

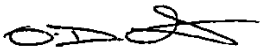
Stormwater & Flood Management

Parkburn Development

Cromwell, Central Otago
Fulton Hogan Land Development Ltd

Final

Document Control

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Statement of Qualifications and Experience

Pranil Wadan (Flowstate Consulting)

I am a Director of Flowstate Consulting LP and act as a Technical Consultant to Wood and Partners Consultants Limited, trading as Woods.

I hold a Bachelor of Engineering from the University of Auckland, completed in 2007. I am a Chartered Professional Engineer and a member of Engineering New Zealand and Water New Zealand. My additional professional qualifications and appointments include International Professional Engineer (IntPE(NZ)), Certified Independent Hearing Commissioner, and a Certificate in Company Direction and Governance.

I have more than 18 years' experience in stormwater design, hydrodynamic modelling, flood risk assessment, water infrastructure, and stormwater management for land development projects. I have acted as principal author and lead stormwater engineer for a wide range of stormwater management plans and flood modelling assessments prepared for projects across New Zealand.

My experience includes the development of catchment-scale flood models, detailed stormwater network models, and integrated catchment management plans for both private sector clients and territorial and regional authorities.

In my role as originator and reviewer of this report, I confirm that I have read and comply with the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Boniface Kinnear

I am a Principal Engineer in the Water Infrastructure & Planning at Wood and Partners Consultants Limited ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since 2020.

I hold a Bachelor of Science in Environmental Engineering from the University of Southern California, Los Angeles, California which I obtained 2004. I also hold Master of Engineering Studies and a Master of Engineering in Environmental Engineering both from the University of Auckland completed in 2007 and 2008 respectively. I am a Chartered Professional Engineer (CPEng), a chartered member of Engineering New Zealand (CMEngNZ) and an International Professional Engineer (IntPE)/APEC Engineer. Additionally, I am a member of the Environment Institute of Australia and New Zealand (EIANZ) as well as a member of the Rivers Group NZ.

I have over 18 years of experience in environmental management, contaminated land, impact assessments, stormwater design and modelling, flood risk assessments, water infrastructure and stormwater management. I have authored several stormwater management plans, flood modelling reports, infrastructure assessment/design reports, earthworks reports and detailed site investigation reports to support numerous projects.

I confirm that, in my capacity as contributor of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Simran Bassan

I am an Engineer at Wood and Partners Consultants Limited (Woods), holding a Bachelor of Engineering from the University of Auckland, completed in 2021. I am a member of Engineering New Zealand and Water New Zealand.

I have four years' experience in hydrodynamic modelling, flood risk assessment, and stormwater management for land development projects. This experience encompasses catchment-scale flood models, detailed stormwater network models, and stormwater management plans spanning a range of projects across New Zealand, for both private sector clients and territorial and regional authorities.

I confirm that, in my capacity as contributor of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Executive Summary

This Stormwater Management Plan has been prepared to support a substantive application under the Fast-track Approvals Act 2024 for the Parkburn Development at 922 Luggate-Cromwell Road, Cromwell. The development is being progressed by Fulton Hogan Land Development Ltd and will enable a large-scale residential and mixed-use subdivision across approximately 118 ha of land currently used for quarrying, fronting Lake Dunstan.

The stormwater strategy has been informed by site-specific hydrological and hydraulic modelling. It has been prepared in accordance with Central Otago District Council and Otago Regional Council requirements.

The overall approach is to manage stormwater in a way that responds to the site conditions, supports the proposed land use change, protects development areas from flood risk, and provides appropriate treatment before discharge towards Lake Dunstan.

Stormwater Management Approach

The development has been divided into two main stormwater catchments based on proposed levels, ground conditions, and available discharge options.

Catchment 1 covers approximately 24.42 ha of the higher parts of the site. Stormwater in this area can be managed through in-ground soakage, consistent with established practice in Cromwell, where ground conditions support this approach.

Catchment 2 covers approximately 92.19 ha of the lower parts of the site, where soakage is not suitable as the primary disposal method. Stormwater from this catchment will be collected through a reticulated piped network, treated, and discharged through the proposed stormwater management system. Four stormwater management zones have been identified within Catchment 2 to reflect differences in land use, drainage arrangement, discharge location, and treatment requirements.

Stormwater quality will be managed through a combination of source control and treatment devices. All buildings will use low-contaminant roofing and spouting materials to reduce contaminant generation at source. For Zone A, vegetated swales are proposed along both sides of the central conveyance channel and have been sized to convey the water quality design flow, with a target contaminant removal efficiency of at least 75 % in accordance with GD01. For Zones B to D, treatment will be provided through an at-source and network-based toolbox, which may include bioretention devices, tree pits, catchpit filters, gross pollutant traps, and proprietary devices. Final device selection and sizing will be confirmed at detailed design stage in consultation with CODC.

The primary stormwater network will be designed to convey the minimum 5-year ARI event in accordance with CODC engineering standards and NZS 4404:2004. Larger events will be managed through the secondary network, with overland flow paths generally provided within road corridors and the central drainage corridor. The central drainage corridor will provide the main flood conveyance function for the site and includes two major culverts and a bridge crossing to connect the northwestern part of the development with the balance of the site. Overland flow paths will be maintained free of obstruction and designed so that the development does not create or worsen flooding effects on neighbouring properties.

Flood and Natural Hazard Assessment

Hydrological and hydraulic modelling has been undertaken using HEC-HMS and HEC-RAS, with design rainfall derived from NIWA HIRDS V4 and allowance for the RCP8.5 climate change scenario projected to 2100.

The catchment-wide modelling confirms that, for the 100-year ARI event including climate change, flood flows from the wider Mount Pisa catchment are contained within the central drainage corridor and do not overtop into the proposed development areas. The post-development modelling also accounts for the reduced floodplain area within the neighbouring Bonisch site and confirms that the development does not create adverse flooding effects on upstream properties.

Internal flood modelling for the 5-year, 10-year, and 100-year ARI events, including climate change, shows that flood flows within the development are generally contained within road corridors and the central drainage corridor. The ARR flood hazard assessment confirms that the maximum hazard classification within the developed areas, including road corridors, is H1, which is generally safe for people, vehicles, and buildings. Higher hazard areas are limited to the drainage corridors, where flood conveyance is expected and where habitable development is not proposed.

Minimum finished floor levels will be set 0.5 m above the modelled 1 % AEP flood level, including climate change, in accordance with CODC Engineering Standards and NZS 4404:2004.

Otago Regional Council alluvial fan mapping identifies a small part of the northeastern development area as being within an active, floodwater-dominated fan extending from Mount Pisa towards Lake Dunstan. A conservative sensitivity assessment, based on three times the 100-year ARI discharge, confirms that flood flows remain contained within the revised drainage corridor and do not inundate the proposed development platforms. Habitable buildings have been located outside the active fan corridor, with infrastructure and open space proposed within the fan area. This provides a risk-proportionate response to the mapped hazard.

The flood and alluvial fan hazard assessment demonstrates that the development is consistent with the National Policy Statement for Natural Hazards 2025. Flood hazard risk across the proposed development platforms is assessed as Low to Negligible under the NPS-NH risk matrix. No Very High risk areas have been identified within the proposed habitable development footprint.

Conclusion

The proposed stormwater management strategy represents the Best Practicable Option for the Parkburn Development. It provides a practical and site-responsive framework for managing the change from quarrying and rural land use to urban development.

The strategy provides for stormwater collection, treatment, conveyance, and disposal in a way that protects people and infrastructure, manages flood risk, avoids adverse effects on neighbouring properties, and provides appropriate stormwater quality treatment before discharge towards Lake Dunstan.

On this basis, the proposed stormwater management approach is considered appropriate to support the substantive Fast-track Approvals Act application.

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1. Introduction

The site is approximately 118ha in area and located at 922 Luggate-Cromwell Road, Mt Pisa, Cromwell, approximately 8.5km from Cromwell, as illustrated in (Figure 1).

The majority of the site is, or has historically been, utilised as the Parkburn Quarry, which is being progressively quarried from south to north, with rehabilitation works already undertaken in some areas. The northern end of the site accommodates a range of small-scale yard-based industrial activities.

The site occupies a low-lying, modified area within the rural environment, situated outside any identified Outstanding Natural Landscape or Significant Amenity Landscape. It is positioned on a terrace landform forming part of the lake-edge area between Mount Pisa and Lake Dunstan / Te Wairere. At its western boundary, the site runs parallel to SH6, from which vehicular access is obtained. The eastern boundary adjoins the riparian edge of Lake Dunstan / Te Wairere, providing a strong landscape and ecological interface. To the south, the site directly adjoins the existing urban area of Pisa Moorings, while the northern boundary adjoins rural-zoned land that also accommodates an operational quarry.

The character of the site is predominantly industrial, with machinery, infrastructure, and stockpiling associated with quarry operations. Due to the existing ground levels, bunding, and peripheral vegetation (including along the SH6 frontage), visibility of on-site activities from adjoining areas is limited. Views into the site are generally only available from elevated locations further afield.



Figure 1: Site location

1.1. Purpose

This Stormwater Management Plan (SMP) has been prepared in support of the substantive FTAA application by Fulton Hogan Land Development Ltd.

The purpose of this report is to outline the stormwater management strategy for the Development, and to demonstrate how the requirements of the Central Otago District Council (CODC) and Otago Regional Council (ORC) have been met. The overarching objectives are as follows:

- Demonstrate that the proposed stormwater management meets the requirements of CODC and ORC;

- Incorporate a water-sensitive urban design approach that manages the impact of land use change from rural to urban;
- Ensure stormwater runoff is conveyed safely to the receiving environment through appropriately designed primary and secondary networks;
- Provide appropriate stormwater quality treatment for the receiving environment, including avoidance of high contaminant-generating roof and cladding materials. This will ensure the water quality of Lake Dunstan/Te Wairere and areas if Iwi interest are protected and not degraded;
- Identify flood risk areas and provide for development outside the 1% AEP floodplain without creating adverse flooding effects on upstream or downstream properties; and
- Account for climate change in the design of stormwater infrastructure, using NIWA HIRDS V4 with RCP8.5 scenario in accordance with CODC and ORC guidelines.
- Recognise and have regard to Lake Dunstan/Te Wairere as a Statutory Acknowledgement Area under the Ngai Tahu Claims Act 1998.

2. Description of Application Site

The site is located at 922 Luggate-Cromwell Road, Cromwell, Central Otago. The Development comprises a large landholding of approximately 118 ha in total, owned by Fulton Hogan Land Development Ltd. The site is situated to the west and southwest of the existing Cromwell township, with Lake Dunstan / Te Wairere forming the eastern boundary.

The site is generally bounded by State Highway 6 (Luggate-Cromwell Road) to the west , existing residential area to the south, and Lake Dunstan / Te Wairere to the east. The site is currently used for rural purposes, predominantly quarrying activities.

The site is legally described as:

- Part Section 62-63 Block IV Wakefield Survey District and Part Section 63;
- Block IV Wakefield Survey District and Section 1 Survey Office Plan 365897 and Section 4 Survey Office Plan 557380;
- Section 64-65 Block IV Wakefield Survey District.

2.1. Description of the Receiving Environment

The receiving environment comprises the site and Lake Dunstan /Te Wairere. Lake Dunstan/Te Wairere is a Statutory Acknowledgment Area and is of significant cultural significance to Kāi Tahu whānui, Approximately 7km to the south of the site is the Nohoanga entitlement at McNulty Inlet (This is a central meeting point for many trails that traversed inland Otago).

2.2. Summary of Data Sources and Dates

A summary of key background data sources used in the development of this SMP is provided in Table 1.

Table 1: Data sources

Existing Site Appraisal Item	Source and Date of Data Used
Topography	LP2000 & NZVD16 survey data, Landpro Ltd, April 2026; LiDAR, LINZ Data Service
Soakage / infiltration testing	Infiltration test results reviewed by Landpro Ltd, Drawing No. 24113/109_01, draftV2, May 2026
Existing stormwater network	Central Otago District Council GIS / IntraMaps
Existing hydrological features	Otago Regional Council GIS; Drains and Waterways; Lake Dunstan / Te Wairere boundary conditions 195.6mRL - Source: Contact Energy
Flooding and flow paths	Inflows from 922A Luggate-Cromwell Rd, Mt Pisa provided by Bonisch (February 2025)
Ecological / environmental areas	Ecological Impact Assessment (Draft – April 2026), Viridis
Geotechnical and Earthworks	Geotechnical Assessment for 922 Luggate-Cromwell Road (SH6), Cromwell (June 2026), Insight Engineering

2.3. Topography

The site topography has been established using LP2000 and NZVD16 survey data prepared by Landpro Ltd (Figure 2). The site generally falls from north to south, and from west to east toward Lake Dunstan / Te Wairere. Ground levels range from approximately 215 mRL at the northern extent of the site to approximately 196 mRL at the lake margin.

Contour data indicates a broadly undulating landform, with localised ridgelines and shallow drainage depressions across the site.

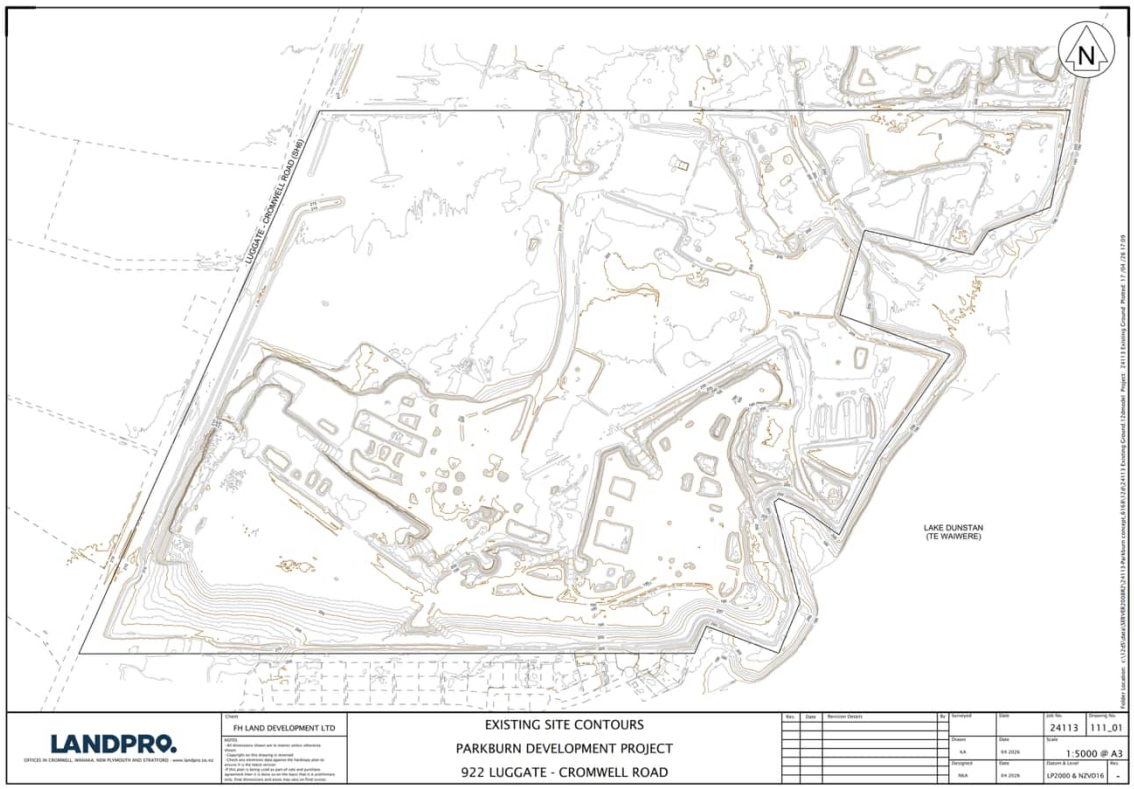


Figure 2: Existing Site Contours (Landpro Drawing 24113/111_01)

2.4. Existing Stormwater Network

The site is currently used for rural and mining/quarry activities and does not contain any existing reticulated stormwater infrastructure. The nearest public stormwater infrastructure forms part of the existing Cromwell residential stormwater network, located to the south of the site.

Although no existing stormwater network is available within the site, the proposed development will provide its own primary stormwater network in areas where soakage is not adopted. Stormwater discharges from the site will be managed independently of the existing public network. As such, the proposed stormwater management system will operate as a standalone system and will not rely on the existing stormwater network.

2.5.Existing Hydrological Features and Waterways & Ecology

Lake Dunstan / Te Wairere forms the eastern boundary of the site. The lake is a significant water body and forms the primary receiving environment for surface runoff from the lower portions of the site. The lake is managed by Contact Energy Ltd as part of the Clutha / Mata-Au hydroelectric scheme.

An Ecological Impact Assessment (EcIA) was prepared by Viridis Limited (April 2026) to assess the ecological values of the site and the effects of the proposed development. The site is located within the Pisa Ecological District and has been heavily modified through approximately 40 years of quarrying, with ecological values within the site largely limited to lizard habitat and intermittent use by native birds.

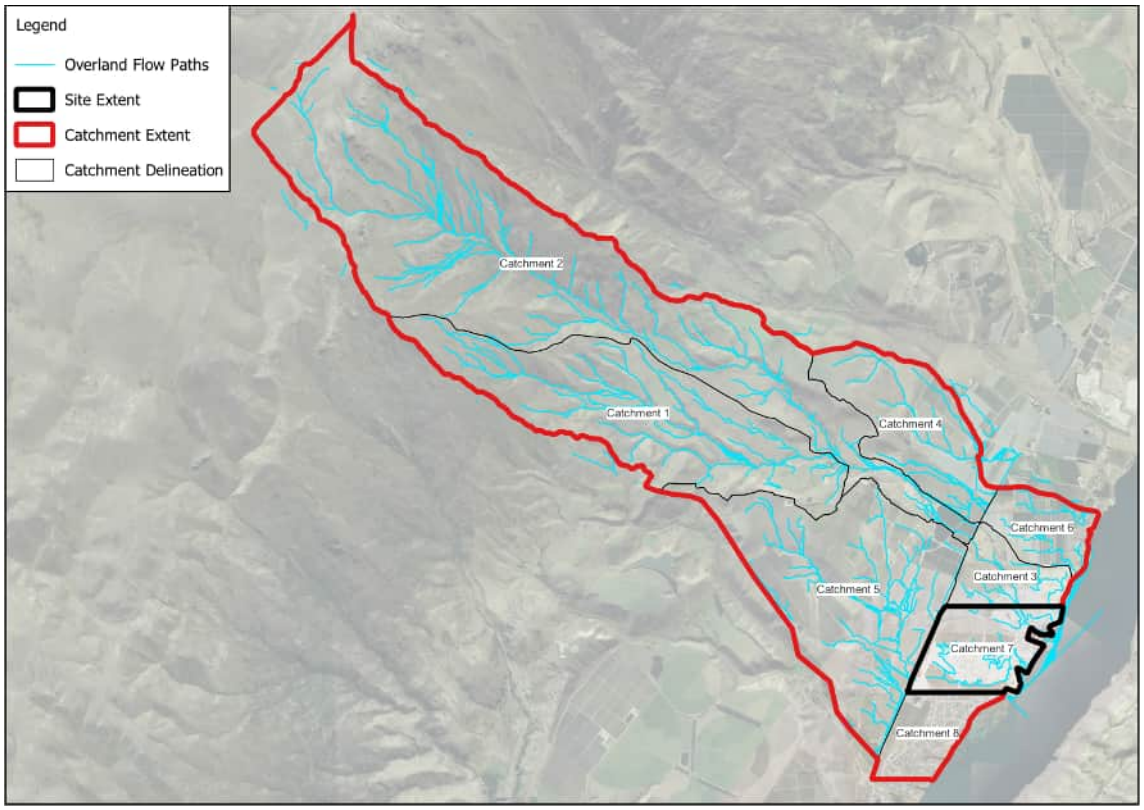
The Parkburn flows through the northeastern corner of the site, classified as an intermittent stream with moderate ecological value. Macroinvertebrate sampling indicated degraded but functional water quality, consistent with the agriculture and horticulture-dominated catchment. Lake Dunstan / Te Wairere forms the eastern boundary of the site and is assigned high ecological value, providing habitat for a range of Threatened and At-Risk bird and fish species.

No natural inland wetlands (as defined under the NPS-FM) are present within or within 100 m of the site. Several areas of non-natural wetland associated with the margins of Lake Dunstan / Te Wairere are present and provide limited habitat values.

2.6. Flooding and Overland Flow Paths

Overland flow paths have been mapped based on LiDAR-derived topographic data. The Catchment Plan identifies external catchment areas and overland flow path alignments across the wider catchment (Figure 3). The map shows large upstream catchment areas originating from Mount Pisa, through extensive farmland and funnelling runoff past the development site via a floodway that leads to Lake Dunstan / Te Wairere.

Internal overland flow paths (Figure 4) characterised by the existing quarry activities will be altered as the landform is modified by the proposed earthworks.



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Figure 3: Existing overland flow paths (wider catchment)

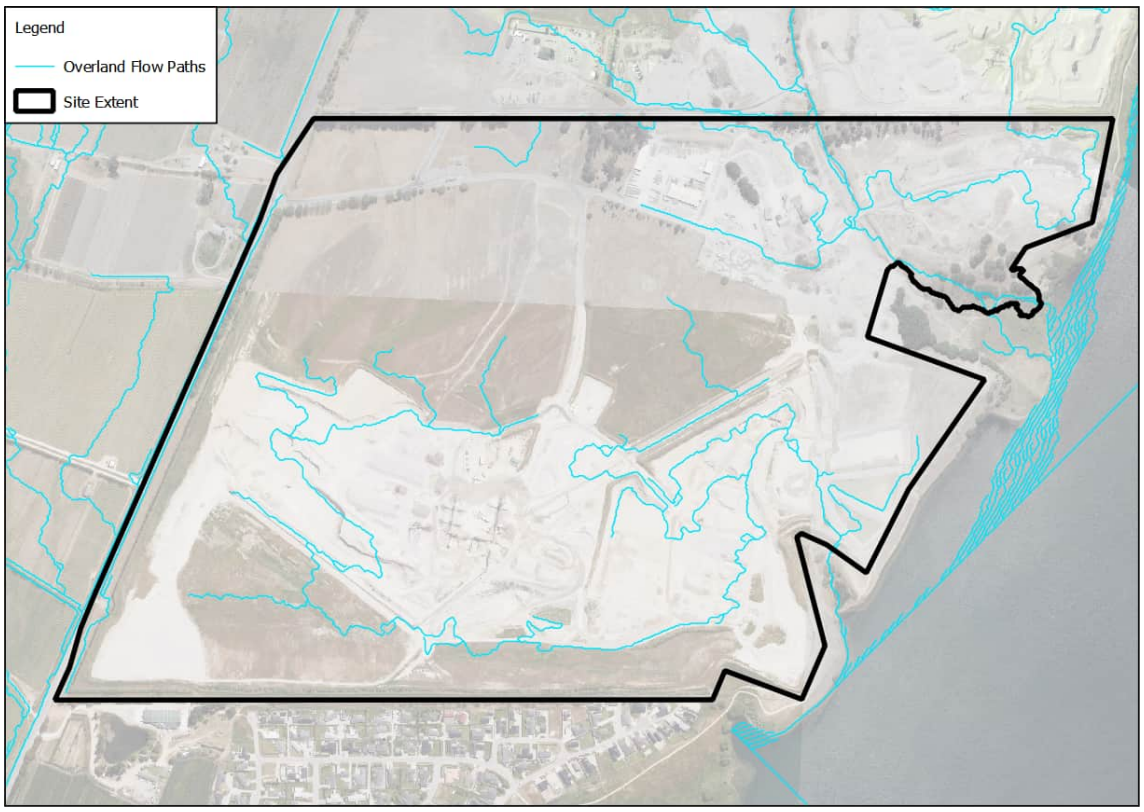


Figure 4: Existing overland flow paths (development site)

3. Development Summary and Planning Context

A review of the relevant stormwater guidelines, policies, and planning instruments has been undertaken to determine appropriate stormwater and flooding requirements for this SMP. The documents reviewed and their relevance are summarised in Table 2.

Table 2: Development documents summary

Guidance Document	Summary	Relevance
Fast-track Approvals Act 2024 (FTAA)	Primary approval pathway for this application, administered by the EPA.	Yes - sets application process and expert evidence requirements
NPS for Freshwater Management 2020 (NPS-FM)	National policy for managing and improving New Zealand's freshwater systems.	Yes - Te Mana o te Wai obligations; water quality and quantity objectives
NES for Freshwater (NES-F) 2020	Establishes permitted activity conditions for activities in or near waterbodies.	Yes
Otago Regional Policy Statement (RPS)	Strategic policy direction for the Otago region including natural hazards and freshwater.	Yes - flood hazard, stormwater management, and receiving environment policies
Otago Regional Plan: Water	Rules governing stormwater discharges to water and land in the Otago region.	Yes
Central Otago District Plan	District Plan provisions for subdivision, land use, and stormwater infrastructure.	Yes - flood hazard overlay, minimum floor levels, infrastructure standards
CODC Land Development and Subdivision Engineering Standards	CODC engineering standards for subdivision infrastructure design.	Yes - primary network design standards, NZS 4404:2004 referenced; GD01 adopted as superseding ARC TP10
NZS 4404:2004 Land Development and Subdivision Infrastructure (including 2008 Addendum)	NZ standard for subdivision infrastructure. CODC references NZS 4404:2004 which draws on ARC TP10.	Yes - NZS 4404:2004 referenced by CODC. ARC TP10 has been superseded by GD01; GD01 adopted for stormwater performance criteria in this SMP
Auckland Council Guideline Document GD01 (2017)	Updated guidance on stormwater management devices, superseding ARC TP10. Adopted for water quality device sizing in this SMP as the current best-practice standard.	Yes - used for sizing of vegetated swales, bioretention devices, and tree pits Note: GD01 adopted as superseding ARC TP10
NIWA HIRDS V4	High-intensity rainfall design system providing design rainfall depths by AEP event and climate change projections.	Yes - rainfall inputs for hydrological modelling including climate change

Note: The CODC Land Development and Subdivision Engineering Standards reference NZS 4404:2004, which in turn draws on ARC TP10. ARC TP10 has since been superseded by GD01. Accordingly, the stormwater performance criteria and device sizing in this SMP are based on GD01 as the current best-practice standard.

4. Stakeholder Engagement and Consultation

This section summarises the stormwater-related consultation and review process undertaken with Central Otago District Council (CODC) and Otago Regional Council (ORC) as part of the Fast-track Approvals Act application.

Table 3: Consultation Summary

Stakeholder	Date	What Engagement Has Been Completed?
Otago Regional Council (ORC)	14 July 2026 (comments received) 20 July 2026 (responses issued)	ORC (Nick Keenan) reviewed the SW and Flood Management report (Woods, 24 June 2026) and the Draft EMP (LandPro, 20 June 2026) and raised 25 review comments. We have reviewed and responded to each comment. The full comment-by-comment record is provided in the Comments Register attached as Appendix E. A high-level summary of the key themes raised and response is provided in Table 4.
Central Otago District Council (CODC) - independent technical review by Mott MacDonald	3 July 2026 (review commissioned) 28 July 2026 (comments received)	CODC separately commissioned Mott MacDonald to undertake an independent high-level review of the Stormwater and Flood Management report (26 June 2026), concentrated on the flood risk assessment. Comments were received 28 July 2026. The comments have been reviewed and responded to in Table 5.

ORC provided 25 comments on the Stormwater Management Plan (SMP). The comments have been reviewed and responded to. The complete comment register, including responses to each item, is provided in Appendix A.

Of the 25 comments received, 15 relate to matters that are appropriately addressed through further design development during the detailed engineering design of the relevant infrastructure. These items are identified in the comment register.The remaining 10 comments have either been addressed using information contained in the current SMP and supporting Model Build Memo or relate to straightforward documentation updates that will be incorporated into the next revision of this report. A high-level summary of the key themes raised during the review, together with response to each, is provided in the Table 4.

Central Otago District Council (CODC) separately commissioned Mott MacDonald to carry out an independent high-level review of the "Stormwater and Flood Management - Parkburn Development" report, dated 26 June 2026. The review was scoped to the flood risk assessment only; external references, supporting documents, and the hydraulic model itself were excluded. Comments were issued to Taylor Planning on 28 July 2026. A high-level summary of the key themes raised during the review, together with response to each, is provided in the Table 5.

Table 4: Response Summary – Otago Regional Council

Theme	Summary of Query	Summary of Response
Hydrological & hydraulic modelling methodology	Clarification sought on the software and methods used to build the hydrology and hydraulic models, including the time of concentration method, curve number assumptions, rainfall data, subcatchment delineation, and the top elevation of the Parkburn catchment.	HEC-HMS and HEC-RAS (v7) are confirmed as the modelling software, coupling a 1D preliminary pipe network to a 2D surface model (5 m grid, refined to 2 m along road/drainage corridors), with rainfall-runoff applied as inflow at discrete subcatchment loading nodes - this approach is considered appropriate at the current stage, with further 1D network refinement at the subsequent design phase. A comparison against alternative time-of-concentration methods has now been added to the Model Build Memo (Appendix C), with the adopted TP108 method falling within the average range; boundary hydrographs reflecting future upstream development and SH6 culvert blocked/unblocked

		scenarios are considered beyond the scope of the SMP and will be reviewed if required at detailed design. Figure 2 has been updated to label subcatchments and show flow direction arrows, and the SMP is being updated to include the top-of-catchment elevation/profile. The CN=60 assumption for upper catchments is confirmed as conservative, noting the corridor cross-section referenced by the reviewer sits within the neighbouring Bonisch site, not Parkburn.
Lake Dunstan boundary conditions	Evidence requested for the Contact Energy dam operating range, spillway and Probable Maximum Flood (PMF) levels used to set the downstream lake boundary condition.	The adopted model boundary of 196.5 mRL is confirmed as conservative, sitting above Contact Energy's normal operating range of approximately 193.5-194.5 mRL (as reported by LandPro). The Contact Energy information is included in Appendix C and will be revisited during the subsequent design phase, alongside detailed design of the lake-edge infrastructure and outlet structures.
Flood conveyance - culverts, bridge & SH6 interface	Hydraulic calculations and hydraulic grade line through the culverts and bridge, a concept bridge design, and clarification of how the SH6 frontage and perimeter lots (including a ponding area) interface with NZTA drainage.	The culverts and bridge are confirmed as sized to convey the 1% AEP event, with results in Appendix B/C. Detailed hydraulic grade line calculations, structure design and scour protection will follow at the subsequent design phase. Long-section, velocity and discharge hydrograph information requested for the corridor and bridge is likewise to be provided at detailed design, noting the design already adopts the conservative 196.5 mRL lake level; Woods has requested clarification from ORC on the extent of erosion/scour assessment considered necessary ahead of that stage. The SH6/perimeter lot drainage interface, including the southwest ponding area, will be confirmed at detailed design in consultation with NZTA/Waka Kotahi.
Secondary network, freeboard & blockage risk	Confirmation of freeboard assumptions, typical cross sections, long section drawings for Zones A-D relative to lake levels and Parkburn hydraulic grade line, and how blockage risk at catchpits, pipes, culverts and the bridge is managed.	A minimum 0.5 m freeboard above the 1% AEP flood level is confirmed, and the preliminary model already adopts a conservative blocked-pipe assumption (<600 mm excluded) - noted as a proof-of-concept assessment only. Typical cross sections, Zone A-D long sections, and structure-specific blockage management measures (e.g. maximised pipe/inlet sizing, maintenance access) will be developed at the subsequent design phase.
Alluvial fan, sediment & debris hazard	Further assessment requested of sediment transport capacity at the SH6 culverts, design flow velocities, channel gradient and buffer allowance for channel migration within the alluvial fan corridor, and	Sediment/debris risk from the upper catchment is confirmed as a matter more appropriately addressed through the neighbouring Bonisch application; the SH6-to-1034 Luggate-Cromwell Road corridor is unaffected by the Parkburn proposal. The 3x100-year sensitivity assessment confirms the corridor safely contains an extreme event with habitable buildings located outside the fan corridor, which is considered adequate to confirm corridor width at this planning stage (the Figure 23 cross-section is illustrative only -

	consideration of blockage/avulsion risk.	the actual design grade is gentler than shown). Woods has queried with ORC whether the full extent of further sediment/velocity/migration assessment requested is necessary ahead of detailed design, at which stage this would in any case be refined.
Catchment 1 - soakage design	A typical Caudwell pit detail, stated level of service, and further conceptual detail on soakage disposal for private lots and the public road corridor, including groundwater and operation/maintenance considerations.	The 203 mRL FSL contour is confirmed as a conservative Catchment 1 boundary, with site-specific infiltration testing required for final sizing. Typical soakage details, level of service, private lot/road corridor arrangements, groundwater/O&M considerations and secondary overland flow paths are confirmed as best addressed at the subsequent (relevant) design stage.
Water quality treatment, toolbox & O&M	Clarity sought on O&M responsibilities for treatment devices, evidence of Council engagement/acceptance of the treatment approach, and conceptual long section drawings for the Zone A central conveyance channel and swale connectivity.	Table 5 confirms private devices are maintained by lot owners/body corporate and public devices by Council, with final device selection, sizing and O&M to be confirmed with CODC at the subsequent design stage. For Zone A, LandPro has confirmed the 0.74 m channel lowering and swale connectivity, and the preliminary network already demonstrates hydraulic connectivity to the swale inlets; long section drawings with levels/gradients relative to lake levels will be prepared once the pipe network and swale catchments are finalised.
Earthworks, land use areas, lot assumptions & primary network level of service	Typical earthworks cross sections relative to floor levels and SH6/lake levels; a breakdown of land use areas by type with associated runoff coefficients; confirmation of the primary network level of service against the site's proposed zoning; and a typical residential lot/building platform drawing demonstrating the 60% impervious assumption.	Typical earthworks cross sections will be developed at the subsequent design phase once floor levels are confirmed. The primary network assessment has been extended to include both the 5-year and 10-year ARI events and the SMP updated accordingly, confirming the Development's urban residential/mixed-use zoning (not rural residential); the network will be extended across the balance of the Development at detailed design. A land use area/runoff coefficient table will be provided once finalised at detail design stage, noting the adopted 60% imperviousness is not expected to materially change given lower-imperviousness catchments elsewhere.
Documentation updates - figures, mapping	Labelled subcatchment areas and contours on existing figures, additional flood model output figures (velocity, combined flood extent mapping),	Figure 4 has been updated to show overland flow paths, labelled subcatchment boundaries and LandPro contours together, and Figure 2 has been updated to show subcatchments with flow direction arrows. Additional flood model output figures have been added to the SMP in response to the ORC request. No further action is required in response to the EMP review comment.

Table 5: Response Summary – Central Otago Disctrict Council

Theme	Summary of CODC Query	Summary of Response
Catchment 1 - soakage / infiltration evidence	Catchment 1 is proposed to be managed by soak pits, however no infiltration test details or rates are documented to confirm suitability, and the report does not reference infiltration testing to confirm onsite disposal is viable.	The 203 mRL FSL contour has been adopted as a conservative based on guidance from LandPro for Cauldwell pit performance in Cromwell SMP to be updated to include infiltration testing once data has been received and to be confirmed during detailed design.
Catchment 2 - justification for on-site disposal not being viable (CODC 2008 Addendum cl 4.2.4)	Catchment 2 is proposed to be managed by a primary network. CODC 2008 Addendum cl 4.2.4 requires the developer to demonstrate stormwater cannot be disposed of on-site before connection to Council's trunk system is considered. Please provide additional detailed explanation (beyond the low ground level relative to lake level).	The 203 mRL FSL contour boundary reflects the infiltration data available to date - ground levels within Catchment 2 (Zones A–D) are located near Lake Dunstan and therefore high likely resulting in high groundwater levels and materially reduced infiltration capacity. On this basis onsite disposal is not a viable primary treatment method for Catchment 2 and a reticulated primary network is proposed instead. This can be further assessed at detail design stage.
Primary network level of service (5-year ARI, NZS4404 Table 4-1)	Primary system designed to a minimum 5-year ARI (Section 6.5.1). NZS4404:2004 Table 4-1 confirms residential / rural residential areas must be designed to a minimum 5-year ARI.	Following ORC's review, Section 6.5.1 has been updated to now state minimum 10-year ARI event (however both the 5yr and 10yr have been assessed). This will be refined during the detail design stage. We have also confirmed the Development is proposed as urban residential/mixed-use (not rural residential) under the FTAA application.
Bridge crossing - critical asset & future upstream development	The bridge is a critical asset (sole access to Zone D) crossing a stream draining a large catchment within the alluvial fan. Assumed acceptable for now; bridge design assumed to follow relevant standards at detailed design. CODC should consider potential future upstream development when finalising the bridge design.	Agreed. The bridge and culverts are sized to convey the 1% AEP event including the applicable climate change allowance (Section 6.5.2/Appendix C); detailed hydraulic grade line calculations, structure design and scour protection follow at detailed design. Potential upstream development (the adjoining Bonisch site) is already reflected as a boundary condition in the current model (Appendix D correspondence). We will continue to coordinate with the Bonisch design team and CODC on any resulting bridge capacity implications at detailed design.
Freeboard, secondary flow depths & lot-by-lot FFL schedule	Section 6.5.3 does not specify the minimum freeboard required or secondary flow/flood depths, nor the predicted 10-year and up to 100-year ARI (incl. climate change) results. Flooding is	Section 7.3.2 confirms a minimum 0.5 m freeboard above the modelled 1% AEP (100-year ARI, including climate change) flood level is required for habitable floor levels; the 100-year model conservatively assumes pipes below 600 mm are blocked. A lot-by-lot FFL/freeboard compliance schedule will be prepared once finished floor levels are confirmed, as part of the subsequent design phase.

	predicted at some Zone A lots. Please provide a lot-by-lot FFL/freeboard schedule against the 1% AEP plus climate change flood level.	
Flood hazard at roadway – Zone A, 100-year blockage scenario	Flood hazard is high at sections of the proposed roadway (Zone A) under the 100-year blockage scenario. Freeboard and safe access to/from properties should be specified at detailed design.	Notes – this is consistent with the conservative blocked-pipe assumption already adopted for the 100-year event (pipes <600 mm excluded, Appendix C Section 2.3.3). Road corridor cross-sections, safe access/egress provisions and freeboard confirmation will be developed at detailed design once lot and road levels are finalised.
Hydraulic neutrality	Hydraulic neutrality was not assessed/discussed in the report. If required by CODC at Engineering Acceptance, Council to advise the developer/consultants to prepare an assessment per ORC guidelines or other relevant guidelines.	Noted – Should CODC confirm that this is required at Engineering Acceptance, An assessment in accordance with Otago Regional Council's guidelines, or any other standard nominated by CODC can be prepared, at the appropriate design stage.
Stormwater treatment devices (GD01)	Elements of stormwater treatment discussed in the report generally follow Auckland's GD01 specifications. No issue raised.	Noted - No further action required.
Model extent, overland flow paths & ground model resolution	Catchment model extent does not cover the full extent of identified overland flow paths (deemed a minor anomaly). Ground model resolution (LandPro data) is unclear (deemed a minor consideration given preliminary design).	Figures 2 and 4 have already been updated, in response to an equivalent comment from Otago Regional Council, to label subcatchments, add flow direction arrows, and combine LandPro contour information with overland flow path mapping. These updated figures also address the model extent observation raised here. The resolution of the underlying LandPro ground model will be reviewed and refined as necessary as part of the detailed design phase.
Curve Number / impervious area assumption (60%) vs Plan Change 19	60% impervious area assumed for lots (100% for roads, agreed). Plan Change 19 requires a minimum 20% of each lot to be landscaped, implying up to 80% could be made impervious. Not flagged as a notable issue given the small catchment and the design accommodating the MPD scenario.	Noted - The Model Build Memo (Appendix C) has been updated to address the adopted 60% impervious area assumption for residential lots. This assumption is considered appropriate at SMP stage, noting the Plan Change 19 requirement for a minimum of 20% landscaped area per lot. A land use area/runoff coefficient table will be provided once the Development's masterplan land use areas are finalised, to support refinement of the hydrology model at the detailed design stage.
Curve Number derivation method & stream/bridge capacity	Unclear how CNs were derived (possibly via soil drainage class, Figure 5, p.60); LRIS FSL Soil Drainage Class indicates different	A Curve Number of 60 was adopted for the upper catchment subcatchments, based on the mapped soil drainage class, representing moderately-drained soil conditions.

	drainage characteristics. Adopted CNs are generally at the lower end of the typical range, producing lower estimated runoff volumes. As only a portion of this runoff is conveyed through the bridge, not considered critical at preliminary stage – but stream/bridge capacity should be reassessed at detailed design against confirmed design flows.	We note that this value is a representation of the mapped soil conditions, not as a value selected to maximise or minimise estimated runoff. We agree that observation that CN values at the lower end of the typical range will tend to produce lower estimated runoff volumes; However as part of the alluvial fan hazard assessment the 100yr flows were bulked by a factor of 3 (which is significantly higher than any increase in CN value) this demonstrated that flows would still be contained within the Parkburn. We agree that the capacity of the stream and bridge crossing should be confirmed against final design flows as part of the detailed design phase, however noting the alluvial fan hazard assessment scenario do not consider this to be problematic.
Rainfall inputs	Hydrograph (nested storm, midday peak), 1% AEP RCP8.5 (2081–2100) design event, and 24-hour critical duration are all deemed appropriate; note the hydrograph itself was not included in the report to confirm the correct profile.	Appendix C, Table 1 presents the adopted 24-hour rainfall depths for the 5-, 10- and 100-year ARI events under RCP8.5 (61 mm, 72 mm and 114 mm respectively), together with a 24-hour nested Type 2A temporal distribution peaking at midday, sourced from NIWA HIRDS V4. A design hyetograph will be included as an appendix to the SMP to confirm the adopted profile.

5. Proposed Development

The Parkburn Development Project (the Project) involves the staged subdivision and development of land at 922 Luggate-Cromwell Road (State Highway 6), Cromwell, located approximately 8 kilometres north of the Cromwell township and adjoining Lake Dunstan / Te Wairere. The site includes part of the existing Parkburn Quarry. The Project provides for the establishment of a mixed-use urban development, including quarry rehabilitation, residential development, supporting commercial and community activities, open space, and associated infrastructure. Works are also proposed within the State Highway 6 (SH6) road reserve. The proposed masterplan is illustrated in Figure 5.

