I hereby give notice that a hearing by commissioners will be held on:

Date:	**Monday 4 to Friday 8 November 2024**
Time:	**9:30am**
Meeting room:	**Warkworth Town Hall**
Venue:	**2 Alnwick Street, Warkworth 0910, Auckland**

NOTIFICATION MATERIAL

VOLUME IV

PRIVATE PLAN CHANGE 93 WARKWORTH SOUTH

KA WAIMANAWA LIMITED PARTNERSHIP AND STEPPING TOWARDS FAR LIMITED

COMMISSIONERS

Chairperson	**Karyn Kurzeja**
Commissioners	**Vaughan Smith**
	David Mead

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ATTACHMENT 18

APPENDIX 13
STORMWATER MANAGEMENT PLAN
FOR PPC REQUEST

STORMWATER MANAGEMENT PLAN FOR PPC REQUEST

Warkworth South Plan Change, Warkworth Auckland

CIVIL ENGINEERING ▾ SURVEYING ▾ LAND DEVELOPMENT

PROJECT INFORMATION

CLIENT	KA Waimanawa Limited Partnership & Stepping Towards Far Ltd
PROJECT	211001

DOCUMENT CONTROL

DATE OF ISSUE	28/07/2023
REVISION	E
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1 INTRODUCTION

The purpose of this Stormwater Management Plan (‘SMP’) is to outline the proposed management of Stormwater for the Warkworth South Plan Change Area (‘PCA’), located south of Warkworth. This SMP is prepared to support the Warkworth South PCA application with Auckland Council to rezone from Future Urban to a mixture of Terrace Housing and Apartment Buildings (THAB), Mixed Housing Urban (MHU), Single House Zone (SHZ), Conservation Zone (CZ), Large Lot (LL), Local Centre (LC) and Mixed Rural Zone. The proposed zoning for this PCA can be find in Figure 1 below.

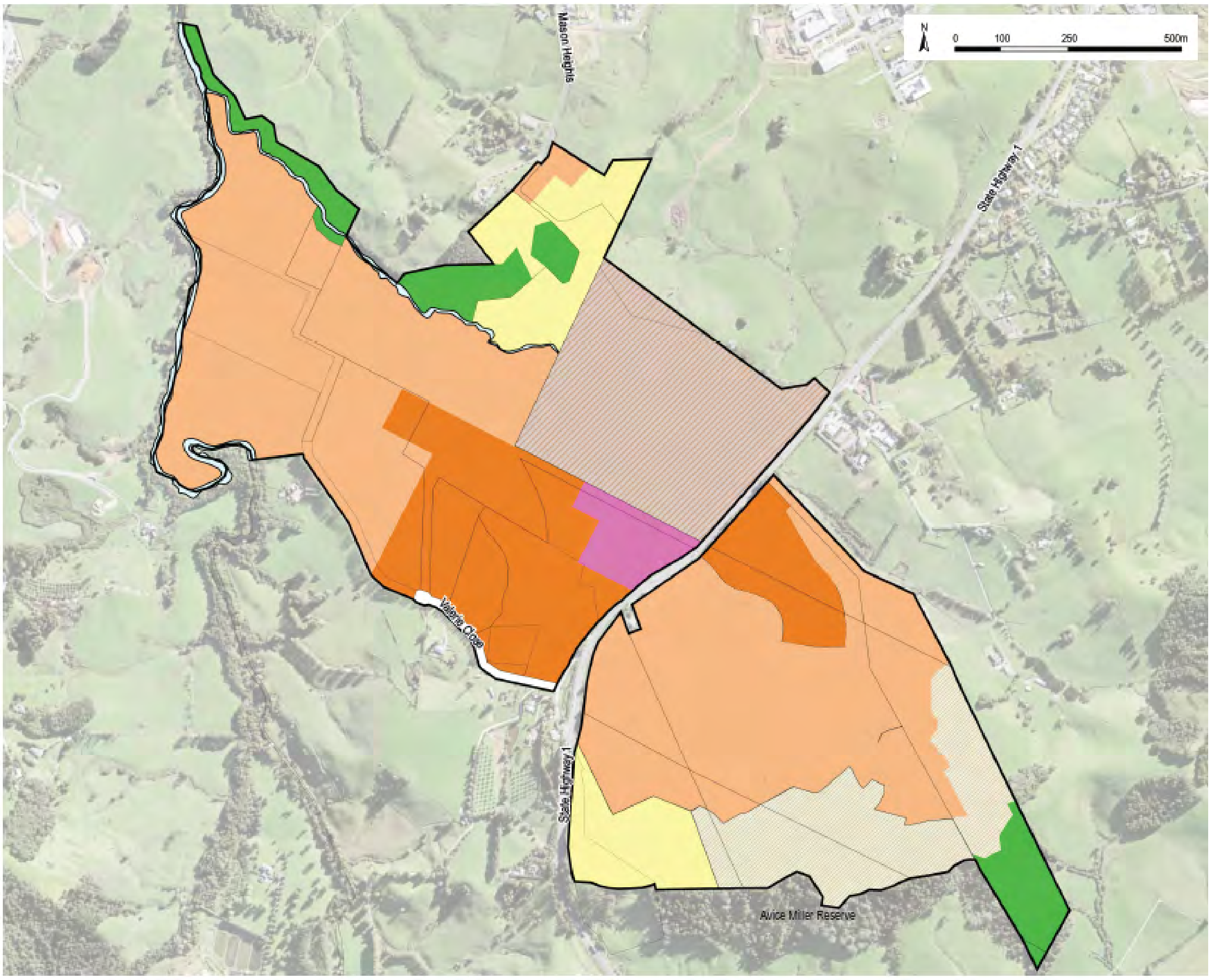


Figure 1: Preliminary Zoning Plan for Warkworth South Plan Change

Auckland Council has published a Structure Plan for Warkworth which provided a long-term guidance for urbanization of the Warkworth area. A preliminary SMP for the whole Warkworth Structure Plan area has been prepared by Tonkin Taylor in 2019. This SMP provides direction for future stormwater management outcomes and approaches which accord with Healthy Water’s Auckland Wide Networks Discharge (NDC).

This SMP prepared for Warkworth South PCA has adopted the framework from the Tonkin and Taylor’s Structural SMP to ensure that the receiving environment is protected and enhanced as it undergoes change from the current rural environment to an urban form. The stormwater management approach is considered to generally align with the outcomes of the NDC. Final stormwater management solutions will be worked through in detail as part of any future resource consent(s), based on locked down layouts, design and site-specific constraints. Future resource consent applications will, however, ensure compliance with the outcomes of this overarching SMP.

2 EXISTING SITE APPRAISAL

This section of the report summaries the existing site characteristics and conditions within the plan change area (PCA), as the relate to stormwater management.

2.1 SUMMARY OF DATA SOURCES AND DATES

This section provides a summary on key datasets used in the writing of this SMP, including those that have been used to generate supporting figures provided in Appendixes.

Table 1: Regulatory and design requirements

PCA Characteristics	Source and date of data used
Topography	• Maven Topographical Survey, March 2020
Geotechnical / soil conditions	• Private Plan Change- Geotechnical Assessment Valerie Close, Warkworth by Land Development & Engineering Ltd
Existing stormwater network	• Maven Topographical Survey, March 2020 • Auckland Council GeoMap, Stormwater Assets, 2021
Existing hydrological features	• Auckland Council GEOMAPS, Catchments And Hydrology Layer, 2021 • Maven Topographical Survey, March 2020 • Auckland Council GEOMAPS, Catchments And Hydrology Layer, 2021
Stream, river, coastal erosion	• Warkworth South Plan Change: baseline Ecology July 2021 by Bioresearches • Auckland Council GEOMAPS, Catchments And Hydrology Layer, 2021
Flooding and flowpaths	• Flood modelling report by Maven Associates Ltd • Auckland Council GEOMAPS, Overland Flow Paths Layer, 2021
Coastal Inundation	• N/A
Ecological / environmental areas	• Auckland Council Unitary Plan Viewer, significant vegetation layer, 2021 • Auckland Council Unitary Plan Viewer, significant ecological area layer, 2021
Cultural and heritage sites	• Warkworth South Plan Change, 1738 State Highway 1: Archaeological Assessment by Clough & Associates Ltd • Auckland Council GEOMAPS, cultural heritage site, 2021

PCA Characteristics	Source and date of data used
Contaminated land	• Soil Contamination preliminary Site Investigation for Proposed Resident Subdivision December 2020 by Land Development & Exploration Ltd • Auckland Council GEOMAPS, contaminated land site, 2021

2.2 LOCATION AND GENERAL INFORMATION

The PCA is approximately 2km south (via State Highway 1) of the Warkworth township and about 55km from downtown Auckland City. The development site is currently accessible directly off SH1, Valerie Close and will be accessible from a proposed road, referred to as the Wider Western Link Road that will be constructed in part during the development of the western side of the Plan Change area. The location in relation to the greater Auckland Region is illustrated in Figure 1, below

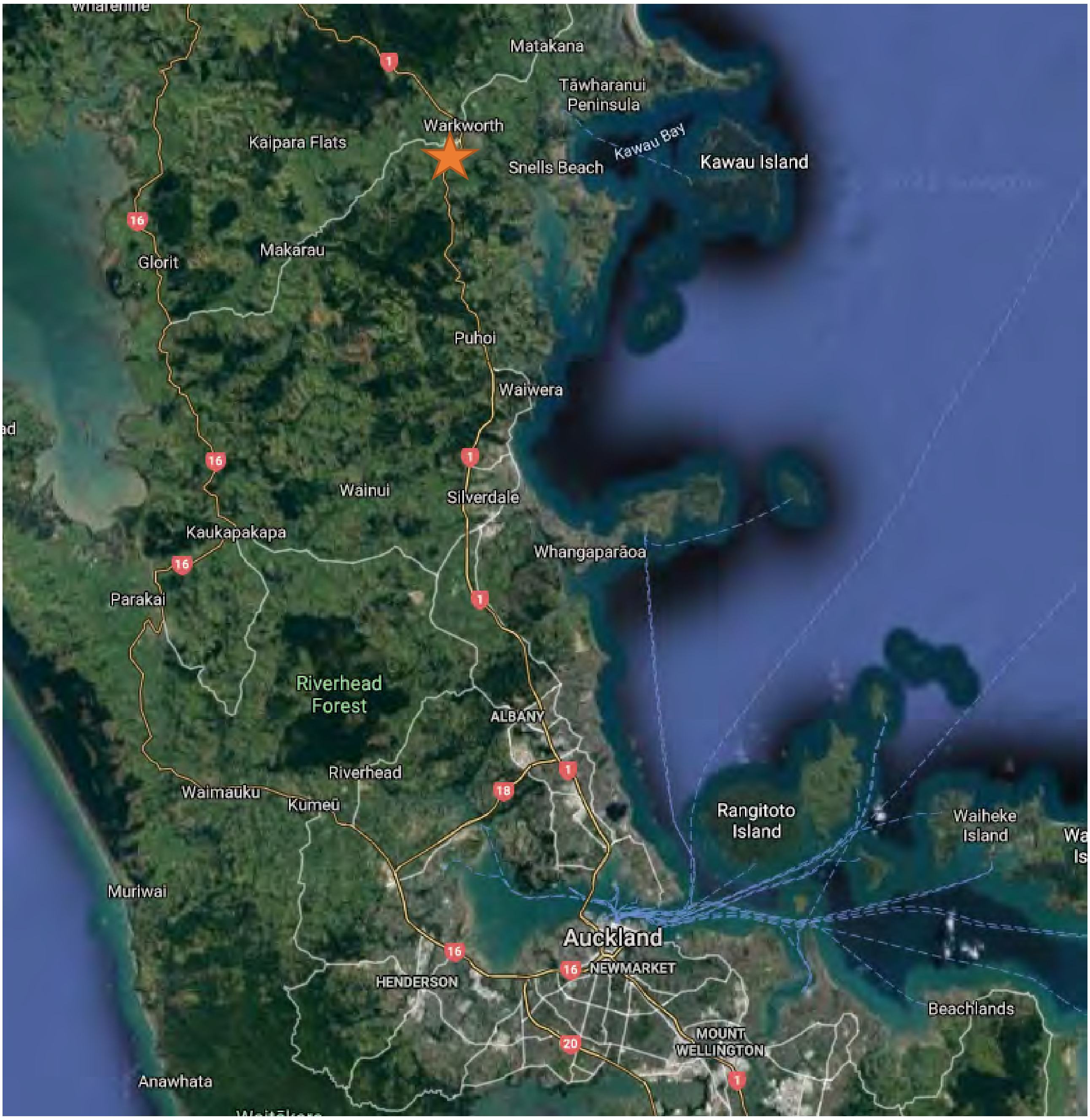


Figure 2: Warkworth South Precinct Location (Star)

The PCA is located within a predominantly rural area within the Warkworth Future Urban Zone (FUZ) in the Auckland Unitary Plan (AUP). It comprises two areas divided by State Highway 1 (SH1) through the combined PCA. The PCA is approximately 164ha in total size and is greenfield in nature. The western portion is bounded by Valerie Close to the south, SH1 to the east, a permanent stream to the west and surrounded by private properties to the north and south. The eastern portion is bounded SH1 to the west, Avice Miller Scenic Reserve to the south and surrounded by private properties to the east and north.

Table 2 provides key property details of the PCA and Figure 2 show the location and extent of the PCA with addresses shown.

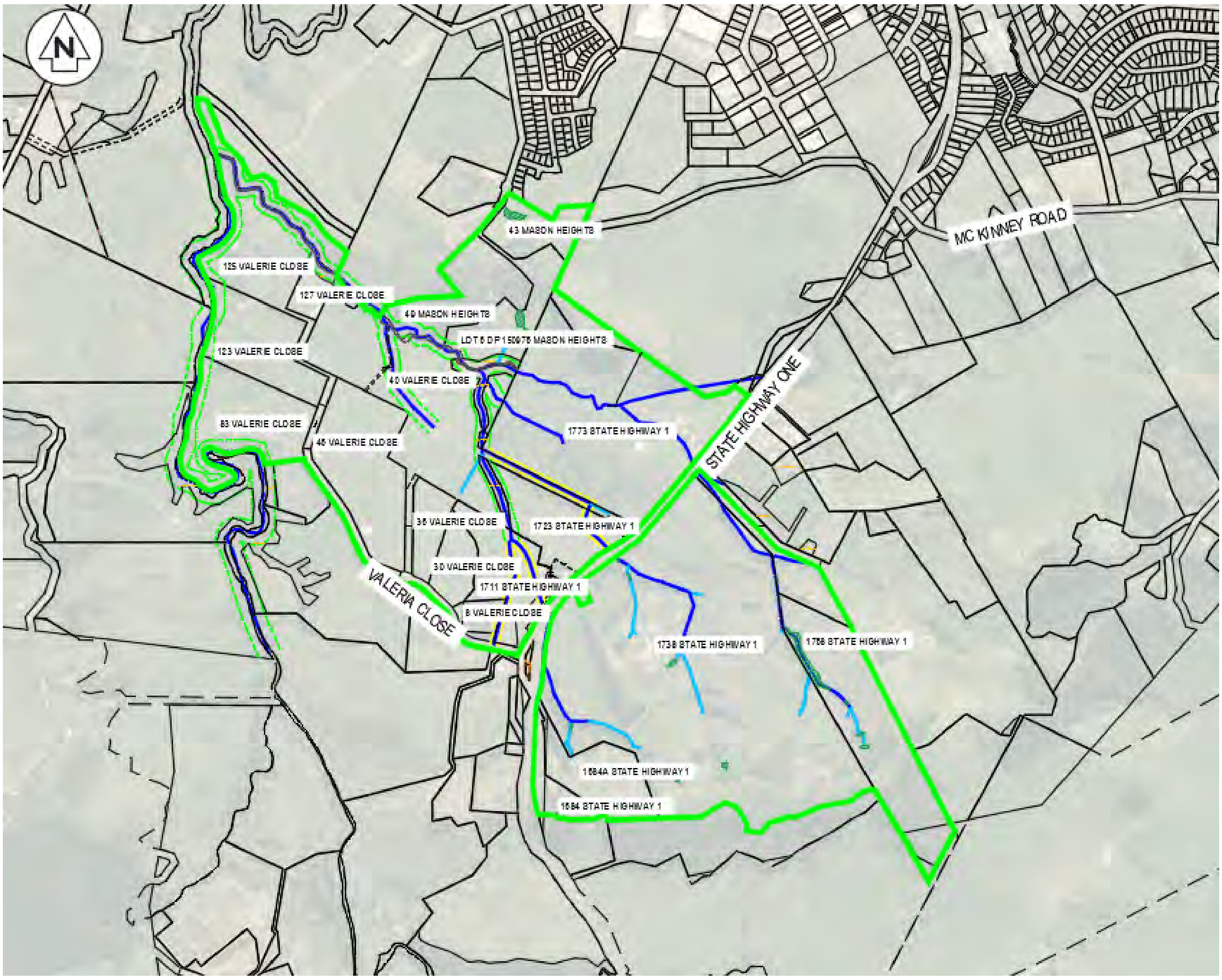


Figure 3: Map Showing Warkworth South Plan Change Area outlined in green

Table 2: Property information

Existing site element	Details
Site address	• 1684, 1684a, 1711, 1723,1738, 1768 & 1773 State Highway 1; • 8, 30, 36, 40, 46, 83, 123, 125 & 127 Valerie Close; • 43,49 & Lot 6 DP 150976 Mason Heights
Legal description	• Pt Allot 72 Psh of Mahurangi SO 891, Pt Allot 73 Psh of SO 891E, PT Allot 64 Psh of Mahurangi SO 891E, Pt Allot 72 Psh of Mahurangi SO 891, Pt Allot 73 Psh of Mahurangi SO 891E • Pt Allot 64 Psh of Mahurangi SO 891E, Pt Allot 72 Psh of SO 891E, Pt Allot 73 Psh of SO 891E

Existing site element	Details
	• Lot 1-4 DP539629 • PT ALLT 64 Paro Mahurangi • Lot 4-6 DP 353748 • Lot 2 DP 451512 • Lot 3, 5 & 6 DP 155544 • Lot 1 & 2 DP 344489 • Lot 5-7 DP 150976 • Lot 1-2 DP 119449
Current Land Use	• The PCA comprises open greenspace for farming, horticulture, and rural lifestyle
Current building coverage	• Approximately 4.4Ha of the PCA comprise buildings or other impervious surfaces
Historical Land Use	• Rural- residential and farmland

2.3 TOPOGRAPHY AND CATCHMENTS

2.3.1 Topography

The western portion of the PCA is moderately flat with a valley centrally located, that runs in an east-west direction. The landform is characterised by two ridge lines which run along the north-eastern and south-eastern boundaries. The existing ground elevations fall approximately 30m & 60m respectively from the top of the ridge lines on the south & north to the central gully.

The eastern portion of PCA has rolling terrain with the high point at the south boundary and moderately sloping land towards the north. The elevation falls approximately 85m from the highest point toward the lowest point across site.

2.3.2 Catchments

The greater Warkworth Structure Plan area is located within the lower Mahurangi River Catchment in the north of the Auckland Region. The Mahurangi River Catchment is approximately 5,892ha in area and drains to the Mahurangi Harbour within the Hauraki Gulf. In total, 164ha of land is located within the PCA.

The western site catchment is constrained by the two ridgelines running east-west along the northern and southern boundaries. The flat central plain of the western portion is dissected by permanent streams and a series of farm drains. The permanent streams are tributaries of the southern Mahurangi River branch.

The eastern site catchment is undulating, with the predominant fall and gullies provided with a westerly aspect. These catchments are upstream of the western portion of the plan change area.

The whole catchment is predominantly used for agricultural purposes and are undeveloped, farmlands. The extent of the catchment is illustrated in Figure 4 below:

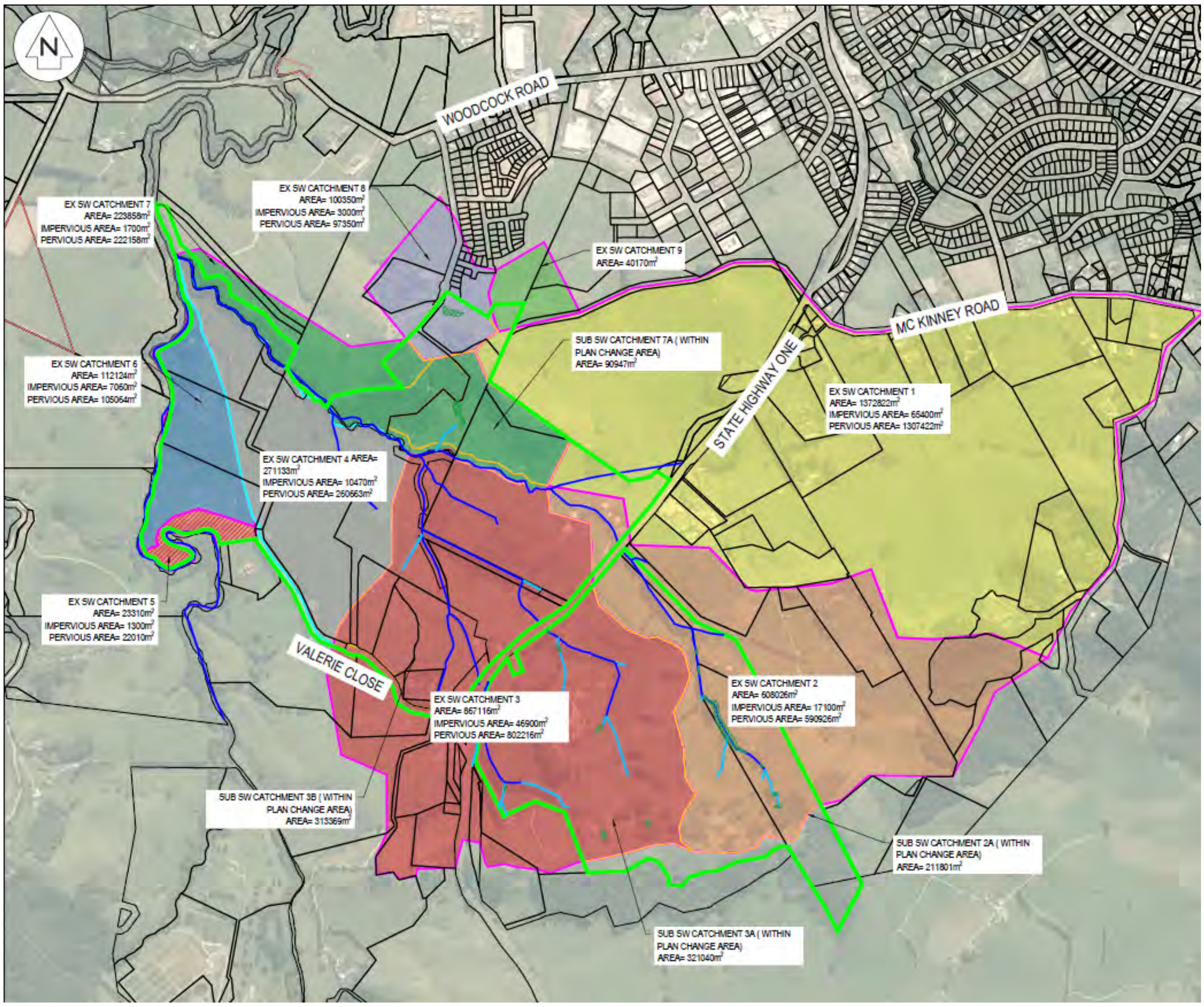


Figure 4: Existing stormwater catchment plan

The natural topography of the PCA forms twelve catchments. Some of these catchments extend outside of the PCA area as shown in Figure 3, above. A summary of these catchments can be found in Table 3 below and discussed further in Section 2.6 of this Report

Table 3: catchment coverage summary

Catchment	Pasture/crop/ forest area	Roading/ driveway	Residential & farm building	Total area (m^2)	Total Impervious Area (m^2)[1]	Total Pervious Area (m^2)
1	1,307,422	18,500	46,900	1,372,822	65,400	1,307,422
2	590,926	3,300	13,800	608,026	17,100	590,926
3	820,216	19,400	23,000	867,116	46,900	820,216
4	260,663	4,070	6,400	271,133	10,470	260,663
5	22,010	300	1,000	23,310	1,300	22,010
6	105,064	660	6,400	112,124	7,060	105,064
7	222,158	-	1,700	223,858	1,700	222,158
8	97,350	1,200	1,800	100,350	3,000	97350
9	40,179	-	-	40,179	-	40179
				3,618,918	152,930	3,465,988

Notes: The impervious area is based on desktop study.

2.4 GEOTECHNICAL

Geotechnical investigation has been undertaken throughout the PCA. The western portion has been investigated by Land Development & Engineering Ltd and CMW Geotechnical for the eastern portion.

Published geological maps and geotechnical fieldwork indicate the proposed development is predominantly underlain by Pakiri Formation of the Waitemata Group and the hillslope deposits of the Tauranga Group. The Tauranga Group soil is generally located at the base of hill slopes and adjacent to the stream margins. The remaining area is mostly residual soils of the weathered Pakiri Formation.

The Pariki formation is Neogene Sedimentary rock comprising of alternating, thick-bed, volcanic rich graded sandstone and siltstone with volcaniclastic grit beds. The residual soils generally comprise of a silty clays and silts with varying degrees of sand and gravels. They tend to be bright orange, red, pinks and purple in colour. These deposits typically comprise weak to very weak sandstones and siltstones. This type of soil is generally classified as Soil Class C in accordance with TP108 soil classification.

The reporting identifies some land stability matters of interest within the southern extent of the PCA. The balance of the PCA is considered generally suitable for intensified residential development. The low-lying areas of the region will be required to undercut and backfill with competent engineering fill that complies with NZS4404. The steep southern area of the PCA will be suitable for a lower-density residential development.

Please find attached geotechnical investigation reports for detail information and recommendations regarding the PCA.

2.5 EXISTING DRAINAGE FEATURES AND STORMWATER INFRASTRUCTURE

2.5.1 PUBLIC STORMWATER INFRASTRUCTURE

Figure 5: GEOMAPS Extract

Figure 6: GEOMAPS Extract

Auckland Council's GEOMAPS (Figure 5&6) identifies that there are no extensive public stormwater networks present in the vicinity of the plan change area, other than a few existing stormwater culverts have been identified by GEOMAPS within State Highway 1, along Valerie Close and at the intersection of Valerie Close & State Highway 1. There are also existing public stormwater networks located at Mason Height Road. This public network terminates at the northern boundary of the PCA and discharges to the existing watercourse within the PCA. All sites within the plan change area currently discharge stormwater run-off via various private stormwater systems to watercourse and overland flow path directly.

2.5.2 EXISTING DRAINAGE FEATURES

Streams within the PCA are all part of the Mahurangi River system. These streams vary from natural permanent streams with good quality indigenous riparian vegetation to farm drains. The southern branches of the main Mahurangi River tributary traverse the western boundary of the PCA. Various tributaries of this southern branch originate and/or bisect the PCA area. Many of the existing watercourse have been modified to some degree in the past through historical farming practices and to manage stormwater drainage within the sites. The existing drainage features are summarised below:

- Catchment 1: this is the largest catchment that contributes to the main permanent stream that crosses through the western portion of the PCA. Only a small portion of the PCA flows into this catchment. The overland flowpath / stream within this catchment has been heavily modified due to historic farming activities. More than half of this catchment is restricted by a culvert under SH1. This culvert has been identified by Healthy Waters to be upgraded in the future.

- Catchment 2: this catchment is located immediately north of the eastern portion of the PCA. The overland flowpath / stream in this area is comparable to Catchment 1 which has been modified to suit. There is a good quality constructed wetland located near SH1. The overland flow path/ stream is then piped under SH1. This culvert also been identified to be upgraded as part of the Structure Plan.
- Catchment 3: This is the second largest catchment within the PCA. Two tributaries originate from the eastern portion of the PCA. These tributaries are conveyed under SH1 via existing stormwater culverts.
- Catchment 4: this catchment is relatively flat with a series of farm drains within the grassed paddocks and vineyards. A constructed wetland with established vegetation is located at the downstream of this catchment. Established riparian planting is present along the northern extent of this catchment along the permanent river.
- Catchment 5: this catchment comprises of various smaller sub-catchments that drain directly into the southern branches of the Mahurangi River. A part of this area has been identified as significant ecological areas – Terrestrial under the AUP.
- Catchment 6: this catchment is flat with two noticeable farm drains that discharge directly towards the southern branches of the Mahurangi River with good riparian planting along the western boundaries of this catchment.
- Catchment 7: this catchment is hilly with re-established forest planting. The overland flow paths within this catchment are largely unmodified.
- Catchments 8 & 9: these two catchments are at the top of their catchment. there is a natural wetland located on the downstream of catchment 8. Both catchment 8 and 9 is adjacent to a developed area south of Warkworth township extent.

Ultimately all catchments within this SMP drain to the southern branches of the Mahurangi River. Refer to the catchment plan in Figure 7, below:

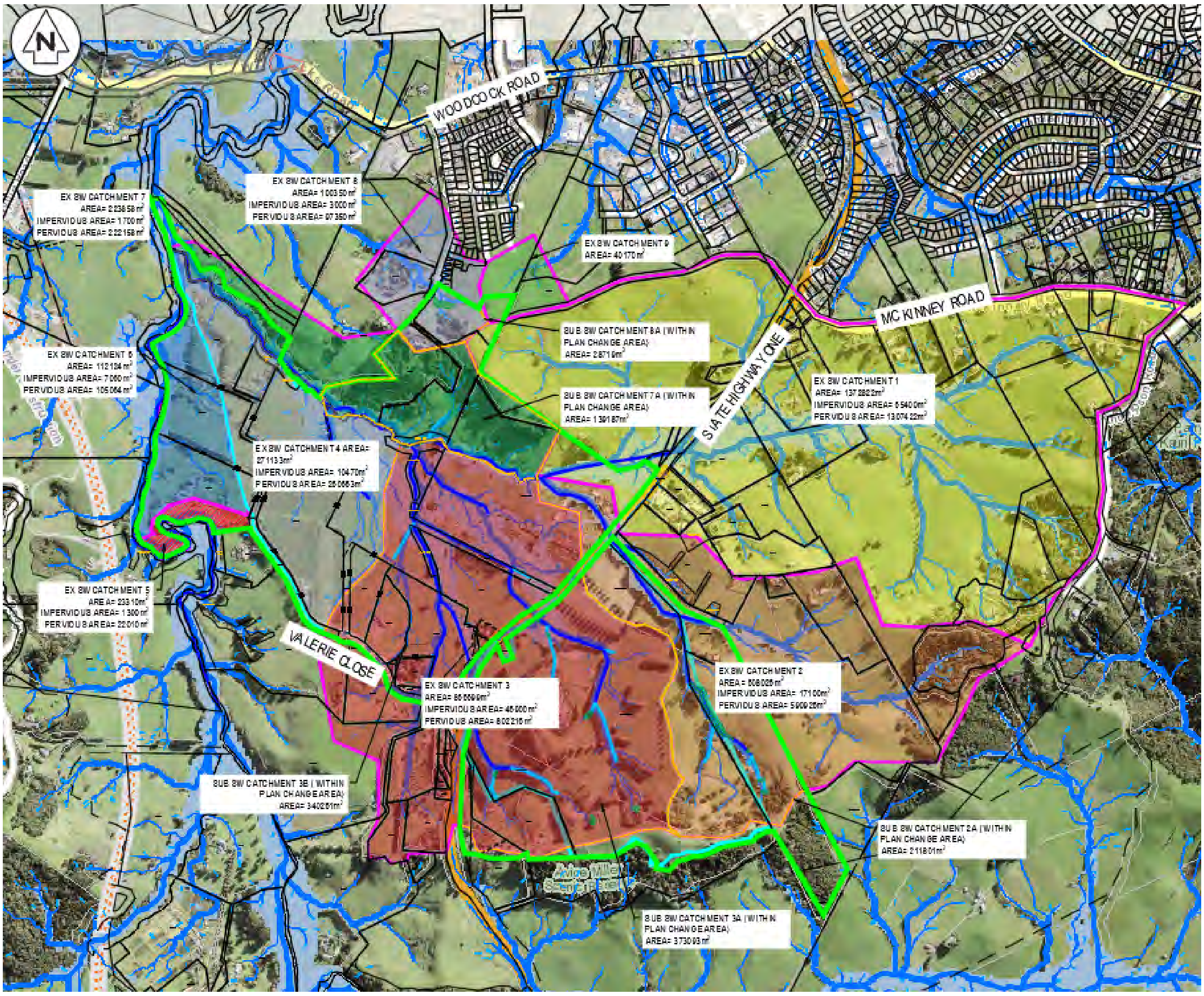


Figure 7: Existing catchments and hydrological features

2.6 RECEIVING ENVIRONMENT

2.6.1 MAHURANGI RIVER

All catchments within the PCA discharge to the main southern tributary flowing to the Mahurangi River. The river section immediately downstream of the PCA has been identified as a Natural Stream Management Area, the riparian margin of the western boundary to the PCA is also identified as being within the Significant Ecological Areas overlay of the AUP. Refer to Figure 8, below for reference:

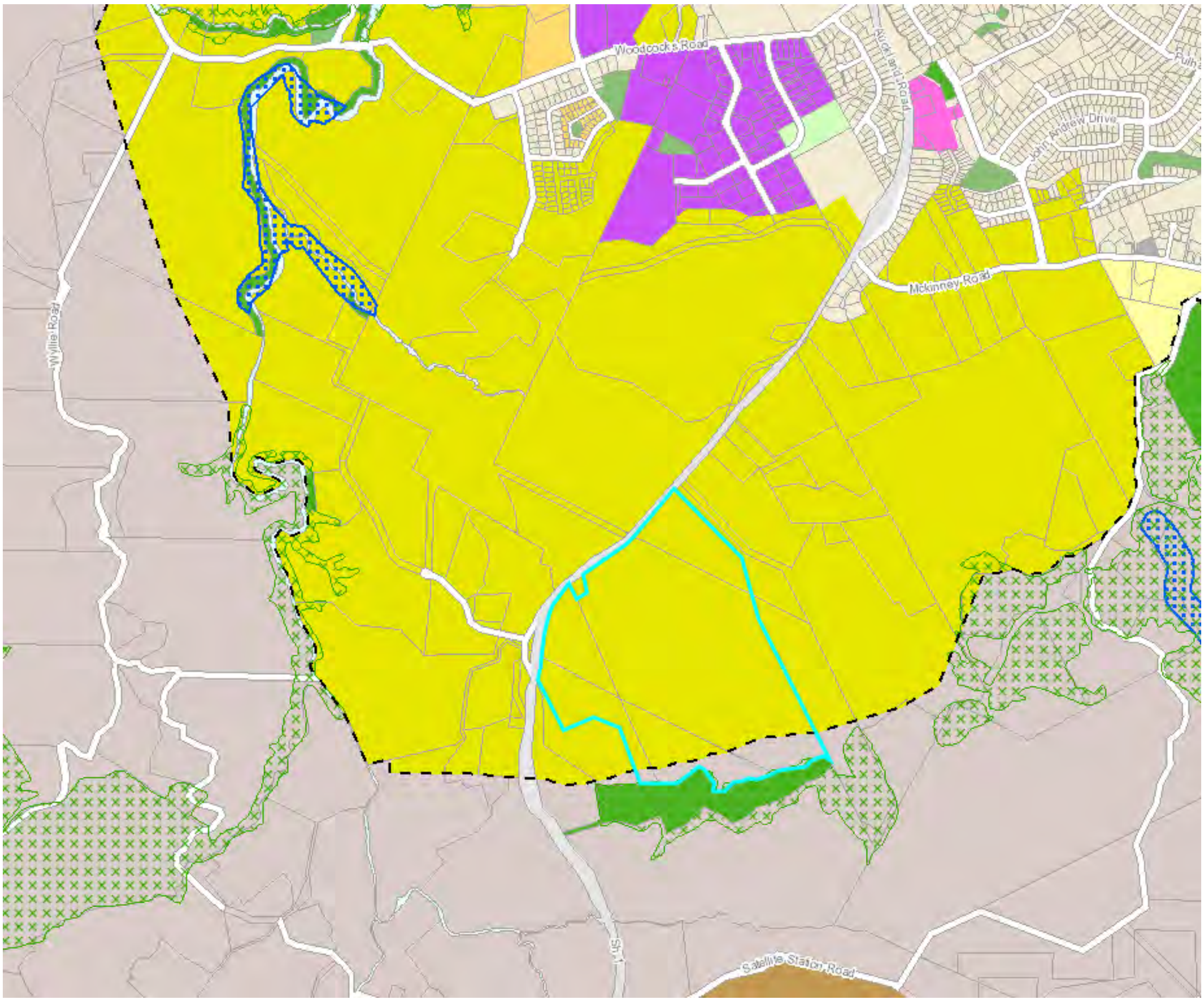


Figure 8: Significant Ecological Areas overlay

The overall health of the Mahurangi River has been scored as average to good from the Auckland Council Fresh Water Report Card with a good riparian margins planting. Most of the catchment of the Mahurangi River still pastoral land with large forest area remained. However, the water quality within the river only achieved a lower-than-average score due to the farming activities over the wider catchments.

The urbanisation of the Mahurangi river will increase the downstream flood risk and potential loses to the upstream habitat. With a careful planning and the use of stormwater management devices, these effects can be mitigated or offset. There is potential of enhancing the existing upstream tributaries with riparian planting and improvement of water quality with the implementation water sensitive design practices.

2.6.2 HAURAKI GULF

The ultimate receiving environment is the Coastal Marine Area (CMA), the Mahurangi Harbour within the Hauraki Gulf. The overall health of the Hauraki Gulf is declining over a century due to anthropogenic activity. The New Zealand Government has put in place a series of measurement and control in place such as the New Zealand Coastal Policy Statement 2010, the Hauraki Gulf Marine Park Act 2000 and the latest Revitalising the Gulf: Government action on sea change Plan. These legislation and plan aim to restore and regenerate the Gulf's environment.

The policies and objective of those documents mentioned above will have direct influence on the objective and outcomes of this SMP. The key outcome for this SMP would involve the control and/or elimination of contamination at source, improving the stormwater run-off quality and enhancing the riparian yard to improve the overall health and biodiversity of the existing stream and watercourse on site to improve the overall health of the downstream received environment.

2.7 FLOODING AND FLOWPATHS

The greater Warkworth Structure Plan's SMP identified that upstream development may increase the flood risk to existing buildings in Warkworth. If this is found to be the case, then catchment scale attenuation devices may be required to avoid increasing flooding to existing developed areas.

A comprehensive flood modelling report has been prepared by Maven Associates Ltd has been developed to accompany this plan change proposal. The flood modelling has been calibrated against the previous flooding information provided by Heathy Waters who has developed a flooding extent for the Mahurangi Catchment. The flood modelling report provides a detailed assessment of the potential effects of increased impervious area due to the development associated with this plan change. The report compares design run-off with baseline flows in various scenario to demonstrate that no adverse effects to the downstream environment can be expected. Maven's Flood Modelling Report can be found in Appendix D of this report.

While this SMP was being prepared, a similar report was being prepared and was subsequently published by Healthy Waters, which is available online, within Auckland Council GeoMaps. The results of that modelling exercise are based on an assumed climate change increase of 3.8 Celsius, which prompts a significant increase of the rain fall depth across all design rain fall events. It is notable that this increase is much more conservative than the current Auckland Council's Stormwater Code of Practice (SWCOP) revision 3.0. The flood modelling that Maven has provided in Appendix D of this report only considers 2.1 Celsius degree increased by 2090, as recommended in the currently operative SWCOP.

Within the PCA area, there is a networks of streams/ overland flow paths that convey stormwater run-off generated from the highland areas towards the southern branch of the Mahurangi River which is located on the western extent of the PCA. A snapshot of these stream/overland flow path and 100 years flood plan can be found in Figure 9, below:

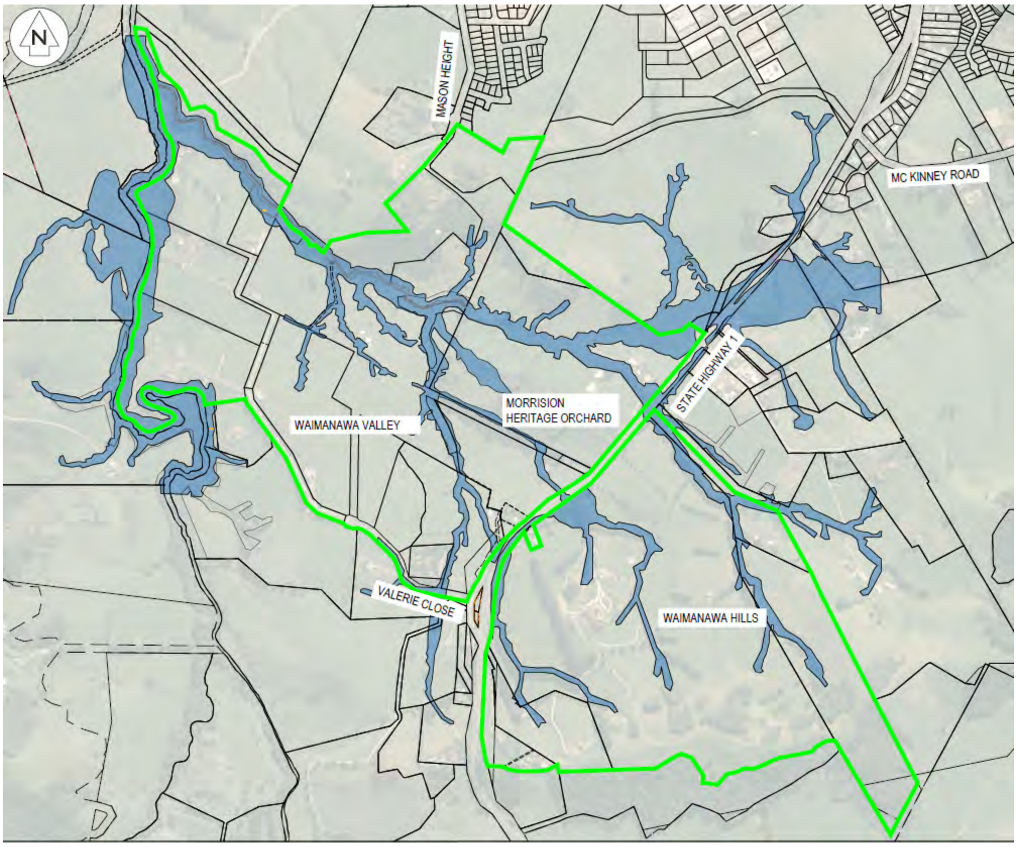


Figure 9: Existing Overland Flow Path and Flood Plain area

The comprehensive flood report identified that the wider catchments peak water run-off from the upstream environment is approximately one hour behind the peak water run-off generated from within the PCA. Based on modelling outcome and in summary, the flood modelling report recommendation is to pass forward flows for both 10 and 100 year events to mitigate coinciding peak flow from upstream and newly generated or detained flows.

2.8 COASTAL INUNDATION

The plan change area is located above the influence of the coastal inundation area, as such no further investigation has been completed.

2.9 BIODIVERSITY

Bioresearches has prepared an ecological report in support of the Plan Change application. In accordance with their Report, there are various permanent and intermittent watercourses and natural wetlands found within the PCA.

In accordance with the findings of the ecology report mentioned above, the biodiversity of the PCA can be broken down into two main areas, of which are summarised below:

2.9.1 FOREST COVERAGE

The western portion of the PCA contains two significant stands of indigenous vegetation cover which included the Kanuka Forest in the north-west and the Puriri forest in the southwest. The Puriri forest has been scored as high value within the ecology report while the Kanuka forest area has been scored at moderate value.

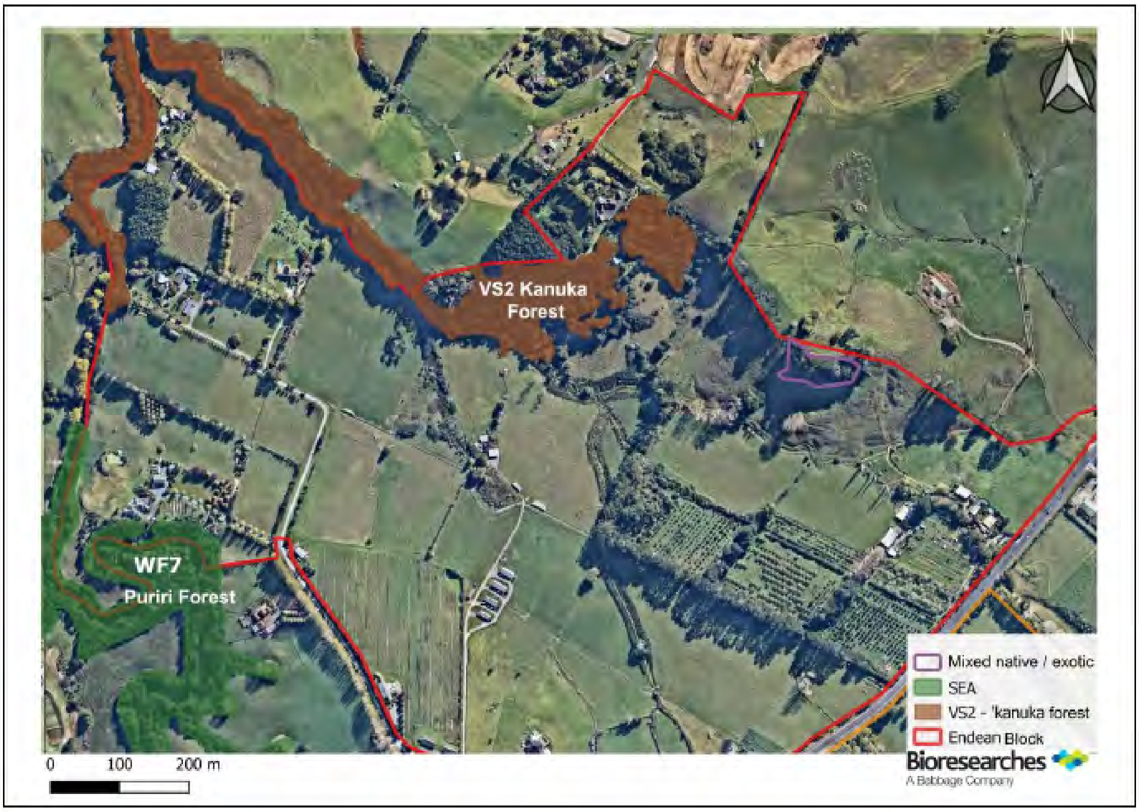


Figure 10: Extent of existing forests on the western portion.

The Puriri forest to the south of the area has been classified as Significant Ecological Area (SEA) under the Auckland GEOMAPS. While the Kanuka forest area has a Natural Stream Management Area overlayed. Please refer figure below:

Figure 11: Extent of Significant Ecology Area and Natural Stream Management Area overlay

This eastern portion of the PCA contain a few fractions of indigenous vegetation cover with the largest area located to the south. This area is abutting the Avice Miller Scenic Reserve which has been classified as a SEA under the AUP and has scored a high value in the ecology report. Please refer to the figure below for the extent of the indigenous vegetation cover within this portion of the PCA.

Figure 12: Extent of Significant Ecology and indigenous vegetation area on the eastern portion.

2.9.2 STREAM AND WETLAND ECOLOGY VALUE

The western side of the PCA contains the following stream and wetland features:

- Permanent River
  - Watercourse 19: This is a permanent river which is one of the main tributaries to the southern branch of the Mahurangi River. The catchment relates to watercourses 1- 17.
- Permanent Stream
  - Watercourse 1: upper catchment of this stream is located outside of the PCA area. The watercourse is piped under Valerie Close. The wetted width of the upper reach was 0.5-1.5m wide and the deepest section was 0.38m.
  - Watercourse 2: this stream originates from the eastern portion of the PCA. The stream is piped under SH1 with a large pool downstream of the pipe (up to 1m in depth). This flows west in a defined channel prior joining watercourse 1
  - Watercourse 4: this water course originates from the eastern portion of the PCA. The stream is piped under SH1. The channel size and depth varies along the length. The catchment is large with continuous flowing water. This stream is piped under the existing farm driveway of #40 Valerie Close before discharging towards Stream 5.
  - Watercourse 5: the upper reach of this watercourse is a constructed drain along the farm driveway on #40 Valerie Close. This upper reach has a few still pools and is classified as an intermittent

stream. After the confluence with Watercourse 4, the stream bank is wider and deeper. This section is classified as permanent stream.

- Watercourse 12: this watercourse receives water from watercourses 1,5 and 7. It has a deep channel with regenerating native planting within the 10m of riparian yard.
- Watercourse 13: this watercourse originates from the existing Morrison Orchard with a well-defined channel and native vegetation along the channel. This stream discharges toward Watercourse 12.

➢ Modified Permanent Stream

- Watercourse 15: this watercourse receives the water from watercourses 9,10 & 11 on the eastern, upper reach and 14 & 16 on the western, lower reach. The watercourse has a narrow well-defined channel. Predominantly terrestrial vegetation is located downstream within the riparian yard. A man-made wetland is located around this watercourse which is covered with more detail within the ecological report.

➢ Intermittent Stream

- Watercourse 7: a shallow channel is present along this watercourse with deep pools along the length if the watercourse.
- Watercourse 11: this contains a well-defined channel with boggy ground and aquatic vegetation within the base of the channel.
- Watercourse 18: this watercourse is quite short with a well-defined channel with large amount of water celery and macrophyte throughout the channel. The channel has no flowing water at the time of site visit. The upper reach of this stream has been piped or reclaimed. The current channel is the remnant of and old watercourse. A manmade pond is located north of this stream.

➢ Ephemeral overland flow path

- Watercourse 3: in accordance with Auckland Council GEOMAPS, an overland flow path is located in this location. There is a small depression found during the site visit with no sign of any aquatic vegetation.

➢ Artificial watercourse

- Watercourse 6,8,9,10,14,16 and 17: these watercourses are classified as artificial watercourses which was constructed as part of the farming activities on site.

➢ Wetlands

- Natural wetlands 23 and 24 are identified in the ecological report. However, it has a low water depth or insignificant water ponding which does not support any aquatic habitat.

The watercourse maps for this area from Bioresearch can be find in figure below.

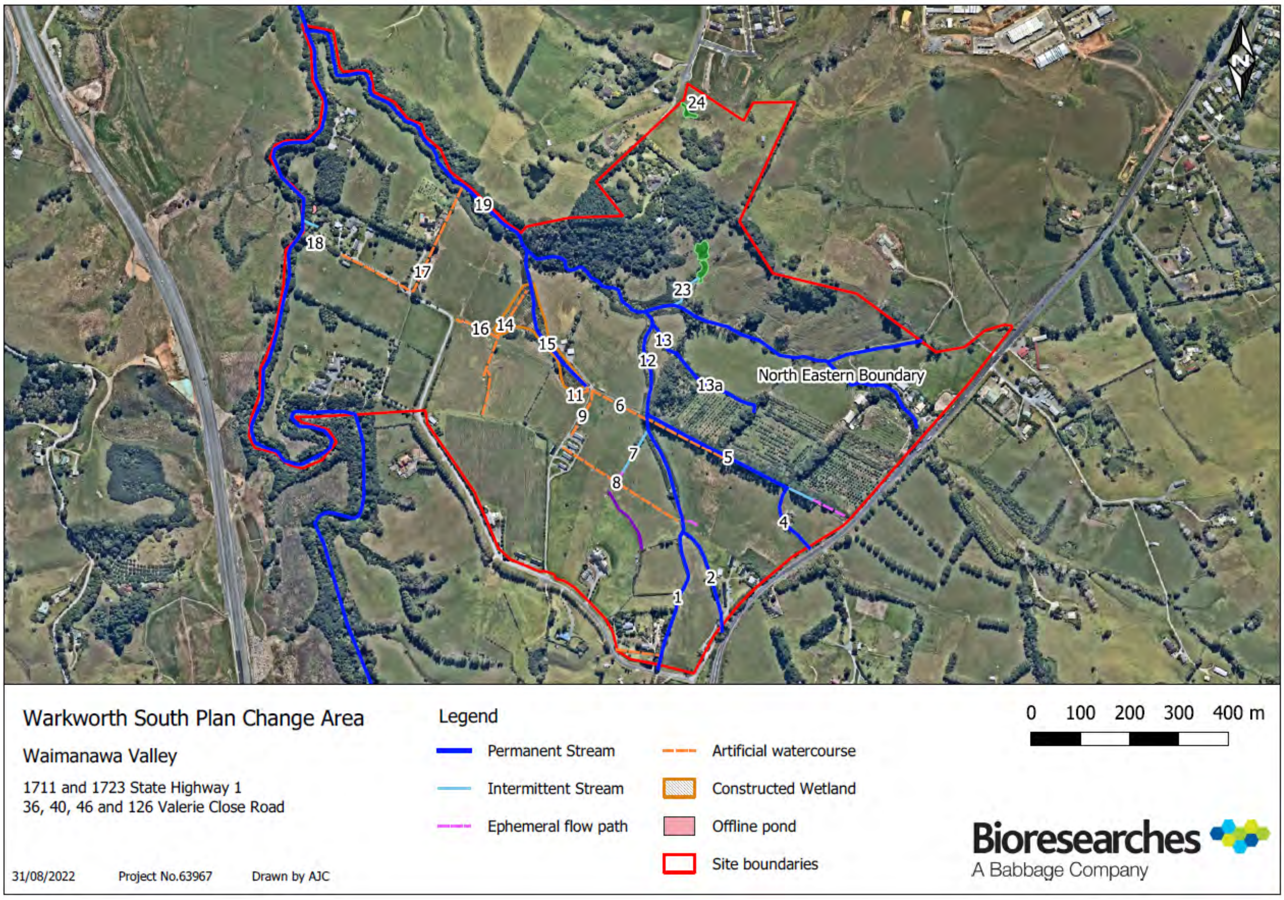


Figure 13: Existing watercourse classification and location maps by Bioresearch on the western portion.

The eastern portion of the PCA contains three main catchments; identified as eastern, central and western systems in the ecology report. A summary of the stream and wetland features is provided below:

- Permanent Stream
  - Watercourse 35: the main collector of the stormwater run-off from the eastern system with an average depth of 0.15m and an average width of 1.5m. This drains west via a culvert under SH1 and connects to watercourse 19 to the west.
  - Watercourse 38: This watercourse located upstream of watercourse 35. It has ab average width of 0.3m and an average depth of 0.16m with a general slow flow of water. The upstream of this watercourse contain a high drop which acts as barrier for fish passage.
  - Watercourse 25: the main collector of the stormwater run-off from the central area. This watercourse is restricted by the undersized culvert with a vertical drop which prevents fish passage. This

watercourse has a water depth between 0.1-0.25m deep and is approximately 1m wide. This watercourse drains west though a culvert under SH1 which connect to Watercourse 4 on the western side.

- Watercourse 30: the main watercourse of the western system has an approximate stream width of 0.5 to 1m and average depth of 0.1-0.2m. The watercourse is piped under SH1 and connects to Watercourse 2 on the western side.

➢ Intermittent Stream

- Watercourse 36 & 37: these watercourses are upstream of permanent stream 35 and 38 within the eastern system. The stream receives water from within the PCA and lacks aquatic habitat and low riparian vegetation.
- Watercourse 26, 27, 28, 29: these watercourses are upstream of permanent stream 25 of the central system. These watercourses have defined stream banks, and some have running water. However, most of the riparian planting consist of low value grazed pasture grass.
- Watercourses 31, 32, 33, 34: these watercourses are upstream of the permanent stream 30 of the western system. Some of these watercourses originated from within the PCA some are outside of the PCA area. These watercourses have defined banks with some having shallow, running water.

➢ Wetlands

- Wetland 4, 5 & 10-16: Wetland 4 is approximately 133m², while wetland 5 is approximately 170m². Wetland 6 which is later described as a combination of 4 wetland (wetland 13,14,15,16) is the largest wetland located within the PCA. These wetlands receive runoff from watercourse 36, 37 & 38. Wetland 10-12 is relatively small, boggy and pugged. All the wetlands within this eastern system are low quality with dominance of exotic pest vegetation and poor-quality aquatic habitat.
- Wetland 1, 2, 3 & 7: Wetland 1 is approximately 93m², Wetland 2 is approximately 36m², Wetland 3 is approximately 290m². The size of Wetland 7 is not defined. All these wetlands are within the central system with limited riparian planting with mostly grassed or exotic pest vegetation.
- Wetland 8 & 9: belong the western system with Wetland 9 being approximately 125m², receiving runoff water from watercourse 32 whilst Wetland 8 is located at the upstream of an ephemeral stream. Both of these wetlands feature low biodiversity and low-quality aquatic habitat.

The watercourse maps for this area from Bioresearch can be find in figure below.

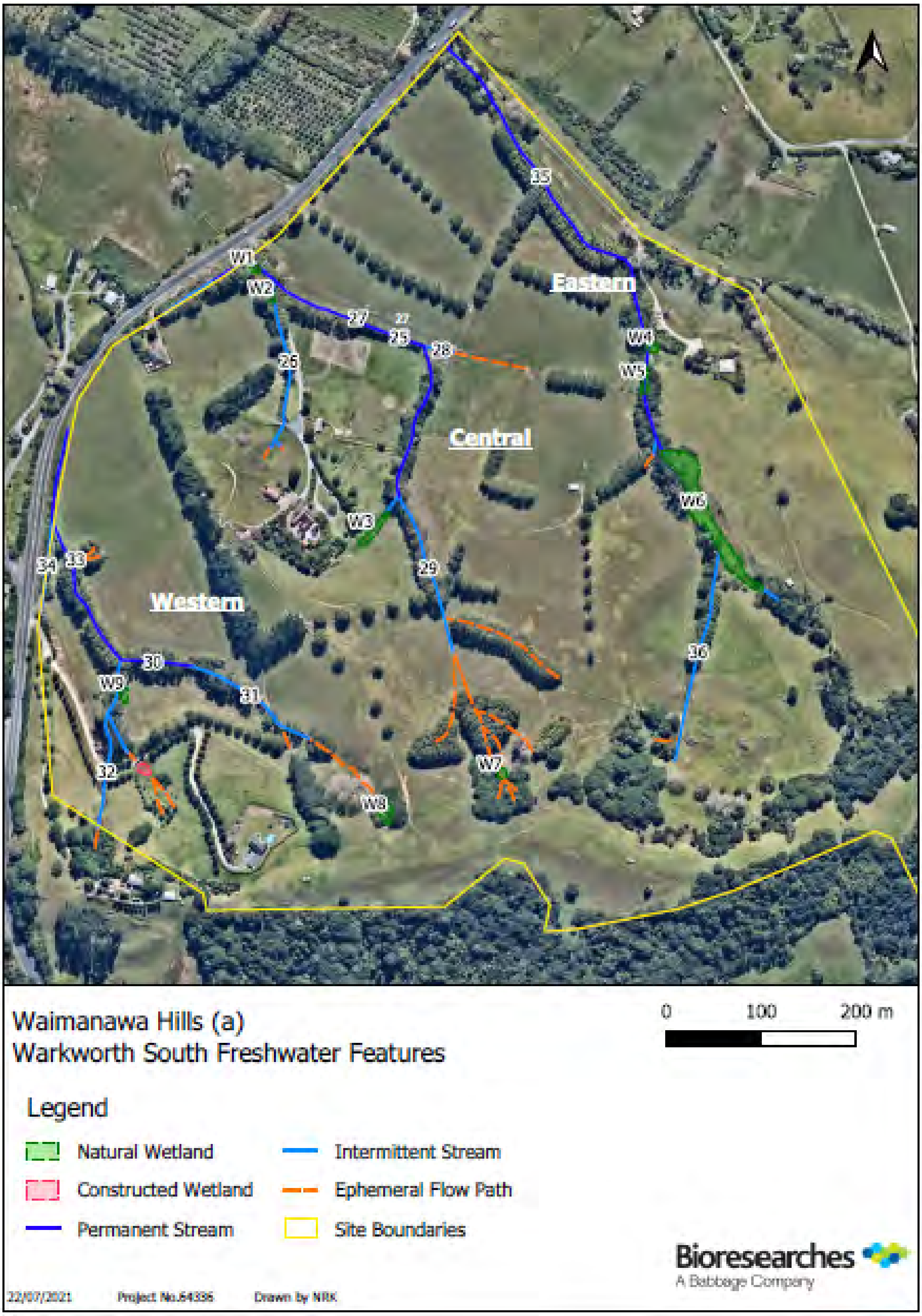


Figure 14: Existing watercourse classification and location maps by Bioresearch on the eastern portion.

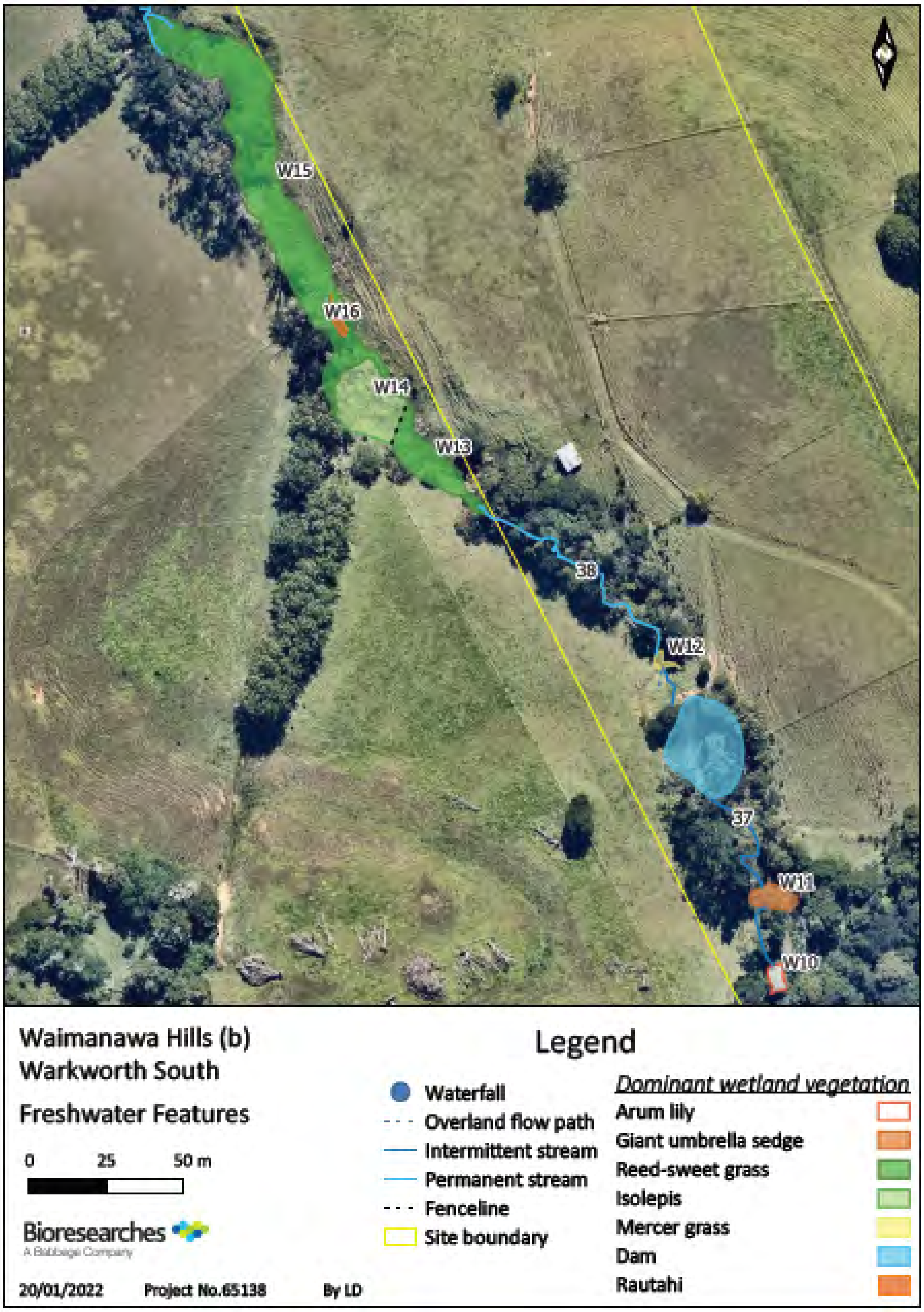


Figure 15: Further investigation on existing watercourse classification by Bioresearch on the eastern portion.

Overall, streams within the PCA have low ecological value, with the exception of watercourses 15 and 19. A fish survey was carried out within the PCA which only recorded one shortfin eel. This has further indicated that most of the watercourses on site are degraded and do not support aquatic habitat. Most of existing streams have some form of fish barrier such as farm crossing which prevents the natural movement of fish species.

2.10 CULTURAL AND HERITAGE SITES

An archaeological assessment was prepared for the plan change area by Clough & Associates Ltd in July 2021. The conclusion of the Archaeological assessment can be found below:

"There is no archaeological or other historic heritage sites have been previously recorded within the proposed Plan Change Area, and none were identified during the archaeological survey. For more information, please refer the archaeological assessment report attached.

Future development as a result of the proposed Plan Change is therefore unlikely to have any adverse effects on archaeological/historic heritage sites. However, if unidentified archaeological remains were to be exposed by future development, this is provided for in the AUP OP under the Accidental Discovery Rule and by the archaeological provisions of the HNZPTA."

Furthermore, a desktop study based on the information provided on the AUP management layers in Auckland Council GEOMAPS has concluded that there are no identified natural heritage sites, historic heritage sites or places of significant to Mana Whenua within this PCA. However, the Warkworth Structural Plan has identified the significant value of the existing Orchard located on the Northern boundary along SH1. This orchard is going to be preserved as Morrison's Heritage Orchard within this PCA application and there will be no development proposed within this area.

2.11 CONTAMINATED LAND

Land Development & Exploration Limited have completed a Soil Contamination Preliminary Site Investigation (PSI) Report for the Western PCA area. The report concluded the following:

"Historical imagery, site observations and anecdotal information show that the site has been used primarily for dairy farming, viticulture and grazing, and more recently, lifestyle purposes. As a result, the handling and application of sprays and other hazardous materials has more than likely taken place. There has also been waste disposal to land in the form of pruning waste incineration and landfilling, as well as the bulk storage of treated timbers on bare ground, motor vehicle workshops and possible boat maintenance activities therefore we consider that **HAIL A10:** 'Persistent pesticide bulk storage or use including sport turfs, market gardens, orchards, glass houses or spray sheds', **HAIL G5:** 'Waste disposal to land (excluding where biosolids have been used as soil conditioners)', **HAL G3:** 'Landfill sites', **HAIL A18:** 'Wood treatment or preservation including the commercial use of anti-sapstain chemicals during milling, or bulk storage of treated timber outside', **HAIL F4:** 'Motor vehicle workshops', **HAIL F5:** 'Port activities including dry docks or marine vessel maintenance facilities', **HAIL H:** 'Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment', and **HAIL I:** 'Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment', are more likely than not to have occurred at the site.

LDE considers that the NES applies under Regulation 5(5) and 5(6) due to the proposed change in landuse and proposed subdivision of the site. As HAIL A10, G5, G3, A18, F4, F5, and I have been identified to have possibly occurred, or is occurring on the site, a Detailed Site Investigation (including specific site sampling) was therefore required to establish any actual human health risks associated with future land use at the site."

For the eastern portion of the PCA, a Detailed Site Investigation (DSI) done by Focus Environmental Services Ltd. The DSI report has concluded that the soil on site is suitable for retention onsite for future development. However, there are localised spot where soil contain low levels of contamination which are not suitable to classified as clean fill and need to be disposed of at suitable licensed disposal facility during the construction phrase. For more information, please refer the PSI and DSI report provided in support of the PPC application.

3 DEVELOPMENT SUMMARY AND PLANNING CONTEXT

Following the initial site appraisal through the section two of this report, the regulatory and planning requirement of the AUP will be discussed in details below

3.1 REGULATORY AND DESIGN REQUIREMENTS

In accordance with the AUP, the Auckland Council's Regulatory and design requirements are listed in Table 4, below:

Requirement	Relevant regulatory / design to follow
National Policy Statement for Freshwater Management 2020	• Ministry for the Environment
New Zealand Coastal Policy Statement 2010	• Department of Conservation
Natural resources of the Regional Policy Statement	• AUP Chapter B7
High-use stream management areas	• AUP Chapter D3
Natural Stream Management Area	• AUP Chapter D4
Significant Ecological Areas	• AUP Chapter D9
Water Quality and integrated management	• AUP Chapter E1
Discharge and Diversion	• AUP Chapter E8
High Contaminant Generating Areas	• AUP Chapter E9
Hydrological mitigation	• AUP Chapter E10
Natural Hazards and Flooding	• AUP Chapter E36
Auckland Council Regionwide Network Discharge Consent	• NDC Schedule 4
Structural Plan	• Warkworth Structural Plan (Auckland Council, 2019)
Catchment Management Plan	• Warkworth FUZ SMP (T&T, Draft 2019)
Stormwater Management Devices in the Auckland Region	• GD01 (Auckland Council, 2017)
Application of principals of water sensitive design	• GD04 (Auckland Council, 2015)

3.1.2 NETWORK DISCHARGE CONSENT

The Auckland region-wide network discharge consent (NDC) came into effect in October 2019. The NDC allows for the stormwater diversion and discharges from developments to be incorporated under Auckland Council's consent, and for stormwater infrastructure assets to be vested to Auckland Council, provided they comply with the NDC conditions. The NDC requirements for greenfield developments, relevant to the PCA, and as stipulated in the NDC Schedule 4, are:

Receiving Environment:

- Minimise the stormwater related effects of the development.
- Retain/ restore natural hydrology as far as practicable.
- Minimise the generation and discharge of contaminants (including gross stormwater pollutants and stormwater flows at source).
- Minimise temperature related effects.
- Enhance freshwater systems including streams and riparian margins.
- Minimised the location of engineered structures in streams.
- Protect the values of Significant Ecological Areas as identified in the AUP.

Water Quality:

- Treatments of impervious areas by a water quality device designed in accordance with GD01 for the relevant contaminants

Stream hydrology:

- Achieve equivalent hydrology (runoff volume, peak flow) to pre-development (grassed state) level via SMAF 1 stormwater controls.

Flooding:

- Ensure that there is sufficient capacity within the pipe networks downstream of the connection point to cater for the stormwater runoff associated with development in the 10% AEP even including incorporating flows from contributing catchments as maximum probable development by:
    - Demonstrating sufficient capacity is available including flows from the catchment at (maximum probable development) draining to the relevant pipe network in the 10% AEP event;
    - Attenuating and reducing stormwater flows and volume on-site such that there is no increase in peak flow in a 10% AEP event from the site compared to that prior to the new development. Note that any devices associated with this option will also require an operation and maintenance plan to ensure the long-term efficacy of such a system;
    - Upgrading the relevant pipe network to a size that can cater for the additional flows from the development in the 10% AEP even (taking into account existing flows from the contributing catchment); or
    - Upgrading the relevant pipe network to a size that is larger than would otherwise be required to cater for the 10% AEP event for the development, due to the need to cater for flows from the contributing catchment at maximum probable development, subject to a fair and proportionate funding agreement with Healthy Waters.
    - Building in 1% AEP event shall be in accordance with Stormwater Code of Practice.

Assets:

- All new assets that are intended to become part of the public stormwater network are to be designed and constructed to be durable and perform to the required level of service for the life of the asset, subject to reasonable asset maintenance.

3.1.3 STRUCTURE PLAN

The Warkworth Structure Plan sets out key stormwater opportunities and constraints relating to development of the structure plan area, and include:

Flooding

Constraints:

- Upstream development may increase the flood risk to existing buildings in Warkworth. If this is found to be the case, then catchment scale attenuation devices may be required to avoid increased flooding to habitable areas.
- Any new development should occur outside of the 100-year floodplain.
- Allow for conveyance of overland flow.

Opportunities:

- Protection of 100-year floodplain also provides an opportunity to enhance riparian corridors. This provides enhanced stormwater management functions, contributes to the ecological values of stream corridors and provides public amenity. Green corridors should be considered to manage the flood hazard, protect ecological values, provide amenity and for walking and cycling tracks.

Hydrological change

Constraints:

- The presence of low permeability ultic clays in the structure plan area may preclude the use of infiltration devices in some areas.
- Slope instability risk may preclude the use of infiltration devices in some areas.
- The viability of water reuse as a stormwater management tool is contingent on land use activity and will need to be assessed on a site-by-site basis.
- Opportunities:
- The structure plan area is a greenfield area which provides an opportunity to incorporate integrated stormwater management to maintain pre-development hydrology.
- Providing opportunity for on-site infiltration to improve aquifer recharge and stream baseflows.
- Providing opportunities for water reuse especially for housing and for industrial/commercial activities (depending on water demand).

Enhancing freshwater systems

Constraints:

- Permanent and intermittent streams will need to be protected.
- Riparian buffer areas around streams needs to be included. In some areas existing riparian vegetation has been classified as a terrestrial SEA and must be protected.

Opportunities:

- Water quality in the water bodies within the structure plan area is currently relatively good for an urban catchment. Use of integrated stormwater management is an opportunity to maintain or enhance water quality.
- Design stormwater management for future urban areas that provides for a high level of water quality to protect the high ecological values and good water quality present in the area.
- Use riparian margins as part of the water conveyance system and to provide connections to other freshwater systems and other habitat types.
- The change in land use from rural land to urban is an opportunity to revert to natural sedimentation loading in freshwater systems and in the harbour.
- Naturalisation of existing modified watercourses to re-develop hydraulic and habitat diversity.
- Removal/modification of artificial fish passage barriers to improve the ability of migrant fish species to access upstream habitat.
- Restoration of wetlands to help regulate stream flows and enhance ecological functions.
- Erosion and sedimentation management during development applying best practice that responses to the sensitive receiving environments and aspirations for freshwater management set out in the SMP and AUP.

3.1.4 CATCHMENT MANAGEMENT PLAN

The Warkworth Structure Plan has provided a high-level guidance on the stormwater management framework for the Warkworth area which will be relevant to the PCA. The high-level stormwater management recommendations are summaries below:

General

- Use an integrated stormwater management approach involving water sensitive design. This will involve the following components:
  - Minimise the generation of stormwater runoff and contaminants with measures such as clustering development, reducing impervious surfaces and using inert building materials.
  - Manage runoff and contaminants as close to source as possible with measures such as capture and reuse, green roofs, permeable pavements and terrestrial revegetation.
  - Use swales for stormwater conveyance where possible as an alternative to pipes and filter strips where practicable as pre-treatment to downstream treatment devices.
  - Utilising downstream treatment devices which mimic natural physical, biological and physical treatment processes.
  - Enhance the receiving environment by preserving and restoring riparian vegetation along banks, natural floodplains and wetland margins, including linking areas of riparian vegetation to create continuous green corridors.
  - Utilise existing natural systems for stormwater management function including the restoration/enhancement of wetlands
- Remove or modify artificial fish passage barriers where possible to improve the ability of migrant fish species to access upstream habitat. Water quality

- Provide near or at-source water quality treatment of runoff for high use roads and High Contaminant Generated Carparks (>30 carparks). Water quality treatment to target sediment, metals and gross pollutants.
- Use “inert” building materials, or otherwise site-specific treatment is required.
- Minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges.
- Erosion protection in the stormwater systems including discharges to streams. Consider green outfalls for discharges to streams.

Minimising and mitigating hydrological change

- Further assessment that considers the site-specific constraints of the Warkworth Structure Plan Area is required to determine how to minimise or mitigate any changes in hydrology and whether it can practicably be achieved. If there are residual impacts on streams after implementing hydrological mitigation (as per AUP section E10) then other solutions such as instream works should be considered to mitigate the effects of changes in hydrology.
- After exploring location specific options in accordance with greenfield policies and where those options are demonstrably not practical to implement, the minimum standard shall be to provide ‘hydrological mitigation’ in accordance with Table E10.6.3.1.1 of the AUP where the specific effect to be managed is in-stream erosion.
- Utilise stormwater infiltration for retention where it is possible to do so in a safe, and effective manner.
- Utilise rainfall harvesting for retention for residential buildings and industrial/commercial where there is re-use demand.

Flood management

- Use streams and their associated riparian margins to provide storage and conveyance to manage flood waters.
- Avoid locating buildings or infrastructure within the 100-year ARI modified floodplain unless it can be designed to be resilient to flood related damage.
- Ensure all development and changes within the 100-year floodplain do not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site.
- Identify overland flowpaths and ensure that they remain unobstructed and able to safely convey runoff.

3.1.5 STORMWATER MANAGEMENT DEVICES IN AUCKLAND REGION

The stormwater management devices in Auckland Region Guideline Document 001 (GD01) is developed in 2017 to replace Technical publication 10 (TP10) . GD01 provide wide range of stormwater management devices to address the stormwater detention, retention, and water quality requirement for the whole Auckland region. Those devices listed in this document is considered a best practice options for mitigating the adverse effects from the land-use and subdivision activities.

4 MANA WHENUA MATTERS

5 STAKEHOLDER ENGAGEMENT AND CONSULTATION

5.1 HEALTHY WATERS

Private plan change documentation has been provided to Healthy Waters for their feedback. Healthy water has provided initial feedback regarding this SMP. These feedbacks have been adopted to reflect on this updated revision of this SMP. The changes is listed below:

Water quality:

The water quality chapter has been revised to include a wide range contamination present in impervious area within the urban setting as per GD01.

Hydrology mitigation:

The requirement for hydrology mitigation has been revised to SMAF 1 as per Schedule 4 of the NDC.

Flooding management:

The flooding report has been revised to expand the effect to further downstream with consideration to other reach located further downstream. Overall, the flood modelling report has been revised as per the comments from the initial feedback.

Stormwater management approach:

The SMP has been updated with the preference of using Wetland as the main stormwater management devices where practically possible.

Overall, the applicant is committed to working with Healthy Water to achieve the best possible outcome and one that it is consistent with HW's expectations. On-going consultation will be carried out with Healthy Water to ensure that the SMP meet HW's expectation.

5.2 IWI CONSULTATION

Various iwi groups have been contacted for providing feedback toward this SMP. The consultation process is on-going. And this chapter will be updated accordingly.

6 PROPOSED DEVELOPMENT

KA Waimanawa Limited Partnership and Stepping Towards Far Ltd are applying to rezone the proposed Warkworth South PCA from the current FUZ to a mixture of residential, commercial and open space zones. The total dwellings forecasted for this plan change is approximately 1400 HUE to 2000 HUE. For the purpose of the Plan Change and infrastructural assessments, a yield of 2000 HUEs has been used as the baseline equivalent for modelling purposes.

The land zoning is generally in accordance with the Warkworth Structure Plan which was approved by Auckland Council in 2019. The final residential yield for this PCA is subject to market drivers and resource consents to Auckland Council. The proposed development comprises the PCA shown in Figure 2 and discussed in detail within Section 2. This section of the report summarises the planned future development in the PCA, particularly as it relates to stormwater management.

6.1 PROPOSED REZONING INFORMATION

The proposed plan change is considered a greenfield development as the proposal entails changing the existing zoning from FUZ to a combination of residential, commercial, and open space zonings. The conceptual design is shown in Figure 16 and summarised below:

- A local centre at the heart of the PCA abutting SH1 with multiple transports modes and options.
- A major park with multiple recreational sporting options and various smaller parks throughout the PCA
- Various drainage reserves created to cater for the stormwater mitigation and management.
- The creation of Morrison's Heritage Orchard which was identified by the Warkworth Structure Plan.
- Medium density THAB zoning to allow for apartments or terrace houses adjacent to the proposed Town Centre and amenities.
- MHU zone within the walking distance to the Town Centre.
- MHS zone at the outskirts of the PCA; and
- Large lot/ lifestyle blocks/ single house zone in the highlands (stepper areas) of the PCA.

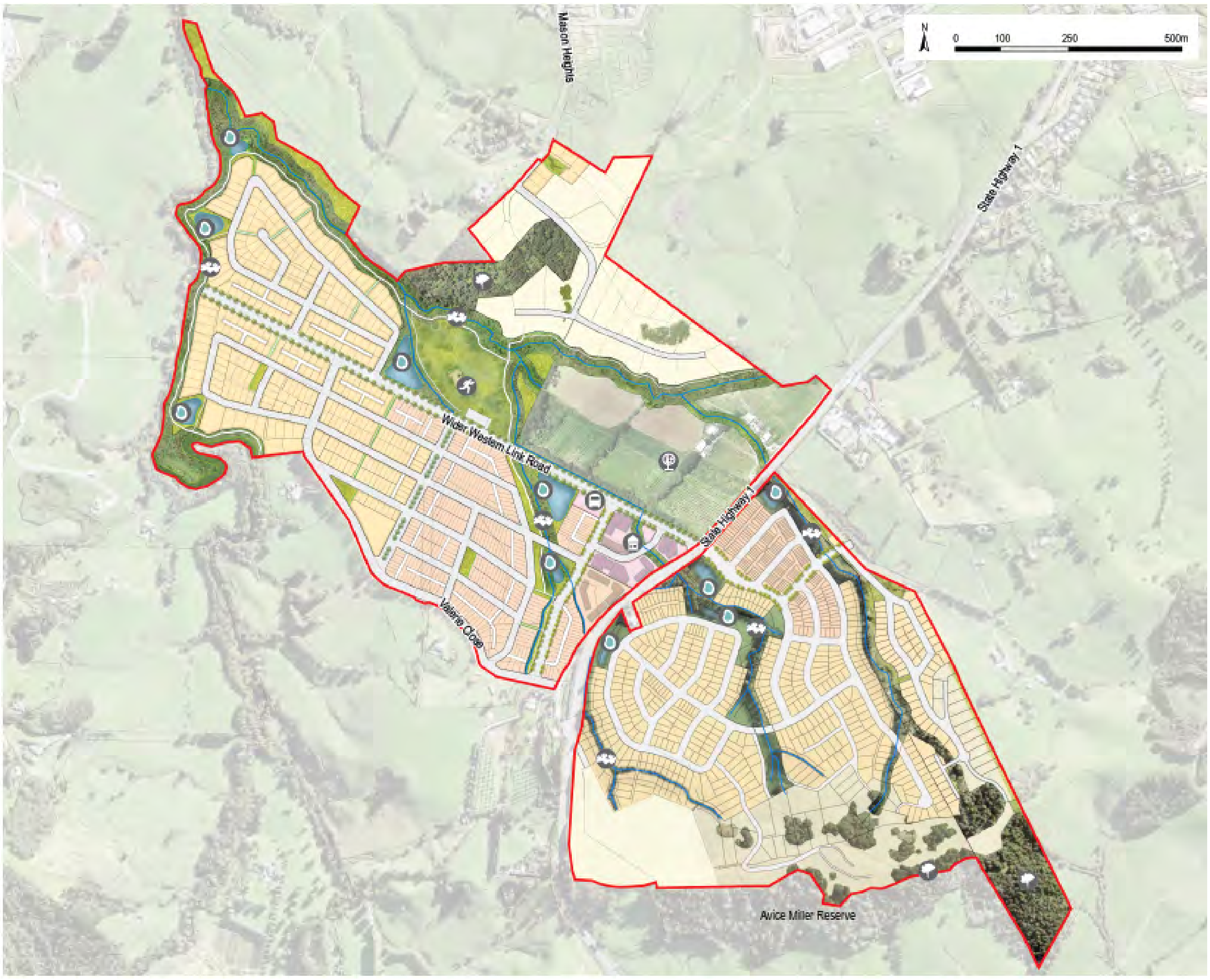


Figure 16: Proposed Development Overview

6.2 SITE LAYOUT AND URBAN FORM

The proposed layout of Waimanawa Valley and Waimanawa Hill are shown in Figure 17 & 18, below:

Figure 17: Proposed Waimanawa Valley Development Overview

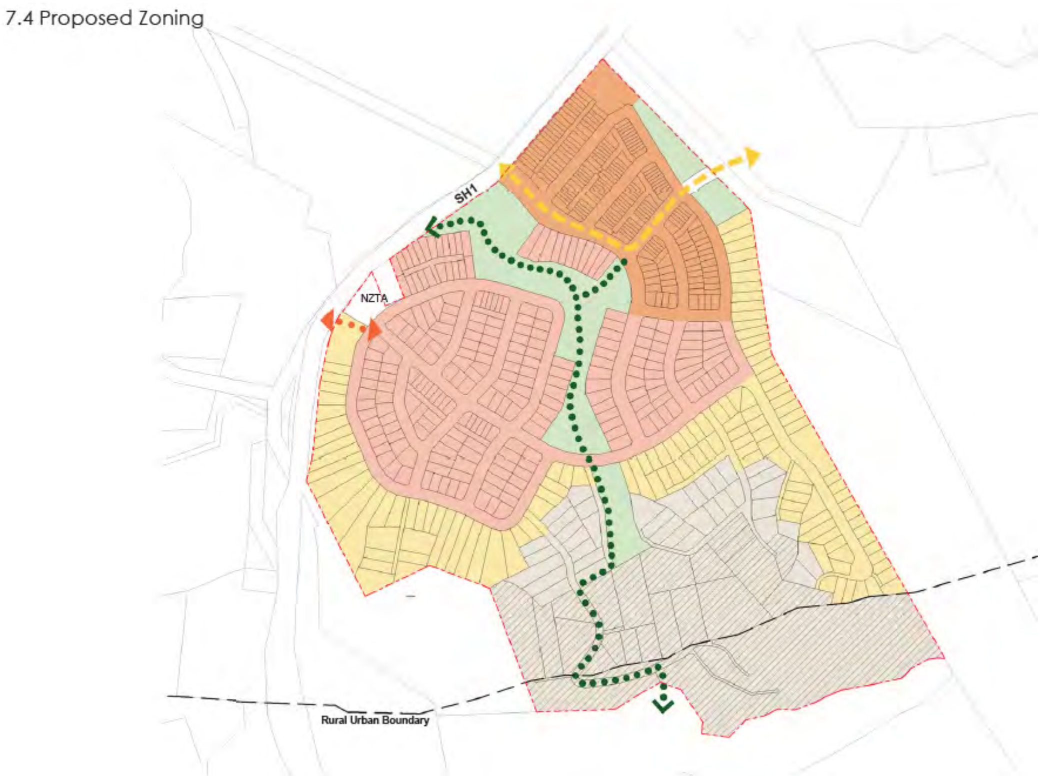


Figure 18: Proposed Waimanawa Hill Development Overview

The urban form of the PCA has been developed around Water Sensitive Urban Design (WSUD) principles. Substantial areas have been reserved for stormwater drainage reserves and stream riparian yards which is consistent with the Warkworth Structure Plan layout (refer to Figure 19 below for comparison). The wetlands are strategically located within the low points of the catchments to provided treatment to the stormwater run-off prior to discharge into the receiving environment.

Figure 19: Warkworth Structure Plan blue & green corridors

6.3 EARTHWORKS

An infrastructure report has been prepared to support this plan change application. A preliminary earthworks modal is developed for the plan change area to indicate the volume of enable earthworks required to provide a suitable building platform and the roading networks servicing the plan change area.

The preliminary earthworks design has taken the following into consideration:

- Ex permanent and intermittent streams and associated riparian yards.
- The northern side of watercourses 19 & 23.
- The Morrison's Heritage Orchard.
- The southern ridgeline abutting Avice Miller Scenic Reserve.

See appended Earthworks Plans for further details. Proposed earthworks volumes are tabled below:

Site Area	164.0 Ha
Earthworks Area	81.3 Ha
Cut Volume	355,000 m^3
Fill	444,000 m^3

All major overland flow paths / Watercourse within the greater PCA site are to be maintained. A number of lesser overland flow path will be modified / redirected to enable the proposed plan change layout and enable key features outlined in the Structure plan such as the collector road. The detail design of these engineered overland flow paths will be provided at the resource consent stage.

Future resource consents will require erosion and sediment control measures to be implemented and maintained in accordance with the approved Engineering Drawings.

Silt control measures will need to be installed onsite prior to or during (as specified) earthworks commencement. All silt control measures will be checked and confirmed acceptable by the Engineer and relevant council compliance and monitoring specialists before relevant earthworks commence.

The site will be progressively stabilised as areas of earthworks are completed. Erosion and sediment control measures will be maintained in accordance with the Engineering Drawings.

6.4 POST DEVELOPMENT CATCHMENT PLAN

A comprehensive post-development catchment plan has been formulated for the plan change area, considering the existing topography of the site and identifying the essential infrastructure needed for feasible development. It is important to note that this post-development catchment plan is based on a desktop analysis of the proposed masterplan, which is subject to alteration during resources consent design and processing.

