 by Stantec (formerly MWH). This hydraulic model was later modified and used by Aurecon to design a number of drain upgrades that form part of the overall Leeston Stormwater Bypass scheme.

This report includes recommended upgrades downstream of High Street (Stage 3), design drawings for the proposed Leeston Stormwater Bypass (Stage 4) and recommended upgrades for Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass (Stage 5). Refer Figure 1 in Section 1.1 of this report for the location of these outstanding project stages.

This investigation includes hydraulic modelling to investigate potential downstream impacts (Stage 3) that may occur as a result of different drain upgrading options from the end of Stage 1 (High Street) downstream to Beethams Road or further if required. The objective of this investigation was to identify the preferred option for upgrading downstream drains (Stage 3) sufficiently to enable the upstream system to convey the 1% AEP design flow.

Flood modelling has been completed for the existing scenario, design scenario (existing layout with the proposed Leeston Stormwater Bypass included) and a number of mitigation option scenarios.

The hydraulic capacity of the Leeston Creek reach between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass (Stage 5) has also been undertaken.

Flood Modelling

This investigation has developed a 1D/2D coupled MIKE FLOOD model of the Leeston Stormwater Bypass by linking the existing 1D MIKE 11 model to a new 2D MIKE 21 model developed from LiDAR survey flown in January 2016. This model has been used to identify both positive and negative flood impacts associated with various mitigation options downstream of High Street.

Flood modelling has been completed for the existing scenario, design scenario (existing layout with the proposed Leeston Stormwater Bypass included) and a number of mitigation option scenarios. Peak flood depth and difference maps have been prepared for these hydraulic model scenarios to allow a flood impact assessment to be undertaken and help identify the preferred Stage 3 upgrade options.

A hydraulic assessment of the upstream reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass (Stage 4) has been undertaken. This assessment was undertaken by developing a steady-state HEC-RAS hydraulic model of this reach of Leeston Creek based on cross-section survey completed in February 2019.

Model Results

Downstream Drains (Stage 3)

The mitigation scenarios investigated in this study all result in a minor increased peak flood depth and inundation extent within rural land downstream of Leeston Road. There are some existing properties in this area that include rural dwellings and farm buildings.

A floor level survey was undertaken for selected dwellings at critical locations identified from the flood modelling. This floor level survey was required to undertake a floor level flood impact assessment of existing dwellings in the catchment.

Based on an assessment of both inundated and at risk of inundation floor levels between all of the flood model scenarios, the optimal scenario for Stage 3 was found to be Mitigation Option 1. This mitigation option has a smaller number of inundated and at risk of inundation buildings than the existing scenario. It is noted that the freeboard to some existing buildings is expected to be reduced but these buildings still have an adequate freeboard to ensure they are not at risk of inundation. It is also noted that this increase in peak flood depth and level occurs in large infrequent flood events.

Flood maps are presented in Appendix A for all scenarios that were investigated in this study. The Mitigation Option 1 flood maps are presented on Figures A4 to A6.

Leeston Stormwater Bypass (Stage 4)

The proposed Stormwater Bypass has adequate freeboard to convey the 1% AEP event peak flow without constructing raised bunds along both banks. As these bunds will prevent overland flow upstream of the stormwater bypass from entering the waterway it is recommended that consideration is given to not constructing these bunds as part of the proposed Leeston Stormwater Bypass (Stage 4) works. Alternatively, bunding or disposing of excavated material through raising of land on the south side of the channel would also not create any adverse flooding effects. The need for these bunds or land raising could be re-evaluated during design of the adjacent Oakvale Development.

Leeston Creek between Harmans Road and the Leeston Stormwater Bypass (Stage 5)

Initial model results indicated that the Leeston Creek reach upstream of the Leeston Stormwater Bypass confluence has insufficient capacity to convey the 1% AEP design flow. A significant breakout was predicted to occur from the right bank of Leeston Creek downstream of Harmans Road. This breakout then flows through the adjacent farmland before re-entering Leeston Creek immediately upstream of the Leeston Dunsandel Road culvert. This potential breakout from Leeston Creek therefore exits upstream of the high-flow weir, which is positioned immediately downstream of the confluence between Leeston Creek and the proposed Leeston Stormwater Bypass channel. As this floodwater can then re-enter Leeston Creek upstream of Leeston Dunsandel Road, the full peak flow would not be diverted around the Leeston Township but could instead enter the Leeston Township and cause flooding. A hydraulic assessment of the upstream reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass has been undertaken using new cross-section survey completed in February 2019. This confirmed that this reach of Leeston Creek is under capacity for the 1% AEP event peak flow.

Other Drains

The reach of Manse Road Drain upstream of the CDHB Drain confluence cannot convey the 1% AEP flow without flood breakouts occurring.

Proposed Stage 3 Upgrades

A workshop was held with SDC on the 9 April 2019 to discuss the preferred upgrade option for the Stage 3 of the Leeston Stormwater Bypass. At this workshop Design Mitigation Option 1 was identified as the preferred upgrade option. The benefits of this option are that it has no inundated or at risk of

inundated existing floors, it reduces the total number of inundated or at risk of inundated garages and this scenario conveys a larger peak flow from the proposed Leeston Stormwater Bypass within the main Volckman Road Drain flow channel.

A drawing that shows the extent of proposed upgrades for Stage 3 and a typical cross-section profile is presented in Appendix B.

Mitigation Option 1 includes upgrading the existing High Street culverts to have twin 2 x 1m box culverts (or alternative configuration with similar capacity) and limited capacity upgrades to the existing reach of Volckman Road Drain from the downstream extent of the High Street culverts to the intersection between High Street and Volckman Road. It is noted that whilst a number of options were investigated that permanently remove the flood gate immediately downstream of the High Street culverts to allow more floodwater to be conveyed down Drain 58, this is not proposed in Mitigation Option 1.

The next step is for SDC to undertake consultation with adjacent land owners regarding this proposed upgrade option.

Leeston Stormwater Bypass (Stage 4)

Design drawings for the proposed Leeston Stormwater Bypass are presented in Appendix E. Any upgrades to downstream drains (Stage 3) need to be completed prior to the construction of the proposed Leeston Stormwater Bypass (Stage 4).

An investigation into the resource consents that are required to construct the remaining stages of the Leeston Stormwater Bypass is required. This includes the proposed Stage 3, 4 and 5 works.

Proposed Stage 5 Upgrades

The reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass has insufficient capacity to convey the 1% AEP event peak flow that the Leeston Stormwater Bypass has been designed for. It is therefore recommended that this upstream reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass is upgraded with an increased hydraulic capacity. The existing culvert within this reach will also need to be upgraded.

A workshop was held with SDC on the 9 April 2019 to discuss the preferred upgrade option for the reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass. At this workshop Design Upgrade Option 2 (refer Section 4.3 for details) was identified as the preferred upgrade option. The benefits of this option are that it allows the full 1% AEP peak flow in Leeston Creek to be conveyed around Leeston Township (via the proposed stormwater bypass) and also reduces the likelihood of flooding within existing properties immediately adjacent to this reach of Leeston Creek. The flatter batter slope along the edge of Leeston Creek also makes the waterway safer and easier to access for ongoing maintenance.

A drawing that shows the extent of upgrades to Leeston Creek and a typical cross-section profile is presented in Appendix C. Upgrades to the upstream reach of Leeston Creek (Stage 5) need to be undertaken at the same time or after construction of the proposed Leeston Stormwater Bypass (Stage 4). The full flood mitigation benefits of the Leeston Stormwater Bypass cannot be realised until the Stage 5 works are completed.

The next step is for SDC to undertake consultation with adjacent land owners regarding this proposed upgrade option.

1 Introduction

1.1 Background

Hydraulic modelling and design of the proposed Leeston Stormwater Bypass commenced in 2006 but the physical works were placed on hold due to budgetary constraints. Resource consents were obtained from Environment Canterbury (ECan) for the Leeston Stormwater Bypass. These consents required the stormwater bypass to be designed to convey the 1% Annual Exceedance Probability (AEP) flood event peak flows around the Leeston Township. An investigation of potential downstream impacts associated with the proposed stormwater bypass was not completed for these early stages of the project.

A significant flood event in June 2013 resulted in extensive flooding within Leeston Township and shortly after this further design of the Leeston Stormwater Bypass commenced.

A one-dimensional (1D) MIKE 11 hydraulic model was developed for the Leeston Stormwater Bypass in 2004 by Stantec. This hydraulic model was later modified and used by Aurecon to design a number of drain upgrades that form part of the overall Leeston Stormwater Bypass scheme.

The Leeston Stormwater Bypass is to be constructed in the following stages:

Stage 1 - High Street Drain and CDHB Drain Upgrade (complete).

Stage 2 – Manse Road Drain and Reids Culvert (complete).

Stage 3 – High Street culvert and downstream drain upgrading (scope of this investigation).

Stage 4 – Stormwater bypass channel (design complete).

Stage 5 – Leeston Creek upgrade between Harmans Road and the confluence with the stormwater bypass channel (Stage 4).

Stage 6 – Future wetland – to be constructed in conjunction with the proposed Oakvale Development.

The various components of the remaining stages are presented below in Figure 1.



Figure 1 Location and Extent of Future Leeston Stormwater Bypass Stages

Upgrading the High Street culvert and downstream drains has been identified as necessary to enable the stormwater bypass to operate to a 1% AEP design level of service. However, this could potentially worsen the flooding vulnerability of properties downstream of the works.

This investigation includes hydraulic modelling to investigate potential downstream impacts that may occur as a result of different drain upgrading options from the end of Stage 1 (High Street) downstream to Beethams Road or further if required. As agreed with SDC, the downstream upgrade option that was initially modelled was the splitting of flow down a partially upgraded Volckman Road drain and rural Drain 58 to reduce width of Volckman Road Drain upgrade. Following the initial model runs, further mitigation options were investigated including upgrading Beethams Road culvert and constructing a bund alongside part of Volckman Road Drain.

The objective of this investigation was to identify the preferred option for upgrading downstream drains (Stage 3) sufficiently to enable the upstream system (Stage 4) to convey the 1% AEP design flow. It is not intended that the downstream drains will be upgraded to a 1% AEP event level. Following initial hydraulic modelling for this investigation, SDC identified that some model refinement was required to include Drain 57 from Beethams Road to Lochheads Road in the hydraulic model.

Some additional mitigation model scenarios were also required to assist SDC in determining the option that will result in the best outcomes for the community.

This investigation has developed a 1D/2D coupled MIKE FLOOD model of the Leeston Stormwater Bypass by linking the existing 1D MIKE 11 model to a new 2D MIKE 21 model developed from LiDAR survey flown in January 2016. This model has been used to identify both positive and negative flood impacts associated with various mitigation options downstream of High Street.

Floor level survey has been obtained for existing properties (residential and non-residential buildings) within predicted flood inundation extents and used to identify the preferred upgrade option for Stage 3 to ensure there are no adverse flood impacts to existing buildings.

An investigation into the capacity of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass (Stage 5) has also been undertaken.

1.2 Scope of Work

The scope of work for the flood modelling investigation is summarised below:

- Undertake additional channel cross section survey on Volckman Road drain and rural drain south of High Street culvert, including picking up levels at likely overflow points.
- Update existing 1D MIKE 11 model with the additional topographic survey.
- Build fully coupled MIKE Flood Model (1D MIKE 11 linked with 2D MIKE 21).
- Model existing scenario, design scenario and a number of mitigation options.
- Further model refinement to include Drain 57 from Beethams Road to Lochheads Road in the hydraulic model for some of the model scenarios.
- Additional mitigation scenario modelling for Options 2A and 2B.
- Undertake assessment of flooding impacts. This includes the extent and depth of flooding in all model scenarios.
- Determine peak flood levels in the RCL block (to the north of High Street) in the design and mitigation Option 1 scenarios. These peak flood levels can be compared against existing finished floor levels to identify the need for the proposed High Street culvert and associated downstream drain upgrade works.

- Undertake floor level survey for selected dwellings at critical locations identified from the flood modelling. This floor level survey was required to undertake a floor level flood impact assessment of existing dwellings in the catchment.
- Obtain additional survey of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass channel (Stage 4). This survey was required to assess the capacity of this reach of Leeston Creek and identify any required upgrade works.
- Identify a preferred option which represents a practical scope of work to complete Stage 3 of the proposed Leeston Stormwater Bypass.
- Prepare consultation drawings for the recommended Stage 3 and Stage 5 works.
- Completion of design drawings for the proposed Leeston Stormwater Bypass (Stage 4).
- Summarise findings in a technical report to enable consultation with potentially affected land owners. This report includes mapping to show any predicted change in flood depth and inundation extent, the Stage 4 design drawings and consultation drawings for Stage 3 and Stage 5.



Image 1: Upgraded High Street Drain in Flood

2 Flood Model Development

2.1 Catchment Description

The Leeston Creek catchment is predominately low lying flat farmland with a network of raised roads and associated culverts of waterways. This catchment includes the township of Leeston. Leeston Creek conveys floodwater from the surrounding pastoral land before passing through the Leeston Township and then along the Volckman Road Drain to Lake Ellesmere.

The catchment has experienced significant flooding in the past, particularly within the Leeston Township. This can be attributed to the difficult drainage conditions presented by the combination of flat topography and limited capacity of existing waterways.

The proposed Leeston Stormwater Bypass will convey floodwater within Leeston Creek upstream of the township around Leeston before ultimately discharging into Lake Ellesmere. The Leeston Stormwater Bypass includes a new bypass channel from Leeston Creek around the northern side of the township and upgrades to the CDHB Drain, Manse Road Drain, High Street culvert and associated downstream upgrade works to ensure the Leeston Stormwater Bypass can convey the 1% AEP flows within the Leeston Township whilst also not impacting existing downstream properties.

The flow rate and inflow location for each sub-catchment has been adopted from the previous Stantec hydraulic model, as discussed in Section 2.2 below.

The location of relevant waterways for this investigation are presented on the flood maps included in Appendix A.

2.2 Existing Hydraulic Model Overview

The current MIKE FLOOD model utilises components of the existing MIKE 11 1D hydraulic model, originally developed by Stantec (formally MWH) in 1998 in MIKE UD and then updated to MIKE 11 in 2004. The 1998 MIKE UD model was used to review the proposed design to divert stormwater from a 1% AEP event around Leeston Township whilst also limiting flow into urban areas of Leeston.

The updated 2004 MIKE 11 model included a new section of drain from Leeston to Lake Ellesmere, as well as, four additional catchments downstream of Leeston Township. The Lake Ellesmere boundary condition was set as a permanent water level of 1.6mRL. This level was recorded just prior to the 1992 flooding event in Leeston and is considered to be very conservative but found to not have any significant back water effect. The discharges from the 1998 hydraulic model were originally calculated using DHI's MOUSE – Model A package and NIWA's HIRDS v1 rainfall data. These discharges were recalculated with the latest HIRDS v2 rainfall values (including climate change impacts) at the time the model was updated.

The existing 2004 MIKE 11 model was developed in NZMG coordinate system. For the purpose of the MIKE FLOOD model development, this MIKE 11 model was converted to NZTM coordinate system so that it matches the LiDAR and aerial imagery provided by SDC.

This MIKE 11 model was updated by Aurecon to include the CDHB Drain, Manse Road Drain and High Street Drain upgrades completed as part of Stages 1 and 2 of the Leeston Stormwater Bypass.

This model has retained the same peak flows as the Stantec model as the Leeston Stormwater Bypass was designed for these peak flows and the resource consent conditions require the drain to be designed to convey these peak flows.

Revised rainfall data included in HIRDS v4 is larger than previous values from HIRDS v2. Therefore, the peak discharges used in this investigation are less than would be calculated from the latest HIRDS v4 design rainfall parameters. This investigation has adopted these peak flows as they match peak flows include in the consent conditions for this project.

Preliminary hydrologic modelling using HEC-HMS has estimated that the 1% AEP peak flows (HIRDS v2 design rainfall parameters including climate change) included in the consent conditions (used to design the Leeston Stormwater Bypass) are similar to the 2% AEP peak flows (HIRDS v3 design rainfall parameters including climate change).

The consented 1% AEP level of service for the proposed Leeston Stormwater Bypass capacity exceeds the level of service typically adopted for rural waterways in New Zealand. The proposed Leeston Stormwater Bypass will have an estimated 2% AEP capacity based on the latest design parameters.

2.3 Model Scenarios

The following model scenarios were completed for the Leeston Stormwater Bypass flood modelling in this investigation. All model scenarios were completed for the 1% AEP design event consented peak flows.

- Existing scenario: This scenario includes the existing MIKE 11 hydraulic model linked to a 2D MIKE 21 model of the Leeston catchment topography. The Leeston Stormwater bypass has been excluded from the model and only the upgraded CDHB Drain, Manse Road Drain and High Street Drains have been included. This scenario represents the current infrastructure and only includes infrastructure upgrades that are currently under construction or completed. This model scenario has been refined to include Drain 57 from Beethams Road to Lochheads Road.
- Design scenario: As per the Existing scenario but with the inclusion of the Leeston Stormwater Bypass waterway. This scenario represents the existing scenario along with proposed drain upgrades that are both designed and consented. This includes the proposed Leeston Stormwater Bypass.
- Mitigation Option 1 scenario: As per the Design Scenario but with the existing High Street culverts upgraded to two 2.0m x 1.0m culverts and limited capacity upgrades to the upstream reach of Volckman Road Drain from the downstream extent of the High Street culverts to the intersection of High Street and Volckman Road.
- Mitigation Option 2 scenario: As per Mitigation Option 1 but with the weir removed from the existing Drain 58 immediately downstream of the High Street culverts.
- Mitigation Option 2A: As per the Option 2 scenario but without the High Street culvert upgrade i.e. retain existing culvert in this location.
- Mitigation Option 2B: As per the Option 2 scenario and also including the southern bund that is included in Mitigation Option 4 (below).
- Mitigation Option 3 scenario: As per the Mitigation Option 2 scenario but with the existing Beethmans Road culvert upgraded to a 2.1m x 1.2m box culvert.
- Mitigation Option 4 scenario: As per the Mitigation Option 3 scenario but with a bund/stopbank added to the right bank (southern side) of Volckman Road Drain near the intersection between High Street and Volckman Road to prevent floodwater breakout from the existing drain in this location.

Note that a more extensive upgrade of the Volckman Road Drain was investigated in previous modelling that used the 1D MIKE 11 model only. This resulted in a large drain upgrade that widened the existing drain profile to within 1m of Volckman Road. Given the high-speed environment of Volckman Road, this drain upgrade was not considered to be a viable upgrade option. The development of a linked 1D/2D MIKE FLOOD model allows downstream upgrades to be completed

that remove the tailwater constraint on the Leeston Township waterways to ensure they have 1% AEP capacity but with a lower level of service for the downstream waterways.

2.4 Hydrologic Model

The Leeston Stormwater Bypass hydraulic model was developed for the 1% AEP design event. The critical duration was found to be the six-hour event when the model was originally developed by Stantec. All flows and boundary conditions for this investigation were adopted from the existing MIKE 11 hydraulic model. No flow analysis has been undertaken by Aurecon for this investigation.

2.5 Hydraulic Model

2.5.1 MIKE 11

The majority of the MIKE 11 model was adopted from Stantec's 2004 MIKE 11 model. However, a number of modifications have been made to this model by Aurecon to include the design profile for the Leeston Stormwater Bypass, CDHB Drain, Manse Road Drain (downstream of the CDHB Drain confluence) and High Street Drain upgrades. Additional cross section detail has been included in the Volckman Road Drain based on detailed topographic survey undertaken by Aurecon for this investigation.

All existing culvert and bridge structures have been included in the waterways included in the model. A high-flow bypass weir will be included on Leeston Creek immediately downstream of the confluence between Leeston Creek and the proposed Stormwater Bypass. This structure will allow an ecological flow to enter Leeston Creek but can be closed during large flood events to ensure all floodwater is bypassed around Leeston Township. This structure has been closed in all scenarios modelled in this investigation.

The existing drain to the north of Leeston Dunsandel Road, Drain 58 and Drain 57 down to Lochheads Road are also included in the MIKE 11 model for this investigation. It is noted that Drain 57 has been included in the model based on LiDAR and representative cross sections from Drain 58 because no detailed survey of this drain is currently available. No existing structures that may be located on Drain 57 are included in the model as these details are currently unknown.

The proposed future wetland has not been included in the MIKE 11 model.

It is noted that the cross-section survey for Leeston Creek (upstream of the proposed stormwater bypass confluence), Manse Road Drain (upstream of the CDHB Drain confluence) and Volckman Road Drain (downstream of Beethams Road) have not been updated beyond what is included in the MIKE 11 model originally developed by Stantec. Therefore, the cross-section profiles in these areas are based on limited cross section survey completed over ten years ago. It is unknown if this cross-section survey still accurately reflects the current profile of these waterways. The profile of these waterways may be changed as a result of the Canterbury earthquake sequence and sedimentation. Detailed cross-section survey of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass was undertaken in February 2019 and used to assess the hydraulic capacity of this reach of Leeston Creek.

Roughness parameters have been adopted based on the original MIKE 11 model, but some values have been updated based on site photographs taken during recent site walkovers.

Boundary conditions have been adopted for the 1% AEP design event and Lake Ellesmere tailwater level as per the original MIKE 11 model.

The location of all waterways included in the MIKE 11 model are presented on the flood maps included in Appendix A.

2.5.2 MIKE 21

A 2D hydraulic model has been developed using MIKE 21 with a flexible mesh topography. This approach allows for the smaller details of a large catchment to be modelled while still maintaining reasonable run times. The MIKE 11 model has been linked to the MIKE 11 model using MIKE FLOOD.

LiDAR data (January 2016) was provided by SDC to be used in this investigation. This LiDAR data was used to develop the MIKE 21 topography. The model topography has adopted a fine mesh in all road corridors within the model extent and a courser mesh in flat rural areas. This approach allows features that will impact floodwater such as elevated roads to be accurately modelled. This catchment topography file will also be used for the Leeston Township flood modelled project that requires a finer mesh resolution to accurately identify flood impacts within the urban stormwater network in Leeston Township in a number of design events.

A roughness map was developed based on the aerial photography provided by SDC. In the absence of site specific data, standard DHI parameters were used in accordance with best practice methods.

The crest level of all roads included in the model extent have also been represented using dikes with levels set based on the LiDAR survey provided. This approach ensures that floodwater overtopping rural roads is accurately represented in the model.

Note that there are a number of existing smaller drains within the model extent and culverts beneath rural roads that have not been included in the model. Two existing culverts beneath Leeston Road have been included in MIKE 21 to more accurately represent flood impacts to the north of Leeston Road.

MIKE 11 waterways where floodwater breakouts occur have been blocked out of the MIKE 21 mesh to prevent duplication of both floodwater conveyance and storage.

The extent of the MIKE 21 topography is presented on the flood maps included in Appendix A.

2.5.3 MIKE FLOOD

The 1D MIKE 11 and 2D MIKE 21 models have been dynamically coupled using the MIKE FLOOD software. All waterways have lateral links along both left and right banks to allow floodwater to both exit and re-enter waterways included in the MIKE 11 model when their capacity has been exceeded.

This approach allows the inundation extent and depth of floodwater breakouts from the waterway network to be accurately represented in the model.

2.6 Model Calibration

The MIKE flood model has not been calibrated to any historic flood events due to the lack of flow and associated rainfall data.

However, aerial photography flown preceding historic flood events in the catchment has been used to undertake a high-level validation of the model results where possible. Overall there is a good correlation between the historic flood event photographs and the modelled flow paths, with most major breakouts represented in the model (Figure 2). There are some discrepancies between the historic flood event photographs and the modelled results, a portion of these differences can be attributed to the differences between rainfall depth, and the use of point source inflows to represent stormwater catchments.



Figure 2 Comparison between Historic Flood Event Photograph and 1% AEP Design Scenario Flood Model Results.



Image 2: Upgraded Manse Road Drain in Flood

3 Model Results

3.1 Existing Scenario

The existing model results validate the need for the Leeston Stormwater Bypass because significant flooding occurs throughout the Leeston Township, with multiple residential and commercial properties inundated. Leeston Creek overtops north of the township and the excess floodwater then crosses Leeston Dunsandel Road and flows along roads and through residential properties. Within the township, Leeston Creek has insufficient capacity and overtops at multiple locations. Additionally, Manse Road Drain has insufficient capacity to convey its flow and a significant breakout occurs to the east of the drain which inundates residential lots.

There is significant flooding south of the township which is predominantly through farmland. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The existing scenario peak flood depth and inundation extent is presented on Figure A1 in Appendix A.

3.2 Design Scenario

Initial model results indicated that the Leeston Creek reach upstream of the Leeston Stormwater Bypass confluence has insufficient capacity to convey the 1% AEP design flow. A significant breakout occurs from the right bank of Leeston Creek downstream of Harmans Road. This breakout then flows through the adjacent farmland before re-entering Leeston Creek immediately upstream of the Leeston Dunsandel road culvert. This potential breakout therefore exits Leeston Creek upstream of the high-flow weir, which is positioned immediately downstream of the confluence between Leeston Creek and the proposed Leeston Stormwater Bypass channel. As this floodwater can then re-enter Leeston Creek upstream of Leeston Dunsandel Road, the full peak flow would not be diverted around the Leeston Township but could instead enter the Leeston Township and cause flooding. As discussed in Section 2.5.1, the Leeston Creek cross section survey has not been updated beyond what is included in the MIKE 11 model originally developed by Stantec. These existing cross-sections may not accurately represent the current profile of Leeston Creek given that the profile may have changed as a result of the Canterbury earthquake sequence and sedimentation.

Given that the downstream mitigation measures need to be designed on the basis of the full 1% AEP peak flow being conveyed through the stormwater bypass, the lateral links have been removed from Leeston Creek upstream of the proposed weir structure to prevent breakout of floodwater upstream of the proposed Leeston Stormwater Bypass. Therefore, no flood breakouts can be seen on the flood maps in this location.

Topographic cross-section survey was obtained for Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass in February 2019. Whilst the MIKE FLOOD hydraulic model has not been updated with these cross-sections, a separate hydraulic analysis for this reach of Leeston Creek has confirmed that it does not have adequate capacity to convey the 1% AEP event peak flow. Refer Section 4 for details of this hydraulic assessment.

Additionally, the Manse Road Drain upstream of the confluence with the CDHB Drain still has insufficient capacity to convey the 1% AEP design flow. To ensure that the correct flow was modelled in the areas of interest for this investigation, the Manse Road Drain inflow boundary was moved downstream to the confluence between Manse Road Drain and the CDHB Drain.

Having made the above changes to the model, the following results were observed for the 1% AEP event:

- The proposed Stormwater Bypass, CDHB Drain, Leeston Creek (reach between the proposed stormwater bypass confluence and the western extent of the Leeston township) and mid reach of Manse Road Drain has sufficient capacity to convey the full 1% AEP flow without breakout occurring. The proposed Stormwater Bypass has adequate freeboard without constructing raised bunds along both banks. As these bunds will prevent overland flow upstream of the stormwater bypass from entering the waterway it is recommended that consideration is given to not constructing these bunds as part of the proposed Leeston Stormwater Bypass. The need for these bunds or land raising can be assessed during design of the adjacent subdivision.
- There is significant flooding south of High Street in the Leeston Township which can be attributed to the stormwater network having insufficient capacity for the 1% AEP event. Previous hydraulic modelling has found that the existing Leeston Creek waterway profile within Leeston Township has approximately 10% AEP event capacity. The floodwater that exceeds the capacity of the Leeston township stormwater network travels via overland flow into the rural land and Drain 58 downstream of High Street.
- The High Street culverts have insufficient capacity and are overtopping and creating a significant tailwater constraint on the lower reach of the Manse Road Drain and High Street Drain. This finding is consistent with previous findings that indicated that the High Street culverts are undersized and will create a significant tailwater constraint to the Leeston Stormwater Bypass.
- The Beethmans Road culvert on Volckman Road Drain is under capacity and causes floodwater to spill into the neighbouring farmland.
- Floodwater breaks out from the upstream reach of the Volckman Road Drain, immediately downstream of the High Street culverts. This results in the reach of Volckman Road Drain between Leeston Road and Lochheads Road having underutilised capacity.
- Some floodwater is conveyed along the northern side of Leeston Road in an easterly direction towards the MIKE 21 model boundary. The model extent could not be extended further east due to there being no LiDAR survey available in this location. It is noted that there are some existing culverts (not included in the model) that will convey this floodwater under Leeston Road.
- Similar to the existing scenario the vast majority of flooding south of the Leeston Township is through farmland. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The design scenario peak flood depth and inundation extent is presented on Figure A2 in Appendix A. The Design scenario difference map is presented on Figure A3 in Appendix A. This map presents the difference in peak flood level between the design and existing scenarios.

Peak flood levels in the RCL parcel upstream of High Street are presented on Figure A20 in Appendix A. It can be seen from Figure A20 that peak flood levels are significantly lower in the mitigation Option 1 scenario than they are in the design scenario.

3.3 Mitigation Scenarios

3.3.1 Mitigation Option 1 Scenario

The upgrading of the High Street culverts will increase the flow through the culverts by 3.3m³/s (from 5.0m³/s to 8.3m³/s). This increased High Street culvert capacity reduces the flood inundation extent along the High Street Drain.

However, the additional flow conveyed by Volckman Road Drain causes increased overtopping of the Beethmans Road Culvert and a flood breakout at the upper reach of the Volckman Road Drain. The change in flow paths has resulted in increased flooding in the adjacent rural paddocks. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The Mitigation Option 1 scenario peak flood depth and inundation extent is presented on Figure A4 in Appendix A.

The Mitigation Option 1 scenario difference map is presented on Figure A5 in Appendix A. This map presents the difference in peak flood level between the mitigation Option 1 and design scenarios. It can be seen from Figure A5 that the peak flood depth will increase by up to 100mm within an existing drainage path to the east of Drain 58. The peak flood depth will increase by up to 50mm within rural properties between Beethams Road and Lake Ellesmere. The existing scenario difference map is present on Figure A6 in Appendix A.

Peak flood levels in the RCL parcel are presented on Figure A20 in Appendix A.

3.3.2 Mitigation Option 2 Scenario

The removal of the upstream weir in the Drain 58 has improved the tailwater condition for the upgraded High Street culvert. This results in a further reduction in peak flood levels along the High Street Drain. There is a flood breakout immediately upstream of the Beethams Road culvert on the Volckman Road Drain and this floodwater is conveyed in a southerly direction towards Drain 58. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The Mitigation Option 2 scenario peak flood depth and inundation extent is presented on Figure A7 in Appendix A.

The Mitigation Option 2 scenario difference map is presented on Figure A8 in Appendix A. This map presents the difference in peak flood level between the mitigation Option 2 and design scenario. The existing scenario difference map is present on Figure A9 in Appendix A.

3.3.3 Mitigation Option 3 Scenario

The removal of the upstream weir in Drain 58 and the upgrading of the Beethams Road culvert has improved the tailwater condition for the upgraded High Street culvert. This results in a further reduction in peak flood levels along the High Street Drain.

The upgrading of the Beethams Road culvert has allowed the central reach of Volckman Road Drain to convey a greater flow and as a result the flood level is reduced in some areas when compared to Mitigation Option 1. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The Mitigation Option 3 scenario peak flood depth and inundation extent is presented on Figure A10 in Appendix A. It can be seen from Figure A10 that the increased flow in Volckman Road Drain results in a breakout to the east of the drain in the vicinity of Lochheads Road. This results in inundation of rural land with flood depths up to 100mm. This flood breakout occurs because the existing Lochheads Road culvert capacity is insufficient to convey the increased peak flow in Volckman Road Drain.

The Mitigation Option 3 scenario difference map is presented on Figure A11 in Appendix A. This map presents the difference in peak flood level between the mitigation Option 3 and design scenarios. It can be seen from Figure A11 that the peak flood depth will increase by up to 100mm within an existing drainage path to the east of Drain 58, but the depth of flooding in this location will be less than in Mitigation Option 1. The peak flood depth will typically be similar or drop within rural land between Beethams Road and Lochheads Road. The existing scenario difference map is presented on Figure A12 in Appendix A.

The inclusion of a bund on the right bank of Volckman Road Drain increases the flow contained within the drain. This further reduces the peak flood depth between Leeston Road and Beethams Road, but some areas of increased flood depth are still predicted to occur.

The increased flow within the Volckman Road Drain further increases the magnitude of the flood breakout to the east of the drain in the vicinity of Lochheads Road. As per the Mitigation Option 3

scenario, this flood breakout occurs because the existing Lochheads Road culvert capacity is insufficient to convey the increased peak flow in Volckman Road Drain.

The mitigation Option 4 scenario peak flood depth and inundation extent is presented on Figure A13 in Appendix A.

The mitigation Option 4 scenario difference map is presented on Figure A14 in Appendix A. This map presents the difference in peak flood level between the mitigation Option 4 and design scenarios. The existing scenario difference map is present on Figure A15 in Appendix A.

3.3.4 Mitigation Option 2A Scenario

This scenario does not include any upgrades to the existing High Street culverts. The mitigation Option 2A scenario peak flood depth and inundation extent is presented on Figure A16 in Appendix A. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The mitigation Option 2A scenario difference map is presented on Figure A17 in Appendix A. This map presents the difference in peak flood level between the mitigation Option 2a and design scenarios.

The mitigation option 2A scenario has limited change in peak flood level when compared to the design scenario, due to the existing High Street culverts not being upgraded in this mitigation scenario. Therefore, this scenario does not increase peak flood depths and inundation extent downstream of High Street.

3.3.5 Mitigation Option 2B Scenario

This scenario results in a reduction in floodwater entering rural land immediately downstream of High Street but as a result increases peak flows entering the Volckman Road Drain. This scenario therefore reduces peak flood levels upstream of High Street but results in flood impacts downstream of Beethams Road due to a breakout from the Volckman Road drain. Refer Section 3.4 for flood risk assessment based on the surveyed floor levels.

The mitigation Option 2B scenario peak flood depth and inundation extent is presented on Figure A18 in Appendix A.

The mitigation Option 2B scenario difference map is presented on Figure A18 in Appendix A. This map presents the difference in peak flood level between the mitigation Option 2b and design scenarios.

3.4 Flood Impact Assessment

As part of the proposed Leeston Stormwater Bypass design, a number of mitigation scenarios have been investigated in the hydraulic model developed for this project. In order to select the preferred upgrade option for Stage 3, floor level survey was undertaken in February 2019 for selected dwellings at critical locations identified from the flood modelling. This floor level survey was required to undertake a flood impact assessment of existing dwellings in the catchment.

The surveyed floor levels were compared against peak flood levels from each of the model scenarios previously completed for this project. These scenarios included the existing, design and mitigation option 1, 2, 2A, 2B, 3 and 4 scenarios.

The full floor level flood impact assessment is included in Appendix D. This includes a list of the building (house, garage, shed etc) floor levels, corresponding peak flood levels and freeboard. In areas where the floor is predicted to be inundated the cell is highlighted in 'red'. When the floor is not predicted to be inundated, but the predicted peak flood level is less than 100mm below the floor level,

the cell is highlighted in 'yellow'. These floors highlighted in 'yellow' are considered at risk of flood inundation.

A summary of the floor level flood impact assessment is presented in Table 1.

Table 1 Summary of Floor Level Flood Impact Assessment

Building Type	Flood Model Scenario							
	Existing	Design	Mitigation Option 1	Mitigation Option 2	Mitigation Option 2A	Mitigation Option 2B	Mitigation Option 3	Mitigation Option 4
House	0 (1)	0 (1)	0 (0)	0 (1)	0 (1)	0 (1)	0 (1)	0 (1)
Garage	2 (7)	4 (7)	0 (3)	1 (7)	3 (8)	0 (7)	1 (7)	1 (7)
Auxiliary Shed	0 (1)	0 (1)	0 (1)	0 (1)	0 (1)	0 (1)	0 (1)	0 (1)

Notes:

1. Refer Section 3.3 for a description of all model scenarios.
2. The values presented in this table are both inundated building floors and at risk (in brackets) building floors.

Below is a summary of the results presented in the table above:

- There are no predicted inundated houses in any of the model scenarios. The proposed Stage 3 works will reduce the freeboard at some existing houses as can be seen in the Appendix D summary. Also, the design and mitigation scenarios typically all have one house at risk of inundation, with the exception of Mitigation Option 1 that has no houses predicted at risk of inundation. The optimal option to minimise the impact on existing houses is considered to be Mitigation Option 1.
- With regard to existing garages; the Design, Mitigation Option 2 and Mitigation Option 3 scenarios all result in an increase in either predicted inundated or at risk of inundation garage floors. Mitigation Options 2, 2B, 3 and 4 all reduce the number of inundated garages but do not change the number of garages at risk of inundation. Mitigation Option 1 reduces the number of inundated and at risk of inundation garage floors.
- With regard to auxiliary sheds, there is no change in the number of inundated or at risk of inundation floors between all of the scenarios. All scenarios have no inundated floors and one at risk of inundation floor.

Based on an assessment of both inundated and at risk of inundation floor levels between all of the flood model scenarios, the optimal scenario for Stage 3 is Mitigation Option 1.

Mitigation Option 1 includes upgrading the existing High Street culverts to have twin 2 x 1m box culverts (or alternative configuration with similar capacity) and limited capacity upgrades to the existing reach of Volckman Road Drain from the downstream extent of the High Street culverts to the intersection between High Street and Volckman Road.

The hydraulic modelling has identified that the existing High Street culverts have insufficient capacity and are overtopping and creating a significant tailwater constraint on the lower reach of the Manse Road Drain and High Street Drain. For this reason, the existing culverts need to be upgraded.

The hydraulic modelling has also identified that the section of Volckman Road Drain immediately downstream of these culverts has insufficient capacity and this results in a floodwater breakout. The modelling also identified that the Volckman Road Drain has some underutilised capacity and therefore

upgrading a short length of this drain will convey more water within the drain channel and minimise floodwater conveyed through rural land.

It is noted that whilst a number of options were investigated that remove the flood gate immediately downstream of the High Street culverts to allow more floodwater to be conveyed down Drain 58, this is not proposed in Mitigation Option 1.

The Mitigation Option 1 flood maps are presented in Appendix A on Figures A4 to A6. Whilst Mitigation Option 1 does result in a slight increase in peak flood depth and level, this is typically in rural land and does not have any adverse impacts on existing buildings. It is also noted that this increase in peak flood depth and level occurs in large infrequent flood events.

Note that the lowest road crown level on High Street / Leeston Road immediately adjacent to the RCL block is 18.53 mRL. The lowest floor level in the adjacent RCL block is 18.72 mRL so this building has 190mm freeboard.

A workshop was held with SDC on the 9 April 2019 to discuss the preferred upgrade option for the Stage 3 of the Leeston Stormwater Bypass. At this workshop Design Mitigation Option 1 was identified as the preferred upgrade option. The benefits of this option are that it has no inundated or at risk of inundation existing floors, reduced total number of inundated or at risk of inundation garages and conveys a larger peak flow from the proposed Leeston Stormwater Bypass within the main flow channel.

A drawing that shows the extent of proposed upgrades and a typical cross-section profile is presented in Appendix B.

The next step is for SDC to undertake consultation with adjacent land owners regarding this proposed upgrade option.



Image 3: High Street Culvert Outlet in Flood – June 2013

4 Leeston Creek Hydraulic Capacity Upstream of Proposed Bypass

4.1 Introduction

As discussed in Section 3.2, the MIKE FLOOD hydraulic model results indicated that the Leeston Creek reach upstream of the Leeston Stormwater Bypass confluence has insufficient capacity to convey the 1% AEP design flow. The model results show a significant breakout occurring from the right bank of Leeston Creek downstream of Harmans Road. This breakout then flows through the adjacent farmland before re-entering Leeston Creek immediately upstream of the Leeston Dunsandel road culvert. This potential breakout from Leeston Creek therefore exits upstream of the high-flow weir, which is positioned immediately downstream of the confluence between Leeston Creek and the proposed Leeston Stormwater Bypass channel. As this floodwater can then re-enter Leeston Creek upstream of Leeston Dunsandel Road, the full peak flow would not be diverted around the Leeston Township but could instead enter the Leeston Township and cause flooding.

As discussed in Section 2.5.1, the Leeston Creek cross-section survey in the MIKE FLOOD model had not been updated beyond what is included in the MIKE 11 model originally developed by Stantec. There was uncertainty as to whether these existing cross-sections still accurately represent the current profile of Leeston Creek given that the profile may have changed as a result of the Canterbury earthquake sequence and sedimentation.

New cross-section survey of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass channel (Stage 4) was obtained in February 2019. This survey was required to assess the capacity of this reach of Leeston Creek and identify any required upgrade works.

A hydraulic assessment of the upstream reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass has been undertaken. This assessment was undertaken by developing a steady-state HEC-RAS hydraulic model of this reach of Leeston Creek based on the 2019 cross-section survey completed by Aurecon for this project. The model adopted the same 1% AEP event inflow as the previous MIKE FLOOD hydraulic modelling for this project.

4.2 Existing Scenario Hydraulic Model

The HEC-RAS model was initially run for the existing scenario Leeston Creek topography (cross-section profile) for both a lower and upper limit roughness values. The lower roughness value of 0.035 was adopted for the design of the downstream Leeston Stormwater Bypass and this roughness value is based on a grassed waterway that is maintained. The higher roughness value of 0.05 is based on the longer vegetation that is currently present in this upstream section of Leeston Creek. The existing Leeston Creek cross-section profile in this reach typically has a 1.5 to 2m base width, 1.1m depth and varying batter slopes, but typically around 1H:1V.

In both of these existing scenario model runs, the reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass has insufficient capacity to convey the 1% AEP event peak flow that the Leeston Stormwater Bypass has been designed for. This outcome is the same for a well maintained or poorly maintained waterway. The existing 1,050mm diameter single culvert in this reach of Leeston Creek is also under capacity and this results in floodwater breakout upstream of this existing structure into adjacent properties.

Given that the topography in this area grades in southerly direction towards the Leeston Dunsandel Road, flood breakouts from this reach of Leeston Creek would be expected to be conveyed through

the Leeston Township. This would result in a smaller than intended design flow being conveyed through the proposed Leeston Stormwater Bypass and a larger than intended flow passing through Leeston Township on the current Leeston Creek alignment.

An assessment of the existing concrete arch culvert at Harmans Road has been undertaken. This culvert is under capacity in the existing scenario due to tailwater constraints but when the reach of Leeston Creek downstream of Harmans Road is upgraded, the tailwater level drops and this results in the existing culvert having adequate capacity for the 1% AEP event design flow that the Leeston Stormwater Bypass has been designed for.

It is therefore recommended that the reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass is upgraded with an increased hydraulic capacity. The existing culvert within this reach will also need to be upgraded.

4.3 Design Scenario Hydraulic Model

Two design upgrade scenarios have been investigated for the reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass. These options are summarised below:

- Design Upgrade Option 1: Minor upgrades to the current Leeston Creek cross-section profile and improving the longitudinal grade of Leeston Creek to remove the localised high and low points that are currently present. The upgraded waterway profile has a 1.8m base width, 1.1m depth and 1H:1V batters along both banks. A Manning's roughness parameter of 0.035 has been adopted for this option which represents a predominantly grassed-lined and well-maintained reach of waterway. The existing single 1,050mm diameter culvert will also need to be replaced with twin 1,200mm diameter culverts or potentially a box culvert or single span bridge structure. Note that this design upgrade option has currently been modelled with twin 1,200mm diameter culverts. Note that this option could result in minor flood breakouts if the vegetation in the drain was longer than a well-maintained waterway.
- Design Upgrade Option 2: This option has a more significant upgrade to the cross-section profile and improved longitudinal grade of Leeston Creek to remove the localised high and low points that are currently present. The upgraded profile has a 2.5m base width, 1.1m depth and batter slopes of 1H:1V on the right bank and 2H:1V on the left bank. A Manning's roughness parameter of 0.05 has been adopted for this option which represents a less frequently maintained waterway. The existing single 1,050mm diameter culvert will also need to be replaced with twin 1,200mm diameter culverts or potentially a box culvert or single span bridge structure. Note that this design upgrade option has currently been modelled with twin 1,200mm diameter culverts.

Both design upgrade options assume that the location of the right bank of Leeston Creek will remain unchanged between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass due to the existing trees along this bank. Design Upgrade Option 2 would increase the top width of Leeston Creek and this would also reduce the horizontal separation between Leeston Creek and the adjacent driveway location. Note that if the banks of Leeston Creek were planted with small shrubs instead of being grassed then a higher roughness value would need to be adopted and this would result in a larger cross-section profile.

4.4 Recommended Upgrade Option

It is recommended that the reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass is upgraded with an increased hydraulic capacity. The existing culvert within this reach will also need to be upgraded.

A workshop was held with SDC on the 9 April 2019 to discuss the preferred upgrade option for the reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston

Stormwater Bypass. At this workshop Design Upgrade Option 2 was identified as the preferred upgrade option. The benefits of this option are that it allows the full 1% AEP peak flow in Leeston Creek to be conveyed around Leeston Township (via the proposed stormwater bypass) and also reduces the likelihood of flooding within existing properties immediately adjacent to this reach of Leeston Creek. The flatter batter slop along the edge of Leeston Creek also makes the waterway safer and easier to access for ongoing maintenance.

A drawing that shows the extent of upgrades to Leeston Creek and a typical cross-section profile is presented in Appendix C.

The next step is for SDC to undertake consultation with adjacent land owners regarding this proposed upgrade option.



Image 4: Upgraded CDHB Drain in Flood

5 Leeston Stormwater Bypass

5.1 Design drawings

Design drawings for the proposed Leeston Stormwater Bypass (Stage 4) are presented in Appendix E.

5.2 Safe Design Risk Assessment

A preliminary safe design assessment has been undertaken for the design of the proposed Leeston Stormwater Bypass (Stage 4). This design has been handed over to SDC for the design to potentially be updated by the Oakvale Development designers. A safe design assessment for a project is an ongoing process and as such the current preliminary safe design risk register can be passed onto and updated by other designers as required. The preliminary safe design risk register is included in Appendix E.

As the design upgrades for the downstream upgrade works (Stage 3) and upgrades to the upstream reach of Leeston Creek (Stage 5) are progressed into concept and detailed design, a safe design assessment should also be undertaken for these works.

Note that a safe design workshop has not currently been undertaken for the proposed Leeston Stormwater Bypass (Stage 4) works. It is envisioned that this workshop will be completed by either SDC or the Oakdale Development designers as the design is further progressed. If the current Leeston Stormwater Bypass (Stage 4) design is adopted without change then it is recommended that a safe design workshop is held with all key stakeholders prior to the works being tendered.



Image 5: Flooding in Leeston Township – June 2013

6 Summary and Recommendations

6.1 Proposed Stage 3 Upgrades

Mitigation Option 1 has been identified as the preferred upgrade option for the Stage 3 downstream upgrade works. The benefits of this option are that it has no inundated or at risk of inundated existing floors, it reduces the total number of inundated or at risk of inundated garages and this scenario conveys a larger peak flow from the proposed Leeston Stormwater Bypass within the main Volckman Road Drain flow channel.

A drawing that shows the extent of proposed upgrades for Stage 3 and a typical cross-section profile is presented in Appendix B. Any upgrades to downstream drains need to be completed prior to the construction of the proposed Leeston Stormwater Bypass (Stage 4).

Mitigation Option 1 includes upgrading the existing High Street culverts to have twin 2 x 1m box culverts (or alternative configuration with similar capacity) and limited capacity upgrades to the existing reach of Volckman Road Drain from the downstream extent of the High Street culverts to the intersection between High Street and Volckman Road. It is noted that whilst a number of options were investigated that permanently remove the flood gate immediately downstream of the High Street culverts to allow more floodwater to be conveyed down Drain 58, this is not proposed in Mitigation Option 1.

The next step is for SDC to undertake consultation with adjacent land owners regarding this proposed upgrade option.

6.2 Leeston Stormwater Bypass (Stage 4)

Design drawings for the proposed Leeston Stormwater Bypass are presented in Appendix E. Any upgrades to downstream drains (Stage 3) need to be completed prior to the construction of the proposed Leeston Stormwater Bypass (Stage 4).

An investigation into the resource consents that are required to construct the remaining stages of the Leeston Stormwater Bypass is required. This includes the proposed Stage 3, 4 and 5 works.

6.3 Proposed Stage 5 Upgrades

The reach of Leeston Creek between Harmans Road and the confluence with the proposed Leeston Stormwater Bypass has insufficient capacity to convey the 1% AEP event peak flow that the Leeston Stormwater Bypass has been designed for. It is therefore recommended that this upstream reach of Leeston Creek is upgraded with an increased hydraulic capacity. The existing culvert within this reach will also need to be upgraded.

Design Upgrade Option 2 (refer Section 4.3 for details) was identified as the preferred upgrade option. The benefits of this option are that it allows the full 1% AEP peak flow in Leeston Creek to be conveyed around Leeston Township (via the proposed stormwater bypass) and also reduces the likelihood of flooding within existing properties immediately adjacent to this reach of Leeston Creek. The flatter batter slop along the edge of Leeston Creek also makes the waterway safer and easier to access for ongoing maintenance.

A drawing that shows the extent of upgrades to Leeston Creek and a typical cross-section profile is presented in Appendix C. Upgrades to the upstream reach of Leeston Creek (Stage 5) need to be undertaken at the same time as construction of the proposed Leeston Stormwater Bypass (Stage 4).

The next step is for SDC to undertake consultation with adjacent land owners regarding this proposed upgrade option.



7 References

Leeston Drain Modelling (MWH, August 2004).

Leeston Stormwater and Land Drainage Background Report (SDC, August 2013).

Leeston North Stormwater Diversion Design Upgrades (Aurecon, December 2013).

