REPORT

Tonkin+Taylor

Stormwater Management Plan

Private Plan Change 28

Prepared for

CCKV Maitahi Dev Co Lp and Bayview Nelson Ltd

Prepared by

Tonkin & Taylor Ltd

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Exceptional thinking together

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1 Introduction

This Stormwater Management Plan (SMP) has been prepared by Tonkin & Taylor Ltd (T+T) to support a Private Plan Change application (PPC28) by CCKV Maitai Dev Co Lp and Bayview Nelson Limited (hereafter referred to as "the applicant") to re-zone approximately 287 ha of land located within the Kākā Valley, along Botanical Hill and Atawhai Hills (hereafter referred to as "PPC28 area"), from Rural and Rural-Higher Density Small Holdings Area, to a mixture of:

- Residential (Higher, Standard and Lower Density Areas)
- Rural-Higher Density Small Holdings
- Open Space Recreation
- Suburban Commercial

Figure 1: PPC28 extent (source NCC)

T+T previously prepared an "Infrastructure and Flooding Report" (March 2021) and a "Response to Request for Further Information" letter (20 August 2021) to support PPC28. Morphum Environmental Ltd (Morphum) also prepared a "Preliminary Structure Plan Environmental Review" report (April 2021), providing guidance and recommendations in relation to stormwater management and ecological effects management.

1.1 Purpose

This SMP has been prepared to support PPC28 and provides a high-level summary of the proposed stormwater management approach within the PPC28 area, to a level of detail consistent with a Plan Change stage. The SMP is based on current information available at this time and will be updated and developed in more detail as the project progresses, and at future Resource Consent and Subdivision application stages.

The overall purpose of the SMP is to provide guidance to the applicant and Nelson City Council (NCC) on how stormwater will be managed for a future land use scenario, and to support the PPC application.

The SMP is consistent with Council’s policies and plans. Non-statutory policy and planning documents have also been considered.

1.2 Scope

The scope of the SMP is to:

- Summarise proposed stormwater management options for development of the PPC28 area;
- Demonstrate how stormwater management related expectations under the Nelson Resource Management Plan (NRMP) and Nelson Tasman Land Development Manual (NTLDM) have been met; and
- Demonstrate feasibility of design principles for initial approval of concept for stormwater assets to be vested to Council.

1.3 Outcomes of SMP

The outcomes sought by the SMP are:

- An integrated stormwater management approach;
- A water sensitive treatment framework that manages and mitigates the impact of land use changes from agricultural to urban;
- Provide for retention of stream habitat, and protection and enhancement of riparian margins;
- Identification of flood risk areas so that new development is located outside the flood plain;
- Assess and provide options for mitigation of any potential impacts of the proposed development on flood risk to adjacent and downstream property;
- A set of Best Practicable Options (BPO) for stormwater that can be applied to the PPC28;
- Promotion of water conservation where possible and practicable; and
- Identification of opportunities to manage stormwater areas for multiple values and functions.

2 Existing site appraisal

This section of the report summarises the existing characteristics and conditions of the PPC28 area as they relate to stormwater management.

2.1 Summary of data sources

Characteristics	Data source
Topography	Top of the South Maps, Nelson City Council LINZ Data services - Nelson LiDAR 1m DEM (2021)
Geotechnical	PPC28 Geology and Geotechnical Hazards report, prepared by T+T, March 2021 PPC28 Geological mapping, prepared by T+T (Appendix A) PPC28, Impact of geology on sediment yield letter, prepared by T+T dated 10 June 2022
Existing stormwater network	Top of the South Maps, Nelson City Council. PPC28 Infrastructure and Flooding Report, prepared by T+T, March 2021 Response to Request for Further Information letter, T+T, 20 August 2021 Site visit by T+T
Existing hydrological features	Site visit by T+T Site visit by Morphum PPC28 Ecological Opportunities and Constraints Assessment Report, prepared by T+T, March 2021 Preliminary Structure Plan Environmental Review report, prepared by Morphum, April 2021 Field Stream classification map, prepared by Morphum, October 2020 (Appendix A)
Maitahi/Mahitahi River erosion	Ecological Restoration Plan Report, Maitai River, prepared for Nelson City Council by Morphum, July 2020
Flooding and flow paths	Top of the South Maps, Nelson City Council Maitai/Brook/York and Wakapuaka Flood Models report, prepared by T+T, 28 July 2021. Additional flood hazard information - PC28 letter, prepared by T+T, May 2022 PPC28 Infrastructure and Flooding Report, prepared by T+T, March 2021 Response to Request for Further Information letter, prepared by T+T, 20 August 2021
Ecological areas	PPC28 Ecological Opportunities and Constraints Assessment report, prepared by T+T, March 2021 PPC28 Existing terrestrial habitat occupying survey area map, prepared by Robertson Environmental, May 2022 (Appendix A)
Archaeology	PPC28 Historical & Archaeological Assessment, prepared by Amanda Young, December 2020

2.2 Topography and land use

The Maitahi and Bayview areas of the proposed development comprise approximately 287 ha. Broadly the topography and land use of the site comprises:

- Ridgelines of the hills surrounding Kākā Valley, vegetated with open grassland on the western side of the valley and open matagouri scrubland on the eastern side of the valley
- Rolling slopes and hill country forming the Atawhai Hills ridge crest and west facing slopes, vegetated in a mixture of grass, and native and exotic scrub
- Moderate to steep hill country (generally between 22° and 40°) forming the upper slopes of Kākā Valley, vegetated in a mix of scrub, grass and scattered mature native and exotic trees.
- Rolling slopes and hill country (generally between 5° and 22°) west and east facing slopes forming the sides of Kākā Valley and vegetated in a mixture of grass, and native and exotic scrub
- Gently undulating to flat inclined slopes (generally less than 5°) forming the flood plain of the Maitai River (hereafter referred to as Maitahi/Mahitahi River so that the dialects of all Te Tauihu Iwi are represented) and Kākā Hill tributary. These areas are predominantly pastoral grazing land with isolated mature exotic trees.

The Kākā Hill tributary (hereafter referred to as "Kākā Stream") flows from its headwaters in the relatively steep and confined upper hill catchment into the relatively shallow meandering channel in the flatter flood plain at its confluence with the Maitahi/Mahitahi River. In the lower reaches the channel has been modified.

The western extent of the PPC28 area is located on outside the Kākā Stream Catchment and runoff generated in this area drains to the north-west towards the Nelson Haven. This area is hereafter referred to as the Walters Bluff/Brooklands Catchment. Stormwater generated in these areas flows down gullies and flow paths within the moderate to steep hill country, some of which is urbanised.

There are two smaller sub-catchments at the peripheries of the PPC28 area which drain directly to the Maitahi/Mahitahi River.

The extent of the principal catchments within the PPC28 area is shown in Figure 2.1 below.

Figure 2.1: Stormwater catchments within the PPC28 area

2.3 Geotechnical overview

2.3.1 Geology

The underlying geology at the site is predominantly hard strong rock on the sloping land in the Kaka Valley and extensively along the Atawhai Hills. The distribution of rock types in the plan change area is shown on Figure 1012397-F3 from the T+T report titled "Private Plan Change request, geology and geotechnical hazards Report" dated March 2021 (ref 1012397.v3). A copy is included in Appendix A.

Botanical Hill formation bedrock dominates the Atawhai Hills and the western slopes of the Kākā Valley where residential zoning is proposed. Grampian Formation bedrock dominates the eastern slopes of Kākā Valley where residential development is shown on the Structure Plan, which at the time of writing this report is being updated for the Plan Change request. These rock types do not produce easily erodible or dispersive clay soils.

Quaternary age deposits that occur within the gently sloping to flat valley floor of the Kākā Valley are dominated by gravel deposits which are also comparatively erosion resistant.

Colluvium soils can be seen in various track excavations within Kākā Valley and on the Atawhai hillsides and form a thin soil veneer overlying the bedrock. These soils are typically at least 50%

gravel, derived from physical weathering of the underlying bedrock. The finer content of these soils is a mix of sand, silt and clay.

2.3.2 Slope stability

Aerial photographs, LiDAR imagery and site observations indicate that most of the land is not subject to slope instability.

There is no evidence of significant, recent slope instability within the PPC28 area. However, there are localised small landslip scarps on some steeper slopes, mainly within gullies and on slopes flanking spur lines, as is typical of Nelson hillside terrain.

Slope stability is discussed in more detail in the T+T report titled "Private Plan Change request, geology and geotechnical hazards Report" dated March 2021.

2.3.3 Soil erosion

The dominant rock types of the PPC28 area are not expected to weather, to sandy or silty soils that are easily erodible. However, the steeper slopes (particularly those generally in excess of 30°) may be susceptible to gully and sheet erosion if stripped of topsoil.

In localised reaches the Kākā Stream has eroded and undercut the Quaternary gravel terraces immediately adjacent to the active stream channel. Such erosion is common in hillside stream channels, particularly when natural vegetation has been removed by land management practices.

2.3.4 Suitability for infiltration

The PPC58 area has limited opportunity for infiltration due to the nature of the topography. Most of the area consists of moderate to steep slopes and hill country and is not considered suitable for groundwater recharge.

The only area that has been identified as potentially suitable for groundwater recharge is the flatter inclined slopes within the existing flood plain area. It proposed to fill this area by up to approximately 3 m with site-won rock fill material, which could potentially provide a minimum infiltration rate of at 5 mm/hr. This would need to be confirmed through permeability testing once the fill material has been placed.

2.4 Resource Management Plan Overlays

The NRMP identifies the PPC28 area as generally within the Rural Zone and Rural – High Density Small Holdings Area, and partly located within the Landscape, Land Management, Services, Riparian, and Flood Overlays. Of importance to potential development of PPC28, is that the site has areas located within the Land Management, the Flood and the Fault Hazard Overlays.

2.5 Existing stormwater context

2.5.1 Drainage and hydrological features

The existing stormwater drainage features within the PPC28 area are typical of rural undeveloped catchments, and can be broadly described by the following five categories:

- Broad and steep vegetated and grassed slopes which sheet flow into minor watercourses;
- Minor watercourses such as intermittent streams, ephemeral streams and overland flow paths located on either side of the ridge forming tributaries of the Kākā Stream, or directing flow towards the Nelson Haven;

- The Kākā Stream which conveys flows from the upper reaches to its confluence with the Maitahi/Mahitahi River. It is noted that the lower reach of the Kākā Stream (downstream of woolshed) has been highly modified/realigned to facilitate ‘drainage’ of the flat land for farming purposes. This has resulted in a straightened channel. The extent of this channel is shown in Figure 2.2. This area is referred to as the ‘flood plain’ area.
- Various artificial and modified watercourses. primarily located on the lower flood plain;
- The receiving Maitahi/Mahitahi River and Nelson Haven.

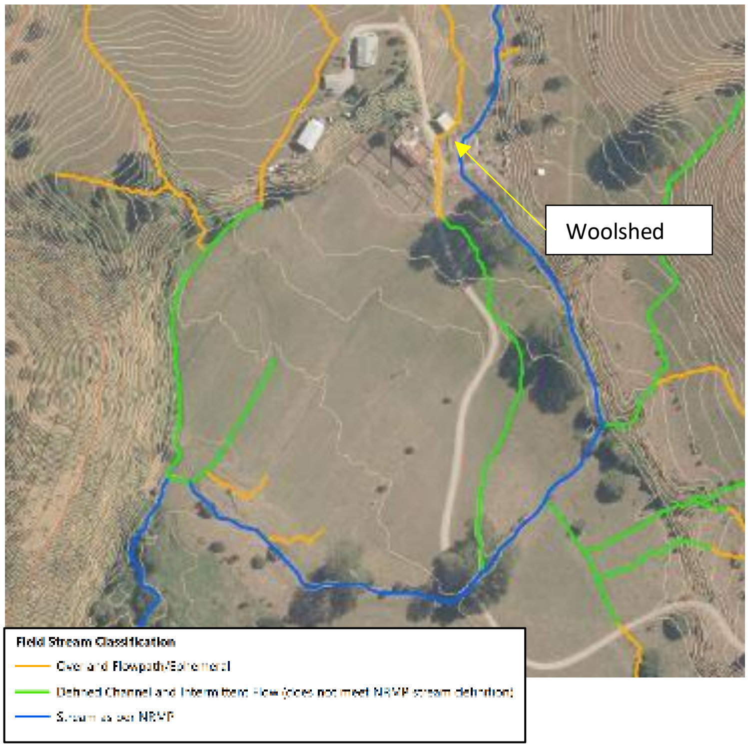


Figure 2.2: Modified section of Kākā Stream

2.5.2 Receiving environment

2.5.2.1 Maitahi/Mahitahi River

The Maitahi/Mahitahi River and catchment can broadly be divided into three sections:

- The relatively undeveloped upper catchment with the municipal water supply catchment area;
- Forestry, farming and recreational land use in the mid catchment; and
- Urbanised lower catchment where the river flows through the City.

The Kākā Stream confluence with the Maitahi/Mahitahi River at the lower end of the mid catchment reaches is typically willow-lined and surrounded by pasture and reserves. The lower section of the Maitahi/Mahitahi River within the Nelson urban area is impacted by potentially contaminated urban runoff and periodic E.coli discharges and discharges into the Nelson Haven, with tidal influence on flows and levels in the lower reaches.

2.5.2.2 Nelson Haven

Runoff from the Walters Bluff/Brooklands Catchment presently discharges directly to the Nelson Haven, as either flow conveyed in the NCC stormwater network through a series of culverts under State Highway 6, or as overland flow across the existing urban area.

The Walters Bluff/Brooklands Catchment primarily consists of low to medium density urban development. Stormwater treatment of runoff from roads, hardstands and other existing contaminant-generating surfaces is virtually non-existent, and all runoff currently discharges directly into the Nelson Haven.

2.5.3 Kākā Stream Baseflow

As part of the Preliminary Structure Plan Environmental Review report (Morphum, April 2021, refer Appendix D) the waterways across the Kākā Stream Catchment were identified as having complex hydrology, with many tributaries transitioning from above to below ground flow. It was noted that all tributary streams are likely to be dry for prolonged periods of low rainfall, and are classified as ephemeral under the NRMP.

