

**BEFORE THE COMMISSIONERS APPOINTED BY THE CENTRAL OTAGO  
DISTRICT COUNCIL**

**UNDER** the Resource Management Act 1991

**IN THE MATTER** of RC230179 an application for a 33-lot  
subdivision at Rocky Point on Tarras-  
Cromwell Road (SH8)

**BY** **TKO PROPERTIES LIMITED**

Applicant

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**STATEMENT OF EVIDENCE OF BRONWYN RHYND**

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Dated: 3<sup>rd</sup> November 2024

## **Statement of evidence of Bronwyn Rhynd**

### **Introduction**

- [1] My name is Bronwyn Patricia Rhynd.
- [2] I hold the position of Director and environmental engineer at CKL NZ Ltd. I have held that role since 1 May 2015. Previously, I was employed by Stormwater Solutions Consulting Ltd where I held the position of Managing Director and environmental engineer. I founded Stormwater Solutions Consulting Ltd in 2004 and was the Co-Director since its inception on 4 September 2004 until merging with CKL over a decade later, on 1 May 2015.
- [3] I hold a New Zealand Certificate in Civil Engineering from NZQA in 1986, a Bachelor of Engineering from the University of Auckland in 1998, and a Masters in Environmental Engineering Science from the University of New South Wales in 2010. I am a full member of Engineering New Zealand and am registered as a Chartered Professional Engineer as well as being registered on the New Zealand Section of the International Professional Engineers. I have been made a Fellow of Engineering New Zealand and received this recognition of my contribution to the engineering industry on 21st March 2020.
- [4] I have over 20 years professional experience in the water resource area. My expertise is in that area, with a focus on stormwater treatment, disposal, and management. I also have experience and expertise in flood and flow regulation. I have been involved in many projects that have required an assessment of effects with regard to stormwater and overland flow path management for projects and catchments that are either greenfields or have established land uses which vary from residential, commercial, and industrial. These projects have been throughout New Zealand. This means that in the course of my practice, I have and regularly liaise with other industry professionals and territorial authorities regarding appropriate stormwater management solutions
- [5] I have been instructed by TKO Properties Limited to give evidence regarding stormwater management and flood risk matters in respect of

RC230179, an application for a 30-lot subdivision at Rocky Point on Tarras-Cromwell Road (SH8).

### **Code of conduct for expert witnesses**

[6] While this is not an Environment Court hearing I have read and agree to comply with the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023. This evidence is within my area of expertise, except where I state that I am relying on material produced by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

### **Scope of evidence**

[7] My evidence will address:

- (a) my involvement in the project
- (b) my assessment of the appropriateness of the proposal from a stormwater management servicing perspective.
- (c) my original stormwater and flooding assessment, including any updates or changes to that assessment, as appended to this evidence
- (d) the matters raised by submitters; and my response to these matters to the extent these have not been addressed in (b), and
- (e) my response to the matters raised by the Central Otago District Council's planner in its section 42A report.

### **Executive summary**

[8] My assessment focuses on the critical aspects of stormwater management and flood risk, considering the site's unique characteristics and the potential effects of the development on the receiving environment.

[9] Several stakeholders have expressed concerns about the project, including Iwi, the Department of Conservation, Waka Kotahi, and other individuals. These concerns largely relate to the potential impact on the

natural environment, including water quality, indigenous vegetation, and the overall character of the landscape.

- [10] A comprehensive Stormwater Management Plan (SMP) has been developed for the Rocky Point subdivision. This plan, informed by detailed hydrological analysis and hydraulic modelling, incorporates a range of best practice options designed to mitigate potential adverse effects.
- [11] While this development is considered low contaminant generating, the SMP incorporates measures such as using non-contaminant building materials and incorporating swales for water quality treatment
- [12] The plan details strategies for managing both primary flow and secondary flow conveyance. This involves the use of techniques such as rain tanks, soakage systems, road swales, maintaining existing watercourses, and culverts for road crossings.
- [13] The flood assessment identifies five existing overland flow paths (OLFPS) traversing the site. OLFPS can be accommodated within the layout of the development. However, there is one associated with an existing watercourse adjacent to Bendigo Loop Road, which traverses lots 27-30. There is to be a slight modification of the (watercourse) alignment to accommodate building platforms while maintaining existing entry and exit points to the subject site to ensure there is no impacts upstream and downstream with respect to conveyance of flows.
- [14] The watercourse modification will include culverts for road and driveway crossings. Side slopes will be planted for visual amenity, stability, and maintenance purposes. The depth of 100yr flow through the watercourse will provide sufficient freeboard to the build platforms proposed within these lots 27-30.
- [15] Importantly, flood modelling demonstrates that the proposed development will result in minimal changes in flood levels downstream and will not impact the operation of the State Highway or adjacent land uses.

- [16] The SMP is designed to ensure that effects on water quality and quantity are minimized, helping to preserve the mauri of the surface water. Specific measures outlined in the plan include the strategic placement of structures to reduce water velocities and prevent soil erosion, the use of inert materials to minimize contamination, the implementation of retention tanks to decrease roof runoff, the provision of swales for treating runoff before discharge, and the incorporation of soakage systems to reduce surface runoff and recharge baseflows where geotechnical conditions permit.
- [17] Recognizing the presence of indigenous vegetation and potential impacts on biodiversity, the implementation of the SMP will mitigate the development's effects.
- [18] Addressing concerns about potential stormwater runoff onto the state highway, the flood assessment provides assurance that the highway will not experience increased flood risk due to the development. The plan also outlines that the necessary intersection upgrade will adhere to the SMP's principles, further minimizing any potential impact.
- [19] The Section 42A report raised concerns about potential changes in stormwater runoff patterns that could affect saline areas, particularly lots 23 and 25. While the SMP outlines general mitigation measures, the location and design of the discharge points will be carefully determined during the detailed design phase. This approach ensures that runoff from impervious surfaces is discharged effectively while protecting the sensitive saline areas.
- [20] It is my opinion that the comprehensive Stormwater Management Plan effectively addresses the concerns raised by various stakeholders and the Section 42A report. By implementing the outlined best practices and mitigation measures, the development can move forward while safeguarding the natural environment and cultural values of the Rocky Point site.
- [21] In conclusion it is my opinion that the proposed development can proceed without detrimental effects on the environment with respect to stormwater and flood management.