DRAFT

Appendix A

Flood Maps



Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. Peak flood depth within the MIKE 11 model extent is not shown
3. The flood information represented on this map does not include for freeboard and as such is not recommended building level
4. Aerial photography and stormwater network asset data provided by SDC

Date: 3/10/2017

Version: 2



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A1 LDD E01 Depth.mxd 31/10/2016
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling
Figure A1: 1% AEP Event - Existing Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

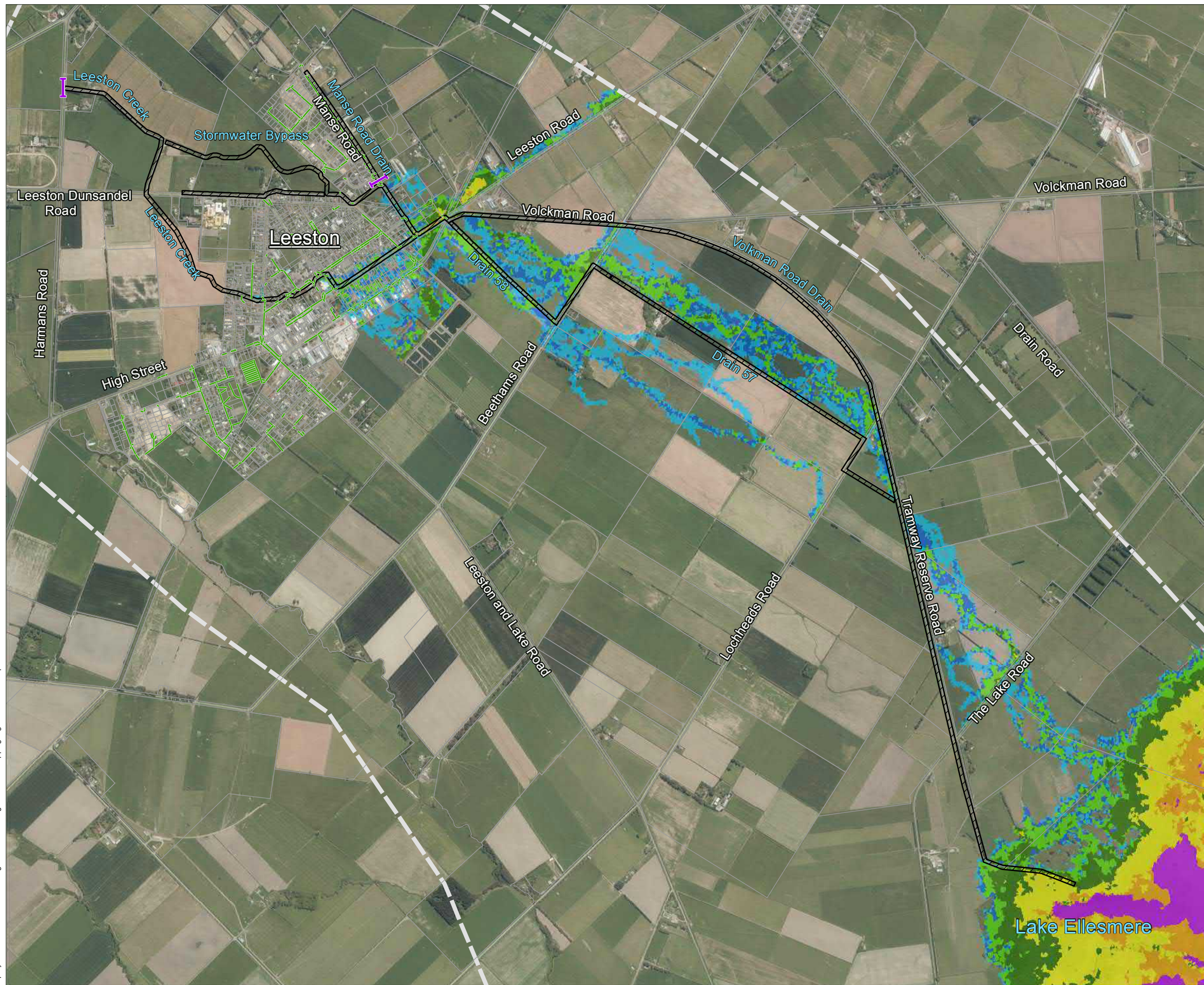
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. Peak flood depth within the MIKE 11 model extent is not shown
3. The flood information represented on this map does not include for freeboard and as such is not recommended building level
4. Aerial photography and stormwater network asset data provided by SDC
5. This model scenario represents the existing scenario with the consented Leeston Stormwater Bypass and Manse Road Drain upgraded profile included

Date: 3/10/2017

Version: 2



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A2 LDD D01 Depth.mxd 31/10/2016

Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling
Figure A2: 1% AEP Event - Design Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

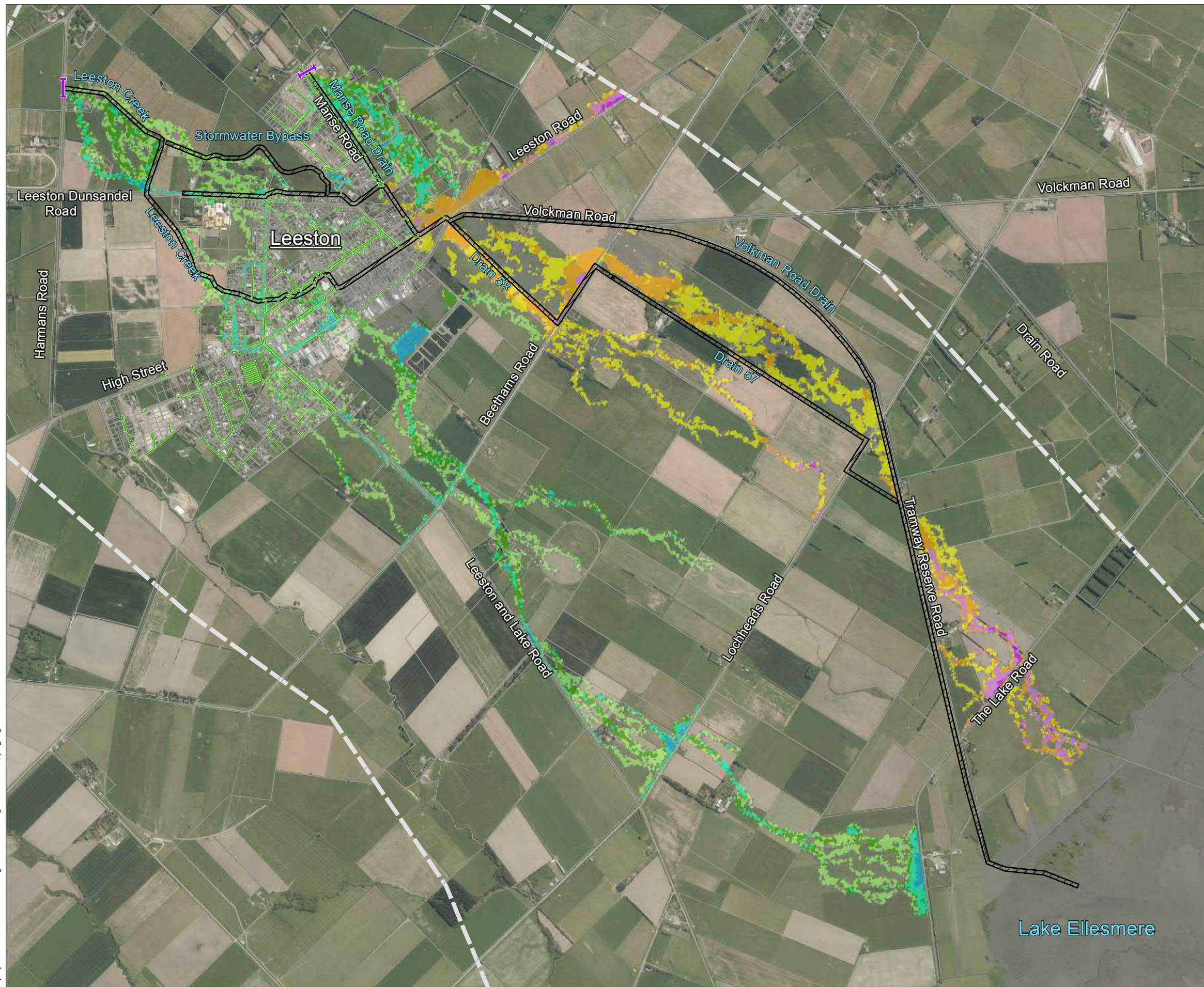
1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. This model scenario represents the existing scenario with the consented Leeston Stormwater Bypass and Manse Road Drain upgraded profile included

Date: 3/10/2017

Version: 2

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A3: 1% AEP Event - Design Scenario - Difference Map



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A3 LDD D01 Diff.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

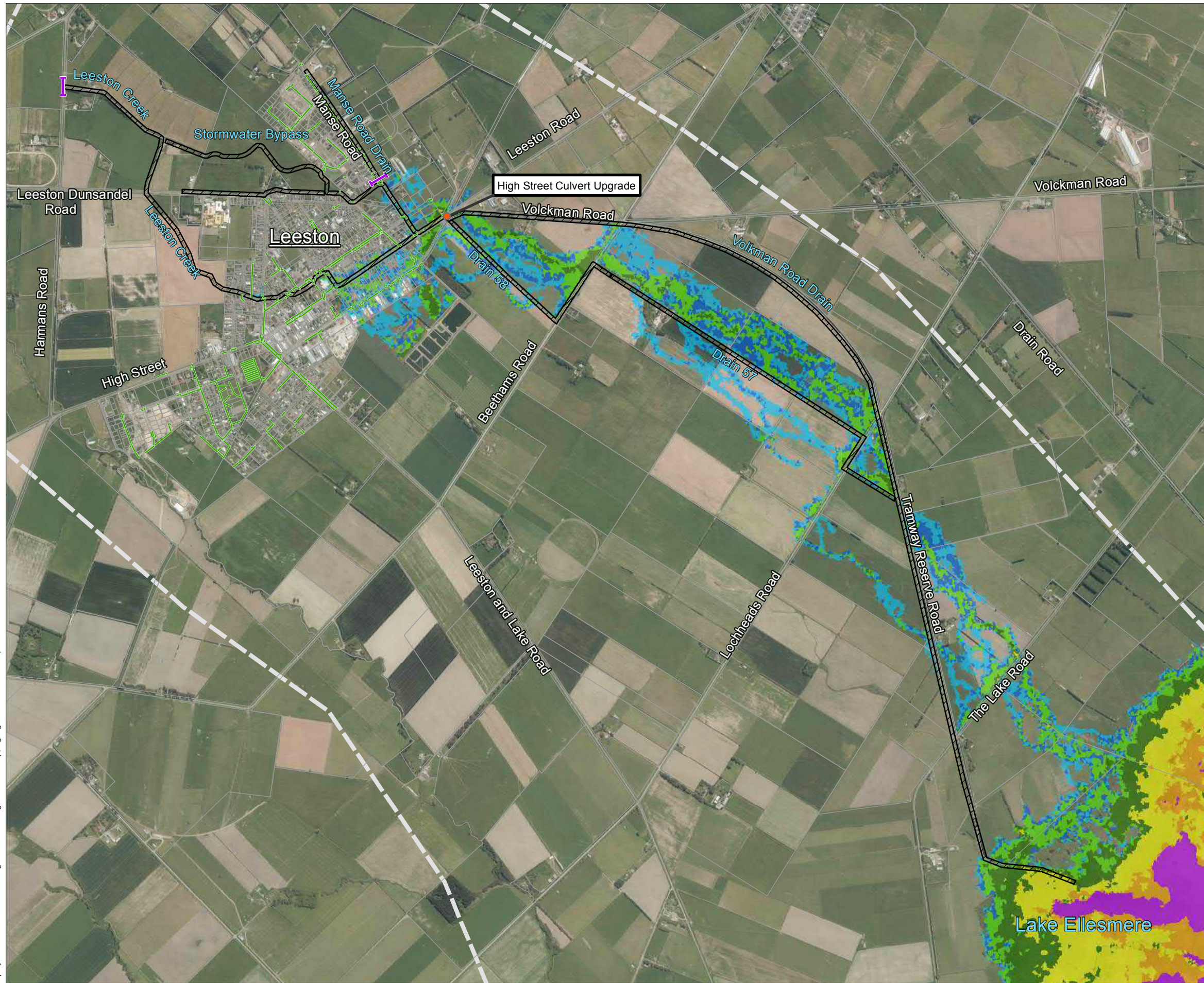
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. Peak flood depth within the MIKE 11 model extent is not shown
3. The flood information represented on this map does not include for freeboard and as such is not recommended building level
4. Aerial photography and stormwater network asset data provided by SDC
5. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 2



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A4 LDD MIT OP 1 Depth.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A4: 1% AEP Event - Mitigation Option 1 Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

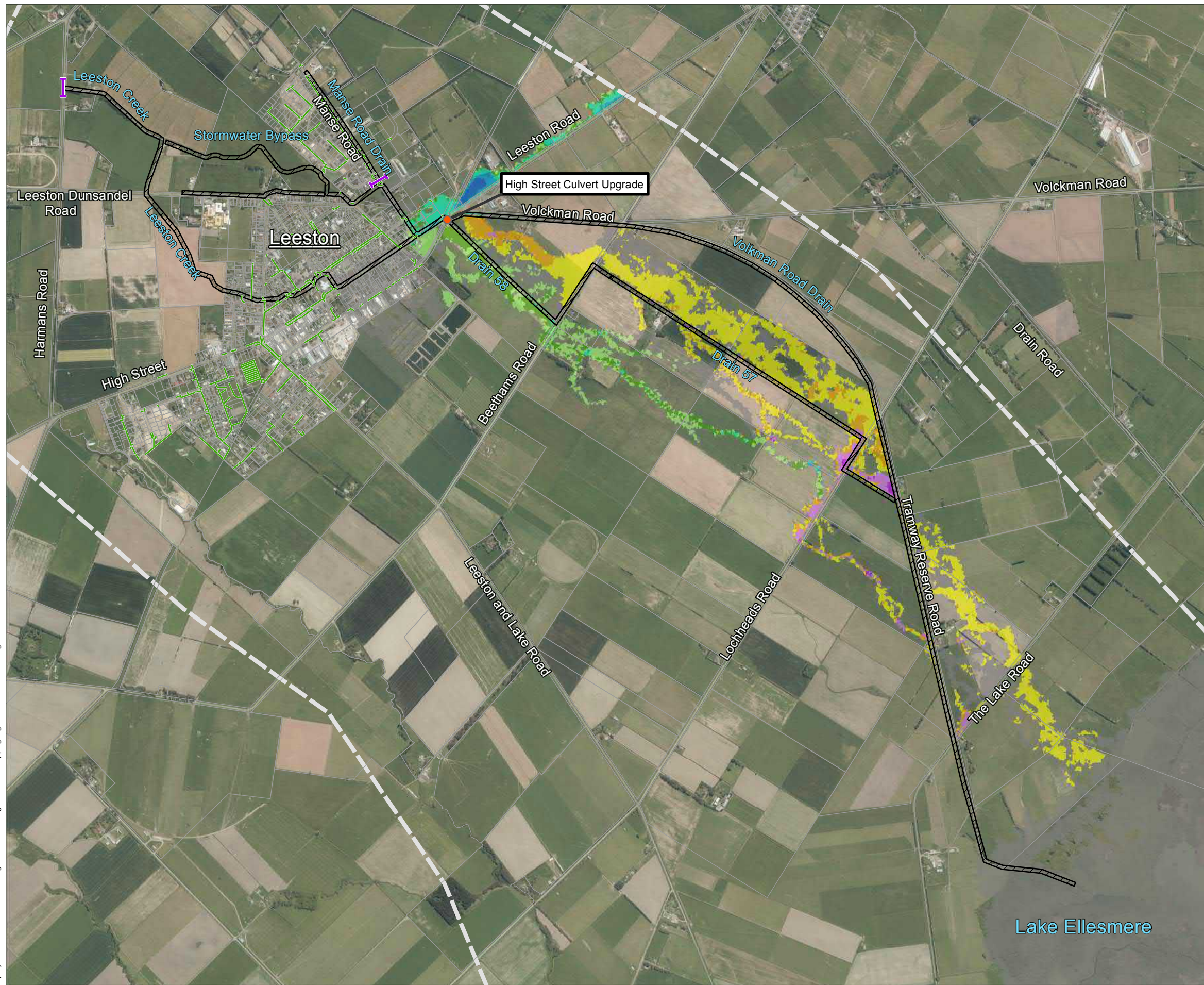
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 3



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A5 LDD MIT OP 1 Design Diff.mxd 31/10/2016
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A5: 1% AEP Event - Mitigation Option 1 Scenario - Design Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

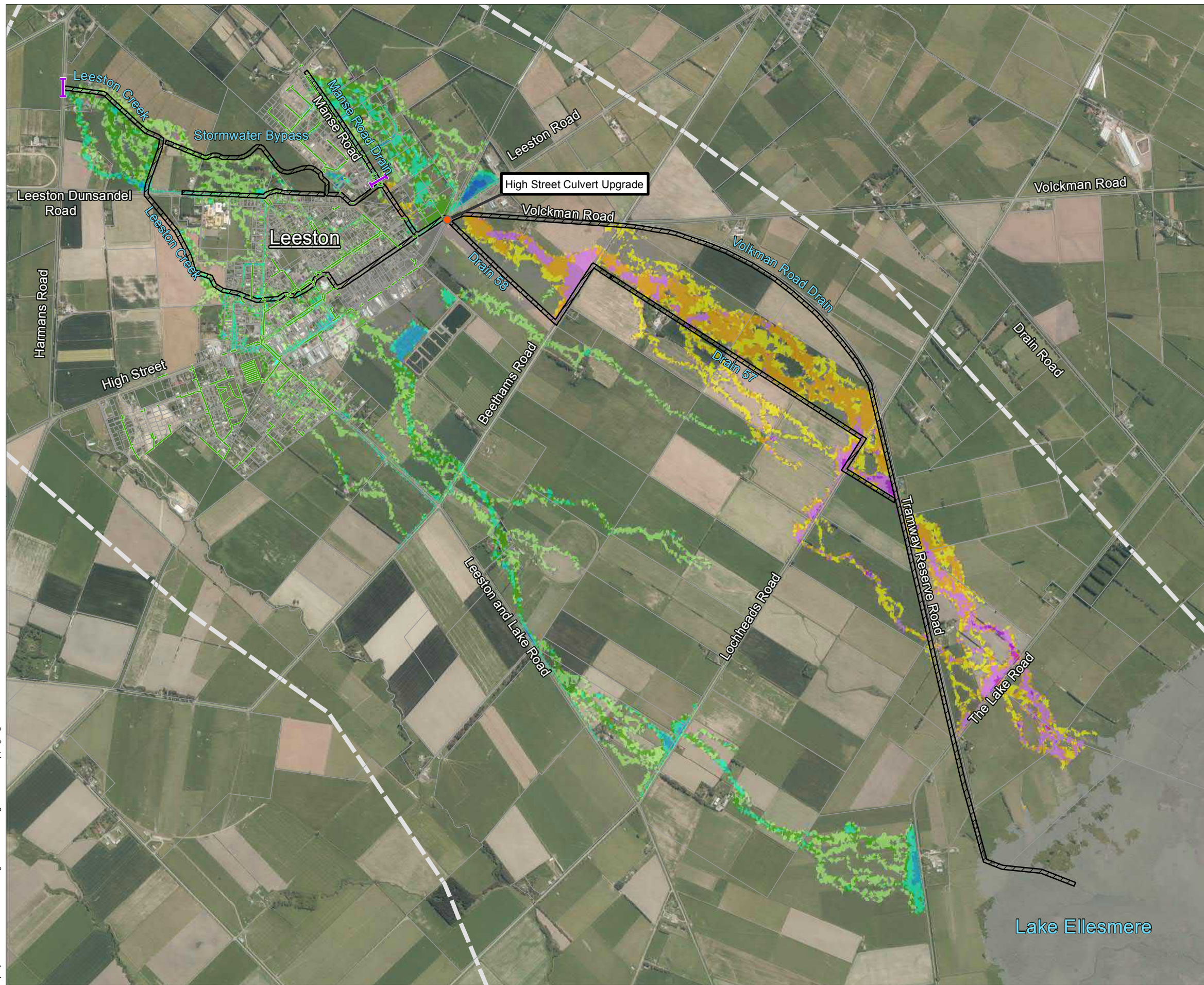
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 2



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A6 LDD MIT OP1 Exist Diff.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A6: 1% AEP Event - Mitigation Option 1 Scenario - Existing Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

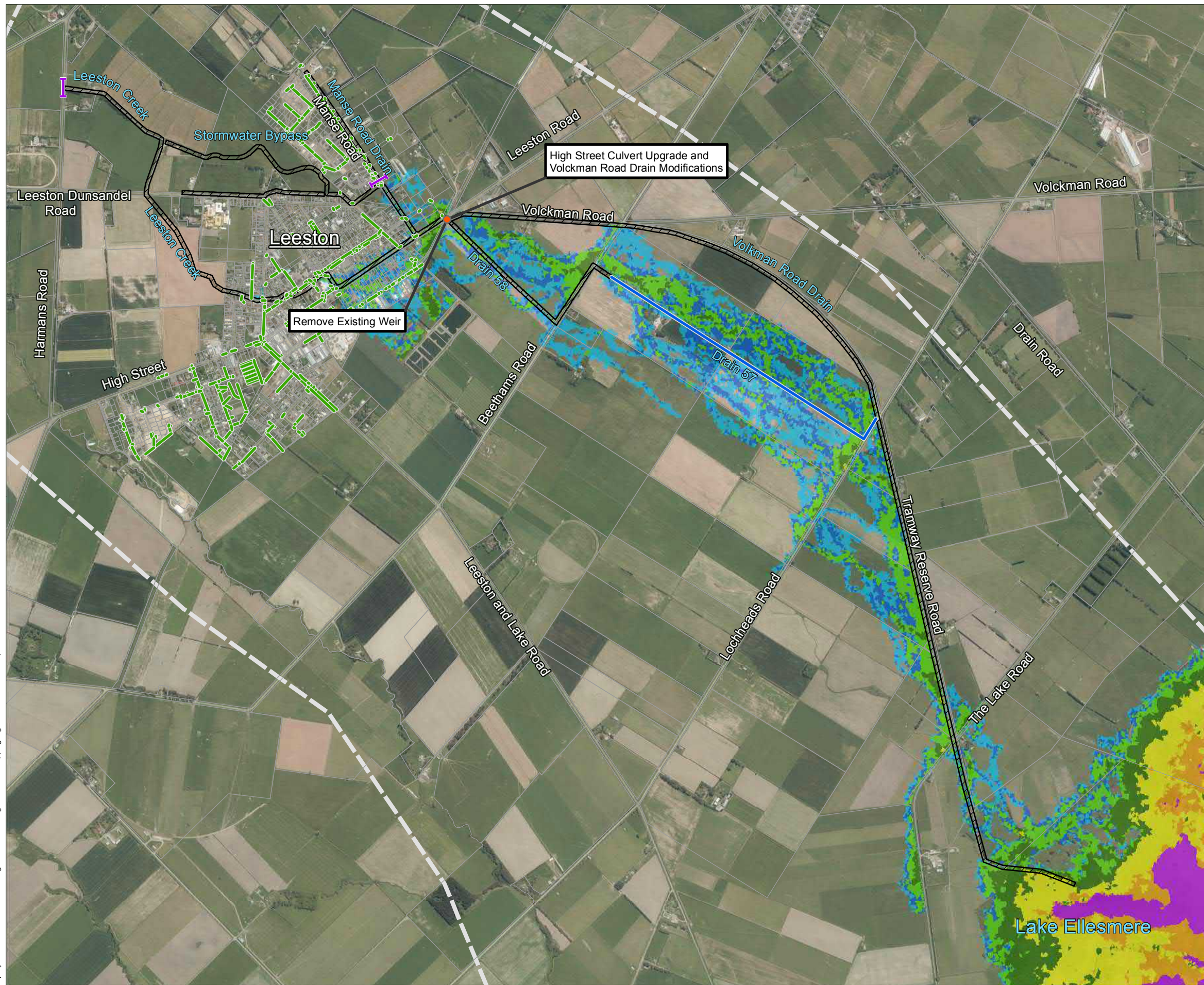
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 2



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A7 LDD MIT OP2 Depth.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A7: 1% AEP Event - Mitigation Option 2 Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

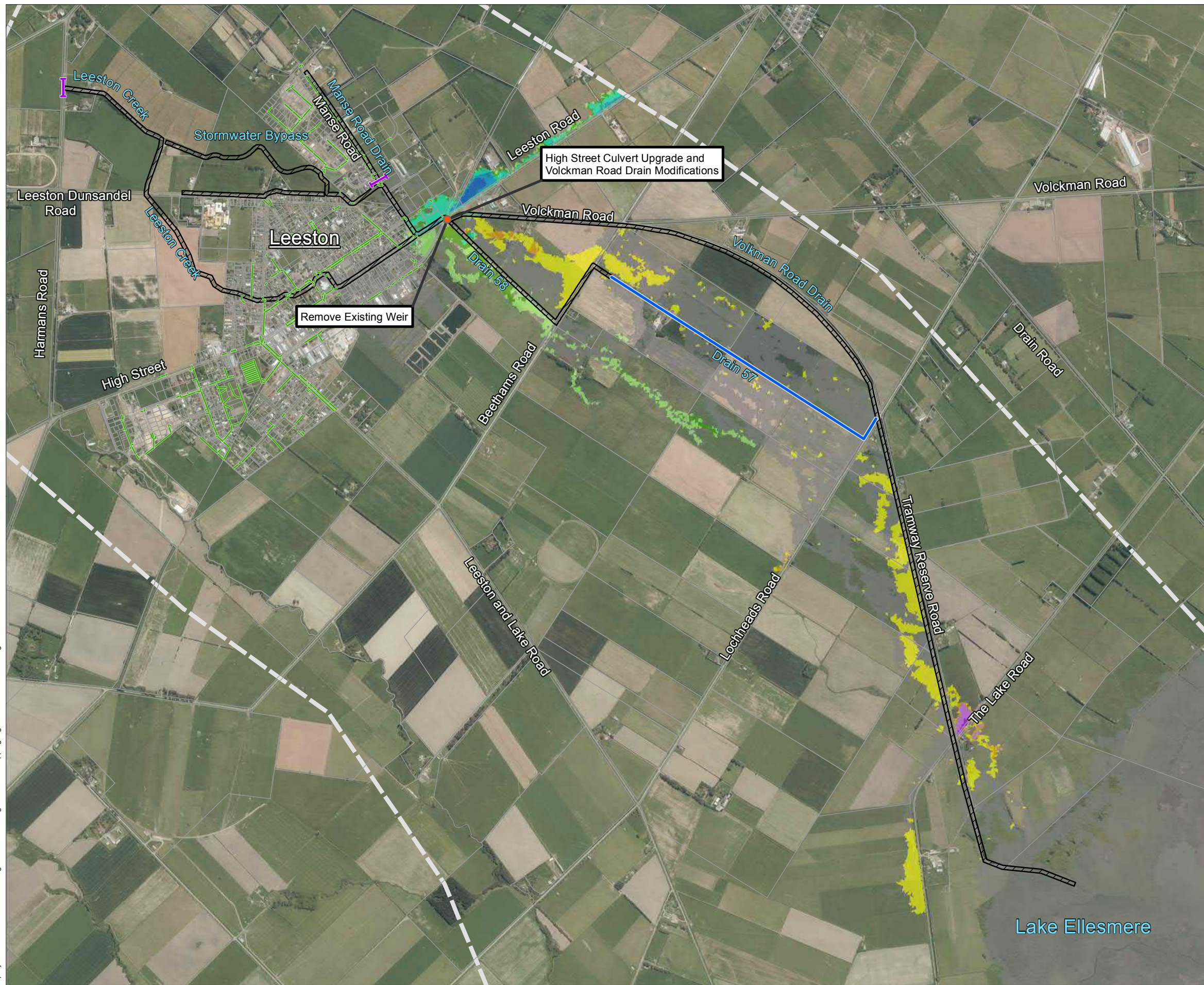
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 2



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A8 LDD MIT OP2 Design Diff.mxd 31/10/2016
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling
Figure A8: 1% AEP Event - Mitigation Option 2 Scenario - Design Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

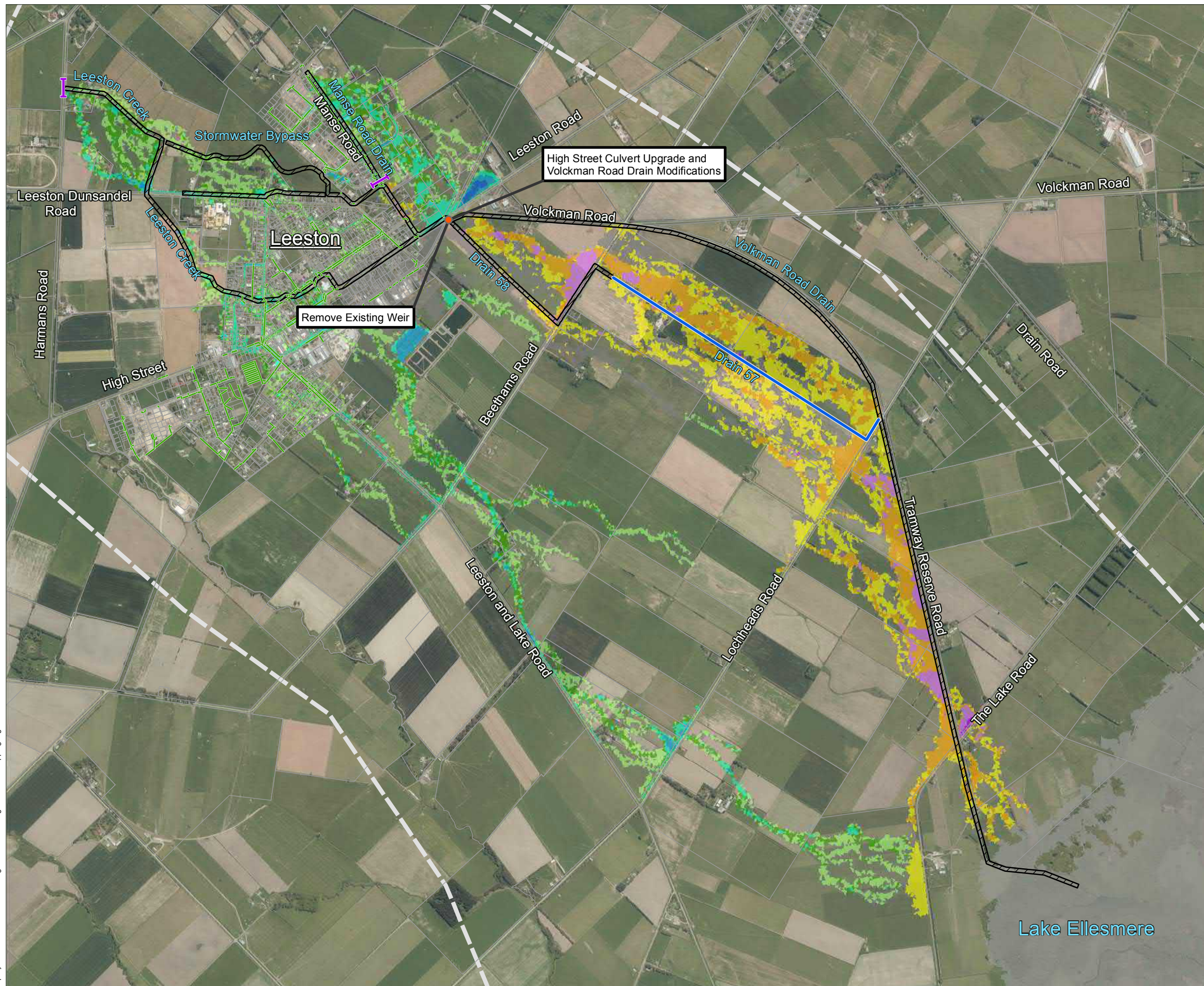
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 1



Map by: CB P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A9 LDD MIT OP2 Exist Diff.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A9: 1% AEP Event - Mitigation Option 2 Scenario - Existing Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

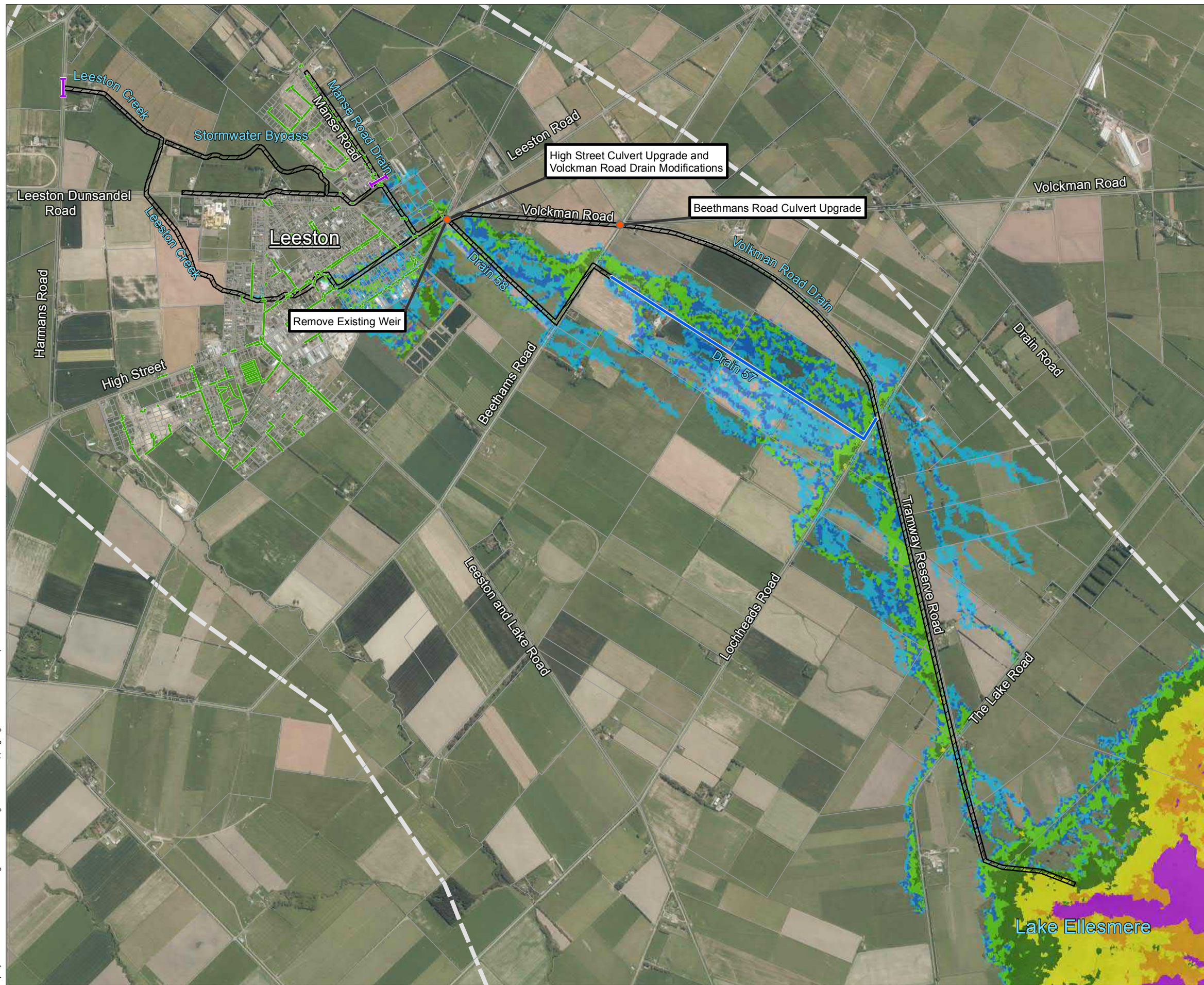
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 2



Map by: CB P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A10 LDD MIT OP3 Depth.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A10: 1% AEP Event - Mitigation Option 3 Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

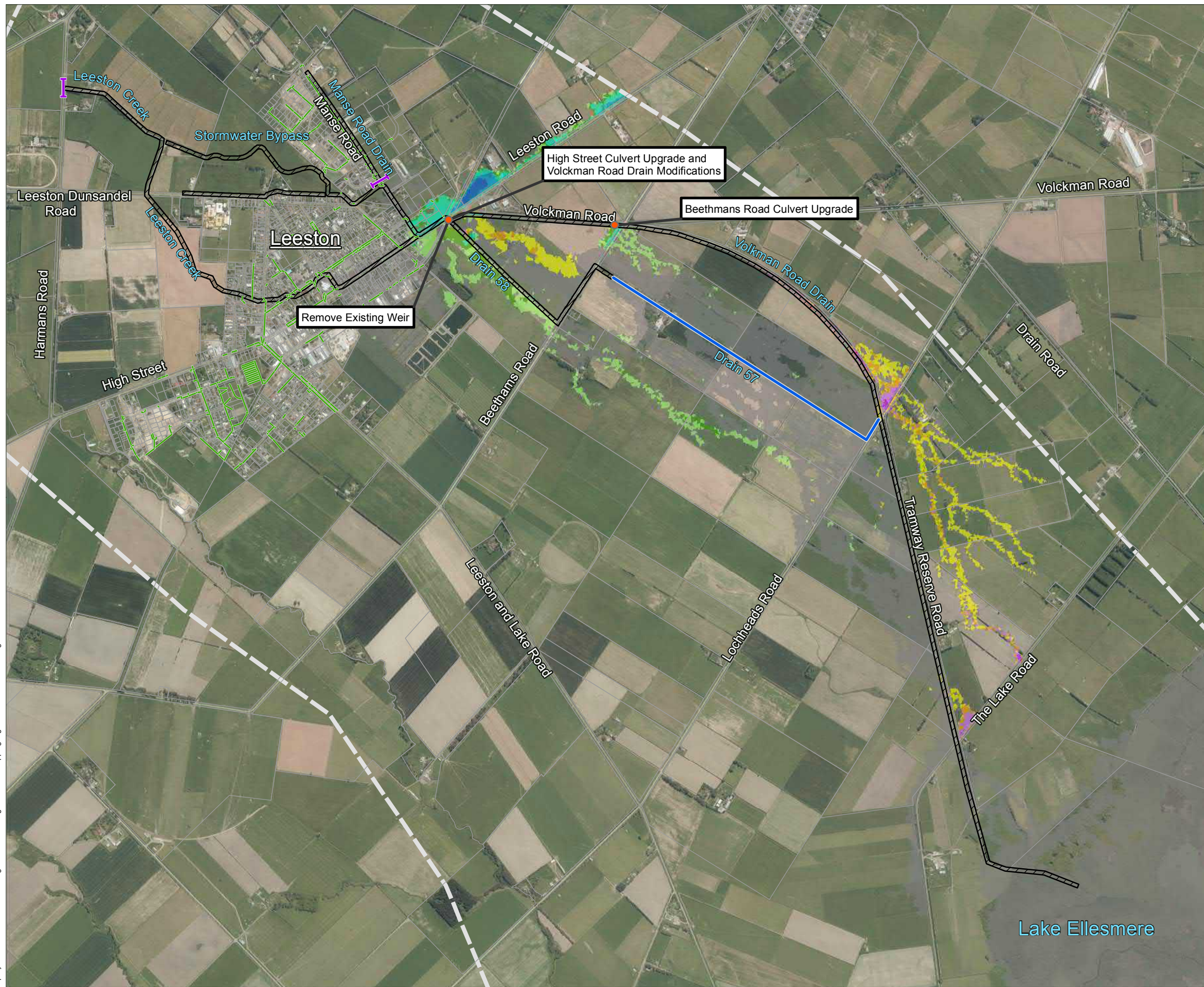
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 2



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A11 LDD MIT OPS Design Diff.mxd 31/10/2016



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A11: 1% AEP Event - Mitigation Option 3 Scenario - Design Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

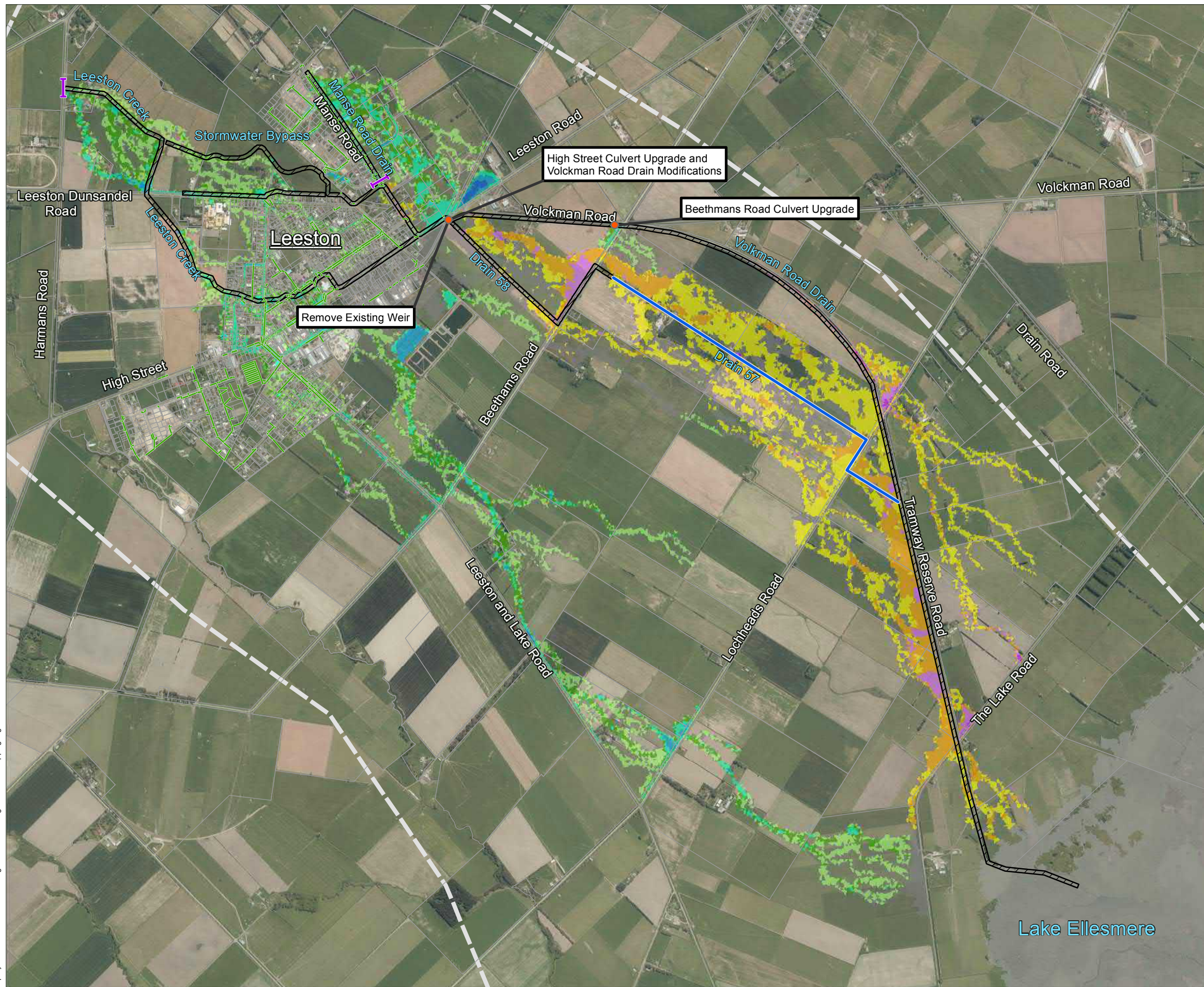
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 22/08/2017

Version: 2



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A12 LDD MIT OP3 Exist Diff.mxd 31/10/2016
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A12: 1% AEP Event - Mitigation Option 3 Scenario - Existing Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

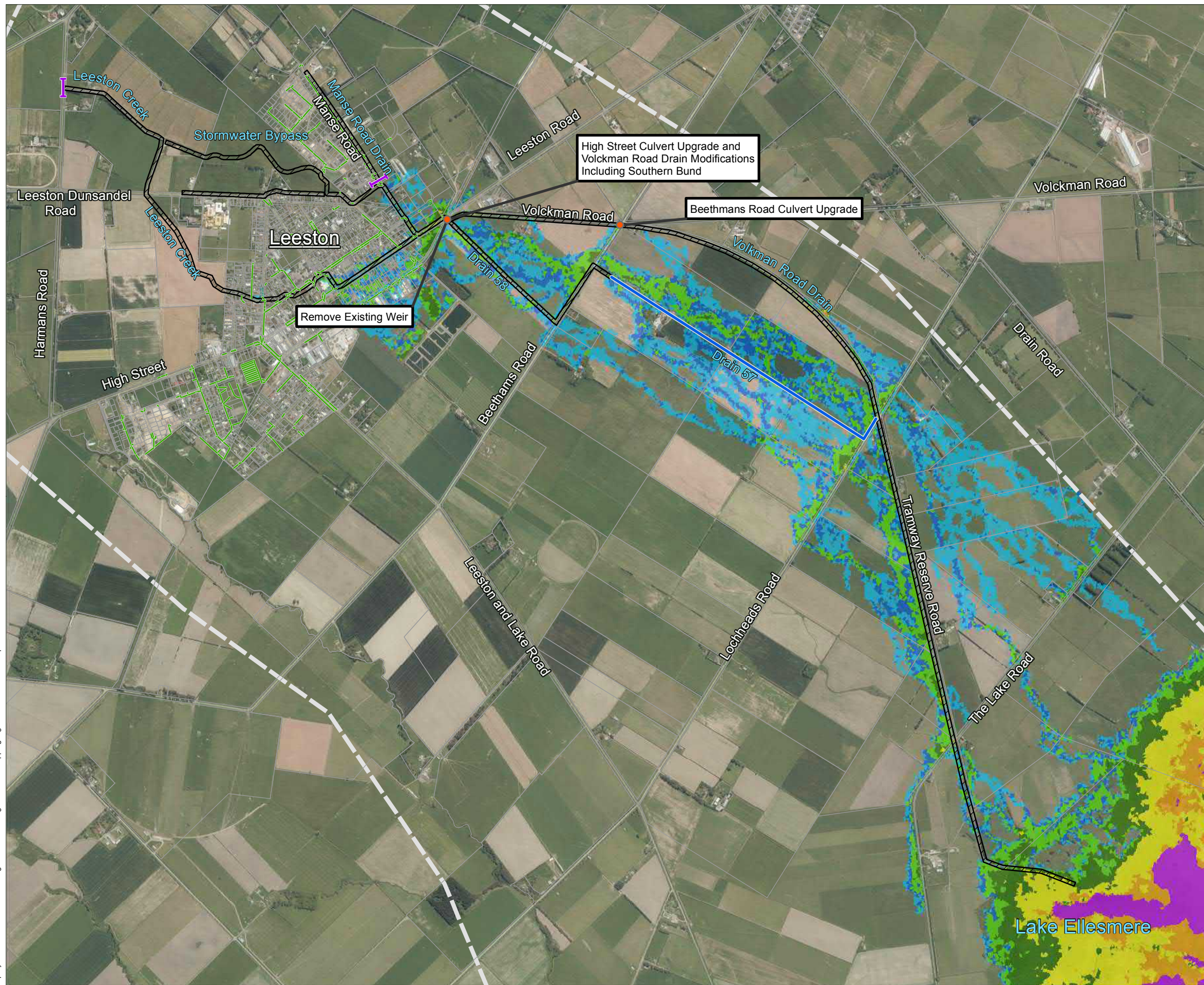
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 2



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A13 LDD MIT OP4 Depth.mxd 31/10/2016
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A13: 1% AEP Event - Mitigation Option 4 Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

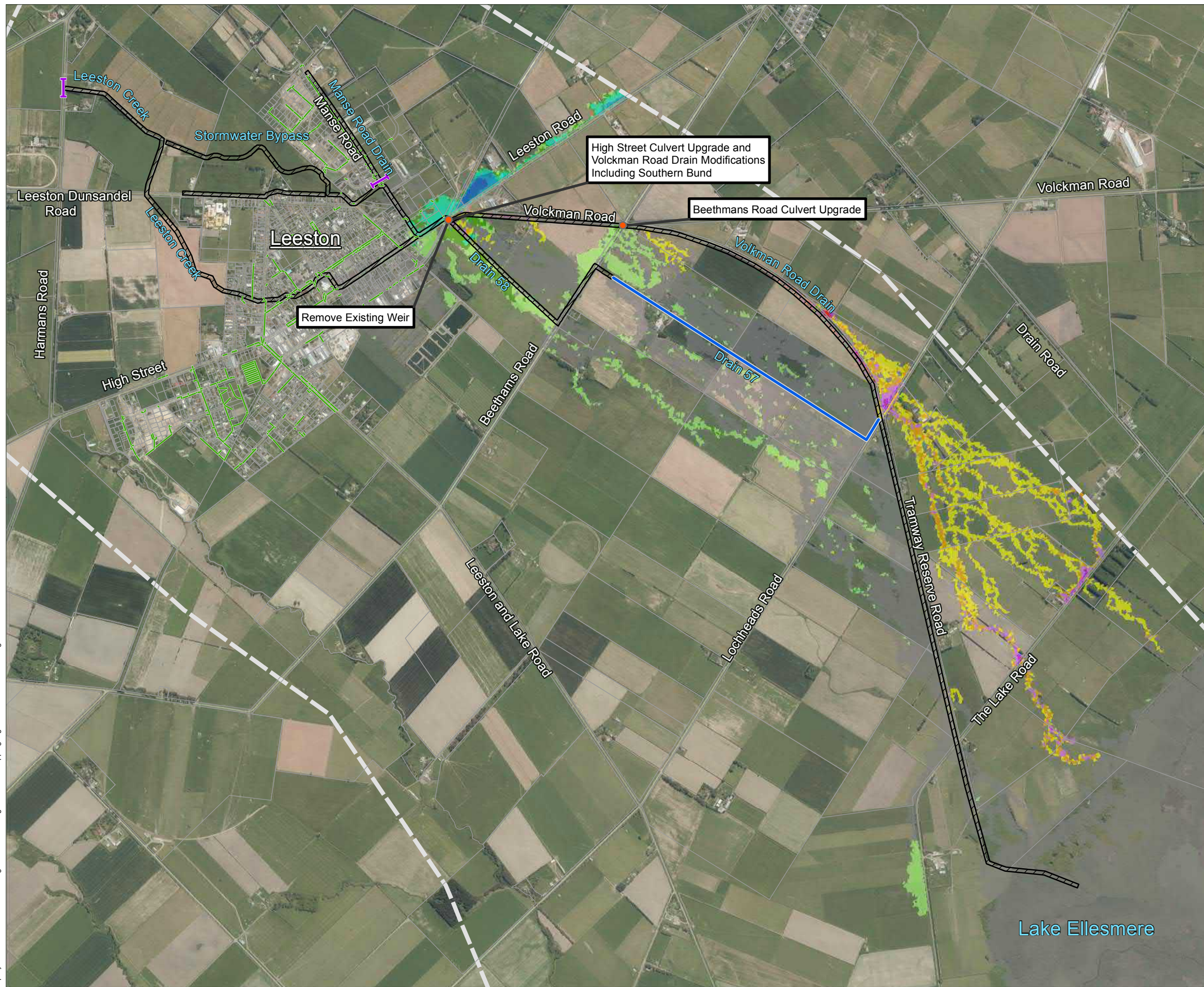
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 16/01/2017