The project comprises the following components:

- Bulk earthworks to backfill and rehabilitate part of the existing Parkburn Quarry.
- Subdivision and development to enable approximately 1,000 residential allotments, supporting the construction of approximately 1,000 residential units across a range of housing densities.
- Subdivision and development to establish a neighbourhood centre, including retail, commercial, medical, and early childhood education activities, together with land for a primary school.
- Landscaping and development of an open space network, including recreation reserves, esplanade reserves, and restoration along the margins of Parkburn Stream and Lake Dunstan / Te Wairere.
- Formation of two coves extending into Lake Dunstan / Te Wairere.
- Construction of associated infrastructure, including three waters infrastructure, internal transport networks, and external access works connecting the site to State Highway 6.



Figure 5: Parkburn Illustrative Masterplan (April 2026)

6. Stormwater Management

This section describes the proposed stormwater management strategy for the Parkburn Development. The strategy has been developed in accordance with CODC and ORC requirements and best-practice guidance and is designed to ensure stormwater runoff is managed to avoid, remedy, or mitigate adverse effects on the receiving environment.

The overall stormwater management approach seeks to:

- Develop a set of best practicable options (BPO) for stormwater treatment that can be incorporated into the Development;
- Emphasise a water-sensitive urban design approach that manages the impact of land use change from its current state to urban;
- Minimise or mitigate adverse effects on water quality, freshwater systems, and ecological values of the receiving environment; including Lake Dunstan / Te Wairere; through the implementation of appropriate stormwater management devices;
- Minimise the generation and discharge of contaminants and sediment into the receiving environment;
- Facilitate urban development and protect key infrastructure, people, and the environment from significant flooding events; and
- Account for climate change using the NIWA HIRDS V4 dataset and an RCP 8.5 scenario in accordance with CODC and ORC guidelines.
- Recognise and have regard to Lake Dunstan/Te Wairere as a Statutory Acknowledgement Area under the Ngai Tahu Claims Act 1998.

6.1. Stormwater Catchment Areas

The Development has been divided into two primary catchments for the purposes of stormwater disposal, as detailed in Table 6. Catchment 1 will be drained to in ground soak pits and Catchment 2 will be drained via a piped reticulation network. Within Catchment 2, four separate stormwater management zones (Zones A through D) have been identified based on discharge locations, land use characteristics, and the appropriate treatment devices for each area. Catchment areas have been illustrated in Figure 6.

Table 6: Stormwater Catchment Areas

Catchment/ Zone	Area	Primary Discharge	Description
Catchment 1	24.42 ha	In-ground soak pits	Stormwater soaked to ground via in-ground soak. This catchment generally encompasses the higher-elevation areas of the site above the 203mRL FSL contour. Test pits in this area indicate sandy gravels with cobbles and other coarse-grained material. Site specific testing will be required for sizing of soakholes/trenches.
Catchment 2	92.19 ha	Piped reticulation network	Stormwater conveyed to discharge point via piped network. This catchment encompasses the lower-elevation areas of the site where soakage is not feasible. The stormwater management strategy for Catchment 2 is subdivided into Zones A through D, detailed in the sections below

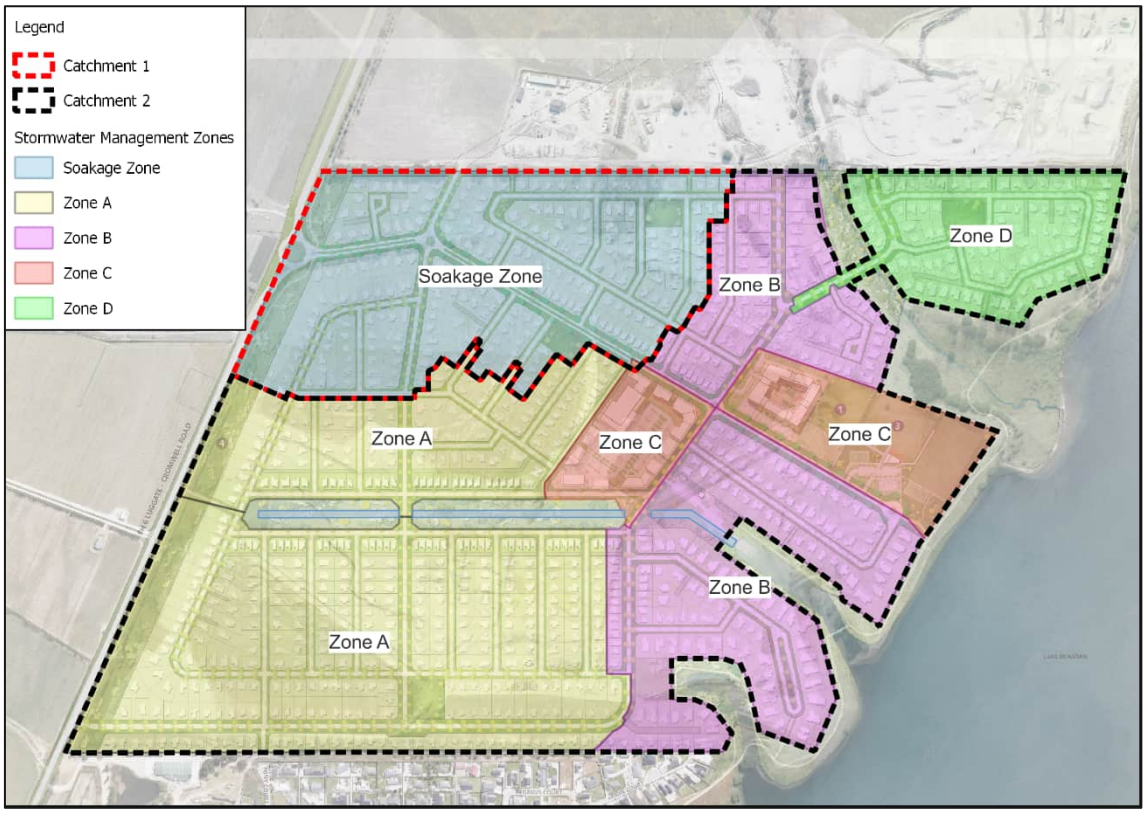


Figure 6: Catchment Plan

6.2. Stormwater Management Toolbox

A stormwater management toolbox has been prepared to summarise the Best Practicable Options (BPO) for the proposed stormwater devices for each stormwater management zone. The toolbox, included in Table 7, has been prepared to provide guidance on the types of devices that are to be used for the management of stormwater.

Devices in the toolbox has been reviewed against the proposed preliminary layout for the plan change to determine the best practicable option. Consideration is given to the following:

- Receiving Environment
- Existing drainage characteristics and topography
- Land use characteristics
- Ability to meet objectives and best practice guidance, and
- Constructions and maintenance

The following table presents a range of stormwater management devices that may be adopted to meet the stormwater management requirements of the development. Device selection, sizing and placement will be confirmed at detailed design. All devices are to be designed in accordance with relevant design standards and industry best practice.

Details of the water quality management approach within each catchment is discussed in the subsequent sections.

Table 7: Stormwater Management Toolbox

Device	Applicable Catchment & Zone	Private Applications	Public Applications	Design Details	Performance Standard TSS Removal*	Key Considerations
Bioretention Devices (rain gardens / tree pits)	Catchment 2 Zones B–D	Private roads, accessways, carparks	Public roads, parking bays, footpaths	Possible devices include, but are not limited to, rain gardens (individual or communal) and tree pits. Indicative sizing has been conducted on a per unit area basis, and is included in Appendix B.	> 75%	Preferred primary at source treatment device for public and private roads. To be integrated into landscape and planting schemes, providing opportunities for biodiversity and habitat. Good contaminant removal performance makes these appropriate for meeting reduction targets for sensitive receiving environments. Pre-treatment via structural devices to trap sediment, litter and debris to be considered at detailed design. Private devices maintained by lot owners or body corporate; public devices maintained by Council.
Communal Device (wetland)	Catchment 2 Zones D	Residential hardstand, private roads, accessways, carparks	Roads, parking bays, footpaths	A single device can be placed within the downstream areas of Catchment 2 - Zone D, prior to discharge into the stream. The device will be sized to treat the water quality flow and will comprise a footprint of approximately 3-5% of the contributing impervious area, in accordance with appropriate design standards.	> 75%	Communal treatment can be provided in areas draining to a single discharge point. Devices are to be placed within downstream sections of the catchment, to maximise runoff capture from the upstream area. To be integrated into landscape and planting schemes with opportunities for biodiversity and habitat. Public devices maintained by Council.
Swales	Catchment 2 Zone A	Residential and commercial hardstand, private roads, accessways, carparks	Roads, parking bays, footpaths	Preliminary device sizing has been conducted for swales within Catchment 2 - Zone A. A total of 6 swales have been sized to treat the water quality flow from this management zone, with calculations provided in Appendix B.	> 75%	Can collect both roof and hardstand runoff. To be integrated into landscape and planting schemes with opportunities for biodiversity and habitat.
Gross Pollutant Traps	Catchment 1 and Catchment 2 Zones B–D	Residential and commercial hardstand, private roads, accessways, carparks	Roads, parking bays, footpaths	A list of possible devices is included below, with indicative drawings (where possible) included in Appendix B: - Hynds Downstream Defender - Atlan Vortceptor - Atlan Baffle Box	< 73% - 93%	Used to remove contaminants including litter, debris and gravel. Numerous commercial products available. Private devices maintained by lot owners or body corporate; public devices maintained by Council.
Catchpit Inserts	Catchment 1 and Catchment 2 Zones B–D	Residential hardstand (small areas)	Passive applications	A list of possible devices is included below, with indicative drawings (where possible) included in Appendix B: - Atlan Stormsack - Stormwater 360 EnviroPod - Stormwater 360 LittaTrap	< 45% - 50%	Suitable for capturing runoff from small hardstand areas that are low contaminant generating. Simple, low-cost passive device.
Inert Roofing Materials	Catchment 1 and Catchment 2 Zones A–D	Residential and commercial roofing	Not applicable	Not applicable	-	Buildings to incorporate low-contaminant generating roofing and spouting materials to minimise contaminant generation at source. A source control measure rather than a treatment device.
Proprietary Treatment Devices	Catchment 1 and Catchment 2 Zones A–D	Private roads, accessways, carparks and commercial areas	Roads, parking bays	A list of possible devices is included below, with indicative drawings (where possible) included in Appendix B: - Hynds Upflow Filter or similar - Stormwater 360 Jellyfish Filter - Stormwater Storm Filter	< 80% - 90%	To be considered where other options have been assessed and found to be unsuitable or impractical for a specific catchment. Can be used as part of a treatment train in conjunction with bioretention devices or infiltration where subsurface conditions allow. Numerous commercial products available. Specific design required for each application.

*Removal efficiency rates have been obtained from currently available manufacturer data. Performance criteria as per CODC Standards that references TP10 and therefore minimum 75% TSS removal efficiency.

6.3. Catchment 1 Management

Catchment 1 encompasses the higher-elevation areas of the Development, generally above the 203 mRL FSL contour. For this catchment (24.42 ha), stormwater is proposed to be disposed of via in-ground soak pits, which is consistent with established practice in Cromwell for properties at this elevation.

Based on information provided by Landpro, it is understood that traditional Caudwell pits (6 m deep with 1 m of cover) have been used historically in Cromwell for soakage disposal. Based on soakage infiltration testing reviewed by Landpro Ltd and, the infiltration rate at RL 196 was found to be minimal. By adopting the 203 mRL FSL contour as the upper catchment boundary, the base of soak pits within Catchment 1 will not be below approximately RL 196, providing confidence that soakage will perform as required. Furthermore, test pits as discussed in the geotechnical report by Insight Engineering show the material in this area to be sandy gravels with cobbles and other course-grained material that is generally well draining. Site specific testing will be required for detailed sizing of disposal pits.

Note it is understood that it may be possible to extend the in-ground soakage area if alternative soak pit systems (not requiring the same depth as traditional Caudwell pits) are adopted. However, the current design conservatively reticulates Catchment 2, ensuring the worst-case is addressed.

6.3.1. Water Quality Management

All buildings within the Development are to incorporate low-contaminant generating roofing and spouting materials (e.g. colour-steel, zinc-free materials) to minimise contaminant generation at source across all zones.

This catchment will adopt an at-source treatment approach utilizing a toolbox of stormwater management devices specific to the characteristics of each catchment area. This approach prioritizes treating runoff as close to its source as possible before discharge to the receiving environment.

Treatment devices will be selected from the stormwater toolbox based on site-specific constraints, land use characteristics, contaminant generation potential, available space, and integration with the development layout. Final device selection for each catchment area will be determined through detailed design in consultation with CODC, with specific devices and supporting design calculations documented in the Stormwater Treatment Toolbox appended to this report.

The stormwater management approach for the entire development is summarised in Section 7.5.

6.4. Catchment 2 Management

Catchment 2 encompasses the lower-elevation areas of the Development (92.19 ha), generally below the 203 mRL FSL contour, where soakage is not feasible. For this catchment, stormwater will be collected via a reticulated piped network and conveyed to appropriate treatment devices and a point of discharge.

6.4.1. Water Quality Management

The stormwater management strategy for Catchment 2 is divided into four zones, Zone A through D, based on the nature of the receiving environment and the proposed treatment approach for each area. The delineation of the stormwater management zones is detailed in Table 8 and Figure 6.

All buildings within Catchment 2 of the development are to incorporate low-contaminant generating roofing and spouting materials (e.g. colour-steel, zinc-free materials) to minimise contaminant generation at source across all zones.

Table 8: Catchment 2 Stormwater Management Zones

Catchment	Area	Land use	Description
Zone A	40.30 ha	Residential	Zone A covers the central portion of the Development and is characterised by a central conveyance channel running roughly east-west through the site. Runoff from adjacent residential catchments is discharged into the central conveyance channel.
Zone B	27.99 ha	Residential	Zone B covers residential areas and the immediate lakefront precinct that do not drain to the central conveyance channel. Stormwater runoff will be conveyed via the piped reticulation network directly to the discharge location into the lake.
Zone C	10.44 ha	Commercial	Zone C covers the commercial and mixed-use precincts of the Development, including the neighbourhood centre, preschool precinct, and lakeside commercial areas
Zone D	9.29 ha	Residential	Zone D covers the eastern residential area of the Development adjacent to the SH6 landscape buffer. Zone D stands as an isolated catchment where stormwater runoff will be conveyed via the piped reticulation network directly to the stream.

The stormwater management across Catchment 2 is further discussed in the subsequent sections and summarised in Section 6.6.

6.4.1.1. Zone A (Catchment 2)

Zone A covers the central portion of the Development and is characterised by a central conveyance channel running roughly east-west through the site. Runoff from adjacent residential catchments is intercepted by vegetated swales along both banks of the central conveyance channel before discharge into the channel.

Landpro Ltd has confirmed that the stormwater reticulation can discharge to the proposed swale locations within Zone A. To facilitate this, the invert level of the central conveyance channel has been lowered by 0.74 m to ensure that the vegetated swales can drain into it.

Six vegetated swales (Swales 1 through 6) are proposed, each serving a discrete sub-catchment as shown in the Swale Catchment Plan (Figure 7). Swales 3 and 5 are located along the north bank of the central conveyance channel, and Swales 1, 2, 4, and 6 are located along the south bank.



Figure 7: Swale Catchment Plan

Vegetated swales are the primary water quality treatment device for Zone A. The swales will be sized to convey the water quality design flow in accordance with appropriate design standards, based on a design rainfall intensity of 10 mm/hr. The indicative swale design parameters are included in Table 9.

Table 9: Vegetated Swale Sizing

Parameter	Value
Slope	1%
Base width	2.0 m
Top width	5.0 m
Depth	0.3 m
Side slopes	1V:5H
Design rainfall intensity (water quality flow)	10 mm/hr (Water Quality Flow)
Target contaminant removal efficiency	Minimum 75% (Best Practicable Option)

The design will target a minimum 75% contaminant removal efficiency, consistent with the BPO under appropriate design standards. The final contributing catchment areas to each swale are subject to confirmation following completion of the detailed stormwater pipe network design by Landpro Ltd.

6.4.1.2. Zones B – D (Catchment 2)

Where runoff is not being treated communally via the vegetated swales (Zones A), the Development will adopt an at-source treatment approach utilizing a toolbox of stormwater management devices specific to the characteristics of each catchment area. This approach prioritizes treating runoff as close to its source as possible before discharge to the receiving environment.

Treatment devices will be selected from the stormwater toolbox based on site-specific constraints, land use characteristics, contaminant generation potential, available space, and integration with the development

layout. Final device selection for each catchment area will be determined through detailed design in consultation with CODC, with specific devices and supporting design calculations documented in the Stormwater Treatment Toolbox appended to this report.

6.4.2. Alternative Approach

Where adequate pipe cover cannot be achieved, alternative stormwater treatment approaches may be adopted, including roadside channels, tree pits, catchpit filters, or proprietary treatment devices. Proprietary devices may also be suitable for areas with higher contaminant generation, subject to stakeholder agreement.

Where proprietary devices are not feasible or preferred, alternative treatment solutions such as tree pits, catchpit filters, or other compliant measures may be considered, depending on the final site layout, land availability, and approval requirements.

6.5. Primary and Secondary Networks

6.5.1. Primary Network Design

The primary stormwater network is to be designed to a minimum 10-year ARI, in accordance with the applicable Central Otago District Council (CODC) and National Engineering Design Standards (NZS 4404:2004 – refer 2008 Addendum) in effect at the time detailed design plans are prepared for Engineering Acceptance.

A preliminary pipe network been developed as part of the flood modelling exercise to demonstrate how primary flows are expected to be conveyed and is shown in Figure 8. Further discussion of the network design is provided in Section 7.5. The primary network design incorporates the following elements:

- A piped network with catchpits for stormwater collection;
- Swales (planted or grassed); and
- Soakage systems, where appropriate.

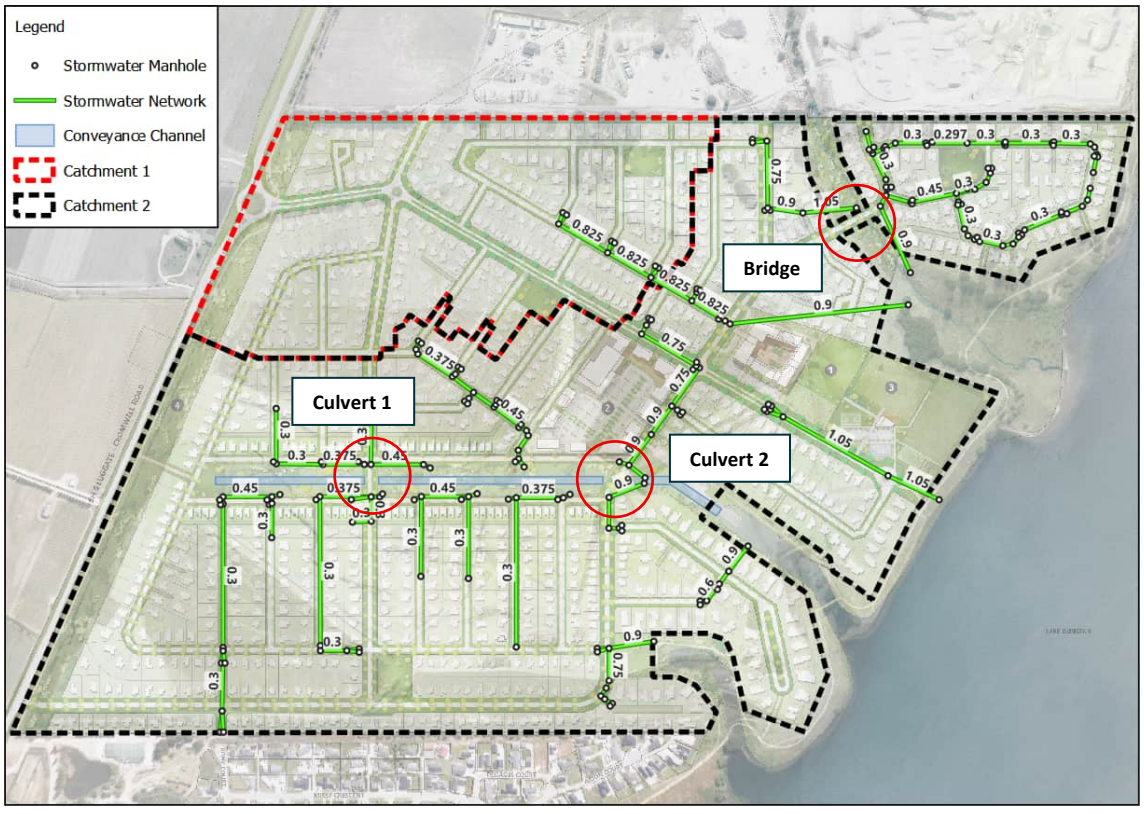


Figure 8: Preliminary stormwater pipe network

6.5.2. Culverts and bridges

As part of the overall conveyance strategy, two major culverts are proposed within the central drainage corridor (Figure 8). Culvert 1 measures 1.2mH x 4mW while culvert 2 measures 1.2mH x 6mW.

In addition to the culverts, a bridge is also proposed over the floodway to connect the northwestern part to the rest of the development.

The proposed conveyance infrastructure has been sized and modelled to convey the 100-year ARI storm event, inclusive of climate change allowance.

6.5.3. Secondary Network Design

Habitable floor levels will be set in accordance with NZS4404, with adequate freeboard above the design flood level.

The secondary flow, events greater than a 5-year ARI storm event and up to a 100-year ARI storm, will be conveyed along road corridors as overland flow paths. Overland flow path alignments will be dependent on the overall built environment and maintain existing discharge locations as far as practicable. As part of the overall design, large pipes and high-capacity catchpits will be incorporated into the network to ensure adequate drainage is achieved.

The overland flow paths should meet the following design criteria: Overland flow paths will be designed with sufficient capacity to accommodate the 100-year ARI storm event for the MPD, including RCP8.5 future climate change.

- They will be unobstructed, and convey runoff without creating significant hazards
- They will not create/exacerbate flooding at neighbouring properties.

Preliminary flood modelling has been provided in Section 8.

6.6. Stormwater Management Summary

The stormwater management approach for the entire development is summarised in Figure 9.

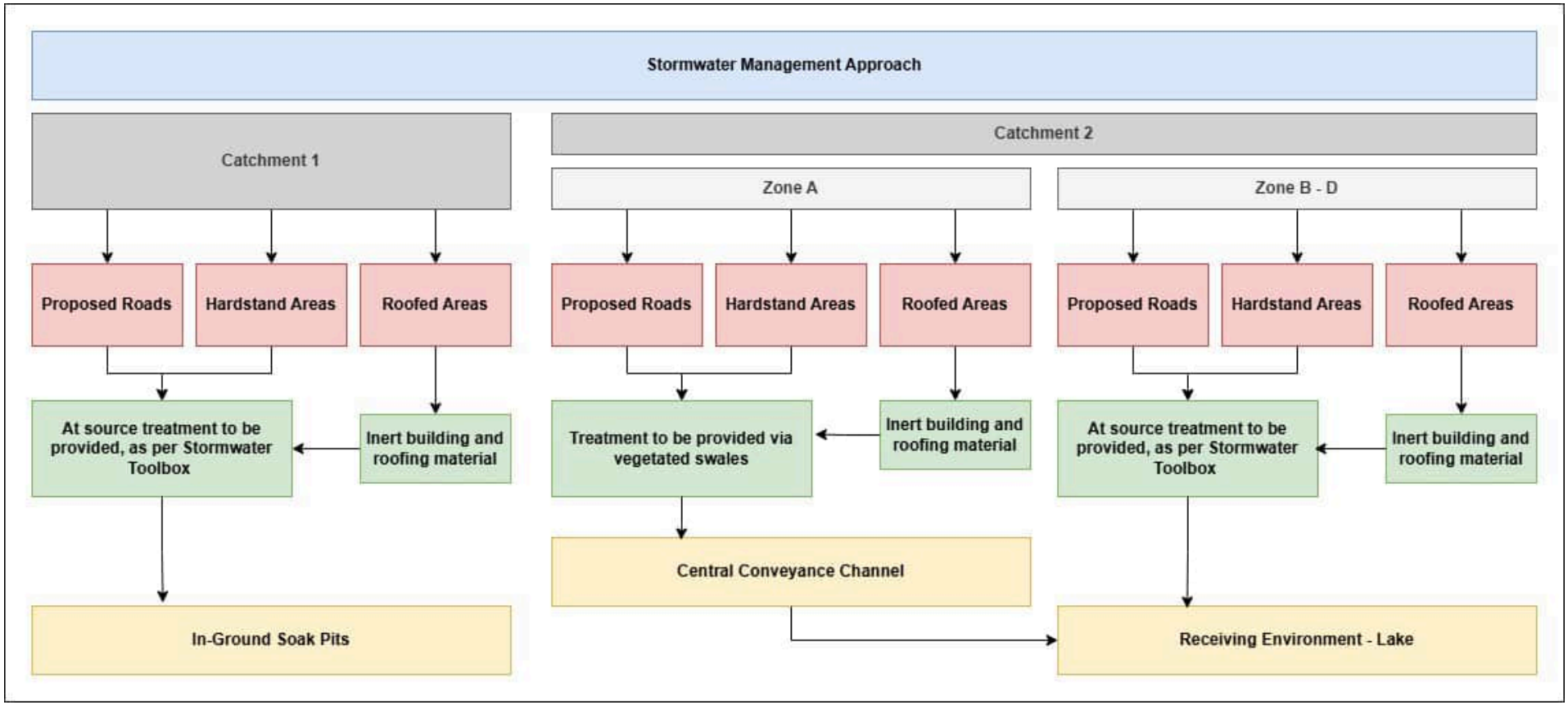


Figure 9: Stormwater Management Summary

7. Flooding and Overland Flow Paths

7.1. Modelling Summary

7.1.1. Hydrology Model

Using LiDAR and design surface provided by LandPro and GIS/SAGA tools, the contributing catchment to the site and adjacent areas were delineated. Using soils map data, curve numbers for the various subcatchments were assumed. Time of concentration for each subcatchment was calculated using the equal area method as adopted from ARC TP108. Rainfall depths (5, 10, and 100-year ARI events for 24-hour duration) for the area were extracted from HIRDS v4 (with allowance for future rainfall based on RCP8.5 projected to year 2100). Utilising the SCS methodology and using HEC-HMS, flows generated by each of the subcatchments were calculated. For the post development scenario, the internal (proposed site) subcatchments were delineated based on the design surface.

Hydrographs generated by the HEC-HMS models were used as inputs into the hydraulic method.

Refer to the model build report for additional details (Appendix C).

7.1.2. Hydraulic Model

For the hydraulic model, HEC-RAS (v7) was used. The LiDAR and design surface was used to create a digital elevation model to route the flows through the catchment. The neighbouring site to the north of the proposed development site is also to be developed by third parties and based on conversation with the consultant (Bonisch – correspondence in Appendix D), it is understood that that the drainage corridor through that site is to be altered. The existing corridor, which is linked to the development site, measures approximately 200m and will be constricted to approximately 40m. In building the HEC-RAS model, the surface in neighbouring site was modified to create the smaller corridor.

As noted previously, hydrographs calculated from the HEC-HMS model were used as direct inputs (inflow boundary conditions) to the hydraulic model. Various Manning's coefficients were applied for the different land covers within the catchment. The downstream boundary was set based on the projected Lake Dunstan / Te Wairere levels (information from Contact Energy which operates the lake) and set at 196.5mRL. The model domain was characterised by grids of varying sizes from 5m x 5m (within the development area) to 25m x 25m (in the wider catchment). Breaklines were applied along streams corridors, channels and stop banks (also with smaller grid sizes) for better model representation.

For the post-development scenario, two models were built, (1) for the wider catchment and (2) for the internal/site catchment.

As shall be discussed below, the internal/site catchment model is more detailed to allow for analysis of flows within the site. For this exercise, a cutdown site model was created. The development was broken down into internal subcatchments and flows generated from these subcatchments were introduced into the hydraulic model. The grid was further refined to 2m x 2m to better capture flooding behaviour. The model also incorporates pipe networks to ensure the potential ponding zones are drained. It is noted that external boundary conditions were extracted from the wider catchment model for use in the cutdown model. For the 100-year ARI run, pipes less than 600mm were not included to mimic blockage conditions which is deemed conservative. High-capacity inlets were incorporated to increase/improve collection and conveyance of runoff.

Additional details provided in the model build memo (Appendix C).

7.2. External Flooding

Two catchment wide models were created i.e., pre and post development. As discussed above, the Bonisch site to the north is being redeveloped and as part of that development, the floodplain is to be reduced, and this was incorporated into the post development model surface. Figure 10 and Figure 11 show the pre and post development results respectively.

The results indicate that for the 100-year ARI event (plus RCP8.5) the reduced corridor within the Bonisch site does not create a negative flooding effect at the property further north (Figure 12 and Figure 13). At the Parkburn Development site, it has been observed that the flows will be contained within the existing corridor without overtopping in the proposed development areas (Figure 14).

It should be noted that for the post development model, the catchment wide model does not incorporate the proposed pipe network within the site. Therefore, flood levels within the site have been assessed using the internal model as discussed in section 7.3.

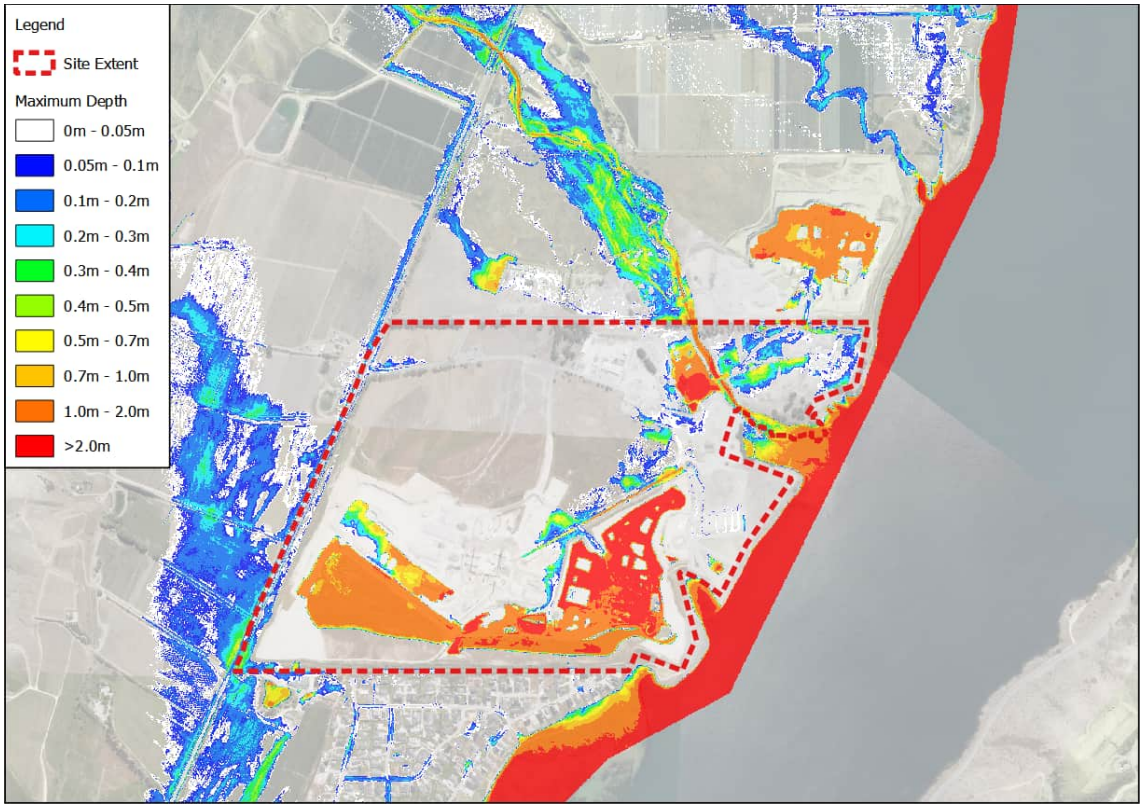


Figure 10: Predevelopment 100-year ARI RCP8.5

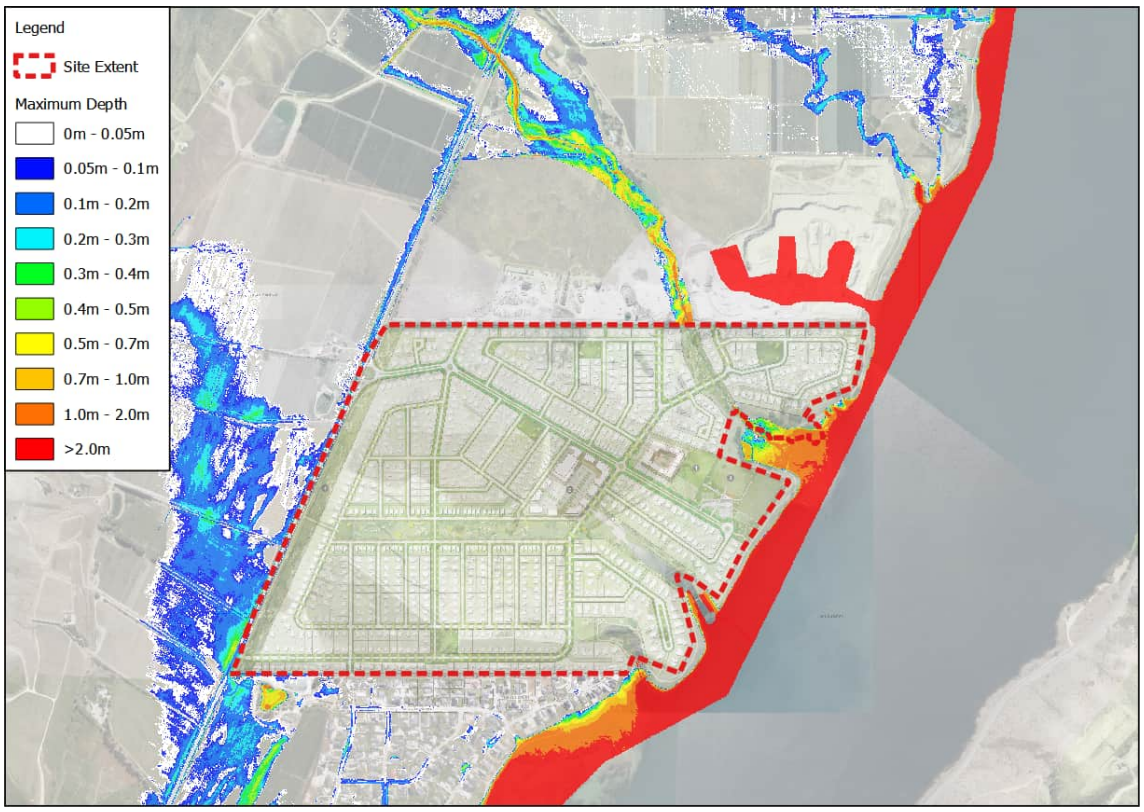


Figure 11: Post development 100-year ARI RCP8.5

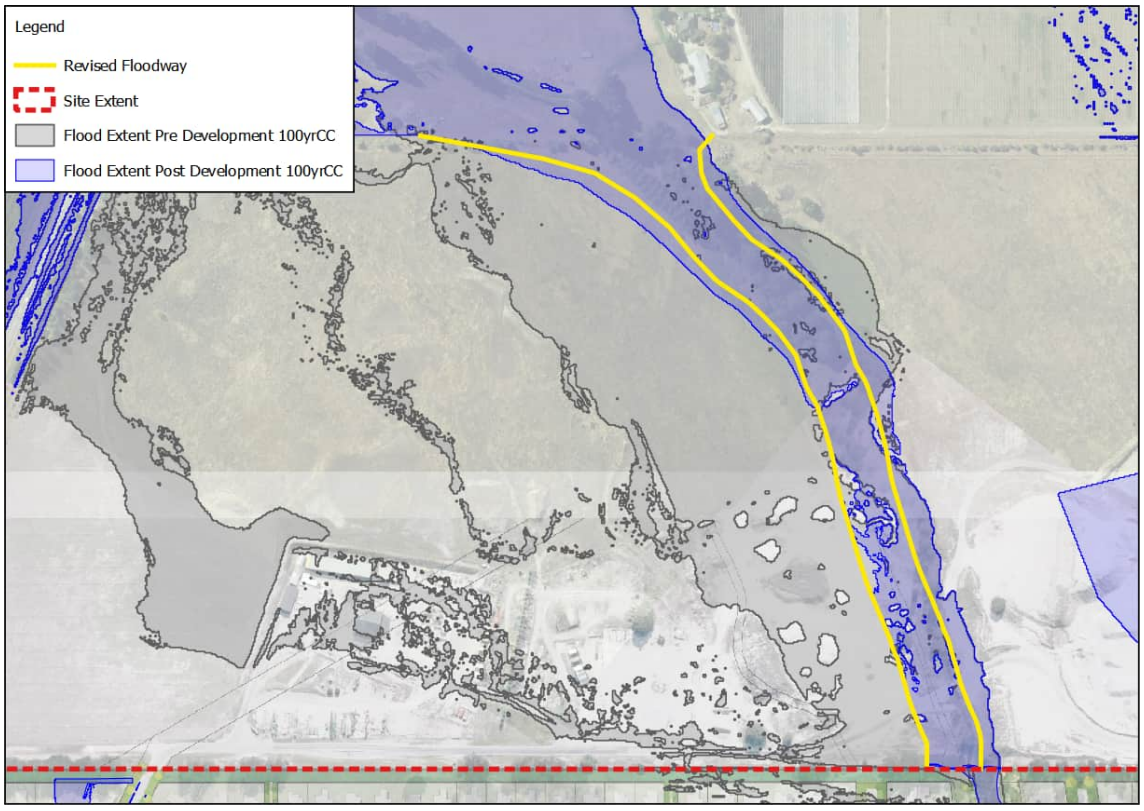


Figure 12: Flooding upstream Bonisch Site

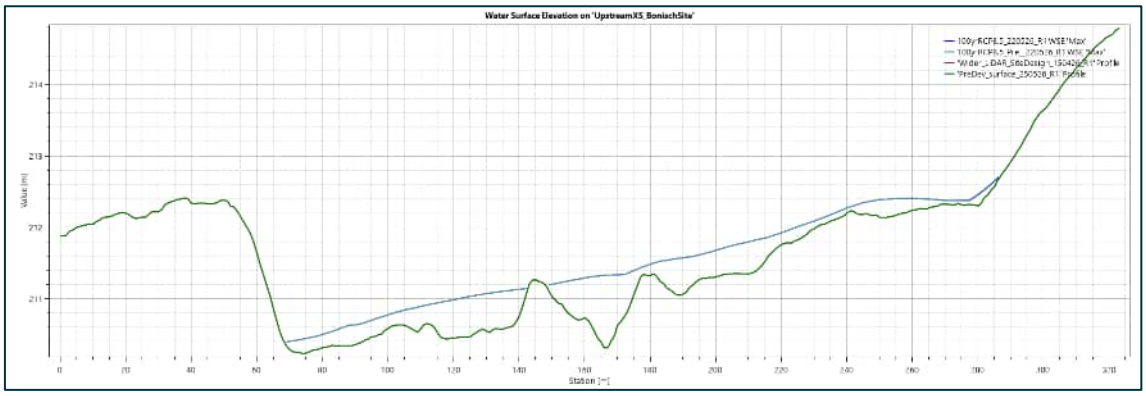


Figure 13: XS upstream Bonisch Site

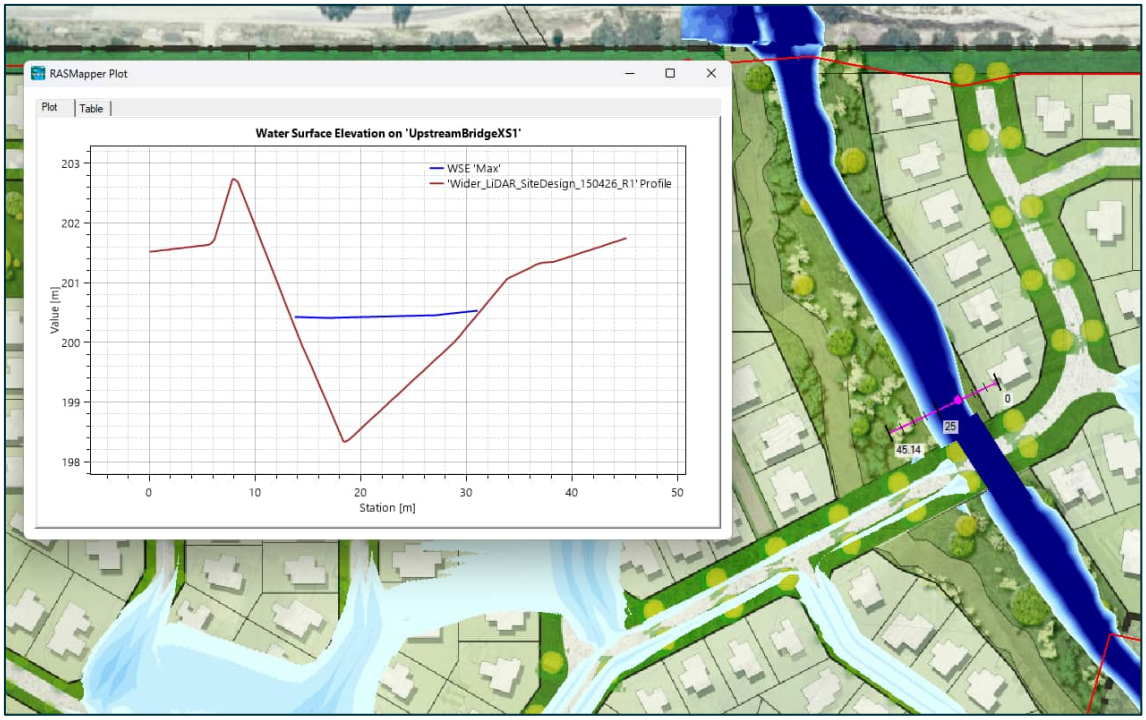


Figure 14: Flooding within Parkburn Site along corridor

7.3. Internal Flooding and Overland Flow Assessment

As previously noted, a cutdown model was created for assessing flooding behaviour for the 5-year, 10-yearand 100-year ARI (with RCP8.5). As shown on Figure 15, Figure 16 and Figure 17, for all the events, the flooding is mainly contained within the road corridors and central drainage corridor. While some inundation has been observed on some of the lots, it is expected that in the detailed flood model when the full pipe network (and soakage where it is proposed), lot inundation will be reduced. For those lots where the 100-year ARI levels cannot be reduced by the network (general assumption that most of the pipe network is blocked), adequate finished floor levels will be recommended.