This reflects the site soils which appear to be dominated by fractured rock and colluvium with deposits of free draining material in side gullies. The upper reaches of the Kākā Stream were also observed to retain persistent baseflow which is expected to remain across the full year.

2.5.4 Stream erosion

As outlined in Morphum Environmental Review report, the existing conditions of the receiving streams within the PPC28 area are summarised as:

- *"Kākā Stream, and side tributaries, channels, under current land use, are stable with little sign of active scour or erosion.*
- *The stream appears to support a stable channel which displays sinuosity through gentle meanders, point bars, lateral flood benches and stable overhangs.*
- *Whilst a detailed geomorphological assessment was not undertaken, substrates appear to comprise a mix of well bound alluvial sediments through the mid reaches with bedrock and large boulders in upstream reaches. The lower reach (extending from the woolshed to river confluence) appears to be finer sediments (silts) with excessive deposition likely a result of elevated sediments from stock and increased deposition due to flat grade".*

2.5.5 Existing flooding and flow paths

The PPC28 area is subject to flood risk from three separate sources:

- Flooding of the lower Kākā Stream flood plain (Figure 2.2) from both Kākā Stream and the Maitahi/Mahitahi River.
- Flooding in the Kākā Stream Catchment, including the main Kākā Stream channel and contributing minor tributaries
- Flooding in minor watercourses such as intermittent and ephemeral streams and overland flow paths within the Walters Bluff/Brooklands Catchment

These are described in more detail in the following sections.

2.5.5.1 Maitahi/Mahitahi River flooding

The Maitahi/Mahitahi Catchment is approximately 100 km², with the river flowing through central Nelson City to The Haven. The present day peak 1% annual exceedance probability (AEP) flood flow through the lower reaches is approximately 365 m³/s (per NIWA's 2021 frequency analysis of data collected at the "Maitai @ Avon Terrace" flow gauge).

Photograph 2.1 shows flooding during the February 1995 flood event. Based on a reported flow of about 295 m³/s in the City, the frequency of this event is considered to be approximately 2% AEP (1 in 50-year return period).

Photograph 2.1: Looking to the North from Maitahi/Mahitahi Valley Road during the February 1995 flood event. Source: nzfloodpics.com

Photograph 2.2 shows flooding during the December 2011 flood event. This event was measured at 237 m³/s at the Avon Terrace flow gauge, approximately 5% AEP (1 in 20 year return period).

Photograph 2.2: Maitahi/Mahitahi Valley Road flooding near Ralphine Way during the December 2011 flood event.

The NCC Maitahi/Mahitahi River flood model has been used to provide flows and flooding depths and extents in the lower flood plain. This flood modelling results indicate that a 1% AEP flow event will cause widespread flooding in the rural/semi-rural valley upstream of the City, including in the flood plain at the Kākā Stream confluence. Figure 2.3 below shows 2130 1% AEP flood mapping, based on the existing catchment land use.

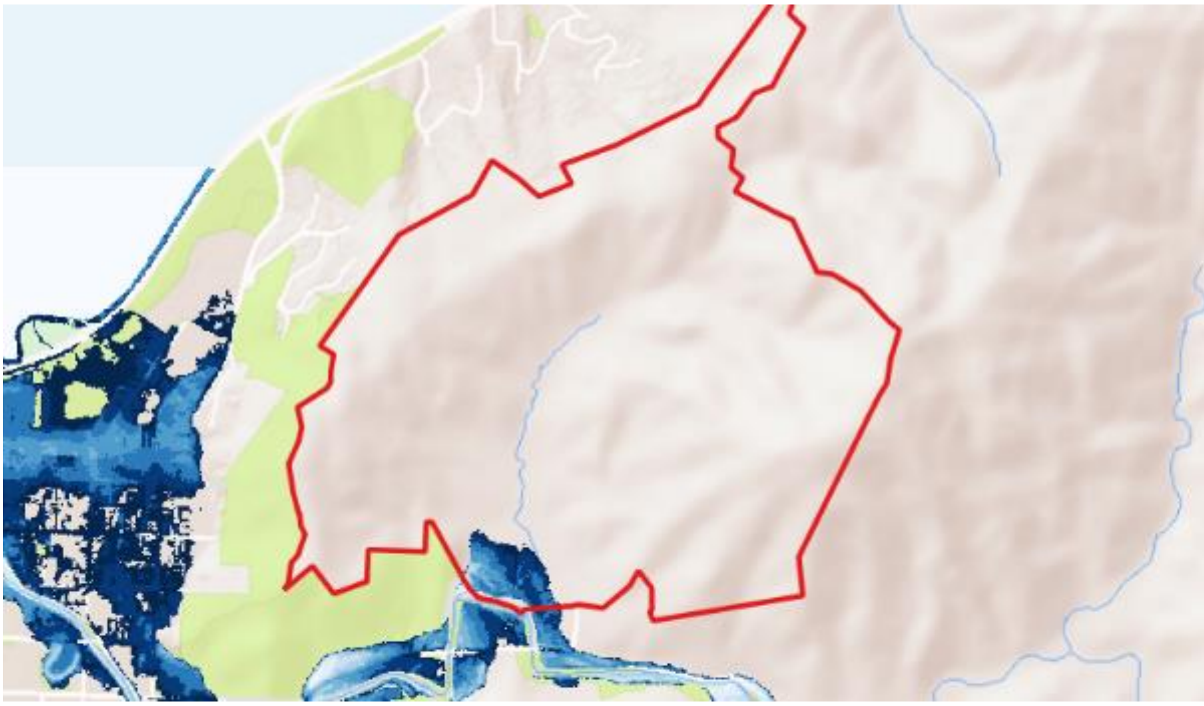


Figure 2.3: Maitahi/Mahitahi River flood depths in blue (2130 RCP8.5 1% AEP event) sourced from NCC Maitai River flood model (http://www.nelson.govt.nz/assets/Environment/Downloads/Nelson-Plan/reports/2021/Maitai-Brook-York-Wakapuaka-Flats-2021.pdf). PPC28 boundary in red.

NCC modelling shows flood levels at the flood plain area within the PPC28 area of up to approximately RL 17.6 m (NZVD 2016) for the 2130 1% AEP flooding. These occur during the 12-hour event, which is considered the critical duration at the Kākā Stream confluence (note further downstream, the 24-hour duration event becomes critical). The modelled flows in the Maitahi/Mahitahi River include a contribution from the Kākā Stream. However, the model does not represent/route overland flow paths for runoff within the Kākā Valley (i.e. Kākā Stream flows are input as point flows to the Maitahi/Mahitahi River in the model).

2.5.5.2 Kākā Stream Catchment

- Kākā Stream flooding was assessed as follows:
- A range of hydrological methods was used to estimate the peak flows from the catchment
- A rainfall/runoff model was developed using HEC-HMS v4.9 software
- A 2D direct rainfall model was developed for the Kākā Stream itself (i.e. upstream of the Maitahi/Mahitahi River flood plain), based on TUFLOW software. This model was developed to identify existing flooding and flow path extents.

2.5.5.2.1 Hydrological peak flow assessment

- Various methods were used to estimate the peak pre-development flows from the Kākā Stream, including:
  - NIWA Regional method (Henderson Collins 2018);

- SCS 1986 loss method with SCS transform and frequency storm developed from HIRDS v4 data;
- Rational method as per NTLDM and NZBC E1.

For the SCS and Rational method calculations, the Kākā Stream Catchment was delineated into five sub-catchments, as shown in Figure 2.4. The rainfall depths and shapes were taken from NIWA HIRDS v4, with effects of climate change based on RCP8.5M, per NTLDM 5.4.6.2. For the purposes of assessing inundation levels (for example in the lower flood plain), the 2130 climate projection has been used, noting that the NTLDM Inundation Practice Note requires consideration of climate change to at least 2120.

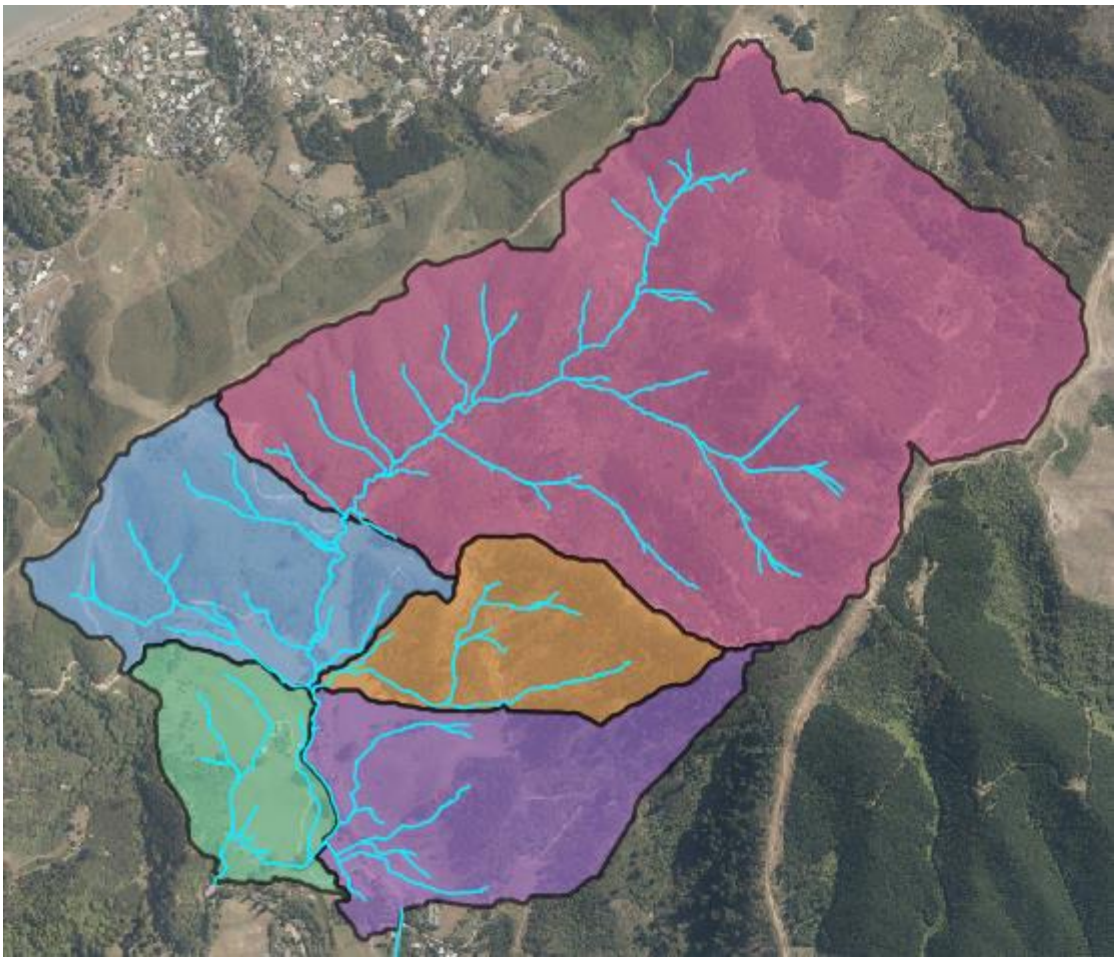


Figure 2.4: Kākā Stream sub-catchments and flow paths based on 2021 LiDAR data.

Table 2.1 below presents the results from the preliminary hydrological assessment for the existing catchment. The associated calculations are attached in Appendix B.

Table 2.1: Peak 2130 runoff estimates for Kākā Stream

Rainfall frequency	Climate	Pre-development peak flow (m^3/s)
10% AEP	2130 RCP8.5M rainfall	8.0 to 19.1
6.67% AEP		8.6 to 20.9
1% AEP		13.3 to 31.8

2.5.5.2.2 Direct rainfall flood modelling

The TUFLOW model was developed using:

- NCC 2021 LiDAR data (2 m grid, with 1m sub-grid sampling from a 1 m DEM);
- Landcare Research's Land Cover Database 5 (LCDB5) information;
- Landcare Research's Soil Maps;
- NIWA HIRDS v4 rainfall data and storm profiles;
- NCC Maitai River flood model results as downstream boundary conditions for a range of design events . A flow hydrograph was extracted from the model, and input Maitai River reach in the TUFLOW model.
- Similar hydrological parameters to those in more detailed models within the Nelson Region (these parameters will reviewed during subsequent more detailed phases of consenting and design for PPC28 development).

Initial model runs indicated that the 6-hour rainfall event (based on the HIRDS v4 storm profile) produced the greatest peak flows from the catchment. The 2130 RCP8.5 1% AEP 6-hour event (with peak 6-hour flows in the Maitahi/Mahitahi River) is shown in Figure 2.5.

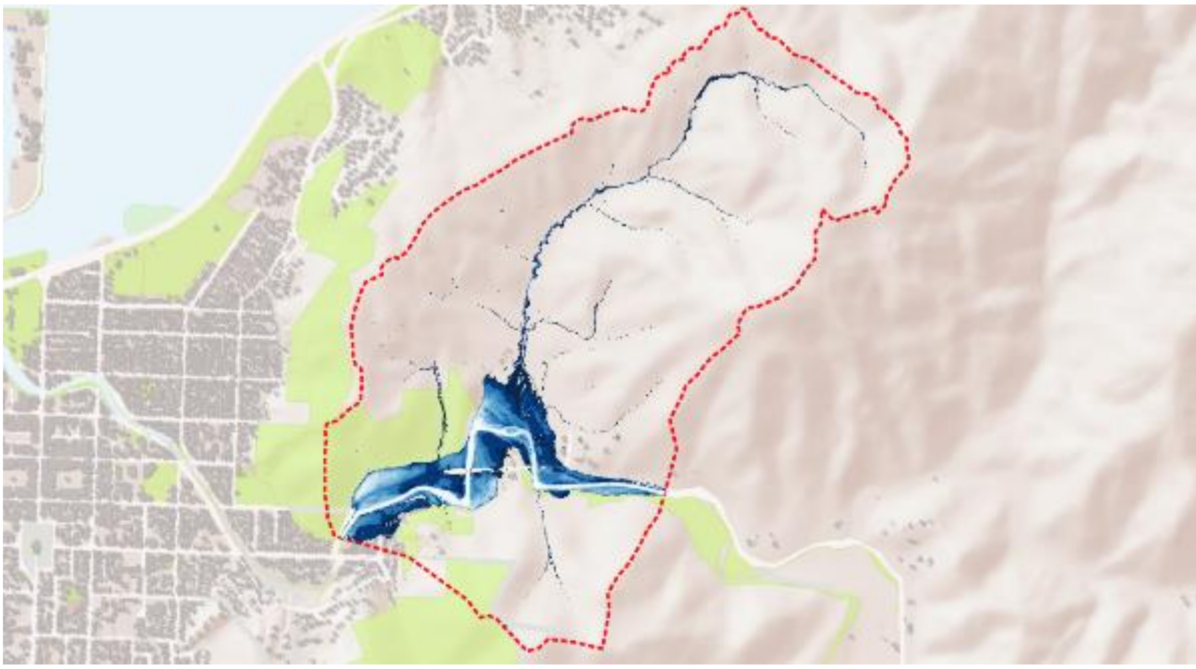


Figure 2.5: Flood depth mapping within the Kākā Catchment in blue – 2130 RCP8.5 1% AEP 6-hour event. The red dashed line is the model boundary.

