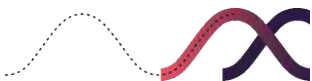


Appendix K – Stormwater Masterplanning Assessment



REPORT

2025 Ohaupo Road: Stormwater Masterplanning Assessment

for Te Awamutu Developments Ltd

Rev 1 - 01/12/2022



2025 Ohaupo Road: Stormwater Masterplanning Assessment

for Te Awamutu Developments Ltd

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Rev 1 - 01/12/2022

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1 Introduction

BTW Company (BTW) has been engaged by Ultimate Holdings Ltd to undertake a stormwater assessment to inform the master planning design process for a proposed development located at 2025 Ohaupo Road, Te Awamutu, Waikato. The development requires a Private Plan Change submission to the Waipā District Council.

The site is located north of Te Awamutu and South of Hamilton City and is adjacent to State Highway 3, Figure 1 presents the site location. The site is a 25.78 Ha (257,800 m²) parcel of land (Part Lot 1 DP 356454 and Lot 1 DPS 36696).

The preliminary scheme plan for this subdivision is shown in Figure 2.

This report outlines the stormwater management strategy for the proposed development. The assessment includes a review of the site and catchment characteristics, definition of the site-specific design parameters and provides initial concept for the stormwater management system.

This design statement has been prepared in general accordance with the requirements of the RITS, WRC Stormwater Management Guide, NPS-FW, and the Te Aranga design principles¹.

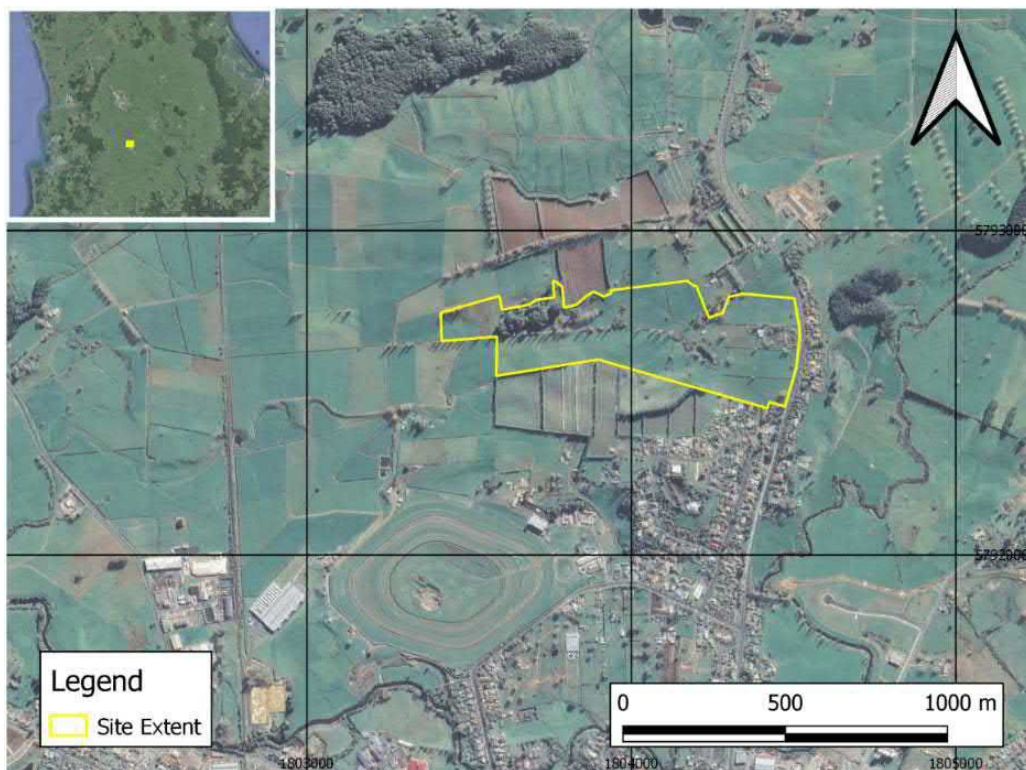


Figure 1: Site location

¹ <https://www.aucklanddesignmanual.co.nz/design-subjects/maori-design/te-aranga-principles>

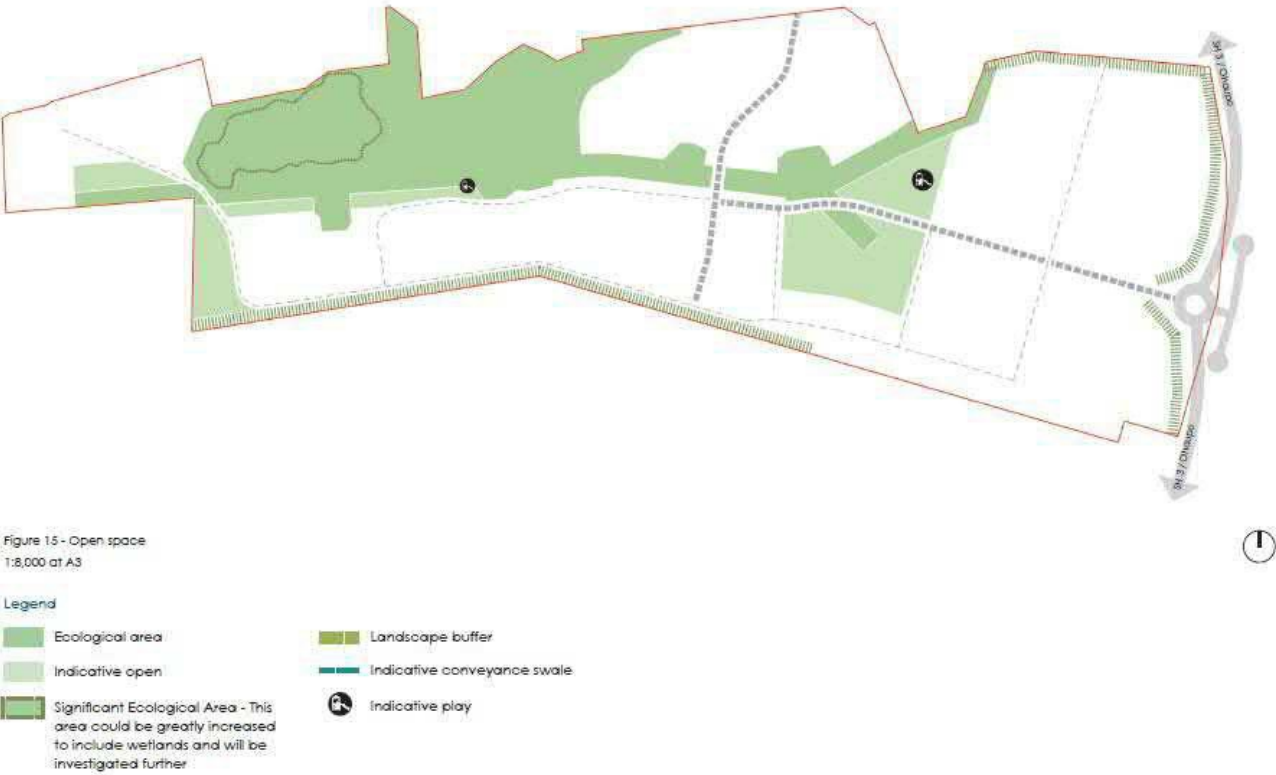


Figure 2: Subdivision Scheme Plan

2 Site Description

The site is an irregular shaped rectangle located approximately 200 metres north of the Te Awamutu peri-urban boundary. The site is currently utilised as grassed pasture (Figure 2.2).

The site is bounded by farmland towards the south, north and west. Ohaupo Road forms the eastern boundary of the site. A residential area extends to the south-eastern edges of the site and along the eastern side of Ohaupo Road.

There are two constructed amenity ponds on the eastern side of the property. The northern pond is located partially in the adjacent property as shown in Figure 2.1.



Figure 2.1: Aerial image .Site imagery collected by BTW, surrounding aerial imagery sourced from Google Satellite Map Service © 2022 Maxar Technologies.

A farm drain (Figure 2.3) runs through the centre of the site, flowing from the east to the west. This drain discharges into and unnamed tributary of the Mangapiko Stream at the south-western end of the site.



Figure 2.2: Site view towards the north west



Figure 2.3: View of the farm drain

2.1 Waipa Growth Strategy

The site is in the Waipā District Council (WDC) territorial area, and the Waikato Regional Council (WRC) Regional Authority. Under the WDC District Plan, the site is zoned as rural, but borders the urban limit boundary (residential zone).

Within the *WDC 2050 Growth Strategy, Nov 2017* a Growth Cell Map for the Te Awamutu area is provided. The overall growth cell plan is shown in Figure 2.4.