### **My involvement and engagement**

- [22] My involvement in the TKO Properties Ltd (TKO) site has been since November 2023 when I was engaged to provide stormwater and flood management expertise for the subdivision project.
- [23] I have led the CKL team in providing stormwater management advice and design in respect of the Rocky Point subdivision and in respect of this hearing.
- [24] I have visited the site virtually, through various consultants' reports, photographs, and virtual streams, and physically on 14<sup>th</sup> December 2023.

### **Stormwater Management and Flooding Assessment - Summary**

- [25] I have assessed various options for the management of stormwater and flood risk analysis for this development, as discussed within CKL's "Stormwater Management and Flood Risk Assessment" report (provided to Central Otago District Council within the application material). An overview of this report is included in the following paragraphs.
- [26] A stormwater management and flood risk assessment has been undertaken for the Rocky Point proposed subdivision at Bendigo Loop Road, Central Otago. This assessment provides guidance to support resource consent and the future design stages for the delivery of this subdivision

The best practicable stormwater management plan has been developed to deliver the overarching Rocky Point strategic principles and objectives of how the site's stormwater is to be managed. High-level objectives are designed to be consistent with the regulatory requirements, which are:

- (a) Minimising or mitigating any detrimental effects of urban development on the receiving environment.
- (b) Meeting the Central Otago District Council Guidelines and other regulatory requirements

- (c) Initiating best practice low-impact design that integrates with urban design.

These objectives are the cornerstone to preparing the Stormwater Management Strategy for Rocky Point. As a result, the approach to Stormwater management in this area has the objective of minimising or mitigating any detrimental effects of urban development on the receiving environment

[27] The stormwater management plan addresses the elements of stormwater quality, primary and secondary flow conveyance.

[28] With respect to stormwater quality: This development could be considered a low contaminant generating environment, however specific quality mitigation principles are to be adopted. These are managed in the following ways:

- (a) Non contaminant generating building cladding and architectural features.
- (b) Integrated primary flow conveyance with water quality management techniques.

- (i) Swales for both quality and conveyance capability

[29] With respect to Primary flow conveyance, the primary flow conveyance is associated with the 10yr<sub>CC</sub> ARI rainfall events and are managed in combination with the other stormwater management attributes of quality and secondary flow conveyance. Management systems must consider the site's topography and soil conditions. In summary the application of best practicable options are:

- (a) Rain tank for lots for retention purposes, if (each lot) site conditions allow.
- (b) Soakage system: recommended for lots only where geotechnical constraints are deemed acceptable.
- (c) On – lot private connection is dependent on individual lot site condition, as follows

- (i) To proposed road swale.
- (ii) To existing watercourses and/or natural ground topography

[30] It is to be noted that attenuation is not required for discharge of runoff from the proposed development for both primary and secondary conveyance, as the effects of the increase of runoff can be accommodated within the site development design without causing detrimental effects.

[31] With respect to secondary conveyance: The secondary conveyance is associated with the 100yr<sub>CC</sub> ARI rainfall events and are managed in combination with the other stormwater management attributes of quality and primary flow conveyance. In summary the application of best practicable options are:

- (a) Swales for conveyance of road runoff and lot discharge where appropriate.
- (b) Existing watercourses and overland flow paths are to be maintained and accommodated within the Access roads, ROWS and lot design.
- (c) Provide adequate culverts for conveyance of flow under roads.

[32] Flood modelling and a flood risk assessment has been undertaken to determine the flow presence, location and magnitude during large rainfall events and changes to these due to the proposed development. The hydrological analysis and hydraulic modelling have been assessed for a 100yr<sub>CC</sub> ARI rainfall event, including the effects of climate change, for the subject site and contributing catchments. The outcome of this assessment is summarised as follows:

- (a) 5 OLFPs pass through the site
- (b) All overland flow paths are accommodated within the natural gullies and watercourses.
- (c) Minor modification of OFLP is to occur within subcatchment 5 to allow for lots 27-30



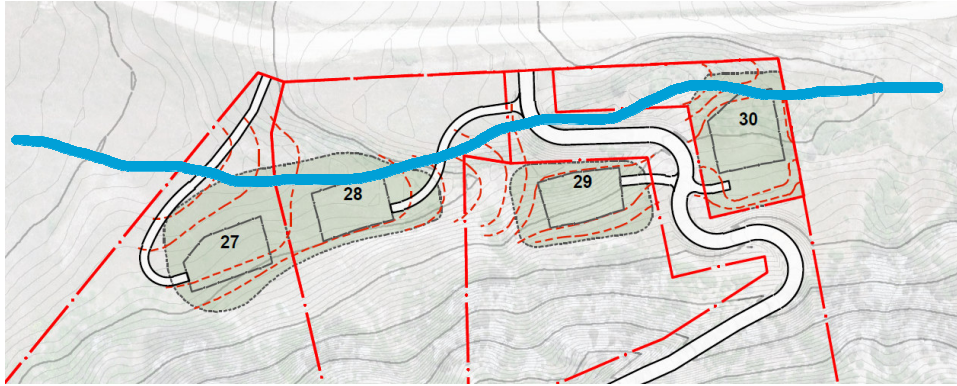
- (d) Lot 27-30 (inclusive)
  - (i) Associated with sub catchment #5
  - (ii) Flow maximum depth between 130mm - 980mm in these lots.
  - (iii) Future development within lots will require further assessment with regard to development adjacent to this flow path.
  - (iv) Refer to Paragraphs 34 to 38, inclusive, for assessment of watercourse accommodation within these lots
- (e) Development within the Rocky Point subdivision will need to adhere to NZ Building code for any mitigation with respect to freeboard.
- (f) Downstream effects
  - (i) The change in flood levels is minimal, between 7mm and 33mm, which could be considered as within the tolerances of modelling.
  - (ii) There is no change in use of land due to flood flows post development.