Version: 2



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A14 LDD MIT OP4 Design Diff.mxd 31/10/2016
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A14: 1% AEP Event - Mitigation Option 4 Scenario - Design Scenario Difference Map

Job No: 227110

Projection: NZTM

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

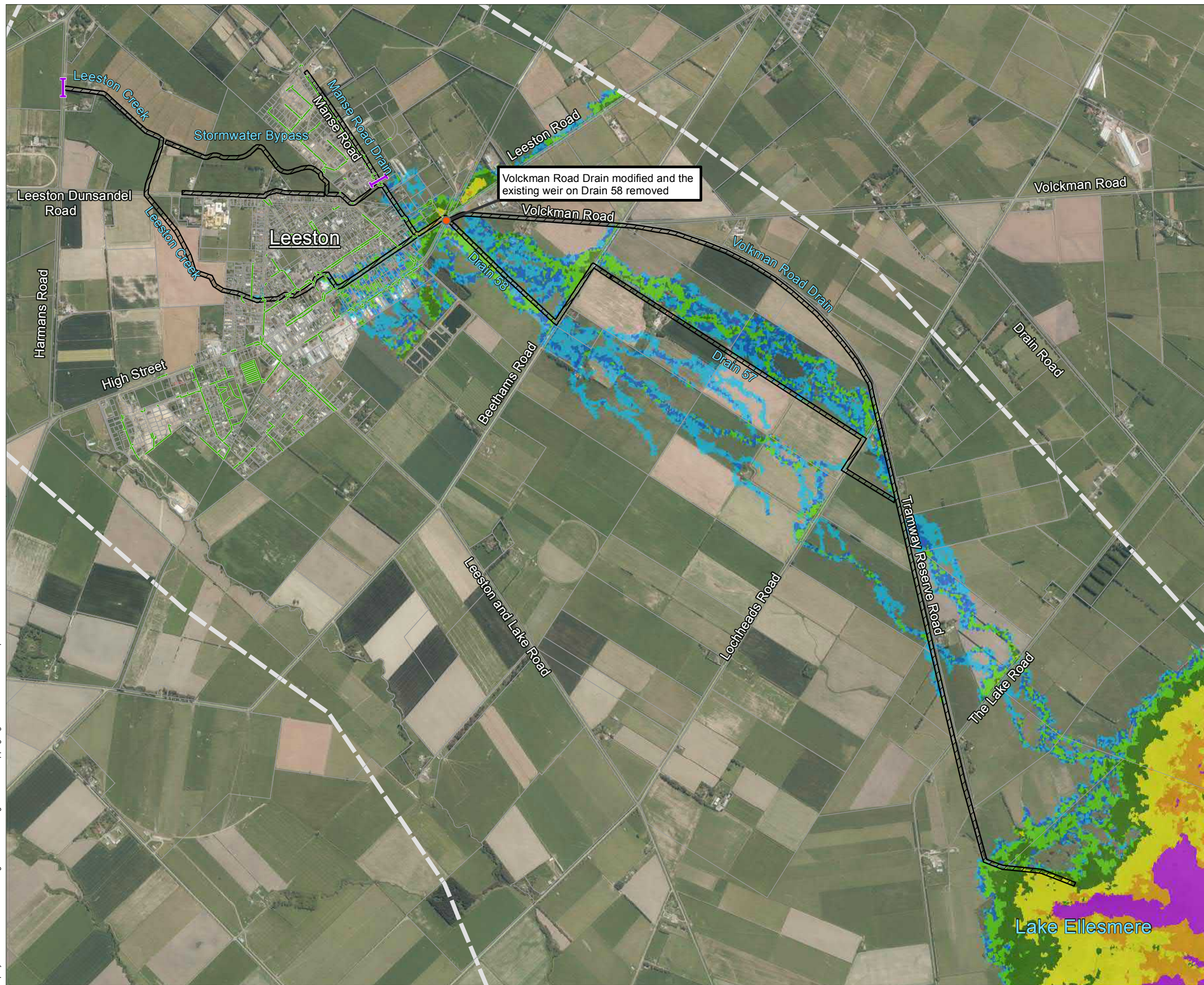
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 1



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A16 LDD MIT OP2A Depth.mxd
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A16: 1% AEP Event – Mitigation Option 2A Scenario – Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

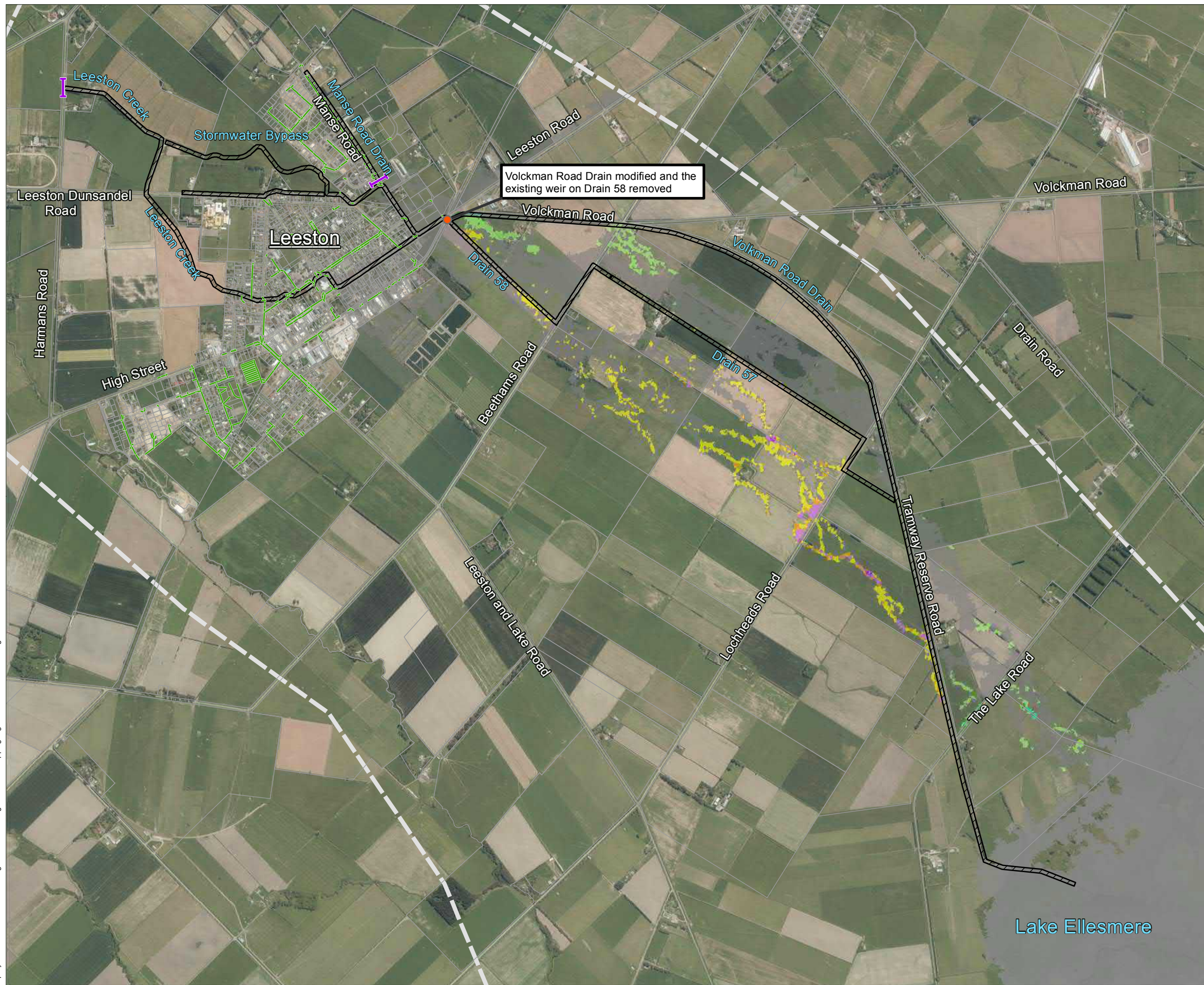
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 1



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig 17 DD MIT OP2A Design Diff.mxd
Map by: CB



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A17: 1% AEP Event - Mitigation Option 2A Scenario - Design Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Water Depth (m)

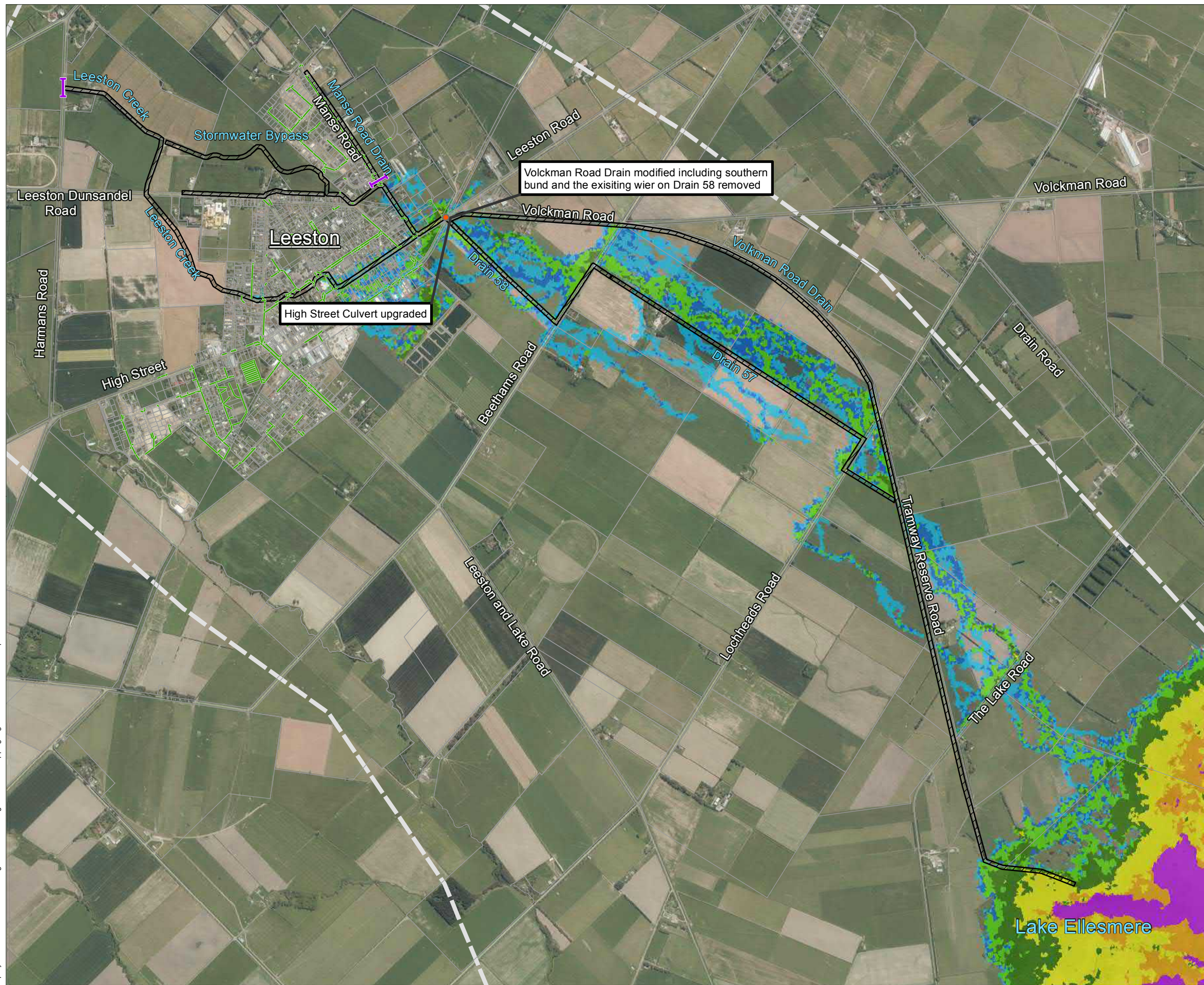
-  >1.00
-  0.75 - 1.00
-  0.50 - 0.75
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.00 - 0.05

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 1



Map by: CB P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A18 LDD MIT OP2B Depth.mxd



A3 scale: 1:20,000
0 100 200 300 400 500m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A18: 1% AEP Event - Mitigation Option 2B Scenario - Peak Flood Depth and Inundation Extent

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  MIKE 21 Model Extent

Difference (m)

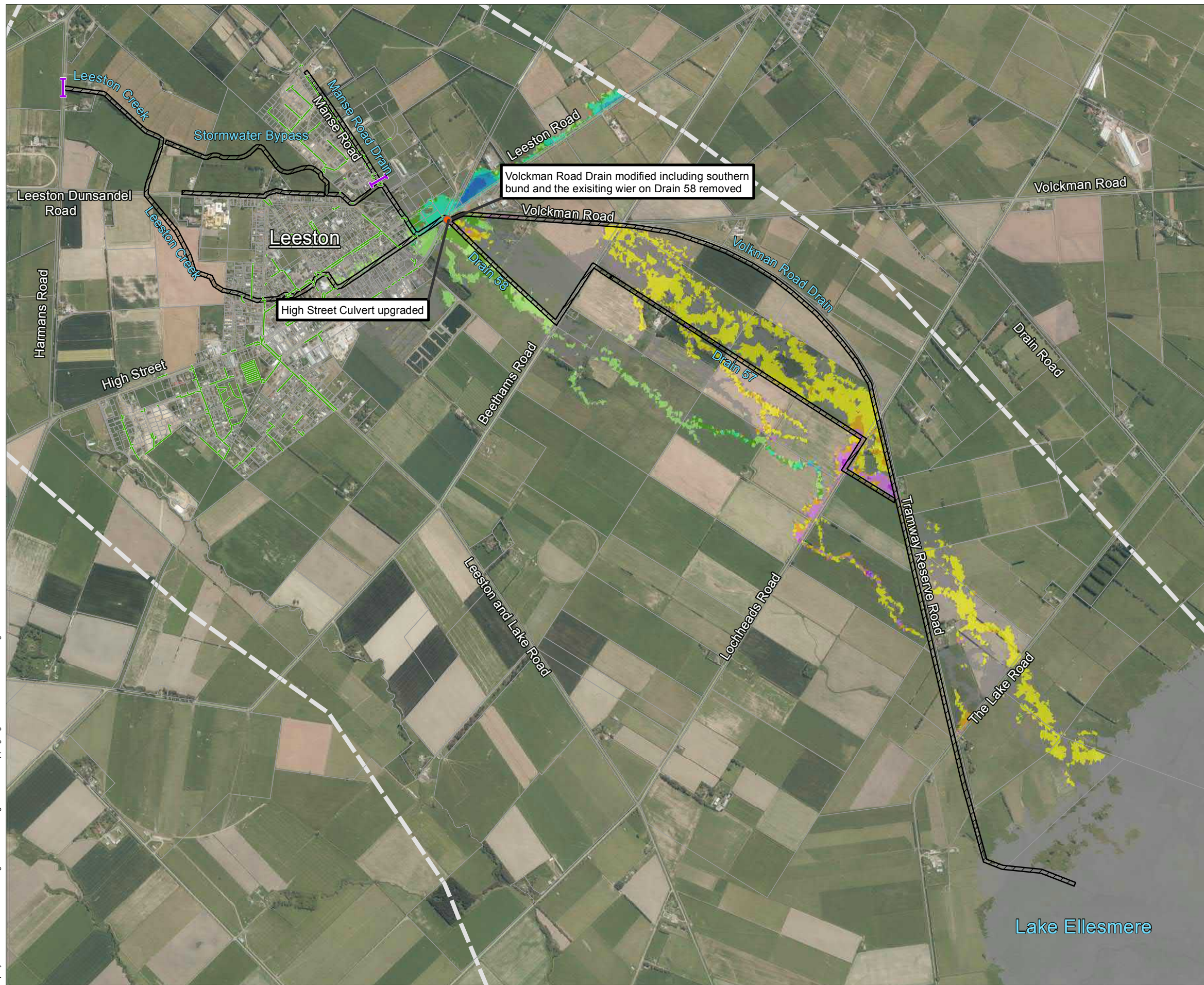
-  <0.50
-  0.25 - 0.50
-  0.10 - 0.25
-  0.05 - 0.10
-  0.02 - 0.05
-  -0.02 - 0.02
-  -0.05 - -0.02
-  -0.10 - -0.05
-  -0.25 - -0.10
-  -0.50 - -0.25
-  >-0.50

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. The flood information represented on this map does not include for freeboard and as such is not recommended building level
3. Aerial photography and stormwater network asset data provided by SDC
4. See design report for a description of the mitigation measures included in this model scenario

Date: 3/10/2017

Version: 1



Map by: CB
P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A19 LDD MIT OP2A Design Diff.mxd



A3 scale: 1:20,000
0 100 200 300 400 500 m

Job No: 227110
Projection: NZTM

Selwyn District Council Leeston Stormwater Bypass Flood Modelling

Figure A19: 1% AEP Event - Mitigation Option 2B Scenario - Design Scenario Difference Map

Legend

-  Inflow Boundary
-  Cadastral Boundaries
-  Stormwater Pipes
-  MIKE 11 Network
-  Design Scenario Innudation Extent

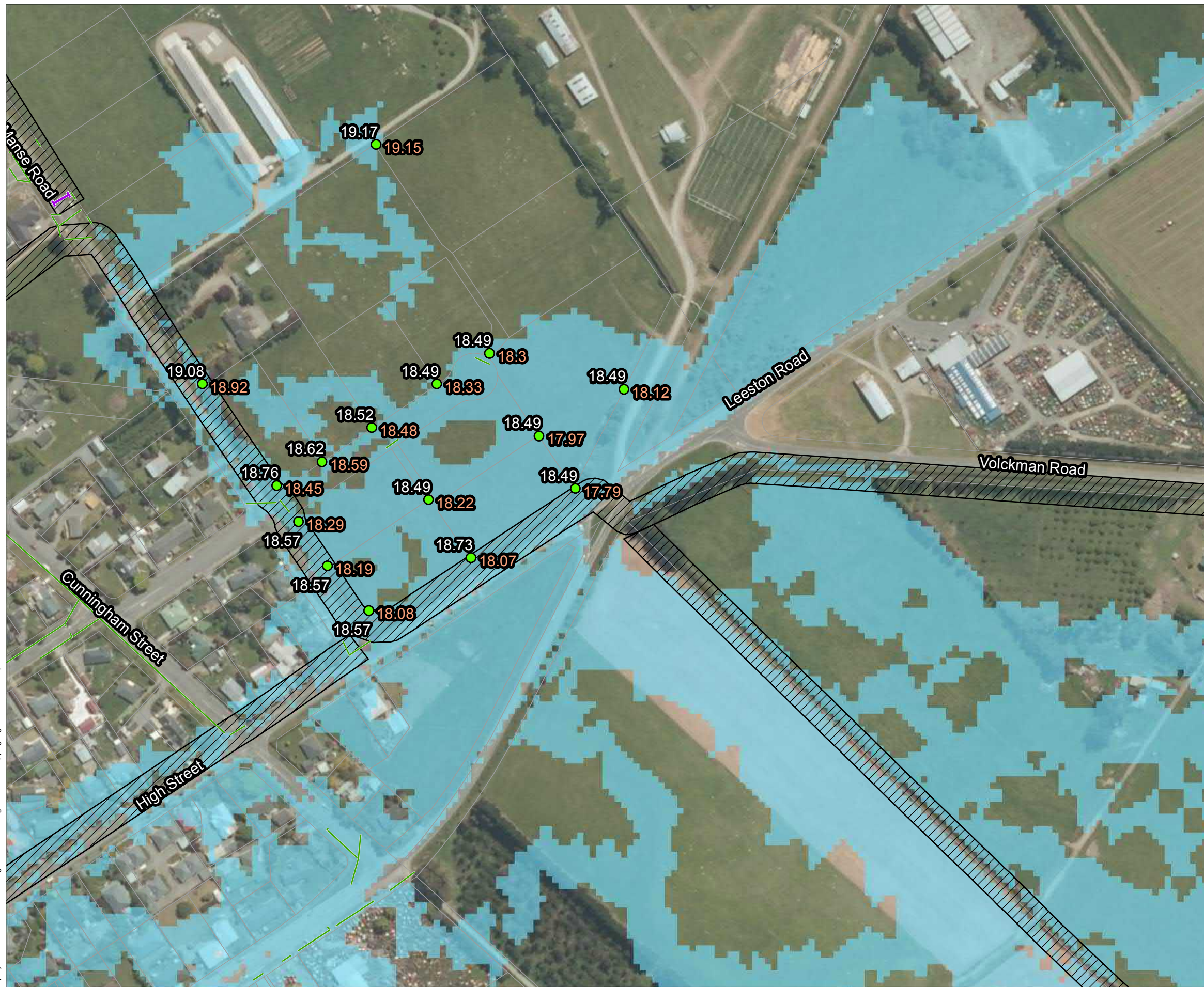
- 18.57** Design Scenario Flood Level (m)
- 18.57** Mitigation Option 1 Scenario Flood Level (m)

Notes:

1. The flood information represented on this map has been derived based on the Leeston Stormwater Bypass hydraulic model developed by Aurecon. Refer to the Leeston Stormwater Bypass Flood Modelling Report (Aurecon, December 2016) for hydraulic model assumptions and limitations
2. Peak flood depth within the MIKE 11 model extent is not shown
3. The flood information represented on this map does not include for freeboard and as such is not recommended building level
4. Aerial photography and stormwater network asset data provided by SDC
5. Flood levels presented are in terms of MSL vertical datum

Date: 3/10/2017

Version: 1



P:\227110\Stage 3 SW Modelling\GIS\Flood Mapping\Fig A20 RCL Diff Map.mxd
Map by: CB



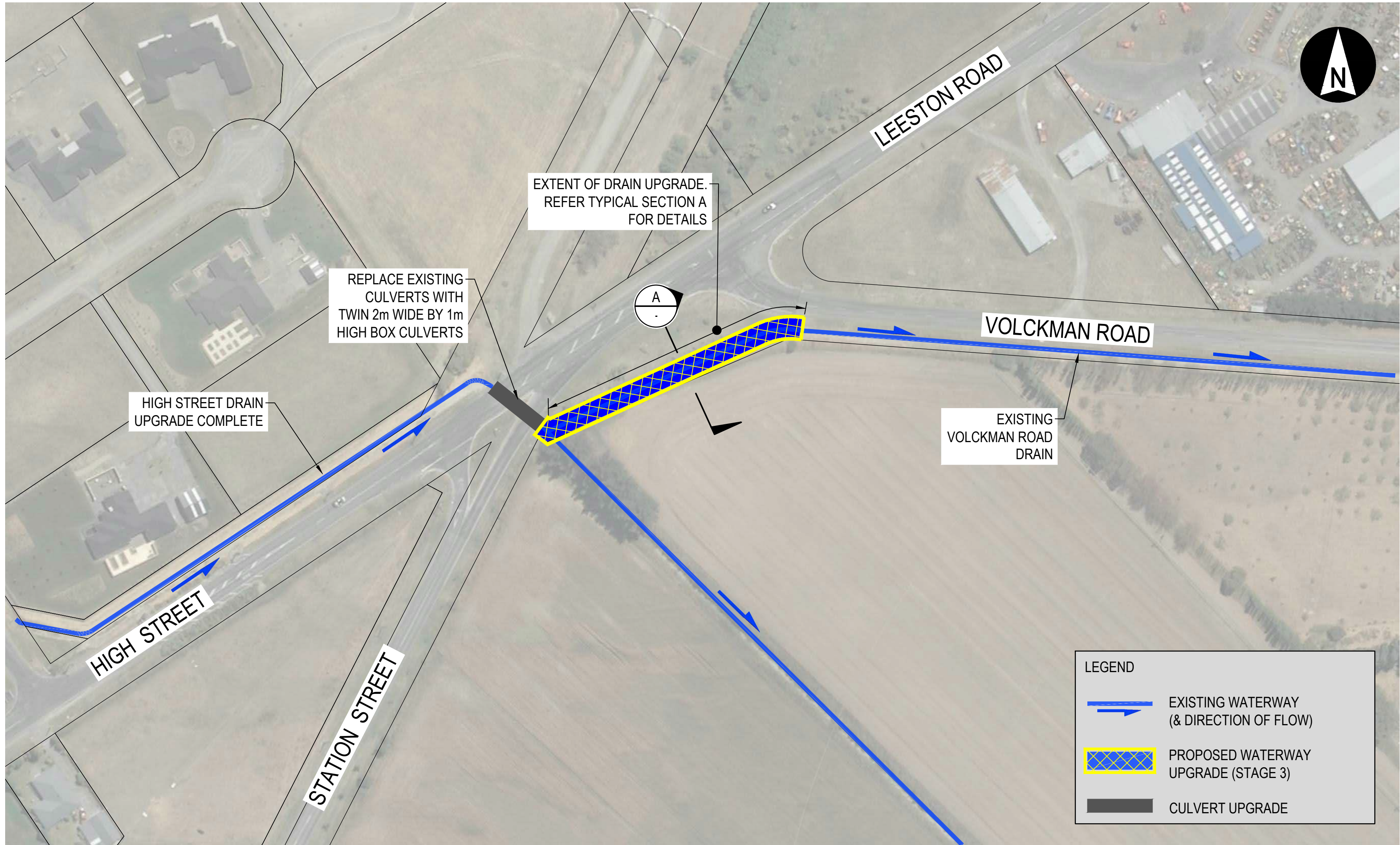
A3 scale: 1:2,500
0 10 20 30 40 50m

Job No: 227110
Projection: NZTM

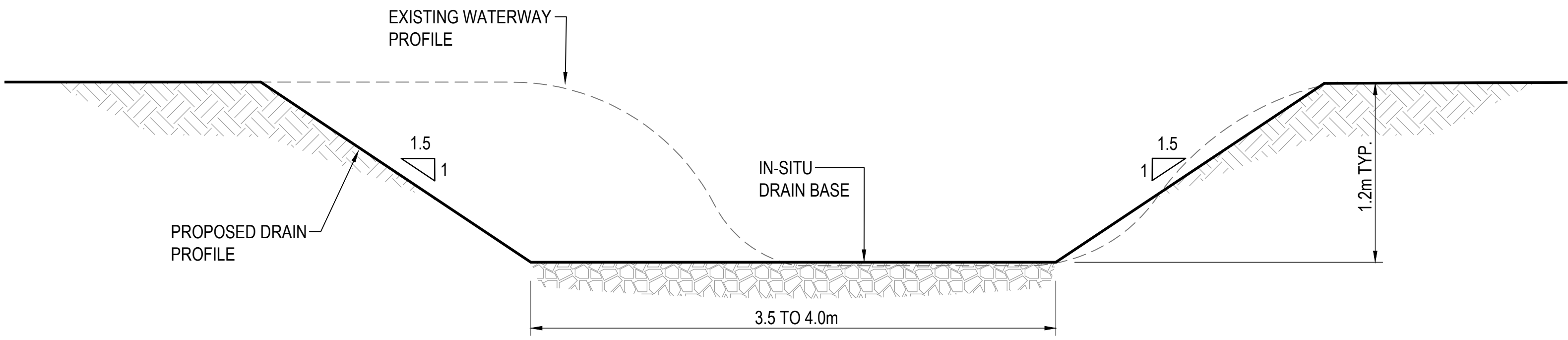
Appendix B

Proposed Stage 3 Upgrades





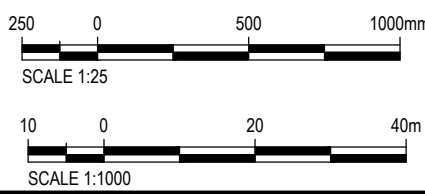
PLAN VIEW
1:1000



SECTION A
1:25

AERIAL IMAGERY FROM LINZ DATA SERVICE BY A
CREATIVE COMMONS LICENCE FLOWN 2015-2016

Plot Date: 16/05/2019 2:24:40 PM Office: NZ/C/C Planning: P 565193 - SDC LEESTON SW BYPASS STAGE 3 1:4.6 DELIVER DESIGN/3D CAD/DRAWINGS/565193.DWG CC:0000 C10.01.DWG



REV	DATE	REVISION DETAILS	APPROVED
A	17/05/19	PRELIMINARY FOR DISCUSSION	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	M.STONE
REVIEWED	D. DELAGARZA

PRELIMINARY NOT FOR CONSTRUCTION
APPROVED DATE

PROJECT	LEESTON STORMWATER BYPASS
TITLE	PROPOSED STAGE 3 UPGRADES
DRAWING No.	505193
PROJECT No.	0000
WBS	DRG
TYPE	CC
DISC	C10.01
NUMBER	A
REV	

Appendix C

Proposed Stage 5 Upgrades



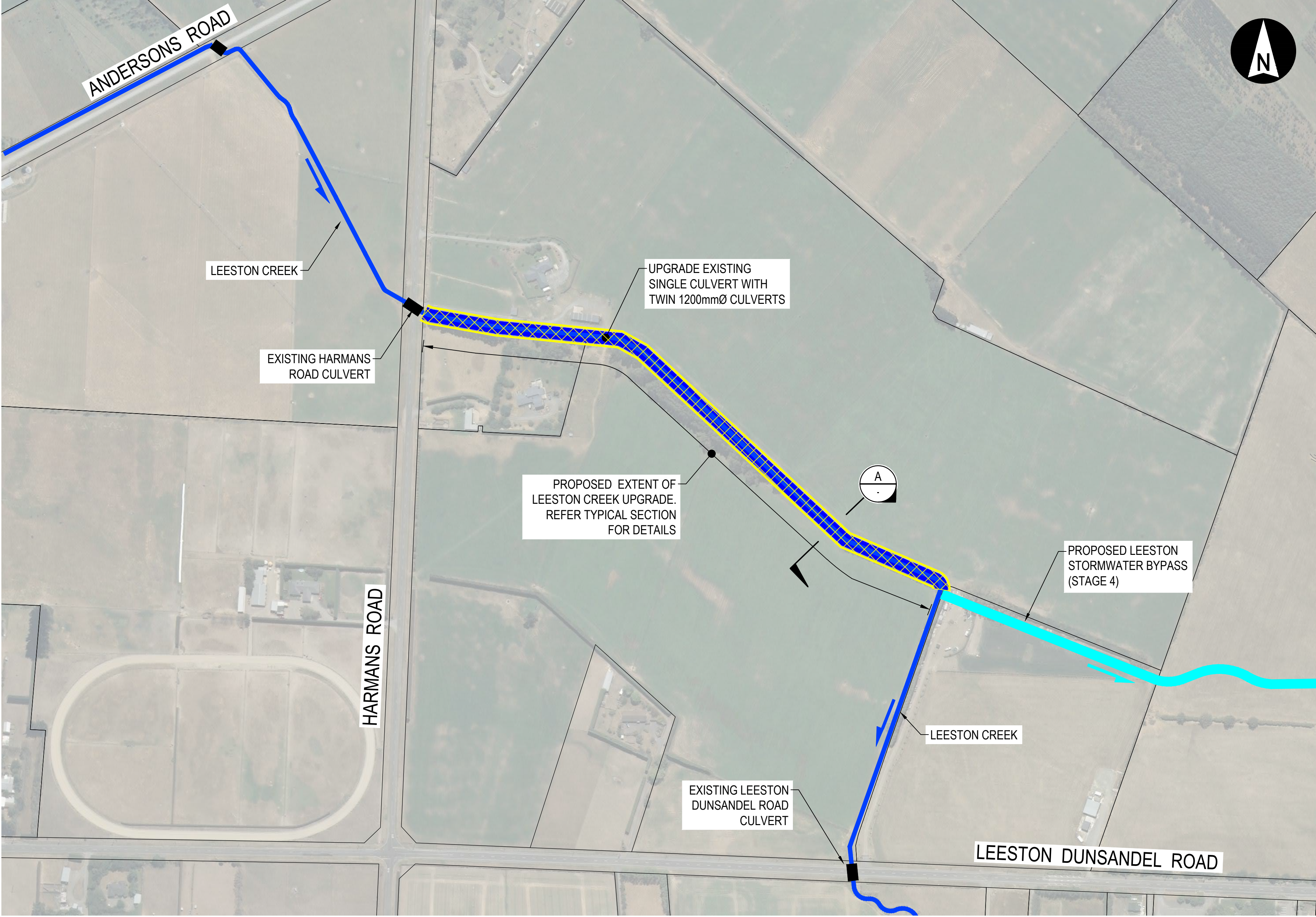
LEGEND

EXISTING WATERWAY
(& DIRECTION OF FLOW)

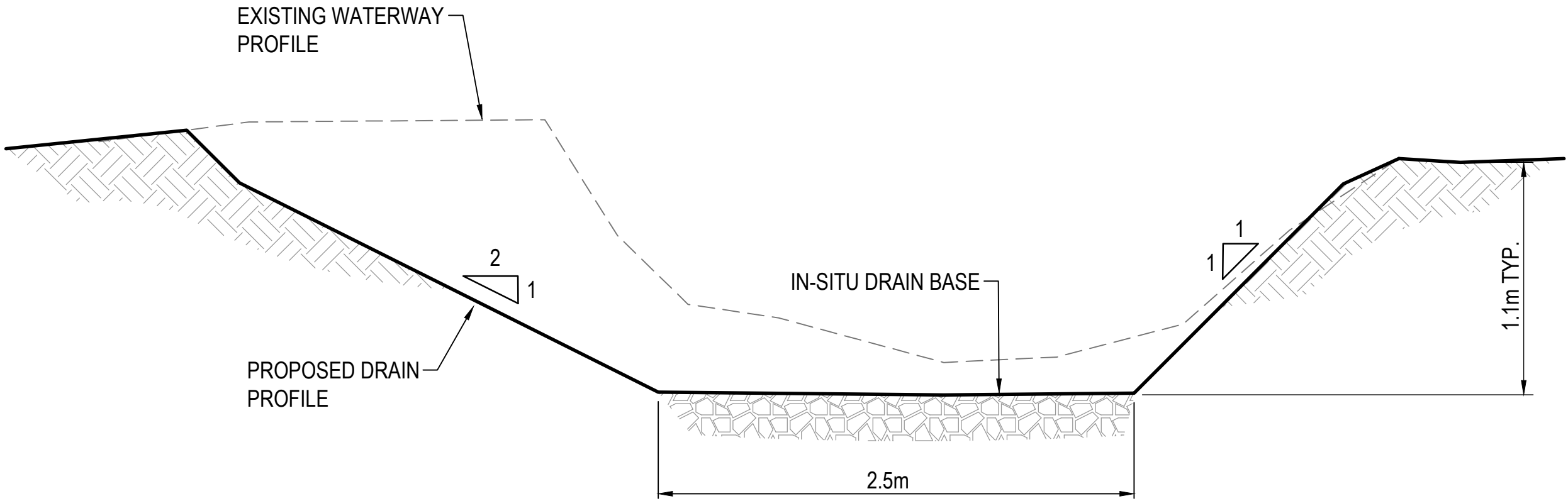
PROPOSED WATERWAY
UPGRADE (STAGE 5)

PROPOSED LEESTON
STORMWATER BYPASS (STAGE 4)

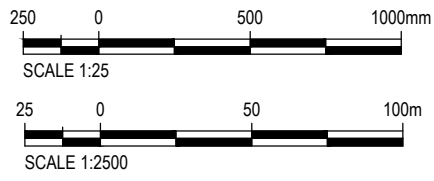
CULVERT



PLAN VIEW
1:1000



SECTION A
1:25



AERIAL IMAGERY FROM LINZ DATA SERVICE BY A
CREATIVE COMMONS LICENCE FLOWN 2015-2016

REV	DATE	REVISION DETAILS	APPROVED
A	17/05/19	PRELIMINARY FOR DISCUSSION	A. LINDGREN

SCALE	SIZE
AS SHOWN	A1
DRAWN	R DAWSON
DESIGNED	M.STONE
REVIEWED	D. DELAGARZA

PRELIMINARY NOT FOR CONSTRUCTION
APPROVED
DATE

PROJECT	LEESTON STORMWATER BYPASS
TITLE	PROPOSED STAGE 5 UPGRADES
DRAWING No.	505193
PROJECT No.	505193
WBS	0000
TYPE	DRG
DISC	CC
NUMBER	C10.02
REV	A

Appendix D

Flood Impact Assessment





Appendix D

Flood Impact Assessment

As part of the proposed Leeston Stormwater Bypass design, a number of mitigation scenarios have been investigated in the hydraulic model developed for this project. In order to select the preferred upgrade option for Stage 3, floor level survey was undertaken in February 2019 for selected dwellings at critical locations identified from the flood modelling. This floor level survey was required to undertake a flood impact assessment of existing dwellings in the catchment.

The surveyed floor levels were compared against peak flood levels from each of the model scenarios previously completed for this project. These scenarios included the existing, design and mitigation option 1, 2, 2A, 2B, 3 and 4 scenarios.

The full floor level flood impact assessment is included in this appendix. This includes a list of the building (house, garage, shed etc) floor levels, corresponding peak flood levels and freeboard for each model scenario.

In areas where the floor is predicted to be inundated the cell is highlighted in 'red'. When the floor is not inundated, but the peak flood level is predicted to be less than 100mm below the floor level, the cell is highlighted in 'yellow'. These floors highlighted in 'yellow' are considered at risk of flood inundation.

[illegible]

[illegible]

Appendix E

Leeston Stormwater Bypass Design Drawings



LEESTON NORTH STORMWATER BYPASS

DRAWING INDEX

DRG NO	REV	TITLE
C01.01	A	OVERALL LAYOUT SHEET INDEX
C02.01	A	LAYOUT PLAN SHEET 1 OF 3
C02.02	A	LAYOUT PLAN SHEET 2 OF 3
C02.03	A	LAYOUT PLAN SHEET 3 OF 3
C04.01	A	FLOOD DIVERSION CHANNEL LONG SECTION SHEET 1 OF 2
C04.02	A	FLOOD DIVERSION CHANNEL LONG SECTION SHEET 2 OF 2
C04.04	A	FLOOD DIVERSION CHANNEL CROSS SECTIONS SHEET 1 OF 3
C04.05	A	FLOOD DIVERSION CHANNEL CROSS SECTIONS SHEET 2 OF 3
C04.06	A	FLOOD DIVERSION CHANNEL CROSS SECTIONS SHEET 3 OF 3
C05.01	A	TYPICAL SECTIONS
C06.05	A	DETAILS SHEET 1 OF 2
C06.06	A	DETAILS SHEET 2 OF 2



LOCALITY DIAGRAM
1:5000

aurecon

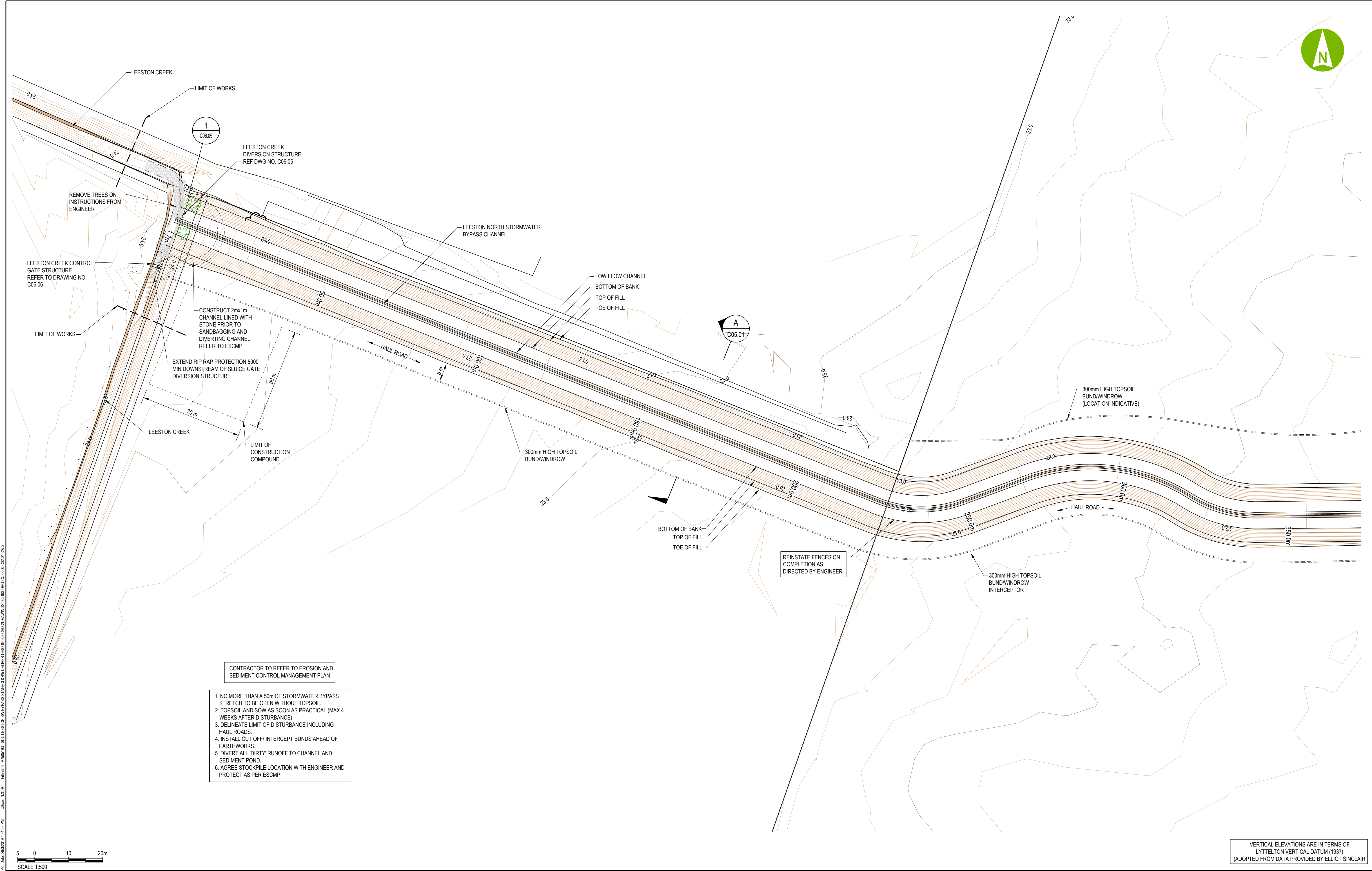
www.aurecongroup.com



A person using the Aurecon drawings and other data accepts the risk of using the drawings and other data:
1. In electronic form without requesting and checking them for accuracy against the original hard copy versions;
2. For any purposes not agreed to in writing by Aurecon.
Wherever a discrepancy in the contract documents is found and unless directed otherwise by the Principal/Engineer, the contractor shall adopt, at their own cost the greater quantum, class of finish, grade, or specification where applicable.