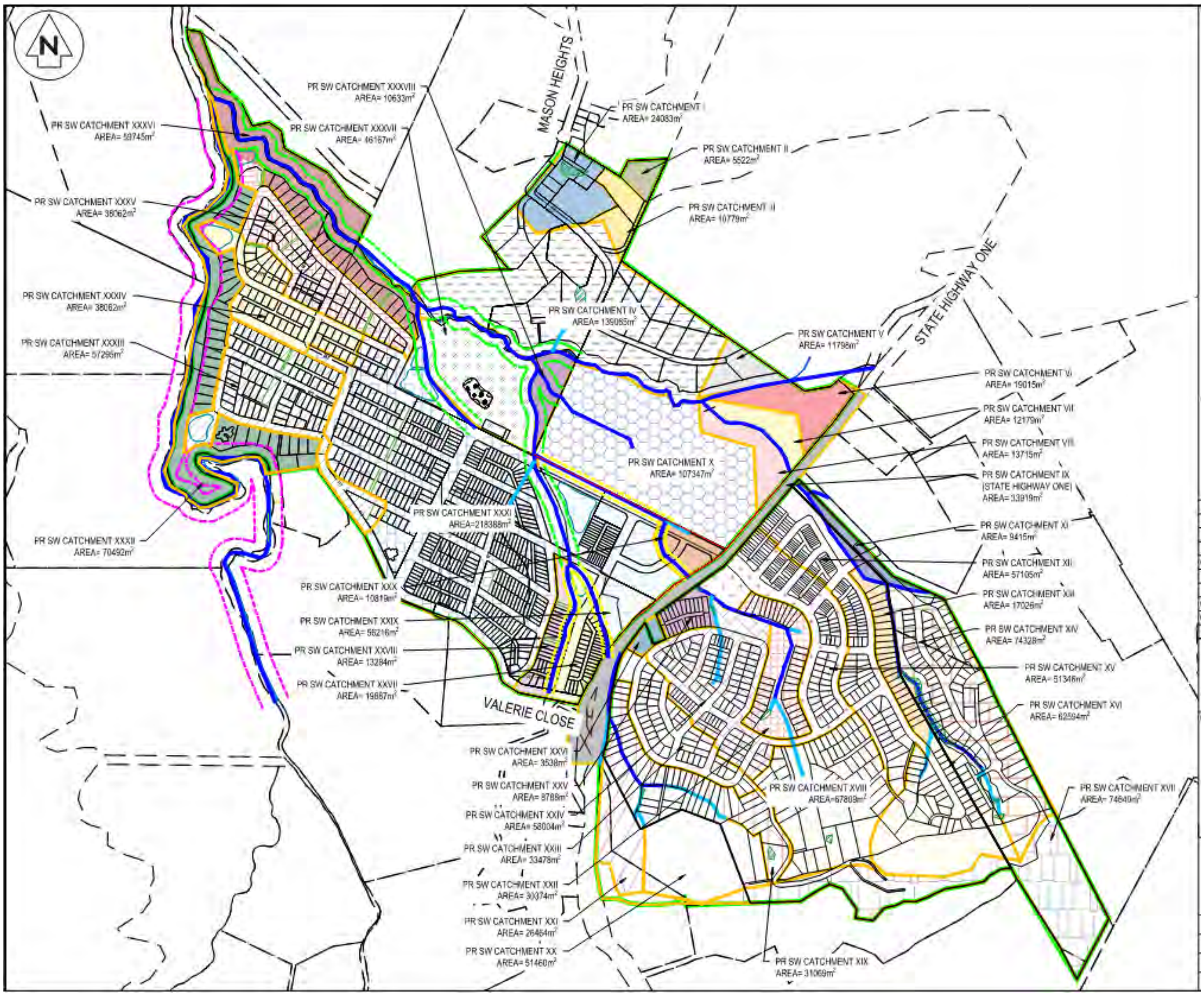


Figure 20: Preliminary Post development Catchment Plan

The plan change area consists of a total of approximately 38 post-development catchment areas, which can be further categorized into four main zones: Stormwater Management Zone A, B, C, and D. These zones have distinct characteristics and considerations.

Stormwater Management Zone A is characterised by post-development catchment areas with predominantly flat to gentle slopes, making them highly suitable for wetland construction. Within this zone, the specific post development catchment areas included are XII, XV, XXIV, XXVII, XXIX, XXXI, XXXIII, XXXIV, and XXXV. Additionally, Stormwater Management Zone A is further divided into two sub-zones: Sub-zone A-1, which pertains to the Waimanawa Valley Precinct, and Sub-zone A-2, designated for the Waimanawa Hills Precincts.

Stormwater Management Zone B encompasses catchment areas that are typically situated in highland areas with steeper slopes or fragmented catchments near existing streams. These areas are not suitable for large communal stormwater devices. Instead, it is recommended to manage stormwater at the source through a Best Practice Option (BPO) approach to quality treatment. The post-development catchment areas falling within Zone B include I-V, XI, XIII-XIV, XVI-XXIII, XXV-XXVI, XXVIII, XXX, XXXII, and XXXVI. Due to the scattered distribution of post-development catchments within this zone, Stormwater Management Zone B is further divided into five sub-zones.

Stormwater Management Zone C encompasses the catchments of Morrison Orchard and the open space area. The Morrison Orchard is designated as a proposed heritage site, and its land use and activities are expected to remain largely unchanged. The open space area will primarily consist of green spaces, with minimal increases in impervious areas. While these catchments are still subject to water quality and hydraulic mitigation requirements outlined in this SMP, the relatively small and minor increase in impervious areas suggests that smaller at source devices provide for their management in a Best Practice Option (BPO) approach. The catchments within Stormwater Management Zone C include VI-VIII, X, XXXVIII, and XXXVII.

Stormwater Management Zone D is specifically designated for the section of State Highway one that traverses through the plan change area. Currently, this highway section cuts across multiple existing stormwater catchment areas and has its own established stormwater network that discharges into various existing streams. As this section of State Highway one is expected to undergo urbanisation and upgrade to an arterial road, it is important to note that the discharge locations remain fixed, and significant changes to the road's vertical alignment are not anticipated. Consequently, there is no opportunity to introduce wetlands or bulk management devices within this area. To meet the objectives outlined in this SMP, it is recommended to utilise smaller at source devices providing treatment and stormwater mitigation at source as preferable treatment measures as a BPO. Stormwater Management Zone D only encompasses the post-development catchment IX.

Please refer to the Figure below for a visual representation of the stormwater management zone area.

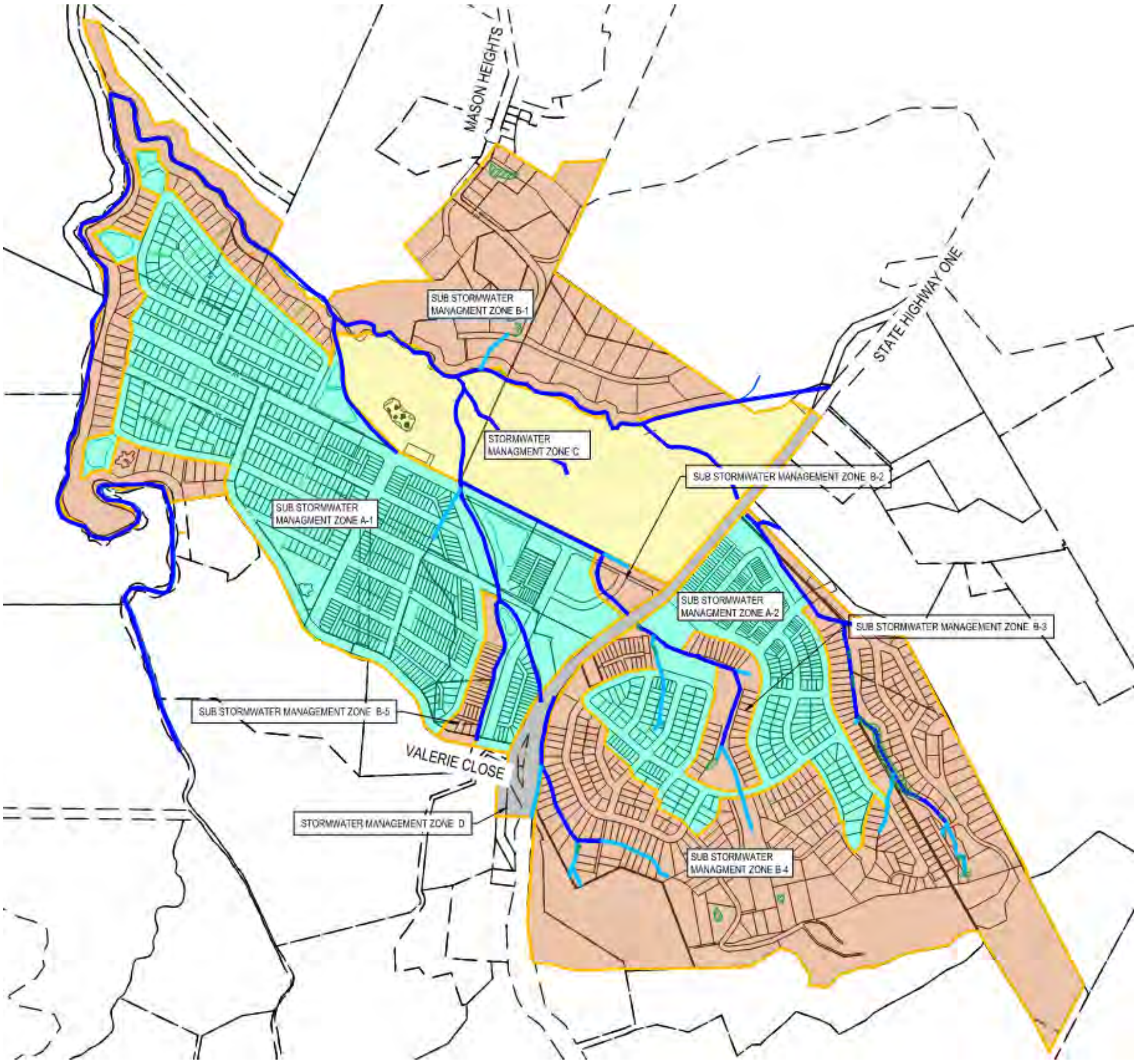


Figure 21: Post Development Catchment Management Zone Plan

A thorough desktop analysis of each post-development catchment plan has been conducted to determine the appropriate classification of each catchment area into its respective stormwater management zone. This analysis provides detailed information and justification for the placement of each catchment within the designated zones A through D. Please refer to Appenedix E for more information.

7 STORMWATER MANAGEMENT

The post development stormwater management plan is presented and discussed within this section of the report. This SMP has been developed in accordance with relevant policies and regulatory requirements. The stormwater management techniques are considered to provide the best practice options (BPO) whilst providing a flexible framework for interdisciplinary planning for an integrated stormwater management approach.

7.1 PRINCIPLES OF STORMWATER MANAGEMENT

7.1.1 ORIGINAL PRINCIPLES

The stormwater management principles present below are consistent with the site-specific constraints & opportunities, AUP policies and the networks discharge consent.

The stormwater management frameworks for this plan change pursues:

- Water Quality –
  - Treatment of all impervious areas by a water quality device designed in accordance with GD01/TP 10 for the relevant contaminants.

Or

  - An alternative level of mitigation determined through a SMP that:
    - applies an Integrated Stormwater Management Approach (as per above);
    - meets the NDC Objectives and Outcomes in Schedule 2; and
    - is considered the BPO.

- <u>Frequent Rain Event Management</u> – Hydrology mitigation in accordance with the Stormwater Management for Flow Area 1 provisions as defined in Chapter E10 of the AUP(OP).
- <u>Conveyance</u> – Provide a stormwater network to convey runoff generated from the 10% AEP event from the development and convey this to the receiving environment. Where this network is proposed to be vested with the Auckland Council, the network should be designed in accordance with the requirements set out in the SWCoP.
- <u>Overland Flow Management</u> – Natural overland flowpaths are to be retained and improved where practical in the developed scenario. Flowpaths through development sites will be required to be incorporated into the final landform with the improvement of flood storage and conveyance. So that flooding does not to pose a risk to property or people. Flowpaths will also be protected and kept free from obstruction. Similar to flow attenuation, where alterations are made to the overland flowpath as a result of earthworks, it will be necessary for the developer to demonstrate no negative impacts are caused by the proposed changes.
- <u>Floodplain Management</u> – The management of the floodplain will be provided through the provisions contained within the AUP(OP). No vulnerable activities will be allowed within the floodplain (unless suitably mitigated) and general levels of development will be kept to a minimum in such areas. It is noted that the existing landform may subject to change, to suite the development layout. Although development must demonstrate that any change will not have any adverse effect.

- Flood mitigation: - adopting pass forward flow approach with no hydrology mitigation proposed beyond SMAF 1 requirement listed above.
- Receiving Environment – To provide protection to and promotion of the receiving environment.
- Residential Zones:

– Consideration of catchment wide approach, which could include, but is not limited to the following solutions:

  - Wetlands at end of catchment

or

– Consideration of lot-based application of WSUD where catchment wide approach is not possible, which could include, but is not limited to the following solutions:

  - Reuse tanks for roof water.
  - Bioretention devices for trafficable and impervious area

- Roads – No additional requirements or considerations above the minimum set out (above).

The SMP ensures compliance with the NDC Schedule 4 requirements for Greenfield developments, these requirements are listed in Table 2 in section 6.2.1 and form the outcomes sought by the stormwater management strategy. The stormwater strategy developed for the site demonstrates the overarching principles of how stormwater is to be managed within the development, as required by the regional NDC. The stormwater management proposed for the site generally aligns with the concept of a Water Sensitive Design.
The strategy for the stormwater management is outcome focused. The stormwater management plan provides a solution-based approach for the receiving environment. The plan sets up a clear process to mitigate the effects on the receiving environment, which is the Mahurangi River - located immediate downstream of the development.

Maven Associates believes the proposed stormwater strategy ensures the proposed outcomes are consistent with Schedule 4 of the regional NDC and relevant mana whenua values.

7.1.2 UPDATED PRINCIPLES

*****Not applicable within this SMP version***’**

7.2 PROPOSED STORMWATER MANAGEMENT

7.2.1 GENERAL

The water quality, conveyance, hydrological and flood mitigation outcomes are consistent throughout the PCA. The key outcomes are listed below:

Water quality:

Mitigating the contamination generated from land-use activity via the use of water quality treatment devices designed in accordance with council guidelines, best practice, or the relevant device specification.

The preferred treatment devices will be an end of catchment bulk treatment device such as a wetland to provide full water quality treatment for the catchment wide with exception of any areas not able to be served/captured by strategically located wetland.

A high-level review of the potential post development catchment areas has been developed to sort catchments where wetland is the preferred stormwater management device from catchment where a BPO approach to managing stormwater outcomes is recommended. Refer to Appendix E for more information.

Stream hydrology mitigation:

- Provide SMAF-1 hydrological control to mitigate ongoing hydrological effects to Watercourse

Flooding:

- Overland flow paths (secondary systems) shall be designed with sufficient capacity to accommodate the 1% AEP event for the MPD/adjusted climate change scenario.
- Utilising the existing intermittent and permanent stream riparian yards for the storage and conveyance of the 100-year flows.
- Proposed buildings shall be clear of the flooding hazards and designed in accordance with stormwater code of practice.

Assets:

- All new public stormwater networks (primary systems) shall be designed to accommodate the 10% AEP event (incl. MPD and climate change) in accordance with stormwater code of practice.

Receiving Environment:

- Enhancing the riparian margin planting and overall health of the existing streams.
- Removing redundant culverts and in stream obstructions to restore fish passage through the PCA.
- Minimise were possible hard engineering structures within existing streams and provide integrated fish ladder designs into any structures that remain where of ecological benefit.
- Safeguarding the Significant Ecological Areas immediately downstream of the PCA

7.2.2 WATER SENSITIVE DESIGN

The key principals of water sensitive design approach can be implemented to the stormwater management framework for this PCA as shown below:

Promoting inter-disciplinary planning and design, through:

- Water sensitive urban design workshops were undertaken early with other consultants to develop a master plan based around core WSUD outcomes.
- Developing the BPO toolbox and circulate the BPO toolbox with other consultants for feedback to refine the BPO toolbox for resource consent applications.
- Undertake consultation with Iwi and Healthy Waters and integrate this feedback into the SMP.

Protect and enhance the values and functions of natural ecosystems, by:

- Promoting and adopting the blue-green networks throughout the PCA.
- Protecting and enhancing the riparian planting of the existing streams within the PCA.
- Removal of barrier to fish passage.
- Incorporate fish ladder designs within instream structures that need to be retained/provided.

Address stormwater effects as close to source as possible, through the inclusion of:

- Prevention of contamination via the use of inert building materials, and private proprietary stormwater treatment devices for privately own high contaminant carparks and COALs.
- For high use roads, the stormwater treatment devices will be located at source, where possible.
- Design wetlands to be located at the downstream of catchments (where practical/possible) to mitigate the effect of the stormwater prior to discharge into the receiving environment.
- Where catchment wide treatment is not feasible, adopting at source or smaller stormwater treatment devices to mitigate the effect of the stormwater prior to discharge into the receiving environment.

Mimic natural systems and processes for stormwater management by:

- Restoring and enhancing the riparian planting to improve the natural hydrological function of the existing streams.
- Design stormwater devices and green infrastructure that provides infiltration where practical/possible.

7.2.3 WATER QUALITY

The change of land-use from rural to residential has the potential to increase the adverse effects on the receiving environment through contamination, if left unmitigated. The common contaminations that can generated from residential areas are listed below:

- Heavy metals
- Oil & grease
- Temperature
- Sediment and suspend solid
- Indicative bacteria
- Nutrients

The proposed strategy will incorporate a WSUD approach focusing on reducing or eliminating stormwater contaminates through source control, using stormwater treatment devices consistent with Auckland Council guidelines such as GD01, GD04 and GD05. The water quality principals of this SMP targets the mitigation of all contamination generated from land-use activities. This can be achieved with stormwater quality treatment devices developed through guidance of GD01 & GD05. Please refer to Tables below for each respect Stormwater management Zone.

Table 7: Water quality treatment toolbox within the PCA for Stormwater Management Zone A

Stormwater Devices Toolbox for Water Quality		
Activity	Water quality treatment target	Recommended devices
Residential communal car park or COAL	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland

Residential and commercial roof area	• Metal from roofing material • Organic debris from natural sources	• Catchment wide stormwater management device ➢ Wetland
High contaminant generating car park	• Heavy metal, grease, and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland
Public local Road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland
High use road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Catchment wide stormwater management device ➢ Wetland
Stormwater run-off from any communal waste storage areas in apartment and multi-unit development	• Indicative bacteria • Nutrients	• Catchment wide stormwater management device ➢ Wetland
Earthworks	Mitigate the sediment generated from earthworks	Provide sediment and erosion control in accordance with GD05: • Decant earth bund • Sediment retention pond • Silt fence • Water diversion bund • Filter socks • Stabilised vehicle entrance • Wheel wash station • Chemical Treatment

Table 8: Water quality treatment toolbox within the PCA for Stormwater Management Zone B,C,D

Stormwater Devices Toolbox for Water Quality		
Activity	Water quality treatment target	Recommended devices
Residential communal car park and COAL	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Bioretention devices for private lot ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit ➢ Planter box

		Proprietary treatment devices
Residential and commercial roof area	• Metal from roofing material • Organic debris from natural sources	• Living roof • Planter box • Tree pit • Rain garden
High contaminant generating car park	• Heavy metal, grease, and oil • Suspended solid removal • Water Temperature	• Bioretention devices: ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit • Proprietary treatment devices if located in private land
Public local Road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Bioretention devices at source ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit
High use road	• Heavy metal, grease and oil • Suspended solid removal • Water Temperature	• Provide at sources treatment Bioretention devices: ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit
Stormwater run-off from any communal waste storage areas in apartment and multi-unit development	• Indicative bacteria • Nutrients	• Provide at sources treatment Bioretention devices: ➢ Rain gardens ➢ Grass or vegetated swales ➢ Stormwater tree pit ➢ Planter box • Proprietary treatment devices if located in private land
Earthworks	Mitigate the sediment generated from earthworks	Provide sediment and erosion control in accordance with GD05: • Decant earth bund • Sediment retention pond • Silt fence • Water diversion bund • Filter socks • Stabilised vehicle entrance • Wheel wash station • Chemical Treatment

7.2.4 WATER QUANTITY

The intended urbanisation of the PCA will increase the impervious area which will increase stormwater runoff (both flow rates and volume). The existing impervious area of catchments within the PCA ranges from 0-5%. The post development impervious area will be increased to a range between 30 to 70%.

The water quantity principals of this SMP have proposed to pass forward flow for the 10 year and 100 year events. The SMP area will only provide hydrological mitigation for stream protection. Any rainfall event larger than the SMAF 1 event will not be detained. This approach is discussed further in the flood management chapter (7.2.5).

High level TP108 calculations have identified the hydrological mitigation volume required in post development scenarios for the PCA. Detailed values will be provided at resource consent stage(s) when the final layout has been confirmed. Table 8 outlines the high-level mitigation volume required for each catchment:

Catchment	SMAF1 Detention (m^3)
2	1516
3	7706
4	3143
6	1319
7	363
8	293

Table 9: Post development hydrological mitigation volume required for the PCA

Notes:

- The preliminary geotechnical investigation report has identified that there is limited infiltration on site. Hence the retention volume as per SMAF1 requirement has been added to the detention volume.
- The post development impervious area of catchments 1,5 & 9 are only increased a small fraction with the increase in volume and peak flow rate being negligible. The actual calculations will be provided at resource consent stage(s), as required. All new impervious areas within these catchments will required to meet the SMP objectives in terms of water quality and hydrological mitigation.

7.2.4.1 Hydrological mitigation

As mentioned in the early chapter of this Report, the Warkworth Township is subject to the SMAF 1 control. Given the PCA is located upstream of Warkworth and discharges directly to the southern branches of the

Mahurangi River. It is considered important to provide hydrology mitigation (as per SMAF 1) to mitigate the effect of lesser and more frequent storm events on the downstream stream erosion.

Consistent with the requirement of E10: Stormwater Management Area of AUP, the stormwater hydrological control on site will be as below:

Retention:

- Due to geotechnical/geological constraints, it has been recommended that no ground disposal/infiltration devices are included in the stormwater management plan. As such, the only likely cases where retention (greywater reuse) will be practical will be in any area not served by catchment-wide management devices (Wetlands) and at source management devices required, in accordance with AUP E10 requirements.

Detention:

- Provide detention (temporary storage) and a drain down period of 24 hours for the difference between the predevelopment and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus any retention volume that is achieved, over the impervious area for which hydrology mitigation is required.

A toolbox of hydraulic mitigation devices has been developed for the PCA to meet the stormwater hydraulic mitigation for each stormwater management zone as listed below:

Table 10: Hydrological mitigation device toolbox within the PCA for stormwater management zone A

Activity	Recommended Devices for Hydrological Mitigation
Residential communal car park and COAL	• Catchment-wide management devices ➢ Wetland
Residential and commercial roof area	• Catchment-wide management devices ➢ Wetland
Public Road	• Catchment-wide management devices ➢ Wetland

Table 11: Hydrological mitigation device toolbox within the PCA for stormwater management zone B,C,D

Activity	Recommended Devices for Hydrological Mitigation
Residential communal car park and COAL	• At source management devices ➢ Bioretention devices ➢ Detention tank
Residential and commercial roof area	• At source management devices ➢ Bioretention devices ➢ Retention/ reuse tank
Public Road	• At source management devices ➢ Bioretention devices

The SMP for the Warkworth Structure Plan has indicated that infiltration may be challenging for some areas of Warkworth. Preliminary geotechnical investigation and soakage tests has been carried out on the PCA. Please refer to the geotechnical report for more information. Based on the finding today, the soakage ability of the site is low. There are opportunity for ground infiltration. However, it is limited to a few pocket on the PCA. This will ultimately need to be confirmed by via geotechnical investigation and recommendation at resource consent stage. E10 of AUP has provided an alternative solution for location where soakage is not an option to meet the retention requirement under the SMAF control:

- *A suitably qualified person has confirmed that soil infiltration rates are less than 2mm/hr or there is no area on the site of sufficient size to accommodate all required infiltration that is free of geotechnical limitations (including slope, setback from infrastructure, building structures or boundaries and water table depth); and*
- *Rainwater reuse is not available because:*
  - *(i) The quality of the stormwater runoff is not suitable for on-site reuse (i.e. for non-potable water supply, garden/crop irrigation or toilet flushing); or*
  - *(ii) There are no activities occurring on the site that can re-use the full 5mm retention volume of water.*
- *The retention volume can be taken up by detention as follows:*
  - *(i) Provide detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post development runoff volumes from the 95th percentile (SMAF 1) / 90th percentile (SMAF 2), 24 hour rainfall event minus any retention volume that is achieved, over the impervious area for which hydrology mitigation is required.*

7.2.4.2 Riparian Planting

Planting of riparian margins assists in evapotranspiration and infiltration improving ground water retention and stream health within the PCA. Riparian planting is a key player of the water cycle progress, planting initiates the natural water intake and infiltration through tree roots, promotes the water evaporation through tree leaves, protects the stream banks via tree roots and slows down the water velocity via the obstruction of flow, enhancing the water quality by absorbing the nutrients and heavy metals within the stormwater run-off while enhancing the eco system via the planting of native trees. As such these key measurements are proposed for the PCA:

- Minimum of 10m riparian planting required along the permanent streams and wetlands.
- Provide for and enhance riparian planting along intermediate streams & overland flow paths where possible.
- Stormwater outfall structures to be design in accordance with Auckland Council Technical Report 2013/018 - Hydraulic Energy Management.
- Promote the use of indigenous species for the riparian yard planting

Within the extent of this PCA there are various permanent streams, intermediate streams, and natural wetlands. Through a multiple discipline design approach, these natural assets will be preserved and enhanced to achieve improved freshwater and amenities outcome.

7.2.5 FLOODING MANAGEMENT

7.2.5.1 Downstream flooding management

There is risk of flooding downstream properties located in low-lying areas in the Mahurangi Catchment. The PCA is located in the middle of the Mahurangi Catchment. As a result, the peak run-off generated during large storm events has a lag from the upstream catchment compared to peak run-off generated from the PCA. This lag of peak run-off flow is presented in the Flood Modelling report in Appendix D.

Further flood modelling has been carried out to assess the impact to the down stream flood risk which is included in the Flood modelling report. In accordance with the flood modelling report passing forward the stormwater run-off from the PCA will not generate any adverse effect the downstream flooding. Please refer to an overlay of the pre to post hydrograph below for more information, in summary, increased time of concentration pushes PCA flows (yellow on graph) ahead of upstream flows (green, magenta) visible through the slight deviation ahead of an equivalent peak flow (in blue) within Figure 20.

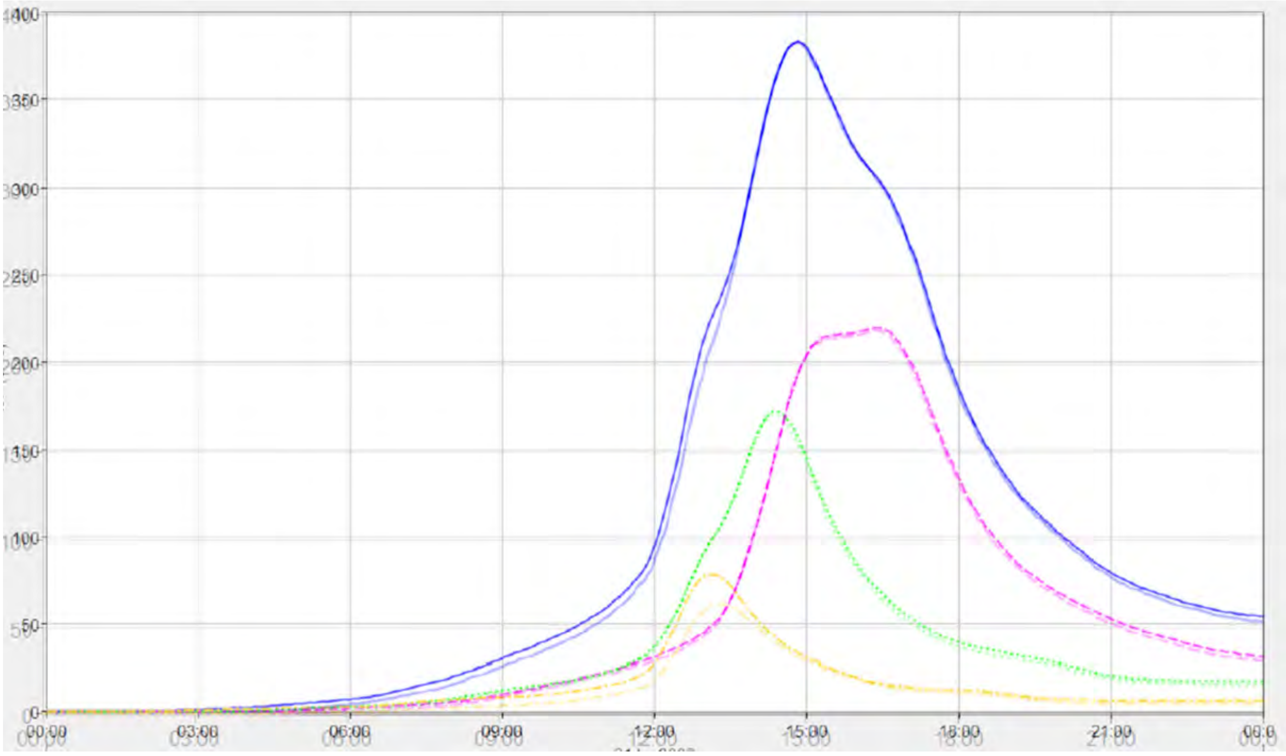


Figure 22: The Pre & Post Development Hydrograph overlay (faint line is pre-dev hydrograph)

It is therefore crucial to pass forward the stormwater generated from this site to mitigate the known risk of flooding downstream. Any attenuation of PCA flows will otherwise coincide with the large stormwater run-off generated from the upstream of the PCA and would amplify any existing downstream flooding issues.

The passing forward of the post-development 100-year flows is the primary tool for managing downstream flood risk in the wider catchment.

Another key recommendation from the flood modelling report is the recommendation to not provide any mitigation for the 10-year rainfall event. Attenuation of the 10-year storm event potentially delays the peak flow coinciding with upstream flows, similarly to the 1% AEP events, potentially causing adverse effect to the downstream environment.

7.2.5.2 Onsite flood management

The PCA has a network of major overland flow paths and extensive flood plain areas. This on-site constraint has been considered within the precinct and zoning plans developed for the PCA. Flood risks will be avoided within the PCA through the following recommendations:

- All building platforms to be located outside of the flood plain extent in the 100-year ARI MPD with climate change scenario.

- A minimum floor level will be set for each dwelling in accordance with Building Code and Auckland's Stormwater Code of Practice.
- Infrastructure to be located outside of the 100-year flood plain area, unless designed to be flood resilient.
- A networks of secondary flow paths will be designed to convey future 100-year flows.
- Utilising stream margins as areas of flood storage in the 100-year storm event.

7.2.6 CONVEYANCE

The stormwater run-off generated from within the PCA will be conveyed via primary and secondary stormwater systems. These systems will be designed in accordance with the current Stormwater Code of Practice.

The primary stormwater system:

This system consists of mainly manmade assets such as road kerbs, catchpits, manholes and pipes. This system will be designed to convey the stormwater runoff generated for and up to a 10-year storm event. The water runoff will be collected from each sub-catchment from the road catchpits and lot connections and conveyed to the water quality devices at the end of each catchment prior to discharge towards the existing stream networks/ secondary flow paths.

The secondary stormwater system:

The secondary stormwater system will consist of man-made assets such as roading networks, engineering swales and overland flow path discharging to naturally occurring conveyance means; the existing stream networks located throughout the PCA.

This system will be designed with the capacity to convey the run-off generated from the PCA in storm event up to the 100 year ARI. The existing stream networks on site will be investigated and improve (removing in stream structures/obstructions) to ensure there is adequate capacity in the 100 year ARI, for the MPD include climate change scenario.

The secondary flow path will be in large consistent with the existing over land flow path route located on the PCA extent.

7.2.7 DEVELOPMENT STAGING

*****To be addressed at Resource Consent stage*****

7.3 HYDRAULIC CONNECTIVITY

*****To be addressed at Resource Consent stage***'**

7.4 ASSET OWNERSHIP

All proposed public stormwater networks & management devices within land, road or park reserves will be vested to, owned and maintained by Auckland Council or the relevant CCO (Healthy Waters, Auckland Transport).

All stormwater management devices in the public road reserve shall be vested to, owned and maintained by Auckland Transport.

Stormwater devices treating JOALs are to be owned and maintained by Body Corporates/Resident Associations or Lot owners.

All public roadways and related assets within public reserves will be owned by Auckland Transport.

7.5 ONGOING MAINTENANCE REQUIREMENTS

All public stormwater extensions at the site, pipes and manholes forming the extent there of, are to be maintained by Auckland Council. All private devices are to be maintained by related Body Corporates/Resident Associations or lot owners.

It is proposed that all stormwater devices proposed are proprietary systems that have documented operation and maintenance schedules and plans for such activities.

Operation and maintenance plans will be provided for all stormwater management devices that will be vested with Council. This will be required as a condition of any approved consent.

7.6 IMPLEMENTATION OF STORMWATER NETWORK

It is expected that the new stormwater network will be constructed progressively as the PCA is developed, catchment wide stormwater devices will be required to be built at the cost of the developer, ensuring the device is able to cater or be developed to serve the full MPD catchment. Provisions on protecting the downstream network shall be met through implementing temporary sediment and erosion controls to ensure stormwater discharge is properly treated and discharged during construction.

The methodology for implementation of the proposed networks are as follows:

- Bulk Earthworks completed.
- Construction/relocation of public stormwater/wastewater infrastructure.
- Construction of private drainage under accessways.
- Stabilisation of the site and construction of accessways.
- Vesting of newly constructed public drainage assets.
- Construction of residential dwellings and associated private drainage.

The specific design and implementation of the stormwater network and associated devices will be subject to detailed design at future resource consent stages. The details of which will be included in future SMPs that will be required in support of the resource consent(s). This SMP sets out the high-level framework for the PCA, of which any future SMP will adhere too.

7.7 DEPENDENCIES

*****Not applicable within this SMP*****

7.8 RISKS

Table 10: Risk Matrix for the PCA

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	What other management / mitigation could be used?	When does this risk need to be addressed?	What is the resultant level of risk?
Passing forward the 100- & 10-years flood flow which may inundate downstream property	Working closely with Healthy Water flood modelling team to verify the finding and recommendation of pass forward flow	Detention ponds for up to 100 years, however, if this may have a negative impact to the flooding downstream if the time of concentration is as per the flood modelling report finding.	Plan change stage	moderate
The effectiveness of downstream stream erosion protection	Detail stream bank investigation to ensure that existing stream has adequate capacity and there is no known risk of erosion	SMAF 1 hydrological mitigation will provide stream erosion protection on the frequent rainfall event which has been detailed in the chapter 7.2.4.1.	Through the implementation of this SMP	moderate
The possibility of ground infiltration on the PCA	Detail ground soakage testing through the PCA	n/a	Plan change stage and detail investigation at resources consent stage	low
The ground stabilities due to the use of ground soakage devices	Detail site geotechnical investigation	n/a	Plan change stage and detail investigation at resources consent stage	low
The water quality discharge from the plan change area does not meet NDC requirement	Implementing the water quality treatment guidelines as set out in chapter 7.2.3 of this SMP. This will ensure that the water quality discharge from the plan	Promoting the water quality treatment train and water sensitive design throughout all phrases of the development	Through the implementation of this SMP	Low

	change area meet the design criteria from NDC.			
Riparian planting fails to thrive and damaged during large storm event	Promote the use of indigenous plant species to be used for the riparian planting to ensure survival rate of the riparian planting. Ensure a maintenance plan is put in place for annual survey and maintenance the riparian yard planting or after a large storm event	n/a	Plan change stage where the principal has been set and resources consent stage when the development layout has been confirmed.	Low
Existing natural stream will be polluted with rubbish and illegal dumping	Provide workshop with the local residents to promote a sense of guardianship toward natural resources	n/a	Through out all phrases of development	Low
An increase in provision for climate change due to revision of the Stormwater Code of Practice (SWCoP)	Working closely with Healthy Waters flood modelling team to analyse the findings of revised modelling and adopt a new management strategy if required.	n/a	If the SWCoP is revised	Low

8 DEPARTURES FROM REGULATORY OR DESIGN CODES

There are no known departures from Auckland regulatory and design standards.

9 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

9.1 CONCLUSIONS

This SMP for the Warkworth South PCA has been developed based on AUP regulatory policies, Auckland Council stormwater-specific guidelines and the overarching NDC requirements.

The overarching principle of the SMP is to implement an integrated stormwater management approach, which includes:

- Recognising the key constraints and opportunities on site and wider Mahurangi catchment.
- Devising an integrated stormwater management approach to facilitate urban development and optimise available land.
- Emphasising a water-sensitive design approach that:
  - manages the impact of land use change from rural to urban
  - protects and enhances stream systems
  - mitigates for hydrological changes and manages flooding effects
- Mitigate the generation and discharge of contaminants/sediments into the sensitive receiving environments downstream of the PCA.
- Facilitating urban development and protecting key infrastructure, people and the environment from significant flooding events.
- To achieve these outcomes, the proposed stormwater management approach will:
  - Provide catchment wide treatment devices such as Wetland at the end of each catchment or at source stormwater devices where wetland is not feasible.
  - Provide a minimum of SMAF 1 hydrological mitigation for all impervious surfaces within the PCA
  - Adopt the 'pass forward flow' flood management approach which is recommended in the flood modelling report to mitigate the effects on downstream flooding
  - Protect, restore, enhance and incorporate streams and overland flow paths as elements of future primary and secondary stormwater conveyance systems.

The detailed design of the proposed stormwater management approach, including device selection, sizing and location will be addressed at the resource consent stages of plan change area.

Based on the investigations that have been completed at this stage, it is expected that stormwater effects from the PCA can be appropriately and adequately managed consistently with the requirements of the AUP and NDC. The plan change can, therefore, proceed with all stormwater management matters mitigated through the recommendations of this SMP.

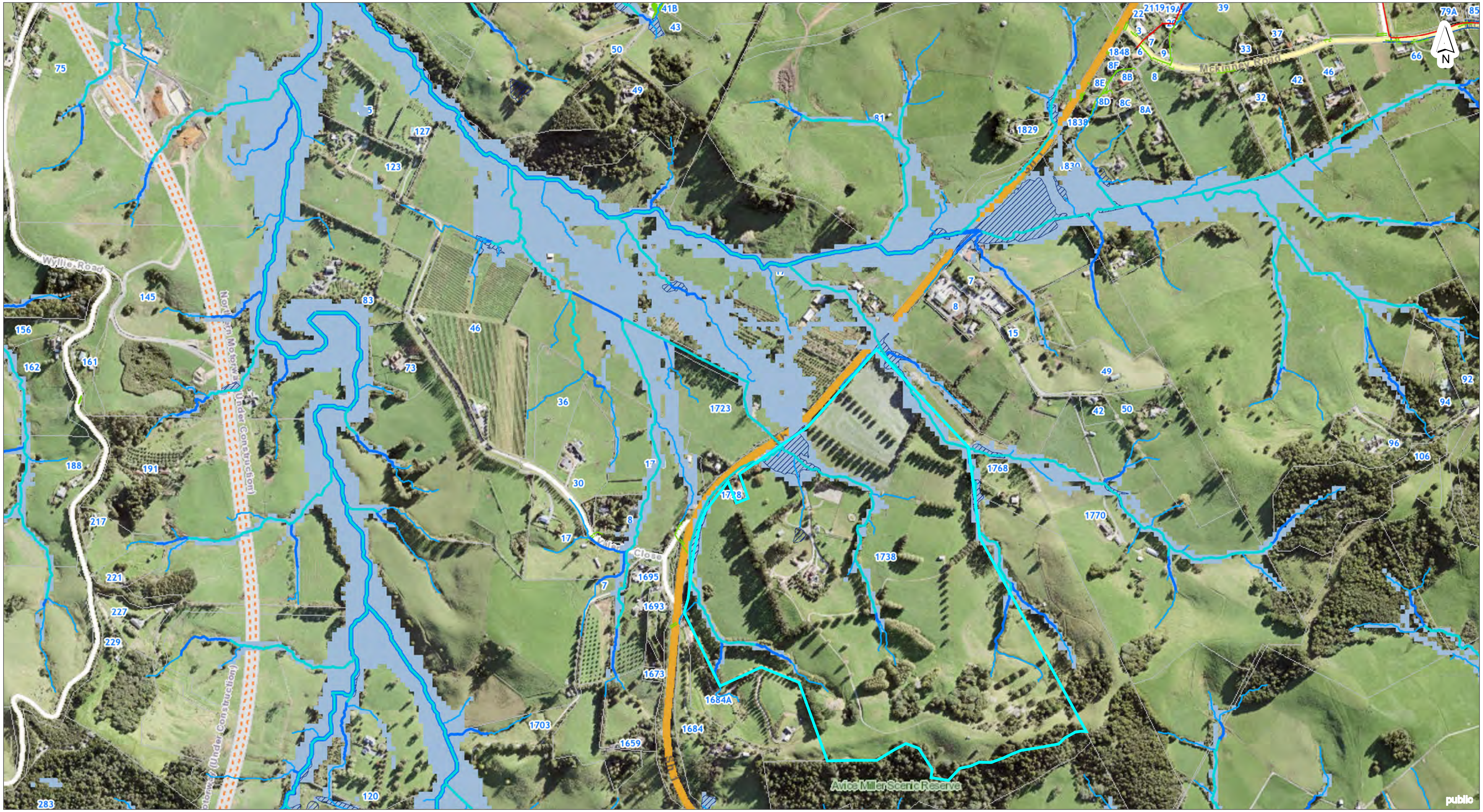
9.2 RECOMMENDATIONS

This SMP sets out a high-level stormwater management framework for the PCA. Detailed SMPs will be required at the resource consent design stage to provide a detailed design response for the respective catchments. These future SMPs will adhere to the overarching principals of this Plan Change SMP. These future SMPs will be adopted under the Healthy Waters Region wide NDC and will authorise the future stormwater discharge from the PCA.

Further recommendation to support the next phases of development within the Waimanawa development are listed below:

- The design recommended within this SMP will guide site specific SMPs which will support the future development within the PCA.
- Specific design and implementation of the stormwater network and associated devices will adhere to the design outcomes set out in this Plan Change SMP.
- Site specific SMPs will detail compliance with Schedule 4 of the Region wide NDC, and once adopted will authorise stormwater discharge.
- Targeted percolation testing in support of resource consent(s) is recommended to confirm if there are localised areas, outside of the catchment wide stormwater management devices, with infiltration capacity.

APPENDIX A – PLANS OF EXISTING SITE FEATURES



Warkworth South

0 80 160 240
Meters

Scale @ A3
= 1:8,000

Date Printed:
22/07/2022

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Rivers and Permanent Streams
- Open Watercourse
- Piped Watercourse
- Culvert
- Pond

Overland Flow Paths
Overland Flow Paths - 100ha and above (25,000)
- Overland Flow Paths - 100ha and above (25,000)

Overland Flow Paths - 3ha to 100ha (25,000)
- Overland Flow Paths - 3ha to 100ha (25,000)

Overland Flow Paths - 1ha to 3ha (15,000)
- Overland Flow Paths - 1ha to 3ha (15,000)

Overland Flow Paths - 4000m2 to 1ha (8,000)
- Overland Flow Paths - 4000m2 to 1ha (8,000)

Stormwater Management Plans
- Adopted
- Provisional

Flood Prone Areas
- Flood Prone Areas

Flood Sensitive Area
- Flood Sensitive Area

Flood Plains
- Flood Plains

Wastewater
Local Network
Wastewater Pipe GIS ID Label (Local)
- Wastewater Pipe GIS ID Label (Local)

Wastewater Pipe (Local)
- Operational
- Operational Not Vested
- Abandoned / Not Operational

Wastewater Structure (Local)
Wastewater Other Structure (Local)
- Wastewater Other Structure (Local)

Wastewater Pump Station (Local)
- Wastewater Pump Station (Local)

Transmission Network
Wastewater Pipe (Transmission)
- Operational
- Not Operational
- Proposed

Wastewater Structure (Transmission)
Stormwater
Stormwater Treatment Device
- Public
- Private

Stormwater Pond or Wetland Components
Stormwater Forebay
- Public
- Private

Stormwater Treatment Facility
- Public
- Private

Stormwater Watercourse
- Public
- Private

Stormwater Pipe SAP ID label
- Stormwater Pipe SAP ID label

Stormwater Pipe
- Public - Gravity Mains
- Private - Gravity Mains
- KiwiRail, Gravity Mains
- Public - Culvert/Tunnel
- Private - Culvert/Tunnel
- KiwiRail, Culvert/Tunnel; KiwiRail, In Service, Culvert
- Public - Rising Main
- Private - Rising Main
- Public - Subsoil Drain
- Private - Subsoil Drain

Stormwater Connection
- Public
- Private

Stormwater Channel
- Public lined
- Public Watercourse
- Private Watercourse

Stormwater Pump Station
- Public
- Private

Stormwater Planting
- Public
- Private

Stormwater Erosion And Flood Control
- Public - Wall Structure
- Private - Wall Structure
- Public - Other Structure
- Private - Other Structure

Stormwater Abandoned Assets
Stormwater Abandoned Pipe
- Public - Gravity Mains
- Public - Culvert/Tunnel
- Public - Rising Main
- Public - Subsoil Drain

Stormwater Abandoned Connection
- Public

Septic Tank
- Public - Hi-Tech
- Private - Hi-Tech
- Public - Other
- Private - Other

Water
Local Network
Water Fitting (Local)
Water Pipe (Local)
- Operational (Non-Potable)
- Operational (Potable)
- Operational Not Vested
- Abandoned / Not Operational

Water Structure (Local)
Water Other Structure (Local)
- Water Other Structure (Local)

Water Pump Station (Local)
- Water Pump Station (Local)

Legend

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Date Printed:
22/07/2022

Auckland Council
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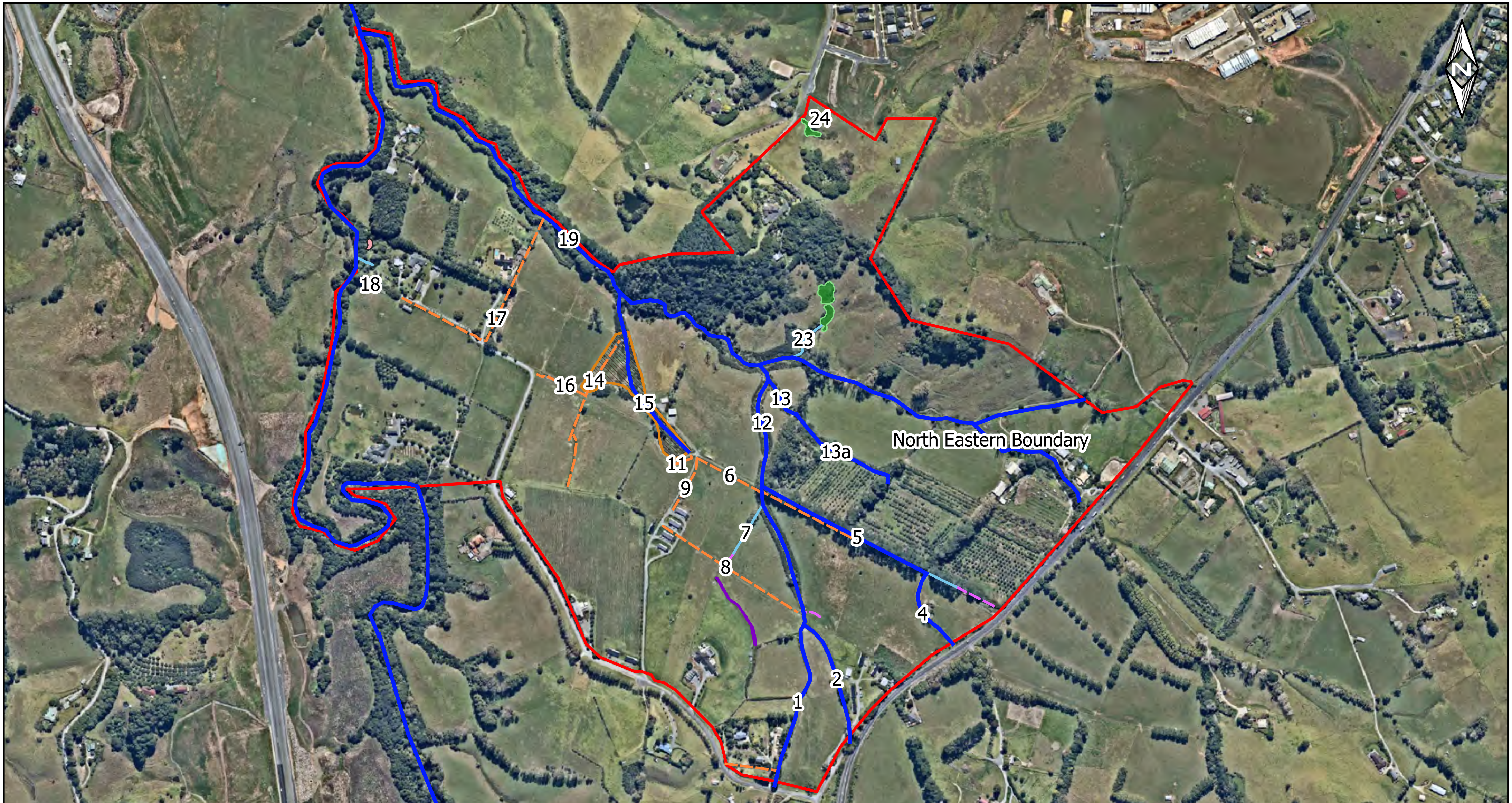


Warkworth South Plan Change Area

Waimanawa Valley

1711 and 1723 State Highway 1
36, 40, 46 and 126 Valerie Close Road

Legend

- Permanent Stream
- Intermittent Stream
- Ephemeral flow path
- Artificial watercourse
- Constructed Wetland
- Offline pond
- Site boundaries

0 100 200 300 400 m

Bioresearches
A Babbage Company

31/08/2022 Project No.63967 Drawn by AJC

0 100 200 m

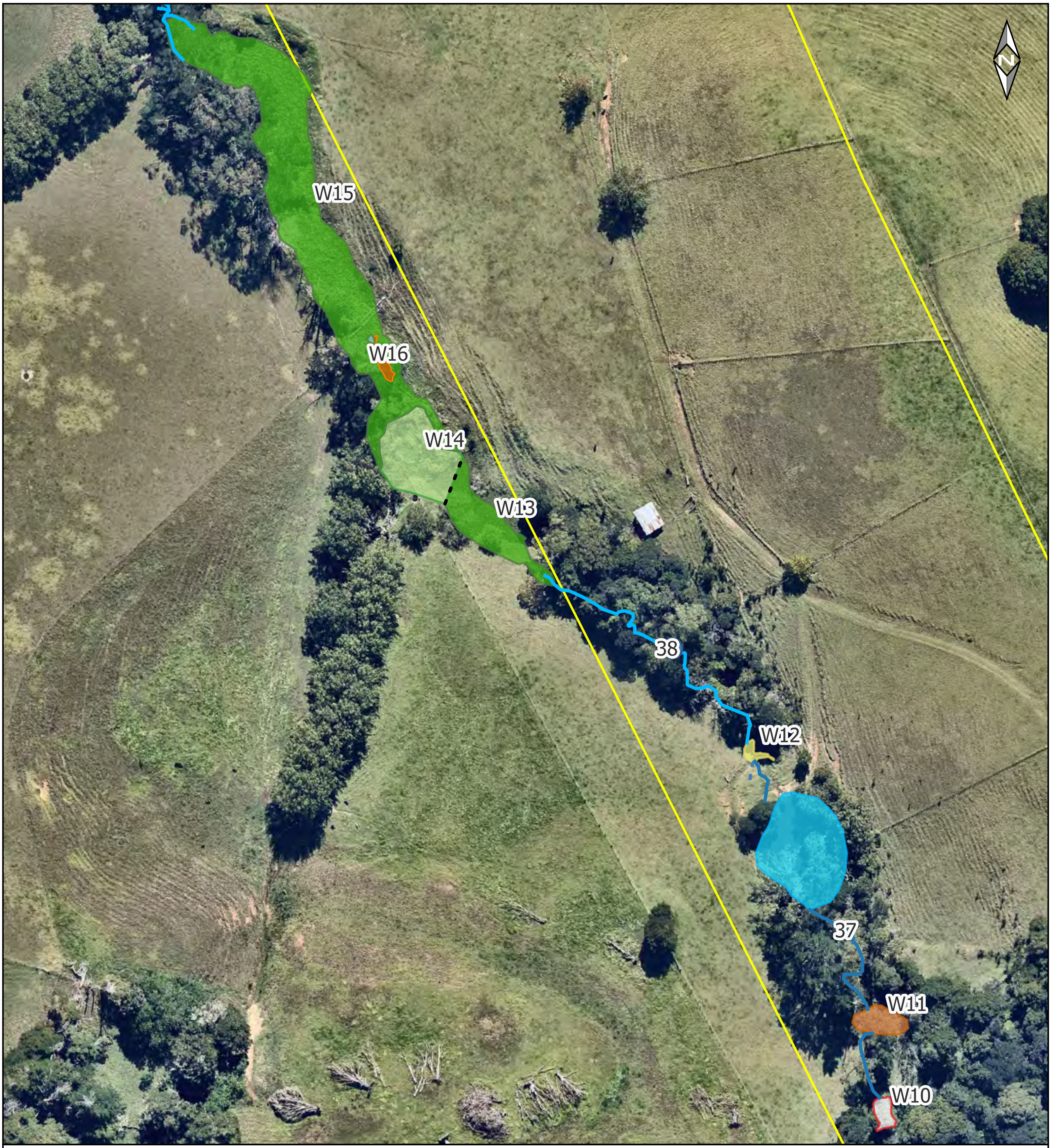
Waimanawa Hills (a)
Warkworth South Freshwater Features

Legend

- Natural Wetland
- Constructed Wetland
- Permanent Stream
- Intermittent Stream
- Ephemeral Flow Path
- Site Boundaries

Bioresearches
A Babbage Company

22/07/2021 Project No.64336 Drawn by NRK



Waimanawa Hills (b)
Warkworth South
Freshwater Features

0 25 50 m

Bioresearches
A Babbage Company

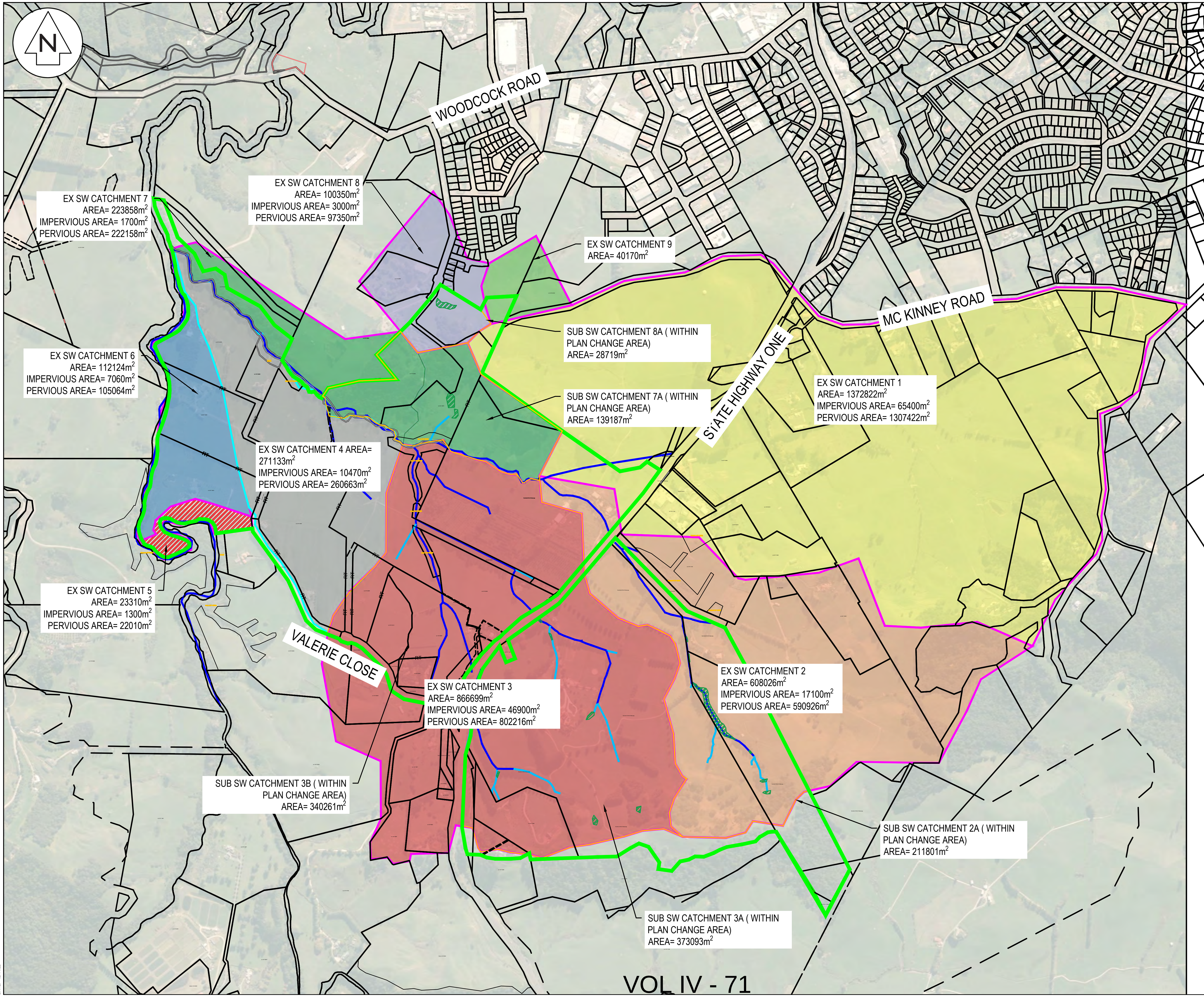
20/01/2022 Project No.65138 By LD

Legend

Waterfall
Overland flow path
Intermittent stream
Permanent stream
Fenceline
Site boundary

Dominant wetland vegetation
Arum lily
Giant umbrella sedge
Reed-sweet grass
Isolepis
Mercer grass
Dam
Rautahi

APPENDIX B – ENGINEERING PLANS



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

- EX BDY
- PLAN CHANGE BDY
- SW CATCHMENT
- SUB SW CATCHMENT
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
B	PPC EXTENT UPDATE	KH	12/22
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design		
Drawn	KH	08/22
Checked	GB	08/22

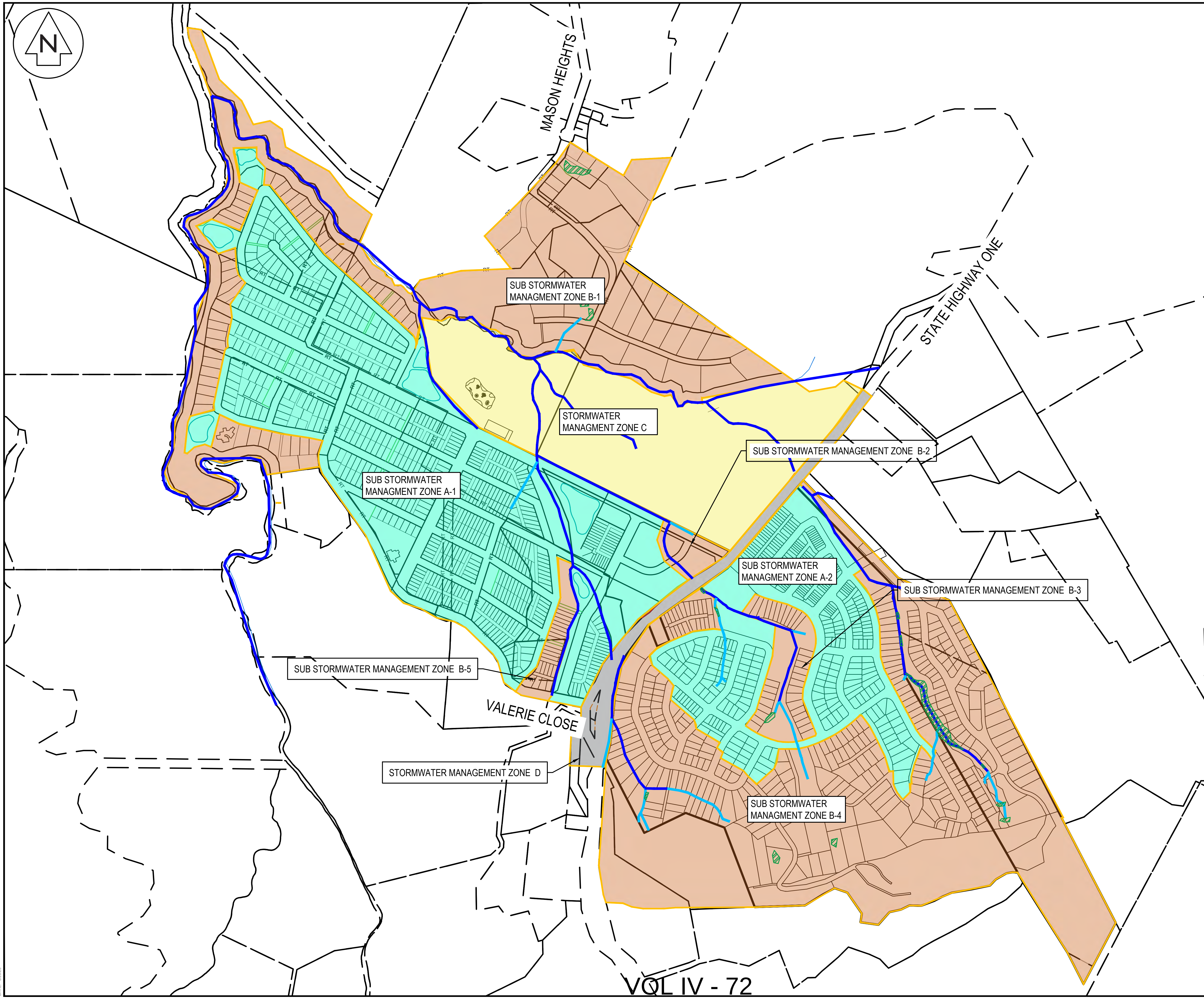
MAVEN
Maven Associates
09 571 0050
info@maven.co.nz
www.maven.co.nz
5 Owens Road, Epsom
Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
EXISTING STORMWATER CATCHMENT PLAN

Project no.	211001		
Scale	1:10000 @ A3		
Cad file	SMP PLAN.DWG		
Drawing no.	C450	Rev	B

DATE: 12/14/22



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

- EX BDY
- PLAN CHANGE BDY
- SW CATCHMENT
- SUB SW CATCHMENT
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND
- SW MANAGEMENT ZONE A
- SW MANAGEMENT ZONE B
- SW MANAGEMENT ZONE C
- SW MANAGEMENT ZONE D

Rev	Description	By	Date
A	PPC RFI	KH	06/23

	By	Date
Survey	PARALAX & MAVEN	03/21
Design	KH	06/23
Drawn	KH	06/23
Checked	LC	06/23

MAVEN
Maven Associates
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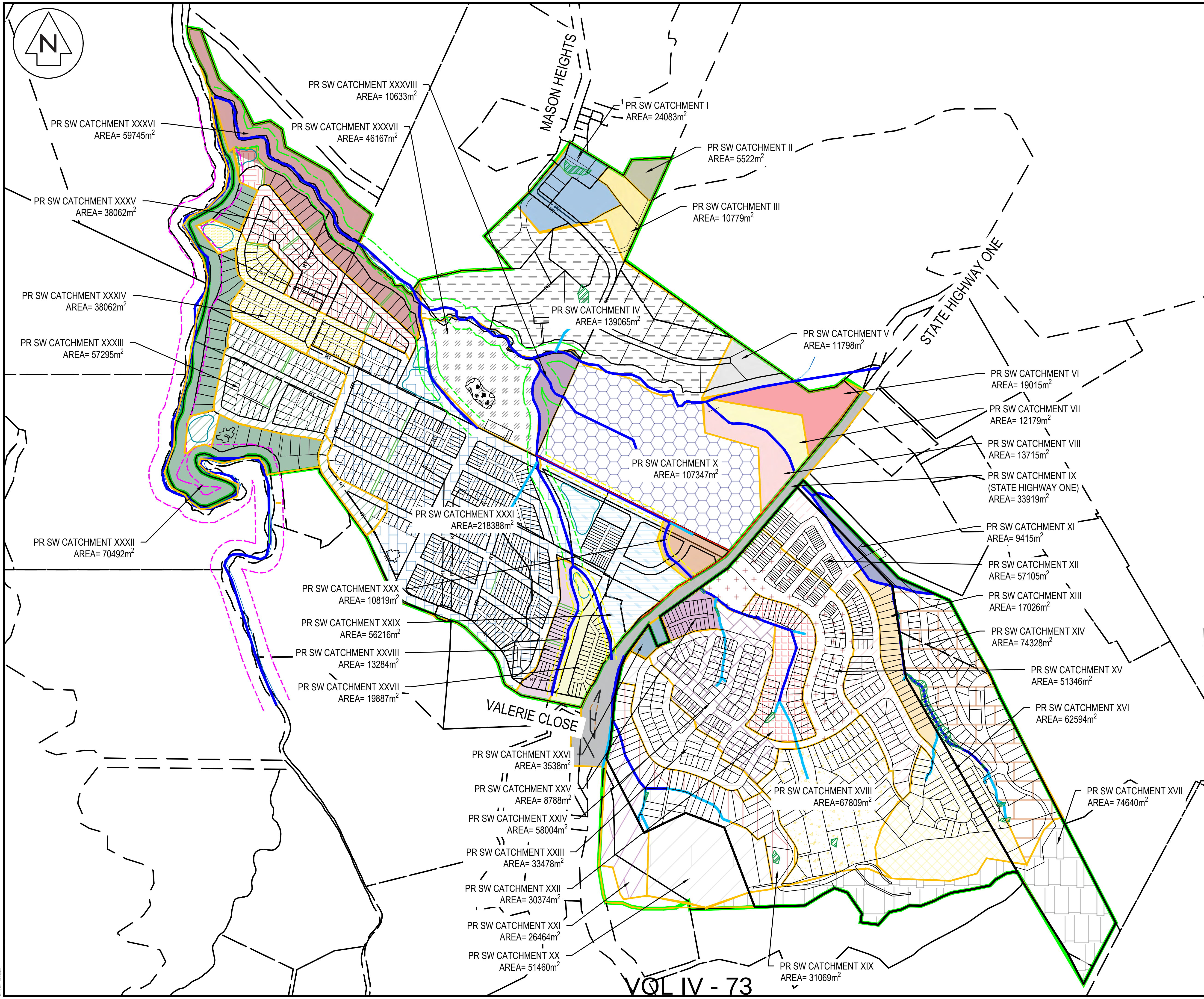
Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

POST DEVELOPMENT STORMWATER MANGEMENT ZONE PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	211001- C452 SMZ.DWG
Drawing no.	C452 — Rev A



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

- EX BDY
- PLAN CHANGE BDY
- SW CATCHMENT
- SUB SW CATCHMENT
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design		
Drawn	KH	08/22
Checked	GB	08/22

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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

POST DEVELOPMENT STORMWATER CATCHMENT PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	211001- C451 PRO DEV CATCHMENT.DWG
Drawing no.	C451
Rev	A

APPENDIX C – ENGINEERING CALCULATIONS

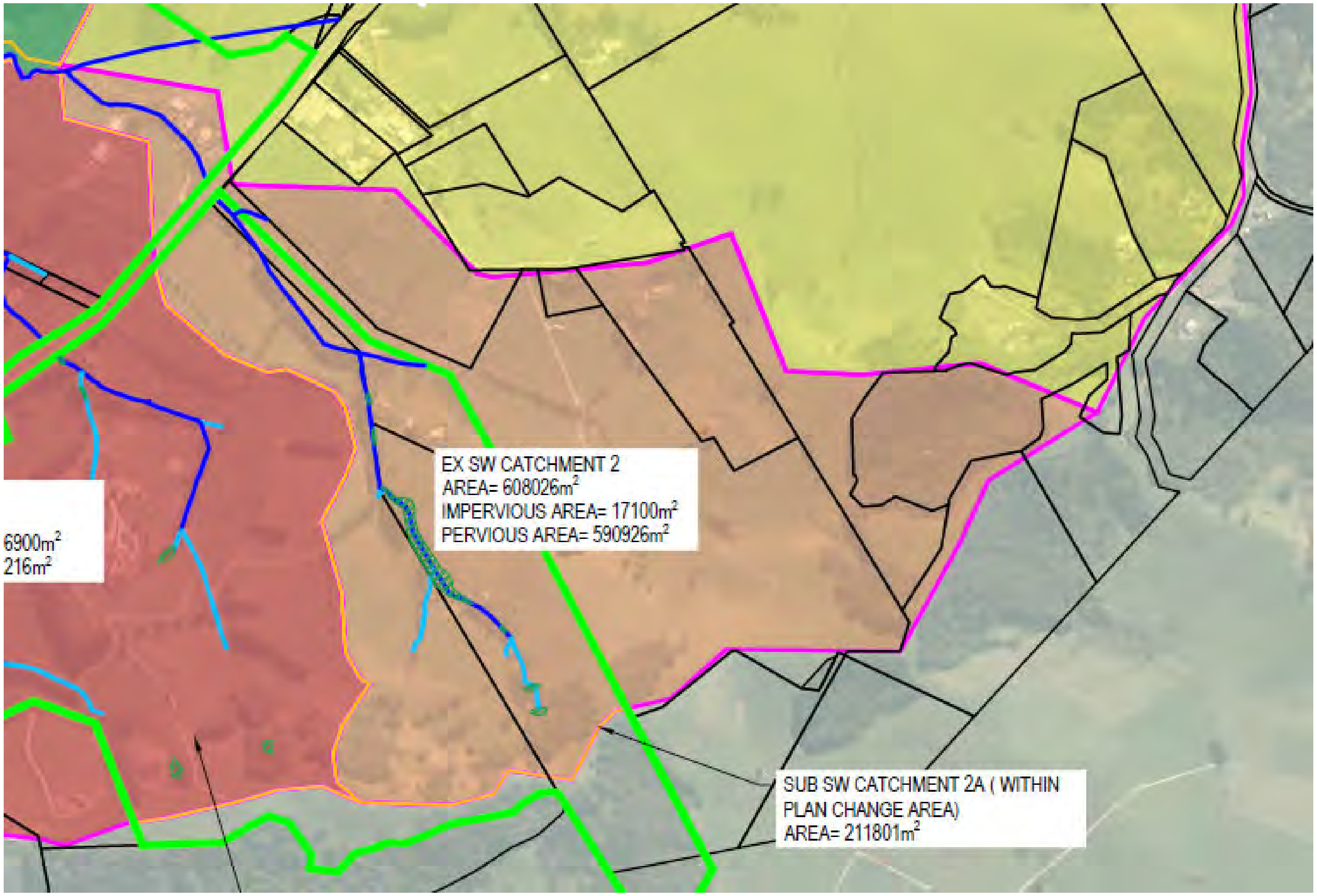
MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

Catchment	Area*	SMAF1 Detention volume (m3)**
2	608020	1516
Total	608020	1516

* the plan change area within this catchment is 211801m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 2 is assumped to be 50% where the upper reach of the catchment is large lot and single zone lot with maximum impervious area is 35% of the site as per AUP and there is one major watercourse running at the center of catchment within plan change area . While the outside of the plan change area the total impervious area is assumped to be 5% of the total catchment


EX SW CATCHMENT 2
AREA= 608026m²
IMPERVIOUS AREA= 17100m²
PERVIOUS AREA= 590926m²
6900m²
216m²
SUB SW CATCHMENT 2A (WITHIN
PLAN CHANGE AREA)
AREA= 211801m²

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA / PRE TO POST SW RUN-OFF / CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	3.0401	297.93
C	Open space (Pervious)	74	57.7619	4274.38
* from Appendix B		Totals =	60.8020	4572.31

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{4572.31}{60.802} =$ 75.2

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 57.7619}{60.802}$ 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.338 km (along drainage path)

Catchment Slope Sc= 0.0195 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{75.2}{200- \; 75.2} =$ 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.75 1.32 3.26 = 1.06 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.71 hrs

42.44 mins

OK

use

1.06 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.60802	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	1.06	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.023				
7. Peak flow rate, q_p=q*A*P_{24}	**0.587**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	6971.52				(m3)

Worksheet 2: Graphical Peak Flow Rate

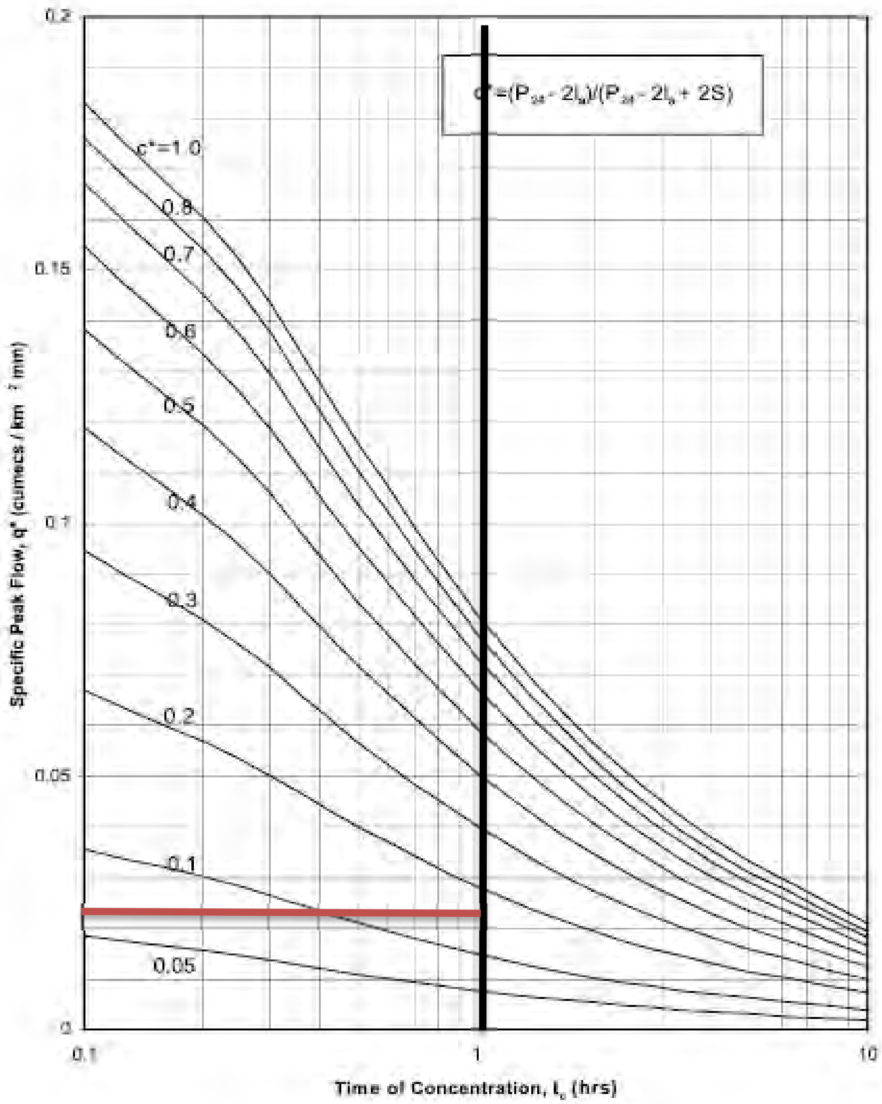


Figure 5.1 – Specific Peak Flow Rate

F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 2

MAVEN ASSOCIATES		Job Number 211001	Sheet 4	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	13.6302	1335.75
C	Grass (landscape and gardens)	74	47.1719	3490.72
* from Appendix B		Totals =	60.8020	4826.47

CN (weighted) = total product / total area = 4826.47 / 60.802 = 79.4

Ia (average) = 5 x pervious area / total area = 5 x 47.1719 / 60.802 = 3.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 2.338 km (along drainage path)

Catchment Slope Sc= 0.0195 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 79.4 / (200- 79.4) = 0.66

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.75 1.26 3.26 = 0.60 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.40 hrs

4.26 mins

OK

use

0.6034553 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 2	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.60802	km2(100ha =1km2)
Runoff curve number	CN=	79.4	(from worksheet 1)
Initial abstraction	Ia=	3.9	mm (from worksheet 1)
Time of concentration	tc=	0.60	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 66.0 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.21				
6. Specific peak flow rate q*	0.036				
7. Peak flow rate, q_p=q*A*P_{24}	0.919				m3/s
PEAK FLOW RATE PRE DEV=	0.587				
PRE TO POST FLOW RATE=	**0.332**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	14.0				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	8487.74				(m3)
RUNOFF VOLUME PRE DEV=	6971.52				
PRE TO POST VOLUME=	**1516.22**				

Worksheet 2: Graphical Peak Flow Rate

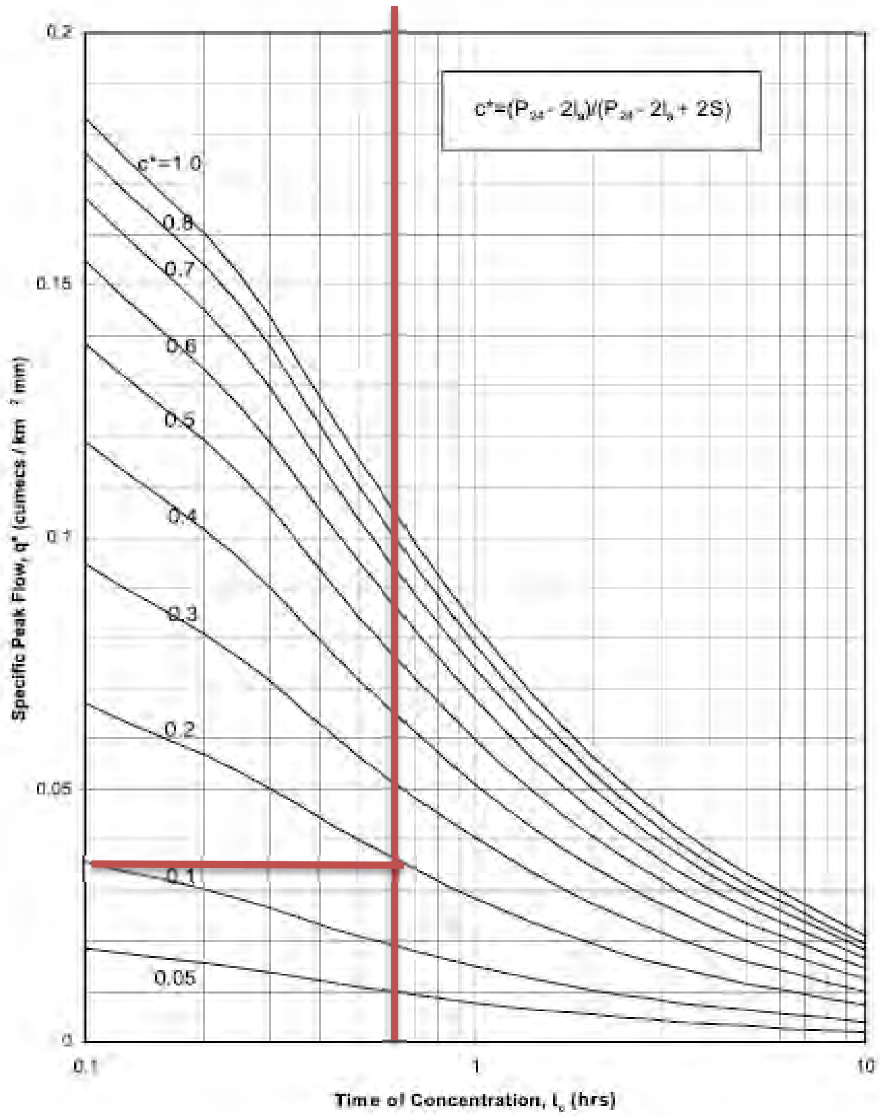


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

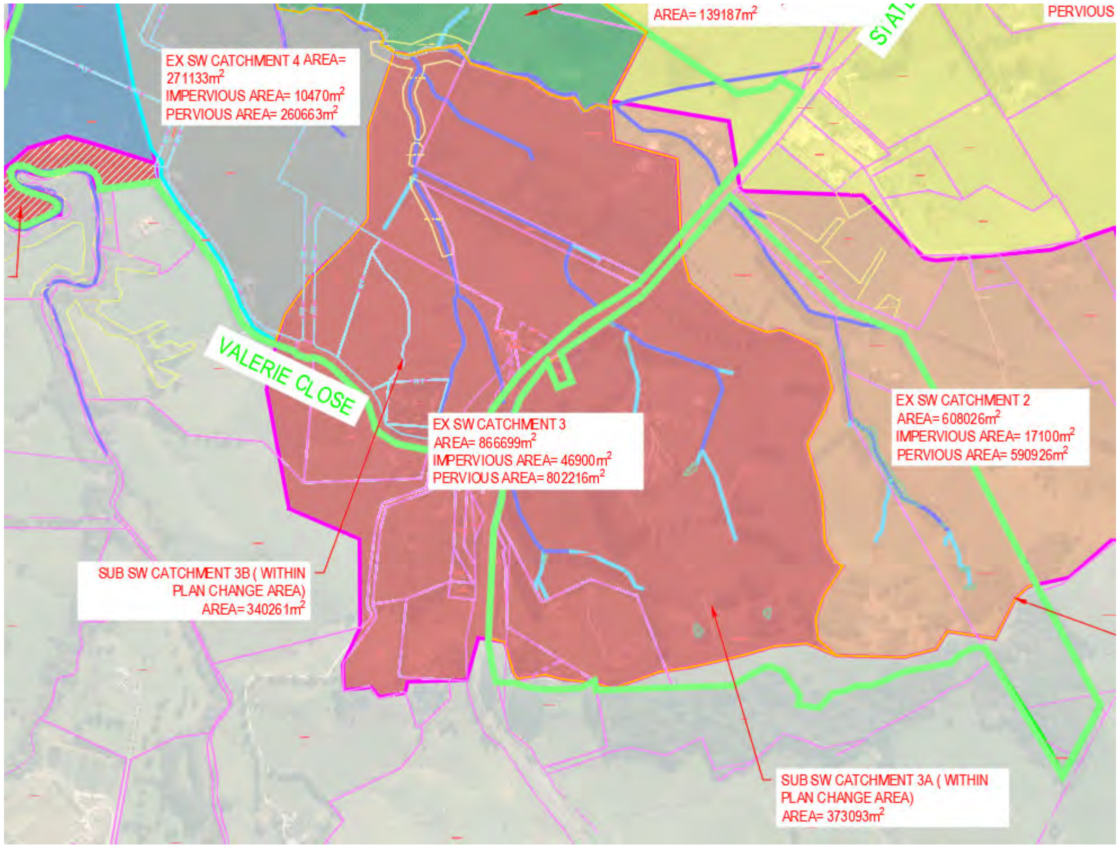
Catchment	Area*	SMAF1 Detention volume (m3)**
3	866699	7706
Total	866699	7706

* the plan change area within this catchment is 713354m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 3 is assumped to be 60% where the upper reach of the catchment is large lot and single zone lot with maximum impervious area is 35% of the site as per AUP and there is central park area plus various watercourses . While the outside of the plan change area the total impervious area is assumped to be 5% of the total catchment

F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 3



F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 3

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	4.3335	424.68
C	Open space (Pervious)	74	82.3364	6092.89
* from Appendix B		Totals =	86.6699	6517.58

CN (weighted) = total product / total area = 6517.58 / 86.670 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 82.3364 / 86.670 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.11 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   1.64   1.32   3.06   = 0.93 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.62 hrs

37.27 mins

OK
use
0.93 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.866699	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	0.93	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.023				
7. Peak flow rate, q_p=q*A*P_{24}	**0.837**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})\text{+S}$	11.5				mm
9. Runoff volume, $V_{24} = 1000\text{x}Q_{24}A$	9937.52				(m3)

Worksheet 2: Graphical Peak Flow Rate

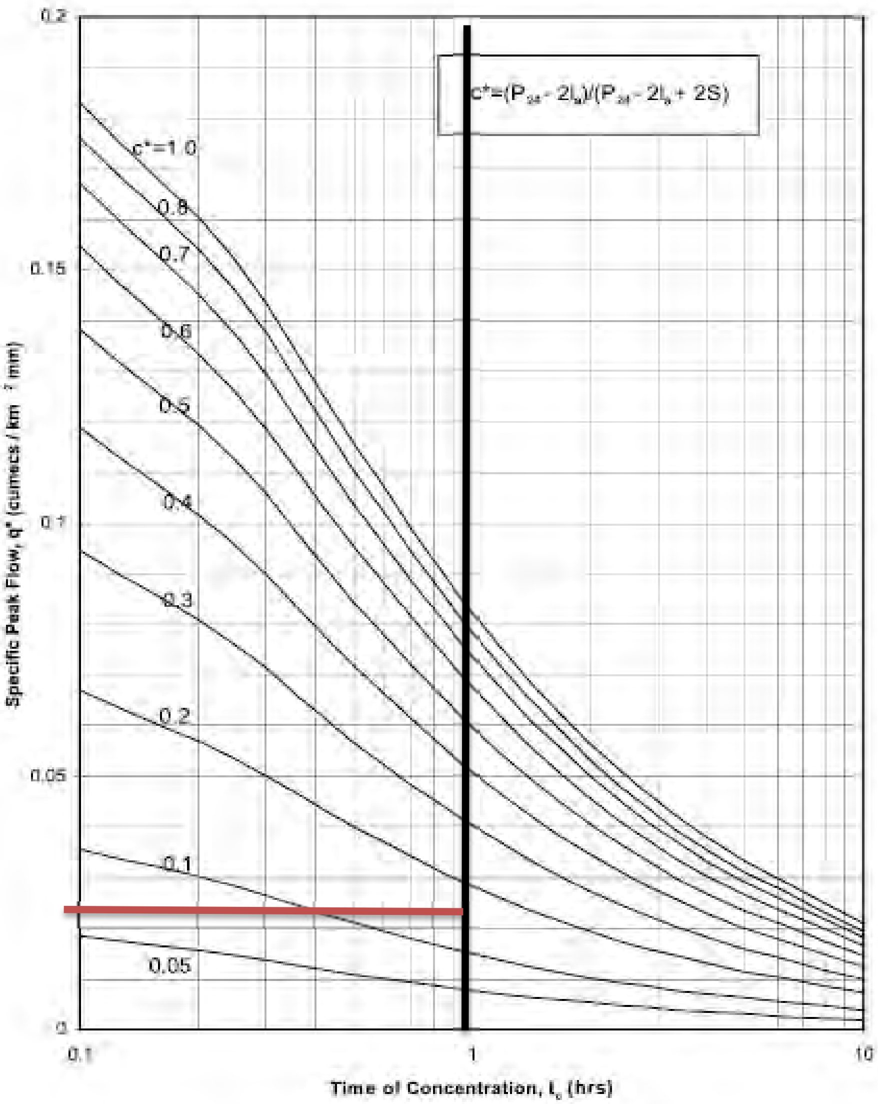


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title / Calc Title — WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	47.1347	4619.20
C	Grass (landscape and gardens)	74	39.5352	2925.60
* from Appendix B		Totals =	86.6699	7544.81

CN (weighted) = total product / total area = 7544.81 / 86.670 = 87.1

Ia (average) = 5 x pervious area / total area = 5 x 39.5352 / 86.670 = 2.3 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 2.11 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 87.1 / (200- 87.1) = 0.77

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.64 1.15 3.06 = 0.49 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.33 hrs

4.26 mins

OK

use

0.4857874 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title WARKWORTH SOUTH PCA Calc Title PRE TO POST SW RUN-OFF CATCHMENT 3	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.866699	km2(100ha =1km2)
Runoff curve number	CN=	87.1	(from worksheet 1)
Initial abstraction	Ia=	2.3	mm (from worksheet 1)
Time of concentration	tc=	0.49	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 37.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.33				
6. Specific peak flow rate q*	0.057				
7. Peak flow rate, q_p=q*A*P_{24}	2.075				m3/s
PEAK FLOW RATE PRE DEV=	0.837				
PRE TO POST FLOW RATE=	**1.238**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	20.4				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	17643.24				(m3)
RUNOFF VOLUME PRE DEV=	9937.52				
PRE TO POST VOLUME=	**7705.71**				