### **Stormwater Management and Flooding Assessment – Changes since lodgement**

[33] There have been minor changes to the stormwater management and flood risk assessment report since the lodgement. The changes are due to the following aspects, and are included in the addendum [Exhibit BR1], to the submitted report, titled “Stormwater Management and Flood Risk Assessment” Rev 2 dated 12/07/2024:

- (a) Change to scheme plan layout
- (b) Responding to submissions
- (c) Responding to Section 42a findings

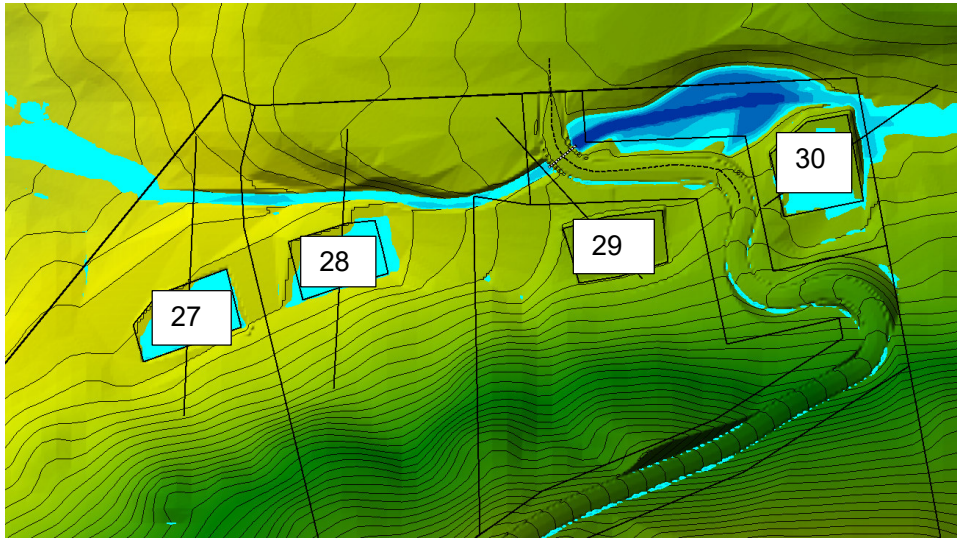
[34] Lots 27 to 30 inclusive accommodate a watercourse which traverses from east to west in the northern sector of each lot. This is shown as a blue line in the following snip of the scheme plan [exhibit BR2].



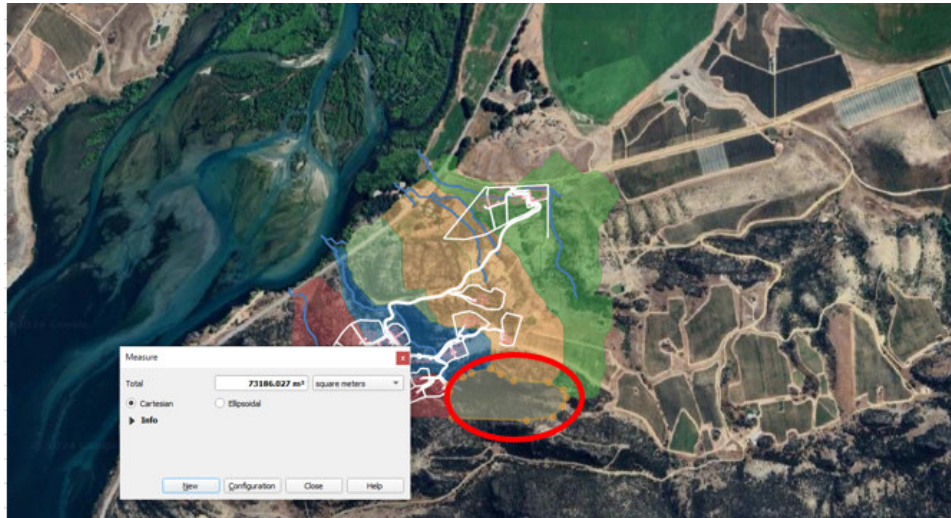
[35] It is to be noted that the scheme plan has been updated on 31<sup>st</sup> October 2024, to accommodate the driveway layout to Lot 28. This change has not been included in the hydraulic modelling of the watercourse modification. However, for completeness the alignment of the watercourse, prior to modification, is presented in the following snip from the revised scheme plan dated 31 October 2024 [Exhibit BR3]



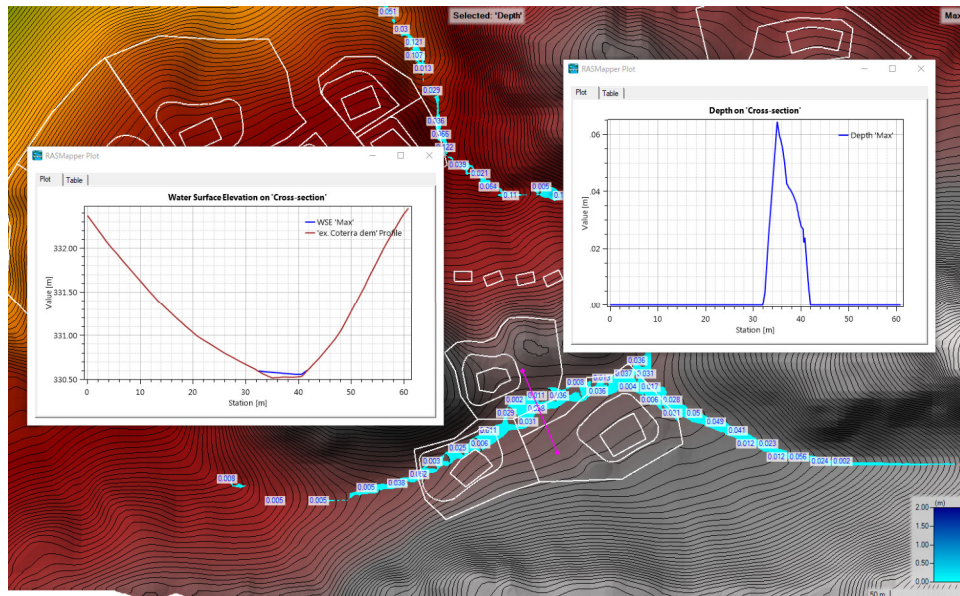
[36] The proposed management of this watercourse flow is to modify the alignment of the watercourse slightly to accommodate the future (proposed) lot building platforms whilst maintaining the entry and exit points of the existing watercourse alignment. Which is illustrated in the following diagram which is a view from the flood modelling of the final ground model with the watercourse and the 100yr<sub>CC</sub> rainfall runoff.