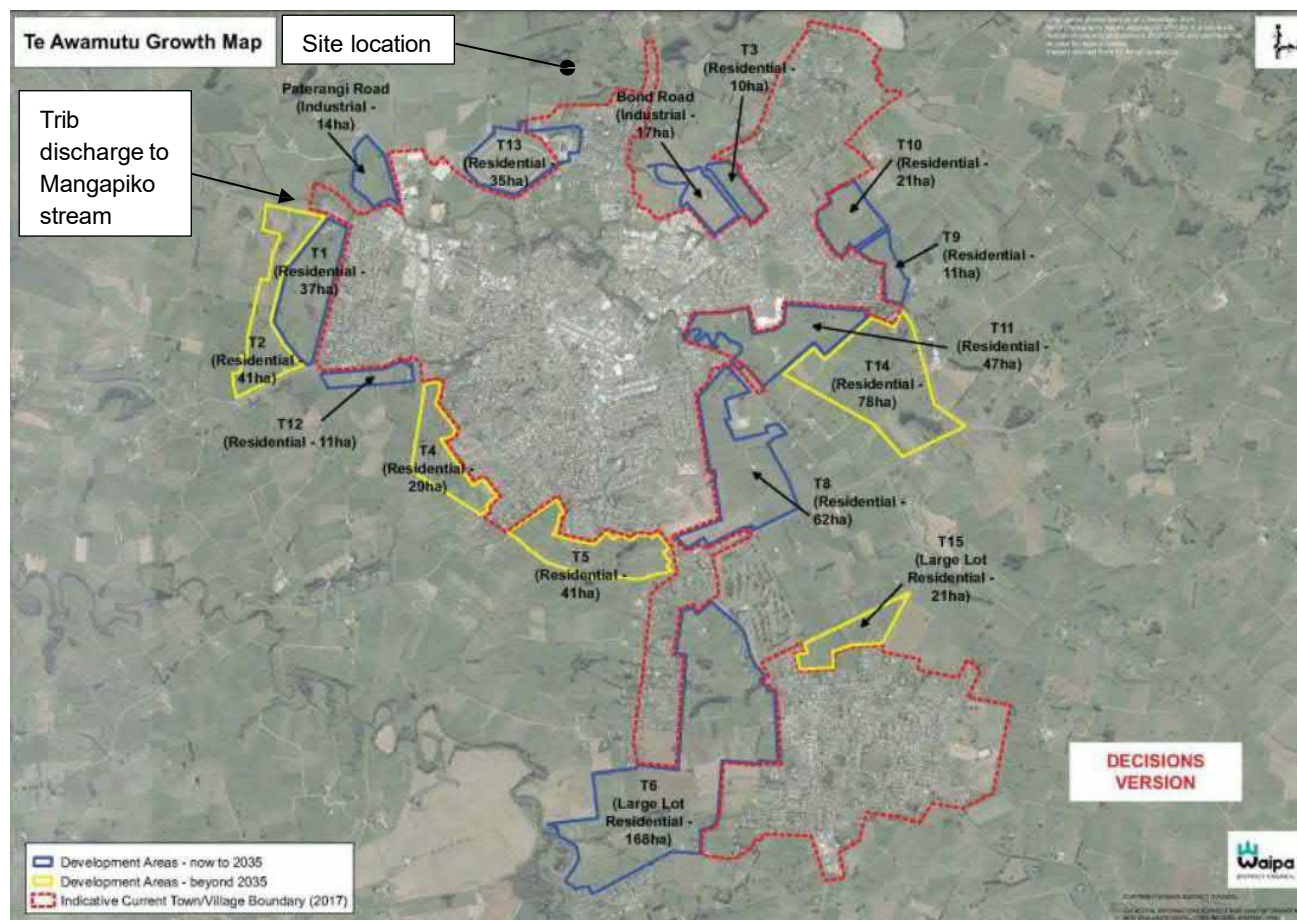


Figure 2.4: Te Awamutu growth cells (Figure from Waipa2050 Growth Strategy)

The site is located north-east of the growth cell area T13². The stormwater discharge point from the site is downstream of the future growth areas as shown in Figure 2.4.

² Identified as T13 (35 ha) in the location of the current Te Awamutu Racecourse. T13 is identified as a potential future residential growth cell if no longer needed for its current purpose.

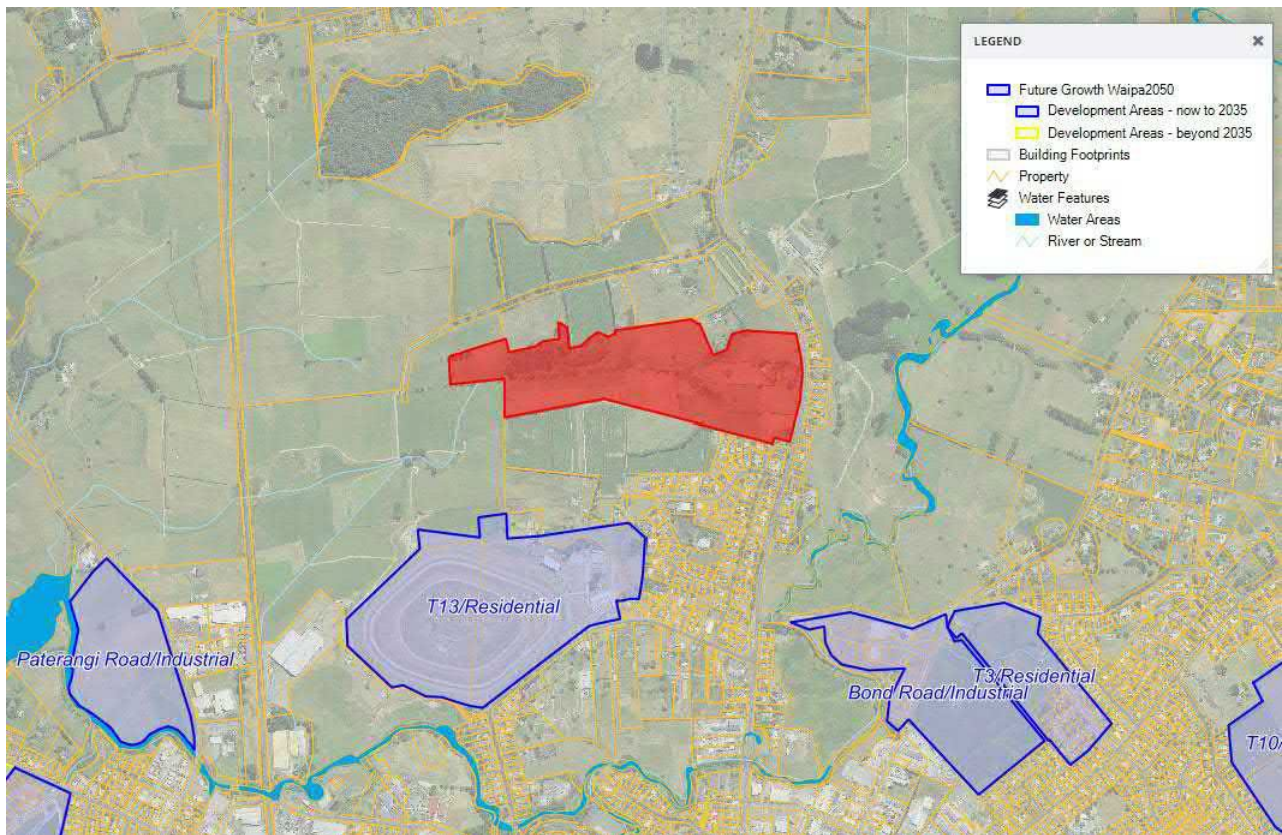


Figure 2.5: Operative Waipā District Plan Future Growth Waipā2050. The site is highlighted in red. Source: Waipā District Council IntraMaps.

3 Catchment Assessment

3.1 Global Catchment

The development site is located within the lower third of the Waipā Catchment Figure 3.1 which covers 3093 km² and is dominated by the Waipā River channel and associated tributaries. The Waipā River discharges into the Waikato River just north of Ngāruawahia.

The site is located within the Mangapiko sub-catchment which has an area of 307km². The Mangapiko Stream flows into the Waipā River just north of Pirongia. The site is located immediately downstream of Te Awamutu within the lower third of the Mangapiko Stream Catchment.

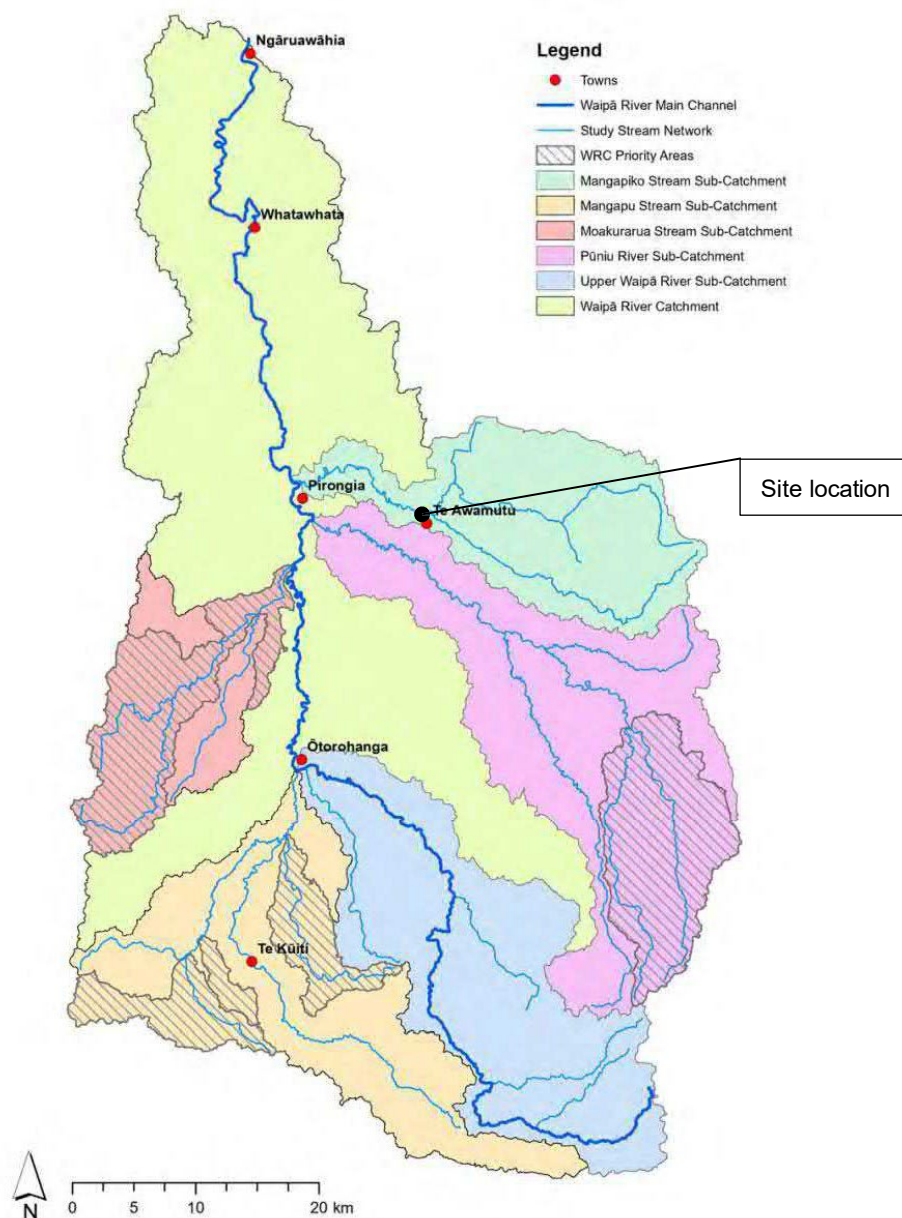


Figure 3.1: Site Location within the Waipā Catchment (Waipa Catchment Plan, Waikato Regional Council Technical Report 2021/01)

At the point where the site discharges into the Mangapiko Stream, the stream has a catchment area of 21.5 km² (21,481 hectares) with the site located in a tributary catchment of 415 Ha. The site has a total catchment area of 25.8 Ha as shown in Figure 3.2 below. The discharge point from the site is located close to the stream, relative to the upstream catchment.