The modelled peak runoff rates using this method are within the range of other estimates outlined in Table 2.1 (see below), and the model is considered adequate to inform the understanding of existing flooding and flow paths.

The model has been used to identify indicative flow paths, depths, widths, velocities and extents throughout the catchment for the 10% and 1% AEP events in both the present day and 2130 RCP8.5 planning horizons. The 6-hour event has been modelled at this stage.

During later stages of consenting and design, various combinations of Maitahi/Mahitahi River and Kākā Stream events will be assessed to determine the most critical design cases. For example, in areas mostly affected by Maitahi/Mahitahi River flooding, the 12-hour event is likely to produce greatest flood depths; whereas for areas where the Kākā Stream flows govern flooding characteristics, the 6-hour event is likely to be more critical. The relative timing of the peak flows from the Kākā Stream and the greater Maitahi/Mahitahi Catchment will also be considered.

2.5.5.3 Walters Bluff/Brooklands Catchment

The Walters Bluff/Brooklands Catchment generally drains to Nelson Haven to the west, with a small sub-catchment north of the Kākā Valley draining through developed areas in Dodson Valley to discharge ultimately also into Nelson Haven.

An initial assessment of the existing NCC piped stormwater network in this catchment indicates that the network is already undersized in relation to design flows from existing land use. Therefore, there is no capacity to accommodate increased flows from development in the PPC28 area. Figure 2.6 shows the NCC stormwater network and mapped overland flow paths.

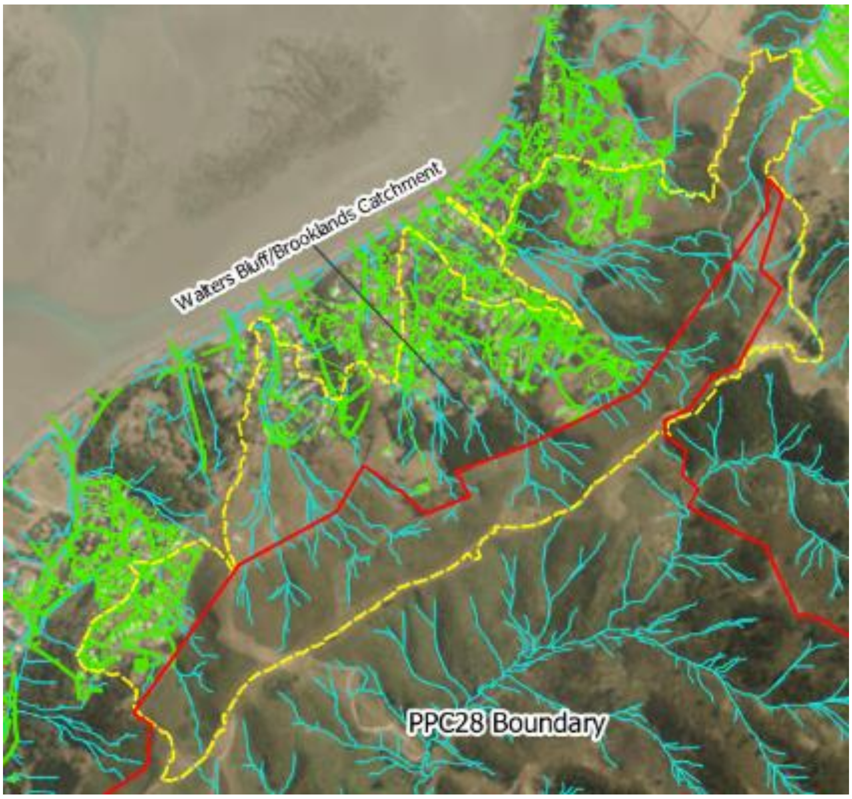


Figure 2.6: Walters Bluff/Brooklands Catchment overland flow paths and downstream stormwater network

The SCS and Rational methods, as described in Section 2.5.5.2.1, were also used to determine the peak pre-development flows from the five sub-catchments in the Walters Bluff/Brooklands areas. These sub-catchments are shown in Figure 2.7 below.

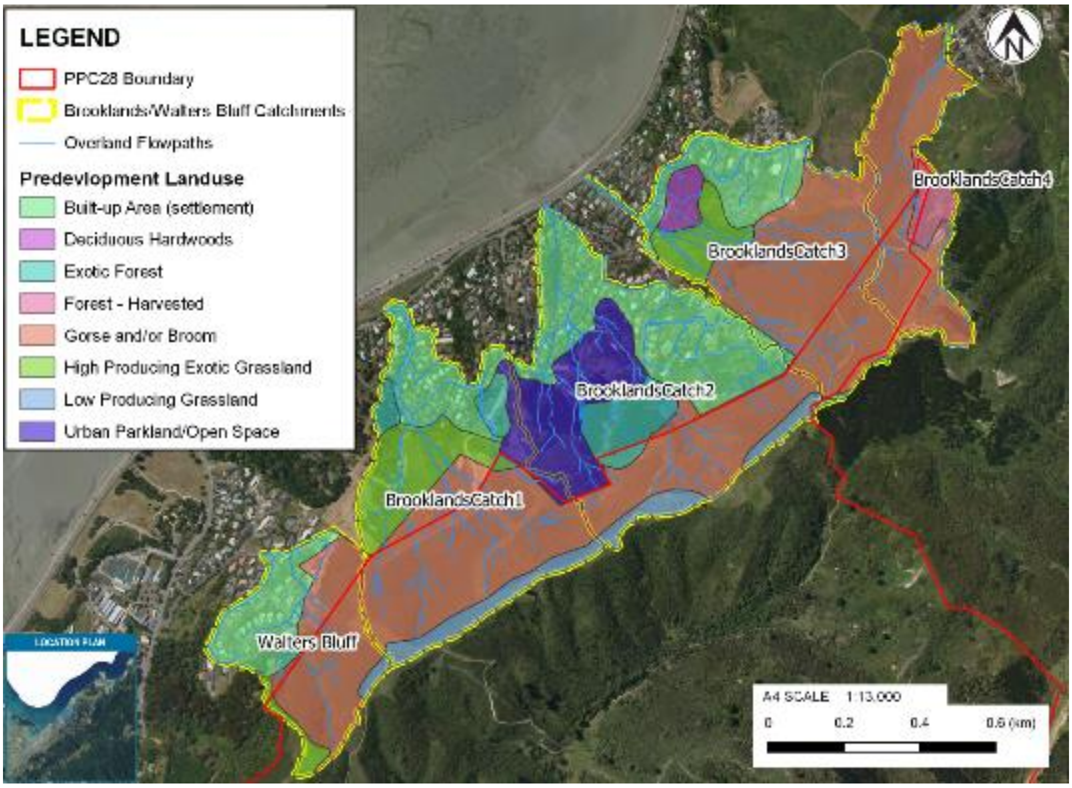


Figure 2.7: Walters Bluff/Brooklands sub-catchments and flow paths based on 2021 LiDAR data.

The table below presents the results from the preliminary hydrological assessment for the existing catchment. The associated calculations are attached in Appendix B.

Table 2.2: Peak runoff estimates for Walters Bluff/Brooklands sub-catchments

Rainfall frequency	Climate	Pre-development peak flow (m³/s)				
		Sub-catch 1	Sub-catch 2	Sub-catch 3	Sub-catch 4	Walters Bluff
10% AEP	2130 RCP8.5M rainfall	2.6 to 3.2	3.4 to 3.9	2.2 to 2.7	1.0 to 1.3	1.3 to 1.6
6.67% AEP		2.9 to 3.4	4.0 to 4.3	2.4 to 2.9	1.1 to 1.4	1.4 to 1.7
1% AEP		5.0 to 5.4	6.2 to 7.6	4.2 to 4.4	1.8 to 2.1	2.5 to 2.8

2.6 Biodiversity

T+T prepared an ecological opportunities and constraints assessment in March 2021, to support the PPC28 application.

The assessment concluded that most terrestrial habitats within the PPC28 area are highly degraded with an abundance of exotic plants and animal pests. The exception is an area of mature kānuka forest on the elevated eastern side of the PPC28 area, being the western face of Kākā Hill.

In terms of aquatic ecology, the lower reaches of Kākā Stream are intermittent and generally degraded. These have been impacted by historical and current agricultural land use practices. The upper Kākā Stream reaches have permanent flow with greater diversity and availability in aquatic habitat for freshwater fauna.

Specific initiatives to increase aquatic habitat values for native species identified within Kākā Stream, to reduce the abundance and influence of pests, and to increase the prevalence of indigenous flora and fauna are included in the ecological opportunities and constraints assessment and will be confirmed at the time of Resource Consent Application.

3 Regulatory and design contexts

The relevant planning and regulatory requirements for future stormwater management within the PPC28 area have been informed by the initial site appraisal are discussed in detail in the following sub-sections.

3.1 Regulatory objectives/policies and design guidelines

The stormwater aspects of the proposed structure plan zonings and plan change have been evaluated with consideration of objectives and policies within the NRMP, as well as the relevant design guidelines, as shown in Table 3.1.

Whilst it is noted that the NRMP is limited with regards to clear and definitive requirements, it clearly outlines the intent to manage stormwater in a manner consistent with community values, the Resource Management Act and the NPS-Freshwater Management.

The main design guideline for development with the Nelson and Tasman Regions is the NTLDM (2020). The NTLDM is intended to provide consistent minimum standards and guidance for network assets that Council will accept as part of its network.

Table 3.1: Regulatory and design requirements

Requirement	Relevant regulatory / design to follow	Comment/description
		NRMP objectives and policies
Water management	NRMP DO1.1.6	Make policy decisions on water management having regard to the provisions of resource management plans such as eel management and iwi environmental management plans that promote the sustainable use of water and associated resources.
Drainage, water and utilities	NRMP DO14.3.2	Subdivision and development should provide for: The disposal of stormwater in a manner which maintains or enhances the quality of surface and ground water, and avoids inundation of any land, and
Water quantity (NPS – Freshwater Management 2014)	NRMP DO18.1.4	When considering an application for a discharge, the consent authority must have regard to the following matters: The extent to which the change would adversely affect safeguarding the life supporting capacity of freshwater and of any associated ecosystem and The extent to which it is feasible and dependable that any adverse effect on the life supporting capacity of freshwater and of any associated ecosystem resulting from the change would be avoided.
Highest practicable water quality	NRMP DO19.1	All surface water bodies contain the highest practicable water quality
Effect of land use activities on surface water bodies	NRMP DO19.1.7	To control land use activities which have potential to adversely affect surface water quality and to encourage land use activities that minimise and filter contaminants entering water bodies.
Stormwater discharges	NRMP DO19.1.8	The level of contaminants in point source stormwater discharges to water bodies will be avoided or remedied.
New development	NRMP DO19.1.10	Maintain existing water quality by requiring use of techniques to limit both nonpoint discharges and control point source stormwater discharges caused by land disturbing activities such as forestry, subdivisions and land development, increased impervious surfaces, and commercial and industrial activities.
Water quality (NPS – Freshwater Management 2014)	NRMP DO19.1.12	When considering any application for a discharge, the consent authority must have regard to the following matters: The extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of fresh water including on any ecosystem associated with fresh water; and The extent to which it is feasible and dependable that any more than minor adverse effect on fresh water, and on any ecosystem associated with freshwater, resulting from the discharge would be avoided; and

Requirement	Relevant regulatory / design to follow	Comment/description
		The extent to which the discharge would avoid contamination that will have an adverse effect on the health of people and communities as affected by their secondary contact with fresh water; and The extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their secondary contact with freshwater resulting from the discharge would be avoided.
Integrated water management	NRMP DO20.1	A management approach that integrates the expertise of relevant statutory authorities and mana whenua iwi and other stakeholders in the community
	NTLDM /Design Guidelines	
Stormwater Design	Chapter 5 - NTLDM 2020	This chapter outlines standards and good practice matters for the design and construction of stormwater systems for land development and subdivision in the Nelson and Tasman Districts. These aim to achieve flood management, environmental and amenity expectations in an effective and efficient matter.
Performance Outcomes	Section 5.1 - NTLDM 2020	The performance outcomes for the design and construction of stormwater systems sought by the standards and good practice matters in this document are as follows: Appendix AA management solution that is based on a holistic catchment-based assessment, including consideration of topography, soil and slope, vegetation, built development, existing drainage patterns, freshwater resources, stormwater network infrastructure, natural values and natural hazards; Appendix BAn integrated design approach to stormwater management, which accommodates stormwater functions including access for maintenance and operations, as well as amenity, recreation and ecological values; Appendix CA network that manages stormwater flows to a standard that minimises people and property from harm or damage and nuisance effects, especially from risk to safety, health and well-being; Appendix DA management approach that aims to improve water quality; Appendix EDevices and design solutions that are robust, durable and easily maintained; Appendix FA whole-of-life operations, maintenance and replacement or renewal programme that is clearly described, costed, and can be afforded; Appendix GA stormwater system design that takes into account the foreseeable demands of future development;

Requirement	Relevant regulatory / design to follow	Comment/description
		Appendix HA resilient network infrastructure that performs well against the risk of geotechnical, seismic, flood hazards and coastal hazards (erosion and inundation); Appendix IA design that maintains or improves values associated with freshwater resources, including riparian management and in-stream habitat values; Appendix JStormwater assets that have high amenity value, and shared use of open-space areas where practicable and agreed to by Reserves and Facilities Manager; Appendix KA network that maintains a high visual amenity that enhances the value of adjoining property and neighbourhood values as a whole. Note all performance outcomes are also subject to the applicable Resource Management Plan objectives and policies and appropriate bylaws, which take precedence over the requirements of the Nelson Tasman Land Development Manual (NTLDM).
Application of principles of water sensitive design	GD04 (Auckland Council, 2015)	The NTLDM 2020 recommends further guidance on the implementation of WSD is available in the Auckland Council guideline document GD2015/004 (Water Sensitive Design for Stormwater)
Stormwater management devices design	GD01 (Auckland Council, 2017) Three Waters Practice Notes: HCC01 to HCC07 (Hamilton City Council); Bioretention and Wetland Practice Notes (NCC/TDC, 2017).	The NTLDM 2020 recommends that the design of WSD should be guided by the following documents Stormwater management devices in the Auckland region. Auckland Council guideline document, GD2017/001 (GD01) Hamilton City Council Three Waters Practice Notes: HCC01 to HCC07; Nelson City Council/ Tasman District Council, Bioretention and wetland Practice Notes, version 1, June 2017.