- [37] This modification will include culverts for road crossings, such as the main accessway and any driveways to Lots 27 and lot 28. These culverts are to be sized for 100yr rainfall events including the effects of climate change.
- [38] The watercourse internal gradient will have a continuous fall from the entry to exit of the site with a base width of approximately 3m and side slopes of no steeper than 3H:1V. This is in keeping with the capacity of the geology. The side slopes will be planted for visual amenity, stability and maintenance purposes.
- [39] The depth of flow is between 130mm and 980mm during the 100yr rainfall event from the upper reaches within the site to lower to which the platforms are located between 1050mm and 2100mm above this flow depth, at the centroid of the platforms presented in the scheme plan [exhibit BR2]
- [40] The flood modelling has been refined in Catchments 1 and 2 which are the southernmost catchments associated with the subject site. This refinement is with respect to the response of the overland flow during the larger rainfall events and the interaction with this flow path for Lots 19 to 20 inclusive.
- [41] The location of the refinement is presented in the following figure:



- [42] The upper catchment is in the order of 7.3ha with the surface flow that traverses through the Lots 19 -20 in the east to west direction with a peak flow of circa 380L/s during 100yr ARI rainfall event including the effects of climate change.
- [43] The depth of flow reaches a maximum of circa 70mm between lots 19 and 20. This is illustrated in the figure below



- [44] The alignment of the flow path and conveyance of flow can be accommodated within the fully developed lots. This can be within the driveway design and placement of building platforms without detrimental effects to the built and natural environment

## Submissions

[45] The relevant submissions to stormwater have been addressed as follows.

### ***Iwi Auhaka (Kāti Huirapa Rūnaka ki Puketeraki, Te Rūnanga o Ōtākou and Te Rūnanga o Moeraki (Kā Rūnaka))***

[46] Iwi Auhaka (Kāti Huirapa Rūnaka ki Puketeraki, Te Rūnanga o Ōtākou and Te Rūnanga o Moeraki (Kā Rūnaka)) oppose the application. Their concerns pertaining to stormwater are:

- (a) Kā Rūnaka are concerned about inappropriate development and intensification which changes the character of the ancestral landscapes in their takiwā. Key amongst these concerns are stormwater and wastewater management approaches that have the potential to degrade the mauri of the receiving cultural landscape. These development activities alter the natural elements of a landscape and wai māori, and have a very real potential to undermine the role of Kā Rūnaka as rakatira and kaitiaki of all natural resources.

[47] Response:

- (a) The “Stormwater Management and Flood Risk Assessment” and addendum to this report, provides a detailed hydrology assessment for the proposed development, as detailed in Section 6. Five sub-catchments were delineated which reflect the stormwater runoff patterns associated with the overland flow path within the site.
- (b) The increase in the 100yr<sub>CC</sub> rainfall event (including effects of climate change) peak flow within each sub-catchment (due to the developments increase in impervious area) was found to be:
  - (i) Sub-catchment 1 = 26 L/s = 2.8%
  - (ii) Sub-catchment 2 = 45 L/s = 4.5%
  - (iii) Sub-catchment 3 = 0.0 L/s = 0.0%

- (iv) Sub-catchment 4 = 20 L/s = 0.7%
  - (v) Sub-catchment 5 = 19 L/s = 1.5%
- (c) The minor increase of flow during rainfall events, up to 100yr<sub>CC</sub> ARI rainfall event, indicates that this flow is likely to be accommodated in the current OLFP's and gullies within the site and downstream environment.
- (d) The small increase in top water level has been identified near SH8 adjacent to the culverts under the road carriageway, of up to 33mm. This is considered minor
- (e) Providing the stormwater management plan will guide the development to honour the objectives and principles of upholding the mauri of the natural resource (water) and protect the downstream environment. Examples of the implementation of the objectives and principles are:
- (i) Structures to reduce velocities (level spreaders, riprap aprons, swale check dams) which will also prevent erosion of the soils
  - (ii) Use of inert material, such as cladding, will result in a low contaminant environment,
  - (iii) Installation of retention tanks to decrease roof runoff, where possible
  - (iv) Provision of swales for treatment of runoff prior to discharge
  - (v) Where geotechnical conditions allow, soakage systems will be implemented to decrease surface runoff and provide recharge of baseflows.
- (f) With respect to kaitiakitanga, the objective of the SMP is to ensure that the effects on water quality and quantity due to the proposed development will be less than minor.

(g) It is my opinion that the successful implementation of the stormwater management plan will preserve the mauri of the surface water being a precious toanga of the environment.

[48] The relationship of Kā Rūnaka with the Mata-au catchment is a matter of national importance that must be recognised and provided for in managing natural and physical resources. The discharge of stormwater and wastewater are a threat to the values of this wāhi tūpuna landscape and the relationship of Kāi Tahu with the Mata-au.

[49] *Response:*

(a) Refer to the response above in Paragraph 46.

[50] Given the scale of the application, Kā Rūnaka have specific concerns about the on-site wastewater and stormwater management and uncertainty regarding how these discharges will be managed. Groundwater and nearby surface water contamination is always a potential with on-site disposal.

[51] Kā Rūnaka are concerned about the uncertainty regarding on-site stormwater treatment. The Wastewater Suitability Report states that onsite stormwater disposal could be problematic across the proposed site due to a combination of low permeability soils and depth to rock and states that stormwater runoff from site should mimic that of pre-development conditions. However, it is unclear how stormwater will be managed to protect the receiving environment.

[52] *Response:*

(a) Refer to the response above in Paragraph 46.

***The Department of Conservation***

[53] The Department of Conservation (DOC) oppose the application:

(a) The proposed activity would have adverse effects and potentially significant adverse effects on the environment with the proposed clearance of four hectares of indigenous vegetation in an

ecosystem dominated by at-risk plant species, and with the presence of at least two threatened plant species.

***The application has not made mention of the conservation covenant.***

***The site contains significant indigenous biodiversity values and is a significant natural area using the assessment criteria in Appendix 1 of the National Policy Statement for Indigenous Biodiversity 2023 (NPSIB).***

- (b) The application and assessment of effects has not fully identified the Threatened or At-Risk species present and affected by the proposed activity. Therefore, the assessment of effects is inadequate.

[54] Response:

- (a) No specific effects of stormwater infrastructure have been identified, however the implementation of a stormwater management plan, as recommended and within the application, will mitigate the effects of the development.

***Waka Kotahi***

[55] Waka Kotahi opposes the application. Their concerns pertaining to stormwater and flooding are:

- (a) Submitter indicates that an upgrade of the SH8/Bendigo Loop Road intersection would be required, along with a separate right hand turn bay.
- (b) It is also noted that stormwater must be managed entirely on site so that there is no runoff onto the state highway or into the state highway stormwater network.
- (c) The detailed design of the intersection upgrade must include devices to manage and treat stormwater runoff from the increased pervious area due to the upgrade.