Worksheet 2: Graphical Peak Flow Rate

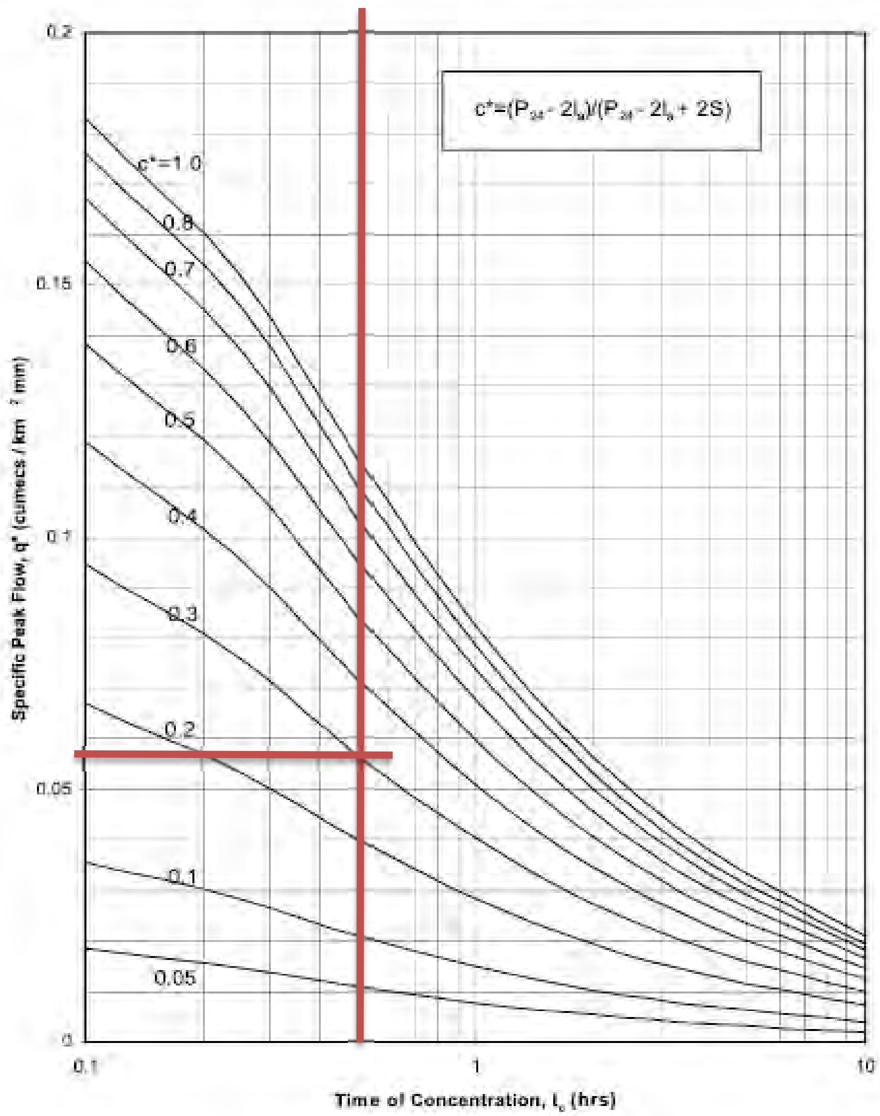


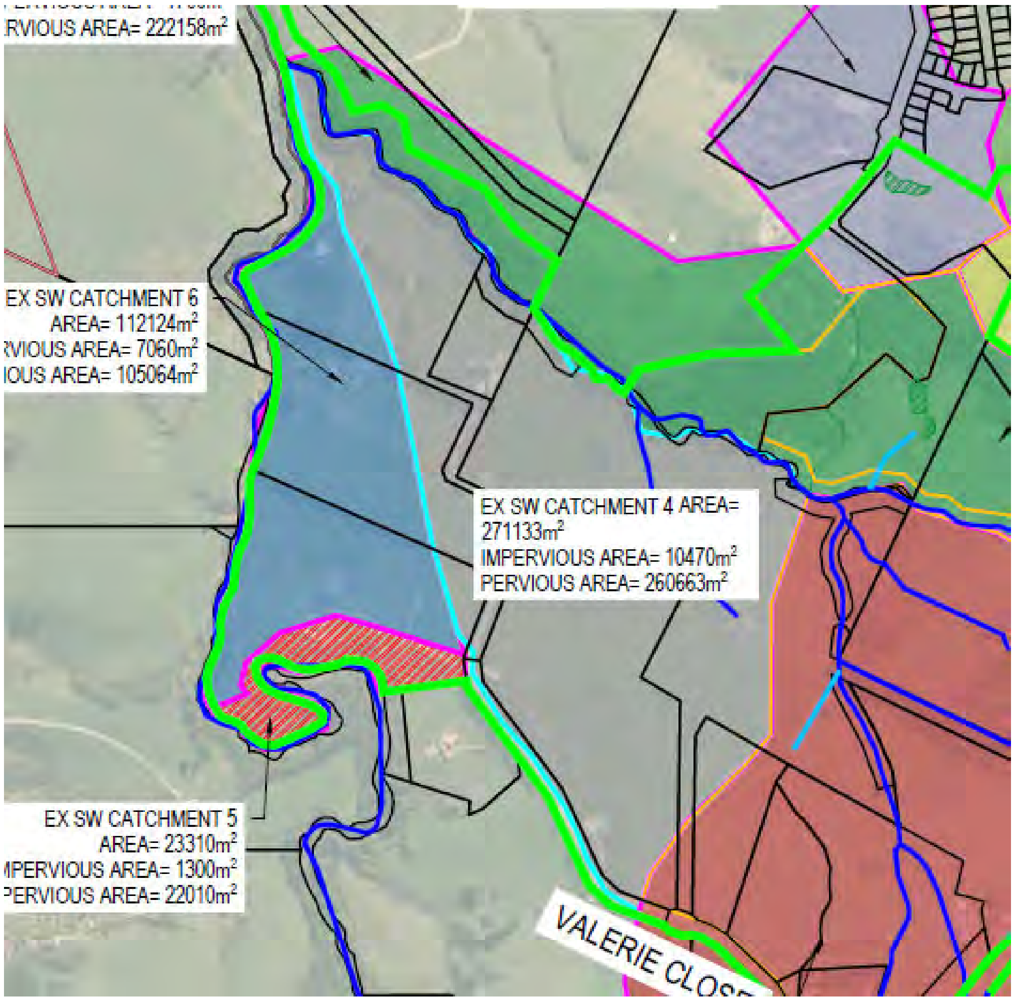
Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

Catchment	Area	SMAF1 Detention volume (m3)*
4	267102	3143
Total	267102	3143

* the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 4 is assumped to be 65% where a major watercourses running paralel to its catchment



RVIOUS AREA= 222158m2
EX SW CATCHMENT 6
AREA= 112124m2
RVIOUS AREA= 7060m2
IOUS AREA= 105064m2
EX SW CATCHMENT 4 AREA=
271133m2
IMPERVIOUS AREA= 10470m2
PERVIOUS AREA= 260663m2
EX SW CATCHMENT 5
AREA= 23310m2
IPERVIOUS AREA= 1300m2
PERVIOUS AREA= 22010m2
VALERIE CLOSE

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title WARKWORTH SOUTH PCA Calc Title PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	1.3355	130.88
C	Open space (Pervious)	74	25.3747	1877.73
* from Appendix B		Totals =	26.7102	2008.61

CN (weighted) = total product / total area = 2008.61 / 26.710 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 25.3747 / 26.710 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.981 km (along drainage path)

Catchment Slope Sc= 0.0187 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.57 1.32 3.30 = 0.96 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.64 hrs

38.53 mins

OK
use
0.96 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.267102 km2(100ha =1km2)

   Runoff curve number CN= 75.2 (from worksheet 1)

   Initial abstraction Ia= 4.8 mm (from worksheet 1)

   Time of concentration tc= 0.96 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.023				
7. Peak flow rate, q_p=q*A*P_{24}	**0.258**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000 \text{x} Q_{24} A$	3062.58				(m3)

Worksheet 2: Graphical Peak Flow Rate

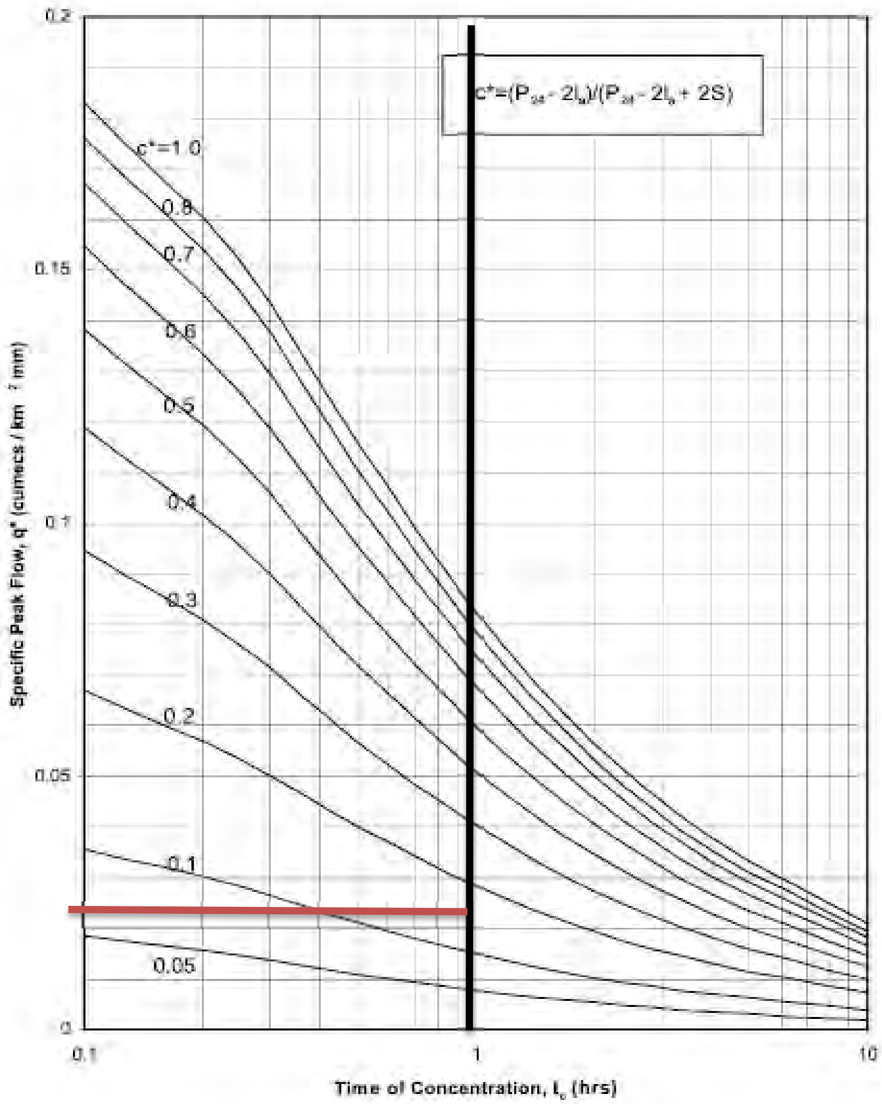


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	17.3616	1701.44
C	Grass (landscape and gardens)	74	9.3486	691.79
* from Appendix B		Totals =	26.7102	2393.23

CN (weighted) = total product / total area = 2393.23 / 26.710 = 89.6

Ia (average) = 5 x pervious area / total area = 5 x 9.3486 / 26.710 = 1.8 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.981 km (along drainage path)

Catchment Slope Sc= 0.0187 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.6 / (200- 89.6) = 0.81

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.57 1.12 3.30 = 0.49 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.33 hrs

4.26 mins

OK

use

0.4881285 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 4	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.267102	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.8	mm (from worksheet 1)
Time of concentration	tc=	0.49	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29.5 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.40				
6. Specific peak flow rate q*	0.071				
7. Peak flow rate, q_p=q*A*P_{24}	0.796				m3/s
PEAK FLOW RATE PRE DEV=	0.258				
PRE TO POST FLOW RATE=	**0.538**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	23.2				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	6205.49				(m3)
RUNOFF VOLUME PRE DEV=	3062.58				
PRE TO POST VOLUME=	**3142.91**				

Worksheet 2: Graphical Peak Flow Rate

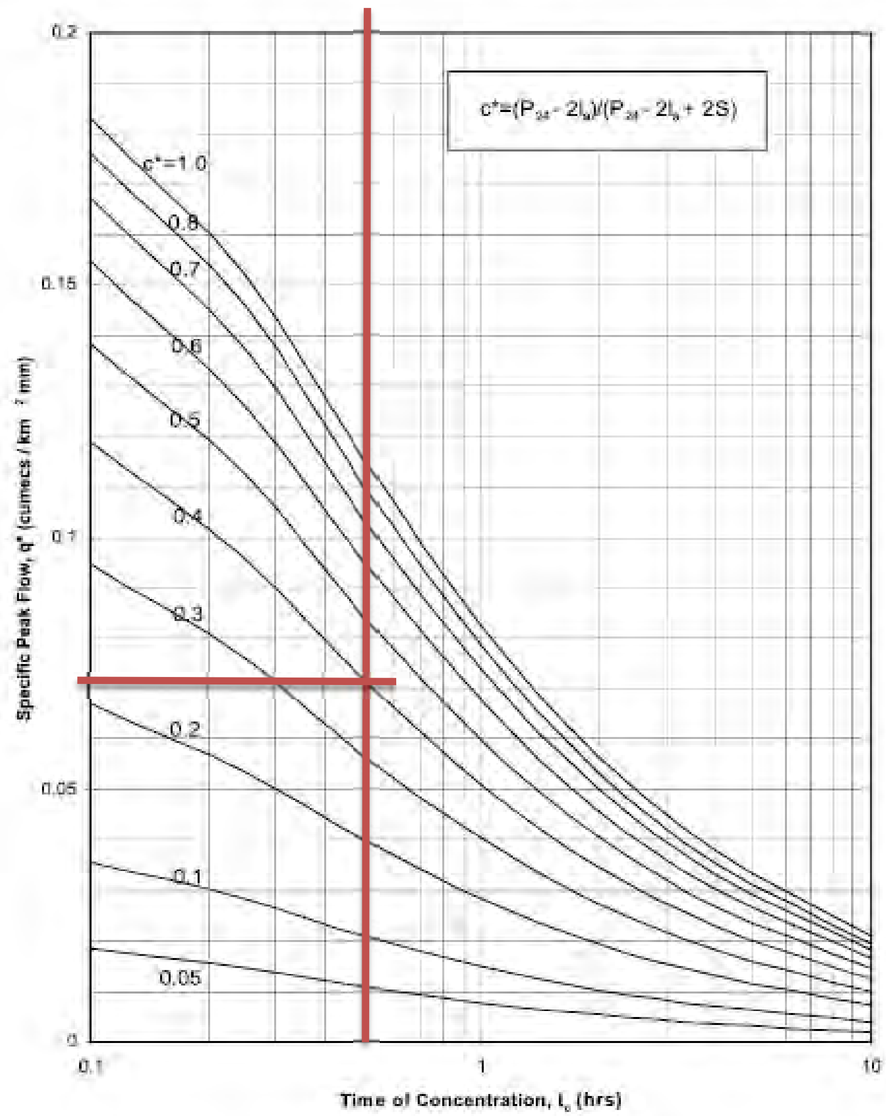


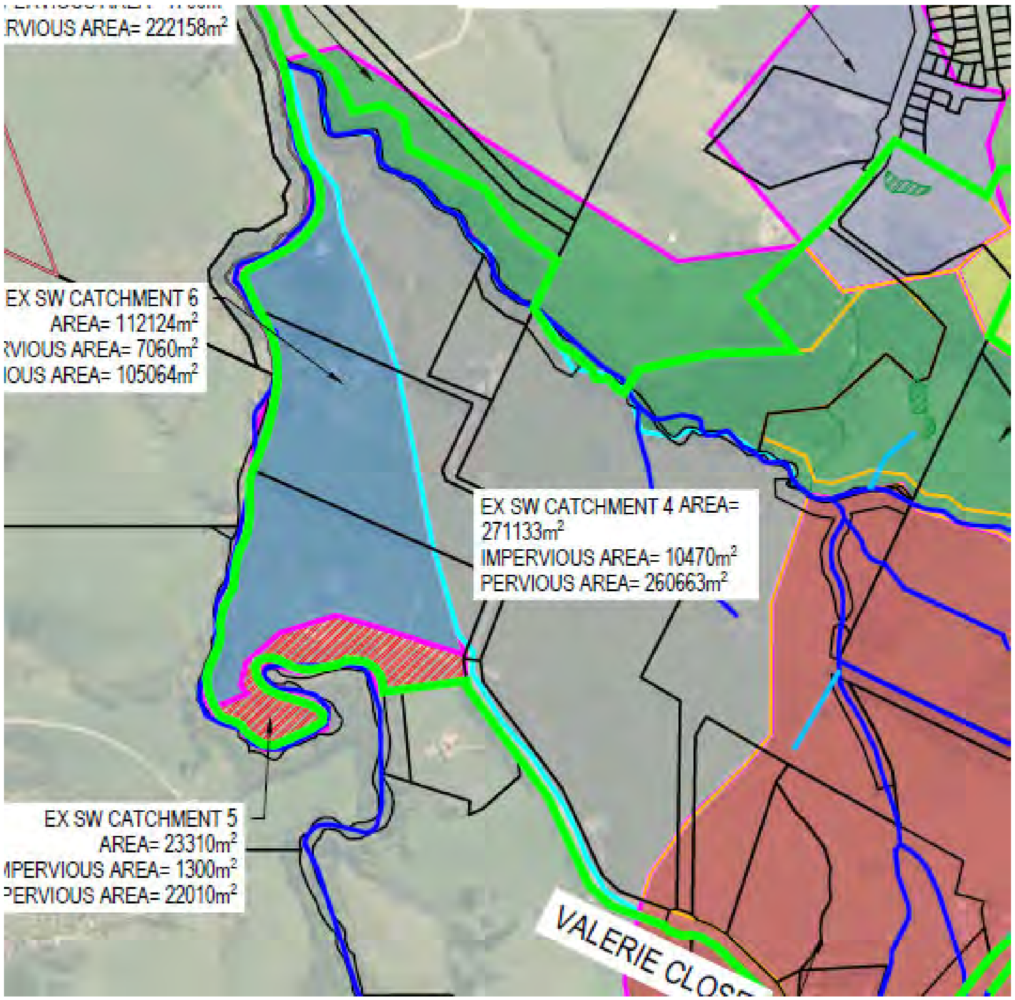
Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev C
Job Title WARKWORTH SOUTH PCA Calc Title PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

Catchment	Area	SMAF1 Detention volume (m3)*
6	112124	1319
Total	112124	1319

* the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 6 is assumped to be 65% where a major watercourses running paralel to its catchment



RVIOUS AREA= 222158m²
EX SW CATCHMENT 6
AREA= 112124m²
RVIOUS AREA= 7060m²
IOUS AREA= 105064m²
EX SW CATCHMENT 4 AREA=
271133m²
IMPERVIOUS AREA= 10470m²
PERVIOUS AREA= 260663m²
EX SW CATCHMENT 5
AREA= 23310m²
IPERVIOUS AREA= 1300m²
PERVIOUS AREA= 22010m²
VALERIE CLOSE

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.5606	54.94
C	Open space (Pervious)	74	10.6518	788.23
* from Appendix B		Totals =	11.2124	843.17

CN (weighted) = total product / total area = 843.17 / 11.212 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 10.6518 / 11.212 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.363 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.23 1.32 3.87 = 0.88 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.59 hrs

35.29 mins

OK

use

0.88 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.112124	km2(100ha =1km2)
Runoff curve number	CN=	75.2	(from worksheet 1)
Initial abstraction	Ia=	4.8	mm (from worksheet 1)
Time of concentration	tc=	0.88	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. <u>24 hour rainfall depth</u>	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.026				
7. Peak flow rate, q_p=q*A*P_{24}	**0.122**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1285.61				(m3)

Worksheet 2: Graphical Peak Flow Rate

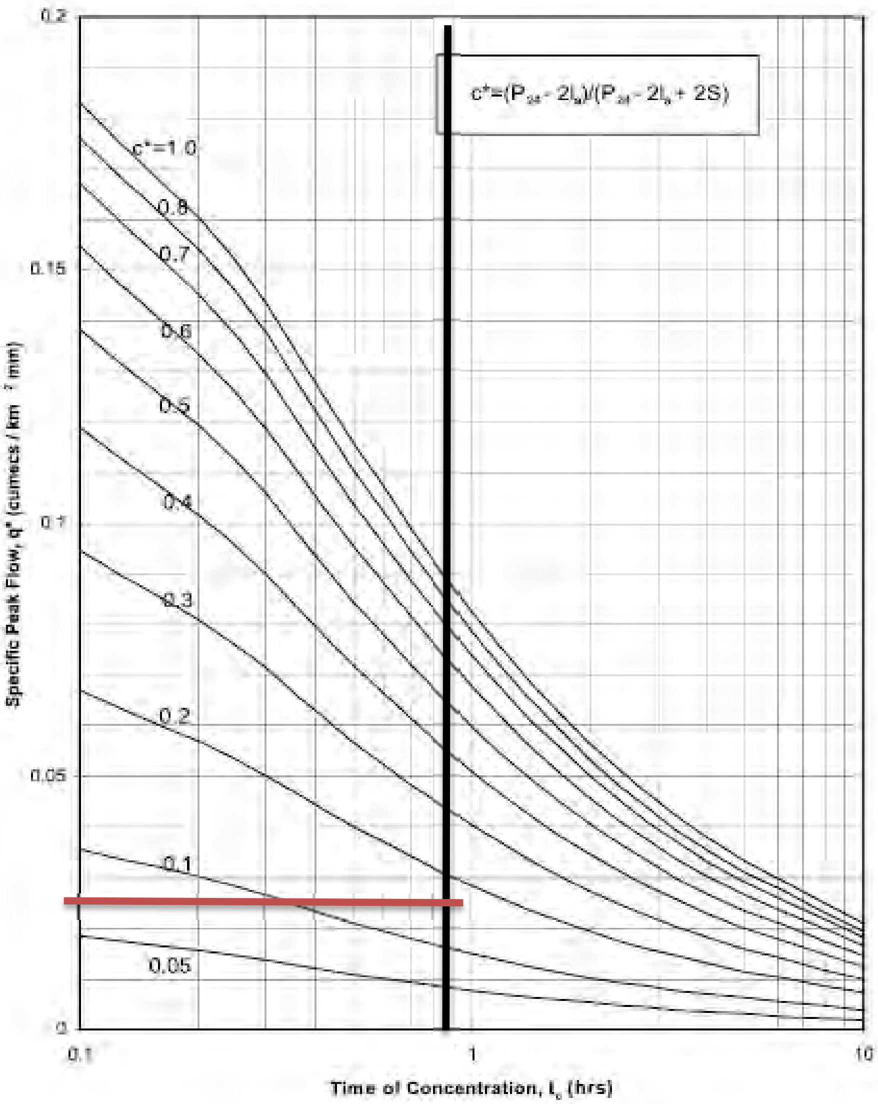


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	7.2881	714.23
C	Grass (landscape and gardens)	74	3.9243	290.40
* from Appendix B		Totals =	11.2124	1004.63

CN (weighted) = total product / total area = 1004.63 / 11.212 = 89.6

Ia (average) = 5 x pervious area / total area = 5 x 3.9243 / 11.212 = 1.8 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.363 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 89.6 / 200- 89.6 = 0.81

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.23 1.12 3.87 = 0.45 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.30 hrs

4.26 mins

OK

use

0.4471903 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 6	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.112124	km2(100ha =1km2)
Runoff curve number	CN=	89.6	(from worksheet 1)
Initial abstraction	Ia=	1.8	mm (from worksheet 1)
Time of concentration	tc=	0.45	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 29.5 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.40				
6. Specific peak flow rate q*	0.076				
7. Peak flow rate, q_p=q*A*P_{24}	0.358				m3/s
PEAK FLOW RATE PRE DEV=	0.122				
PRE TO POST FLOW RATE=	**0.235**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	23.2				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2604.94				(m3)
RUNOFF VOLUME PRE DEV=	1285.61				
PRE TO POST VOLUME=	**1319.33**				

Worksheet 2: Graphical Peak Flow Rate

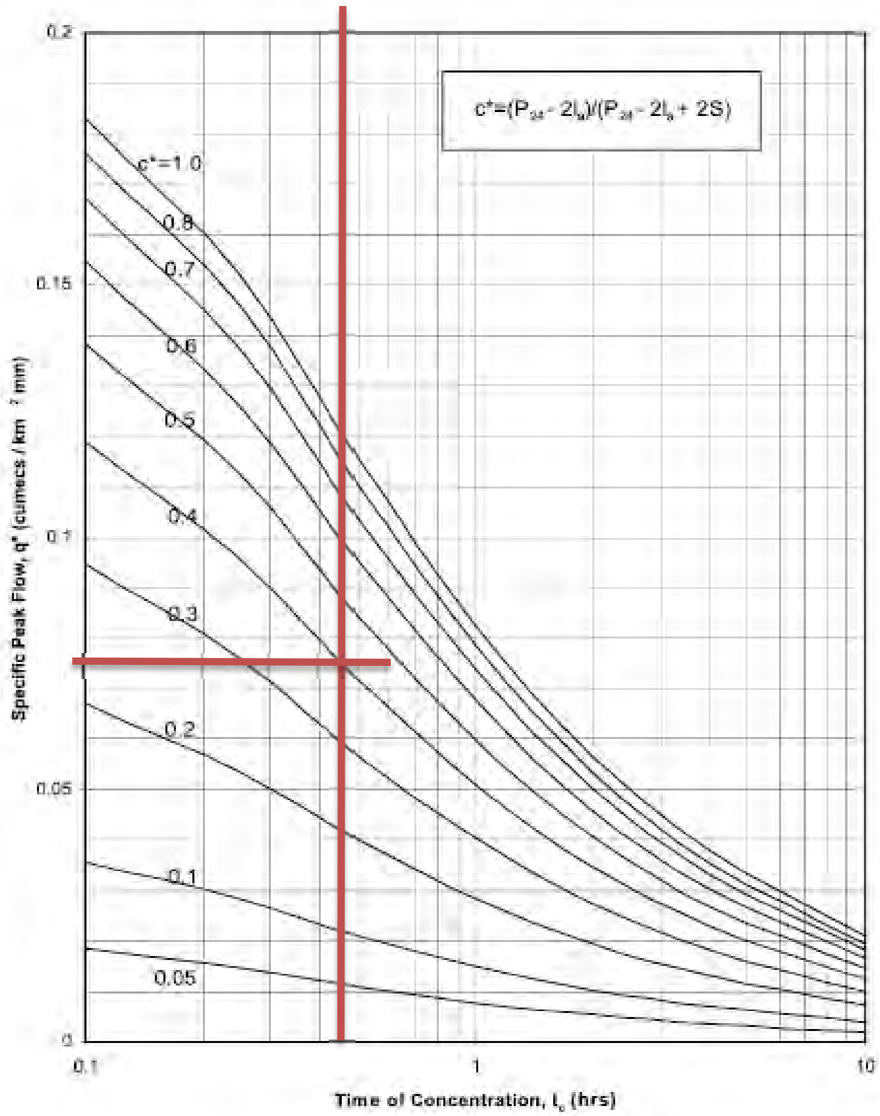


Figure 5.1 – Specific Peak Flow Rate

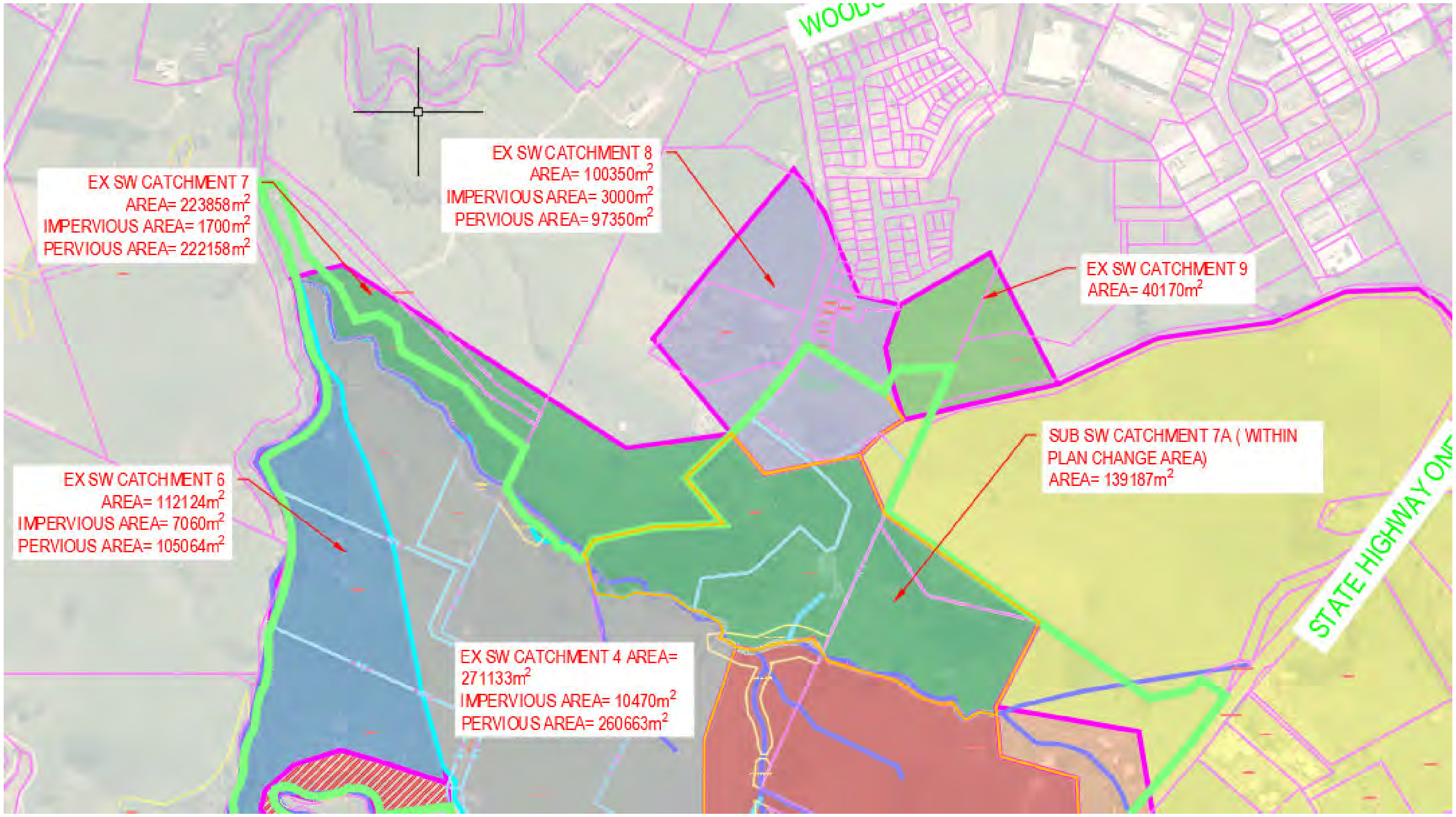
MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

Catchment	Area*	SMAF1 Detention volume (m3)**
7	223858	363
Total	223858	363

* the plan change area within this catchment is 139187m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 7 is assumped to be 20% where a major watercourses running paralel to its catchment, most of the lot will be large lot or rural zone, protective bush area


WOODC
EX SW CATCHMENT 7
AREA= 223858m2
IMPERVIOUS AREA= 1700m2
PERVIOUS AREA= 222158m2
EX SW CATCHMENT 8
AREA= 100350m2
IMPERVIOUS AREA= 3000m2
PERVIOUS AREA= 97350m2
EX SW CATCHMENT 9
AREA= 40170m2
SUB SW CATCHMENT 7A (WITHIN PLAN CHANGE AREA)
AREA= 139187m2
EX SW CATCHMENT 6
AREA= 112124m2
IMPERVIOUS AREA= 7060m2
PERVIOUS AREA= 105064m2
EX SW CATCHMENT 4 AREA= 271133m2
IMPERVIOUS AREA= 10470m2
PERVIOUS AREA= 260663m2
STATE HIGHWAY ONE

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	22.3941	1657.16
* from Appendix B		Totals =	22.3941	1657.16

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1657.16}{22.394} = 74.0$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 22.3941}{22.394}$ 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.342 km (along drainage path)

Catchment Slope Sc= 0.041 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.0}{200 - 74.0} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.21 1.34 2.61 = 0.59 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.40 hrs

23.88 mins

OK
use
0.59 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.223941	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.59	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15				
6. Specific peak flow rate q*	0.028				
7. Peak flow rate, q_p=q*A*P_{24}	**0.263**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2428.45				(m3)

Worksheet 2: Graphical Peak Flow Rate

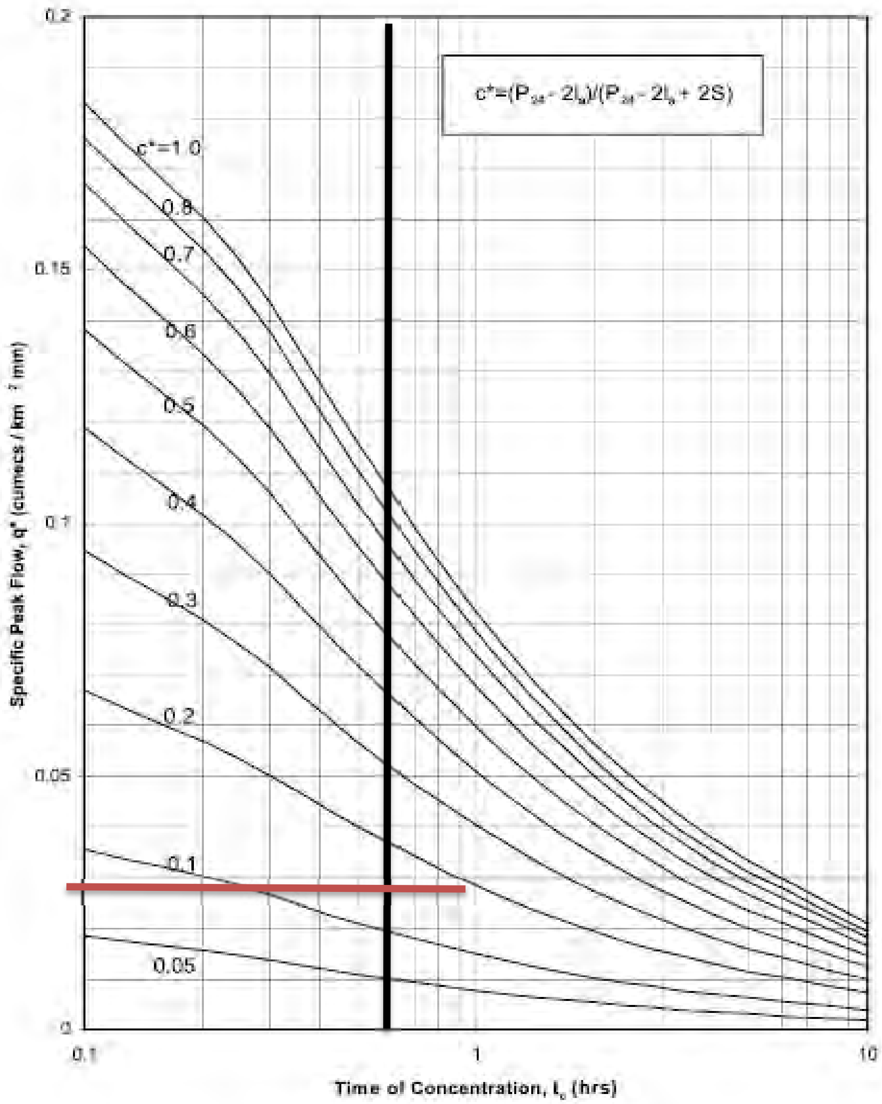


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 4	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	2.7837	272.81
C	Grass (landscape and gardens)	74	19.6104	1451.17
* from Appendix B		Totals =	22.3941	1723.97

CN (weighted) = total product / total area = 1723.97 / 22.394 = 77.0

Ia (average) = 5 x pervious area / total area = 5 x 19.6104 / 22.394 = 4.4 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.342 km (along drainage path)

Catchment Slope Sc= 0.041 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 77.0 / 200- 77.0 = 0.63

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.21 1.29 2.61 = 0.34 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.23 hrs

4.26 mins

OK

use

0.3441301 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 7	Author KH	Date 13/12/2022	Checked LC

1. Data
   - Catchment Area A= 0.223941 km2(100ha =1km2)
   - Runoff curve number CN= 77.0 (from worksheet 1)
   - Initial abstraction Ia= 4.4 mm (from worksheet 1)
   - Time of concentration tc= 0.34 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 75.9 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth P24	42				(mm)
					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.18				
6. Specific peak flow rate q*	0.044				
7. Peak flow rate, q_p=q*A*P_{24}	0.414				m3/s
PEAK FLOW RATE PRE DEV=	0.263				
PRE TO POST FLOW RATE=	**0.150**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	12.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2791.07				(m3)
RUNOFF VOLUME PRE DEV=	2428.45				
PRE TO POST VOLUME=	**362.62**				

Worksheet 2: Graphical Peak Flow Rate

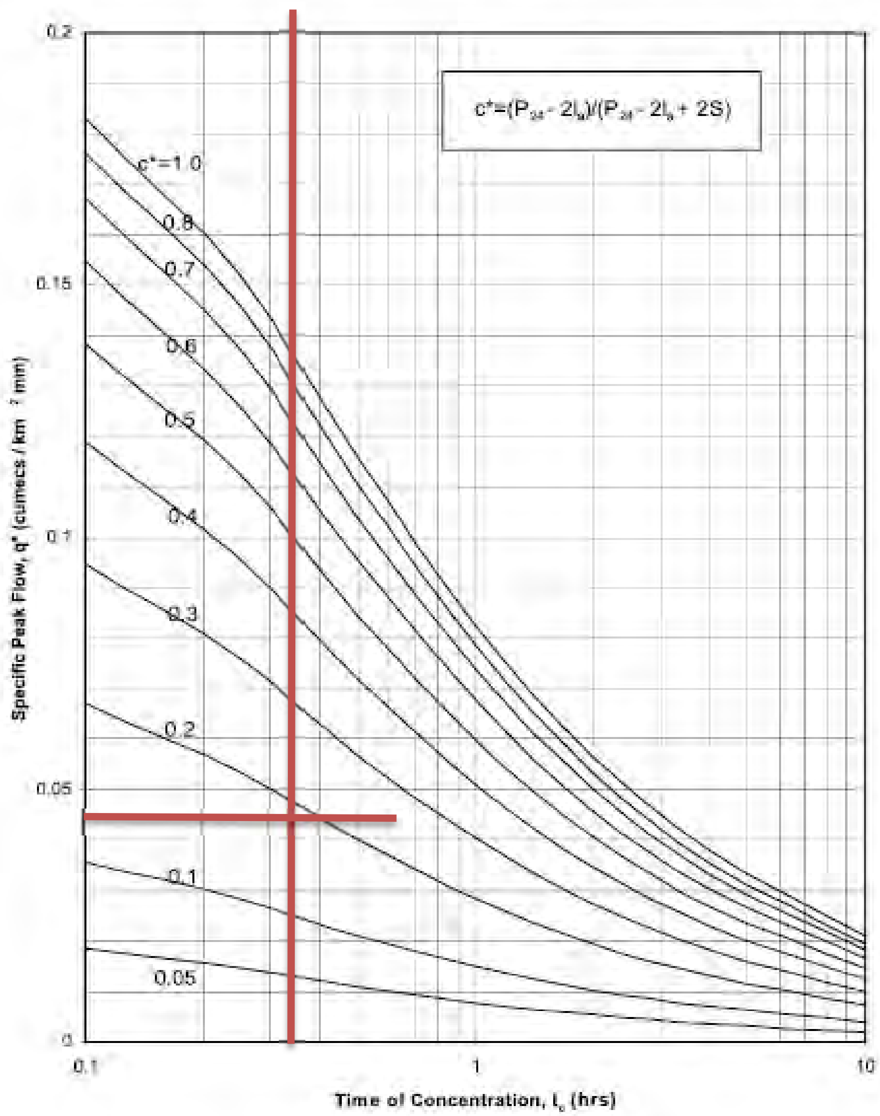


Figure 5.1 – Specific Peak Flow Rate

F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 7

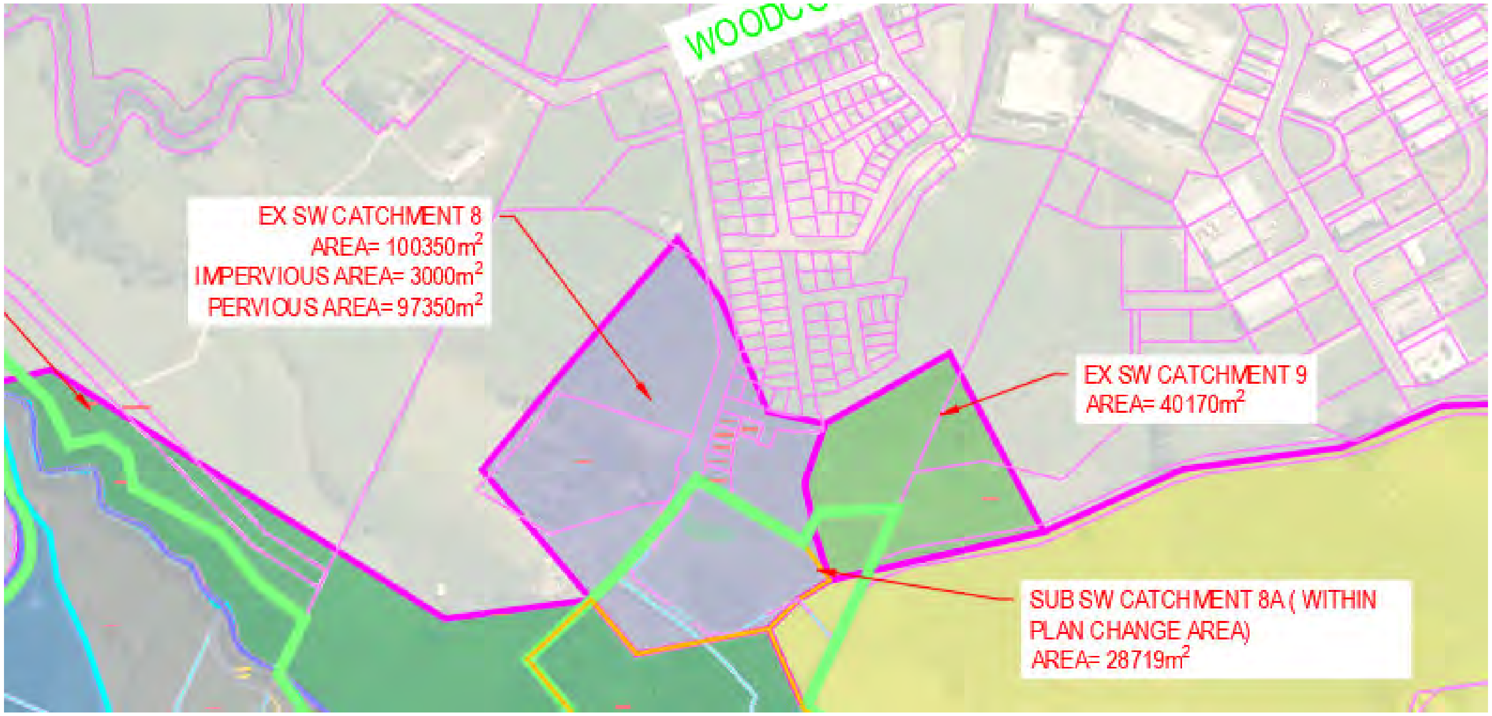
MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

Catchment	Area*	SMAF1 Detention volume (m3)**
8	100350	293
Total	100350	293

* the plan change area within this catchment is 28719m2

** the geotechnical report has indicate that there is limited infiltration on site. Hence the retention volume is added on top of the detention volume

post development MPD within the plan change area of catchment 8 is assumped to be 70% and area outside of plan change is assumped to be 5% where a large portion of this area still undevelop



F:\MAVEN\Projects\211001\Excel\tp108 for volume mitigation\221213 Detention SW CALC TP108 Catchment 8

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev C
Job Title / Calc Title: WARKWORTH SOUTH PCA / PRE TO POST SW RUN-OFF / CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.5018	49.17
C	Open space (Pervious)	74	9.5333	705.46
* from Appendix B		Totals =	10.0350	754.63

CN (weighted) = total product / total area = 754.63 / 10.035 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 9.5333 / 10.035 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.351 km (along drainage path)

Catchment Slope Sc= 0.057 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.50 1.32 2.36 = 0.22 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.15 hrs

8.80 mins

OK

use

0.22 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

1. Data
   - Catchment Area — A= 0.10035 km2(100ha =1km2)
   - Runoff curve number — CN= 75.2 (from worksheet 1)
   - Initial abstraction — Ia= 4.8 mm (from worksheet 1)
   - Time of concentration — tc= 0.22 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 83.8 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. <u>24 hour rainfall depth</u>	42				(mm)
Climate change %					
24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.16				
6. Specific peak flow rate q*	0.044				
7. Peak flow rate, q_p=q*A*P_{24}	**0.185**				m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	11.5				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1150.61				(m3)

Worksheet 2: Graphical Peak Flow Rate

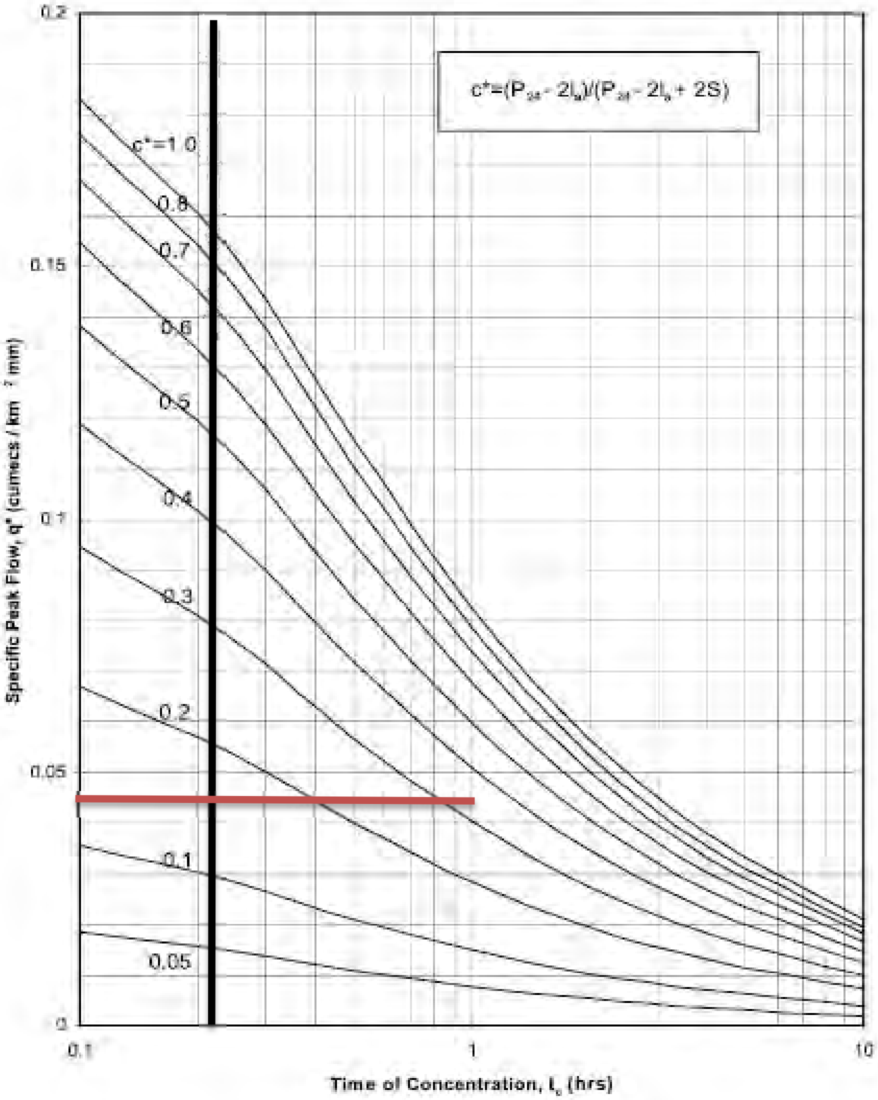


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 4	Rev C
Job Title Calc Title	WARKWORTH SOUTH PCA PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	2.5121	246.18
C	Grass (landscape and gardens)	74	7.5229	556.70
* from Appendix B		Totals =	10.0350	802.88

CN (weighted) = total product / total area = 802.88 / 10.035 = 80.0

Ia (average) = 5 x pervious area / total area = 5 x 7.5229 / 10.035 = 3.7 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.351 km (along drainage path)

Catchment Slope Sc= 0.057 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 80.0 / 200- 80.0 = 0.67

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.50 1.25 2.36 = 0.12 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.08 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 5	Rev C
Job Title: WARKWORTH SOUTH PCA Calc Title: PRE TO POST SW RUN-OFF CATCHMENT 8	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.10035	km2(100ha =1km2)
Runoff curve number	CN=	80.0	(from worksheet 1)
Initial abstraction	Ia=	3.7	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 63.5 mm

3. Average recurrence interval, ARI	95th %				(yr)
4. 24 hour rainfall depth	42				(mm)
P24					(%)
4. 24 hour rainfall depth, P24	42				(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.21				
6. Specific peak flow rate q*	0.063				
7. Peak flow rate, q_p=q*A*P_{24}	0.266				m3/s
PEAK FLOW RATE PRE DEV=	0.185				
PRE TO POST FLOW RATE=	**0.081**				
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	14.4				mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1443.48				(m3)
RUNOFF VOLUME PRE DEV=	1150.61				
PRE TO POST VOLUME=	**292.87**				

Worksheet 2: Graphical Peak Flow Rate

APPENDIX D – FLOOD MODELLING REPORT

STORMWATER MODELLING REPORT

FOR

PROPOSED WARKWORTH SOUTH

PLAN CHANGE AREA

Maven Associates	Job Number 211001		Rev G
Job Title 1711 & 1723 State Highway 1, Warkworth Plan Change Area **Title** Stormwater Modelling Report	**Author** YW	**Date** 18.01.23	**Checked** LC

CONTENTS

1 INTRODUCTION

1.1 PROJECT

Maven Associates have been engaged to assist in the development of a plan change application including determining setting baseline scenarios for predevelopment scenarios in various storm events and assessing the effects of development specific to the proposed plan change area (PCA) at 1711 & 1723 State Highway 1, Warkworth. Figure 1.1 shows the study area.

The objective of this report is to provide a preliminary analysis of the overland flowpaths in terms of peak flows and water level constraints. This will enable the assessment of mitigation measures required to ensure the proposal does not result in any adverse effect on the downstream properties. The analysis will be for a range of annual return period storms and include rainfall increases due to climate change.

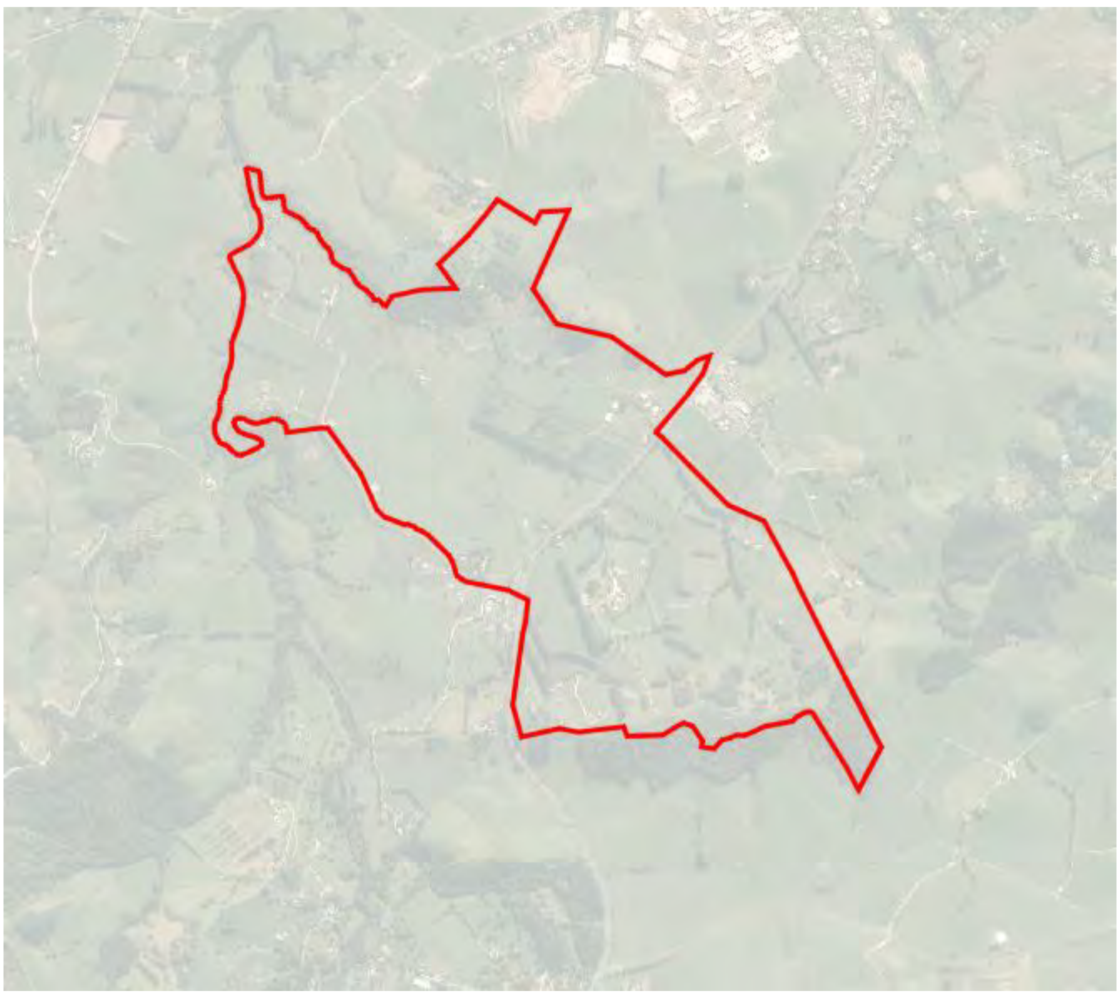


Figure 1.1 – Catchment Delineation

1.2 PREVIOUS STUDY

A Rapid Flood Hazard Assessment was undertaken by DHI in 2009. This was done on a 10m grid. This assessment did not include either climate change or land development changes.

1.3 PROPOSED STRATEGY

A 2D model will be used in the area around the Scheme Plan boundary. This will enable the identification of all overland flowpaths. The upper catchment area will be modelled as individual catchments to provide boundary inflows. All analyses will be done using TP108, HEC-HMS and HEC-RAS in accordance with guidelines of the Auckland Council Stormwater Code of Practice.

1.4 SCENARIOS MODELLED

Table 1.1 shows the scenarios modelled. Scenarios will indicate the difference between today's existing flow environment and the future.

Scenario	**Return period**	**Land-use**	**Rainfall**
1	100-year	Existing	Existing - historical
2	100-year	Existing	Climate change
3	100-year	Developed	Climate change
4	50-year	Developed	Climate change
5	20-year	Developed	Climate change
7	10-year	Developed	Climate change
8	100-year	Developed	Existing - historical
9	10-year	Developed	Existing - historical
10	10-year	Existing	Existing - historical

Table 1.1 – Scenarios modelled

1.5 SOURCES OF DATA

Attribute	**Organisation**
Catchment Plans	Auckland Council Geomaps
Contours	LINZ DEM 1m. The Terrain datum is New Zealand Vertical Datum. LiDAR/Site Survey by Parrallax Ltd. LiDAR/Site Survey by Maven Associates.
Flow & WL data	Healthywaters
Flood level evidence	None

Table 1.2 – Source of Data

1.6 REFERENCE TECHNICAL DOCUMENTS

- AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION. CHAPTER4 – STORMWATER, VERSION 3.00
- ACCEPTABLE SOLUTIONS AND VERIFIABLE METHODS, DOCUMENT E1 SURFACE WATER, MINISTRYOF BUSINESS, INNOVATION AND EMPLOYMENT,
- AUCKLAND COUNCIL TP108

2 HYDROLOGICAL MODELLING WITH HEC-HMS

2.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the catchments,
2. Use Tp108 to calculate parameters,
3. Use HEC-HMS to create a rainfall hyetograph and flow hydrographs,

2.2 RAINFALL DATA

TP108 gives the following rainfall depths which are then adjusted for climate change as shown in Table 2.2. Climate change factor have been applied in accordance with Auckland Council code of practice (Version 3) assuming a 2.1°C increase in temperature as shown below;

Annual Exceedance probability exceedance	Percentage Increase in 24-hour design rainfall depth due to future climate change*
50%	9.0%
10%	13.2%
5%	15.1%
2%	16.8%
1%	16.8%

* Assuming 2.1°C increase in temperature

Table 2.1 - Climate change factors

In accordance with TP108 section 2.3 an areal reduction factor (ARF) has been applies as the catchment has an area above 10 km2. ARF adjusted rainfalls are also shown in table 2.2. An ARF factor of 0.92 was used per TP108 table 2.2.

	TP108	Climate change	ARF adjusted
2-year	112	122	112
10-year	170	192	176
20-year	208	239	220
50-year	238	278	256
100-year	270	315	290

Table 2.2 – Rain depths

2.3 CATCHMENT SIZE

Figure 2.1 shows the catchment area modelled. Naming conventions of the subcatchments have been split between upstream and downstream of the PCA. The upper catchments are named upstream A to F and downstream catchments, downstream A to H. The yellow area (including the red boundary) is the 2D grid with the excess *Rain*. The catchment outflow of the Mahurangi River is at the northern edge. The Scheme Plan boundary is blue. The total area is 49km^2.

2.4 LAND-USE AND SOILS

The soil is assumed to be Group C with a curve number of 74. The land cover for the existing scenario has been obtained via delineation of impervious areas shown on the Auckland Council GIS aerial. The land-use is predominantly Rural-production and Rural-coastal with a small area of conservation, according to the AUP, see Figure 2.2. For the proposed scenario, the MPD (maximum probable development) of the proposed zoning has been used as well as MPD for the yellow designated FutureUrban. The FutureUrban zoning included in the developed scenarios assumes an average impervious area of 60%. The combined curve numbers and initial abstractions have been calculated according to TP108 and may be found in appendix D based on existing and developed land-use. Only catchments *Rain* and upstream catchment *F* will have a change in impervious area.

The full TP108 details to calculate the peak flows and times of concentration may be found in Appendix D. The total catchment area and the time of concentration suggests an area reduction factor of 0.92. This has been applied to the rainfall as per Table 2.2. This data can now be inserted into a HEC-HMS model.

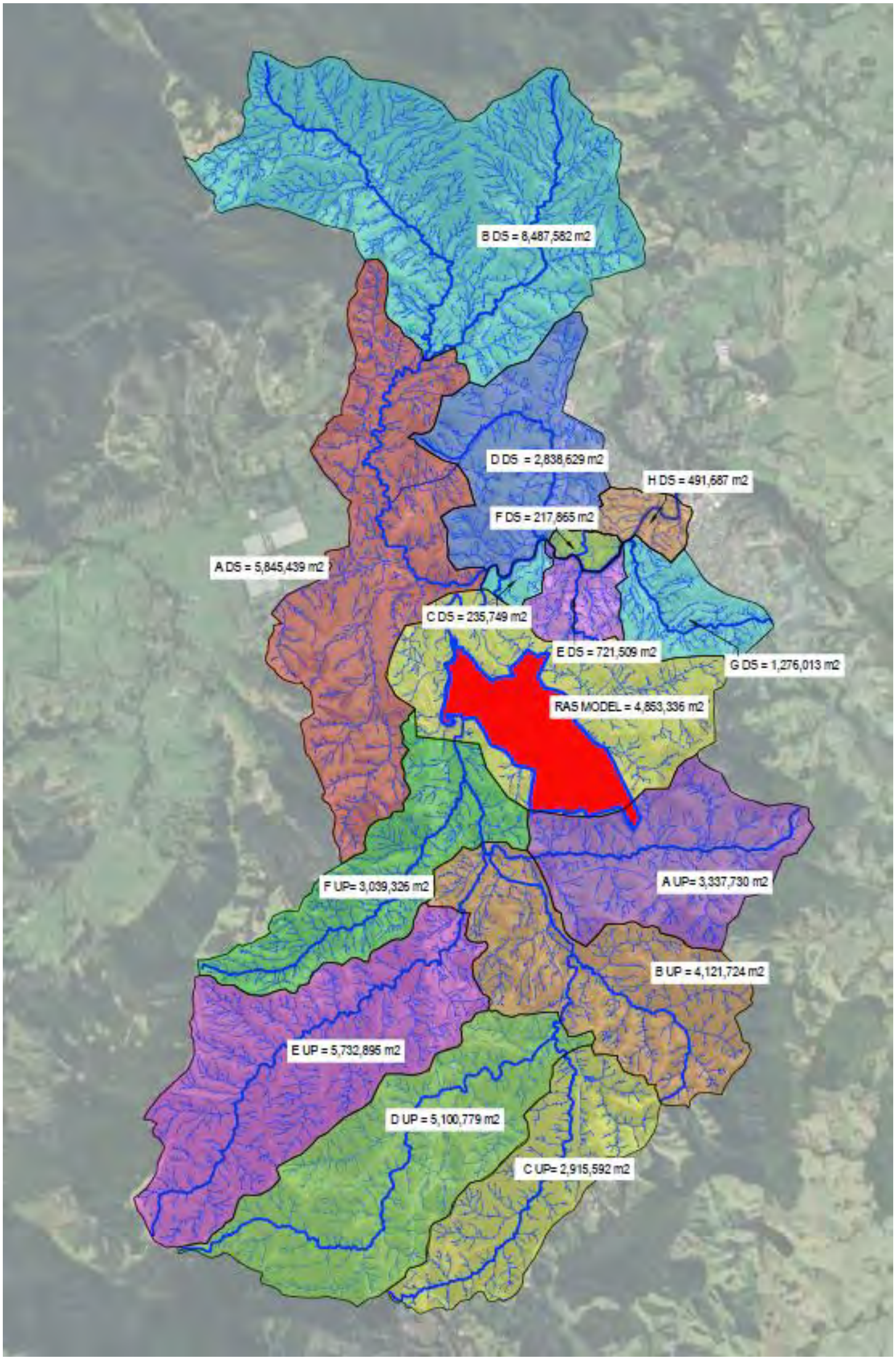


Figure 2.1 – Catchment Boundary

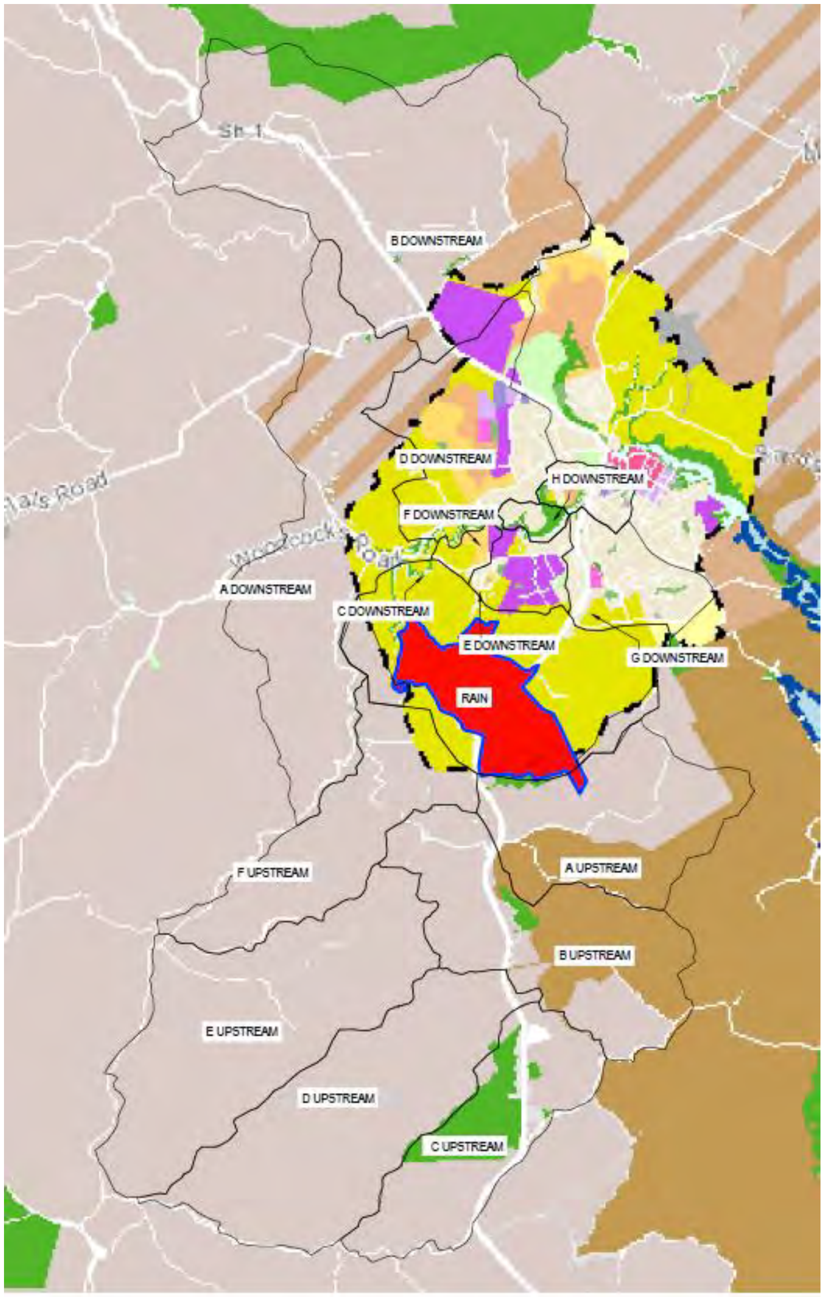


Figure 2.2 – Land-use zones

		Upstream of PCA							Downstream of PCA							
	Impervious %	Rain	A	B	C	D	E	F	A	B	C	D	E	F	G	H
Total		485	334	412	292	510	573	304	585	849	24	284	72	22	128	49
Rural / Vegetated area	1%	471	331	405	291	481	572	302	581	845	12	276	27	22	15	10
Urban MPD	60%	0	0	0	0	0	0	0	0	0	12	5	0	0	113	39
Open Space - Conservation	1%	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transort Corridor	90%	13	3	7	1	0	0	2	4	4	0	3	0	0	0	0
Residential - Large Lot	35%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Single House	60%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Mixed Housing Urban	60%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Terrace & Apartment	70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Business - Local Centre Zone	100%	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Impervious		16.42	6.01	10.35	3.81	4.81	5.72	4.82	9.41	12.05	7.32	8.46	45.27	0.22	67.71	23.60
Pervious		468.91	327.76	401.82	287.75	505.27	567.57	299.11	575.13	836.71	16.25	275.40	26.88	21.57	59.89	25.57

Figure 2.3 – Existing land use calculations

		Upstream of PCA							Downstream of PCA							
	Impervious %	Rain	A	B	C	D	E	F	A	B	C	D	E	F	G	H
Total		485	334	412	292	510	573	304	585	849	24	284	72	22	128	49
Rural / Vegetated area	1%	51	331	405	291	481	572	285	581	845	12	276	27	22	15	10
Urban MPD to	60%	276	0	0	0	0	0	17	0	0	12	5	0	0	113	39
Open Space - Conservation	1%	5.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transort Corridor	90%	13.0	3	7	1	0	0	2	4	4	0	3	0	0	0	0
Residential - Large Lot	35%	13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Single House	60%	22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Mixed Housing Urban	60%	74.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Terrace & Apartment	70%	25.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Business - Local Centre Zone	100%	3.4	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Impervious		261.76	6.01	10.35	3.81	4.81	5.72	15.10	9.41	12.05	7.32	8.46	45.27	0.22	67.71	23.60
Pervious		223.57	327.76	401.82	287.75	505.27	567.57	288.83	575.13	836.71	16.25	275.40	26.88	21.57	59.89	25.57

Figure 2.4 – Developed land use calculations

2.5 HEC-HMS MODEL

The data was then transferred to HEC-HMS. Figure 2.5 shows the model set-up. Calculations for the time of concentration of the reaches may be found in Appendix D. The reaches between junctions have been incorporated respectively to reflect the time it would take to arrive at the downstream connection.

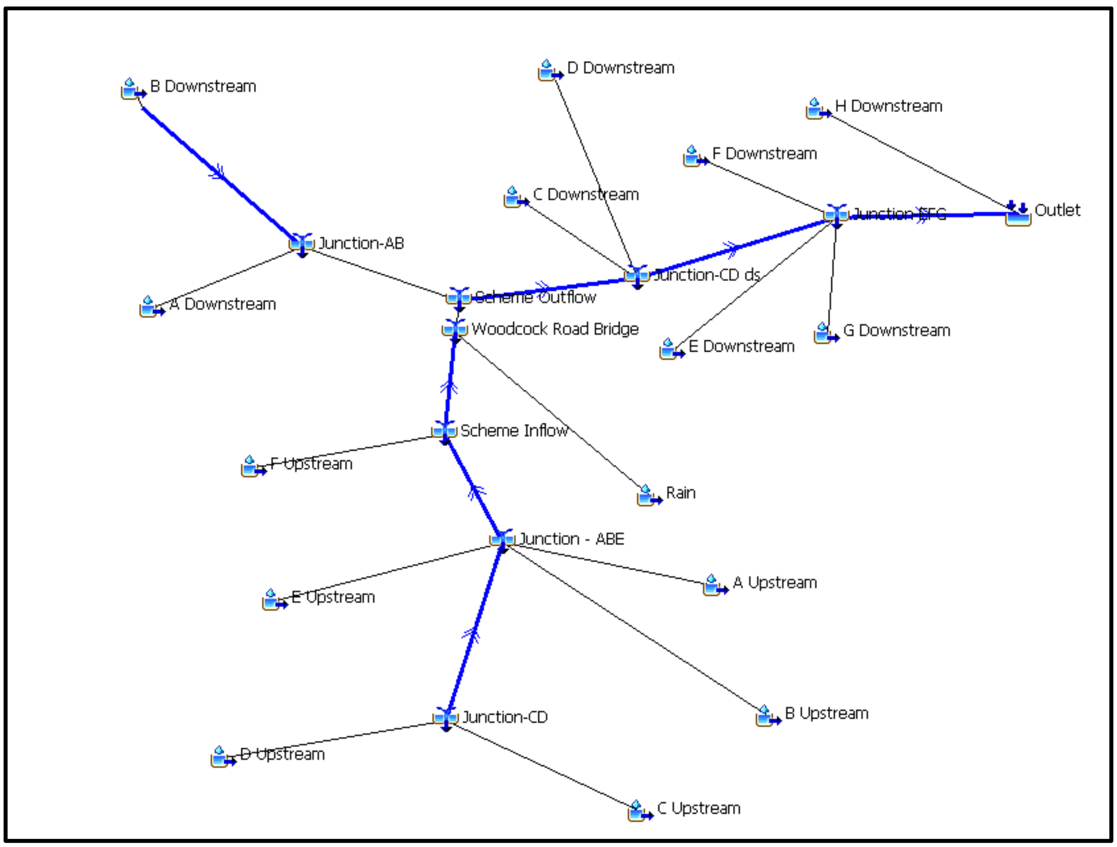


Figure 2.5 – HEC-HMS model set-up

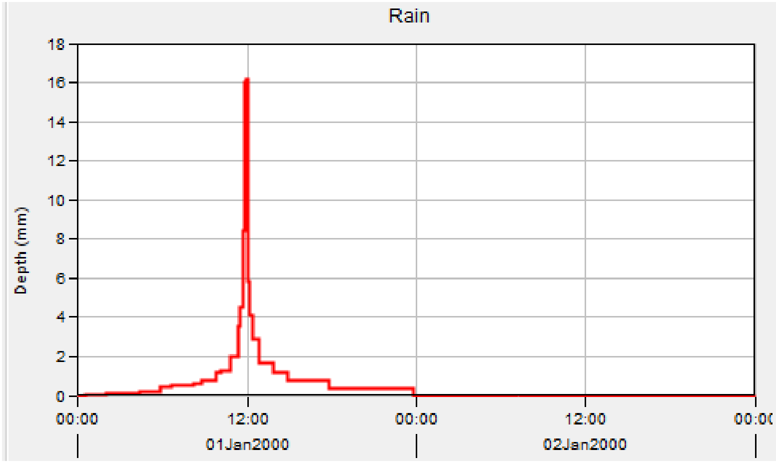


Figure 2.6 shows the 100-year developed land-use rainfall hyetograph for the grid.

Figure 2.6 – Rainfall excess, 100-year, climate change, developed

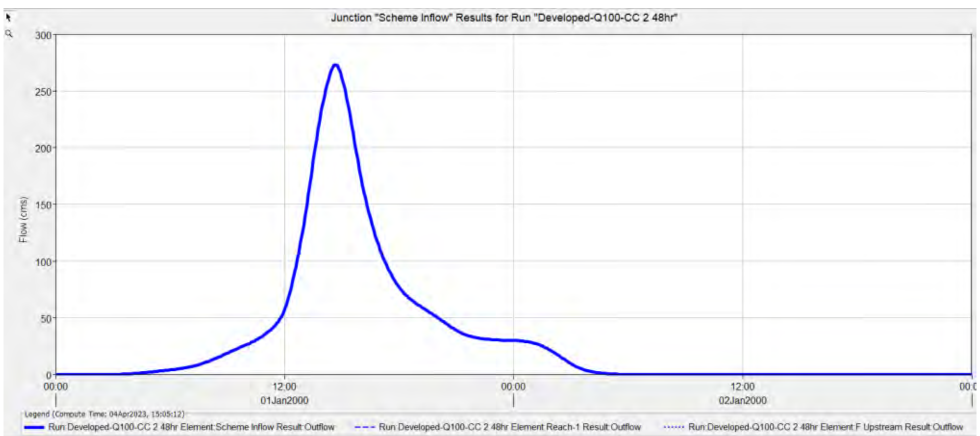


Figure 2.7 shows the hydrograph for scheme inflow for the 100-year storm with climate change rain and developed.

Figure 2.7 – Flow hydrograph, 100-year, climate change, developed

2.5.1 Effects of climate change

Figure 2.8 shows the global summary of the existing catchment flows against those that are expected to occur due to climate change and development. The scheme inflow has increased from 224m^3/s to 273m^3/s. Most of the 49m^3/s increase is due to climate change. The volume increase is almost 0.91 million m^3.

At the scheme outflow the changes are 347m^3/s to 421m^3/s. Thus, the catchment is expected to yield 74m^3/s, (this entire increase is due to climate change as explained in section 2.5.2). This increase is 17%. The volume increase is 1.6 million m^3.

Figure 2.8 – Global summary of flows and volumes for the 100-year storm (historical rain, existing land-use vs climate change rain and existing land-use vs. historical rain, proposed land-use vs climate changed rain and developed)

Global Summary Results for Run "Existing-Q100-existing"

Project: Warkworth South   Simulation Run: Existing-Q100-existing

Start of Run: 01Jan2000, 00:00   Basin Model: Existing Land-Use
End of Run: 03Jan2000, 00:00   Meteorologic Model: 100yr-existing-existing-land
Compute Time: 19Jul2023, 13:37:48   Control Specifications: 24hr

Show Elements: All Elements   Volume Units: MM 1000 M3   Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.845	55.714	1 January 2000, 13:50	1045.239
A Upstream	3.338	36.862	1 January 2000, 13:20	596.881
B Downstream	8.488	91.342	1 January 2000, 13:25	1515.594
B Upstream	4.122	46.674	1 January 2000, 13:20	739.118
C Downstream	0.236	5.013	1 January 2000, 12:25	46.655
C Upstream	2.916	35.384	1 January 2000, 13:10	520.626
D Downstream	2.839	36.462	1 January 2000, 13:00	509.696
D Upstream	5.101	56.151	1 January 2000, 13:20	909.088
E Downstream	0.722	16.171	1 January 2000, 12:25	157.655
E Upstream	5.733	58.755	1 January 2000, 13:35	1021.743
F Downstream	0.218	4.582	1 January 2000, 12:20	38.855
F Upstream	3.039	38.647	1 January 2000, 13:00	543.469
G Downstream	1.276	25.093	1 January 2000, 12:30	270.600
H Downstream	0.492	11.328	1 January 2000, 12:20	102.645
Junction - ABE	21.209	209.162	1 January 2000, 13:55	3787.456
Junction-AB	14.333	132.158	1 January 2000, 14:50	2560.833
Junction-CD	8.016	90.794	1 January 2000, 13:15	1429.714
Junction-CD ds	46.509	356.995	1 January 2000, 16:05	8321.218
Junction-EFG	48.725	361.625	1 January 2000, 16:55	8788.329
Outlet	49.216	362.659	1 January 2000, 17:35	8890.974
Rain	4.853	54.418	1 January 2000, 13:20	873.110
Reach-1	21.209	208.985	1 January 2000, 14:40	3787.456
Reach-2	8.016	90.655	1 January 2000, 14:20	1429.714
Reach-3	8.488	91.306	1 January 2000, 15:00	1515.594
Reach-4	24.249	225.278	1 January 2000, 15:55	4330.925
Reach-5	43.435	348.691	1 January 2000, 16:10	7764.868
Reach-6	46.509	356.945	1 January 2000, 16:55	8321.218
Reach-7	48.725	361.625	1 January 2000, 17:35	8788.329
Scheme Inflow	24.249	225.278	1 January 2000, 14:40	4330.925
Scheme Outflow	43.435	348.781	1 January 2000, 15:30	7764.868
Woodcock Road Bridge	29.102	243.581	1 January 2000, 15:50	5204.035

Global Summary Results for Run "Developed-Q100-existing"

Project: Warkworth South Simulation Run: Developed-Q100-existing

Start of Run: 01Jan2000, 00:00 Basin Model: Developed Land-Use
End of Run: 03Jan2000, 00:00 Meteorologic Model: 100yr-existing-existing-land
Compute Time: 19Jul2023, 13:37:45 Control Specifications: 24hr

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.845	55.714	1 January 2000, 13:50	1045.239
A Upstream	3.338	36.862	1 January 2000, 13:20	596.881
B Downstream	8.488	91.342	1 January 2000, 13:25	1515.594
B Upstream	4.122	46.674	1 January 2000, 13:20	739.118
C Downstream	0.236	5.013	1 January 2000, 12:25	46.655
C Upstream	2.916	35.384	1 January 2000, 13:10	520.626
D Downstream	2.839	36.462	1 January 2000, 13:00	509.696
D Upstream	5.101	56.151	1 January 2000, 13:20	909.088
E Downstream	0.722	16.171	1 January 2000, 12:25	157.655
E Upstream	5.733	58.755	1 January 2000, 13:35	1021.743
F Downstream	0.218	4.582	1 January 2000, 12:20	38.855
F Upstream	3.039	39.328	1 January 2000, 13:00	549.792
G Downstream	1.276	25.093	1 January 2000, 12:30	270.600
H Downstream	0.492	11.328	1 January 2000, 12:20	102.645
Junction - ABE	21.209	209.162	1 January 2000, 13:55	3787.456
Junction-AB	14.333	132.158	1 January 2000, 14:50	2560.833
Junction-CD	8.016	90.794	1 January 2000, 13:15	1429.714
Junction-CD ds	46.509	356.525	1 January 2000, 16:05	8486.109
Junction-EFG ds	48.725	361.134	1 January 2000, 16:55	8953.220
Outlet	49.216	362.168	1 January 2000, 17:35	9055.865
Rain	4.853	68.200	1 January 2000, 13:10	1031.679
Reach-1	21.209	208.985	1 January 2000, 14:40	3787.456
Reach-2	8.016	90.655	1 January 2000, 14:20	1429.714
Reach-3	8.488	91.306	1 January 2000, 15:00	1515.594
Reach-4	24.249	225.289	1 January 2000, 15:55	4337.247
Reach-5	43.435	348.169	1 January 2000, 16:10	7929.758
Reach-6	46.509	356.454	1 January 2000, 16:55	8486.109
Reach-7	48.725	361.134	1 January 2000, 17:35	8953.220
Scheme Inflow	24.249	225.289	1 January 2000, 14:40	4337.247
Scheme Outflow	43.435	348.268	1 January 2000, 15:30	7929.758
Woodcock Road Bridge	29.102	242.998	1 January 2000, 15:50	5368.926

Global Summary Results for Run "Developed-Q100-CC"

Project: Warkworth South   Simulation Run: Developed-Q100-CC

Start of Run: 01Jan2000, 00:00   Basin Model: Developed Land-Use
End of Run: 03Jan2000, 00:00   Meteorologic Model: 100yr-CC-developed-land-use
Compute Time: 19Jul2023, 13:37:44   Control Specifications: 24hr

Show Elements: All Elements   Volume Units: MM 1000 M3   Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.845	67.891	1 January 2000, 13:50	1275.513
A Upstream	3.338	44.937	1 January 2000, 13:20	728.378
B Downstream	8.488	111.357	1 January 2000, 13:25	1849.780
B Upstream	4.122	56.845	1 January 2000, 13:20	901.669
C Downstream	0.236	6.011	1 January 2000, 12:25	56.238
C Upstream	2.916	43.112	1 January 2000, 13:10	635.423
D Downstream	2.839	44.413	1 January 2000, 13:00	621.694
D Upstream	5.101	68.484	1 January 2000, 13:20	1109.811
E Downstream	0.722	19.120	1 January 2000, 12:25	187.628
E Upstream	5.733	71.633	1 January 2000, 13:35	1247.341
F Downstream	0.218	5.578	1 January 2000, 12:20	47.430
F Upstream	3.039	47.852	1 January 2000, 13:00	670.018
G Downstream	1.276	29.809	1 January 2000, 12:30	323.317
H Downstream	0.492	13.482	1 January 2000, 12:20	122.895
Junction - ABE	21.209	254.787	1 January 2000, 13:55	4622.622
Junction-AB	14.333	160.933	1 January 2000, 14:45	3125.293
Junction-CD	8.016	110.711	1 January 2000, 13:15	1745.234
Junction-CD ds	46.509	433.327	1 January 2000, 16:05	10328.154
Junction-EFG ds	48.725	438.681	1 January 2000, 16:55	10886.529
Outlet	49.216	439.897	1 January 2000, 17:35	11009.424
Rain	4.853	80.989	1 January 2000, 13:10	1232.289
Reach-1	21.209	254.638	1 January 2000, 14:40	4622.622
Reach-2	8.016	110.516	1 January 2000, 14:15	1745.234
Reach-3	8.488	111.298	1 January 2000, 15:00	1849.780
Reach-4	24.249	274.228	1 January 2000, 15:55	5292.640
Reach-5	43.435	423.234	1 January 2000, 16:05	9650.223
Reach-6	46.509	433.171	1 January 2000, 16:55	10328.154
Reach-7	48.725	438.681	1 January 2000, 17:35	10886.529
Scheme Inflow	24.249	274.228	1 January 2000, 14:40	5292.640
Scheme Outflow	43.435	423.321	1 January 2000, 15:30	9650.223
Woodcock Road Bridge	29.102	295.252	1 January 2000, 15:50	6524.929

2.5.3 Effects of the proposed development

A graph of the flows at the scheme outflow of the existing catchment flow with climate change against flow of the developed catchment with climate change can be found in the appendix A, the table below summaries the findings.

Rain event	Land-use	Climate change	Catchments A-F (m3/s)	Rain (m3/s)	Woodcock bridge (m3/s) outflow	Scheme Outflow (m3/s)
100yr	Existing	No	225.3	54.4	243.6	348.8
100yr	Developed	No	225.3	68.2	243.0	348.3
100yr	Existing	Yes	274.2	66.3	296.4	424.4
100yr	Developed	Yes	274.2	81.0	295.3	420.6
10yr	Existing	No	121.1	38.6	128.1	184.3
10yr	Developed	No	121.1	48.8	129.2	185.7

Table 2.3 – Peak flow comparison, 10-year & 100-year, climate change, existing vs developed.

Table 2.3 shows that the peak flow for 100year storm events exiting the scheme area (Scheme outflow) decreases by 0.9m^3/s for the climate change scenario and decrease of 0.6m3/s for the scenario without climate change , even though there is an increase in impervious area of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F). As shown in figure 2.8, for the developed catchment, the 100year time of peak flow of the *Rain* catchment is 13:10 and for the upstream catchments, *A to F* (Reach 4) is 15:55. This demonstrates the peak flow from the *Rain* catchment exits the catchment boundary 2 hour 45 min prior to the arrival of upper catchment peak flow.

For the 10-year storm event (without climate change), the increase in impervious area from the development shows an increase in peak flow of 10.2 m3/s (from 38.6 m3/s to 48.8 m3/s) exiting the PCC. However, at the confluence to the stream (at Woodcock Road bridge) an increase in peak flow of 1.1 m3/s is shown. Similar to the 100year storm event effect described above the peak flow from the catchment upstream (A to F) of the PCC arrives at 15:55 later than the peak flow from the Rain catchment at 12:45.

Hydrographs for the described rain events may be found in Appendix A.

Downstream effects

Table 2.4 below shows the peak 100year stormwater events at the catchment junctions downstream of the site. Similarly to the effects described above the it is noted that the peak flows decrease as a result of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F).

Rain event	Land-use	Climate change	Downstream Junction CD (m3/s)	Downstream Junction EFG (m3/s)
10yr	Existing	No	188.0	190.8
10yr	Developed	No	189.4	192.2
100yr	Existing	No	354.7	359.4
100yr	Developed	No	352.3	358.9
100yr	Existing	Yes	431.7	437.1
100yr	Developed	Yes	430.6	436.0

Table 2.4 Peak 10yr & 100yr flows at junctions downstream of the proposed development

2.5.3 Localised event scenario

A localised event scenario has been modelled which includes an Upstream PCA 2yr event and a 100yr event within the PCA (rain catchment) and downstream catchments of the PCA 100yr ARI for before and post development, no climate change. These runs are considered necessary to understand the effects of the development on the existing scenarios.

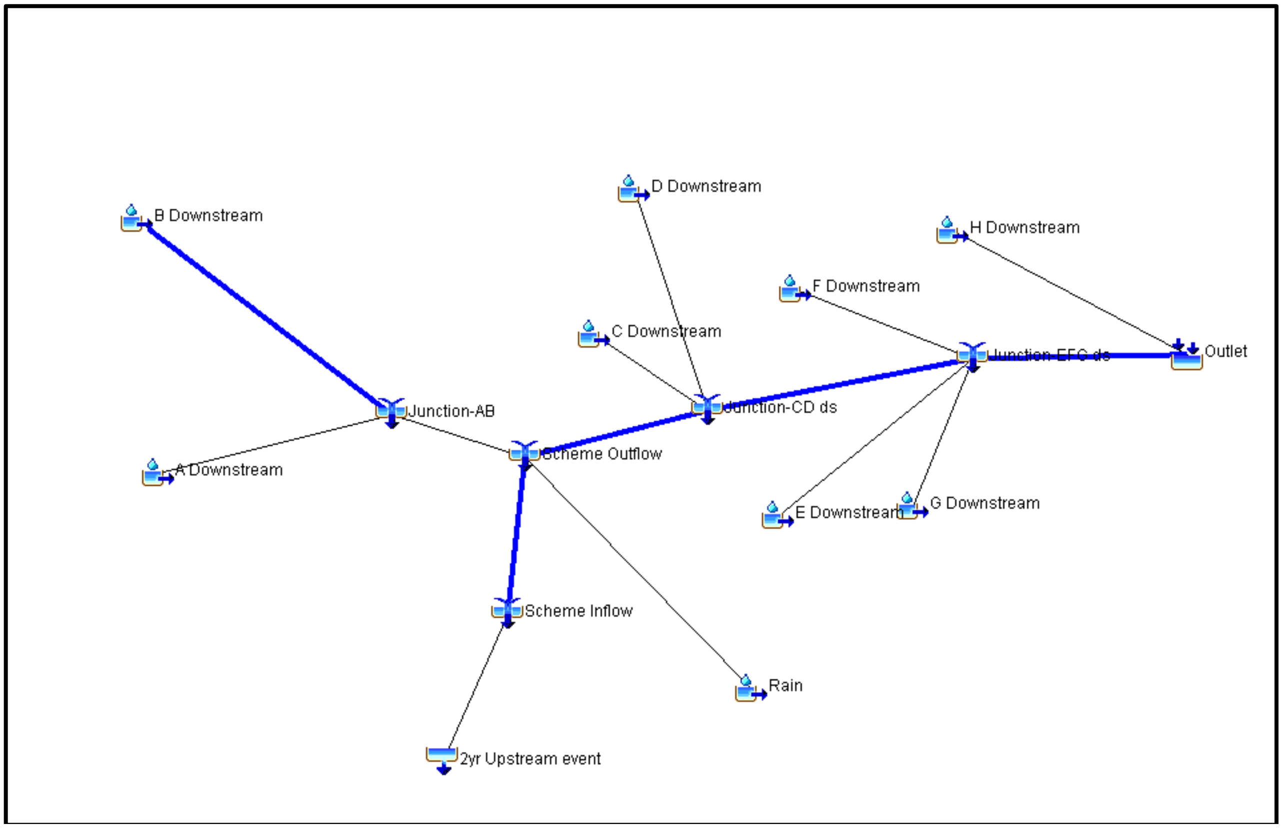


Figure 2.-9 Localised Event Scenario

Rain event	Land-use	Climate change	Scheme Outflow (m3 /s)	Downstream Junction CD (m3/s)	Downstream Junction EFG (m3/s)
100yr	Existing	No	212.6	222.8	227.6
100yr	Developed	No	212.4	222.6	227.4

Table 2.5 Peak 100yr flows at junctions downstream of the proposed development for a localised 100yr event scenario without climate change

Table 2.5 above shows the 100yr peak stormwater event for a localised 100yr event for the PCA area and downstream PCA area. Similarly to the effects described above the it is noted that the peak flows slightly decrease as a result of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F).

3 HYDRAULIC MODELLING WITH HEC-RAS

3.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the perimeter for the grid,
2. Create a grid and sub-grid areas,
3. Input flow hydrographs and other boundaries
4. Input structures,
5. Run scenarios.

3.2 HEC-RAS MODEL LAYOUT

HEC-RAS software was used to generate water levels throughout the catchment. A 2D model was developed using a combination of LINZ Terrain data and site-specific LiDAR and topographical survey. A Manning's n of 0.1 was used in the grid.A 5m x 5m grid was used. Figure 3.1 shows the grid and its boundary conditions. Appendix B shows culvert details used in the model.