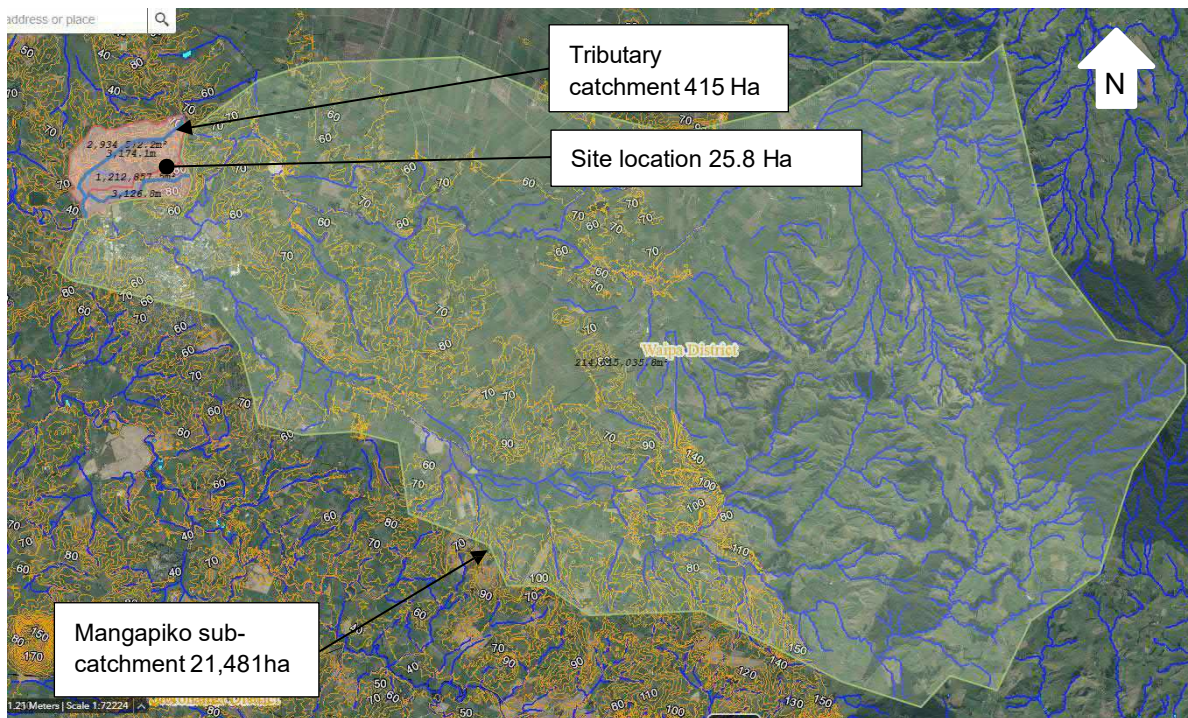


Figure 3.2: Site location within Mangapiko Stream Sub-Catchment ((WRC GIS 2022))

The site is located in the upper reaches of the immediate tributary catchment as shown in Figure 3.3.

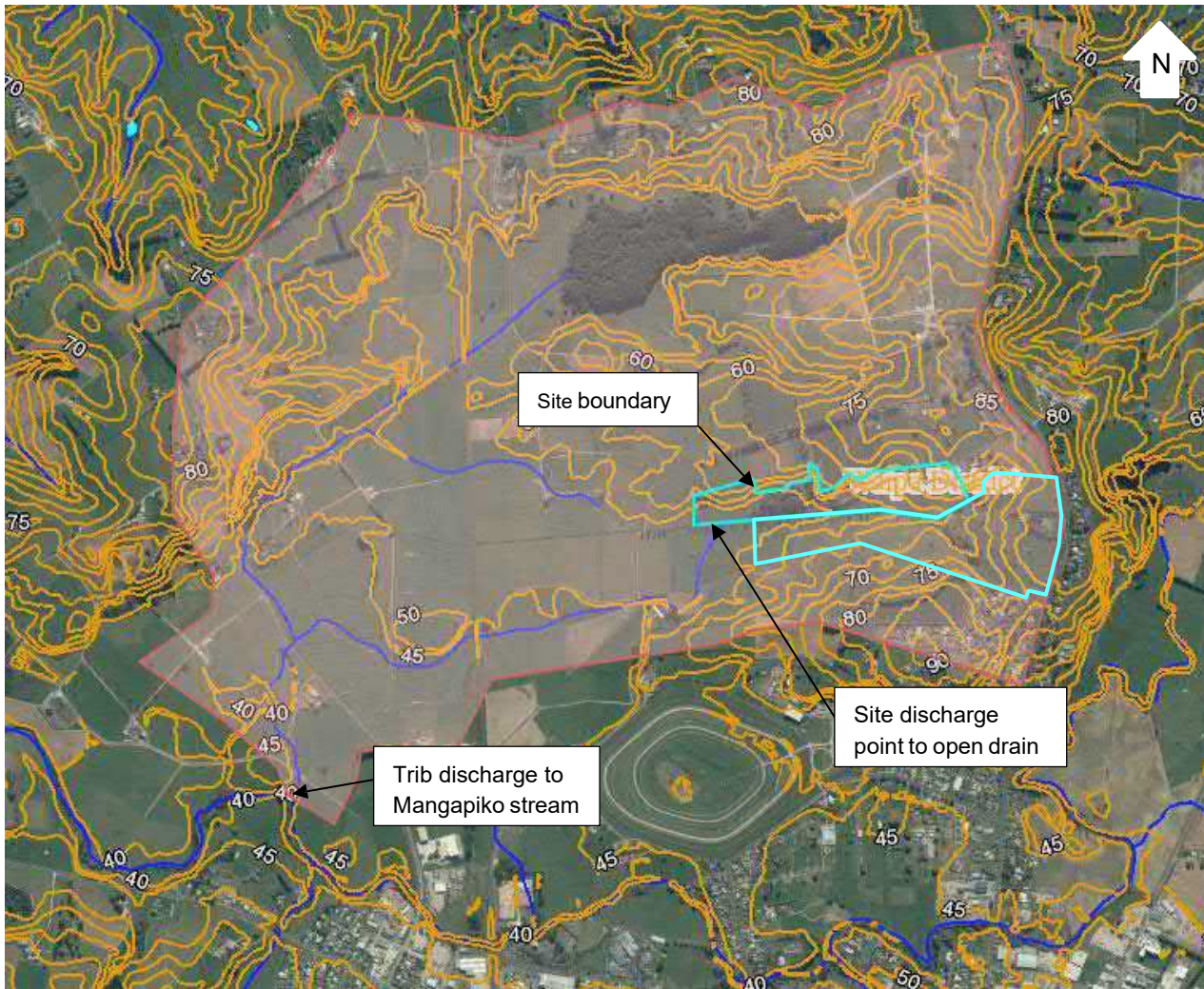


Figure 3.3: Site location within the Mangapiko Tributary catchment (WRC GIS 2022)

Figure 3.4 shows the site location in relation to local streams and tributaries in the area. Runoff from the site generally flows from east to west (with the contour of the land). An existing farm drain is located centrally within the site, which is assumed to provide the primary drainage for the existing site farmland. Historic images show that this watercourse has been heavily modified and channellised.

The drain appears to initiate from both existing ponds located on the site, joins near the centre of the site, and discharges near the southwestern corner of the site into the neighbouring property. The drain discharges into a tributary, which feeds the Mangapiko Stream as shown in Figure 3.4. The tributary has an approximate length of 2,132 metres. This tributary flows across four farming properties and also has a road crossing underneath Paterangi Road and a railway crossing under the North Island Main Trunk Rail.



The site area comprises of 25.8 hectares, the historic and current land use appears to be pastoral agriculture, excluding the residential dwelling and surrounding curtilage area. The site is lightly vegetated with agricultural grasses and occasional mature trees.

A farm drain conveys the runoff along the gully from the east to the western boundary of the site. Two constructed ponds are located at the head of the farm drain. The ponds are located in local gully features likely formed for agricultural purposes by damming the natural waterways and receive runoff from their respective upstream catchments.

Based on site observations the farm drain most likely has a continuous base flow which is fed by high ground water in the low-lying areas.
A catchment plan is attached in Appendix A and shown in Figure 3.5.