[56] Response:

- (a) The flood assessment, summarised in the SMP and addendum, provide confidence that the highway will not be exposed to greater flood risk than currently experienced during large rainfall events.
- (b) The detailed design of the intersection upgrade will follow the objectives and principles of stormwater management as outlined in the SMP.
- (c) It is my opinion ta the effects of the intersection upgrade can be mitigated by implementation of the SMP and protect the receiving environment.

***H. Pledger, K. Wardle, L. Lucas, P. Blakely, R. Moorehouse, and S. Kenderdine***

[57] There were 6 other submissions which opposed the application due to adverse effects on the outstanding natural landscape, ecology and natural character: H. Pledger, K. Wardle, L. Lucas, P. Blakely, R. Moorehouse, and S. Kenderdine.

[58] Response:

- (a) Whilst the submissions do not directly relate to the stormwater and flooding matters the implementation of the SMP will provide support with respect to protection of natural landscape, ecology and natural character of the Rocky Point development site and receiving environs.

#### **Section 42A responses**

[59] In response to relevant sections of the S-42A report, both the original s42A report and the addendum, I comment as follows.

#### ***Change in stormwater runoff patterns for saline areas [Original S42a para 6.37, addendum page 9 &10]:***

[60] This issue is with respect to the change in stormwater catchment runoff that may affect the saline areas in particular the nature of the soils within the watershed catchments of the proposed development.

- [61] In particular within the Section 42A report it is noted that the biggest risk is for Lots 23 and 25. Lot 23 to be divert via piped system whereas Lot 25 is discharge through level spreader downstream of the saline area.
- [62] Whilst this is indicated within the SMP as the best practical option the detail of the discharge points is to be determined through the next stage of design.
- [63] Notwithstanding this, the discharge of the runoff will ensure that the runoff from the impervious surfaces is discharged without detrimental effects and supports the level of service required for a lifestyle subdivision.
- [64] The pervious surface runoff will continue to discharge through natural contour and in the first instance enter the ground soils to continue as per the pre-development state through the subterrain system.
- [65] I concur with the author of the S42 report that the future development of the individual lots will require an evaluation of the stormwater management to ensure that there are no detrimental effects to the saline areas.

***Conveyance of flow through swales and piped system [original S42a para 6.70-6.71]***

- [66] The conveyance of stormwater runoff through the site post development will be through swales or piped conveyance where appropriate. This is to provide a level of service to the fully developed lots that can facilitate the activities of the subdivision
- [67] The swales and piped system will be sized at the engineering design phase of the project.
- [68] The SMP will guide the best practicable option for the design and as such present options of r mitigation of effects.
- [69] The road will be serviced through roadside swales, which is common practice for rural lifestyle subdivisions and will be deigned to prevent erosion occurring.

[70] The utilisation of rock check bunds and dispersed outlet dissipation devices will also provide robust erosion protection to the natural gullies and receiving environment.

***Discharge of stormwater runoff to ground [Original S42a para 6.71, addendum page 13]***

[71] The site has varying geotechnical conditions including areas where there is the ability to discharge stormwater runoff to ground.

[72] The availability of the soil conditions to receive the runoff is dependent on the lot location, such as the Lots in the area of the upper plateau, Lots 1 to 3 are located in an area where the bed rock is close to the surface, therefore discharge to ground is not possible in a formal manner, i.e. soakage pits. This location is more suited to a communal conveyance system to discharge at a more appropriate location with erosion protection.

[73] However once the runoff enters the natural gullies the subterrain conditions change and the ability of the runoff to firstly enter this substratum is available.

[74] Within the SMP this is discussed as assessment of the best practicable approach to stormwater management in the lots.

***Armouring of roadside swales [Original S42a- 6.72]***

[75] The roadside swales will be formed during the road accessway construction and will batter into the natural soil/ground conditions.

[76] Roadside swales will be designed to include rock/earth bunding to dissipate energy of the conveyed flow as necessary to prevent erosion occurring. This will be assessed during the next design phase of the road accessways.

[77] The natural ground conditions, which are covered in the geotechnical assessment by Mr Tippet, Mt Iron Geodrill Ltd, are generally of rock nature. Therefore, rock armouring is a best practicable way to include a natural visual context whilst providing erosion protection to this conveyance option.

***Semi reticulated stormwater system [Original para 6.73, addendum page 13]***

- [78] A stormwater conveyance system has been presented in the SMP as a fit for purpose scenario. This includes both reticulated via piped and swale system as well as individual lots having dissipated outlets to prevent scour and orison occurring.
- [79] The detailed deign is to follow the compliance with CODC code of practice which follows NZ4404:2010.
- [80] It is my option that a semi reticulated system that complies with NZS4404:2010 is the most appropriate solution for this development.

**Conclusion**

- [81] It is my opinion that the Stormwater Management Plan provides guidance to the development of the 30 Lot subdivision at Rocky Point to implement the best practicable management options and mitigation measures, the development can move forward while safeguarding the natural environment and cultural values of the Rocky Point site.
- [82] In conclusion it is my opinion that the proposed development can proceed without detrimental effects on the environment with respect to stormwater and flood management.



Bronwyn Rhynd

3<sup>rd</sup> November 2024



Planning | Surveying | Engineering | Environmental


# **Stormwater Management Plan and Flood Assessment - Addendum**


**Rocky Point – Bendigo Loop Road**


**TKO Properties Ltd**

## Document Information

|                          |   |
|--------------------------|---|
| <b>Client</b>            | Infracon Limited for TKO Properties Ltd |
| <b>Site Location</b>     | Bendigo Loop Road, Central Otago        |
| <b>Legal Description</b> | -                                       |
| <b>CKL Reference</b>     | A23205                                  |
| <b>Office of Origin</b>  | Hamilton                                |

|               |   |             |            |
|---------------|---|-------------|------------|
| <b>Author</b> | Bronwyn Rhynd – Environmental Engineer  |             |            |
| <b>Signed</b> |  | <b>Date</b> | 31/10/2024 |

|                    |   |             |            |
|--------------------|---|-------------|------------|
| <b>Reviewed By</b> | Joshua Raynes – Environmental Engineer  |             |            |
| <b>Signed</b>      |  | <b>Date</b> | 31/10/2024 |

|                      |   |             |            |
|----------------------|---|-------------|------------|
| <b>Authorised By</b> | Bronwyn Rhynd – Environmental Engineer  |             |            |
| <b>Signed</b>        |  | <b>Date</b> | 31/10/2024 |

| Revision | Status | Date | Author | Reviewed By | Authorised By |
|----------|--------|------|--------|-------------|---------------|
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Updated Scheme plan, dated 29<sup>th</sup> August 2024