3.2 Mana Whenua Matters

This Stormwater Management Plan has been prepared together with evidence and conferencing for the PPC28 application hearing. While this work has been undertaken on the basis that iwi is supportive of PPC28, further work is required as a part of the detailed design phase to ensure mana whenua values and the principles of Te Mana o te Wai are appropriately integrated into the design process.

As per the applicant's commitment, this will occur alongside the preparation of a Cultural Values Assessment with the recommendations in that assessment being part of the integrated design process. This next step will for a part of the lead up to, and preparation of, a resource consent application to subdivide and develop the site.

4 Proposed development

4.1 Proposed land use

PPC28 proposes to re-zone approximately 287 ha of land located within the from Rural and Rural-Higher Density Small Holdings Area to a mixture of: Residential (Higher, Standard and Lower Density Areas), Rural-Higher Density Small Holdings Area, Open Space Recreation, and Suburban Commercial.

4.2 Site layout

A revised structure plan for the PPC28 area (Rough and Milne, 14 June 2022) is shown in Figure 4.1 and attached in Appendix A.

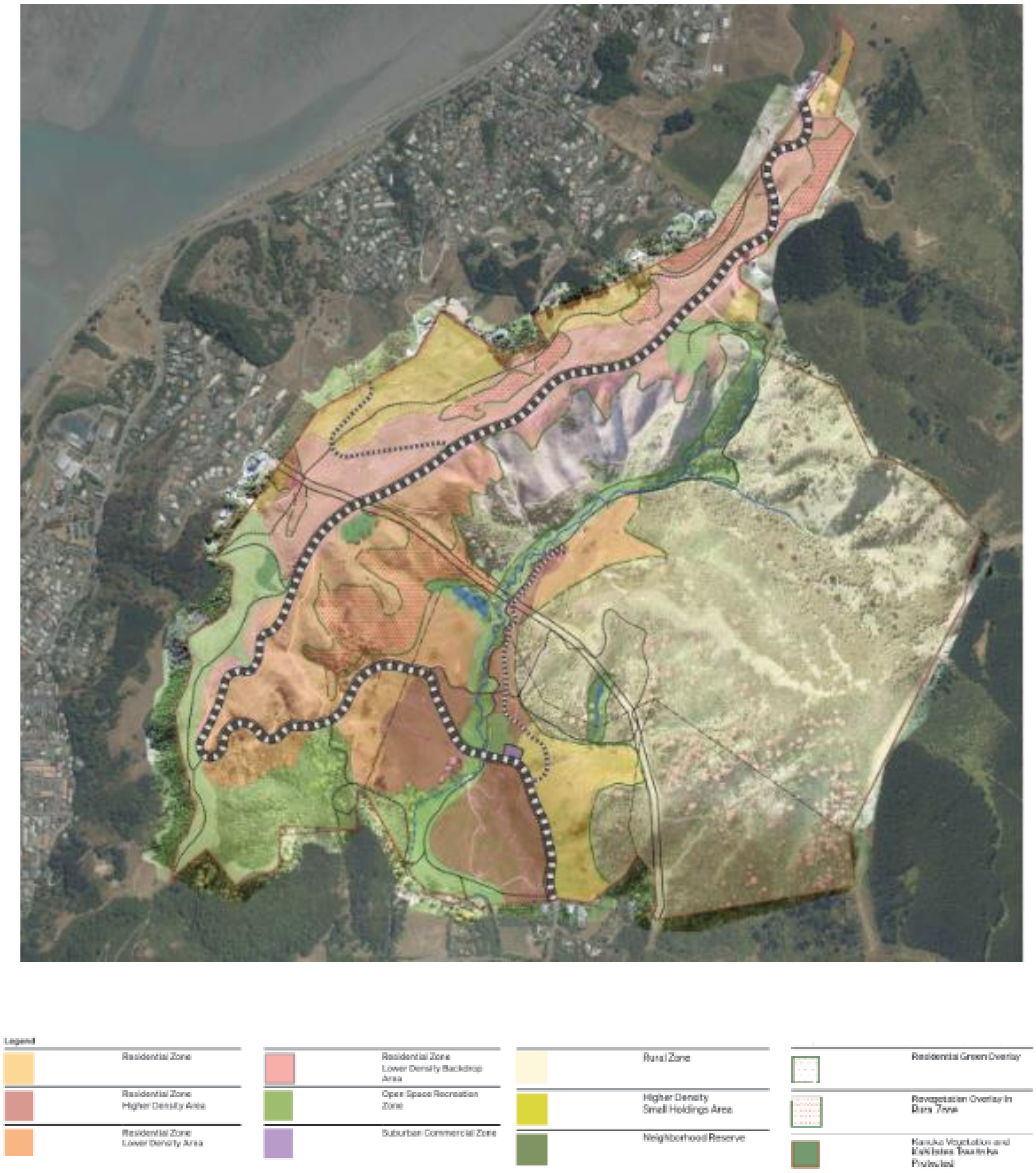


Figure 4.1: Proposed structure plan (Rough and Milne, 14 June 2022)

4.3 Earthworks

The proposed subdivision layout for the PPC28 area will influence the extent and quantity of earthworks for the development. At the plan change stage, this level of detail has not yet been determined.

The feasibility and extent of earthworks will be carefully evaluated as part of specific subdivision consent applications and will be informed by the physical constraints in particular areas, for example topography and stability, and the relevant rules in the NRMP

The methodology around how the earthworks are managed will be covered through the regulatory process at future stages of the consenting process.

5 Stormwater management

This section presents the proposed approach to manage stormwater runoff from development within the PPC28 area. The approach has been identified with consideration of:

- Site-specific constraints and opportunities identified and presented in Section 2.
- Objectives and policies within the NRMP and the NTLDM, refer Table 3.1.

5.1 Principles of stormwater management

The overarching principle for stormwater management in the PPC28 area to achieve the outcomes sought in Section 1.3 is to implement an integrated stormwater management approach, which includes:

- Recognition of the key constraints and opportunities within the PPC28 area and receiving environments.
- Devising an integrated stormwater management approach to facilitate urban development and optimise available land.
- Developing a set of BPO's for future stormwater management for each specific catchment areas.

Emphasising water-sensitive design approach, as outlined in the NTLDM, that:

- Mitigates the impact of land use change from rural to urban.
- Protects and enhances stream systems.
- Mitigates hydrological changes.
- Manages flooding effects.
- Eliminate where possible, and otherwise minimise the generation and discharge of contaminants/sediments into Maitahi/Mahitahi River and Nelson Haven.
- Facilitate urban development and protect key infrastructure, people and the environment from significant flooding events.
- Areas which are not to be developed, will be managed in ways to reduce catchment runoff and sediment yield.

5.2 Proposed stormwater management

The proposed approach, which addresses potential adverse effects on stream quality, streambank erosion and degradation of stream health, and increased flood risk, comprises:

- Eliminating where possible and otherwise minimising the generation of contaminants.
- Providing near-source water quality treatment of first-flush runoff from contaminant generating impervious surfaces in the Kaka Stream Catchment.
- Designing public stormwater pipes (primary systems) to convey the 6.67% AEP storm flows, including climate change to 2090 (based on RCP8.5) and in accordance with the NTLDM.
- Designing overland flow paths (secondary systems) with sufficient capacity to convey safely the 1% AEP storm flows including climate change to 2090 (based on RCP8.5) and in accordance with the NTLDM.
- Incorporating existing intermittent streams (and overland flow paths) as elements of future primary and secondary stormwater conveyance systems.
- Protection and improvement of Kākā Stream.

- Managing site development so the offsite flood effects are mitigated, by managing fill extents in the lower Kākā Catchment and providing attenuation to limit post-development peak flows to pre-development levels in all catchments; and
- Ensuring infrastructure is kept above the 1% AEP flood event for safety and to prevent water damage, unless specifically built with flood resilience.

The requirements for stormwater management that will be adopted for the PPC28 area are based primarily on the NTLDM stormwater section, and are summarised in Table 5.1.

Details of the following aspects of the stormwater system will be addressed as part of subdivision design and land use consenting:

- Overland flow path layout;
- Location and specific use and design of proposed stormwater management device(s), including outfall location; and
- Primary stormwater conveyance network for 6.67% AEP flows.

Table 5.1: Regulatory and design requirements

Activity	Component	Minimum standards	Proposed approach	Reference
Residential lots/ Commercial buildings – Roof area	Water Quality Hydrological mitigation	No requirements Provide storage of the EDV equivalent to a 50% AEP event with a two-hour duration, slowly release over 24 hours, for impervious areas greater than 50 m^2 and a new and direct discharge point into a stream or open drain.	1 Eliminate contaminants through the use of Inert building materials where feasible. 2 Where feasible, provide retention of at least 5 mm of runoff depth from all impervious surfaces Detention and a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from a 95th percentile, 24-hour rainfall event minus the achieved retention volume, over the impervious area using below options: • Above ground rainwater storage/re-use tanks. • Underground storage tanks. • Raingardens/planter boxed.	3 4 5 6 NTLDM 5.4.11
Roads, Hardstand and driveways	Water Quality Water Quality	Stormwater management of runoff from all impervious surfaces before discharging into the receiving environment. The NTLDM requires stormwater treatment for all stormwater treatment that originates from 'high	7 Isolation of hazardous substances using Pre-treatment Devices including: • Grated catchpits and inlets • Gross Pollutant Traps <u>Kākā Catchment</u>	NTLDM 5.4.8 NTLDM 5.4.8.4 NTLDM 5.4.10

Activity	Component	Minimum standards	Proposed approach	Reference
		contaminant' areas – No 'high contaminant' areas, as defined by the NTLDM are proposed as part of PPC28.	Additional water quality treat (above the minimum requirement) is proposed for the Kaka catchment to reflect the specific constraints and recognise the receiving environment as outlined below: • Minimise the generation of contaminants as much as reasonably practical. • Where contaminants are generated, it is proposed to use green infrastructure to treat the first flush runoff at-source or as close to the source as practicable. • Bioretention devices • Raingardens • Tree Pits • Vegetated swales • Wetlands	
	Infiltration	When within recharge zones (as classified by the NTLDM), a minimum of 5 mm of runoff from the newly created impervious surfaces shall be infiltrated within 24 hours to offset the loss of the initial abstraction of 5 mm of rainfall that uncompacted pre-development pervious areas have.	It is considered that the majority of the PPC28 area is not located within a groundwater recharge zone, therefore infiltration not feasible. However, the flat inclined slopes within the existing flood plain area that are proposed to be filled may be suitable for infiltration. This may be achieved through the following devices: • Bioretention systems with pervious bases	NTLDM 5.4.10

Activity	Component	Minimum standards	Proposed approach	Reference
			• Infiltration through trench drains • Permeable pavement	
Public spaces only, i.e. Roads, Carparking, HCGA Carriageway, Open Spaces and Riparian Margins	Stormwater conveyance	Convey runoff generated from the 6.67% AEP through a public piped stormwater network, allowing for climate change to tear 2090. Allowance for runoff flows greater than the 6.67% AEP up to the 1% AEP event should be made in overland flow paths. Existing overland flow paths should be protected. Note all runoff estimates are to account for future climate change scenarios as per NTLDM 5.4.6.2	Primary Conveyance: • Retain and enhance intermittent streams • Vegetated swales • Pipe network Secondary Conveyance: • Retain and enhance intermittent streams • Vegetated swales and open channels Road corridor	NTLDM section 5.4.6
Open Spaces and Riparian Margins	Stream hydrology and erosion protection	Enhance water quality, flows, stream channels and their margins and other freshwater values where the current condition is below the relevant thresholds.	• Green outfall (where practicable) • Riparian margin enhancement and planting, where necessary to mitigate identified adverse effects	NTLDM 5.4.9
Development – hydraulic mitigation	Water Quantity	Provide detention so that post development peak flows shall not exceed pre-development peak flows for the 10% AEP (10-year ARI) and 1% AEP (100-year ARI) events as per the NTLDM. Note all runoff estimates are to account for future climate change scenarios as per NTLDM 5.4.6.2	Storage or at source, i.e. individual onsite stormwater detention tanks: • Online – this involves the potential restriction of higher flows within the Kākā Stream (or a major tributary) and attenuates both developed and undeveloped catchments within the site • Offline – this involves separating the runoff from the developed	NTLDM 5.3.13

Activity	Component	Minimum standards	Proposed approach	Reference
			areas and providing restrictions for those flows only. Undeveloped catchments within the site will be left to drain as presently.	
Mitigate adverse flooding effects within and outside the PPC28	Flood Management	Managing site development so that onsite and offsite flood effects are mitigated. This can be achieved by managing fill extents in the lower Kākā Catchment and through providing attenuation and extended detention to limit post development peak flows to pre-development levels and mitigate the effects of increased duration of flows during rain events; and	All building platforms to be located outside of and set above the 2130 RCP8.5M 1% AEP Maitahi/Mahitahi Flood level, with a suitable allowance for freeboard as per NTLDM. Any earthworks within the lower flood plain shall be designed with appropriate flood mitigation to avoid adverse site and offsite effects and should be limited in extent so as to ensure that they do not cause increases in flood depths in adjacent or downstream property (i.e. modelling should be carried out to assess final earthworks footprints, and demonstrate < 50 mm increase in flood depths within adjacent or downstream property).	NTLDM 5.4.5
	Conveyance	Ensuring infrastructure is kept above the 1% AEP flood event for safety and to prevent water damage, unless specifically built with flood resilience.	All building platforms to be located outside of and set above the 1% AEP Flood level, with a suitable allowance for freeboard as per NTLDM. Where Infrastructure is required to be within the 1% AEP Flood extent, e.g. secondary flow paths, roadways,	

Activity	Component	Minimum standards	Proposed approach	Reference
			this infrastructure shall be designed to be flood resilient. For events greater than a 10% AEP storm event and up to a 1% AEP storm event, secondary flows will be conveyed along road corridors into existing overland flow paths. Ideally flow paths will be located within public areas (roads and parks) and not private properties. Enhancement of intermittent stream riparian margins, providing public amenity improved ecological value, and assisting flood management with capacity for secondary flows. Any secondary flows are required to be designed/managed to reduce the impact on private or public property. All flow paths will be provided with sufficient freeboard and alternative flow paths to allow for blockages at the top of development areas, to enable flows to pass from the upper undeveloped slopes through the urbanised areas to the main Kākā Stream corridor at the base. These flow paths will be formally identified and designated (when in private property). This could be a mix of road corridors (with consideration of risks related to depth and velocity) and interconnecting greenways.	