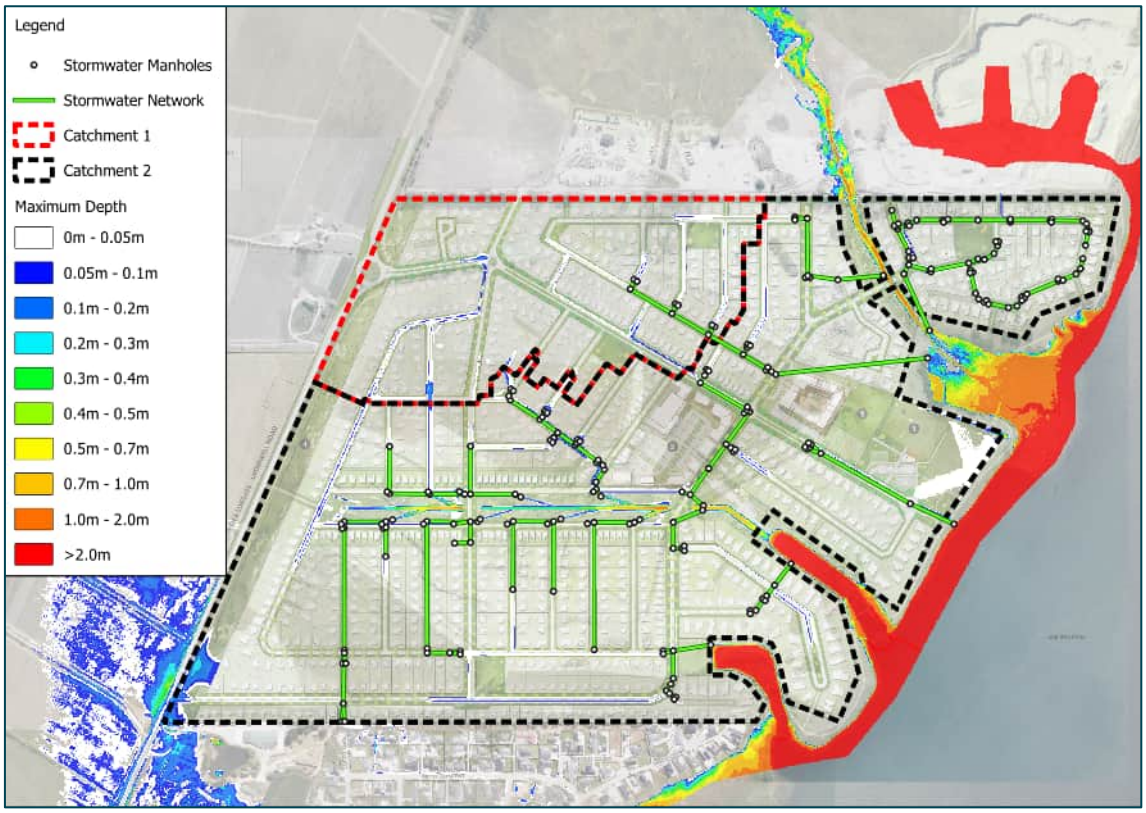


Figure 15: 5-year ARI internal flooding

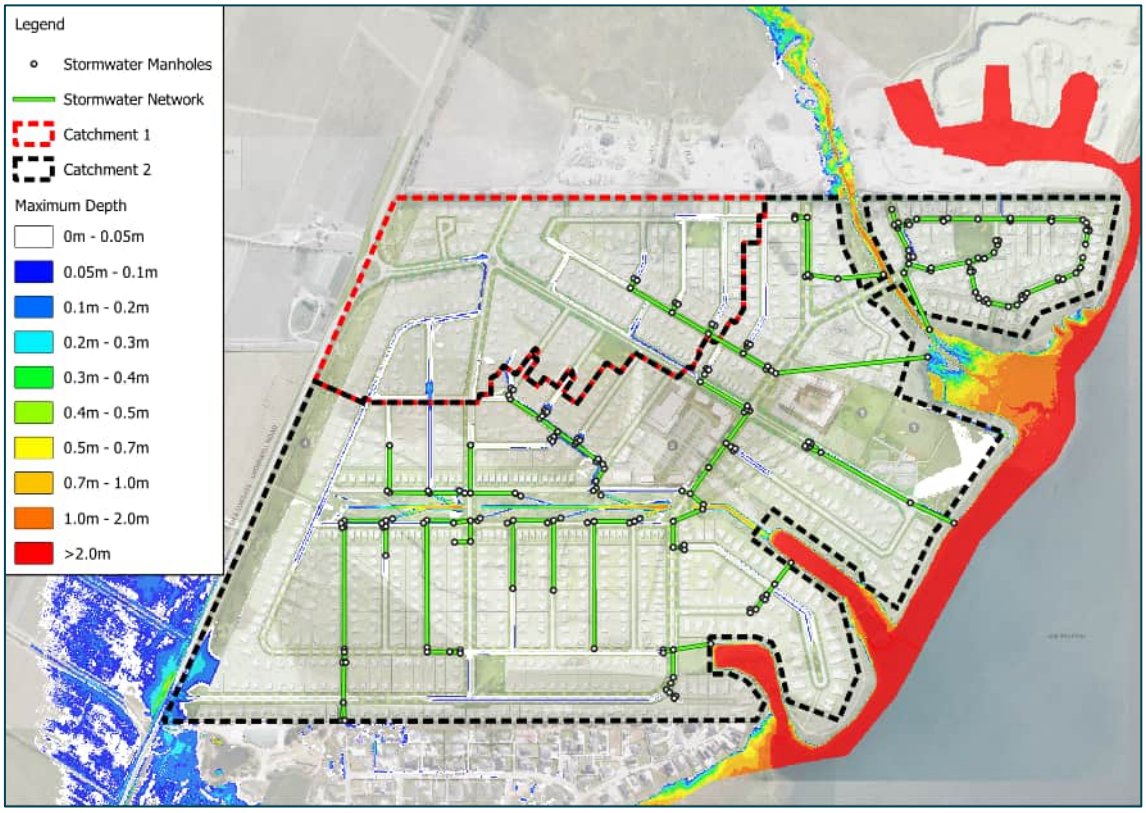


Figure 16: 10-year ARI internal flooding

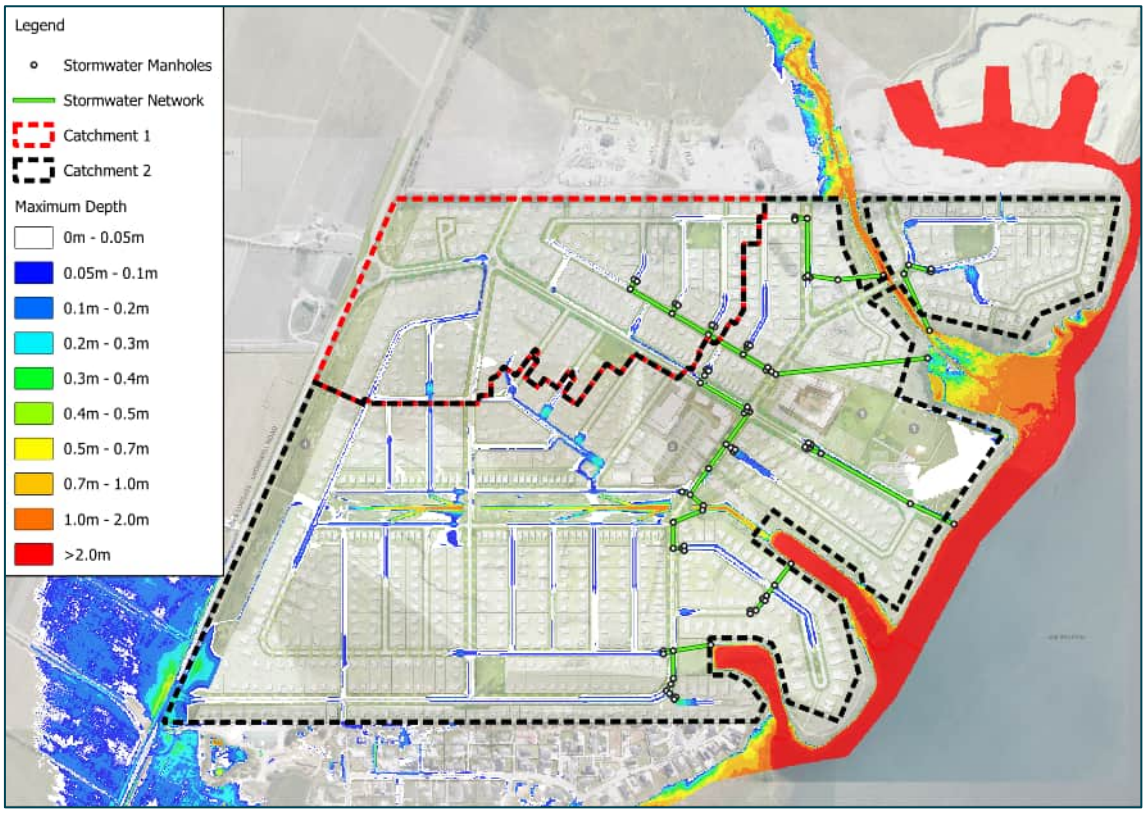


Figure 17: 100-year ARI internal flooding

7.3.1. ARR Hazard Assessment

A hazard assessment using the Australian Rainfall Runoff (ARR) Flood Hazard classification has been undertaken. This is a nationally recognised quantitative assessment tool that utilises modelled depths and velocity to identify areas of risk. It classifies flood hazards vulnerability into six categories as follows:

- H1: Generally safe for vehicles, people and buildings
- H2: Unsafe for small vehicles.
- H3: Unsafe for vehicles, children and the elderly.
- H4: Unsafe for vehicles and people.
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
- H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Figure 18 and Table 10 respectively, show the flood hazard vulnerability curves and criteria.

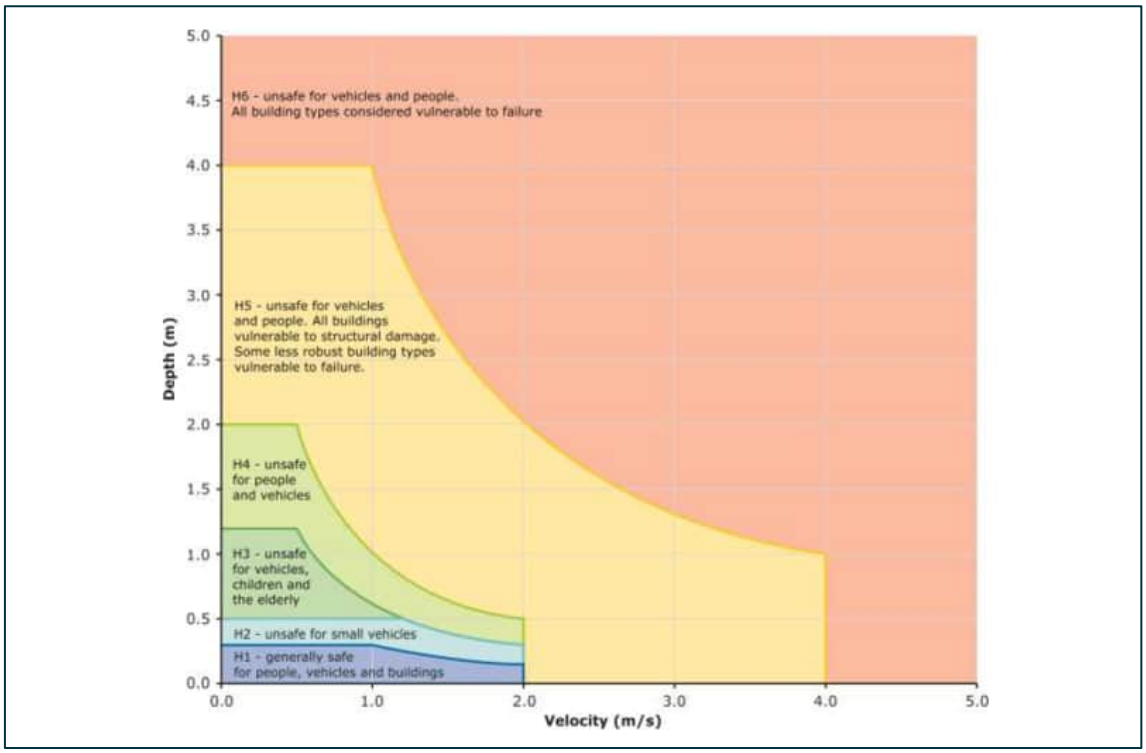


Figure 18: ARR flood hazard vulnerability curves

Table 10: Hazard Curves – vulnerability thresholds classification limits

Hazard Vulnerability Classification	Classification limit (D & V in combination) m2/s	Limiting Still Water Depth (D) m	Limiting Velocity (V) m/s
H1	D*V≤0.3	0.3	2.0
H2	D*V≤0.6	0.5	2.0
H3	D*V≤0.6	1.2	2.0
H4	D*V≤1.0	2.0	2.0
H5	D*V≤4.0	4.0	4.0
H6	D*V>04.0	-	-

Results for the 100-year are shown on Figure 19 and indicate that within the development (along the road corridors), the maximum hazard identified is H1. Hazards exceeding H1 have only been noted along drainage corridors thus do not pose an immediate danger to future occupants. Based on the modelling assumptions and preliminary designs, the hazards are considered acceptable.

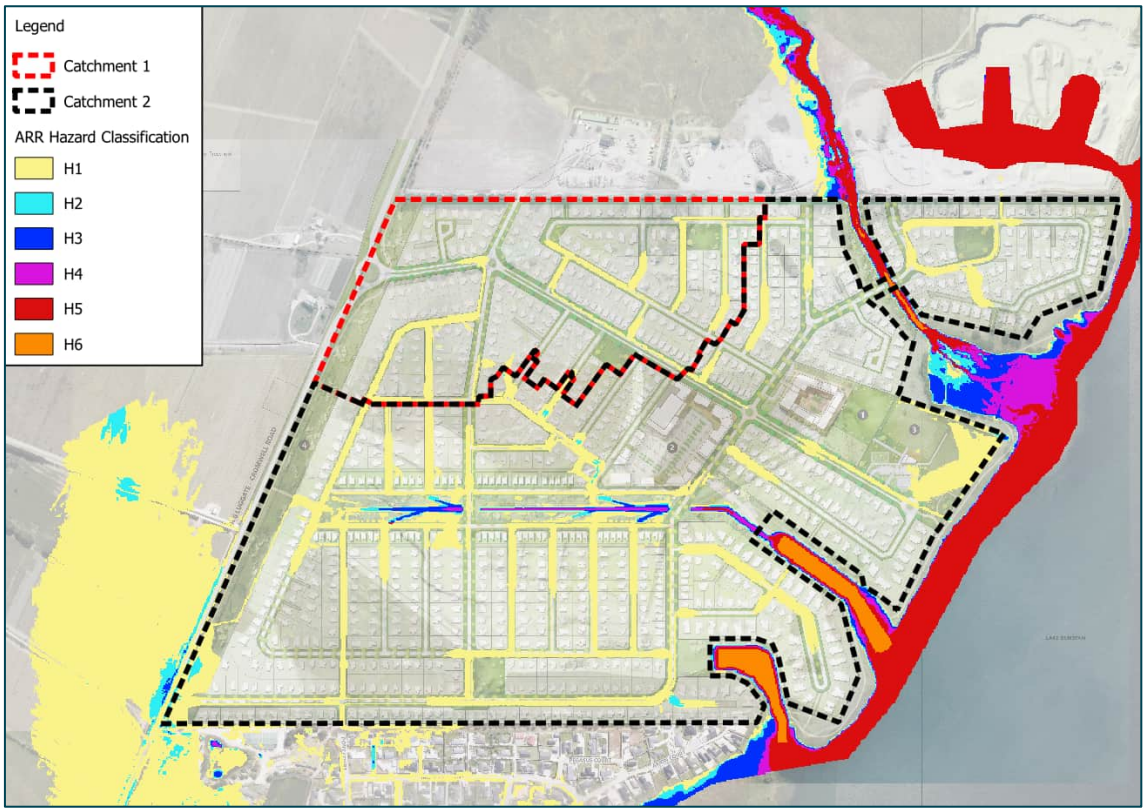


Figure 19: 100-year ARI ARR Hazards

7.3.2. Required Finished Floor Levels

As per CODC Engineering Standards and NZS 4404:2004, habitable building floor levels are required to include a minimum freeboard of 0.5 m above the computed top water level for the 1% AEP (100-year) design stormwater event (including climate change allowance).

8. Alluvial Fan Hazards

The Otago Regional Council alluvial fan mapping has identified that a small portion of the development is overlaid by a 'active floodwater dominated' fan which extend from Mount Pisa to Lake Dunstan / Te Wairere (Figure 20). Further uphill (more than 5km from the development site) are smaller 'active debris dominated fans' which for the purpose of this report are not considered to potentially affect/inundate the development with debris.

The portion of the fan noted on the site, is within an existing drainage corridor. A high-level assessment was conducted to determine whether very extreme flood flows might have a negative impact on the development. For this, the 100-year ARI was bulked up three times (as this is floodwater dominated, no allowance for sediment/debris being carried from the hills was accounted for) and routed through the site using the previously constructed flood model. It was determined that even at these extreme flows (and with the reduction of the floodplain in the Bonisch site) the runoff is contained within the revised drainage corridor. Figure 21 shows the extents of the 100-year and the of the 3 x 100-year. Figure 22 and Figure 23 shows the upstream and downstream cross sections within the development site, respectively, where the terminal point of the alluvial fan is shown.

It is acknowledged that the Council's Request for Further Information (RFI) has raised matters regarding the alluvial fan hazard assessment. In response, it is noted that a detailed Alluvial Fan Hazard Assessment is currently being undertaken by Haskoning in conjunction with the adjoining HWR development. This assessment will be submitted to Council once completed.

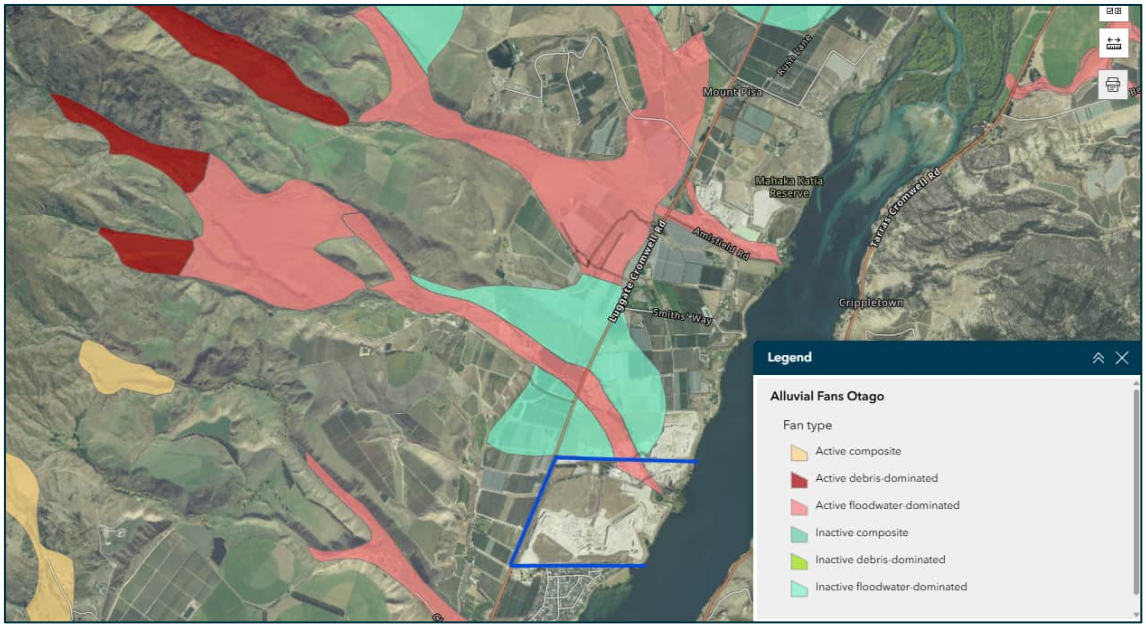


Figure 20: ORC Alluvial Fans Mapping

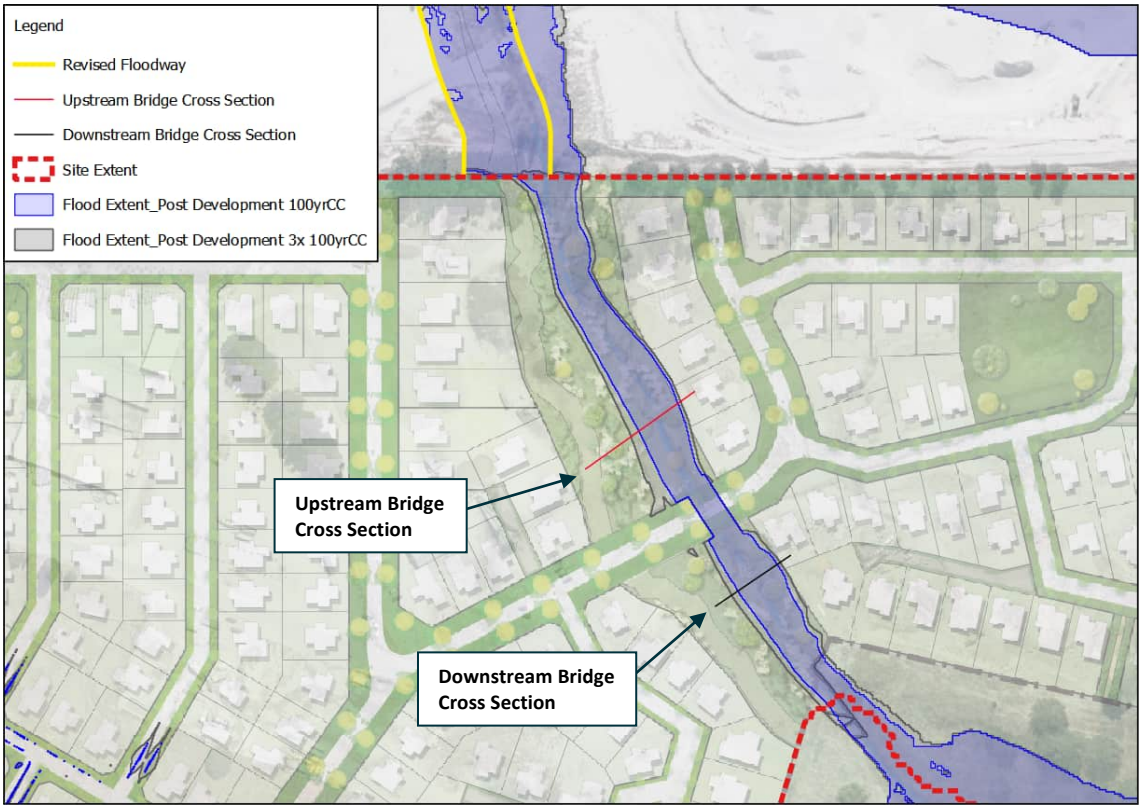


Figure 21: Extreme flood levels through drainage corridor

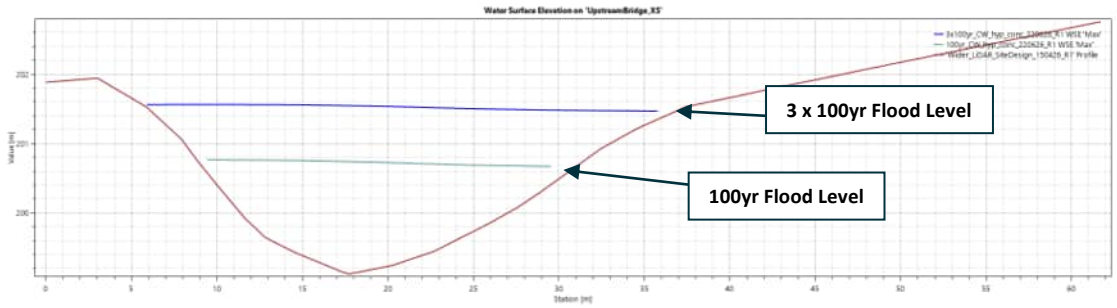


Figure 22: Upstream flood levels (1x100yr vs 3x100yr events)

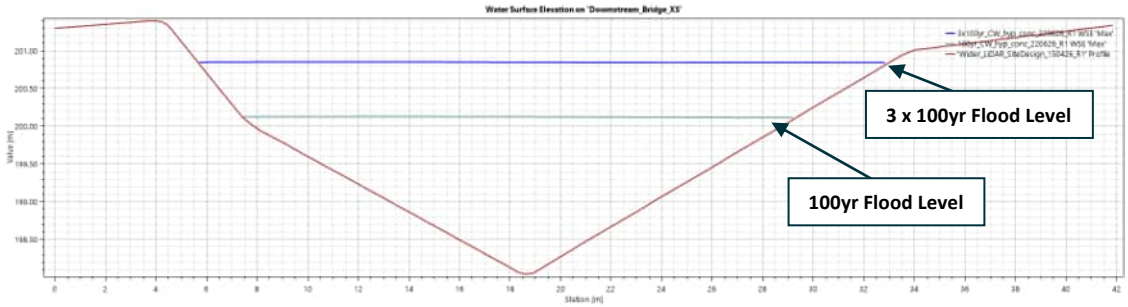


Figure 23: Downstream flood levels (1x100yr vs 3x100yr events)

9. National Policy Statement: Natural Hazards

The National Policy Statement for Natural Hazards 2025 (NPS-NH) was notified on 18 December 2025 and came into force on 15 January 2026. It is made under the Resource Management Act 1991 (RMA) and establishes national direction for managing natural hazard risk associated with subdivision, use, and development. Of direct relevance to this Stormwater Management Plan, the NPS-NH applies to flood hazard risk and requires that this risk be assessed and managed in a proportionate manner for all new subdivision, use, and development.

The NPS-NH establishes a risk matrix framework (Figure 24) that characterises flood hazard risk by combining the likelihood of a flood event with its potential consequences for life and property. Likelihood is assessed by reference to annual exceedance probability (AEP) and average recurrence interval (ARI), and consequence is assessed across five levels from Negligible to Catastrophic. Together, these determine whether the overall level of risk is Negligible, Low, Medium, High, or Very High. Where risk is assessed as Very High, development must be avoided. Where risk is assessed as Medium or High, it must be avoided or mitigated proportionate to the level of risk, having regard to the cost-effectiveness of mitigation measures. The NPS-NH also requires that the potential impacts of climate change to at least 100 years into the future be considered in any risk assessment, and that decisions be made on the basis of the best available information, even where that information is uncertain or incomplete.

The Parkburn site is subject to flood hazard risk from two primary sources:

a) Overland flow and fluvial flooding associated with the Park Burn, which flows through the northeastern corner of the site before discharging to Lake Dunstan / Te Wairere; and

b) Potential inundation associated with the alluvial fan hazard zone of the Park Burn, as identified by the Otago Regional Council. Each source has been assessed within the NPS-NH risk framework as set out below.

Consequence Level	Likelihood Level: Almost Certain	Very Likely	Likely	Possible	Unlikely	Rare	Very Rare
ARI (years)	up to 10	10-20	20-50	50-100	100-500	500-5000	> 5000
AEP	10% or more	10% to 5%	5% to 2%	2% to 1%	1% to 0.2%	0.2% to 0.02%	< 0.02%
Catastrophic	Very High	Very High	Very High	High	Medium	Medium	Medium
Major	Very High	Very High	High	High	Medium	Medium	Medium
Moderate	High	High	High	Medium	Medium	Low	Low
Minor	Medium	Medium	Medium	Medium	Low	Low	Low
Negligible	Low	Low	Low	Low	Low	Low	Low

Figure 24: NPS-NH Risk Matrix Framework

9.1. Fluvial and Overland Flow Hazard

Flood hazards associated with Park Burn and overland flow paths across the site have been assessed using a two-dimensional HEC-RAS hydrodynamic model, as described in Section 8. The model was developed using LP2000 and NZVD16 survey data from Landpro Ltd, dated April 2026, with design rainfall derived from NIWA HIRDS V4. The RCP8.5 climate change scenario has been applied for the 100-year planning horizon, in accordance with CODC and ORC guidance.

The external flood modelling results, presented in Section 8.2, show that flood flows from the wider Mount Pisa catchment are contained within the existing drainage corridor for the 100-year ARI event, including climate change, and do not overtop into the proposed development areas. The post-development model, which includes the reduced floodplain within the neighbouring Bonisch site, confirms that the proposal does not cause adverse flooding effects on upstream properties.

The internal flood modelling results, presented in Section 8.3, show that flooding during the 5-year, 10-year, and 100-year ARI events, including climate change, is generally contained within the road corridors and central drainage corridor. The ARR hazard assessment for the 100-year ARI event indicates that the maximum flood hazard classification within the development area, including road corridors, is H1, which is generally safe for vehicles, people, and buildings. Higher hazard classifications are limited to drainage corridors and do not directly affect habitable building areas.

Based on the NPS-NH consequence and likelihood framework, the overall flood hazard risk across most of the development site is assessed as low to negligible. Minimum finished floor levels have been set 0.5 m above the computed 1% AEP flood level, including climate change, in accordance with CODC Engineering Standards and NZS 4404:2004.

The proposed stormwater management system, including the central conveyance channel, primary pipe network, secondary overland flow paths within road corridors, and upgraded culvert crossings, is designed to improve conveyance and maintain or reduce flood levels compared with the pre-development scenario. This is consistent with the NPS-NH requirement to avoid increasing flood risk on other land.

9.2. Alluvial Fan Hazard

ORC alluvial fan mapping identifies a small portion of the northeastern development area as being within an active, floodwater-dominated fan. This area coincides with the existing drainage corridor.

As described in Section 8, an extreme flow sensitivity assessment was undertaken using three times the 100-year ARI design discharge. The results show that flows remain contained within the revised drainage corridor and do not inundate the proposed development platforms.

The proposed layout avoids habitable buildings within the mapped active alluvial fan area. The corridor is instead used for infrastructure and open space, with channel improvements and upgraded culvert crossings providing a defined flow path to Lake Dunstan / Te Wairere.

9.3.Climate Change

The NPS-NH requires that climate change effects be considered to at least 100 years into the future as part of any flood hazard risk assessment. The flood modelling described in Section 8 incorporates climate change projections based on NIWA HIRDS V4 using the RCP8.5 high-emissions scenario projected to year 2100. This represents the upper range of plausible future rainfall intensification and has been applied to assess flood hazard risk for the full 100-year planning horizon, consistent with the NPS-NH requirement and CODC and ORC guidelines.

The minimum FFLs to be specified following completion of the detailed internal flood model will incorporate the climate change-adjusted 1% AEP flood level, providing resilience over the lifetime of the proposed development consistent with the NPS-NH.

9.4. NPS:NH Summary

The flood and alluvial fan hazard assessment demonstrates that the proposed Parkburn Development can be achieved in a manner consistent with the NPS-NH 2025. The key findings are summarised below:

- Flood hazard has been assessed using a two-dimensional HEC-RAS hydrodynamic model, with design rainfall derived from NIWA HIRDS V4 and RCP8.5 climate change projections applied to the 100-year planning horizon.
- The NPS-NH risk framework has been applied to the proposed residential and mixed-use activities. Flood hazard risk across the development platforms is assessed as low to negligible, with no very high risk areas identified within the proposed habitable development footprint.
- The ARR hazard assessment for the 100-year ARI event confirms that flood hazard within road corridors is generally classified as H1. Higher hazard categories are confined to drainage corridors.

- Minimum finished floor levels will be set 0.5 m above the 1% AEP flood level, including climate change, to manage residual risk for habitable buildings.
- The proposed stormwater infrastructure has been designed to maintain or reduce flood levels on upstream and downstream properties relative to the pre-development scenario.
- The alluvial fan hazard has been considered in the development layout. Habitable buildings are located outside the active fan corridor, and the extreme flow assessment confirms that flows remain contained within the revised drainage corridor.

On this basis, flood hazard risk has been assessed and managed in a proportionate manner appropriate to the scale, nature, and location of the proposed development. The proposal is therefore considered consistent with the relevant requirements of the NPS-NH 2025.

10. National Policy Statement – Freshwater Management

The National Policy Statement of Freshwater Management 2020 (NPS-FM) came into effect in September 2020 and provides local authorities with direction on how to manage freshwater under the Resource Management Act 1991. The NPSFM is a first step to improve freshwater management at a national level. The previous NPS-FM released in 2014, revised in 2017 and amended in 2025, sets out an objective and outlines policies for freshwater management.

The objective of the NPS is to ensure that natural and physical resources are managed in a way that priorities:

a) The health and well being of water bodies and freshwater ecosystems

b) The health needs of people (such as drinking water)

c) The ability of the people and communities to provide for their social, economic and cultural well-being, now and in the future

The policies include:

- Managing freshwater in a way that gives effect to Te Mana o te Wai
- Actively involving Tangata Whenua in freshwater management (including decision-making processes), and Maori freshwater values identified and provided for.
- Managing freshwater in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects of the receiving environments
- Managing freshwater as part of New Zealand's integrated response to climate change
- Managing freshwater to ensure health and well-being of water bodies and ecosystems is maintained/improved
- Protection of habitats of indigenous species
- Monitoring of conditions of water bodies and freshwater ecosystems systematically over time

In this project, effect is given to these policies via the design approaches adopted which include but not limited to the following:

- Consultation with mana whenua has been undertaken as part of the broader resource consent process. Matters relevant to freshwater values and Te Mana o te Wai have been considered through the Cultural Impact Assessment prepared in support of the application
- Working with the topography adjacent to the lake ensuring minimal impact
- The stormwater and flood modelling incorporates climate change projections using the RCP8.5 high-emissions scenario projected to year 2100, consistent with the NPS-FM requirement to manage freshwater as part of New Zealand's integrated response to climate change.
- Design of coves allowing access to the lake for the community

- The stormwater management strategy prioritises the health of Lake Dunstan/ Te Wairere as the primary receiving environment. Stormwater quality treatment is provided across all catchments prior to discharge.

On this basis, the proposed stormwater management strategy is considered consistent with the relevant policies and objectives of the National Policy Statement for Freshwater Management 2020.

11. Conclusion

The proposed stormwater management strategy for the Parkburn Development provides a practical, site-responsive, and risk-proportionate approach to managing stormwater across the site.

The strategy recognises the varying drainage conditions within the development area. Higher parts of the site will manage stormwater through soakage where ground conditions allow, while lower areas will be serviced by a reticulated stormwater network with appropriate treatment prior to discharge. This approach responds to the site levels, ground conditions, proposed land use, and receiving environment.

Stormwater quality will be managed through a combination of source control, vegetated swales, and a toolbox of at-source and network-based treatment devices. Appropriate treatment is proposed in accordance with current best practice to ensure stormwater discharges are suitably treated before discharge towards Lake Dunstan / Te Wairere. This will protect the water quality of the receiving environment and avoid degradation associated with the proposed development. Final device selection and sizing will be confirmed at detailed design stage in consultation with Central Otago District Council.

The water quality outcomes will also be secured through proposed conditions of consent, including specific treatment standards and pre-development and post-development water quality monitoring. These conditions will provide a clear framework for confirming treatment performance and ensuring the ongoing protection of Lake Dunstan / Te Wairere.

Flood modelling confirms that the proposed development can be managed without creating adverse flooding effects on neighbouring properties. Flood flows from the wider Mount Pisa catchment are contained within the central drainage corridor, and internal overland flow paths are generally directed through road corridors and designated drainage areas. Finished floor levels will be set above the modelled 1 % AEP flood level, including climate change, to manage residual flood risk to habitable buildings.

The alluvial fan assessment also confirms that habitable development is located outside the active fan corridor, with infrastructure and open space proposed in areas where this form of use is more appropriate. This provides a risk-proportionate response to the mapped natural hazard setting.

Overall, the proposed stormwater management strategy represents the Best Practicable Option for the Parkburn Development. It provides for stormwater collection, treatment, conveyance, and disposal in a manner that supports the proposed land use change, manages flood and natural hazard risk, protects people and infrastructure, and provides appropriate water quality treatment before discharge to Lake Dunstan / Te Wairere.

On this basis, the stormwater management approach is considered appropriate to support the substantive Fast-track Approvals Act application.

Appendix A – RFI Response Table

Comment Date	Review Comments	Designer Response	Response From	Response Date
14-Jul-26	Provide sediment transport capacity from SH6 culverts through proposed development site. Further assessment information including potential for blockage at the narrowings or asymmetries present in the indicated floodway, and potential bypassing impact if structures are blocked by sediment/debris during a major event.	The SMP modelling (Appendix C, Section 5.0) assumes all watercourses and culverts remain fully operational, with no allowance made for sediment build-up or blockage. The potential for debris and sediment from the upper catchment has been identified in the Bonisch correspondence (Appendix D) as an issue requiring further investigation and would likely be covered in that application. It is worth noting that the proposed development at the Bonisch site does not extend to SH6 and the flood corridor which starts downstream of SH6 and traversing through 1034 Luggate-Crowell Road (north of the Bonisch site) is not altered. The reason for referencing the Bonisch site in the Parkburn application was to confirm how their likely proposal will interface with Parkburn and how the reduced corridor (on the Bonisch site) will influence the downstream flow characteristics.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide evidence of Contact Energy Ltd dam operating range and spillway levels. Consider using a conservative understanding of the Clutha Dam operation to apply to design boundary conditions for flood modelling. LandPro Page 9 "*reported daily fluctuation of approx. 750 mm (with a normal operating range of 193.5 to 194.5 m AOD*." What is Clutha Dam emergency spillway overflow operation level and PMF level (for context).	The downstream boundary condition in the hydraulic model has been set at a constant water level of 196.5 mRL, based on the projected future Lake Dunstan level provided by Contact Energy Ltd (refer to Appendix C). This level is conservative, as it is higher than Contact Energy's normal operating range for Lake Dunstan, which is approximately 193.5 mRL to 194.5 mRL (as reported by Landpro). Adopting an elevated downstream boundary ensures that the hydraulic assessment considers a higher tailwater condition, providing a conservative estimate of upstream water levels and flood extents. The information provided by Contact Energy is included in Appendix C and will be revisited during the next phase of design, where the downstream boundary conditions will be reviewed alongside the detailed design of the lake-edge infrastructure and outlet structures.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Figure 4 - show flowpaths and subcatchment areas. Include labelled contours. Combine info from LandPro contours.	Figure 4 as it curretly appears in the SMP refers to overland flow paths based on the existing surface. The requested figure i.e., that based on post development finished surface, is provided in Figure 3 in Appendix C (Model Build Report). The figure shows, contours, post development overland flows and delineated subcatchment	Pranil Wadan / Boniface Kinnear	21-Jul-26

14-Jul-26	Provide cross sections or long sections of proposed cut/fill depths required to build site floor levels. Provide a few typical conceptual earthwork cross sections to indicate proposed finished levels relative to north/south boundaries, SH6 levels and lake levels. This to support the bulkearthworks plan view model outputs (LandPro drawings 113.01 to 113.19 EMP, Appendix A)	Bulk earthworks concept information is presented in the LandPro bulk earthworks plan view model outputs (Drawings 113.01 to 113.19, EMP Appendix A). The SMP does not currently include cross sections or long sections showing proposed cut and fill depths relative to site levels, SH6, and the lake. Typical conceptual earthworks cross sections will be prepared once the lot layout and finished floor levels have been confirmed, as part of the next phase of the earthworks and civil design, alongside the Insight Engineering geotechnical assessment.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide proposed areas for other land zoning: community centre, education, commercial, etc. A list or table of conceptual areas. This information to show relative runoff coefficients for different development land use areas.	SMP Table 6 (Section 6.4.1) identifies Zone C (10.44 ha) as covering the commercial and mixed-use precincts, including the neighbourhood centre, preschool precinct, and lakeside commercial areas, with the remaining zones being predominantly residential. The SMP has been prepared using the adopted land use assumptions appropriate for this stage of the project noting that a 60% imperviouness was adopted and given that some catchments have lower imperviouness the overall result is not expected signficantly vary. A land use area table with corresponding runoff coefficients will be provided once the masterplan land use areas are confirmed, to support refinement of the hydrology model at detailed design.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide typical details of a Caudwell Pit and include into typical Lot detail to indicate intended use. State the level of service the Caudwell pit will provide (justify a case for less than 1%AEP). Provide more conceptual details of soakage disposal over Catchment 1. Provide a typical conceptual detail of soakage disposal infrastructure for a private house lot and for public road corridor. State the intended level of service of the soakage infrastructure and discuss assumptions with regards to normal engineering constraints of groundwater, elevation, spatial footprint. Confirm that freeboard to floor levels is feasible. Describe assumed operation and maintenance responsibility and feasibility. Describe secondary overland flowpaths through Catchment 1 that provide freeboard assurance to building platforms.	Section 6.3 confirms that traditional Caudwell pits, typically 6 m deep with 1 m of cover, have historically been used in Cromwell for soakage disposal. It also explains that adopting the 203 mRL FSL contour as the Catchment 1 boundary keeps soak pit bases at or above RL 196, where infiltration testing indicates soakage will perform adequately. Testing below RL 196 showed minimal infiltration. Section 6.3 also notes that site-specific infiltration testing will be required to confirm the final sizing of soak pits. The information requested, including typical Caudwell pit details and integration within a representative lot layout, the proposed level of service, conceptual soakage arrangements for private lots and the road corridor, groundwater, elevation and spatial constraints, confirmation of floor level freeboard, operation and maintenance responsibilities, and secondary overland flow paths within	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	With all water quality management strategies - clarify assumed responsibilities for operations and maintenance of toolbox devices. Provide evidence of Council engagement and acceptance of the proposed stormwater treatment approach and device responsibility.	SMP Table 5 (Stormwater Management Toolbox, Section 6.2) identifies the intended ownership and maintenance responsibilities for stormwater devices, with private devices to be maintained by individual lot owners or the body corporate, and public devices by Council. Sections 6.3.1, 6.4.1.2 and the Conclusion (Section 11) also confirm that the final selection, sizing and operation and maintenance requirements for individual devices will be determined during the subsequent design phase in consultation with CODC. Operation and maintenance responsibilities for individual devices, together with formal confirmation of the proposed treatment approach by CODC, will be documented as part of the subsequent design phase in consultation with Council.	Pranil Wadan / Boniface Kinnear	21-Jul-26