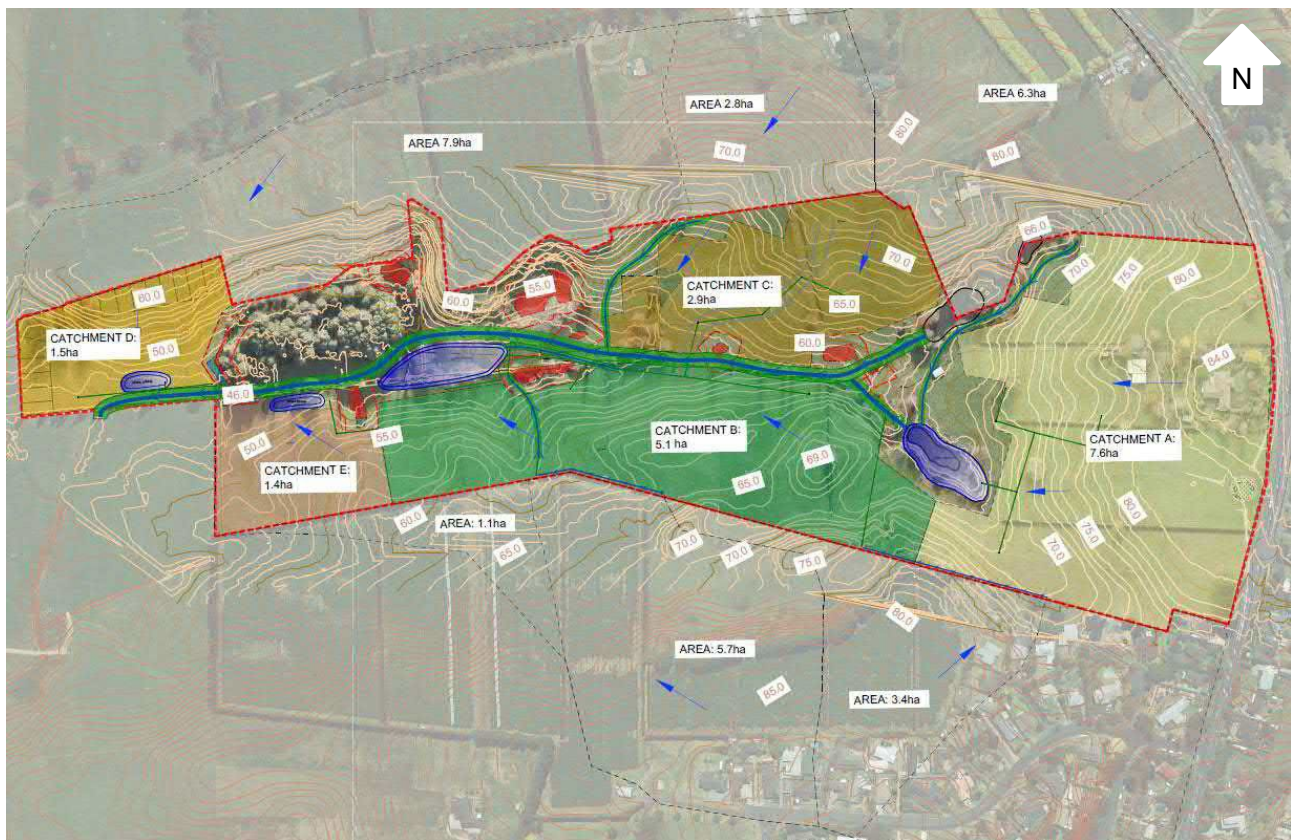


Figure 3.5: Catchment plan with 1m contours

3.3 Ground Conditions

Geotechnical testing was undertaken over a period in late winter and early spring (July to September) by BTW. Cone Penetrometer Testing (CPT) was undertaken in late June.

The BTW field investigation comprised a walkover assessment, hand auger boreholes with in-situ shear vane testing and dynamic cone penetrometer tests. Double ring infiltration tests and falling head soakage tests were undertaken in various landform elements

The results from the geotechnical field investigation are provided in the *BTW Geotech Suitability Report*.

3.3.1 Subsoil Description

In general, the Hamilton Ash formation soils cover approximately 90% surface of the site to a minimum depth of 2 metres. The western lower lying end of the site is dominated by Hinuera Formation sediments.

3.3.2 Groundwater

In general, groundwater was not encountered across the proposed development area with the exception of in low lying areas (at the toe of the slope adjacent to the drain) and elsewhere as perched groundwater.

On the alluvial flats within the gully bases, adjacent to flowing streams, it is likely that a water level similar to that encountered within the drain will occur. It is expected that as the alluvial areas extend away from the stream that the groundwater level will occur at increasing depth.

Within the gully bases, after extended periods of rain, groundwater may be either locally elevated for short periods while it drains through the less pervious subsoil layers or be locally perched along the base of the gully.

3.3.3 Soakage

Soakage testing were completed to determine the suitability of the existing soils for on-site soakage of stormwater (falling head) and soil permeability class. Highly variable soakage rates were encountered across the site, with design rates ranging from 8-600 mm/hour with a recommended soakage rate of 60mm/hr recommended for Hamilton Ash soils present across the majority of the site.

As the majority of the site is comprised by fine grained soils, the site has low soakage and the majority of the rainfall on the development area will be disposed of by overland flow as in its current configuration.

In the gully areas within the Hinuera sediments it is considered that the material is feasible for soakage although limited and not sufficient to manage the bulk disposal of stormwater generated by urbanisation of the catchment.

In the lower areas of site where elevated groundwater is present it is anticipated that discharge of soakage will not be feasible.

The soakage testing results and further discussion and analysis regarding the soakage characteristics of the soils are provided in the *BTW Geotechnical Suitability Report Proposed Private Plan Change at 2025 Ohaupo Road, Te Awamutu* (In Progress).

3.4 Historical Imagery

Historical aerial imagery sourced from Retrolens (Figure 3.6:) shows the watercourse has been channelised to convey the runoff within the farm drain and it appears that the water bodies at the head of the drain have been created by damming of the watercourse.



Figure 3.6: 1943 aerial image of 2025 Ohaupo Road, Te Awamutu (the site – highlighted yellow). Image source: Retrolens

3.5 Flood Hazard Mapping

The Waikato Regional Council Hazards Portal confirmed that the site is outside of the region wide modelled river flooding extents and flood management areas, as shown below in Figure 3.7.

Flooding shown appears to be limited to within the Mangapiko Stream flood plain.

Given that parts of the site area and downstream receiving areas are flat and without defined drainage systems it is considered that the flood hazard mapping may not have been extended to include the site location.



A site visit was undertaken by a suitably qualified and experienced ecologist from BTW Company on 26 May 2022 to identify potential wetland areas within the subject site. The subject site was found to support nine natural inland wetland units within the identified area as shown on the Wetland Delineation Plan in Figure 3.8. The full wetland delineation assessment is provided in the BTW Memo: *2025 Ohaupo Road – Wetland Delineation Assessment* (29th June 2022).



Figure 3.8: Wetland delineation plan

4 Stormwater Management

4.1 Design Objectives

The following design objectives have been identified as outcomes for the design of the stormwater management system;

- Develop a technically sound and workable overall stormwater management system for the sites development that provides site drainage and flood protection while working with other urban design elements of the development.
- Achieve excellent sustainable and environment outcomes through incorporation of water sensitive design elements into the built environment.
- Design a stormwater system that meets the Waipa District Council (WDC) level of protection and level of service requirements (as defined within RITS).
- Give effect to Te Mana o te Wai by prioritising the health and well-being of the receiving water bodies and freshwater ecosystems by designing a stormwater management system that is consistent with this approach.
- Consider water sensitive design objectives and considers stormwater management in parallel with the ecology of a site, best practice urban design, Te Aranga Design Principles and community values.
- Provide preliminary location, layout and size of the required stormwater management infrastructure for preliminary engagement for development within a Stormwater Management Plan.

4.2 Catchment Assessment Outcomes and Design Criteria Discussion

The catchment assessment has determined the following key points which inform the design criteria for the preparation of a Stormwater Management plan for the development:

- The site is located in the lower reaches of the wider Waipa River catchment and the Mangapiko Stream sub catchment on an unnamed tributary of the Mangapiko Stream.
- The site discharges into an unnamed Tributary of the Mangapiko Stream, which has been significantly modified. The discharge point is downstream of the existing developed areas of Te Awamutu as well as proposed growth cell areas.
- The lower reach of the tributary is located within a flooding area identified on the Waikato Regional Council Hazards Portal. This flooding is likely caused by flood levels within the Mangapiko Stream rather than inflow from the tributary.
- The unnamed tributary extends for approximately 2.1km to the site generally through flat farmland via a network of farm drains across four different properties. Two significant constraints exist in the tributary where the channel is culverted beneath the Kiwi Rail Railway Line and the Paterangi Road.

It is considered that given the sites location within the lower reaches of the Waipa and Mangipiko sub catchment that peak flow attenuation is not desired and globally the stormwater network would benefit from releasing stormwater prior to the arrival of upstream peak flows.

Locally however an increase in post development peak flows and volumes will likely have an effect on the tributary reach downstream of the site, particularly at the identified points of constraint. To understand the downstream effects further assessment would be required to quantify the downstream effects and if required provide appropriate mitigation measures such as stream daylighting, culvert upsizing and protection from stream erosion.

Given the reliance on third party landowners and stakeholders approval to implement the likely mitigation measures, for the purposes of initial master planning it is proposed to proceed with the design of a stormwater management system which mitigates all effects of the development on the downstream receiving environment.

It is recommended that further assessment and refinement of the system should be undertaken at later stage which may result in an amendments to the design criteria outlined below and significant optimisation to the sites stormwater management requirements.

4.3 Design Parameters

A preliminary stormwater design criteria for the proposed development has been determined from the catchment review based on the above considerations as outlined below in Table 4.1.