5.3 Water-sensitive design approach

Stormwater from the PPC28 area will discharge either:

- To the Kākā Stream and the Maitahi/Mahitahi River and ultimately into Nelson Haven, or
- For the Walters Bluff/Brooklands Catchment, directly or via Dodson Catchment to Nelson Haven.

Management of stormwater quality and quantity will be critical to protection of the existing Kākā Stream, Maitahi/Mahitahi River and other receiving downstream waterways. As a result, a water-sensitive design (WSD) approach has been adopted for PPC28.

Clause 5.4.8.6 of the NTLDM says *"Appropriate stormwater treatment shall be selected based on water-sensitive design principles and designed for on specific land use, associated contamination of concern and site constraints".* NTLDM references national best practice guidance documents which include Auckland Council GD2017/001 (GD01), Hamilton City Council HCC07 and NCC/TDC Bioretention and wetland practice note (2019) which identify roads as a key producer of non-point source pollution resulting from development.

The key water-sensitive design principles outlined in the Section 5.3.2.2 of the NTLDM and how they are proposed to be incorporated in the stormwater management approach are summarised in Table 5.2, and explained in further detail in the following sections.

Table 5.2: Water-sensitive design principles

Water-sensitive design principles	Application within the development
Protect and enhance the values and functions of natural ecosystems	It is noted that the main stem of the Kākā Stream is proposed to be protected via a designated linear riparian reserve extending along its full length. This includes the lower reach which is proposed to be realigned. The width of this riparian reserve was initially defined with a minimum width (40 m) to follow the general stream alignment (i.e. does not vary for all meanders). This riparian reserve will create a natural green corridor and allow for colonisation and/or movement of flora and fauna across the landscape. Vegetated watercourse margins will also function to filter surface runoff from surrounding land.
Address stormwater effects as close to source as possible	Generation of contaminants will be prevented as far as possible through the use of inert building materials. Where contaminants are generated and it is feasible (e.g. road and car parks), green infrastructure will be provided to mimic natural physical, biological and physical treatment processes as close to the source as practicable.
Mimic natural systems and processes for stormwater management	The enhancement of natural hydrological features by restoring riparian margins with vegetation along stream banks. Stormwater treatment devices and green infrastructure incorporating evapotranspiration and infiltration where practicable.

Water-sensitive design principles	Application within the development
Support inter-disciplinary planning and design where practicable	PPC28 Ecological Opportunities and Constraints Assessment Report (T+T, 2021) provided specialist Ecological input to development of the stormwater management approach. Preliminary Structure Plan Environmental Review report (Morphum, 2021) provided specialist WSD input to development of the stormwater management approach.
WSD principles shall be considered during the initial design and planning	By adopting the principles and objectives of this SWMP it is considered that WSD principles will be met throughout the design process.

5.4 Integrated stormwater design approach

An integrated design approach is proposed as part of the WSD process within the PPC28. This means the proposed stormwater system will be considered in parallel with the ecology, best practice urban design, and community values. This approach will be developed in more detail through the planning and design processes.

This integrated approach ensures that asset groups, community stakeholders, and operation and maintenance personnel are consulted as part of the stormwater design. Some key considerations are provided below:

- Potential to combine open spaces with stormwater management areas (e.g. attenuation/detention) to allow recreation and increase community value.
- Keep (non-flood resilient) infrastructure above the 1% AEP flood event for safety and to prevent water damage.
- Design stormwater features that provide for landscape amenity, natural character values, social interaction and education/interpretation as appropriate.
- Design stormwater management features to augment and/or buffer existing ecosystem functions and values.
- Promote biodiversity from wetland to upland environments.
- Include WSD responses to hard surfaces and structures such as car parking.
- Design swales and watercourses so that they resist erosion and minimise maintenance requirements.
- Rehabilitate soils and increase regenerating vegetation within open spaces to enhance stormwater attenuation potential.
- The identification of existing site values and functions, receiving environment values, and socio-cultural values.
- The identification and establishment of areas (e.g. open space network, stream setbacks, areas of restoration) that will protect and enhance ecosystem health.

Key inputs for the integrated design approach are summarised below:

- PPC28 Ecological Opportunities and Constraints Assessment Report, prepared by T+T, March 2021 provided specialist Ecological input to development of the stormwater management approach.
- Preliminary Structure Plan Environmental Review" report prepared by Morphum, April 2021 provided specialist WSD input to development of the stormwater management approach.

- Rough & Milne (RMM) urban design/landscape drawings and indicative cross sections submitted as “Graphic Attachment” with RMM evidence.

5.5 Water quality

The proposed water quality management approach below seeks to achieve the relevant stormwater management outcomes:

- Eliminate where possible, and otherwise minimise the generation and discharge of contaminants/sediments into Maitahi/Mahitahi River and Nelson Haven;
- Implement where possible, a water-sensitive design approach, as outlined in the NTLDM, that:
  - mitigates the impact of land use change from rural to urban
  - protects and enhances stream systems
  - mitigates hydrological changes
  - manages flooding effects;
- A set of BPO for future stormwater management;
- Areas which are not to be developed, will be managed in ways to reduce catchment runoff and sediment yield.

These outcomes will be met through the adoption of approaches outlined below for the differing land uses. An appropriate level of water quality treatment will be applied for each land use application and anticipated contaminants in the context of the catchment constraints.

5.5.1 Residential buildings

Using inert building materials to prevent generation of contaminant-laden runoff within residential lots, i.e. avoiding use of high contaminant yielding building products which have:

- Exposed surface(s) or surface coating of metallic zinc of any alloy containing greater than 10% zinc.
- Exposed surface(s) or surface coating of metallic copper or any alloy containing greater than 10% copper.
- Exposed treated timber surface(s) or any roof material with a copper-containing or zinc-containing algaecide.

5.5.2 Roads, carparks, hardstand and driveways

Treating runoff from contaminant generating impervious areas (i.e. parking areas and roads regardless of traffic volumes) within the Kākā Stream Catchment, through methods such as:

- Install grated sumps and inlets to the stormwater network for capturing gross contaminants, solids, sediment, and gravels.
- Install catchpits in sumps and manholes to reduce sediment transport through the stormwater network.
- Where feasible, include near-to-source devices such as vegetated swales, rain gardens, tree pits, and permeable pavements where effective.

5.5.3 Catchment approach

Stormwater sub-catchments will be managed with ‘traditional’ pipe networks as the primary drainage system to collect and convey excess flows from lots and runoff from roads.

Sub-catchment stormwater treatment in the Kākā Stream Catchment is to be via consolidated treatment devices to mitigate impacts prior to discharge to any natural waterway beyond the development boundary. Treatment devices will be sized to treat the first flush and may include:

- Consolidated rain gardens designed with internal storage, and infiltration to shallow groundwater where feasible:
  - These can be integrated within the proposed Kākā Stream esplanade (where suitable) or in dispersed parklets which support community connection with water management and support amenity, urban ecology and education. These will be designed with careful consideration of lifecycle maintenance. Rain gardens will all be offline to full pipe flow with appropriately design bypass although flood attenuation can be accommodated above the operational water level as required.
- Consolidated constructed wetland designed to be integrated into green spaces and provide a high level of water quality treatment:
  - These will be integrated within the proposed Kākā Stream esplanade, in particular on the lower terrace alongside the re-aligned channel reach. High quality constructed wetlands will support community connection with water management and support amenity, urban ecology and education. Consideration will be given to options to harvest treated water from wetlands to augment irrigation of high amenity planted gardens, community gardens or irrigation of parks. These will be designed with careful consideration of lifecycle maintenance. Raingardens will all be offline to full pipe flow with appropriately design bypass although flood attenuation can be accommodated above the operational water level as required.
- Generally, provide fewer larger treatment devices, in favour of numerous smaller devices to allow treatment as close to the source as possible. Typically, these will be wetlands upstream of catchment discharge points, with gross pollutant traps further upstream as part of the treatment train to increase treatment efficiency. The devices may be dual-purpose as they could also provide some flood attenuation, if required.

Where the stormwater is to discharge to a downstream piped network beyond the PPC28 boundary (i.e. the Brooklands Catchment), then stormwater will be managed as per the NTLDM requirements.

5.5.4 Receiving environment

The proposed stormwater options will be tailored for their specific constraints and receiving environments. Therefore, a different treatment strategy will be adopted for discharge to the Kākā Stream compared to a downstream piped stormwater network (Walters Bluff/Brooklands Catchments):

- Provide riparian margins that protect and enhance the Kākā Stream, and with the secondary benefit to stormwater management through the disconnection of impervious areas from the receiving environment
- Limiting sediment generation and controlling erosion effectively during earthworks and construction.

The above options are not an exhaustive list and mitigation options suitable for each specific location will be investigated in latter design stages to achieve the water quality management objectives.

5.5.5 Hydrological mitigation

The proposed rezoning of the site will result in an increase in impervious surfaces and changes to the hydrology of the existing catchment. Thus, there will be a decrease in infiltration and a resulting increase in runoff during the smaller but more frequent storm events. In addition, the increased hardstand areas will likely also affect the temperature and pH of the runoff compared.

This section considers the mitigation of these smaller but more frequent storm events to offset the effects of development. Smaller storm events can also strongly influence the geomorphology of receiving streams and therefore the effects on downstream erosion risk are considered in Section 5.5.2.

The hydrological mitigation measures identified below will be most effective during smaller events, but will mitigate (to some extent) effects of increased runoff in all storm events. This mitigation is covered in the NTLDM Section 5.4.11 which requires extended detention to slow down flows from more frequent storm events.

The general approach to water quantity management for small storm events is to implement extended detention according to the following:

- Provide storage of the extended detention volume (EDV) that is the equivalent of a 50% AEP event with a two-hour duration, slowly release over 24-hours. Any volume that infiltrates on site may be subtracted from the extended detention volume.
- A minimum of 5 mm of runoff from the newly created impervious surfaces will be infiltrated, when located in a recharge zone, within 24 hours to offset the loss of the initial abstraction of 5 mm of rainfall in pre-development pervious areas.
- To meet the hydrological mitigation objectives, consideration of the following management options are proposed:
  - Where feasible, dwellings to include rainwater capture with reuse to service internal and external non potable demands to intercept an initial volume of runoff as a surrogate for naturally occurring evapotranspiration losses.
  - All dwellings on suitable ground will include infiltration via dedicated infiltration device, designed to receive runoff from driveways and overflow from rainwater tanks. These will be sized based on a minimum of 5 mm of runoff, within 24 hours of a rainfall event
  - Rain gardens, planter boxes, vegetated swales and tree pits are bio-retention devices which can be designed to also provide the extended detention requirement within private residential property or along road corridors and within public impervious spaces, while adding to the landscape value of the development.

As outlined, any stormwater discharged via infiltration reduces the required EDV. Infiltration rates within the site have not been tested yet. This extended detention requirement is expected to be reduced via onsite measures on individual properties and managed within the proposed water quality deceives (wetlands/rain gardens).

5.5.6 Spatial requirement

Water quality mitigation measures have been investigated in the Morphum Environmental Memorandum (Appendix D), to ensure there is sufficient area available within the development area to accommodate these. Generally, water quality treatment shall be provided prior to discharge to natural waterways by routing a proportion of stormwater runoff through a treatment device optimally located where flows can be conveyed by gravity. It is noted that modelling has provided recommendations for the required land area for both rain gardens and wetlands (i.e. treatment requirements duplicated). The final development design will include either one of the two devices or a combination in response to site conditions. Calculations supporting the estimation of site hardstand are shown in Table 5.3.

Table 5.3 shows the summary of sub-catchment land use, and the estimated footprint to manage stormwater as estimated by Morphum (Appendix D, refer also Figure A1, Appendix A). It is noted that the reported footprints for rain gardens/wetlands are for either of these options (i.e. not combined) and the distribution of these is expected to be split into more than one device per sub catchment. The final selection of optimal treatment devices, layout and distribution will be developed in close co-ordination with urban designers, landscape architects, civil designers and geotechnical engineers.