14-Jul-26	Provide conceptual design long section drawings of channel connectivity and show levels/gradients and context with Lake levels (typical and extreme). Indicate the effects of the 0.74m lowering of the central conveyance channel. Show how buried pipes connect to 6 shallow depth vegetated swales, and connect to corridor conveyance.	Section 6.4.1.1 confirms that the central conveyance channel invert has been lowered by 0.74 m to allow the six vegetated swales (Swales 1 to 6, shown in Figure 7) to discharge into the channel. This hydraulic connectivity has been confirmed by Landpro. Indicative swale design parameters, including base width, side slopes, and effective length, are provided in Table 7 and Appendix B. As the Stormwater Management Plan (SMP) does not include long sections showing channel and pipe connectivity, longitudinal gradients, or invert levels relative to typical and extreme Lake Dunstan water levels. These details will be developed as part of the detailed drainage design. For the hydraulic modelling completed to date, a conservative downstream boundary level of 196.5 mRL has been adopted for all model scenarios. This level represents a worst-case tailwater condition and is above the normal operating range of Lake Dunstan, ensuring the assessment is conservative. Long section drawings, together with confirmation of pipe and channel connectivity, invert levels, and longitudinal grades, will be prepared during the subsequent detailed design phase once the pipe network layout and associated contributing catchments have been finalised. Based on the preliminary pipe network incorporated into the primary event hydraulic model, runoff is conveyed through the drainage network to the outlet structures located at the inlets of the vegetated swales, demonstrating that the proposed drainage concept provides hydraulic connectivity to the downstream discharge points.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide a rationale for designing the primary network to 5 year ARI level of service with respect to best practice and climate change risk at this site. Confirm the proposed residential zoning - is the zone considered "rural residential" as per NZS4404?. Consider a 10 year ARI level of service to NZS4404 for rural residential areas (ref NZS4404, Table 4.1).	Section 6.5.1 confirms that the preliminary primary stormwater network assessment is based on 10-year ARI events (note that the SMP also covers the 5-year ARI assessment). The development is proposed as urban residential and mixed-use under the FTAA application, rather than rural residential. At the detailed design stage the network will be extended to the rest of the development (except for soakage areas) and the assessment updated accordingly.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide hydraulic calculations and hydraulic grade line through culverts and bridge to demonstrate appropriate sizing. Confirm the level of service of the culverts is 1%AEP. Show modelling that includes the structures and the flood levels in a 1%AEP post-development scenario.	Section 6.5.2 confirms that both culverts (Culvert 1: 1.2 m high × 4 m wide, Culvert 2: 1.2 m high × 6 m wide) and bridge have been sized and modelled to convey the 100-year ARI event (1% AEP), including the applicable climate change allowance. The associated hydraulic modelling results, including flood extents through the central drainage corridor, are presented in Appendix C and Appendix B (Figure 16 / Drawing DR0003). The detailed hydraulic grade line calculations and structure-specific design, including invert levels, headloss coefficients and scour protection, will be completed as part of the subsequent design phase.	Pranil Wadan / Boniface Kinnear	21-Jul-26

14-Jul-26	Confirm freeboard assumptions. Provide a typical cross section of the road corridor and building platforms indicating freeboard allowances. Show a flood map from modelling output indicating flood extents in a 1%AEP event assuming pipelines are neglected/blocked as a conservative case.	Section 7.3.2 confirms that a minimum freeboard of 0.5 m above the modelled 1% AEP (100-year ARI) flood level, including climate change, is required for habitable floor levels in accordance with the applicable design standards. The hydraulic model already adopts a conservative assumption for the 100-year ARI event, with pipes smaller than 600 mm diameter in the conceptual/preliminary network design excluded from the model (Appendix C, Section 2.3.3) and high capacity inlets incorporated to transfer overland flows into the network. The resulting flood extents are shown in Figure 17 and Appendix B (Drawing DR0003). Note that the purpose of the preliminary design is proof of concept that the development can be drained. A typical cross section illustrating the proposed road corridor and building platform freeboard allowances will be prepared as part of the subsequent design phase, once the road and lot levels have been confirmed.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Confirm what software was used to model the pipelines and state how flood mapping was prepared on the proposed earthworks surfaces. 1D or 2D model software, was rain applied to grid or at 'catchment' injection points?	Section 7.1.2 and Appendix C, Section 2.0 confirm that HEC-HMS was used for the hydrology and HEC-RAS (Version 7) for the combined 1D/2D hydraulic modelling. The hydraulic model couples the preliminary 1D pipe network with a 2D surface model based on the proposed post-earthworks design surface, using a 5 m x 5 m mesh with a 2 m × 2 m computational grid refinement along road and drainage corridors (Appendix C, Sections 2.3.2 and 2.3.3). Rainfall runoff was generated in HEC-HMS for each subcatchment, with the resulting hydrographs applied as inflow boundary conditions at discrete loading nodes within the 2D model (Appendix C, Sections 2.3.1 and 2.3.3). This assesment is deemed appropriate at this stage. Further refinement of the hydraulic model, including updates to the 1D drainage network and inflow locations where required, will be undertaken as part of the subsequent design phase.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	State how blockage risk is proposed to be managed at catchpits, pipes, culverts and bridge. Discuss secondary overland flowpaths system.	Blockage risk within the pipe network has been conservatively represented in the 100-year ARI model by excluding pipes smaller than 600 mm diameter, with the exception of catchpit leads, and incorporating high-capacity inlets to improve surface flow collection under these conditions (Appendix C, Section 2.3.3). The culverts and bridge have been modelled as fully operational, consistent with the stated modelling assumptions and limitations (Appendix C, Section 5.0). Blockage management measures, including any requirements for debris control, maintenance access, or structure-specific treatments, will be developed as part of the subsequent design phase. As part of the detailed design, allowances will be made to maximise the size of the pipes (as far as compliant cover is maintained) and inlets to ensure localised ponding zones are minimised. Roads will function as secondary overland flow paths conveying runoff to the lake.	Pranil Wadan / Boniface Kinnear	21-Jul-26

14-Jul-26	Provide working that shows the critical time of concentration for the Parkburn at the northern boundary of the site. Use a range of 3 or 4 ToC methods and justify the critical duration storm event. Using the ARC TP108 time of concentration method along with 3 other methods. Compare peak design discharge with other hydrology methods for context (for example, the Regional Flood Frequency method subject to catchment size considerations) Provide design hydrographs at boundary line including allowance for future-developed upstream residential area, narrowed flood flow channel, SH6 culverts blocked/unblocked (which may change the location of some of the overland flows?)	Appendix C, Section 2.2.2 confirms that the time of concentration for the external catchment subcatchments (46 to 146 minutes) was calculated using the SCS method in accordance with Auckland Council's TP108, adopted in the absence of a Central Otago-specific methodology. A comparison with alternative time of concentration methods is provided in the Model Build memo Appendix C of the SMP with a representative catchment used to calculate the runoff for comparision. The methods show a great variation in the times of concentration with the TP108 method falling in the average range. A representative catchment was used to calculate the runoff for comparision. For the purpose of this SMP, we are assessing specific rainfall events (i.e., 5, 10 and 100-year for a 24-hour duration) and determining whether the proposal can adequately conveyed the runoff from these events (primary and secondary). This duration has been selected given that it is the basis for the TP108 methodology for hydrology which has been adopted for this project. Separate boundary hydrographs representing variations in future upstream development or blocked and unblocked SH6 culvert scenarios have not been developed, as this level of sensitivity testing is beyond the scope of the SMP. Any additional hydrological sensitivity testing, including comparisons of time of concentration methods and refinement of boundary hydrographs where required, will be undertaken as part of the subsequent design phase to support the final design of the drainage corridor.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	State the top elevation of the Parkburn catchment and show profile of the catchment	Appendix C, Section 2.1 confirms that the model extends from the upper Mount Pisa catchment to Lake Dunstan, covering approximately 11 km. While the model extent is described, the SMP does not currently identify the top-of-catchment elevation or include a longitudinal catchment profile. SMP to be updated to include the top-of-catchment elevation and a longitudinal catchment profile extracted from the existing LiDAR and terrain data used to develop the hydraulic model.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Figure 2 catchment wide delineation model. State the sub-catchment areas in km2 or hectares draining through the proposed site. Label the subcatchments, indicate catchment connectivity to Parkburn. Show that Catchments 1,2,3,7 connect for Parkburn. Show how other catchments 4,5,6,8 drain through the Site to the Lake.	SMP has been updated to show catchments with respective flow arrows	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide full NIWA HIRDS design rainfall table for the site for RCP8.5. Show the nested temporal profile.	Include - Appendix C, Table 1 (Section 2.2.1) presents the adopted 24-hr rainfall depths for the 5-, 10- and 100-year ARI events under RCP8.5 (61 mm, 72 mm and 114 mm respectively), with a 24-hr nested Type 2A temporal distribution peaking at midday adopted for the analysis.	Pranil Wadan / Boniface Kinnear	21-Jul-26

14-Jul-26	Provide typical details drawing of proposed private residential lot size and building platform size. Demonstrate 60% impervious surface inside residential lots is appropriate, using assumption of typical Lot drawing, showing full area and roof footprint assumptions	Model build memo updated regarding this assumption.	Pranil Wadan / Boniface Kinnear	23-Jul-26
14-Jul-26	Provide discussion of conservative CN=81 runoff scenario for upper elevation subcatchments of Parkburn. Minimal vegetative cover (ref: TP108, Table 3.3). What effect on peak channel design discharge and corridor width. Is the corridor width conservatively sized? Provide discussion.	The corridor is not part of the Parkburn development and is instead within the Bonisch site. It has been included in the Parkburn hydraulic assessment solely to assess the hydraulic interface between the two developments. The corridor geometry adopted in the model reflects the width specified by Bonisch, as documented in the correspondence included in Appendix D. For the upper catchments, a Curve Number (CN) of 60 was adopted, representing moderately drained soil conditions. This is considered an appropriate and conservative assumption based on the available information, which indicates that the adjacent low-lying areas comprise a range of soil drainage characteristics, with well-drained soils being the predominant condition.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Show 1%AEP rainfall event HGL and assess freeboard to building levels. Catchment 2, Zones A-D. Provide a typical conceptual design long section drawings of pipeline infrastructure relative to typical and extreme Lake operation levels and Parkburn hydraulic grade line flood levels. Demonstrate that buried pipelines will be clear of Lake levels and indicate proposed finished ground levels in all zones. Provide pipe outlet velocities and outlet details including scour protection especially for outlets into the Parkburn stream where sediment transport and erosion/deposition may	The internal 100-year ARI (1% AEP) model results (Figure 17, Appendix B, Drawing DR0003) show the predicted flood extents and depths across the site, including the road corridors, from which hydraulic grade lines and floor level freeboard can be assessed. Confirmation of compliance with the minimum 0.5 m freeboard requirement (Section 7.3.2) will be completed once the proposed finished floor levels have been confirmed. These elements will be developed as part of the subsequent design phase, when the pipe network design is finalised and the associated hydraulic and structural details are confirmed.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Indicate how SH6 and perimeter lots will drain to the Lake. What is proposed in southwest corner of development against SH6, where there is ponding shown. Any impacts on NZTA drainage?	The preliminary pipe network (Figures 8 and 9) shows stormwater being conveyed generally towards the central drainage corridor and the discharge points to Lake Dunstan. The SMP does not include the detailed drainage design for the SH6 frontage or perimeter lots, including the drainage arrangement for the ponding area in the southwest corner of the site adjacent to SH6, or the interface with the existing NZTA/Waka Kotahi drainage network. These aspects will be developed as part of the subsequent design phase, including consultation with NZTA/Waka Kotahi to confirm the proposed interface with the state highway drainage infrastructure.	Pranil Wadan / Boniface Kinnear	21-Jul-26

14-Jul-26	referring to Appendix B flood model results: 1. provide long section hydraulic grade line profiles of Parkburn and central corridor drainage lines. 2. provide velocity information in Parkburn at main cross sections. Identify if scour is to be mitigated. 3. provide discharge hydrographs at upstream property boundary, bridge and oputlet to Lake. State the peak design discharges from the model. 4. Indicate effects of Lake level changes on drainage and freeboard during typical and extreme lake levels 5. Describe concept bridge: lanes, span, abutment types, deck and soffit elevation, indicative scour protection, freeboard assessment. 6. Provide erosion and scour assessment, gradient, hydraulic gradient, including bridge, including delta, including variations in lake level, debris loading and sediment transport, conservative hydrology assessment, conservative Lake level assessment, cross section drawing showing side	1. To be provided at detailed design 2. To be provided at detailed design 3. To be provided at detailed design 4. Designs already based on extreme lake level of 196.5mRL as per Item#2 comment above . 5. To be provided at detailed design where cross sections will be derived and relevant levels and scour protection matters detailed. *6. Request clarification why all these items are required*	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Flood maps: show contours and water surface elevations, show velocity information, show a combined flood map of Parkburn through development into Lake delta. Provide more model outputs for context and assessment by CODC / ORC.	SMP has been updated to include	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	Provide design flow velocity in the proposed resultant Parkburn cross section. More alluvial fan hazard assessment is needed to consider potential effects and mitigations. A fan exists and debris or sediment entrained flow is likely. Assessment of flood levels in a 3x100yr event should extend to building platforms and discuss available freeboard within the subdivision lower levels. The channel cross section Figure 23 is artificial looking with triangular section. Show the modified Parkburn channel gradient, design peak flow, design velocity, and available buffer room for channel to move to manage debris into the delta and Lake edge. Is the sediment transport capacity relatively uniform, or are there constrictions that could cause localised deposition, blockage, and avulsion (flow leaving the channel and finding other pathways)	Section 8 confirms that the 3×100-year ARI sensitivity assessment demonstrates the proposed central drainage corridor has sufficient capacity to safely contain an extreme flow event, with all proposed habitable buildings located outside the active alluvial fan corridor (Figures 21 to 23). This represents a conservative assessment of the proposed corridor and is considered appropriate for establishing the required corridor width and confirming the overall development layout at the SMP stage. The conceptual channel cross-section presented in Figure 23 is intended to illustrate the proposed corridor arrangement with the channel regraded accordinly - please note the scale on Figure 23 is exagerated and the preliminary design has a gentler grade. The detailed design of the drainage corridor will further refine the channel geometry and associated erosion protection measures. This may include additional assessment of flow velocities, sediment transport, channel stability, lateral channel migration, debris loading and avulsion risk, where required to support the final design. These assessments will inform the detailed design of the corridor but are not necessary to demonstrate the suitability of the proposed corridor at the current planning stage.	Pranil Wadan / Boniface Kinnear	21-Jul-26
14-Jul-26	EMP information reviewed with the SMP. No comments on the EMP.			

Appendix B - Stormwater Devices

WOODS
Engineers. Surveyors. Planners.

Indicative Raingarden Design

PROJECT NUMBER:	P24-487
ADDRESS:	Parkburn
BY:	SB
DATE:	4/06/2026

Required Volumes

Impervious Area (m^2)	500
Soil Infiltration Rate (mm/hr)	2
Evapotranspiration Rate (mm/day)	3

Rain Garden Design Parameters

Surface Width (m)	2.50
Surface Length (m)	10.00
Ponding Area (m^2)	25.00

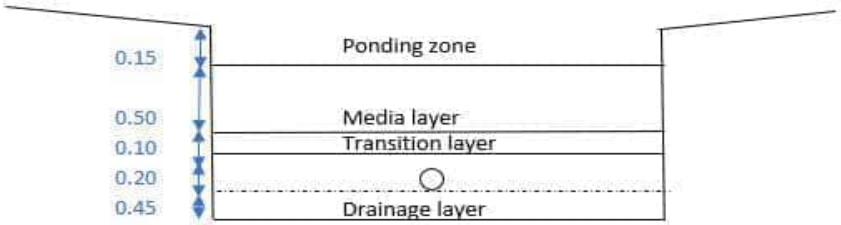
Ponding Depth (m)	0.15
Media Depth (m)	0.50
Transition layer Depth (m)	0.10
Aggregate Depth - above underdrain invert (m)	0.20
Aggregate Depth - below underdrain invert (m)	0.45
Infiltration Area Provided (m^2)	25.00

Media Void Space (%)	30%
Transition layer void ratio (%)	30%
Aggregate Void Space (%)	35%

Ponding Volume - Detention (m^3)	3.75
Media Volume - Detention (m^3)	3.75
Transition Volume - Detention (m^3)	0.75
Aggregate Volume Above Underdrain - Detention (m^3)	1.75
Aggregate Volume Below Underdrain (m3)	3.94

Total Depth (m)	1.40

* The diagram below is not not to scale



WOODS
Engineers. Surveyors. Planners.

Swale Sizing - (no check dams)

PROJECT NUMBER:	P24-487
ADDRESS:	Parkburn
BY:	SB
DATE:	7/04/2026
REVIEWED:	

Swale Design

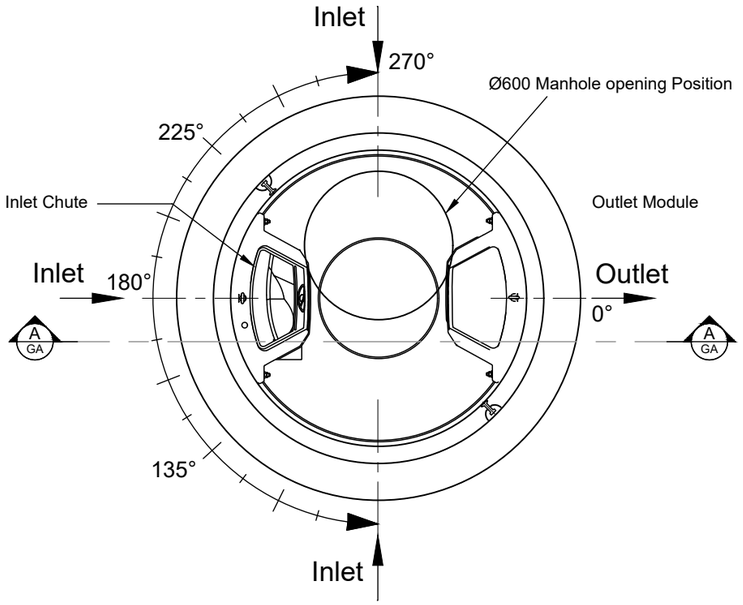
Water depth d(wq) (m)	0.3
Side slopes z (1V:zH)	5
Manning's roughness coefficient n	0.25
Channel slope i (m/m)	0.01
Base width b (m)	2
Total swale width (top width) (m)	5.00

Effective length (m)	80
Cross-sectional area of channel A (m2)	1.05
Hydraulic radius of channel R(hy) (m)	0.21
Flow velocity in the channel v (m/s)	0.14
Flow rate in the channel Q (m3/s)	0.1465

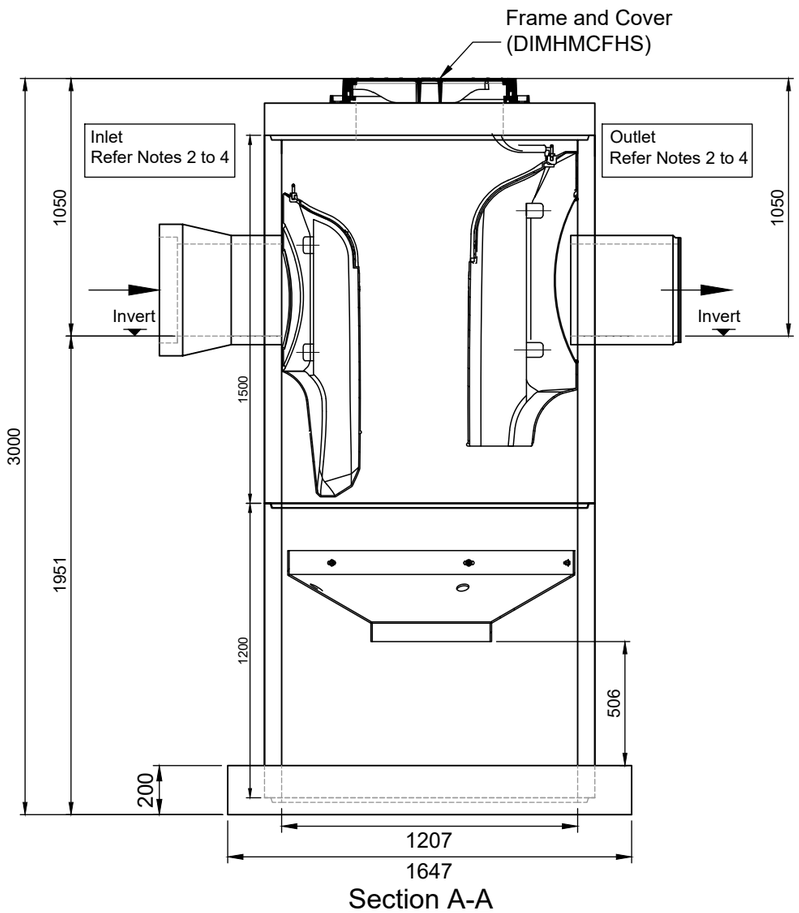
Total Hydraulic residence time HRT (min)	9.56
Required length (m)	**75**

Water Quality Runoff

Impervious percentage (%)	0.6
Pervious percetage (%)	0.4
Peak rainfall rate (mm/hr)	10
coefficient - impervious	0.95
coefficient - pervious	0.5
Water quality catchment area (ha)	**9.24**



Plan View



Section A-A

1. Pipes Diameter Range: Ø150mm to Ø375mm
2. *Inlet and Outlet openings are core drilled by Hynds at Factory
3. Contractor to provide and epoxy Inlet & Outlet Pipe Shorts to Manhole. Maximum allowable inlet/outlet pipe grade of 1:100.
4. *Minimum angle between inlet and outlet must be 90 degrees. This General Arrangement drawing represents a standard DDS supplied with single inlet.
5. For multiple inlets (maximum of 3), minimum angle between any connections must be 90 degrees. Additional inlet chutes to be priced separately. DDS with multiple inlets will be a made to order design.
6. Standard Manhole Lid designed to HD60 Vehicle Loads
7. For install in B2 Exposure Classification environment, consult with Hynds if C or U exposure classification is required

* Check Hynds Manhole Data sheets for guidance as to Maximum allowable openings and Minimum distance between pipes

Pipe Details	Inlet Pipe	Outlet Pipe
Pipe Type (Concrete, PVC ,PE ,Other)		
Pipe Class (If Concrete)		
Nominal ID		
Outside Diametre		
Inlet Pipe Angle		N/A

Please Note:
Invert Dimensions maybe subject to minor changes.
Check with Hynds Stormwater Team prior to conformation of order to confirm details.

I AUTHORISE **HYNDS PIPE SYSTEMS LTD** TO PROCEED WITH THE MANUFACTURING OF THIS PIPE SPECIAL AS DETAILED
I ACKNOWLEDGE THAT ANY SPECIALS, ONCE MANUFACTURED, ARE DEEMED TO BE MY (CONTRACTOR'S) PROPERTY & ARE NON REFUNDABLE. STORAGE & HANDLING FEES WILL BE INCURRED FOR PRODUCTS THAT ARE NOT DELIVERED/COLLECTED WITHIN 1 MONTH OF THE DATE AGREED AT THE TIME OF ORDER. PRODUCT NOT DELIVERED/COLLECTED WITHIN 3 MONTHS OF THE DATE AGREED MAYBE DESTROYED AT MY EXPENSE.

NAME :- ..... SIGNATURE :- .....

DATE :- .....

NOTES:

South Island Option

MATERIALS

VOL (m^3/unit) =	-
WT (ton/unit) =	-
CODE =	-

REVISIONS

REV #:	REVISION DESCRIPTION:	DATE:	DRAWN:
A	Issued For Approval	25 May 2023	GH
1	Issued For Construction	01 Feb 2024	GH
2	Fixing Locations Amended	15 July 24	GH
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PO Box 58142, Botany, Auckland, 2163
Tel: 09-274 0316
Fax: 09-272 7485
email: technicalservices@hynds.co.nz

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ISO 9001 CERTIFIED MANAGEMENT SYSTEM

PROJECT DESCRIPTION:
Hynds Pipe Systems
Stormwater
Downstream Defenter Select
South Island

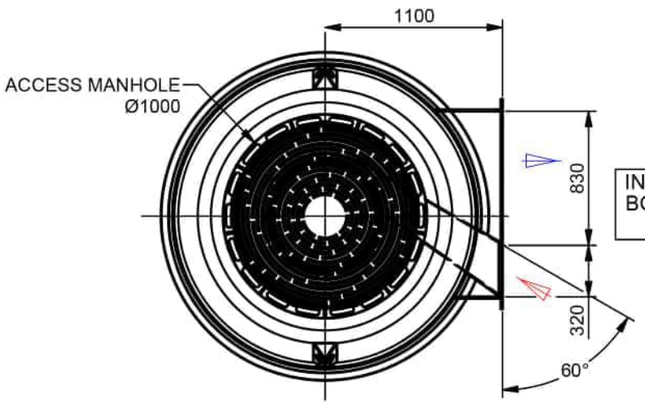
SERVICE DETAIL:
Downstream Defender Select 1200
Concrete Advance Vortex (CAV)
Spun Manhole Ø1200
General Arrangement

REFERENCE/QUOTE NUMBER:	-	
DRAWN: GH SIGNATURE:	DESIGN: GH/BH SIGNATURE:	CHECKED: BH SIGNATURE:
SCALE: 1:25 PAPER SIZE: A3	Note: Do not scale drawing if in doubt **ASK!!!**	DATE: 29-Jan-25
DRAWING NUMBER: T8530 SI	SHEET NUMBER: SI of --	REVISION NUMBER: 2

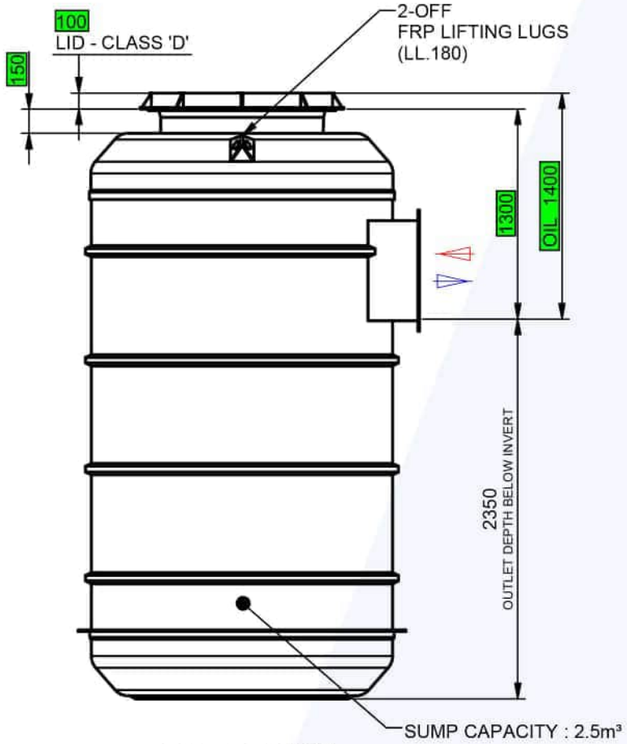
LEFT SIDE INFLOW

MODEL NO.: OVOR.100.18.L
TITLE: MAIN ASSEMBLY
TFR: 100 LPS
MAX. FLOW: PROJECT SPECIFIC DESIGN

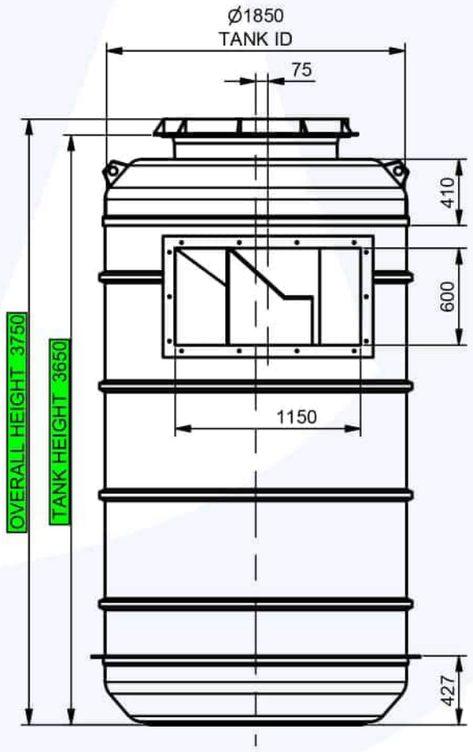
Dimensions that can be modified.



PLAN VIEW

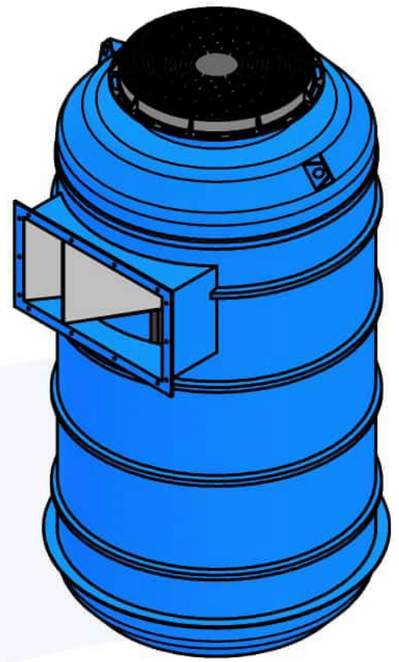


ELEVATION VIEW



BOX OPENING VIEW

Atlan STORMWATER
MASTER DRAWING
NO SUBSTITUTIONS OR MODIFICATIONS



ISOMETRIC VIEW

Atlan Vortceptor				
Site Level Confirmation				
Vortceptor Flow	Off-Line ☑	In-Line ☐		
Flow Configuration	Left ☑	Right ☐		
finished surface level (FSL)	RL.			
Access Cover Thickness		mm		
Inlet Pipe Size	Ø			
Inlet Invert Level	RL.			
Outlet Pipe size	Ø			
Outlet Invert Level	RL.			
Company				
Name :				
Date :				

TOLERANCE: All Dimensions to Closest 10 mm & +/- 30 mm

ALL INTERCONNECTING PIPEWORK, PITS AND ASSOCIATED DRAINAGE BY OTHERS

REV	DATE	BY	DESCRIPTION	CHK
1	18/05/2026	R.R.	INITIAL RELEASE	

CLIENT:

CONFIDENTIAL - The drawings must not be disclosed to any third parties without written permission from ATLAN STORMWATER . Unauthorized disclosure may result in prosecution.
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Drawn	R.R.	Date 18/05/2026
Check		Date
Verified		Date
Approved		Date
Request No.		

Atlan STORMWATER

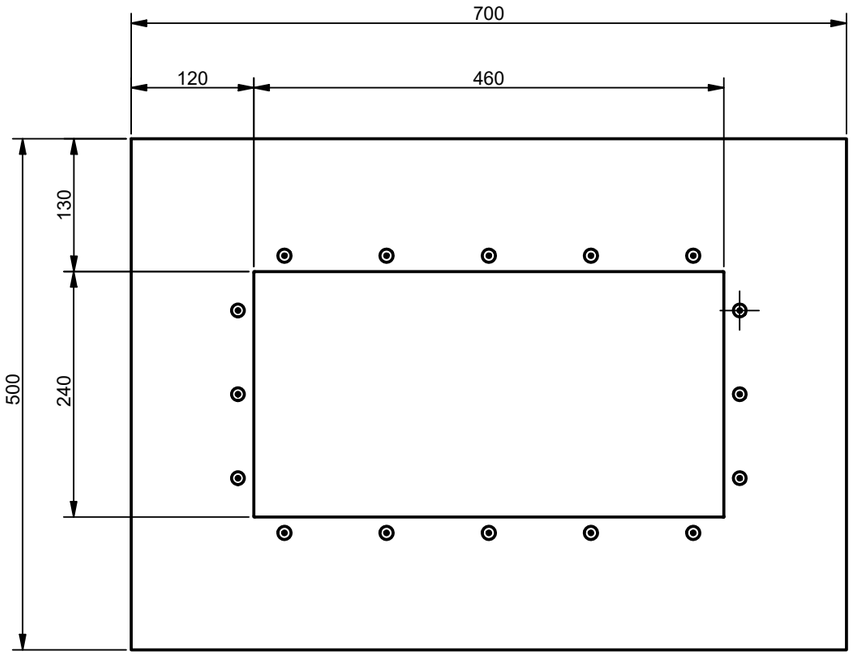
PROJECT :

TITLE
ATLAN VORTCEPTOR - OFFLINE
OVOR.100.18.L
GENERAL ARRANGEMENT

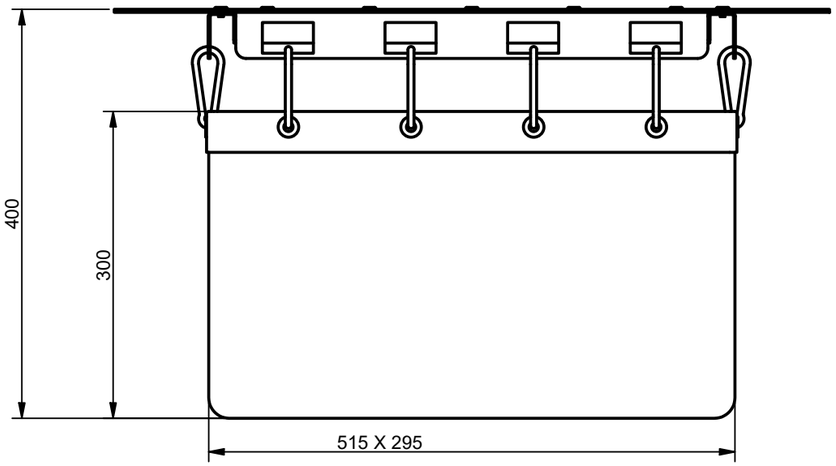
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CUSTOMER CODE :
DWG No. OVOR.100.18

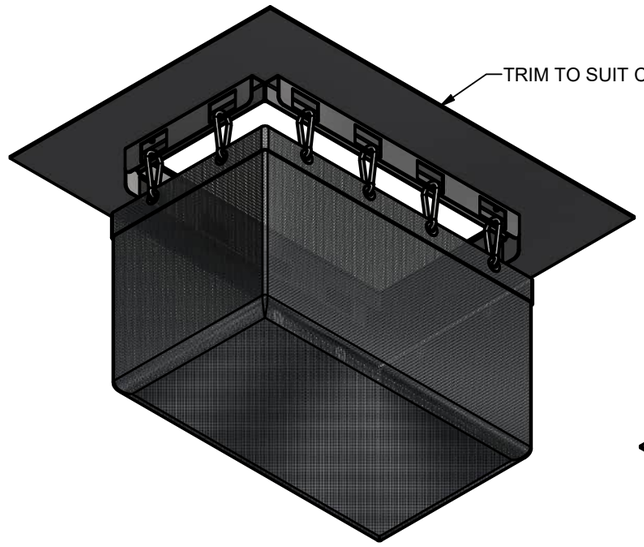
C:\Users\Robin Radoc\OneDrive\Documents\Vault\Designs\ATLAN\01 - STANDARDS\VORTCEPTOR\OFFLINE (OVOR)\OVOR.100.18\OVOR.100.18.idw



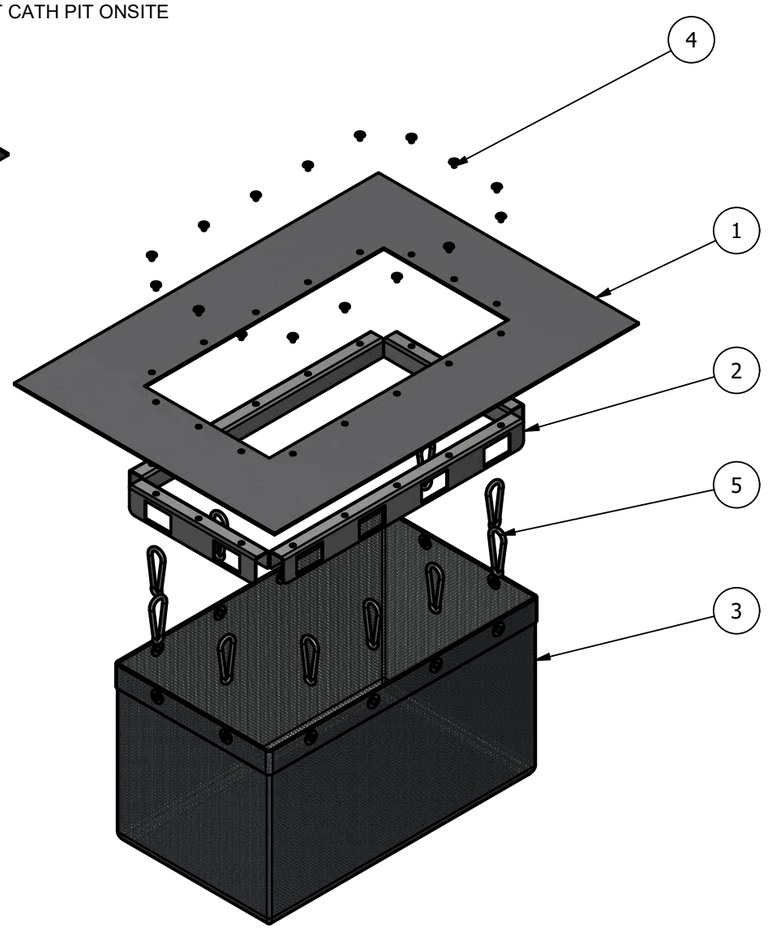
PLAN VIEW



ELEVATION VIEW



ISOMETRIC VIEW
BOTTOM VIEW



ISOMETRIC VIEW
EXPLOSION

ISSUE FOR APPROVAL
NOT FOR CONSTRUCTION

TOLERANCE: All Dimensions to Closest 10 mm & +/- 30 mm

ALL INTERCONNECTING PIPEWORK, PITS AND ASSOCIATED DRAINAGE BY OTHERS

REV	DATE	BY	DESCRIPTION	CHK
1		M.M	INITILT RELEASE	

CLIENT:

CONFIDENTIAL - The drawings must not be disclosed to any third parties without written permission from ATLAN STORMWATER . Unauthorized disclosure may result in prosecution.
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Drawn	M.M	Date 12/08/2024
Check		Date
Verified		Date
Approved		Date

Request No.

ATLAN STORMWATER

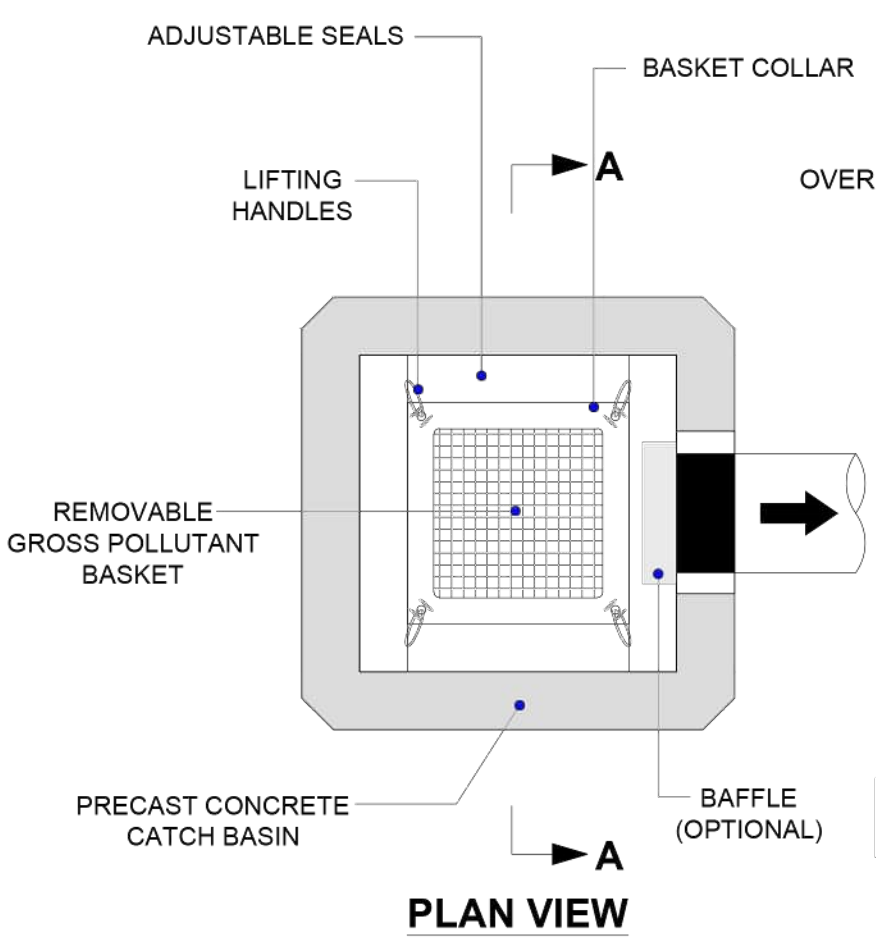
PROJECT :

TITLE
ATLAN STOMSACK
SSS.4060.C1
BLACK POLY SIZE : 700 X 500
GENERAL ARRANGEMENT

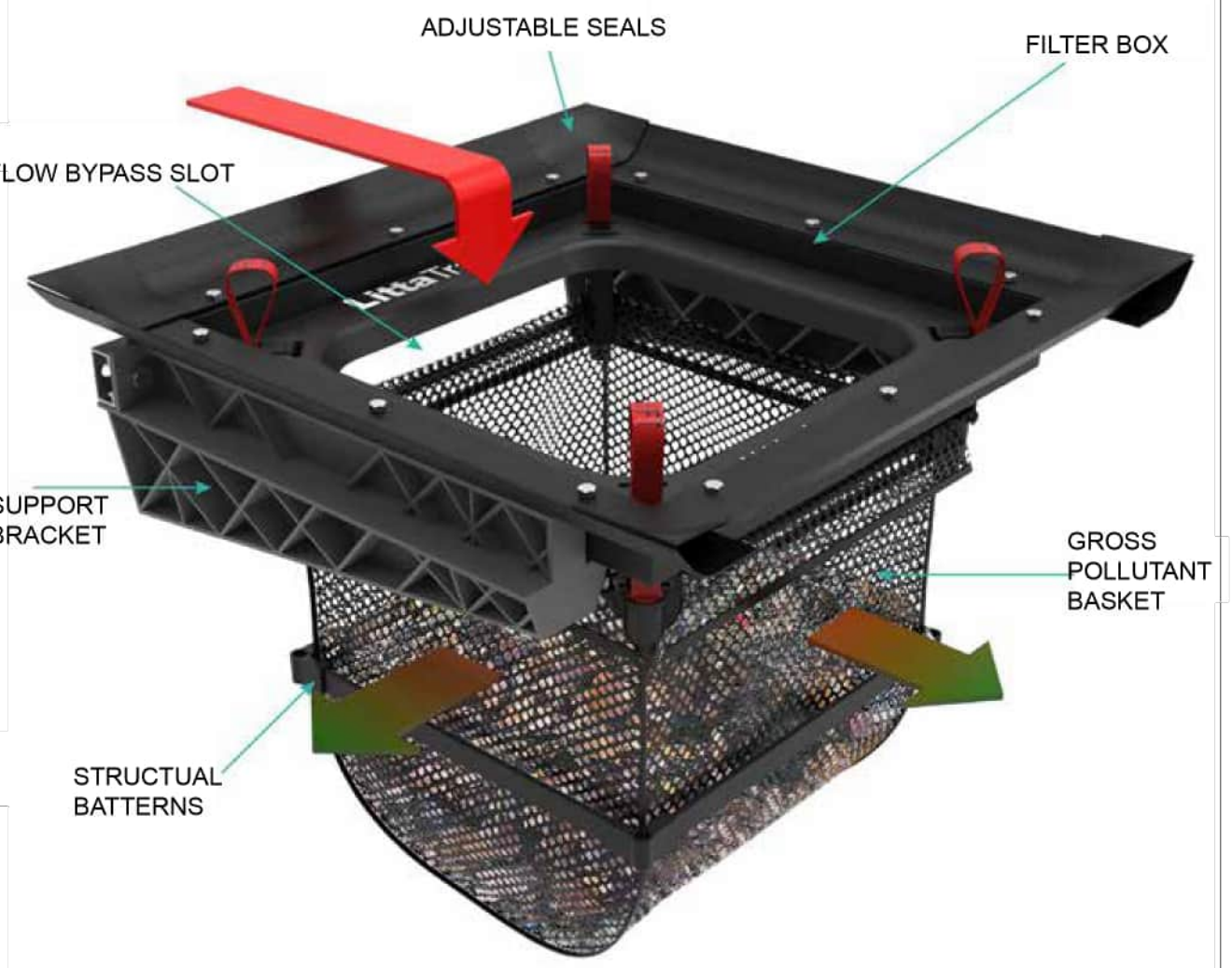
SCALE	SIZE	SHEET	REV
N.T.S	A3	1	1

CUSTOMER CODE :
DWG No. SP22-SK46850-S

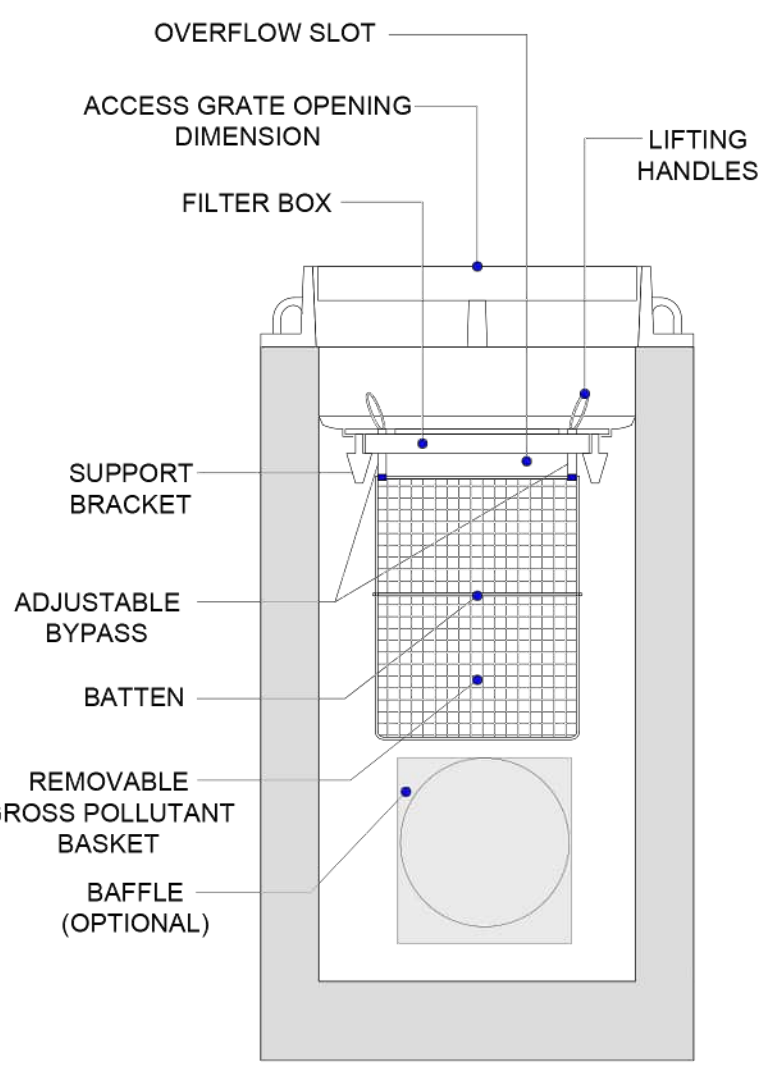
C:\Users\smart\OneDrive\Documents\Vault\Designs\PRODUCT DEVELOPMENT\NZ STORMSACK\SP22-SK46850-S.idw



PLAN VIEW



LITTATRAP™ COMPONENTS



SECTION A-A

MODEL AND SIZE SPECIFICATION

Catch pit size (mm)	LittaTrap™ model	Bracket width (mm)	Filter box size (mm)		Seal kit size (mm)		Basket size** (mm)		
			Length	Width	Length	Width	Length	Width	Depth
450x450	LT4545	435	377	377	492	492	225	225	400
600x400	LT6040	570	522	302	647	427	370	150	400
675x450	LT6745	648	587	367	722	542	435	223	400
600x600	LT6040*	570	522	302	677	677	370	150	400
800x500	LT6745*	648	587	367	842	572	435	223	400

Notes:
* Requires seal kit extension.
**Basket Collar is 80 mm greater in length and width than the basket.