Table 4.1: Stormwater Design Criteria

DESIGN OBJECTIVES	DESIGN CRITERIA	DESIGN PARAMATERS	REFERENCE
<i>STORMWATER MANAGEMENT</i>			
Flood Hazard Management	Required	Flood hazard mitigation provided in accordance with RITS level of protection requirements. Secondary flow routes for major design storms via roads corridors into adjacent stormwater areas.	RITS
Flood Control	Required subject to further assessment.	Detention required, limiting the post-development 100 year ARI event flow rates to 80% of the pre-development 100 year ARI event flow rates. For purposes of master planning assessment assume flood control will be required. Increase in post development flows will likely have a minor effect on downstream top water levels. Assessment of effects on downstream reach that may conclude negligible effects and that flood control not required.	RITS
Flow Attenuation	Required subject to further assessment.	Match pre-development flow rates for the 2 and 10 year ARI events through controlled attenuation and multi stage outlets or devices that reduce the runoff flow. If the development is located close to the catchment outlet and discharging to a watercourse with sufficient capacity, then flow mitigation may not be required. This may also apply if the site is in the lower half of the catchment, and attenuation might worsen flooding due to relative timing of peaks from the upper catchment. For purposes of master planning assessment assume flow attenuation will be required. Increase in post development flows will likely have a minor effect on downstream top water levels. Assessment of effects on downstream reach that may conclude negligible effects and that flood control not required.	RITS

DESIGN OBJECTIVES	DESIGN CRITERIA	DESIGN PARAMETERS	REFERENCE
Water Quality Treatment	Required	Water quality treatment proposed for all hardstand surfaces. 1/3 of 2 year 24-hour ARI rainfall depth with climate change used to calculate water quality volume (WQV)	RITS / WRC Stormwater Management Guide
Extended Detention / Stream Erosion	Required	Discharge is into a natural stream or modified channel	RITS / WRC Stormwater Management Guide
Volume	Required	Required when discharge is into a natural stream or modified channel Match pre-development volume runoff through reduced runoff practices and sub-catchment management If this cannot be achieved, mitigation within the receiving environment will be required, such as channel stabilisation.	RITS
Retention / Groundwater Recharge	Required	Minimum retention of pre-development initial abstraction.	WRC Stormwater Management Guidelines, AC GD07
Natural Wetlands	Required	Diversion of water within 100m of natural wetlands requires resource consent. Pre-development wetland hydrology must be maintained. Ensure post development hydrology remains consistent with predevelopment hydrology in consideration to surface water flows and groundwater recharge.	NES-F
Manage Cross Boundary SW Flows	Required	The concept design of the drainage system should consider and allow to maintain cross boundary flow for upstream catchment areas.	NZS4404
Onsite Lot/ROW Runoff	Required	10- year ARI, 60min design storm. Disposal/treatment hierarchy: a) Soakage where feasible b) Piped connection to management facility c) Rain water reuse tanks with on-site design where practical System designed for impermeable surfaces with maximum site coverage as specified in the District Plan or calculated from 1st principles where detailed lot plans are available.	RITS
WRC Low Impact Design Scoring Matrix	Required	Stormwater Management Design to incorporate Low Impact Design (LID) considerations and meet the minimum target score for the site or justify exclusion for the items not incorporated.	WRC Stormwater Management Guide
STORMWATER RETICULATION			
Primary drainage system	10 - year ARI design storm.	Infrastructure design will be undertaken using the RCP 6.0 climate change scenario for rainfall intensity. Capacity to convey the design storm without surcharge.	RITS
Outlet Scour Protection – Energy Dissipation/Rip rap apron	10-year ARI design storm	Scour protection at reticulation outlets using energy dissipaters and rock rip rap.	WRC TR2018

DESIGN OBJECTIVES	DESIGN CRITERIA	DESIGN PARAMETERS	REFERENCE
WATERWAYS/WETLANDS			
Ecosystem Health	Ecological and Habitat Impact Assessment	Assessment of biophysical components including Water Quality, Water Quantity, Habitat, Aquatic Life, Ecological Processes. Overall levels of ecological effect of the proposed activities were determined to be Very Low, following ecological management, through low impact design, avoidance and minimisation measure and aquatic ecological offsetting. Refer to BTW EclA Report for more details.	NPS FW (Appendix 1A) Te Aranga Principles
Stream Restoration	Ecological and Habitat Impact Assessment	Stream daylighting, restoration and planting of waterway. Enhanced habitat values and net ecological gains through restoration of the water course and riparian margins. Access points to stream to be provided.	NPS FW/ Te Aranga Principles
Protection and enhancement of wetlands	Required	Enhanced habitat values and net ecological gains through protections and restoration of the wetlands Access points to water bodies be provided.	NPS FW/ Te Aranga Principles
Tangatata Whenua	Te Mana o Te Wai	Tangata Whenua are actively involved in freshwater management. Identify the local approach to giving effect to Te Mana o Te Wai.	NPS FW/ Te Aranga Principles
Mahinga Kai	Kai is safe to eat and harvest	Promote restoration of environment to support Mahinga Kai	NPS FW/ Te Aranga Principles
Māori names are celebrated	NA	Naming of reserve areas	Te Aranga Principles

4.4 Stormwater Management System Design

4.4.1 Design Philosophy

The following design philosophy's have been a focus throughout the development of this SMP:

- Consideration of water sensitive design objectives to consider stormwater management in parallel with the ecology of a site, best practice urban design, and community values.
- Give effect to Te Mana o te Wai by prioritising the health and well-being of the receiving water bodies and freshwater ecosystems by designing a stormwater management system that protects the receiving environment from the effects of the development.

4.4.2 Methodology

The stormwater management design approach has been prepared with consideration of the physical environment, catchment assessment, ecological constraints and opportunities, the Te Aranga Design Principles and the urban design of the proposed development. Consultation with Tangata Whenua regarding the stormwater management system has yet to be undertaken.

Using the design objectives (Section 4.1) and design parameters (Section 4.3) identified, a system design strategy (Section 4.4.3) has been prepared outlining the operation of the various components of the system.

Preliminary hydrological and hydraulic modelling has been undertaken to identify the approximate footprint of the required infrastructure and facilities. The required infrastructure has been positioned

logically considering the natural topography, existing flow paths, site constraints and urban design strategy and the infrastructure footprint proportioned based on the contributing catchment size.

This process has been iterated to arrive on the Stormwater Management General Layout Plans presented in Appendix A.

4.4.3 System Design Summary

A stormwater management system design summary is presented in Table 4.2 which summarises the proposed implementation of the various system components.

Table 4.2: Stormwater Management System Design Summary

Stormwater Management Objective	Description
Residential Lots	a) Soakage where feasible in accordance with Clause E1 NZBC b) Piped connection to management facility where soakage not feasible c) Water reuse tanks with on-site design where practical
ROW's	a) Soakage where feasible in accordance with Clause E1 NZBC b) Piped connection to management facility where soakage not feasible
Public Roads	Roadside collection via network of catchpits discharging into integrated stormwater management facility.
Retention/Groundwater Recharge	Recommended retention of the difference between the pre and post development total volume of runoff for smaller storms up to the 2 year ARI design. Minimum retention of pre-development initial abstraction. Ensure post development hydrology remains consistent with predevelopment hydrology in consideration to surface water flows and groundwater recharge.
Primary Conveyance System	Catchpits and piped reticulation discharging to stormwater management facility.
Secondary Conveyance System	Roads and/or channels grading secondary flows towards appropriate stormwater management features via dedicated flow paths.
Water Quality Treatment	Water quality treatment provided within catchment specific centralised integrated constructed wetland.
Extended Detention	Extended detention provided within catchment specific centralised integrated constructed wetland.
Attenuation	Flow attenuation (Restrict peak post-development flows to peak pre development flows) of the 2 and 10 year ARI events within a catchment specific centralised integrated constructed wetland.
Flood Control	Detention required, limiting the post-development 100 year ARI event flow rates to 80% of the pre-development 100 year ARI event flow rates within centralised integrated constructed wetland.

4.4.4 Residential Lots and Right of Ways – Onsite Stormwater Disposal

Stormwater discharge from residential lots and right of ways (ROW) are proposed to be undertaken in general accordance with the Stormwater Management Hierarchy specified within the RITS as outlined below:

- Retention of rainwater/stormwater for reuse on site
- Soakage techniques
- Treatment and detention and gradual release to a watercourse
- Treatment and detention and gradual release to a piped stormwater system

As discussed further in Section 4.4.6 and Section 4.4.7, an important component of the stormwater management system is ensuring the pre-development hydrology is maintained in the post development land form via retention and groundwater recharge. Soakage techniques have therefore been preferred for the at source disposal of onsite stormwater runoff.

The results of preliminary geotechnical assessment have indicated the site is generally comprised by fine grained soils with low soakage rates. Although soakage rates are generally considered low, soakage of low quantities in this material is considered feasible subject to specific engineering design.

For master planning purposes, it is assumed that it is feasible to achieve onsite stormwater disposal via soakage in accordance with the requirements of Clause E1 of the New Zealand Building Code. Onsite systems will likely require specific engineering design and be via horizontal soakage system which have a higher base area to achieve soakage. All soakage systems shall be designed with pre-treatment and be designed to allow operation and maintenance.

Further investigation should be undertaken during detailed design phase to confirm suitability of the soils and to delineate any areas where soakage is not feasible.

4.4.5 Public Roads

A traditional pit and piped primary system is proposed for the collection and conveyance of stormwater runoff from public road areas to appropriate downstream stormwater management areas.

The roads shall also provide secondary flow paths directing runoff to the appropriate downstream stormwater management areas.

It is noted that Waikato Regional Council specify a minimum required retention volume for all runoff as discussed further in Section 4.4.6. It is considered that this requirement will be achieved via the specification of onsite soakage however further assessment and consultation with Waikato Regional Council should be undertaken to achieve that this requirement is achieved.

4.4.6 Retention / Groundwater Recharge

The development shall be required to match the pre-development hydrology including the pre-development groundwater recharge.

The WRC Stormwater Management Guidelines recommend retention of the difference between the pre and post development total volume of runoff for smaller storms up to the 2 year ARI design storm and specify a minimum retention volume of the predevelopment initial abstraction.

Given the presence of natural wetlands on the site any proposed development will be subject to consent (non complying) under the NES-F for diversion of water within 100m in which the applicant needs to demonstrate the proposed development has less than minor effect on the natural wetlands. This requires careful assessment of the existing wetland hydrology to understand the existing conditions however generally the post development landform needs to replicate the pre-development wetland hydrology.

It is anticipated that bulk earthworks will be required to modify the existing landform to be suitable for development and is noted that the compaction associated with bulk earthworks decreases the natural permeability of the soil. It is noted that the initial geotechnical investigation has identified that the natural soils do not have a high permeability and hence are subject to limited pre-development infiltration.

For master planning purposes it is intended that groundwater recharge will primarily be achieved via retention and discharge to ground of onsite (Residential and ROW) runoff. This provides a scattering of at source discharge points which replicate pre-development infiltration patterns and is preferable to fewer larger soakage systems.

Further assessment needs to be undertaken to understand the hydrology of the existing natural wetlands to ensure their baseline conditions are maintained and more detailed stormwater assessment will need to be undertaken to determine the post development hydrology is equivalent to the pre development hydrology.

4.4.7 Constructed Wetlands

A series of constructed wetlands are proposed to be constructed throughout the development as stormwater management devices.