### Appendix 2 Calculation Summary

# 1 Introduction

The purpose of this report is to provide details of updates to the stormwater management and flood assessment to support the subdivision at Rocky Point, Bendigo Loop Road. The areas that have been of focus for this update are the following:

- Watercourse adjacent to Bendigo Loop Road
  - Lots 27-30
- Upper Catchment 1&2 overland flowpath
  - Lots 19-21

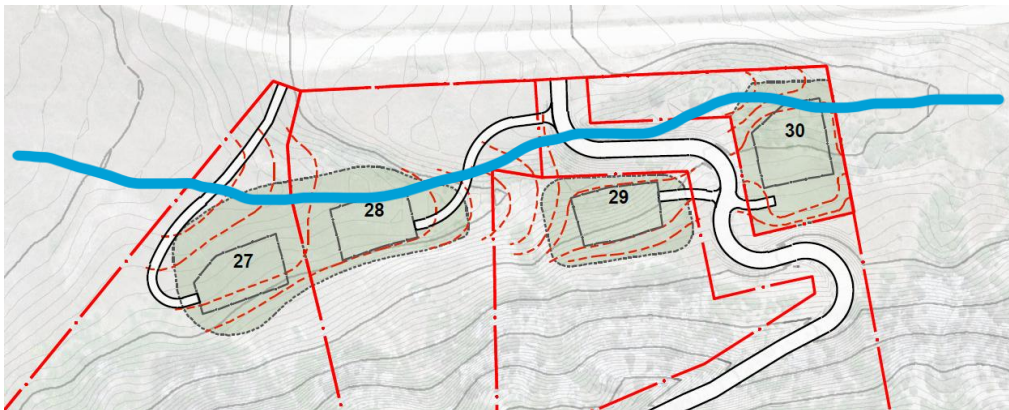
The overland flowpath management for both areas are detailed in the following sections.

There has been an update to the scheme plan since the previous reporting that supports the subdivision, which is appended for reference, Appendix 1.

This report is to be read as an addendum the Stormwater Management Plan and Flood Assessment, Rev 2, dated 12/07/2024.

## 2 Watercourse – Bendigo Loop Road

There is a natural watercourse that is located adjacent to Bendigo Loop Road, within the subject site. This watercourse traverses from east to west through the proposed lots 27 to 30 inclusive. The location is presented diagrammatically in the figure below:



*Figure 1: Natural watercourse adjacent to Bendigo Loop Road*

The existing characteristics of the water course is presented in the photo within Figure 1 below. The photo is taken looking from the existing entry/access track upstream, as such the location of Lot 30 is to the right of the watercourse.





Figure 2: Existing watercourse adjacent to Bendigo Loop Road

The peak flow that is generated for the total catchment, catchment 5, is  $1.327\text{m}^3/\text{s}$  during 100yr ARI rainfall event including the effects of climate change (100yr<sub>CC</sub> ARI). This flow has been used to model the effects with respect to the flow through the watercourse, which is a conservative approach as the flow through this location is some 200-400m upstream of the SH8 crossing (which is the point of catchment assessment).

The proposal is to modify the alignment of the watercourse slightly to accommodate the future (proposed) lot building platforms whilst maintaining the entry and exit points of the existing watercourse alignment and convey the flow generated from the catchment. The re-aligned watercourse is illustrated in the following figure, which is a “view” from the flood modelling which includes the final ground model with the watercourse and the 100yr<sub>CC</sub> rainfall runoff. It is to be noted the model shows localized ponding on the building platforms however this is simply spill over from upstream areas that have not drained away due to the flat grade of the platforms, it is not overflow from the watercourse.

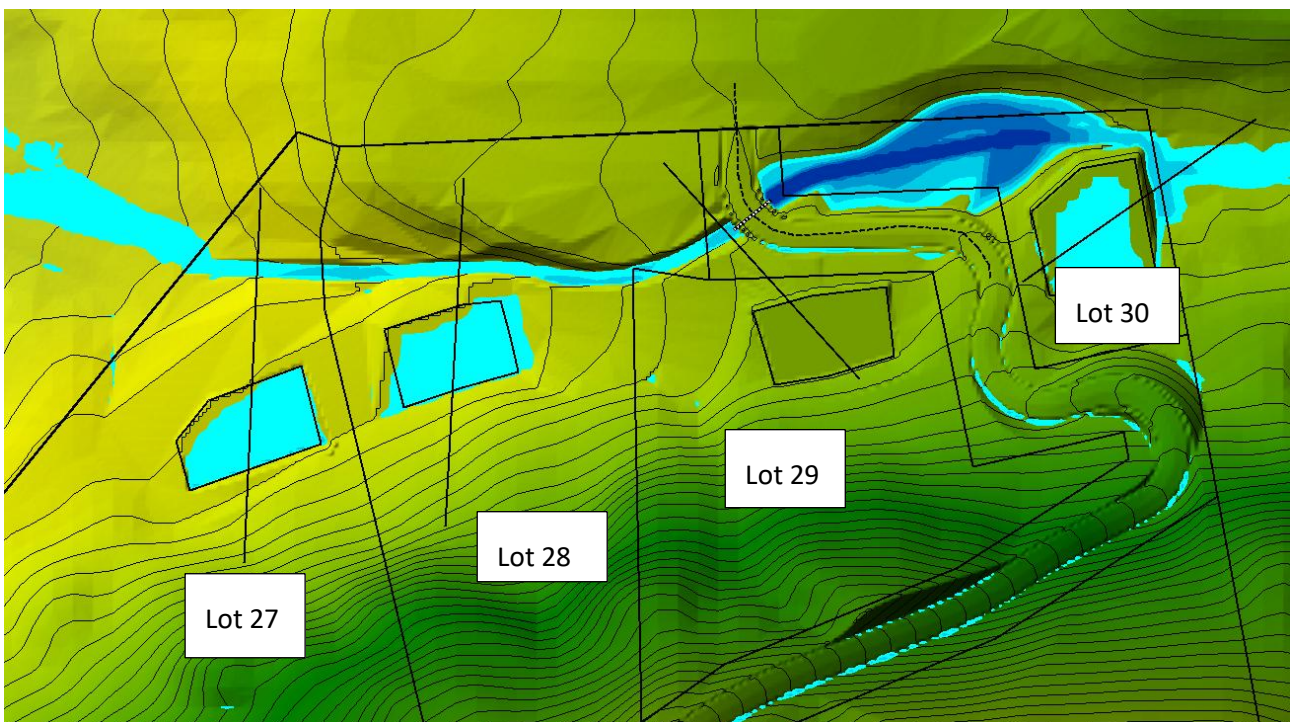


Figure 3: Watercourse alignment with 100yr<sub>CC</sub> flow

The proposed watercourse will have a uniform internal gradient from entry to exit and shaped to be in sympathy with the surrounding ground topography with 3H:1V side slopes. The watercourse characteristics are presented in the following table.