FLOW AND STORAGE SPECIFICATION

Catch pit size (mm)	LittaTrap™ model	Screen area (cm^2)	Capture volume (L)	Design flow rate (L/s)[1]	Maximum treatable flow rate (L/s)[2]	Bypass flow rate (L/s)[3]
450x450	LT4545	3 880	17	21	42	55
600x400	LT6040	4 100	19	26	53	63
675x450	LT6745	5 900	34	33	67	80
600x600	LT6040*	4 100	19	26	53	63
800x500	LT6745*	5 900	34	33	67	80

Notes:
[1] design flow rate for gross pollutant trap taken at 75% maximum capture volume.
[2] maximum treatable flow rate taken at 75% maximum capture volume.
[3] factor set bypass based on bypass orifice dimensions.
* Requires seal kit extension.

The Enviropod® LittaTrap™ may be protected by one of the following Canadian, USA or International patent numbers and has other patents pending :
2,810,974, 13/824,376, 15/459,964, 2011302712, 588049

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Stormwater360®

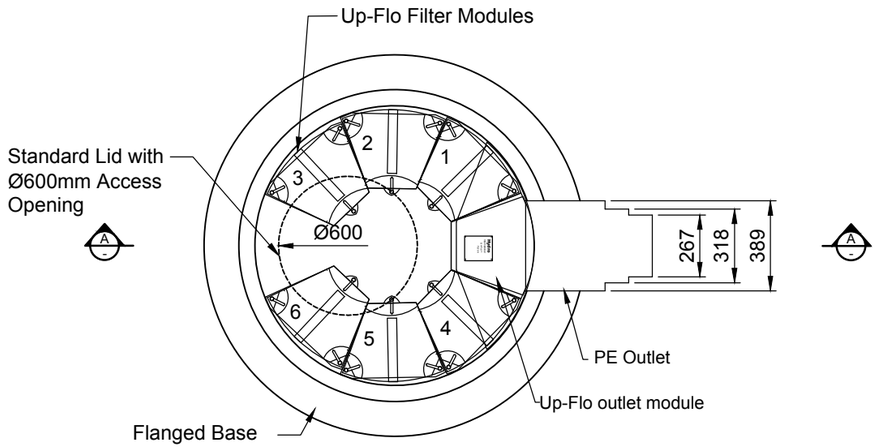
LITTATRAP™ SPECIFICATION DRAWING

REV #	DATE	REVISION DESCRIPTION	BY
A	12.01.21	DRAFT	M.M.
B	21.01.21	MAX PITS ADDED	D.T.
C	26.01.22	BASKET COLLAR NOTE ADDED	B.V.

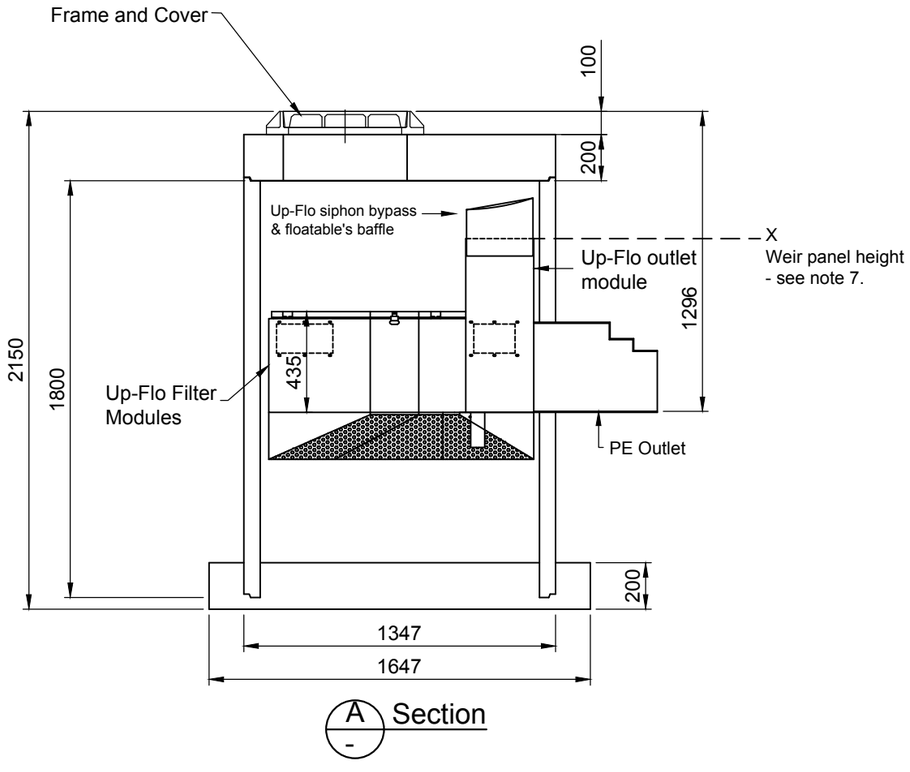
SHEET NUMBER 1 OF 1

www.stormwater360.co.nz | sales@stormwater360.co.nz | 0800 STORMWATER

DRAWN : M.M. | CHECKED : M.H. | DATE : 21.01.21 | SCALE : NTS | REV : A

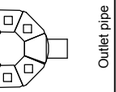


Plan



A - Section

ITEM	DESCRIPTION - MATERIAL	CODE	UNIT WEIGHT (T)	
1	Ø1200mm FB Up-Flo Filter			
	with 1 module	UP-FLO.1KIT	2.390	
	with 2 modules	UP-FLO.2KIT	2.402	
	with 3 modules	UP-FLO.3KIT	2.415	
	with 4 modules	UP-FLO.4KIT	2.427	
	with 5 modules	UP-FLO.5KIT	2.439	
	with 6 modules	UP-FLO.6KIT	2.451	LOCATION INDICATOR
	STANDARD SUPPLIED OUTLET Ø300mm (O/D 315mm)			
2	Lid			
			0.613	☑
3	Streetware			
	Ductile Iron Cover & Frame Ø600mm		0.058	☑



* PLEASE TICK THE NUMBER OF MODULES REQUIRED. IF THE LOCATION OF THE MODULES IS IMPORTANT, PLEASE USE THE ABOVE LOCATION INDICATOR TO SELECT YOUR PREFERENCE.

NOTE:

1. The Up-Flo Filter can contain 1 to 6 modules. The invert level of optional inlet/s can be a minimum of 240mm above the invert level of the outlet pipe. Inlet pipework is installed by the contractor on site.
2. The standard PE outlet pipe provides the following optional outside diameters: 389mm / 318mm / 267mm. The contractor simply trims the outlet back to the size required.
3. Some dimensions could change to accommodate a site constraint situation. Please contact Hynds for technical assistance.
4. The orientation and elevation of the inlet pipe can be adjusted to suit site requirements. Refer to the site plan for orientation.
5. If the outlet invert depth to the ground level is >1296mm, the contractor will need to provide an appropriate riser to suit the on-site requirements.
6. The unit includes an 1200Ø x 1800mmH flanged based manhole chamber and a 200mm thick heavy duty concrete lid. A 600Ø ductile iron cover & frame is Hynds standard supply throughout NZ.
7. If Up-Flo is installed in an offline configuration and is connecting to a weir chamber - please note that the weir panel height within the weir chamber must match the height of the UpFlo outlet shaft, level " X " as shown on drawing.
   Height between invert of outlet stub to "X" is approximately 750mm

I AUTHORISE **HYNDS PIPES SYSTEMS LTD** TO PROCEED WITH THE MANUFACTURING OF THIS PRODUCT SPECIAL AS DETAILED ABOVE.
I ACKNOWLEDGE THAT ANY SPECIALS, ONCE MANUFACTURED, ARE DEEMED TO BE MY (CUSTOMERS) PROPERTY & ARE NON REFUNDABLE. PLEASE NOTE COSTS ARISING FROM CHANGES REQUESTED AFTER SIGNING THIS DRAWING WILL BE BORNE BY THE CUSTOMER.

NAME :- ..... SIGNATURE :- .....

DATE :- .....

NOTES:

1. Concrete : ƒ'c = 40MPa
2. Reo : ƒy = Grade 500E
3. Reo Cover : 30mm Min
4. Min Lap Length : 40 x Bar Dia
5. Dimensional tolerances:Table 1-NZS3109:1997
6. Do not re-bend reinforcing steel
7. Traffic loading to HN-HO-72 Transit New Zealand load criteria
8. Consult Engineer where exposure classification C or U is required (Saltwater Tidal/Splash Zone or other aggressive environment).

MATERIALS

VOL (m³/unit) =
WT (ton/unit) = See Table
CODE =

REVISIONS

REV #:	REVISION DESCRIPTION:	DATE:	DRAWN:
1	Details Updated	17 Nov 2015	HJ
2	Finalise drawing for issuing	20 Nov 2015	HJ
3	Txt Update GA ready to load into HUB	04 Dec 2015	DA
4	Update invert on notes	10 May 2016	HJ
5	Update outlet to US version and notes	15 Jun 2016	HJ
6	Update notes and mark up for weir panel height	4 May 2018	KI
7	CAD Stamp updated	23/7/2018	KI

PO Box 58142, Botany, Auckland, 2163
Tel: 09-274 0316
Fax: 09-272 7485
email: technicalservices@hynds.co.nz

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ISO 9001 CERTIFIED MANAGEMENT SYSTEM

PROJECT DESCRIPTION:
Hynds Environmental

Up-Flo Filter

SERVICE DETAIL:
Ø1200 x 1800mm High Flanged Base
Up-Flo Filter - 1 to 6 Modules

General Arrangement

REFERENCE/QUOTE NUMBER:	T2965-1	
DRAWN: DA SIGNATURE:	DESIGN: SIGNATURE:	CHECKED: HJ SIGNATURE:
SCALE: As Shown PAPER SIZE: A3	Note: Do not scale drawing if in doubt **ASK!!!**	DATE: 16 Sep 2015
DRAWING NUMBER: E1000		REVISION NUMBER: 8

STORMFILTER™

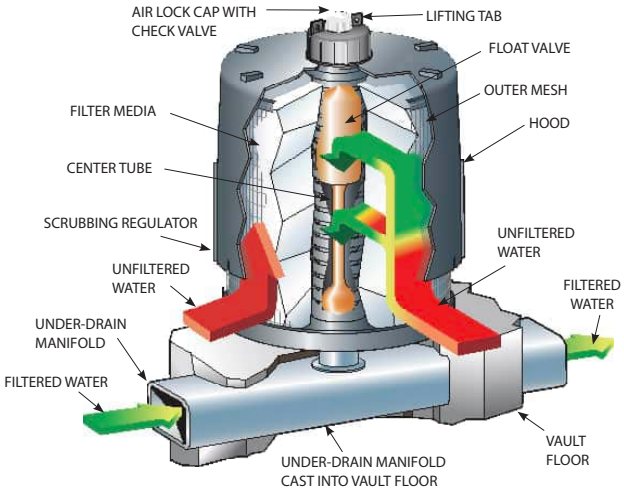
High efficiency / low maintenance stormwater filter.

SIPHON-ACTUATED FILTRATION The stormwater management StormFilter™ cleans stormwater through a patented passive filtration system, effectively removing pollutants to meet the most stringent regulatory requirements. Highly reliable, easy to install and maintain, and proven performance over time, StormFilter™ products are recognised as a versatile BMP for removing a variety of pollutants, such as sediments, oil and grease, metals, organics, and nutrients. These systems come in variable configurations to match local conditions and come with prolonged maintenance periods to ensure long-term performance and reduce operating costs.

HOW DOES IT WORK?

During a storm, runoff passes through the filtration media and starts filling the cartridge center tube. Air below the hood is purged through a one-way check valve as the water rises. When water reaches the top of the float, buoyant forces pull the float free and allow filtered water to drain.
After the storm, the water level in the structure starts falling. A hanging water column remains under the cartridge hood until the water level reaches the scrubbing regulators. Air then rushes through the regulators releasing water and creating air bubbles that agitate the surface of the filter media, causing accumulated sediment to drop to the vault floor. This patented surface-cleaning mechanism helps restore the filter's permeability between storm events.

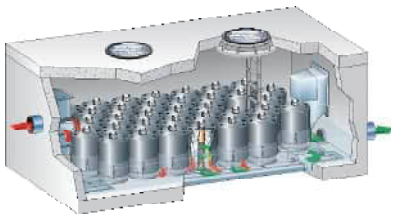
STORMFILTER™ CARTRIDGE



PROVEN PERFORMANCE

- First independently verified filter by Washington Department of Ecology, New Jersey Department of Environmental Protection and USEPA's Environmental Technology Verification program
- Approved and accepted by most regulatory bodies across New Zealand
- Over 16,800 x StormFilter's™ cartridges installed throughout New Zealand
- Continual innovation Design refined and perfected over two decades of research and experience

STORMFILTER™ VAULT



STORMFILTER BENEFITS

UNDERGROUND SYSTEMS MAXIMISE PROFITABILITY

- Save land space allowing denser developments reducing sprawl
- Add parking spaces and increase building size, increasing profitability
- Compact design reduces construction and installation costs by limiting excavation

RELIABLE LONGEVITY & LOWER MAINTENANCE COSTS

- Self cleaning hood prevents surface blinding, ensures use of all media and prolongs cartridge life
- 1-3 year maintenance cycles
- 20 years maintenance experience
- Minimal or no standing water. Lower disposal costs

CONTACT DETAILS

Stormwater360

FREEPHONE:
0800 STORMWATER
(0800 786769)

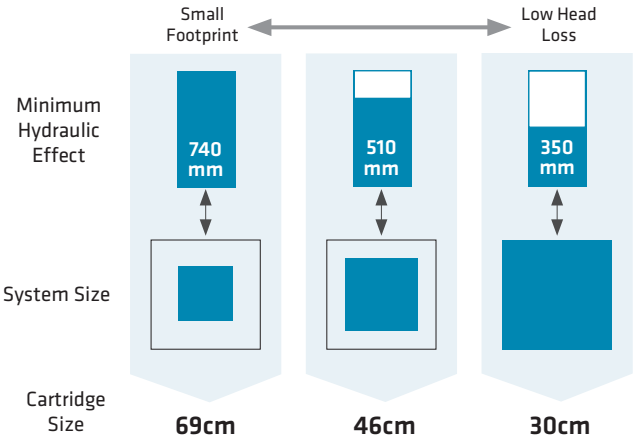
www.stormwater360.co.nz

Stormwater360®
BETWEEN SKY AND SEA

Nothing in this brochure should be construed as an expressed warranty or an implied warranty of merchantability or fitness for any particular purpose.
See the Stormwater360 standard quotation or acknowledgement for applicable warranties and other terms and conditions of sale.

SUPERIOR HYDRAULICS

Multiple cartridge heights gives design solutions for site restraints.

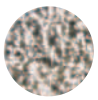


Other hydraulic benefits

- Hydraulic effect as low as 350mm head loss
- Zero surcharge of inlet pipe unlike upward flowing filters
- Can be designed for tail water e.g tidal conditions
- Online and offline configurations can limit hydraulic effects

MEDIA CHOICES

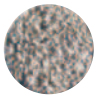
Our filtration products can be customised using different filter media to target site-specific pollutants. A combination of media is often recommended to maximise pollutant removal effectiveness.



Perlite is naturally occurring puffed volcanic ash. Effective for removing TSS, oil and grease.



ZPG™ is a multi-purpose media option approved for highly trafficked sites or sites with high metal loadings. ZPG is a mixture of Zeolite, Perlite and GAC (granular activated carbon). ZPG is ideal for removing soluble metals, TSS, oils and grease, organics and ammonium.



Zeolite is a naturally occurring mineral used to remove soluble metals, ammonium and some organics.



GAC (Granular Activated Carbon) has a micro-porous structure with an extensive surface area to provide high levels of adsorption. It is primarily used to remove oil and grease and organics such as PAHs and phthalates.

CONFIGURATION

Stormfilter's can be configured in any drainage structure. Please contact SW360 for a customised design.



PRECAST VAULT

- Treats medium sized sites
- Simple installation – arrives on-site fully assembled
- Plug and play solution

PRECAST MANHOLE

- Provides a low drop, point-of-entry configuration
- Uses drop from the curb inlet to the conveyance pipe to drive the passive filtration cartridges
- No crane required (Hi-AB lifting for most sizes)
- 1050-2400mm diameter sizes available





HIGH FLOW

- Treats flows from large sites
- Consists of large, precast components designed for easy assembly on-site
- Several configurations available, including: Panel Vault, Box Culvert, or Cast-In-Place

PEAK DIVERSION



- Combines off-line bypass and StormFilter™ pollutant removal into one structure
- Internal weir allows high peak flows with low hydraulic head losses
- Approved and accepted as offline configuration by councils around NZ
- Eliminates cost of additional structures to bypass peak flows
- Reduces the overall footprint of the treatment system

Stormwater360®
BETWEEN SKY AND SEA

StormFilter Project Details

Project Name	Parkburn	Project Number	
Project Address	Cromwell	Local Council	Other
Location	Cromwell	Author	Boniface Kinnear

Catchment Details

Reference	Catchment Type	Runoff Coefficients (C)	Area, m^2 (A)	Product, m^2 (CxA)
	Roof	0.9	3000	2700
	Hardstand/Road	0.85	3000	2550
	Pervious	0.25	4000	1000
Totals	-	0.63	10000	6250

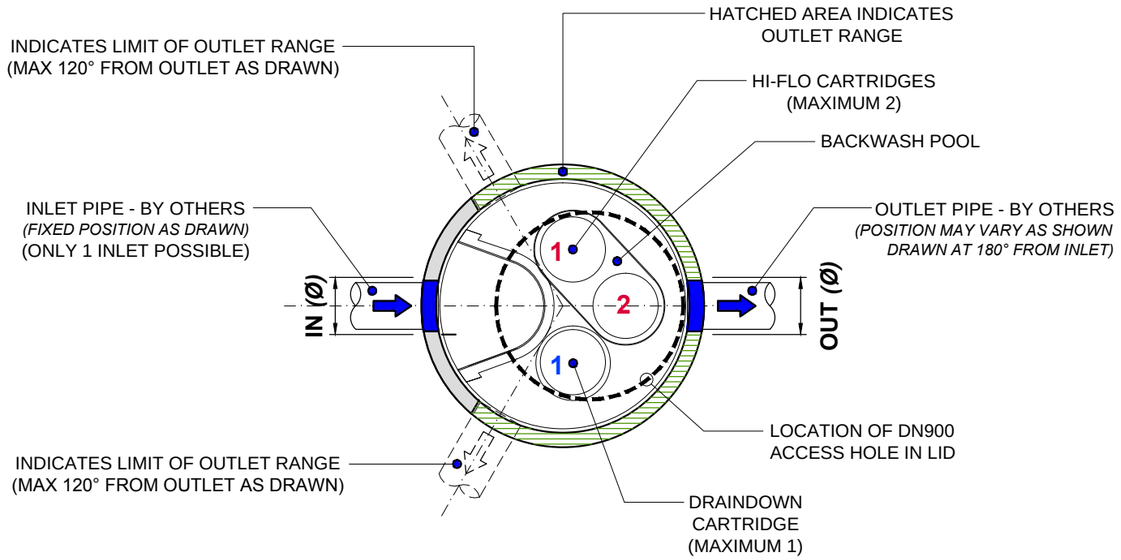
Rainfall Intensity (iwq): 10 mm/hr

*Note: The chosen rainfall intensity value is to treat 90% of annual rainfall (10mm/hr for Auckland region as per Auckland Council. 5mm/hr for Christchurch region as per Christchurch City Council, and 10mm/hr for other councils). If unsure, please contact Stormwater360

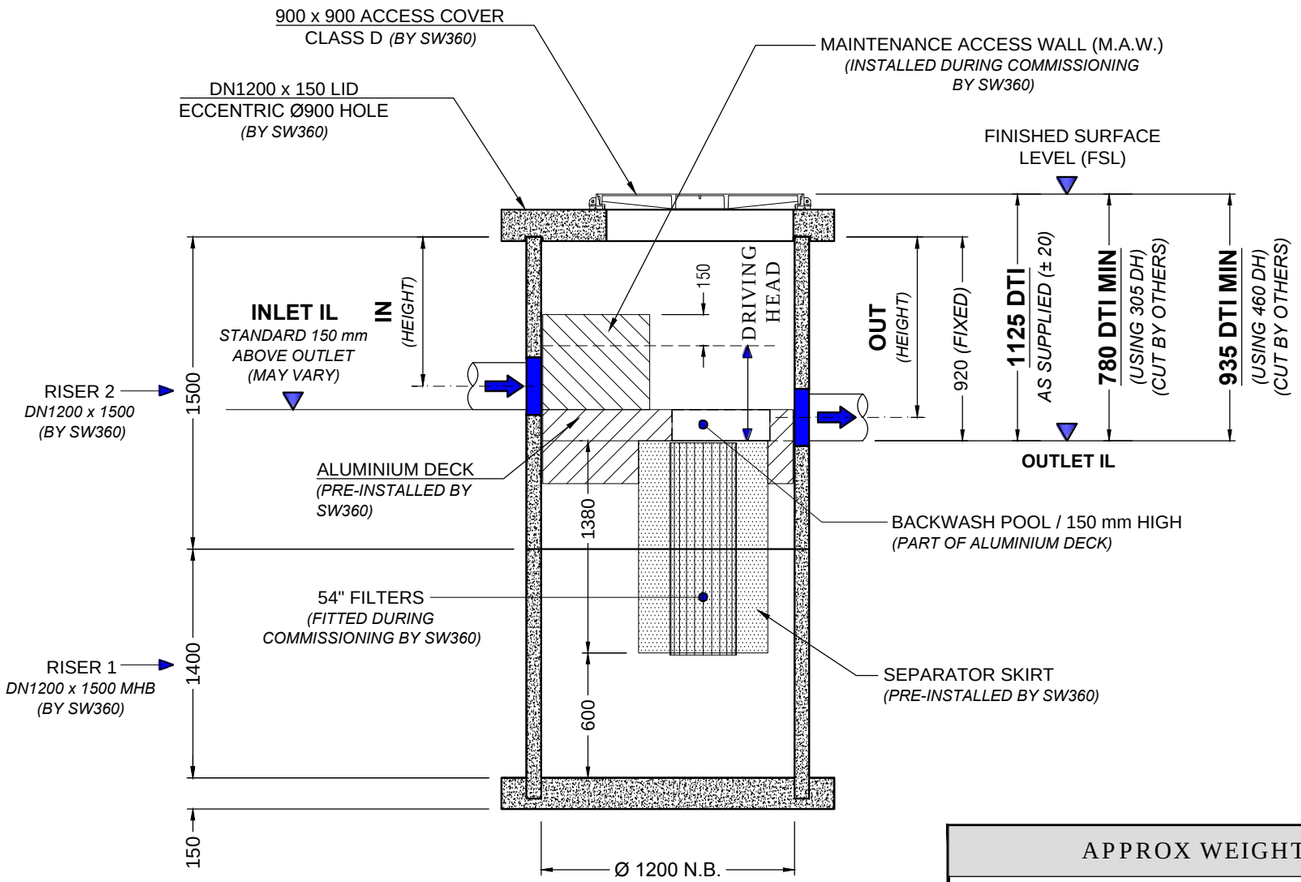
Output

Required treatable flow rate (Qwq)	17.36 L/s	Calculated using Rational method Qwq = C x iwq x A (L/s)
StormFilter model required	Contact Stormwater360	Please refer to drawing for footprint and size
No. of cart required (nCart)	13	Calculated - Qwq/Qcart (Rounded up to whole number)
Cartridge size/height	69cm	Recommended hydraulic effect is 770mm, for lower hydraulic effect option please contact Stormwater360
Media	Perlite	Other media options are available, please contact Stormwater360
Design treatment flow rate per cartridge (Qcart)	1.42 L/s	
Design StormFilter treatment flow (QSF)	18.46 L/s	Calculated - Qcart x nCart
Is QSF > Qwq?	Yes	

For any questions or further details please contact sales@stormwater360.co.nz



PLAN



ELEVATION

TO BE COMPLETED BY CUSTOMER / CONTRACTOR

COMPANY :		P.O. NUMBER :	
SITE ADDRESS :			
SITE CONTACT & PHONE :			
PREFERRED DELIVERY DATE *(TBC SW360)* :			
FILTER REFERENCE *(IF APPLICABLE)* :		LID LEVEL *(INPUT REQUIRED)* :	
INLET PIPE DATA *(DN225 RCRRJ-MAX)* : *(DN300 PVC-MAX)*	IL :	DIA :	MATERIAL :
OUTLET PIPE DATA *(DN225 RCRRJ-MAX)* : *(DN300 PVC-MAX)*	IL :	DIA :	MATERIAL :
OUTLET PIPE ORIENTATION : *(CIRCLE 180° OR INPUT REQUIREMENT)*	AS DRAWN : *180° FROM INLET*	CLOCKWISE FROM INLET : *(60° MIN)*	ANTICLOCKWISE FROM INLET : *(60° MIN)*
COMPLETED BY :	SIGNED :		DATE :

TO BE COMPLETED BY SW360

DRIVING HEAD (DH) *(CIRCLE REQUIREMENT OR INPUT CUSTOM VALUE)* :	305 mm	460 mm	CUSTOM DRIVING HEAD : *(INPUT DETAILS IF REQUIRED)*
DEPTH TO INVERT (DTI) CHECK : *(CALCULATE AND RECORD)* :	INLET / OUTLET IL CHECK : *(CALCULATE AND RECORD)* :		No. OF FILTERS :
ACCESS COVER : 900 x 900 WEBFORGE / CLASS D : *(SUPPLIED UNLESS STATED OTHERWISE)*		DETAILS OF OTHER : *(IF REQUIRED)*	
COMPLETED BY :	SIGNED :	DATE :	

NOTES :

1. CONCRETE MANHOLE RISER UNITS FITTED WITH SWIFTLIFT ANCHOR POINTS (QTY 2). DO NOT EXCEED 60 DEGREE LIFT ANGLE. CONCRETE LID FITTED WITH SWIFTLIFT ANCHOR POINTS (QTY 4).
2. UNIT SUPPLIED WITH BOTH INLET AND OUTLET CORE DRILLED.
3. SEALING / GROUTING OF MANHOLE COMPONENTS AND PIPES BY CONTRACTOR. ENSURING LOCAL CODES AND REGULATIONS ARE COMPLIED WITH.
4. ANY RISERS REQUIRED TO INCREASE THE DEPTH TO INVERT (DTI) FROM THAT AS DRAWN TO BE SUPPLIED BY THE CONTRACTOR.
5. FOR A DTI EXCEEDING 5m PLEASE CONTACT **0800STORMWATER**.
6. BACKFILL, BEDDING AND BUOYANCY DESIGN BY ENGINEER OF RECORD.
7. CONCRETE MANHOLE RISERS ARE DESIGNED AND MANUFACTURED IN ACCORDANCE WITH AS/NZS 4058 : 2007
8. CONCRETE MANHOLE BASES ARE DESIGNED AND MANUFACTURED IN ACCORDANCE WITH NZS 3101 : 2006 AND NZS 3109 : 1997
9. CONCRETE LID DESIGNED AND MANUFACTURED TO HN-HO-72.
10. FILTERS AND MAINTENANCE ACCESS WALL (MAW) TO BE INSTALLED DURING COMMISSIONING BY STORMWATER360.
11. COMMISSIONING TO OCCUR ONLY WHEN CONSTRUCTION IS COMPLETE, AND SITE IS CLEAN.
12. CONTRACTOR TO ENSURE MANHOLE IS CLEAN FROM SITE RUN-OFF PRIOR TO COMMISSIONING.
13. CONTACT **0800STORMWATER** FOR COMMISSIONING OR ANY REQUIREMENTS OUTSIDE THIS DRAWING.

APPROX WEIGHTS

- RISER #1 *(BASED ON DN1200 x 1500)* : 1900 Kg
- RISER #2 *(DN1200 x 1500 INCL DECK)* : 1150 Kg
- CONCRETE LID *(DN1200 x 150 THICK)* : 520 Kg

DATA FOR PRODUCTION ONLY (COMPLETED BY SW360)

OUT *(Ø) OUTLET CORE Ø*	*MAX Ø 350*	**OUT** *(HEIGHT) = 920 mm - 0.5 PIPE ID*	**IN** *(Ø) OUTLET CORE Ø* *MAX Ø 350*	**IN** *(HEIGHT)* **= OUT** *(HEIGHT) - Δ INVERT*
INLET TO OUTLET DISTANCE : *WRAP MEASUREMENT FROM C/L INLET TO C/L OUTLET*	= (ANGLE) x (3.14 x RISER *OD*) / 360			
COMPLETED BY :	SIGNED :	DATE :		

Stormwater360 BETWEEN SKY AND SEA

0800 STORMWATER
sales@stormwater360.co.nz
www.stormwater360.co.nz

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JELLYFISH® FILTER
STORMWATER MEMBRANE FILTER
DN1200 / 54" FILTERS 2 + 1 / OFFLINE / TRAFFICABLE
GENERAL ARRANGEMENT

SCALE : N.T.S. | DRG No : JF-MH-54-1200-T-OFF-20 | REV : 1 | DATE : 25.05.19

			REV	REVISION DETAIL	DATE
JOB NO :					
PROJECT :			0	APPROVED	25.05.19
			1	FORMULA REV	12.08.19
DRN :	R.P.	25.05.19			
CKD :	G.S.	25.05.19			

JellyFish Project Details

Project Name	Parkburn	Project Number	
Project Address	Parkburn	Local Council	Other
Location	Cromwell	Author	Boniface Kinnear

Catchment Details

Reference	Catchment Type	Runoff Coefficients (C)	Area, m2 (A)	Product, m2 (CxA)
	Hardstand/Road	0.85	4000	3400
	Pervious	0.25	1000	250
Totals	-	0.73	5000	3650

Rainfall Intensity (iwq): 10 mm/hr

*Note: The chosen rainfall intensity value is to treat 90% of annual rainfall (10mm/hr for Auckland region as per Auckland Council. 5mm/hr for Christchurch region as per Christchurch City Council, and 10mm/hr for other councils). If unsure, please contact Stormwater360

Output

Required treatable flow rate (Qwq)	10.14 L/s	Calculated using Rational method Qwq = C x iwq x A (L/s)
Jellyfish model required	JF1200-2-1 (54")	Please refer to drawing for footprint and size
No. of cart required (nCart)	3	Calculated - Qwq/Qcart (Rounded up to whole number)
Cartridge size/height	1.4m	For smaller cartridge, please contact sales@stormwater360.co.nz
Designed Head Loss	460mm	For lower hydraulic effect, please contact sales@stormwater360.co.nz
Design Jellyfish max treatment flow (Qcart)	12.5 L/s	Calculated using nCart x Qcart
Is QSF > Qwq?	Yes	

For any questions or further details please contact sales@stormwater360.co.nz

Appendix C – Model Build Memo

Memorandum

Fulton Hogan Land Development Tim James, Development Manager	Woods Simran Bassan – Engineer
	W-REF: P25-561 22 July 2026 Reviewer: Boniface Kinnear – Principal Engineer Revision 2

1.0 Introduction

Wood and Partners Consultants Ltd ('Woods') has been engaged by Fulton Hogan Land Development to undertake flood modelling for the proposed development at 922 Luggate-Cromwell Road, Cromwell Central Otago (the Site). The flood modelling has been undertaken in support of a substantive application to the Environmental Protection Authority (EPA) under the Fast-Track Approvals Act 2024 (FTAA).

This memo summarises the flood modelling undertaken for the Site, including the modelling methodology, assumptions, and key findings. It is intended to be read in conjunction with the Stormwater Management Plan (SMP) prepared by Woods, which provides the broader stormwater design context and an interpretation of the key findings. A site location plan is included in Figure 1.

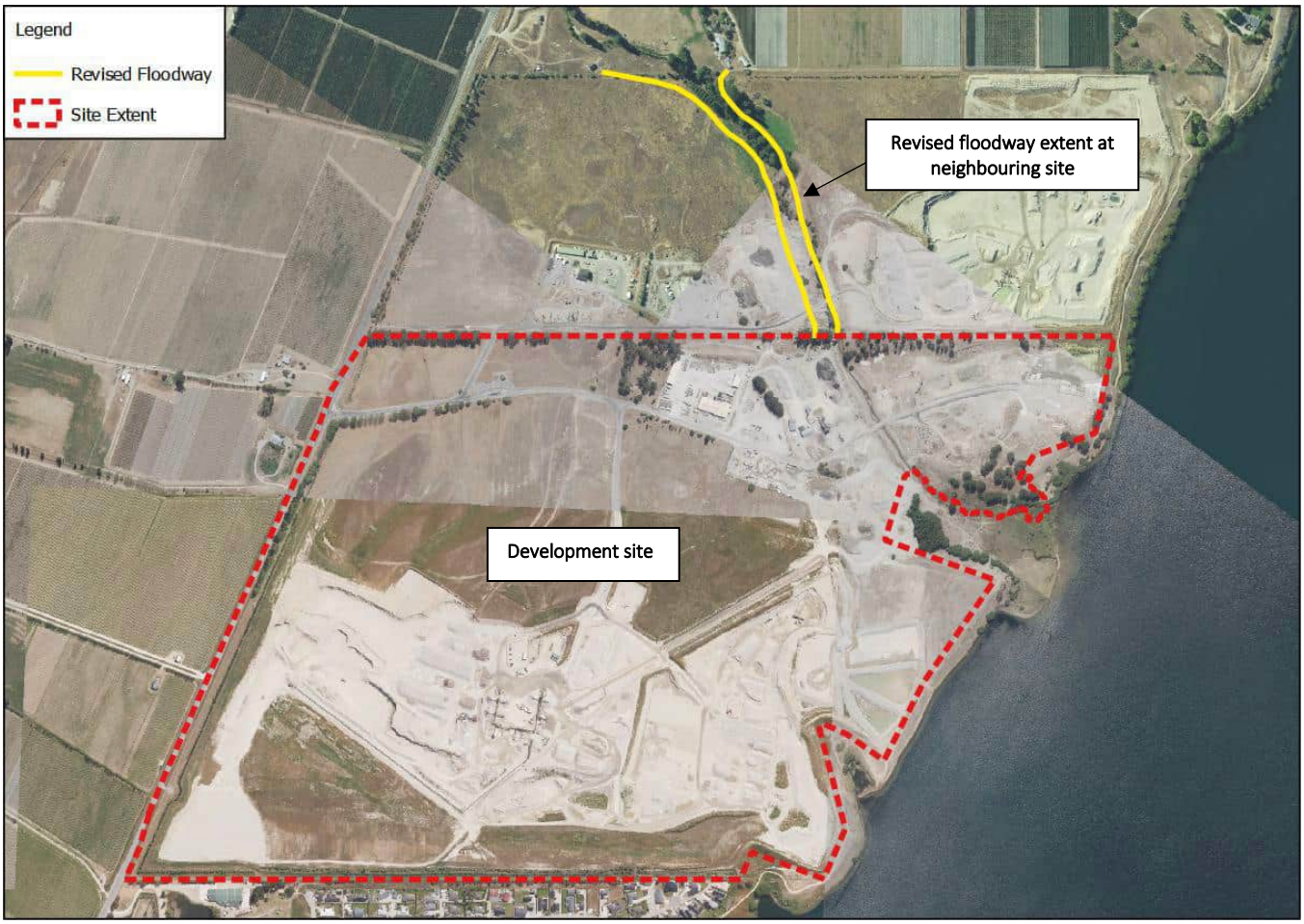


Figure 1: Site Location

2.0 Flood Modelling

A series of flood models have been developed to assess the potential impacts of the proposed. The modelling has been completed using U.S. Army Corps of Engineers' Hydrologic Engineering Center – River Analysis System (HEC-RAS) and Hydrologic Modeling System (HEC-HMS). The modelling parameters and assumptions are consistent with best practice and recognise New Zealand Standards 4404:2010.

Three flood models have been developed: a catchment model, an alluvial fan model, and an internal site model. The catchment model assesses runoff contributions from the external catchment to the development site, with its outputs used as boundary inputs to the internal site model.

The second model adopts the same modelling parameters as the catchment model and assesses alluvial fan hazard across the portion of the development overlain by an active, floodwater-dominated fan extending from Mount Pisa to Lake Dunstan. Further details of this model are included in Section 2.4.

The internal/site model is more detailed to allow for analysis of flows within the site. For this exercise, a cutdown site model was created. Hydrographs were extracted from the wider catchment model for use as external/upstream boundary conditions for the cutdown model.

Details for these models are discussed within the subsequent sections of this report.

2.1 Terrain Data

Existing and design model surfaces were provided by Landpro Ltd, extending from the top of the catchment on Mount Pisa to Lake Dunstan (approximately 11 km). The site topography has been established using LP2000 and NZVD2016 vertical datum survey data prepared by Landpro Ltd, projected in NZTM2000 coordinates.

The property to the north is subject to a separate redevelopment that includes a reduction of the existing floodway entering the development site. Although these works do not form part of the proposed development, their influence on flood behaviour at the site has been accounted for in this assessment. Accordingly, the post-development model incorporates modifications to the northern property's landform to reflect the revised floodway configuration at the site boundary.

2.1.1 Catchment Delineation and Model Extents

Two model extents have been developed: (1) catchment-wide and (2) internal. The catchment-wide extent is used by both the catchment model and the alluvial fan model (with some modifications), while the internal extent is used in the cut-down site model. Catchment analyses were undertaken using QGIS and SAGA tools to delineate contributing catchments from surfaces provided by Landpro. The resulting catchment extents are shown in Figure 2 and Figure 3.

The delineated subcatchments were also used to derive times of concentration and calculate design hydrographs in HEC-HMS, which were subsequently applied as inputs to the hydraulic models and are discussed further in later sections of this report.