FOR APPROVAL
NOT FOR CONSTRUCTION

SIZE	PROJECT No.	DATE	DRAWING No.	REV
A1	505193	27/03/19	C00.00	A



Proj Date: 29/03/2019 4:21:28 PM
Office: NZPC
Filename: P-505193 - SDC LEESTONS NW BYPASS STAGE 1 & 4-6 DELIVER DESIGN/DRG CADD/DRAWINGS/505193.DWG CC-0000-0201.A1.DWG

5 0 10 20m
SCALE 1:500

- CONTRACTOR TO REFER TO EROSION AND SEDIMENT CONTROL MANAGEMENT PLAN
1. NO MORE THAN A 50m OF STORMWATER BYPASS STRETCH TO BE OPEN WITHOUT TOPSOIL.
 2. TOPSOIL AND SOW AS SOON AS PRACTICAL (MAX 4 WEEKS AFTER DISTURBANCE)
 3. DELINEATE LIMIT OF DISTURBANCE INCLUDING HAUL ROADS.
 4. INSTALL CUT OFF/ INTERCEPT BUNDS AHEAD OF EARTHWORKS.
 5. DIVERT ALL 'DIRTY' RUNOFF TO CHANNEL AND SEDIMENT POND.
 6. AGREE STOCKPILE LOCATION WITH ENGINEER AND PROTECT AS PER ESCMP

VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

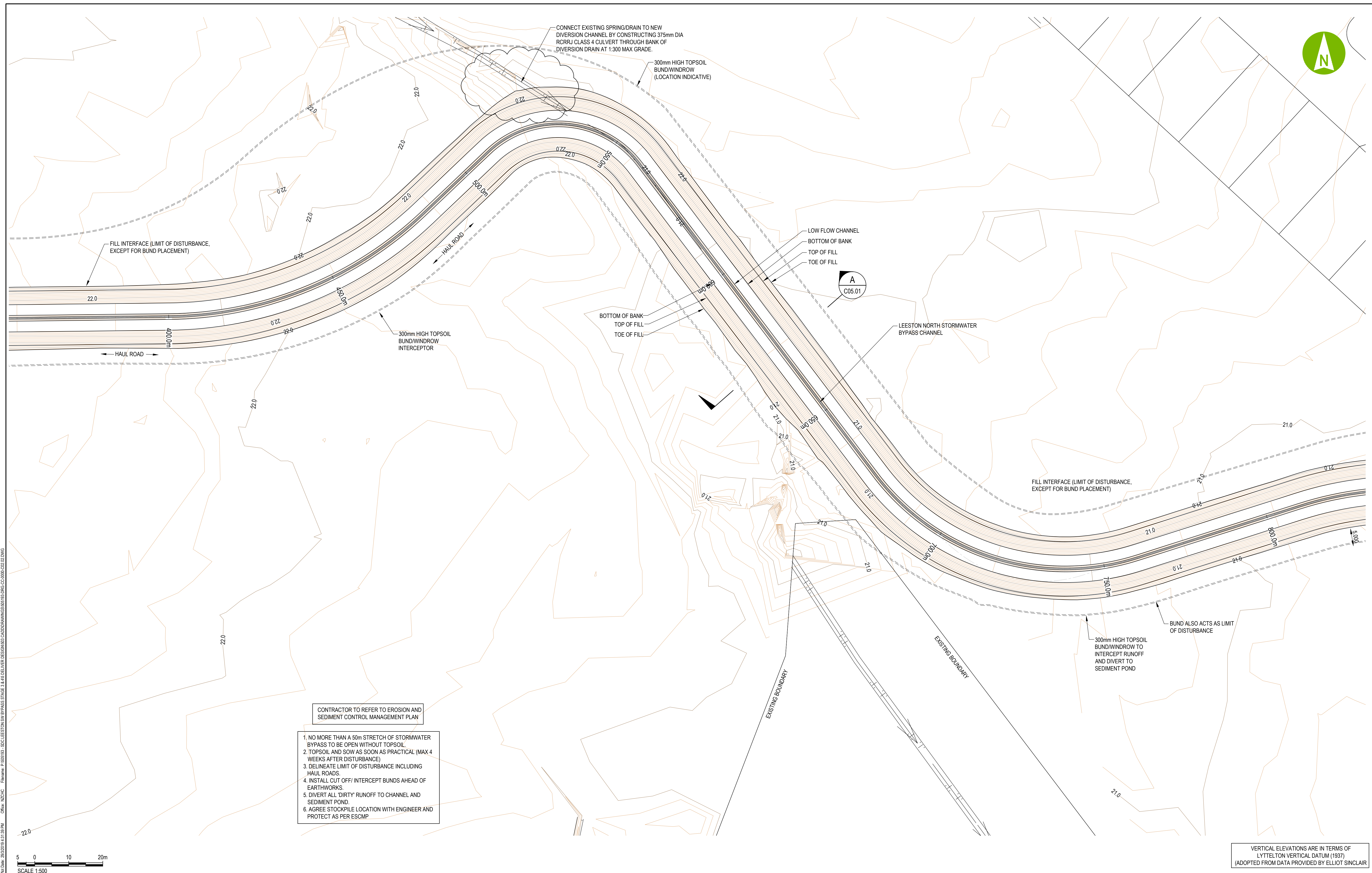


REV	DATE	REVISION DETAILS	APPROVED
A	29.03.19	FOR APPROVAL	R.SMITH

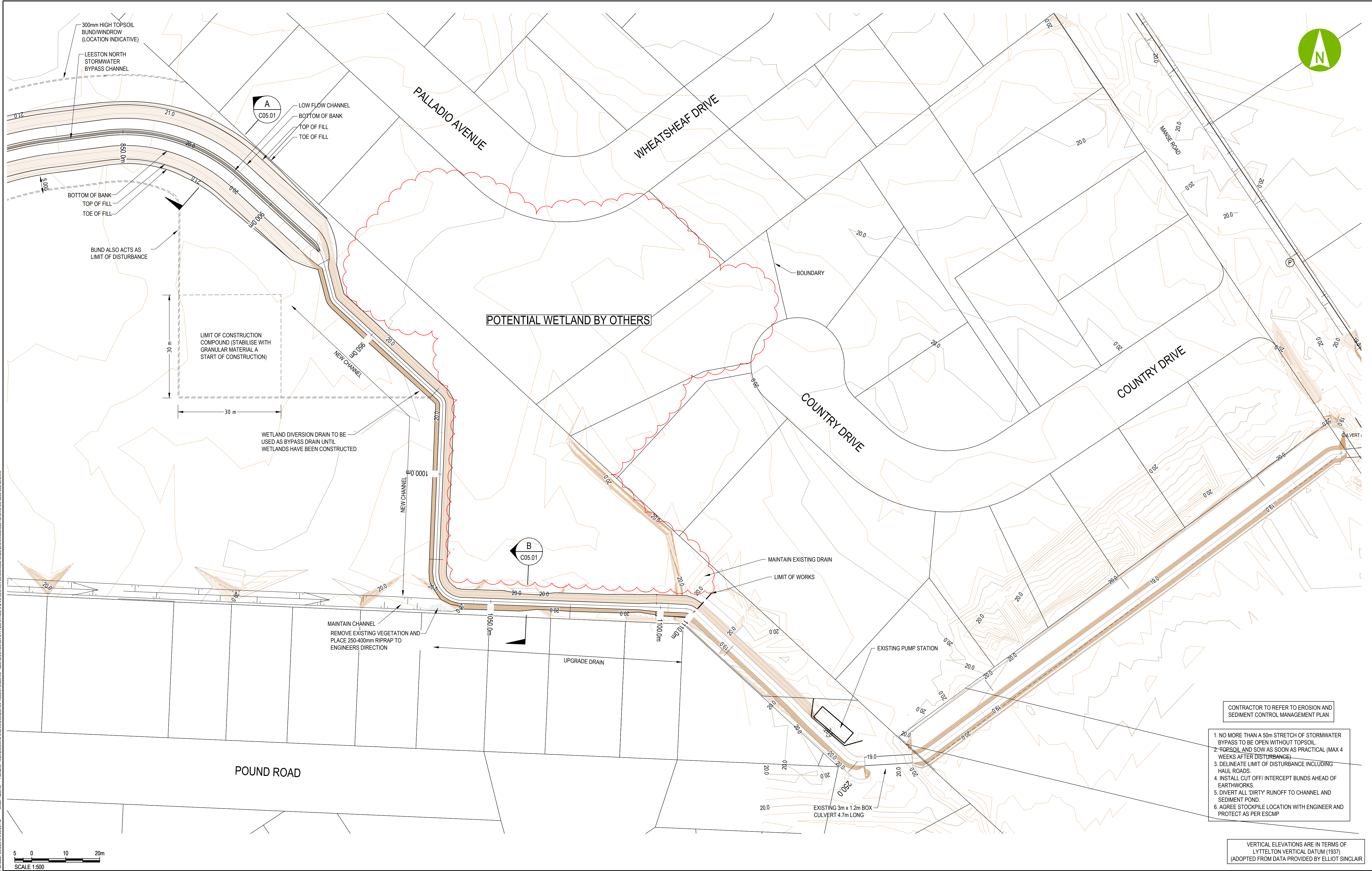
SCALE	SIZE
AS SHOWN	A1
DRAWN	J.WARLICH-KOOLE
DESIGNED	M.STONE
REVIEWED	R.SMITH

PRELIMINARY NOT FOR CONSTRUCTION
APPROVED DATE

PROJECT	LEESTONS NORTH STORMWATER BYPASS										
TITLE	LAYOUT PLAN SHEET 1 OF 3										
DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV					
	505193	0000	DRG	CC	C02.01	A					



REV	DATE	REVISION DETAILS	APPROVED	SCALE	SIZE	PRELIMINARY NOT FOR CONSTRUCTION	PROJECT	LEESTONS NORTH STORMWATER BYPASS					
A	29.03.19	FOR APPROVAL	R.SMITH	AS SHOWN	A1	APPROVED DATE	TITLE	LAYOUT PLAN SHEET 2 OF 3					
				DRAWN J.WARLICH-KOOLE									
				DESIGNED M.STONE									
				REVIEWED R.SMITH									
							DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
								505193	- 0000	- DRG	- CC	- C02.02	- A



File Name: AURECON\WORKS\RESOURCES\PROJECTS\505193 - SCC LEESTON SW BYPASS STAGE 3\4.46 DELIVER DESIGNED CADD\DRAWINGS\505193-DRG-CC-002-03.DWG
Plot Date: 20/03/2019 4:25 PM
Office: NZ-C

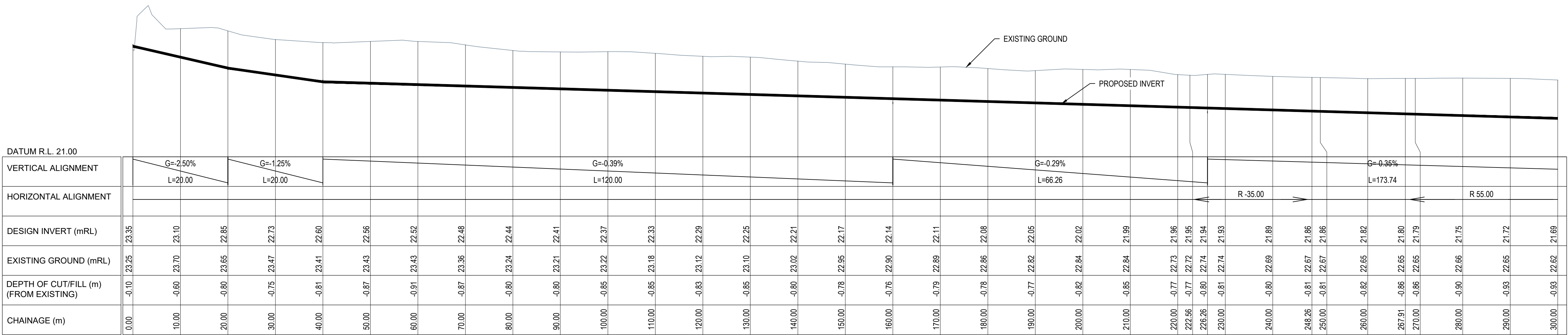
REV	DATE	REVISION DETAILS	APPROVED
A	29.03.19	FOR APPROVAL	R.SMITH

SCALE	SIZE
AS SHOWN	A1
DRAWN	J.WARLICH-KOOLE
DESIGNED	M.STONE
REVIEWED	R.SMITH

PRELIMINARY NOT FOR CONSTRUCTION
APPROVED
DATE

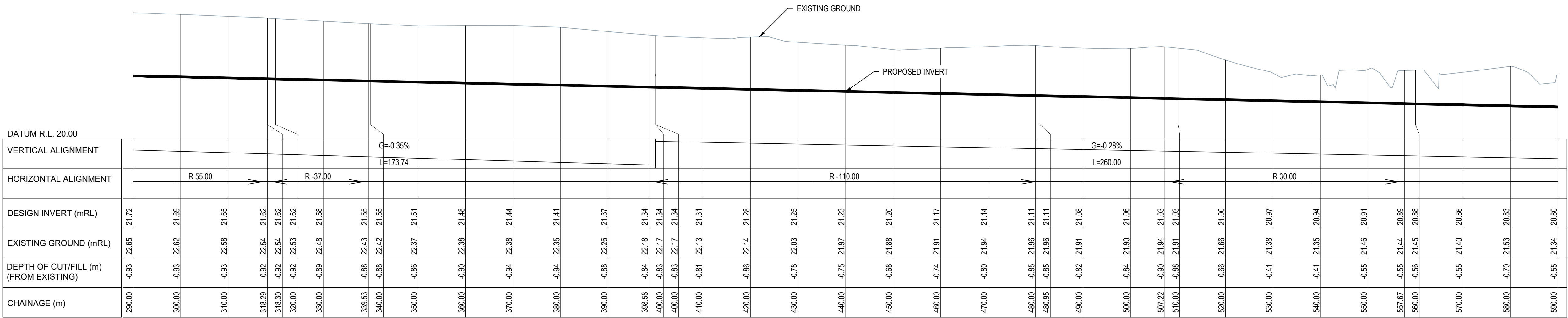
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TITLE	LAYOUT PLAN SHEET 3 OF 3
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Plot Date: 20/03/2014 12:20 PM Office: NZPC Filename: P:\655193 - SDC LEESTONS BYPASS STAGE 3 & 4 - DELIVER DESIGN\B0 CAD\DRAWINGS\55193.DWG CC-0000-0041.DWG



LONG SECTION 0m TO 300m

HORZ: 1:500, VERT: 1:50



LONG SECTION 300m TO 590m

HORZ: 1:500, VERT: 1:50

VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

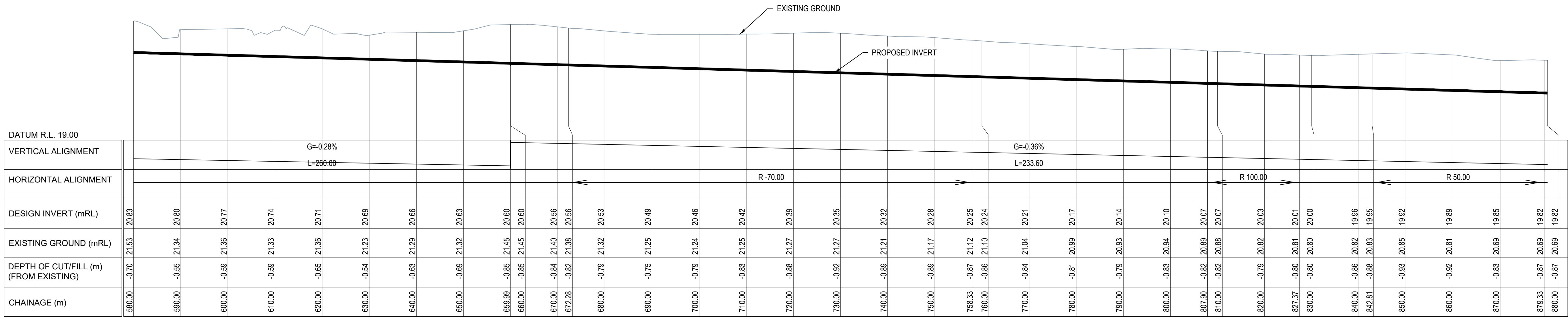
REV	DATE	REVISION DETAILS	APPROVED
A	29.03.19	FOR APPROVAL	R.SMITH

SCALE	SIZE
AS SHOWN	A1
DRAWN	J.WARLICH-KOOLE
DESIGNED	M.STONE
REVIEWED	R.SMITH

PRELIMINARY NOT FOR CONSTRUCTION
APPROVED
DATE

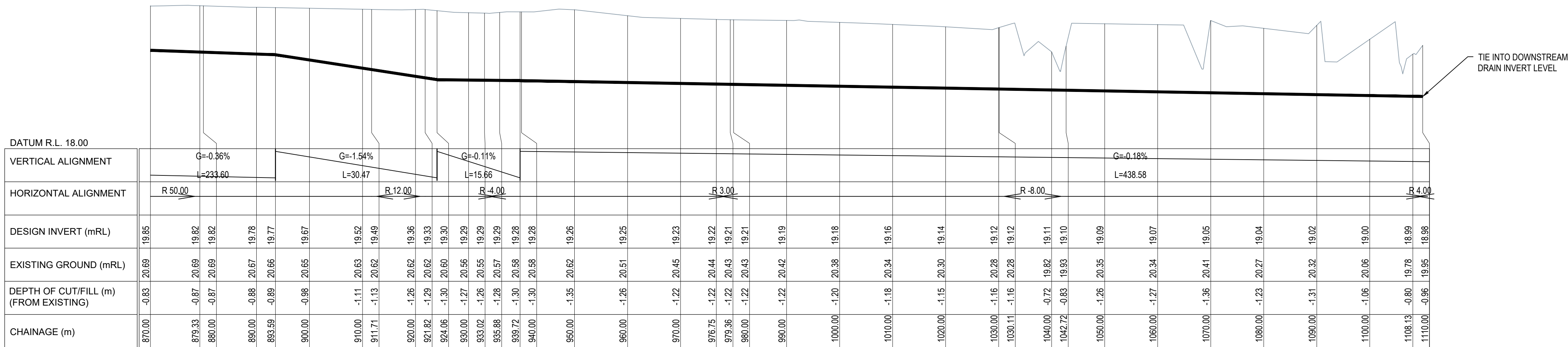
PROJECT	LEESTONS NORTH STORMWATER BYPASS
TITLE	FLOOD DIVERSION CHANNEL LONG SECTION SHEET 1 OF 2
DRAWING No.	505193
PROJECT No.	505193
WBS	0000
TYPE	DRG
DISC	CC
NUMBER	C04.01
REV	A

Plot Date: 28/03/2014 4:21:12 PM Office: NZHC Filename: P:\656193 - SDC LEESTONS BYPASS STAGE 3\4.46 DELIVER DESIGN\B3 CAD\DRAWINGS\55193.DWG CC:0000.C04.02.DWG



LONG SECTION 590m TO 880m

HORZ: 1:500, VERT: 1:50



LONG SECTION 880m TO 1110m

HORZ: 1:500, VERT: 1:50

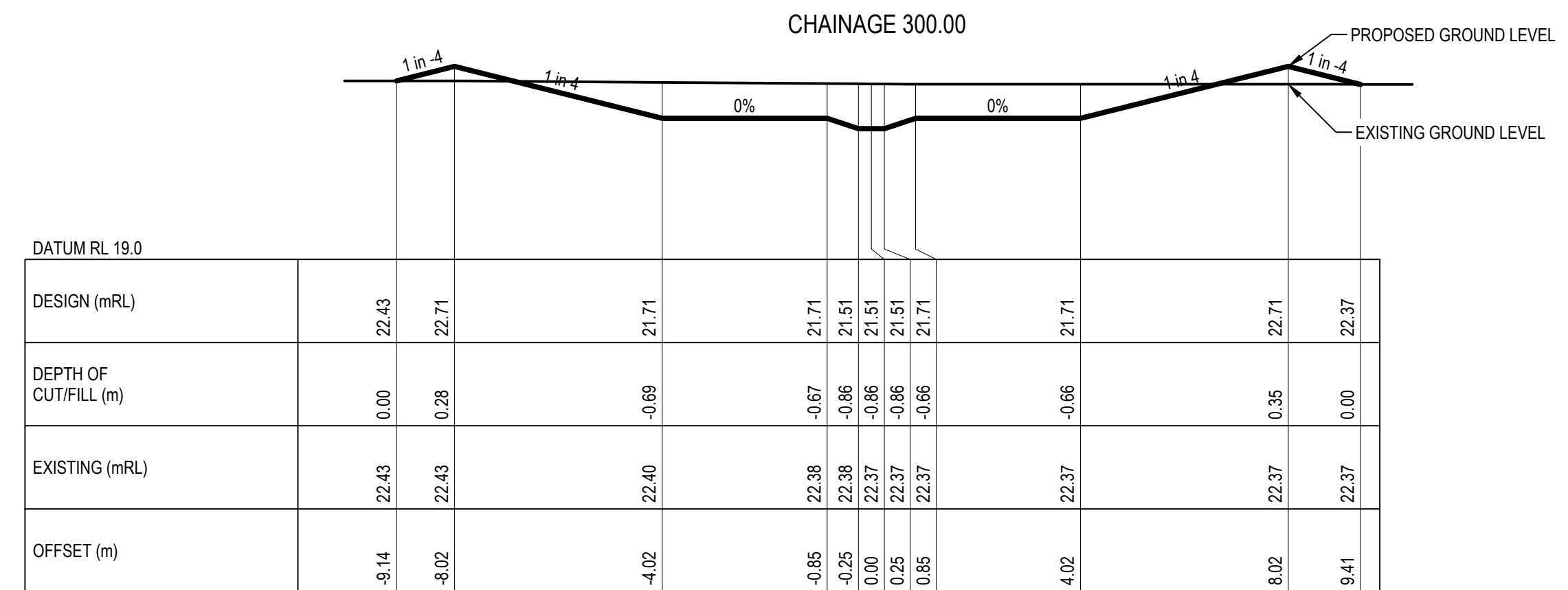
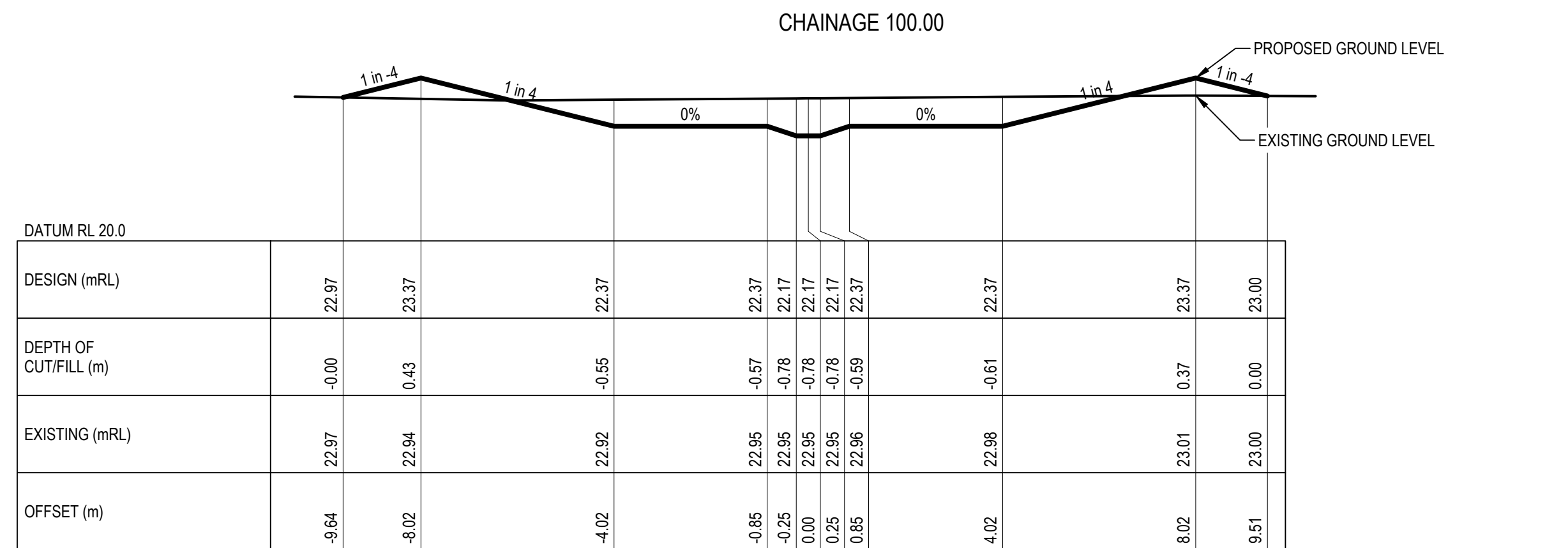
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LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

REV	DATE	REVISION DETAILS	APPROVED
A	29.03.19	FOR APPROVAL	R.SMITH

SCALE	SIZE
AS SHOWN	A1
DRAWN	J.WARLICH-KOOLE
DESIGNED	M.STONE
REVIEWED	R.SMITH

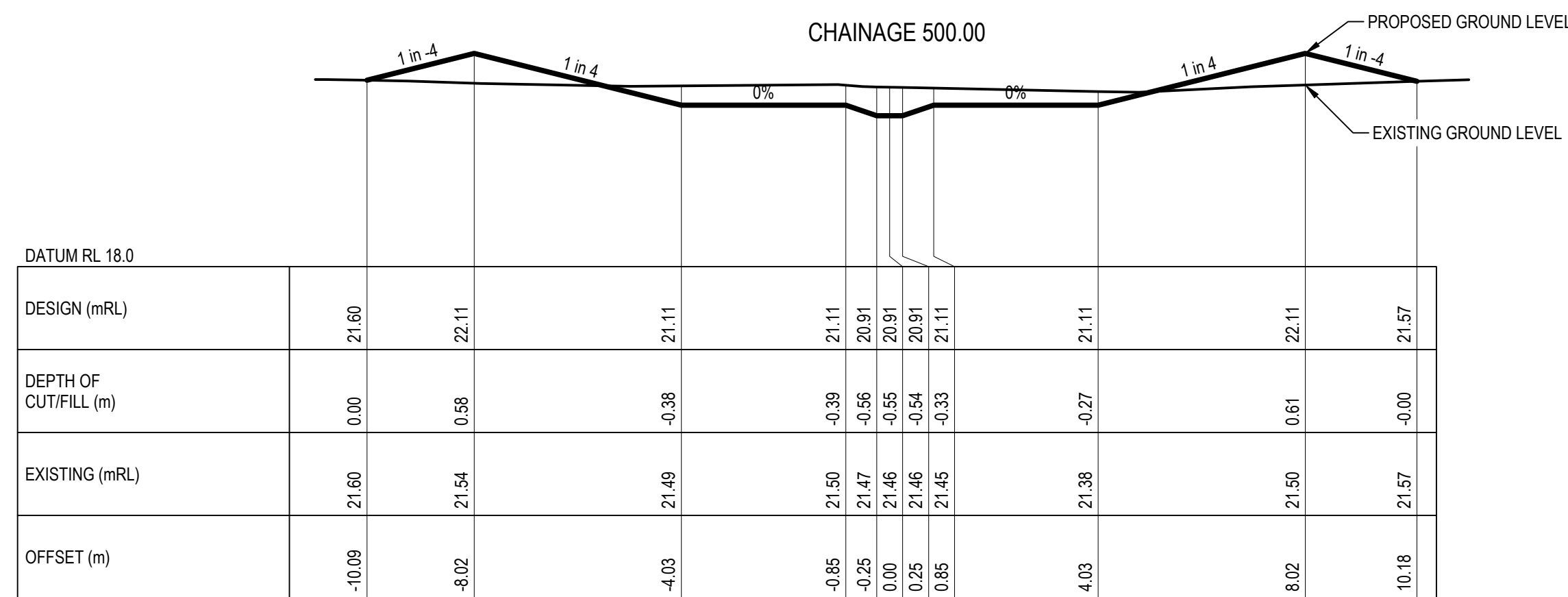
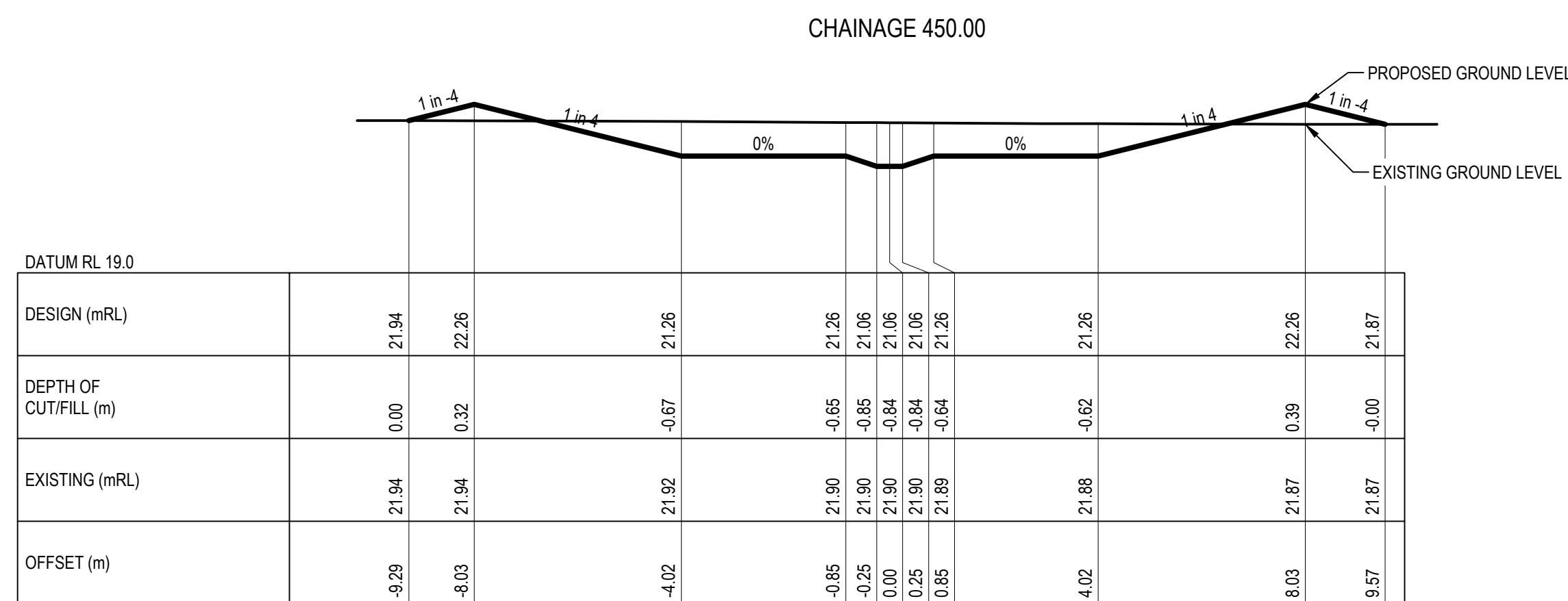
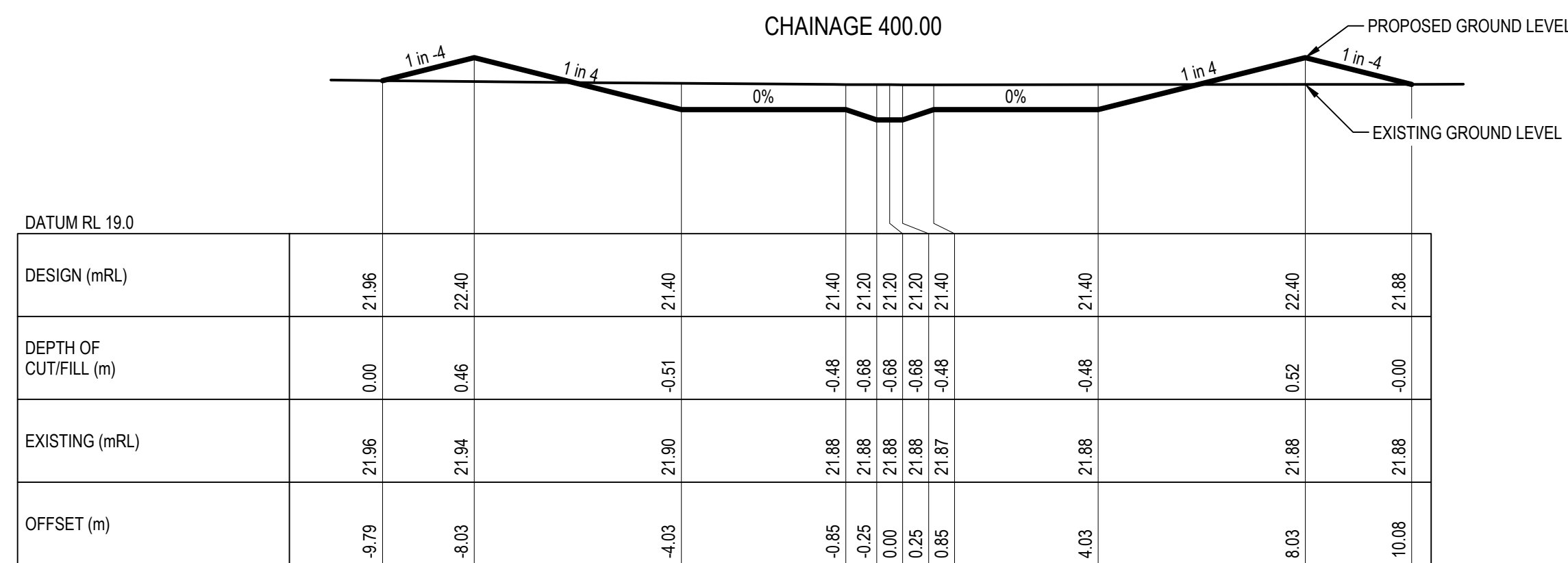
PRELIMINARY NOT FOR CONSTRUCTION
APPROVED DATE

PROJECT	LEESTONS NORTH STORMWATER BYPASS					
TITLE	FLOOD DIVERSION CHANNEL LONG SECTION SHEET 2 OF 2					
DRAWING No.	PROJECT No. 505193	WBS 0000	TYPE DRG	DISC CC	NUMBER C04.02	REV A

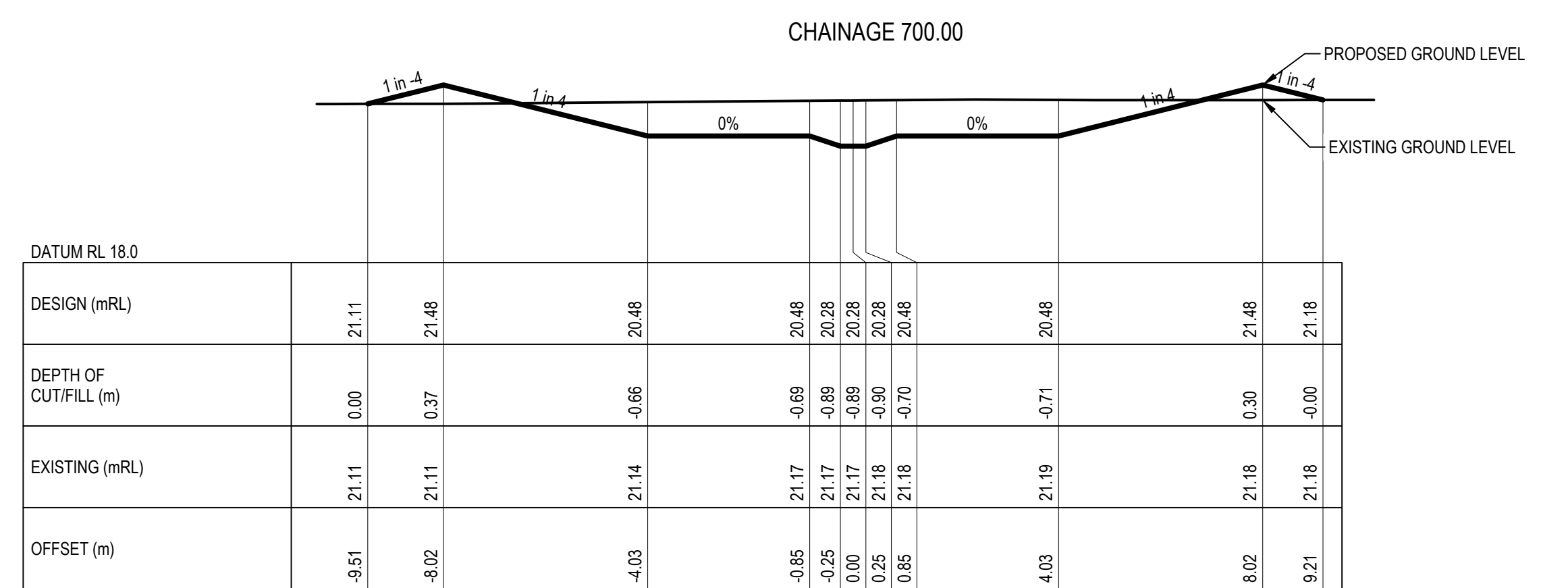
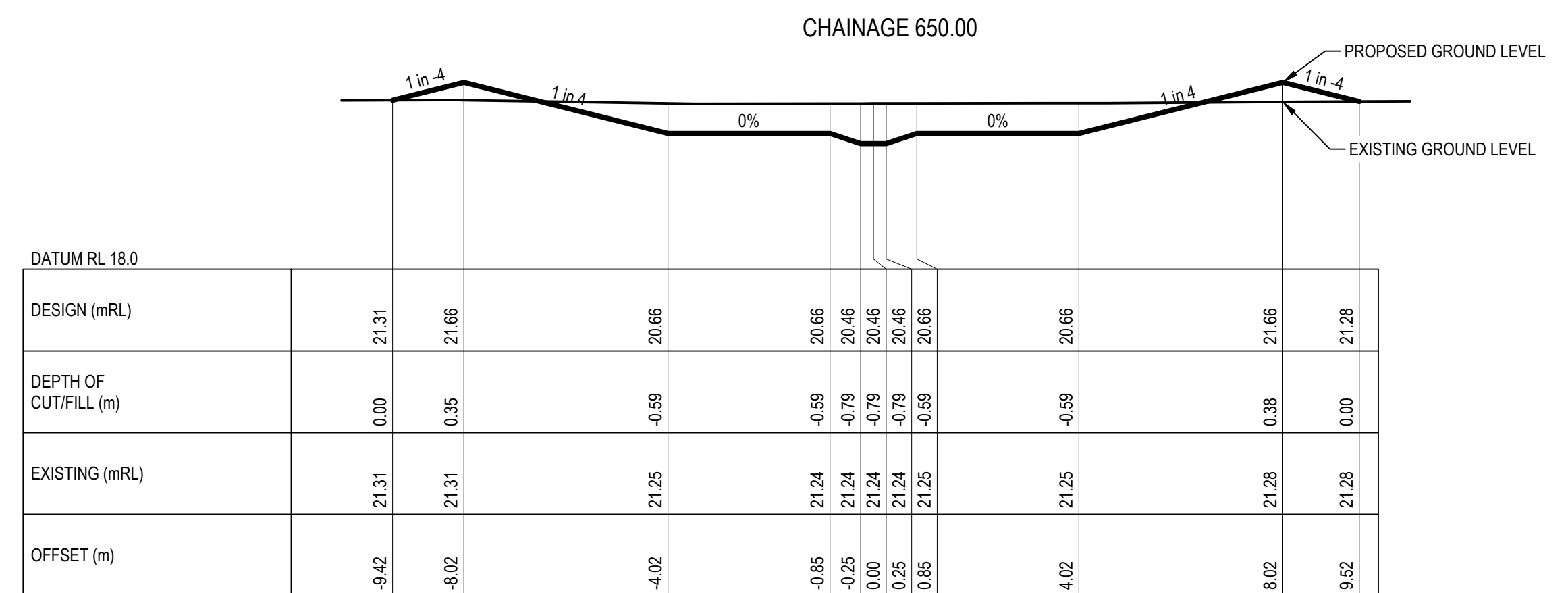
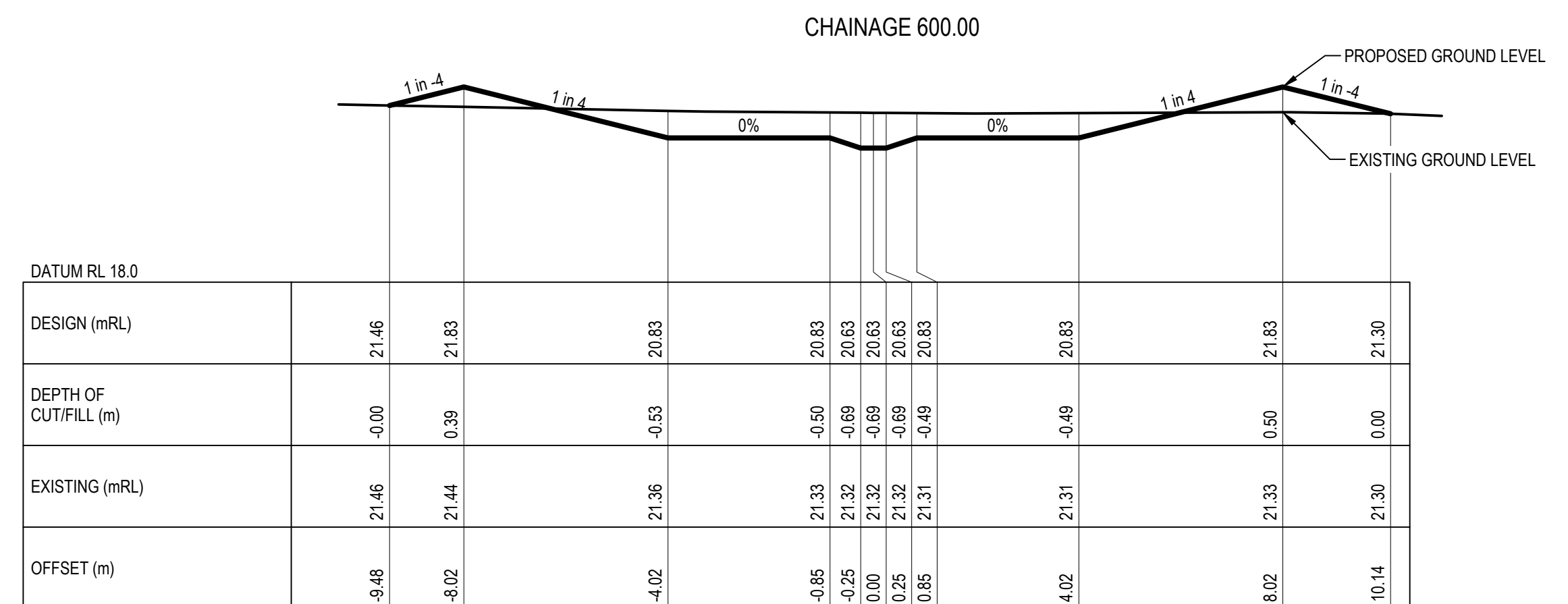
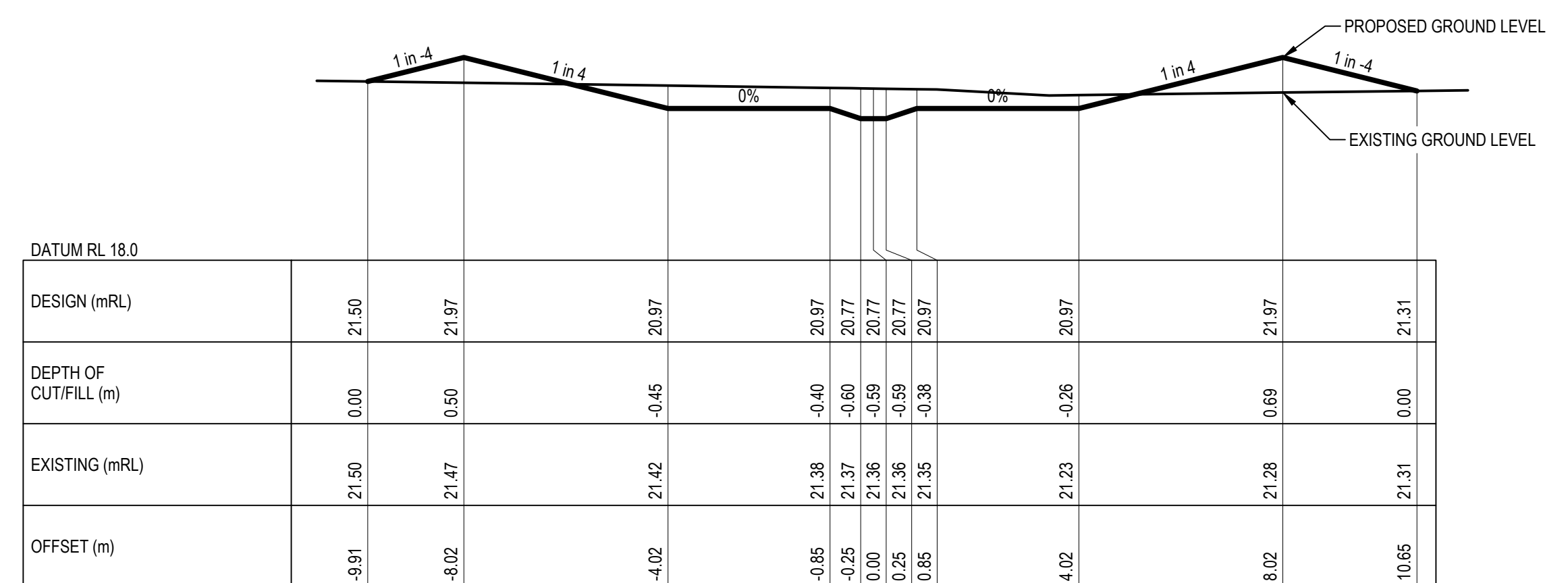


VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

	CLIENT	REV	DATE	REVISION DETAILS	APPROVED	SCALE	SIZE	PRELIMINARY NOT FOR CONSTRUCTION	PROJECT	LEESTONS NORTH STORMWATER BYPASS					
		A	29.03.19	FOR APPROVAL	R.SMITH	AS SHOWN	A1								
						DRAWN J.WARLICH-KOOLE		APPROVED DATE	TITLE	FLOOD DIVERSION CHANNEL CROSS SECTIONS SHEET 1 OF 3					
						DESIGNED M.STONE									
						REVIEWED R.SMITH									
									DRAWING No.	PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
										505193	- 0000	- DRG	- CC	- C04.04	- A



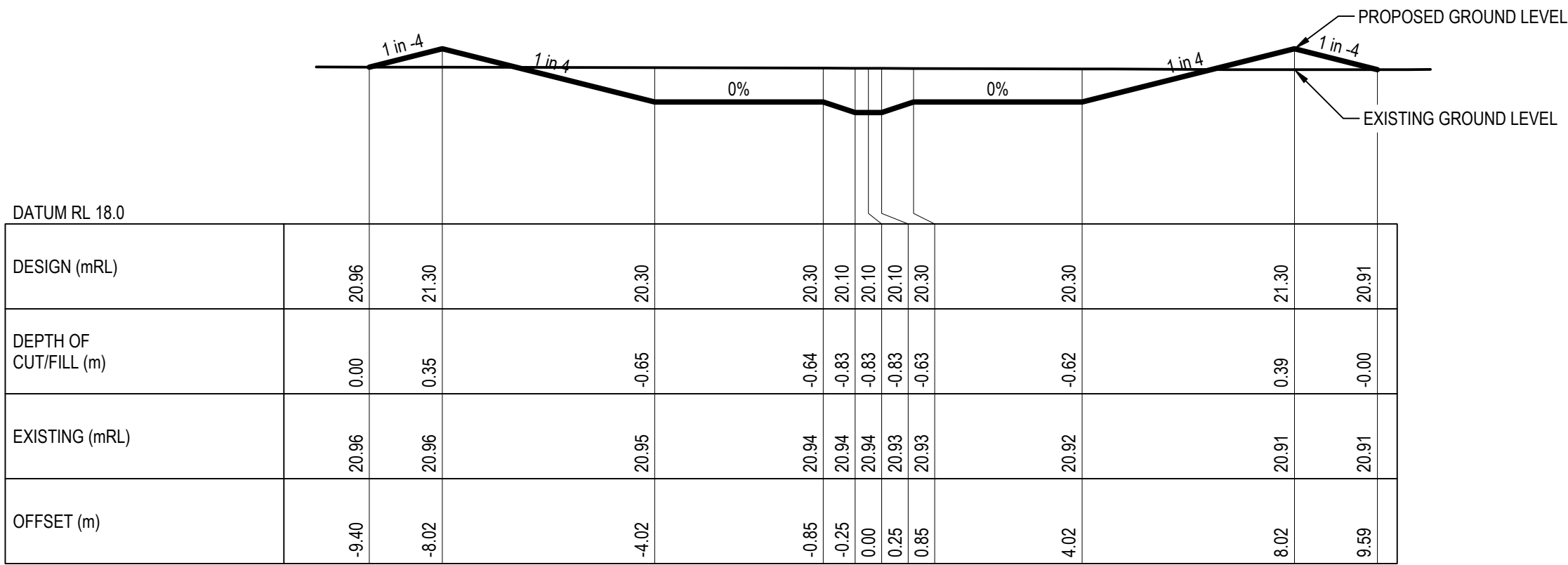
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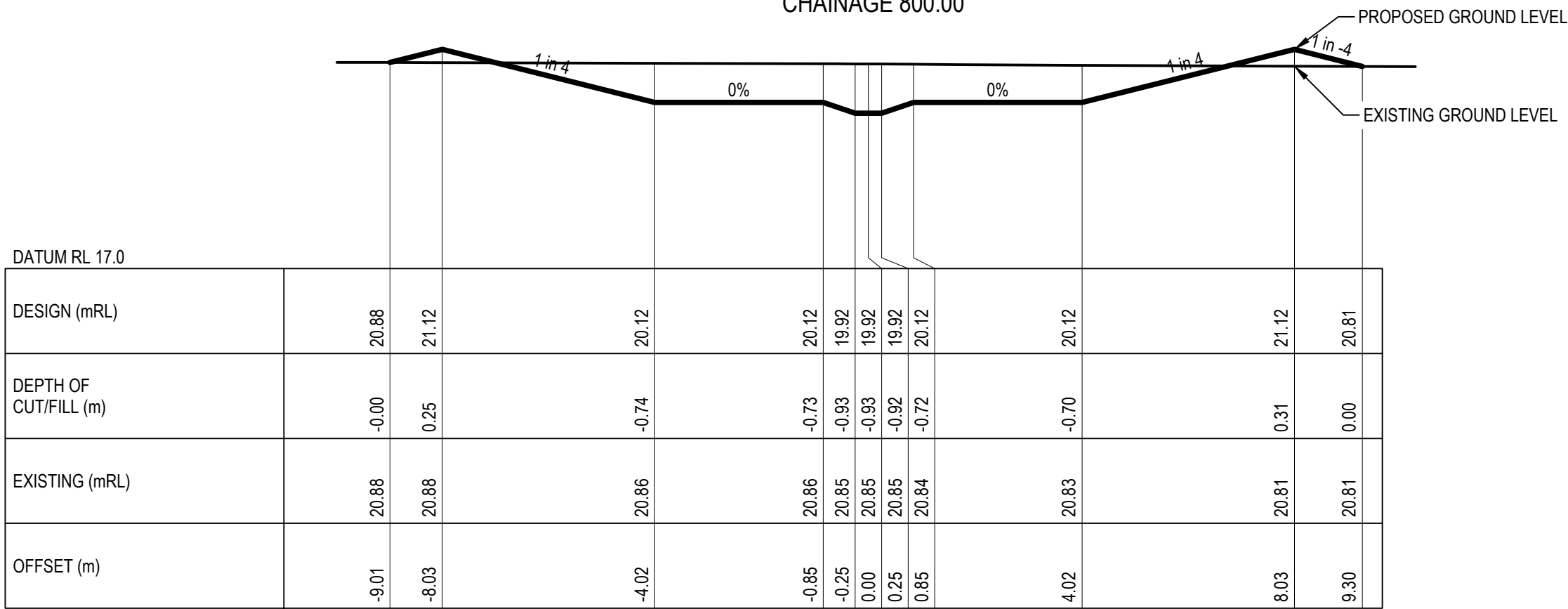
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VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