The proposed wetlands shall be integrated within a central linear reserve concept combining the engineering and urban design aspects of the project.

The constructed wetland shall be designed to provide the following stormwater management functions;

- Water Quality Treatment
- Extended Detention/Stream Erosion Protection
- Flow Attenuation (If required)
- Flood Protection (If required)

For master planning purposes, preliminary hydrological and hydraulic modelling has been undertaken to size the required wetlands assuming flow attenuation (2 and 10 year ARI events) and flood control to limit the post development flow rates to 80% of the pre-development 100-year ARI event are required.

A pre and post development assessment has been completed for the site using the SCS unit hydrograph method. The hydrological assessment was completed using the HIRDS historical rainfall data and repeated using the HIRD predicted future rainfall with RCP6.0 climate change allowance for the period 2081– 2100.

A hydrological model was developed using the SCS Method in HEC HMS and the normalised 24-hour design storm temporal rainfall pattern specified within the WRC TR2020/06.

A summary of the input parameters is provided in Table B 2 and Table B 3.

The peak flows calculated during the analysis in the 2, 10 and 100 -year design storm events are summarised in Table B 4.

Preliminary results indicate a total storage volume of 7,380 cubic metres is required to provide the appropriate stormwater management. provides a summary of the volumetric requirements. It is noted that preliminary modelling hasn't allowed for retention and efficiencies between flow attenuation and extended detention.

Table 4.3: Summary of Basin Volumes

Design Parameter	Volume (m3)
Attenuation & flood control	6,100
Stream protection (EDV)	900
Water Quality Treatment (WQV)	380
Total	7,380

The overall volume will be achieved through four management facilities located at catchment low points and integrated into the broader urban and landscape design. The respective management area has been proportioned based on the contributing catchment size. A summary of the volumetric requirements for each catchment is provided in Table B 5 within Appendix B.

For purposes of allocating a footprint to the constructed wetlands, an average maximum storage depth of 1.2m has been assumed providing an approximate footprint for each area. Preliminary stormwater layout plans indicating the size and location of the infrastructure is included below in Figure 4.1 and attached in Appendix A.

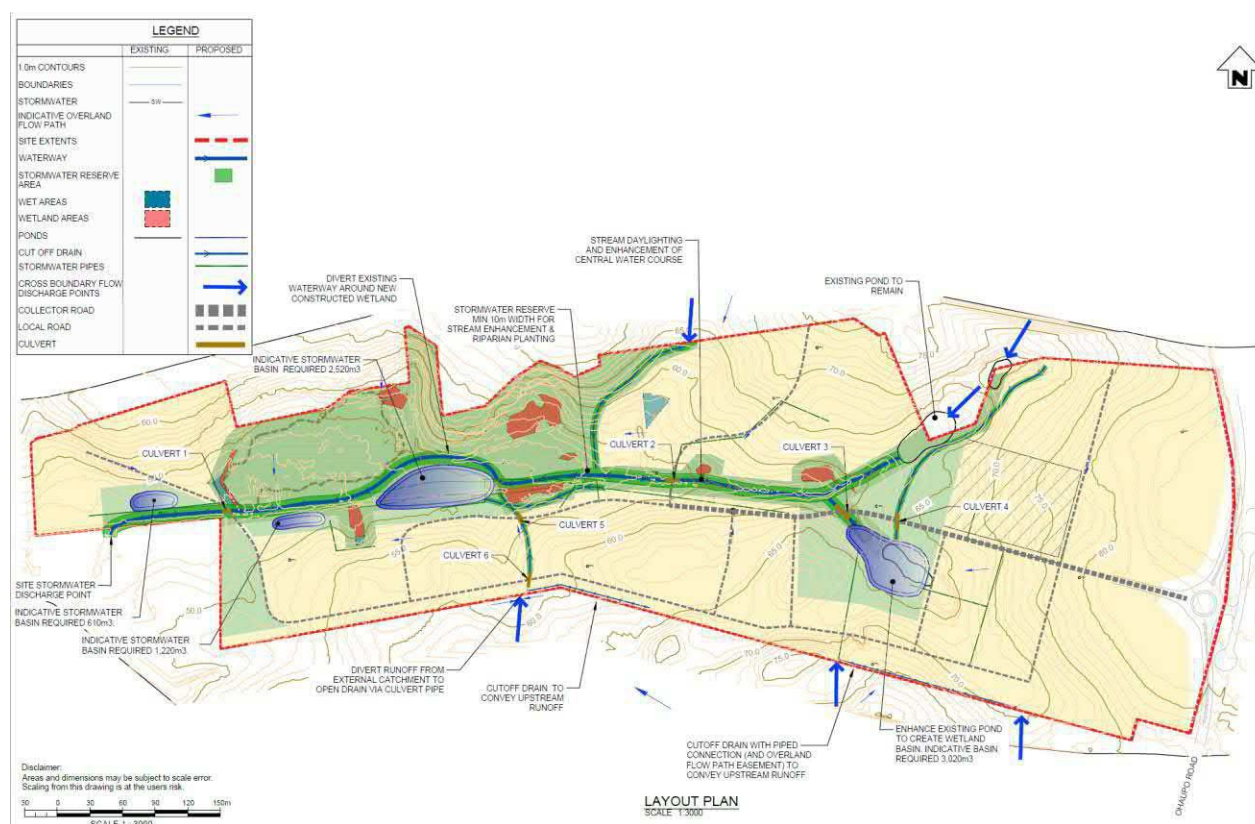


Figure 4.1: Preliminary Layout Plan

Further design should be undertaken to determine the final size, arrangement and details of the constructed wetland areas.

Following consultation with WRC, BTW were provided with a document outlining the proposed RITS amendments for design rainfall which recommend that a sensitivity testing should be

undertaken using RCP 8.0 rainfall data. This should be undertaken during the next stages of assessment as may impact the sizes of the proposed constructed wetlands.

4.4.8 Stream Daylighting

The central watercourse is an unnamed tributary of the Mangapiko Stream and is classified as a modified watercourse (see Figure 4.2 for example of the central watercourse). Multiple discharge points for water to flow into the central watercourse were observed, from spring-fed streams, natural inland wetlands, drainage ditches, and ponds.

The stream is significantly modified being channelised and straightened. Historical images (See section 3.4) indicate the lowlands were once likely wetland flood plains and it is assumed the central watercourse and the downstream farm drainage system were installed to dewater the adjacent farmlands to enable agricultural land use.



Figure 4.2: Typical reach of the central watercourse

The proposed development proposes undertaking significant stream daylighting and enhancement works which will provide multiple engineering, ecological, landscape, cultural and social outcomes.

Key objectives of the stream enhancement works will include:

- Increased conveyance capacity within the stream controlling flood water levels and providing flood hazard management.

- Stream naturalisation (including recontouring banks) and improved floodplain connectivity (with flatter bank angles and wider stream profiles).
- Establishment of riparian buffers to achieve suitable ecological and habitat function enhancing water quality, erosion protection and shading.
- Restoration of fish passage within the catchment (outside of the site), including retrofitting fish passage devices to identified fish barriers where removal is not feasible.
- Improved provision of fish and macroinvertebrate habitat heterogeneity and in-stream fish spawning habitat, including establishing pools and riffles with suitable interstitial spaces (this can be achieved by embedding boulders, cobbles and gravels of varying sizes).

Increasing riparian cover will directly provide faunal habitat through overhanging vegetation and will indirectly provide habitat through litter and branch fall, as well as stream shading promoting submergent and emergent macrophyte growth.

Further details regarding the proposed stream enhancement works are provided within the BTW *Wetland, Riparian and Waterways Protection and Enhancement Plan* (In Progress).

4.4.9 Cross Boundary Flows

The site is located within the lower catchment portion of the surrounding basin and is subject to cross boundary flows from upper catchment areas. The stormwater management system shall be designed to ensure that all upstream overland flows are maintained and considered within the design of the stormwater management system.

Generally, the upstream topography is undefined from which the site is subject to sheet flow. In select locations the basin topography concentrates upstream flows and the site is subject to concentrated flow. The site extent, catchment boundary, natural flow paths and locations of concentrated flow are shown in Figure 4.3.