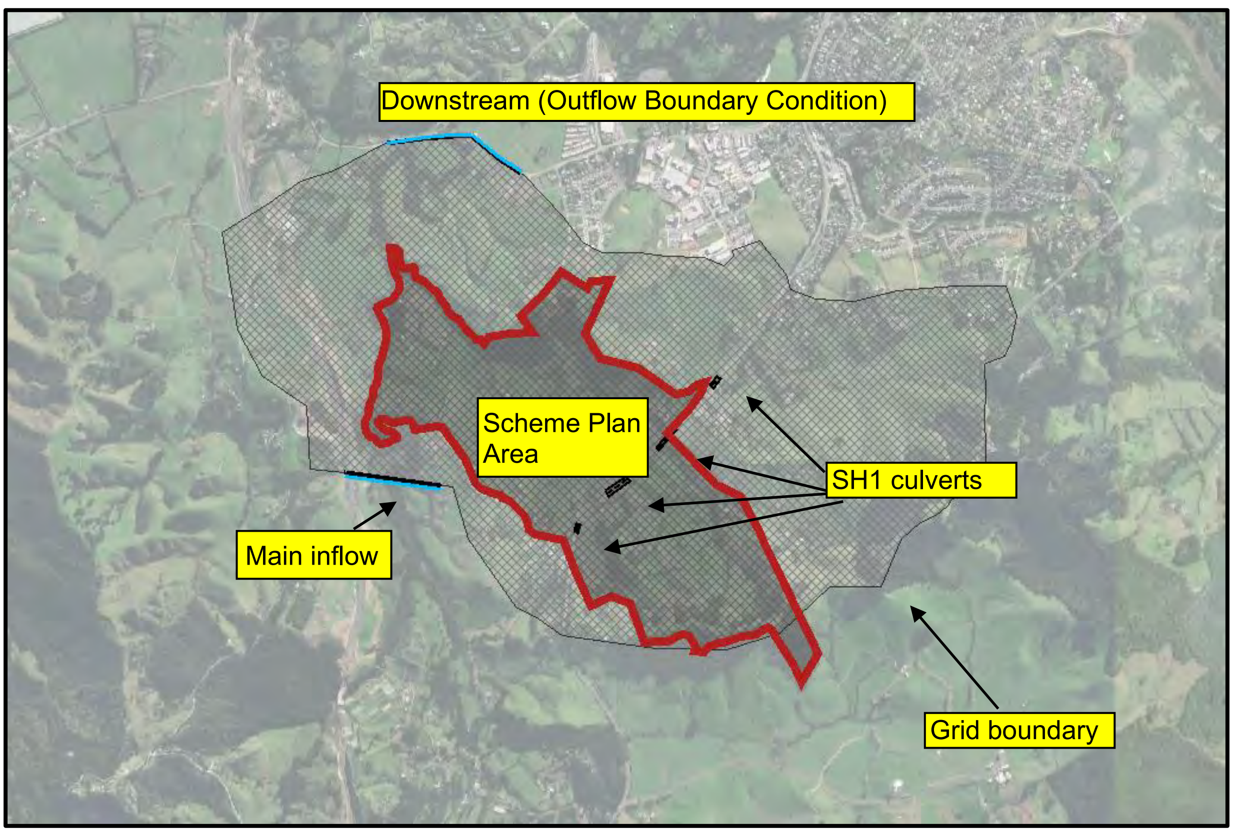


Figure 3.1 – HEC-RAS model set-up

3.3 BOUNDARIES

There are three boundaries. These are:

- Rain on grid – as per figure 3.1.
- Main inflow for Mahurangi river gradient of 0.004
- Downstream boundary using a normal depth method with a gradient of 0.004 (refer to figure 3.1 above for location).

  The outflow boundary condition is located at Woodcock bridge. Flow at the bridge has been assessed in section 3.8 confirming flow is unobstructed and freeflowing for all assessed scenarios.

3.4 FLOODPLAIN COMPARISON

Figure 3.2 compares the Geomaps floodplain against the 100-year storm for developed land and climate change rainfall. The patterns are similar. The flow at critical pinch points in the north-east at the confluence have similar widths.

The only difference of note is in the central scheme area, area A. Geomaps shows more flooding while the new model is more defined in the channels due to a specific site survey of the stream being modelled. In general, the new model appears to replicate the Geomaps floodplain.

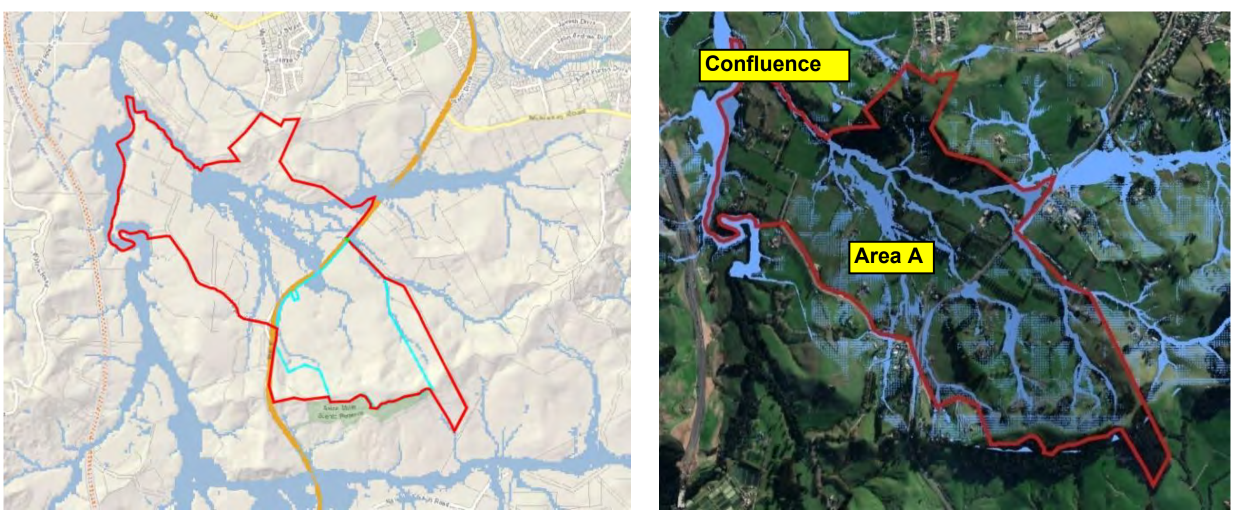


Figure 3.2 – Floodplain comparison – 100yr-storm

3.5 FLOW CHECK

All watercourse arrive at the point of confluence from the east making up about 332ha. The estimate TP108 graphical method 100-year peak flow is estimated at 47m^3/s. This is the existing rainfall and land-use. The modelled peak flow at this point is 53m^3/s. The model is higher than what TP108 estimates catchment run-off should be. However, the 2D terrain model uses a Manning's n of 0.1 which might be smoother than reality, but it also encourages higher flows. Importantly the model gives reasonable peak flows even though the finite volume method in HEC-RAS has pockets of water "stuck in hollows" inside the 5m grid. However, this does not affect the peak flow.

3.6 HYDRAULIC GRADE LINE

Figures 3.3 shows the HGL along the Mahurangi River on the west boundary of the scheme plan. The 100-year developed scenario ranges from RL32.4m to RL26.6m NZVD at a grade of 1 in 240. The range of water levels from 10-year to 100-year is about 1.3m.

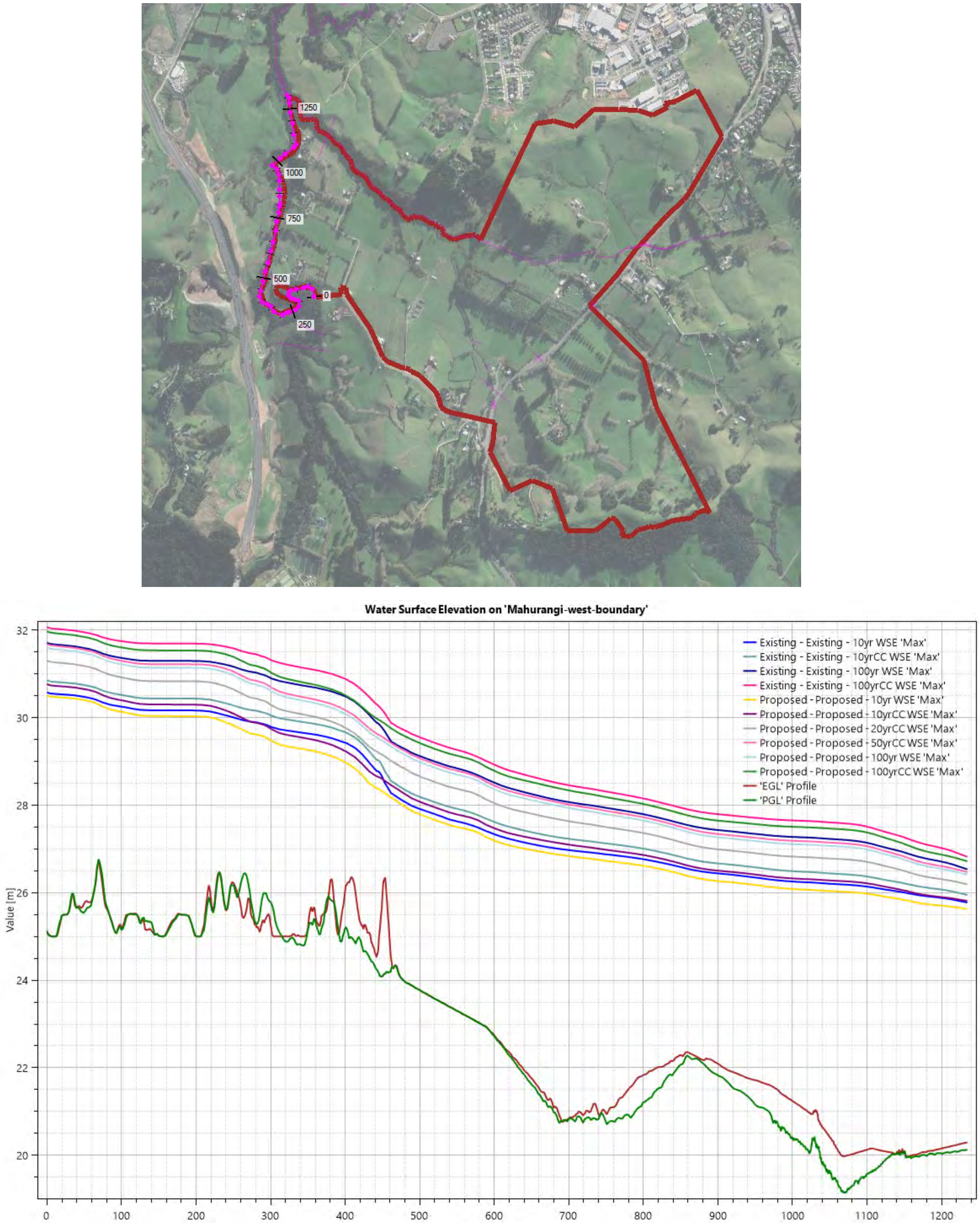


Figure 3.3 – HGL– Mahurangi River boundary (NZVD)

Figure 3.4 shows the HGL along the main scheme stream from east of the SH1 culverts across to the confluence with the Mahurangi River. The SH1 Culverts will cause a pond that is 200m long and 135m wide.

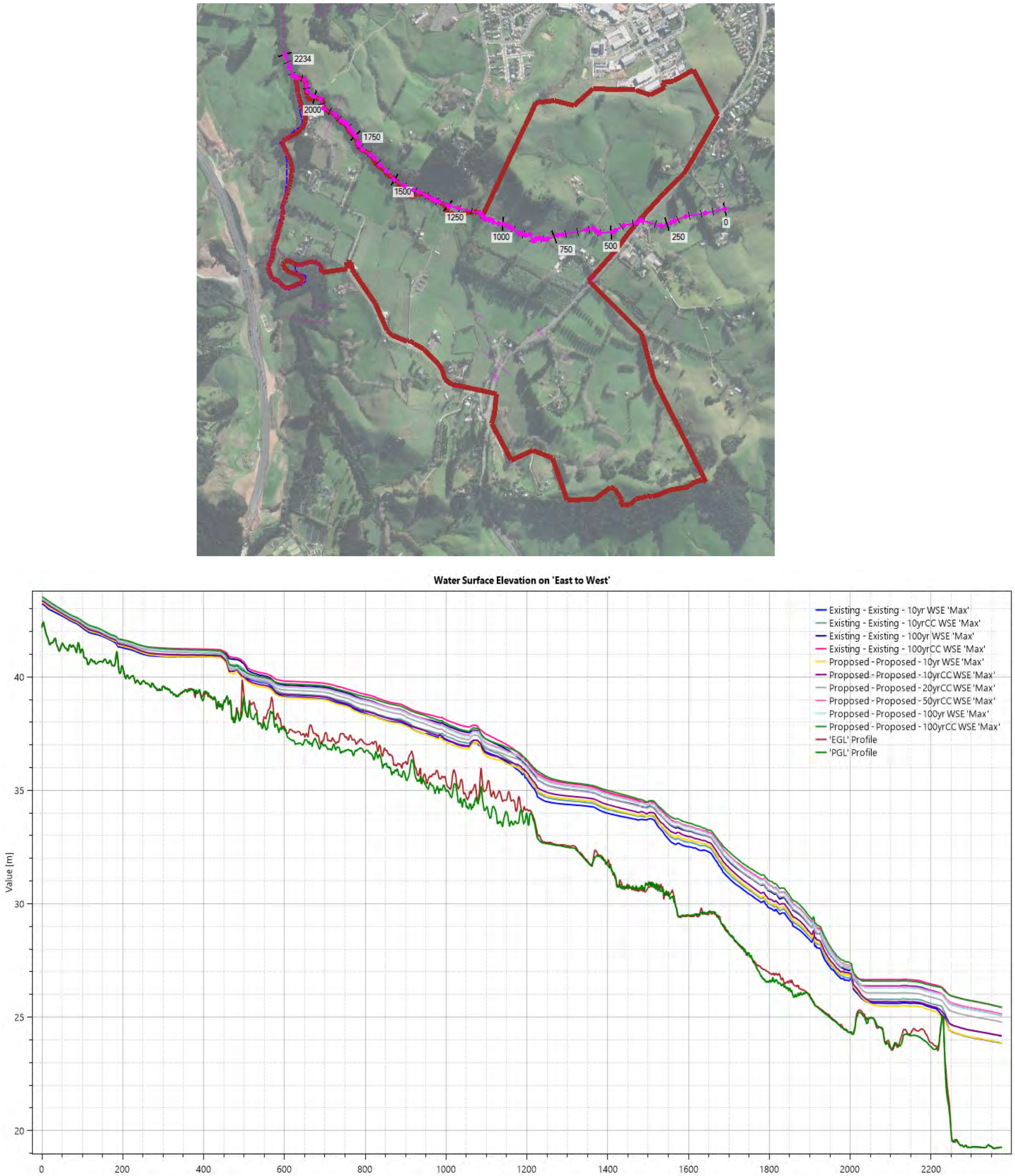


Figure 3.4 – HGL– Main east to west stream (NZVD)

3.7 FLOW HYDROGRAPHS

Figure 3.5 shows the flow hydrographs in the east-west stream just before the connection to the Mahurangi River. Table 3.1 below shows peak flows and time to peak at connection to Mahurangi River. The table shows increase in peak flows and a minor decrease in time of concentration as a results of the plan change.

As noted earlier in the report (refer to section 2.5), due to the large time of concentration difference between the plan change site and the overall catchment, the increase in peak flows produced from the proposed plan change has no effect on the peak flows downstream of the site.

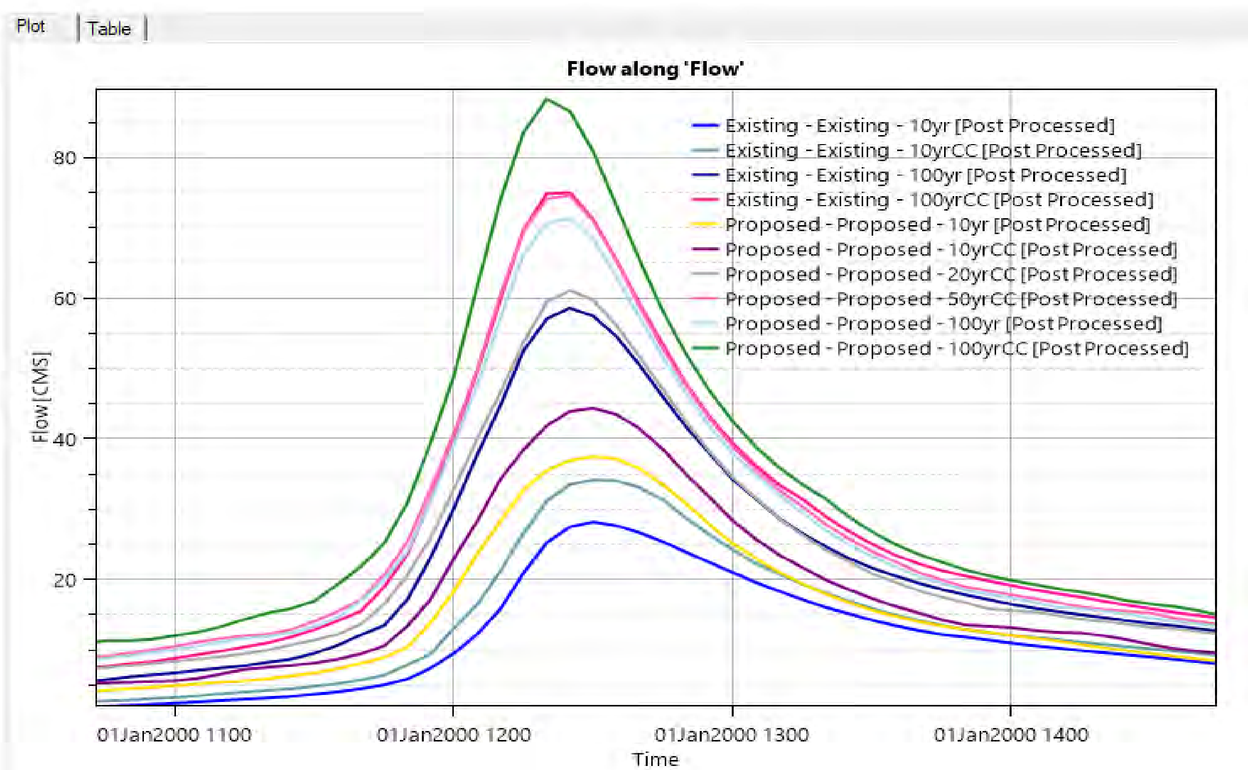


Figure 3.5 – Flow hydrograph for east-west stream outlet

Rain event	Land use	Climate change	Peak flow (m3/s)	Peak flow time (hr)
100yr	Developed	Yes	88.32	12:20
100yr	Developed	No	71.34	12:25
100yr	Existing	Yes	75.00	12:25
100yr	Existing	No	58.62	12:25
50yr	Developed	Yes	74.61	12:25
20yr	Developed	Yes	61.12	12:25
10yr	Developed	Yes	44.36	12:30
10yr	Developed	No	36.51	12:30
10yr	Existing	Yes	34.18	12:30
10yr	Existing	No	28.20	12:30

Table 3.1 HEC HMS Peak flows and times to peak

3.8 CHECK ON DOWNSTREAM LEVEL

The model grid stops at Woodcocks Road bridge. Plan C050 shows site topographical survey of the bridge and may be found in Appendix E. The road deck of the bridge has been surveyed to be RL23.52. The peak 1% AEP event with climate change flow level at this location has been calculated to a level of 19.31m for the existing and proposed scenario, this shows a freeboard of approximately 3.5m (between water surface and underside of bridge). We conclude there is sufficient freeboard to prevent any backwater effects.

3.9 CULVERTS CAPACITY ASSESSMENT

Cross sections showing water surface elevations across the four culverts through SH 1 maybe found in appendix B.

Cross sections indicate the two northern culverts (names Culvert north and Culvert mid) are under capacity and are overtopped for all modelled storm events (10yr through to 100yr). The next adjacent culvert to the south (culvert south) is show to only overtop during a 100yr event for the developed scenario. The southern most culvert is shown to have sufficient capacity for the developed scenario.

It is noted that the entire section of SH1 which is shown to be have under capacity culvert is proposed to be upgraded in the future by Auckland Transport once the road is eventually repurposed as an arterial road and the opening of Ara Tūhono – Pūhoi to Warkworth state highway.

3.10 OUTFLOW VOLUME VALIDATION

HEC-RAS uses an Implicit Finite Volume Algorithm. The consequence of this is to have small volumes of water in the base of a cell that does not escape. A method to remove the potential holding back of water is to run the models with low flows in the initial stages to fill the hollows. The main storm run-off can then flow over the top. This is not a problem as long as there is volume continuity.

Figure 3.6 shows the volume generated in HEC-HMS for the existing land-use and 100- year historical rainfall. The volume is 5,204,000m^3. Figure 3.7 shows the volume accumulated at the HEC-RAS downstream boundary after 36 hours of simulation. The volume is 5,153,000m^3. This is an error of 0.01% which is extremely small. The volume integrity is excellent.

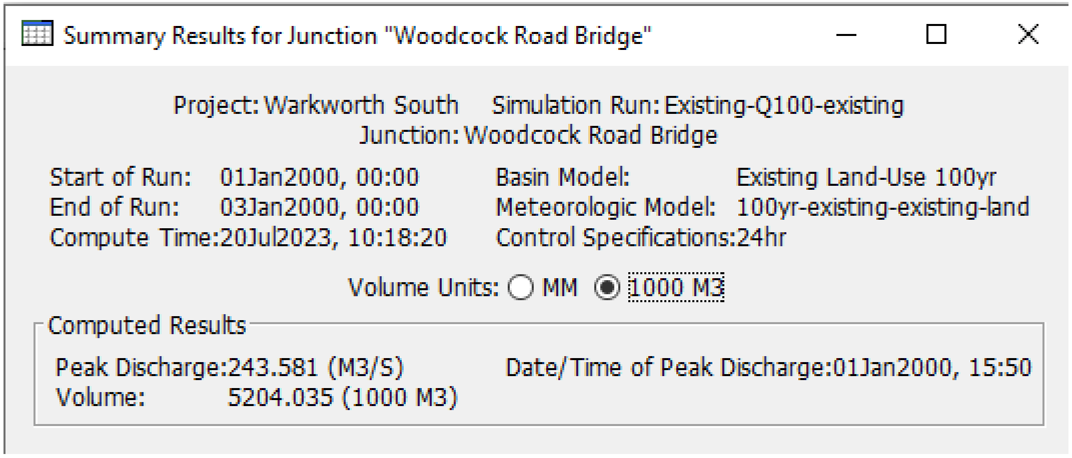


Figure 3.6 – HEC-HMS volume of run-off

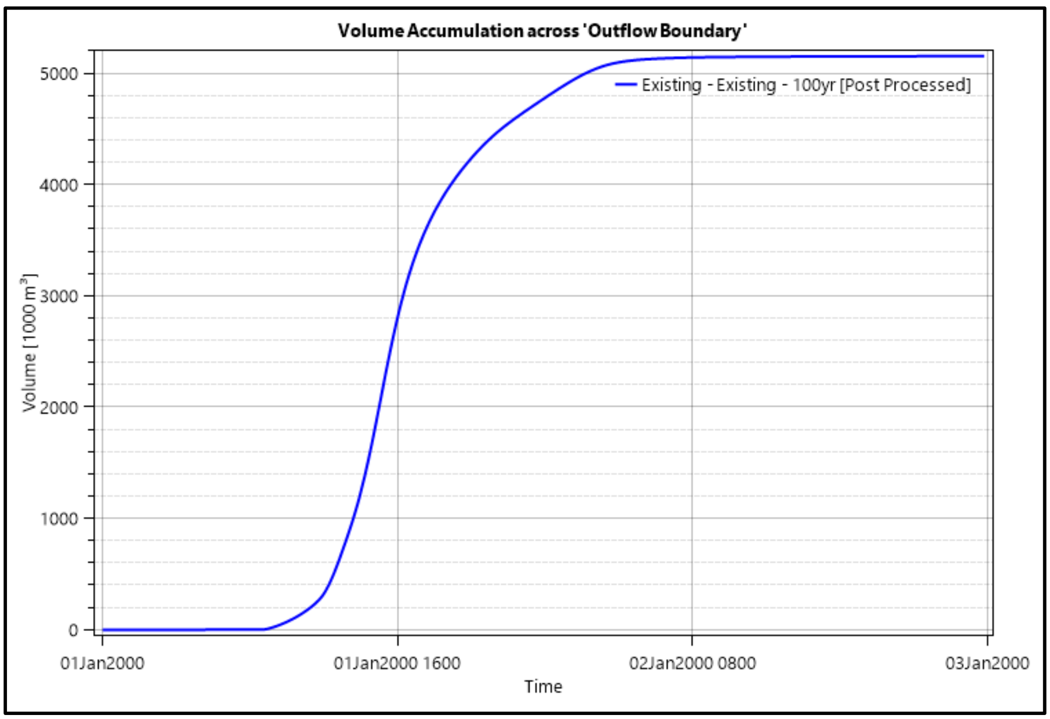


Figure 3.7 – HEC-RAS outflow boundary cumulative volume

3.11 HEALTHY WATERS MODELLING

Auckland Council HealthyWaters have supplied flow data of their modelling of the Warkworth catchment, for Mahurangi River. A comparison of this reports results and Healthywaters are summarised in the table below;

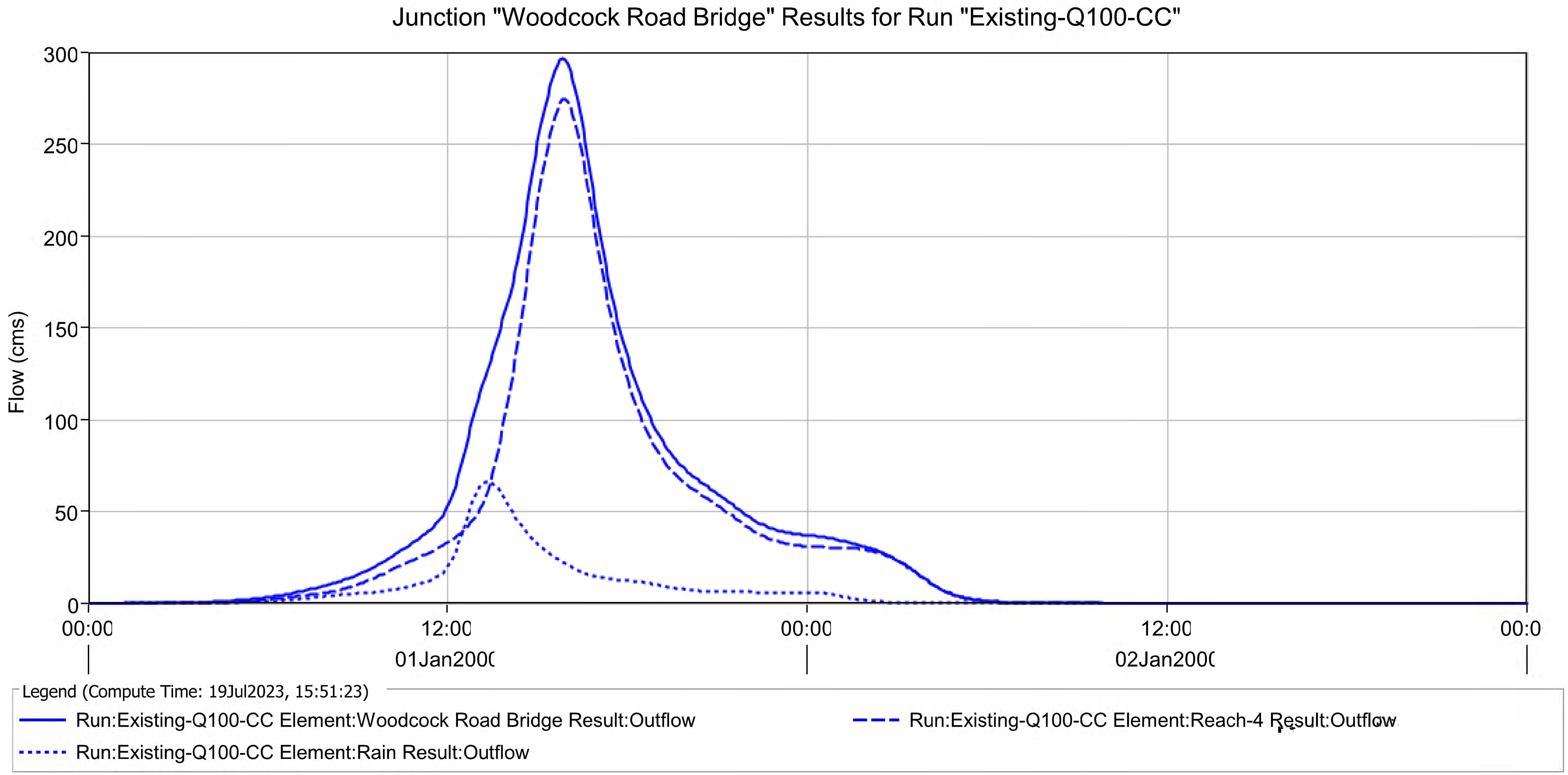
	XS 95 - SCHEME INFLOW (m3/s)					
	10yr Developed CC			100yr Developed CC		
Scenario	Peak Time	Peak Flow	Water level	Peak Time	Peak Flow	Water level
Healthy waters	13:40	199	31.34	13:40	340	32.88
Maven	14:40	143	31.92	14:40	273	33.19

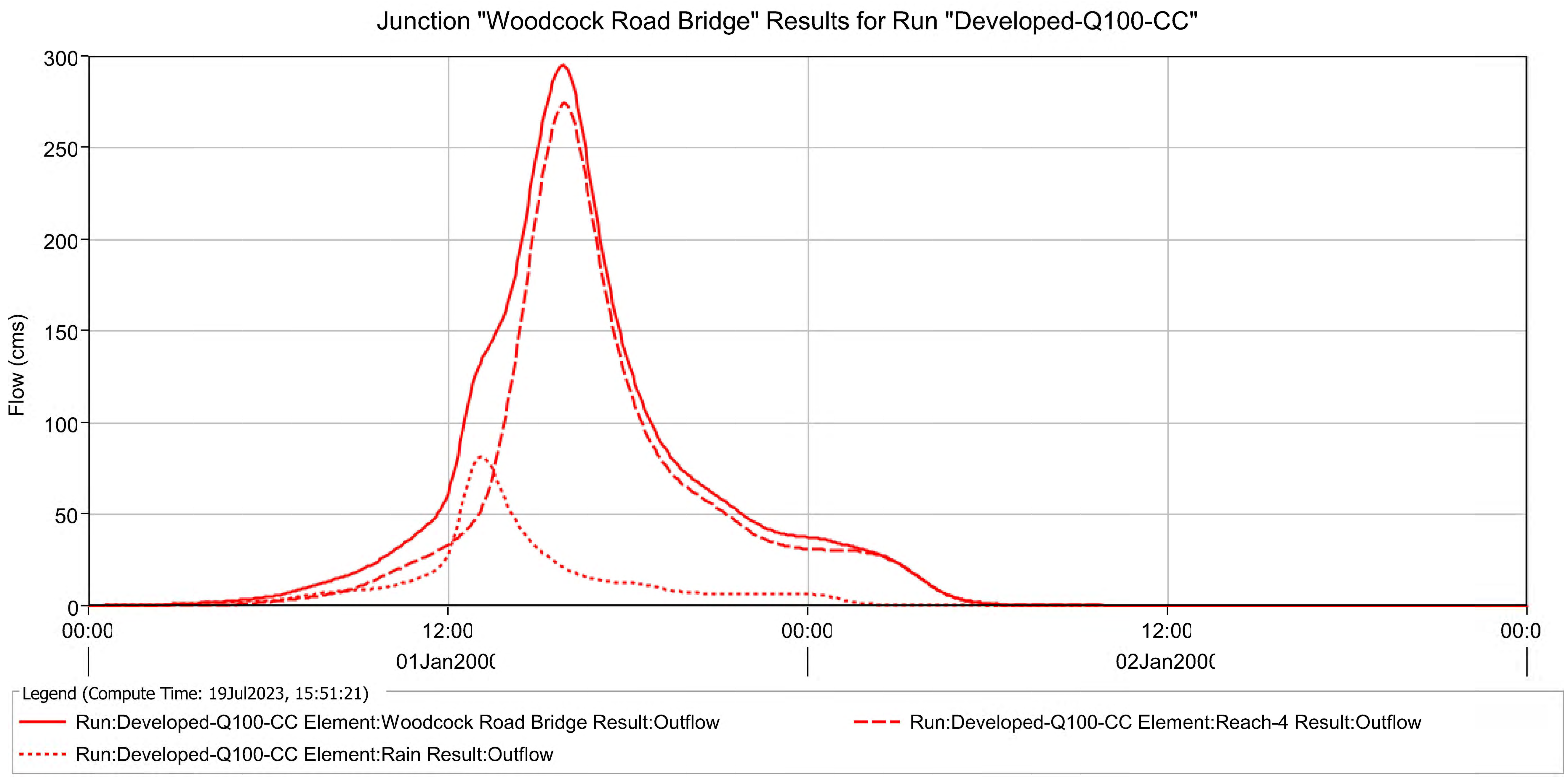
	XS87 - SCHEME OUTFLOW (m3/s)					
	10yr Developed CC			100yr Developed CC		
Scenario	Peak Time	Peak Flow	Water level	Peak Time	Peak Flow	Water Level
Healthy waters	14:10	223	22.16	14:15	326	23.74
Maven	15:10	152	22.12	15:15	289	23.15

Figure 3.8 MPD Modelling results comparison to Healthy waters model

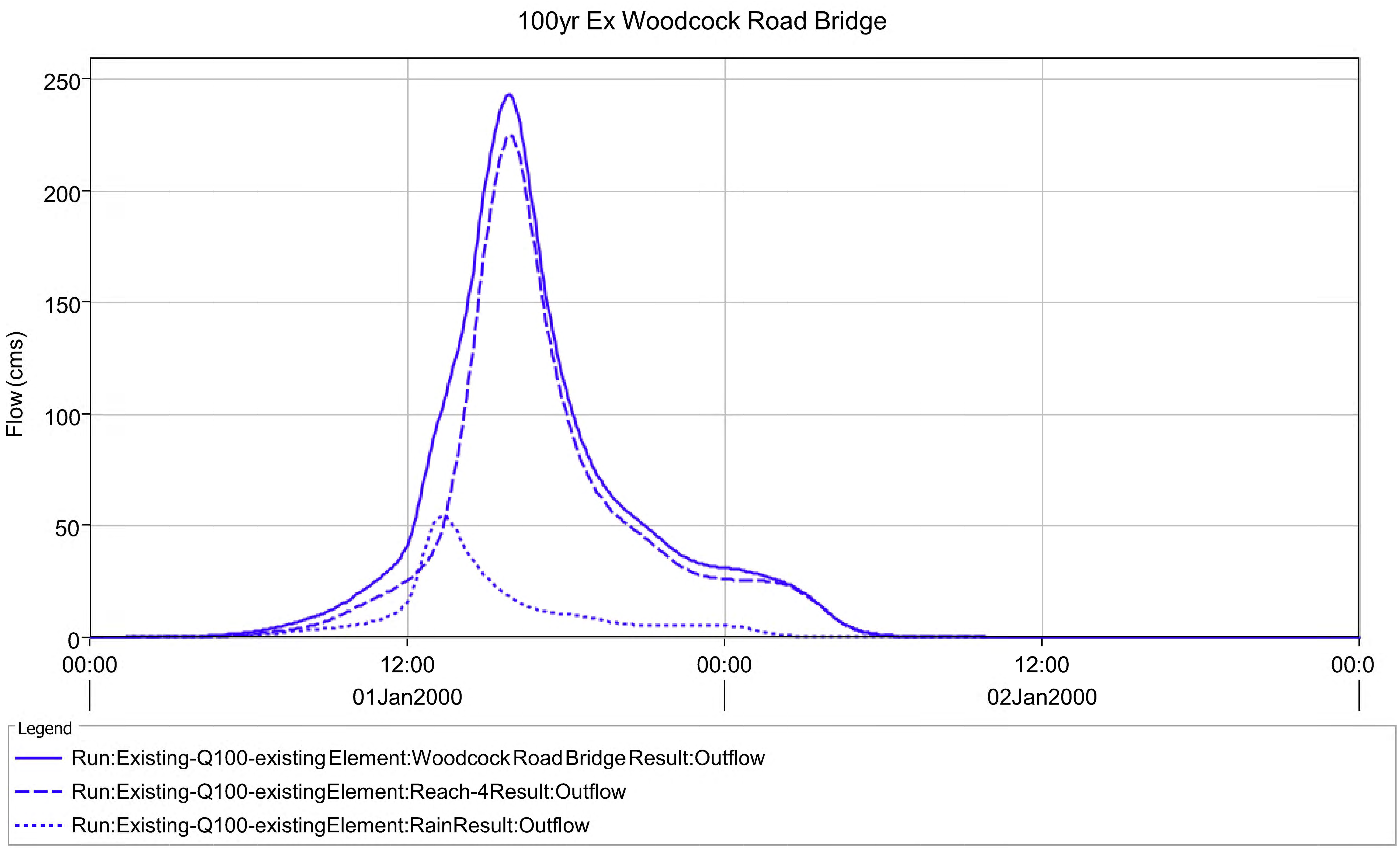
Two notable points of comparison of modelling results are the times of peak flows and the water levels. The peak flow times produced in the model are generally 1 hour later than that from the Healthywaters model. A comparison of the water levels show similar peak flood levels with a difference of upto to 0.59m. This discrepancy is likely a result of the difference in terrain model used. As the terrain used in this reports model uses a combination of site survey and drone data, it has a higher degree of accuracy in comparison to the Lidar survey used in the Healthwaters model.

APPENDIX A – 100YR YEAR FLOW HYDROGRAPH

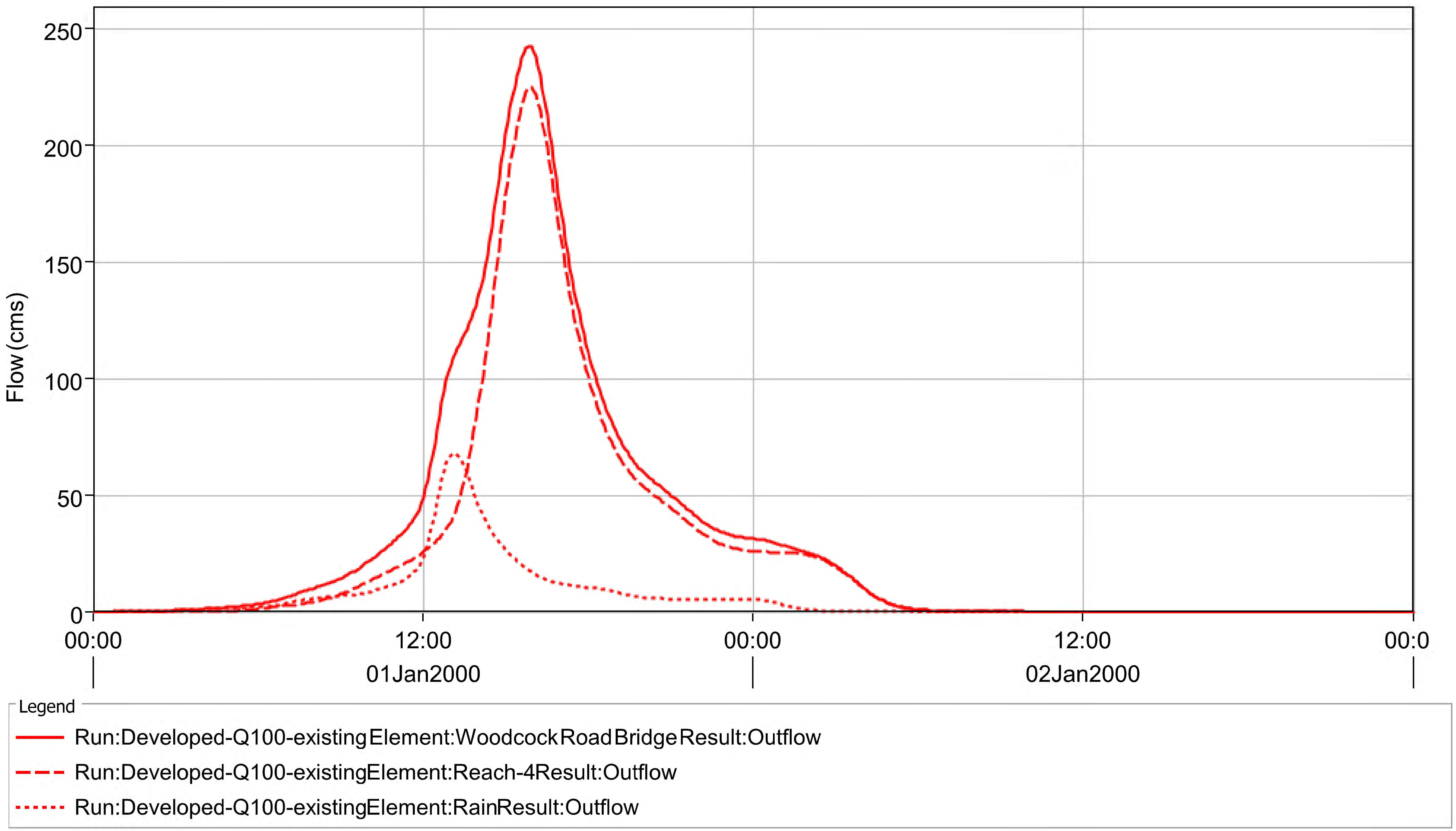

Junction "Woodcock Road Bridge" Results for Run "Existing-Q100-CC"
Flow (cms)
300
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan200(
02Jan200(
Legend (Compute Time: 19Jul2023, 15:51:23)
Run:Existing-Q100-CC Element:Woodcock Road Bridge Result:Outflow
Run:Existing-Q100-CC Element:Reach-4 Result:Outflow
Run:Existing-Q100-CC Element:Rain Result:Outflow

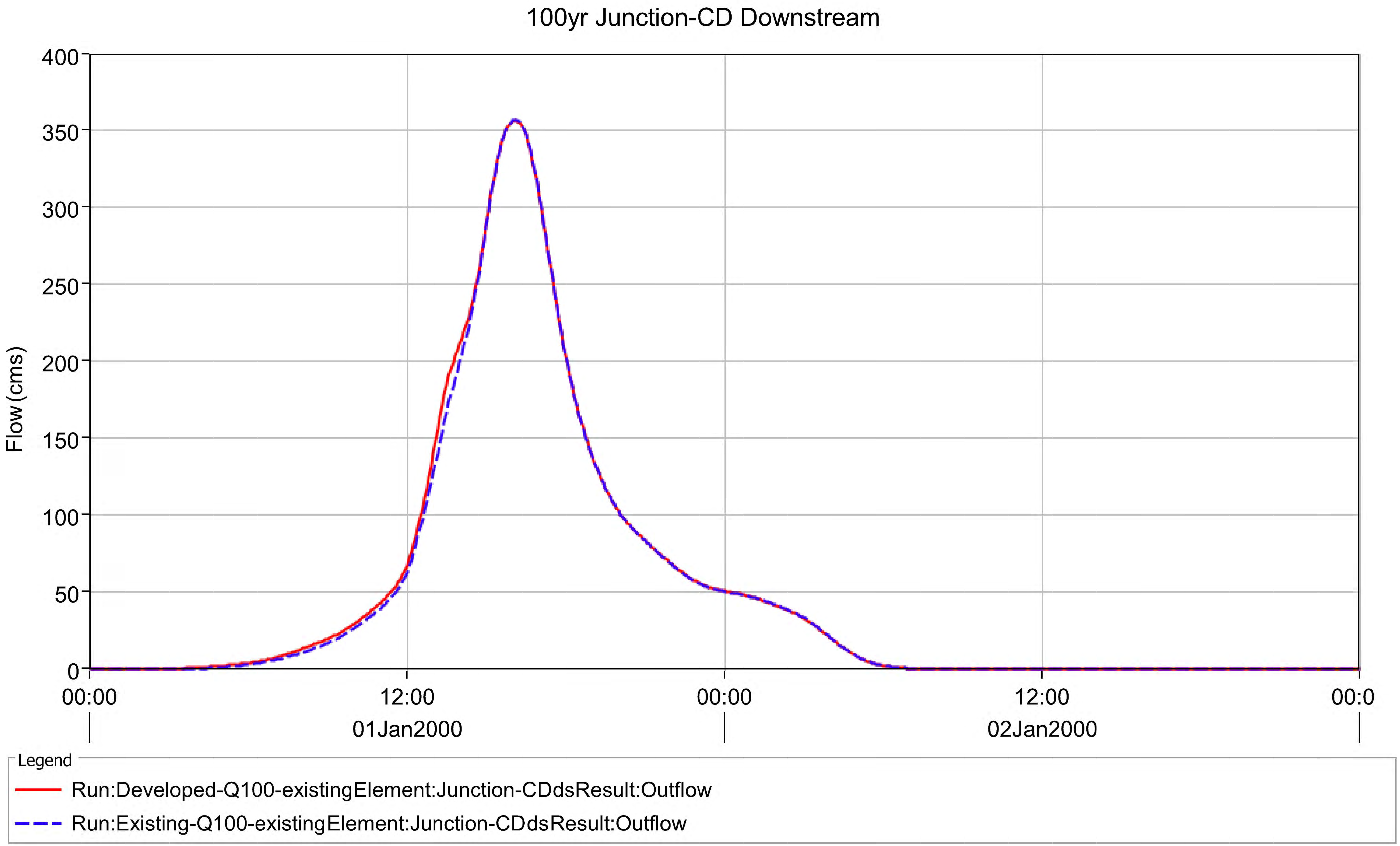


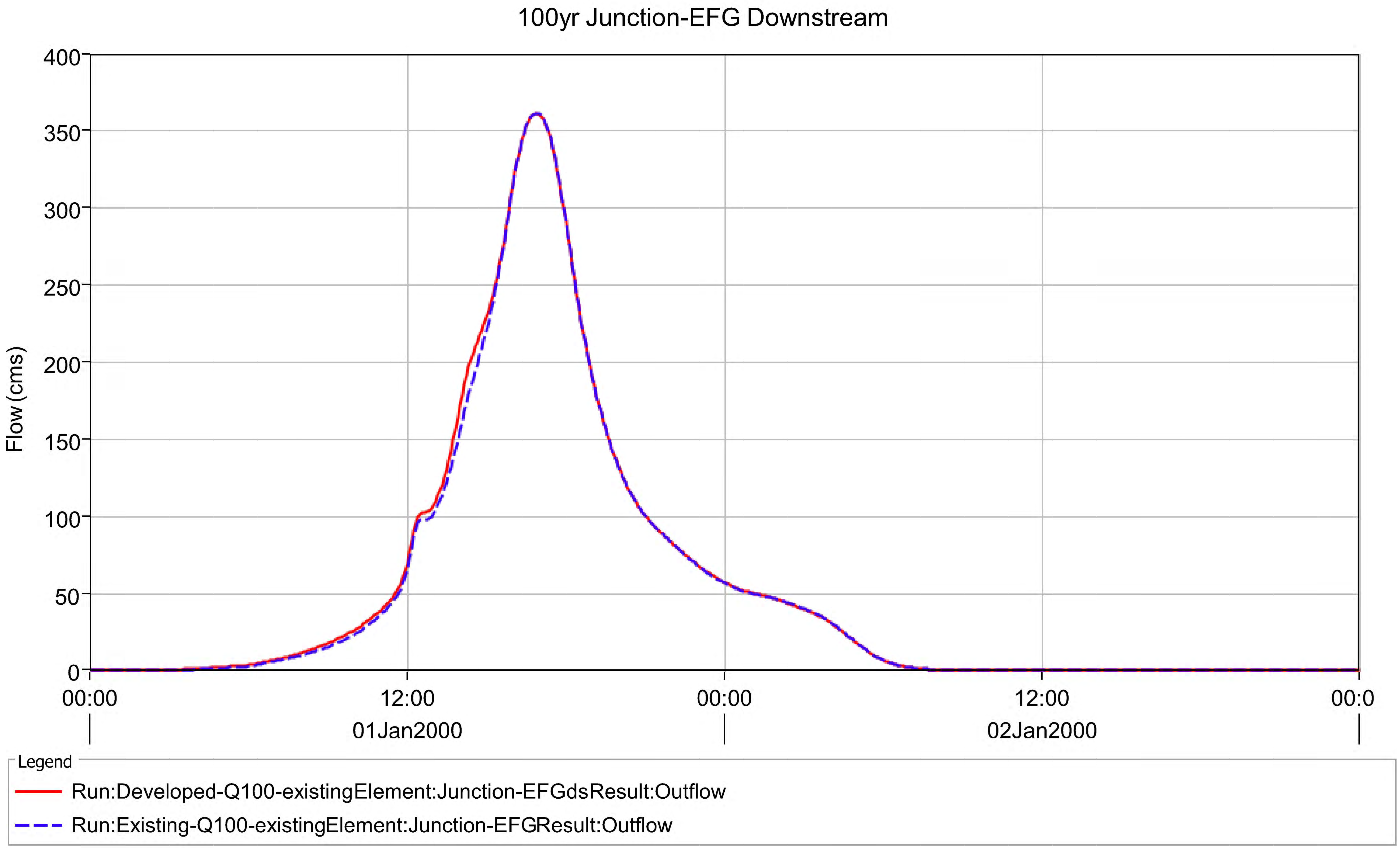
Junction "Woodcock Road Bridge" Results for Run "Developed-Q100-CC"
Flow (cms)
300
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend (Compute Time: 19Jul2023, 15:51:21)
Run:Developed-Q100-CC Element:Woodcock Road Bridge Result:Outflow
Run:Developed-Q100-CC Element:Reach-4 Result:Outflow
Run:Developed-Q100-CC Element:Rain Result:Outflow

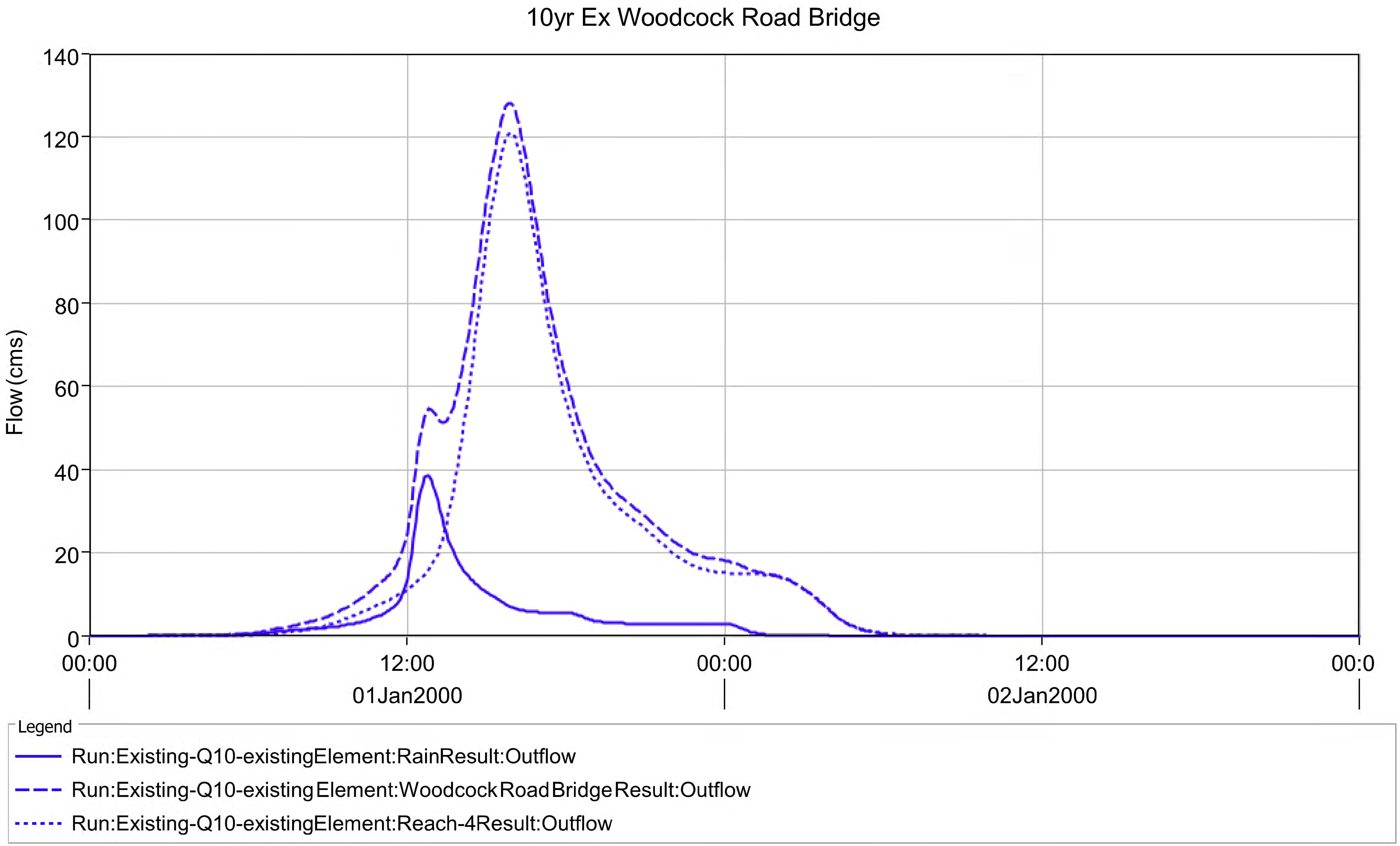

100yr Ex Woodcock Road Bridge
Flow (cms)
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Existing-Q100-existing Element:Woodcock Road Bridge Result:Outflow
Run:Existing-Q100-existingElement:Reach-4Result:Outflow
Run:Existing-Q100-existingElement:RainResult:Outflow

100yr Pr Woodcock Road Bridge

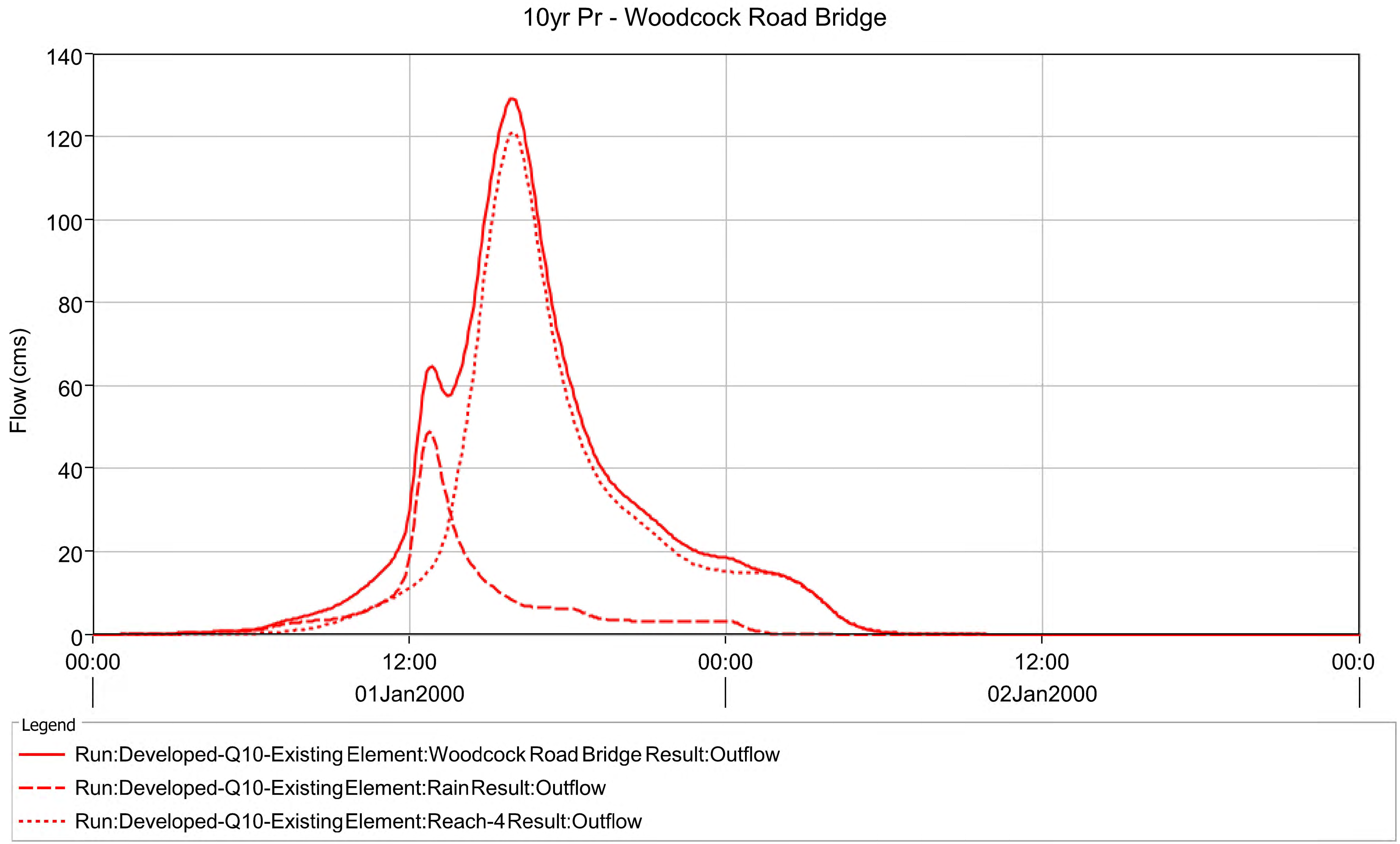


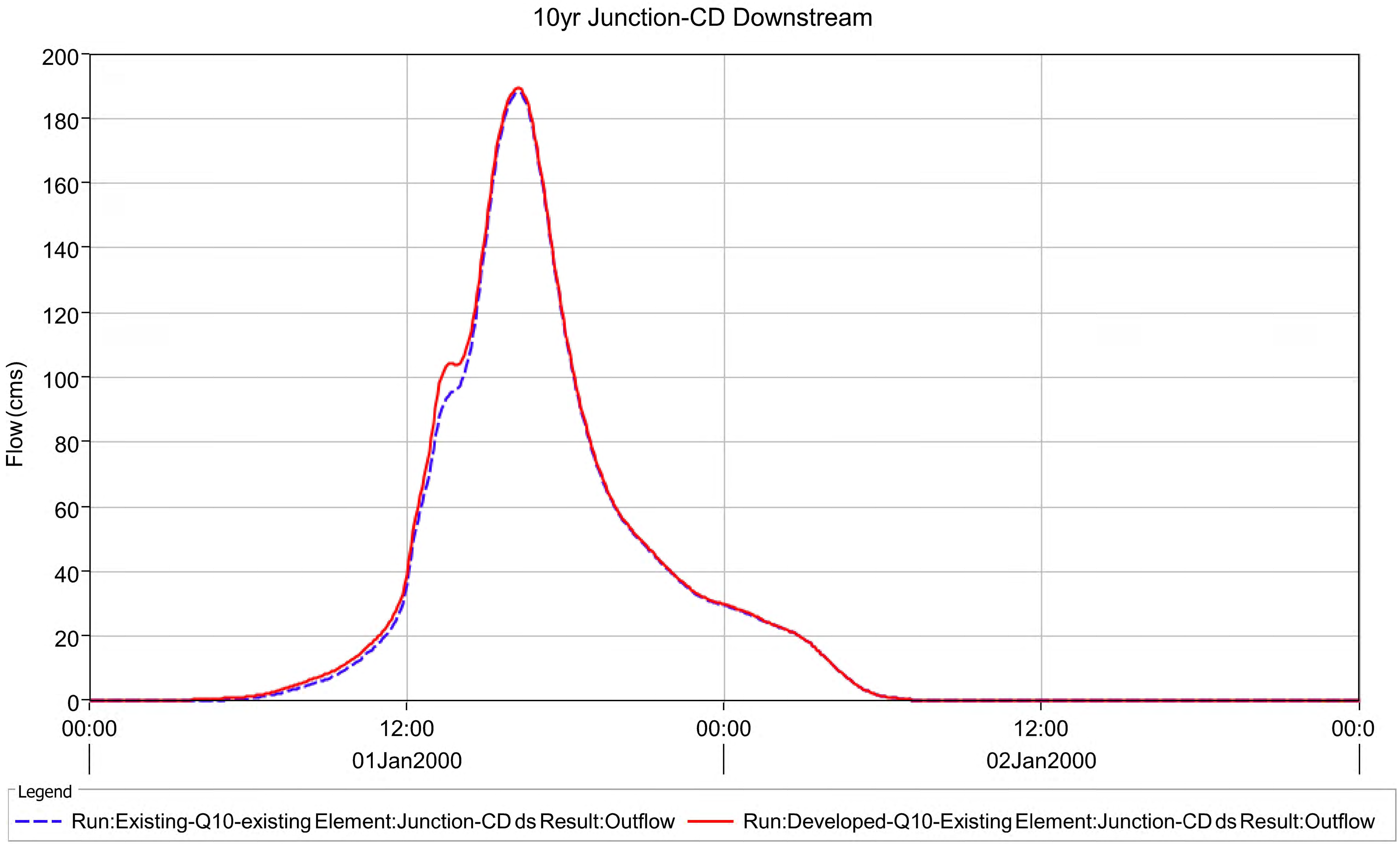

100yr Junction-CD Downstream
Flow (cms)
400
350
300
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q100-existingElement:Junction-CDdsResult:Outflow
Run:Existing-Q100-existingElement:Junction-CDdsResult:Outflow

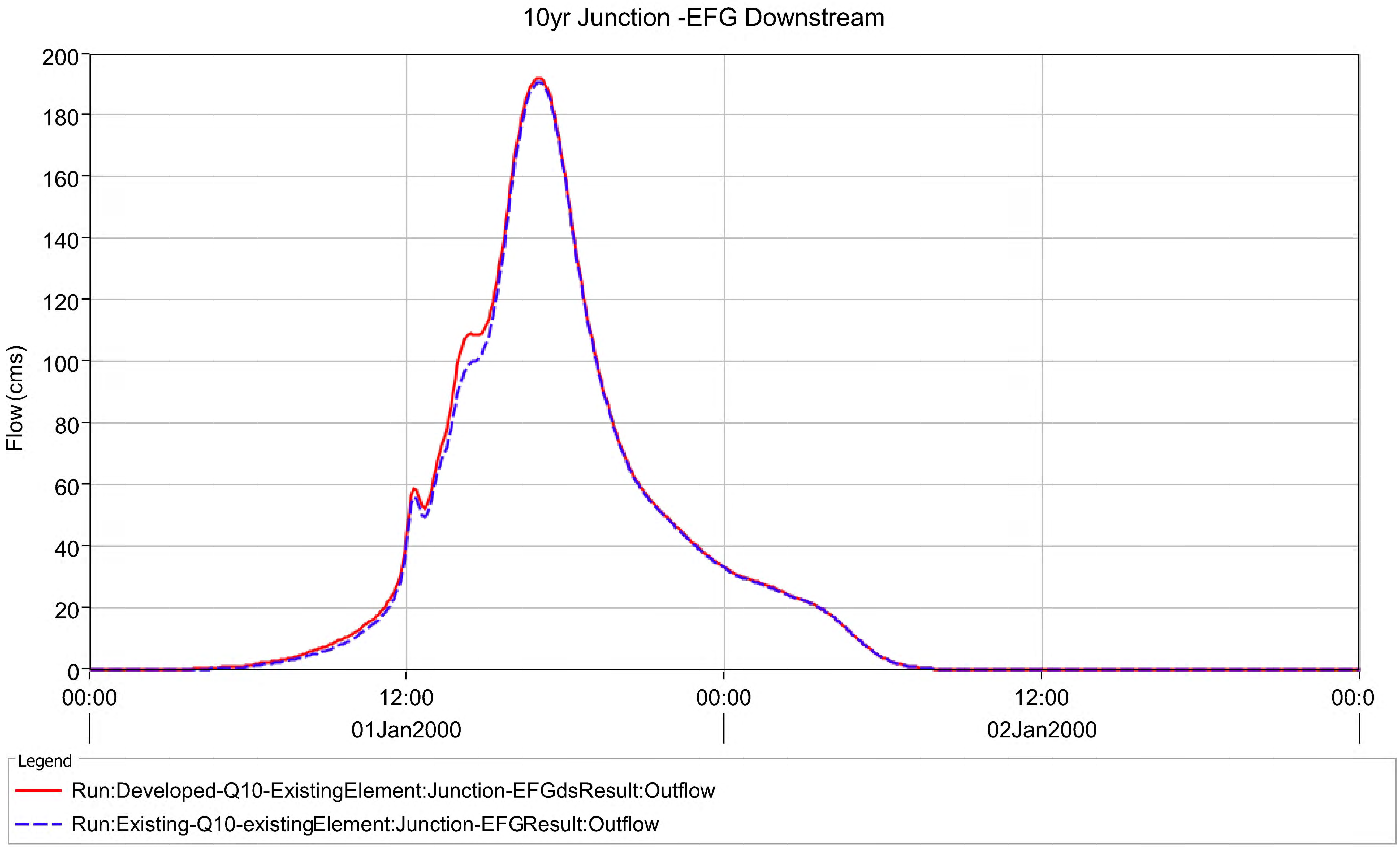

100yr Junction-EFG Downstream
Flow (cms)
400
350
300
250
200
150
100
50
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q100-existingElement:Junction-EFGdsResult:Outflow
Run:Existing-Q100-existingElement:Junction-EFGResult:Outflow



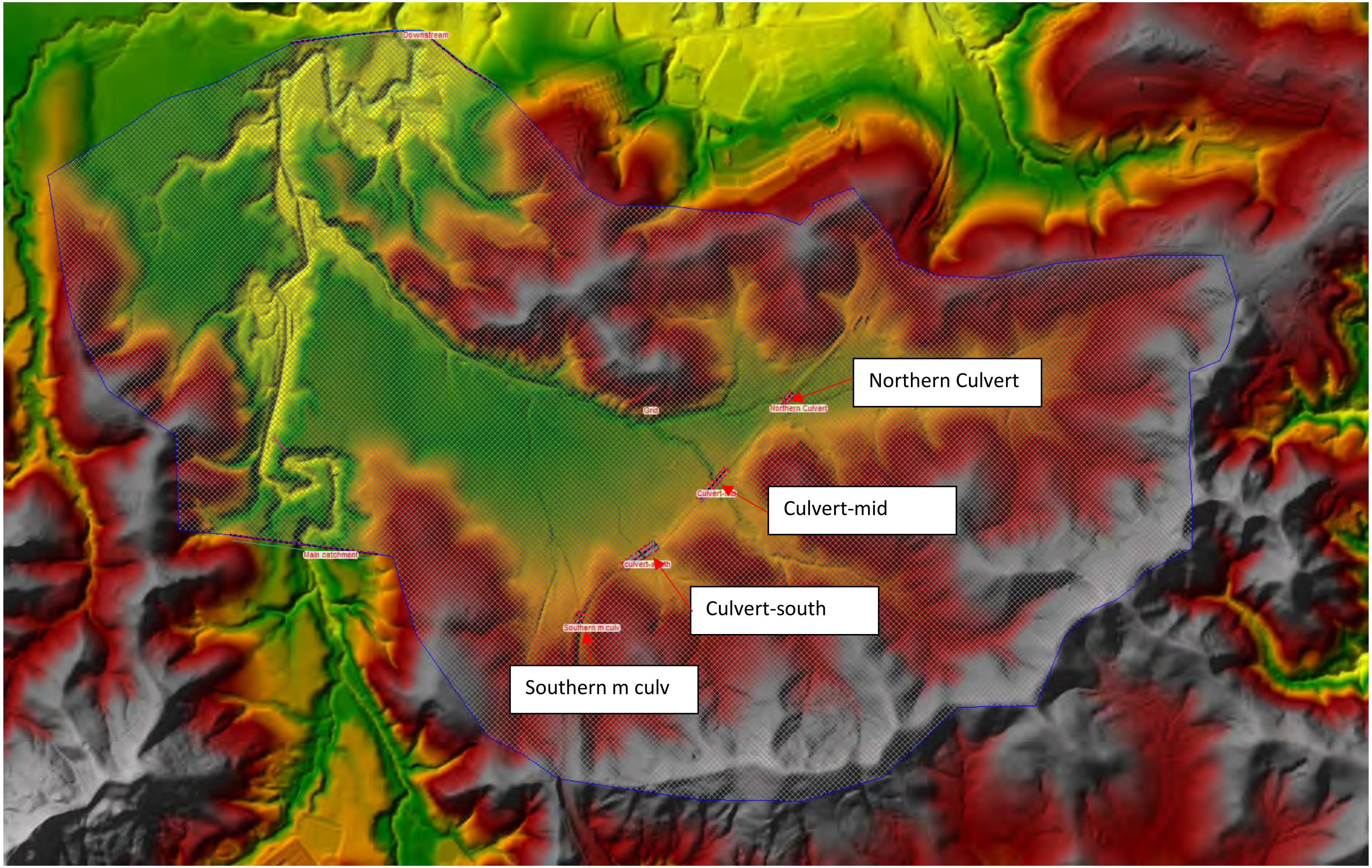
10yr Ex Woodcock Road Bridge
Flow (cms)
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Existing-Q10-existingElement:RainResult:Outflow
Run:Existing-Q10-existingElement:WoodcockRoadBridgeResult:Outflow
Run:Existing-Q10-existingElement:Reach-4Result:Outflow


10yr Pr - Woodcock Road Bridge
Flow (cms)
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q10-Existing Element:Woodcock Road Bridge Result:Outflow
Run:Developed-Q10-Existing Element:Rain Result:Outflow
Run:Developed-Q10-Existing Element:Reach-4 Result:Outflow

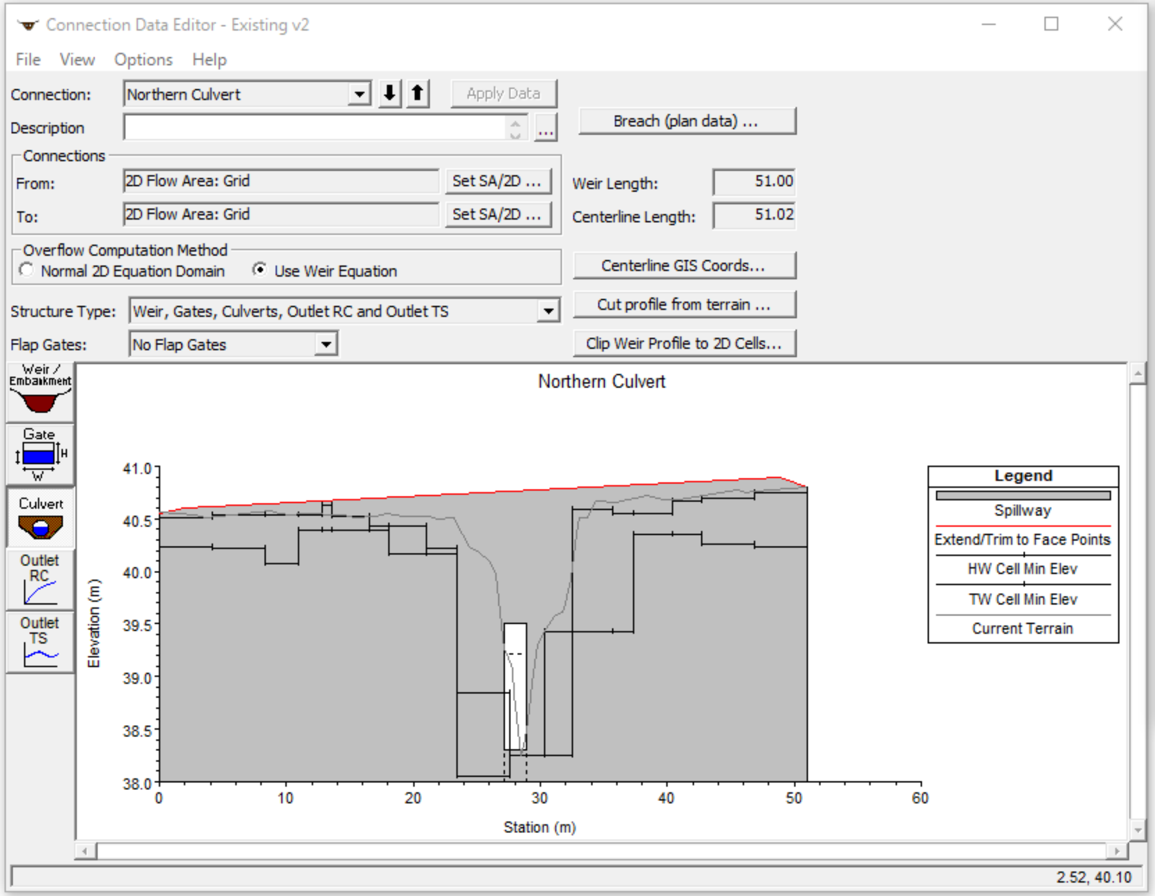

10yr Junction-CD Downstream
200
180
160
140
120
100
80
60
40
20
0
Flow (cms)
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Existing-Q10-existing Element:Junction-CD ds Result:Outflow
Run:Developed-Q10-Existing Element:Junction-CD ds Result:Outflow

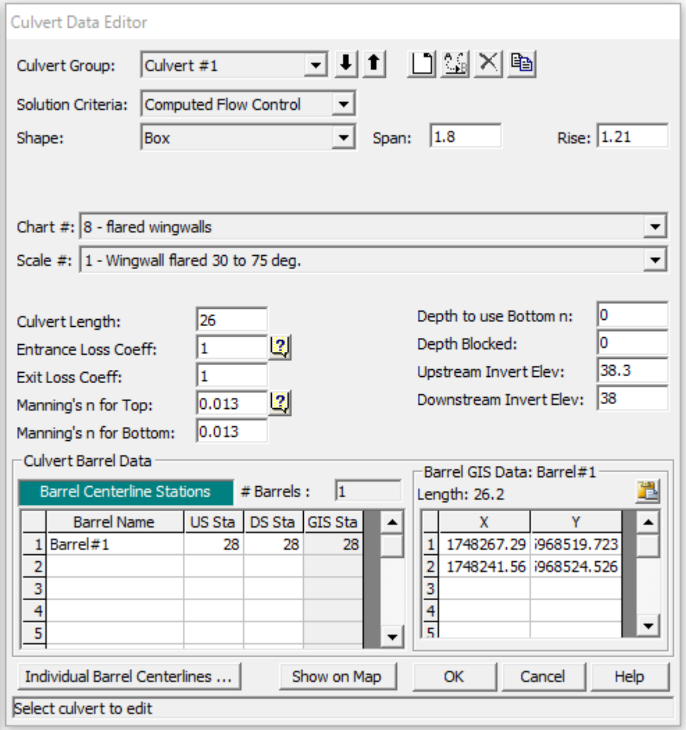

10yr Junction -EFG Downstream
Flow (cms)
200
180
160
140
120
100
80
60
40
20
0
00:00
12:00
00:00
12:00
00:0
01Jan2000
02Jan2000
Legend
Run:Developed-Q10-ExistingElement:Junction-EFGdsResult:Outflow
Run:Existing-Q10-existingElement:Junction-EFGResult:Outflow

APPENDIX B – HEC RAS CULVERT DETAIL

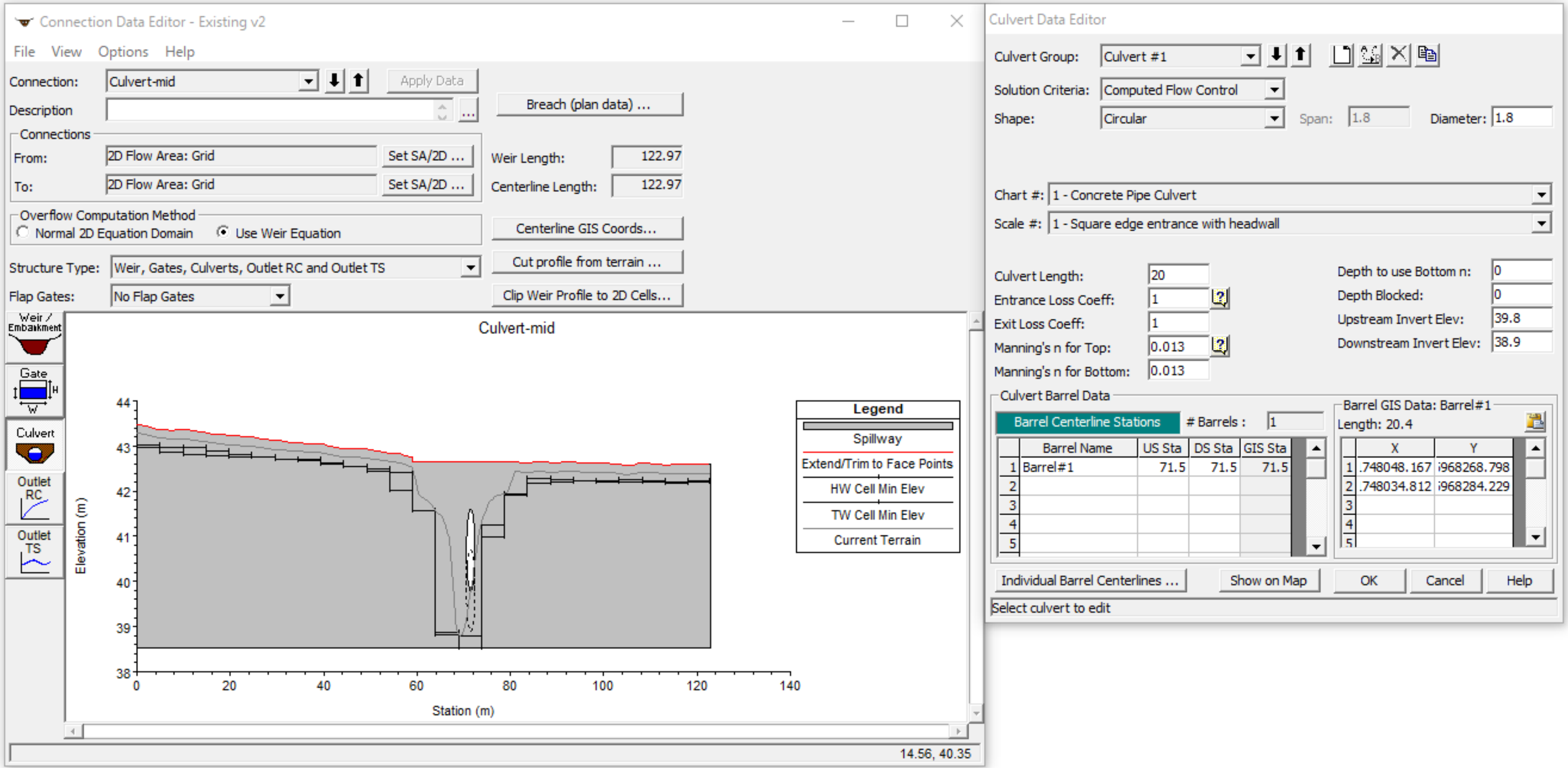

Downstream
Northern Culvert
Grid
Northern Culvert
Culvert-mid
Culvert-mid
Main catchment
culvert-south
Culvert-south
Southern m culv
Southern m culv

Northern Culvert - Details

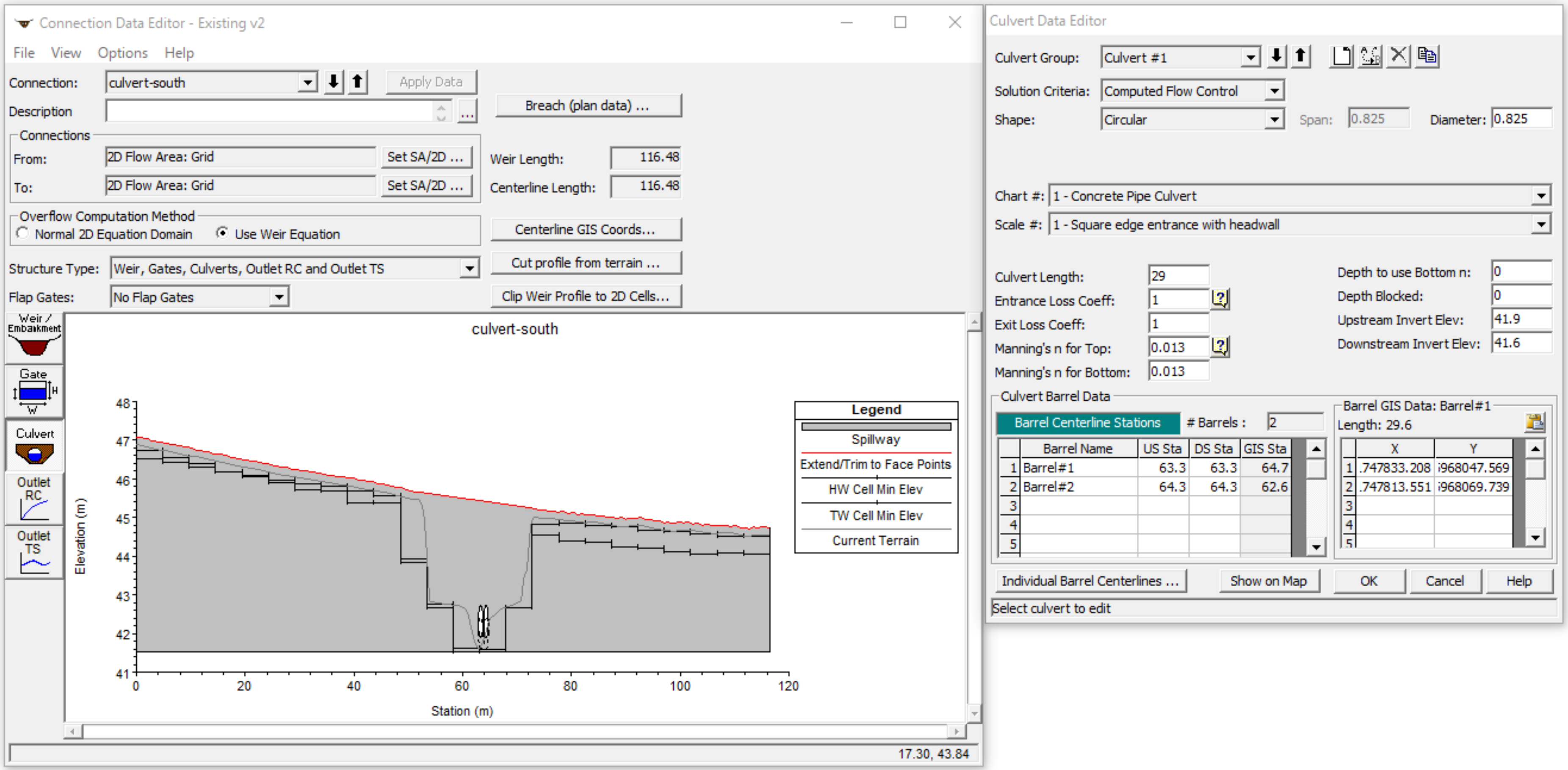




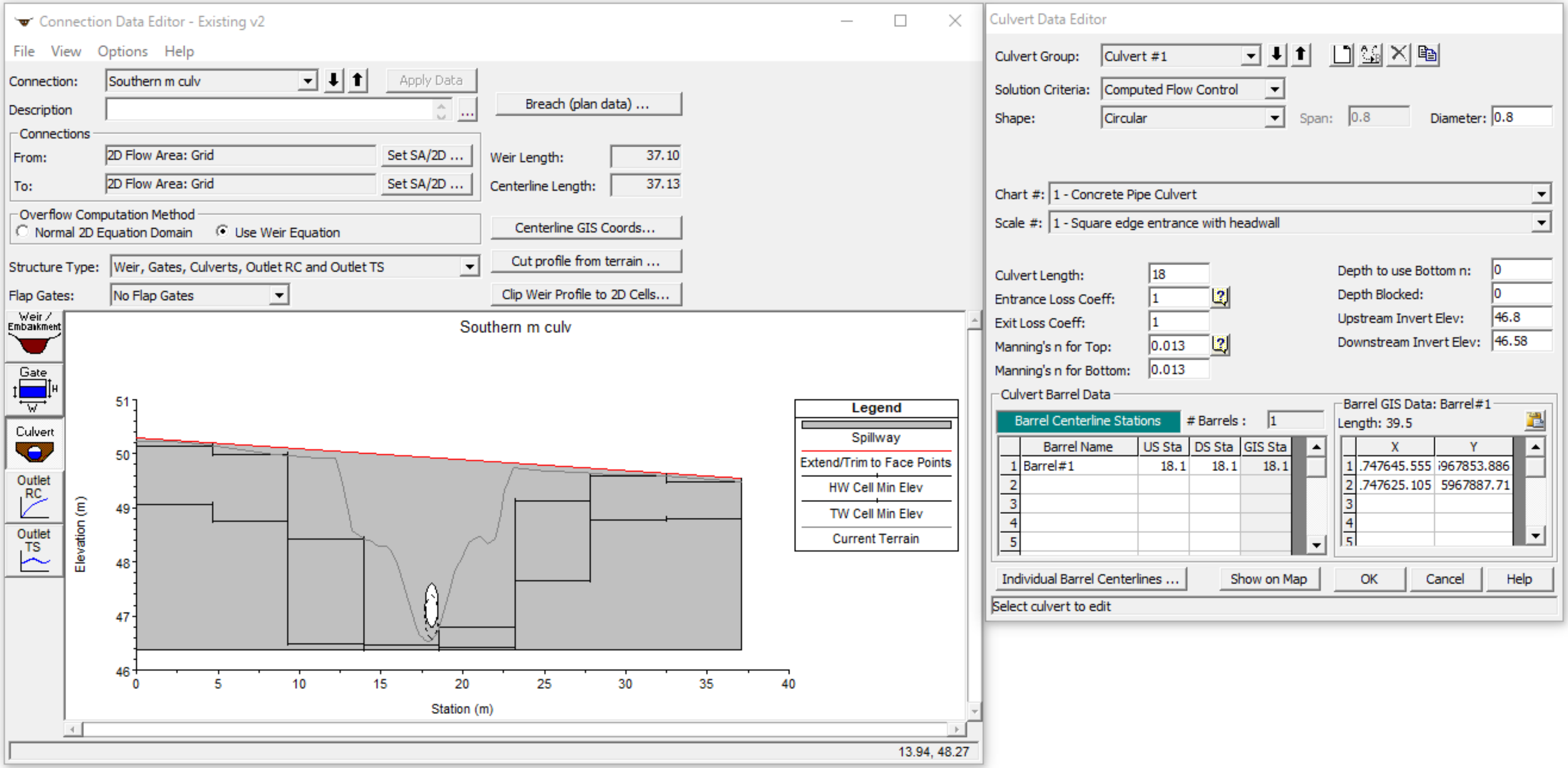
Culvert mid - Details



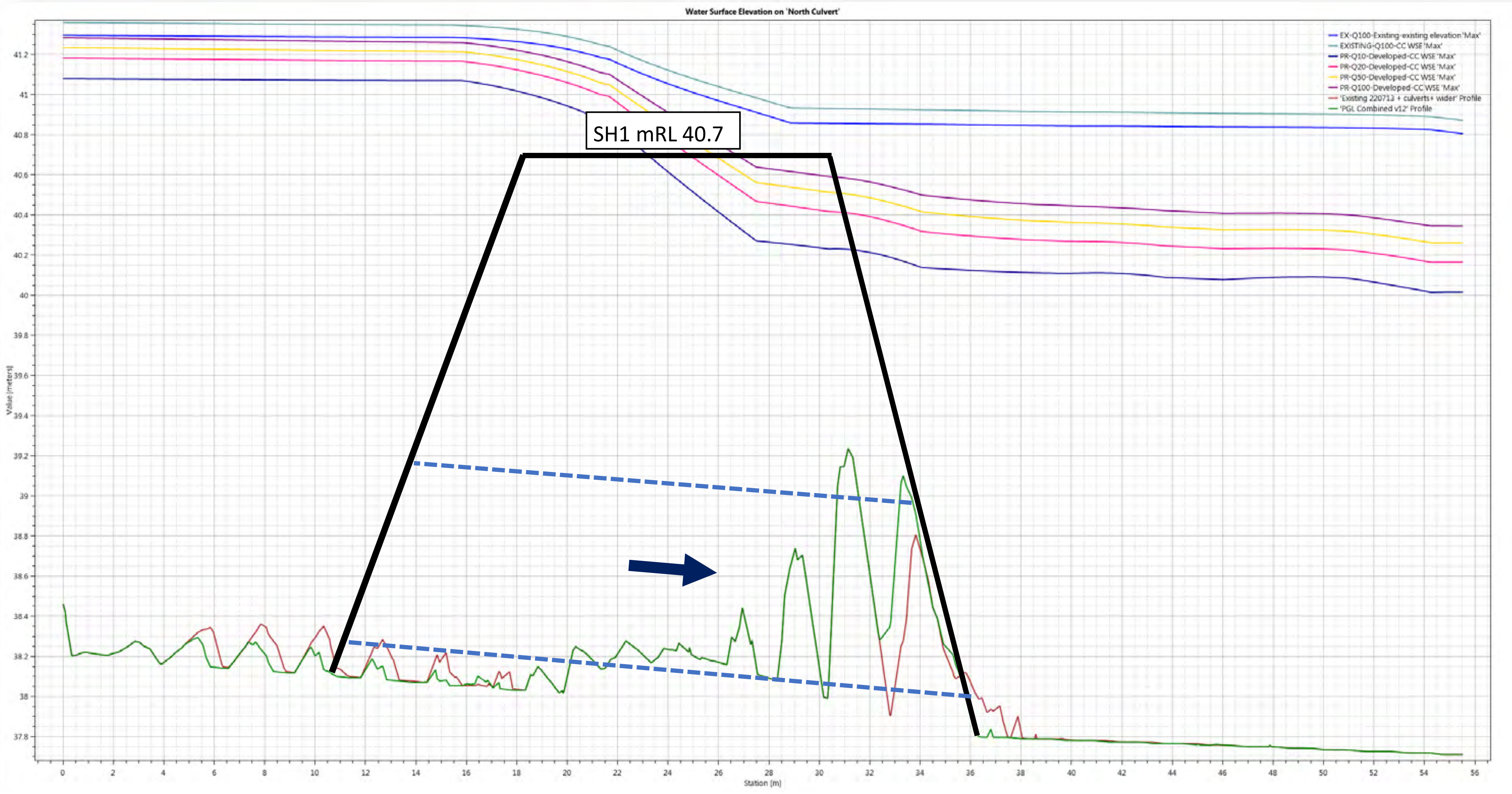
Culvert south - Details



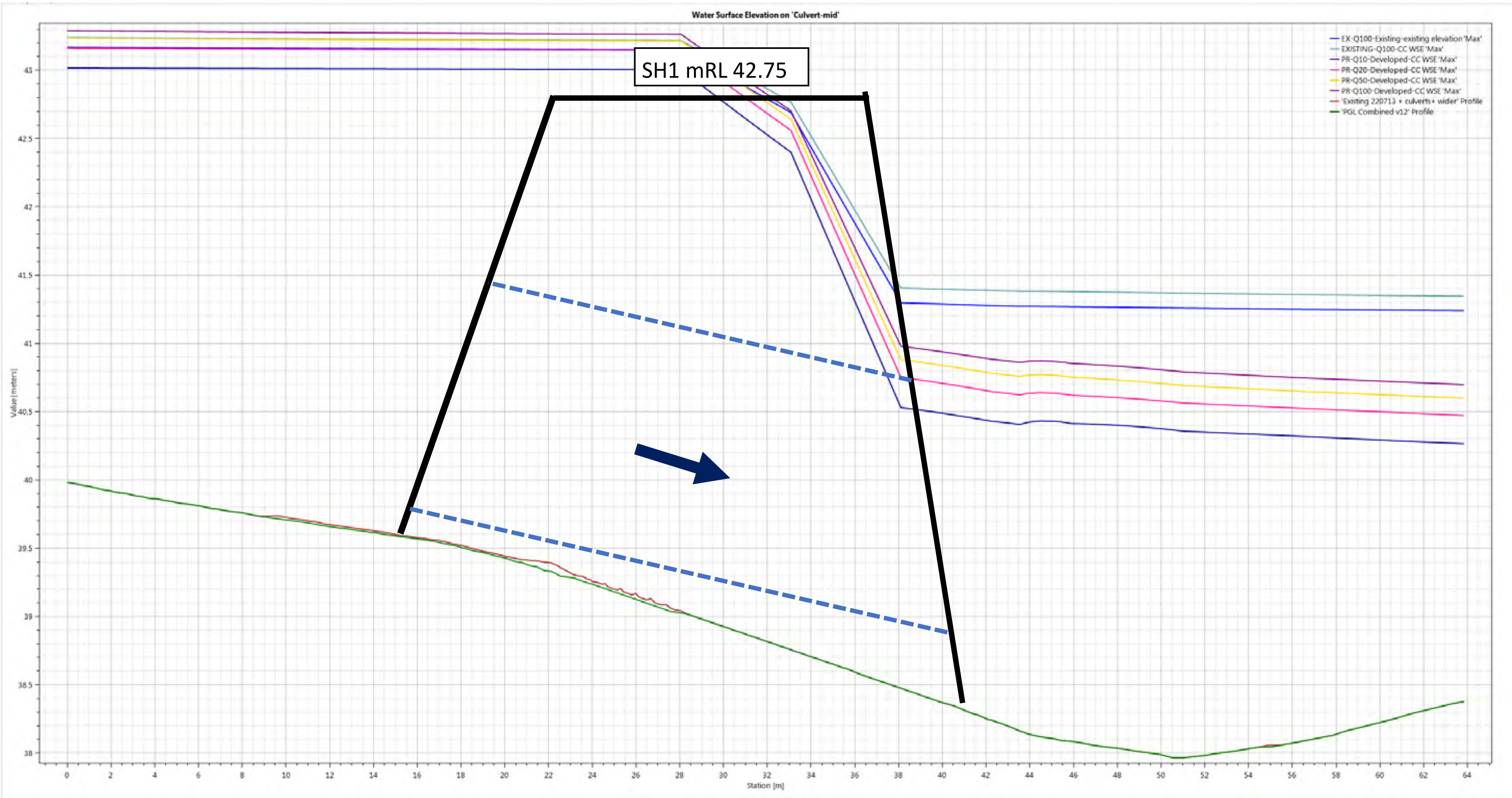
Culvert m south - Details



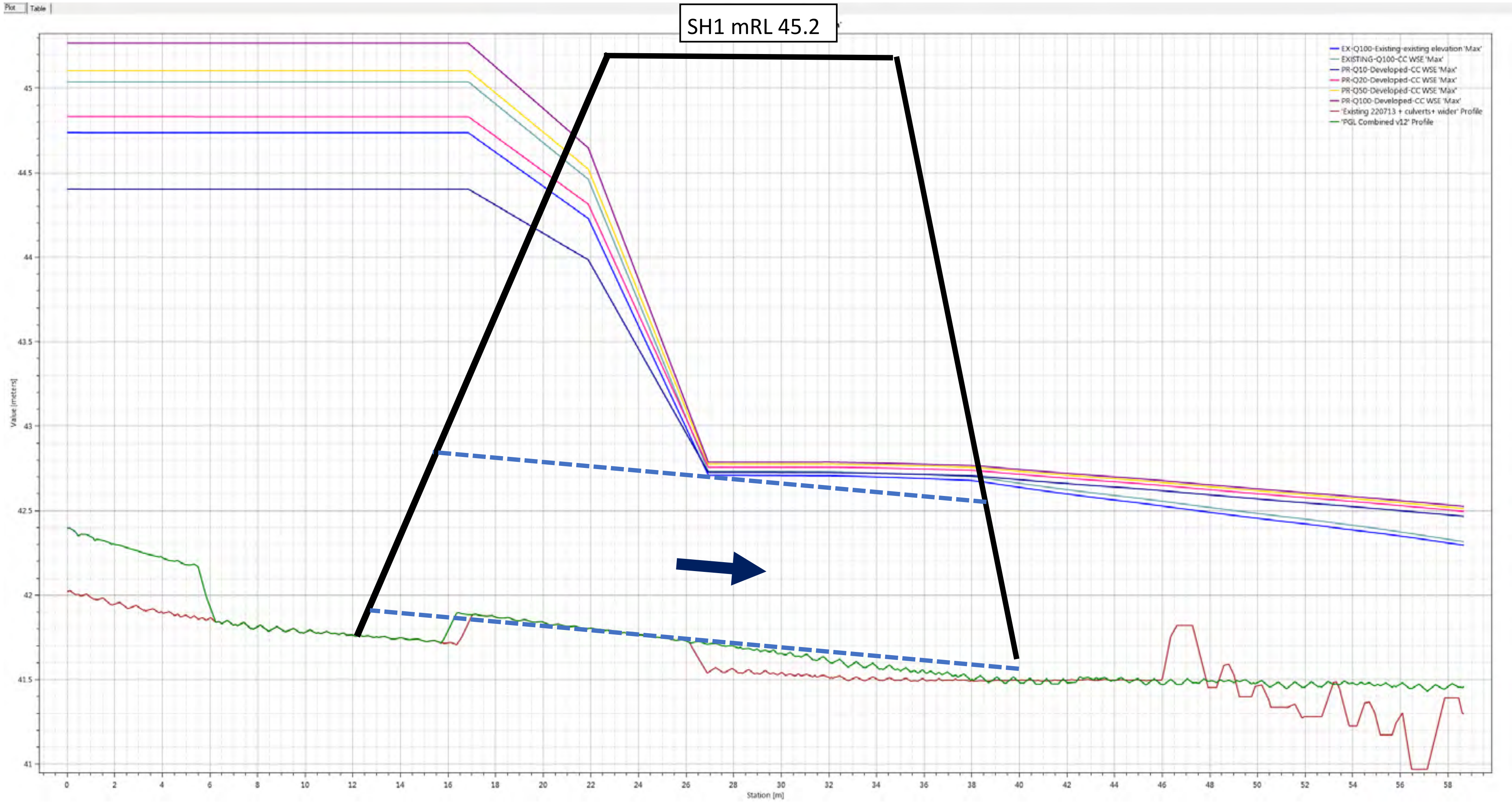
Northern Culvert (1800mm x 1200mm box)