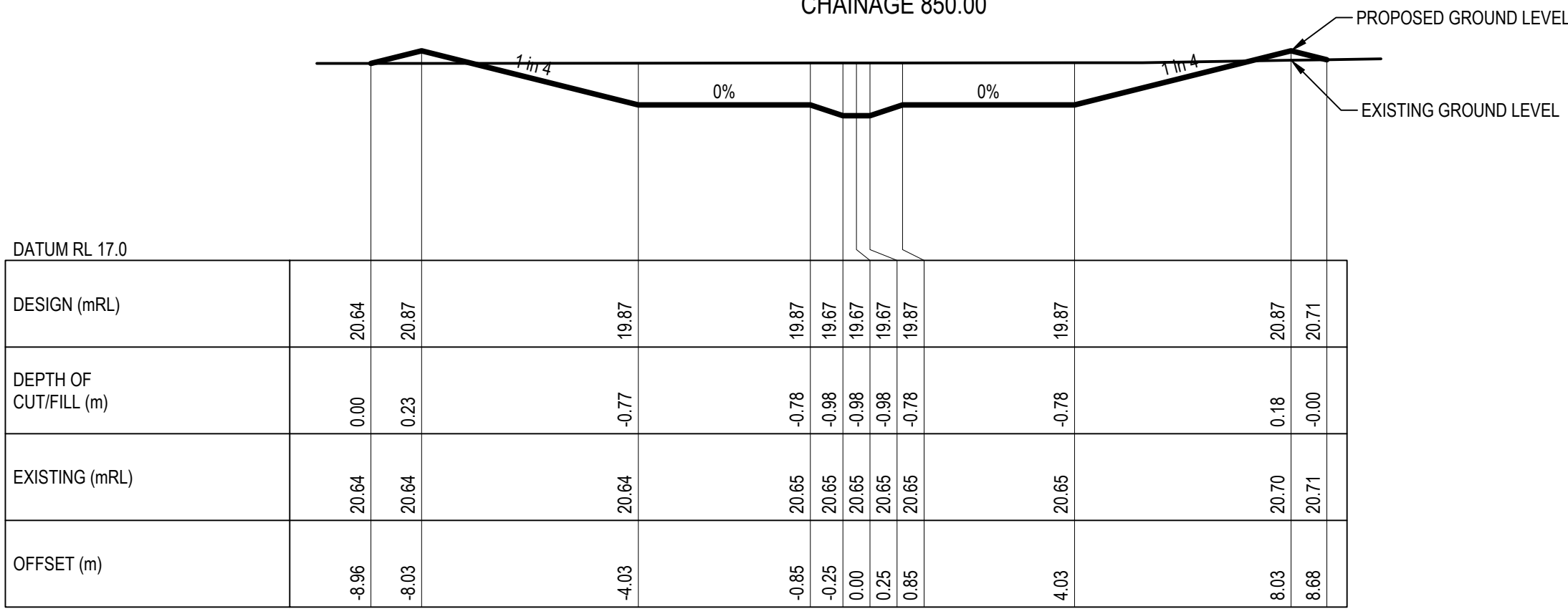
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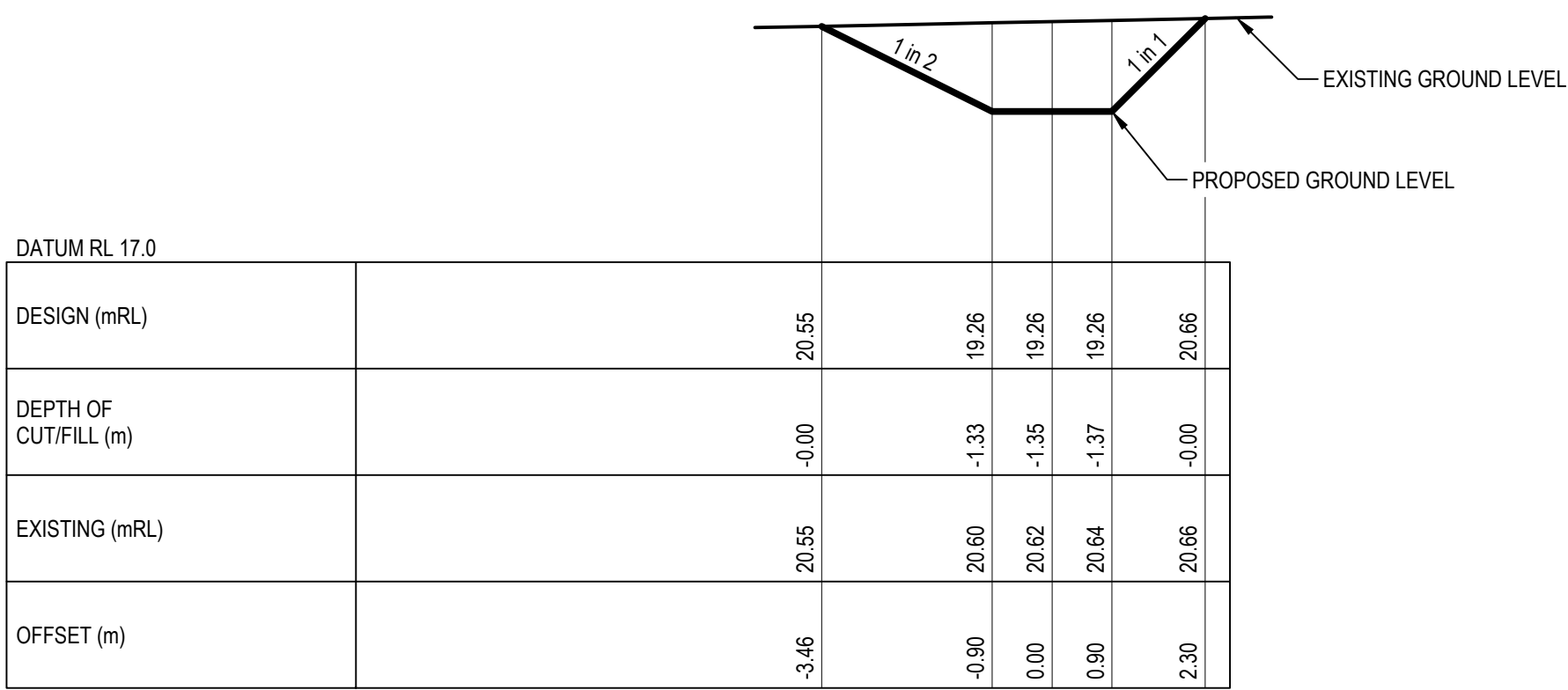
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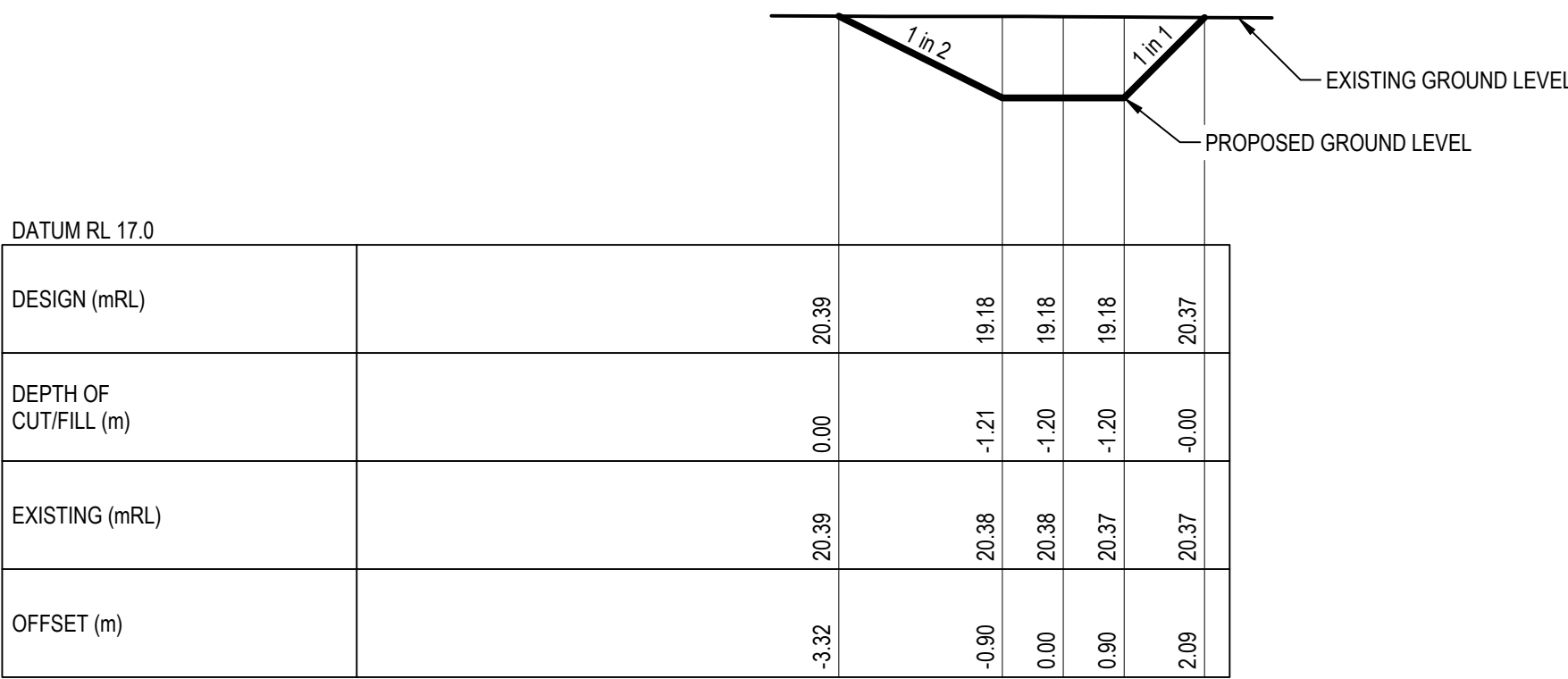


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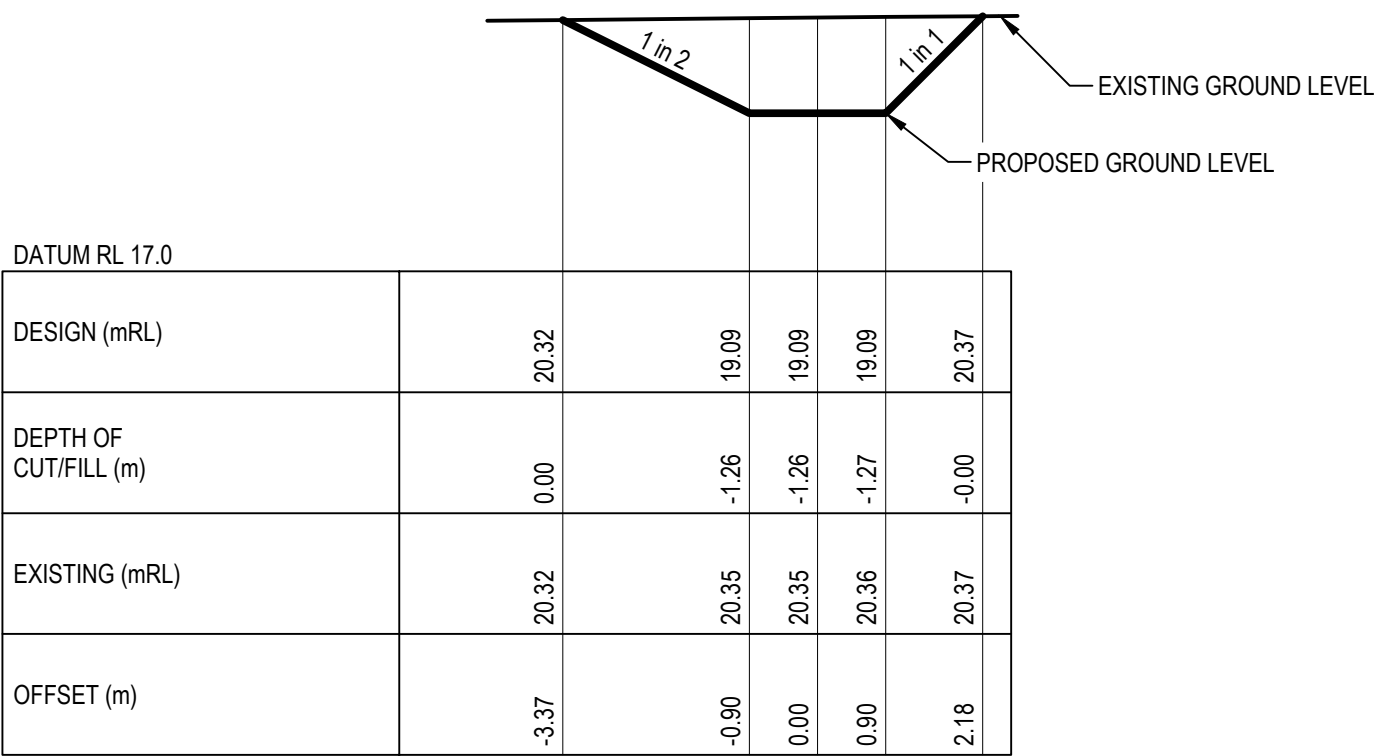


CHAINAGE 950.00

CHAINAGE 1000.00



CHAINAGE 1050.00



VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

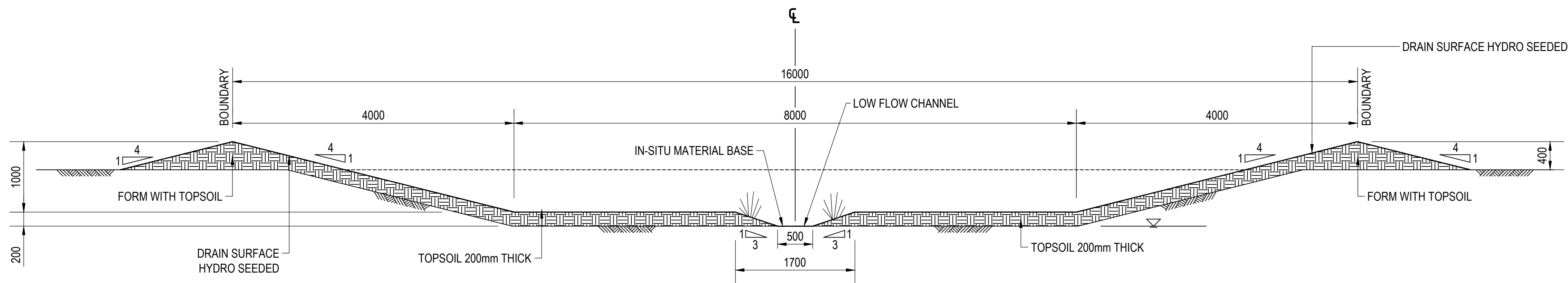
REV	DATE	REVISION DETAILS	APPROVED
A	29.03.19	FOR APPROVAL	R.SMITH

SCALE	SIZE
AS SHOWN	A1
DRAWN	J.WARLICH-KOOLE
DESIGNED	M.STONE
REVIEWED	R.SMITH

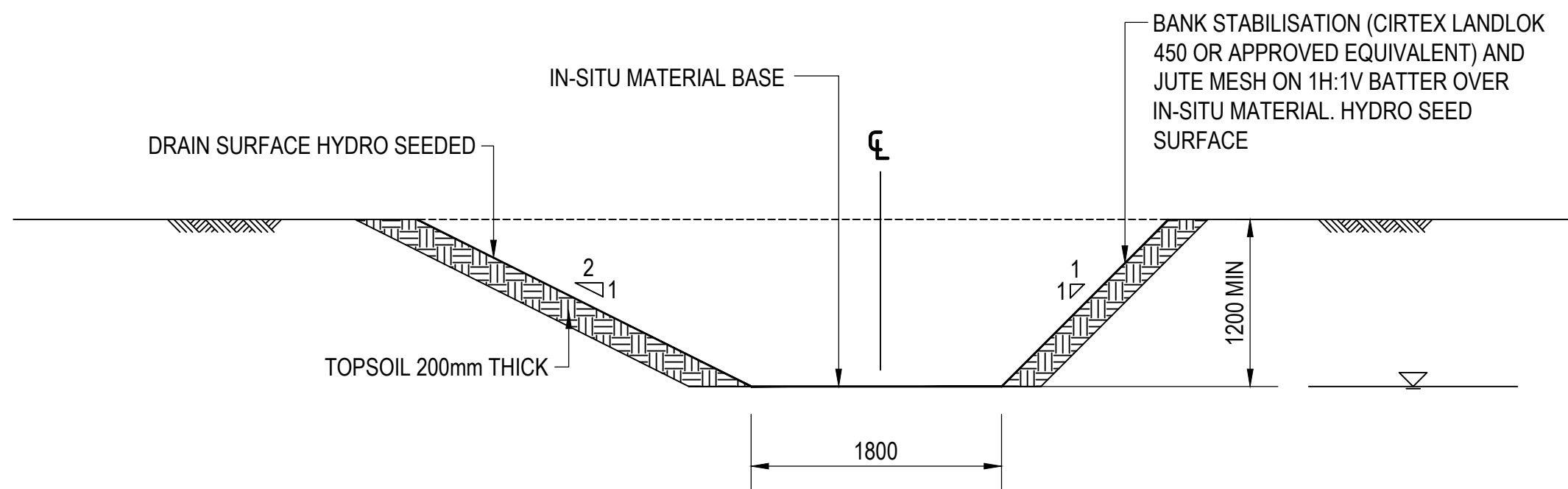
PRELIMINARY NOT FOR CONSTRUCTION
APPROVED
DATE

PROJECT	LEESTONS NORTH STORMWATER BYPASS
TITLE	FLOOD DIVERSION CHANNEL CROSS SECTIONS SHEET 3 OF 3
DRAWING No.	PROJECT No. 505193 WBS 0000 TYPE DRG DISC CC NUMBER C04.06 REV A

Proj Date: 29/03/2014 12:27 PM Office: NZ/C Filename: P 505193 - SDC LEESTON SW BYPASS STAGE 3 1:46 DELIVER DESIGN/BD CAD/DRAWINGS/505193.DWG CC:0000 C05.01.DWG



SECTION A LEESTON NORTH STORMWATER BYPASS DRAIN
1:50
C02.01
C02.02
C02.03



SECTION B WETLAND BYPASS CHANNEL
1:50
C02.03

CHAINAGE	SECTION
0-920	A
920-1100	B

- NOTES:
- BANK STABILISATION AND JUTE MESH PINNED TO SURFACE IN ACCORDANCE WITH MANUFACTURES SPECIFICATIONS
 - ALL DIMENSIONS IN MILLIMETRES UNLESS SHOWN OTHERWISE



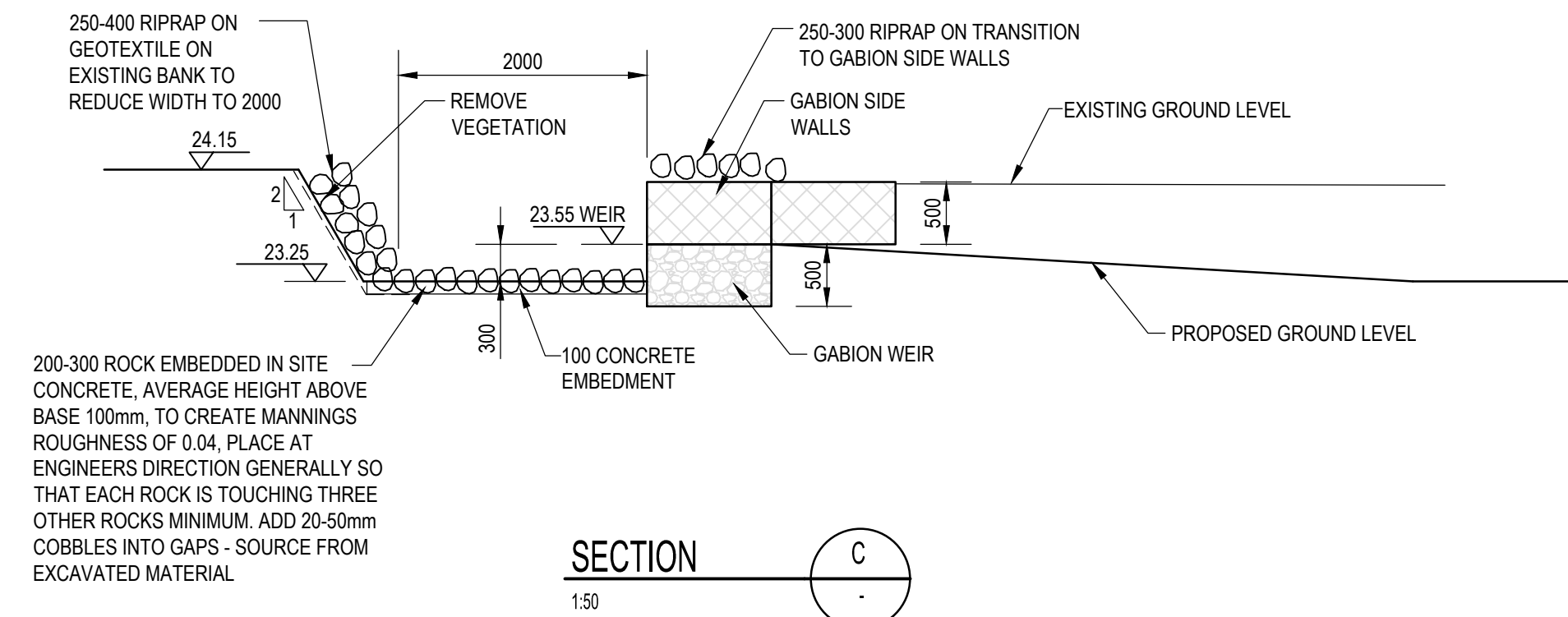
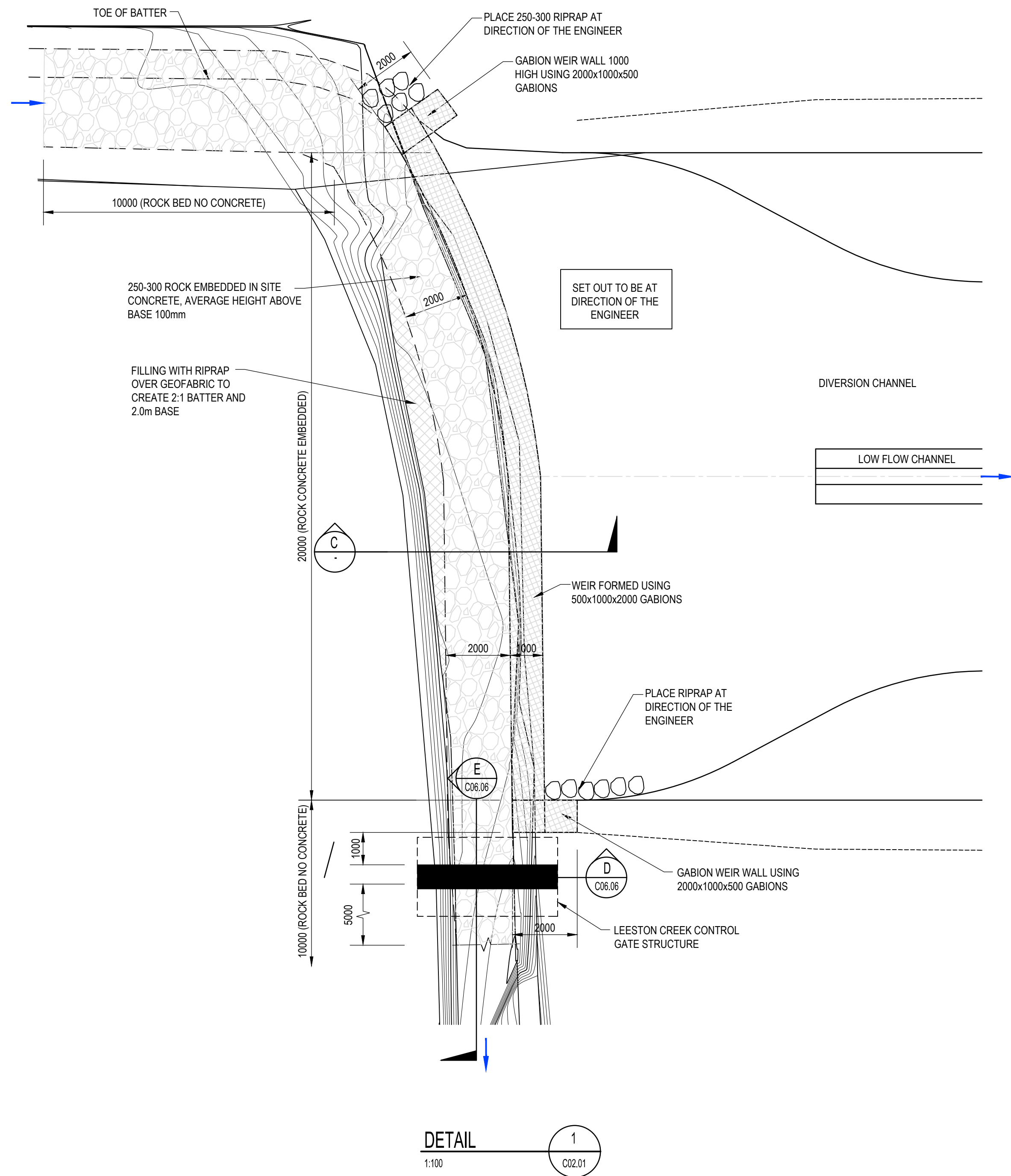
VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

REV	DATE	REVISION DETAILS
A	29.03.19	FOR APPROVAL

APPROVED	SCALE	SIZE
R.SMITH	AS SHOWN	A1

PRELIMINARY	DATE
NOT FOR CONSTRUCTION	

PROJECT	LEESTONS NORTH STORMWATER BYPASS
TITLE	TYPICAL SECTIONS
DRAWING No.	505193
PROJECT No.	505193
WBS	0000
TYPE	DRG
DISC	CC
NUMBER	C05.01
REV	A



NOTES:

1. ALL DIMENSIONS IN MILLIMETRES UNLESS SHOWN OTHERWISE

VERTICAL ELEVATIONS ARE IN TERMS OF
LYTTELTON VERTICAL DATUM (1937)
(ADOPTED FROM DATA PROVIDED BY ELLIOT SINCLAIR)

REV		DATE	REVISION DETAILS		APPROVED	SCALE	SIZE	PRELIMINARY NOT FOR CONSTRUCTION		PROJECT		LEESTONS NORTH STORMWATER BYPASS					
A		29.03.19	FOR APPROVAL		R.SMITH	AS SHOWN		A1				SECTIONS AND DETAILS SHEET 1 OF 2					
						DRAWN J.WARLICH-KOOLE		APPROVED DATE		TITLE							
					DESIGNED M.STONE												
					REVIEWED R.SMITH												
										DRAWING No.		PROJECT No.	WBS	TYPE	DISC	NUMBER	REV
												505193	- 0000	- DRG	- CC	- C06.05	- A

Safe Design Risk Register – Design of Leeston Stormwater Bypass																				
Client	Selwyn District Council						Date	09-Apr-19				Risk Rating Matrix	Most Likely Consequence		Likelihood of occurrence					
Stakeholders							Revision No.	1							5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely	
Meeting Attendees	NA						Project No.	505193							A - Disastrous	Extreme	Extreme	Extreme	High	
															B - Critical	Extreme	Extreme	Extreme	High	High
															C - Serious	Extreme	High	High	Moderate	Moderate
												D - Significant	High	High	Moderate	Low	Low			
							Project Director	Regan Smith				E - Minor	Moderate	Moderate	Low	Low	Low			

- Notes:
1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
 2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
 3. The risk register is focussed on hazards resulting from typical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
 4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
 5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
Design Phase (Pre-construction)																
1.01	Site inspections	Injury as a result of accident during site inspection	Designer	2 - Unlikely	C - Serious	Moderate	Follow consultant H&S procedures to assist in identifying and managing hazards prior and during site visits including SWMS form and Take 5	1 - Very unlikely	D - Significant	Low	Consultant	Yes	Current design undertaken by Aurecon has been issued to SDC. This design may be completed by the Oakdale Development consultant and/or SDC.			Open
Construction and Commissioning Phase																
2.01	Contamination	Dangers associated with exposure to contaminated site.	Contractor	3 - Likely	D - Significant	Moderate	The contractor shall complete all work in accordance with the relevant Selwyn District Council Construction and Work Safe NZ guidelines and regulations to remove and dispose off contaminated material from site. Work shall be undertaken by competent persons.	2 - Unlikely	D - Significant	Low	Contractor		It is unknown if a PSI or DSI has been completed along the proposed Leeston Stormwater Bypass alignment.			Open
2.02	Access for movement of mobile machinery	Unsuitable access for mobile plant and machinery movement	Client	2 - Unlikely	D - Significant	Low	Ensure there is sufficient working corridor along the proposed Stormwater Bypass alignment.	2 - Unlikely	D - Significant	Low	Contractor					Open
2.03	Dust inhalation	Dust inhalation and eye irritation. Reduced visibility to operate equipment safely.	Community / Contractor / Designer	3 - Likely	D - Significant	Moderate	Designer to include dust control management strategy in the Specifications. Contractor to implement measures manage dust during construction	2 - Unlikely	D - Significant	Low	Contractor		Assumed specification will be prepared by the Oakdale Development consultant and/or SDC.			Open
2.04	Stockpile in limited corridor	Excavated fill stockpiling is within a limited construction corridor	Contractor	1 - Very unlikely	E - Minor	Low	Limit the height of stockpile and create designated stockpile areas for excess spoil that can be safely managed. Refer proposed stockpile areas on the design documentation.	1 - Very unlikely	E - Minor	Low	Contractor					Open
2.05	Electric shock	Electric shock from overhead or underground power lines	Contractor	2 - Unlikely	A - Disastrous	Extreme	Contractor to locate all underground services prior to any excavation. Contractor to implement safety measures for crossing underneath power lines and adjacent underground powerlines particularly high voltage powerlines. Power service providers to be involved as required. Contractor to be extremely careful around overhead power both within the site and at site access locations.	1 - Very unlikely	A - Disastrous	High	Contractor					Open
2.06	Service strike during construction	Damage to services during construction, leading to injury from gas, electrical shock, exposure to wastewater (sewers). Disruption to communications (optic fibre), HP water supply etc.	Community / Contractor	3 - Likely	B - Critical	Extreme	The contractor to locate all services through CBYD and potholing prior to commencing excavation. Minimum separation distance shall be maintained between any existing services. A spotter shall be used when work is near powerlines. Where possible isolate (de energise) the service when constructing in the vicinity.	1 - Very unlikely	B - Critical	High	Contractor					Open
2.07	Manual handling	Injuries sustained to personnel during operation and maintenance of the system.	Contractor	2 - Unlikely	D - Significant	Low	All relevant Selwyn District Council manual handling procedures shall be followed through operation and maintenance of the system.	2 - Unlikely	D - Significant	Low	Contractor					Open

Safe Design Risk Register – Design of Leeston Stormwater Bypass																																														
Client	Selwyn District Council					Date	09-Apr-19		Risk Rating Matrix	<table><tr><th>Most Likely Consequence</th><th colspan="5">Likelihood of occurrence</th></tr><tr><th>A - Disastrous</th><th>5 - Very likely</th><th>4 - Good chance</th><th>3 - Likely</th><th>2 - Unlikely</th><th>1 - Very unlikely</th></tr><tr><th>B - Critical</th><td>Extreme</td><td>Extreme</td><td>Extreme</td><td>High</td><td>High</td></tr><tr><th>C - Serious</th><td>Extreme</td><td>High</td><td>High</td><td>Moderate</td><td>Moderate</td></tr><tr><th>D - Significant</th><td>High</td><td>High</td><td>Moderate</td><td>Low</td><td>Low</td></tr><tr><th>E - Minor</th><td>Moderate</td><td>Moderate</td><td>Low</td><td>Low</td><td>Low</td></tr></table>	Most Likely Consequence	Likelihood of occurrence					A - Disastrous	5 - Very likely	4 - Good chance	3 - Likely	2 - Unlikely	1 - Very unlikely	B - Critical	Extreme	Extreme	Extreme	High	High	C - Serious	Extreme	High	High	Moderate	Moderate	D - Significant	High	High	Moderate	Low	Low	E - Minor	Moderate	Moderate	Low	Low	Low
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- Notes:
1. This risk register has been prepared to document hazards and risk treatments associated with project elements designed by Aurecon, including subconsultants where applicable.
 2. The full life cycle of the project has been considered including design, construction (and commissioning), operation, maintenance, modification and demolition phases.
 3. The risk register is focussed on hazards resulting from typical features specific to the design. It is expected that risks associated with generic hazards (working at heights, excavations, etc) will be addressed by other stakeholders using appropriate risk management techniques during subsequent phases of the project.
 4. Residual risks which cannot reasonably be actioned by Aurecon during the design phase have been identified and require action by other stakeholders during subsequent phases of the project (e.g. construction, operations, maintenance, modification or demolition).
 5. This risk register does not replace the need for other stakeholders to complete their own hazard identification and risk assessment for the project (including the development of safe work procedures for specific activities) in due course.

IDENTIFY HAZARD				ASSESS RISK			IMPLEMENT RISK TREATMENT									
ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
2.08	Excessive noise	Damage to hearing via exposure to excessive noise.	Contractor	1 - Very unlikely	D - Significant	Low	Work to be undertaken in accordance with Selwyn District Council guidelines. All personnel must wear appropriate PPE during construction and operation including ear protection as required.	1 - Very unlikely	D - Significant	Low	Contractor					Open
2.09	Trip Hazards	Workers trip due to uneven ground and injure themselves.	Contractor	2 - Unlikely	E - Minor	Low	Contractor to ensure a safe working environment for all employed on site - stated in Specifications. Minimal infrastructure is above ground. Valves and pits covers to be mounted finish with surrounding ground to remove trip hazards.	2 - Unlikely	E - Minor	Low	Contractor					Open
2.10	Hot weather	Dehydration	Contractor	1 - Very unlikely	E - Minor	Low	Follow guidelines stipulated in Selwyn District Council Induction. All personnel must wear appropriate PPE during construction / maintenance activities.	1 - Very unlikely	E - Minor	Low	Contractor					Open
2.11	Earthquakes / Aftershocks	Risk of injury during earthquakes / aftershocks	Contractor	2 - Unlikely	C - Serious	Moderate	Implement management plans to prevent the injury	2 - Unlikely	C - Serious	Moderate	Contractor					Open
2.12	Public Access	A member of the public is injured through interaction with the site	Community	2 - Unlikely	C - Serious	Moderate	Contractor to implement measures to restrict and manage public access to work site	1 - Very unlikely	C - Serious	Moderate	Contractor					Open
2.13	Flowing water in Leeston Creek channel during storm events	Risk of drowning or being swept away	Contractor	2 - Unlikely	A - Disastrous	Extreme	Contractor to monitor forecasts daily, ensuring channel and pipe networks are free from obstructions. Contractors gear and person will be moved out of water channels prior to any event.	1 - Very unlikely	A - Disastrous	High	Contractor					Open
2.14	Site fencing during construction	Fences blown down during high winds, risking injury to anyone nearby and potentially allowing access to the site.	Contractor/Community	3 - Likely	D - Significant	Moderate	Contractor to ensure all fences are appropriately secured	2 - Unlikely	D - Significant	Low	Contractor					Open
						-				-						
Operations Phase																
3.01	Public Access	A member of the public is injured through interaction with the site	Community	2 - Unlikely	D - Significant	Low	The details of the adjacent Oakdale Development are currently unknown. Hence it is unknown what measures may be implemented to deter people from entering or being in close proximity with the Stormwater Bypass. The waterway will have grassed-lined batters with a flat grade and the design has minimised infrastructure that could injure a member of the public.	2 - Unlikely	D - Significant	Low	Client					Open
3.02	Flowing water in channel during storm events	Risk of drowning or being swept away	Community	2 - Unlikely	A - Disastrous	Extreme	The details of the adjacent Oakdale Development are currently unknown. Hence it is unknown what measures may be implemented to deter people from entering or being in close proximity with the Stormwater Bypass. Channel longitudinal grades are flat to limit velocity in flood events. The channel batters are flat to make it easier for people to get out of the waterway.	1 - Very unlikely	A - Disastrous	High	Client					Open
Maintenance Phase																

Safe Design Risk Register – Design of Leeston Stormwater Bypass																																									
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ID	Risk Source (Hazard)	Event / Cause / Consequence	Persons Affected	Likelihood	Consequence	Risk Rating	Control Measure (Risk Treatment)	Likelihood	Consequence	Risk Rating	Risk Owner	Implement Control - Y/N?	Action / Comment (or justification if no action)	Action Owner(s)	Timing / Date	Status (Open / Closed)
4.01	Unsafe mowing of surfaces	Wet/boggy ground conditions	Client (Maintenance staff)	4 - Good chance	E - Minor	Moderate	Grass areas of waterway designed to be clear of low flow water level	2 - Unlikely	E - Minor	Low	Client					Open
4.02	Unsafe mowing of surfaces	Accident due to steep slopes	Client (Maintenance staff)	3 - Likely	D - Significant	Moderate	Channel batters to a maximum slope of 4H:1V or flatter when grassed to ensure they are ride-on lawn mower accessible. Steeper batters to be planted.	1 - Very unlikely	D - Significant	Low	Client					Open
4.03	Conflict between maintenance plant and public.	Accident due to lack of safe access for plant and adequate separation between public and maintenance plant during operation	Community	3 - Likely	C - Serious	High	Integrate into design access provision for various plant to safely enter the waterway for cleaning and maintenance access for the removal of silts. Separate plant access and public pathways where possible. Install barriers between plant and public during plant operation.	1 - Very unlikely	D - Significant	Low	Client					Open
Modification, Demolition and Dismantling Phases																
5.01	Hazardous construction materials	Dangers associated with exposure to contaminated material	Maintenance or demolition Contractor	1 - Very unlikely	B - Critical	High	Specify construction materials that do not contain contaminants	1 - Very unlikely	E - Minor	Low	Client					Open

Risk Rating Matrix								
Most Likely Consequence				Likelihood of occurrence				
	<i>People</i>	<i>Property</i>	<i>Environment</i>	<i>5 - Very likely</i> The threat is expected to occur (once per week, say)	<i>4 - Good chance</i> The threat will quite commonly occur (once per month, say)	<i>3 - Likely</i> The threat may occur occasionally (once per year, say)	<i>2 - Unlikely</i> The threat could occur infrequently (1 in 10 years, say)	<i>1 - Very unlikely</i> The threat may occur in exceptional circumstances (1 in 100 years, say)
<i>A - Disastrous</i>	Single or multiple fatality	Virtual complete loss of plant or system	Permanent widespread ecological damage, not able to be remediated	Extreme	Extreme	Extreme	Extreme	High
<i>B - Critical</i>	Disabling injury or illness i.e. amputation and/or permanent loss of bodily function, or any kind of permanent health impact	Extensive damage to plant or system	Heavy ecological damage, costly and lengthy remediation process	Extreme	Extreme	Extreme	High	High
<i>C - Serious</i>	Any lost time injury (LTI) resulting in one or more consecutive days off work or any (RWI) resulting in more than 1 week off normal duties	Significant damage to plant or system	Major ecological damage but able to be remediated	Extreme	High	High	Moderate	Moderate
<i>D - Significant</i>	A medical treatment injury (MTI) or restricted work injury (RWI) i.e. any injury resulting in less than 1 week on alternate duties	Damages impact on budget and program	Localised ecological damage, easily remediated	High	High	Moderate	Low	Low
<i>E - Minor</i>	Minor First Aid Injury or an injury not requiring treatment	Minor damage to plant or system	Negligible ecological damage, may or may not require any remediation	Moderate	Moderate	Low	Low	Low

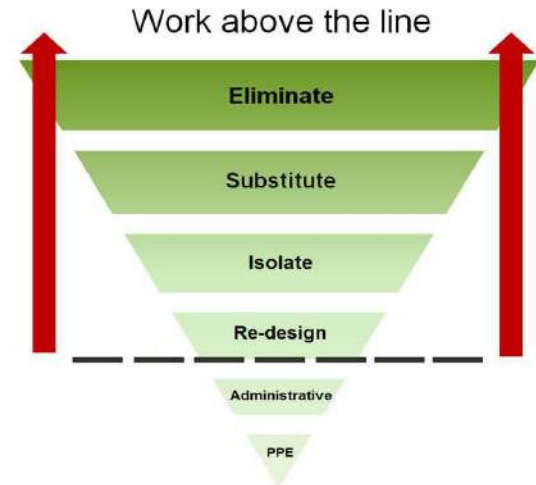
Risk Category		
Rating	Tolerability	Response
Extreme	Generally unacceptable	Further risk treatment required. Work shall not proceed without further risk assessment of the specific hazard. Acceptance of residual risk to be confirmed by Risk Owner.
High	Generally undesirable	Risks with this ranking can only be tolerated if it is not reasonably practicable to reduce the risk further. Acceptance of residual risk to be confirmed by Risk Owner.
Moderate	Generally tolerable	Risks with this ranking can be tolerated if it is not reasonably practicable to reduce the risk further.
Low	Broadly acceptable	Risks with this ranking are considered tolerable in their current form. However, if there are options for further reduction of risk level, then such measures should be considered.

Hierarchy of Control

You should attempt to remove or control the hazard in the following order:

If the hazard cannot be eliminated completely (Option 1) then apply any one or a combination of controls (Option 2) in descending order until the work can be done safely.

Option 1	Eliminate	Eliminate the hazard at its source, ie complete removal or termination of whatever is generating the hazard, could be a process, work method, equipment, material or substance, etc.
Option 2 (Control the hazard through one or a combination of these controls)	Substitute	Replace whatever is generating the hazard with a non-hazardous or less hazardous process, work method, equipment, material or substance, etc.
	Engineer / Isolate	Redesign or modify whatever is generating the hazard to control the effects of the hazard or prevent people from coming into contact with it, this includes isolating the hazard to prevent access. Engineer and re-design includes the use of barriers, guards, enclosures, engineering control systems and protective devices, re-designed layouts and work processes, design of new equipment to handle the hazardous source, etc.
	Administrate	Administrative controls include the use of procedures, training and information, signage, hours of work, etc.
	Personal Protective Equipment (PPE)	Use appropriately designed and properly fitting personal protective equipment where other controls are not practicable. <i>Note: This is not a primary control and should be considered only as a support to other controls.</i>





Aurecon New Zealand Limited

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Aurecon offices are located in:

Angola, Australia, Botswana, China,
Ghana, Hong Kong, Indonesia, Kenya,
Lesotho, Macau, Mozambique,
Namibia, New Zealand, Nigeria,
Philippines, Qatar, Singapore, South Africa,
Swaziland, Tanzania, Thailand, Uganda,
United Arab Emirates, Vietnam.

Appendix D

Preliminary Design Consent Conditions 2007

FILE

C07C/85235



10 September, 2007

Connell Wagner Limited
PO Box 1061
Christchurch

58 Kilmore Street, PO Box 345, Christchurch

General enquiries: 03 365 3828

Fax: 03 365 3194

Email: ecinfo@ecan.govt.nz

Customer services: 03 353 9007

or: 0800 EC INFO (0800 324 636)

Website: www.ecan.govt.nz

Attention to: Rob Kerr

Dear Sir/Madam

NOTICE OF RESOURCE CONSENT DECISION

NUMBER: CRC071838 AND CRC071839 AND CRC071840 AND CRC072300

NAME: Selwyn District Council

The decision of Environment Canterbury is to grant your application on the terms and conditions specified in the attached resource consent document. The reasons for the decision are:
The adverse affects on the environment are likely to be minor.

For some activities a report is prepared, with officer recommendations, to provide information to the decision makers. If you require a copy of the report please contact our Customer Services section and a copy will be provided.

If you do not agree with the consent authority decision, you may appeal to the Environment Court, P O Box 2069, Christchurch. The notice of appeal must be lodged with the Court within 15 working days of receipt of this decision, with a copy forwarded to Environment Canterbury within the same period. If you are in any doubt about the correct procedures, you should seek legal advice.

The commencement date for your resource consent is the date of this letter advising you of the decision, unless you lodge an appeal against the decision. The commencement date will then be the date on which the decision on the appeal is determined.

Enclosed is our Customer Satisfaction Survey. Please help us to provide a quality service that meets our customer needs by filling out the survey form and returning it in the postage paid envelope provided. Your feedback is anonymous unless you complete the space provided on the survey form with your name and consent number. If you would like a reply to any matters raised in your survey reply, please tick the box provided on the form.

Also enclosed is a Consent Holder Fact Sheet which you should read and keep for future reference. This fact sheet contains important information about your consent and answers some commonly asked questions about what will happen next in the life of your resource consent.

Charges, set in accordance with section 36 of the Resource Management Act 1991, shall be paid to the Regional Council for the carrying out of its functions in relation to the administration, monitoring and supervision of resource consents and for the carrying out of its functions under section 35 of the Act.

Thank you for helping us make Canterbury a great place to live.

Our Ref: CO6C/26163

Your Ref:

Contact: Customer Services

For all queries please contact our Customer Services Section by telephoning 03) 353 9007, 0800 ECINFO (0800 324 636), or email ecinfo@ecan.govt.nz quoting the CRC number above.

Yours sincerely

A handwritten signature in black ink, appearing to read 'G. Smith', written in a cursive style.

Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
on behalf Environment Canterbury
Enc

RESOURCE CONSENT

Pursuant to Section 104 of the Resource Management Act 1991

The Canterbury Regional Council (known as Environment Canterbury)

GRANTS TO: Selwyn District Council

A WATER PERMIT To divert a watercourse, being the flood overflow channel of Leeston Creek as part of a proposed residential subdivision comprising of approximately 330 lots on land which has been rezoned Living 2 and Living LXA under the Selwyn District Plan.

DATE DECISION: 24 August 2007

EXPIRY DATE: 24 August 2042

LOCATION: Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

SUBJECT TO THE FOLLOWING CONDITIONS:

- 1) The works carried out in accordance with condition (2) shall be located at Leeston Creek as shown on Plan CRC071839 at or about map reference NZMS 260 M36:5275-1675.
- 2) The works shall be limited to the diversion of Leeston Creek only when the flow immediately upstream of the diversion structure reaches 0.6 cubic metres per second or greater.
- 3) Detailed design drawings of the diversion flow path including the Manse Drain upgrade described in condition (7) shall be submitted to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, at least four weeks prior to construction commencing.
- 4) The Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, shall be notified at least 48 hours prior to the diversion being operational.
- 5) Prior to commencing excavation, a copy of this resource consent shall be given to all persons undertaking activities authorised by this consent.
- 6) The diversion channel shall be constructed in accordance with Plan CRC072300A. This shall be grassed, with a minimum coverage of 75 percent and minimum height of 25 millimetres before flow from Leeston Creek may be diverted, and shall be evenly graded to avoid any ponding areas prior to discharge to the wet pond.
- 7) The consent holder shall upgrade the capacity of Manse Road drain, from the discharge point downstream to the confluence with Leeston Creek, such that it has capacity to pass 5.89 cubic metres per second without overtopping. This shall include, but not be limited to upgrading of the culverts and widening of the channel in accordance with the drawings provided under condition (3).
- 8) The works to divert water and the diversion shall not prevent the downstream passage of any fish through the high flow diversion channel and back into Manses Road Drain and Leeston Creek.
- 9) All practicable measures shall be undertaken to ensure that the works to divert water and the diversion shall avoid the stranding of fish in pools or channels in the high flow diversion channel and Manses Road Drain.
- 10) A certificate signed by a chartered professional engineer confirming that the works were completed according to the approved design and specifications, shall be submitted to The Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager.
- 11) The diversion shall not cause erosion of the banks and bed of any watercourse.

Environment Canterbury is the promotional name of the Canterbury Regional Council

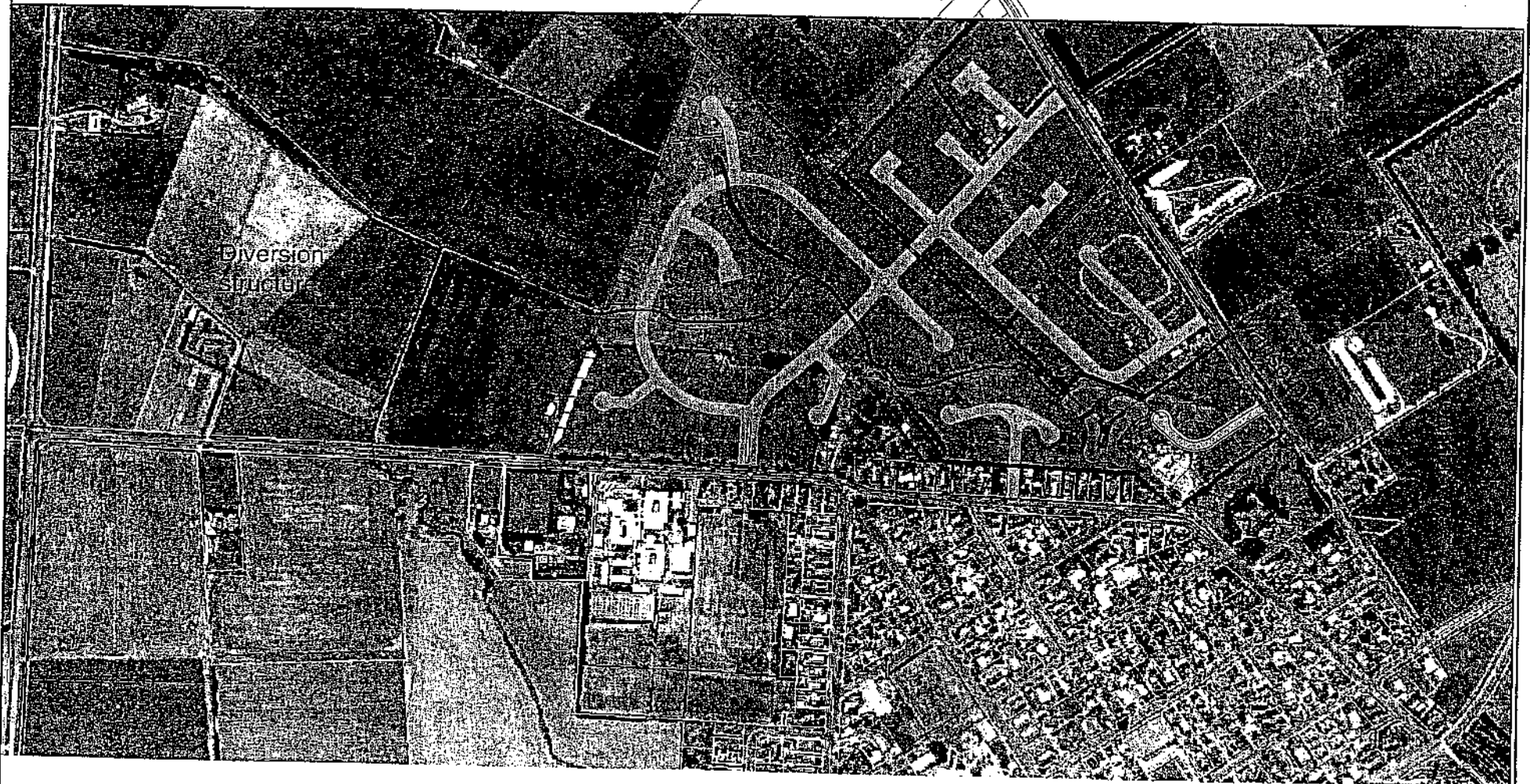
- 12) Following any operation of the diversion, the consent holder shall undertake the following actions within 48 hours after flows have ceased into the high flow diversion channel:
- (a) Complete a visual inspection of the high flow diversion channel and Manses Road Drain.
 - (b) Record the location and number of any stranded fish.
 - (c) Immediately advise the North Canterbury Fish and Game Council and the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, of any fish strandings, including the location and number of fish stranded.
 - (d) Record the location of any visible bed or bank erosion.
 - (e) Undertake remedial work where necessary and install protection works within 10 working days to ensure that further erosion does not occur.
 - (f) Immediately advise the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, of any works required prior to works being undertaken.
- 13) The consent holder shall negotiate with the landowners between the diversion structure and Leeston Township, within two months of the granting of this consent, with a view to installing a fenced and planted buffer strip of at least 2 metres width on each side of Leeston Creek, and an alternative water supply for cattle where possible.
- 14) The Canterbury Regional Council may, once per year, on any of the last five working days of May or November, serve notice of its intention to review the conditions of this consent for the purposes of dealing with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage.
- 15) The lapsing date for the purposes of section 125 shall be 30 September 2012.

Issued at Christchurch on 10 September 2007



Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
on behalf of the Canterbury Regional Council

Plan CRC071839



Connell Wagner Connell Wagner Limited Level 4, Commerce Centre, 125 Main Street PO Box 65411 Christchurch 8140 New Zealand Telephone: +64 (0) 3 366 9921 Facsimile: +64 (0) 3 379 9322 Email: c.wagner@connellwagner.com		Selwyn District Council		Project: LEESTON NORTH STORMWATER PLAN		PRELIMINARY NOT FOR CONSTRUCTION Project No: 19482 Scale: 1:2000 Drawing No: C01.09	
Revision: 01 Date: 01-02-07 Description: PRELIMINARY PLAN		Drawn: JRD Checked: JRD Date: 05-06		Designed: RK Signed: RK Date: 06-06		Drawing Title: DIVERSION GENERAL ARRANGEMENT	
Rev: 01 Date: 01-02-07 Description: PRELIMINARY PLAN		Drawn: JRD Checked: JRD Date: 05-06		Designed: RK Signed: RK Date: 06-06		Drawing Title: DIVERSION GENERAL ARRANGEMENT	
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Exercising of resource consent

It is important that you notify Environment Canterbury when you first start using your consent.

GRANTED TO:
A WATER PERMIT

Selwyn District Council

To divert a watercourse, being the flood overflow channel of Leeston Creek as part of a proposed residential subdivision comprising of approximately 330 lots on land which has been rezoned Living 2 and Living LXA under the Selwyn District Plan.

LOCATION:

Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

Even if the consent is replacing a previous consent for the same activity, you need to complete and return this page.

Providing this information will:

- Validate your consent through to its expiry date
- Minimise compliance monitoring charges
- Help provide an accurate picture of the state of the environment.

If consent CRC071839 is not used before 30/09/2012 this consent will lapse and no longer be valid.

Declaration:

I have started using this resource consent.

Action taken: (e.g. pasture irrigated, discharge from septic tank/boiler/spray booth etc).