Table 5.3: Sub-catchment land use and estimated stormwater management footprint

Subcatchment	Combined Developed Area (ha)	Impervious %	Sum of Impervious Area (ha)	Assumed roof area (ha)	Managed Hardstand (ha)	Un-managed hardstand (ha)	Road impervious (ha)	Rain garden Area (m^2)	Wetland Area (m^2)
1	14.96	41%	6.13	3.07	0.31	0.92	0.98	494	1,112
2	26.35	42%	11.07	5.53	0.55	1.66	1.77	892	2,007
3	0.86	65%	0.56	0.28	0.03	0.08	0.09	45	101
4	13.69	65%	8.90	4.45	0.45	1.34	1.42	717	1,614
5A	7.11	56%	3.98	1.99	0.20	0.60	0.64	321	723
5B	3.42	65%	2.22	1.11	0.11	0.33	0.36	179	403
Grand Total	**66.39**		**32.86**	**16.43**	**1.64**	**4.93**	**5.26**	**2,649**	**5,960**

5.6 Water quantity

The proposed rezoning of the PPC28 area and development resulting in an increase in impervious surfaces will also increase the peak flow and volume of stormwater runoff.

The proposed water quantity management approach seeks to achieve the relevant stormwater management principles:

- Recognise the key constraints and opportunities within the PPC28 site and receiving environments;
- A water-sensitive design approach, as outlined in the NTLDM, that:
  - mitigates the impact of land use change from rural to urban
  - mitigates hydrological changes
  - manages flooding effects;
- Facilitate urban development and protect key infrastructure, people and the environment from significant flooding events.

These principles will be met through the adoption of approaches outlined below for the differing catchments.

5.6.1 Water quantity requirements

Section 5.4.13 of the NTLDM states that stormwater runoff shall be detained to mitigate the effects of any additional volume or increased peak discharge rate resulting from the development.

For a greenfields development resulting in additional impervious surfaces, where the downstream receiving network has insufficient capacity for the increased flow and/or where there are known downstream flood risks, attenuation shall be provided such that post-development peak flows do not exceed pre-development peak flows for events between the 10% AEP and the 1% AEP frequency.

To comply with this requirement, hydrological mitigation is proposed to attenuate post-development peak flows in both the Kākā Stream and Walters Bluff/Brooklands Catchments. This will be primarily achieved by the collection, storage and the controlled release of attenuated flows. The outlet is generally designed so that normal flows pass under normal conditions with attenuation only occurring during more infrequent and larger events.

The range of attenuation/detention options includes:

- Storage at source, i.e. individual onsite (private) stormwater detention tanks
- Online stream storage, involving restriction of higher flows within the Kākā Stream (or a major tributary/flow path) to attenuate runoff from both developed and undeveloped catchments within the site
- Offline, involving separation of the runoff from the developed areas and providing attenuation for those flows only. Undeveloped catchments within the PPC28 area would be left to drain as presently.

In the sections below, a post-development peak flow assessment of the Kākā Stream and Walters Bluff/Brooklands Catchments is presented and compared to the pre-development peak flows calculated in Section 2.5.

The proposed flood management strategy identifies the use of flood detention dams, and indicative pond sizes are presented. Any flood detention device would be required to meet the performance standards of the NTLDM and would be designed in accordance with the NZ Dam Safety Guidelines 2015 (or equivalent operative standards applicable at the time of design). This would include consideration of the potential impacts of a dam break.

Consideration of how these water quantity mitigation options interact with the flood flows with the Maitahi/Mahitahi River is discussed in Section 5.6.2.3.1 below and should be refined in later design stages. The analysis shows that by providing water quantity mitigation of the post-development flows within the Kākā Stream Catchment, the resulting hydrograph entering the Maitahi/Mahitahi River is delayed, i.e. by restricting flow and releasing in a controlled manner, water will arrive at the Maitahi/Mahitahi River slightly later than for the unmitigated option. For any future development stage, the timing of peak flows from the Kākā Catchment should be assessed relative to the timing of elevated water levels in the Maitahi/Mahitahi River. If appropriate the designers could then consider a pass-forward flows approach, or extension of the detention time (through use of additional storage) to mitigate any elevated flood risk associated with timing effects. The initial assessment indicates that the change in timing is small and insignificant in terms of Maitahi/Mahitahi River flows.

5.6.2 Water quantity modelling

Stormwater runoff from the proposed post-development land-use within the PPC28 area has been modelled using the SCS hydrological method to enable a comparison between the peak pre- and post-development runoff and for preliminary sizing of attenuation devices.

5.6.2.1 Lot yield

The landform above the valley floor in Kākā Valley and the landform forming the Atawhai ridgeline and slopes to the west of the ridgeline has formed to reflect the dominant underlying geology and past geological processes.

As discussed in the T+T Geotechnical report, the landform above the valley floor in Kākā Valley and the landform forming the Atawhai ridgeline and slopes to the west of the ridgeline, have been identified as areas of Moderate and High geotechnical risk (Refer Figure F5 in Appendix A). These areas do not preclude subdivision development, but these factors will impact on where residential lots can be located and the overall subdivision lot yield on this land. These constraints will need to be considered be considered as part of future subdivision planning.

Subdivision development on the Atawhai hillside, highlights the constraints that geology, landform, and slope stability place on development. The effect of these constraints is to reduce potential yield in such areas. To assess what the impact of geology, landform (in particular slope gradient) and past slope instability have on both yield and long-term stormwater management we have examined existing subdivisions that are on the moderately steep slopes on the Atawhai Hills in the vicinity of PPC28.

Two completed subdivision areas, Walters Bluff/Davies Drive and the upslope portions of the Ledbury subdivision illustrate how landform, bedrock geology and slope instability influence subdivision design and lot yield. These areas show relatively high density of lots on areas downslope of the Flaxmore Fault and a lower density of residential lots on land upslope of the Flaxmore Fault (refer Figure F4 in Appendix A), where underlying geology is similar to the geology underlying PPC28 area hillside slopes.

We have measured the areas of impervious areas (road, roof and hardstand) from aerial photography and where lots have not been developed, we have made an estimate of future likely imperious area based on how adjacent lots have been developed. Ground cover that is not impervious has been measured and/or estimated based on a ground cover being either grass or tree/shrub.

At Walters Bluff, separate areas upslope and downslope of the Flaxmore Fault were assessed and indicate that the upslope portions of the subdivision, which adjoin the PPC area, achieved a much lower yield (approximately 3.3 lots/ha) compared to gentler slopes downslope and west of the Flaxmore Fault (yield of 6.6 lots per/ha). In addition to a reduced density of lots there is a marked change in vegetation cover with the upslope areas largely being covered with bush/shrub cover post residential development (58%) and with little impervious cover (20%) compared to downslope areas.

The portion of Ledbury subdivision assessed is all upslope of the Flaxmore Fault and includes large areas covered by ancient landslides. The past slope instability influenced the way the subdivision was developed. The landform and ancient slope instability resulted in a Lot yield of 2.8 lots per hectare, even less than the Bayview subdivision. The land is now dominated by establishing bush shrub vegetation that constitutes 80% of the subdivided area, with impervious surfaces constituting 9% of the subdivision area.

Based on our assessment of adjacent subdivision areas we consider that overall subdivision yield of residential zoned land is likely to fall between 2.8 and 4 lots per hectare on hillside land. However, for the water quantity modelling for the SMP we have adopted a conservative approach as outlined in Table 5.4

5.6.2.2 Modelling parameters

The land use from the developed PPC28 area has adopted a conservative approach based on the minimum allowable lot sizing from the proposed zoning reported in the Structure Plan (Appendix C) and an equivalent average lot size from SCS curve number tables, as shown in Table 5.3.

Post-development stormwater modelling will be refined throughout the design process to determine more accurately the stormwater parameters for the detailed subdivision design.

Note that due to the low soakage rates expected on hillslopes we have assumed that the proportion of private hardstand and driveway areas that can be directly managed by soakage is 25%.

Table 5.4: Zoning and SCS cover type

Proposed Zoning	Cover type and hydrologic condition	Average impervious area[1]
Residential	Residential districts by average lot sizes - 1/8 acre or less (town houses)	65%
Residential – higher density	Residential districts by average lot sizes - 1/8 acre or less (town houses)	65%
Residential – lower density	Residential districts by average lot sizes - 1/4 acre	38%
Open Space Recreation Zone	Brush-weed-grass mixture with brush the major element	5%[2]
Suburban Commercial Zone	Commercial and business	85%
Rural Zone	Brush-weed-grass mixture with brush the major element	5%[2]
Higher Density small holdings are	Residential districts by average lot sizes - 1 acre	20%
Neighbourhood Reserve	Open Space (lawns, parks, golf courses, cemeteries, etc.)	5%[2]

Average percent impervious area sourced from SCS TR-55 Table 2-2a
Where Average percent impervious area not reported in SCS TR-55 Table 2-2a, a nominal 5% impervious has been assumed

Source: SCS TR-55 Table 2-2a Runoff curve number for urban areas , https://www.hec.usace.army.mil/software/hec-hms/documentation/HEC-HMS_Technical%20Reference%20Manual_(CPD-74B).pdf

The pre-development peak flows may also be analysed further to capture the 'permitted' land use within the currently rural zoned valley, i.e. the potential peak flows given the entire catchment was cleared of vegetation and used primarily as pasture, as is allowed under its rural zoning.

5.6.2.3 Kākā Stream Catchment

Based on the proposed future land uses outlined in Table 5.4, the impervious cover within the Kākā Stream Catchment is expected to increase, from probably less than 5% to approximately 23%.

This assumed post-development land use within the Kākā Stream Catchment has also been modelled using the SCS hydrological method, with no detention/attenuation. The results have been compared to the pre-development SCS runoff assessment in Section 2.5.5.2.1 above, with detailed calculations included in Appendix B.

The same sub-catchments have been used, as the extent of fill and sub-catchment modification cannot be confirmed at this design stage, except for sub-catchment 5 which has been split to reflect the proposed channel realignment. An updated sub-catchment figure is shown in Figure 5.1.

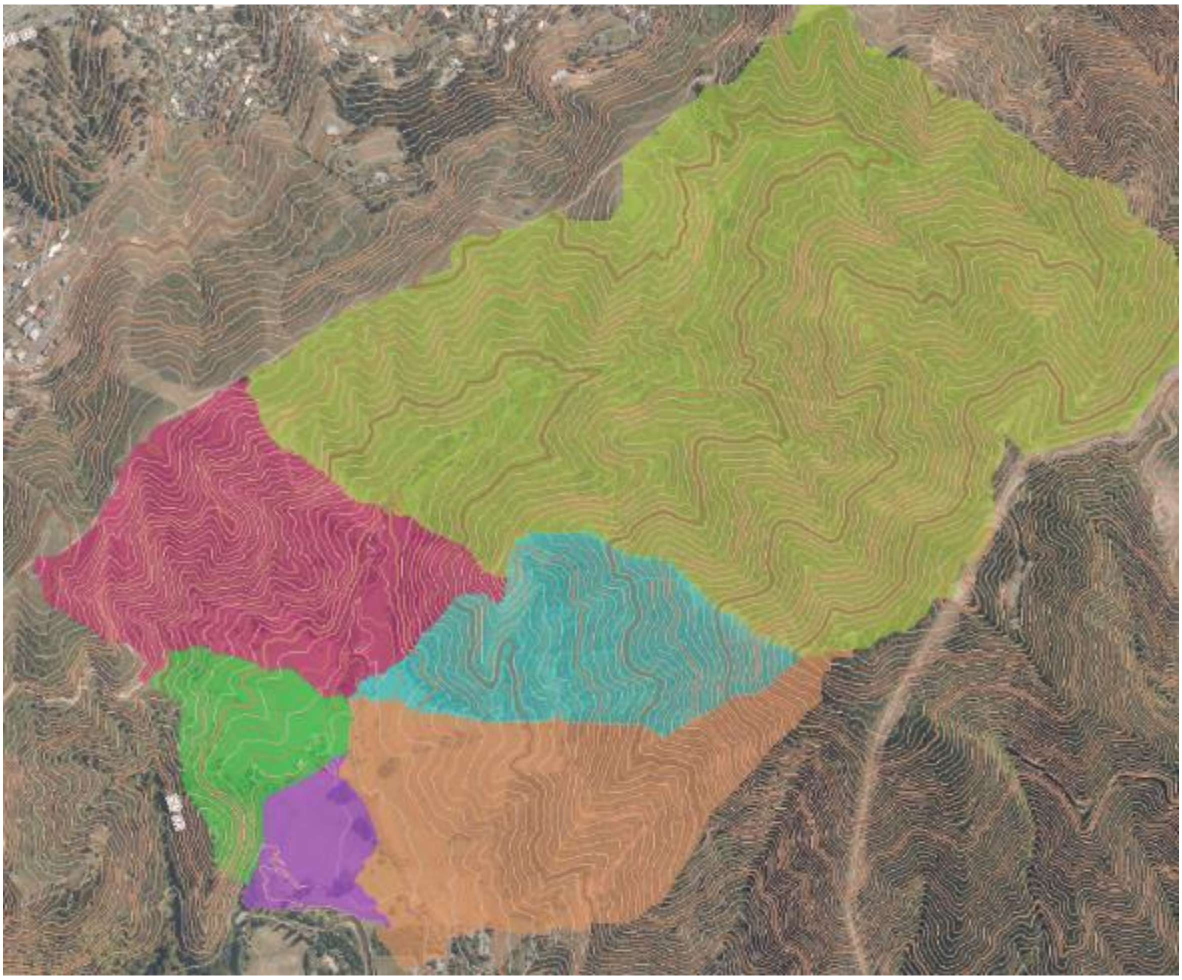


Figure 5.1: Post development sub-catchments

As shown in Table 5.5 the post-development peak flow from the Kākā Stream Catchment increases as a result of the changes in land use. to comply with the requirements of NTLDM 5.4.13, attenuation of post-development peak flows will be required to mitigate adverse effects of flood flows in the Kākā Stream where at the Maitahi/Mahitahi River confluence.

To demonstrate the feasibility of attenuation, a post-development option was developed within the PPC28 area to identify the likely location of attenuation devices. Conceptual water attention basins have been sited as indicated in Figure A2 Appendix A and assessed against the critical attenuation event (1 hour 100% AEP (2130 RCP8.5 rainfall)). The storage elevation curves for these basins have been derived from existing site contours. The post-development attenuated peak flows are shown in Table 5.5. Hydraulic performance during more events, will be refined during detailed design, most likely incorporating a staged inlet/outlet structure.