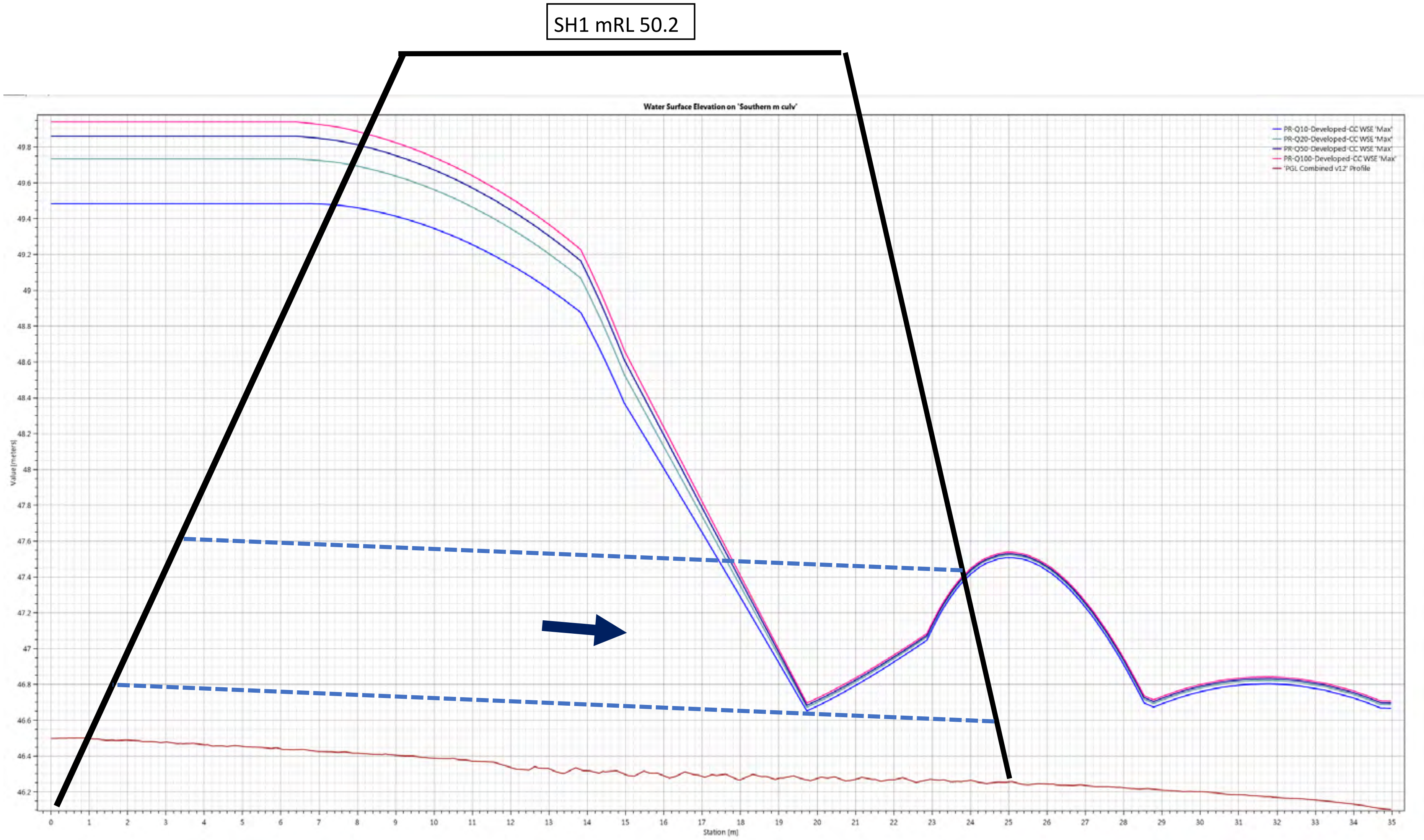
Mid Culvert (1800mm circular)



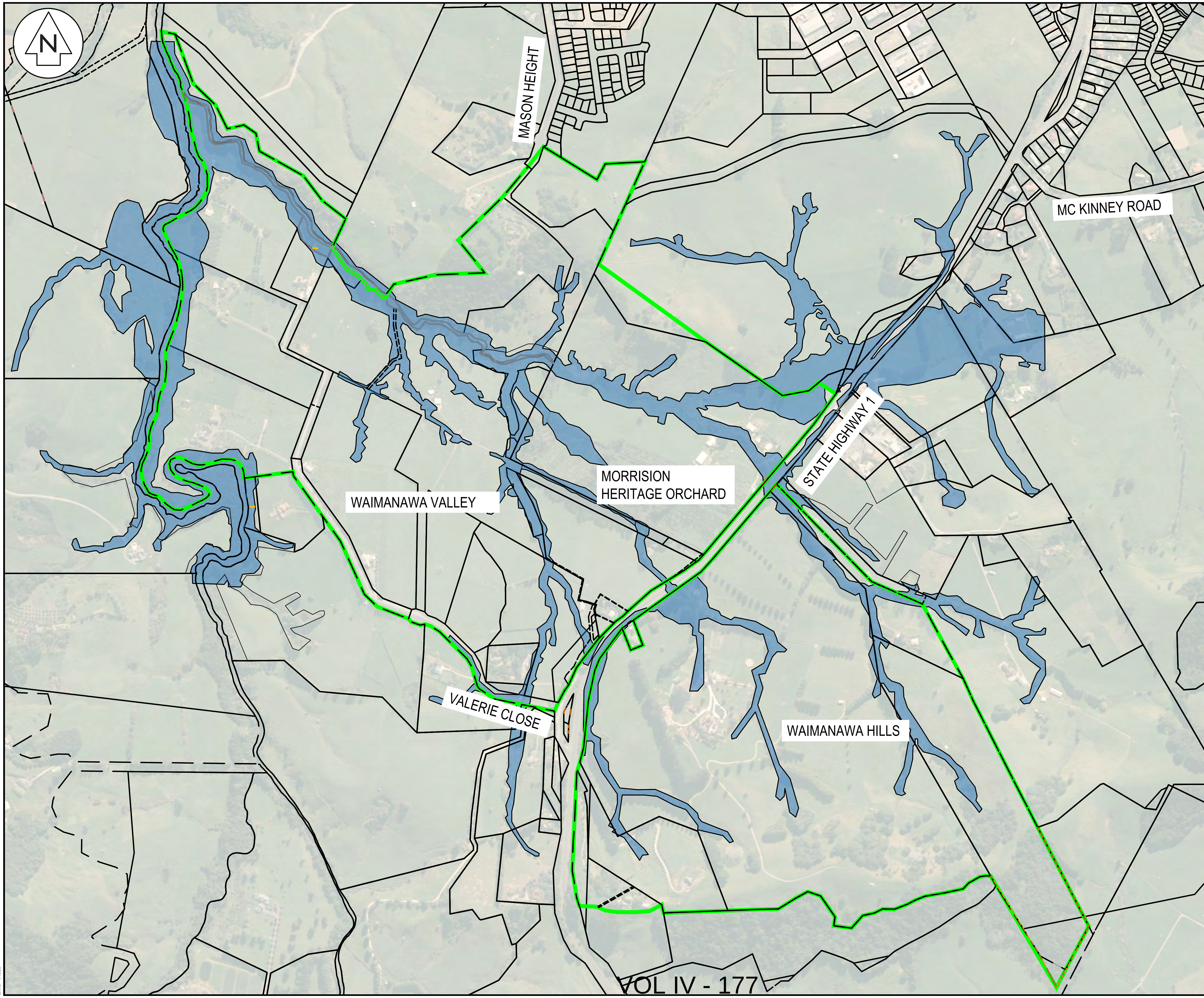
Culvert South (825mm circular x 2)



Culvert m south (800mm circular)



APPENDIX C – Preliminary Pre & Post Development Flood Extent Plan



Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

- EX BDY
- PLAN CHANGE BDY
- FLODD EXTENT

Rev	Description	By	Date
B	PC EXTENT UPDATE	KH	12/22
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design	-	-
Drawn	KH	08/22
Checked	GB	08/22

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5 Owens Road, Epsom
Auckland 1023

Project

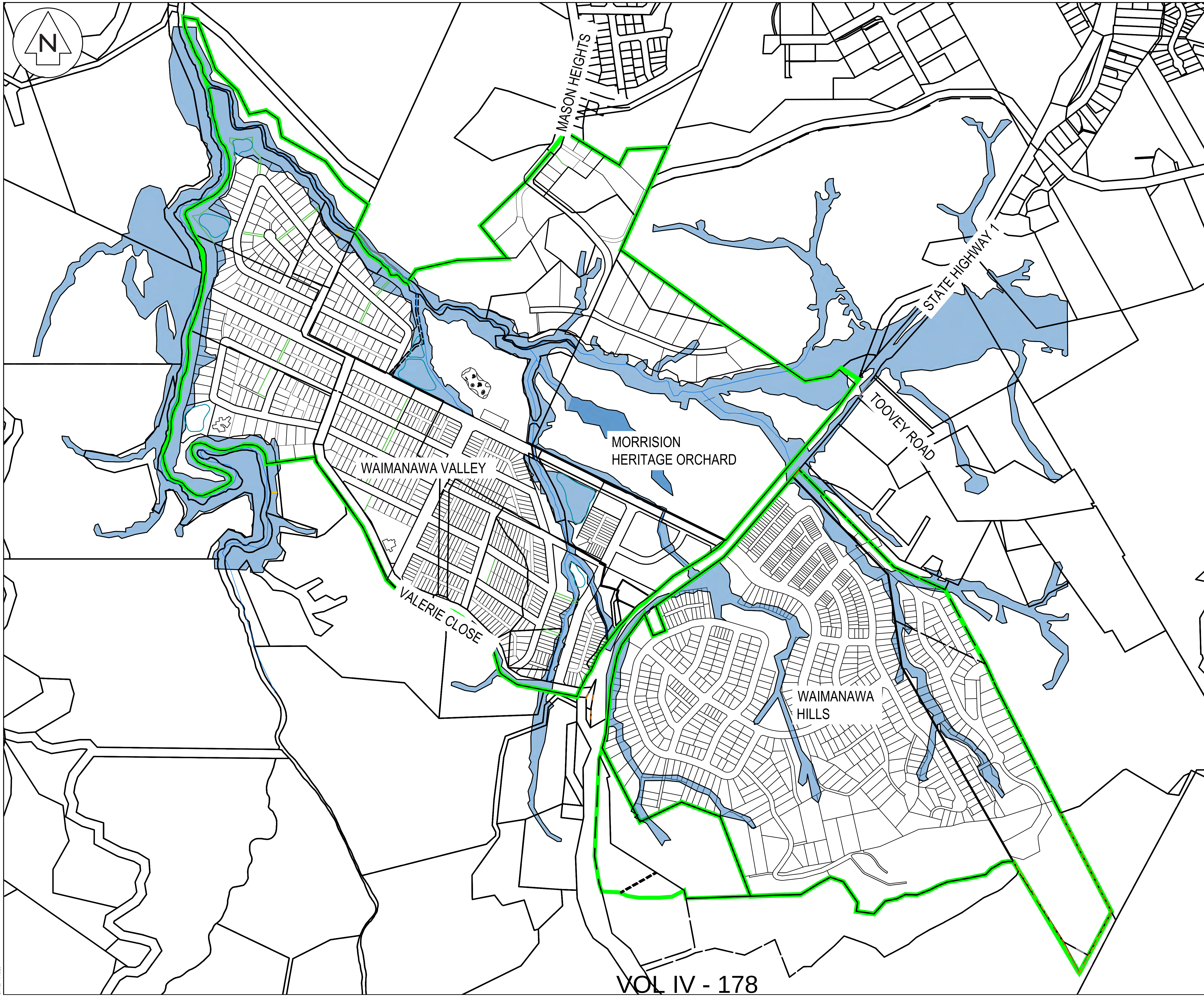
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

EXISTING 100 YEARS FLOOD EXTENT PLAN

Project no.	211001
Scale	1:7500 @ A3
Cad file	100YR EX FLOODING.DWG
Drawing no.	C460 Rev B

Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.
3. It is the contractors responsibility to locate all services that may be affected by his operations.



Legend
EX BDY
PLAN CHANGE BDY
FLODD EXTENT

Rev	Description	By	Date
B	PC EXTENT UPDATE	KH	12/22
A	PPC	KH	08/2022

	By	Date
Survey	PARALAX & MAVEN	03/21
Design	-	-
Drawn	KH	08/22
Checked	GB	08/22

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Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
PROPOSED 100 YEARS FLOOD EXTENT PLAN

Project no.	211001
Scale	1:7500 @ A3
Cad file	100YR CC EX PROPOSED.DWG
Drawing no.	C465
Rev	B

APPENDIX D – TP108 and Time of concentration calculations

Notes
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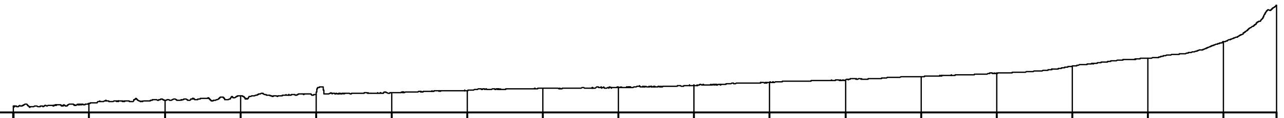
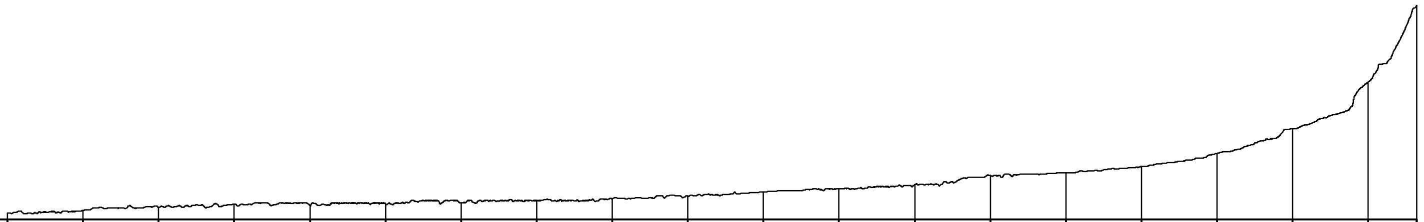


DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	39.17	40.12	41.28	42.75	44.24	44.70	46.13	48.24	49.61	51.99	54.17	58.84	64.00	75.19	99.44
DESIGN LEVELS	32.28	34.00	36.25	39.17	40.12	41.28	42.75	44.24	44.70	46.13	48.24	49.61	51.99	54.17	58.84	64.00	75.19	99.44
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4175.47

Upstream A Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.75	43.25	46.24	48.25	50.92	57.29	58.86	63.00	71.78	88.16	119.12	169.78
DESIGN LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.75	43.25	46.24	48.25	50.92	57.29	58.86	63.00	71.78	88.16	119.12	169.78
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4659.46

Upstream B Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

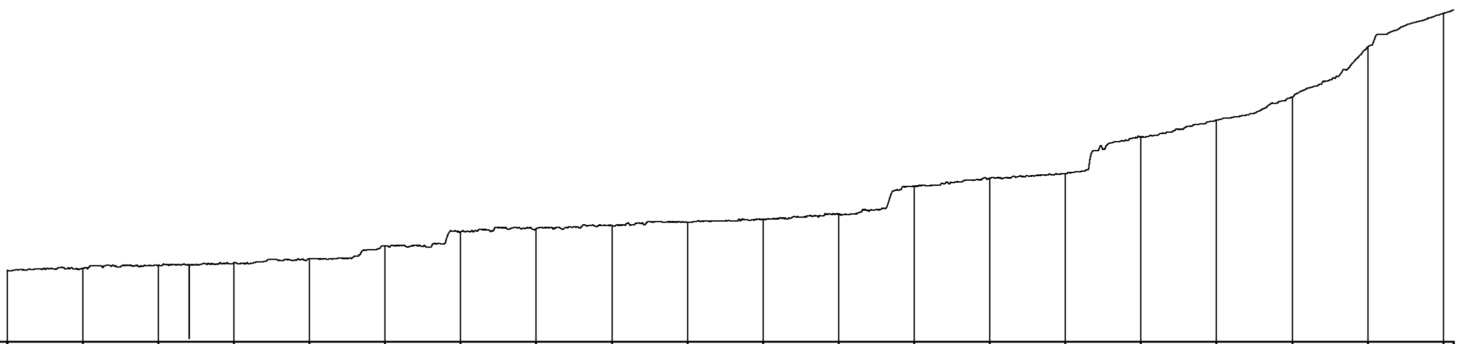
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK001
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



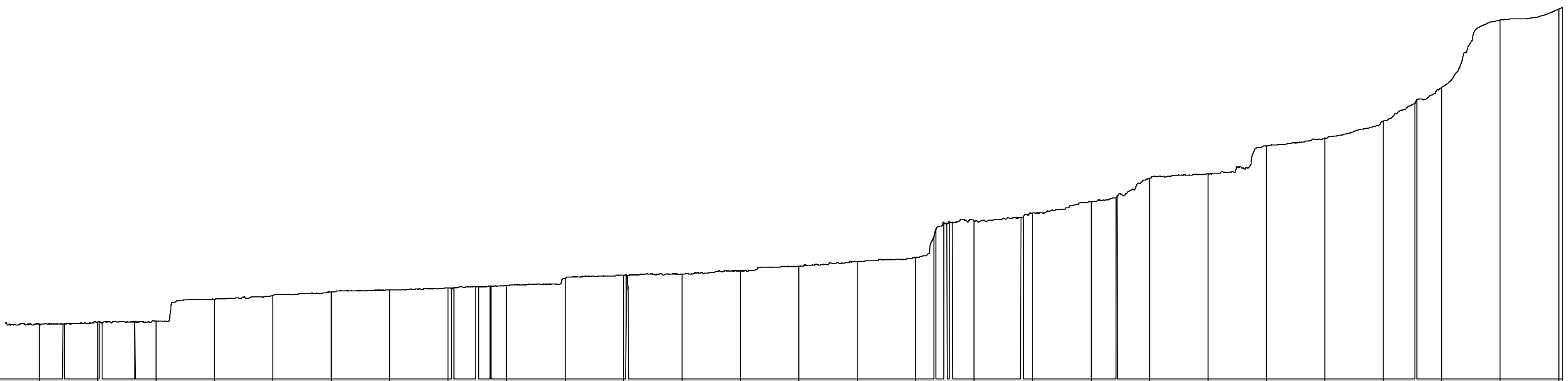
DATUM -2.00m

EXISTING LEVELS	45.50	46.62	48.65	50.35	53.20	61.68	70.62	73.09	74.95	77.25	79.02
DESIGN LEVELS	45.50	46.62	48.65	50.35	53.20	61.68	70.62	73.09	74.95	77.25	79.02
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00

EXISTING LEVELS	82.58	101.03	106.38	109.38	133.64	144.97	160.00	193.31	215.51	
DESIGN LEVELS	82.58	101.03	106.38	109.38	133.64	144.97	160.00	193.31	215.51	
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CHAINAGE	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	4764.22

Upstream C Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM -2.00m

EXISTING LEVELS		46.95	48.59	49.62	68.25	71.28	74.24	76.00	78.00	80.00
DESIGN LEVELS		46.95	48.59	49.62	68.25	71.28	74.24	76.00	78.00	80.00
CUT/FILL		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00

EXISTING LEVELS	86.00	88.56	89.51	92.54	96.42	100.66	104.05	134.95	141.95	151.52
DESIGN LEVELS	86.00	88.56	89.51	92.54	96.42	100.66	104.05	134.95	141.95	151.52
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00

EXISTING LEVELS	171.50	175.39	199.50	205.84	220.55	249.44	307.01	316.43	317.73
DESIGN LEVELS	171.50	175.39	199.50	205.84	220.55	249.44	307.01	316.43	317.73
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	5000.00	5250.00	5500.00	5750.00	6000.00	6250.00	6500.00	6750.00	[illegible]

Upstream D Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

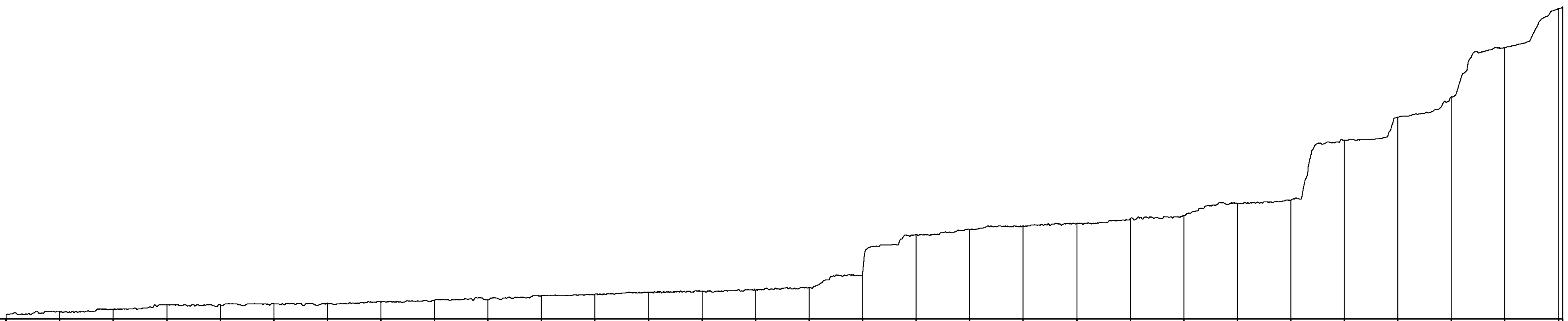
Project no.	211001		
Scale			
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG		
Drawing no.	SK002	Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



DATUM 28.00m

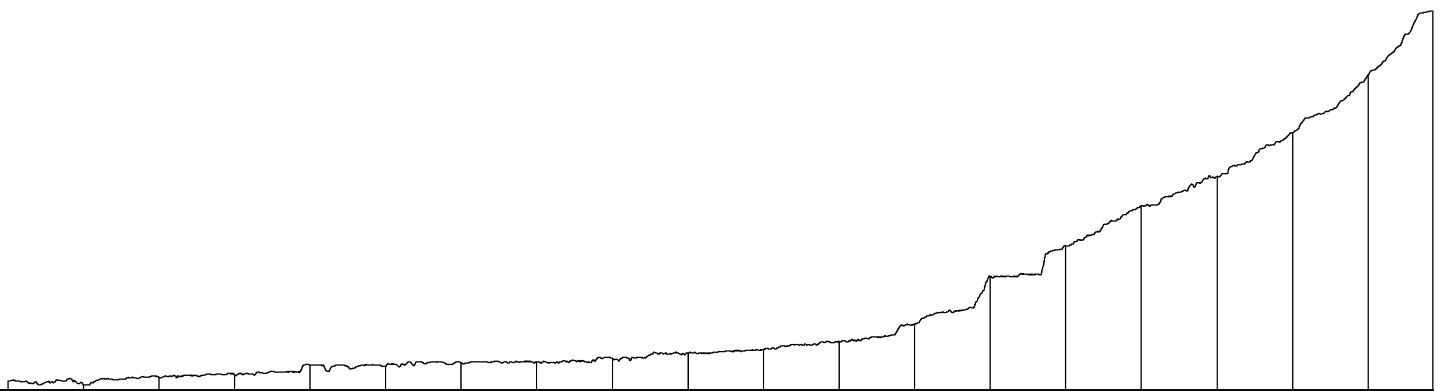
EXISTING LEVELS	32.28	34.30	36.89	40.94	41.10	42.21	42.20	43.56	45.09	45.93	49.28
DESIGN LEVELS	32.28	34.30	36.89	40.94	41.10	42.21	42.20	43.56	45.09	45.93	49.28
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00

EXISTING LEVELS	50.91	52.65	53.91	54.75	57.17	70.10	106.58	111.41	114.56	117.06
DESIGN LEVELS	50.91	52.65	53.91	54.75	57.17	70.10	106.58	111.41	114.56	117.06
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	5000.00

EXISTING LEVELS	121.38	124.48	135.68	138.56	194.75	216.09	235.23	280.99	317.36 316.91
DESIGN LEVELS	121.38	124.48	135.68	138.56	194.75	216.09	235.23	280.99	317.36 316.91
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0.00
CHAINAGE	5250.00	5500.00	5750.00	6000.00	6250.00	6500.00	6750.00	7000.00	7250.00 7269.99

Upstream E Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 24.00m

EXISTING LEVELS	29.95	27.50	32.26	33.64	40.50	39.50	41.91	42.75	44.86	48.59
DESIGN LEVELS	29.95	27.50	32.26	33.64	40.50	39.50	41.91	42.75	44.86	48.59
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00

EXISTING LEVELS	50.50	55.91	67.32	99.25	119.28	145.68	165.10	194.00	232.28	274.71
DESIGN LEVELS	50.50	55.91	67.32	99.25	119.28	145.68	165.10	194.00	232.28	274.71
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4714.37

Upstream F Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK003
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 24.00m

EXISTING LEVELS	29.95	27.50	31.89	32.02	32.01	32.28
DESIGN LEVELS	29.95	27.50	31.89	32.02	32.01	32.28
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1186.53

Upstream Reach ABE to Inflow

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.67	42.07			
DESIGN LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.67	42.07			
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	2864.59

Upstream Reach CD TO ABE

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK004
Rev	A

DRAFT FOR REVIEW

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 22.00m

EXISTING LEVELS				27.00	29.21	29.97	29.94	30.28	32.47	32.26	33.04	32.75	33.50	34.33	36.28	37.86	37.42	38.05	39.90	40.55	45.00	52.27	58.22	67.56	97.30	140.02
DESIGN LEVELS				27.00	29.21	29.97	29.94	30.28	32.47	32.26	33.04	32.75	33.50	34.33	36.28	37.86	37.42	38.05	39.90	40.55	45.00	52.27	58.22	67.56	97.30	140.02
CUT/FILL				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	5000.00	5250.00	5500.00	5750.00	6000.00	6121.08

Downstream A Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 36.00m

EXISTING LEVELS	40.68	42.00	43.75	45.80	48.87	49.50	53.82	56.49	62.25	94.33	148.64	288.82
DESIGN LEVELS	40.68	42.00	43.75	45.80	48.87	49.50	53.82	56.49	62.25	94.33	148.64	288.82
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	500.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00	4500.00	5000.00	5305.61

Downstream B Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

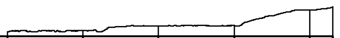
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK005
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

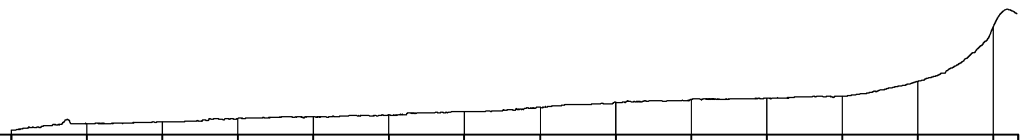
Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



DATUM 8.00m

EXISTING LEVELS	11.10	12.01	15.07	15.32	25.65	27.77
DESIGN LEVELS	11.10	12.01	15.07	15.32	25.65	27.77
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1077.43

Downstream C Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 8.00m

EXISTING LEVELS	11.10	15.39	16.50	18.89	20.21	21.24	23.25	26.41	29.58	31.42	32.24	33.74	43.47	79.73	
DESIGN LEVELS	11.10	15.39	16.50	18.89	20.21	21.24	23.25	26.41	29.58	31.42	32.24	33.74	43.47	79.73	
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3331.05

Downstream D Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	8.98	11.99	10.36	18.24	26.47	34.17	44.66	57.08
DESIGN LEVELS	8.98	11.99	10.36	18.24	26.47	34.17	44.66	57.08
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1695.06

Downstream E Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

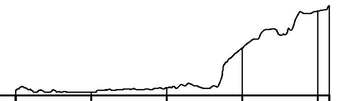
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK006
Rev	A

DATE: 4/5/23

DRAFT FOR REVIEW

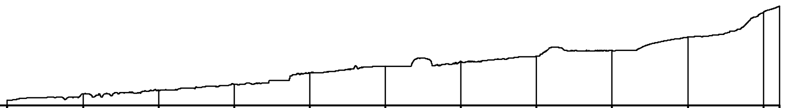
DATUM 6.00m



EXISTING LEVELS	8.98	8.25	10.88	37.35	61.78	65.08
DESIGN LEVELS	8.98	8.25	10.88	37.35	61.78	65.08
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	[illegible]

Downstream F Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

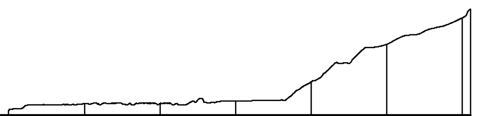


EXISTING LEVELS	9.39	13.78	16.27	20.00	27.46	31.75	35.09	38.48	42.35	51.20	67.66	71.51
DESIGN LEVELS	9.39	13.78	16.27	20.00	27.46	31.75	35.09	38.48	42.35	51.20	67.66	71.51
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2553.95

Downstream G Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM -4.00m



EXISTING LEVELS	-0.75	3.75	3.58	5.25	18.08	43.07	60.60	[illegible]
DESIGN LEVELS	-0.75	3.75	3.58	5.25	18.08	43.07	60.60	[illegible]
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	[illegible]

Downstream H Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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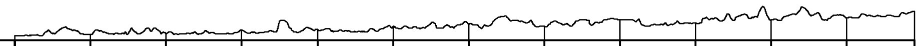
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK007
Rev	A

DRAFT FOR REVIEW

DATUM 12.00m

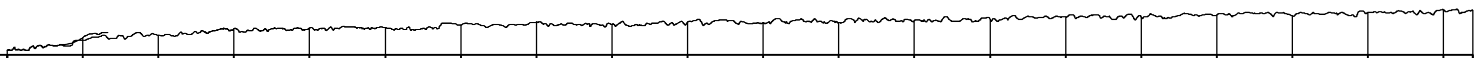


EXISTING LEVELS	15.00	16.00	16.25	18.76	19.25	21.21	22.75	21.19	25.66	23.47	25.60	26.79	31.12
DESIGN LEVELS	15.00	16.00	16.25	18.76	19.25	21.21	22.75	21.19	25.66	23.47	25.60	26.79	31.12
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	2973.05

Reach Scheme In to Scheme Out

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 12.00m



EXISTING LEVELS				29.43	29.86	30.15	31.76	33.75	32.25	33.75	33.58	33.34	34.85	35.73	37.29	37.03	38.50	37.84	40.12	42.08	41.68
DESIGN LEVELS	15.02	23.42																			
CUT/FILL																					
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	4847.70

Downstream Reach B to A Scheme Out

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK008
Rev	A

DATE: 4/5/23

DRAFT FOR REVIEW

DATUM 8.00m

EXISTING LEVELS	11.10	11.77	15.05	15.33	15.00	15.00
DESIGN LEVELS	11.10	11.77	15.05	15.33	15.00	15.00
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1006.09

Downstream Reach Scheme Out B to CD
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	9.38	9.81	9.88	11.71	11.00	11.02	11.11
DESIGN LEVELS	9.38	9.81	9.88	11.71	11.00	11.02	11.11
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1303.55

Downstream Reach CD to EFG
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 0.00m

EXISTING LEVELS	2.75	3.92	3.45	5.74	8.00	9.41
DESIGN LEVELS	2.75	3.92	3.45	5.74	8.00	9.41
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1078.37

Downstream Reach EFH to Out
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

Maven Associates
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5 Owens Road, Epsom
Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

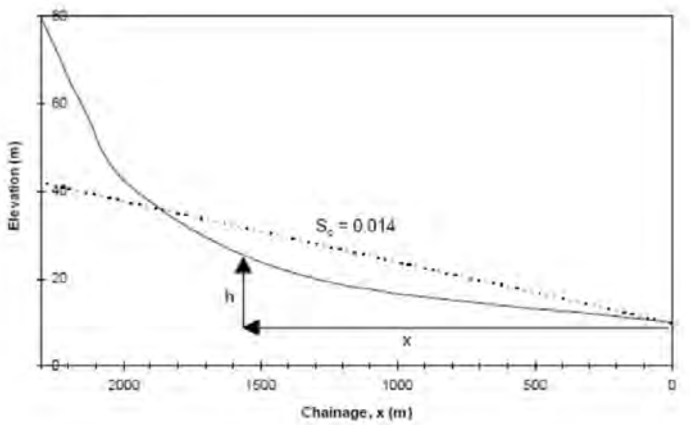
Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK009
Rev	A

DRAFT FOR REVIEW

DATE: 4/8/23

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment A	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	42.75	10.45	1500	1500	5.225	7837.5
3	52	19.7	3000	1500	15.075	22612.5
4	64	31.7	3750	750	25.7	19275
5	99.4	67.1	4175	425	49.4	20995
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4175	TOTAL =	70720

S_c = 0.008

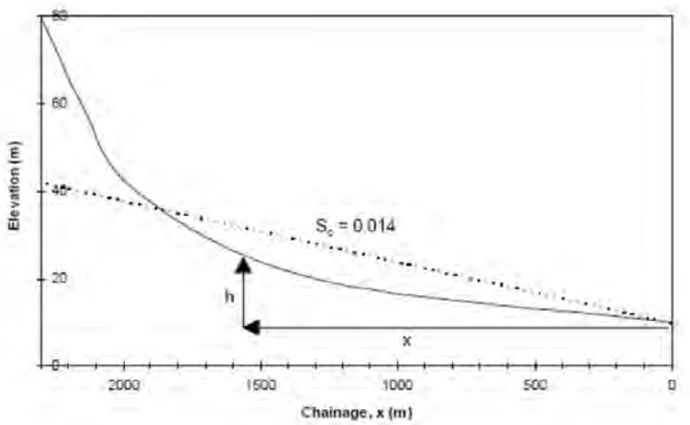
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment B	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	32.3	0	0			
2	40.6	8.3	1750	1750	4.15	7262.5
3	50.9	18.6	3000	1250	13.45	16812.5
4	57.3	25	3250	250	21.8	5450
5	88	55.7	4250	1000	40.35	40350
6	169.8	137.5	4660	410	96.6	39606
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4660	TOTAL =	109481

S_c = 0.010

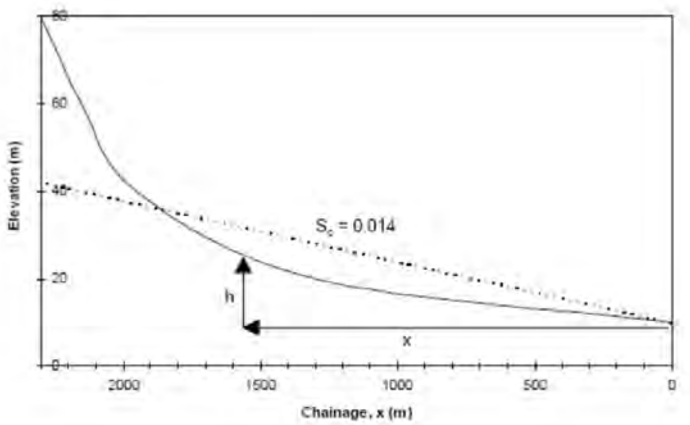
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment C	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	45.5	0	0			
2	70.6	25.1	1500	1500	12.55	18825
3	82.6	37.1	2750	1250	31.1	38875
4	101	55.5	3500	750	46.3	34725
5	133.6	88.1	3750	250	71.8	17950
6	215.5	170	4750	1000	129.05	129050
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4750	**TOTAL =**	239425

S_c = 0.021

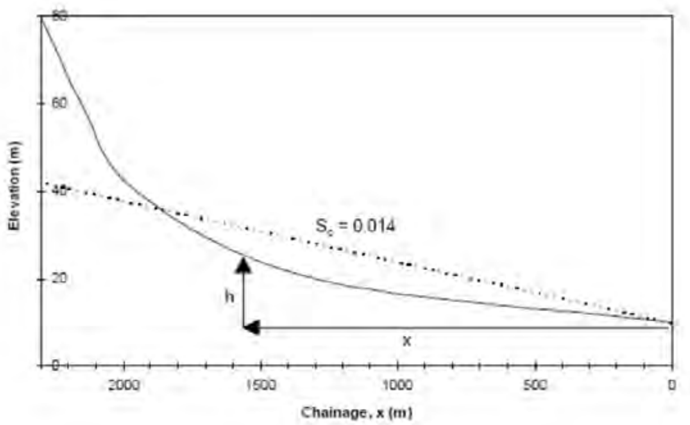
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Upstream Catchment D	CHKD BY:	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	46.95	0	0			
2	76	29.05	1750	1750	14.525	25418.75
3	92.5	45.55	3250	1500	37.3	55950
4	142	95.05	4500	1250	70.3	87875
5	205.84	158.89	5750	1250	126.97	158712.5
6	317	270.05	6750	1000	214.47	214470
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	6750	TOTAL =	542426.25

S_c = 0.024

Post-development

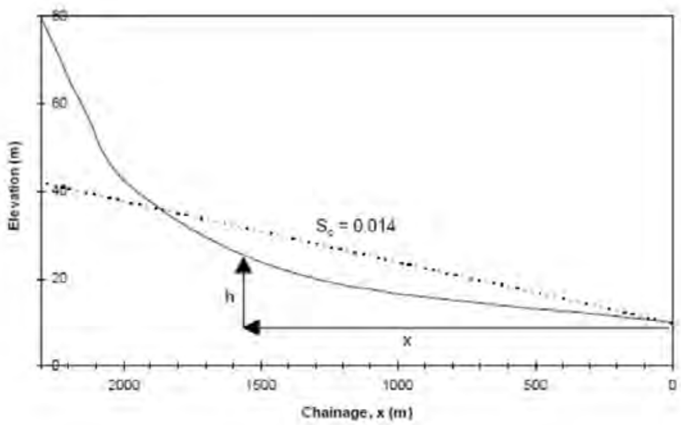
Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

D

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Upstream Catchment E	CHKD BY:	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1	32.3	0	0			
2	45.1	12.8	2000	2000	6.4	12800
3	57.2	24.9	3750	1750	18.85	32987.5
4	111.4	79.1	4500	750	52	39000
5	135.7	103.4	5750	1250	91.25	114062.5
6	194.8	162.5	6250	500	132.95	66475
7	317	284.7	7250	1000	223.6	223600
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	7250	TOTAL =	488925

S_c = 0.019

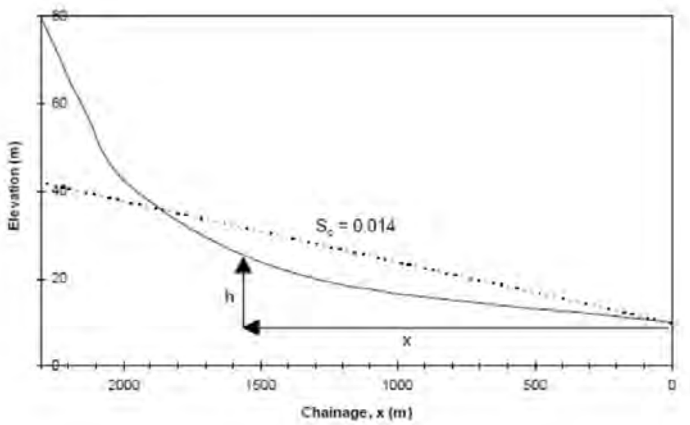
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment F	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	29.95	0	0			
2	44.86	14.91	2000	2000	7.455	14910
3	55.91	25.96	2750	750	20.435	15326.25
4	99.25	69.3	3250	500	47.63	23815
5	165.1	135.15	4000	750	102.225	76668.75
6	274.7	244.75	4714.4	714.4	189.95	135700.28
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4714.4	TOTAL =	266420.28

S_c = 0.024

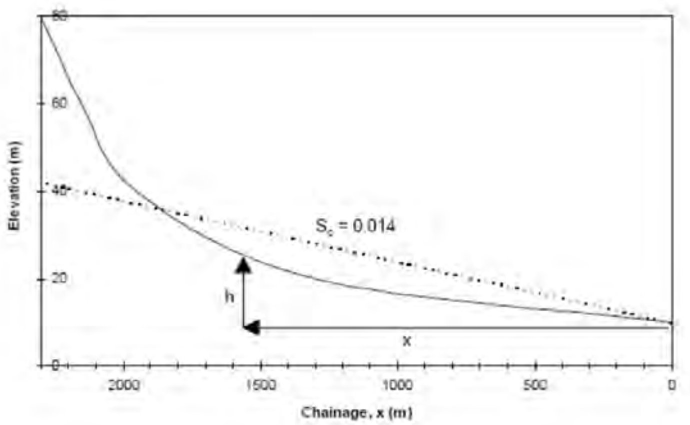
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Reach ABE to Scheme Inflow	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	29.95	0	0			
2	31.9	1.95	500	500	0.975	487.5
3	32.01	2.06	750	250	2.005	501.25
4	32.28	2.33	1186	436	2.195	957.02
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1186	**TOTAL =**	1945.77

S_c = 0.003

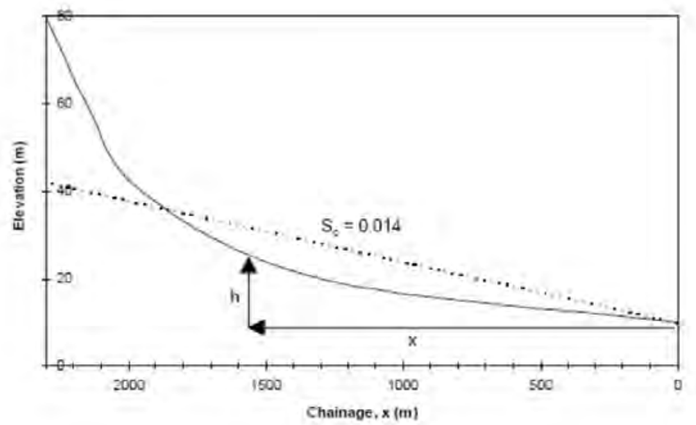
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Reach CD to ABE	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h} \Delta x)$
1	32.3	0	0			
2	37.2	4.9	1000	1000	2.45	2450
3	39.1	6.8	1500	500	5.85	2925
4	42.1	9.8	2250	750	8.3	6225
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	2250	**TOTAL =**	11600

S_c = 0.005

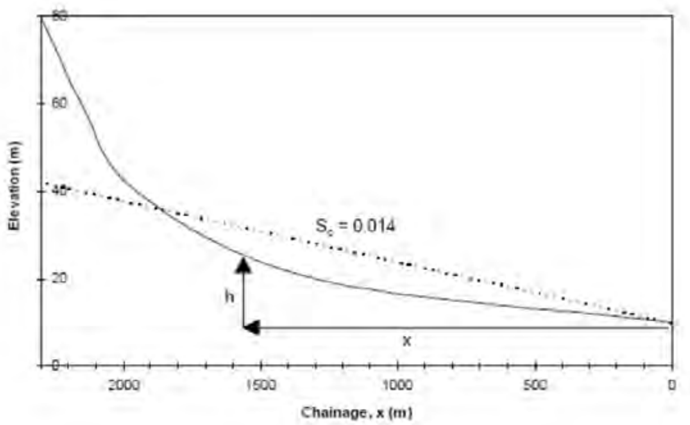
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream A	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h} \Delta x)$
1	27	0	0			
2	33.5	6.5	3000	3000	3.25	9750
3	39.9	12.9	4500	1500	9.7	14550
4	67.56	40.56	5750	1250	26.73	33412.5
5	140	113	6120	370	76.78	28408.6
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	6120	**TOTAL =**	86121.1

S_c = 0.005

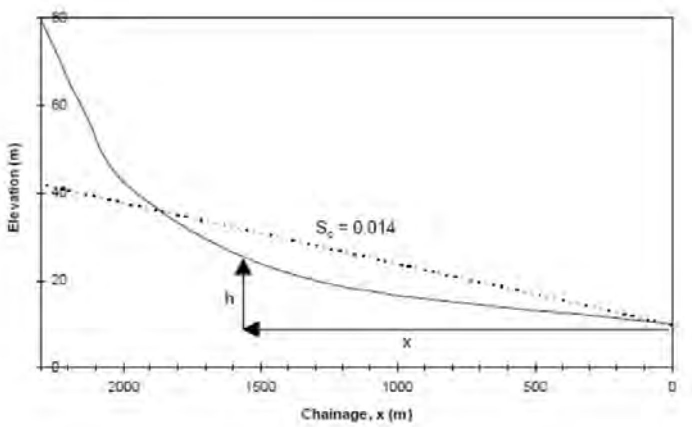
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream B	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells	(green)
Result cells	(yellow)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	40.7	0	0			
2	48.87	8.17	2000	2000	4.085	8170
3	56.5	15.8	3500	1500	11.985	17977.5
4	94.3	53.6	4500	1000	34.7	34700
5	148.64	107.94	5000	500	80.77	40385
6	288.82	248.12	5306	306	178.03	54477.18
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	5306	**TOTAL =**	155709.68

S_c = 0.011

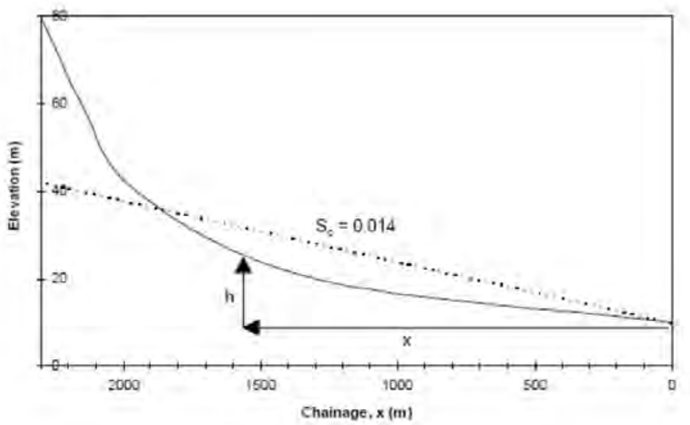
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream C	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	11.1	0	0			
2	15.07	3.97	500	500	1.985	992.5
3	15.3	4.2	750	250	4.085	1021.25
4	25.67	14.57	1000	250	9.385	2346.25
5	27.77	16.67	1077	77	15.62	1202.74
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1077	TOTAL =	5562.74

S_c = 0.010

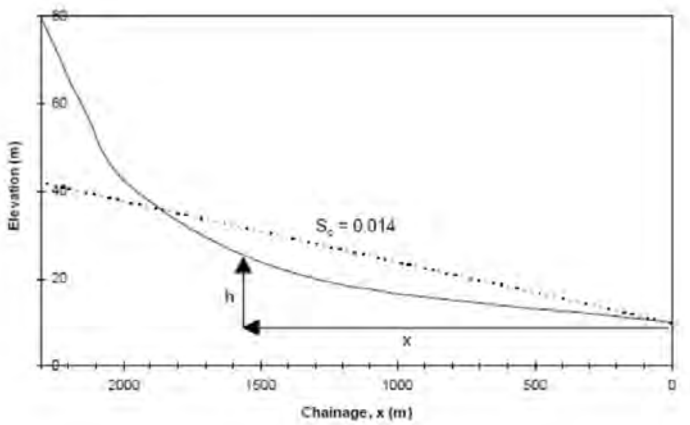
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Downstream D	CHKD BY:	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	11.1	0	0			
2	20.2	9.1	1000	1000	4.55	4550
3	29.6	18.5	2000	1000	13.8	13800
4	33.74	22.64	2750	750	20.57	15427.5
5	43.5	32.4	3000	250	27.52	6880
6	79.7	68.6	3250	250	50.5	12625
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	3250	TOTAL =	53282.5

S_c = 0.010

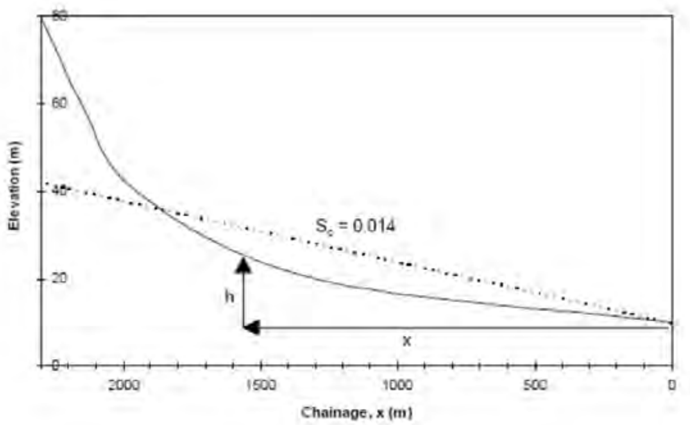
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream E	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1	8.9	0	0			
2	10.36	1.46	500	500	0.73	365
3	18.24	9.34	750	250	5.4	1350
4	34.2	25.3	1250	500	17.32	8660
5	57.1	48.2	1695	445	36.75	16353.75
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1695	**TOTAL =**	26728.75

S_c = 0.019

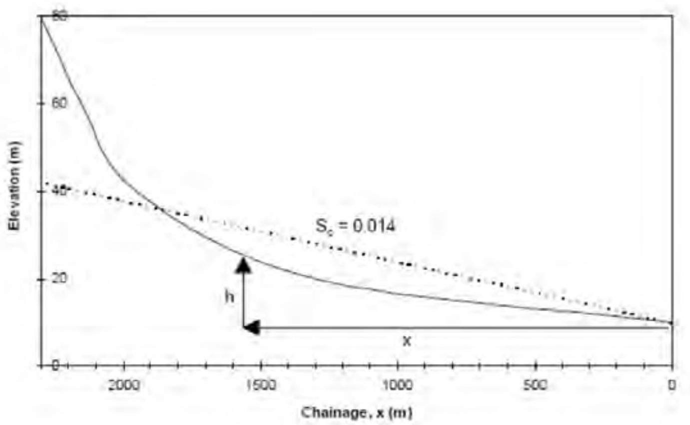
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream F	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	8.98	0	0			
2	10.88	1.9	500	500	0.95	475
3	37.35	28.37	750	250	15.135	3783.75
4	65	56.02	1036	286	42.195	12067.77
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1036	**TOTAL =**	16326.52

S_c = 0.030

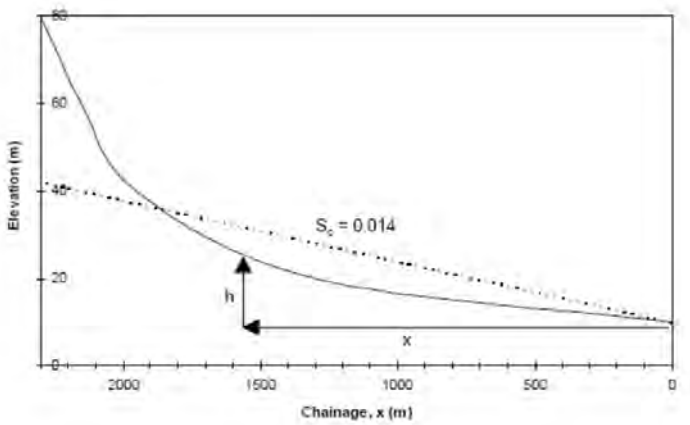
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Downstream G	CHKD BY:	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	9.4	0	0			
2	27.5	18.1	1000	1000	9.05	9050
3	38.5	29.1	1750	750	23.6	17700
4	71.5	62.1	2553	803	45.6	36616.8
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	2553	TOTAL =	63366.8

S_c = 0.019

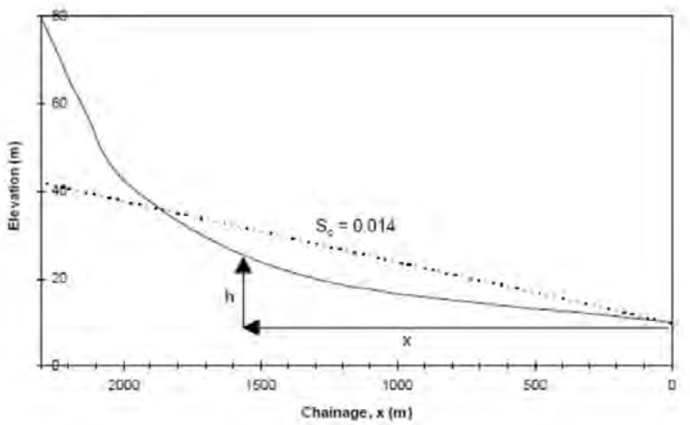
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream H	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	0	0	0			
2	3.75	3.75	250	250	1.875	468.75
3	5.25	5.25	750	500	4.5	2250
4	18.1	18.1	1000	250	11.675	2918.75
5	43.1	43.1	1250	250	30.6	7650
6	60	60	1520	270	51.55	13918.5
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1520	TOTAL =	27206

S_c = 0.024

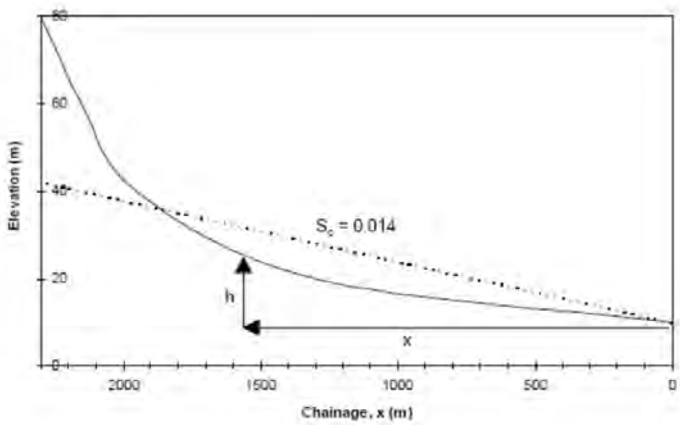
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Scheme In to Out	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	15	0	0			
2	19.25	4.25	1000	1000	2.125	2125
3	25.66	10.66	2000	1000	7.455	7455
4	31.1	16.1	2973	973	13.38	13018.74
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	2973	**TOTAL =**	22598.74

$\mathbf{S_c}$ **=** 0.005

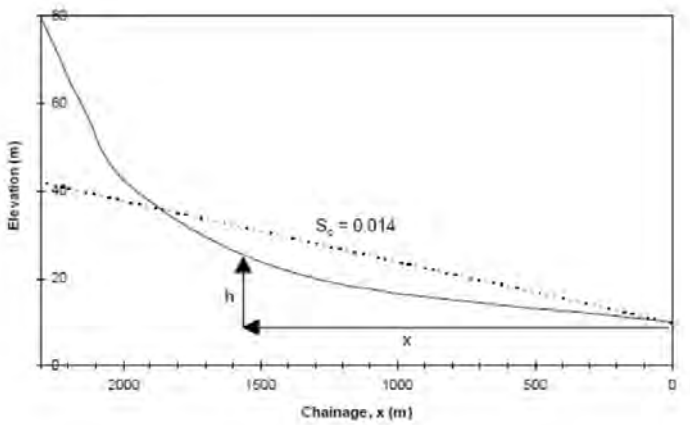
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

$\mathbf{S_c}$ **=** #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Bto Scheme Out	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	15	0	0			
2	29.43	14.43	750	750	7.215	5411.25
3	32.25	17.25	2000	1250	15.84	19800
4	35.73	20.73	3250	1250	18.99	23737.5
5	41.7	26.7	4850	1600	23.715	37944
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4850	**TOTAL =**	86892.75

S_c = 0.007

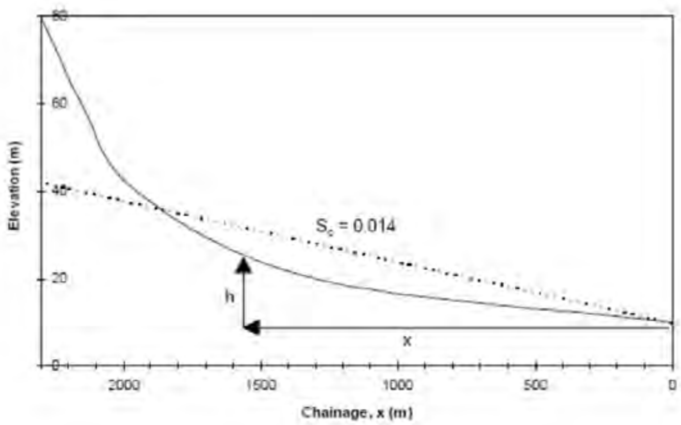
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Scheme Out B to CD	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	11.1	0	0			
2	11.77	0.67	250	250	0.335	83.75
3	15	3.9	1000	750	2.285	1713.75
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1000	TOTAL =	1797.5

S_c = 0.004

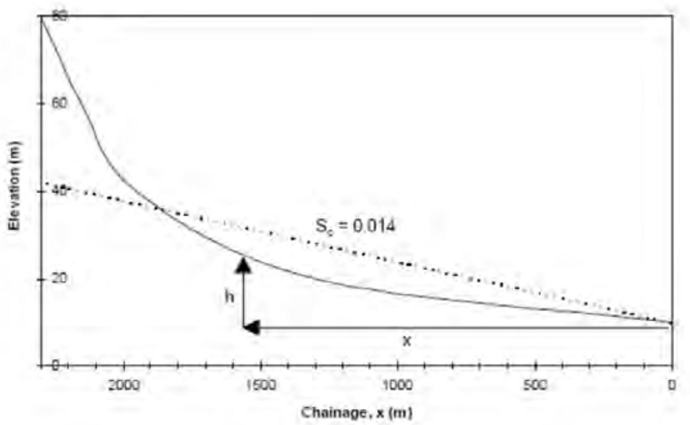
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach CD to EFG	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	9.38	0	0			
2	9.8	0.42	250	250	0.21	52.5
3	11	1.62	1000	750	1.02	765
4	11.11	1.73	1303	303	1.675	507.525
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1303	**TOTAL =**	1325.025

S_c = 0.002

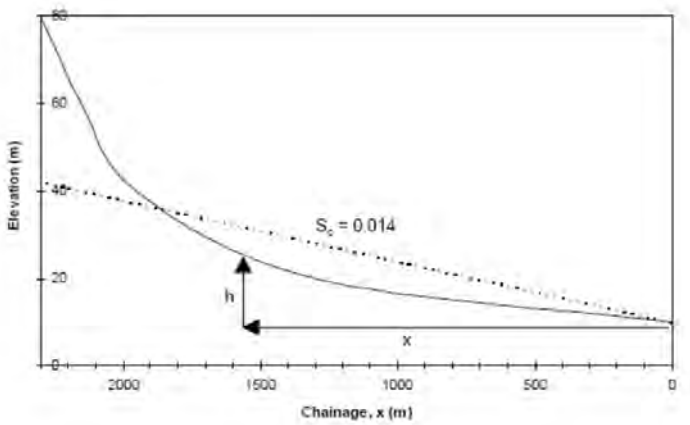
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach EFG TO OUT	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	2.75	0	0			
2	3.45	0.7	500	500	0.35	175
3	8	5.25	1000	500	2.975	1487.5
4	9.41	6.66	1080	80	5.955	476.4
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1080	**TOTAL =**	2138.9

S_c = 0.004

Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

100YR TIME OF CONCENTRATION CALCS

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment A	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	6.0077	588.75
C	Total Pervious	74	327.7623	24254.41
* from Appendix B		Totals =	333.770	24843.16

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 327.7623 / 333.770 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.117 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.54 1.33 4.26 = 2.02 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.35 hrs

OK

use

2.0218088 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment B	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	10.3517	1014.47
C	Total Pervious	74	401.8183	29734.55
* from Appendix B		Totals =	412.170	30749.02

CN (weighted) = total product / total area = ###### / ###### = 74.6

Ia (average) = 5 x pervious area / total area = 5 x 401.8183 / 412.170 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.29 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.6 / (200- 74.6) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.61 1.33 3.98 = 1.94 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.30 hrs

OK
use
1.939068 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment C	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	3.8056	372.95
C	Total Pervious	74	287.7544	21293.83
* from Appendix B		Totals =	291.560	21666.77

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 287.7544 / 291.560 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.89 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.85 1.34 3.19 = 1.70 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.14 hrs

OK
use
1.6979653 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment D	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	4.8100	471.38
C	Total Pervious	74	505.2700	37389.98
* from Appendix B		Totals =	510.080	37861.36

CN (weighted) = total product / total area = 37861.36 / 510.080 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 505.2700 / 510.080 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 6.687 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.50 1.34 3.06 = 2.01 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0076355 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Warkworth South Plan Change **Calc Title** TP108 Calculation - Pre-Development Upstream Catchment E	**Author** YW	**Date** 30/03/2023	**Checked**

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	5.7200	560.56
C	Total Pervious	74	567.5700	42000.18
* from Appendix B		Totals =	573.290	42560.74

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{42560.74}{573.290} = 74.2$

Ia (average) = $\frac{\text{5 x pervious area}}{\text{total area}} = \frac{5 \times 567.5700}{573.290}$ 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 7.153 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.2}{200 - 74.2} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.66 1.34 3.28 = 2.25 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.51 hrs

OK
use
2.2509428 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Upstream Catchment F	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	4.8193	472.29
C	Total Pervious	74	299.1107	22134.19
* from Appendix B		Totals =	303.930	22606.48

CN (weighted) = total product = / total area = 22606.48 / 303.930 = 74.4

Ia (average) = 5 x pervious area = / total area = 5 x 299.1107 / 303.930 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.4 / 200- 74.4 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.33 3.06 = 1.56 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5646387 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development Upstream Catchment F	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	15.1030	1480.09
C	Total Pervious	74	288.8270	21373.20
* from Appendix B		Totals =	303.930	22853.29

CN (weighted) = total product / total area = 22853.29 / 303.930 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 288.8270 / 303.930 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.32 3.06 = 1.55 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.04 hrs

OK
use
1.5497843 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development pstream Reach Catchment ABE - Inflow	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	22.0794	2163.78
C	Total Pervious	74	1297.1506	95989.14
* from Appendix B		Totals =	1319.230	98152.93

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 1297.1506 / 1319.230 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.186 km (along drainage path)

Catchment Slope Sc= 0.003 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.12 1.33 5.71 = 1.19 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.193873089 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Reach CD to ABE	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	8.6156	844.33
C	Total Pervious	74	793.0244	58683.81
* from Appendix B		Totals =	801.640	59528.13

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 793.0244 / 801.640 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.25 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.71 1.34 4.90 = 1.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5656087 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment A	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	9.4054	921.73
C	Total Pervious	74	575.1346	42559.96
* from Appendix B		Totals =	584.540	43481.69

CN (weighted) = total product / total area = 43481.69 / 584.540 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 575.1346 / 584.540 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.848 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.83 1.33 4.90 = 2.59 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.74 hrs

OK
use
2.5945274 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment B	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{63097.38}{848.760} = 74.3$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 836.7124}{848.760}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 5.031 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.3}{200 - 74.3} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.90 1.33 3.87 = 2.10 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.41 hrs

OK
use
2.0998325 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Catchment C	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	7.3200	717.36
C	Total Pervious	74	16.2500	1202.50
* from Appendix B		Totals =	23.570	1919.86

CN (weighted) = total product / total area = 1919.86 / 23.570 = 81.5

Ia (average) = 5 x pervious area / total area = 5 x 16.2500 / 23.570 = 3.4 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.018 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 81.5 / (200- 81.5) = 0.69

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.01 1.23 3.98 = 0.69 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.46 hrs

OK
use
0.6932339 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development TP108 Downstream Catchment D	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	8.4586	828.94
C	Total Pervious	74	275.4014	20379.70
* from Appendix B		Totals =	283.860	21208.65

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{21208.65}{283.860} =$ 74.7

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 275.4014}{283.860}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 3.056 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.7}{200- \ 74.7} =$ 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.09 1.33 3.98 = 1.55 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.04 hrs

OK
use
1.5480986 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Down Catchment E	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	45.2715	4436.61
C	Total Pervious	74	26.8785	1989.01
* from Appendix B		Totals =	72.150	6425.62

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{6425.62}{72.150}$ = 89.1

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 26.8785}{72.150}$ 1.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.665 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{89.1}{200- 89.1}$ = 0.80

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.40 1.13 3.28 = 0.73 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.49 hrs

OK
use
0.7262942 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment F	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	0.2200	21.56
C	Total Pervious	74	21.5700	1596.18
* from Appendix B		Totals =	21.790	1617.74

CN (weighted) = total product / total area = 1617.74 / 21.790 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 21.5700 / 21.790 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.076 km (along drainage path)

Catchment Slope Sc= 0.03 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   1.05   1.34   2.86 = 0.56 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.38 hrs

OK
use
0.5621775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Warkworth South Plan Change **Calc Title** TP108 Calculation - Pre-Development Downstream Catchment G	**Author** YW	**Date** 18/01/2023	**Checked**

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	67.7100	6635.58
C	Total Pervious	74	59.8900	4431.86
* from Appendix B		Totals =	127.600	11067.44

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{11067.44}{127.600}$ = 86.7

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 59.8900}{127.600}$ 2.3 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.412 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{86.7}{200- 86.7}$ = 0.77

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.79 1.16 3.28 = 0.95 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.64 hrs

OK
use
0.9519511 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment H	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	23.6020	2313.00
C	Total Pervious	74	25.5680	1892.03
* from Appendix B		Totals =	49.170	4205.03

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{4205.03}{49.170} = 85.5$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 25.5680}{49.170}$ 2.6 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.471 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{85.5}{200- \quad 85.5} = 0.75$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.29 1.17 3.06 = 0.65 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.43 hrs

OK
use
0.6491606 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: Warkworth South Plan Change, TP108 Calculation - Pre-Development, Reach Scheme in to out	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	30.9143	3029.60
C	Total Pervious	74	2111.7450	156269.13
* from Appendix B		Totals =	2142.659	159298.73

CN (weighted) = total product / total area = ####### / 2142.659 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 2111.7450 / 2142.659 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.973 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.05 1.33 4.90 = 1.88 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.26 hrs

OK
use
1.87974775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change TP108 Calc Title: Calculation - Pre-Development Downstream Reach B to SCHEME OUT	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{63097.38}{848.760} =$ 74.3

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 836.7124}{848.760}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.85 km (along drainage path)

Catchment Slope Sc= 0.007 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.3}{200- 74.3} =$ 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.84 1.33 4.43 = 2.35 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.57 hrs

OK
use
2.3473116 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\TP108 Downstream Reach B to HG.xlsx

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Reach Scheme out to CD	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	68.7906	6741.48
C	Total Pervious	74	3992.4987	295444.90
* from Appendix B		Totals =	4061.289	302186.38

CN (weighted) = total product / total area = ####### / 4061.289 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 3992.4987 / 4061.289 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 5.24 = 0.98 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.66 hrs

OK
use
0.97848894 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Reach CD to EFG	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	84.5692	8287.78
C	Total Pervious	74	4284.1501	317027.11
* from Appendix B		Totals =	4368.719	325314.89

CN (weighted) = total product = ####### = 74.5
total area 4368.719

Ia (average) = 5 x pervious area = 5 x 4284.1501 4.9 mm
total area 4368.719

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.002 m/m (by equal area method)

Runoff factor, CN = 74.5 = 0.59
200 - CN 200- 74.5

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 6.45 = 1.20 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2038381 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Reach EFG to Outlet	Author YW	Date 31/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	197.7707	19381.53
C	Total Pervious	74	4392.4886	325044.16
* from Appendix B		Totals =	4590.259	344425.69

CN (weighted) = total product / total area = ####### / 4590.259 = 75.0

Ia (average) = 5 x pervious area / total area = 5 x 4392.4886 / 4590.259 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.08 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.0 / (200- 75.0) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.32 5.24 = 1.02 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.68 hrs

OK
use
1.02191107 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

10YR TIME OF CONCENTRATION CALCS

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Catchment Rain	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	16.4233	1609.48
C	Total Pervious	74	468.9067	34699.10
* from Appendix B		Totals =	485.330	36308.58

CN (weighted) = total product / total area = 36308.58 / 485.330 = 74.8

Ia (average) = 5 x pervious area / total area = 5 x 468.9067 / 485.330 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 4.054 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.8 / (200- 74.8) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 2.52 1.33 4.26 = 1.20 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.1954464 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development 10yr Catchment Rain	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	3.3879	332.02
C	Total Pervious	74	261.7558	19369.93
* from Appendix B		Totals =	265.144	19701.95

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{19701.95}{265.144} = 74.3$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 261.7558}{265.144}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 4.054 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.3}{200- \; 74.3} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 2.52 1.34 4.26 = 1.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2025746 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Catchment A	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	9.4054	921.73
C	Total Pervious	74	575.1346	42559.96
* from Appendix B		Totals =	584.540	43481.69

CN (weighted) = total product / total area = 43481.69 / 584.540 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 575.1346 / 584.540 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.848 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.83 1.33 4.90 = 2.59 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.74 hrs

OK
use
2.5945274 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Downstream Catchment B	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 5.031 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.3 / 200- 74.3 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.90 1.33 3.87 = 2.10 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.41 hrs

OK
use
2.0998325 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Catchment C	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	7.3200	717.36
C	Total Pervious	74	16.2500	1202.50
* from Appendix B		Totals =	23.570	1919.86

CN (weighted) = total product / total area = 1919.86 / 23.570 = 81.5

Ia (average) = 5 x pervious area / total area = 5 x 16.2500 / 23.570 = 3.4 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.018 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 81.5 / (200- 81.5) = 0.69

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.01 1.23 3.98 = 0.42 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.28 hrs

OK
use
0.4159403 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR TP108 Downstream Catchment D	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	8.4586	828.94
C	Total Pervious	74	275.4014	20379.70
* from Appendix B		Totals =	283.860	21208.65

CN (weighted) = total product / total area = 21208.65 / 283.860 = 74.7

Ia (average) = 5 x pervious area / total area = 5 x 275.4014 / 283.860 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 3.056 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.7 / (200- 74.7) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 2.09 1.33 3.98 = 0.93 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.62 hrs

OK
use
0.9288591 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\10yr\TP108 Downstream Catchment D

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Down Catchment E	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	45.2715	4436.61
C	Total Pervious	74	26.8785	1989.01
* from Appendix B		Totals =	72.150	6425.62

CN (weighted) = total product / total area = 6425.62 / 72.150 = 89.1

Ia (average) = 5 x pervious area / total area = 5 x 26.8785 / 72.150 = 1.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.665 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.1 / (200- 89.1) = 0.80

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.40 1.13 3.28 = 0.44 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.29 hrs

OK
use
0.4357765 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Downstream Catchment F	Author YW	Date 20/072023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	0.2200	21.56
C	Total Pervious	74	21.5700	1596.18
* from Appendix B		Totals =	21.790	1617.74

CN (weighted) = total product = / total area = 1617.74 / 21.790 = 74.2

Ia (average) = 5 x pervious area = / total area = 5 x 21.5700 / 21.790 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.076 km (along drainage path)

Catchment Slope Sc= 0.03 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.2 / 200- 74.2 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.05 1.34 2.86 = 0.34 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.23 hrs

OK
use
0.3373065 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Downstream Catchment G	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	67.7100	6635.58
C	Total Pervious	74	59.8900	4431.86
* from Appendix B		Totals =	127.600	11067.44

CN (weighted) = total product / total area = 11067.44 / 127.600 = 86.7

Ia (average) = 5 x pervious area / total area = 5 x 59.8900 / 127.600 = 2.3 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 2.412 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 86.7 / (200- 86.7) = 0.77

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.79 1.16 3.28 = 0.57 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.38 hrs

OK
use
0.5711707 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10YR Downstream Catchment H	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	23.6020	2313.00
C	Total Pervious	74	25.5680	1892.03
* from Appendix B		Totals =	49.170	4205.03

CN (weighted) = total product / total area = 4205.03 / 49.170 = 85.5

Ia (average) = 5 x pervious area / total area = 5 x 25.5680 / 49.170 = 2.6 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1.471 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 85.5 / (200- 85.5) = 0.75

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.29 1.17 3.06 = 0.39 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.26 hrs

OK
use
0.3894963 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Reach Scheme in to out	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	30.9143	3029.60
C	Total Pervious	74	2111.7450	156269.13
* from Appendix B		Totals =	2142.659	159298.73

CN (weighted) = total product = ####### = 74.3
total area #######

Ia (average) = 5 x pervious area = 5 x 2111.7450 4.9 mm
total area 2142.659

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.973 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN = 74.3 = 0.59
200 - CN 200- 74.3

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.05 1.33 4.90 = 1.88 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.26 hrs

OK
use
1.87974775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development pstream Reach Catchment ABE - Inflow 10yr	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	22.0794	2163.78
C	Total Pervious	74	1297.1506	95989.14
* from Appendix B		Totals =	1319.230	98152.93

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 1297.1506 / 1319.230 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.186 km (along drainage path)

Catchment Slope Sc= 0.003 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.12 1.33 5.71 = 1.19 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.193873089 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Upstream Reach CD to ABE	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	8.6156	844.33
C	Total Pervious	74	793.0244	58683.81
* from Appendix B		Totals =	801.640	59528.13

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 793.0244 / 801.640 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.25 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.71 1.34 4.90 = 1.57 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5656087 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Reach Scheme out to CD	Author YW 10yr	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	68.7906	6741.48
C	Total Pervious	74	3992.4987	295444.90
* from Appendix B		Totals =	4061.289	302186.38

CN (weighted) = total product / total area = ####### / ####### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 3992.4987 / 4061.289 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14   1   1.00   1.33   5.24   = 0.98 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.66 hrs

OK
use
0.97848894 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Downstream Reach CD to EFG	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	84.5692	8287.78
C	Total Pervious	74	4284.1501	317027.11
* from Appendix B		Totals =	4368.719	325314.89

CN (weighted) = total product / total area = ####### / ####### = 74.5

Ia (average) = 5 x pervious area / total area = 5 x 4284.1501 / 4368.719 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.002 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.5 / (200- 74.5) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 6.45 = 1.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2038381 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title — Warkworth South Plan Change, TP108 Calculation - Pre-Development, 10YR Downstream Reach B to HG	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.85 km (along drainage path)

Catchment Slope Sc= 0.007 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.84 1.33 4.43 = 2.35 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.57 hrs

OK
use
2.3473116 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10YR Downstream Reach EFG to Outlet	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	197.7707	19381.53
C	Total Pervious	74	4392.4886	325044.16
* from Appendix B		Totals =	4590.259	344425.69

CN (weighted) = total product / total area = ####### / ####### = 75.0

Ia (average) = 5 x pervious area / total area = 5 x 4392.4886 / 4590.259 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.08 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.0 / (200- 75.0) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.32 5.24 = 1.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.68 hrs

OK
use
1.02191107 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10yr Upstream Catchment A	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	6.0077	588.75
C	Total Pervious	74	327.7623	24254.41
* from Appendix B		Totals =	333.770	24843.16

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 327.7623 / 333.770 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.117 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.54 1.33 4.26 = 2.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0218088 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10YR Upstream Catchment C	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	3.8056	372.95
C	Total Pervious	74	287.7544	21293.83
* from Appendix B		Totals =	291.560	21666.77

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 287.7544 / 291.560 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.89 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.85 1.34 3.19 = 1.70 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.14 hrs

OK
use
1.6979653 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development 10YR Upstream Catchment D	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	4.8100	471.38
C	Total Pervious	74	505.2700	37389.98
* from Appendix B		Totals =	510.080	37861.36

CN (weighted) = total product = / total area = 37861.36 / 510.080 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 505.2700 / 510.080 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 6.687 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.50 1.34 3.06 = 2.01 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0076355 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development 10yr Upstream Catchment E	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	5.7200	560.56
C	Total Pervious	74	567.5700	42000.18
* from Appendix B		Totals =	573.290	42560.74

CN (weighted) = total product / total area = 42560.74 / 573.290 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 567.5700 / 573.290 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 7.153 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.66 1.34 3.28 = 2.25 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.51 hrs

OK
use
2.2509428 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: Warkworth South Plan Change, TP108 Calculation - Pre-Development, 10yr Upstream Catchment F	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	4.8193	472.29
C	Total Pervious	74	299.1107	22134.19
* from Appendix B		Totals =	303.930	22606.48

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{22606.48}{303.930} =$ 74.4

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 299.1107}{303.930}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.4}{200 - 74.4} =$ 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.33 3.06 = 1.56 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5646387 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development 10yr Upstream Catchment F	Author YW	Date 20/07/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	0.0000	0.00
C	Total Pervious	74	15.1030	1117.62
* from Appendix B		Totals =	15.103	1117.62

CN (weighted) = total product / total area = 1117.62 / 15.103 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 15.1030 / 15.103 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

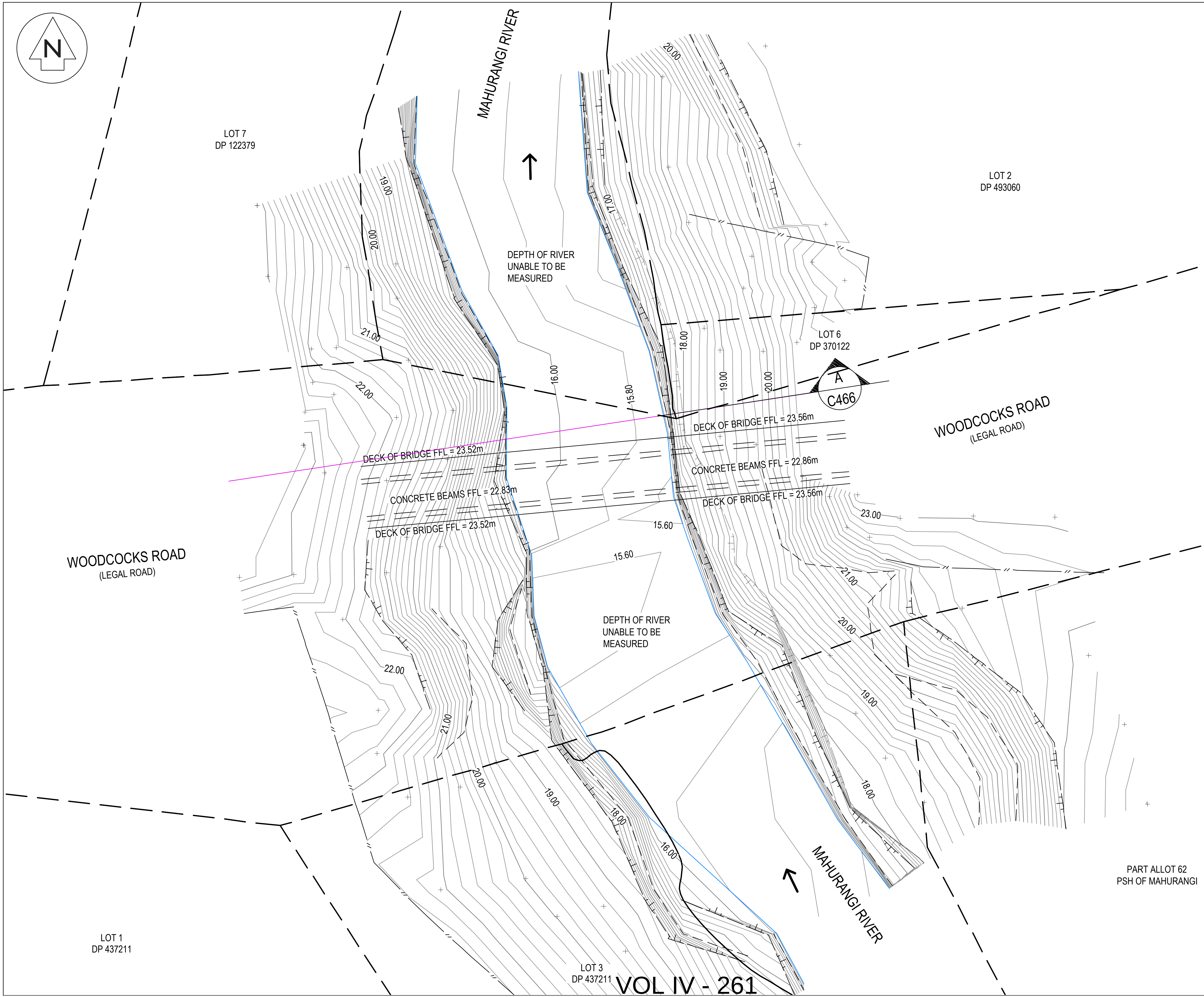
= 0.14 1 2.74 1.34 3.06 = 1.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5716717 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

APPENDIX E – Woodcocks Road Bridge



Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
4. Origin of Levels = CA 97 (ABLQ)
   Published RL= 43.46, sourced from The LINZ Digital Geodetic Database.
5. Boundaries are subject to final survey.