Approximate start date: _____

Signed: _____ **Date:** _____

Full name of person signing (please print): _____

Please return to:

Environmental Protection - Administration
Environment Canterbury
PO Box 345
Christchurch

FILE

C/7C/185239



10 September, 2007

Connell Wagner Limited
PO Box 1061
Christchurch

58 Kilmore Street, PO Box 345, Christchurch

General enquiries: 03 365 3828

Fax: 03 365 3194

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or: 0800 EC INFO (0800 324 636)

Website: www.ecan.govt.nz

Attention to: Rob Kerr

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Thank you for helping us make Canterbury a great place to live.

Our Ref: CO6C/26163
Your Ref:
Contact: Customer Services

For all queries please contact our Customer Services Section by telephoning 03) 353 9007, 0800 ECINFO (0800 324 636), or email ecinfo@ecan.govt.nz quoting the CRC number above.

Yours sincerely

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Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
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The Canterbury Regional Council (known as Environment Canterbury)

GRANTS TO: Selwyn District Council

A LAND USE CONSENT To undertake works in a watercourse to establish the overflow for the flood overflow channel in Leeston Creek as part of a proposed residential subdivision comprising of approximately 330 lots on land which has been rezoned Living 2 and Living LXA under the Selwyn District Plan.

DATE DECISION: 24 August 2007 **EXPIRY DATE:** 24 August 2042

LOCATION: Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

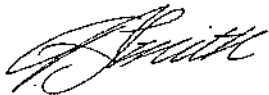
SUBJECT TO THE FOLLOWING CONDITIONS:

- 1) The works carried out in accordance with condition (2) shall be located at Leeston Creek as shown on Plan CRC071839 at or about map reference NZMS 260 M36:5275-1675.
- 2) The works shall be limited to the construction and maintenance of a lined channel and gabion weir in accordance with Plan CRC071840A.
- 3) The Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, shall be notified not less than 48 hours prior to the commencement of works.
- 4) Prior to commencing excavation, a copy of this resource consent shall be given to all persons undertaking activities authorised by this consent.
- 5) The consent holder shall negotiate with the landowners between the diversion structure and Leeston Township, within two months of the granting of this consent, with a view to installing a fenced and planted buffer strip of at least 2 metres width on each side of Leeston Creek, and an alternative water supply for cattle where possible.
- 6) The drain along the Christchurch District Hospital Board land shall be enhanced with native planting in accordance with Plan CRC071840B.
- 7) The consent holder shall adopt the best practicable options to:
 - (a) Minimise soil disturbance and prevent soil erosion;
 - (b) Prevent sediment from flowing into any surface water; and
 - (c) Avoid placing cut or cleared vegetation, debris, or excavated material in a position such that it may enter surface water.
 Including, but not limited to planting, regrassing, or alternative stabilisation of all exposed disturbed areas, as soon as practicable following completion of the works.
- 8) Works shall not cause erosion of the banks and bed of Leeston Creek or the diversion channel.
- 9)
 - (a) All practicable measures shall be undertaken to prevent oil and fuel leaks from vehicles and machinery;
 - (b) There shall be no storage of fuel or refuelling of vehicles and machinery within 20 metres of the bed of a river; and
 - (c) Fuel shall be stored securely or removed from site overnight.

Environment Canterbury is the promotional name of the Canterbury Regional Council

- 10) (a) The consent holder shall take all practicable steps to avoid cementitious material entering the watercourse including waste wash water from tools and machinery; and
(b) Cement shall be stored securely or removed from site overnight.
- 11) The works shall not prevent the passage of fish, or cause the stranding of fish in pools or channels.
- 12) All spoil and other waste material from the works shall be removed from site on completion of works.
- 13) All practicable measures shall be undertaken to minimise adverse effects on property, amenity values, wildlife, vegetation, and ecological values.
- 14) A certificate signed by a chartered professional engineer confirming that the structure was constructed according to the approved design and specifications, shall be submitted to The Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager.
- 15) In the event of any damage to the diversion structure the consent holder shall maintain the flood carrying capacity of Leeston Creek and the diversion channel and take all practicable measures to minimise erosion.
- 16) The Canterbury Regional Council may, once per year, on any of the last five working days of May or November, serve notice of its intention to review the conditions of this consent for the purposes of dealing with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage.
- 17) The lapsing date for the purposes of section 125 shall be 30 September 2012.

Issued at Christchurch on 10 September 2007

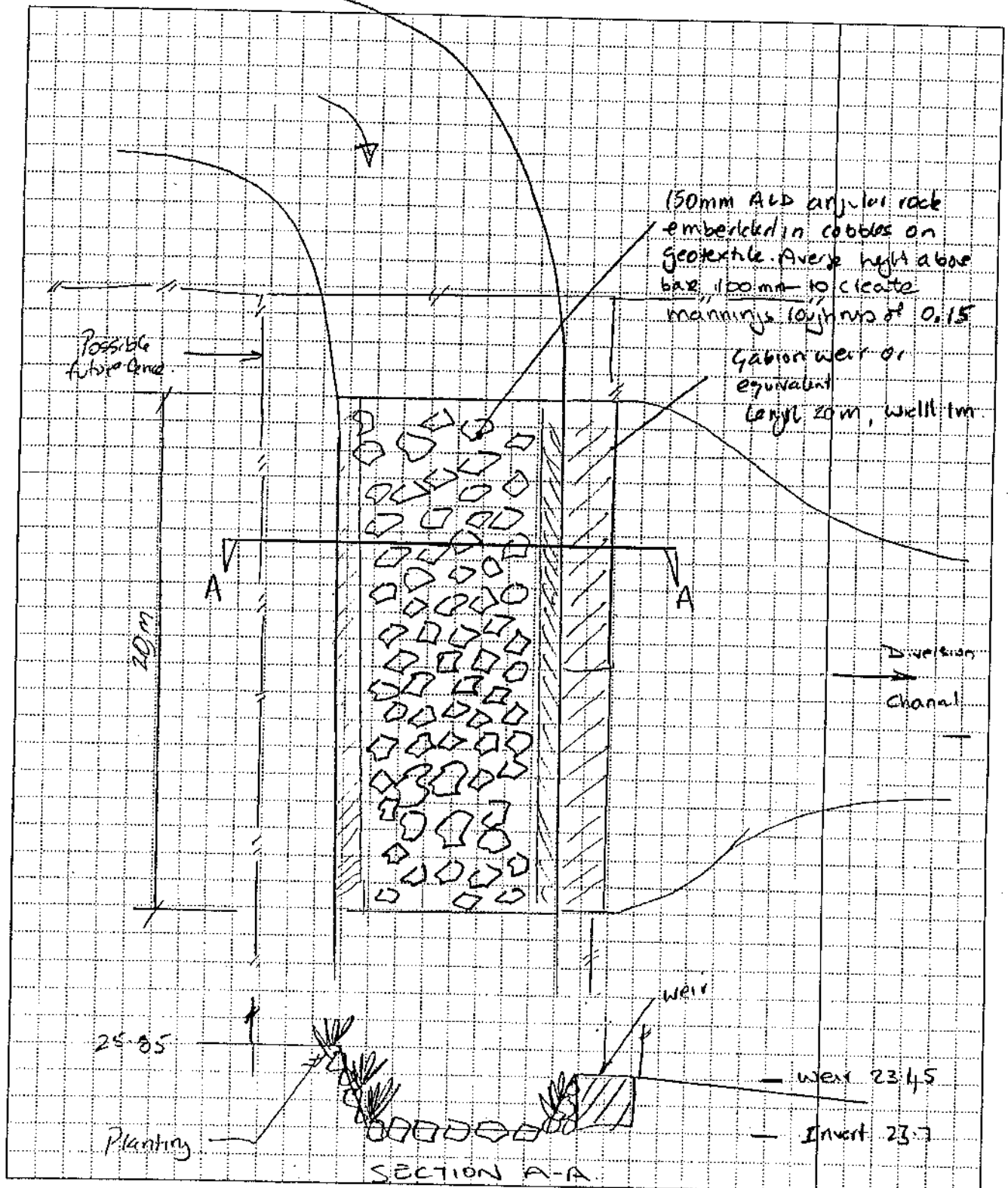


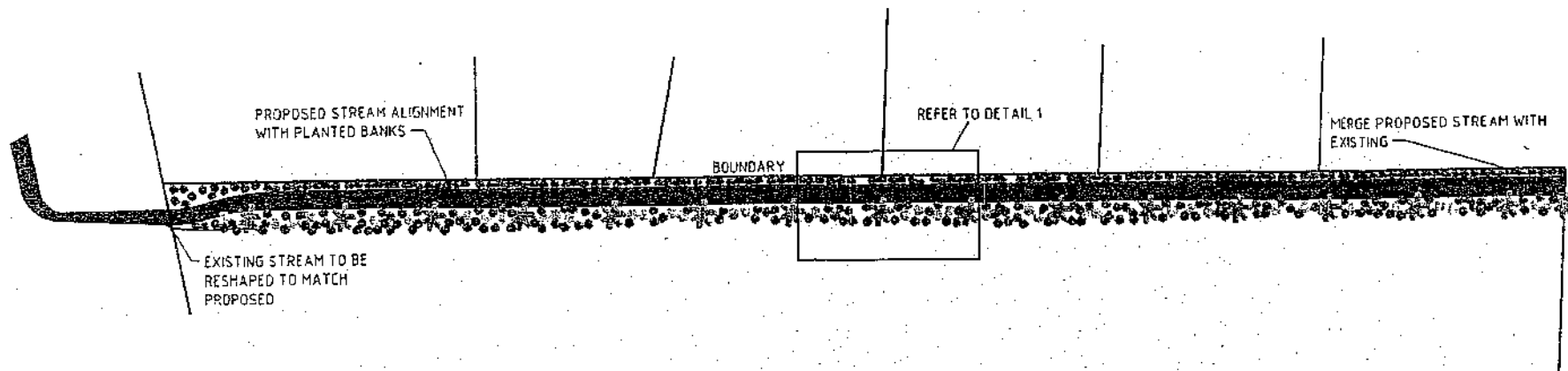
Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
on behalf of the Canterbury Regional Council

Environment Canterbury is the promotional name of the Canterbury Regional Council

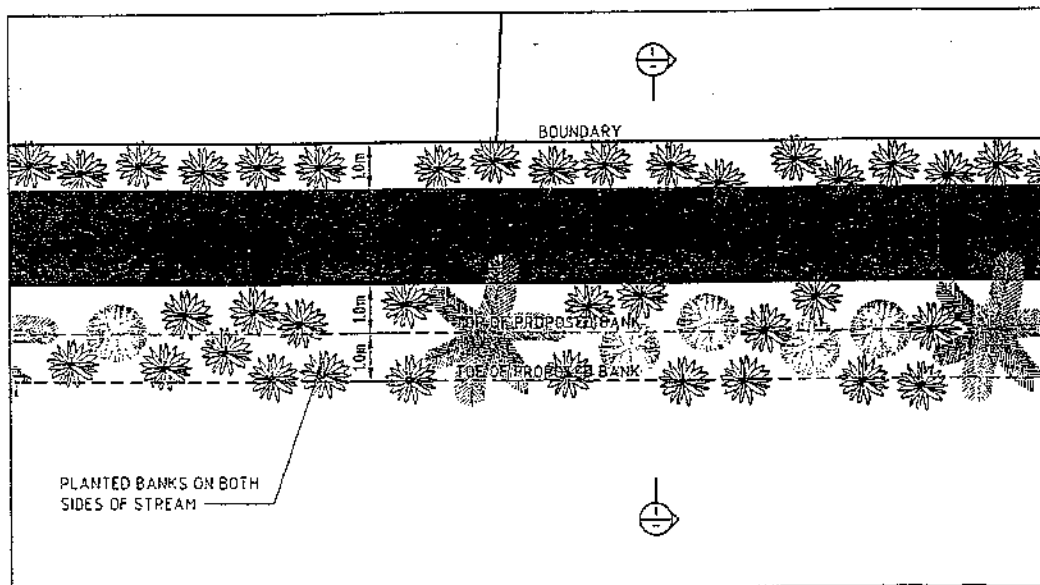
Plan CRC 071840 A

Client: SDC	Date: 15/5/07.
Project/Job: Leeton North Stormwater	Job No: 19482
Subject: Revised Diversion Arrangement	Sheet No: 1
	By: RLC

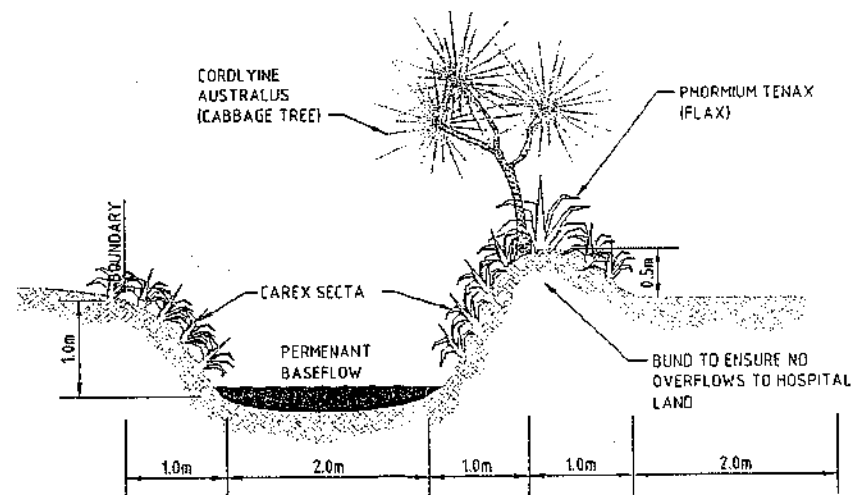




LAYOUT PLAN
1500



DETAIL 1
1:100



SECTION
150



Plan CRC 071 840 B

PRELIMINARY
NOT FOR CONSTRUCTION

Connell Wagner Connell Wagner Limited Level 4, Tarran House 100, Havelock St. P.O. Box 108-19 Christchurch, New Zealand Telephone: +64 3 325 0971 Facsimile: +64 3 271 8938 Email: cwa@cwnw.co.nz			
07	11.06	PRELIMINARY	CH
Rev	Date	Reason for Details	Drawn by



Project:
**LEESTON NORTH
STORMWATER
PLAN**

Drawn	Signed	Date
CM	CM	11.06
Designed	Signed	Date
RK	RK	11.06
Verified	Signed	Date
Approved	Signed	Date

Drawing title:
**PROPOSED
NATURALISED WATERWAY
CDHB BOUNDARY**

Project No	19482
Scale	AS SHOWN
Drawing No	C01.07
Sheet Size	A3
Rev.	01

Exercising of resource consent

It is important that you notify Environment Canterbury when you first start using your consent.

**GRANTED TO:
A LAND USE CONSENT**

Selwyn District Council

To undertake works in a watercourse to establish the overflow for the flood overflow channel in Leeston Creek as part of a proposed residential subdivision comprising of approximately 330 lots on land which has been rezoned Living 2 and Living LXA under the Selwyn District Plan.
Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

LOCATION:

Even if the consent is replacing a previous consent for the same activity, you need to complete and return this page.

Providing this information will:

- Validate your consent through to its expiry date
- Minimise compliance monitoring charges
- Help provide an accurate picture of the state of the environment.

If consent CRC071840 is not used before 30/09/2012 this consent will lapse and no longer be valid.

Declaration:

I have started using this resource consent.

Action taken: (e.g. pasture irrigated, discharge from septic tank/boiler/spray booth etc).

Approximate start date: _____

Signed: _____ **Date:** _____

Full name of person signing (please print): _____

Please return to:

Environmental Protection - Administration
Environment Canterbury
PO Box 345
Christchurch

FILE

C87C/85241



10 September, 2007

Connell Wagner Limited
PO Box 1061
Christchurch

58 Kilmore Street, PO Box 345, Christchurch

General enquiries: 03 365 3828

Fax: 03 365 3194

Email: ecinfo@ecan.govt.nz

Customer services: 03 353 9007

or: 0800 EC INFO (0800 324 636)

Website: www.ecan.govt.nz

Attention to: Rob Kerr

Dear Sir/Madam

NOTICE OF RESOURCE CONSENT DECISION

NUMBER: CRC071838 AND CRC071839 AND CRC071840 AND CRC072300

NAME: Selwyn District Council

The decision of Environment Canterbury is to grant your application on the terms and conditions specified in the attached resource consent document. The reasons for the decision are:
The adverse affects on the environment are likely to be minor.

For some activities a report is prepared, with officer recommendations, to provide information to the decision makers. If you require a copy of the report please contact our Customer Services section and a copy will be provided.

If you do not agree with the consent authority decision, you may appeal to the Environment Court, P O Box 2069, Christchurch. The notice of appeal must be lodged with the Court within 15 working days of receipt of this decision, with a copy forwarded to Environment Canterbury within the same period. If you are in any doubt about the correct procedures, you should seek legal advice.

The commencement date for your resource consent is the date of this letter advising you of the decision, unless you lodge an appeal against the decision. The commencement date will then be the date on which the decision on the appeal is determined.

Enclosed is our Customer Satisfaction Survey. Please help us to provide a quality service that meets our customer needs by filling out the survey form and returning it in the postage paid envelope provided. Your feedback is anonymous unless you complete the space provided on the survey form with your name and consent number. If you would like a reply to any matters raised in your survey reply, please tick the box provided on the form.

Also enclosed is a Consent Holder Fact Sheet which you should read and keep for future reference. This fact sheet contains important information about your consent and answers some commonly asked questions about what will happen next in the life of your resource consent.

Charges, set in accordance with section 36 of the Resource Management Act 1991, shall be paid to the Regional Council for the carrying out of its functions in relation to the administration, monitoring and supervision of resource consents and for the carrying out of its functions under section 35 of the Act.

Thank you for helping us make Canterbury a great place to live.

Our Ref: CO6C/26163

Your Ref:

Contact: Customer Services

For all queries please contact our Customer Services Section by telephoning 03) 353 9007, 0800 ECINFO (0800 324 636), or email ecinfo@ecan.govt.nz quoting the CRC number above.

Yours sincerely

A handwritten signature in black ink, appearing to read 'G. Smith', written in a cursive style.

Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
on behalf Environment Canterbury
Enc

RESOURCE CONSENT

Pursuant to Section 104 of the Resource Management Act 1991
The Canterbury Regional Council (known as Environment Canterbury)

GRANTS TO: Selwyn District Council

A LAND USE CONSENT To excavate soil from over a confined aquifer for the creation of a new channel and wetland.

DATE DECISION: 24 August 2007

EXPIRY DATE: 24 August 2042

LOCATION: Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

SUBJECT TO THE FOLLOWING CONDITIONS:

- 1) The works carried out in accordance with condition (2) shall be located at the Leeston North subdivision as shown on Plan CRC072300A at or about map reference NZMS 260 M36.5361-1663.
- 2) In accordance with Plan CRC072300A the works shall be limited to:
 - (a) The construction of a wet pond;
 - (b) The construction of a wetland; and
 - (c) The construction of a diversion channel.
- 3) The Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, shall be notified not less than 48 hours prior to the commencement of works.
- 4) Prior to commencing excavation, a copy of this resource consent shall be given to all persons undertaking activities authorised by this consent.
- 5) The consent holder shall adopt the best practicable options to:
 - (a) Minimise soil disturbance and prevent soil erosion;
 - (b) Prevent sediment from flowing into any surface water; and
 - (c) Avoid placing cut or cleared vegetation, debris, or excavated material in a position such that it may enter surface water.

Including, but not limited to constructing the wet pond first and utilising it as a sediment retention pond with all runoff from the associated works diverted to the wet pond during construction, planting, regrassing or alternative stabilisation of all exposed disturbed areas, as soon as practicable following completion of the works.
- 6) Spoil disposal sites shall be sited and rehabilitated to prevent sediment entering any surface water body.
- 7)
 - (a) All practicable measures shall be undertaken to prevent oil and fuel leaks from vehicles and machinery;
 - (b) There shall be no storage of fuel or refuelling of vehicles and machinery within 20 metres of the bed of a river; and
 - (c) Fuel shall be stored securely or removed from site overnight.
- 8) All spoil and other waste material from the works shall be removed from site on completion of works.
- 9) The Canterbury Regional Council may, once per year, on any of the last five working days of May or November, serve notice of its intention to review the conditions of this consent for the purposes of dealing with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage.

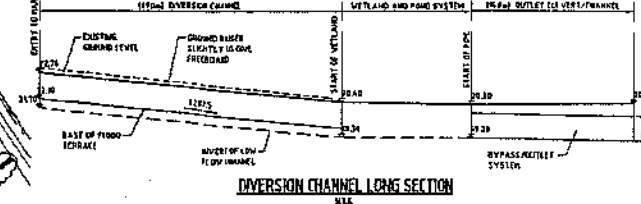
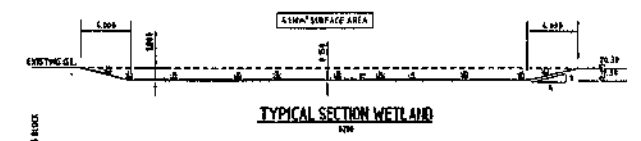
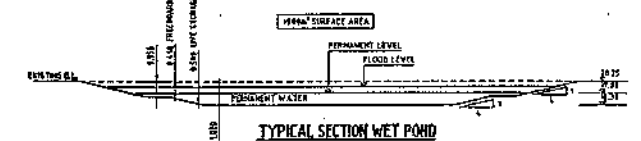
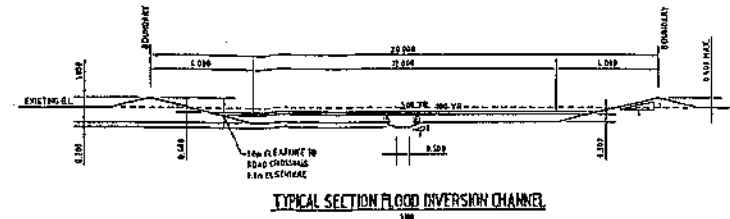
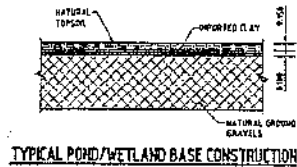
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- 10) The lapsing date for the purposes of section 125 shall be 30 September 2012.

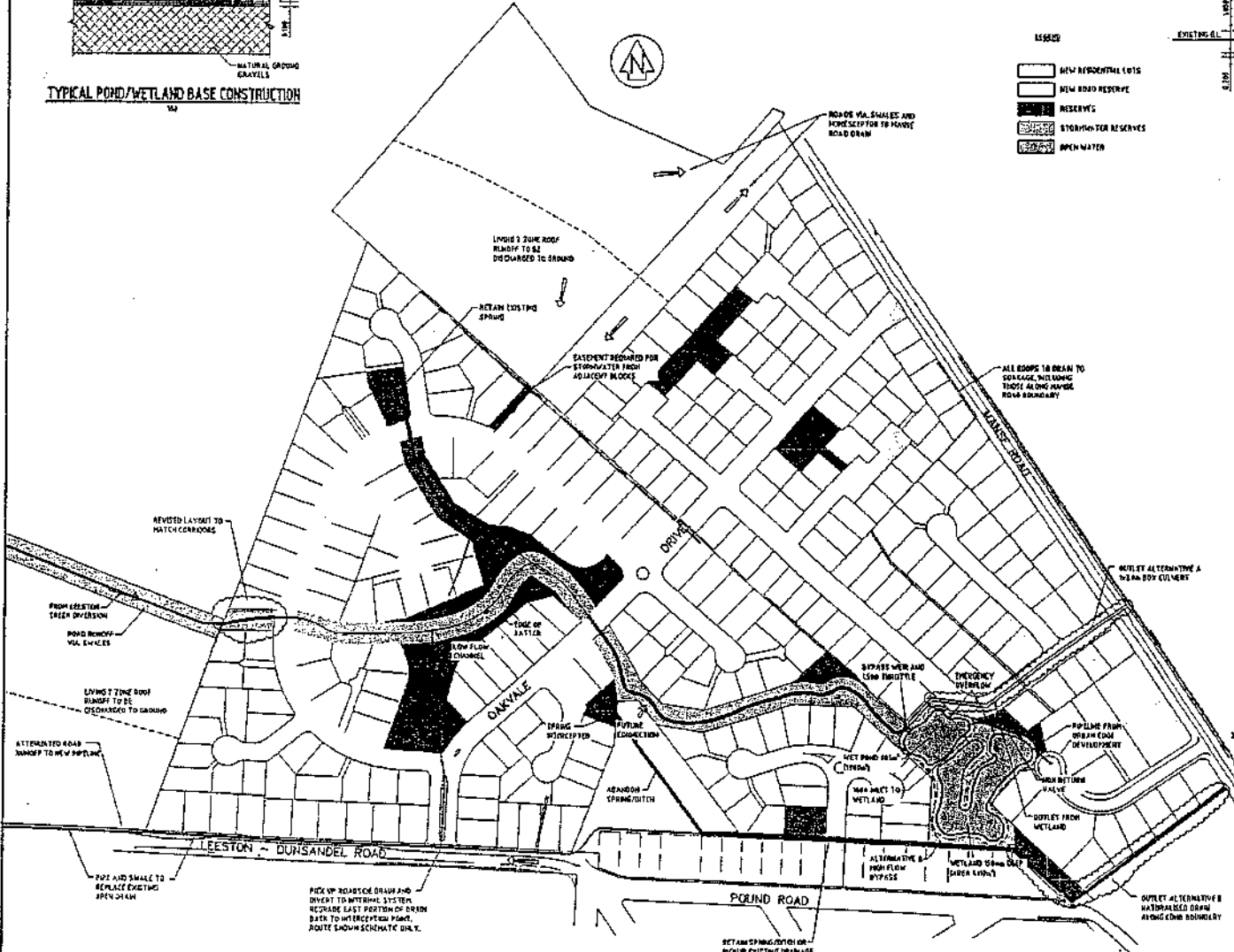
Issued at Christchurch on 10 September 2007



Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
on behalf of the Canterbury Regional Council



- NOTES:
1. ON SITE STORAGE
 2. TYPICAL RESIDENTIAL COTS
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PLAN 1301 Plan CRC 072300 A

BASE DRAWINGS PROVIDED BY ELIOT SNEILAIR PARTNERS

Rev.	Date	Revision Details	Drn.	Ver.	App.
03	1-12-06	PRELIMINARY, MINOR ALTERATIONS	JRD		
02	2-29-06	PRELIMINARY, CO-ORDINATES ADDED AND MINOR AMENDMENTS	JRD		
01	24-08-06	PRELIMINARY ISSUE	JRD		

Cornell Wagner

Cornell Wagner Limited
 Level 4, Torbay House, 188 Howard St.
 (P.O. Box 1001) Christchurch New Zealand
 Telephone: +64 3 366 0821
 Facsimile: +64 3 378 8643
 Email: cwn@cornellwagner.co.nz

Selwyn DISTRICT COUNCIL

Project: LEESTON NORTH STORMWATER PLAN

Drawn	Checked	Date	Drawing Title
JRD	JRD	08-06	STORMWATER CATCHMENT PLAN AND DETAILS
RR	RR	08-06	
RR	RR		
RR	RR		
RR	RR		

PRELIMINARY NOT FOR CONSTRUCTION

Project No. 19482

Scale: A.S. SHOWN

Sheet No. A1

Drawing No. C01.01

Rev. 03

Consent No:

CRC072300

Our Ref:

CO6C/26163

Exercising of resource consent

It is important that you notify Environment Canterbury when you first start using your consent.

GRANTED TO:

Selwyn District Council

A LAND USE CONSENT

To excavate soil from over a confined aquifer for the creation of a new channel and wetland at or about map reference.

LOCATION:

Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

Even if the consent is replacing a previous consent for the same activity, you need to complete and return this page.

Providing this information will:

- Validate your consent through to its expiry date
- Minimise compliance monitoring charges
- Help provide an accurate picture of the state of the environment.

If consent CRC072300 is not used before 30/09/2012 this consent will lapse and no longer be valid.

Declaration:

I have started using this resource consent.

Action taken: (e.g. pasture irrigated, discharge from septic tank/boiler/spray booth etc).

Approximate start date: _____

Signed: _____ **Date:** _____

Full name of person signing (please print): _____

Please return to:

Environmental Protection - Administration
Environment Canterbury
PO Box 345
Christchurch



**Environment
Canterbury**

29 July 2009

Consents Operations Section
Environment Canterbury
PO Box 354
CHRISTCHURCH 8140

Attention: Consenting Officer

EC - CHCH	
FILE REF: <i>COR/76163</i>	
DOCUMENT No.: <i>78688</i>	
- 3 AUG 2009	
ACTION	INFO
<i>V. Johnston</i>	

Dear Sir/Madam

LEESTON NORTH – VARIATION TO A CONDITION OF RESOURCE CONSENT

The purpose of this letter is to apply for a variation to resource consent CRC071838 conditions 8, 9, 14, 20, 22, 23, 24, 26 and 30 which will:

- Allow for staged development and construction of the proposed wetland system,
- Remove ambiguity of current clauses, and
- Provide for a site specific design solution.

Please phone me on 03 347 2972 should you wish any further information or clarification.

Yours faithfully



Murray England
STORMWATER ENGINEER

Encl:

- Copy of original resource consent CRC071838 including attachments,
- Form CON570: Change or cancel a condition of a resource consent,
- An Assessment of Effects on the Environment (AEE), and
- A deposit for a change of conditions.

RESOURCE CONSENT

Pursuant to Section 104 of the Resource Management Act 1991

The Canterbury Regional Council (known as Environment Canterbury)

GRANTS TO: Selwyn District Council

A DISCHARGE PERMIT To discharge stormwater.

DATE DECISION: 24 August 2007

EXPIRY DATE: 24 August 2042

LOCATION: Pound Road Leeston, Dunsandel Road & Manses Road, LEESTON

SUBJECT TO THE FOLLOWING CONDITIONS:

- 1) The discharge shall be only stormwater from the approximately 49.7 hectare residential subdivision north of Leeston township and within Lot 3 DP 33419, Lot 20 DP 37174, Lot 1 and 2 DP 69912, Lot 3 DP 6655, Lot 1 DP 6760, Lot 1 DP 16979 and Lot 2 DP 365379 (excluding certain areas) as shown on Plan 19482 C01.02 which forms part of the consent.

- 2) The discharge shall be only stormwater from:
 - (a) Roofs;
 - (b) Hardstand areas;
 - (c) Roading; and
 - (d) During construction of the subdivision.

STORMWATER SYSTEM

- 3) Stormwater from roofs shall be discharged:
 - (a) Into land within each lot;
 - (b) Via a sealed system that excludes all other stormwater; and
 - (c) Via precast concrete soakage chambers designed and constructed in accordance with Plan 19482 C02.01 Rev 03 with not less than 1.95m³ of storage capacity above the groundwater level.
- 4) The roof stormwater system specified in condition (3) shall have sufficient capacity to infiltrate stormwater from storm events up to and including all 10 percent Annual Exceedence Probability (AEP) events, regardless of duration.
- 5) Stormwater from roofs that exceeds the capacity of the roof stormwater system specified in condition (3), shall be discharged to roading and/or reserve areas within the subdivision.
- 6) Stormwater from hardstand areas and roading shall be conveyed to the community stormwater system.
- 7) Subject to condition (10), stormwater from hardstand areas shall be conveyed to the community stormwater system via a pre treatment system which shall be either:
 - (a) A swale of at least 20 metres in length designed in accordance with the CCC Waterways, Wetlands and Drainage design guide, 2003; or
 - (b) A Humeceptor, or similar proprietary device capable the same or better levels of contaminant removal, of at least the minimum size for the total hardstand area contributing stormwater to the device as shown in Table CRC071838A, which forms part of this consent.
- 8) The community stormwater system shall comprise a wetpond and wetland.

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**Environment
Canterbury**

- 9) The wetpond and wetland shall:
- (a) Have capacity to accommodate the first 25 millimetres of rain from all hardstand areas and roading;
 - (b) Provide a hydraulic residence time of 96 hours; and
 - (c) Have a minimum volume of 1287 cubic metres available to attenuate flows.
- 10) Stormwater from hardstand areas within the portions of Lot 1 DP 6760 and Lot 1 DP 16979 shown on Plan 19482 C01.01 and C01.02 as the Cooper and MacKenzie blocks shall be via the pre treatment system described in condition (7), and then to a Humeceptor or similar proprietary device designed to remove 75 percent of suspended solids, of at least the minimum size for the total hardstand area contributing stormwater to the device as shown in Table CRC071838A, which forms part of this consent.
- 11) Stormwater from the community stormwater system shall be discharged into Manse Drain at map reference NZMS 260 M36: 5386-1652 or NZMS M36: 260 5375-1668.
- 12) Stormwater from the Cooper and MacKenzie blocks shall be discharged into Manse Drain at map reference NZMS 260 M36: 5346-1712.
- 13) The internal swale and piped stormwater system shall be designed to accommodate the critical duration 10 percent AEP storm event without surface ponding above ground or outside the swales.
- 14) Overland flow paths from the wetpond and wetland, and where required elsewhere in the subdivision, shall be provided to accommodate the two percent AEP event regardless of duration without encroaching on habitable flooring levels.
- 15) At least one month prior to the construction of the stormwater system, the consent holder shall submit to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, design plans of the stormwater system to be installed.
- 16) A certificate signed by the person responsible for designing the stormwater system, or by a suitably qualified person, shall be submitted to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, to certify that the stormwater system is constructed and installed in accordance with the design plans and conditions (3) to (14) of this consent.
- EROSION AND SEDIMENT CONTROL**
- 17) The discharge to Manse Drain shall not cause erosion or scouring of the banks of Manse Drain at the discharge point, or where Manse Drain discharges to Leeston Creek.
- 18) Prior to commencing construction of the subdivision, an erosion and sediment control plan shall be prepared in accordance with Environment Canterbury's Erosion and Sediment Control Guidelines (2007) and submitted to Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, a minimum of two weeks prior to commencement of construction of the subdivision. The purpose of this plan is to reduce the sediment laden stormwater discharges during construction.
- 19) Prior to the commencement of earthworks on site a certificate signed by the person responsible for designing the erosion and sediment control plan shall be submitted to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, to certify that the erosion and sediment control measures are constructed and installed in accordance with the plan.
- INSPECTION, MAINTENANCE AND MONITORING**
- 20) The proprietary devices and swales shall be inspected at least once every six months. Any visible hydrocarbons, accumulated sediment, and litter or debris in the stormwater system shall be removed immediately.

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- 21) The proprietary devices shall be maintained by:
- (a) The pumping out of sediments and oil at least annually or when the sediment depth exceeds 200 millimetres.
 - (b) Immediate cleaning after a spill by a licensed liquid waste management company. Any material removed shall be disposed of at an appropriate facility.
- 22) The swales shall be maintained with at least 50 millimetres of grass. The grass in the swales shall be maintained in a healthy condition however, the grass in the swales does not need to be irrigated and the grass may be allowed to brown in the summer.
- 23) The wetpond and wetland shall be inspected at least once every three months and following any rain event greater than 15 millimetres. Any visible hydrocarbons, accumulated sediment, and litter or debris in the stormwater system shall be removed immediately.
- 24) An Operations and Maintenance manual shall be developed which shall detail the maintenance of the wetpond and wetland system and the proprietary devices. The manual shall be submitted to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, a minimum of four weeks following completion of construction of the stormwater system.
- 25) Sump inverts, their gratings, covers, seatings and outlet pipes shall be cleaned at least six monthly in the autumn and spring. Debris shall not be pushed into the outlet pipes during cleaning of the sumps.
- 26) Each year, on two occasions, separated by a minimum of two months, the following shall occur:
- (a) Composite flow weighted samples, shall be collected from the wetland
 - (b) Discharge and the MacKenzie/Cooper block discharge
 - (c) Samples shall be taken by autosampler and triggered by flow monitor, with a minimum of 15 aliquots, during a storm event greater than five millimetres depth (c) composite samples shall be analysed by a laboratory accredited by International Accreditation New Zealand or an equivalent body. The annual average event mean contaminant concentrations in the discharge from both locations shall not exceed the following trigger values.

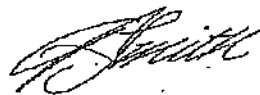
Contaminant	Trigger Value (mg/l)
Total Suspended Solids	50
Total Nitrogen	1.2
Total Phosphorus	0.15
5 Day Biological Oxygen Demand	3.92
Zinc	0.144
Lead	0.027
Copper	0.018
Total Petroleum Hydrocarbons	0.2

- (a) All sampling required under this consent shall be undertaken by a qualified and experienced person using the most appropriate scientifically recognised and current methods; and
 - (b) All samples taken shall be analysed using the most appropriate scientifically recognised and current method by a laboratory that is accredited for that method of analysis;
- 27) Where the annual average of event mean concentrations are above the trigger values the Consent Holder shall:
- (a) Investigate the likely source of the contaminants;
 - (b) Investigate likely effects of contaminants on receiving environment; and
 - (c) Undertake all practical measures to address the exceedence.

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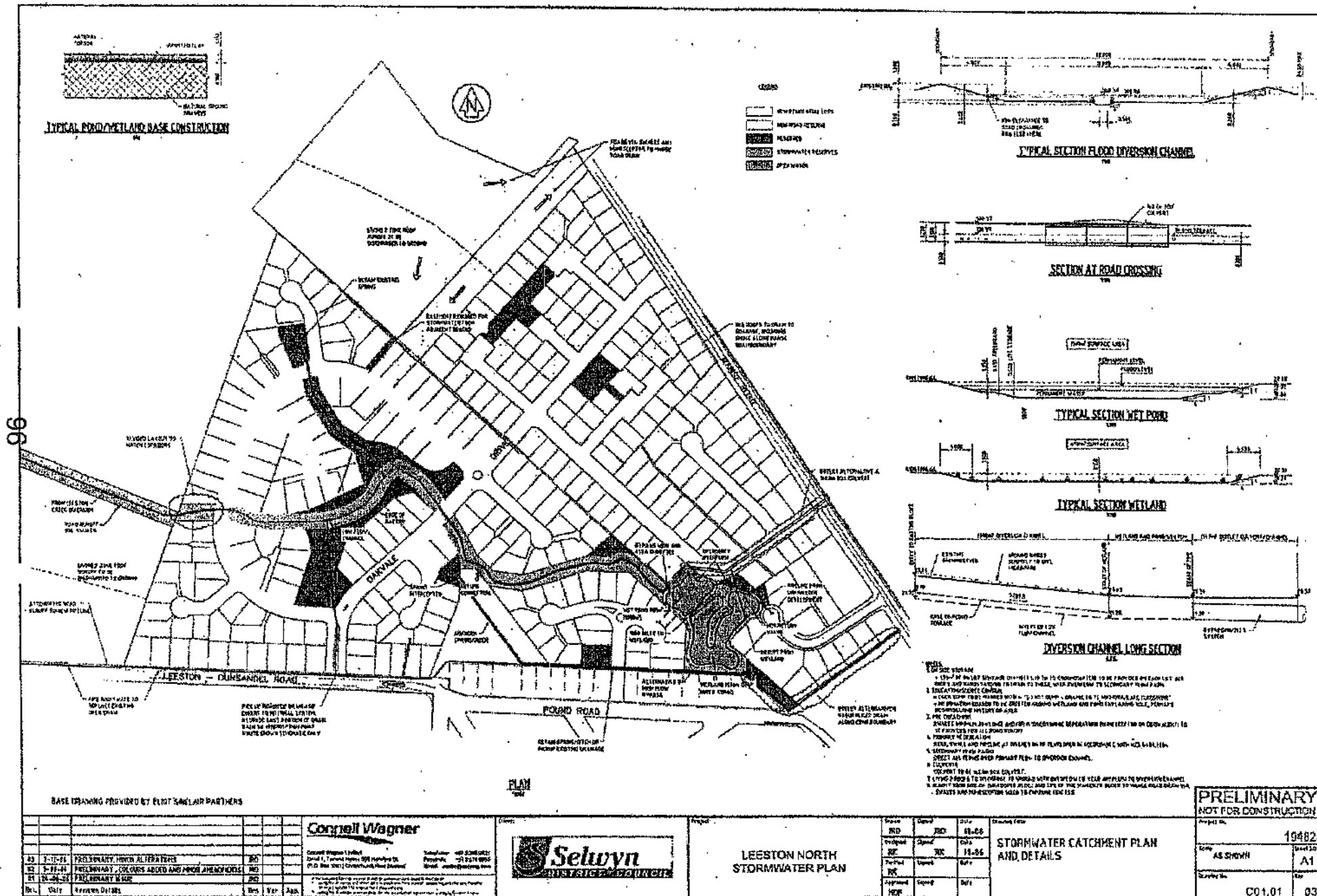
- 28) The consent holder shall submit a stormwater management report each year to the Canterbury Regional Council, Attention: RMA Compliance and Enforcement Manager, prior to the 30 November. The report shall detail the results of monitoring carried out from 1 July to 30 June each year including:
- (a) The name of the person who collected the samples, the date and time the samples collected;
 - (b) The results of all sample analyses;
 - (c) Rainfall records for the corresponding rainfall events sampled;
 - (d) An interpretation of the trends in temporal and seasonal stormwater discharge quality including comparisons to previous years monitoring; and
 - (e) Documentation of actions and findings under condition (27) if an exceedence of the trigger levels occurred.
- 29) The consent holder shall keep records of all inspections, maintenance and monitoring undertaken. These records shall be made available to the Canterbury Regional Council on request. These records shall include, but not be limited to:
- (a) Date and details of inspections of the stormwater system;
 - (b) Date and details of any maintenance work, accidental spills, repairs and upgrades to the stormwater system, including removal of material and its disposal; and
 - (c) Monitoring data, interpretation of results and any complaints about the stormwater discharge.
- OTHER MITIGATION**
- 30) The consent holder shall upgrade the capacity of Manse Road drain, from the discharge point downstream to the confluence with Leeston Creek, such that it has capacity to pass 5.89 cubic metres per second without overtopping. This shall include, but not be limited to upgrading of the culverts and widening of the channel.
- 31) Roof cladding, spouting and down pipes shall not contain zinc or copper or shall be sealed against leaching of copper or zinc for the life of the building or the duration of the consent, whichever is greater.
- ADMINISTRATION**
- 32) The Canterbury Regional Council may, on any of the last five days of September each year, serve notice of its intention to review the conditions of the consents for the purposes of:
- (a) Dealing with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage; or
 - (b) Requiring the adoption of the best practicable option to remove or reduce any adverse effect on the environment.
- 33) The lapsing date for the purposes of Section 125 shall be 30 September 2012.

Issued at Christchurch on 10 September 2007

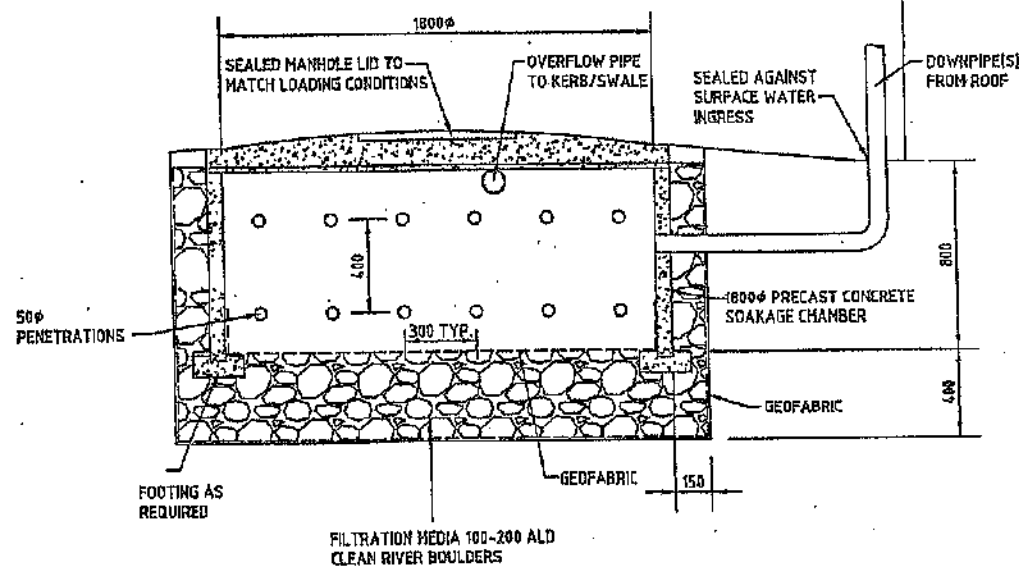
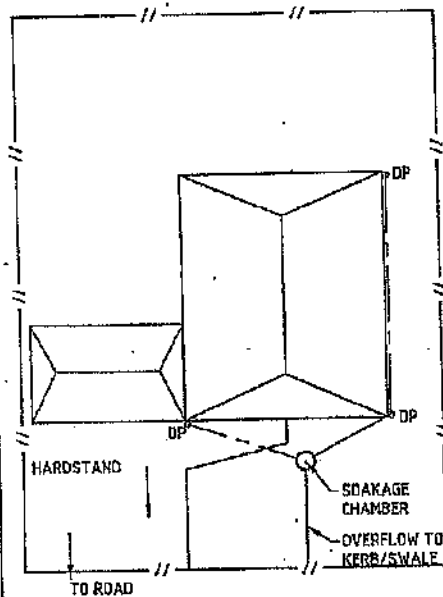


Gaynor Smith
TEAM LEADER CONSENTS OPERATIONS
 on behalf of the Canterbury Regional Council

Environment Canterbury is the promotional name of the Canterbury Regional Council



95

**NOTES:**

1. ALTERNATIVE DESIGNS WHICH PROVIDE THE EQUIVALENT STORAGE VOLUME ARE ACCEPTABLE SUBJECT TO SELWYN DISTRICT COUNCIL APPROVAL. THESE MAY INCLUDE ROCK FILLED PITS (POROSITY 0.38), ACQUIFLOW CHAMBERS OR MULTIPLE CHAMBERS. MINIMUM STORAGE VOLUME ABOVE 800mm BELOW NATURAL GROUND LEVEL TO BE 1.95m³
2. MAINTENANCE/INSPECTION OF SOAKPIT TO OCCUR EVERY SIX MONTHS, AND ALL OIL AND DEBRIS REMOVED.

							
				Connell Wagner Limited Level 4, Taranaki House 200 Taranaki St. (P.O. Box 100) Christchurch 8140 New Zealand			
				Telephone: +64 9 328 9022 Facsimile: +64 9 328 9024 Email: connell@cwnz.co.nz			
				3. person calling Connell Wagner accepts that it will support the Plan 4. using the drawings and other data it provides, but not to be used for any other purpose 5. using the drawings and other data it provides, but not to be used for any other purpose 6. using the drawings and other data it provides, but not to be used for any other purpose			
01	12-01-01	Revision 1 drawings	OK	OK	OK	OK	OK
02	12-01-01	Revision 2 drawings	OK	OK	OK	OK	OK
03	12-01-01	Revision 3 drawings	OK	OK	OK	OK	OK
04	12-01-01	Revision 4 drawings	OK	OK	OK	OK	OK
05	12-01-01	Revision 5 drawings	OK	OK	OK	OK	OK
06	12-01-01	Revision 6 drawings	OK	OK	OK	OK	OK
07	12-01-01	Revision 7 drawings	OK	OK	OK	OK	OK
08	12-01-01	Revision 8 drawings	OK	OK	OK	OK	OK
09	12-01-01	Revision 9 drawings	OK	OK	OK	OK	OK
10	12-01-01	Revision 10 drawings	OK	OK	OK	OK	OK
11	12-01-01	Revision 11 drawings	OK	OK	OK	OK	OK
12	12-01-01	Revision 12 drawings	OK	OK	OK	OK	OK
13	12-01-01	Revision 13 drawings	OK	OK	OK	OK	OK
14	12-01-01	Revision 14 drawings	OK	OK	OK	OK	OK
15	12-01-01	Revision 15 drawings	OK	OK	OK	OK	OK
16	12-01-01	Revision 16 drawings	OK	OK	OK	OK	OK
17	12-01-01	Revision 17 drawings	OK	OK	OK	OK	OK
18	12-01-01	Revision 18 drawings	OK	OK	OK	OK	OK
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28	12-01-01	Revision 28 drawings	OK	OK	OK	OK	OK
29	12-01-01	Revision 29 drawings	OK	OK	OK	OK	OK
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63	12-01-01	Revision 63 drawings	OK	OK	OK	OK	OK
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70	12-01-01	Revision 70 drawings	OK	OK	OK	OK	OK
71	12-01-01	Revision 71 drawings	OK	OK	OK	OK	OK
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74	12-01-01	Revision 74 drawings	OK	OK	OK	OK	OK
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92	12-01-01	Revision 92 drawings	OK	OK	OK	OK	OK
93	12-01-01	Revision 93 drawings	OK	OK	OK	OK	OK
94	12-01-01	Revision 94 drawings	OK	OK	OK	OK	OK
95	12-01-01	Revision 95 drawings	OK	OK	OK	OK	OK
96	12-01-01	Revision 96 drawings	OK	OK	OK	OK	OK
97	12-01-01	Revision 97 drawings	OK	OK	OK	OK	OK
98	12-01-01	Revision 98 drawings	OK	OK	OK	OK	OK
99	12-01-01	Revision 99 drawings	OK	OK	OK	OK	OK
100	12-01-01	Revision 100 drawings	OK	OK	OK	OK	OK

Selwyn District Council

Leeston North Stormwater Plan

Drawn	JRD	Signed	JRD	Date	03-06
Designed	RK	Signed	RK	Date	03-06
Verified	MDF	Signed	MDF	Date	03-06
Approved	MDF	Signed	MDF	Date	03-06

House Soakage Chamber Indicative Design

PRELIMINARY NOT FOR CONSTRUCTION			
Project No.	19482		
Scale	1:20	Sheet No.	A3
Drawing No.	C02.01	Rev.	03

20 10 0 10 20 30 40 50mm

CADREF: G:\P19482\CAD\CON\19482-03.dwg

Table CRC671838A

Leeston North Stormwater Management Plan Table of Humeceptor Sizing

Project: Residential Subdivision
Location: Leeston North, Canterbury
Client: Connel Wagner
Client Contact: Rob Kerr (03) 366 0821
Date: 20 October 2006

Humeceptor Model	Maximum Catchment Area (Ha)	
	40% TSS Removal	75% TSS Removal
STC2	4.7	0.5
STC3	6.6	1.2
STC5	11.0	1.2
STC7	14.0	1.2
STC9	14.0	1.7
STC14	26.0	1.9
STC18	36.0	2.9
STC23	44.0	3.0
STC27	57.0	4.1

Note: % Imperviousness for all areas assumed to be 100%

Provided by Humes Oct 2006

CON570: CHANGE OR CANCEL A CONDITION OF A RESOURCE CONSENT

TO: Consents Operations Section
Environment Canterbury
P O Box 345
CHRISTCHURCH 8140

Ph: (03) 353 9007 Fax: (03) 365 3194

FOR OFFICE USE ONLY		
EC - CHCH		
FILE REF:		
DOCUMENT No.:		
- 3 AUG 2009	ACTION	INFO

A consent holder may apply to change or cancel any condition of a resource consent (other than any condition relating to duration), at any time specified for that purpose in the consent, or at any time if a change in circumstances has caused the condition to become inappropriate or unnecessary.