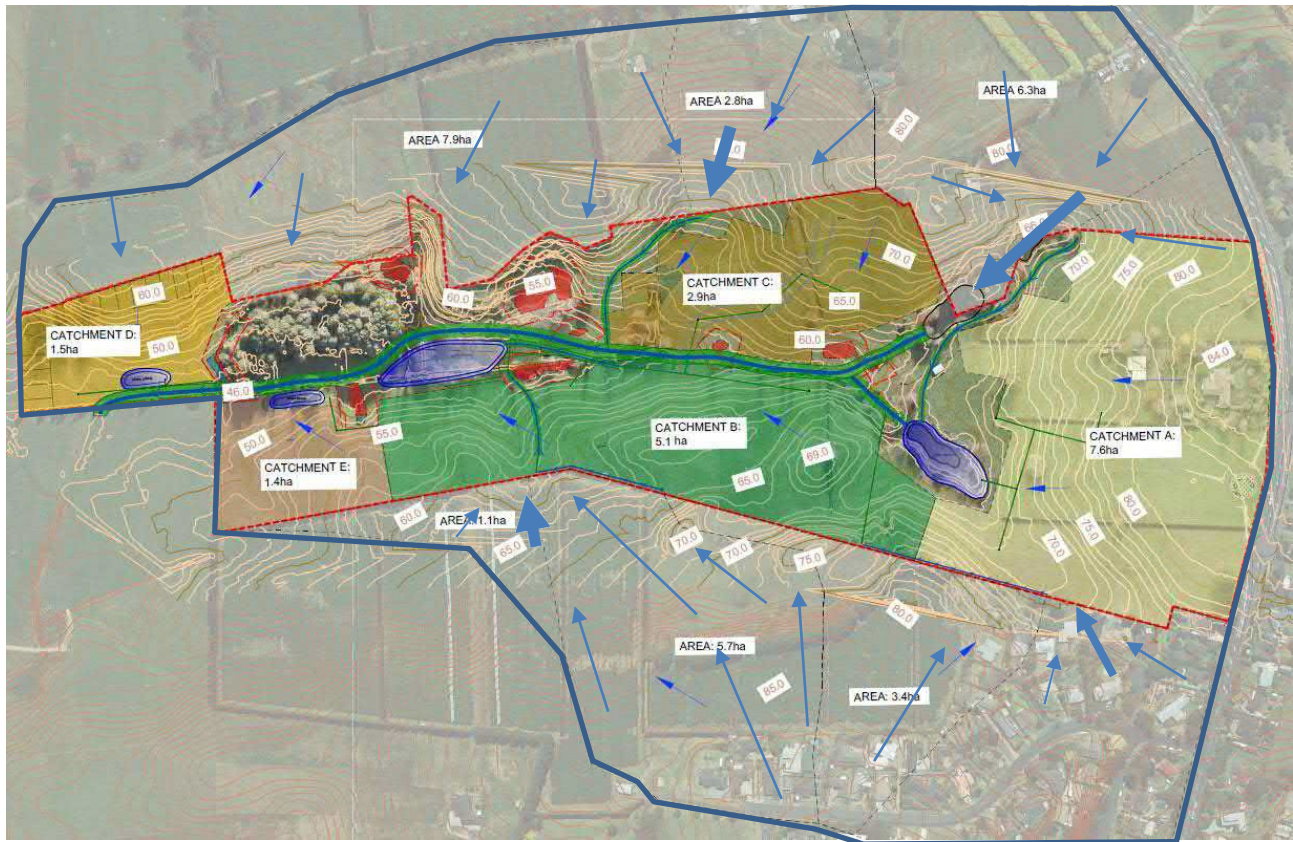


Figure 4.3: Cross Boundary Flows

The stormwater management plan and design landform shall be designed to ensure upstream flowpaths are maintained and with consideration for future development which may occur within the neighbouring catchment areas.

Where the site is subject to concentrated flow, specific infrastructure shall be provided to ensure flow paths are maintained.

Specific conveyance infrastructure has been identified within the stormwater master planning assessment for inclusion within the development masterplan consisting of vegetated swales, open channels, cut off drains and secondary flow paths. Key cross boundary flow infrastructure is indicated in Figure 4.4 and further detail indicating the required cross boundary flow infrastructure is provided on the Preliminary Stormwater Layout Plans attached in Appendix A.

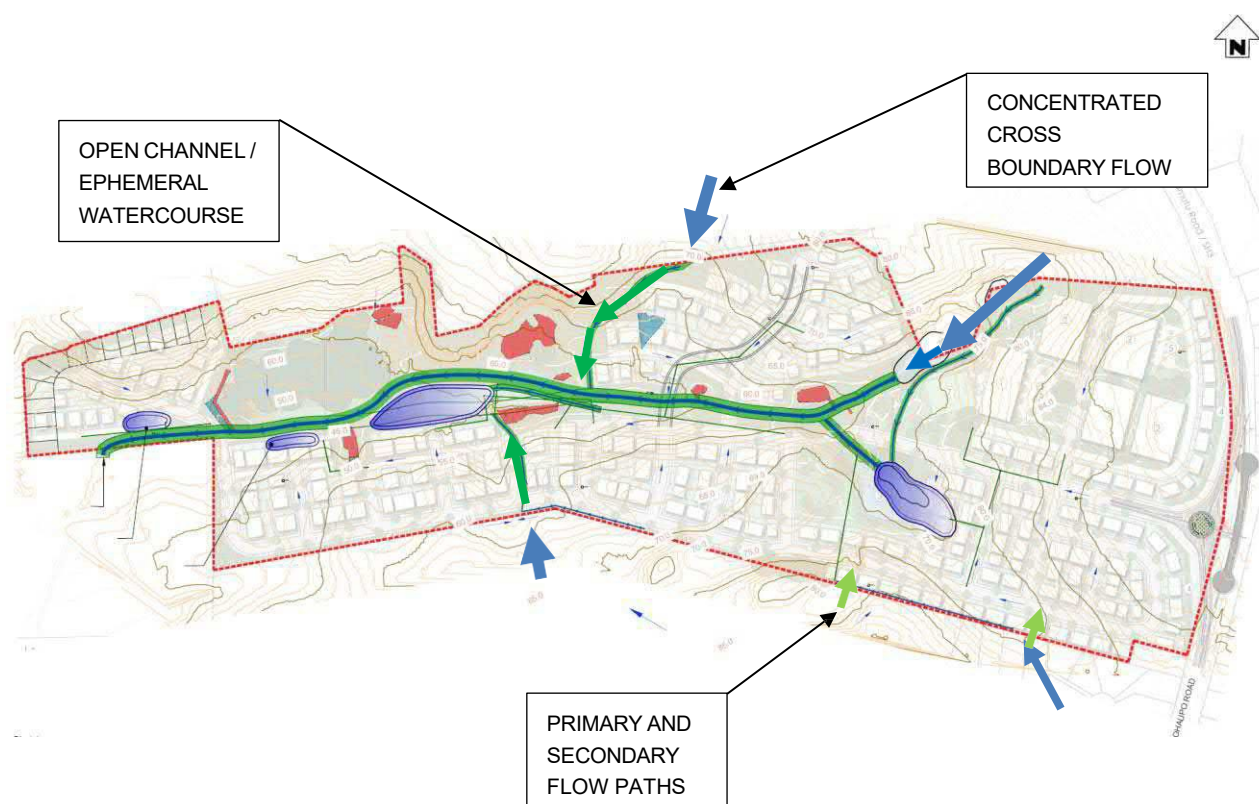


Figure 4.4: Cross Boundary Flow Paths

4.4.10 Secondary Flow Paths

The post development landform shall be designed with a network of secondary flow paths, designed to provide the level of protection requirements the proposed land use during for major stormwater events specified within the RITS.

The overland flow paths shall also be required to direct secondary flows to the appropriate stormwater management facility given the requirement of the stormwater management plan to provide flood control (flow attenuation limiting the post-development 100 year ARI event flow rates to 80% of the pre-development 100 year ARI event flow rates – see Section 4.3)

The road network and final landform design shall be designed to achieve the required overland flow paths supplemented with network of swale drains and open channels as indicated on the Preliminary Stormwater Layout Plans attached in Appendix A.

The following points are noted which will require careful consideration during future design:

- Secondary flows from Catchment C are required to be conveyed across the central watercourse and directed to the downstream stormwater management facility.
- Cutoff drainage is required along the lower catchment boundary of Catchment A to divert secondary flows to the downstream stormwater management facility.

4.4.11 Culvert Crossings

The proposed development will require road crossings of the existing and proposed waterway and stormwater conveyance areas. Culvert crossings shall be designed in accordance with the requirements of the NES-F, NZ Fish passage guidelines, RITS and Waikato Regional Council.

4.4.12 Stormwater Reticulation

A stormwater reticulation will be required to provide primary stormwater conveyance during minor design storms. The stormwater reticulation shall be designed in accordance with the requirements of the RITS.

4.4.13 Low Impact Design

The stormwater management design shall be designed to incorporate Low Impact Design (LID) considerations.

The WRC Stormwater Management Guidelines specify a LID scoring matrix whereby development shall be allocated a score for its relevant LID design outcomes and be required to meet the minimum target score for the site or justify exclusion for the items not incorporated. The target score is developed with consideration for the LID opportunities present onsite based on the physical site features and and requires site specific assessment to develop.

A review of the WRC design criteria and natural site features specifies a minimum target score of 15 shall be required for the site.

An initial assessment of the LID scoring matrix, the natural site elements, the proposed LID design features and the resulting LID score is summarised in Table 4.4.

Table 4.4: WRC Stormwater Management Guidelines

Implementation elements	Typical components	Comment	Score
Source control maximised	Use of building or site materials that do not contaminate	Residential roofs, gutters, down spouts made of non-contaminant leaching materials	1
	Existing streams and gullies located on site (including ephemeral) are protected and enhanced. The entire stream other than possible crossings shall be protected to qualify for points.	Preservation and protection of the watercourse through the site	3
	Riparian corridors are protected, enhanced or created	5 metres on either side of the stream to be protected and enhanced	1
	Protection and future preservation of existing native bush areas	Proposed reserve area exceeds 10% of the site	2
LID stormwater device/practice used	Infiltration devices to reduce runoff volume	Capture and infiltration requirements to be determined.	1-6
	Revegetation of open space areas as bush	Planting open space and providing maintenance of planting for 3 years if open space is equal to or exceeds 10% of overall site area is given 3 points	0-3
	Constructed wetlands	Meeting the water quality design storm and extended detention	4

Implementation elements	Typical components	Comment	Score
Urban design	Stormwater management is designed to be an integral and well considered part of the urban design.	Stormwater management is designed to be an integral and well considered part of the urban design	2
Tangata Whenua Values	Stormwater management has been designed considering tangata whenua values and demonstrates that these have been incorporated into the design. 2 points can be obtained by demonstrating, in a narrative and with design components, how the stormwater management system incorporates tangata whenua values.	System design with cultural considerations. Further consultation required with Tangata Whenua to implement understand and implement cultural considerations	0-2
Total score			14 - 24

It is concluded that the proposed development provides sufficient opportunity to meet the minimum LID target score of 15. Further assessment and consideration of LID considerations will be required as the design is further developed and progressed.

5 SAFETY IN DESIGN

An objective process considering the reduction and management of risk commencing at the design stage has been undertaken.

The reviews were undertaken by the project team as part of the overall design review at the concept and detailed design stages as presented below in Figure 5.1 within the design life cycle.