Legend
- EX BDY ABUTTALS
- EX MAJOR CONTOUR
- EX MINOR CONTOUR
- EX BANK TOP
- EX BANK BOTTOM
- EX FENCE
- EX WATERS EDGE
- EX BRIDGE DECK
- EX CONCRETE BEAM
- SURVEY SPOT HEIGHT

Rev	Description	By	Date
A	FOR ISSUE	MAVEN	04/2023

	By	Date
Survey	CC	04/2023
Design		
Drawn	CC	04/2023
Checked	MH	04/2023

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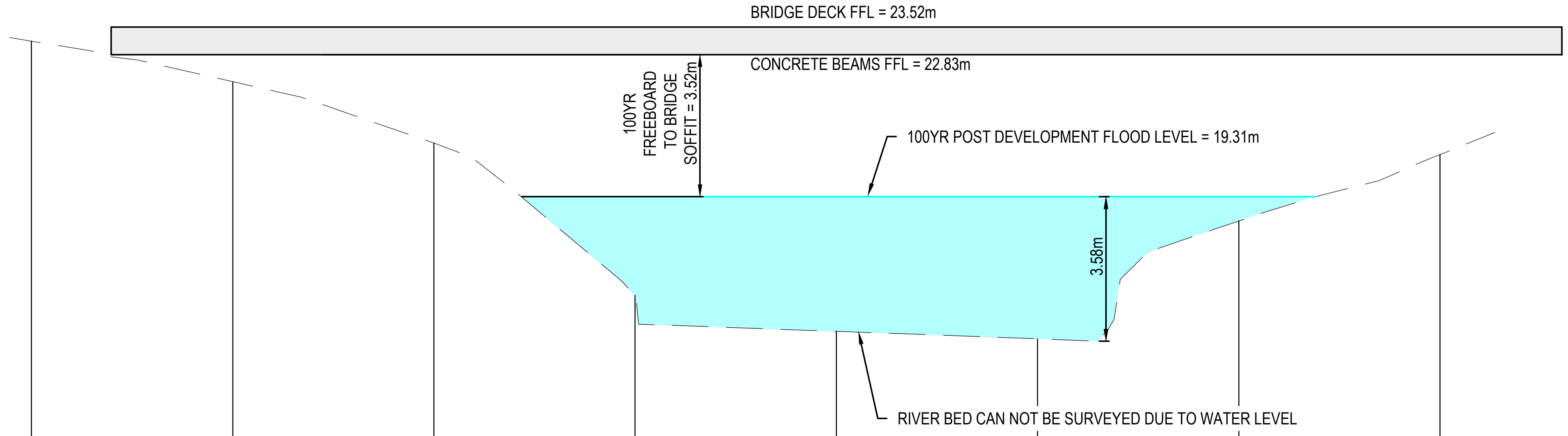
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAMANAWA LP & STEPPIG TOWARDS FAR LTD

Title
TOPOGRAPHICAL SURVEY PLAN (WOODCOCK ROAD)

Project no.	211001
Scale	1:250 @ A3
Cad file	211001-C466 BRIDGE.DWG
Drawing no.	C055
Rev	A

Notes

1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000
3. Levels in terms of the Auckland Vertical Datum 1946.
4. Origin of Levels = CA 97 (ABLQ)
   Published RL= 43.46, sourced from The LINZ Digital Geodetic Database.
5. Boundaries are subject to final survey.



DATUM 12.00m

EXISTING LEVELS		23.17	22.16	20.64	16.87	15.96	15.78	18.70	20.35	
DESIGN LEVELS		23.17	22.16	20.64	16.87	15.96	15.78	18.70	20.35	
CUT/FILL		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	42.08

CROSS SECTION A
SCALE: HORI 1:150 VERT 1:150

Rev	Description	By	Date
B	PCC RFI	YW	07/2023
A	PPC RFI	YW	06/2023

	By	Date
Survey	CC	04/2023
Design		
Drawn	YW	06/23
Checked	LC	07/23

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAMANAWA LP & STEPPIG TOWARDS FAR LTD

Title
WOODCOCK BRIDGE CROSS SECTION PLAN

Project no.	211001
Scale	1:150 @ A3
Cad file	211001-C466 BRIDGE.DWG
Drawing no.	C466 — Rev B

DATE: 7/20/23

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev B
Job Title: Warkworth South Plan Change Calc Title: 100yr Overland Flow at Woodcock bridge Existing Flow Check	Author YW	Date 20-Jul	Checked LC

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

	Q=	$(AR^{2/3}S^{1/2})/n$	R=A/P
Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

S=	**0.004**	m/m

Section Location 1

Depth=	4.2	m
Width=	22.57	m
S=	0.004	m/m
A=	47.79	m^2
P=	6.05	m
R=	7.906	
n=	0.040	Stream, clean, winding , some pools and shoals
Velocity (V) R(2/3) S(1/2)/ n	6.279	m/sec
Channel Flow (Q) VxA	**300,078**	l/sec
100 year peak discharge =	296,360	l/sec OK

* Refer TP108 Modelling for Flow rates

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev B
Job Title Warkworth South Plan Change Calc Title 100yr Overland Flow at Woodcock bridge Proposed Flow Check	Author YW	Date 20-Jul	Checked LC

Design Spreadsheet for Mannings Formula

Calc 1: Capacity of Channel Flow (Q), Mannings formula

Q= $(AR^{2/3}S^{1/2})/n$ R=A/P

Where	Q=	Channel Flow	l/s
	S =	Longitudinal Slope	m/m
	A =	Cross sectional area	m2
	P=	Wetted Perimeter	m
	R =	Hydraulic Radius	m
	n =	Mannings n	

Longitudinal slope

S= **0.004** m/m

Section Location 1

Depth=	4.2	m
Width=	22.57	m
S=	0.004	m/m
A=	47.79	m^2
P=	6.05	m
R=	7.906	
n=	0.040	Stream, clean, winding , some pools and shoals
Velocity (V) R(2/3) S(1/2)/ n	6.279	m/sec
Channel Flow (Q) VxA	**300,078**	l/sec
100 year peak discharge =	295,200	l/sec OK

* Refer TP108 Modelling for Flow rates

APPENDIX E – POST DEVELOPMENT CATCHMENT ANALYSIS REPORT

POST DEVELOPMENT CATCHMENT ANALYSIS

PROPOSED WARKWORTH SOUTH PLAN CHANGE AREA FOR KA WAIMANAWA LP & STEPPING TOWARDS FARS LTD

Maven Associates	**Job Number** 211001		**Rev** A
Job Title: Warkworth South Plan Change **Title:** Post development Catchment analysis	**Author** KH	**Date** Jun 2023	**Checked** LC

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

The objective of this report is to provide further detail of stormwater catchments within the PCA in support of the Stormwater Management Plan (SMP) developed for the Warkworth South Plan Change.

While the SMP outlines the recommended stormwater controls and management strategy of the wider PCA, this report contains a comprehensive assessment considering the unique characteristics and constraints of individual catchments expected post development in order to support the wider recommendations. For a visual representation of the plan change area, please refer to Figure 1: Locality Plan below.

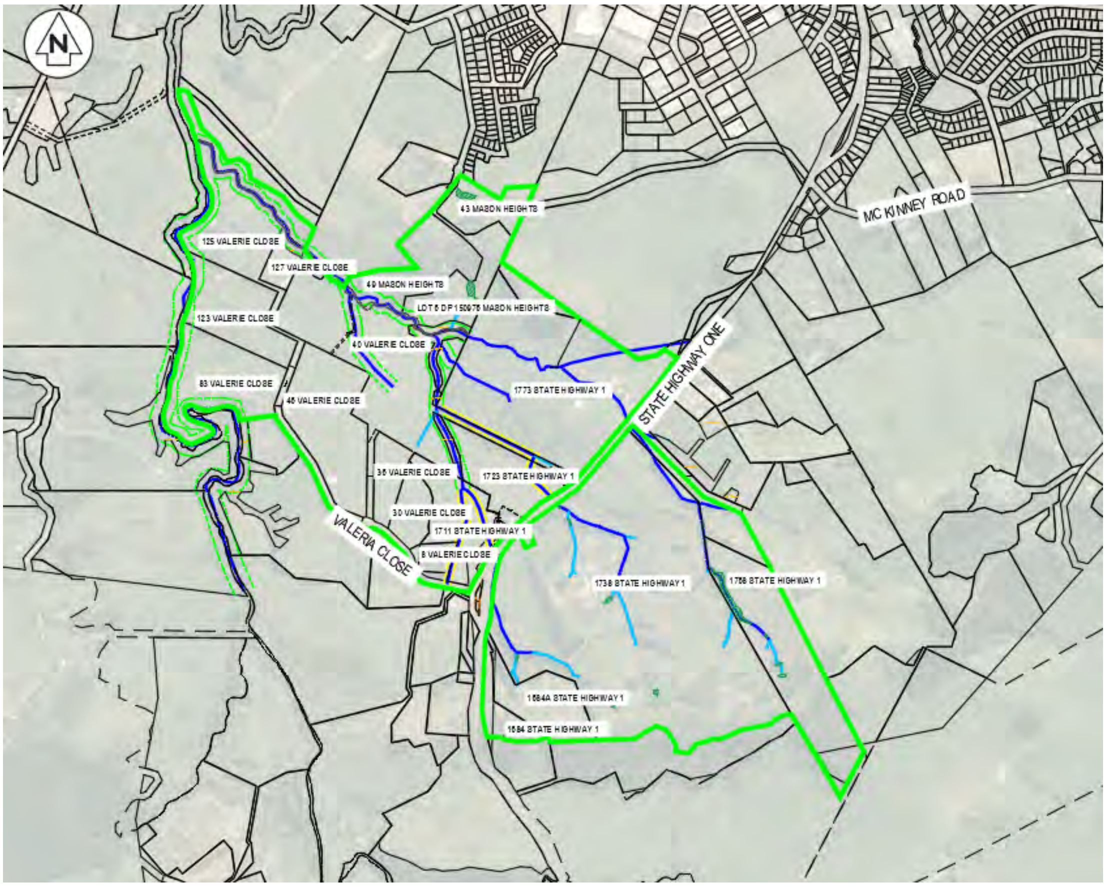


Figure 1: Locality Plan

The SMP has been submitted as part of the support documentation for the Warkworth South Area plan change application. Healthy Waters (HW) has provided initial feedback and requested additional documentation supporting the SMP. In response to this request, a high-level post development catchment plan has been developed, assuming the current master plan is developed without significant alteration. This plan identifies and splits the post development catchment into four distinct stormwater management zones, each with its own recommended stormwater management controls based on the local environment.

To gain a comprehensive understanding of the stormwater strategy, it is recommended that this report is read in conjunction with the SMP, as it provides further clarification and support for the stormwater management strategies of the PCA.

2.0 POST DEVELOPMENT CATCHMENT ANALYSIS

Based on the high-level post development catchment plan, the following four Stormwater Management Zones (SMZ) have been established:

- Stormwater Management Zone A: Catchments are generally a flat to moderate slope where the preferred management method is a Wetland as the preferred stormwater treatment device.
- Stormwater Management Zone B: Catchments are generally steep or too narrow to construct a wetland for stormwater treatment. In this catchment the Best Practical Option (BPO) approach to quality treatment is recommended; likely to be at source type devices.
- Stormwater Management Zone C: These Catchments have an existing specific land use (heritage Orchard and open space area) where no significant increase in impervious area is expected. Although wetland construction is feasible in these catchments, any requirement for treatment will be relatively small (And a bulk catchment device economically burdening for the scale of any small redevelopment)
- Stormwater Management Zone D: This zone is exclusively for the current State Highway One catchment which drains directly to the existing watercourse via an existing swale. The existing road legal width is too narrow, nor is it expected that any adjacent space will be made available for construction given the proximity to existing natural features and given the topography through the PCA. A BPO approach to stormwater quality treatment is recommended.

The four distinct stormwater management zone layouts are shown in Figure below:

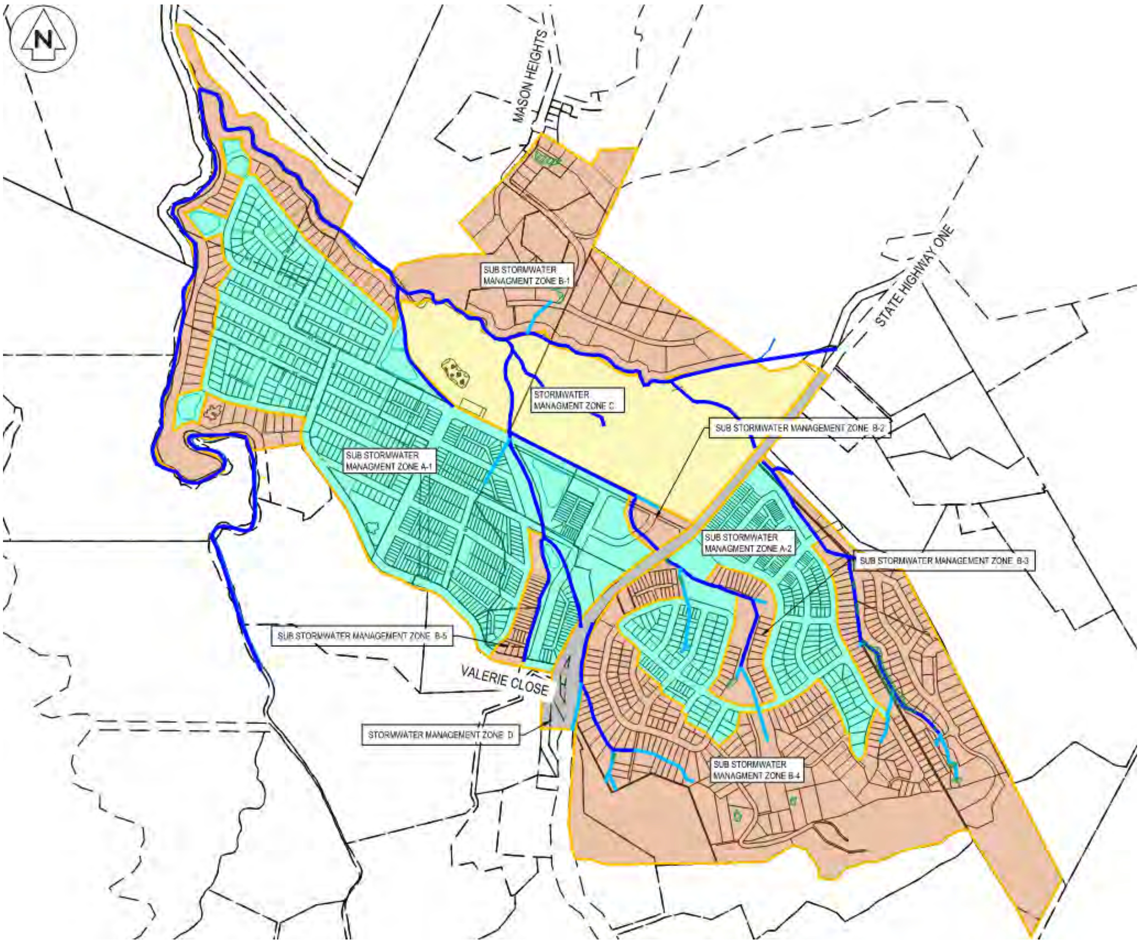


Figure 2: Stormwater Management Zone Plan

2.1 STORMWATER MANAGEMENT ZONE A

The post development catchment contained within this zone are: XII, XV, XXIV, XXVII, XXIX, XXXI, XXXIII, XXXIV, and XXXV.

An initial wetland sizing calculation has been conducted for all stormwater catchments listed above, the results are appended (Appendix A) and indicates the potential size of a typical wetland required to treat this catchment. The initial sizing is based on the maximum MPD and provides a high-level indication of the potential dimensions of the wetland. It should be noted that there are various ways to size the wetland to achieve the required volume required of GD01. This report focuses solely on the catchment and its suitability for specific stormwater devices, while the detailed design and workings of any device within the subdivision will be subject to a more thorough design process and review at a later stage.

CATCHMENT XII:

Catchment XII, located within the Waimanawa Hills Precinct, is adjacent to State Highway one on its northern boundary. Its western boundary aligns with an existing ridgeline, which may be modified however efforts should be made to retain the existing stormwater catchment boundary. The eastern boundary of Catchment XII abuts an existing stream and follows a proposed road alignment, ensuring that the public road is captured and treated by potential Wetland 8 as depicted in the master plan.

As illustrated in the accompanying figure, the downstream portion of Catchment XII is generally flat, making it suitable for wetland construction. Although the sizing and shape factors indicated by the engineering calculations may not be fully met, the overall area does meet the criteria. As the scheme plan is only indicative it can be adjusted as necessary to accommodate the proposed wetland. Please refer to Appendix B for relevant engineering drawings.

Figure 3: Catchment XII layout and section plan

CATCHMENT XV:

Catchment XV is situated within the Waimanawa Hills Precinct and shares its northern boundary with State Highway One. The eastern boundary aligns with an existing ridgeline, which may undergo modifications through earthworks. However, efforts will be made to preserve the highest point of the ridge to minimize alterations to the existing stormwater catchment boundary. On its western side, Catchment XV adjoins a stream and follows a road alignment, ensuring that the public road is encompassed and treated by potential Wetland 7, as indicated in the master plan.

The downstream section of Catchment XV, as depicted in the accompanying figure, includes a gradual slope that can be worked during the bulk earthwork operations, rendering it suitable for constructing a wetland. The chosen location for this wetland also satisfies the specified size, shape, and area requirements determined through engineering calculations. Therefore we find the location suitable and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. Please refer to Appendix B for relevant engineering drawings.

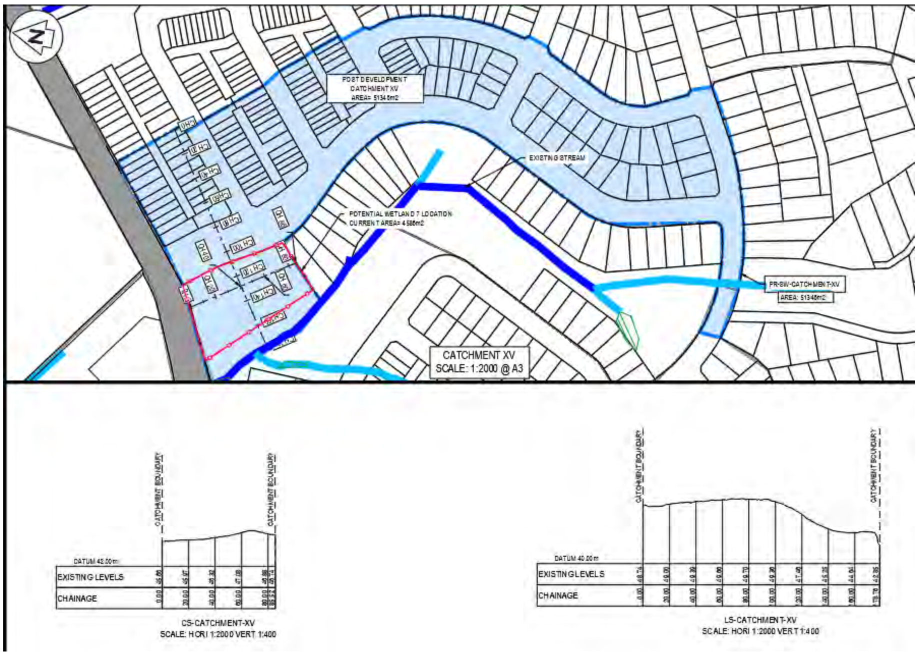


Figure 4: Catchment XV layout and section plan

CATCHMENT XXIV:

Catchment XXIV, situated within the Waimanawa Hills Precinct, has an irregular shape and shares its eastern boundary with a major stream. Its southern boundary aligns with an existing ridgeline, which may undergo modifications. However, efforts should be made to retain the existing stormwater catchment boundary.

The downstream portion of Catchment XXIV, as depicted in the accompanying figure, is generally characterized by a flat to moderate slope. With some minor reshaping of the ground around the designated location according to the master plan, it would be suitable for constructing a bulk treatment device such as a wetland. The chosen location for this wetland also satisfies the specified size, shape, and area requirements determined through engineering calculations. Therefore, we find the location suitable, and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. Please refer to Appendix B for the relevant engineering drawings.

Figure 5: Catchment XXIV layout and section plan

CATCHMENT XXVII:

Catchment XXVII, situated within the Waimanawa Valley Precinct, has an irregular shape and is adjacent to a major stream on both its eastern and western boundaries. Its southern boundary abuts State Highway One.

As shown in the accompanying figure, the downstream portion of Catchment XXVII exhibits a generally flat terrain, making it suitable for the construction of a wetland. The chosen location for this wetland also fulfils the specified length and area requirements based on engineering calculations. Therefore, we find the location suitable and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. However, considering the proximity of this wetland to existing watercourses, additional consideration for ecological constraints and the riparian margin will be necessary during the resources consent stage. Refer to Appendix B, which contains the relevant engineering drawings.

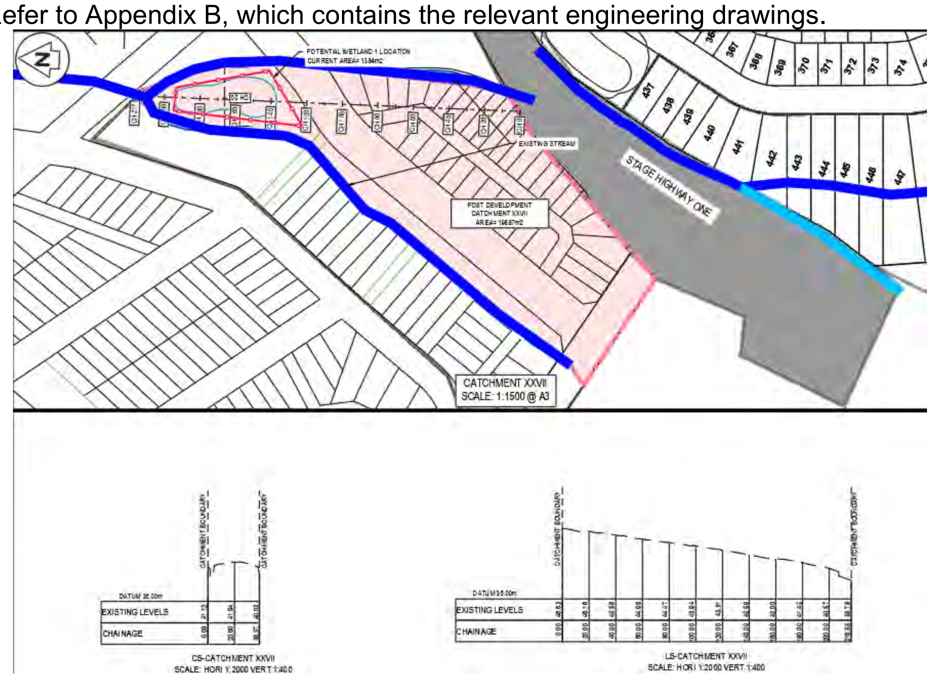


Figure 6: Catchment XXVII layout and section plan

CATCHMENT XXIX:

Catchment XXIX, situated within the Waimanawa Valley Precinct, it is an irregular shape and adjacent to a major stream on its western boundary. On the eastern side, this catchment's boundary abuts the Wider Western Link Road, a future arterial road. Its southern boundary is contiguous with the current State Highway One reserve.

As depicted in the accompanying figure, the downstream portion of Catchment XXIX features predominantly flat terrain, rendering it suitable for the construction of a wetland. The chosen location for this wetland also satisfies the specified size, shape, and area requirements as determined through engineering calculations. Therefore, we find the location suitable and it is recommended the location indicated is utilised for a stormwater management device, such as a wetland. Please refer to Appendix B for relevant engineering drawings.

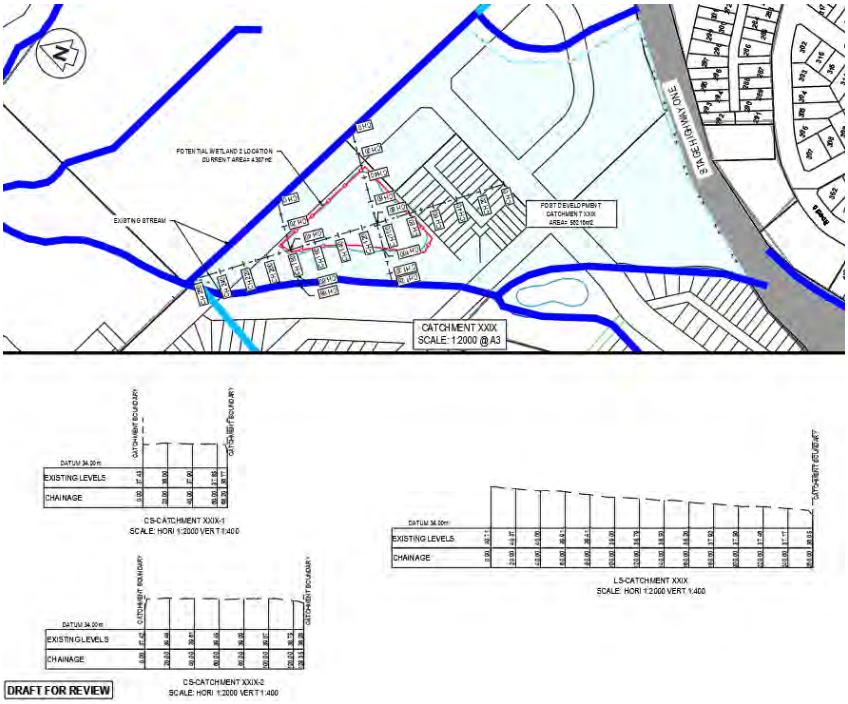


Figure 7: Catchment XXIX layout and section plan

CATCHMENT XXXI:

Catchment XXXI, situated within the Waimanawa Valley Precinct, exhibits an irregular shape and is the largest stormwater catchment, covering an area of 21.8 hectares. It is to be surrounded by a local roading network to the west and the Wider Western Link Road to the south. Its eastern boundary abuts a permanent stream.

As illustrated in the accompanying figure, the downstream portion of Catchment XXXI features generally flat terrain, making it suitable for wetland construction. However, the chosen location for this wetland falls short in terms of the required area as calculated by the engineering assessment. The shape factor is also marginally inadequate. It is important to note that failing to meet these high-level preliminary sizing guidelines does not necessarily mean the wetland is unsuitable for the designated location. Considering the close proximity to an existing stream, a reassessment of the final location for this wetland will be necessary. Nevertheless, the location in principle remains suitable for a bulk treatment device such as a wetland. Therefore, a detailed engineering design of the wetland will be required to ensure a compliant outcome is achieved during the resource consent process. Refer to Appendix B for relevant engineering drawings.

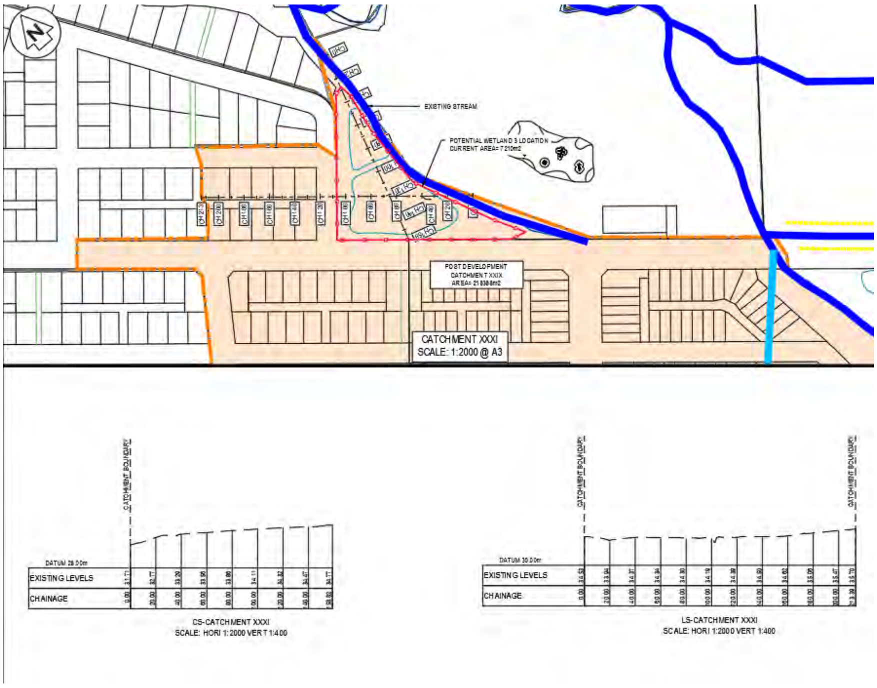


Figure 8: Catchment XXXI layout and section plan

CATCHMENT XXXIII:

Catchment XXXIII, located within the Waimanawa Valley Precinct, exhibits an irregular shape and currently features an inundated landscape, necessitating significant earthworks along its boundaries where housing platforms, infrastructure and other services are to be located.

As depicted in the accompanying figure, the downstream portion of Catchment XXXIII possesses a moderate slope, requiring earthwork to establish a suitable construction area for the wetland. The chosen location for this wetland aligns with the size, shape, and area requirements specified for the wetland within its catchment. Therefore, a wetland is the recommended management device and preferred method of servicing the catchment. However, a detailed engineering design of the wetland will be necessary during the resources consent stage to ensure that the modified landscape can effectively contain the proposed wetland. Refer to Appendix B for relevant engineering drawings.

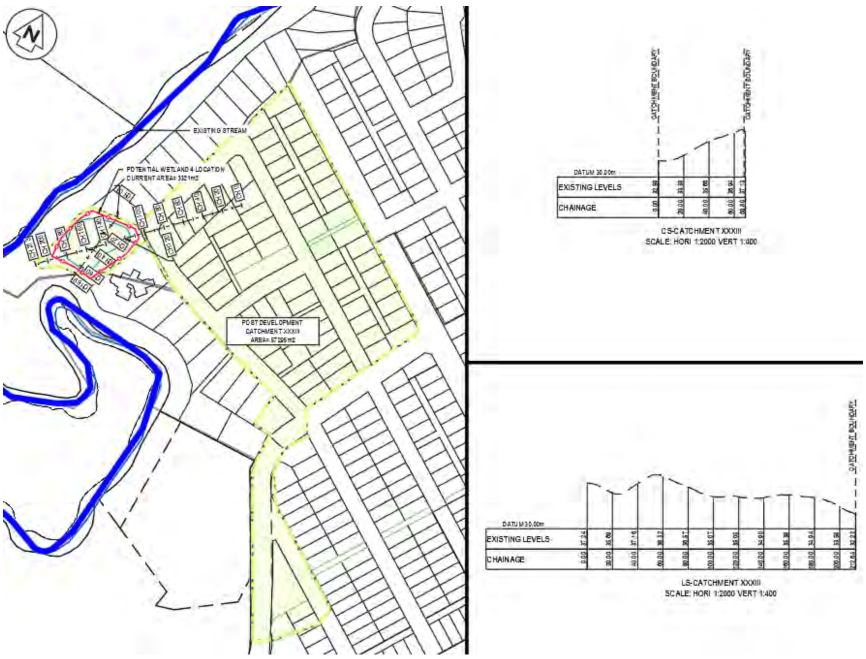


Figure 9: Catchment XXXIII layout and section plan

CATCHMENT XXXIV:

Located within the Waimanawa Valley Precinct, Catchment XXXIV is irregular in shape and is currently characterized by an inundated landscape, necessitating significant earthworks along its boundaries where housing platforms, infrastructure and other services are to be located.

As illustrated in the accompanying figure, the downstream portion of Catchment XXXIV exhibits a moderate slope that will require earthworks to create an appropriate construction area for the proposed wetland. The designated location for this wetland adheres to the specified size, shape, and area requirements of this catchment. Therefore, a wetland is recommended as the preferred stormwater management device. However, during the resources consent stage, a detailed engineering design of the wetland will be necessary to ensure that the modified landscape is capable of effectively containing the proposed wetland. Refer to Appendix B for relevant engineering drawings.

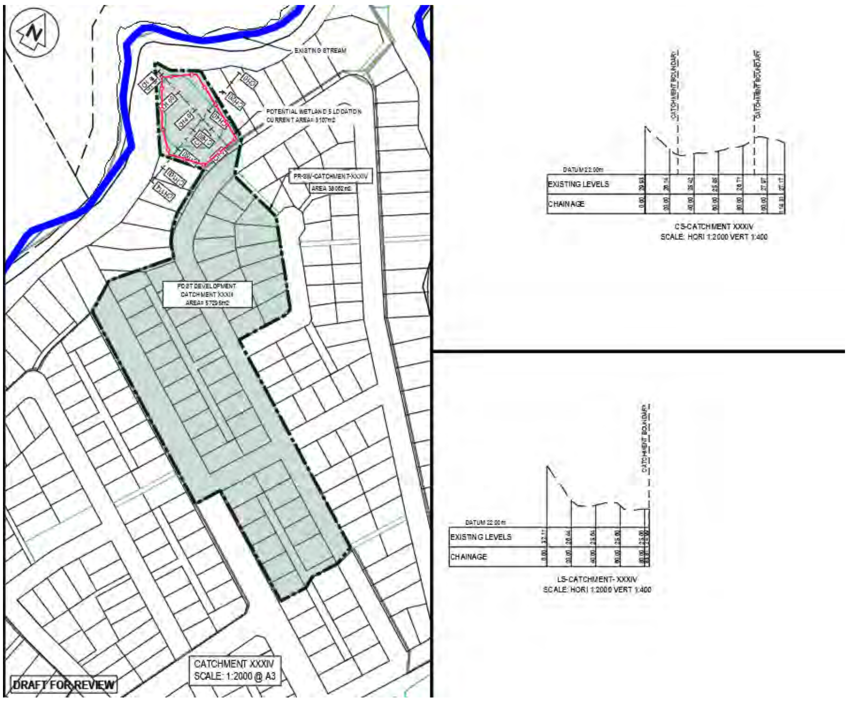


Figure 10: Catchment XXXIII layout and section plan

CATCHMENT XXXV:

Catchment XXXV, located within the Waimanawa Valley Precinct, is irregular in shape and is characterised as moderated sloped.

As illustrated in the accompanying figure, the downstream portion of Catchment XXXV has an undulating and moderate sloped terrain, requiring significant earthworks to create a suitable area for a stormwater management device such as a wetland. The allocated location for this wetland meets the area requirement for the wetland within the catchment, but the shape factor is marginal. It is recommended this catchment is served by a bulk device (wetland) as the preferred treatment device for this catchment, pending further investigation into the earthworks required to establish a wetland. A detailed engineering design of the wetland will be necessary during the resources consent stage to ensure that the modified landscape can effectively contain the proposed wetland. For more information, please refer to Appendix B for relevant engineering drawings.

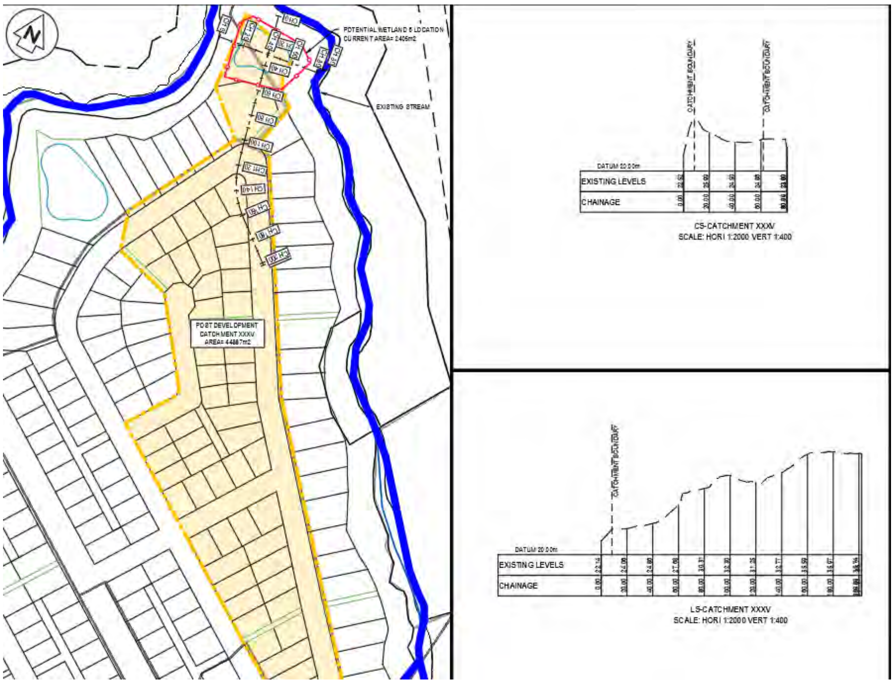


Figure 11: Catchment XXX layout and section plan

2.2 STORMWATER MANAGEMENT ZONE B

The stormwater catchments within this zone that are considered post-development include catchments I-V, XI, XIII-XIV, XVI-XXIII, XXV-XXVI, XXVIII, XXX, XXXII, and XXXVI.

A common characteristic among these post-development catchments is that they either have steeper slopes or are too small and narrow to accommodate large, catchment wide stormwater device effectively. As a result, the Best Practicable Option (BPO) is recommended in terms of providing stormwater management in these catchments. The engineering plans, depicting the locations of the catchments and the general ground profile, can be found within Appendix B.

CATCHMENT I:

Catchment I is situated in the northern portion of the Waimanawa Valley Precinct and can be accessed legally through Mason Heights. This catchment is characterized by hilly terrain, and an interesting feature is the presence of a localized depression that has formed a natural wetland within its northern extent. The natural ground of catchment I can be observed in the Figure provided below.

Figure 12: Catchment I layout and section plan

CATCHMENT II:

Catchment II is situated in the northern portion of the Waimanawa Valley Precinct and shares three of its boundaries with neighbouring lots. It is important to note that any significant changes in the level of Catchment II would have an impact on the neighbouring land. Additionally, Catchment II features a steep slope that descends towards its northern extent, as depicted in the Figure provided below:

Figure 13: Catchment II layout and section plan

CATCHMENT III:

Catchment III is located between Catchment I and Catchment II, and it is characterized by a ridgeline that runs through the catchment. Due to the presence of this ridge line, construction of a wetland in Catchment III is not considered feasible. The natural landform of Catchment III can be observed in the image provided below:

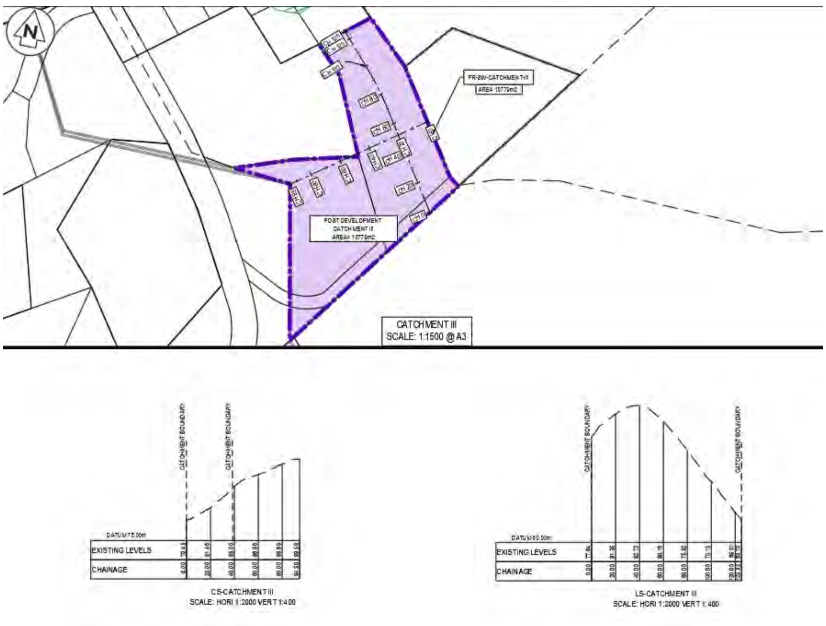


Figure 14: Catchment III layout and section plan

CATCHMENT IV:

Catchment IV, located within the Waimanawa Valley Precinct, is a significant catchment that consists of two hills on its eastern and western extents, with a natural valley situated in the central part of the catchment. The terrain is generally very steep and the catchment is predominantly covered by a protected Kanuka forest located in the western extent of the catchment, imposing limitations on any earthwork or alterations within this protected area. The natural landform of Catchment IV can be observed in the image provided below:

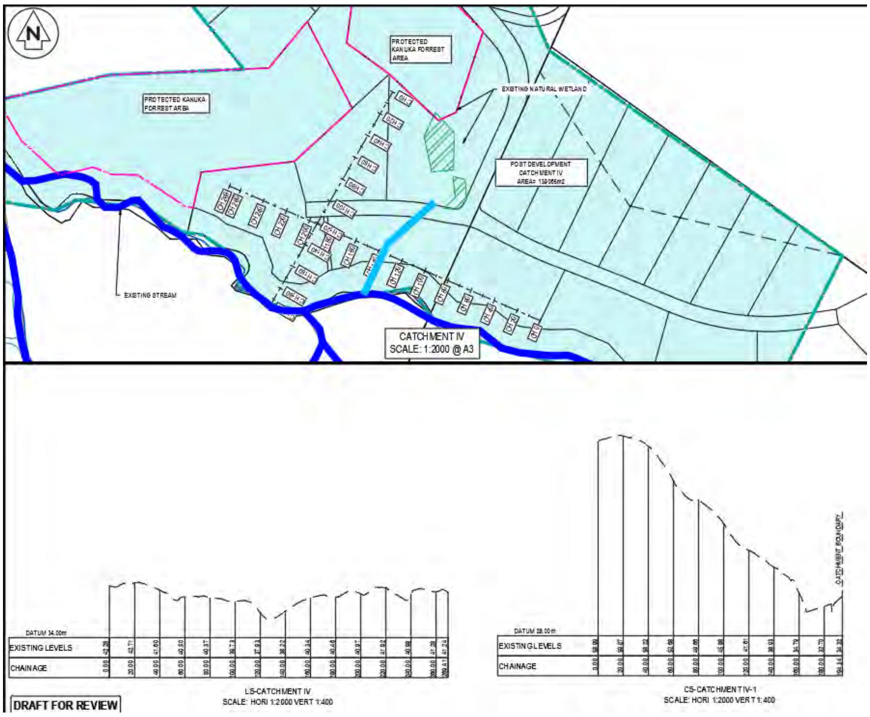


Figure 15: Catchment IV layout and section plan

CATCHMENT V:

Catchment V, positioned within the Waimanawa Valley Precinct, is a small catchment situated to the west of Catchment IV. It has a catchment area of 1.17 hectares, runoff of this catchment would be considered as sheet flow towards the stream traversing its southern boundary. The site exhibits a steep slope, making wetland construction impractical and unfeasible. For a better understanding of the site's characteristics, please refer to the site cross section depicted in the figure below:

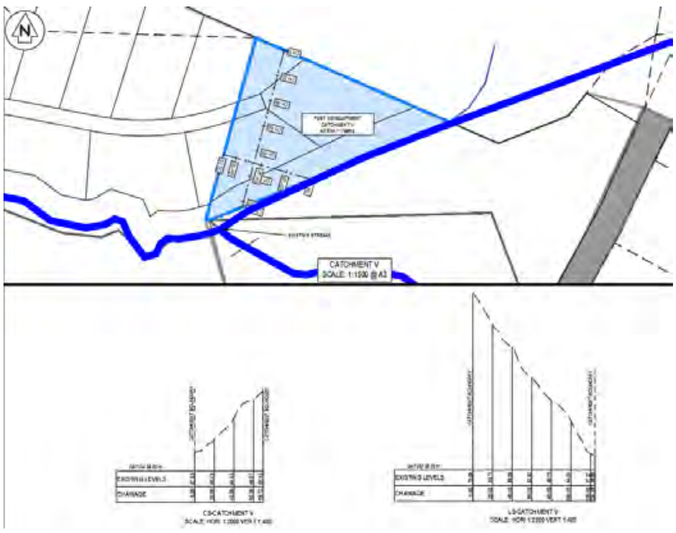


Figure 16: Catchment V layout and section plan

CATCHMENT XI:

Catchment XI, located within the Waimanawa Hills Precinct, is a narrow strip of land that borders a stream along its southwestern boundary. The limited width of this catchment makes it unsuitable for any type of residential development. However, there is a small section designated for a future road connection within this catchment. This road connection is intended to provide access to the northeastern portion of the Waimanawa Hill Precinct and also serve as a future connection to neighbouring lands should they be developed in accordance with the Warkworth Structure Plan.

Considering the shape of the land and its limitations, it is recommended ay development and subsequent stormwater management be the BPO in Catchment XI. The natural landform of Catchment XI can be observed in the image provided below:

Figure 17: Catchment XI layout and section plan

CATCHMENT XIII:

Catchment XII, situated within the Waimanawa Hills Precinct, shares similarities with Catchment XI, as it is also a narrow strip of land. It is bounded by a permanent stream on its eastern boundary and a local road on its western boundary. The land in Catchment XII features a steep cross fall along the stream alignment, making wetland construction challenging.

Considering that most of the catchment comprises residential lots, a BPO to any required stormwater management in Catchment XII is recommended. The specific details and visual representation of Catchment XII can be found in the Figure provided below.

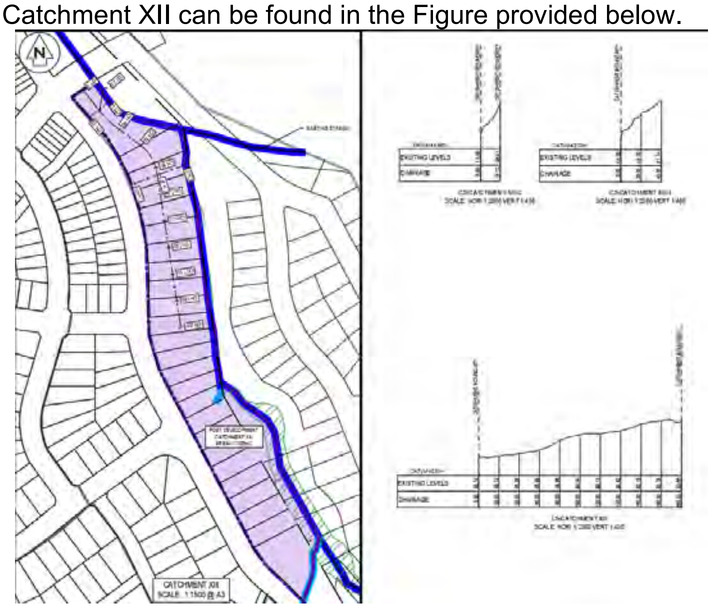


Figure 18: Catchment XIII layout and section plan

CATCHMENT XIV:

Catchment XIV is located as the northeast extent of the Waimanawa Hills precinct. The lower end of this catchment is dissected by two permanent streams, the landform is elevated through its center and low on both fringes as a result. The southern extent of the catchment is the southern ridge line of the Warkworth South PCA. The combination of natural topographical does not support large stormwater devices due to its fragmented falls, non-concentrated flows. Hence a BPO to stormwater management devices is recommended in this catchment. Please refer to Figure below for more information.

Figure 19: Catchment XIV layout and section plan

CATCHMENT XVI:

Catchment XVI, positioned within the Waimanawa Hills Precinct, is similar to Catchment XIV in terms of its constraints. It is limited by a natural stream in the lower catchment and features a steep landform in the north-south direction. This combination of natural features makes the implementation of large stormwater devices unfeasible. Please refer to Figure below for more information.

Figure 20: Catchment XVI layout and section plan

CATCHMENT XVII:

Catchment XVII, situated within the Waimanawa Hills Precinct, is a distinctive catchment situated just south of the main ridge line at the boundary of the future urban zone. Unlike the rest of the plan change area, the stormwater runoff from this catchment is drained into a distinct receiving environment. Due to its location on the ridgeline, any significant earthwork is prohibited in this area to preserve the natural landform

Given these considerations, a BPO approach is recommended for stormwater management in Catchment XVII. The BPO approach will ensure appropriate stormwater treatment while respecting the constraints imposed by the ridgeline and the need to maintain the natural landform. Please refer to Figure below for more information.

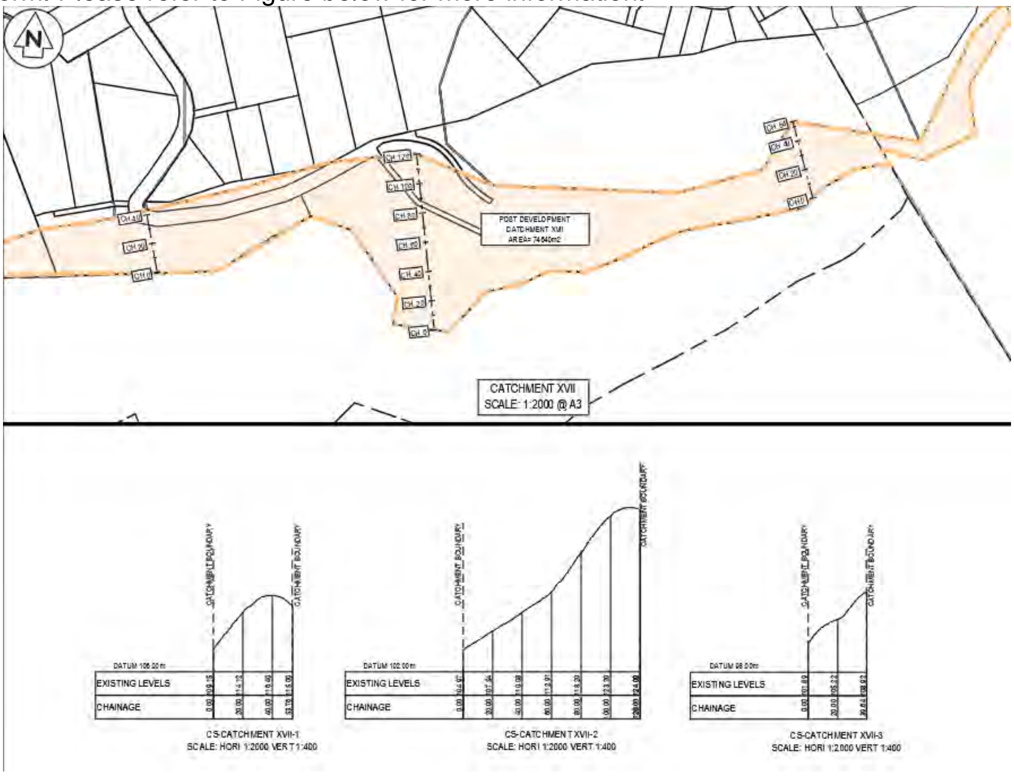


Figure 21: Catchment XVII layout and section plan

CATCHMENT XVIII:

Catchment XVIII, located within the Waimanawa Hills Precinct, is in the high land area of Waimanawa Hill precinct. Its landform is a deep valley with the steep slopes in all direction. Given it landform, a BPO to stormwater management is recommended. Please refer to Figure below for more information.

Figure 22: Catchment XVIII layout and section plan

CATCHMENT XIX:

Catchment XIX, positioned within the Waimanawa Hills Precinct, is a narrow strip of land that is bordered by a permanent stream on its western boundary and a local road on its eastern boundary. Additionally, its level is further restricted by State Highway One. The catchment has a moderate cross fall along the stream alignment, making the construction of a catchment wide device or wetland challenging.

Considering that the majority of the catchment is occupied by residential lots, it is recommended a BPO approach is taken for stormwater management in Catchment XIX. The BPO approach will ensure suitable stormwater treatment while taking into account the constraints posed by the catchment's shape, cross fall, and surrounding infrastructure. Please refer to Figure below for more information.

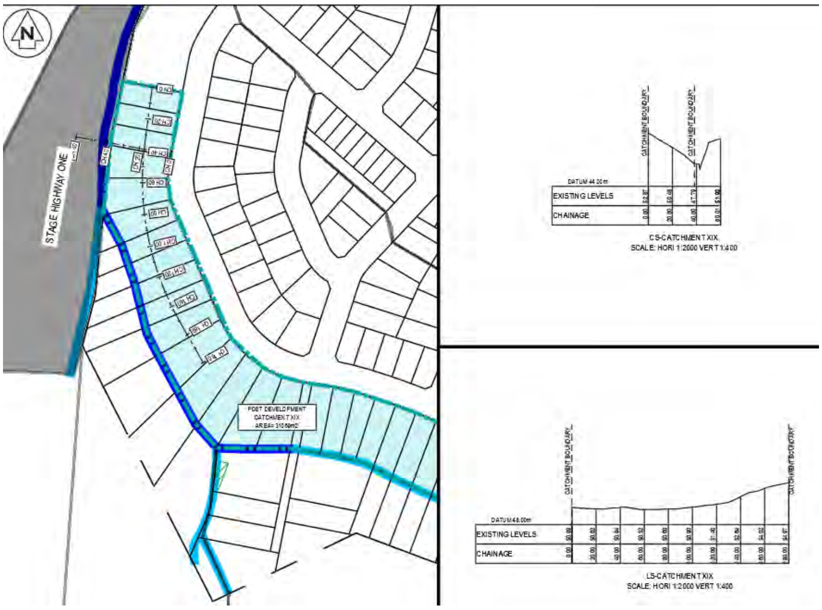


Figure 23: Catchment XIX layout and section plan

CATCHMENT XX:

Similar to Catchment XIV & XVI, catchment XX of the Waimanawa Hill Precinct is constrained by two natural intermediate stream to the lower catchment and the steep landform in the north-south direction, located below a public road and expected stormwater infrastructure. This natural landform making large stormwater devices impractical in terms of construction. Please refer to Figure below for more information

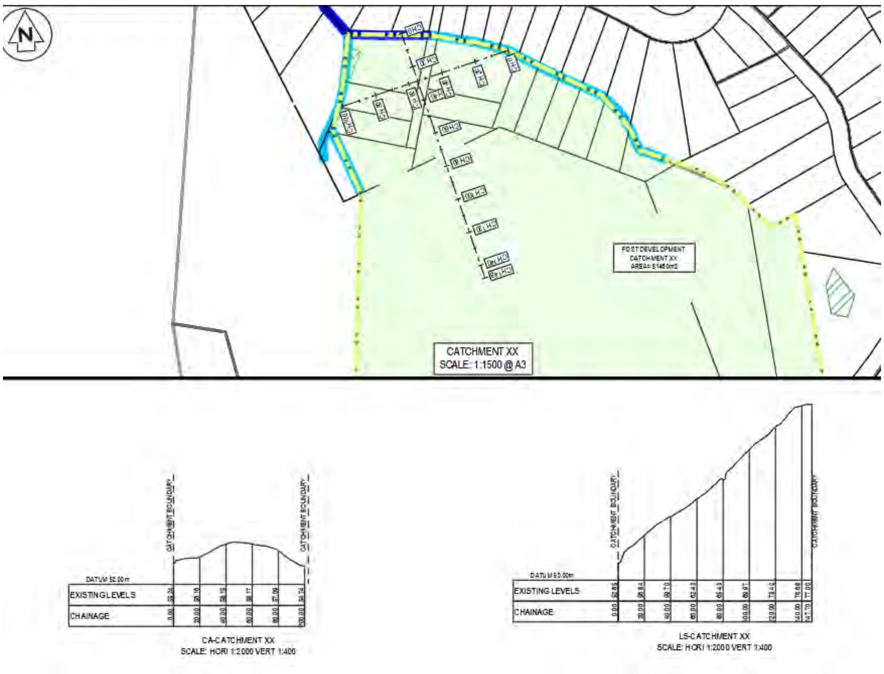


Figure 24: Catchment XX layout and section plan

CATCHMENT XXI:

Catchment XXI, positioned within the Waimanawa Valley Precinct, is constrained by a permanent stream on its eastern boundary and State Highway One to its western boundary. This unique landform restricts any significant earthwork operation in this catchment, a large stormwater device is not considered practical given the surrounding constraints. Please refer to Figure below for more information

Figure 25: Catchment XXI layout and section plan

CATCHMENT XXII:

Catchment XXII, situated within the Waimanawa Valley Precinct, is a combination of three fragmented catchments that are part of an existing stream bank below the expected position of a public road. More than half of this catchment is designated as a stream corridor and open space, while three isolated blocks of residential areas are indicated in the master plan

The first residential block to the west faces a constraint posed by the deep valley created by the stream. This prevents the capture and conveyance of stormwater from this block back to the proposed wetland in Catchment XXIV.

Similarly, the second residential block to the east encounters a similar situation. The first half of the block is constrained by a steep stream embankment, while the second half is restricted by an intermediate stream stub located downstream within its catchment.

The third residential block experiences a steep cross fall that prevents it from discharging its stormwater back to the proposed wetland within Catchment XV.

Given these constraints and limitations, a BPO approach is recommended for stormwater management in Catchment XXII. The BPO approach will ensure appropriate stormwater treatment considering the unique characteristics and challenges within this catchment. Please refer to Figure below for more information.

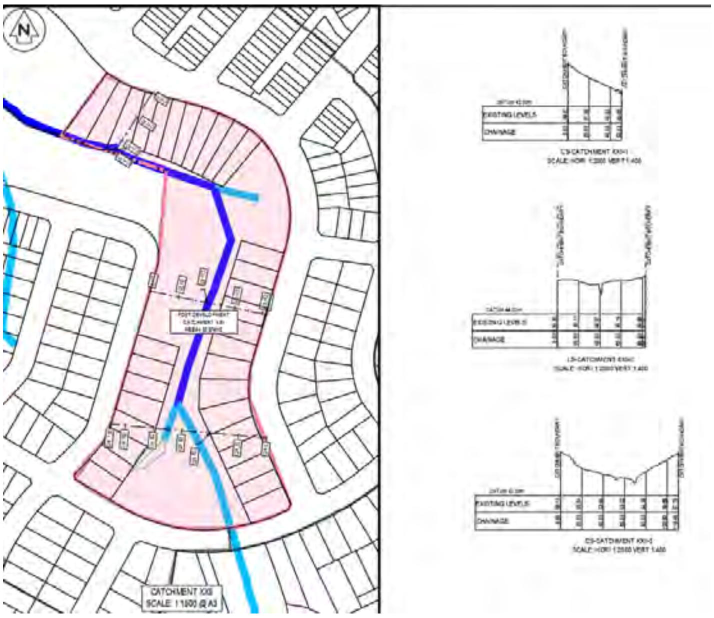


Figure 26: Catchment XXII layout and section plan

CATCHMENT XXIII:

Upon close inspection of the topography near the downstream area of Catchment XXII of Waimnawa Hills Precinct, it has been observed that the site slopes steeply towards the existing watercourse. This topographical feature poses a challenge in creating a level platform for the wetland within the catchment.

To achieve a suitable construction area for a bulk stormwater device, significant earthworks and landscape modifications would be required. These changes may have a significant impact on the natural landscape and may not be practical or feasible within the context of the site.

Please refer to the Figure below for a visual representation and a better understanding of the topographical characteristics and challenges associated with creating a bulk treatment device or wetland in this catchment.

Considering the complexities and constraints involved, it is recommended the stormwater management approach for this catchment is explored further and alternative options that are more compatible with the natural landscape and environmental conditions are considered.

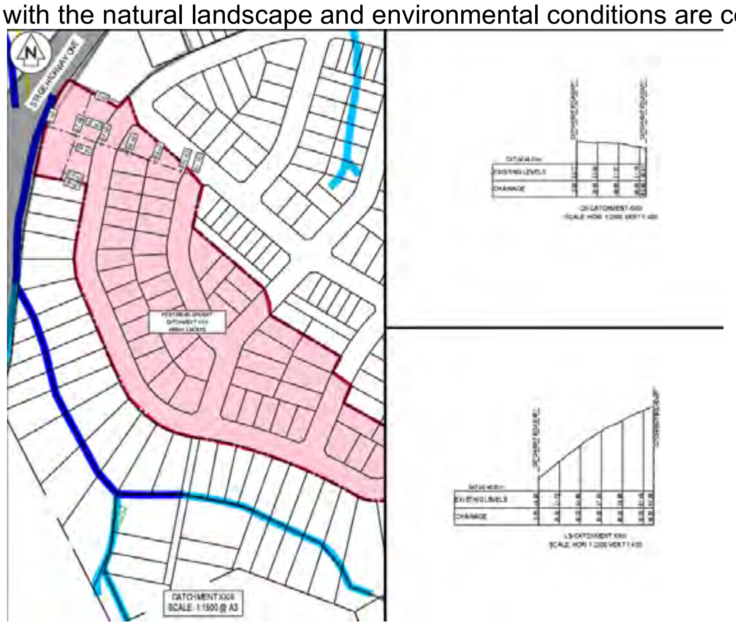
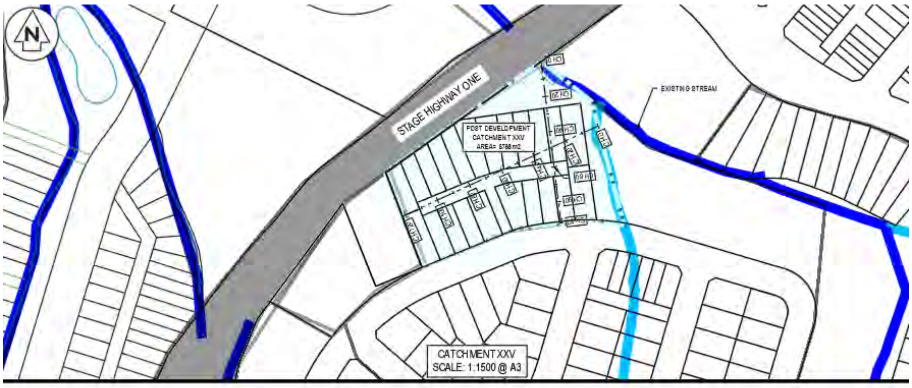


Figure 27: Catchment XXIII layout and section plan

CATCHMENT XXV:

Catchment XXV, positioned within the Waimanawa Hills Precinct, is a fragmented catchment located between State Highway One and the existing stream network. The lower portion of this catchment falls within an existing floodplain. This floodplain has been formed as a result of undersized culverts that were installed during the construction of Stage Highway One. The catchment has a relatively small area of 0.87Ha and consists mainly of residential lots and private property.

Given the size and characteristics of this catchment, implementing a BPO approach to stormwater management would be suitable to mitigate any impact of stormwater runoff from this catchment. Please refer to Figure below for more information.



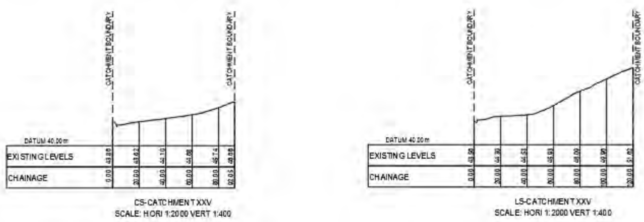


Figure 28: Catchment XXV layout and section plan

CATCHMENT XXVI:

Catchment XXVI is a unique catchment that includes an area not covered by the Warkworth South Plan Change's Stormwater Management Plan (SMP). This specific area is a property located at 1728 Stage Highway One, currently owned by Waka Kotahi. The remaining area within this post-development catchment is designated as open space with minimal impervious surface area expected to be created.

Given the nature of the catchment, where the majority of the area is designated as open space and there is limited potential for significant impervious surface development. The size and scale of any expected development will be relatively small, stormwater treatment will need to be provided to treat any contaminant generating area, subject to the use, size and scale as the BPO. Please refer to Figure below for more information.

Figure 29: Catchment XXV layout and section plan

CATCHMENT XXVIII:

Catchment XXVIII, situiated within the Waimanawa Valley Precinct, is a small catchment wedge between catchment XXXI and catchment XXVII, abutting an existing stream on its eastern boundary and a public road on the western boundary. The catchment only caters for residential lot area without any public road. Its landform is flat in nature. However, given it in close approximate to the stream. A BPO approach to stormwater management will apply given individual lot runoff/discharge to the stream is likely. Please refer to the site cross section in figure below:

Figure 30: Catchment XXVIII layout and section plan

CATCHMENT XXX:

Catchment XXX, lcoated within the Waimanawa Valley Precinct, is a small catchment wedge between an existing stream to its south and west boundary with the Wider Western Link Road located to it the northern portion of the catchment and State Highway one to the east. The presence of key infrastructure and existing stream have reduced the usable catchment to be less than half of its size. These restrictions reduce the possible area that can be utilised for the Wetland hence BPO is recommended for this catchment is recommended. Please refer to Figure below for more information.

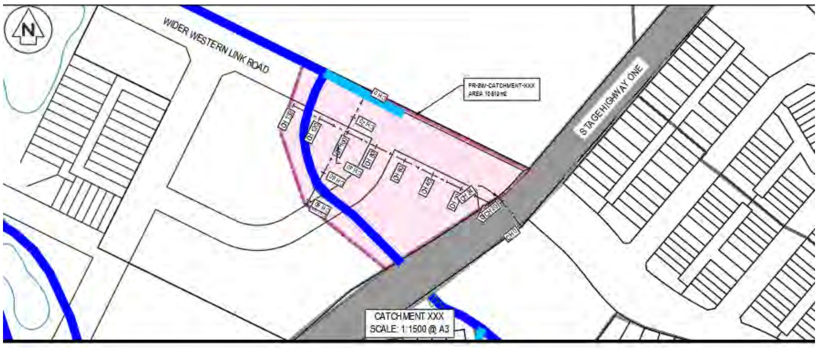


Figure 31: Catchment XXX layout and section plan

CATCHMENT XXXII:

Catchment XXXII, positioned within the Waimanawa Valley Precinct, is a small piece of land between a major stream on the western extent of the plan change area, State Highway 1 and a proposed road. A steep embankment is located along the existing stream alignment which prevents construction of any collecting network or large stormwater management device. Several proposed wetlands are present in the close approximate of this catchment. Those location are where moderated slopes are present which have been utilized to treat the stormwater run-off from various other catchment. A BPO approach to stormwater management will apply given individual lot runoff/discharge to the stream is likely, please refer to figure below for more information.

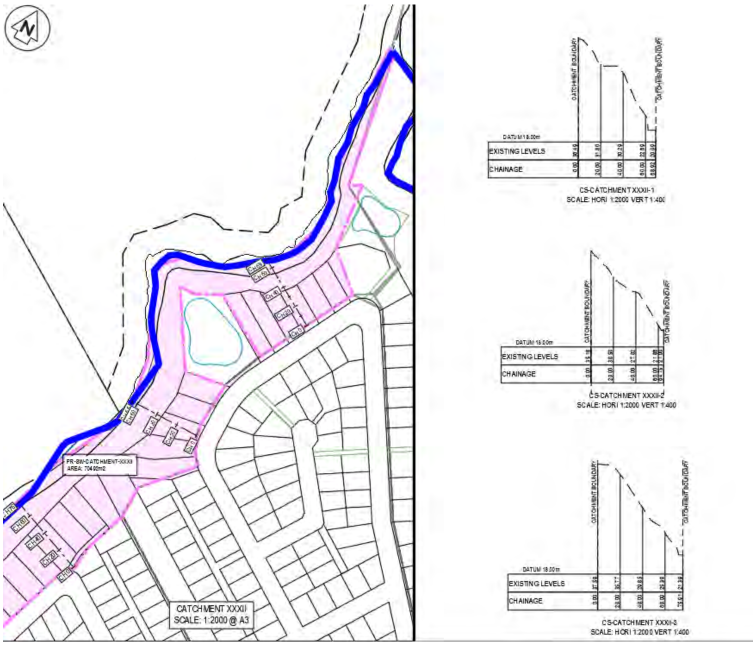


Figure 32: Catchment XXXII layout and section plan

CATCHMENT XXXVI:

Similar to Catchment XXXII, Catchment XXXVI of Waimanawa Valley Precinct, is a thin portion of urban land abutting a major stream and a proposed road, which contains steep cross fall throughout its alignment. This natural topographical is expected to be protected from development for the most part and challenging to capture or manage. Any management requirement will need to be the BPO given the terrain and extent of contaminant generating area and that individual lot runoff/discharge to the stream is likely. Please refer to Figure below for more information.

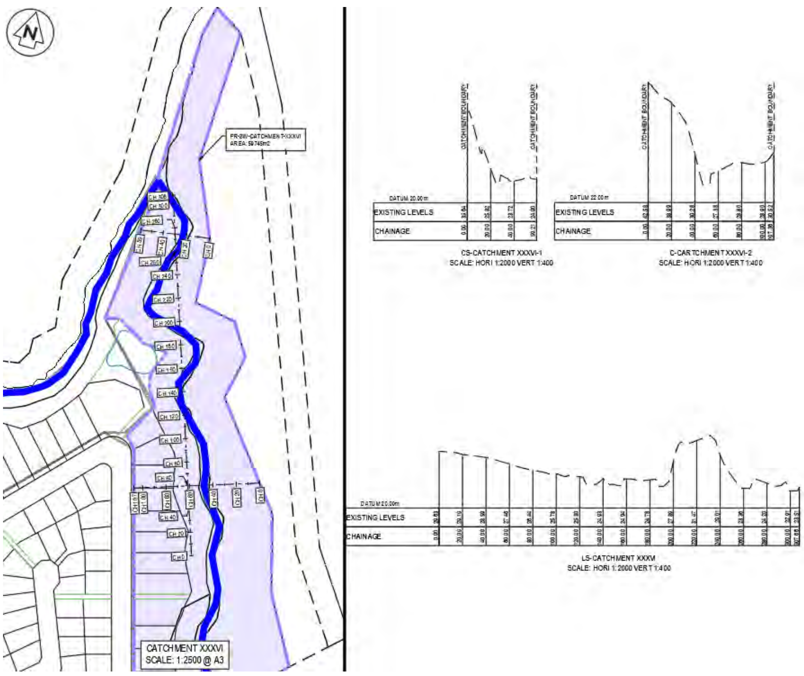


Figure 33: Catchment XXXVI layout and section plan

2.3 STORMWATER MANAGEMENT ZONE C

The stormwater catchments within Zone C cover the existing Morrision Heritage Orchard and the central park area within the Waimanawa Valley Precinct.

Given the proposed land use activities are not overly onerous in terms of creating impervious area, contaminant generating or other trade activities. The stormwater management method is to be the BPO considering the size and scope of any proposed works. The general landform and cross section for these catchments have been prepared and attached in Appendix A. Catchment within this zone are: VI-VIII, X, XXXVII & XXXVIII.

2.4 STORMWATER MANAGEMENT ZONE D

Stormwater Management Zone D contains post development catchment IX. This catchment exclusively exists for what is currently State Highway One. This catchment has established stormwater discharge locations along its narrow corridor which are not suitable for any form of retrofitted bulk stormwater treatment device. Stormwater management shall be considered further at the time of consenting when the regulating authority can comment further. Please refer to image below for more information.

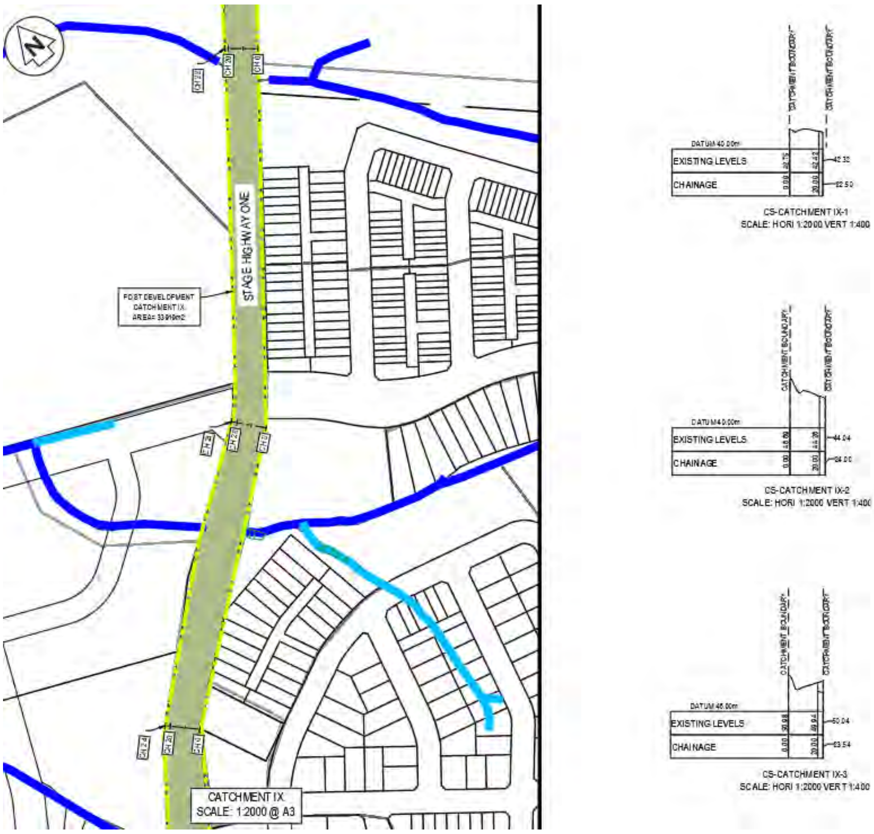


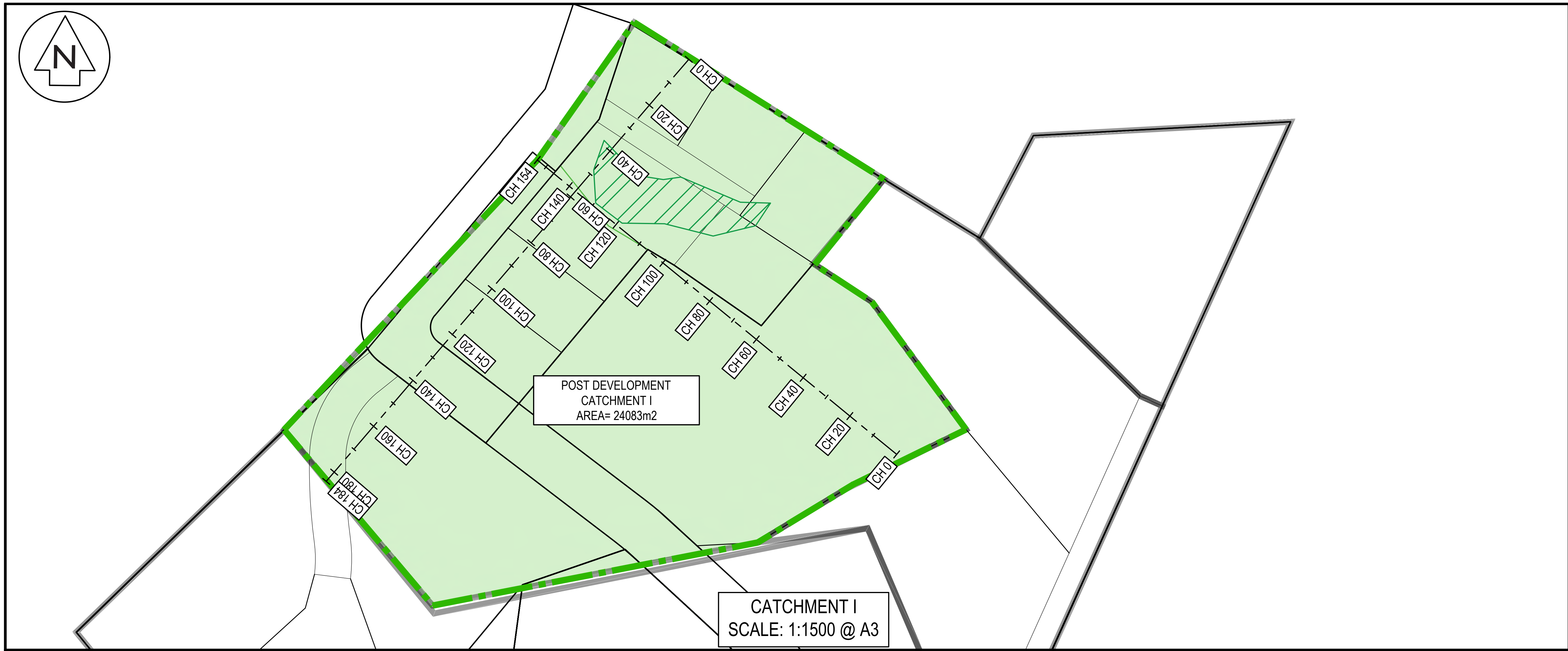
Figure 34: Catchment IX layout and section plan

3.0 CONCLUSIONS

Based on the high-level catchment analysis, four stormwater management zones are recommended for the plan change area. These zones help clarify the required stormwater treatment devices for each catchment. It is important to note that these recommendations are based on preliminary conclusions at the master planning level. During the resources consent stage, there may be changes to the zoning of certain catchments to align them with their preferred stormwater treatment devices. Any changes made will need to be reviewed and approved by Healthy Water.

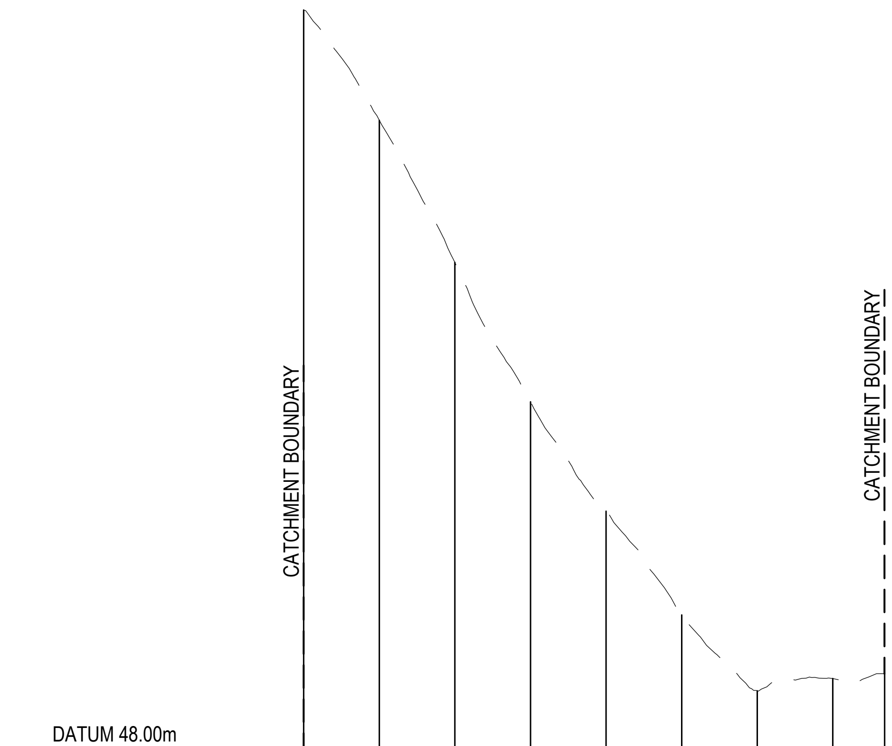
APPENDIX A – ENGINEERING PLAN

Notes
1. All works to be in accordance with Auckland council standards.



CATCHMENT I
SCALE: 1:1500 @ A3

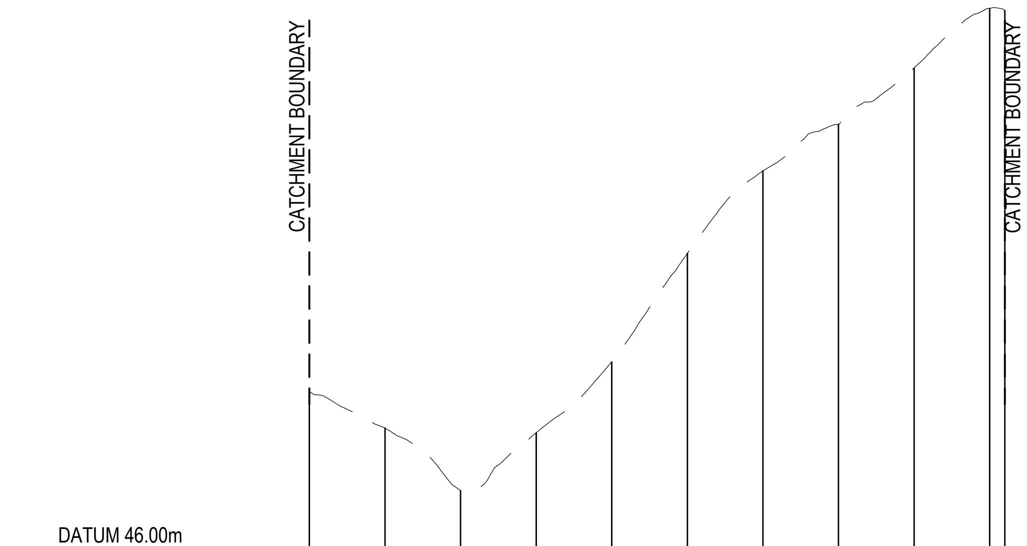
Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



DATUM 48.00m

EXISTING LEVELS	87.09	81.26	73.74	66.37	60.59	55.11	51.09	51.74	52.00
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	153.68

CS-CATCHMENT I
SCALE: HORI 1:2000 VERT 1:400



DATUM 46.00m

EXISTING LEVELS	54.38	52.45	49.15	52.20	55.95	61.69	66.05	68.50	71.48	74.63	74.52
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	184.02

LS-CATCHMENT I
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

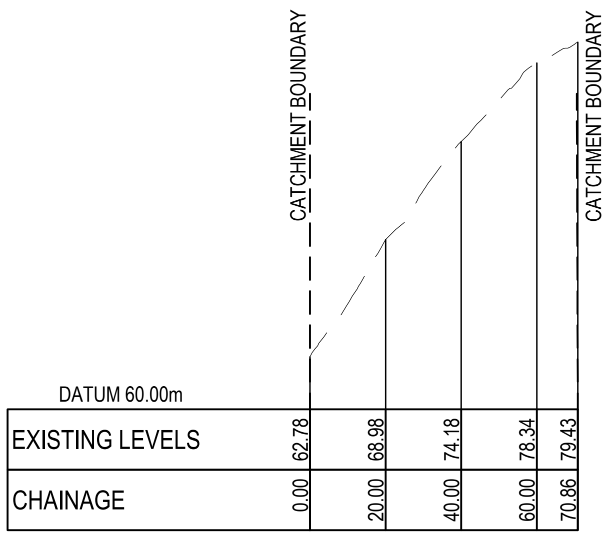
MAVEN
Maven Associates
09 571 0050
info@maven.co.nz
www.maven.co.nz
5 Owens Road, Epsom
Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

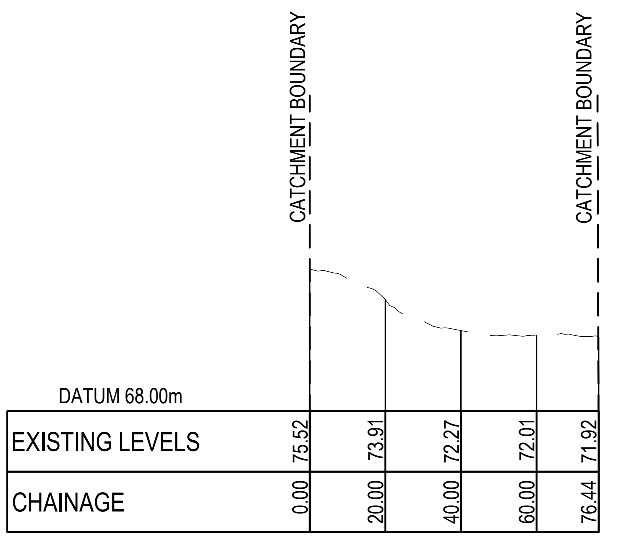
Title
POST DEVELOPMENT CATCHMENT I PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-1
Rev	A

CATCHMENT II
SCALE: 1:1500 @ A3



CS-CATCHMENT II
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT II
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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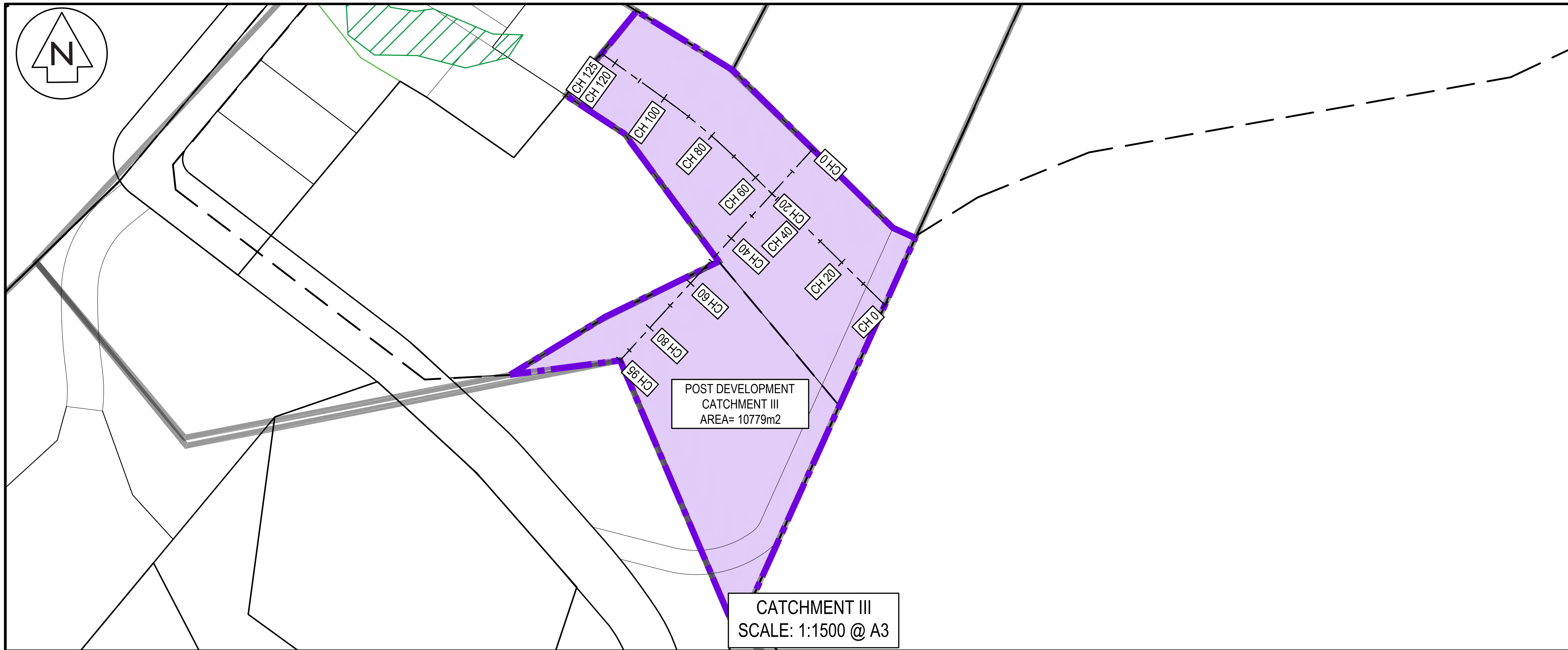
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT II PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-2
Rev	A

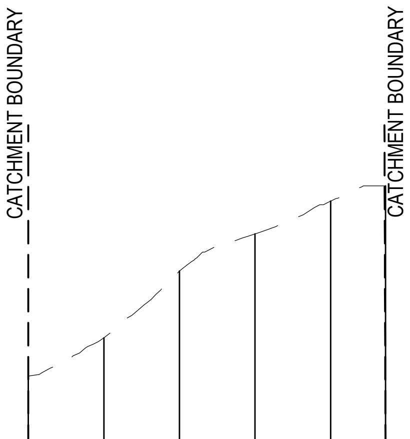
DATE: 7/023



CATCHMENT III
SCALE: 1:1500 @ A3

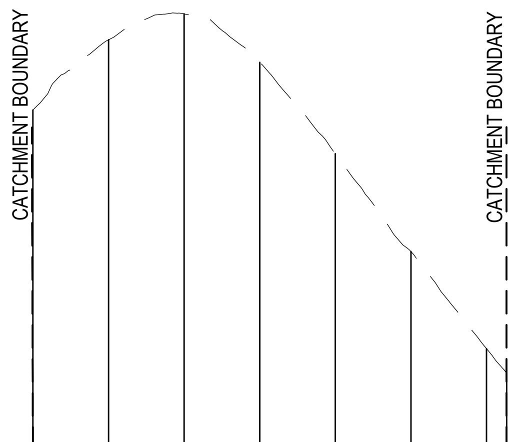
Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



DATUM 76.00m						
EXISTING LEVELS	79.43	81.46	85.00	86.96	88.69	89.50
CHAINAGE	0.00	20.00	40.00	60.00	80.00	94.50

CS-CATCHMENT III
SCALE: HORI 1:2000 VERT 1:400



DATUM 60.00m									
EXISTING LEVELS	77.64	81.35	82.72	80.16	75.32	70.15	65.01	63.70
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	125.32

LS-CATCHMENT III
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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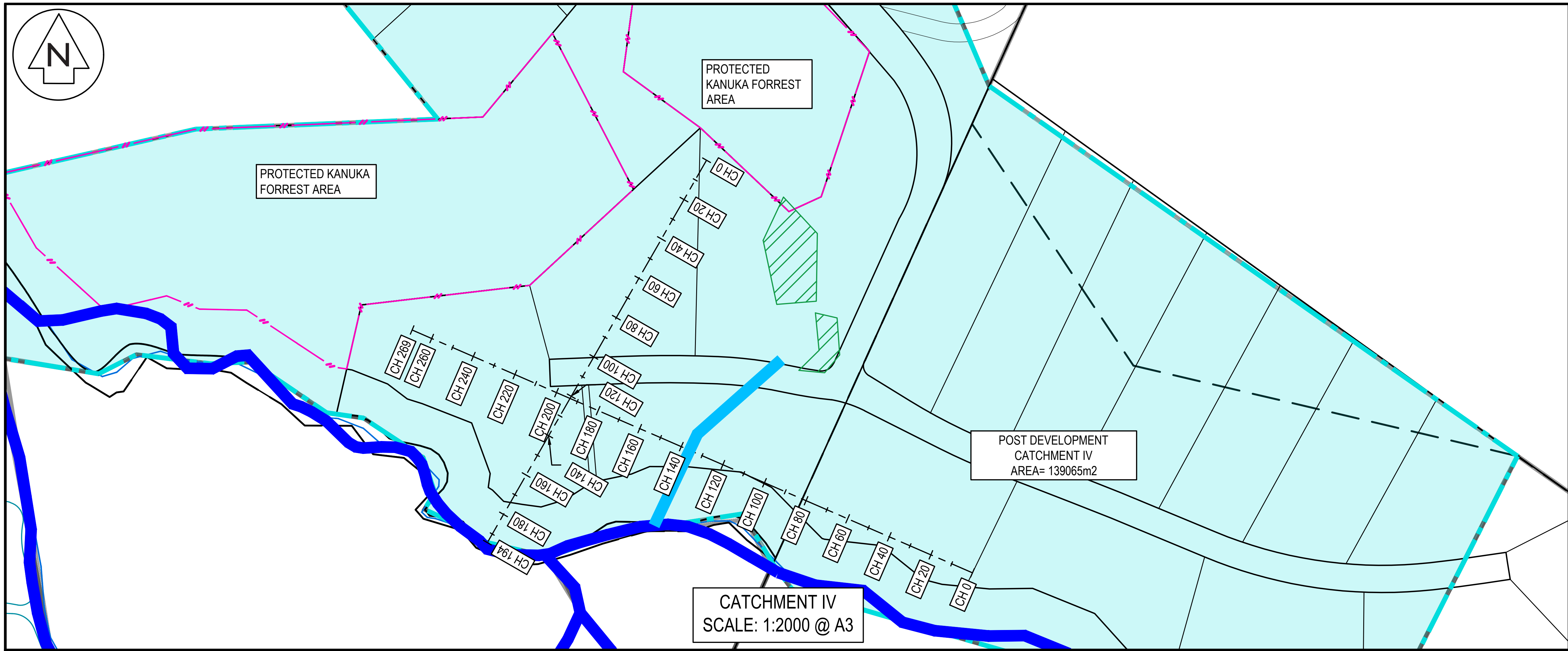
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT III PLAN

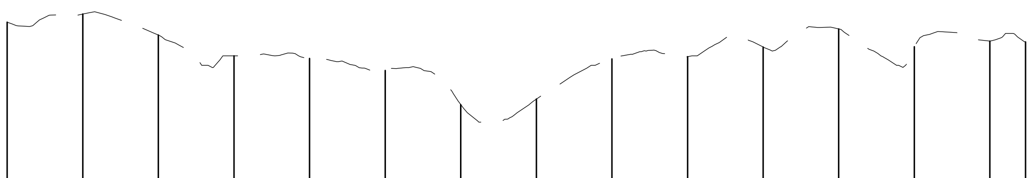
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-3
Rev	A

DATE: 7/2023



Notes
1. All works to be in accordance with Auckland council standards.