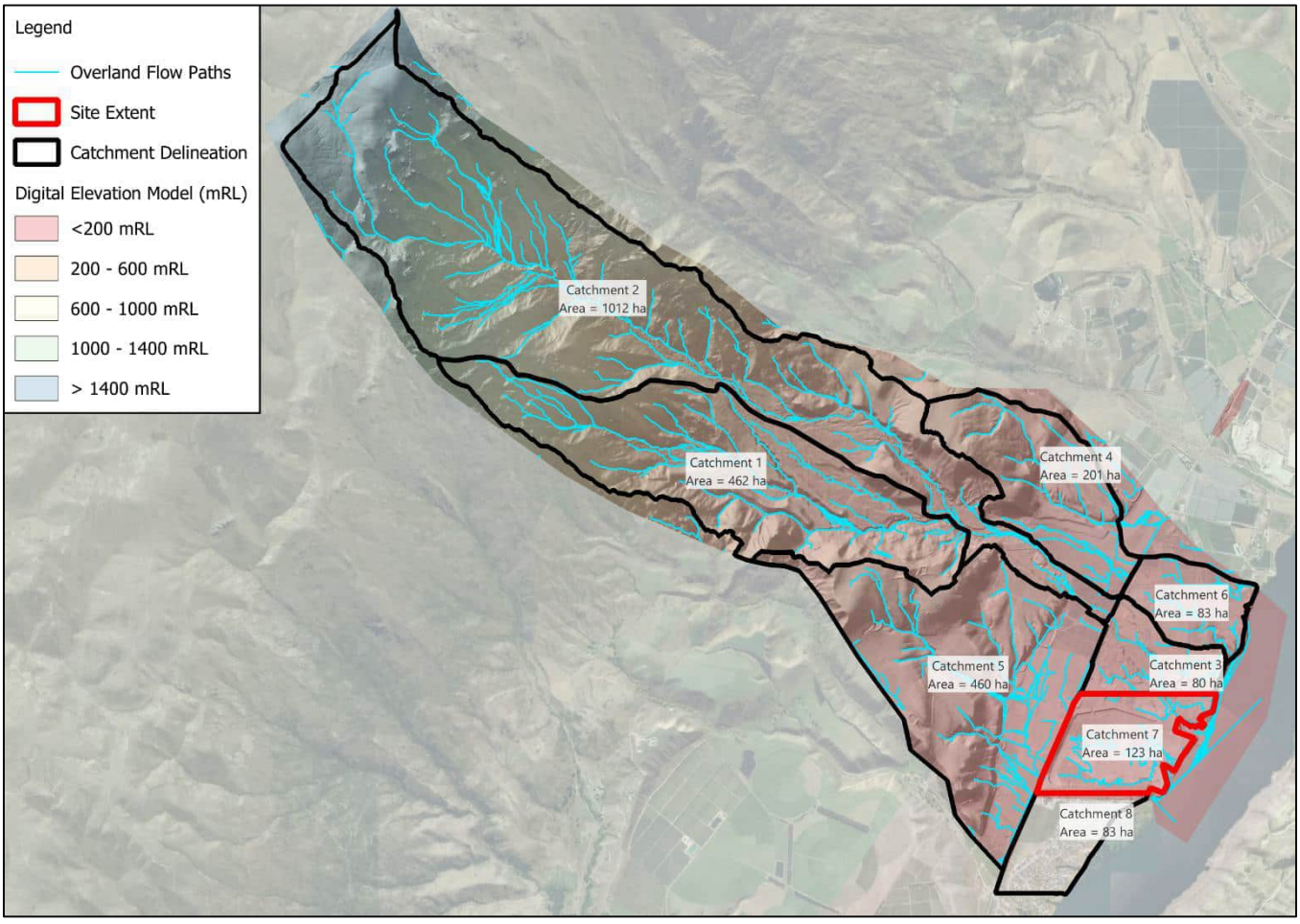


Figure 2: Catchment wide model delineation

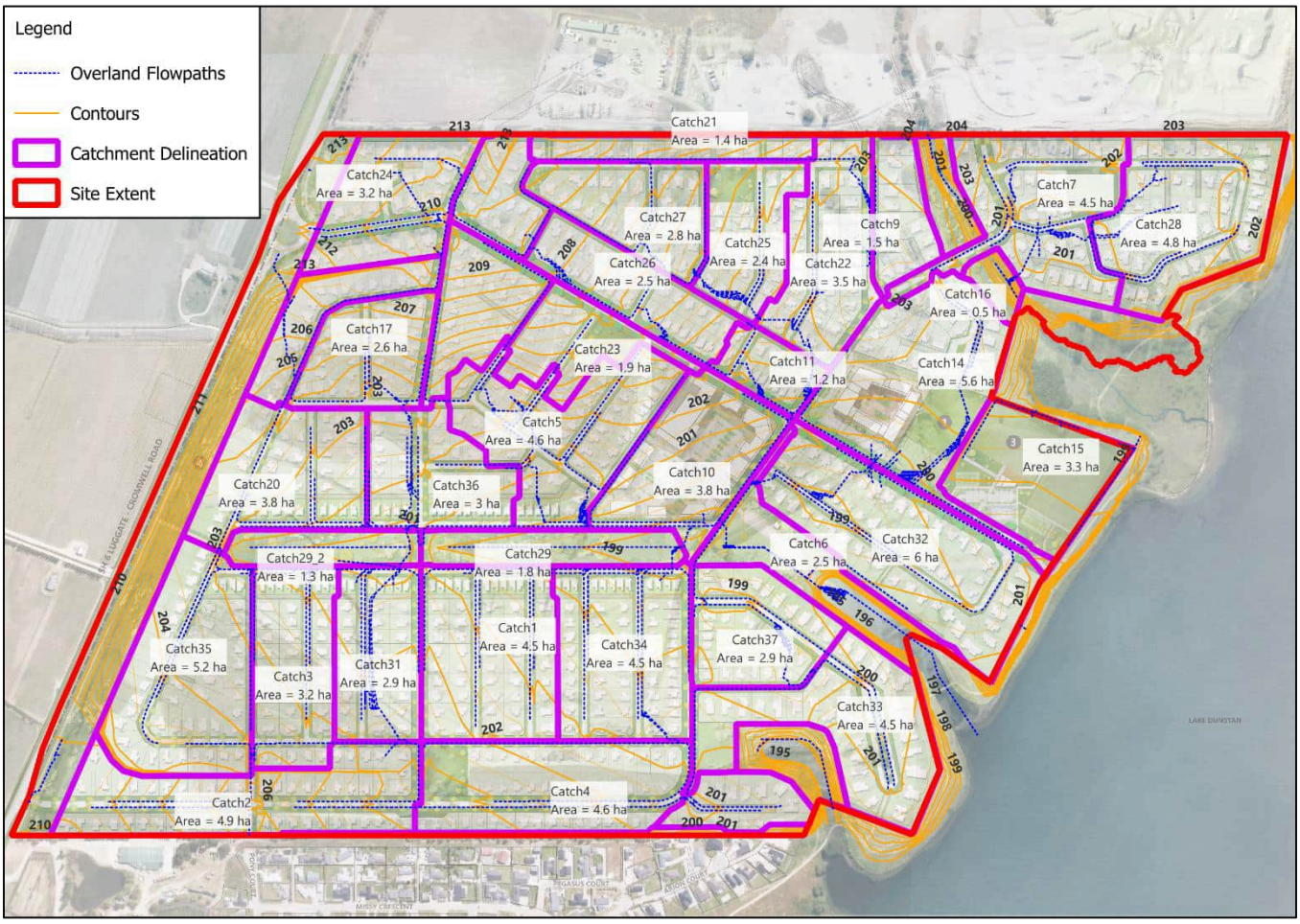


Figure 3: Internal model delineation

2.2 Hydrological Model

The following sections detailed the hydrologic model parameters.

2.2.1 Rainfall Data

A 24-hr nested rainfall event using the Type 2A temporal distribution, peaking at midday, has been adopted for this analysis. This approach is consistent with standard hydrological modelling practice in New Zealand.

The 24-hr rainfall depths have been obtained from HIRDS by NIWA and are summarised in Table 1. To allow for the effects of future climate change, the RCP8.5 scenario has been adopted with climate change projections for the period of 2081-2100.

Table 1: Rainfall Data

Annual Recurrence Interval (ARI)	Duration	Rainfall Depth RCP 8.5
5-year	24-hr	61 mm
10-year	24-hr	72 mm
100-year	24-hr	114 mm

2.2.2 Time of concentration

The time of concentration (ToC) for the modelled subcatchments was calculated following the SCS methodology detailed in Auckland Council's Guidelines for Stormwater Runoff Modelling in the Auckland Region (TP108, 1999). This document was adopted in the absence of a regionally specific methodology applicable to the Central Otago context. The calculation is based on the longest flow path within each subcatchment. A comparison of alternative calculation methods was undertaken and is provided in Appendix A. A representative catchment used to calculate the runoff. The methods show a great variation in the times of concentration with the TP108 method falling in the average range. The adopted ToC values are summarised in Table 2 below.

Table 2: Time of Concentration

Model Extent	Time of Concentration
External catchment (catchment model)	46 min to 146 min
Internal model extent	10 min (minimum applied)

2.2.3 Land use

Within the modelled extents, impervious area assumptions were based on the master plan and existing site coverage, as seen in Figure 4. Within the site extent, the model assumes full build-out of the proposed design, where lots are assumed to be 60% impervious based on a typical lot layout, included in Appendix B, and roads and other hard-stand surfaces are assumed to be 100% impervious. External catchments draining to the site are represented under existing conditions and are assumed to constitute near 100% pervious area.



Figure 4: Proposed Masterplan

2.2.4 Initial Abstraction

Initial abstraction represents losses from storage, vegetation interception, evaporation, and infiltration that occur before runoff begins. Initial abstraction ratios were estimated in accordance with the SCS method. Impervious areas were assigned an initial abstraction of 0 mm, and pervious areas were assigned 5 mm.

2.2.5 Curve Number

Curve numbers for the various subcatchments were selected based on soil type and land use in accordance with the SCS method, detailed in USDA TR-55. The site has historically been used for quarrying activity and comprises predominantly well-drained soils. In the absence of complete site-specific soil investigation data, conservative assumptions have been adopted in the classification of hydrological soil groups.

Pervious areas within the upper catchments were assigned a CN of 60, consistent with Hydrological Soil Group B, reflecting the well-drained nature of the external catchment soils. Within the site extent, pervious areas were assigned a CN of 74, consistent with Hydrological Soil Group C, to reflect the anticipated reduction in infiltration capacity under post-development conditions.

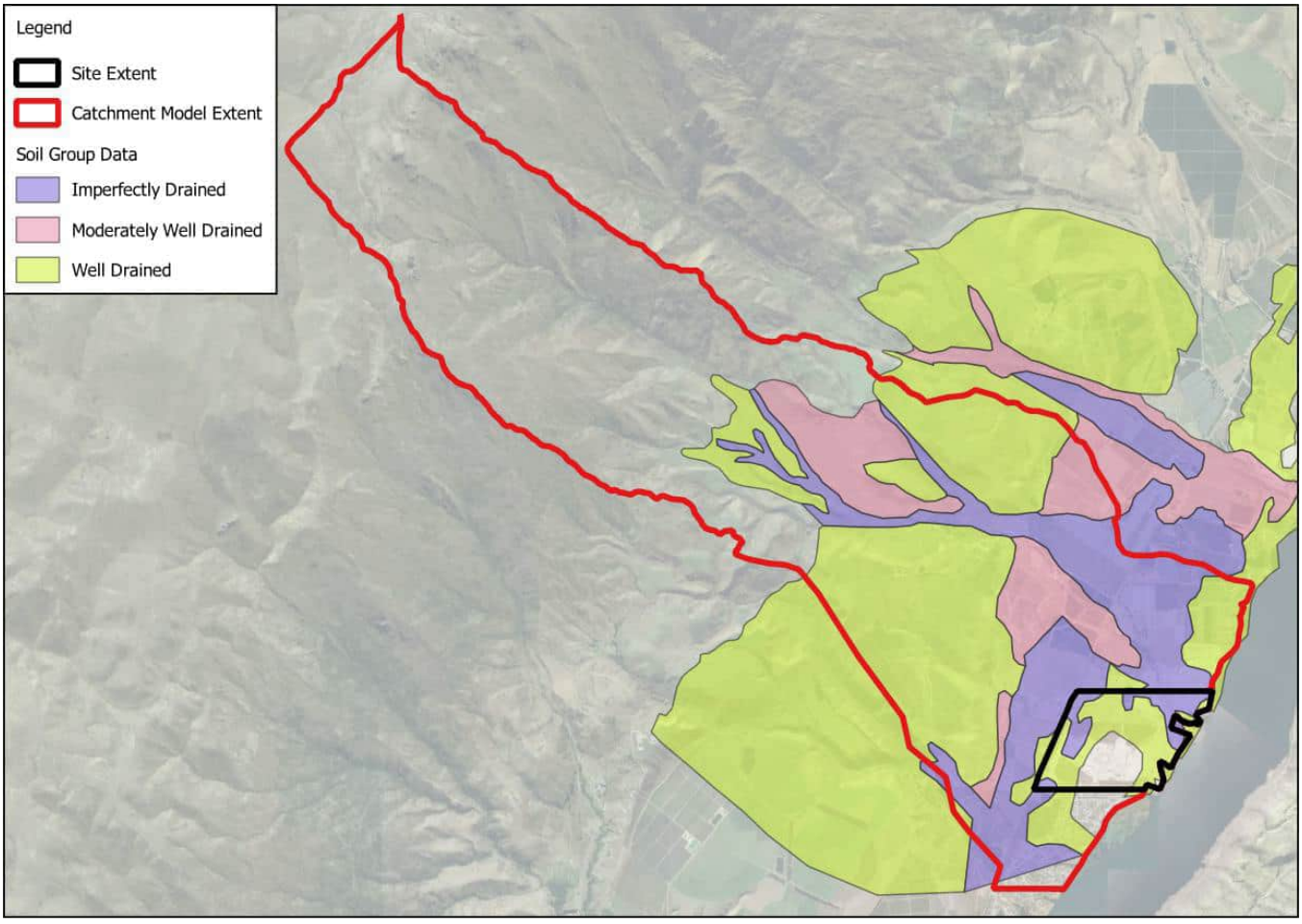


Figure 5: Soil Group Data

2.2.6 2D roughness

Manning's 'n' values have been used to represent the 2D roughness of different areas. Various Manning's coefficients were applied for the different land covers within the catchment, as seen in Figure 6. The manning's values applied are as follows:

a. Public roads – 0.02
b. Open Space – 0.05
c. Lots – 0.1
d. Open Water / Hydro – 0.1



Figure 6: 2d Mannings Roughness

2.3 Hydraulic Model

The following sections detail the hydraulic model parameters. It is noted that hydrographs generated by the HEC-HMS model were used as inputs to the hydraulic model.

2.3.1 Boundary Conditions

The HEC-HMS hydrographs derived from the catchment model were applied as inflow boundary conditions to the hydraulic models. Peak flow outputs from the HEC-HMS models for various subcatchments are provided in Appendix C. Where required, the catchment model also provides inflow boundary conditions directly to the internal site model as seen in Figure 7 and Figure 8.

A constant downstream boundary condition of 196.5 m RL has been applied, representing the future lake level based on reporting undertaken for Contact Energy, the asset owner. This correspondence is attached in Appendix D.

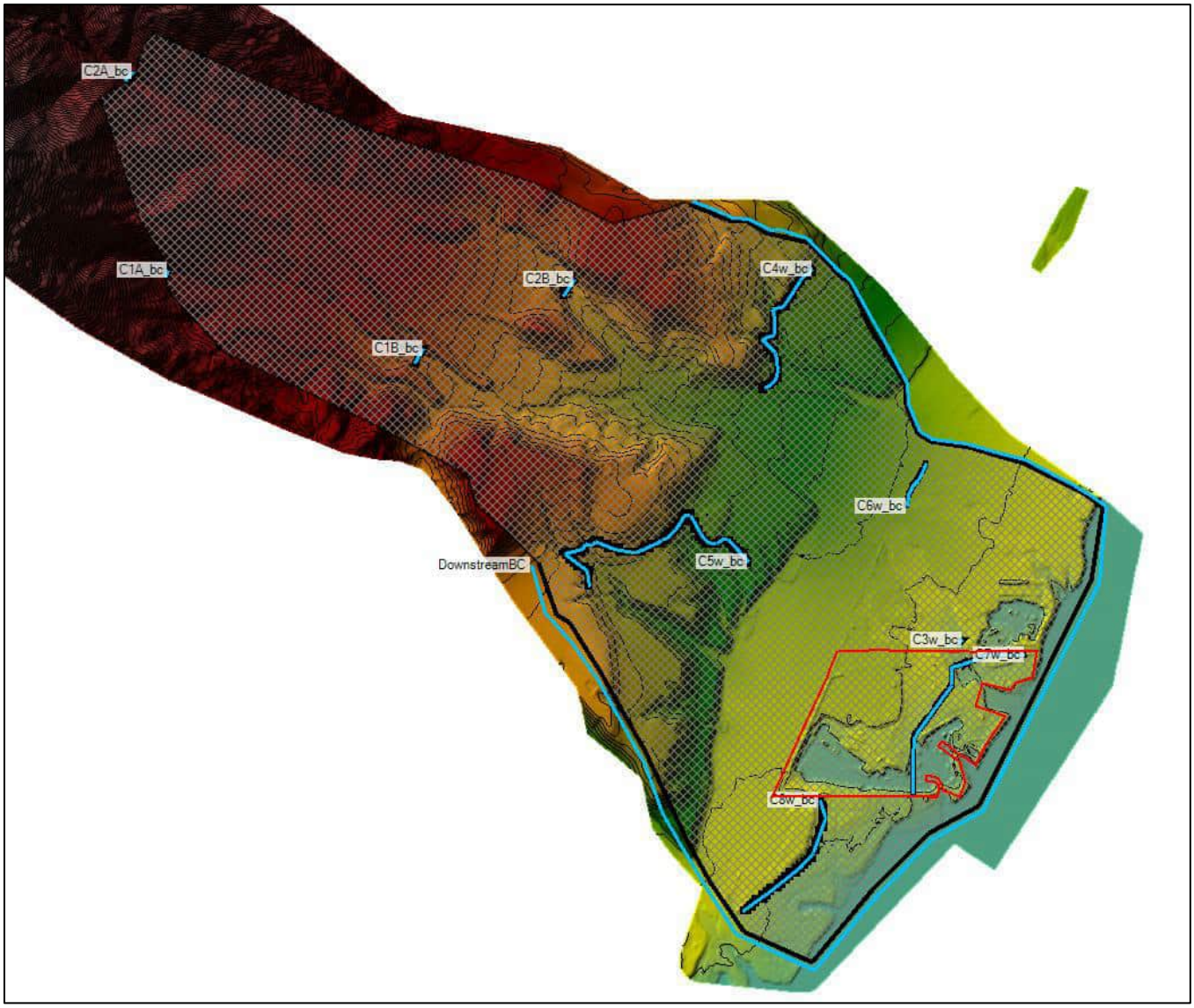


Figure 7: Catchment model boundary conditions



Figure 8: Internal model boundary conditions

2.3.2 2D Model Grid

The catchment model domain was characterised by grids of varying sizes, from 5 m × 5 m within the development area to 25 m × 25 m in the wider catchment. Breaklines were applied along stream corridors, channels, and stop banks, with smaller grid sizes applied in these areas for improved model representation.

The internal model grid was further refined to 2 m × 2 m to better capture flooding behaviour within the site. This mesh resolution is considered suitable to generate flow paths and floodplains through the modelled extent. The model also incorporates the preliminary pipe network to ensure potential ponding zones are adequately captured.

2.3.3 1D network

In the catchment wide model, the pipe network was not included as this model was developed to assess runoff contributions from the external catchment and to provide the basis for the alluvial fan assessment only. The pipe network was included in the internal/site model, as this model was intended to allow for more detailed analysis of flows within the site

The primary piped network within residential areas has been designed to the 5-year ARI in accordance with Central Otago District Council (CODC) guidelines. Figure 9 presents the preliminary pipe network layout, including pipe diameters, illustrating the proposed approach to primary flow management.

It should be noted that, for the 100-year ARI scenario, pipes smaller than 600 mm in diameter (except for catchpit leads) were excluded from the model to simulate partial blockage conditions. High-capacity inlet structures were incorporated to improve surface runoff collection and conveyance under these conditions.

The overall stormwater conveyance strategy includes two rectangular culverts within the central drainage corridor (Figure 9): Culvert 1 (1.2 m H × 4.0 m W) and Culvert 2 (1.2 m H × 6.0 m W). A bridge is also proposed across the floodway to provide connectivity between the north-western portion of the development and the remainder of the site (for modelling purposes this was left as an open channel).



Figure 9: Preliminary stormwater pipe network

2.3.4 Entry and Exit Losses

The head losses applied at the nodes have been adopted from the Auckland Council Modelling Specifications (2011) and are summarized in Table 3.

Table 3: Summary of head losses

Node type	Parameter
Upstream Manhole	Km = 0.2
Downstream Manhole	Km = 0.4
Culvert Inlet	Km = 0.5
Culvert Outlet	Km = 1.0

2.4 Alluvial Fan Model

The Otago Regional Council alluvial fan mapping has identified that a small portion of the development is overlaid by a 'active floodwater dominated' fan which extend from Mount Pisa to Lake Dunstan (Figure 10). Further uphill, more than 5 km from the development site, are smaller active debris-dominated fans which, for the purpose of this assessment, are not considered to pose a debris inundation risk to the development.

The portion of the fan identified within the site falls within an existing drainage corridor. A high-level assessment was conducted to determine whether extreme flood flows could adversely affect the development. For this purpose, the 100-year ARI event was scaled by a factor of three and routed through the site using the existing Catchment flood model. Given the floodwater-dominated classification of the fan, no allowance for sediment or debris loading was applied.

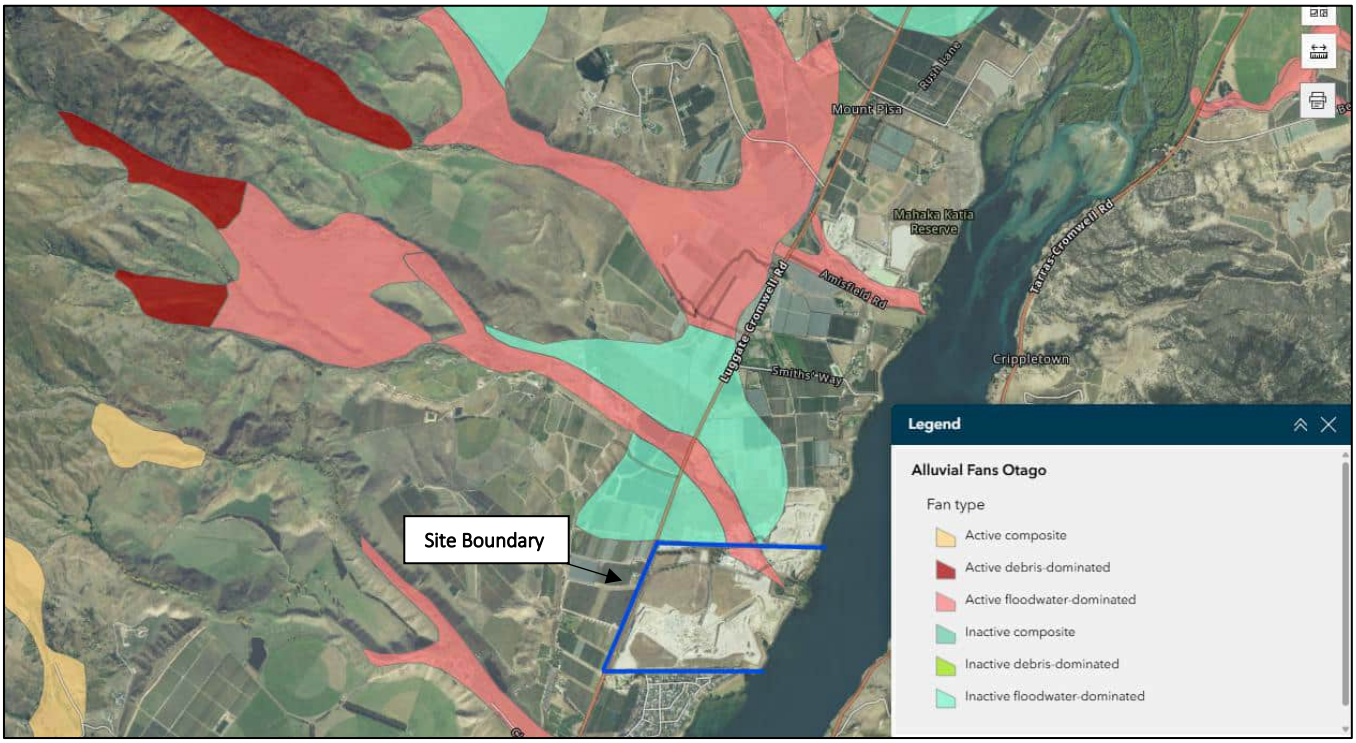


Figure 10: ORC Alluvial Fans Mapping

2.5 Flood modelling scenarios

A series of scenarios have been simulated across the three flood models to assess both pre- and post-development flood behaviour. The modelled scenarios are summarised in Table 4 below.

Table 4: Modelled scenarios

Model Extent	Scenario	Event	Land Use	Terrain	Purpose
Catchment	Pre-development	5, 10, 100-year	Existing conditions; external catchments assumed 100% pervious	Existing surfaces provided by Landpro	Establish baseline flood behaviour and quantify external flow contributions to the site
Catchment	Post-development	5, 10, 100-year	Full build-out; lots 60% impervious, roads and hard-stand 100% impervious; external catchments 100% pervious	Existing surfaces with northern property landform modified to reflect the reduced floodway	Assess the influence of the proposed development and neighbouring redevelopment on flood behaviour; provide boundary conditions to the internal model
Internal Site	Post-development	5, 10, 100-year	Full build-out; lots 60% impervious, roads and hard-stand 100% impervious	Design surfaces incorporating the preliminary pipe network and proposed culverts	Assess localised flood behaviour within the site and inform stormwater design optioneering
Catchment	Alluvial Fan	100-year × 3	Existing conditions	Existing surfaces with northern property landform modified to reflect the reduced floodway	Assess the potential for extreme alluvial fan flows to adversely affect the development

3.0 Flood Modelling Results

This section presents the results of the flood modelling scenarios summarised in Table 4. Results are discussed across the three models - the catchment model, the internal site model, and the alluvial fan model - for the pre- and post-development scenarios. This report should be read in conjunction with the Stormwater Management Plan (SMP), which provides a summary of the key findings.

A full set of flood model results is included in Appendix E.

3.1 Catchment Model Flood Results

Pre- and post-development catchment models were developed for the catchment-wide extent. As discussed in Section 2.1, the post-development model incorporates modifications to the northern property's landform to reflect the proposed reduction of the floodway as part of the separate neighbouring redevelopment. The pre- and post-development 100-year ARI results are shown in Figure 11 and Figure 12 respectively. A comparison of the flood extents upstream of northern property boundary are shown in Figure 13.

It should be noted that for the post development model, the catchment wide model does not incorporate the proposed pipe network within the site. Therefore, flood levels within the site have been assessed using the internal model as discussed in section 3.2.

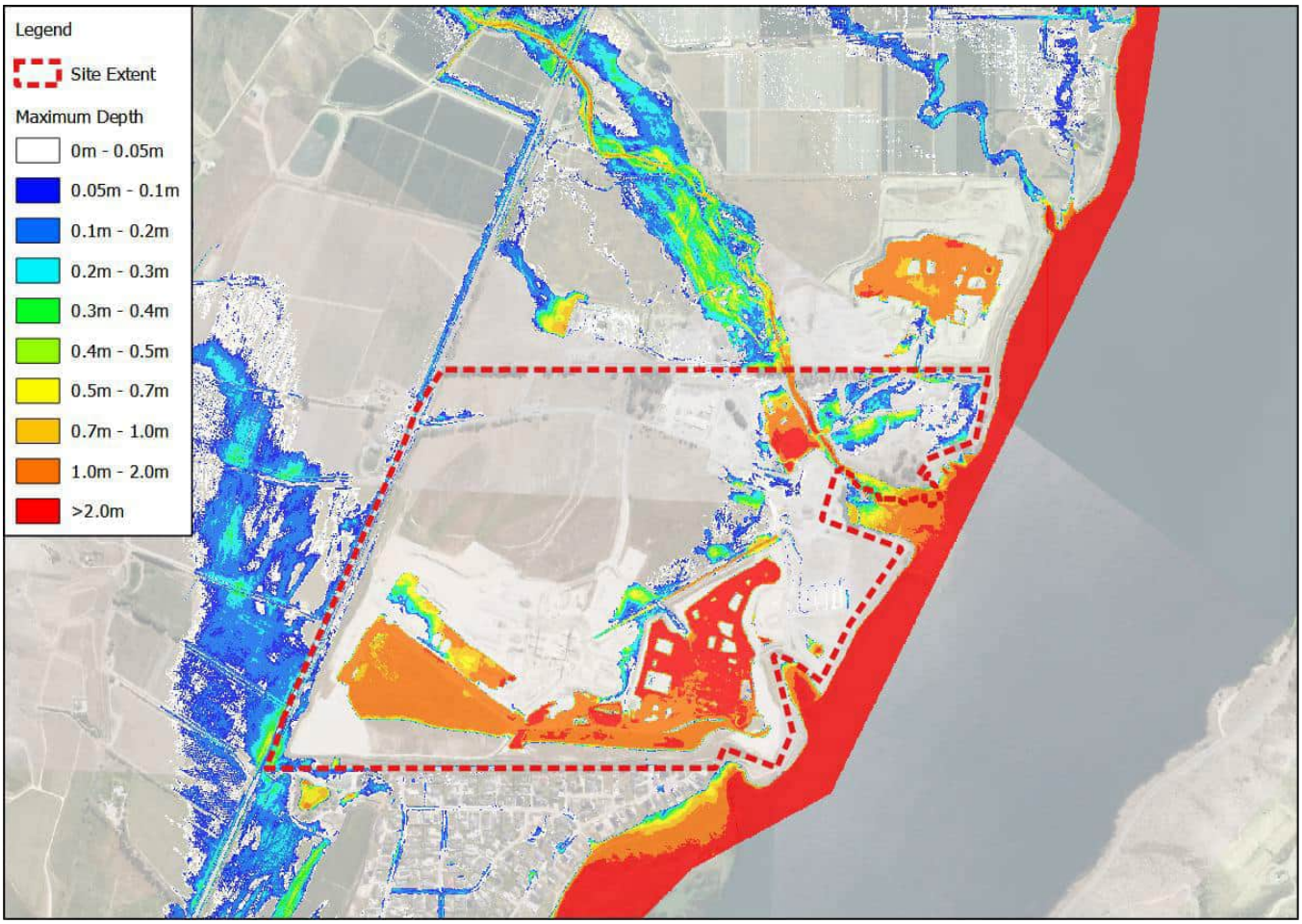


Figure 11: Predevelopment 100-year ARI RCP8.5

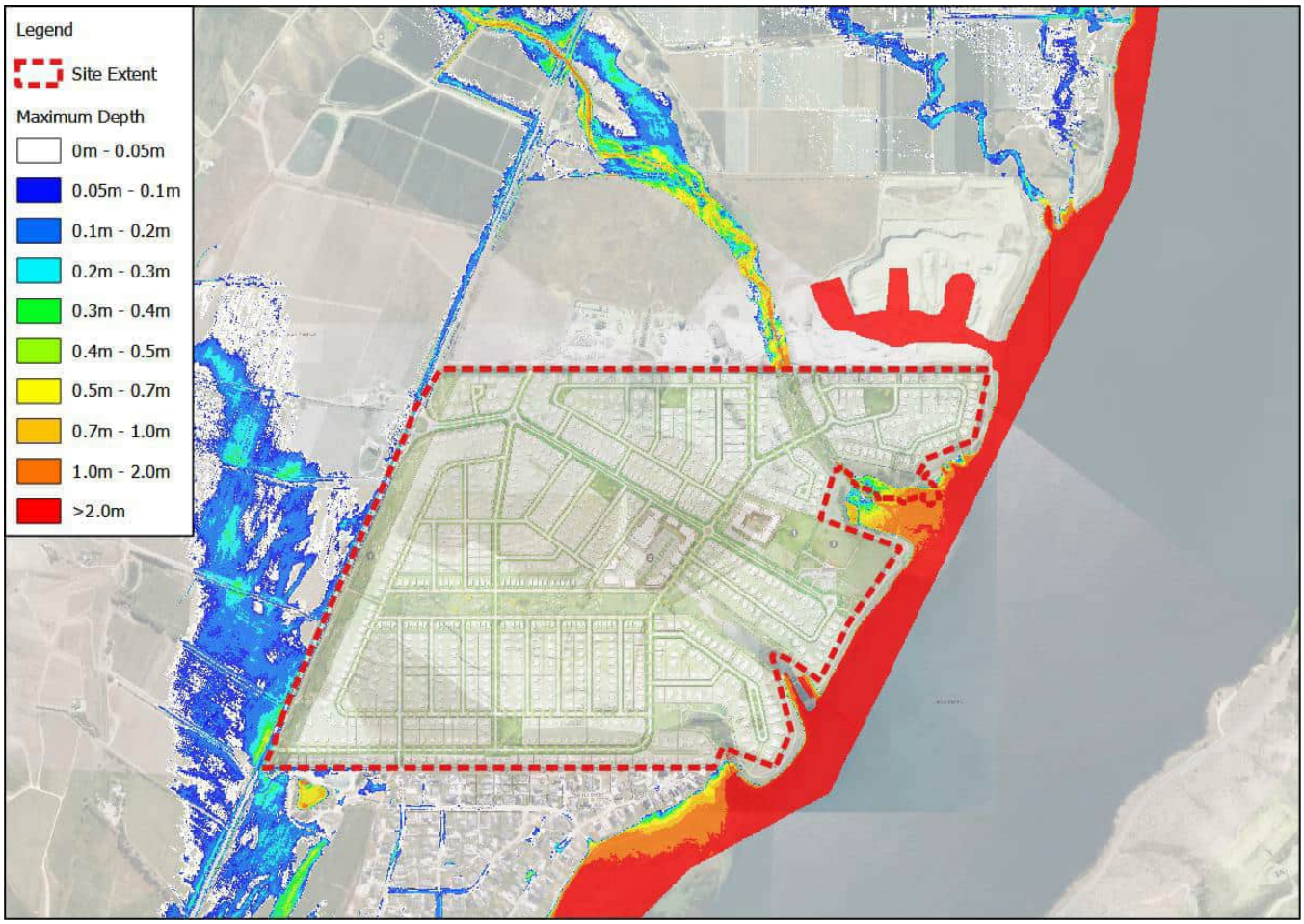


Figure 12: Post development 100-year ARI RCP8.5

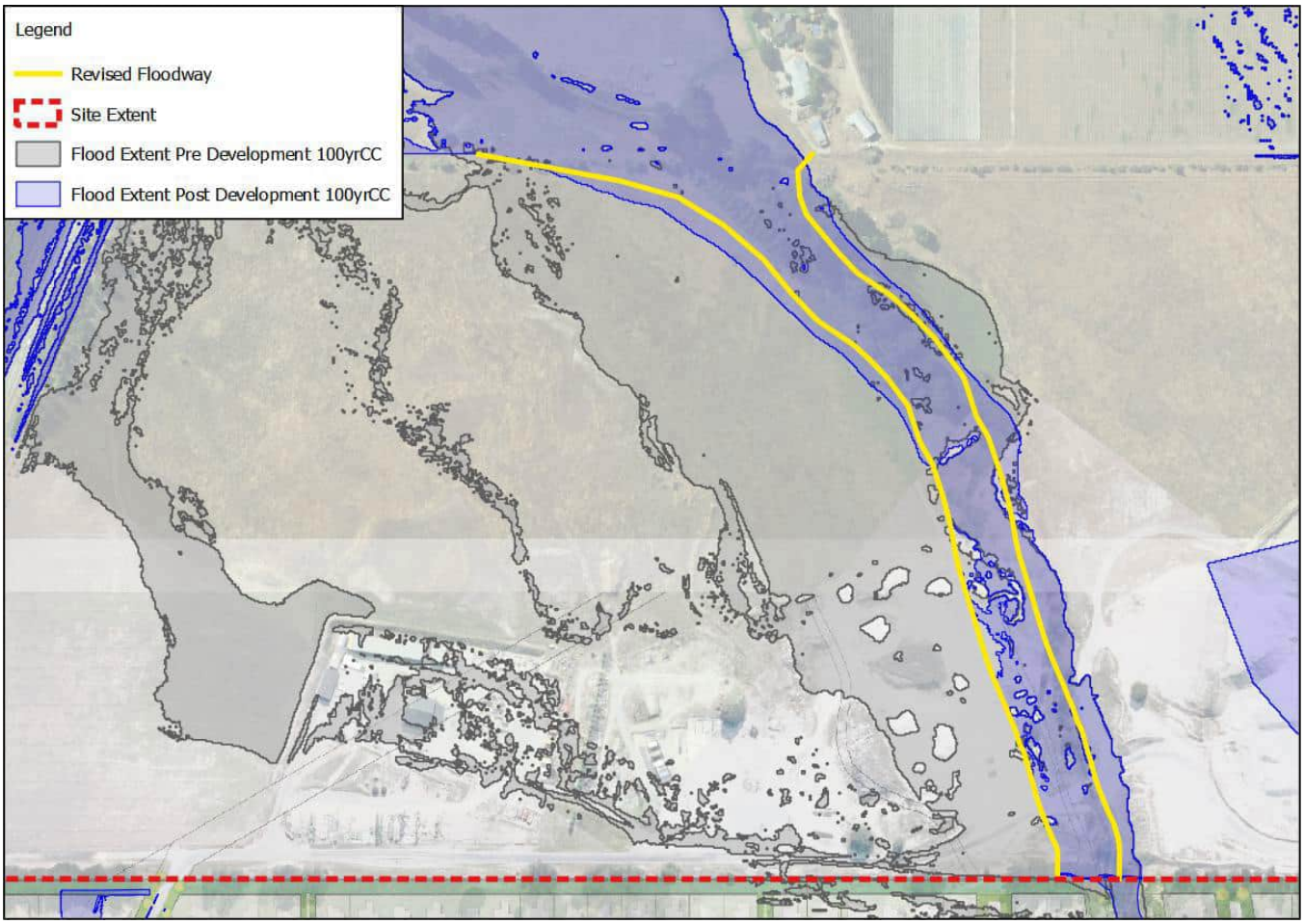


Figure 13: Flooding upstream of northern property (Bonisch Site)

3.2 Internal Model Flood Results

A refined site model was developed to assess flooding behaviour within the development for the 5-year, 10-year, and 100-year ARI events. The results are shown in Figure 14, Figure 14 and Figure 15 respectively.



Figure 14: 5-year ARI internal flooding



Figure 15: 10-year ARI internal flooding

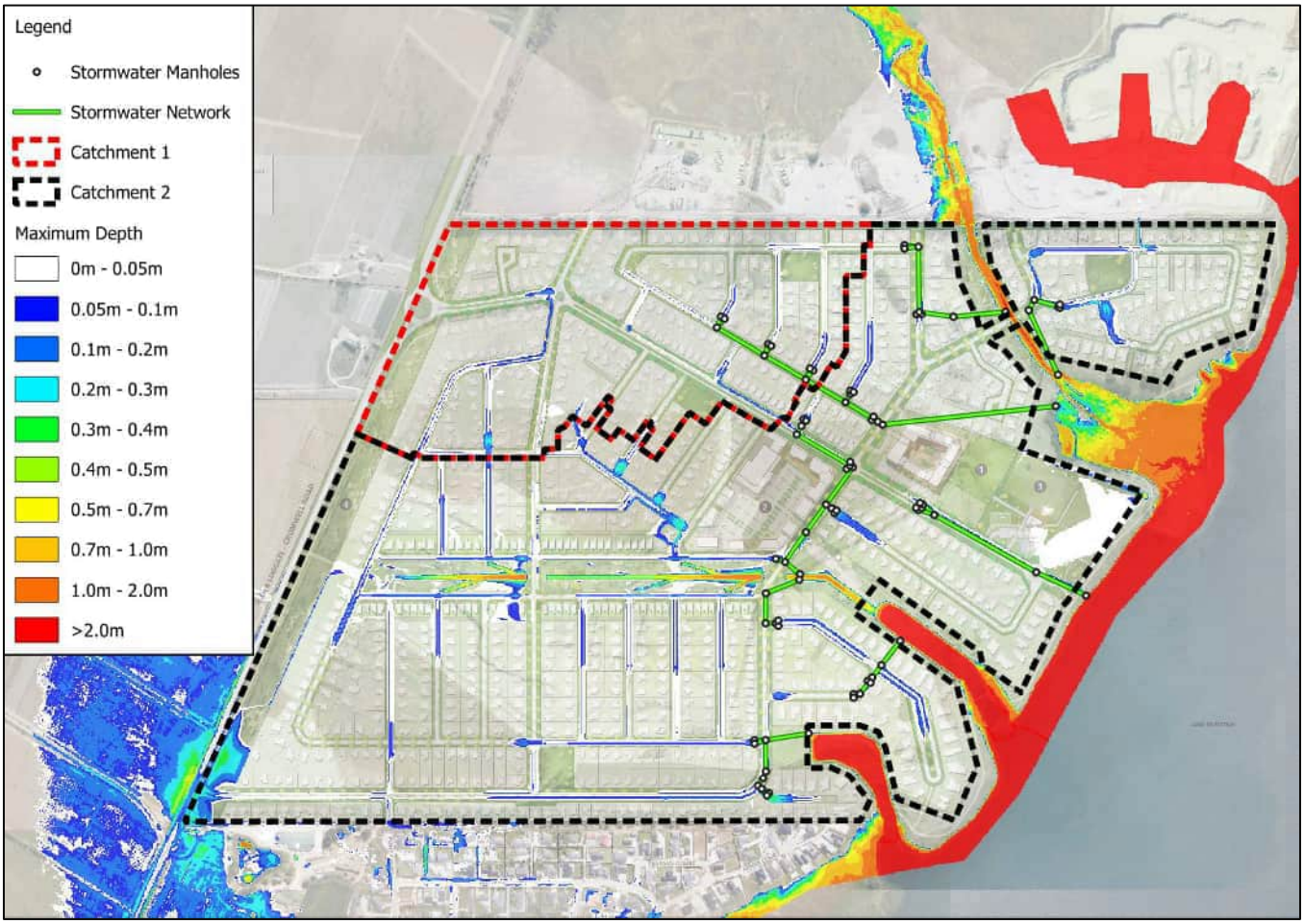


Figure 16: 100-year ARI internal flooding

3.3 Alluvial Hazard Model Results

The alluvial fan model was used to assess whether extreme flood flows from the active, floodwater-dominated fan could adversely affect the development. As described in Section 2.4, the 100-year ARI event was scaled by a factor of three to represent a conservative extreme flow scenario.