Table 5.5: Attenuation requirements for Kākā Stream

	Pre-development peak flows (m^3/s)	Post-development peak flows (unmitigated) (m^3/s)	Difference (m^3/s)	Post-development peak flows (mitigated) (m^3/s)	Storage Required (m^3)
Catchment 1	17.0	17.8	0.8	15.4	3,300

	Pre-development peak flows (m^3/s)	Post-development peak flows (unmitigated) (m^3/s)	Difference (m^3/s)	Post-development peak flows (mitigated) (m^3/s)	Storage Required (m^3)
Catchment 2	5.4	7.3	1.9	5.0	2,700
Catchment 3	3.7	3.6	-0.1	3.6	
Catchment 4	17.0	17.8	0.8	15.4	3,300
Catchment 5 A	2.1	1.9	0.4	1.6	500
Catchment 5 B		0.6		0.5	200
Maitahi/Mahitahi Confluence	29.0	32.0	3.0	28.7	

5.6.2.3.1 Timing of peaks

The assessment above demonstrates that the feasibility of detention devices to limit post-development flows to pre-development levels in the Kākā Catchment. Detention storage would also typically change the catchment runoff peak timing. Depending on the receiving environment (e.g. into the Maitahi/Mahitahi River) there is the potential to impact on downstream flood flows and levels. To assess this risk the HEC-HMS model was used to route post-development flows through the proposed detention devices.

As previously noted, NIWA's design 1-hour, 6-hour and 12-hour rainfall profiles were modelled using the pre-development catchment. The 6-hour event was assessed to be the critical storm duration, with the peak occurring in this design storm after four hours of rainfall. The location of the peak in any given 6-hour duration storm event will depend on the temporal rainfall pattern of that event, and may differ from the design storm.

When the same design storm modelled over the post-development catchment with the detention dams described above, the results show that the peak runoff at the confluence arrives about twelve minutes later, as illustrated in Figure 5.2.

Given that the Maitahi/Mahitahi River is much larger than the Kākā Stream, this difference in timing will be negligible in terms of downstream effects (no observable increases in peak flows or flood levels/extents over the pre-development scenario).

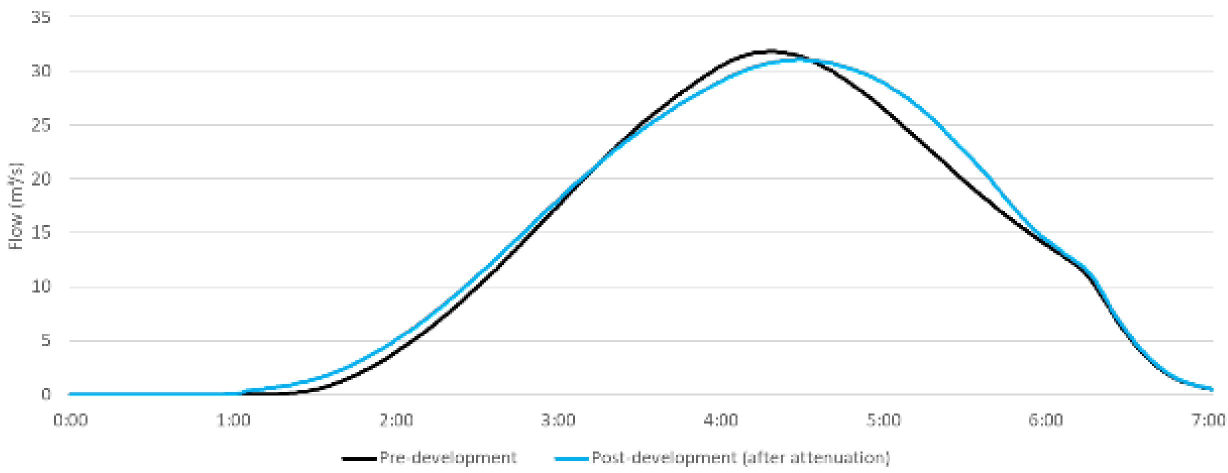


Figure 5.2: Difference in timing of modelled peak runoff from the Kākā Stream catchgment, pre-development vs. post-development for the 2130 1% AEP 6-hour event (using NIWA's HIRDS v4 design storm).

5.6.2.4 Walters Bluff/Brooklands Catchment

Initial investigations indicate that there is no spare capacity downstream of the PPC28 area in the existing NCC stormwater network in the Walters Bluff/Brooklands Catchment. Therefore, post-development flows within the Walters Bluff/Brooklands Catchment are proposed to be managed so that any capacity issues are not exacerbated, as a result of the PPC28 land use changes. On this basis, the options for the management of water quantity include:

- The provision of detention devices to mitigate the effects of any additional volume or peak discharge that would otherwise result from the development. This will include combination of small detention devices close to source, on site detention devices such as rainwater tanks, previous paving, and bioretention devices such as planting strips, that store and release the stormwater. As a result, the flowrate from the PPC28 area will be limited to the pre-development flow rate.
- Upgrading of the existing piped network or providing a new piped system to convey runoff from the PPC28 area to a discharge point to the Nelson Haven on the northern side of Atawhai Drive.

Appropriate stormwater management options will be investigated in more detail as part of future Resource Consent and Subdivision applications.

The proposed post-development land use, with no attenuation, within the Walters Bluff/Brooklands has been modelled using the SCS hydrological method for the sub-catchments shown in Figure 2.73 and using the proposed land use classifications from Table 5.4. These have been compared to the pre-development SCS runoff assessment in Table 5. Detailed calculations are included in Appendix B.

Provisional attenuation options were developed to demonstrate that it is feasible within the development area to site the required attenuation devices. Refer to Figure 1 & 2 in Appendix A.

Table 5.6: Attenuation requirements for Walters Bluff/Brooklands sub-catchments

	Pre-development peak flows (m^3/s)	Post-development peak flows (unmitigated) (m^3/s)	Difference (m^3/s)	Post development peak flows (mitigated) (m^3/s)	Storage required (m^3)
Catchment 1	5.4	7.3	1.9	5.4	**2,700**
Catchment 2	7.6	8.8	1.1	7.3	**2,000**
Catchment 3	4.4	4.9	0.5		
Catchment 4	1.8	0.2	0.3		
Walters Bluff	2.8	3.4	1.5	2.8	**900**

5.6.3 Erosion risk management

Unless carefully managed, urbanisation can lead to adverse stream bank erosion effects due to the increased runoff rate and volume. Mitigation measures (such as increased detention, flood plain management or in-stream works) may be required to manage these when there are already bank erosion and stream stability issues in the downstream watercourses.

The scale and severity of this requires more detailed geomorphological assessment as a part of subdivision and engineering design, and so will be addressed within the Resource Consent processes that will follow the Plan Change.

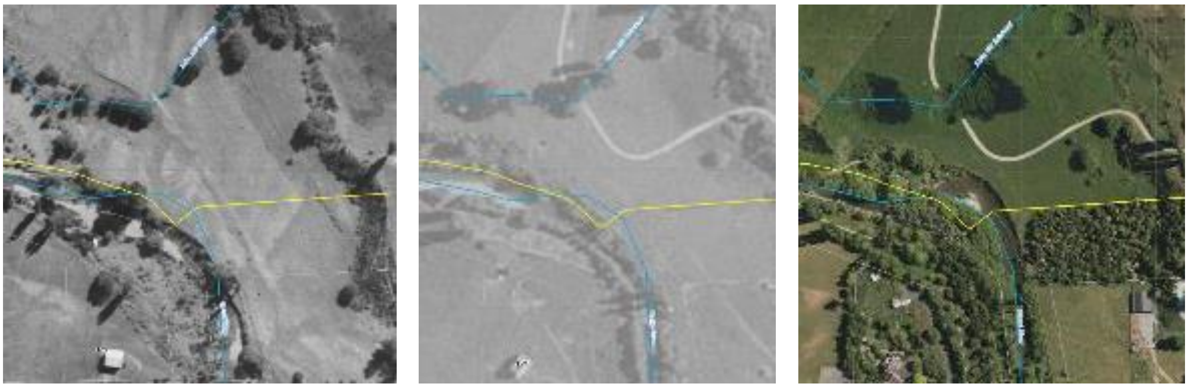
Erosion susceptibility is typically mitigated through retention of post-development stormwater flows. Retention requires a portion of flows to kept out of the stormwater network to reduce the risks associated with flash flows in regular small events, this is expected to be achieved via the hydrological mitigation methods outlined in Section 5.5.5. In addition, the improvements to the riparian plantings are also expected to improve bank erosion vulnerability.

5.6.4 Maitahi/Mahitahi bank erosion

The existing bank of the Maitahi/Mahitahi River has been noted as eroding the northern bank at the bottom end of the site. Figure 5.3 shows the movement of the Maitahi/Mahitahi River into the flood plain and beyond the original boundary since the 1940's. The river has retreated approximately 40 m to the north over this period, resulting in the loss of land within the PPC28 area and neighbouring land to the south-east.

It appears that over time, stopbanks have been constructed and planting established on the southern side of the river. This has reduced the flood storage capacity and constrained natural flood paths, thereby directing increased flow towards the PPC28 area and adjacent private land, contributing to the northern migration of the river and loss of land.

The Ecological Restoration Plan Report, Maitahi/Mahitahi River (Morphum, July 2020) commissioned by NCC recommended bank erosion mitigation, with a focus on creating riparian and wetland habitats. Recent works have removed willows on the southern side of the river as recommended in the report. It is understood that NCC has no programme in place to fully implement the report recommendations, which will be reconsidered in the light of PPC28 outcome.



1940 – 1959 Aerial 1980 – 1989 Aerial Present Day Aerial

Figure 5.3: Maitahi/Mahitahi historical river alignment (source topofthesouthmaps.co.nz)

5.7 Conveyance

The primary and secondary stormwater systems will convey stormwater through a suite of treatment devices to Kākā Stream, which in turn discharges runoff into the Maitahi/Mahitahi River. These drainage systems can consist of built assets (i.e. roadside channels, vegetated swales and piped networks) and natural systems (i.e. ephemeral, intermittent and permanent streams and open watercourses and overland flow paths). Stormwater systems will be designed in accordance with the NTLDM 2020.

Primary flows (i.e. runoff from storms up to a 6.67% AEP frequency) will be conveyed through a separate piped network within each sub-catchment, with open channel conveyance to be incorporated with landscaping where feasible. The piped network will generally follow the road layout and will discharge into the attenuation/treatment devices prior to discharge into Kākā Stream.

Secondary flows (i.e. from storms greater than 6.67% AEP frequency and up to a 1% AEP frequency) will be conveyed along road carriageways, existing overland flow paths where they are maintained, or along dedicated overland flow channels to proposed attenuation devices.

5.7.1 Kākā Stream realignment

It is proposed to realign the lower reach of the Kākā Stream (from near the existing woolshed) and construct a channel with capacity to convey the post-development 1% AEP event. This lower reach of the Kākā Stream is currently considered to be highly modified, currently comprised of a shallow channel interspersed with multiple other smaller intermittent drains and overland flow paths across the flood plain.

This realignment will be further developed in the latter stages using an integrated design approach to ensure that this channel is resilient across the range of flow events up to the 1% AEP frequency, but with a viable ecological corridor from the Maitahi/Mahitahi River confluence to the upper Kākā Stream reaches. This will be integrated with the design of flood detention devices, backwater impacts from the Maitahi/Mahitahi River, and protection of any development in the lower terrace to be factored into hydraulic design assumptions.

ITo confirm there is sufficient space within the proposed riparian corridor to convey the post-development 1% AEP event, a typical channel profile was developed. This profile is based on the preliminary estimates of peak unmitigated flows for the Kākā Stream at the point of discharge to the

Maitahi/Mahitahi River (refer Section 5.6.2), as well as the mean annual flow reported in NIWA's online flooding tool (4.37 m³/s).

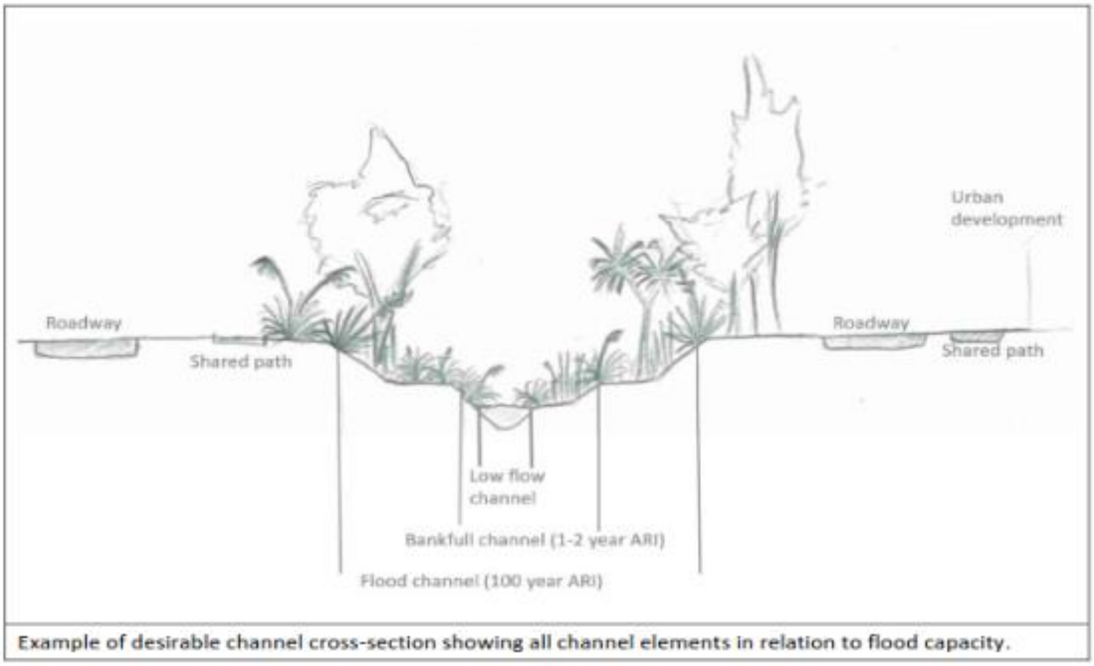


Figure 5.4: Conceptual realigned channel profile

The indicative dimensions are shown in the below Figure 5.5.