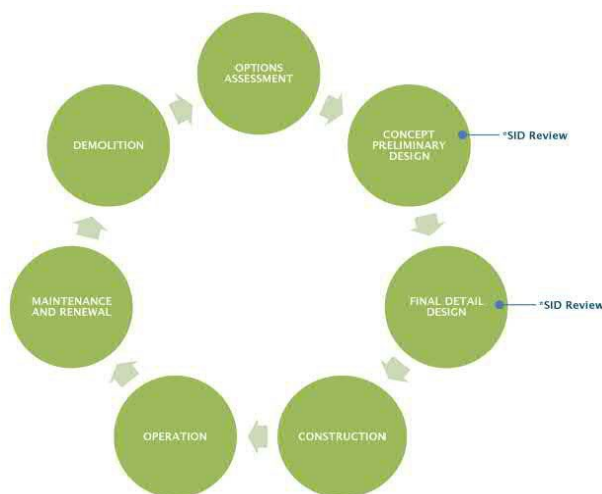


Figure 5.1: Design life cycle ('Safety in Design (SiD) Minimum Standard for Road Projects' NZTA, Section 4.1)

Key items that have been considered in the SiD process are outlined in Table 5.1. It is recommended that a safety and design workshop is undertaken with the relevant stakeholders at the time of detailed design.

Table 5.1: Safety In Design Considerations

Safety in Design Considerations	Comment
<u>Construction Phase</u>	
Construction risks associated with working around deep excavations.	Batter slopes of no steeper than 1:1 to be formed during excavation.
Environmental risks associated with undertaking earthworks and works within the stream.	All works shall be carried out under the supervision of an engineer in and in accordance with the Erosion and Sediment Control Plan and the TRC Resource Consent for undertaking the earthworks.
Construction risks associated with slope stability	Works to be undertaken under supervision of an engineer. Slope stability assessment to be completed for steep slopes and banks that will be susceptible to loads
<u>Operation Phase</u>	
Ponding Water	Proposed basin to hold water volumes > 1 m depth during heavy rainfall events. To allow egress side batters should be gently sloped. Planting/landscaping could be utilised to discourage access. Fencing could be provided to restrict access.
Culvert blockages	- Specification of Finished Floor Levels in lots adjacent to waterway has considered culvert blockage. - Consider inlet/outlet grates
Outlet blockages	- Outlet design should be robust and include overflow spillways for controlled release. - Operations and maintenance plan to identify inspection and maintenance schedule for primary outlet.
Reserves maintenance	Batter slopes of 1 Vertical : 4 Horizontal allowing maintenance to be carried out safely including mowing. Steeper slopes will require planting.

6 RECOMMENDATIONS

This report outlines the stormwater management strategy for the proposed development.

This assessment has reviewed the site and catchment characteristics with the objective of consolidating and defining the site-specific design parameters and provided preliminary stormwater layout plans for the required stormwater management infrastructure to allow early consultation with stakeholders.

The following recommendations are provided:

- A stormwater management system for the site shall be developed that provides water quality treatment, extended detention (stream erosion protection) and hydraulic neutrality for the development during minor and major rainfall events. Preliminary layout plans are provided in Appendix A indicating the proposed catchments and the size and location of the required infrastructure.
- Further assessment should be undertaken to understand the sensitivity of the downstream reach to the proposed development, understand tailwater conditions and to confirm the design parameters which have been specified within this report. Should the downstream effects of the development be minor, or be mitigated (likely via stream daylighting, culvert upsizing, channel armouring), the onsite stormwater management system requirements could likely be reviewed and the resulting system optimised and decreased in footprint.
- The site is located adjacent to natural wetlands. The stormwater management system will be required to mitigate the effects of the development on the natural wetland. Key points identified include:
 - The post development landform will need to maintain pre-development hydrology to ensure groundwater levels are maintained. An emphasis should be placed on soakage devices to maintain groundwater recharge.
 - Further assessment needs to be undertaken to understand the hydrology of the existing natural wetlands to ensure their baseline conditions are maintained. Further detailed assessment will be required to determine the volumes achieved via onsite soakage are equivalent to the pre development conditions.
- The site is located in the bottom of a basin and is subject to cross boundary flows from the upper catchments. The stormwater management plan and design landform shall be designed to ensure upstream flow paths are maintained with consideration for future development which may occur within the neighbouring catchment areas.
- The post development landform shall be designed with a network of secondary flow paths, designed to provide the level of protection requirements the proposed land use during for major stormwater events specified within the RITS. The road network and final landform design shall be designed to achieve the required overland flow paths specified within the stormwater management plan.
- The development proposes undertaking stream daylighting and enhancement works within the central waterway which will provide multiple engineering, ecological, landscape, cultural and social outcomes including:
 - Increased conveyance capacity within the stream controlling flood water levels and providing flood hazard management.
 - Stream naturalisation and improved floodplain connectivity.

- Establishment of riparian buffers to achieve suitable ecological and habitat function enhancing water quality, erosion protection and shading.
- Restoration of fish passage within the catchment, including retrofitting fish passage devices to identified fish barriers where removal is not feasible.
- Improved provision of fish and macroinvertebrate habitat heterogeneity and in-stream fish spawning habitat, including establishing pools and riffles with suitable interstitial spaces.
- Early consultation should be undertaken with the Regional Council (Waikato Regional Council) and the Local Authority (Waipa District Council) in regards to developing a stormwater system that meets the appropriate regulatory requirements and is suitable to vest and be operated by Council Staff.
- Consultation should be undertaken with tangata whenua in regard to the requirements of the NPS-FW and giving effect to Te Mana o te Wai.
- The stormwater management plan should be developed jointly and with consideration for the proposed ecological restoration, landscape, transportation and infrastructure requirements.
- Further hydrological and hydraulic modelling should be undertaken to define flood hazard mapping within the catchment and refine the size and layout of the required infrastructure.

APPENDIX A PRELIMINARY STORMWATER LAYOUT PLANS

APPENDIX B STORMWATER CALCULATIONS

Table B 1: Summary of water quality and stream protection requirements

Total roading catchment area	WQV	EDV
3.7 ha	749 m ³ *	900 m ³

*In accordance with the Waikato Stormwater Management Guideline, by providing extended detention, the water quality volume (WQV) can be reduced by 50%.

Table B 2: Pre-development input parameters

Catchment Description	Catchment Area (ha)	Curve Number (weighted average)	Initial Abstraction (mm)	Lag Time (mins)*
Grass paddock	20.5	61 [#]	8.1	13

*Lag time calculated as 2/3 of the time of concentration

[#] Selected soil class considered conservative for purposes of attenuation calculation (likely to over estimate attenuation requirements) and may be refined through further assessment

Table B 3: Post-development input parameters

Catchment Description	Catchment Area (ha)	Curve Number (weighted average)	Initial Abstraction (mm)	Lag Time (mins)*
Grass	8.6	61	2.7	13
Hardstand	11.9	98		
Total	20.5			

*Lag time calculated as 2/3 of the time of concentration

Table B 4: Summary of peak flows

	1% AEP Design Storm	10% AEP Design Storm	50% AEP Design Storm
	Peak Flow (m ³ /s)	Peak Flow (m ³ /s)	Peak Flow (m ³ /s)
Pre-development	1.9	0.9	0.4
Post-development	3.7	2.1	1.2

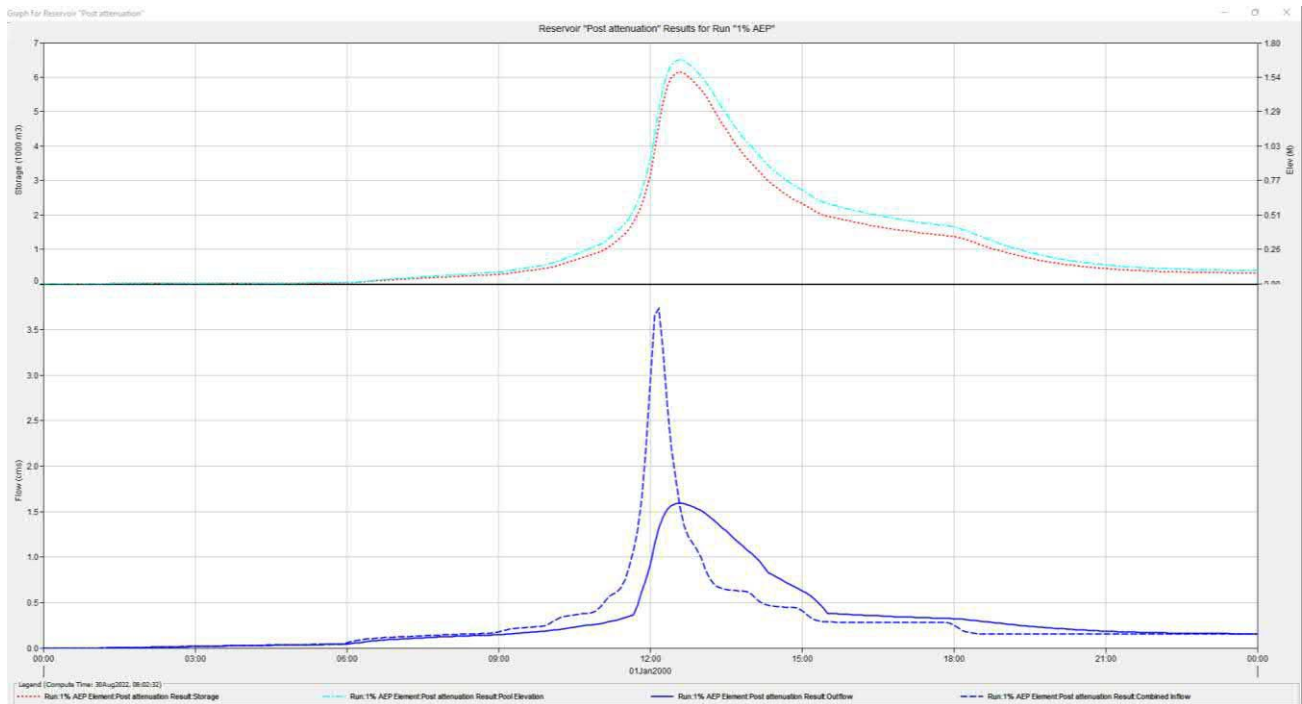


Figure B 1: HEC-results

Table B 5: Summary of stormwater management facilities

Catchment	Catchment Area (ha)	% of catchment	Basin volume required (m3)
A	7.65	41%	3030
B	5.10	19%	3200
C	2.91	16%	
D	1.50	8%	600
E	1.4	16%	600
Total			7,400