Table 1: Watercourse characteristics

| Characteristic    | Values                                 |
|-------------------|--|
| Base width        | 3m                                     |
| Side slopes       | 3H:1V                                  |
| Internal gradient | Continuous gradient from entry to exit |
| Depth of flow     | 130mm – 980mm                          |

The accessway which crosses the watercourse will include a 750mm diameter culvert to ensure that the 100yr<sub>CC</sub> ARI flow can be conveyed without overtopping the roadway.

A summary of the hydraulic analysis is presented in Appendix 2 for reference.

## 2.1 Platforms and freeboard

The proposed lots 27 to 30 inclusive are on the true left bank of the watercourse. The freeboard requirements for these developed lots are to follow Central Otago District Council's (CODC) land development guidelines which adopt NZS 4404:2004, which states a freeboard of 500mm (minimum) above top water level during 100yr event<sup>1</sup>. CODC will be transitioning to NZS4404:2010, which continue the same freeboard requirements<sup>2</sup>.

The details of building platforms and 100yr<sub>CC</sub> top water levels for the lots with freeboard, to the centroid of the proposed building platforms, is presented in the following table:

Table 2: Freeboard per lot -100yr top water level

| Lot | Building platform (mRL) | 100yr <sub>CC</sub> ARI Top water level (mRL) | Freeboard (m) |
|-----|-------------------------|---|---------------|
| 27  | 204.00                  | 201.90  | 2.10          |
| 28  | 205.00                  | 203.90  | 1.10          |
| 29  | 210.50                  | 208.97  | 1.53          |
| 30  | 210.50                  | 209.45  | 1.05          |

It is to be noted the New Zealand Building Code (NZBC) Clause E1.3.2 states:

**E1.3.2** Surface water, resulting from an event having a **2% probability of occurring annually**, shall not enter buildings.

This is expanded on in E1/VM1 Section 4.3.1 outlining freeboard requirements:

<sup>1</sup> Section 4.3.2.5.2 NZS4404:2004 – freeboard for habitable building floors = 500mm, commercial and industrial buildings = 300mm

<sup>2</sup> Section 4.3.5.2 NZS4404:2010 freeboard for habitable dwelling (including attached garages) = 500mm, commercial and industrial buildings = 300mm, non-habitable residential buildings and detached garages = 200mm.

The level of the floor shall be set at the height of the secondary flow plus an allowance for freeboard. The freeboard shall be:

- **500 mm** where surface water has a depth of 100 mm or more and extends from the building directly to a road or car park, other than a car park for a single dwelling.
- **150 mm** for all other cases.

It is noted that Clause E1.3.2 applies only to *Housing, Communal Residential and Communal Non-residential buildings* as per the advice note contained with the NZBC.

### 3 Upper Catchment 1&2 overland flow path

The flood modelling has been refined in the upper catchment areas of Catchments 1 and 2, to better define the overland flow path during the larger rainfall events, in particular the 100yr<sub>CC</sub> ARI (rainfall event). This also provides insights to the interaction during this rainfall event for Lots 19 to 21. The location of this refinement is presented in the following figure.

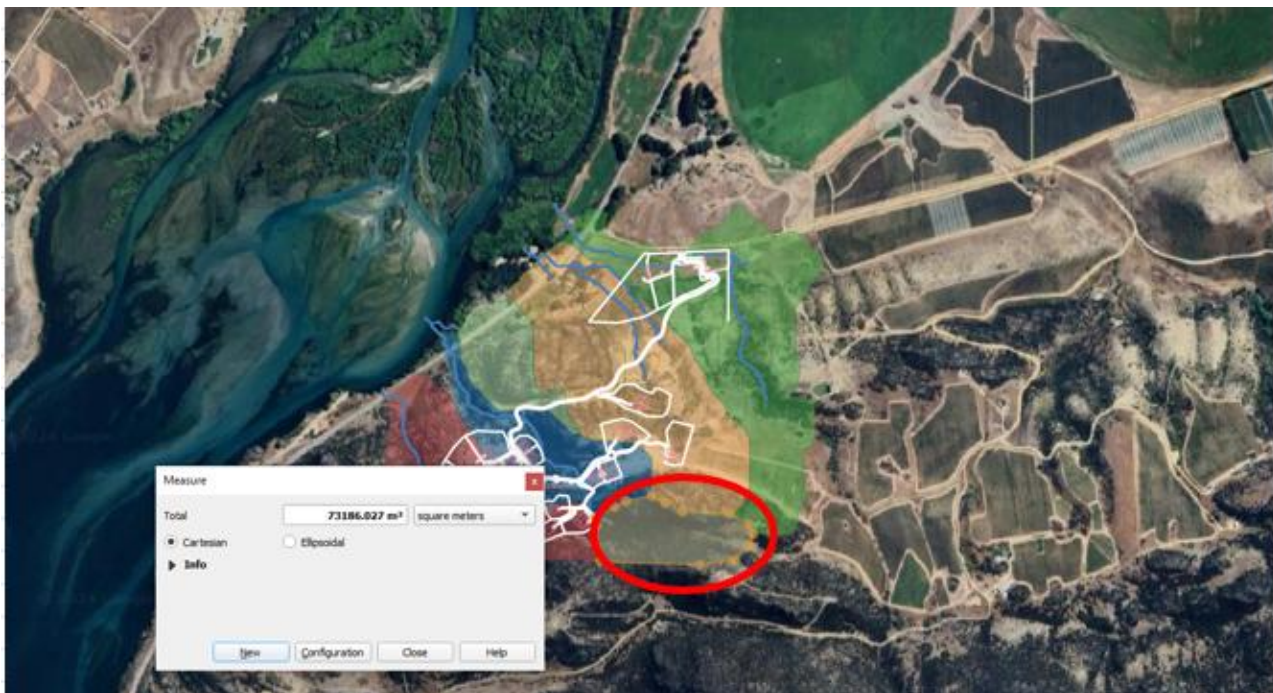


Figure 4: Flood modelling refinement for upper Catchment 1&2

The catchment that is contributing to the overland flow path associated with Lots 19 to 21 is in the order of 7.3ha which has a peak flow during 100yr<sub>CC</sub> ARI rainfall event of circa 380L/s. This flowpath traverses these lots from east to west and reaches a maximum flow depth of 70mm, between lots 19 and 21. This is illustrated in the following figure.