Figure 17 shows the modelled flood extents for both the 100-year ARI and the scaled 100-year ARI × 3 scenario through the drainage corridor. Figure 18 and Figure 19 shows the upstream and downstream cross sections within the development site, respectively, where the terminal point of the alluvial fan is shown.

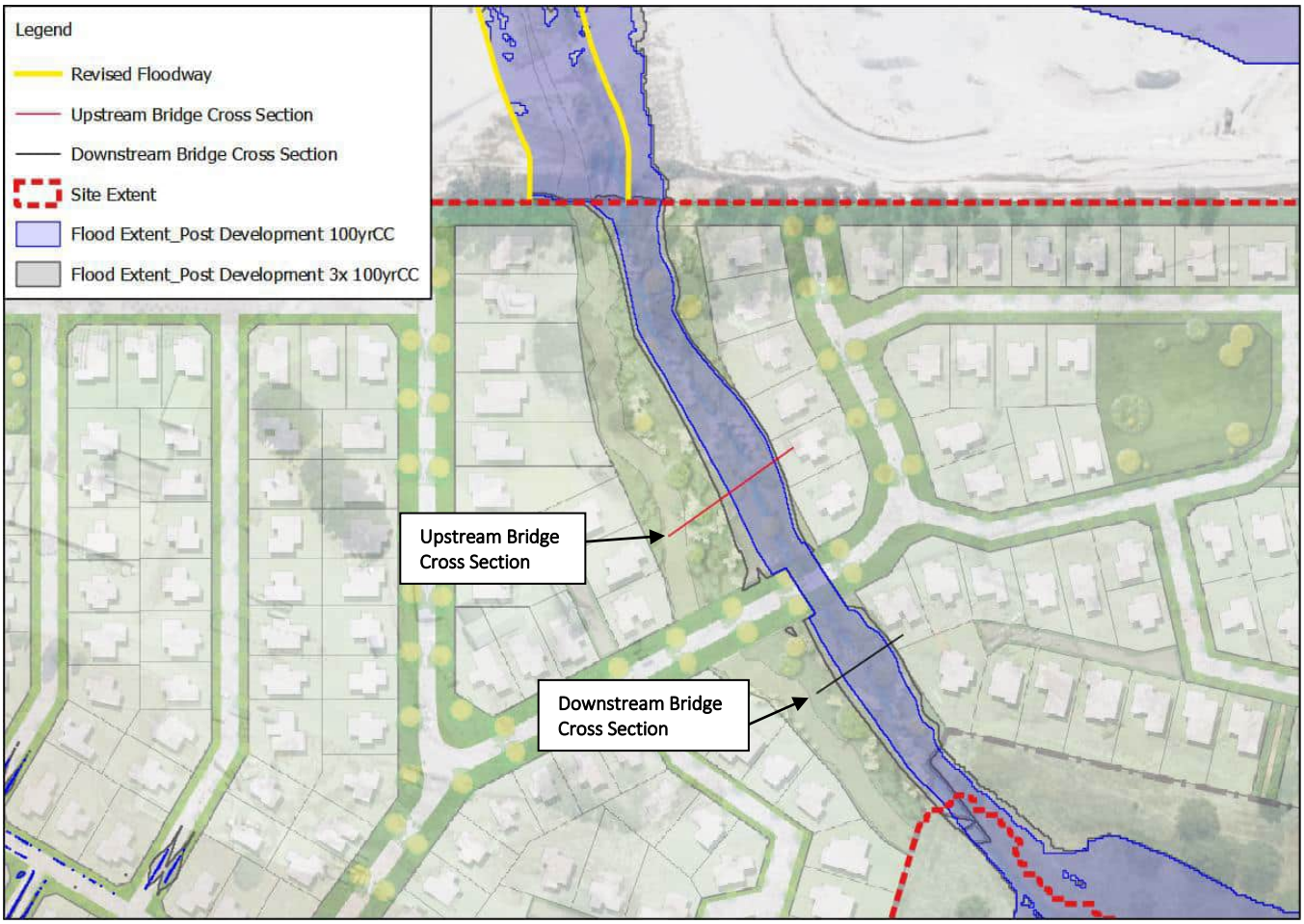


Figure 17: Extreme flood levels through drainage corridor

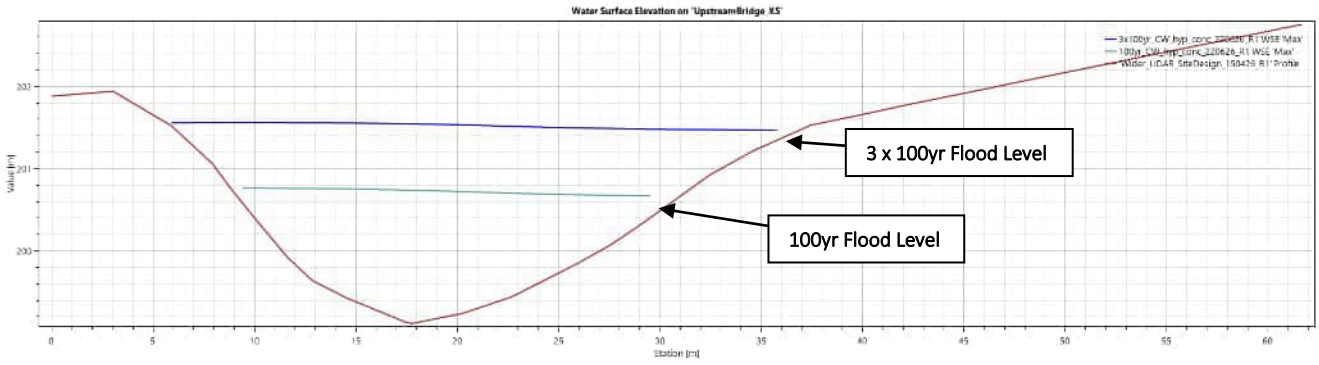


Figure 18: Upstream flood levels (1x100yr vs 3x100yr events)

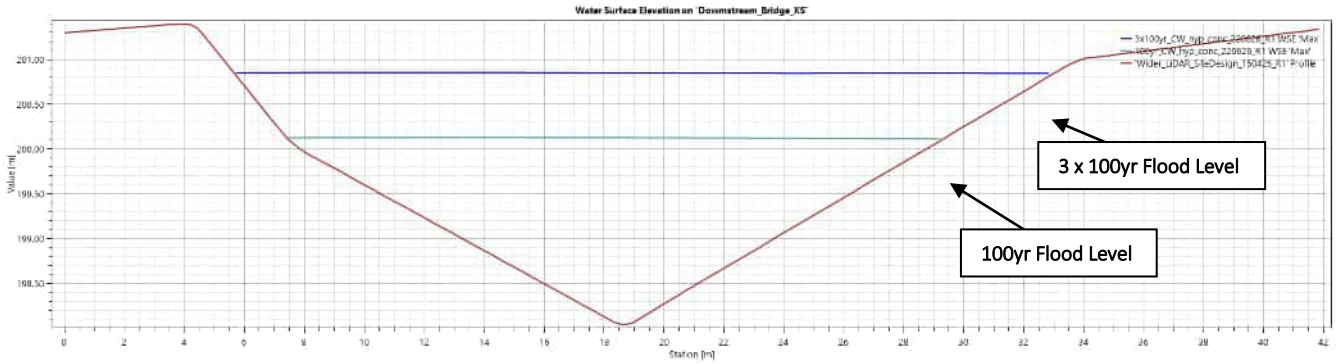


Figure 19: Downstream flood levels (1x100yr vs 3x100yr events)

4.0 Flood Hazard Assessment

The flood risk to people is associated with the likelihood of coming into contact with fast flowing deep flood waters. The Australian Rainfall-Runoff 2019 manual (ARR) methodology is considered best practice in Australia and New Zealand to assess this risk.

A quantitative hazard assessment was undertaken for the 100-year ARI event in accordance with the ARR methodology, assuming the stormwater network is fully operative. The results are shown in Figure 20.

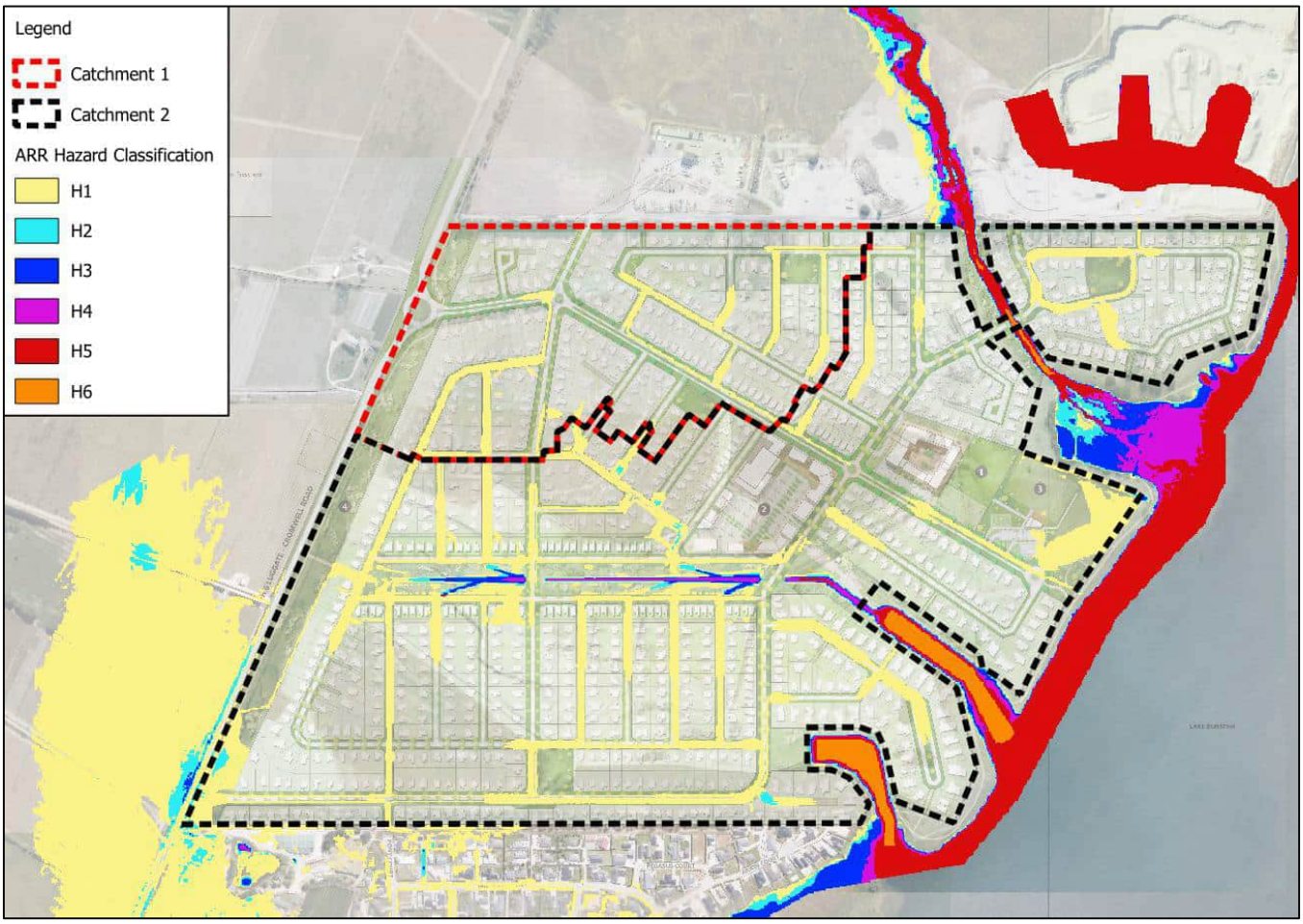


Figure 20: 100-year ARI ARR Hazards

5.0 Modelling Limitations & Assumptions

The flood modelling undertaken represents the flood risk within the modelled extent and are subject to assumptions and limitations outlined below:

- The design storms have been derived in accordance with the applicable regional rainfall methodology. The adopted rainfall model carries inherent uncertainty, and flow results should be understood as estimates within a reported confidence range rather than precise predictions.
- The runoff flows calculated by the hydrological model are loaded in the hydraulic model at specified nodes inside the two-dimensional model extents (structured mesh). Inside the two-dimensional model extents, water can flow in all directions from the loading node. The extents of the flow paths may vary according to the location of the loading node, the elevation of the two-dimensional grid cells (from LiDAR data) and other model assumptions. The location of the loading determines the origin of the overland flow path.
- No sedimentation or blockage has been allowed for in any watercourses or culverts. i.e., it is assumed that all culverts and watercourses are fully operational.
- The potential for change in asset condition over time is not represented.
- This model has been prepared to provide guidance on flood levels and depths within the modelled catchment area for the modelled scenario. The modelling process relies on a range of assumptions and

simplifications and is subject to errors and inaccuracies. The compounding effects of the uncertainties in the rainfall model, the uncertainties in the contour model and the uncertainties in hydraulic parameters such as roughness could result in the water level varying from the mapped levels.

- Topographic data used in the model has been sourced from a combination of survey methods, each carrying their own vertical accuracy tolerances. These tolerances introduce additional uncertainty into modelled flood extents, particularly in areas of low relief or where the flood boundary is sensitive to small changes in ground elevation. Additional error is introduced through the application of geodetic height models to the underlying survey data.
- The results of this modelling should be interpreted in the context of these limitations and used as a guide to inform design and planning decisions rather than as definitive predictions of flood behaviour.

6.0 Conclusion

Flood modelling has been undertaken for the proposed residential development at 922 Luggate-Cromwell Road, Cromwell, in support of a substantive EPA application under the Fast-Track Approvals Act 2024. Three flood models were developed and simulated across the 5-year, 10-year, and 100-year ARI events, incorporating the RCP8.5 climate change scenario for the period 2081-2100.

It is intended that this report be read in conjunction with the Stormwater Management Plan (SMP) prepared by Woods, which provides the broader stormwater design context and an interpretation of the key findings.

Appendix A

ToC Comparison

TP 108 Worksheet

WORKSHEET 1: RUNOFF PARAMETERS AND TIME OF CONCENTRATION - OLFP

Catchment Details

Total Area (ha)	Atotal =	1012.09		
Pervious Area (ha)	Aper =	1001.97		
Impervious Area (ha)	Aimp =	10.12		
Channelisation factor	C =	1	0.6 piped stormwater system.	0.8 engineered grassed channels.
Catchment Length (km)	L =	11.88		
Catchment Slope (m/m)	Sc =	0.087		
Catchment Height (m)	H=	1539.39		

ASSUMPTIONS (IF ANY)

			Area (ha)	CN x Area
Drainage	CN	Ratio	1002	
Well drained	56	0.9	901.8	50500.8
Moderately drained	72	0.05	50.1	3607.2
Poorly drained	80	0.05	50.1	4008
		Weighted pervious CN =		58

RUNOFF CURVE NUMBER (CN) AND INITIAL ABSTRACTION (Ia)

Soil Name & Classification	Cover Desctiption (cover type, treatment and hydrological condition)	Curve number	Area (ha)	Product CN x Area
Group C	Pervious	58	1001.97	58114.43748
Group C	Impervious	98	10.12	991.85212
		Total	**1012.09**	**59106.2896**

CN (weighted) = total product / total area = 59106.29 / 1012.09 = **58.4**

Ia (weighted) = 5 x pervious area / total area = 5009.865 / 1012.09 = **4.95**

TIME OF CONCENTRATION

Runoff Factor = CN / (200 - CN) = 0.412429

TP108 Method

Tc = 0.14CL^0.66 (CN/200-CN)^-0.55 * Sc^-0.30 = **2.429** hrs = **145.744** mins

Ramser-Kirpich Equation

Tc = 0.0195L^0.77 *Sc^-0.385 = **1.143** hrs = **68.584** mins

Bransby-Williams Equation

Tc = (0.953*L^1.2)/(A^0.1*H^0.2) = **3.395** hrs = **203.728** mins



Figure 1 South Island contour maps of q*

WORKSHEET 2 : GRAPHICAL PEAK FLOW RATE

1. Catchment Area (km2) = 10.121

2. Storage, S = 25.4 x [(1000/CN) - 10] = 180.932

			Storm #1	Storm #2	Storm #3
3. Annual Recurrence Interval (ARI)					100
4. 24 hour rainfall depth, P24 (mm)					111
5. Compute C* =	P24 - 2Ia / P24 - 2Ia + 2S	(mm)			0.22
6. specific flow rate q*					0.02
7. Peak flow rate, q_p = q*AP_{24} (m^3/sec)					22.47
8. Runoff depth, Q_{24} =	$(P_{24} - Ia)^2$ / $(P_{24} - Ia) + S$	(mm)			39.19
9. Runoff Volume, V_{24} = 1000 x Q_{24}A (m^3)					396632

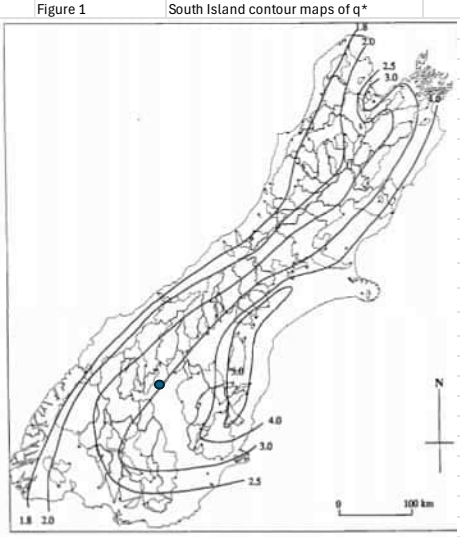


Figure 2 South Island contour maps of q100

WORKSHEET 3 : REIGONAL FLOOD ESTIMATION

10. Catchment Area (km2)		=	10.121	km2
11. Specific Discharge (m3/s)	q* (refer Figure 1)	=	0.5	
	q100 (refer Figure 2)	=	3	
12. Plotted mean Annual Flood, Q* (m3/s)	**Q*** = q*A^0.8	=	3.185	m3/s
13. Peak flow rate, Q100 (m3/s)	Q100=q100***Q***	=	9.556	m3/s

Appendix B

Typical Lot Layout

LOT TESTING

LOT NUMBER: 295

LOT AREA: 625m^2

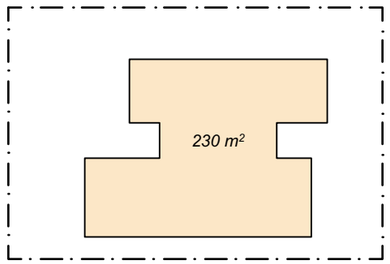
FLOOR AREA: 227m^2

RESIDENTIAL STANDARDS ASSESSMENT

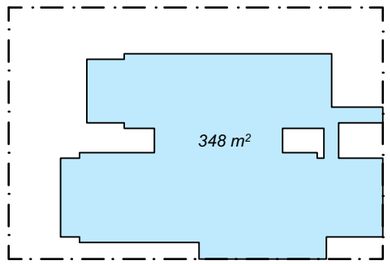
STANDARDS	REQUIREMENT	PROPOSED	COMPLIANCE
BUILDING HEIGHT	Maximum 7.5m	6.1m	☑
BULK AND LOCATION	Front Yards: 4.5m Side and Rear Yards: 3.0m & 1.8m	4.5m front + 1.8m side + 6.3m rear	☑
BUILDING COVERAGE	Maximum 40%	230m^2 (37%)	☑
IMPERVIOUS AREA	Maximum 60%	348m^2 (56%)	☑



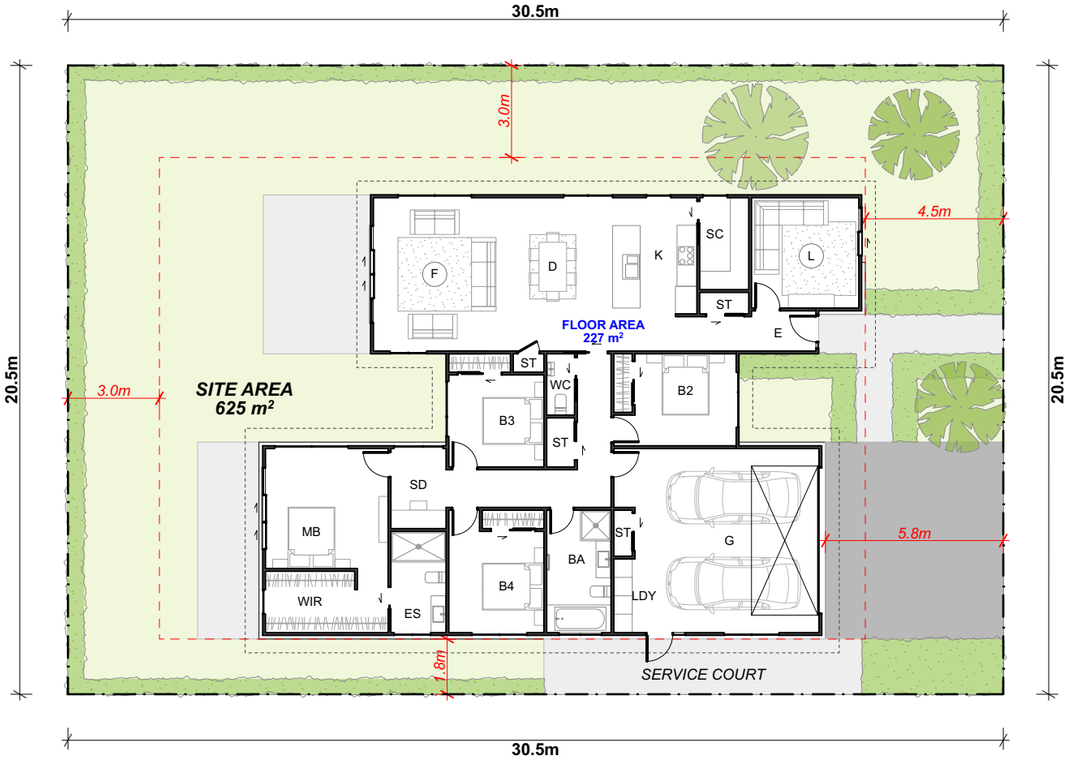
1 - SITE LOCATION



2 - BUILDING COVERAGE
1:500



3 - IMPERVIOUS AREA
1:500



4 - INDICATIVE BUILDING LAYOUT
1:200

N

PARKBURN

Fulton Hogan LAND DEVELOPMENT LTD.

Appendix C

HEC-HMS Outputs

Wider Catchment

Global Summary Results for Run "5yrRCP8.5_catchment"

Project: P24-642 - Luggate Crom Simulation Run: 5yrRCP8.5_catchment

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Jun2026, 17:47:34

Basin Model: Parkburn
Meteorologic Model: 5yrRCP8.5
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Catch2A	7.59694	7.62157	1 January 2000, 12:50	103.9907
Catch1B	2.80843	3.13018	1 January 2000, 12:40	38.6973
Catch2B	2.52400	2.55236	1 January 2000, 12:50	34.5668
Catch1A	1.81599	2.40375	1 January 2000, 12:20	25.2566
CATCH_5	3.17940	4.23229	1 January 2000, 12:50	55.0995
CATCH_4	2.00670	2.85595	1 January 2000, 12:40	34.8850
CATCH_7	1.08300	3.77419	1 January 2000, 12:50	52.8814
CATCH_8	0.83200	2.35936	1 January 2000, 12:50	32.8210
CATCH_6	0.82520	1.54963	1 January 2000, 12:30	16.4985
CATCH_3	0.80000	2.66965	1 January 2000, 12:30	28.5179

5-year ARI

Global Summary Results for Run "10yrRCP8.5_catchment"

Project: P24-642 - Luggate Crom Simulation Run: 10yrRCP8.5_catchment

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Jun2026, 17:46:09

Basin Model: Parkburn
Meteorologic Model: 10yrRCP8.5
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Catch2A	7.59694	10.54235	1 January 2000, 12:50	142.3806
Catch1B	2.80843	4.32946	1 January 2000, 12:40	52.9719
Catch2B	2.52400	3.52972	1 January 2000, 12:50	47.3270
Catch1A	1.81599	3.33164	1 January 2000, 12:20	34.5631
CATCH_5	3.17940	5.70164	1 January 2000, 12:50	73.6969
CATCH_4	2.00670	3.85138	1 January 2000, 12:40	46.6562
CATCH_7	1.08300	4.55150	1 January 2000, 12:50	64.0127
CATCH_8	0.83200	2.91751	1 January 2000, 12:50	40.5806
CATCH_6	0.82520	2.07904	1 January 2000, 12:30	21.9435
CATCH_3	0.80000	3.33483	1 January 2000, 12:30	35.5878

10-year ARI

Global Summary Results for Run "WiderCatch100yr"

Project: P24-642 - Luggate Crom Simulation Run: WiderCatch100yr

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Jun2026, 10:16:26

Basin Model: Parkburn
Meteorologic Model: 100yr RCP8.5
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: MM 1000 M3 Sorting: Watershed Explorer

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Catch2A	7.59694	22.96802	1 January 2000, 12:50	302.9844
Catch1B	2.80843	9.43101	1 January 2000, 12:40	112.6665
Catch2B	2.52400	7.68606	1 January 2000, 12:50	100.7076
Catch1A	1.81599	7.29311	1 January 2000, 12:20	73.4597
CATCH_5	3.17940	11.79533	1 January 2000, 12:40	149.2318
CATCH_4	2.00670	7.95543	1 January 2000, 12:40	94.4574
CATCH_7	1.08300	7.27995	1 January 2000, 12:50	103.2235
CATCH_8	0.83200	4.94497	1 January 2000, 12:50	68.7243
CATCH_6	0.82520	4.21440	1 January 2000, 12:30	43.6352
CATCH_3	0.80000	5.79551	1 January 2000, 12:30	61.6413

100-year ARI

Site Catchment

Global Summary Results for Run "Detailed Catchment 5yr RCP"

Project: P24-642 - Luggate Crom Simulation Run: Detailed Catchment 5yr RCP

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Jun2026, 17:38:30

Basin Model: Detailed Catchment
Meteorologic Model: 5yrRCP8.5
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: MM 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
C1	0.04542	0.30607	1 January 2000, 12:00	1.9216
C10	0.03811	0.25684	1 January 2000, 12:00	1.6125
C11	0.01162	0.07829	1 January 2000, 12:00	0.4916
C12	0.01188	0.04101	1 January 2000, 12:00	0.2560
C13	0.01282	0.08638	1 January 2000, 12:00	0.5423
C14	0.05617	0.37851	1 January 2000, 12:00	2.3764
C15	0.03320	0.22373	1 January 2000, 12:00	1.4047
C16	0.00471	0.01626	1 January 2000, 12:00	0.1015
C17	0.02565	0.17285	1 January 2000, 12:00	1.0852
C18	0.02275	0.15331	1 January 2000, 12:00	0.9625
C19	0.01788	0.12050	1 January 2000, 12:00	0.7566
C2	0.04858	0.32738	1 January 2000, 12:00	2.0555
C20	0.03792	0.25553	1 January 2000, 12:00	1.6043
C21	0.01400	0.09434	1 January 2000, 12:00	0.5923
C22	0.03460	0.23316	1 January 2000, 12:00	1.4639
C23	0.01946	0.13116	1 January 2000, 12:00	0.8235
C24	0.03181	0.21438	1 January 2000, 12:00	1.3460
C25	0.02437	0.16421	1 January 2000, 12:00	1.0310
C26	0.02547	0.17163	1 January 2000, 12:00	1.0775
C27	0.02811	0.18945	1 January 2000, 12:00	1.1895
C28	0.04753	0.32031	1 January 2000, 12:00	2.0110
C29	0.01789	0.06176	1 January 2000, 12:00	0.3855
C29_2	0.01317	0.04546	1 January 2000, 12:00	0.2838
C3	0.03180	0.21430	1 January 2000, 12:00	1.3454
C30	0.01492	0.10053	1 January 2000, 12:00	0.6312
C31	0.02893	0.19497	1 January 2000, 12:00	1.2241
C32	0.05992	0.40378	1 January 2000, 12:00	2.5351
C33	0.04545	0.30628	1 January 2000, 12:00	1.9230
C34	0.04512	0.30405	1 January 2000, 12:00	1.9089
C35	0.05193	0.34996	1 January 2000, 12:00	2.1972
C36	0.02967	0.19993	1 January 2000, 12:00	1.2552
C37	0.02875	0.19374	1 January 2000, 12:00	1.2164
C4	0.04575	0.30830	1 January 2000, 12:00	1.9356
C5	0.04640	0.31268	1 January 2000, 12:00	1.9631
C6	0.02503	0.16868	1 January 2000, 12:00	1.0591
C7	0.04538	0.30582	1 January 2000, 12:00	1.9201
C8	0.00850	0.02934	1 January 2000, 12:00	0.1831
C9	0.01510	0.10176	1 January 2000, 12:00	0.6389

5-year ARI

Global Summary Results for Run "Deatiled Catchment 10yr RCP"

Project: P24-642 - Luggate Crom Simulation Run: Deatiled Catchment 10yr RCP

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Jun2026, 17:41:02

Basin Model: Detailed Catchment
Meteorologic Model: 10yrRCP8.5
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: MM 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
C1	0.04542	0.37457	1 January 2000, 12:00	2.3562
C10	0.03811	0.31432	1 January 2000, 12:00	1.9772
C11	0.01162	0.09582	1 January 2000, 12:00	0.6027
C12	0.01188	0.05549	1 January 2000, 12:00	0.3421
C13	0.01282	0.10572	1 January 2000, 12:00	0.6650
C14	0.05617	0.46323	1 January 2000, 12:00	2.9138
C15	0.03320	0.27380	1 January 2000, 12:00	1.7223
C16	0.00471	0.02200	1 January 2000, 12:00	0.1356
C17	0.02565	0.21154	1 January 2000, 12:00	1.3306
C18	0.02275	0.18762	1 January 2000, 12:00	1.1802
C19	0.01788	0.14747	1 January 2000, 12:00	0.9276
C2	0.04858	0.40065	1 January 2000, 12:00	2.5202
C20	0.03792	0.31272	1 January 2000, 12:00	1.9671
C21	0.01400	0.11546	1 January 2000, 12:00	0.7263
C22	0.03460	0.28535	1 January 2000, 12:00	1.7949
C23	0.01946	0.16051	1 January 2000, 12:00	1.0097
C24	0.03181	0.26236	1 January 2000, 12:00	1.6503
C25	0.02437	0.20097	1 January 2000, 12:00	1.2642
C26	0.02547	0.21004	1 January 2000, 12:00	1.3212
C27	0.02811	0.23185	1 January 2000, 12:00	1.4584
C28	0.04753	0.39199	1 January 2000, 12:00	2.4658
C29	0.01789	0.08357	1 January 2000, 12:00	0.5152
C29_2	0.01317	0.06152	1 January 2000, 12:00	0.3793
C3	0.03180	0.26226	1 January 2000, 12:00	1.6497
C30	0.01492	0.12303	1 January 2000, 12:00	0.7739
C31	0.02893	0.23860	1 January 2000, 12:00	1.5009
C32	0.05992	0.49415	1 January 2000, 12:00	3.1084
C33	0.04545	0.37483	1 January 2000, 12:00	2.3578
C34	0.04512	0.37210	1 January 2000, 12:00	2.3406
C35	0.05193	0.42828	1 January 2000, 12:00	2.6940
C36	0.02967	0.24468	1 January 2000, 12:00	1.5391
C37	0.02875	0.23710	1 January 2000, 12:00	1.4914
C4	0.04575	0.37730	1 January 2000, 12:00	2.3733
C5	0.04640	0.38266	1 January 2000, 12:00	2.4071
C6	0.02503	0.20644	1 January 2000, 12:00	1.2985
C7	0.04538	0.37426	1 January 2000, 12:00	2.3542
C8	0.00850	0.03971	1 January 2000, 12:00	0.2448
C9	0.01510	0.12453	1 January 2000, 12:00	0.7833

10-year ARI

Global Summary Results for Run "Detailed Catchment 100yr RCP"

Project: P24-642 - Luggate Crom Simulation Run: Detailed Catchment 100yr RCP

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Jun2026, 17:42:27

Basin Model: Detailed Catchment
Meteorologic Model: 100yr RCP8.5
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: MM 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
C1	0.04542	0.62199	1 January 2000, 12:00	3.9226
C10	0.03811	0.52192	1 January 2000, 12:00	3.2915
C11	0.01162	0.15912	1 January 2000, 12:00	1.0035
C12	0.01188	0.11309	1 January 2000, 12:00	0.6808
C13	0.01282	0.17555	1 January 2000, 12:00	1.1071
C14	0.05617	0.76921	1 January 2000, 12:00	4.8510
C15	0.03320	0.45466	1 January 2000, 12:00	2.8673
C16	0.00471	0.04483	1 January 2000, 12:00	0.2699
C17	0.02565	0.35126	1 January 2000, 12:00	2.2152
C18	0.02275	0.31155	1 January 2000, 12:00	1.9648
C19	0.01788	0.24487	1 January 2000, 12:00	1.5443
C2	0.04858	0.66529	1 January 2000, 12:00	4.1957
C20	0.03792	0.51928	1 January 2000, 12:00	3.2748
C21	0.01400	0.19172	1 January 2000, 12:00	1.2091
C22	0.03460	0.47383	1 January 2000, 12:00	2.9882
C23	0.01946	0.26652	1 January 2000, 12:00	1.6808
C24	0.03181	0.43565	1 January 2000, 12:00	2.7474
C25	0.02437	0.33372	1 January 2000, 12:00	2.1046
C26	0.02547	0.34878	1 January 2000, 12:00	2.1996
C27	0.02811	0.38498	1 January 2000, 12:00	2.4279
C28	0.04753	0.65091	1 January 2000, 12:00	4.1050
C29	0.01789	0.17030	1 January 2000, 12:00	1.0252
C29_2	0.01317	0.12537	1 January 2000, 12:00	0.7547
C3	0.03180	0.43548	1 January 2000, 12:00	2.7464
C30	0.01492	0.20431	1 January 2000, 12:00	1.2885
C31	0.02893	0.39620	1 January 2000, 12:00	2.4986
C32	0.05992	0.82056	1 January 2000, 12:00	5.1749
C33	0.04545	0.62241	1 January 2000, 12:00	3.9253
C34	0.04512	0.61788	1 January 2000, 12:00	3.8967
C35	0.05193	0.71117	1 January 2000, 12:00	4.4850
C36	0.02967	0.40630	1 January 2000, 12:00	2.5623
C37	0.02875	0.39372	1 January 2000, 12:00	2.4830
C4	0.04575	0.62652	1 January 2000, 12:00	3.9512
C5	0.04640	0.63542	1 January 2000, 12:00	4.0073
C6	0.02503	0.34279	1 January 2000, 12:00	2.1618
C7	0.04538	0.62147	1 January 2000, 12:00	3.9193
C8	0.00850	0.08091	1 January 2000, 12:00	0.4871
C9	0.01510	0.20679	1 January 2000, 12:00	1.3041

100-year ARI

Appendix D

Contact Energy Correspondence

Central Otago News Print

LAKE DUNSTAN
DEVELOPMENT GUIDE

Electricity Corporation
of New Zealand Limited
ELECTRICORP PRODUCTION

April 1990

WATER LEVELS IN LAKE DUNSTAN

(Levels in metres above mean sea level)

	Time from lake filling								
	Immediate			30 years			100 years		
Flow condition:	1	2	3	1	2	3	1	2	3
Water level at:									
Clyde Dam	194.5	195.0	195.1	194.5	195.0	195.1	194.5	195.0	195.1
Pisa Mooring Reach	194.5	195.1	195.3	194.5	195.2	195.4	194.8	196.2	196.8
Clarkes Rd Reach	194.5	195.1	195.3	194.5	195.2	195.4	194.8	196.2	196.8
Lowburn Inlet	194.5	195.1	195.3	194.5	195.2	195.4	194.8	196.2	196.8
Brewery Creek	194.5	195.1	195.3	194.5	195.2	195.3	194.8	196.0	196.5

Flow Condition Columns:

1. Levels with flow for maximum generation at Clyde (1200 cumecs)
2. Levels with a 100 year flood (2600 cu.metres/sec)
3. Levels with a 500 year flood (3200 cu.metres/sec)

Figure 1.

5: Criteria

Generally both on-water and shoreline activities and facilities will need to be designed and sited to take account of the above considerations. All proposals received will be assessed in terms of their response to these features.

(a) Location of Facilities

Electricorp's main concern about the location of facilities will be in relation to the dam and intake structures, in order that a reasonable margin of safety can be maintained.

The proposed location of structures/facilities/activities should be acceptable to the various other agencies having jurisdiction or likely to have future jurisdiction over the designated area. The proposals will be referred to these agencies for comment.

(b) Access

Any development proposal should include an agreement to allow Electricorp to gain access to any area of the reservoir or foreshore to carry out maintenance and other activities related to Electricorp's activities.

(c) Potential for Flooding

There is potential for flooding of the reservoir beyond its maximum operating level of 194.5m above mean sea level to approximately a lake level of 196m. This level is calculated for a one in 500 year flood and to allow for sedimentation effects after 30 years operation of the reservoir. This level is not intended to cover every eventuality or every flood event. Any building which is likely to be extensively damaged by floods should be designed and constructed with a floor level at least 300mm above this. Height limits on other structures will be determined by the nature of the structure — for example jetties will be allowed close to maximum operating level. No habitable structures will be permitted within the designated area.

Further, where a development proposal includes changes to shoreline configuration such that the lake surface is enlarged beyond the designated area, Electricorp will not purchase more land for inundation etc. Agreements will need to be reached concerning these potential floodable areas beyond the project area. Any structures located therein should be designed and constructed to the same standard as above.

(d) Water Level Fluctuation and Wave Movement

The design and siting of facilities and activities needs to take account of water level fluctuations and wave movement.

(e) Potential for Erosion

The action of both floods and lake level fluctuations will modify the profile of the shoreline. Certain areas are known to be "sacrificial" in that they will gradually erode to form a stable shoreline and development will not be approved in these areas.

(f) Siltation and Water Quality

Electricorp Production has only a requirement to monitor and not maintain water quality in the lake. Nevertheless potential adverse impacts from a development on sedimentation and water quality must be a consideration. Siltation can cause a reduction in the volume of the lake therefore reducing the operating range of the reservoir, and adversely affect lake aesthetics, aquatic plant growth and recreational uses. Deterioration in water quality due to events such as fuel spillage from boats, waste and sewage disposal has similar impact. Therefore in assessing proposals consideration will be given to the potential for siltation of the lake, effects on water quality and the potential for lake weed infestation.

(g) Geotechnical Considerations

A significant part of the reservoir margin is bounded by disturbed schist or mass movement areas some of which are being stabilised by Electricorp for reservoir safety purposes. The design of any proposed facilities in areas at risk from mass movement should therefore be based on detailed geotechnical assessment of slope stability of the immediate site and its effect on the surrounding area and cannot be allowed to compromise Electricorp's preventative works.

NOTE

In providing these guidelines Electricorp wishes to ensure that all applicants are aware of the conditions that it predicts are likely to prevail based on the information available to it in September 1989. Applicants are advised that predictions of future occurrences cannot be made with absolute certainty and that they will accept some risk in proceeding with development before conditions of the lake and surrounding areas have established.