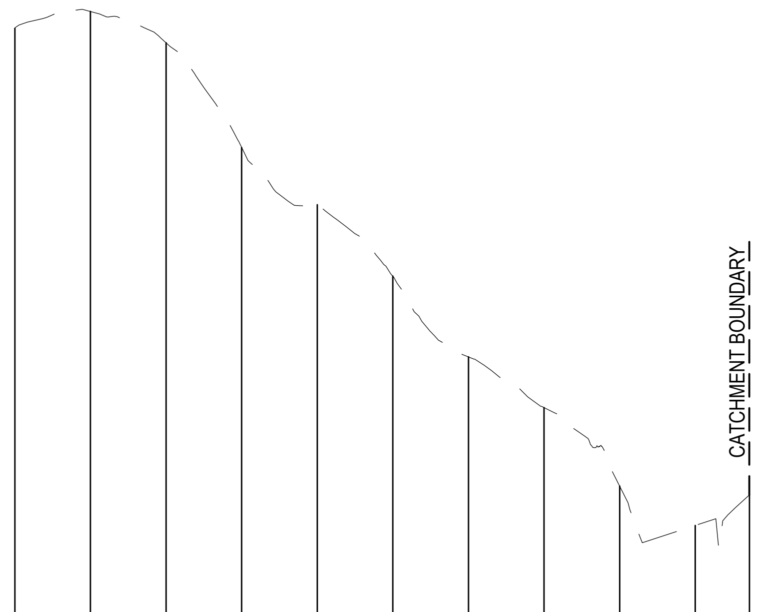
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 34.00m

EXISTING LEVELS	42.28	42.71	41.60	40.50	40.37	39.73	37.93	38.22	40.34	40.46	40.97	41.92	40.98	41.28	41.24
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	269.41

LS-CATCHMENT IV
SCALE: HORI 1:2000 VERT 1:400



DATUM 28.00m

EXISTING LEVELS	58.99	59.87	58.22	52.68	49.66	45.88	41.61	38.93	34.79	32.70	34.32
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	194.34

CS-CATCHMENT IV-1
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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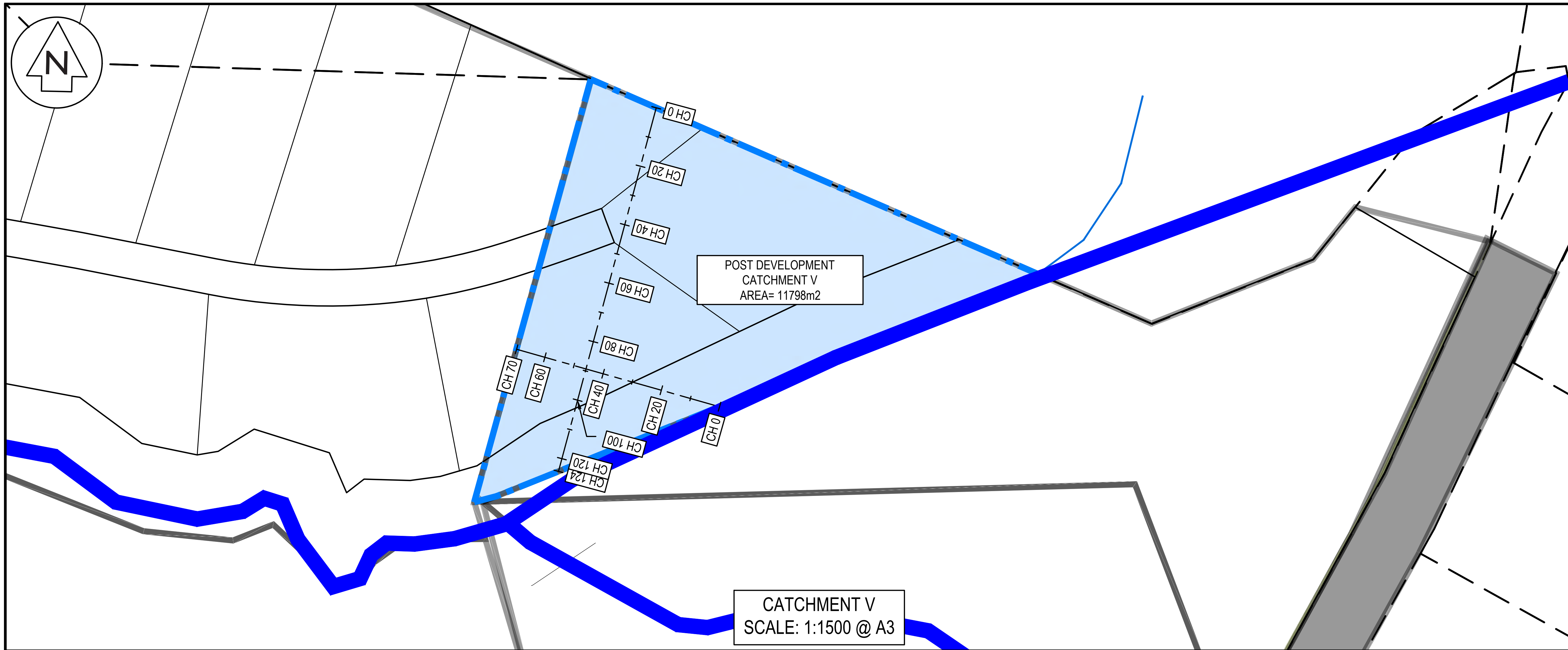
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

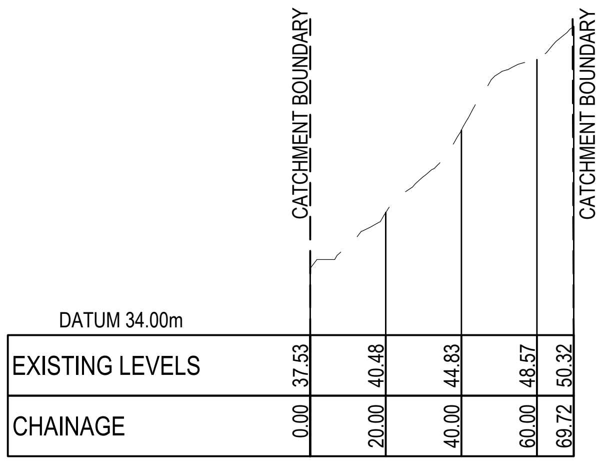
Title
POST DEVELOPMENT CATCHMENT IV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-4 Rev A

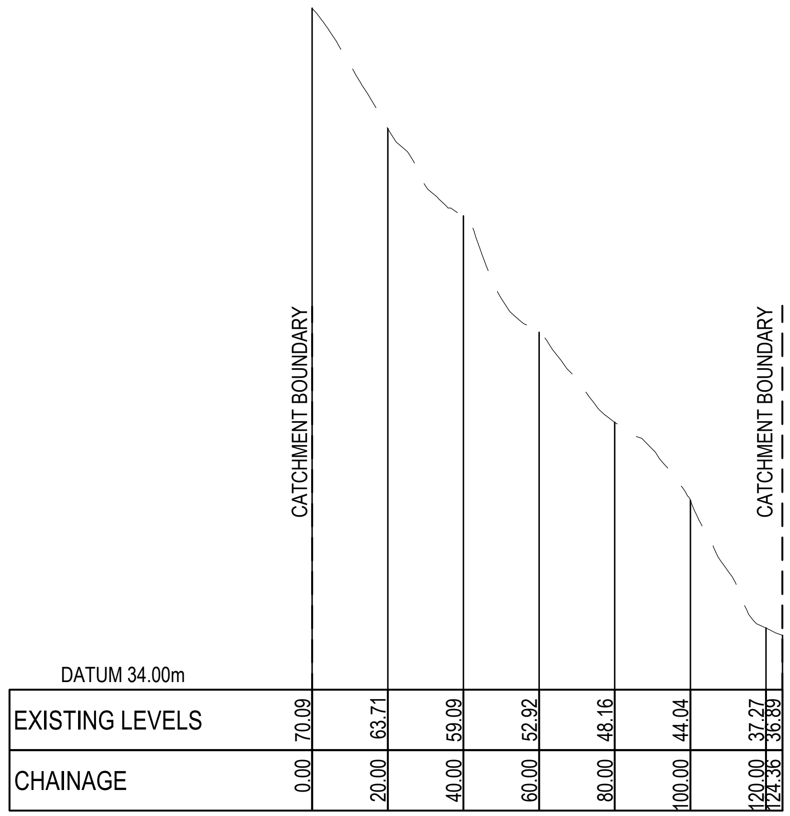


Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



CS-CATCHMENT V
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT V
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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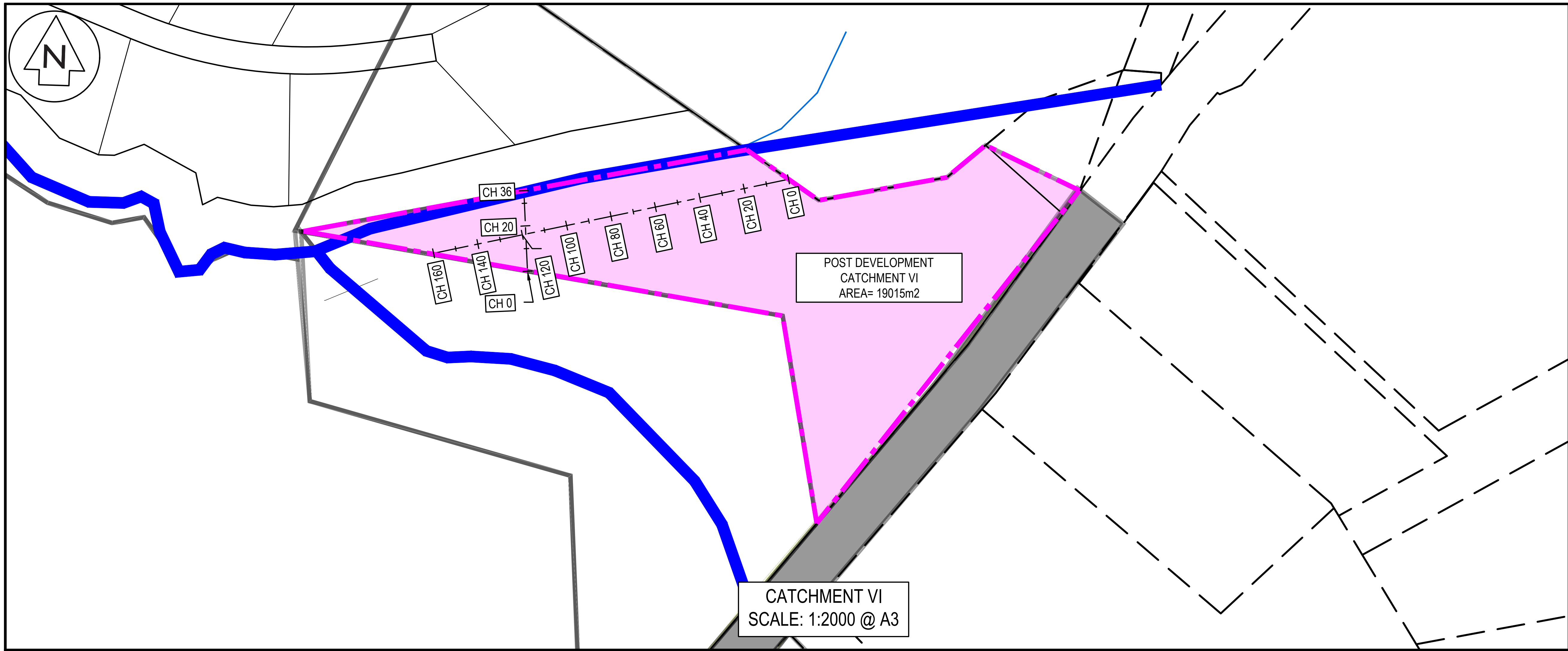
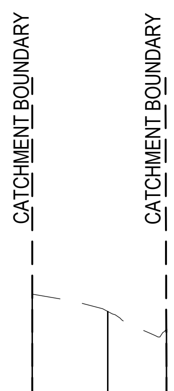
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT V PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-5
Rev	A



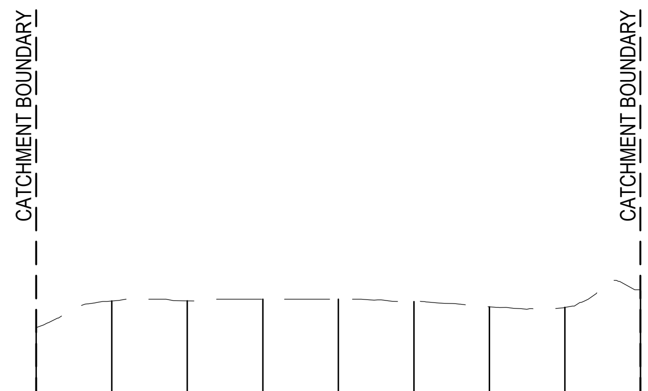
CATCHMENT VI
SCALE: 1:2000 @ A3



DATUM 34.00m

EXISTING LEVELS	39.27	38.35	37.42
CHAINAGE	0.00	20.00	35.52

CS-CATCHMENT VI
SCALE: HORI 1:2000 VERT 1:400



DATUM 34.00m

EXISTING LEVELS	37.52	38.91	38.92	39.00	39.00	38.88	38.60	38.57	39.44
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00

LS-CATCHMENT VI
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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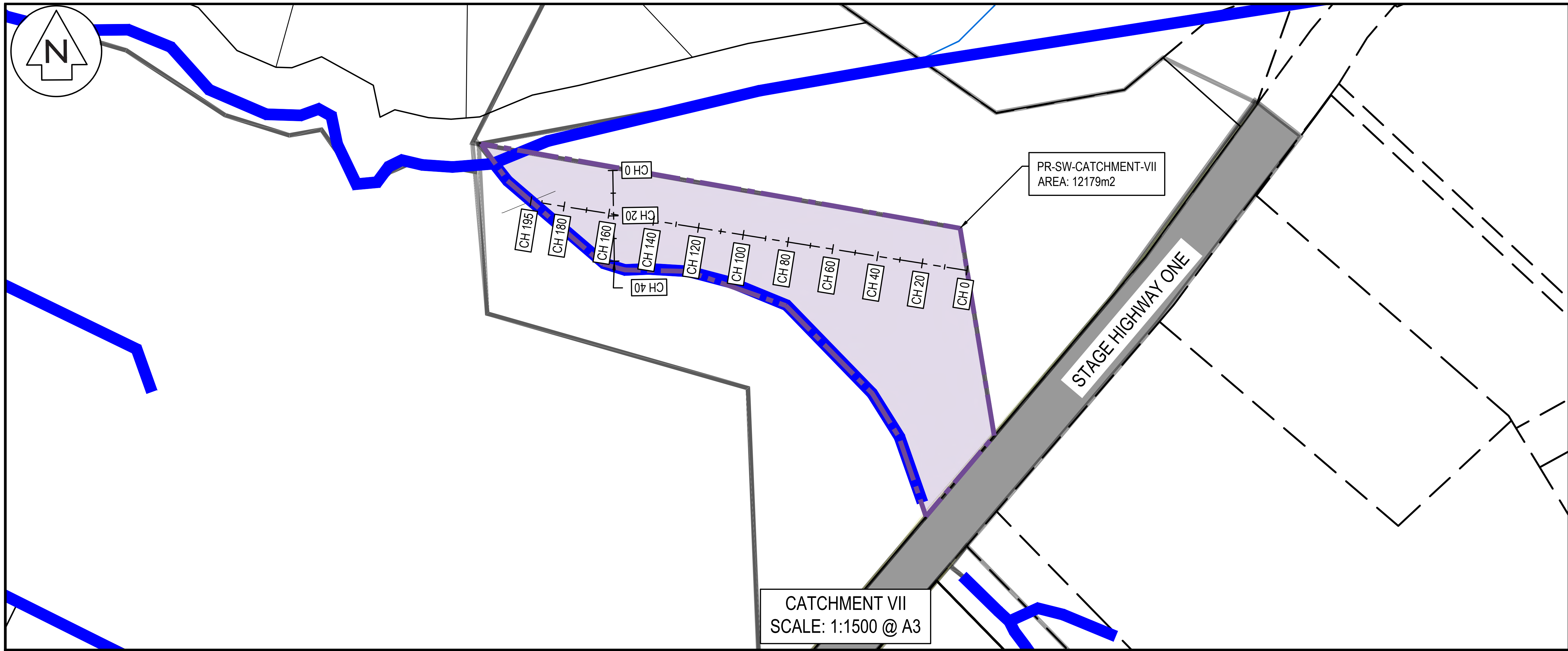
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT VI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-6
Rev	A

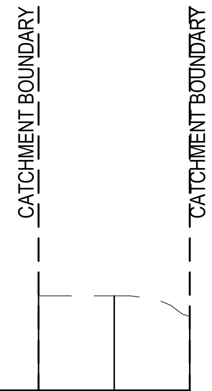


CATCHMENT VII
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

Legend

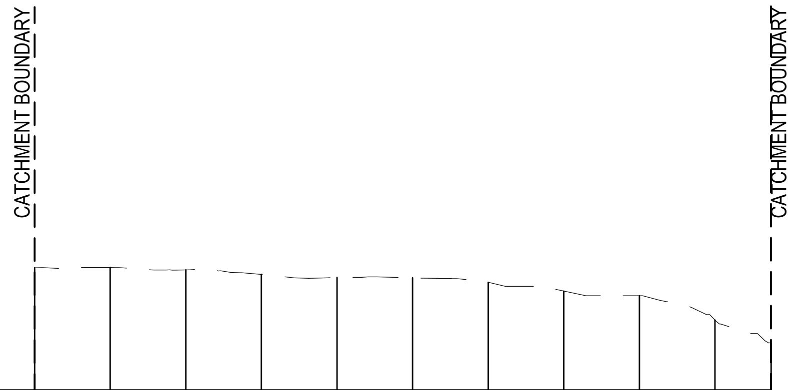
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 34.00m

EXISTING LEVELS	39.03	39.00	37.91
CHAINAGE	0.00	20.00	39.97

CS-CATCHMENT VII
SCALE: HORI 1:2000 VERT 1:400



DATUM 34.00m

EXISTING LEVELS	40.48	40.50	40.37	40.13	39.97	39.94	39.71	39.25	39.00	37.71	36.50
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	194.84

LS-CATCHMENT VII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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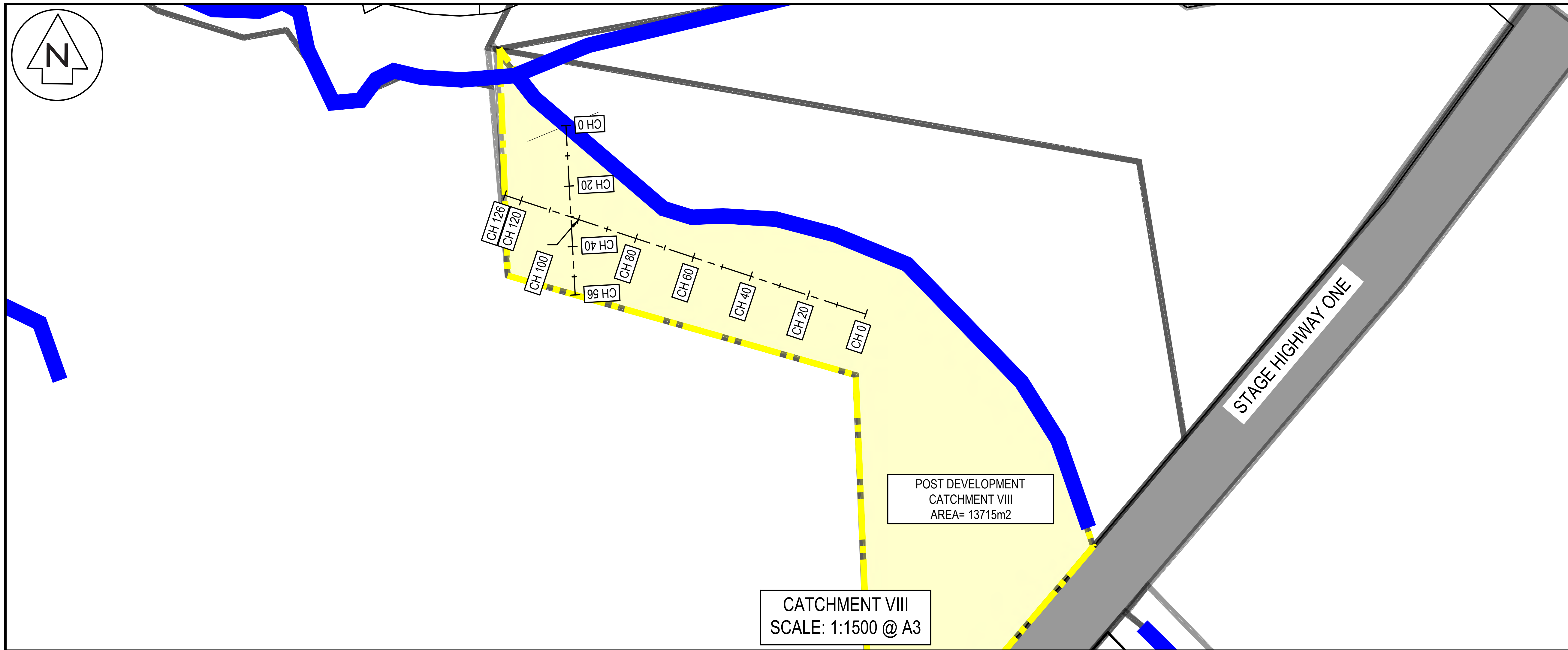
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT VII PLAN

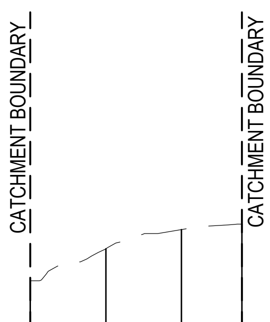
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-7 Rev A



CATCHMENT VIII
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

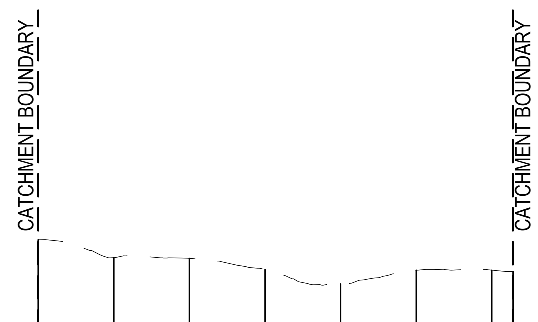
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 34.00m

EXISTING LEVELS	36.50	38.19	39.21	39.50
CHAINAGE	0.00	20.00	40.00	56.00

CS-CATCHMENT VIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 36.00m

EXISTING LEVELS	40.57	39.63	39.59	39.00	38.24	38.96	38.96	38.89
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	125.63

LS-CATCHMENT VIII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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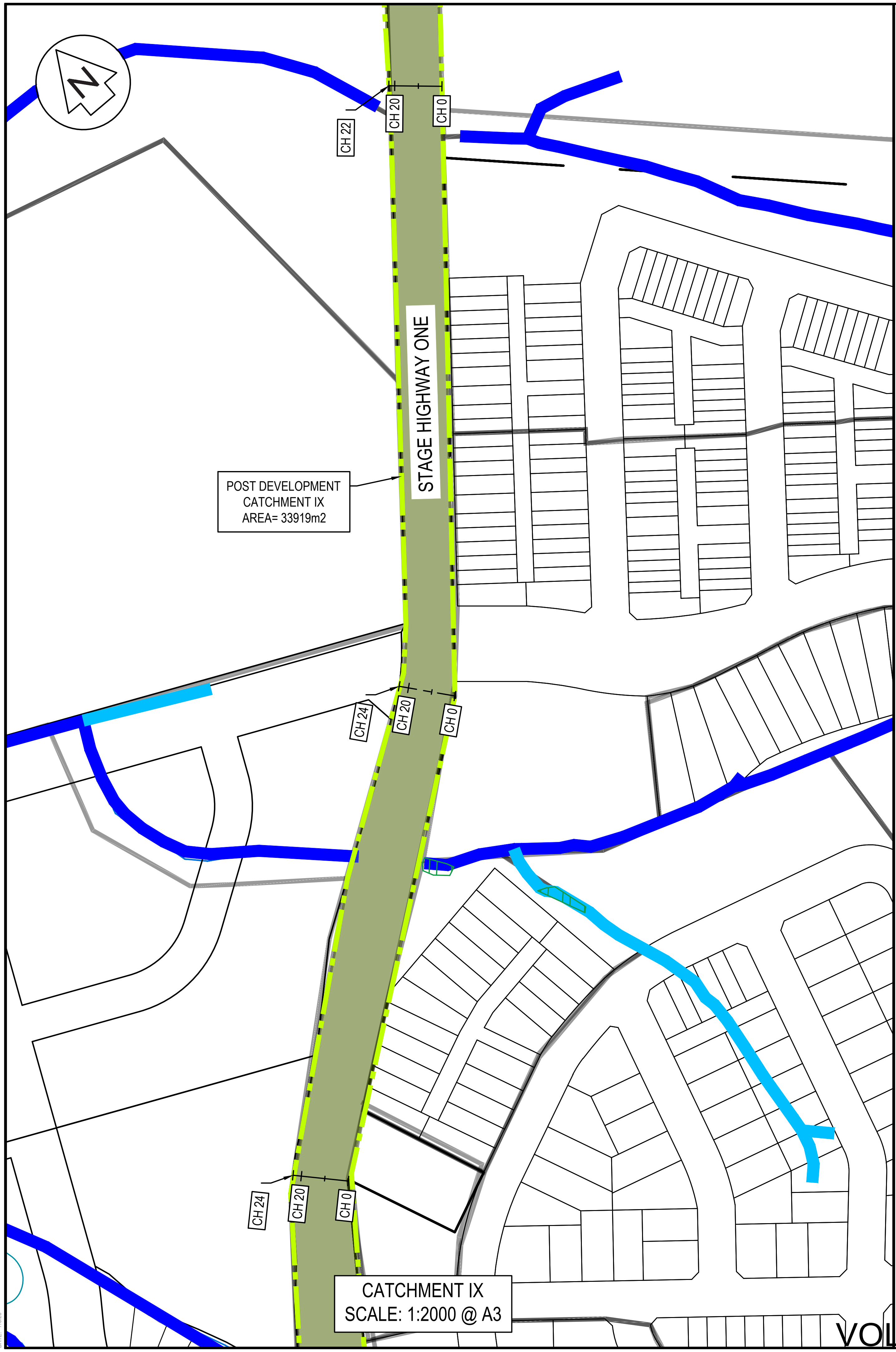
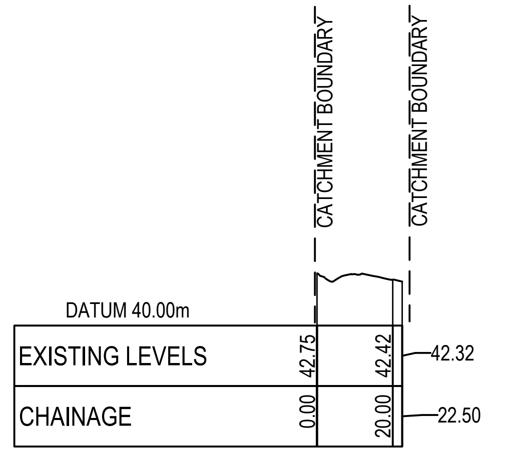
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

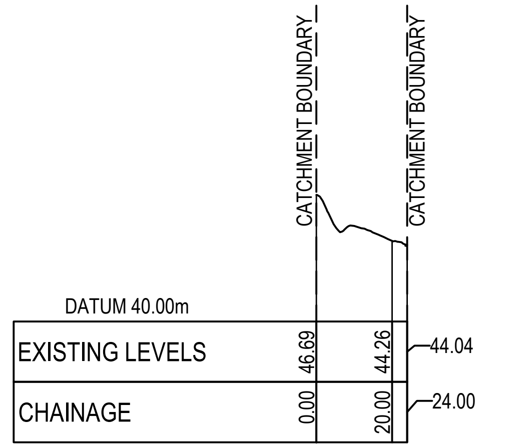
Title
POST DEVELOPMENT CATCHMENT VIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-8
Rev	A

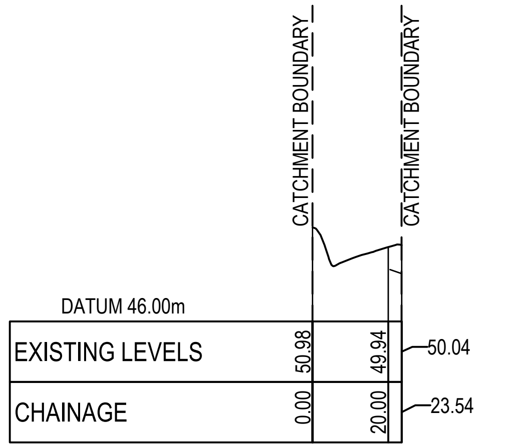




CS-CATCHMENT IX-1
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT IX-2
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT IX-3
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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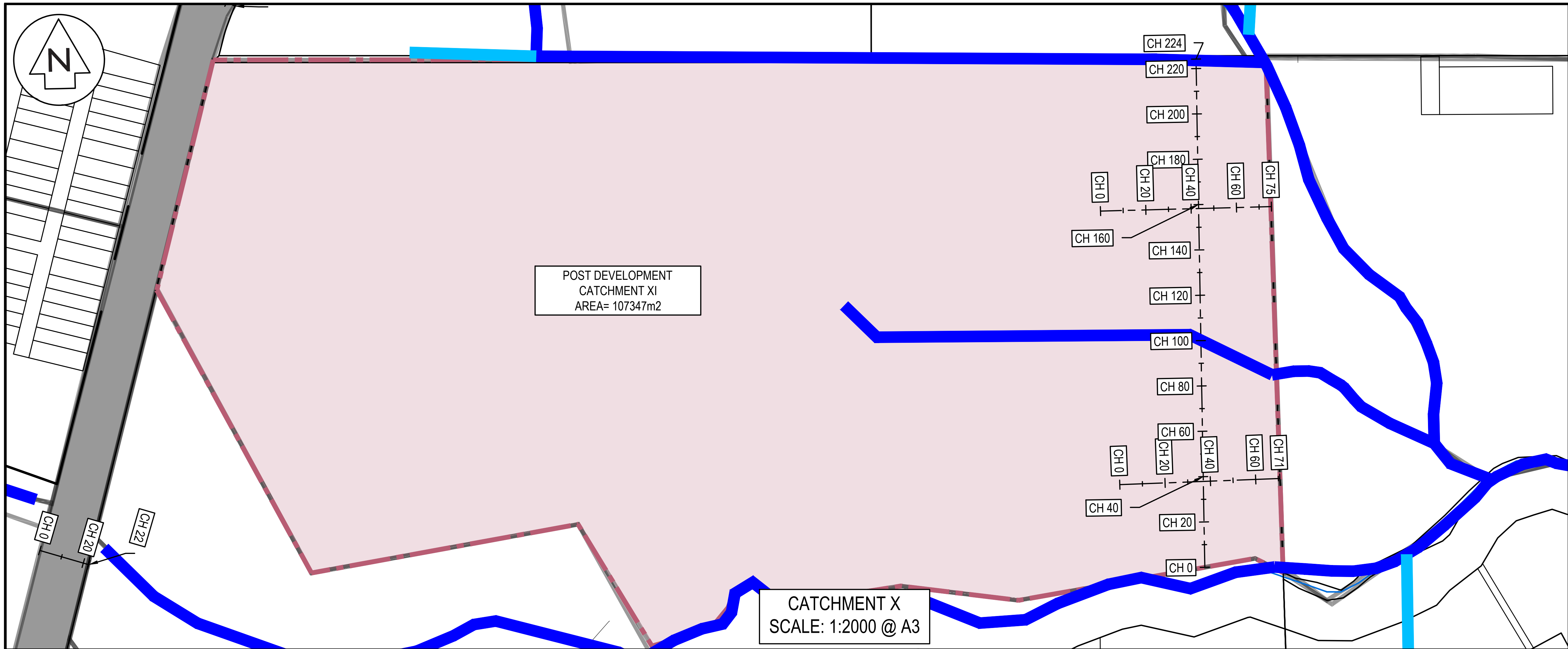
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT IX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-9 Rev A



Notes
1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

DATUM 34.00m

EXISTING LEVELS	37.50	37.50	37.33	37.00	36.86
CHAINAGE	0.00	20.00	40.00	60.00	70.69

CATCHMENT BOUNDARY

CAS-CATCHMENT X-1
SCALE: HORI 1:2000 VERT 1:400

DATUM 32.00m

EXISTING LEVELS	37.00	36.73	36.50	36.00	35.93
CHAINAGE	0.00	20.00	40.00	60.00	75.43

CATCHMENT BOUNDARY

CS-CATCHMENT X-2
SCALE: HORI 1:2000 VERT 1:400

DATUM 32.00m

CATCHMENT BOUNDARY

EXISTING LEVELS	34.50	37.03	37.41	37.19	36.77	35.74	36.33	36.49	36.50	36.74	37.00	36.96	35.75
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	224.19

CATCHMENT BOUNDARY

LS-CATCHMENT X
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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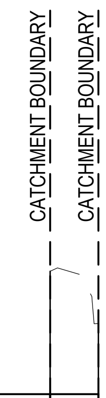
Title
POST DEVELOPMENT CATCHMENT X PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-10 Rev A

DATE: 7/2/23

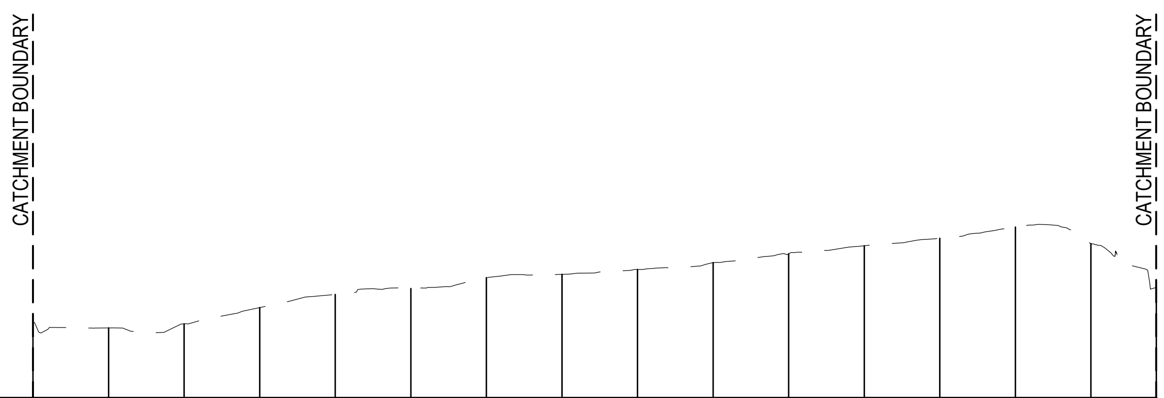
CATCHMENT XI
SCALE: 1:1500 @ A3



DATUM 36.00m

EXISTING LEVELS	42.50	39.73
CHAINAGE	0.00	12.82

CS-CATCHMENT-XI
SCALE: HORI 1:2000 VERT 1:400



DATUM 38.00m

EXISTING LEVELS	42.02	41.70	41.92	42.78	43.47	43.79	44.36	44.54	44.80	45.16	45.62	46.05	46.44	47.03	46.16	43.84
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	297.30

LS-CATCHMENT-XI
SCALE: HORI 1:2000 VERT 1:400

VOL IV - 303

Notes
1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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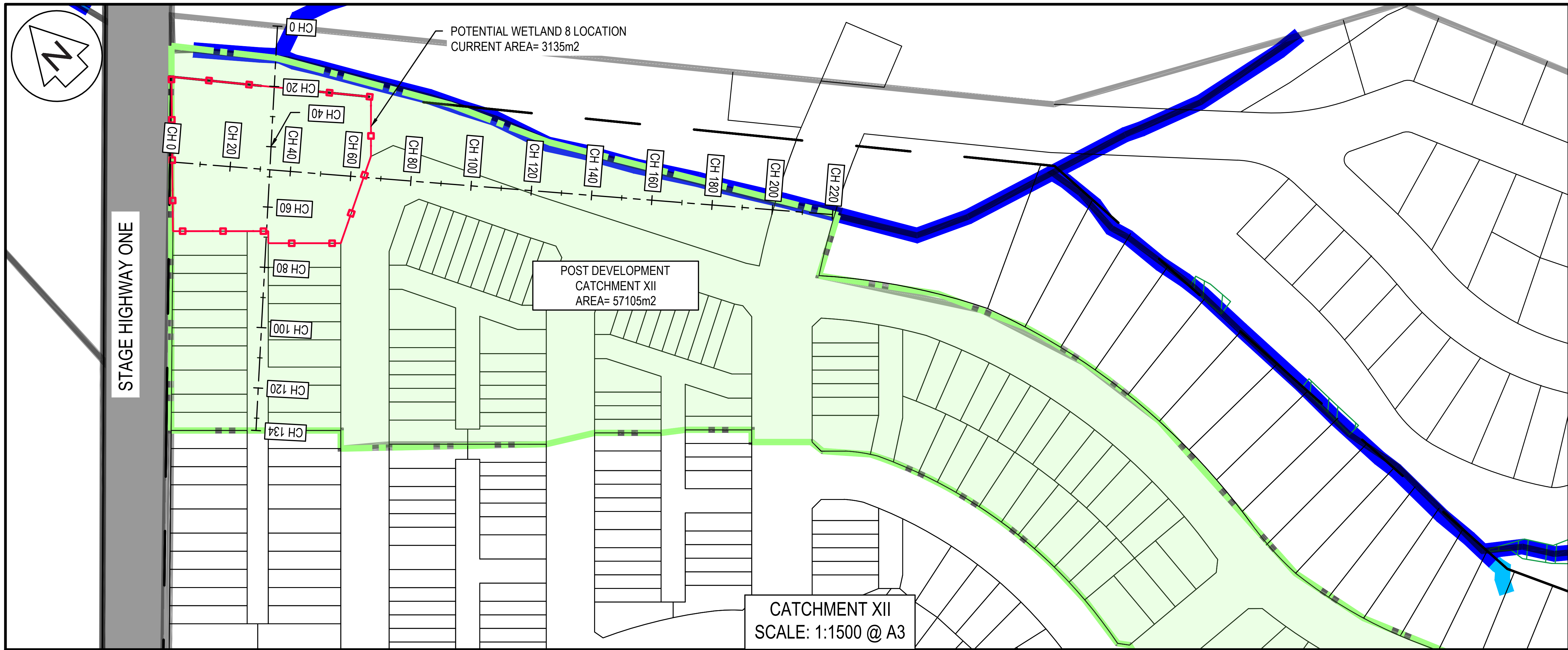
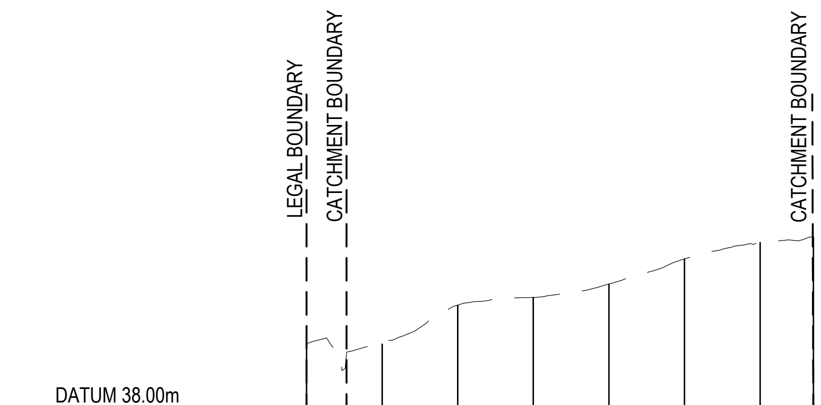
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-11 Rev A



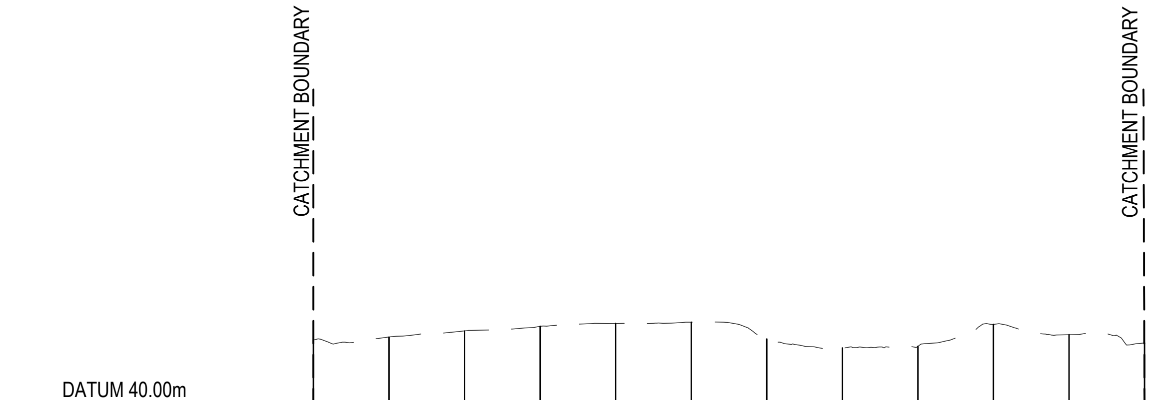
CATCHMENT XII
SCALE: 1:1500 @ A3



DATUM 38.00m

EXISTING LEVELS	41.52	41.49	43.55	43.96	44.67	46.01	46.87	47.16
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	134.09

CS-CATCHMENT XII
SCALE: HORI 1:2000 VERT 1:400



DATUM 40.00m

EXISTING LEVELS	43.44	43.60	43.92	44.17	44.32	44.39	43.49	43.02	43.11	44.27	43.72	43.28
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00

LS-CATCHMENT XII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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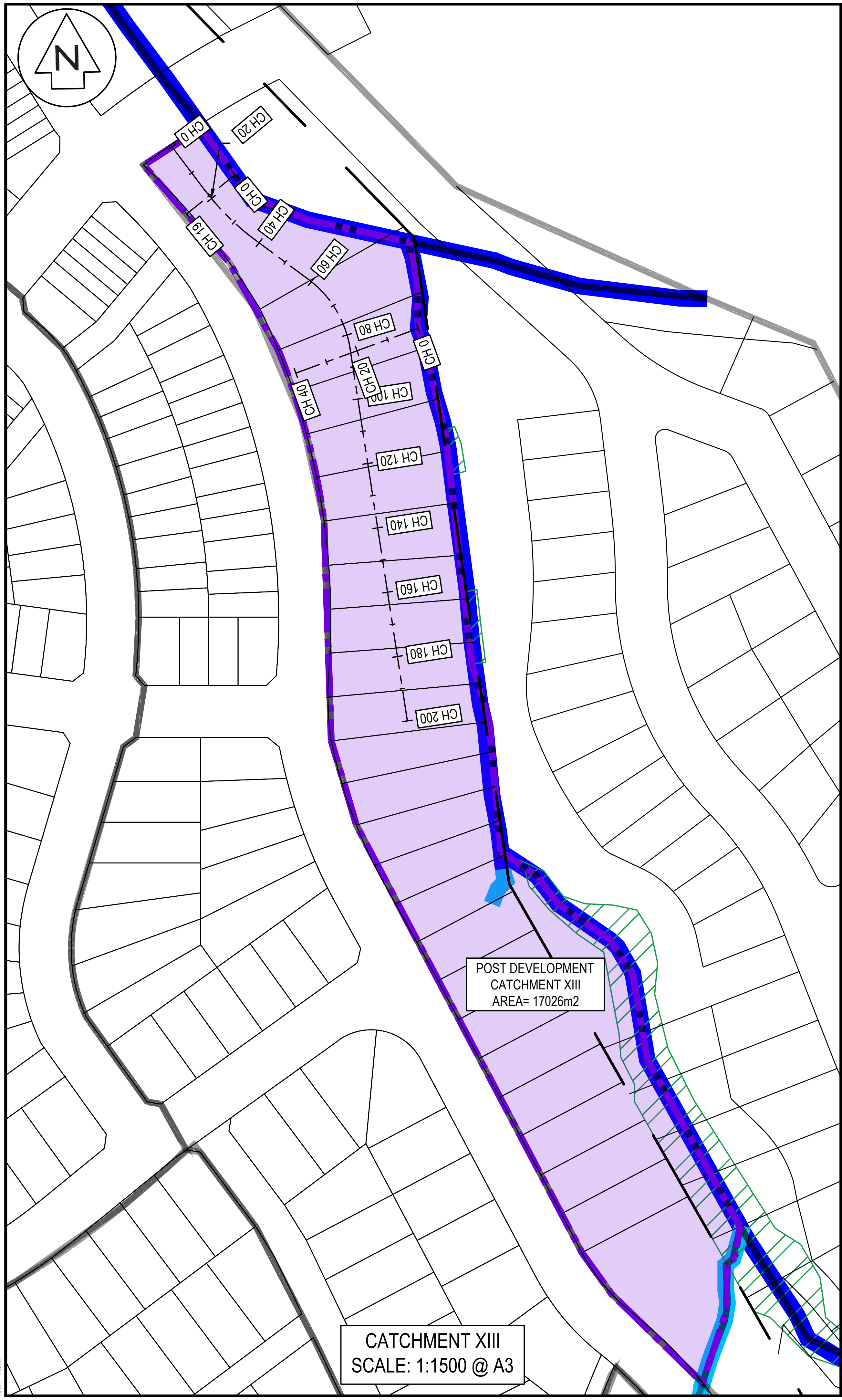
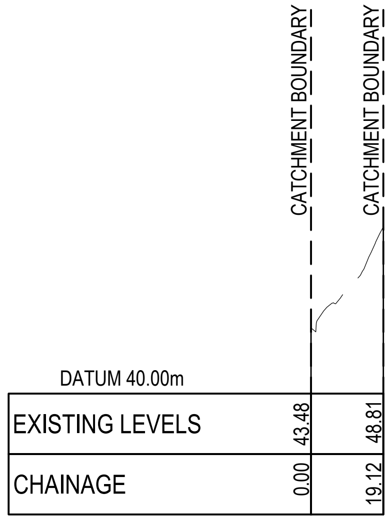
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

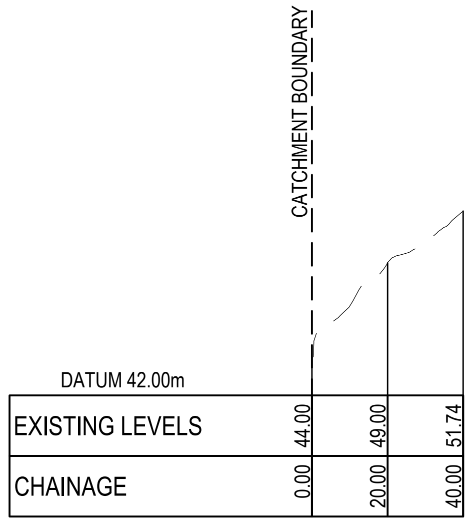
Title
POST DEVELOPMENT CATCHMENT XII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-12
Rev	A

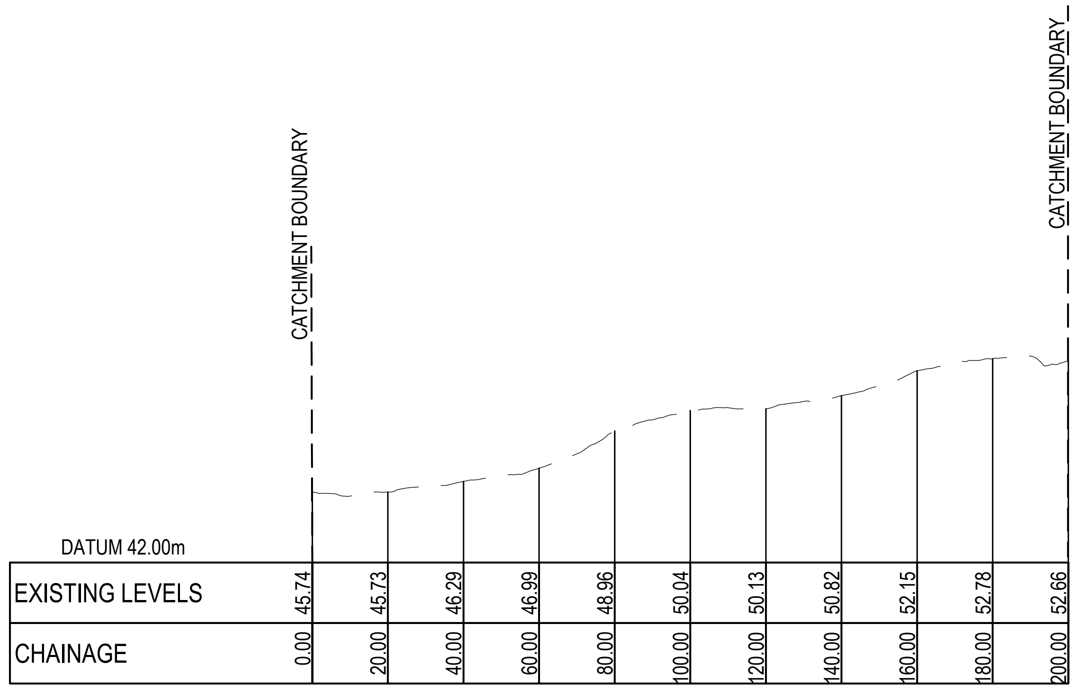




CS-CATCHMENT-XIII-2
SCALE: HORI 1:2000 VERT 1:400



CS-CATCHMENT XIII-2
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT XIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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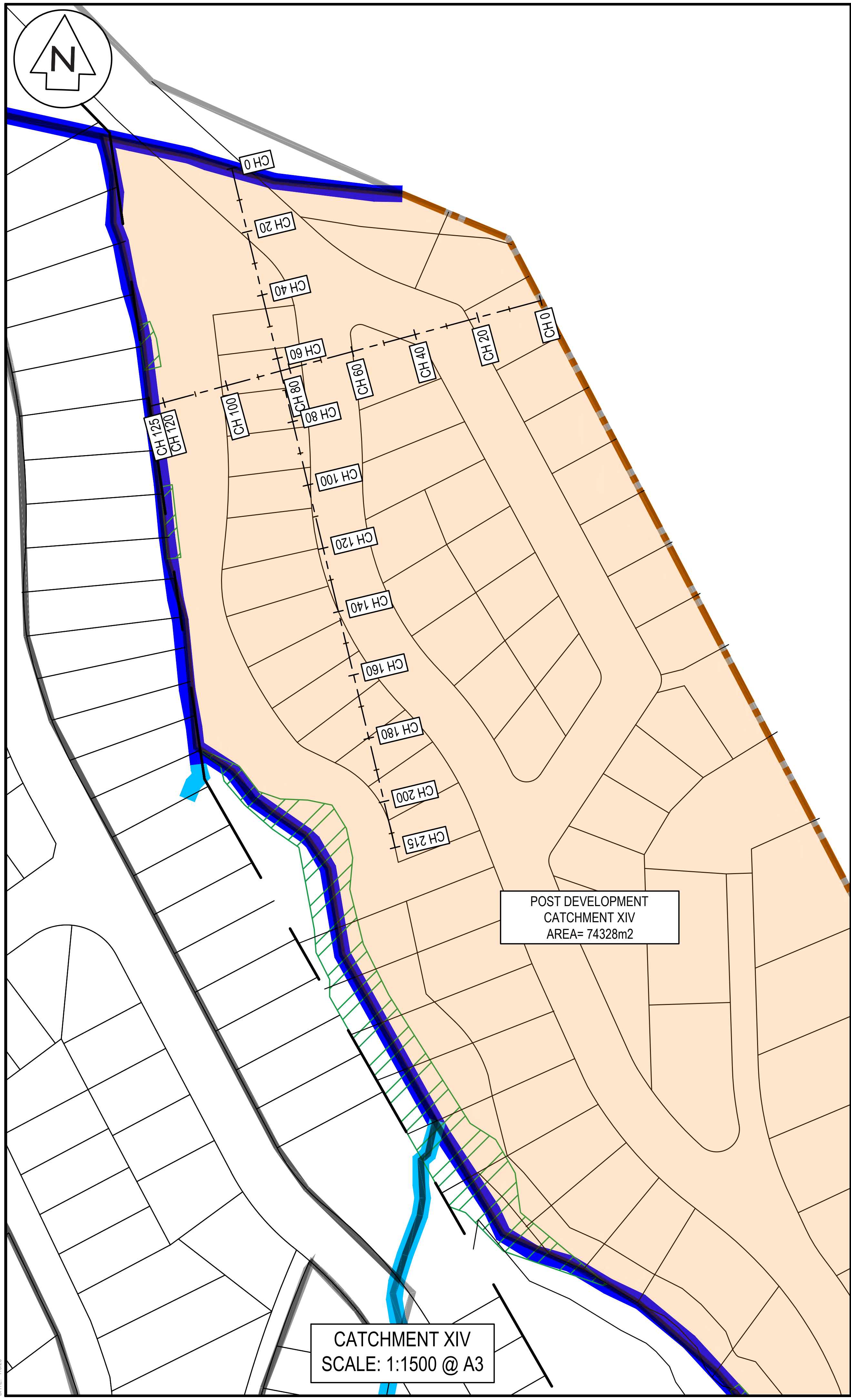
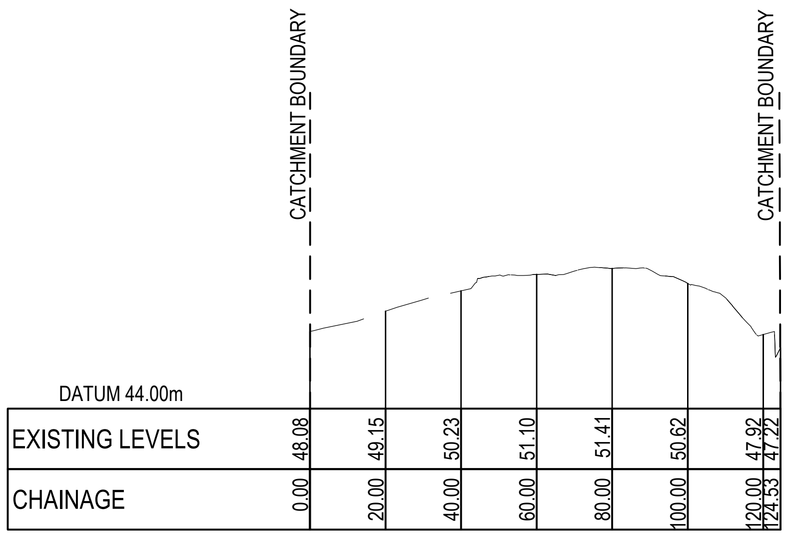
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-13 Rev A

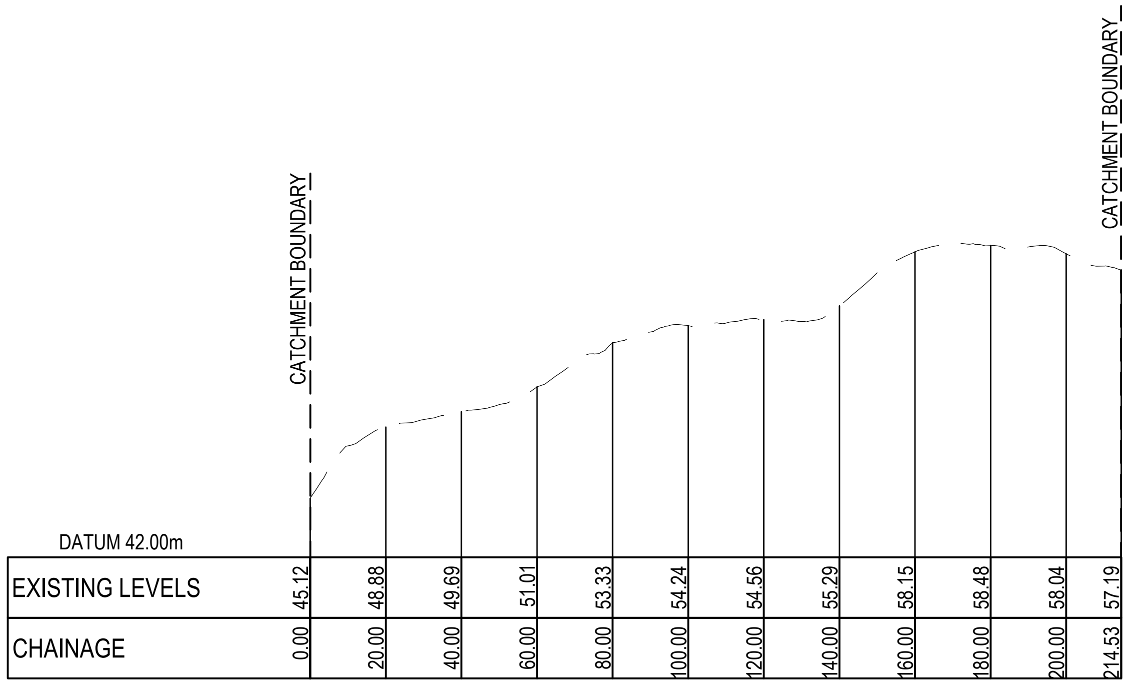


CATCHMENT XIV
SCALE: 1:1500 @ A3



EXISTING LEVELS	48.08	49.15	50.23	51.10	51.41	50.62	47.92	47.72
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	124.53

CS-CATCHMENT-XIV
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	45.12	48.88	49.69	51.01	53.33	54.24	54.56	55.29	58.15	58.48	58.04	57.19
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	214.53

LS-CATCHMENT-XIV
SCALE: HORI 1:2000 VERT 1:400

Notes
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Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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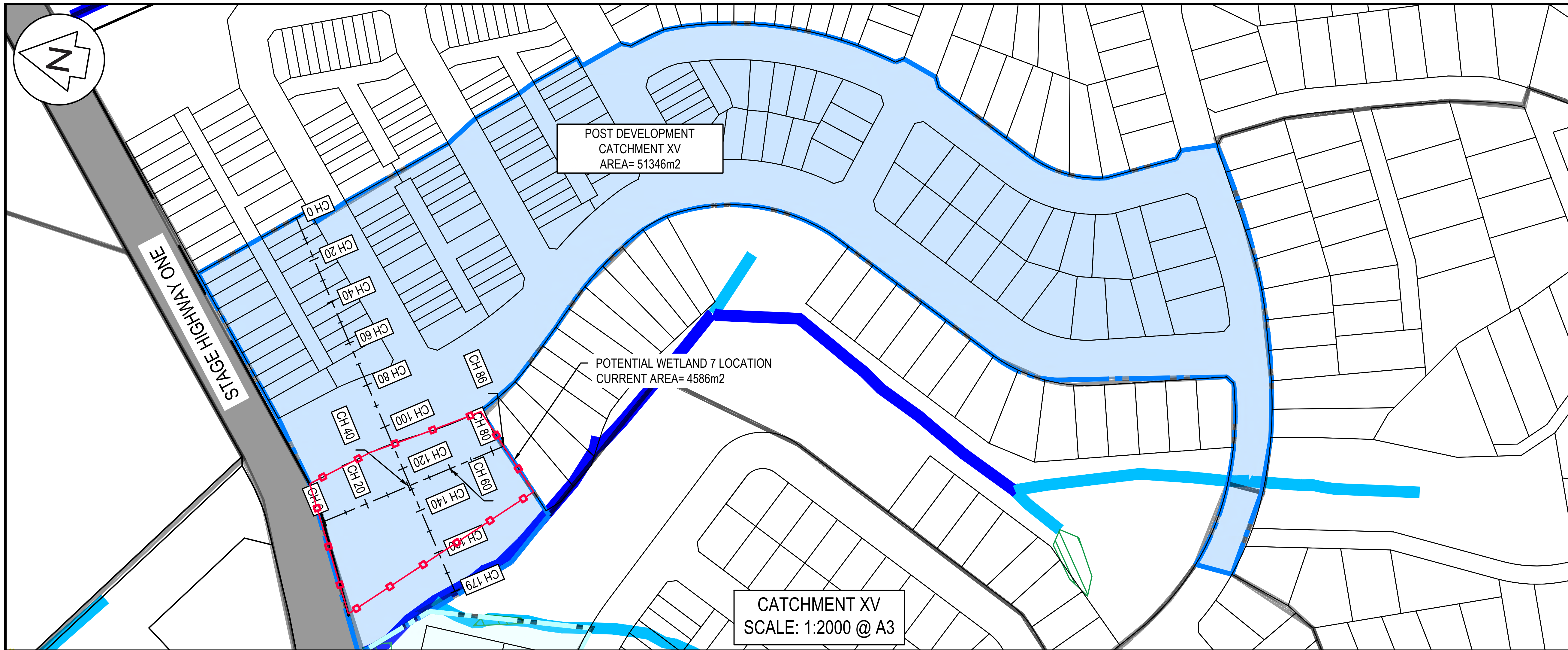
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

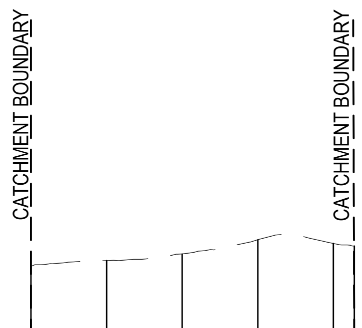
Title
POST DEVELOPMENT CATCHMENT XIV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-14 Rev A



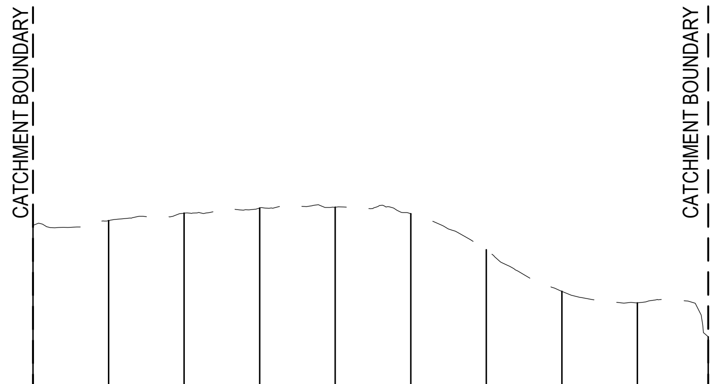
Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



EXISTING LEVELS	45.66	45.97	46.32	47.08	46.88	46.74
CHAINAGE	0.00	20.00	40.00	60.00	80.00	85.52

CS-CATCHMENT-XV
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	48.74	49.00	49.39	49.66	49.70	49.36	47.46	45.25	44.64	42.85
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	178.76

LS-CATCHMENT-XV
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
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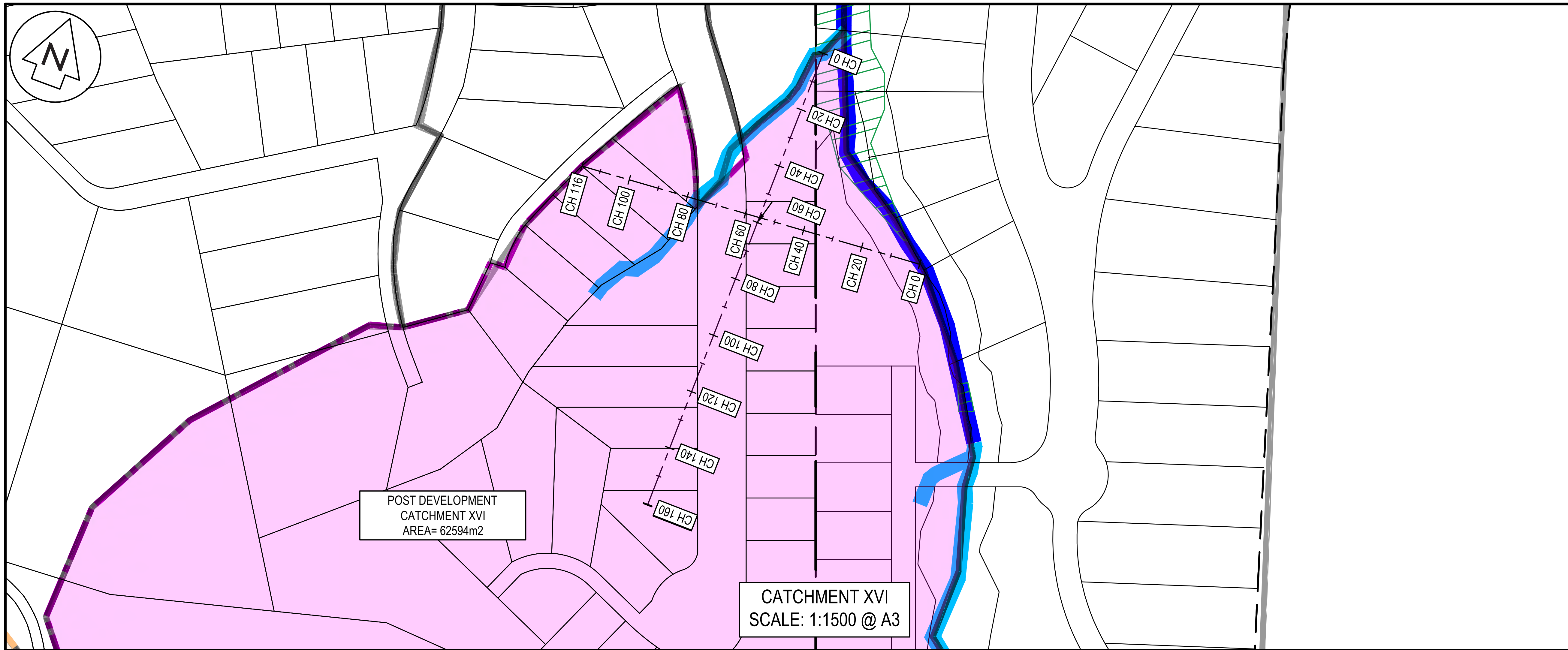
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-15
Rev	A

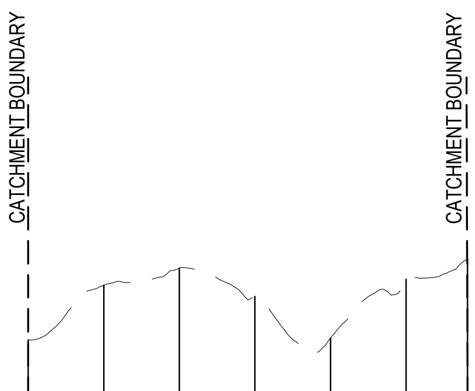


Notes

1. All works to be in accordance with Auckland council standards.

Legend

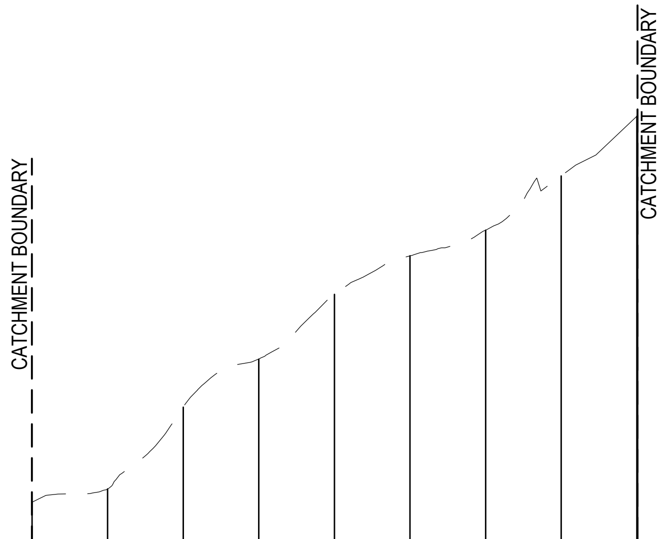
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



DATUM 60.00m

EXISTING LEVELS	62.82	65.71	66.62	65.12	62.92	66.03	67.12
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	116.25

CS-CATCHMENT-XVI
SCALE: HORI 1:2000 VERT 1:400



DATUM 56.00m

EXISTING LEVELS	58.12	58.82	63.15	65.69	69.11	71.15	72.51	75.38	78.58
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00 / 160.24

LS-CATCHMENT-XVI
SCALE: HORI 1:2000 VERT 1:400

A	PPC RFI	LCH	06/2023
Rev	Description	By	Date

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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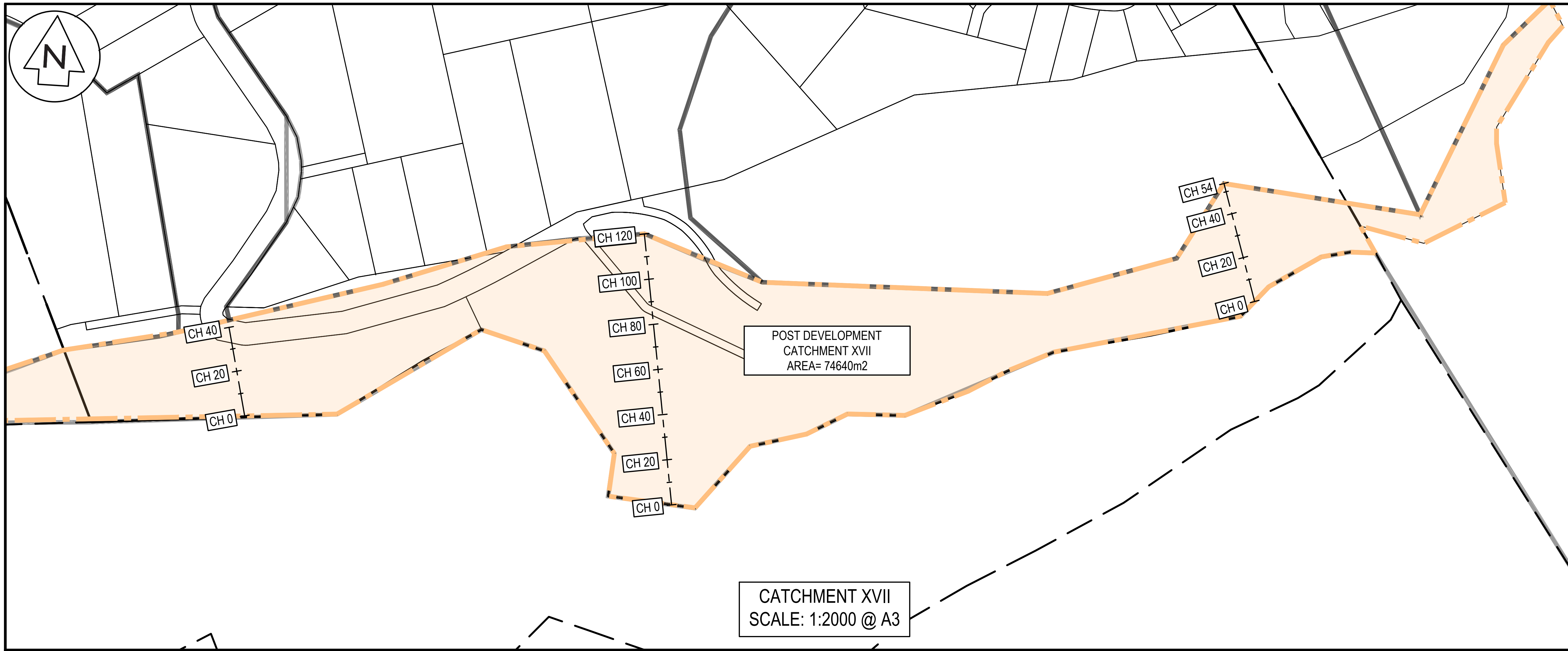
Title
POST DEVELOPMENT CATCHMENT XVI PLAN

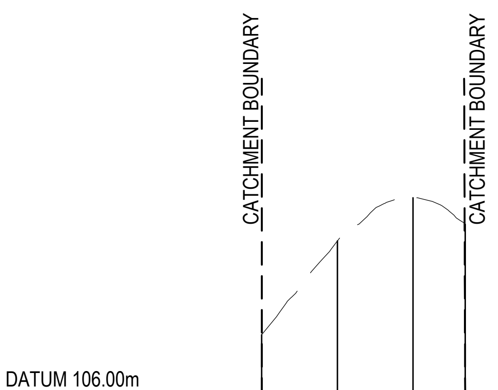
Project no.	211001		
Scale	AS SHOWN		
Cad file	203001- WETLAND ANALYSIS 1.DWG		
Drawing no.	C471-16	Rev	A

DATE: 7/3/23



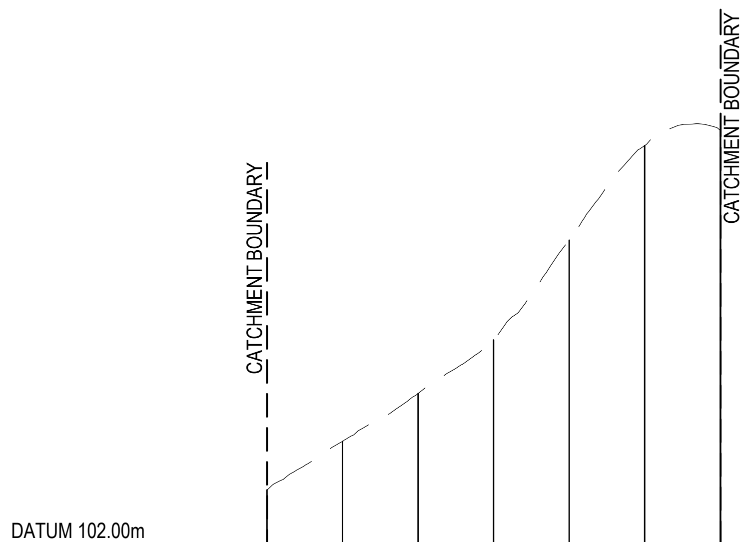
Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



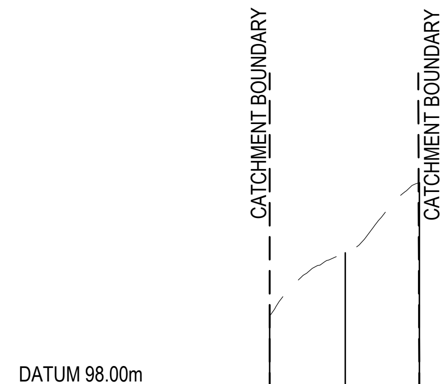
EXISTING LEVELS	109.15	114.12	116.40	115.00
CHAINAGE	0.00	20.00	40.00	53.76

CS-CATCHMENT XVII-1
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	104.97	107.54	110.08	112.91	118.20	123.20	124.02
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00

CS-CATCHMENT XVII-2
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	101.89	105.22	108.92
CHAINAGE	0.00	20.00	39.64

CS-CATCHMENT XVII-3
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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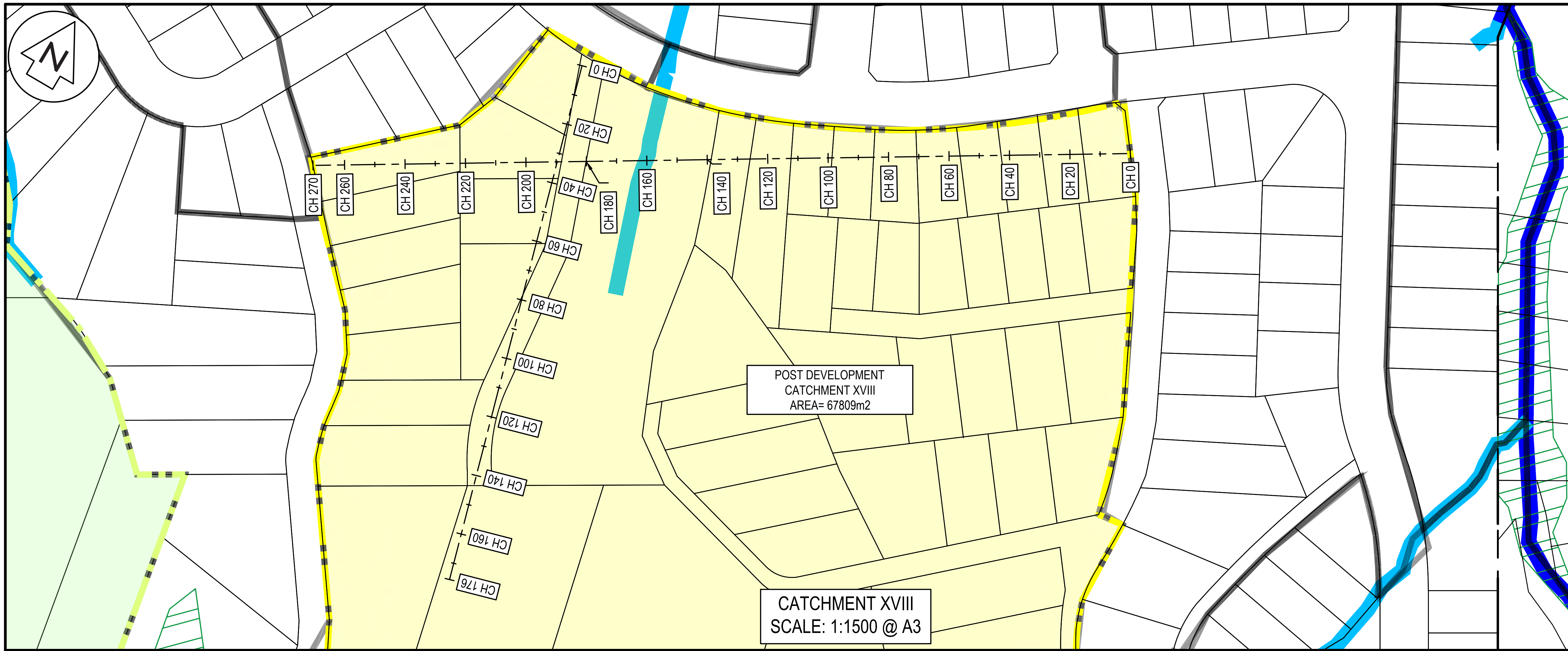
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XVII PLAN

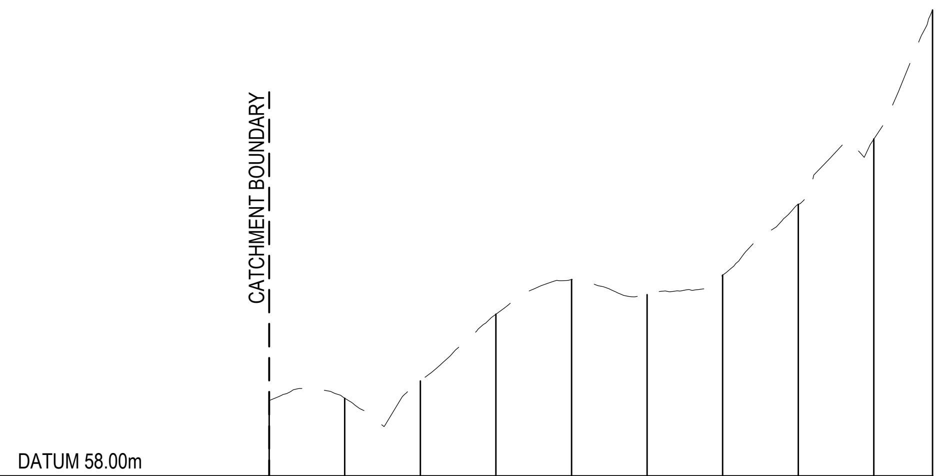
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-17
Rev	A



Notes
1. All works to be in accordance with Auckland council standards.