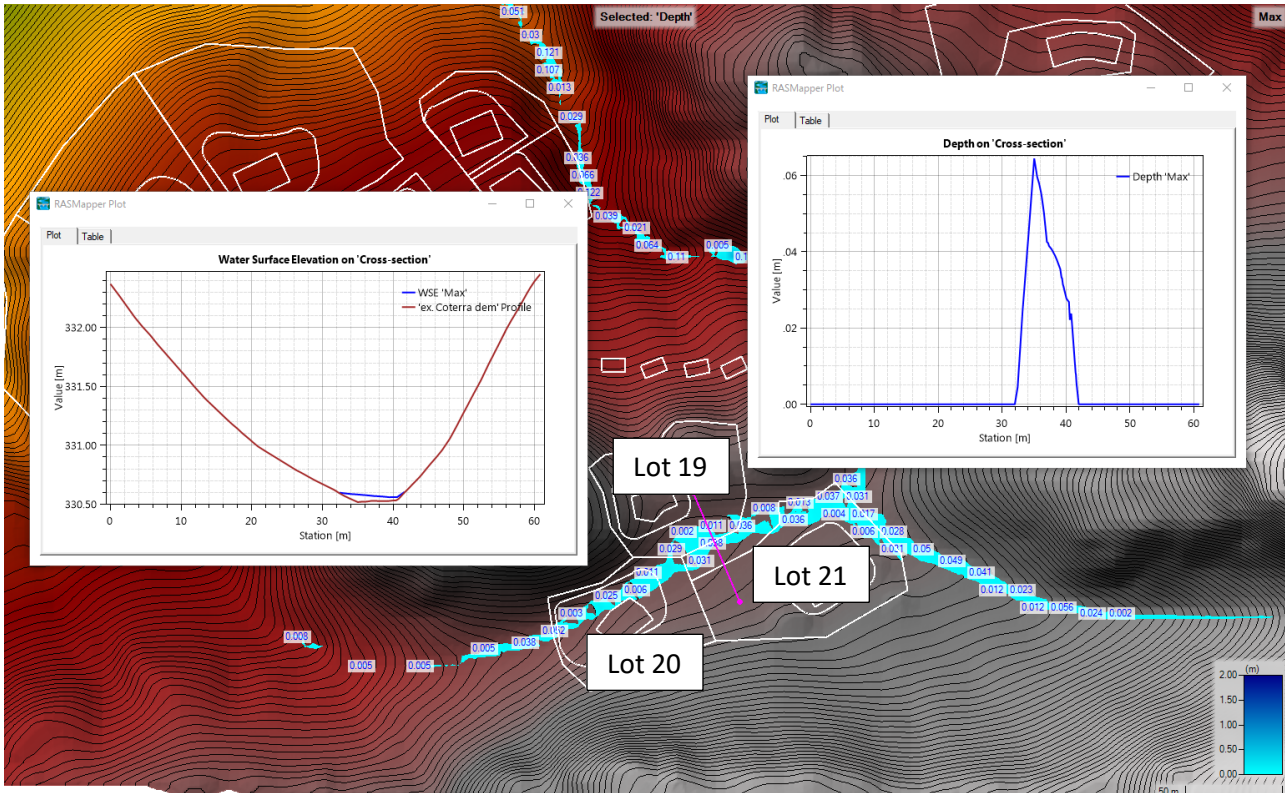


Figure 5: OLFP through Lots 19 - 21

The alignment of the overland flow path and conveyance of flow during these rainfall events can be accommodated within the design of the lots during the development phases, of both the subdivision and building. The flow is of a depth that can be suitably traversed by vehicles during large rainfall events without detrimental effects.

The overland flow path can be integrated within the driveway and building platform design, whilst protecting both the natural and built environment.

Supporting calculations and modelling outcomes are provided within Appendix 2, for reference.

### 3.1 Platforms and freeboard

As with the previous presented information for Lots 27-30, freeboard is to be provided above the top water level during 100yr<sub>CC</sub> ARI rainfall event to the finished floor levels of the proposed buildings. The freeboard is to adhere to the CODC requirements of NZS4404:2004, being:

- habitable building floors = 500mm,
- commercial and industrial buildings = 300mm

## 4 Summary

The stormwater management and flood assessment has been updated to accommodate the refinement of flow paths and watercourses for areas within the proposed subdivision at Rocky Point. The areas of interest are the watercourse adjacent to Bendigo Loop Road and the upper catchments, of sub catchment 1&2, located in the south-eastern portion of the site.

The watercourse traverses through Lots 27 to 30 from east to west and will be re-aligned to accommodate the proposed building platforms. The entry and exit points of the watercourse will remain as per the existing situation thus not effecting both the upstream and downstream conveyance of flow, associated with the watercourse.

This realigned watercourse will have a uniform (internal) gradient from entry to exit and shaped to be in sympathy with the surrounding ground topography with 3H:1V side slopes. The 100yr<sub>cc</sub>ARI rainfall event depth of flow can be accommodated within the watercourse geometry and provide sufficient freeboard to the proposed building platforms.

The overland flow path in the upper catchment of 1&2 has been reviewed in finer detail. This flow path will traverse lots 19-21 in an east to west direction with a maximum depth of flow of 70mm. This flow path can be accommodated within the fully developed lots with considered driveway design and placement of building platforms without detrimental effects on the built and natural environment.

## 5 Limitations

This report has been prepared solely for the benefit of our client with respect to the particular brief and it may not be relied upon in other contexts for any other purpose without the express approval by CKL. Neither CKL nor any employee or sub-consultant accepts any responsibility with respect to its use, either in full or in part, by any other person or entity. This disclaimer shall apply notwithstanding that the memo/report may be made available to other persons including Council for an application for consent, approval or to fulfil a legal requirement.

# Appendix 1 Drawings

Updated Scheme plan, dated 29<sup>th</sup> August 2024

## Appendix 2 Calculation Summary

- Watercourse updates: Summary of Rock Point Modelling – Hydraulic analysis
- Upper catchment 1&2: Flood assessment Lots 19-21