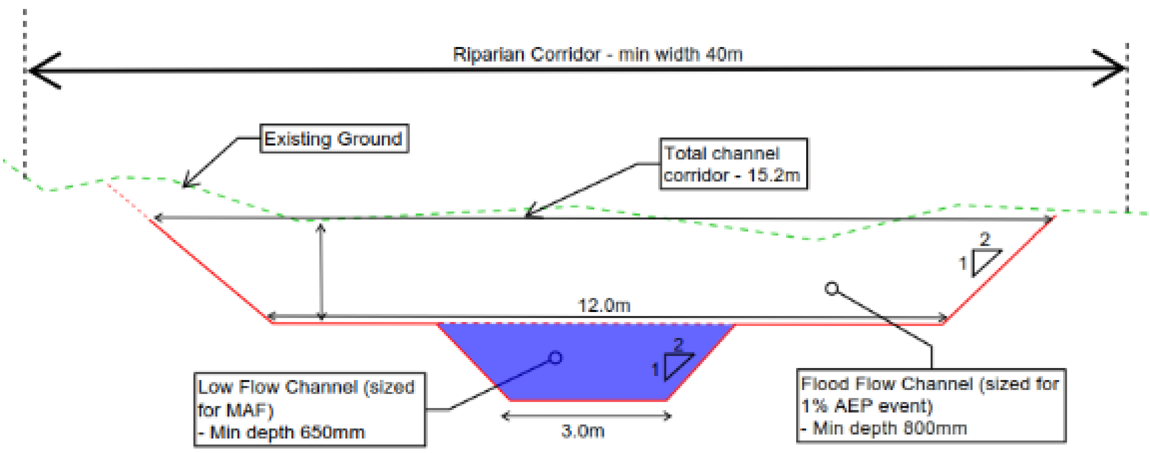


Figure 5.5: Indicative channel cross section

This channel cross section was modelled with an indicative flood plain fill extent to conservatively assess (with no mitigation measures applied) the ability to convey safely the proposed flow and assess changes in flood depth, velocity, frequency, and duration within the Kākā Stream. As shown in Figure 5.7, the revised channel does not overtop in the 1% AEP and 10% AEP 2130 RCP8.5M 6hr events. Note refinement of the transition from the Kākā Stream to the Maitahi/Mahitahi River has not been made and consideration of velocity effects at Dennes Hole and potential outlet will be considered at a later design stage.

5.8 Flood management

The proposed development has the potential to affect existing flood hazard in various ways, including:

- A net reduction in perviousness across the catchment leading to increased runoff (higher flows during rainfall events that could cause increased flooding within and downstream of the PPC28 area);
- Loss of flood storage within the flood plain due to earthworks encroachment (particularly in the Maitahi/Mahitahi River flood plain, where a fill platform is proposed);
- Changes to overland flow paths resulting from building platforms and new road alignments;
- Concentration of fewer overland flow paths;
- Possible coincident timing of peak flood flows.

This section sets out flood approaches that are proposed to mitigate these potential effects.

The proposed flood management approach is based on relevant stormwater management principles:

- A water-sensitive design approach, as outlined in the NTLDM, that manages flooding effects
- Facilitate urban development and protection of key infrastructure, people and the environment from significant flooding events.

5.8.1 Filling within the Maitahi/Mahitahi River flood plain

The applicant proposes filling within the Maitahi/Mahitahi River flood plain within the PPC28 area, and realignment of the Kākā Stream. The loss of flood plain storage could displace and redirect floodwaters during an extreme event, causing adverse flooding effects on adjacent and/or downstream property.

As reported elsewhere the NCC Maitahi/Mahitahi River flood model has been used to assess the effects of proposed filling within the flood plain. This modelling assumes fill-only (i.e. no cut for offset flood storage) and a vertical fill wall. In reality, the fill would be graded down to natural ground at its boundary. This was described in detail in *Additional flood hazard information - PC28 letter*, prepared by T+T May 2022.

The design has been further developed, and the proposed earthworks footprint revised. The 2130 RCP8.5M 1% AEP 12 hour event was modelled for the updated proposed earthworks, and results compared to the pre-development scenario. This has shown that the flood plain can be filled in such a way that any off-site effects are negligible, i.e. within model tolerance levels (less than 0.05 m), as shown in Figure 5.6.

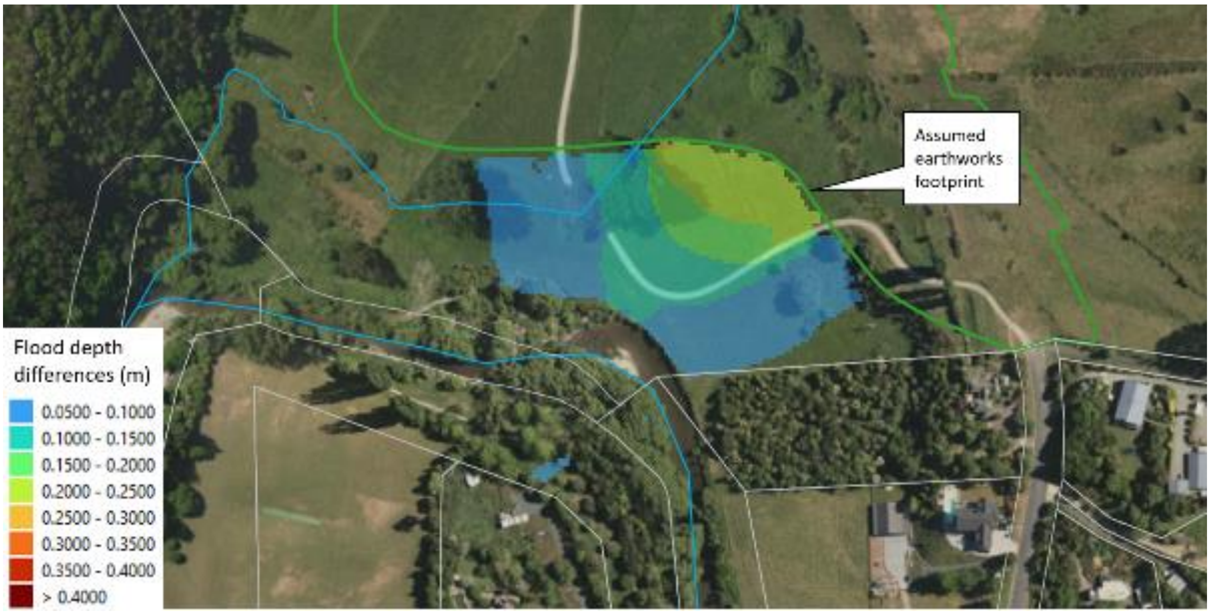


*Figure 5.6: Extent of local **increase** in flood depths as a result of proposed filling (2130 RCP8.5M 1% AEP 12hr event).*

For completeness, a range of present-day and 2130 storm events have also been analysed. The modelling shows that there are no adverse off-site effects for the full range of modelled events.

The TUFLOW direct rainfall model was also used to clarify flooding in the post-development scenario. The model is based on:

- The revised earthworks footprint
- Realigned Kākā Stream watercourse (refer Section 5.7.1 below for realignment details);
- Runoff from the modified post-development catchment (assuming NO attenuation – in reality, these flows would be routed through attenuation devices).

The 2130 RCP8.5M 10% and 1% AEP storm events were run through the model. Modelled depths are presented in Figure 5.7 below. This shows the containment of Kākā Stream flood flows within the realigned stream channel, and the impact of the proposed earthworks on the existing floodplain extents. The modelled effects on adjacent and downstream property are less than 50 mm in terms of depth differences, and therefore the modelling demonstrates that a feasible option exists for mitigating the potential effects on flooding of development within the PPC28 area.

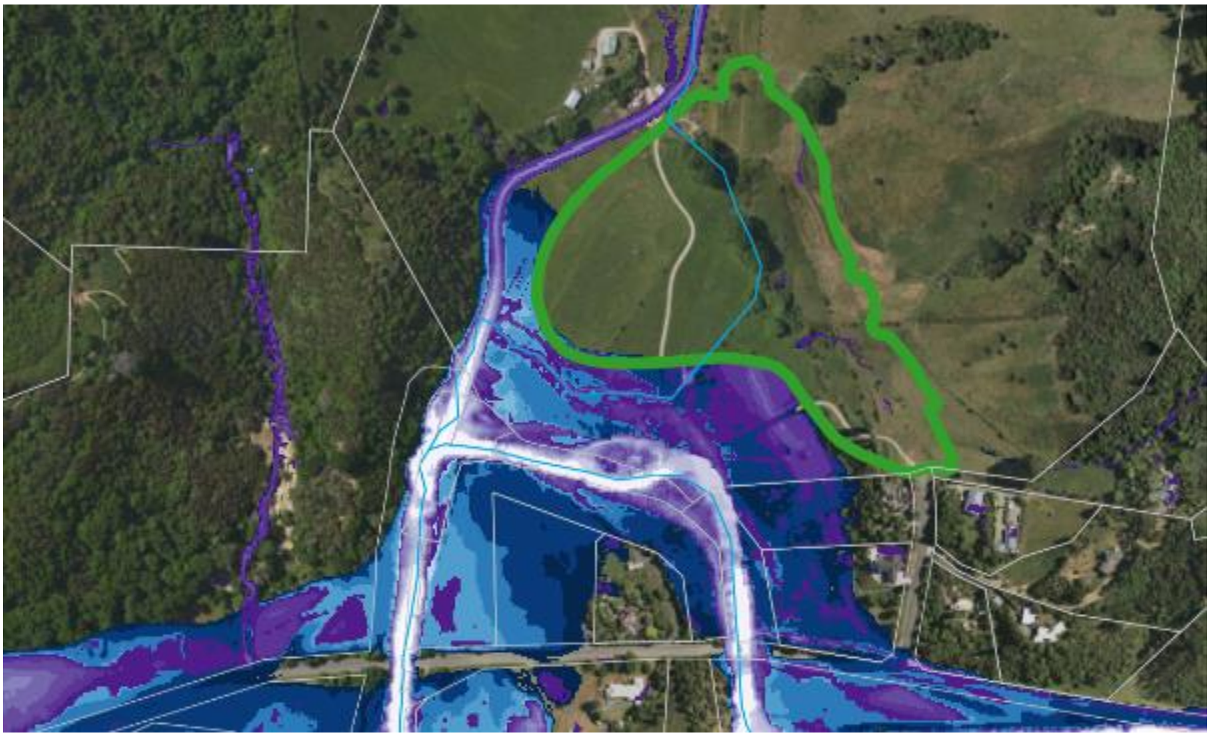


Figure 5.7: Modelled post-development scenario, including realigned Kākā Stream, proposed flood plain earthworks as per green polygon, and unattenuated post-development flows from developed catchment (2130 RCP8.5M 1% AEP 6hr event in blue, 10% AEP event in purple).

5.8.2 Other flood effects mitigation measures

To ensure that there are no other adverse flooding effects within and outside the development, the following mitigation options are recommended to manage flood risk:

- All building platforms to be located outside of and set above the 2130 RCP8.5M 1% AEP Maitahi/Mahitahi flood level, with allowance for freeboard as required by the NTLDM.
- Infrastructure to be located outside the 2130 RCP8.5M 1% AEP Maitahi/Mahitahi Flood level, unless designed to be flood resilient.
- For events greater than a 10% AEP storm event and up to a 1% AEP storm event, secondary flows will be conveyed along road corridors into existing overland flow paths. Ideally flow paths will be located within public areas (roads and parks) and not private properties.
- Enhancement of intermittent stream riparian margins, providing public amenity, improved ecological value, and assisting flood management with capacity for secondary flows.
- Secondary flows to be designed/managed to reduce the impact on private or public property. All flow paths will be provided with sufficient freeboard and alternative flow paths in case of blockages at the top of development areas, to convey runoff from the upper undeveloped slopes through the urbanised areas to the main Kākā Stream corridor downstream. These flow paths will be formally identified and designated (when in private property). This could be a mix of road corridors (with consideration of risks related to depth and velocity) and interconnecting greenways.

5.9 Risks

Table 6.1 presents the identified risks to the proposed stormwater management within the development and addresses how these risks might be mitigated or managed. It is expected that this list will be further populated as more risks are identified.

Table 5.7: Risk Register

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	When does this risk need to be addressed?	What is the resultant level of risk?
Detention requirements for the full PPC28 area cannot be achieved/is not economically viable	Through the resource/subdivision consent process Reduced site development	At the resource/subdivision consent process	The site will not get resource/subdivision consent for the full development
Water quality measures for the full PPC28 area cannot be achieved/is not economically viable	Through the resource/subdivision consent process Reduced site development	At the resource/subdivision consent process	The site will not get resource/subdivision consent for the full development
Conveyance of stormwater from the Walters Bluff/ Brooklands catchment to the Nelson Haven cannot be achieved/is not economically viable	Through the resource/subdivision consent process. Reduced site development	At the resource/subdivision consent process	The site will not get resource/subdivision consent for the full development
Further refinement of the proposed earthworks footprint in the Maitahi/Mahitahi flood plain could result in off-site flood effects.	Through the resource/subdivision consent process. Reduced site development	At the resource/subdivision consent process	The site will not get resource/subdivision consent for the full development

5.10 Implementation of stormwater network

To be addressed at Resource consent stage

6 Conclusions

The initial assessment indicates no fundamental stormwater management issues related to the future development of the PPC28 area.

The proposed approach is based on conventional stormwater management techniques to meet NTLDM provisions, and to integrate with existing and future stormwater provisions in the Kākā Stream, Walters Bluff and Brooklands Catchments and provides appropriate assessment criteria on which future subdivision proposal can be evaluated against.

7 Applicability

This report has been prepared for the exclusive use of our client CCKV Maitahi Dev Co Lp and Bayview Nelson Ltd, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Nelson City Council in undertaking its regulatory functions in connection with Private Plan Change 28.

Tonkin & Taylor Ltd

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