Appendix E

Flood Model Results



REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/07/2026	DESIGNED	-
-	-	-	-	DRAWN	SB
-	-	-	-	CHECKED	BK
				APPROVED	BK

8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

WOODS Est.1970

P24-487 Parkburn
Internal Model Post-development
Flood Depth 5-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0001	

Legend

- Catchment 1
- Catchment 2

Maximum Depth

- 0m - 0.05m
- 0.05m - 0.1m
- 0.1m - 0.2m
- 0.2m - 0.3m
- 0.3m - 0.4m
- 0.4m - 0.5m
- 0.5m - 0.7m
- 0.7m - 1.0m
- 1.0m - 2.0m
- >2.0m

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/07/2026	DESIGNED	-
-	-	-	-	DRAWN	SB
-	-	-	-	CHECKED	BK
				APPROVED	BK

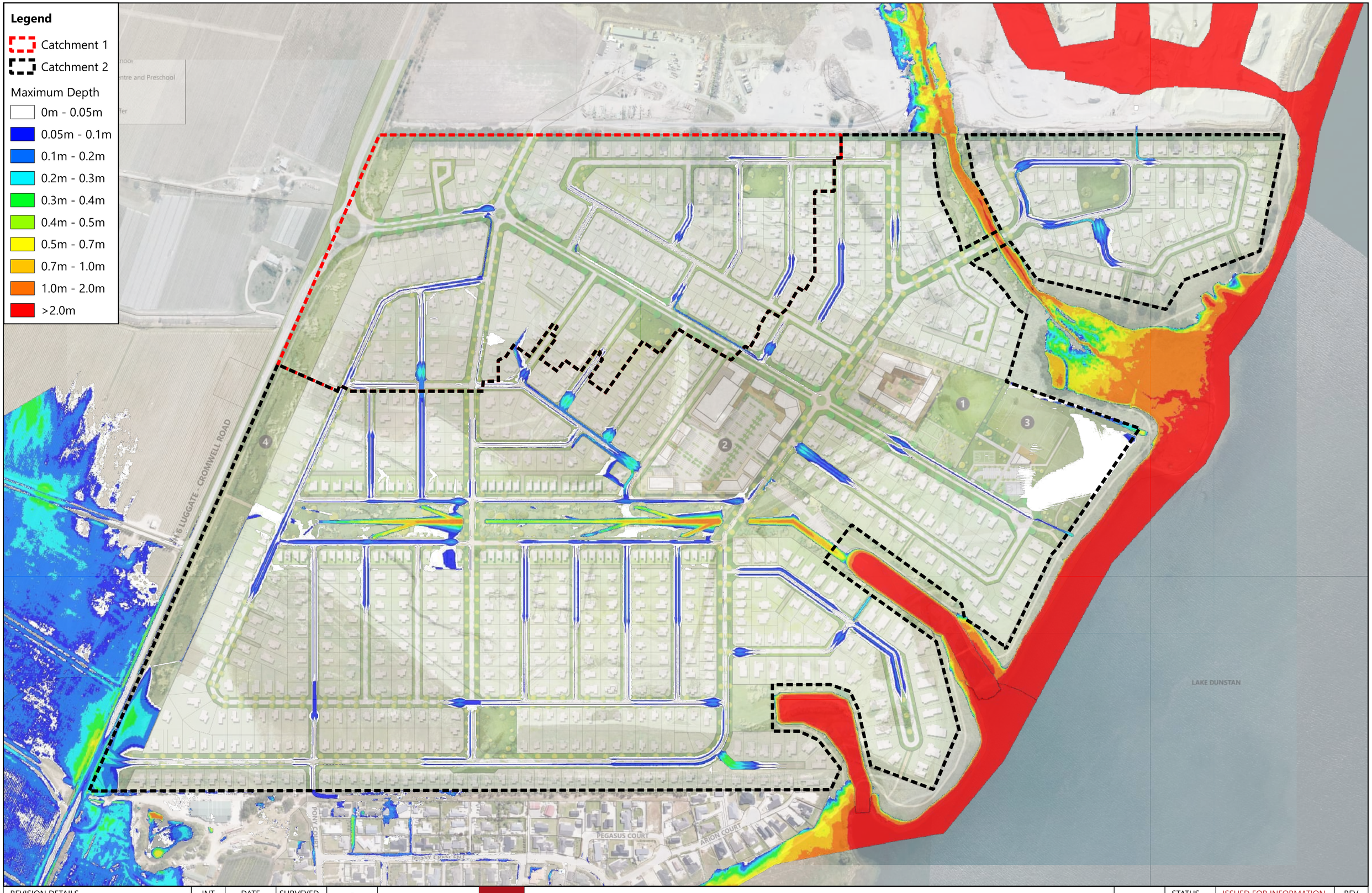
8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS
Est.1970

WOODS.CO.NZ

P24-487 Parkburn
Internal Model Post-development
Flood Depth 10-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0002	

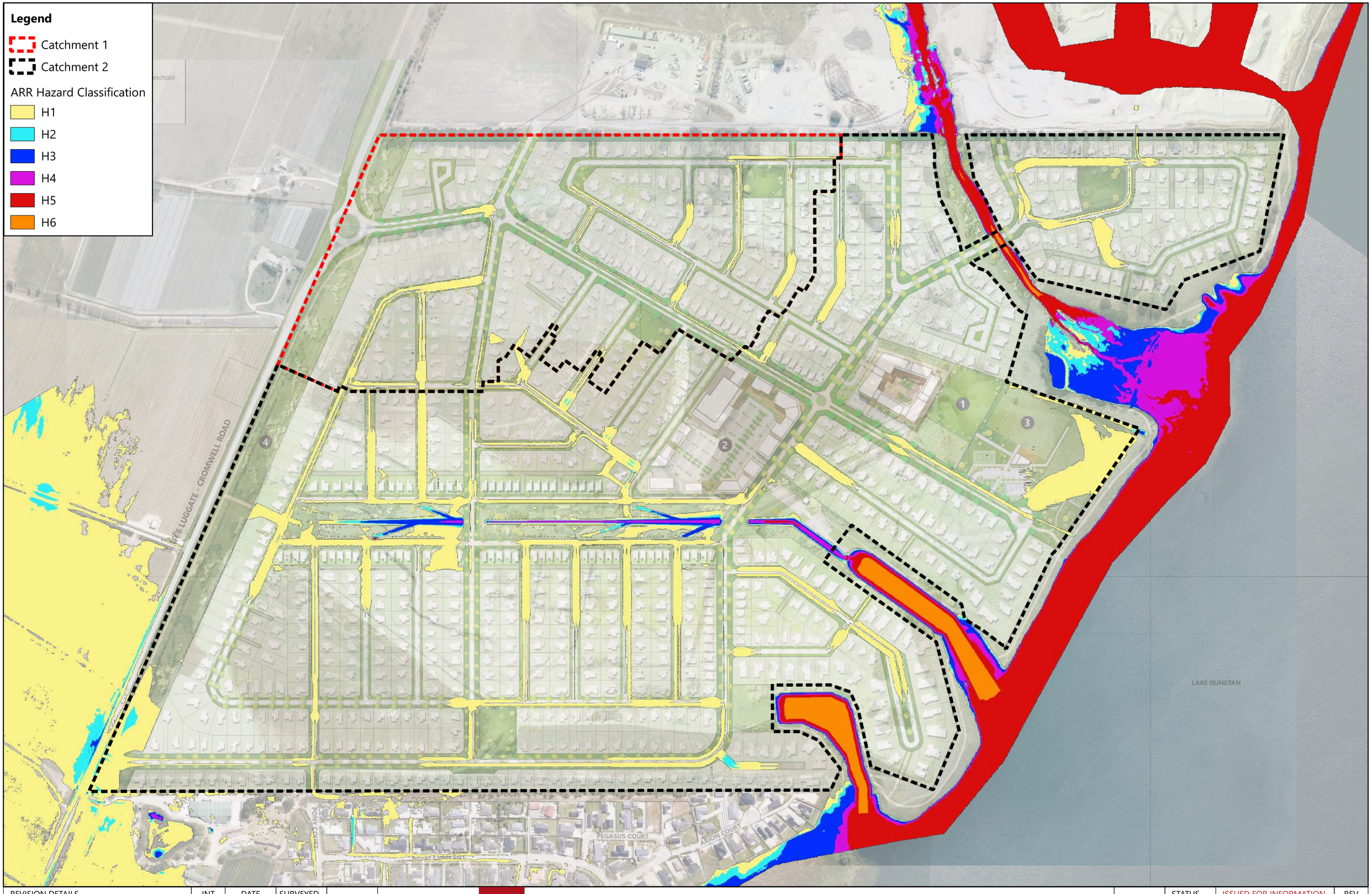


REVISION DETAILS		INT	DATE	SURVEYED	-	8 NUGENT STREET, GRAFTON, AUCKLAND 1023
1.0	For Information	-	22/07/2026	DESIGNED	-	
-	-	-	-	DRAWN	SB	
-	-	-	-	CHECKED	BK	
				APPROVED	BK	WOODS.CO.NZ

WOODS Est.1970

P24-487 Parkburn
Internal Model Post-development
Flood Depth 100-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0003	



REVISION DETAILS		INT	DATE	SURVEYED	-	8 NUGENT STREET, GRAFTON, AUCKLAND 1023
1.0	For Information	-	22/07/2026	DESIGNED	-	
-	-	-	-	DRAWN	SB	
-	-	-	-	CHECKED	BK	
				APPROVED	BK	WOODS.CO.NZ

P24-487 Parkburn
Internal Model Post-development
Flood Hazard 100-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0004	



REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/07/2026	DESIGNED	-
-	-	-	-	DRAWN	SB
-	-	-	-	CHECKED	BK
				APPROVED	BK

8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

WOODS Est.1970

P24-487 Parkburn
Internal Model Post-development
Flood Level 5-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0005	

Legend

- Catchment 1
- Catchment 2

Maximum Level

- < 196 mRL
- 196 - 200 mRL
- 200 - 204 mRL
- 204 - 208 mRL
- > 208 mRL

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/07/2026	DESIGNED	-
-	-	-	-	DRAWN	SB
-	-	-	-	CHECKED	BK
				APPROVED	BK

8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

WOODS Est.1970

P24-487 Parkburn
Internal Model Post-development
Flood Level 10-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0006	



REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/07/2026	DESIGNED	-
-	-	-	-	DRAWN	SB
-	-	-	-	CHECKED	BK
				APPROVED	BK

8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

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P24-487 Parkburn
Internal Model Post-development
Flood Level 100-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0007	



REVISION DETAILS		INT	DATE	SURVEYED	-	8 NUGENT STREET, GRAFTON, AUCKLAND 1023
1.0	For Information	-	22/07/2026	DESIGNED	-	
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-	-	-	-	CHECKED	BK	
				APPROVED	BK	WOODS.CO.NZ

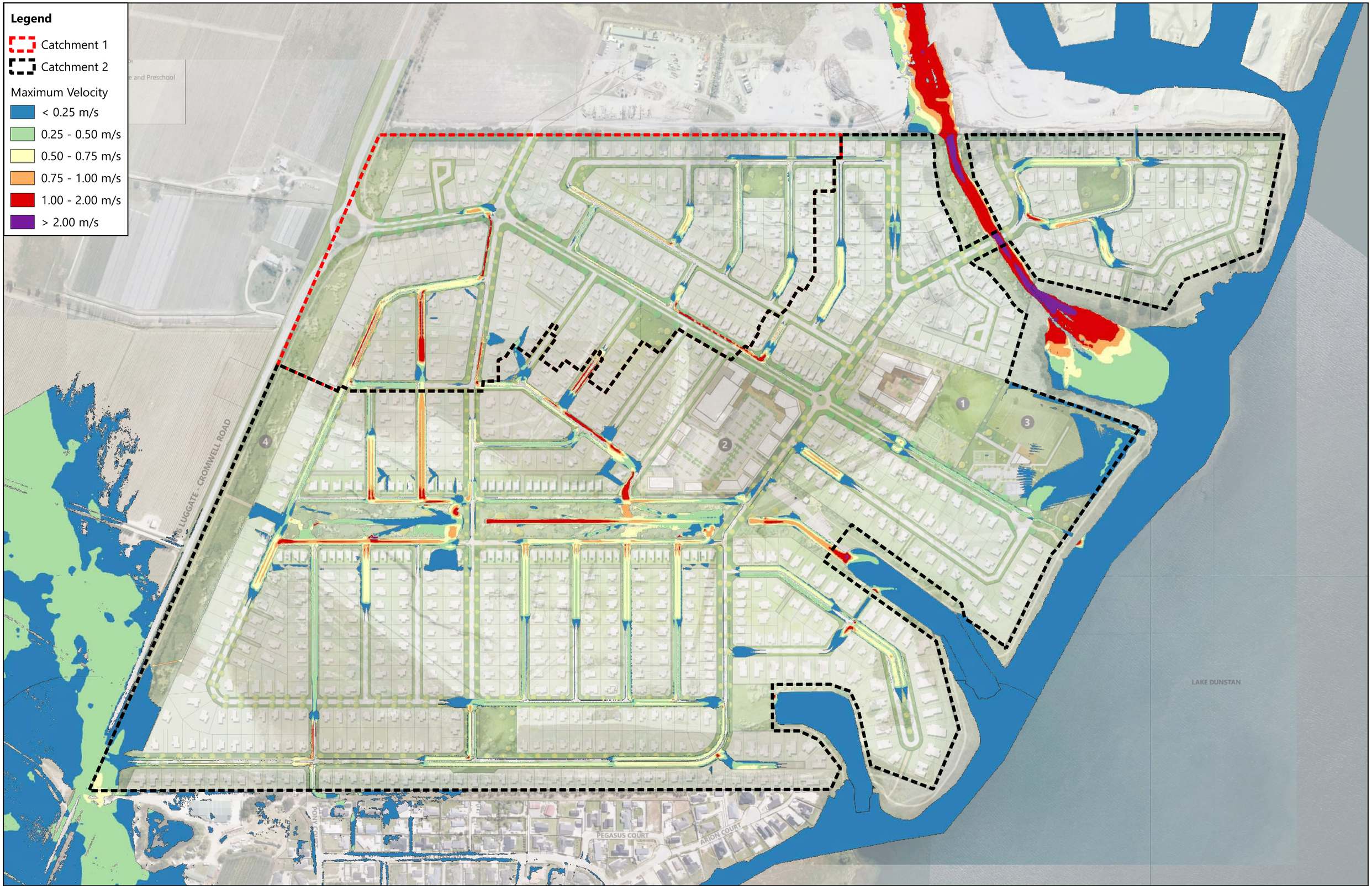
WOODS Est.1970

P24-487 Parkburn
Internal Model Post-development
Flood Velocity 5-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
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SHEET	P24-487 DR0008	



REVISION DETAILS		INT	DATE	SURVEYED	-	8 NUGENT STREET, GRAFTON, AUCKLAND 1023	WOODS Est.1970	P24-487 Parkburn Internal Model Post-development Flood Velocity 10-year ARI RCP 8.5		STATUS	ISSUED FOR INFORMATION	REV
1.0	For Information	-	22/07/2026	DESIGNED	-					SCALE	1:5000 @ A3	1.0
-	-	-	-	DRAWN	SB					COUNCIL	CENTRAL OTAGO	
-	-	-	-	CHECKED	BK					SHEET	P24-487 DR0009	
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REVISION DETAILS		INT	DATE	SURVEYED	-
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Flood Velocity 100-year ARI RCP 8.5

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1.0
COUNCIL	CENTRAL OTAGO	
SHEET	P24-487 DR0010	

Appendix D – Correspondence with Bonisch

Boniface Kinnear

From: Pranil Wadan
Sent: Wednesday, 26 February 2025 8:54 am
To: Boniface Kinnear
Subject: Fw: Parkburn Preliminary SW model results

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Pranil Wadan | BE Civil, CPEng, IntPE(NZ), CMEngNZ
General Manager - Water Infrastructure and Planning
Water Infrastructure and Planning
[redacted]

Warkworth | **Auckland** | Hamilton | Tauranga | Napier | Christchurch | Queenstown

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From: Tim James <[redacted]>
Sent: Tuesday, February 25, 2025 11:25:25 AM
To: Pranil Wadan <[redacted]>; Nathan Archer <[redacted]>
Subject: Fwd: FW: Parkburn Preliminary SW model results

---------- Forwarded message ---------
From: **Boyd Wilson** <[redacted]>
Date: Mon, Feb 24, 2025 at 5:39 PM
Subject: FW: Parkburn Preliminary SW model results
To: Tim James <[redacted]>
Cc: Scott O'Donnell <[redacted]>

Hi Tim

To follow is the summary of the stormwater modelling undertaken for the Parkburn sites.

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The volumes of water traversing the sites is significant, but the protection/engineering of the existing flow paths will ensure the surrounding houses are clear of the hazard.

We need to discuss several things:

1. Earthworks and predicted levels at the common boundaries
2. Access and approach to NZTA
3. Sewer and Water connections and possible developers' agreement with CODC
4. Planning process and approach

When would it suit to catch-up regarding the above?

Regards

Boyd

Boyd Wilson
MANAGING DIRECTOR

bonisch

[redacted]

[redacted]

0800 802 546

Level 4, 25 Esk Street , Invercargill

Connect with us bonisch.nz

LAND DEVELOPMENT SURVEYING PLANNING CIVIL ENGINEERING

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From: Simon Collie <[redacted]>
Sent: Monday, 24 February 2025 4:49 pm
To: Boyd Wilson <[redacted]>
Cc: Kieron Thorpe <[redacted]>
Subject: Fw: Parkburn Preliminary SW model results

Hi Boyd,

Kieron has undertaken a preliminary analysis of the flooding extents of Park Burn within 922A Luggate-Cromwell Rd, Mt Pisa.

High level summary is:

- Upstream catchment is approx. 15km2, with flows through the site at approx. 15m3/s in a 1%AEP event.
- There is a 200m wide floodplain through the site where flow spreads as it passes through in design events
- This should be able to be addressed through constructed channelisation through the site. At this stage we recommend a 40m corridor is allowed for in the site plan for a main channel, spillway and associated amenity elements. This should be able to be aligned to the current legal corridor, but some flexibility in this may be useful.
- Where flow exits the site it is re-channelised by an existing bund within the southern property
- The next key thing to understand for the site and stormwater design is looking into debris flow from the upper catchment, to ensure any channel design through the site deals with this risk.

Regarding your email around the exit point of flow and minimum floor level for an asphalt plant on the common boundary, it is too early to be able to provide definitive direction as this would be tied to earthworks volume balances etc. If it was temporary, you could select an appropriate level with reference to the bunding along the northern boundary and the flood plain extent shown in earlier images. We can look into this further if more information can be provided.

Below is Kieron's full summary:

Inundation Protection Standards

The **NZ Building Act** requires two levels of property protection:

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- The 10% AEP (1 in 10yr ARI) event shall be managed in a way that avoids the likelihood of damage or nuisance to other property.
- The 2% AEP (1 in 50yr ARI) shall not enter buildings.

The Central Otago Land Development and Subdivision Engineering Code of Practice is currently transitioning to basing itself on **NZS4044:2010 Land Development and Subdivision Engineering**, which stipulates:

- Primary stormwater systems in residential and rural residential areas shall be designed to cope with the 10% AEP / 10yrARI event
- Secondary flowpaths shall be designed to cope with the 1% AEP / 100yrARI event
- Habitable dwellings shall be set at a minimum freeboard of 0.5m above the 1% AEP / 100yrARI event

With regard to the **Central Otago District Plan** we understand the area is subject to Plan Change 19, rezoning new land for residential use, and that this is currently under appeal. We are unaware of any existing or potential change from the general requirements of the Act or the Code of Practice with respect to flood protection.

At this early stage we recommend **adopting for design purposes** the following:

- *The critical duration (peak flow) 100yr ARI event shall be contained within the reserve set aside for the Park Burn, without entering private property.*
- *For the above event, minor inundation of road corridors, e.g. at the crossings of the Park Burn, shall be acceptable if limited to within the H1 hazard level as defined by the Australian Institure for Disaster Resilience, Guideline 7-3, Figure 6, below.*
    - *In short, depths shall not exceed 0.3m unless velocity exceeds 1m/s, beyond which, up to v=2m/s, depths shall be progressively limited to 150mm. Depths beyond 0.3m and velocities beyond 2m/s shall not be permitted.*

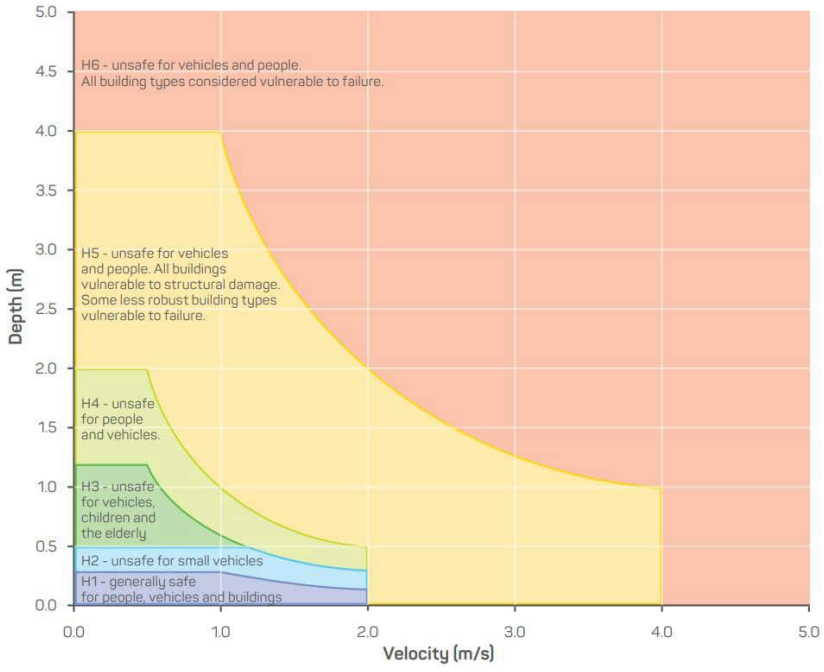


Figure 6: General flood hazard vulnerability curves

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Catchment & Design Flows

The Park Burn catchment covers an area of approximately 15.8 km². We estimate its critical event duration is in the order of 2.5 to 3 hrs, which is estimated to produce peak runoff flows in the orders given below.

Average Recurrence Interval (ARI), yrs	10	20	50	100	1000
Annual Exceedance Probability (AEP)	10%	5%	2%	1%	0.1%
Peak flow (including allowance for climate change), m³/s	9	11	13	15	20

The catchment is not gauged, so these are best estimates only, based on several assessment methods (Henderson & Collins 2018 (adopted), McKerchar & Pearson 1989 (supporting), TP108 (rejected), Rational Method (rejected)).

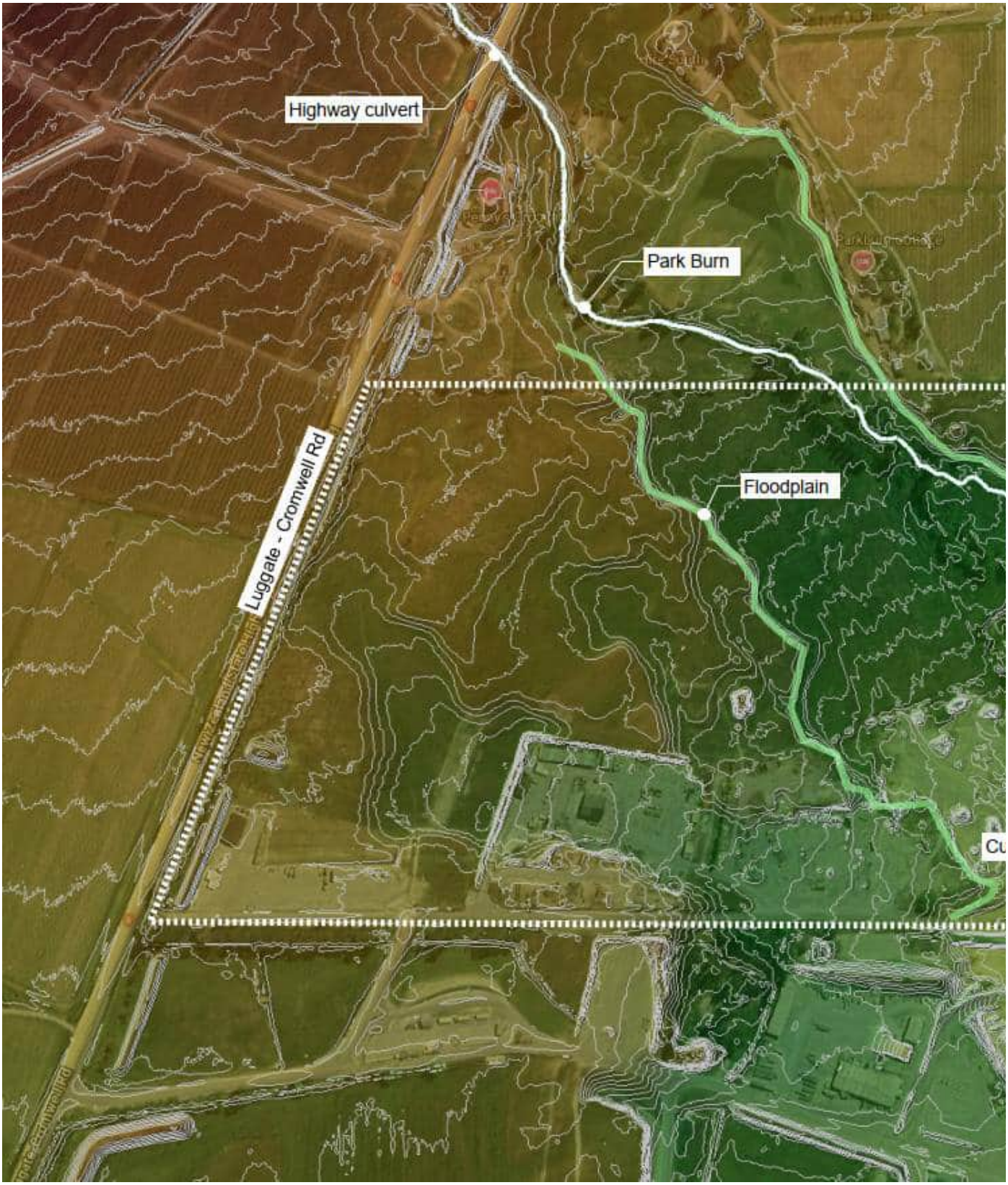
We include a modest allowance for climate change, approximately aligned with the RCP 6.0 (medium high) carbon emission scenario.

The precision is limited to the nearest 1 m³/s to discourage any impression of high accuracy.

Topology

The models consider only the existing topography of the area, derived by LiDAR survey circa December 2024. The site exhibits a notable alluvial floodplain, roughly 200m across. There is strong evidence of historical channel braiding through this area - see results below.

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Modelling Methodology

Preliminary flood modelling includes both two-dimensional and one-dimensional modelling. The latter acts as a sense check of the former. Reasonable to good agreement exists between the two.

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Both models consider a nominal steady state (continuous) flow equal to the peak flows given above.

The 2D model applies these flows to the existing channel approximately 1.4km upstream of the highway, in order to assess the channel capacity in this reach, as it flattens out into the floodplain. The results suggest that the channel contains most flows up to a 1 in 100yr event.

Other, minor inflow into the development site may exist, but we consider these are unlikely to induce a significant increase to the flows we adopt.

Similarly, once developed, the site itself will produce more runoff. However the development's response time will be much faster than the wider Park Burn catchment, so its impact in the kind of events that will produce peak flows in the Park Burn is expected to be minimal.

Hydraulic Structures

Park Burn passes through three culverts in the area (labelled above).

The existing 3-box concrete culvert under the Luggate Cromwell Highway is considered in two states:

1. maximum impedance: with the culvert fully blocked, such that all flows from upstream must spill over the highway.
2. minimum impedance: as an extension of the channel cross section through the highway, with no culvert roof / highway surface. Note that even in this case, for the large events considered, a portion of flows escape the channel and spill across the highway.

In reality the culvert is estimated to have a capacity (i.e immediately prior to overtopping the road) in the region of 5-15m^3/s.

Two culverts further downstream are modelled via the latter method. These produce a limited backwater effect, which leads to conservative results in the lower part of the site.

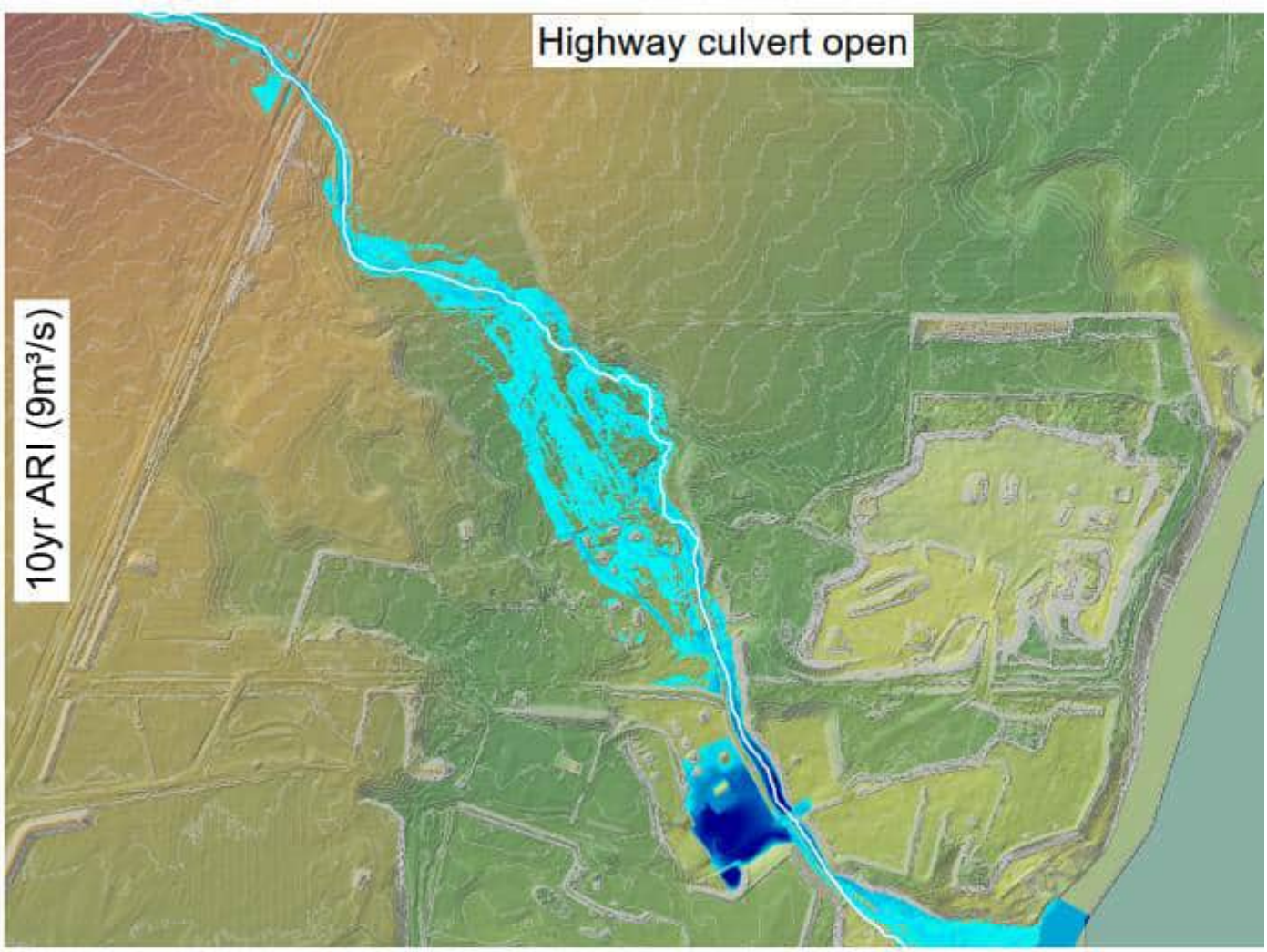
The behaviour of the culverts will be refined in future model revisions if required.

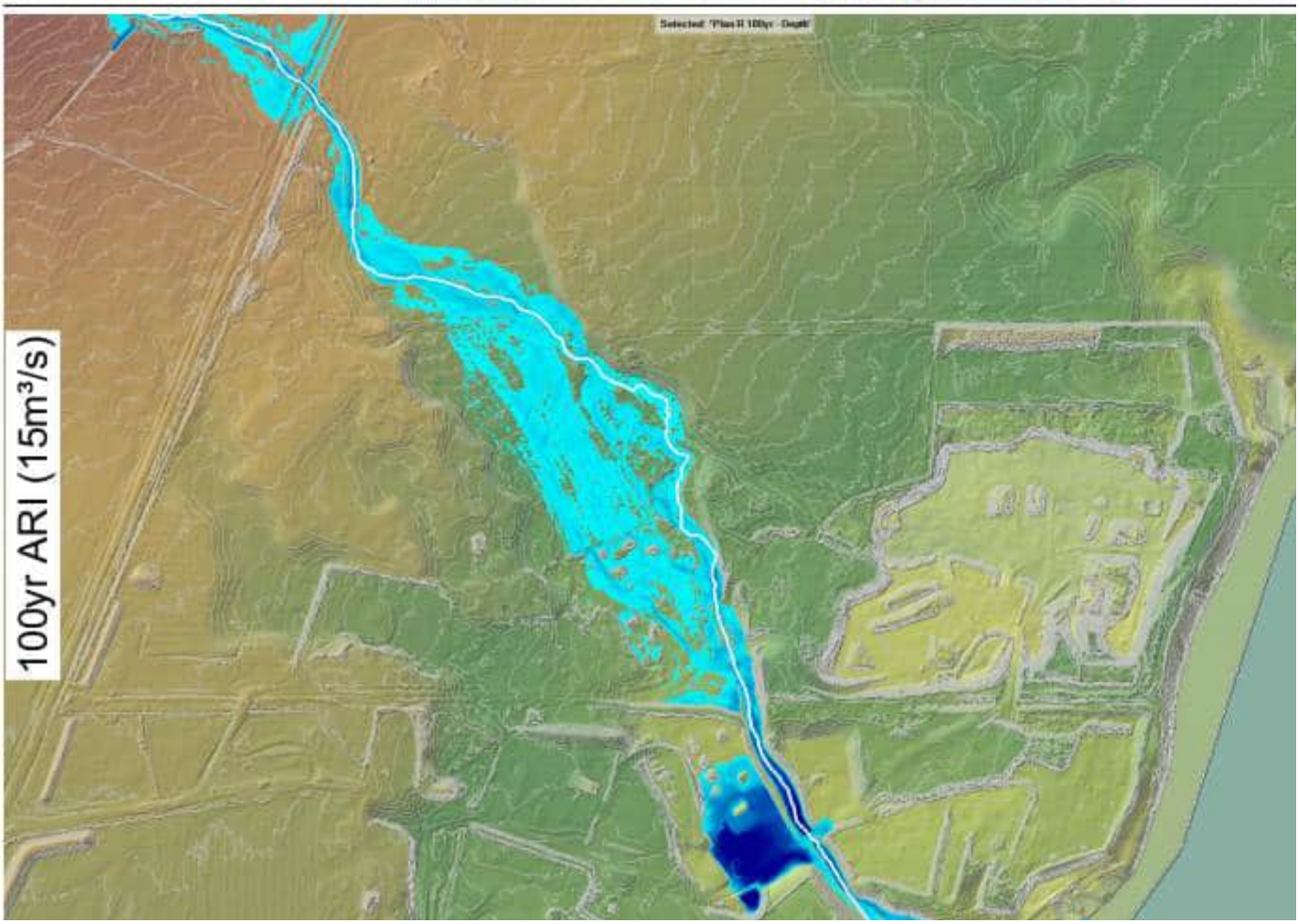
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Preliminary Flooding Extents

Peak flood extents for four scenarios are given below. These are the 10yr and 100yr flood, against the minimum (open) and maximum (blocked) highway culvert impedance:

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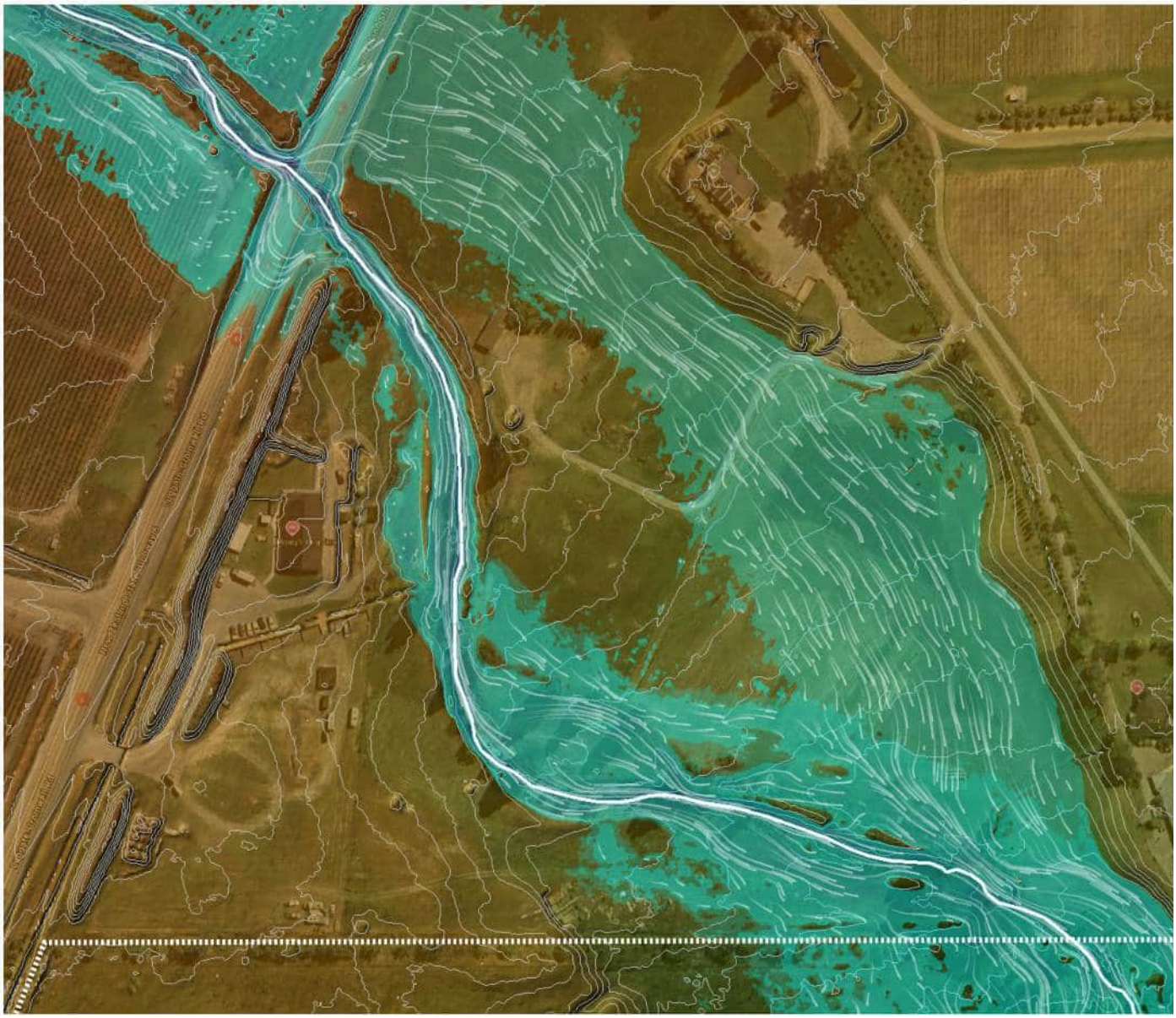




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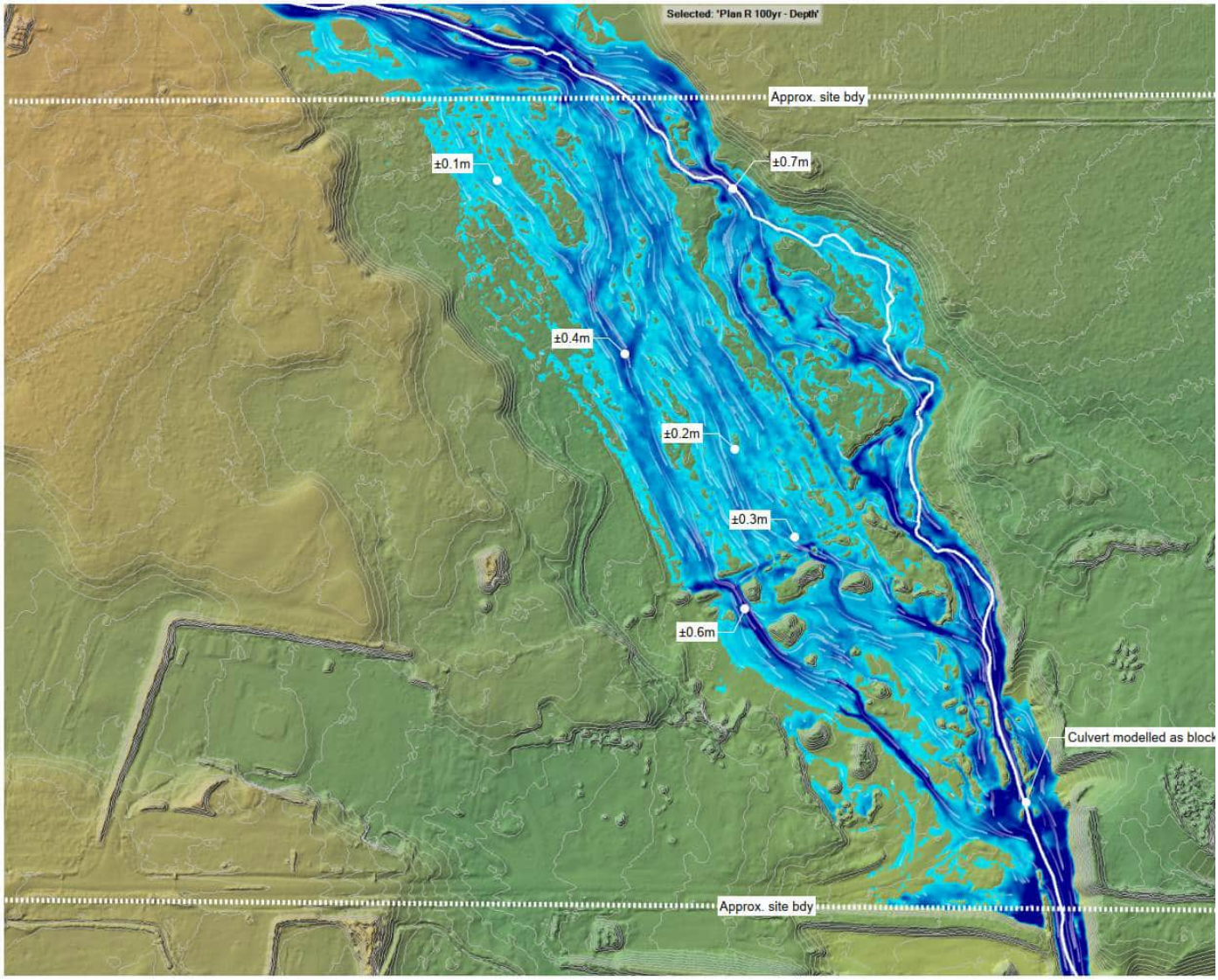
Commentary

Breakout flooding over the highway is largely recaptured by the channel prior to entering the site. Mild bunding along the north boundary appears to play a role in this, but the traversal of the channel from the true right to left of the floodplain appears to be a greater factor. We surmise then that the behaviour of the highway culvert, specifically its risk of blockage, is not critical to flood behaviour within the site. This is the 100yr event with the highway blocked:



Flooding within the site (outside of the channel) is generally in the region of 100-300mm, dispersed, and low velocity (<0.5m/s). Historical channel braids appear to recapture the flow and redirect it to the main channel towards the downstream end of the site. Again, the modified landforms on or near the south boundary - notably the quarry track and a significant bund on stream right / south site boundary - appear to play a significant part. This is the 100yr flood:

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The alluvial nature of the site itself and the upstream catchment (comprised of friable, erodable, sandy/loamy soils with high particulate rock content) will continue to produce significant debris flows, particularly during large events. We note the evidence of this presented in the StreetView images at the highway culvert:

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The topology of the developed site should be carefully considered to ensure this risk is well managed. The risk of debris flow needs to be assessed and quantified to inform the channel conveyance design through the site. The management of this risk needs to be understood also between the various parties including NZTA, CODC and ORC.

We believe it should be possible to convey the 100yr flood through the site within the corridor set aside in the Baxter Design "Parkburn Quarry Concept Masterplan". A preliminary hydraulic assessment suggests that a corridor in the region of 40 to 50m wide should suffice. This allows for some naturalisation of the channel (meander, riffle & run, pools, etc), landscaping improvement (planted areas, playgrounds, furniture, etc), and maintenance access (a trafficable track, suitable for an excavator & ancillary equipment, floodable when necessary).

Below is a 40m corridor (orange lines), offset from a centreline aligned with the existing Crown Land corridor through the site, overlaid on the above concept plan. We note:

- The area set aside by the concept layout appears to be marginal in terms of containing the 100yr flood and is almost certainly insufficient at its upstream end.
- The existing topography that results in recapturing the flow at the north boundary would need to be retained and potentially enhanced. We show a potential arrangement.

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- The impact on neighbouring property may need to be carefully considered, and the design amended accordingly, to avoid any significant departure from current geomorphological behaviours (e.g. debris flows).
- The two road crossings shown must provide adequate flood capacity such that they do not generate undue backwater effects.



Next Steps

- It is key to begin understanding debris flow risk from the upper catchment, and how this interfaces with the site.
- Further detailed modelling will be required as the site shaping and strategy is developed.

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