Please complete this form and attach it to a completed Resource Consent Application form appropriate to the resource consent type, including a full Assessment of Effects on the Environment. The assessment must show what effect changing or cancelling the condition(s) will have. Your application must be accompanied by the preliminary fixed charge as prescribed in the Council's Summary of Charges.

Consent holder (as shown on consent document)

Surname: All first names (in full): Mr

Surname: All first names (in full): Mr

Full Postal address: Postcode:

Telephone no.: Fax no.:

OR

Company name: Selwyn District Council

Full Postal address: PO Box 90, Rolleston Postcode: 7643

Telephone no.: (03) 347 2800 Fax no.: (03) 347 2799

Consultant/Agents details (if applicable):

Contact person: Murray England

Company:

Postal address: Postcode:

Email: murray.england@selwyn.govt.nz

Phone: (03) 347 2972 Fax:

During the processing of your application who will be the contact person for making decisions? ☐ Applicant ☒ Consultant / Agent

Note: All correspondence during the consent investigation process will be directed to this contact person, unless instructed otherwise.

Final decision documents will be sent to the applicant.

Consent Details:

Consent number: CRC071838

Condition numbers to be changed or cancelled: 8, 9 and 22

Change in circumstances that has caused the condition(s) to become inappropriate or unnecessary:

I understand that my/our application will be assessed by Environment Canterbury. If the change or cancellation of conditions is outside the scope of my resource consent I will need to apply for a new resource consent which will require an additional deposit and further information.

Signature of consent holder/s or
duly authorised agent

Date: 29/07/09

NOTE:

1. An application for a change or cancellation of conditions **must** contain the following information in addition to this form:
 - a. All paperwork included with original resource consent; i.e. plans and other attachments referred to in the document provided. You should note that failure to provide this information increases processing time and cost of your application.
 - b. Relevant completed resource application form for activity.
 - c. An Assessment of Effects on the Environment (AEE).
 - d. A deposit for a change of conditions.



Environment
Canterbury

Assessment of Effects on the Environment

In accordance with the Fourth Schedule of the Resource Management Act 1991, an assessment of environmental effects in the detail that corresponds with the scale and significance of the effects that the proposed activity may have on the environment is provided below.

No effect on the environment, in addition to that assessed in the original AEE of the original consent application, will result from the proposed amendments to resource consent CRC071838 conditions 8, 9, 14, 20, 22, 23, 24, 26 and 30

Each consent condition and proposed amendment is detailed below.

Condition 8, 9, 14, 23 and 24 implies that a wetpond and wetland will be constructed. This statement is potentially misleading as in reality one integrated stormwater management device will be constructed.

It is therefore proposed that conditions 8, 9, 14, 23 and 24 be amended so that the phrase 'wetpond and wetland' is replaced with 'wetland pond'.

Condition 9 implies that the wetpond and wetland (wetland pond) shall be constructed in its entirety to be compliant with the same condition.

However, due to funding restraints it is not practicable to complete the construction of the community system in its entirety at this time.

An amendment to the consent condition is therefore requested to allow development to occur on the provision that an effective area of wetland is constructed proportional to the area of development.

A report from Australia (Wong, Breen, Somes, Lloyd, 1999) recommends a ratio of wetland area to catchment area of 2%.

This research is validated by comparing the design parameters of the consented wetland and contributing catchment.

The total catchment draining to the proposed wetland in the ultimate development scenario is approximately 49.7 hectares. The consented wetland pond has a permanent surface water area of 0.71 hectares which is 1.4% of the development area.

The 2% criteria is therefore deemed to be conservative and is adopted.

It is therefore proposed that condition 9 be amended as follows:

The *wetland pond for the ultimate development shall*: (a) Have capacity to accommodate the first 25 millimetres of rain from all hardstand areas and roading; (b) Provide a hydraulic residence time of 96 hours; and (c) Have a minimum volume of 1287 cubic metres available to attenuate flows.

Where development occurs prior to the completion of the community wetland pond the runoff from that development shall be managed within a wetland pond of a surface area equivalent to 2% of the total development area.

Condition 20 requires that any hydrocarbons, accumulated sediment, and litter or debris be removed immediately. Practically however, it may take up to 5 working days to arrange for a contractor to undertake this work.

It is therefore proposed that condition 20 be amended as follows:

INSPECTION, MAINTENANCE AND MONITORING The proprietary devices and swales shall be inspected at least once every 6 months. Any visible hydrocarbons, accumulated sediment, and litter or debris in the stormwater system shall be removed *within 5 working days*.

Condition 22 Limits the vegetation to be used within the swale to 'grass'. Due to the high ground water table in the area the use of alternative vegetation such as wetland species may also be appropriate.

It is therefore proposed that condition 22 be amended as follows:

The swales shall be maintained with at least 50 millimetres of *vegetation*. The *vegetation* in the swales shall be maintained in a healthy condition however, the *vegetation* in the swales does not need to be irrigated and the *vegetation* may be allowed to brown in the summer.

Condition 26 requires that, on two occasions, separated by a minimum of two months, that composite flow weighted samples be collected by auto sampler and triggered by flow monitor. The instillation of the auto sampler will be undertaken in conjunction with the development of the wetland pond.

It is proposed that as an interim measure that, on two occasions, separated by a minimum of two months, that a grab sample be taken.

It is therefore proposed that an addition to condition 26 be added as follows:

Where development occurs prior to the completion of the community wetland pond the runoff from that development shall be sampled, on two occasions, separated by a minimum of two months, by grab sample.

Condition 30 states that the Manse Road drain shall be upgraded to convey a design flow of 5.89 cubic metres per second. This work is not budgeted to occur until 50% of the development has occurred.

It is therefore proposed that an addition to condition 26 be added as follows:

OTHER MITIGATION The consent holder shall upgrade the capacity of Manse Road drain, *once 50% of the development has occurred*, from the discharge point downstream to the confluence with Leeston Creek, such that it has capacity to pass 5.89 cubic metres per second without overtopping. This shall include, but not be limited to upgrading of the culverts and widening of the channel.

Attention: Consenting Officer

EC - CHCH	
FILE REF:	COC / 76163
DOCUMENT No:	78688
- 3 AUG 2009	
V. Johnston	

Dear Sir/Madam

LEESTON NORTH – VARIATION TO A CONDITION OF RESOURCE CONSENT

The purpose of this letter is to apply for a variation to resource consent CRC071838 conditions 8, 9, 14, 20, 22, 23, 24, 26 and 30 which will:

- Allow for staged development and construction of the proposed wetland system,
- Remove ambiguity of current clauses, and
- Provide for a site specific design solution.

Please phone me on 03 347 2972 should you wish any further information or clarification.

Yours faithfully

Handwritten signature

Murray England
STORMWATER ENGINEER



CHEQUE DUTY PAID LIC.11

059856

DATE 23/07/09

PAY
THE
SUM
OF

Five Hundred & Sixty Two
 **Dollars & 50 Cents

NOT TRANSFERABLE

\$562.50

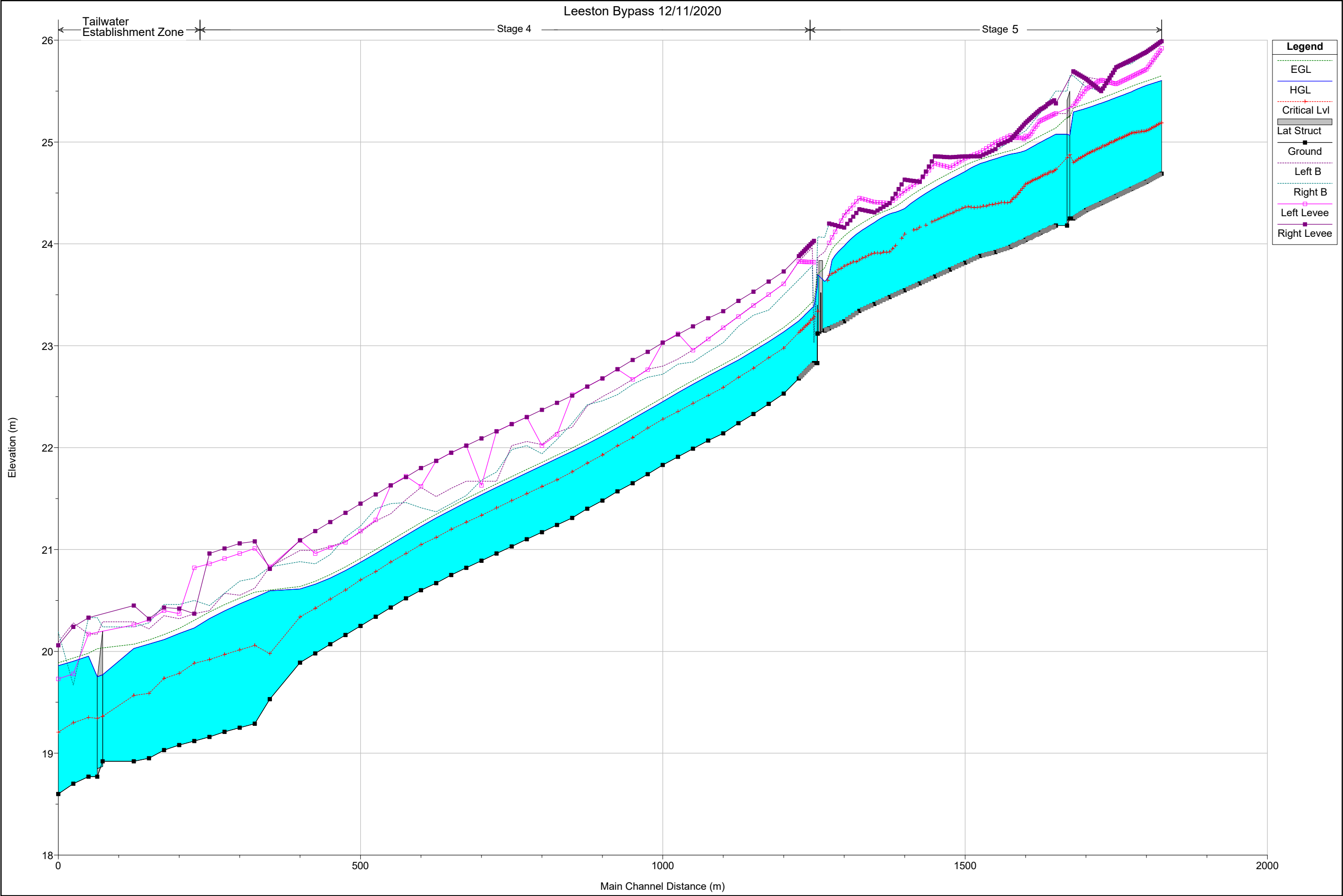
TO THE ORDER OF ENVIRONMENT CANTEBURY

FOR SELWYN DISTRICT COUNCIL

059656 031587: 0050000=00 11

Appendix E

Flood Modelling Output 2020



Appendix F

SDC Communications

From: Ben Henry
Sent: Monday, 31 August 2020 4:55 PM
To: 'Daniel Meehan'
Cc: Anna Lindgren
Subject: RE: Leeston Stage 4 - Walkover follow up

Hi Daniel,

I called earlier to discuss with you my high level estimate of the works involved in changing the profile of the drain to be narrower. In summary there are a number of considerations:

1. **Earthworks cost benefit likely neutral:** Logically to narrow the drain profile, it still needs to have the same cross sectional area to contain the consented flow with freeboard, therefore the same amount of earth volume would need shifting. This would likely indicate that there would be no noticeable savings for SDC in regards to earthworks.
2. **Consent Variation processing cost:** Making changes to the design will require change variation requests to be submitted for the existing consents, of which to my knowledge there are currently four. On the ECan website applications to "Change or cancel the conditions of a resource consent for groundwater or surface water" is \$2,150 or "Change or cancel the conditions of any other resource consent" is \$1,200. I would need to discuss with our Planners to determine how much effort would be required to put this application together and how many applications (\$) would be needed. I haven't proceeded with the Planners for this as I wanted to see what your thoughts were with regards to all of the considerations.
3. **Easement Boundary cost benefit:** As discussed on site with the landowner John Howson, a narrower profile provides John with more land with which to develop his lots, and in turn requires less land for SDC to purchase. Is Geoff Martin also pushing to narrow the proposed bypass drain width? The consented plans show the lot design for the subdivision allow for the wider profile through Geoff Martin's land, and given the cost benefit of earthworks is likely neutral for council, it may therefore make sense to only look at the section through John's land, approximately 250m. This would also reduce the amount of redesign time necessary and any other SDC agreements currently in place.
4. **Time delay:** We would also need to consider that there will be a delay in time in getting the design ready for this summer while waiting on the revised consents to be approved. This would push work out to either winter (unwanted by owners) or next summer.
5. **Design change and Modelling:** We would need to model the modified profile, including draughting (assuming this is for the first 250m only through John's land with a transition into wider current profile through Geoff's land) this would be in the vicinity of \$9,300 (excluding planning input). Working along with this we would need to carry out stormwater modelling of the modified profile which would take approximately two days of the modellers time, approximately \$3,000.

With regards to cost, seeing as John is interested in seeing the narrowing, would it be worth considering that the landowner covers the cost in design change?

Give me a call to discuss.

Regards,
Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com

DISCLAIMER

From: Ben Henry
Sent: Friday, 21 August 2020 4:36 PM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Cc: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Subject: RE: Leeston Stage 4 - Walkover follow up

Thanks for the info Daniel, it was good to meet and carry out that walkover. It gave us a better understanding of the considerations ahead.

I'll go through the plan next week and get back to you on the questions below. I believe you'd be right on the 1.29m height being at the confluence. We will check once the survey info is in the system which is about the end of next week. We can certainly look into what would be involved in reducing the width of the drain and let you know before we head down that path.

Have a good weekend and talk to you soon.

Kind regards,

Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Friday, 21 August 2020 11:33 AM
To: Ben Henry <Ben.Henry@aurecongroup.com>
Cc: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Subject: Leeston Stage 4 - Walkover follow up

Hi Ben,

Thanks both for your time on site yesterday, was good to meet and have a good walk over. Hopefully things make good sense for you now for the design?

I have attached a map showing our records of the Classified Drain and added the Spring channel we noted on site.

These need to be allowed for in the design.

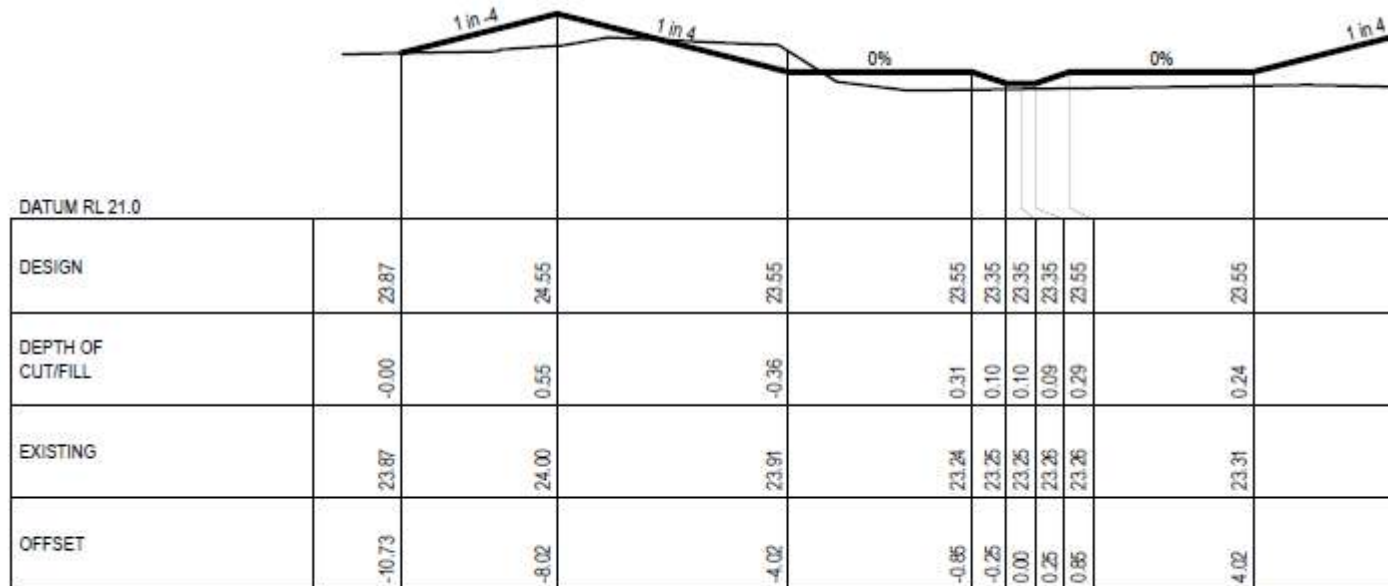
Also just to follow up on a couple of the landowners questions yesterday.

- It would be good to confirm bund heights with landowners, after checking the plans again it seems the only section which was 1.2m is at chainage zero. This may be funny because of the creek and I assume the surveying will confirm that?
- The rest of the section in the first two properties looks to be between 300mm and 500mm, meeting the average 400mm which is on the consultation plans. Is this correct?
- The section is 16m top of bund to top of bund. From the outside toe of each bund this gives the 20m. The landowners did seem concerned about how wide this was. Can you please let me know what would be involved in changing the design to be narrower like the bottom wetland section? And what risks there may be in changing this design at this stage?

Let me know if you have any questions or need anything else.
Happy to discuss if you would like to give me a call.

Cheers,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)



CHAINAGE 0.00



2 Norman Kirk Drive, Rolleston 7614
PO Box 90, Rolleston 7643
Phone: 0800 SELWYN (735 996)
Fax: (03) 347-2799
www.selwyn.govt.nz | www.selwynlibraries.co.nz
www.selwyn.getsready.net

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Tuesday, 3 November 2020 2:48 PM
To: Ben Henry
Cc: Anna Lindgren
Subject: RE: Leeston - Stages 4 and 5

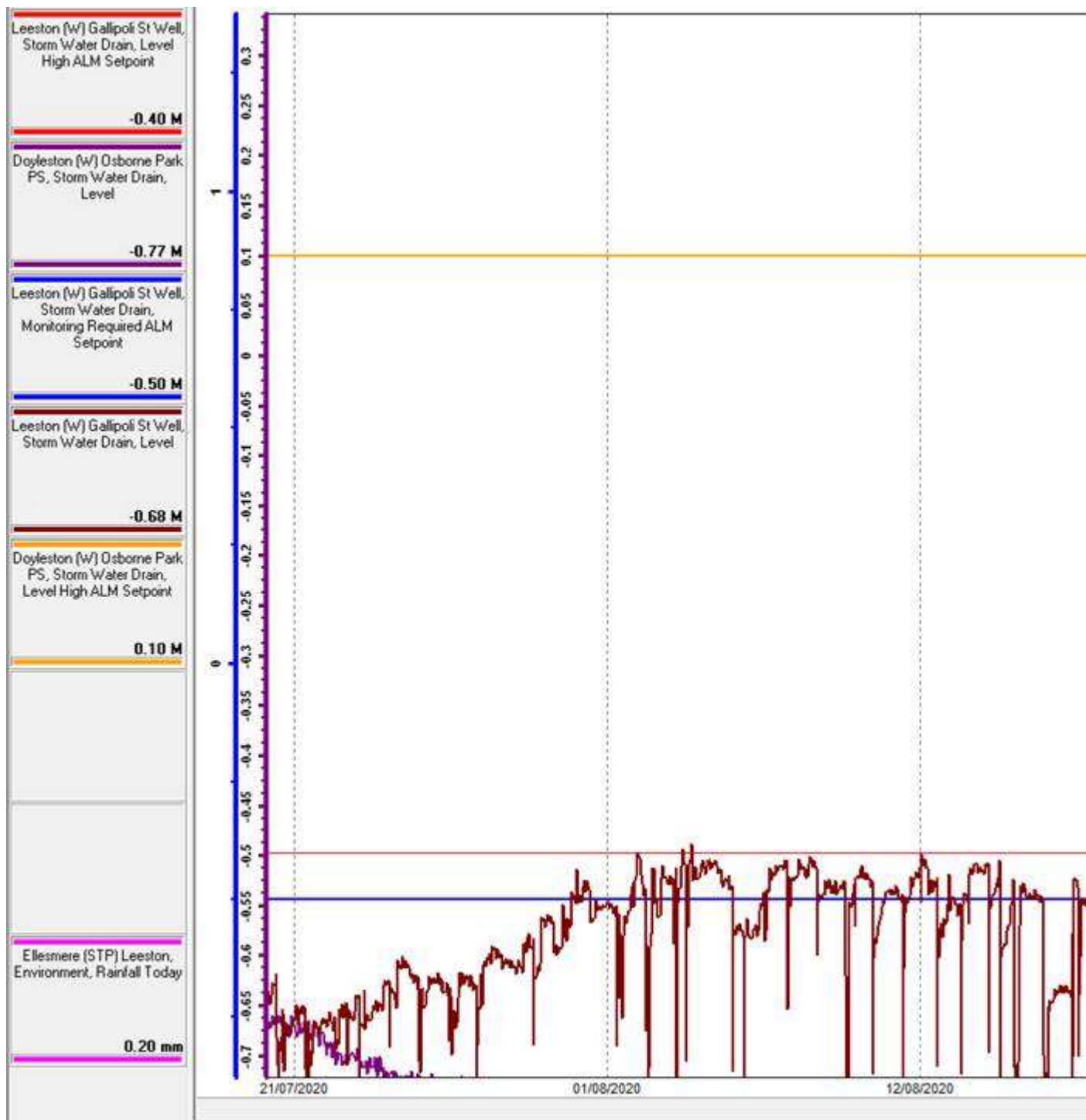
Hi Ben,

No sorry I don't have too much raw data or measurements of average flows etc.
We have a water level monitoring site in Leeston township to give an idea of the creek as it goes up and down, but this has not been gauged or correlated to flows. See below graph, is this useful?
Even less information would exist for Martins Springs.

Happy to discuss if you want to give me a call when you are free?

Cheers,
Daniel,

Daniel Meehan | **Surface Water Engineer** | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)



From: Ben Henry [<mailto:Ben.Henry@aurecongroup.com>]

Sent: Tuesday, 3 November 2020 9:38 AM

To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>

Cc: Anna Lindgren <Anna.Lindgren@aurecongroup.com>

Subject: FW: Leeston - Stages 4 and 5

Hi Daniel,

Does council have the mean depth and the mean velocity of the water within the Leeston Creek and Martins Spring waterways?

Thanks,

Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com

DISCLAIMER

From: Paige Wilkinson <Paige.Wilkinson@aurecongroup.com>
Sent: Tuesday, 3 November 2020 9:24 AM
To: Ben Henry <Ben.Henry@aurecongroup.com>
Cc: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Subject: RE: Leeston - Stages 4 and 5

Hi Ben,

Thanks for your input! It is much appreciated.

The only information that is missing is the mean depth of the water within the culverts, the mean velocity of the water and the slope of the culvert. This information is a requirement under the NES for freshwater 2020

(http://www.legislation.govt.nz/regulation/public/2020/0174/latest/LMS364298.html?search=qs_act%40bill%40regulation%40deemedreg_freshwater_resel_25_h&p=1)

Though we can make a statement noting that this information will be provided at a later date based on this clause:

"63(2) The information specified in this regulation must be collected and provided to the relevant regional council, together with the time and date of its collection, within 20 working days after the activity is finished..."

Is providing this information at a later date more realistic? Happy to discuss.

Thanks,

Paige Wilkinson
Consultant, Environment and Planning, Aurecon
M +64 210 2482703
Paige.Wilkinson@aurecongroup.com

DISCLAIMER

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From: Ben Henry
Sent: Friday, 9 October 2020 4:51 PM
To: Daniel Meehan
Cc: Anna Lindgren
Subject: RE: 505193 Leeston Stage 4&5 Contaminated land investigation
Attachments: Leeston Bypass Contaminated Land Services-stage 4 only.pdf

Hi Daniel,
The requested removal of stage 5 from the costs is shown in the attached proposal.

3 Fees

This work will be a continuation of our existing contract with Selwyn District Council (client) and Aurecon NZ Limited. Our lump sum fees for the investigation and reporting are **\$7,000 excl GST** plus **\$2,050** disbursements for laboratory analysis, with a five-day turnaround time. A three-day turnaround can be requested with an additional cost of \$300, totalling **\$2,250**.

Happy to discuss.

Kind regards,
Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Wednesday, 7 October 2020 7:54 AM
To: Ben Henry <Ben.Henry@aurecongroup.com>
Subject: RE: 505193 Leeston Stage 4&5 Contaminated land investigation

Hi Ben,

Sorry have been tied up with a few other task last couple of days,
This does seem rather expensive? Is there cost savings in doing just Stage 4? Stage 5 is not yet budgeted for construction so we can do this at a later stage.

Cheers,
Daniel,

Daniel Meehan | **Surface Water Engineer** | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Ben Henry [<mailto:Ben.Henry@aurecongroup.com>]
Sent: Tuesday, 6 October 2020 4:32 PM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Subject: RE: 505193 Leeston Stage 4&5 Contaminated land investigation

Hi Daniel,
I called just before to see if you'd had a chance to look through the contaminated land investigation proposal yet?

Kind regards,
Ben Henry
Senior Civil Engineer, Aurecon

T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com

DISCLAIMER

From: Ben Henry
Sent: Wednesday, 30 September 2020 5:44 PM
To: 'Daniel Meehan' <Daniel.Meehan@selwyn.govt.nz>
Cc: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Subject: 505193 Leeston Stage 4&5 Contaminated land investigation

Hi Daniel,

As discussed, please find attached the long awaited proposal for carrying out the contamination investigation. This proposed investigation is to assess for potential contaminants in the spoil from the Leeston Bypass Stage 4&5 construction works for the purposes of disposal.

Regards,
Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com
Level 2, Iwikau Building
93 Cambridge Terrace Christchurch New Zealand 8013
PO Box 1061, Christchurch 8140
aurecongroup.com



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From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Friday, 25 September 2020 4:14 PM
To: Ben Henry; Nic Catto
Cc: Anna Lindgren
Subject: FW: Kowai Control Gate
Attachments: IMG_2181.JPG; IMG_2182.JPG

Follow Up Flag: Follow up
Flag Status: Flagged

Hi Ben and Nic,

Sorry not too much detail from Taeges in terms of drawing for control gate, but I think they would be able to construct something to fit what we need.

Cheers and have a good weekend,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Phil Hair [<mailto:Phil@taege.com>]
Sent: Thursday, 24 September 2020 4:28 PM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Subject: RE: Kowai Control Gate

Hi Daniel

I have had a look at our drawings and have included a couple of our initial concept sketches. We have some detailed profile drawings, but generally the design is just noted down in material lists .

We are able to replicate the Kowai gate to size, which was made for a 1600mm opening, or a variation of, depending on size requirements. There obviously needs to be a concrete support structure in place and then we can build to particular gap sizes and opening requirements as would be required.

It is probably easier for us to work around your workings, if the intention is to use a gate of similar dimensions

Cheers
Phil

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Tuesday, 22 September 2020 2:05 PM
To: Phil Hair <Phil@taege.com>
Subject: Kowai Control Gate

Hi Phil,

Thanks for your time on the phone,

As discussed we are really impressed with the control gate your team constructed for our water race intake on the Kowai. (Photo of this installed for your reference).

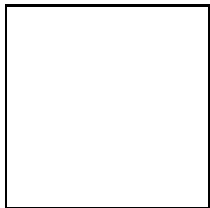
We would like to incorporate a similar gate into another project we are working on. Do you have any shop drawings or sketches which will help us with designing and specifying?

We are thinking of specifying, 'A slide control gate supplied by Taege Engineering'. Is there any other notes that need to be included?

Look forward to hearing from you.

Cheers,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)



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www.selwyn.getsready.net

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Friday, 18 September 2020 12:47 PM
To: Ben Henry; Anna Lindgren
Cc: Nic Catto
Subject: RE: Leeston Stage 4&5 Safety in Design Workshop

Hi Ben,

I have just had a wee chat with the Landowner, he confirmed that the spring channel does generally dry out during summer months.

I was also thinking do we need to add the spring as a risk for the safety in design? And I guess could add in that there is a risk if excavations are too deep they tap a spring and undermine the bunds?

Happy to discuss this further if you want to give me a call when you are free.

Cheers,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Ben Henry [<mailto:Ben.Henry@aurecongroup.com>]
Sent: Wednesday, 16 September 2020 11:21 AM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>; Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Cc: Nic Catto <Nic.Catto@aurecongroup.com>
Subject: Leeston Stage 4&5 Safety in Design Workshop

Good to see you this morning Daniel. Attached is a copy of the Safety in Design register as completed in the meeting.

Anna, this is located on DWS at

<https://aurecongroup.sharepoint.com/:x/r/sites/505193/5%20Deliver%20Design/506%20Safe%20Design/SDC%20Leeston%20Stg4%265%20Safety%20in%20Design%20Register.xlsx?d=wcb870802e9d046adb979b17a032f6856&csf=1&web=1&e=sme220>

Kind regards,

Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com
Level 2, Iwikau Building
93 Cambridge Terrace Christchurch New Zealand 8013
PO Box 1061, Christchurch 8140
aurecongroup.com



From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Wednesday, 12 August 2020 4:01 PM
To: Anna Lindgren
Cc: Ben Henry
Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Thanks Anna, I will make contact and get back you soon.
Cheers,
Daniel,

From: Anna Lindgren [<mailto:Anna.Lindgren@aurecongroup.com>]
Sent: Wednesday, 12 August 2020 3:50 PM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Cc: Ben Henry <Ben.Henry@aurecongroup.com>
Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Daniel,

Thanks for the quick response.

We'd like to carry out the survey mid to late next week and also the walkover, we are happy to work around the landowner with regards to days.

The benefit I see with taking the "dogleg" out of the design would be, less earthworks and costs for construction and more usable land for the landowner. However if you think this will significantly complicate things we can stick with what we have.

I figured your preference was to get the consent sorted asap, will forward the estimates as soon as I receive them.

Cheers, Anna

Anna Lindgren
Associate, Infrastructure, Aurecon
T +64 3 3727689 M +64 21 2156692
Anna.Lindgren@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Wednesday, 12 August 2020 3:35 PM
To: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Cc: Ben Henry <Ben.Henry@aurecongroup.com>
Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Hi Anna,

Thanks for your email, yes if you can please advise costs but my preference is to gain consent ASAP. I will hopefully have a programme from contractor later this week so will know start dates etc.

Stage 4-5

- I will put the meeting with landowners on hold for now, there has been an offer placed on this property subject to Overseas Investment Approval, and we would prefer to wait until we

know outcome of this before committing to meeting with landowner. (We are working through other options of acquiring the required land).

- Yep I think it is best contact is made via SDC / our consultants who are doing the land negotiations. Do you know when this surveying will likely happen?
- Yep happy to arrange walk over, again when would you like this to occur? We need to be cautious as we are now in lambing season and need to be cautious not to disturb stock.
- Changing the alignment significantly could be problematic due to the challenges we are facing with land acquisition etc. Is there clear benefits in this change?
- I am happy to have a virtual meeting for the SID workshop, Just let me know when you were thinking of holding this.

Thanks,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Anna Lindgren [<mailto:Anna.Lindgren@aurecongroup.com>]

Sent: Wednesday, 12 August 2020 3:19 PM

To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>

Cc: Ben Henry <Ben.Henry@aurecongroup.com>

Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Hi Daniel,

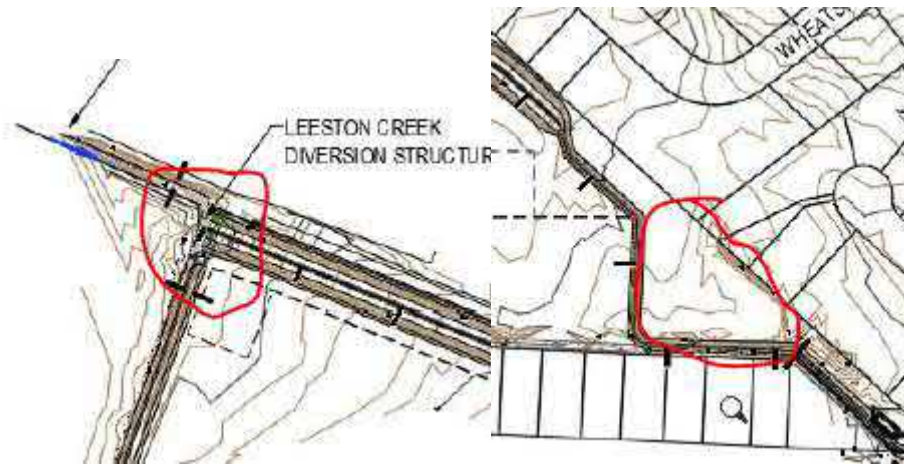
Hope you are well.

Just a bit of a heads up on the consent for Stage 3. We have been told that Ecan is down in terms of resources for processing the consent, our options are either that it goes on hold for a few weeks or that we need to pay for an external consultant to review it. We have asked that ECan provide an estimate for the cost to proceed with processing through an external consultant, once I have the estimate I will pass this on. I assumed that since we want to start construction in September we don't want the application to go on hold, let me know if you for some reason disagree. Once we receive the cost estimate we could reevaluate if it seems too high.

Stage 4-5

We are preparing to make a start on this work and there were few items I wanted to follow up with you on. I have cc'd Ben in who will be leading the technical work.

- We previously discussed that you wanted us to meet with the landowners engineers to discuss their requirements/comments on the bypass design. Do you have any further details/dates for this?
- Our scope allowed for some survey work to be carried out, in terms of contacting landowners for access/informing of the work-how do you want to do this, you or us? Location marked roughly below.



- We'd also like to complete a site walkover and access the land you and I previously couldn't go through, would you be able to contact the landowners for us to do this?
- The existing bypass alignment runs around a future wetland-I am wondering if you'd agree it would be more prudent for our design to run straight along the boundary rather than around this wetland.



- Considering that we are now in Level 2 again and this may change going forward. I wanted to confirm if you use teams meetings? We have a safety in design workshop allowed for and we may need to do this online.

Cheers, Anna

Anna Lindgren

Associate, Infrastructure, Aurecon

T +64 3 3727689 M +64 21 2156692

Anna.Lindgren@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>

Sent: Tuesday, 4 August 2020 4:39 PM

To: Anna Lindgren <Anna.Lindgren@aurecongroup.com>

Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Hi Anna,

I had a good weekend thank you, hope you have a nice one as well?

Thanks for this,
Yep makes sense to me to add it as variation.
I will raise the PO and let you know shortly what this is.

Cheers,
Daniel,

Daniel Meehan | **Surface Water Engineer** | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Anna Lindgren [<mailto:Anna.Lindgren@aurecongroup.com>]
Sent: Monday, 3 August 2020 12:05 PM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Hi Daniel,

Hope that you've had a good weekend.

With regards to the contract for the Leeston Bypass Stage 4-5 would you be ok with it being done as a variation to the existing contract we already have in place for Stage 3? This would be easier and quicker to get through approvals at my end. From your end, I imagine you would give us a new P/O number and I can easily invoice this on a separate invoice to keep things tidy going forward for you. Let me know what you think.

Cheers, Anna

Anna Lindgren
Associate Land Infrastructure Services, Aurecon
T +64 3 3727689 M +64 21 2156692
Anna.Lindgren@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Wednesday, 29 July 2020 11:02 AM
To: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

That's all good just when you get a chance.
Thank you,

From: Anna Lindgren [<mailto:Anna.Lindgren@aurecongroup.com>]
Sent: Wednesday, 29 July 2020 10:56 AM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Hi Daniel,

Thanks for your understanding, I feel the same, although I think it's rather frustrating. I think the extra work required from our end has been about 1.5-2 days. We relodged everything again yesterday and once the previous ECan processing person receives the application she said she was going to recheck the fees again for us.

Great news about Stage 4/5, oh yes I see where your question comes from, I said I had attached a short form to the proposal but hadn't. I will get that sorted and sent out to you, probably won't be until tomorrow if that is ok?

Cheers, Anna

Anna Lindgren

Associate, Infrastructure, Aurecon

T +64 3 3727689 M +64 21 2156692

Anna.Lindgren@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>

Sent: Wednesday, 29 July 2020 10:49 AM

To: Anna Lindgren <Anna.Lindgren@aurecongroup.com>

Subject: RE: Leeston Stormwater Bypass-Stage 3 Consents

Thanks Anna,

That's ok I guess we just got to do what they say...

Is there much work from your side for these extra applications?'

I have had approval to proceed with the Stage 4/5 detailed design. I will send through a PO for this work shortly, but just want to check did you want a SFA signed for this portion of work?

Cheers,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Anna Lindgren [<mailto:Anna.Lindgren@aurecongroup.com>]

Sent: Wednesday, 29 July 2020 10:32 AM

To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>

Subject: Leeston Stormwater Bypass-Stage 3 Consents

Hi Daniel,

As mentioned last week the ECan Stage 3 resource consent application was returned due to the requirement from ECan that we address a further two rules.

The result of the above is that Ecan has stated that a further two consents are required, requiring an additional \$4,700 in application fees. In terms of the applications these have all been covered off in the original application which has been updated to include the additional requested information.

While unfortunate that Ecan has requested these additional application fees I wanted to keep you in the loop to let you know these charges will be coming your way, probably in the next invoicing period (as previously we have paid for these). However on a positive note our planners have told me that as these are small scale activities there is a possibility that some of these application fees can be refunded.

Please let me know if you have any further queries.

Regards, Anna

Anna Lindgren

Associate, Infrastructure, Aurecon

T +64 3 3727689 M +64 21 2156692

Anna.Lindgren@aurecongroup.com

Level 2, Iwikau Building

93 Cambridge Terrace Christchurch New Zealand 8013

PO Box 1061, Christchurch 8140

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From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Wednesday, 19 August 2020 11:51 AM
To: Ben Henry
Cc: Anna Lindgren; James Lynch
Subject: Leeston Bypass Stage 3 Walk Over
Attachments: Leeston Stage 3 Landowners.pdf

Hi Ben,

I have spoken to all three landowners regarding the walkover and survey tomorrow. They have no issues and had no hazards to note. I have attached a map with contact numbers to give to your survey crew if they have any issues and need to contact someone.

Both John Howson and David Rathgen are keen to meet up with us tomorrow, I suggested that it might be best to meet with them first and we can then carry on rest of walk through after meeting them.

They do have some questions about the design;

- Original plan showed the bypass as 16m wide, this is now 20m wide. How come this has increased?
- Does the bypass need to be this wide and is there a way to design so it is narrower? (i.e like the hospital section?)
- With the bund being 400mm high, this will cause overland flow to back up on the northern side of the bund and cause issues.

Access to Howson / Rathgen property is best via the large gates / entranceway on Leeston Dunsandel Rd. Best entrance to Martin Block will be through the Pound Rd end.

Let me know if you need anything else in the meantime.
See you at 11am outside the showgrounds.

Regards,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)



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From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Monday, 12 October 2020 9:44 AM
To: Ben Henry
Cc: Nic Catto
Subject: RE: Kowai Control Gate

Morning Ben,

Supply and install of this gate was about \$9,000.00.

Our quote didn't breakdown the gate cost manufacturing but it took a day onsite to install, so I guess about \$2k for time onsite to install.

The concrete structure was already onsite and this just needed to be dropped down into it.

Hope this helps and makes sense?

Cheers,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Ben Henry [<mailto:Ben.Henry@aurecongroup.com>]
Sent: Monday, 12 October 2020 9:32 AM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Cc: Nic Catto <Nic.Catto@aurecongroup.com>
Subject: RE: Kowai Control Gate

Morning again Daniel,

Also wondering if you have access to the fabrication cost of the Kowai gate? This is to add to the Engineers estimate.

Thanks,

Ben Henry
Senior Civil Engineer, Aurecon
T +64 3 3727663 M +64 211520140
Ben.Henry@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Friday, 25 September 2020 4:14 PM
To: Ben Henry <Ben.Henry@aurecongroup.com>; Nic Catto <Nic.Catto@aurecongroup.com>
Cc: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Subject: FW: Kowai Control Gate

Hi Ben and Nic,

Sorry not too much detail from Taeges in terms of drawing for control gate, but I think they would be able to construct something to fit what we need.

Cheers and have a good weekend,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Phil Hair [<mailto:Phil@taege.com>]
Sent: Thursday, 24 September 2020 4:28 PM
To: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Subject: RE: Kowai Control Gate

Hi Daniel

I have had a look at our drawings and have included a couple of our initial concept sketches. We have some detailed profile drawings, but generally the design is just noted down in material lists

.

We are able to replicate the Kowai gate to size, which was made for a 1600mm opening, or a variation of, depending on size requirements. There obviously needs to be a concrete support structure in place and then we can build to particular gap sizes and opening requirements as would be required.

It is probably easier for us to work around your workings, if the intention is to use a gate of similar dimensions

Cheers
Phil

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Tuesday, 22 September 2020 2:05 PM
To: Phil Hair <Phil@taege.com>
Subject: Kowai Control Gate

Hi Phil,

Thanks for your time on the phone,
As discussed we are really impressed with the control gate your team constructed for our water race intake on the Kowai. (Photo of this installed for your reference).

We would like to incorporate a similar gate into another project we are working on. Do you have any shop drawings or sketches which will help us with designing and specifying?
We are thinking of specifying, 'A slide control gate supplied by Taege Engineering'. Is there any other notes that need to be included?

Look forward to hearing from you.

Cheers,
Daniel,

Daniel Meehan | Surface Water Engineer | Selwyn District Council
DDI: 03 347 2945 | Mobile: 027 458 3322 (internal 945)

From: Anna Lindgren
Sent: Thursday, 10 September 2020 4:52 PM
To: Daniel Meehan
Cc: Elaine McLaren; Ben Henry
Subject: RE: Leeston Bypass Design - Stage 4/5
Attachments: 505193 Project Schedule Leeston SW Bypass Stage 4 and 5.pdf

Hi Daniel,

As discussed I had also noted down the timeframes we discussed and as requested I have put together a programme for delivery of the work. The programme shows the final deliverables will be with SDC by 30 October, with the week before this allocated for SDC review and comments (highlighted at the top of the programme under "Client"). Draft documents are planned to be with you by Friday 16 October.

Ben has scheduled the SiD workshop for next Wednesday 16 September, which is also noted in the programme.

Let me know if you have any queries or require anything further.

Regards, Anna

Anna Lindgren
Associate, Infrastructure, Aurecon
T +64 3 3727689 M +64 21 2156692
Anna.Lindgren@aurecongroup.com

DISCLAIMER

From: Daniel Meehan <Daniel.Meehan@selwyn.govt.nz>
Sent: Friday, 4 September 2020 1:28 PM
To: Anna Lindgren <Anna.Lindgren@aurecongroup.com>
Cc: Elaine McLaren <Elaine.McLaren@selwyn.govt.nz>
Subject: Leeston Bypass Design - Stage 4/5

Hi Anna,

Thanks for your time on the phone the other day,
I just thought it would be good to note down our critical deadlines so that we can make sure all line up with your milestones for the delivery of these designs. Is it possible to get a programme for the delivery of this design?

I mentioned briefly over the phone we need construction of Stage 4 to start in February, below is the key dates and milestone we need to achieve;

- Construction must begin **1st February 2021**.
- Realistically we need the final design no later than **1st November 2020**. (We need a good couple of months to allow for contractors to price and the job to be awarded plus lead time.)
- This would mean we need a draft design for review by **1st October 2020**.
- Safety in Design and Risk Workshop in the next 2 weeks, before 18th September 2020.

Hopefully this makes sense and lines up with your project timeline?
Have a good weekend and will catch up next week.

Cheers,

Daniel,

Daniel Meehan | **Surface Water Engineer** | Selwyn District Council
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Appendix G

SDC Revision Comments and Responses

Action Ref.	Issue	Drawing reference	SDC Comment	Aurecon Response.	SDC Response	Aurecon notes from meeting 2 December 2020
1	Extent of Works	CC-4401	Stage 4 / 5 extent of works need to be adjusted, considering stage 5 will be constructed at a later date. (also refer to point 11)	Extent of works has now been clarified in drawings.	Accept	Accept
2	LINZ Co-Ordinates	CC-4100	Survey Note - What does this mean and what implication might this have for contractor and construction? Is this a risk that needs to be including in SID risk register?	This relates to there being a vertical and horizontal margin of error in the field as explained in the proposal. Has been further detailed in the report and added to risk register.	Accept	Accept
3	Material Grading Table	CC-4100	Should this be a full material grading table? Fence crossing channel needs more detail- Fences crossing channel should be flood gates to prevent blockages?	The grading table has been clarified on the drawings. The inclusion of fencing was not included as part of our proposal and as such this is considered a Scope change , in the interest of time we have however gone ahead and actioned this. The fee associated with making these changes is \$875 .	Accept	Accept
4	Fence	CC-4101		A tension wire with wooden posts that support a hotwire was a proposal by SDC. A detail has been added to the drawing to show a tension wire with wooden posts supporting a hot wire. Where hot wire not available, an example photo of a board and wire is included on the drawing, with notes.	This is not a change of scope, Fences identified during walkover and have been drawn. Detail required for accurate construction.	Ben explained that the fencing requirements were unknown at time of scoping and required extra effort once SDC's requirement for stock proof storm fencing was understood. Consenting was not submitted and the possibilities for fencing requirement were numerous. Time was spent on researching and detailing the best solution. Prelim design indicates to reinstate property fence at ch226. Elaine and Daniel accepted this.
5	Low Flow Channel from Spring d/s	CC-4102	What are the likely consent requirements for this diverted channel? Should this be planted out along banks? Is grassing through appropriate? (refer note 52)	The new consent covers this. If we plant this out then the plants tend to grow in size and increase the chance of roughness and blockage. Preference is to leave grassed as seen with Martins Spring refer photo. This has been factored in the report.	Grass is going to have the same issue? Refer to photo This cannot be mowed or maintained, base of channel will eventually all be come wet and un mowable?	Ben explained that based on past examples the drain functionality would be compromised with planting as previously proposed. Ben suggested that if there are requirements to plant, then this should be done on the bund outside of the high flow level. Elaine and Daniel accepted this was a suitable solution.
6	Location of Bund against Fence	CC-4102/4103	Location of bund near fence and boundary, will this affect access for landowner around paddocks?	Bunding at boundary is modified to existing ground to provide drainage for the existing boundary swale shown on 4103. Hydraulic Model shows high water level is below the proposed bund, so we have removed it and indicate in it's place a AP65 hardstand if vehicle access is absolutely necessary. Grades will be fine for a 4x4 vehicle, across the rip rap sides onto the AP65 base. Alternative access can be made from Leeston Dunsandel Road, corner of Market St and Pound Rd, which is considered a better option than providing a culvert crossing, as per comment 50.	Accept if bunds can be traversed by 4x4 vehicles, Suggest hard stand just around gate entranceway on 4102.	Ben identified the foot of the rip rap would be undesirable for a crossing. The AP65 detail provided for the upstream crossing can be applied further downstream.
7	Extent of Rip Rap where channel narrows	CC-4103	A lot of Rip Rap u/s but appears to only extend d/s for 2m? Is the extent correct? 1 layer is shown is this correct? Is rip rap required in low flow at this section?	Upstream rip rap to account for grade change in the area, d/s rip rap has been extended to 4m	How has the extent and thickness of Rip rap been determined, the design report does not reference calcs etc.?	Daniel has requested that the report is updated with a line indicating what method was used to size the rip rap. Ben identified this will take time to get through the QA process. This will be done as time and expense and added to the variations.
8	Lime Mixture	CC-4103	Mixing Lime material onsite may be difficult, is imported material be acceptable	Further advice for the existing ground conditions indicate that there won't be a need for lime stabilised material. References to this have been removed which will simplify construction.	Accept	Accept
9	Tie in with Dunsandel Drain	CC-4103 Section 3	More details required how this drain ties into bypass? Is there risk of back flow?	We consider the requirement for additional details is a Scope change , in the interest of time we have gone ahead ad actioned this and Cross Section Detail has been added to the CC-4103 drawing. The fee associated with making these changes is \$700 . Backflow not significant for a 100yr storm event.	This is not a scope change? We have not asked for any different structure of design change. Details how the bypass channel to intercept and tie in with existing drain is essential. Accept Backflow comment.	Ben identified that the drawings showed the general application of rip rap and the contractor would have the setout information to be able to make the inference on site. The effort to update the drawings to reflect this is what had been shown. Daniel confirmed that SDC will not going to accept item 9, explaining there was no change to the design and the detail needed to be shown on the drawing to be able to construct the scheme.
10	Cross Sections Tying into GL	CC-4300-4304	Number of cross sections don't tie back into existing ground level. (also refer note 48)	Cross Sections have been updated	Accept	Accept
11	Stage 4 Tie in	CC-4400	Need clearer details how to tie stage 4 into existing watercourse upstream (Banks / bed and scour prevention)	We consider the requirement for clearer details is a Scope change , in the interest of time we have gone ahead ad actioned this. The fee associated with this is \$875 . The design cut profile is to be shaped into the existing profile over 1-2m	This is not a scope change. The drawing ends as a line, needs to clearly say how it is expected to tie rip rap and banks and profile of existing drain section.	Ben identified that the understanding was that Stage 5 was to be done at the same time as Stage 4, based on our recommendations. Without stage 5 upgrades the large event stormwater won't reach the confluence. The effort to update the drawings to reflect this is what has been charged. Elaine and Daniel accepted this.
12	Extent of Rip Rap at Diversion	CC-4400	Seems excessive amount of rip rap in base of channel at the diversion structure. This may cause difficulty maintain channel long term? (also refer note 17)	The base rip rap has been changed out to be compacted AP65. Rip rap was originally there as an indication that the digger is over excavating, however access to the confluence with a digger is going to be restricted due to the layout of the confluence and will require manual weeding with waders. It has been changed to AP65 to reduce the amount of rip rap.	If AP65 is sufficient to protect from scour this is acceptable.	AP65 is suitable all agreed.
13	Concrete Weir structure	CC-4400	Footing details need clarified. (also refer note 22)	Concrete weir to be updated to a wall with toe depth as updated on the drawing. Drawing shows wall can be poured in 2 halves if chosen to do so by contractors.	Accept	Accept
14	Extent of Rip Rap at Diversion	CC-4400	Three layers of rock rip rap on inside corner? Would planting have been better on this bank?	Planting requires more maintenance; it allows erosion and weed growth in between planted spacings, plant growth also adds to increasing the roughness (reduced flow profile) and requires more intensive manual labour to pull out weeds inbetween plants. Refer comparison example photo provided. Consent is applying to avoid planting for these reasons.	This question was about the inside corner not all rock in general? If rock required for scour and erosion this is acceptable	This was explained as maintenance assists keeping the confluence from overgrowth, and was part of the prelim design that was considered as a good idea and hence was kept. Elaine and Daniel accepted this.
15	Culvert Detail	CC-4400 Detail 5	Confirm that culvert detail for the spring channel is to be rocked headwall CCC-CSS-SD371-2.	This has been provided correctly. Detail in CCC-CSS-SD371-2 is what needs to be followed.	Accept	Accept
16	Spring Inlet / Overland Flow	CC-4400 Detail 5	Will the spring channel convey overland flow during flood events, and has this been allowed for in the headwall design to prevent scour etc. and sizing of pipe?	The design meets requirements for a 100yr storm. Drawings have had minor refined detail.	Accept	Accept
17	Diversion into bypass	CC-4400 section c	Should their be a low flow channel allowed for through this section (also refer note 12)	A low flow would not work with the available inverts and grades and has been designed to allow flow through that meets the original channel seasonal flows. Providing a low flow would be ineffective, however if required by SDC would be a scope change.	Accept - AP65 look more natural, please confirm this is sufficient for Scour protection?	AP65 is suitable all agreed.
18	Extent of Rip Rap at Diversion	CC-4400 section c	Three layers of rock rip rap on inside corner? Would planting have been better on this bank?	Drawings will be updated to make this less confusing. Rip rap is not a consistent size like the drawing showed. Depths will be given.	Accept	Accept
19	Control gate structure	CC-4401	Is there a risk silt and debris build up against structure affecting flows? How's will this effect consent conditions? Long term build up (also refer note 24)	This was noted in the report, refer 6.1.1. Control Gate Structure. The new consent application will cover the NES discretionary requirements. Drawings have been updated to show how the design will allow for gate opening to flush debris and silt. Referring note 24 also , no debris grill to be introduced as agreed with Daniel. Debris grill would be a scope change.	Accept - Also noting hard stand has been allowed for to clean with excavator.	Accept
20	Control gate structure	CC-4401	Footing details under the Control gate structure need to be clarified	Drawings have been updated to show the requirements for the control gate and weir, and the depth.	Accept	Accept
21	Control gate structure	CC-4402	No level of top of structure of invert level of orifice opening noted on drawing.	The drawings have been updated to make this more clear.	Accept	Accept
22	Weir Structure	CC-4400	Large concrete mass for weir structure seems excessive? Were other alternatives or options considered? i.e. concrete blanket.	There are large enough flows over this during a 100yr event to warrant a concrete wall to factor erosion protection rather than a concrete blanket. Wall cross section detail has been refined to 200mm width (with reinforcing mesh) on the drawings and shows depth of wall footing.	Refer note 12 - If this section is high energy and requires significant concrete structure, please confirm AP 65 is sufficient?	explained the energy is in the eastern portion of the spillway as the 100yr storm flow spills into the bypass.
23	Debris on Diversion Structure	CC-4400	Should silt/debris trap and hardstand area to clean with machinery be included?	The silt trap/debris grill (as discussed on Wed 28th Oct) would be hard to maintain and would restrict fish passage. Agreed with Daniel during Wed 28th Oct SDC meeting not to include. We consider this is a scope change , in the interest of time we have gone ahead ad actioned this. This change is being modelled, dimensioned and drawn. Drawings have been updated to show a reshaped control gate that enables self flushing of silt, which is different to the original scope. The fee for this is \$1,225 . Hardstand is commented on below.	Drawings do not show grill as per note 19. no scope change no variation required.	Note that the debris grill was exluded. This scope change was to cover the change of the control gate headwall to provide a self flushing design, avoiding the need for a large concrete pit that requires clean out by excavator. Elaine and Daniel accepted this.
24	Control gate structure	CC-4401	Should there be a hard stand area adjacent to allow excavator to sit and clear debris from structure if required? (refer note 19)	The inclusion of hardstand is considered a scope change , in the interest of time this has been actioned and has been updated in drawings, report and spec. The fee for this is \$350 .	Maintenance is a fundamental requirement and therefore we do not see this as a variation.	Maintenance expectations were not identified at the scoping stage. Extra effort was required to provide the hard stand and detail it on the drawings and factor it in the report. Elaine and Daniel accepted this.
25	Control gate structure	CC-4401	Why was a gate chosen and what is purpose? Were other options considered such as v shaped weir or a flume?	Gate comes from previous design to meet 0.6m3/s Consent requirement (as noted in report). Purpose is to allow flows up to 0.6m3/s through. Flows above 0.6m3/s are diverted over the bypass weir. The gate enables closing and diverting all flow upstream during large storm events to free up downstream Leeston Creek for overland flow south of the control gate.	Accepted.	Accept
26	Control gate Structure - Fish Passage	CC-4401	Fish passage noted in other areas, was this considered in the design of this structure?	Upstream Stage 5 does not have a low flow channel, seasonal flow levels were not assessed and the available inverts and grade do not allow for low flow channel. Fish passage design requirements suggest that fish like a rocky base for dynamic hydraulics to provide hiding and rest spots. The flat bottom profile has been kept to match existing profile and the rip rap on the sides to toe will provide for requirements.	The Diversion has to keep flows of 600/s and less in the original leeston creek. It is well know this section of creek flows most of the year. Will narrowing cause issues with meeting NES requirements?	Ben noted it would not. Elaine and Daniel accepted this.
27	Gabion Baskets	CC-4401	More details required on baskets, bedding, how they tie into banks and concrete weir etc. Baskets requirements not in specification?	Gabion baskets are not needed and are now taken out of the design completely to simplify.	Accept	Accept
28	Harman's road Culverts	CC-5501/5400	The proposal was for the Harman's Rd Culvert to be replaced, drawing do not include this culvert and the culvert in the drawing appears to be only the farm culvert?	Proposal dated 5 May 2020 does not refer to the Harmans Rd culvert. Same response applies to item 43 also.	Accept - However what would be the proposed cost to design this culvert to include in stage 5 works?	This can be discussed separate to this project. Ben identified that the focus for this project was to deal with the spilling of SW through Stage 5.
29	Harman's road Culverts	CC-5400	Note- the mould for this box culvert (same as stage 3) has gone to North Island, consideration will be needed at time of construction how to manage this.	The current design is suitable to have twin DN1200 culverts as replacement for the stated box. Because the box cross sectional area and installation is more beneficial, we can update the cost estimate with a provisional amount for DN1200's which can be instructed before or during construction depending on the availability of moulds at the time of construction. Stage 5 is not being built straight away so the templates may be back down south by then.	Accept	Accept
30	Harman's road Culverts	CC-5401	Invert Level and cover not noted on this drawing sheet. What is the cover of the culvert?	Levels for SS culvert taken from long section and added to detail CC-5401. Cover was already shown as 200mm AP40 for farm utility.	Accept	Accept
31	Fence off and Stock on bunds / in channel	Design Report	The design report notes about risk of stock in bypass channel, this needs to be confirmed to allow plans for maintenance etc.	Requires Consent conditions to be approved by Ecan. We are submitting the consent to address this to avoid fencing off the full alignment; Fencing off the bypass will also require gates and is likely a large cost for SDC for a short term (until development of land)	Accept	Accept
32	Disconnection of Spring	Design Report	Has the consents noted implications of disconnection of spring, what are requirements for fish salvage etc.? Is this acceptable?	SDC Ecologist to consult on the process as outlined in the report. P&G of cost estimate has been updated to include fish salvage in the eventuality the drain is not dry as expected during the construction period. Consent conditions around fish salvage are expected to be the same as for the Stage 3 consent.	SDC / Contractor consultant for construction. Is there risk Ecan don't want spring permanently diverted? Is this safety in design question?	Planning question responded and Elaine and Daniel accepted this.

Action Ref.	Issue	Drawing reference	SDC Comment	Aurecon Response.	SDC Response	Aurecon notes from meeting 2 December 2020
33	Ground water Risk	Design Report	Even if spring dries out in summer depth of excavation could be down into groundwater. How can this be mitigated during construction?	Providing commentary on mitigation of groundwater during construction was not part of our scope and as such this is considered a scope change , in the interest of time we have gone ahead and addressed this. The fee for this is \$700 . This can only be managed through a) sump pump or b) spear use for GWL reduction. Option a) is preferable as a less costly option and has been used successfully at Stage 3 culvert installation. Spear install to draw water down is much more costly. We have put both as Provisional Items in cost estimate. Contractor to assess how they would address this in their methodology.	It is the designers responsibility to ensure that the design can be constructed. Therefore commentary on high groundwater is considered as part of scope. No Variation.	High ground water level was not identified at time of scoping. The extra effort was required to consider the options, cost etc and provide the comments on the drawings and factor it in the report and Schedule. Elaine and Daniel accepted this.
34	Bund Design	Design Report	100mm of freeboard is noted, was this checked at each location bund is removed?	This was identified in the report as not a problem. Refer 6.1.5 Channel Bund. Channel has been flood modelled as of 21-Oct-20 indicating a minimum of 100mm freeboard throughout Stage 4 (accounting for the removed bunds). An updated assessment indicates a minimum 190mm where bund is removed. Flood model assessment will be included in the report appendices. 100yr storm high water level is now shown on the cross sections.	Accept	Accept
35	Bund Design	Design Report	(refer note 34) Is there risk of backflow where bund removed?	This was identified in the report as not a problem. Refer 6.1.5 Channel Bund. It is not an issue for a 100yr storm event. Greater events are not modelled as they are not part of the consent and project requirements for the duration of this design. 100yr storm event high water level is now shown on the cross sections. Gaps in Bunds allow for overland flow from paddocks to join with the bypass rather than be pushed into neighbouring properties.	Accept	Accept
36	Ground Conditions at Diversion Structure	Design Report	Not noted in design report (Proposal states allowance for investigation of ground conditions)	Section has been added to the report	Accept - note that no Scala or ground investigation was done as per proposal, assumptions based on photo of pit onsite. Accuracy of this assumption could be low?	Ben identified that the burn pit at the confluence revealed that the ground to be the same profile as that shown in the borelog 90m away from the stage 5 culvert. This indicated that the ground was likely to be good. However this is something that can be confirmed during construction when the exposed ground is not drowned in water. Elaine and Daniel accepted this.
37	Exclusions and Assumptions	Design Report	Section needs to be included outlining what was taken into account for design.	Section has been added to the report	Accept	Accept
38	Basis of Design	Design Report	Section needs to be included outlining basis of this design, incl referral to models, software used. What was taken into account g.w etc. Model results if updated. What was the original design used etc	Section has been added to the report making reference to the Leeston Flood Model report provided to SDC in 2019	Accept	Accept
39	Leeston Flood Model Reference	Design Report	This should be reference as an appendix and referred to where information is used.	Reference has been added and report now included in the appendices	Accept	Accept
40	Long Term Maintenance Requirements	Design Report	Section needs to be included outlining long term maintenance requirements for this design to ensure performs at intended levels of service.	Section in report has been added. Stage 5 to be kept maintained and not overgrown as is currently. Stage 4 will also need to be maintained, grasses kept short.	Accept, however some sections shown as grass are beyond the 1:4 allowable for mower? Will need to be side arm mower or weed eat	We anticipate that the grasses will need to be maintained with a string trimmer and are suggested for the same reasons as explained during meeting and report. Elaine and Daniel accepted this.
41	Long Term Maintenance Requirements	Design Report	(refer note 40) What has been allowed for and assumed in the design for maintenance? What risk implication if poor / no maintenance?	as item 40 above	Accept	Accept
42	Directions from SDC	Design Report	Number of references of instruction by SDC, these need to be cited i.e. by email, who, when etc.?	References have now been detailed in report. Some were verbal instructions.	Accept	Accept
43	Original Model for design	Design Report	Needs to have a section on the Leeston Flood Model to summarise this including details about event size and climate change considerations taken into account.	Reference has been added and report now included in the appendices	Accept	Accept
44	Conclusion Summary	Design Report	There should be a conclusion in this report summarising and outlining and outstanding items to be confirmed before construction.	Summary Section has been added to the report	Accept	Accept
45	Existing Bed Material	Design Report	There should be some comment about existing bed material and expected stability of this in the design.	Report has been updated to include.	Accept - however note no ground investigation was done as per proposal.	Accept
46	Stage 5 Extent	Drawings	Stage 5 stops short of Harman's Rd, the scope and proposal was to replace Harman's Rd culverts. Was this change approved and what is consequence to design and performance of bypass?	Proposal dated 5 May 2020 does not refer to the Harmans Rd culvert. Same response applies to item 28 also.	Accept - SDC GIS suggests existing culvert is 2100mm dia.	Ben noted that the culvert is more likely DN1800 and that overflow was experienced downstream in stage 5.
47	Fence	Drawings	Fencing extent unclear, is temp site fencing required during construction vs permanent fencing and requirements for the whole channel.	Temporary fencing for maintaining separation from stock is to be allowed for in the P&G by the contractor. Contractor to develop strategy to manage stock as this is not a design consideration.	Accept - drawings also have been updated.	Accept
48	Bund Shape	Drawings	Should this be rounded over rather than peak? Does it need a platform / bench at top for access? (also refer note 10)	We consider this change in level of detail to be a scope change , which we have gone ahead and addressed in the interest of time. The fee for this is \$350 .	This is not a scope change as the design should be construct able and the design / drawings should match what is expected to be constructed. Also refer to notes 57/58	Aurecon accept that the changes could have been shown with a note rather than time spent changing the lines to show a curve. Ben considers that construction of the bunds can be easily compacted with a foot compactor or roller on a 1:4 slope. No variation.
49	Bund Shape	Drawings	Does the design report note the bund can be traversed / driven for inspections etc.? What design and construction considerations allow for this? (compaction etc. also refer note 58)	The grades of the design profile are not steep and will be easy to traverse. We will add a sentence in the report.	Accept	Accept
50	Farm access across channel	Drawings	There is a need to access across this for the landowner i.e. culvert in low flow channel this needs to be specified even if the location is stated as TBC.	This is considered this request to be a scope change which we have gone ahead and addressed in the interest of time. The fee for this is \$1050 . The existing Martins Drain currently has only one existing culvert crossing (drawing 4102) outside of the bypass alignment. Providing a culvert crossing in the bypass low flow channel would require hydraulic model reassessment. Upstream of the Martins spring bypass connection there won't be a need for a hardstand crossing as the profile is traversable and the likelihood of it being consistently used by farmer is expected to be low. To meet the newly requested crossing requirements, we have proposed one 3m wide AP65 compacted crossing matching profile + cross section in drawing 4102 and updated the report. Note that due to time constraints we have not added a culvert crossing at the narrow portion of the wetland bypass - the effect of this would need to be modelled. Due to the drain width (5m) a culvert would need to be a wide box culvert to avoid flow disruption (free board small here).	Accept this solution, however fee does not seem reasonable.	Ben noted that the time spent looking through all the different feasible options and providing the end detail is where the extra cost submitted comes from. Elaine and Daniel accepted this.
51	Channel Water Level	Drawings	Should the design flood level be noted in at least one part of the drawings to compare against bund level and existing ground level.	100yr storm high water level is now shown on the cross sections.	Accept	Accept
52	Low Flow Channel	Drawings	The low flow channel is straight line inside bypass, should this have a more meandering naturalised look? (refer note 5)	We recommend leaving the low flow channel as designed. Providing a meandering low flow channel would be a scope change and counter productive for the intended large event design flows. To progress this would require more modelling in 12D and checking in the Hydraulic Model tool for effect on large flows.	Accept	Accept
53	Spelling / Grammar	Drawings	Noted a number of spelling / grammar errors in the notes on the drawings.	Drawing typos are now corrected	Accept	Accept
54	Risk Register	Safety In Design	Comment - Is this appropriate in the drawings or should this be a separate document?	Full SID was available in the Appendices. Construction Phase SID provided in the drawing is suitable for contractor to ensure all risks identified by Consultant are covered by Contractor meeting HSWA requirements.	Accept	Accept
55	Safety In Design	Safety In Design	This is a list of construction risks and doesn't highlight safety elements which have been included within the design.	Updated SID with all considerations has been added to appendices.	Accept	Accept
56	Risk Register	Safety In Design	Comment - Unless there is a change of the activity being done the consequence cannot change for a risk, mitigation measures effect the likelihood of it occurring.	Consequences have been updated.	Accept	Accept
57	Top Soil	Specification	Assumption of topsoil depth and depth of Respread, confirm disposal of excess?	Excess disposal could be in agreement with landowner on area south of the bypass. We have added to the cost estimate a Provisional Item with amount 1m3 to remove the topsoil to another location.	Please refer to where assumed site topsoil depth is noted, this is essential for construction as there is a big different in cost if 100mm v 300mm needs to be removed from bund.	Ben showed the photos around the burn pit at the confluence which indicated that the topsoil was barely much more than 20-50mm. Excess amounts is a risk but has been accounted for as a provisional rate to dispose so that SDC have a fixed rate. Actual variation of topsoil depth will be determined when Sicon excavate the test pits. Also, Daniel identified that the new landowner may likely prefer to keep any spare topsoil and spoil on site for future development.
58	Top Soil	Specification	Can the bunds be formed from top soil? Save stripping away material underneath.	Preference for bunds to be compacted spoil with 100mm topsoil.	Refer to note 57 - Topsoil onsite determines how much work is required to digout and construct bund.	SDC can choose to accept the bunds are made of topsoil to deal with any excess (if developer doesn't want to keep on site as noted above). Aurecon's recommendation is to use spoil and finish with topsoil. Ben considers that construction of the bunds can be easily compacted with a foot compactor or roller on a 1:4 slope.
59	Geotextile	Specification	Is Geotextile requirement clearly stated in specification.	Spec already has geotextile requirement refer 12.3 Placement	Accept	Accept
60	Water Source for Dust suppression / Irrigation	Specification?	Contractor noted that there will be a lot of water required to establish grass, can a temp well be sunk to take groundwater? Are there other sources of water?	Consent application will allow for water take considerations.	Accept	Accept
61	Additional Comment	Proposal says an ESCP will be provided, but this has been specifically excluded from design report?				Not talked about. Proposal says ESCP under "Detailed design of new Stage 5 twin 1.2m diameter culverts" but nowhere else, this made it into the proposal in error.
62	Additional Comment	Scala ground test was not completed as per proposal.				as per item 37. Ben identified that the burn pit at the confluence revealed that the ground to be the same profile as that shown in the borelog 90m away from the stage 5 culvert. This indicated that the ground was likely to be good. However this is something that can be confirmed during construction when the exposed ground is not drowned in water. Elaine and Daniel accepted this.
63	Additional Comment	SID Still doesn't really cover design features, only construction risk. Examples could include checking freeboard where bund removed, rip rap size check for scour risk Things already noted in design report).				We will provide an updated version as part of the re-issue requested to include a section on rip-rap.

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The Aurecon logo consists of a small green square with a white dot inside, followed by the word "aurecon" in a bold, black, sans-serif font.

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Appendix 4 – Floor Level Survey and Analysis 2020

Appendix C

Floor Level Analysis

As part of the proposed Leeston Stormwater Bypass design, a number of mitigation scenarios have been investigated in the hydraulic model developed for this project. In order to select the preferred design option, floor level survey was undertaken in February 2019 for selected dwellings at critical locations identified from the flood modelling. This floor level survey was required to undertake a flood impact assessment of existing dwellings in the catchment.

The surveyed floor levels were compared against peak flood levels from each of the model scenarios previously completed for this project. These scenarios included the existing, design and mitigation option 1, 2, 2A, 2B, 3 and 4 scenarios.

The floor level flood impact assessment for the chosen option (Mitigation 1B Scenario) is included in **Table 8-1** below. This includes a list of the building (house, garage, shed etc) floor levels, corresponding peak flood levels and freeboard for this model scenario. Whilst this option does result in a slight increase in peak flood depth and level, this is typically in rural land and does not have any adverse impacts on existing buildings. It is also noted that this increase in peak flood depth and level occurs in large infrequent flood events. The benefits of this option are that it has no inundated or at risk of inundation existing floors, reduced total number of inundated or at risk of inundation garages and conveys a larger peak flow from the proposed Leeston Stormwater Bypass within the main flow channel.

Table 8-1 Floor Level Assessment

Address	Asset	Surveyed Floor Level (m RL)	Existing Scenario		Mitigation 1B Scenario		Scheme Impact
			Flood Level (mRL)	Freeboard (m)	Flood Level (mRL)	Freeboard (m)	Flood level reduction
2 Showground Place	House	18.79	18.458	0.332	18.467	0.323	0.009
12 Showground Place	Garage	18.38	18.402	-0.022	18.279	0.101	-0.123
483 Volckman Road	Dome Shelter	17.25	NA	NA	NA	NA	NA
144 Beethams Road	House	17.55	15.989	1.561	15.969	1.582	-0.020
55 High Street	House	20.13	19.607	0.523	19.474	0.656	-0.133
55 High Street	Garage	19.54	19.565	-0.025	19.461	0.079	-0.104
53 High Street	House	20.14	19.543	0.597	19.388	0.752	-0.155
53 High Street	Garage	19.58	19.552	0.028	19.422	0.158	-0.129
51 High Street	House	20.1	19.519	0.581	19.437	0.663	-0.082
51 High Street	Garage	19.59	19.541	0.049	19.449	0.141	-0.092
49 High Street	House	20.09	19.470	0.620	19.419	0.671	-0.050
49 High Street	Garage	19.49	19.472	0.018	19.438	0.052	-0.034
49 High Street	Wash house	19.61	19.472	0.138	19.412	0.198	-0.060
43 High Street	Shed	19.73	NA	NA	NA	NA	NA
43 High Street	Club House	19.86	NA	NA	NA	NA	NA
41 High Street	Front of House	19.48	19.257	0.223	19.229	0.251	-0.028

41 High Street	House	19.51	19.260	0.250	19.229	0.281	-0.031
39 High Street	House	19.31	19.257	0.053	19.205	0.105	-0.052
39 High Street	House	19.68	19.257	0.423	19.205	0.475	-0.052
39 High Street	Garage	19.36	NA	NA	NA	NA	NA
37 High Street	Shed	19.4	NA	NA	NA	NA	NA
37 High Street	House	19.82	19.194	0.626	NA	NA	NA
35 High Street	House	19.65	19.163	0.486	NA	NA	NA
35 High Street	House	19.55	NA	NA	NA	NA	NA
483 Volckman Road	Shed	16.7	16.628	0.072	16.632	0.068	0.004
483 Volckman Road	Garage	17.6	NA	NA	NA	NA	NA
483 Volckman Road	House	17.84	NA	NA	NA	NA	NA
483 Volckman Road	House	17.09	16.629	0.461	16.613	0.477	-0.016
15 High Street	House	18.98	18.586	0.394	18.579	0.401	-0.007
19 High Street	Garage	18.8	18.648	0.152	18.637	0.163	-0.012
27 High Street	Garage	19.04	NA	NA	NA	NA	NA
11 Cunningham Street	Shed	18.95	NA	NA	NA	NA	NA
23 High Street	Sleepout	19.19	NA	NA	NA	NA	NA
25 High Street	Garage	18.95	NA	NA	NA	NA	NA

23 High Street	House	19.33	NA	NA	NA	NA	NA
23 High Street	Garage	19.1	NA	NA	NA	NA	NA
23 High Street	Garage	19.08	NA	NA	NA	NA	NA
13 High Street	Garage	18.72	18.586	0.134	18.514	0.206	-0.072
13 High Street	House	19.14	18.587	0.553	18.579	0.561	-0.008
19 High Street	House	19.17	18.648	0.522	18.637	0.534	-0.012
11 Cunningham Street	Garage	18.94	NA	NA	NA	NA	NA
11 Cunningham Street	House	19.19	18.678	0.512	18.644	0.546	-0.034
16 High Street	House	18.86	NA	NA	NA	NA	NA
16 High Street	Garage	18.28	18.136	0.144	18.079	0.201	-0.057
8 Showground Place	House	18.84	18.402	0.438	NA	NA	NA
8 Showground Place	Garage	18.49	18.402	0.088	18.312	0.178	-0.090
16 Showground Place	House	19	18.403	0.597	NA	NA	NA
16 Showground Place	Garage	18.52	18.406	0.114	18.199	0.321	-0.207
159 Beethams Road	Shed	13.02	NA	NA	NA	NA	NA
159 Beethams Road	Shed	14.29	NA	NA	NA	NA	NA
159 Beethams Road	Shed	14.48	NA	NA	NA	NA	NA
159 Beethams Road	House	14.67	NA	NA	NA	NA	NA

159 Beethams Road	Shed	14.51	NA	NA	NA	NA	NA
159 Beethams Road	House	14.74	NA	NA	14.232	0.508	NA
159 Beethams Road	House	15.6	15.444	0.156	15.412	0.188	-0.032
25 High Street	House	19.39	18.894	0.496	18.878	0.512	-0.015
25 High Street	Garage	18.87	18.857	0.013	18.843	0.027	-0.013
31 High Street	Garage	19.18	19.172	0.008	19.067	0.113	-0.105
31 High Street	House	19.6	19.172	0.428	19.032	0.568	-0.140
27 High Street	House	19.57	19.109	0.461	19.081	0.489	-0.029
29 High Street	Garage	19.39	NA	NA	NA	NA	NA
29 High Street	House	19.46	19.163	0.297	19.143	0.317	-0.020
33 High Street	House	19.61	19.163	0.447	19.103	0.507	-0.060
35 High Street	Garage	19.29	19.165	0.125	19.115	0.175	-0.050
33 High Street	Garage	19.25	19.163	0.087	19.083	0.167	-0.080
143 Lochheads Road	House	10.21	9.581	0.629	9.526	0.684	-0.055
143 Lochheads Road	Dairy Shed	10.15	9.120	1.031	9.201	0.949	0.082
211 Beethams Road	Workshop	15.01	NA	NA	NA	NA	NA
211 Beethams Road	Workshop	15.08	NA	NA	NA	NA	NA
189 Beethams Road	House	16.12	NA	NA	NA	NA	NA

143 Lochheads Road	Conservatory	10.08	9.576	0.504	9.524	0.556	-0.052
159 Beethams Road	House	14.79	NA	NA	NA	NA	NA
189 Beethams Road	House	15.98	NA	NA	NA	NA	NA
189 Beethams Road	Garage	15.56	NA	NA	NA	NA	NA
12 Showground Place	House	18.72	18.402	0.318	18.147	0.573	-0.255
15 High Street	Garage	18.75	NA	NA	NA	NA	NA
159 Beethams Road	Garage	14.5	NA	NA	NA	NA	NA

Appendix 5 – 1 in 200 year event effect HEC-RAS modelling check on Howson’s property (60 Leeston Dunsandel Road)

Memorandum

To	Daniel Meehan	From	Nancy Zhang
Copy	Elaine McLaren	Reference	505193
Date	2021-03-03	Pages (including this page)	7
Subject	Leeston Stormwater Bypass (Stage 4): 1 in 200-year event effect HEC-RAS modelling check on Howson's property		

1 Introduction

In the interest of progressing the construction of the stage 4 bypass works before the winter season of 2021, SDC need to be able to demonstrate to the landowner John Howson that there are no adverse effects occurring to his property during a 200-year Annual Return Interval (ARI) storm event as a result of the Leeston Stormwater Bypass project. The portion of the bypass located within the Howson property includes the Stage 4 - confluence spillway and the first 226 metres of the bypass. Refer Figure 1 below.

SDC have requested that Aurecon run the existing HEC-RAS model with flows over the 100-year ARI design event up to a calculated approximation of the 200-year ARI event. The purpose of this assessment is to identify if there are any adverse effects to the Howson property from any bypass overflows during the larger 200-year ARI event.

A summary of the findings of this assessment is found in Section 7 Result analysis and recommendations. Please also refer to Section 8 Exclusions and Assumptions.

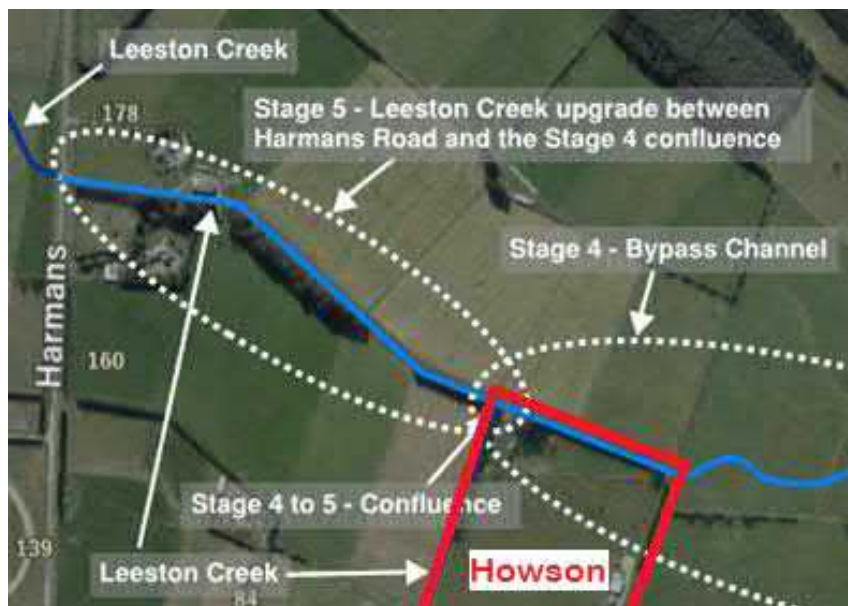


Figure 1 - Location of Howson's block shown within red outline in relation to Leeston Stormwater Bypass project

2 Scope of Works

2.1 Modelling Scope

The scope of this analysis is outlined below:

- Regular communication with SDC Project Manager.
- Review the hydrology and hydraulics used for the previous modelling.
- Based on the review, generate **approximate** 200-year ARI flow rates.
- Rerun the 1D HEC-RAS hydraulic model with the 200-year ARI flow.
- Update the HEC-RAS model as needed to reflect above design conditions, especially surrounding the diversion structure.
- Result analysis - identify locations of spills.
- Assess the potential impact of spilling to adjacent properties.
- Deliverables:
 - This summary memo highlighting identified spill locations and the approximate downstream paths of the spills in relation to the size of the event above the design event of 1 in 100yr, up to 200-year ARI.

3 Hydrologic Calculations –200-year ARI flow rate

The 200-year ARI peak flow rate was estimated based on logarithmic extrapolation. Peak flow rates established for the 10-year, 50-year and 100-year ARI events were used in the extrapolation.

Figure 2 below shows the logarithmic extrapolation chart with trendline, equation and RMSE. The equation obtained was used to calculate the peak flow rate for 1 in 200-year event, resulting in 7.38 m³/s.

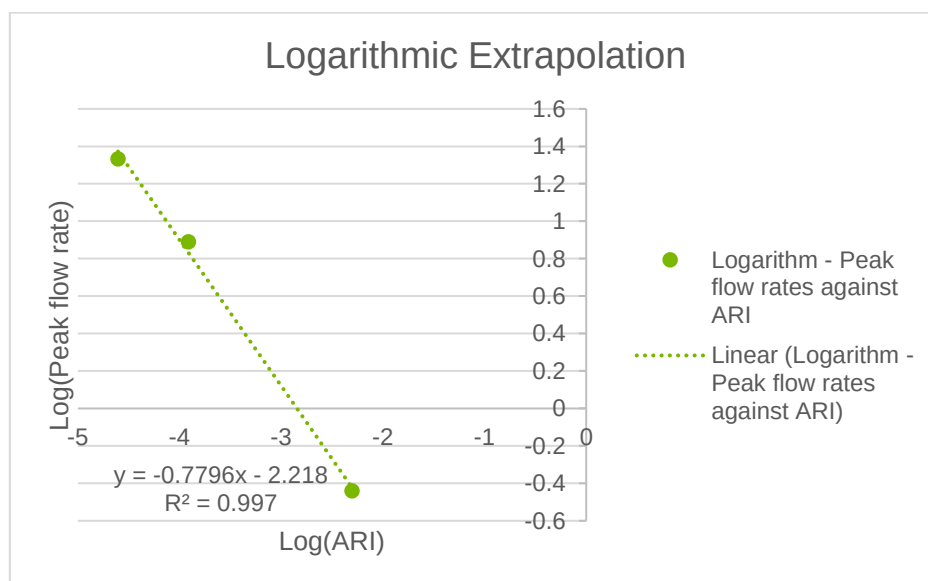


Figure 2 Logarithmic Extrapolation chart

4 Rerun Hydraulic Model with the 1 in 200-year peak flow

4.1 Geometry Data

The modelling for this analysis utilised the HEC-RAS model previously established for the design of stages 4 and 5 of the Leeston Bypass project. This model only considers the channel and bypass itself and is not intended to establish the flooding situation beyond the project area. Nevertheless, the model is considered appropriate for determining the likelihood of breakouts from the channel that may have offsite impacts.

4.2 Rerun the model with the 1 in 200-year peak flow

The approximate 1 in 200-year peak flow rate of 7.38 m³/s was input in the HEC-RAS hydraulic model. We started with the assumption that the Stage 4 bypass and Stage 5 channel are well maintained, with well mown grass with an associated Manning's roughness parameter of 0.035. For the purposes of establishing a 'worst case scenario', the low flow control gate at the confluence structure is kept closed to simulate the maximum potential impact.

The basis for the overall channel design was a 100-year ARI event. The Stage 5 channel has minimal excess capacity to convey events of a greater magnitude. For the 200-year ARI event, the model indicates that significant bank overtopping and spills will occur throughout Stage 5; upstream of the Stage 4-5 confluence, as shown in Figure 3.

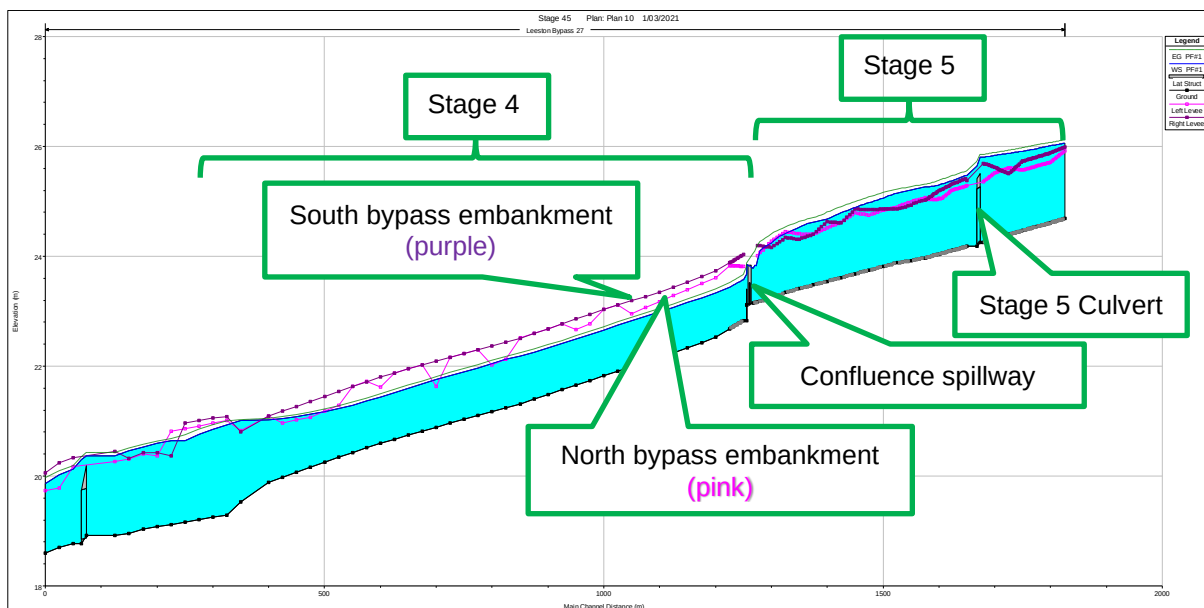


Figure 3 Peak water level profile plot – 1 in 200-year flow

4.3 Rerun the model with channel capacity flow

Water that escapes from the channel in Stage 5 will flow overland and does not return to the Stage 5 channel or confluence. However, we note a comprehensive analysis of where this overland flow goes is not part of the scope of this assessment. Given that Stage 5 has a limited capacity, we therefore analysed the channel embankment heights to determine the maximum capacity of the Stage 5 channel that could actually reach the confluence structure.

The analysis determined, through trial and error, that the maximum Stage 5 channel capacity reaching the confluence structure was 4.37 m³/s. This flow rate represents the maximum flow that can be

5 Channel Roughness (Manning's n) test

The modelling so far has assumed that the Stage 4 bypass and Stage 5 channel have been well maintained with well mown grass with an associated manning's roughness parameter of 0.035. In order to assess the potential impact if either or both stages are unmaintained, a scenario was run with a higher roughness parameter of 0.065, representing moderate overgrowth of shrubbery and high grasses. In all instances we have applied the Stage 5 channel capacity flow rate of 4.37 m³/s for a conservative assessment. This would represent a well-maintained Stage 5 channelling it's maximum capacity to the confluence and through the bypass.

Figure 6 below shows the modelling results for this channel indicating the reduced capacity flow rate would cause spills at multiple locations both above and below the bypass.

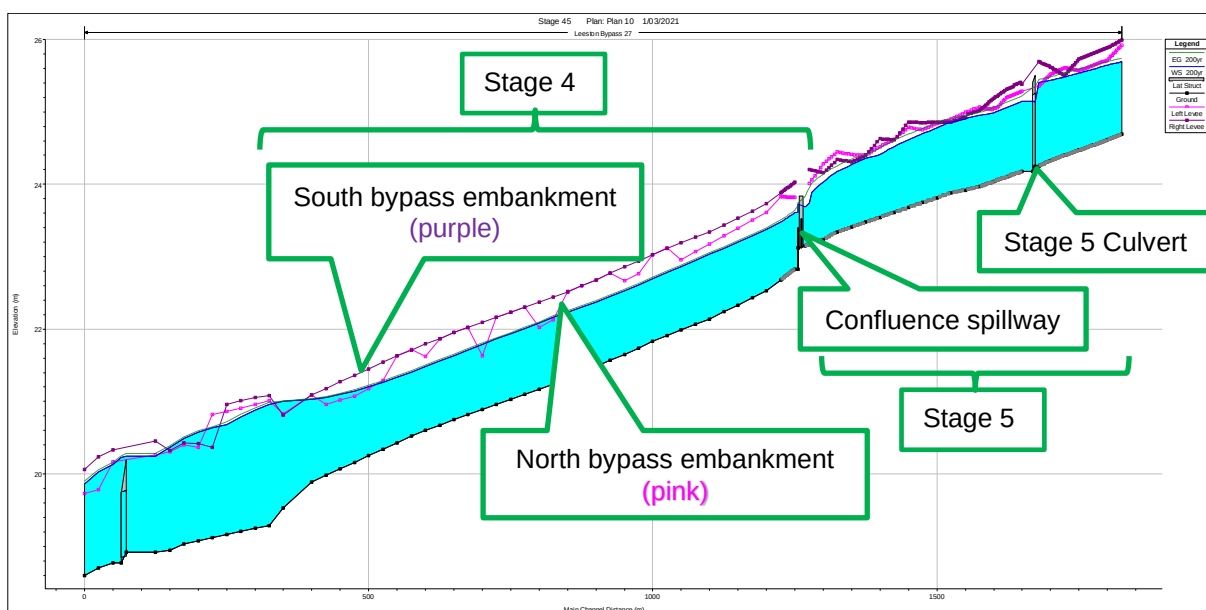


Figure 6 Peak water level profile plot – Channel capacity flow with Manning's n = 0.065 in the bypass

It is noted, however, that under unmaintained conditions, the Stage 5 channel continues to have significantly lower capacity than the bypass. Therefore, the risk of significant spill from the Stage 4 bypass channel would only occur in the event that the Stage 5 portion of the channel is well maintained, while the Stage 4 bypass is unmaintained.

6 Bunding through Howson's property

We can show that during the 200-year ARI event, the capacity flow rate of $4.37 \text{ m}^3/\text{s}$ (noting this is a conservative value) as it flows through the Stage 4 bypass, within Howson's property, does not spill over the embankments with Manning's $n = 0.035$ or 0.065 .

The cross section in Figure 7 below shows the level of water and the Energy Grade Line (EGL) of the for $4.37 \text{ m}^3/\text{s}$ flow, with a Manning's $n = 0.035$. This cross section is taken at approximately chainage 25m. The water and EGL heights resulting from $4.37 \text{ m}^3/\text{s}$ with the Manning's $n = 0.065$ are also drawn onto this cross section for comparison. This shows that even in this conservative scenario during the 200-year ARI event, the bunding through Howson's property is not required along the south embankment in both Manning's scenarios. Note that this is not the case further downstream, refer Figure 6 above.

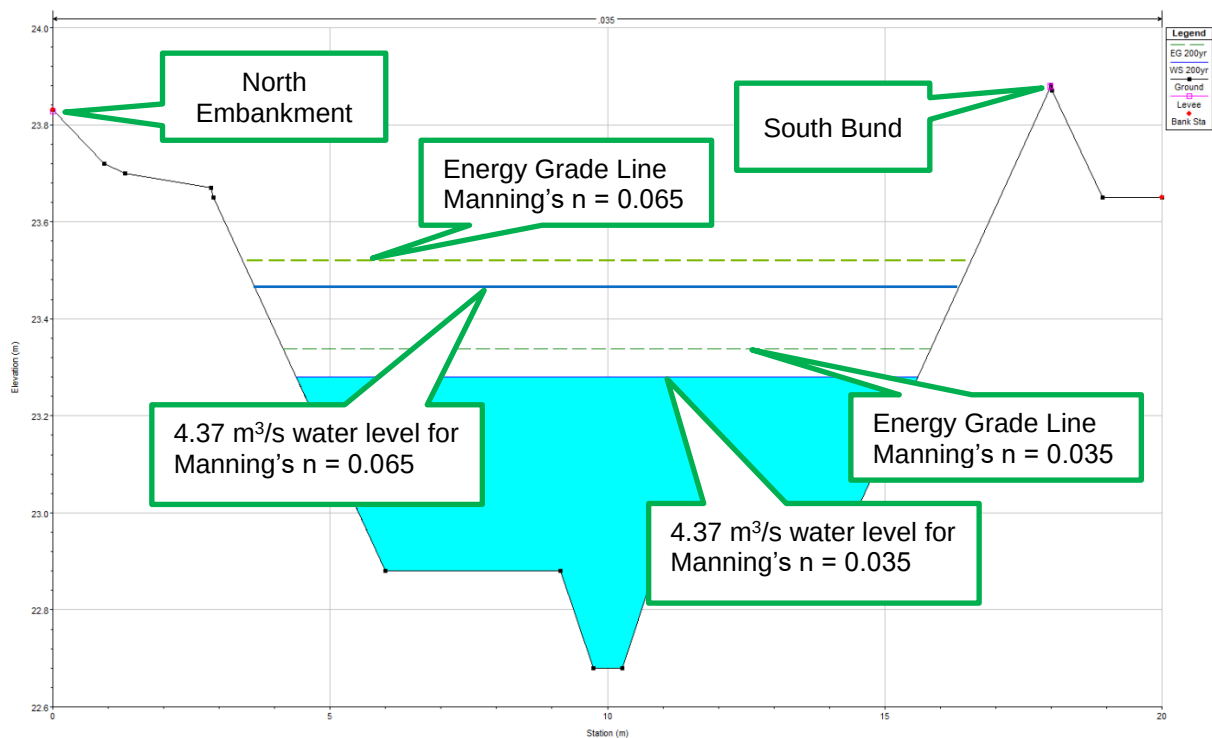


Figure 7 - Cross section at approximate chainage 25m

7 Result analysis and recommendations

Below is a summary of the above runs and their results:

- The 1 in 200-year results in significant overtopping of the channel in Stage 5, before it reaches the confluence structure.
- Stage 5 is the determining reach for the overall channel capacity. The capacity at the confluence structure within the bypass significantly exceeds the capacity in Stage 5.
- If the Stage 4 bypass is poorly maintained in relation to a well maintained Stage 5, there is risk of spills occurring within the bypass.

According to the findings above, Aurecon recommends:

- Ensure that all heights around the confluence structure maintain a level equivalent to or greater than RL 23.8m.
- Ensure both Stage 5 and the bypass are well maintained.

8 Exclusions and Assumptions

- The hydrology has not been fully rerun based on new rainfall – the inputs will be approximated using log-log extrapolation.
- The HEC-RAS model has been used to identify spill locations and approximate magnitudes only. We did not fully model downstream fate of any identified spills.
- The downstream impacts of spills will not be explicitly modelled, and the potential impacts will be based on conservative engineering judgement considering the local terrain.
- Additional follow up work to more accurately understand the hydrology and hydraulics is excluded.
- The model and its results are intended to be a conservative analysis of potential spills from the bypass work. The results are limited in nature and will not be fit for purpose of establishing the overall flood risk of a location.

Appendix 6 – Modelling data of drainage improvements and proposed bank raising

Attachment 2

Modelling data

Location	Chainage (m)	Flood Level (m RL)	Left bank (m RL)	Left bank increase (m)	Right bank (m RL)	Right bank increase (m)	
Drain 57	400		13.803	N/A		13.783 --> 13.919	0.136
	450		13.537	N/A		13.527 --> 13.754	0.227
	650		12.918	N/A		12.876 --> 13	0.124
	700		12.715	N/A		12.709 --> 12.8	0.091
	950		11.823	N/A		11.718 --> 11.918	0.2
	1050		11.441	N/A		11.432 --> 11.532	0.1
	1200		10.947	N/A		10.929 --> 11	0.071
	1350		10.328	10.301 --> 10.442	0.141	N/A	
	1450		9.895	9.802 --> 9.938	0.136	N/A	
u/s Locheheads Road	1500		9.745	9.61 --> 9.9	0.29	9.746 --> 9.9	0.154
Locheheads Road	1600		9.621	9.369 --> 9.717	0.348	N/A	
Locheheads Road	1700		9.485	9.216 --> 9.5	0.284	9.41 --> 9.5	0.09
d/s Locheheads Road	1800		9.286	9.05 --> 9.369	0.319	N/A	
	1850		9.194	8.846 --> 9.2	0.354	9.041 --> 9.2	0.159
	1900		9.057	8.803 --> 9.12	0.317	N/A	
	1950		8.759	8.572 --> 8.8	0.228	8.61 --> 8.8	0.19

Location	Chainage (m)	Flood Level (m RL)	Left bank (m RL)	Left bank increase (m)	Right bank (m RL)	Right bank increase (m)	
	2000		8.555	8.387 --> 8.618	0.231	8.518 --> 8.618	0.1
Tramway Reserve Road	2050		8.53	8.11 --> 8.5	0.39	8.021 --> 8.5	0.479
Volkman Road Drain and Tramway Reserve Road Drain (LEESTON_DownStream)	416		13.371	12.857 --> 13.1	0.243	12.881 --> 13.1	0.219
	827		11.987	11.422 --> 11.784	0.362	N/A	
	1232		10.717	10.17 --> 10.4	0.23	10.321 --> 10.4	0.079
	1248.4		10.678	10.083 --> 10.3	0.217	10.257 --> 10.3	0.043
	1261.6		10.556	10.013 --> 10.3	0.287	10.205 --> 10.3	0.095
	1434		10.154	9.1 --> 10.2	1.1	9.53 --> 10.2	0.67
u/s Locheheads Road culvert	1452.5		10.13	9.041 --> 10.2	1.159	9.471 --> 10.2	0.729

Appendix 7 – Photos of completed works to drainage network

The below photos have been compiled from a range of sources including the 2019 Flood modelling report, 2020 Detailed Design Report prepared by Aurecon and SDC records. As such the date of these photos are not known.

Stage 1: Connection of the Ellesmere Hospital drain to Manse Road and widening of the High Street Drain

Completion Date: 2014/2015



Photo 1: Upgraded Ellesmere Hospital Drain in Flood. Looking west from Manse Road towards Cunningham Street (Ellesmere Hospital – left).



Photo 2: Widening of High Street Drain.

Stage 2: Upgrade of Manse Road Drain and Reids Culvert

Completion Date: 2016



Photo 3: Upgraded Manse Road Drain during a higher rainfall event. Looking north from High Street.

Stage 3: Upgrade capacity of the drainage channels south of Leeston, including the new High Street culvert.

Completion Date: 2021



Photo 4: New culverts under High Street (northern side) Looking south.



Photo 5: Upgraded Culvert (southern side) and Volckman Drain. Looking east from Station Street towards Volckman Road.



Photo 6: Upgraded Volckman Drain. Looking west from Volckman Road towards Leeston Road/High Street.

Completed Maintenance Works



Photo 7: Volckman Road Drain - Before Maintenance



Photo 8: Volckman Road Drain - After Maintenance



Photo 9: Volckman Road Drain - Before Maintenance



Photo 10: Volckman Road Drain - After Maintenance



Photo 11: Volckman Road Drain - Beethams Road - upgraded culvert. Looking West at intersection of Tramway Reserve Road and Beethams Road.