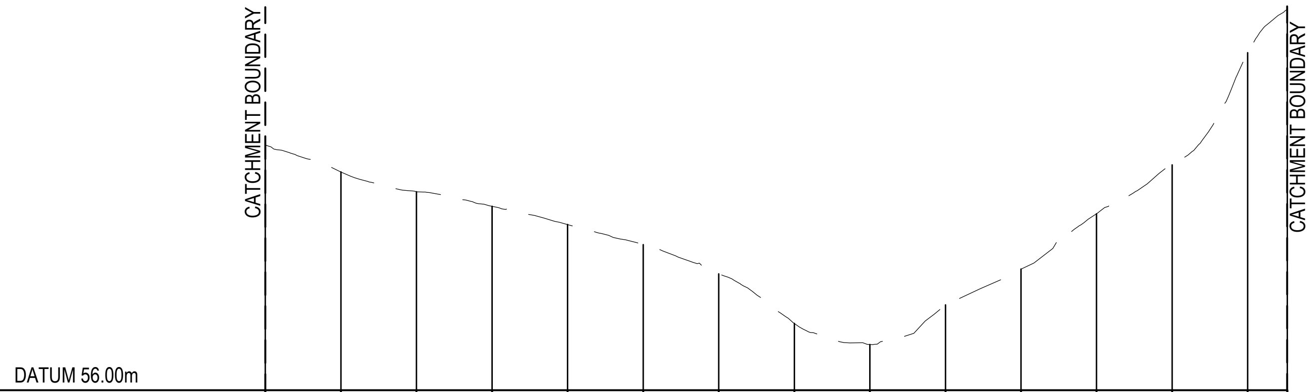
Legend

	EX BDY
	EX PERM. STREAM
	EX INTER. STREAM
	EX WETLAND



EXISTING LEVELS	61.98	62.11	63.03	66.55	68.38	67.59	68.62	72.36	75.82	82.64
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	175.54

CS-CATCHMENT-XVIII
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	68.97	67.56	66.51	65.74	64.77	63.71	62.16	59.53	58.42	60.52	62.41	65.35	67.94	73.88	76.17
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	270.47

LS-CATCHMENT-XVIII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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Project
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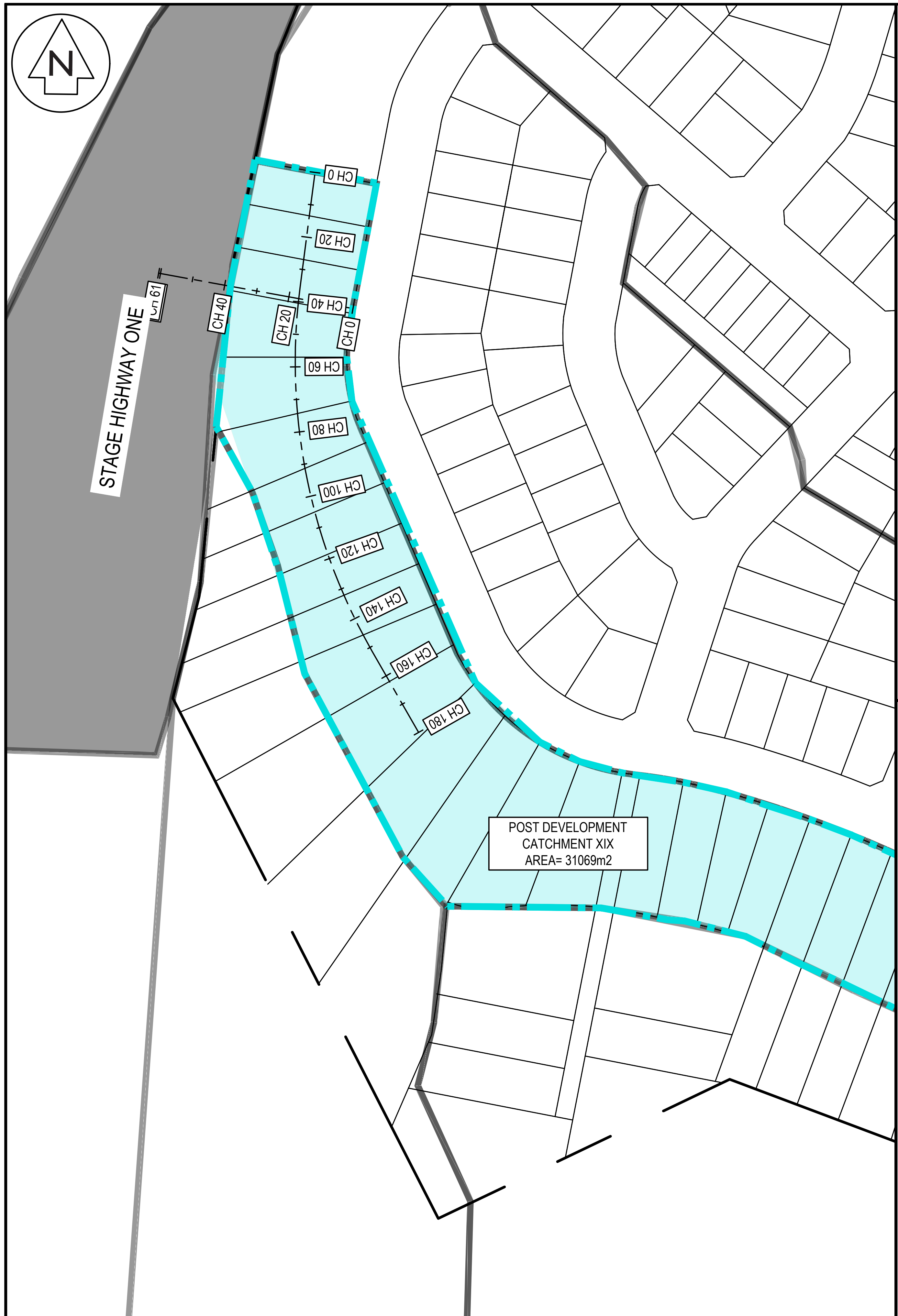
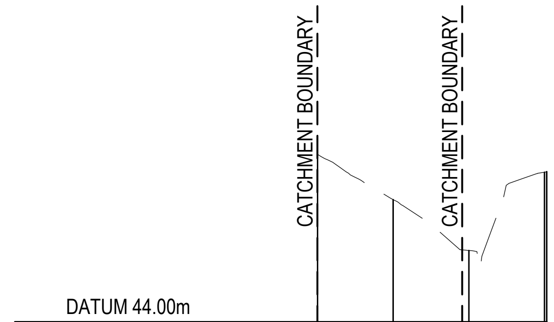
Title
POST DEVELOPMENT CATCHMENT XVIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-18
Rev	A



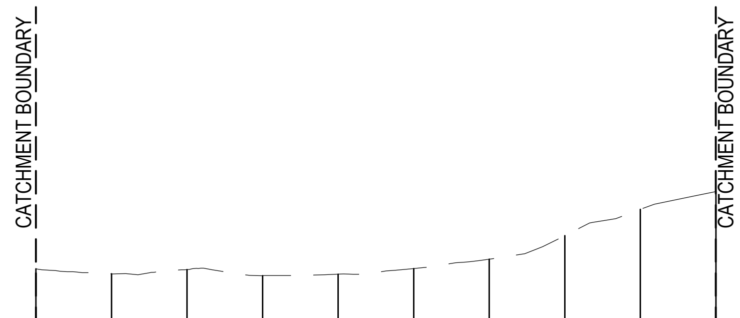
CATCHMENT XIX
SCALE: 1:1500 @ A3



DATUM 44.00m

EXISTING LEVELS	52.87	50.48	47.79	51.96
CHAINAGE	0.00	20.00	40.00	60.69

CS-CATCHMENT XIX
SCALE: HORI 1:2000 VERT 1:400



DATUM 48.00m

EXISTING LEVELS	50.89	50.62	50.84	50.52	50.60	50.90	51.40	52.64	54.02	54.97
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00

LS-CATCHMENT XIX
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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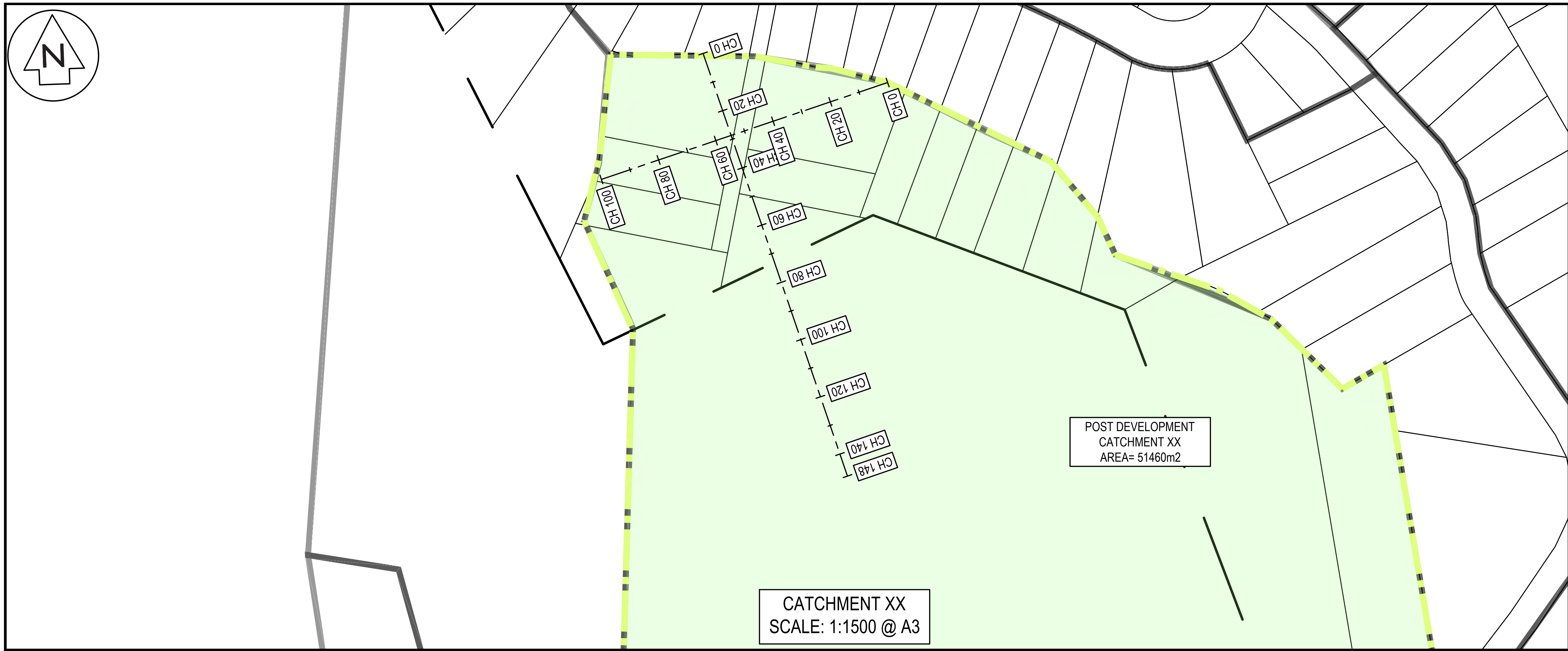
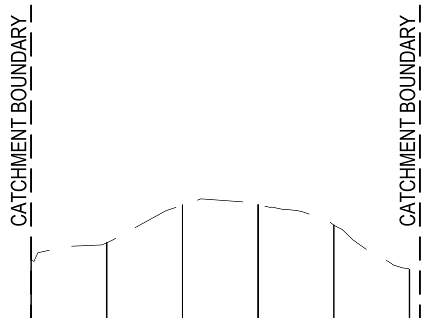
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XIX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-19 Rev A



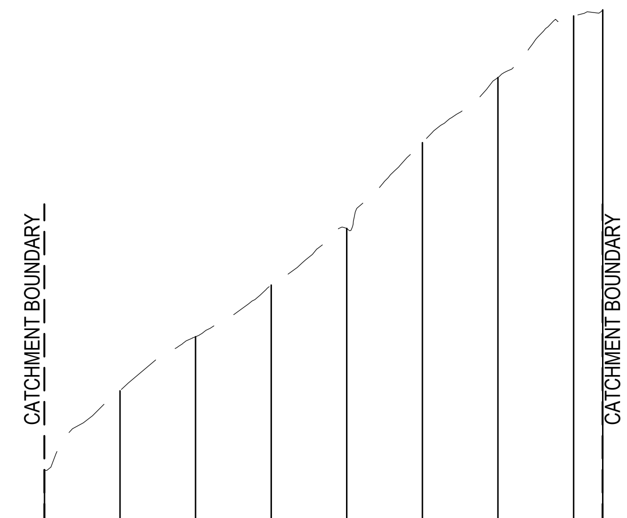
CATCHMENT XX
SCALE: 1:1500 @ A3



DATUM 52.00m

EXISTING LEVELS	55.24	56.16	58.15	58.17	57.09	54.74
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00

CA-CATCHMENT XX
SCALE: HORI 1:2000 VERT 1:400



DATUM 50.00m

EXISTING LEVELS	52.65	56.84	59.70	62.43	65.43	69.97	73.42	76.68	77.00
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	147.70

LS-CATCHMENT XX
SCALE: HORI 1:2000 VERT 1:400

Notes
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Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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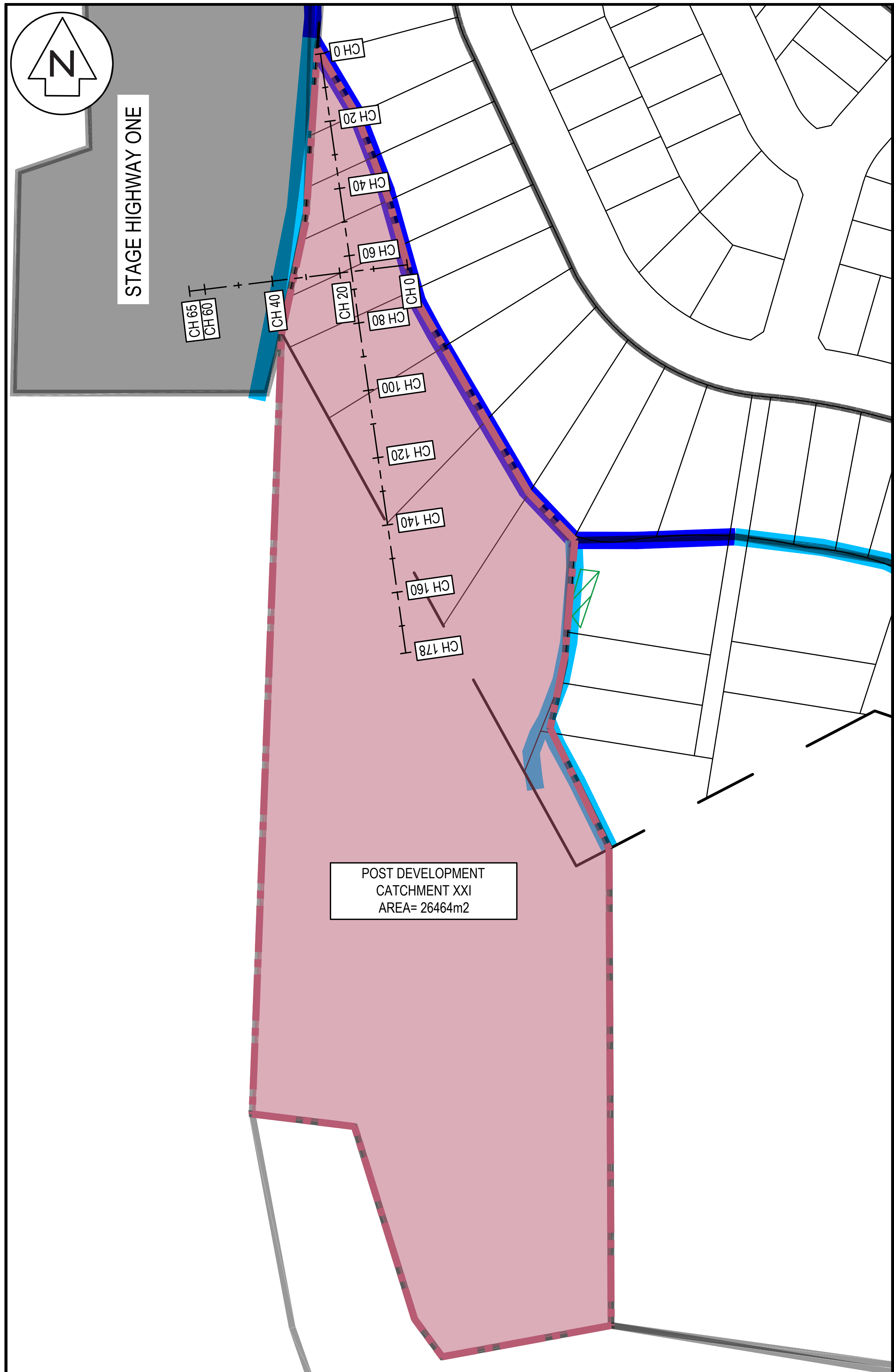
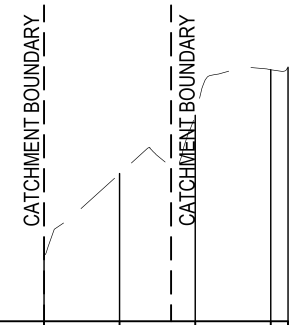
Title
POST DEVELOPMENT CATCHMENT XX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-20 Rev A

DATE: 7/2/23



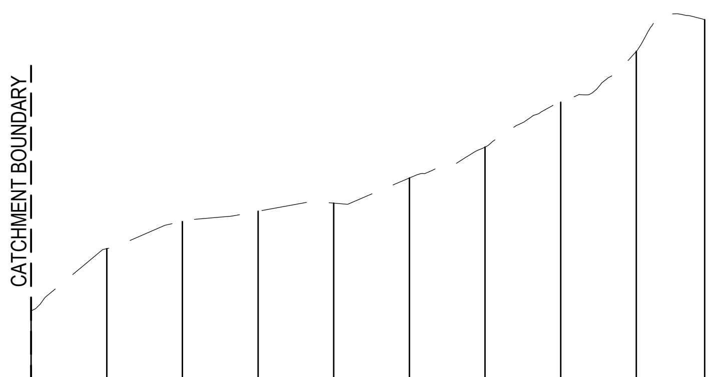
CATCHMENT XXI
SCALE: 1:1500 @ A3



DATUM 46.00m

EXISTING LEVELS	49.50	53.81	56.90	59.31	59.44
CHAINAGE	0.00	20.00	40.00	60.00	64.56

CS-CATCHMENT XXI
SCALE: HORI 1:2000 VERT 1:400



DATUM 44.00m

EXISTING LEVELS	47.75	51.03	52.46	53.01	53.44	54.77	56.41	58.78	61.47	63.14
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	178.03

LS-CATCHMENT XXI
SCALE: HORI 1:2000 VERT 1:400

Notes
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Legend
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- EX PERM. STREAM
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- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
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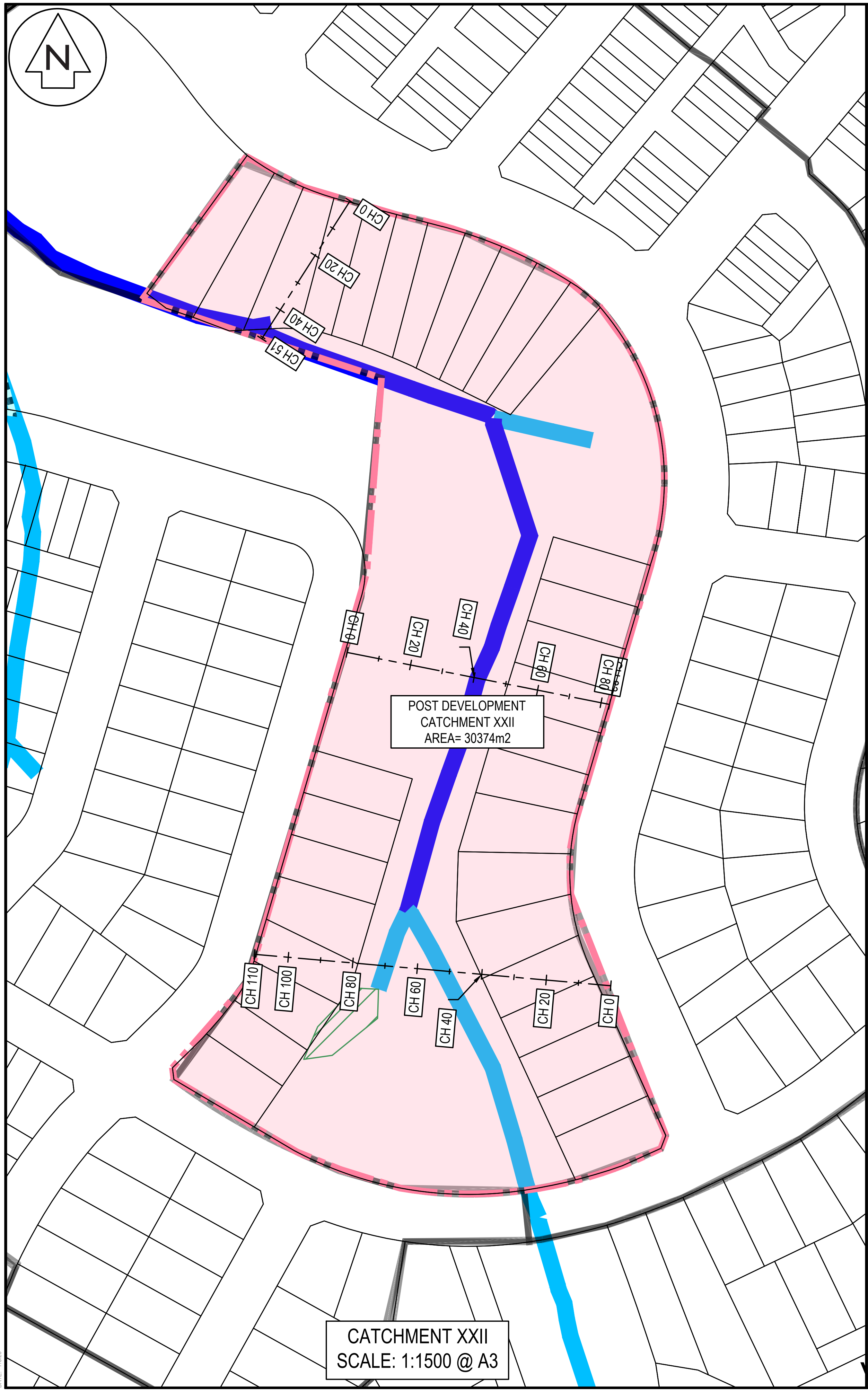
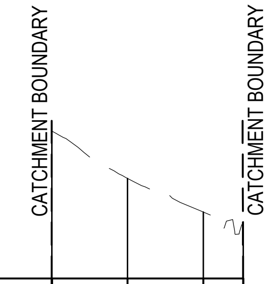
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-21
Rev	A



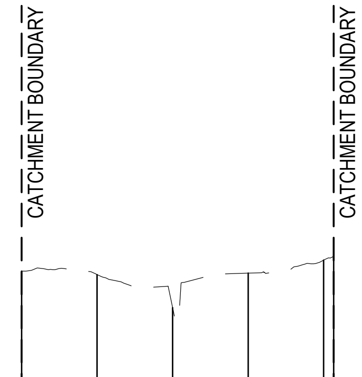
CATCHMENT XXII
SCALE: 1:1500 @ A3



DATUM 42.00m

EXISTING LEVELS	49.81	47.30	45.52	45.00
CHAINAGE	0.00	20.00	40.00	50.53

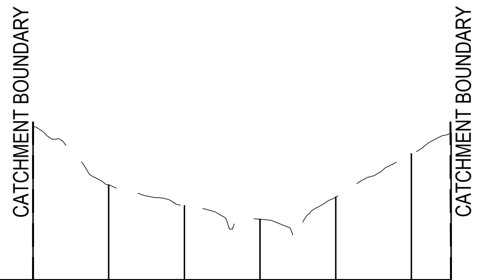
CS-CATCHMENT XXII-1
SCALE: HORI 1:2000 VERT 1:400



DATUM 44.00m

EXISTING LEVELS	50.30	50.11	48.37	50.19	50.88	51.07
CHAINAGE	0.00	20.00	40.00	60.00	80.00	82.07

LS-CATCHMENT XXII-2
SCALE: HORI 1:2000 VERT 1:400



DATUM 50.00m

EXISTING LEVELS	58.13	55.04	53.94	53.22	54.39	56.69	57.79
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	110.48

CS-CATCHMENT XXII-3
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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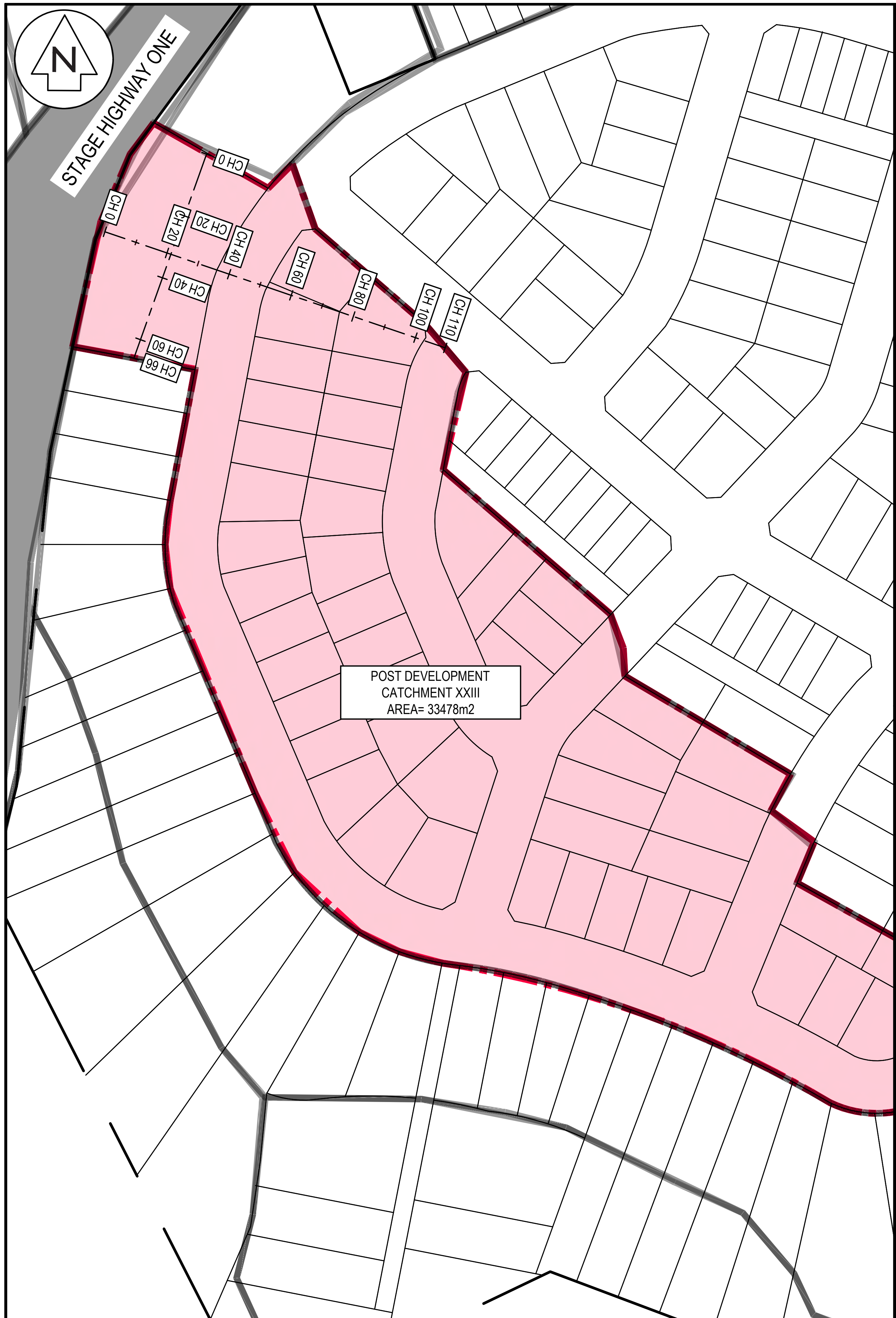
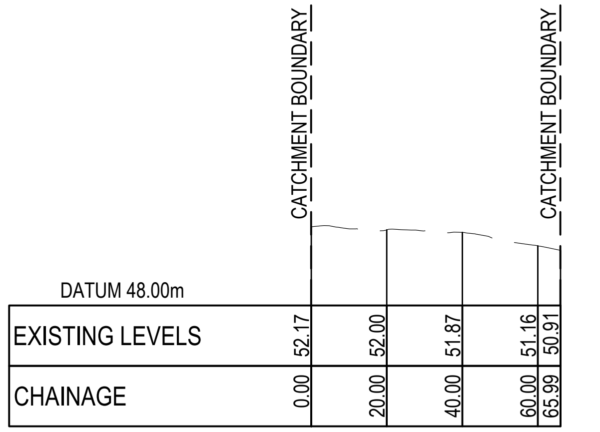
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXII PLAN

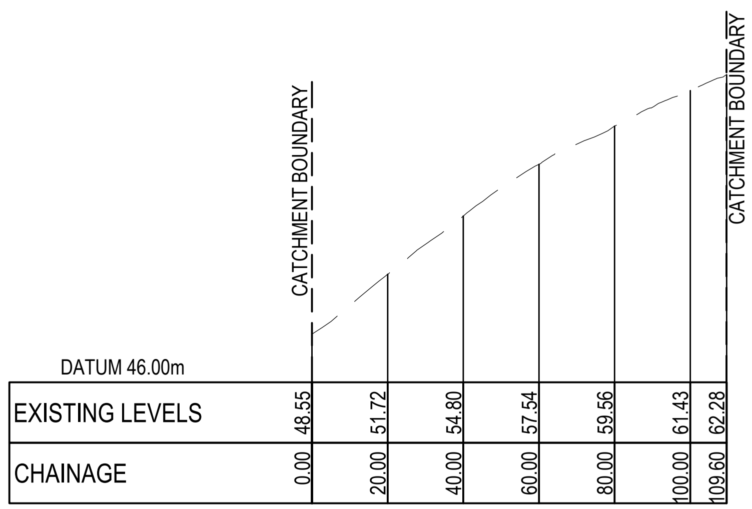
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-22
Rev	A



CATCHMENT XXIII
SCALE: 1:1500 @ A3



CS-CATCHMENT-XXIII
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT XXIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
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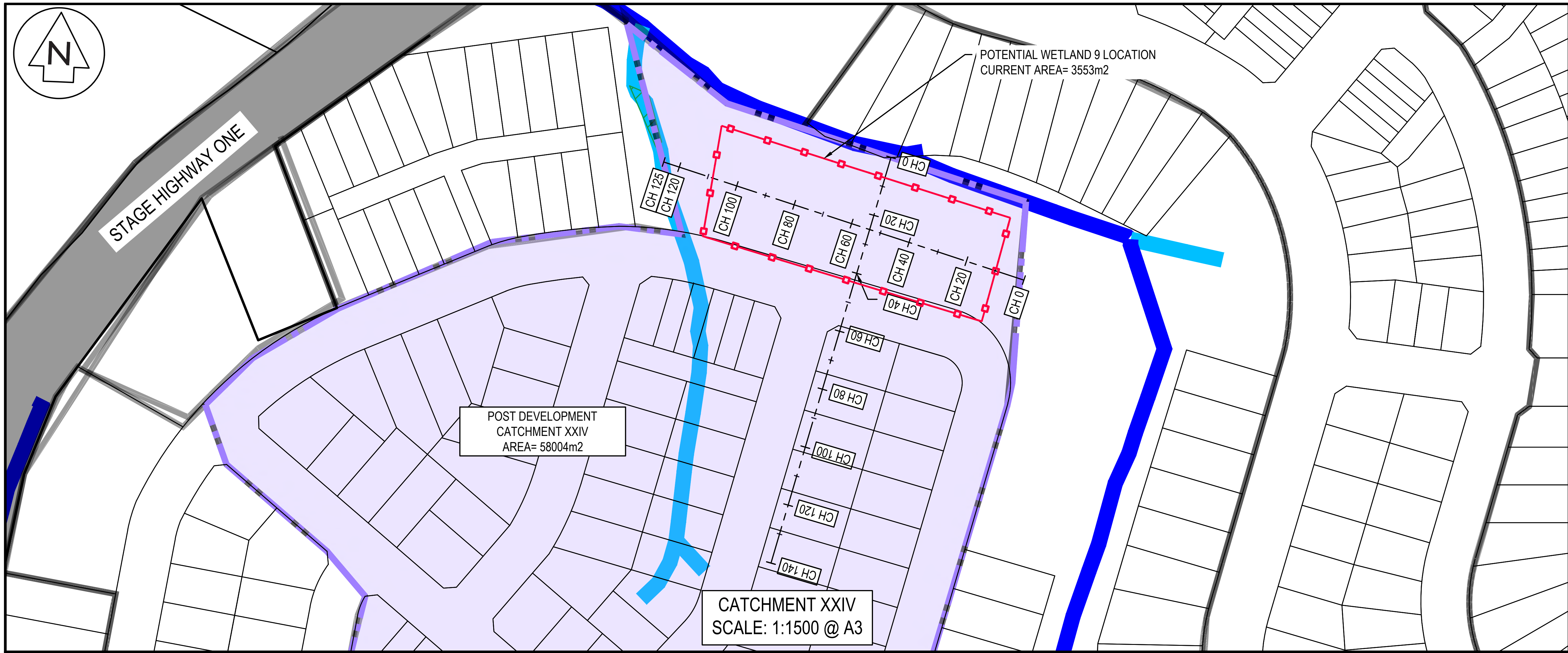
Title
POST DEVELOPMENT CATCHMENT XXIII PLAN

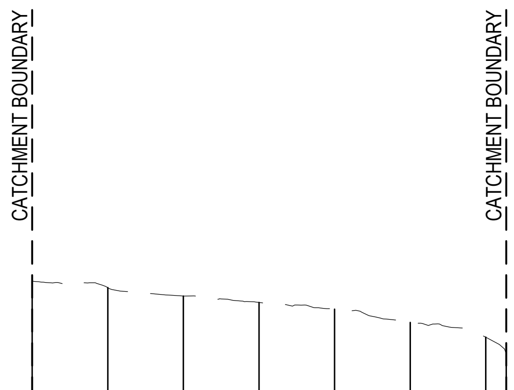
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-23
Rev	A



CATCHMENT XXIV
SCALE: 1:1500 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

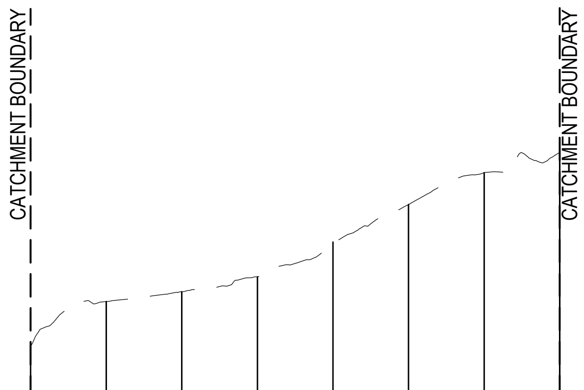
Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



DATUM 42.00m

EXISTING LEVELS	47.92	47.58	47.14	46.80	46.45	45.74	44.96	44.07
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	125.43

CS-CATCHMENT XXIV
SCALE: HORI 1:2000 VERT 1:400



DATUM 42.00m

EXISTING LEVELS	44.42	46.79	47.31	48.09	49.94	51.92	53.61	54.69
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00

LS-CATCHMENT XXIV
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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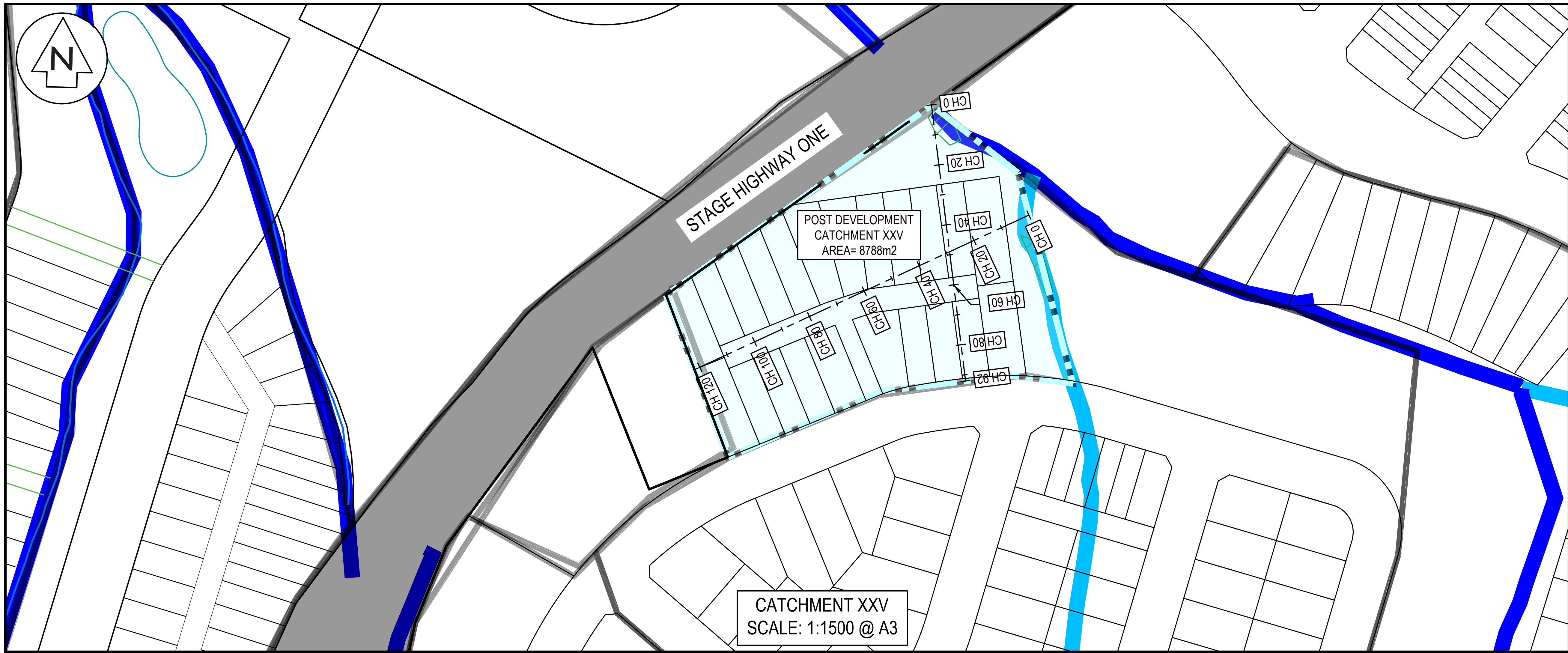
Title
POST DEVELOPMENT CATCHMENT XXIV PLAN

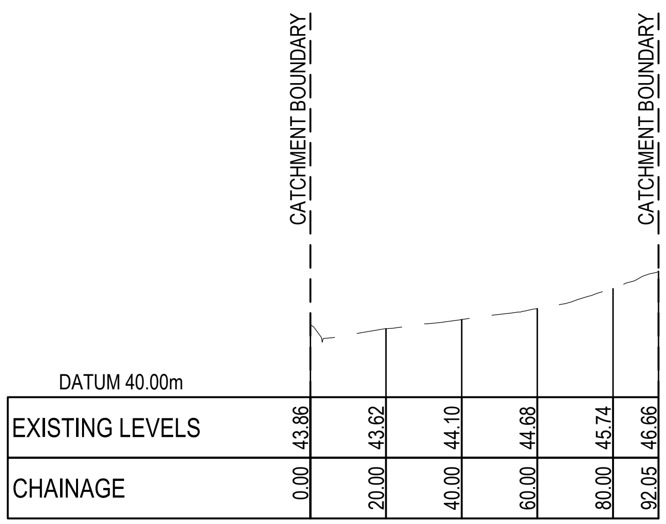
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-24
Rev	A



CATCHMENT XXV
SCALE: 1:1500 @ A3

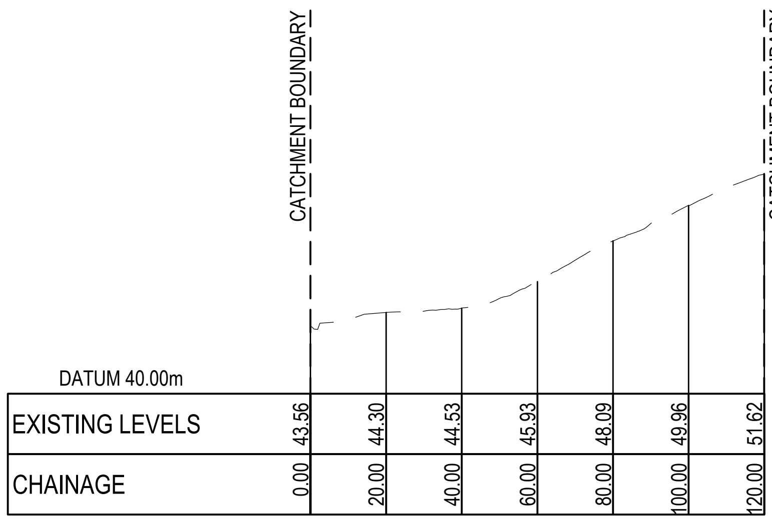
Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



EXISTING LEVELS	43.86	43.62	44.10	44.68	45.74	46.66
CHAINAGE	0.00	20.00	40.00	60.00	80.00	92.05

CS-CATCHMENT XXV
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	43.56	44.30	44.53	45.93	48.09	49.96	51.62
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00

LS-CATCHMENT XXV
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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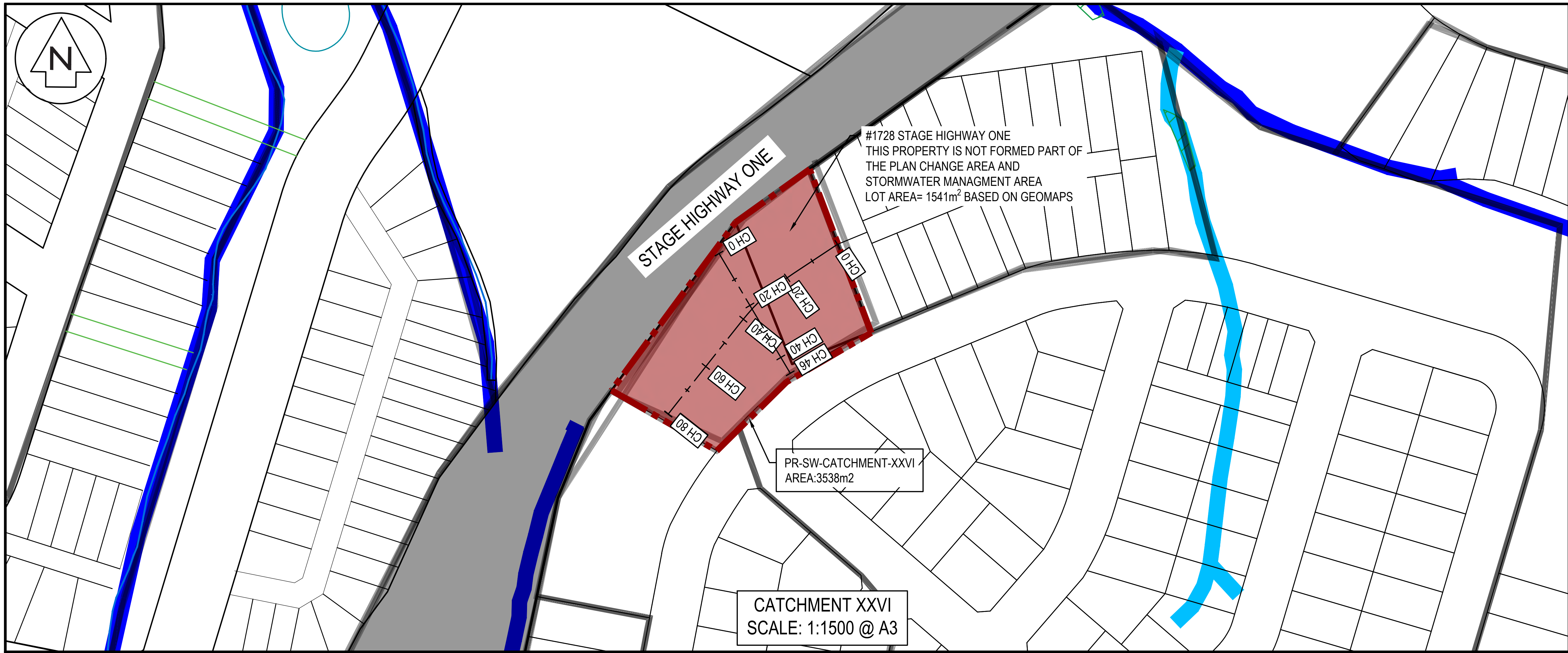
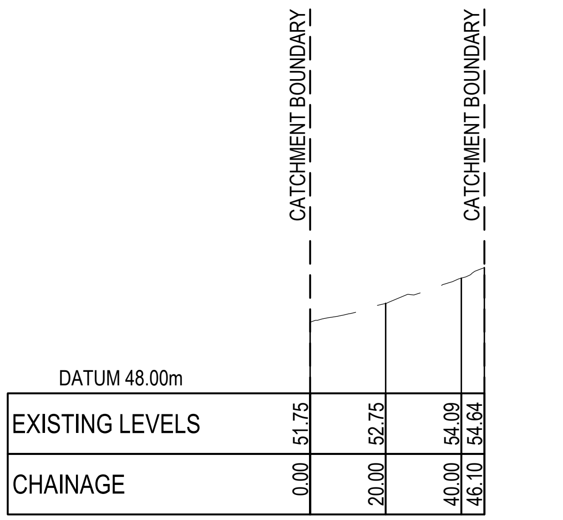
Title
POST DEVELOPMENT CATCHMENT XXV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-25 Rev A

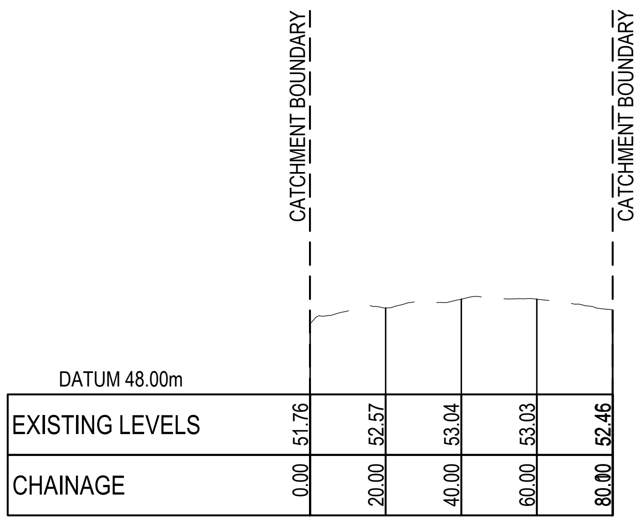


Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



CS-CATCHMENT XXVI
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT XXVI
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	DRAFT	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	DATE
Checked	LC	06/2023

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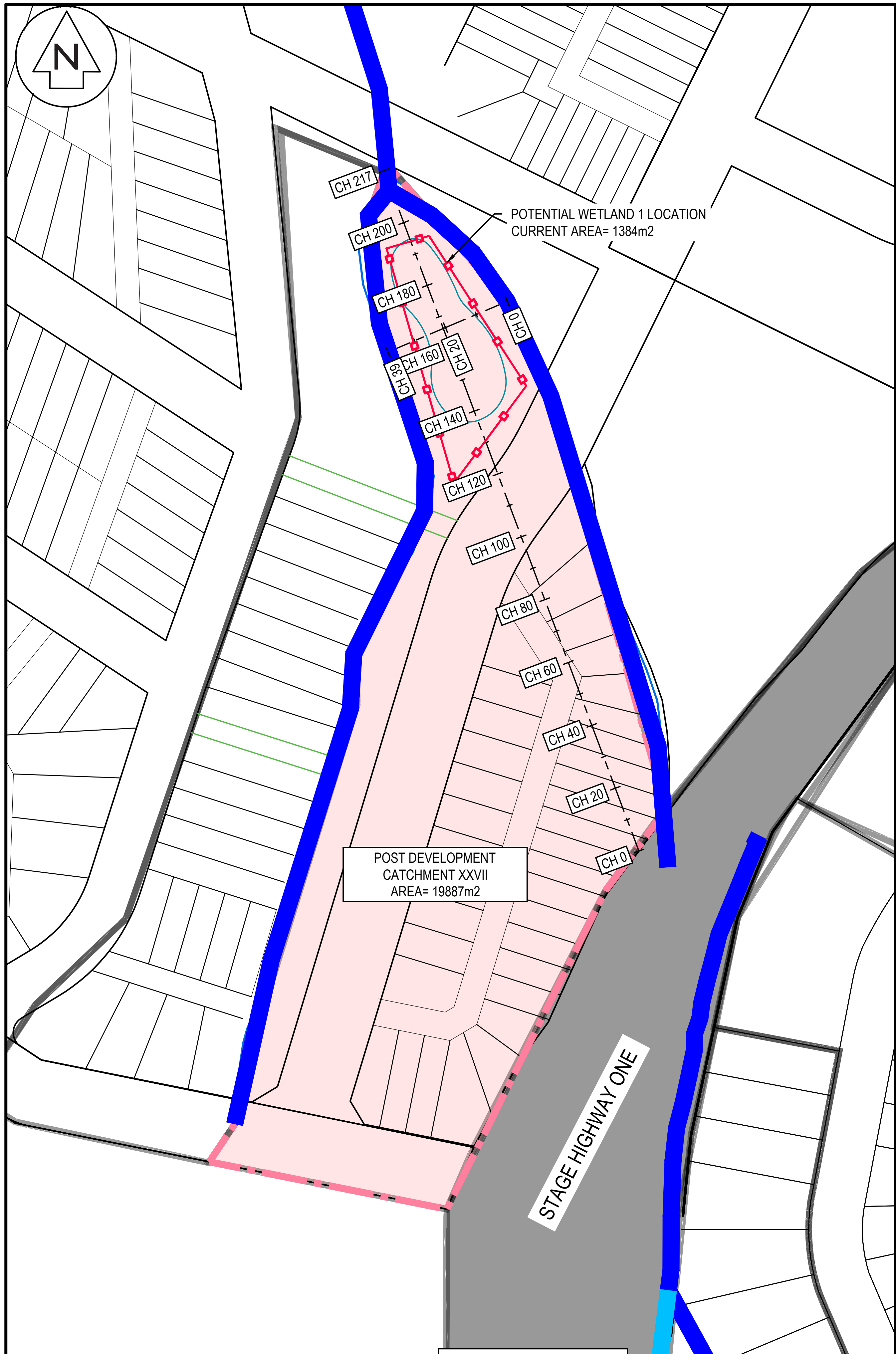
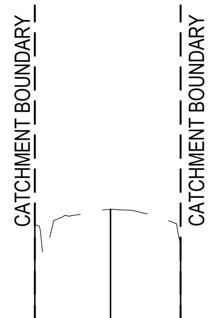
Title
POST DEVELOPMENT CATCHMENT XXVI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 1.DWG
Drawing no.	C471-26
Rev	A

DATE: 7/2023



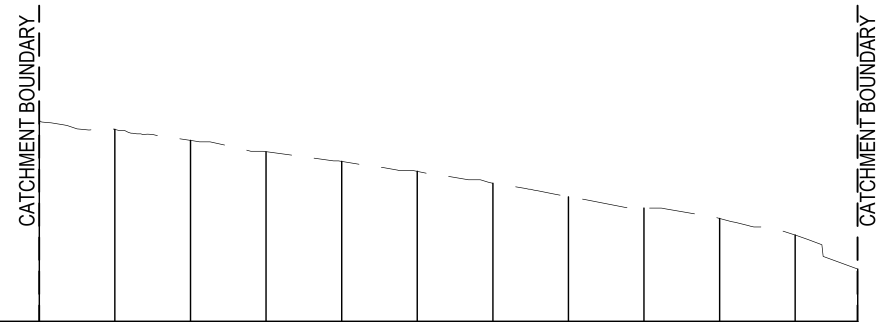
CATCHMENT XXVII
SCALE: 1:1500 @ A3



DATUM 36.00m

EXISTING LEVELS	41.12	41.94	40.03
CHAINAGE	0.00	20.00	38.57

CS-CATCHMENT XXVII
SCALE: HORI 1:2000 VERT 1:400



DATUM 36.00m

EXISTING LEVELS	46.63	46.16	45.58	44.98	44.47	43.94	43.31	42.59	42.00	41.45	40.57	38.78
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	216.55

LS-CATCHMENT XXVII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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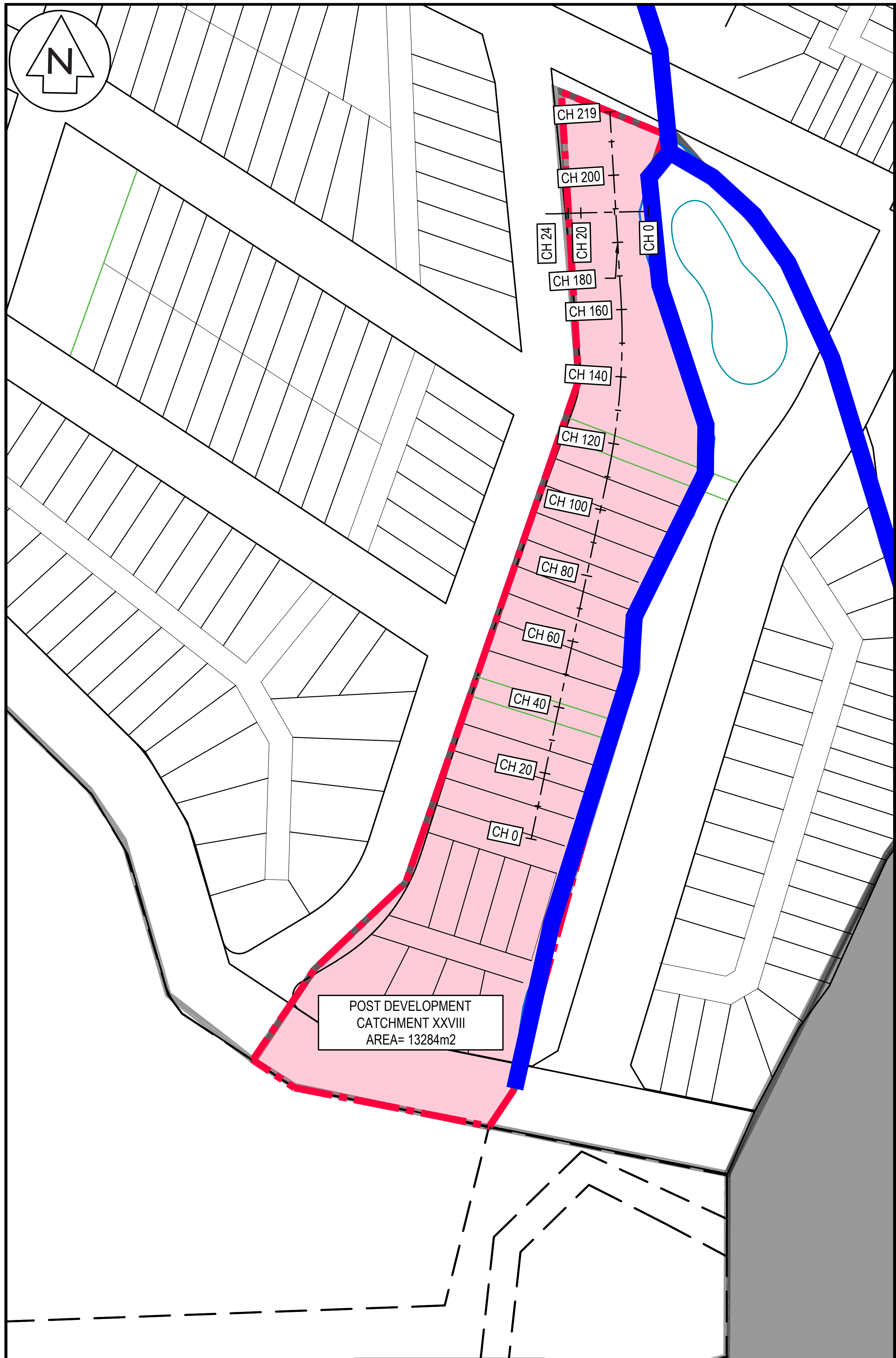
Title
POST DEVELOPMENT CATCHMENT XXVII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-27
Rev	A

DATE: 7/3/23



CATCHMENT XXVIII
SCALE: 1:1500 @ A3

CATCHMENT BOUNDARY

CATCHMENT BOUNDARY

DATUM 38.00m

EXISTING LEVELS	40.54	41.00	41.30
CHAINAGE	0.00	20.00	23.76

CS-CATCHMENT XXVIII
SCALE: HORI 1:2000 VERT 1:400

CATCHMENT BOUNDARY

DATUM 38.00m

EXISTING LEVELS	46.50	46.00	45.10	44.78	44.00	43.47	42.88	42.32	41.75	40.98	40.91	40.72
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	218.87

LS-CATCHMENT XXVIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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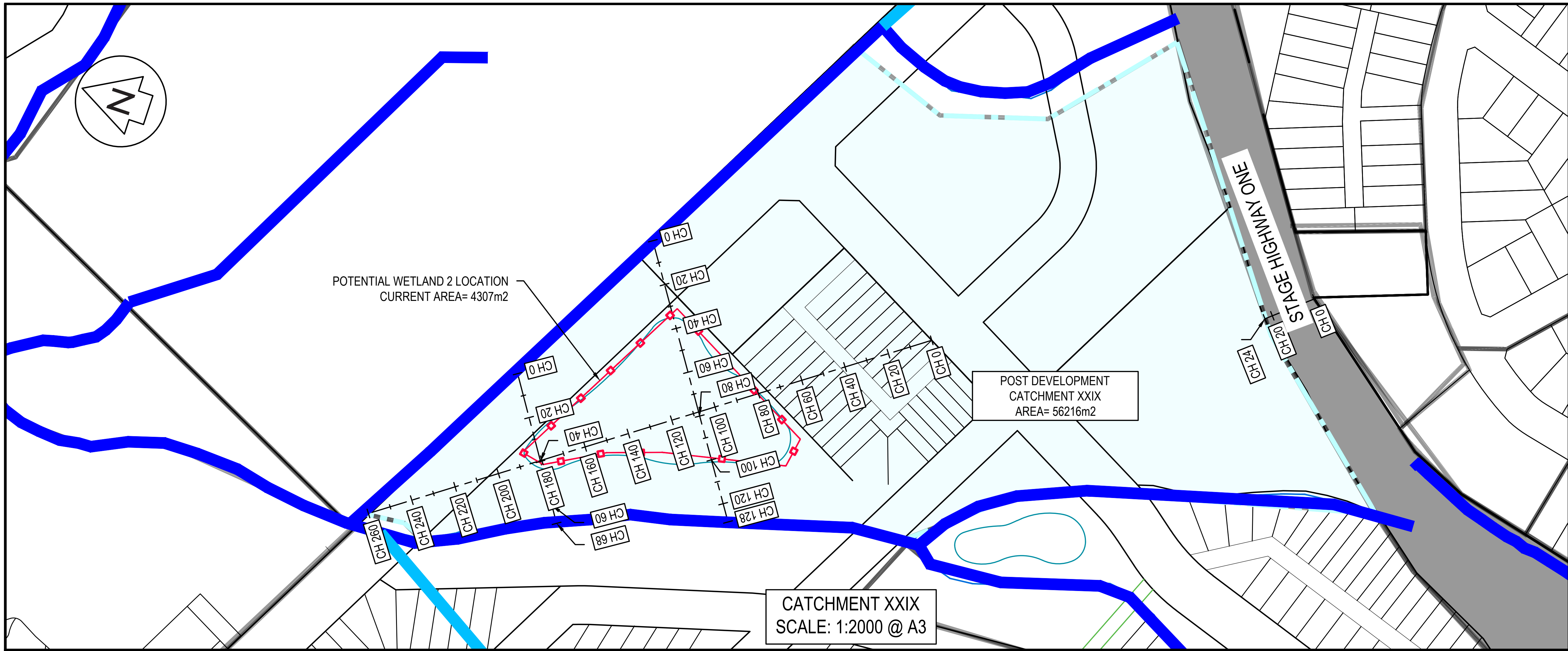
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXVIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-28
Rev	A



CATCHMENT XXIX
SCALE: 1:2000 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

CATCHMENT BOUNDARY — CATCHMENT BOUNDARY

DATUM 34.00m

EXISTING LEVELS	37.43	38.00	37.90	37.85	36.77
CHAINAGE	0.00	20.00	40.00	60.00	68.20

CS-CATCHMENT XXIX-1
SCALE: HORI 1:2000 VERT 1:400

CATCHMENT BOUNDARY — CATCHMENT BOUNDARY

DATUM 34.00m

EXISTING LEVELS	37.42	39.48	39.61	39.45	39.29	39.07	38.75	38.28
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	128.35

CS-CATCHMENT XXIX-2
SCALE: HORI 1:2000 VERT 1:400

CATCHMENT BOUNDARY

DATUM 34.00m

EXISTING LEVELS	40.71	40.37	40.00	39.91	39.41	39.00	38.79	38.50	38.20	37.92	37.56	37.46	37.17	36.05
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00

LS-CATCHMENT XXIX
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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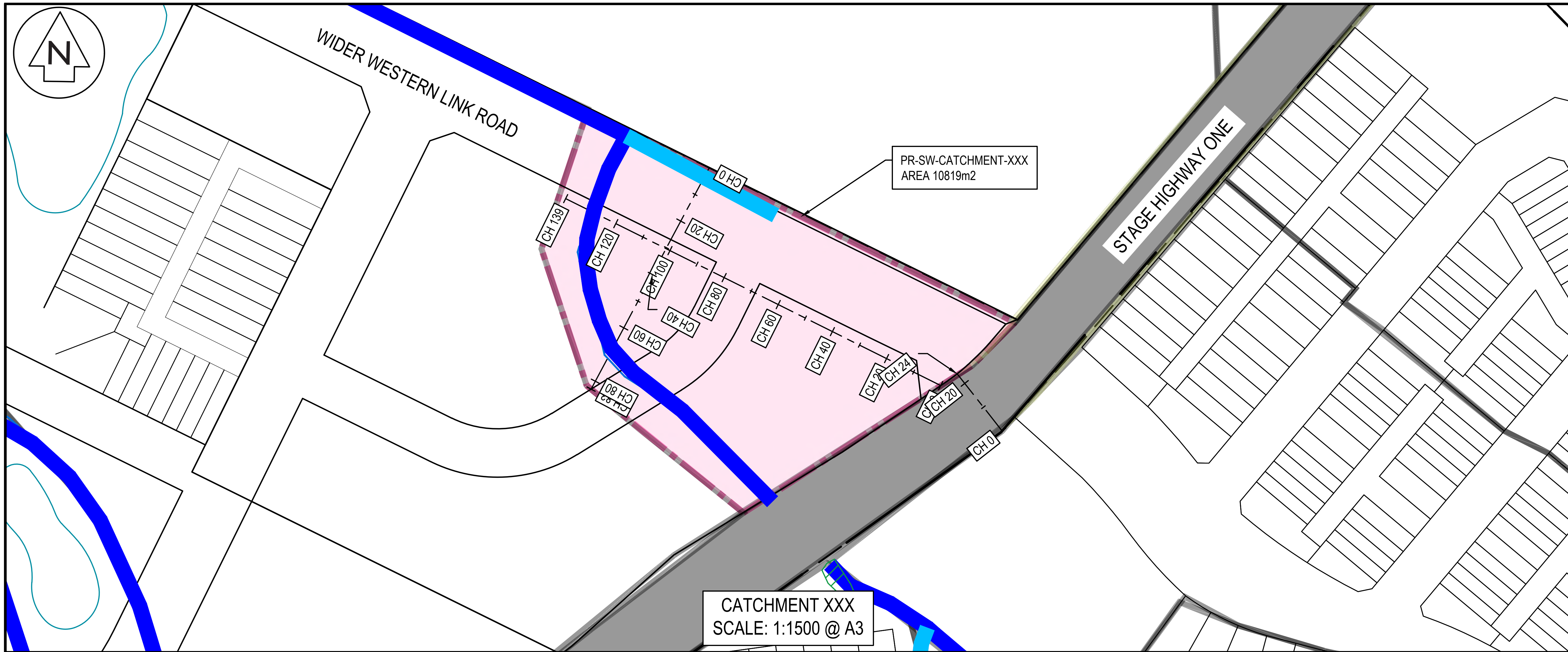
Title
POST DEVELOPMENT CATCHMENT XXIX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-29 — Rev A

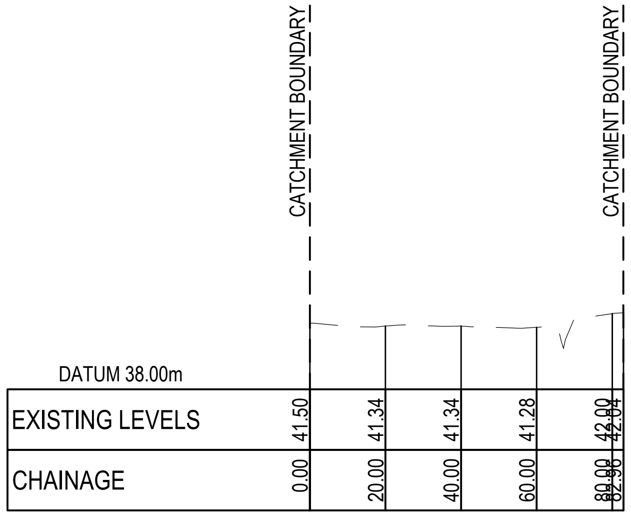
DATE: 7/3/23



Notes
1. All works to be in accordance with Auckland council standards.

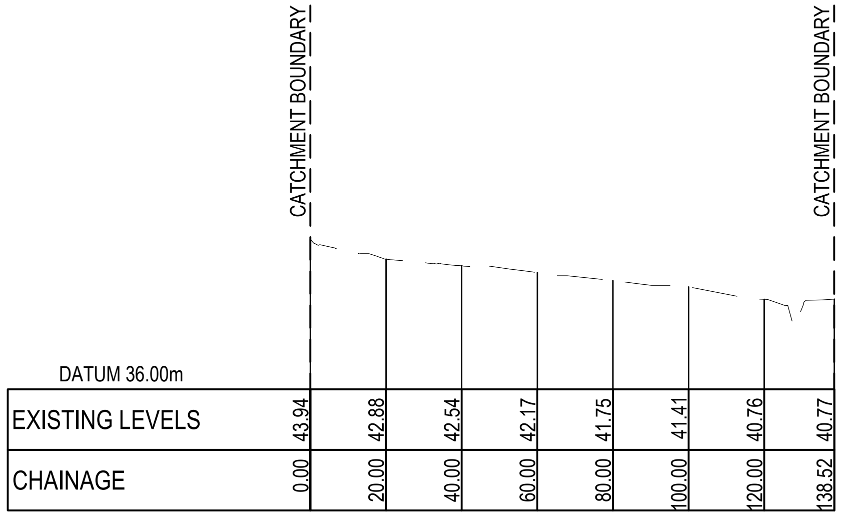
Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



EXISTING LEVELS	41.50	41.34	41.34	41.28	42.00 / 42.04
CHAINAGE	0.00	20.00	40.00	60.00	80.00 / 82.90

CS-CATCHMENT XXX
SCALE: HORI 1:2000 VERT 1:400



EXISTING LEVELS	43.94	42.88	42.54	42.17	41.75	41.41	40.76	40.77
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	138.52

LS-CATCHMENT XXX
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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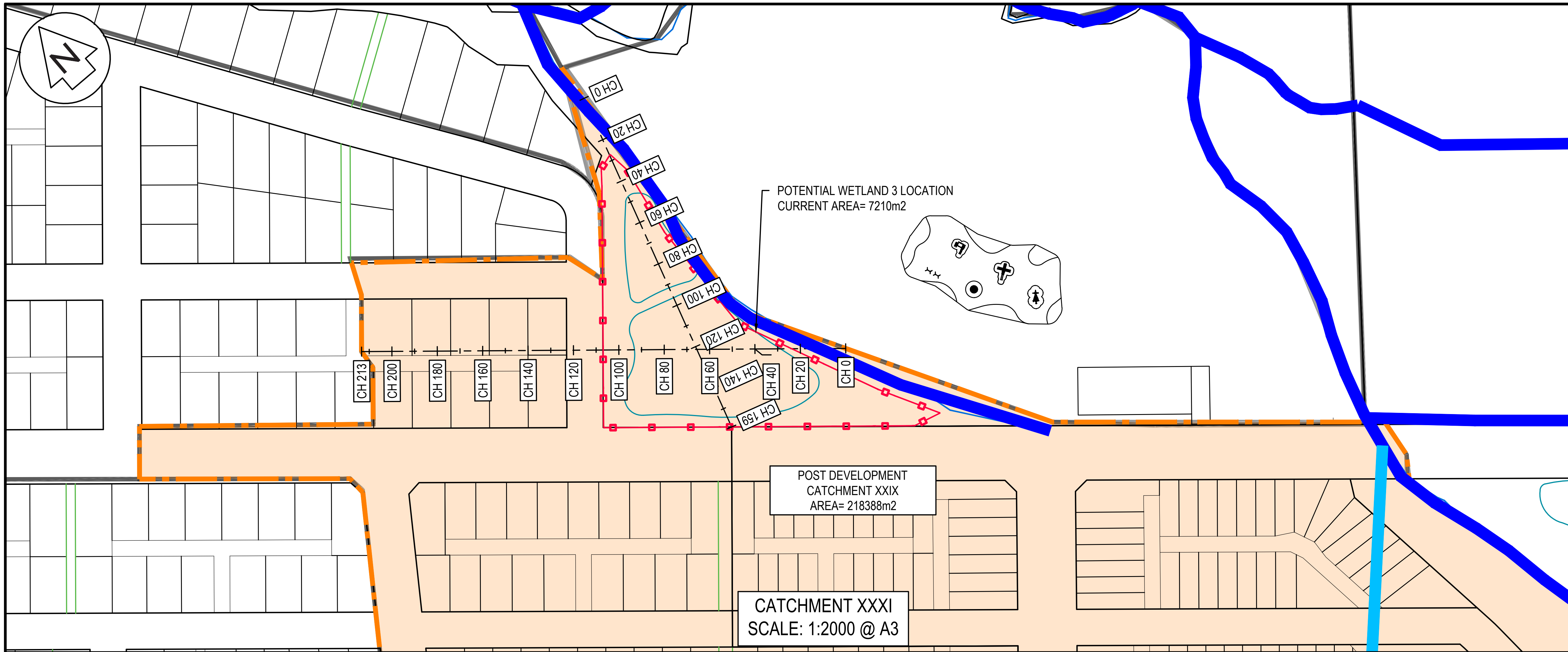
Title
POST DEVELOPMENT CATCHMENT XXX PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-30 — Rev A

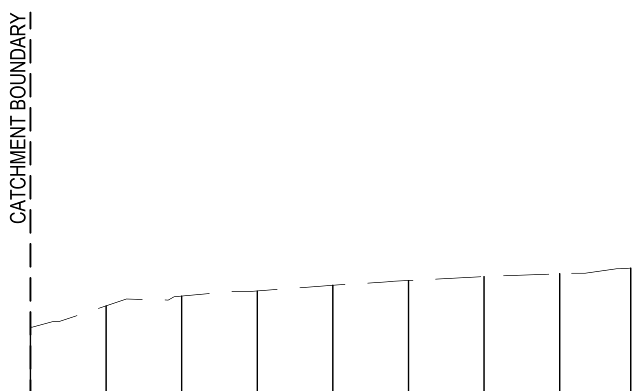
DATE: 7/3/23



Notes
1. All works to be in accordance with Auckland council standards.

Legend

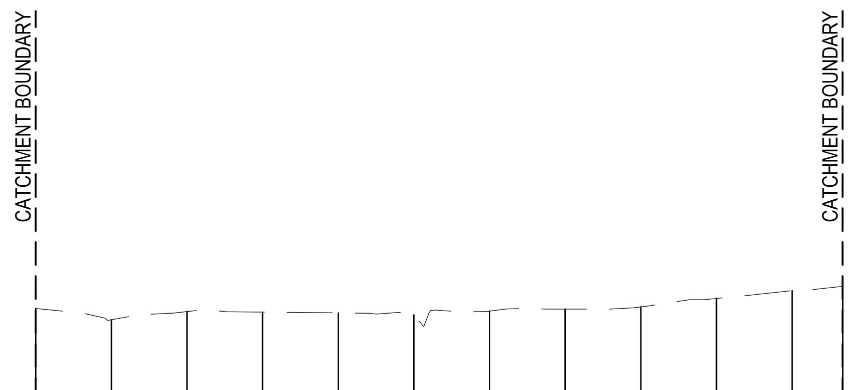
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 28.00m

EXISTING LEVELS	31.71	32.77	33.29	33.56	33.86	34.11	34.32	34.47	34.77
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	158.82

CS-CATCHMENT XXXI
SCALE: HORI 1:2000 VERT 1:400



DATUM 30.00m

EXISTING LEVELS	34.53	33.94	34.37	34.34	34.30	34.19	34.39	34.50	34.62	35.06	35.47	35.70
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	213.39

LS-CATCHMENT XXXI
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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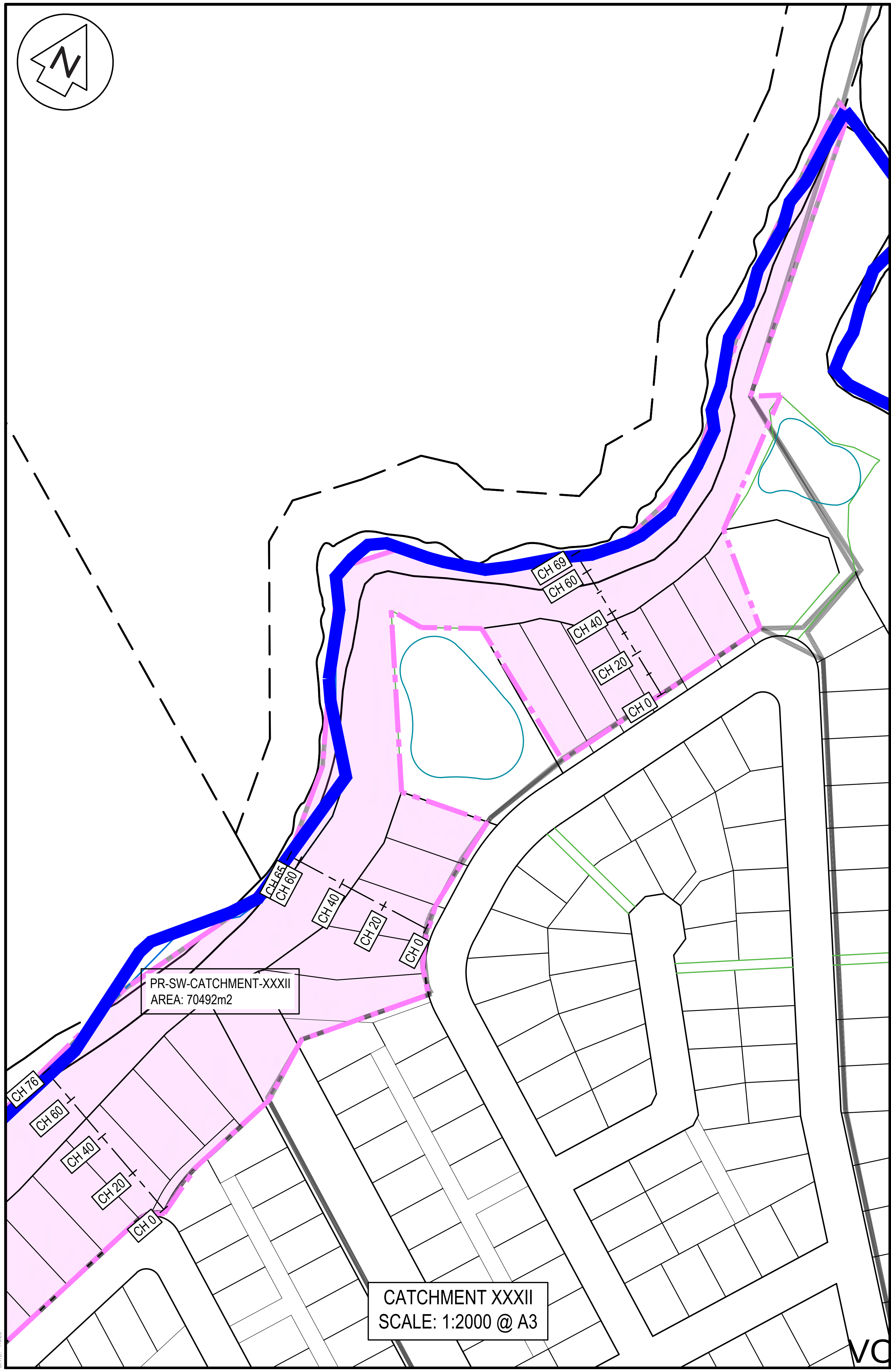
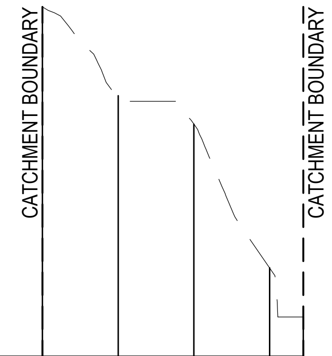
Title
POST DEVELOPMENT CATCHMENT XXXI PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-31
Rev	A



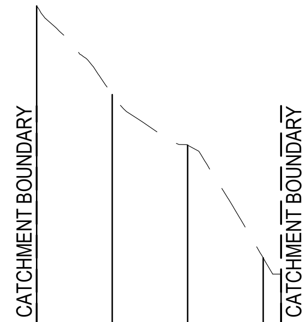
CATCHMENT XXXII
SCALE: 1:2000 @ A3



DATUM 18.00m

EXISTING LEVELS	36.49	31.80	30.29	22.69	20.09	
CHAINAGE	0.00	20.00	40.00	60.00	68.92	

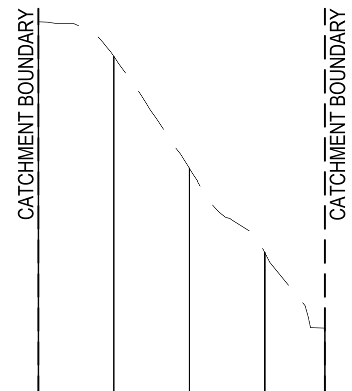
CS-CATCHMENT XXXII-1
SCALE: HORI 1:2000 VERT 1:400



DATUM 18.00m

EXISTING LEVELS	35.18	30.50	27.82	21.86	21.00
CHAINAGE	0.00	20.00	40.00	60.00	64.75

CS-CATCHMENT XXXII-2
SCALE: HORI 1:2000 VERT 1:400



DATUM 18.00m

EXISTING LEVELS	37.59	35.77	29.85	25.39	21.39
CHAINAGE	0.00	20.00	40.00	60.00	75.91

CS-CATCHMENT XXXII-3
SCALE: HORI 1:2000 VERT 1:400

Notes

1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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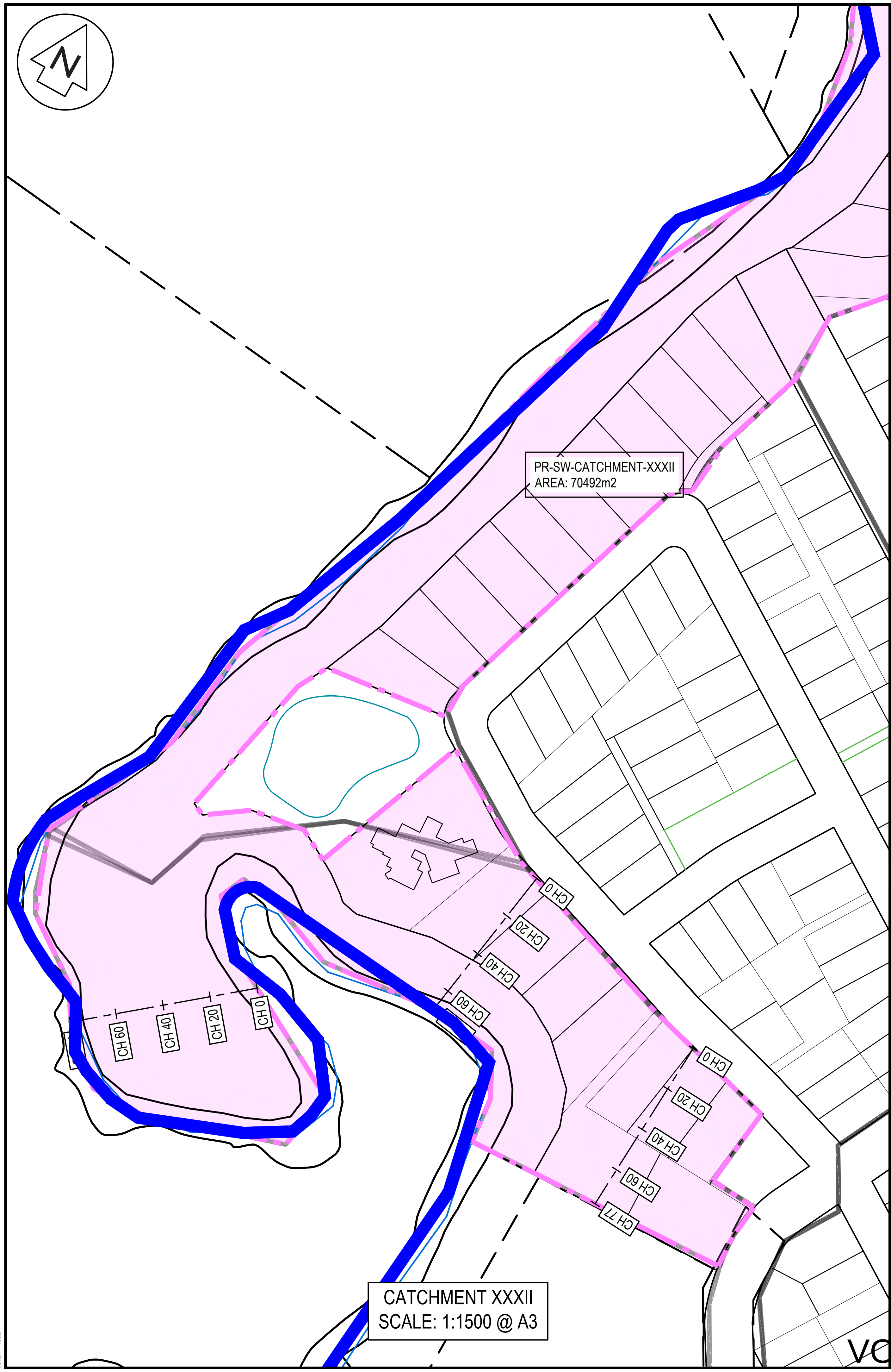
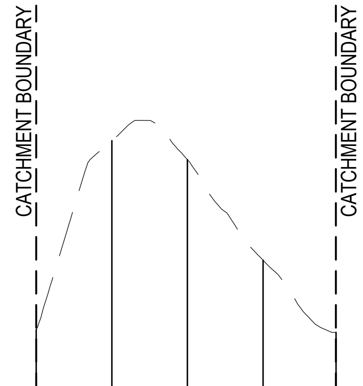
Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXXII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-32-1 Rev A



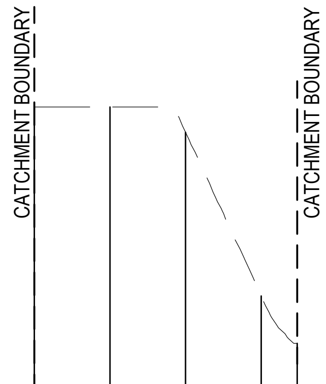
CATCHMENT XXXII
SCALE: 1:1500 @ A3



DATUM 22.00m

EXISTING LEVELS	25.14	35.14	34.14	28.82	25.00
CHAINAGE	0.00	20.00	40.00	60.00	79.30

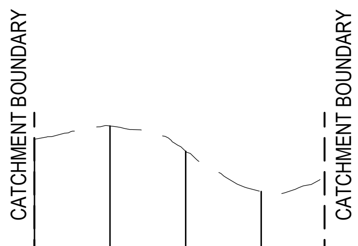
CS-CATCHMENT XXXII-4
SCALE: HORI 1:2000 VERT 1:400



DATUM 24.00m

EXISTING LEVELS	39.00	39.00	37.67	29.00	26.50
CHAINAGE	0.00	20.00	40.00	60.00	69.54

CS-CATCHMENT XXXII-5
SCALE: HORI 1:2000 VERT 1:400



DATUM 34.00m

EXISTING LEVELS	40.07	40.78	39.44	37.30	
CHAINAGE	0.00	20.00	40.00	60.00	76.78

CS-CATCHMENT XXXII-6
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
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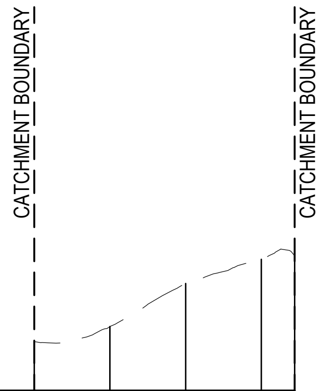
Title
POST DEVELOPMENT CATCHMENT XXXII PLAN

Project no.	211001		
Scale	AS SHOWN		
Cad file	203001- WETLAND ANALYSIS 2.DWG		
Drawing no.	C470-32-2	Rev	A

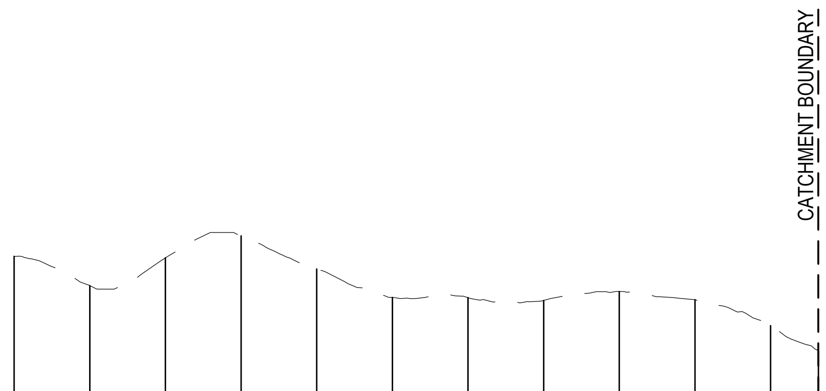
CATCHMENT XXXIII
SCALE: 1:2000 @ A3



DATUM 30.00m

EXISTING LEVELS	32.59	33.38	35.66	36.94	37.13
CHAINAGE	0.00	20.00	40.00	60.00	68.80

CS-CATCHMENT XXXIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 30.00m

EXISTING LEVELS	37.24	35.69	37.16	38.32	36.57	35.07	35.05	34.90	35.38	34.94	33.58	32.22
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	212.64

LS-CATCHMENT XXXIII
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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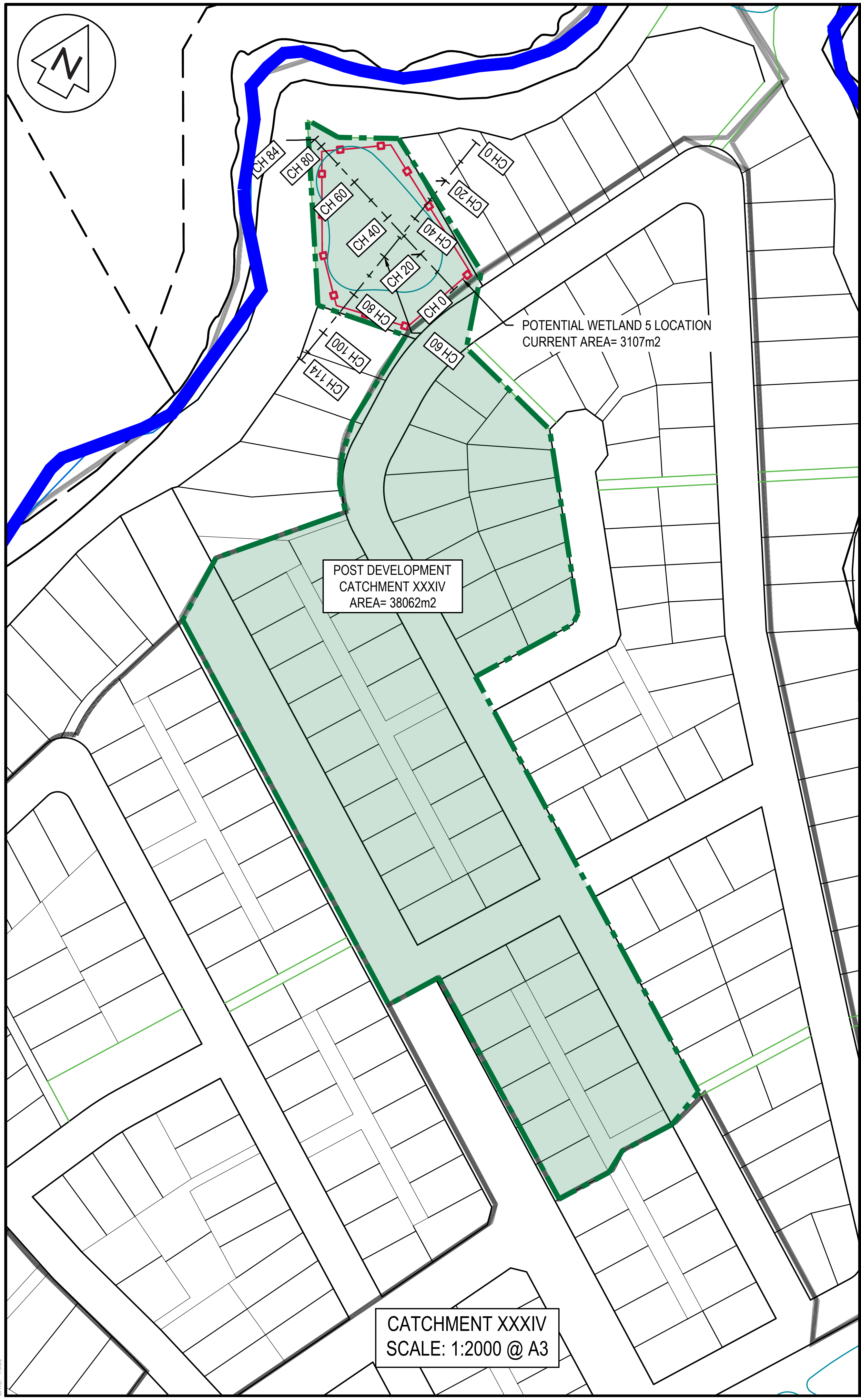
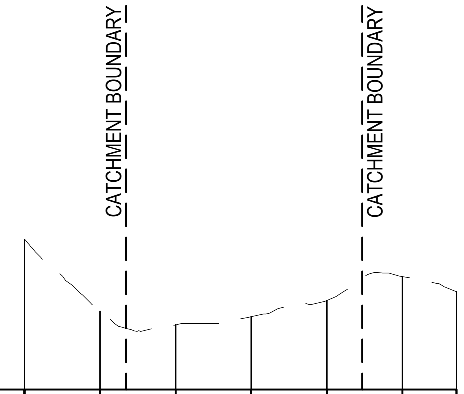
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT CATCHMENT XXXIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-33 Rev A

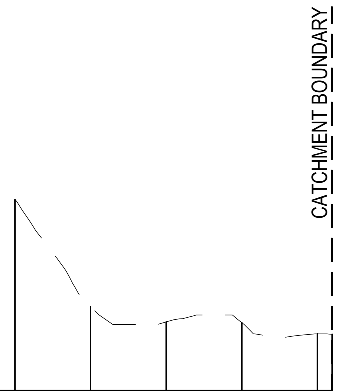




DATUM 22.00m

EXISTING LEVELS	29.93	26.14	25.42	25.85	26.71	27.97	27.17
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	114.31

CS-CATCHMENT XXXIV
SCALE: HORI 1:2000 VERT 1:400



DATUM 22.00m

EXISTING LEVELS	32.11	26.44	25.64	25.60	25.00	24.99
CHAINAGE	0.00	20.00	40.00	60.00	80.00	83.87

LS-CATCHMENT- XXXIV
SCALE: HORI 1:2000 VERT 1:400

Notes
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Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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Design	KH	05/2023
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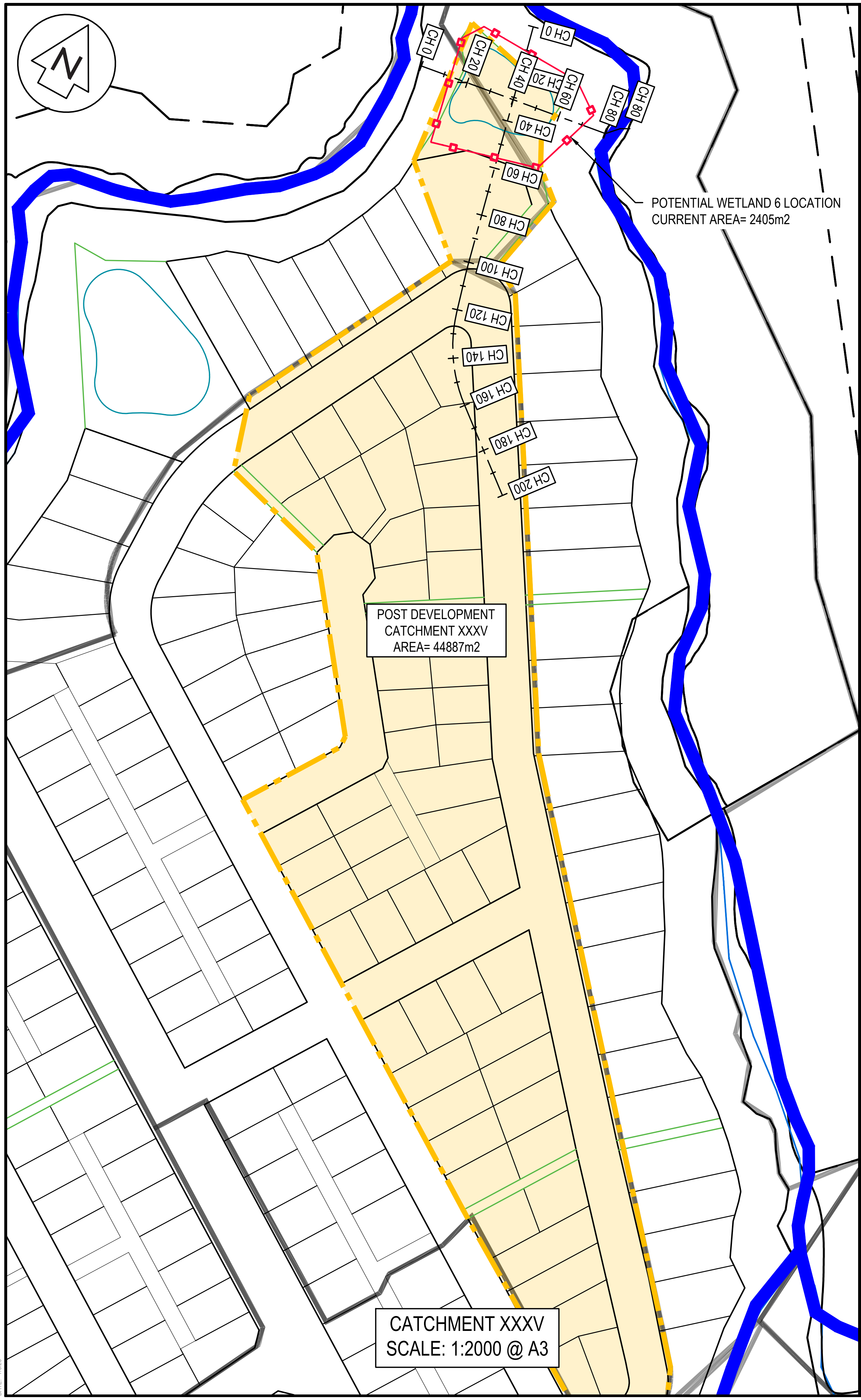
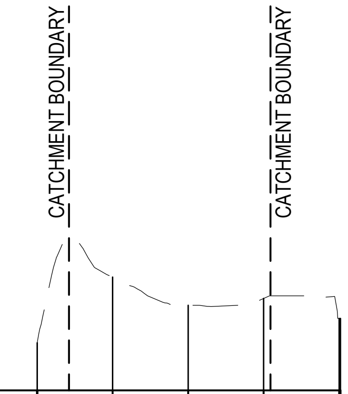
Title
POST DEVELOPMENT CATCHMENT XXXIV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-34
Rev	A



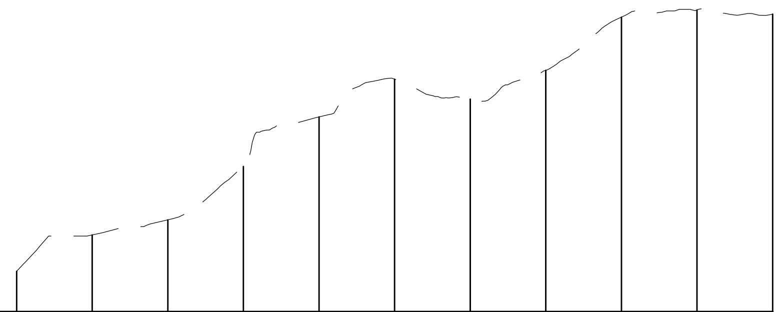
CATCHMENT XXXV
SCALE: 1:2000 @ A3



DATUM 20.00m

EXISTING LEVELS	22.52	25.99	24.50	24.86	23.80
CHAINAGE	0.00	20.00	40.00	60.00	80.00

CS-CATCHMENT XXXV
SCALE: HORI 1:2000 VERT 1:400



DATUM 20.00m

EXISTING LEVELS	22.14	24.06	24.86	27.68	30.31	32.30	31.25	32.77	35.59	35.97	35.74
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00

LS-CATCHMENT XXXV
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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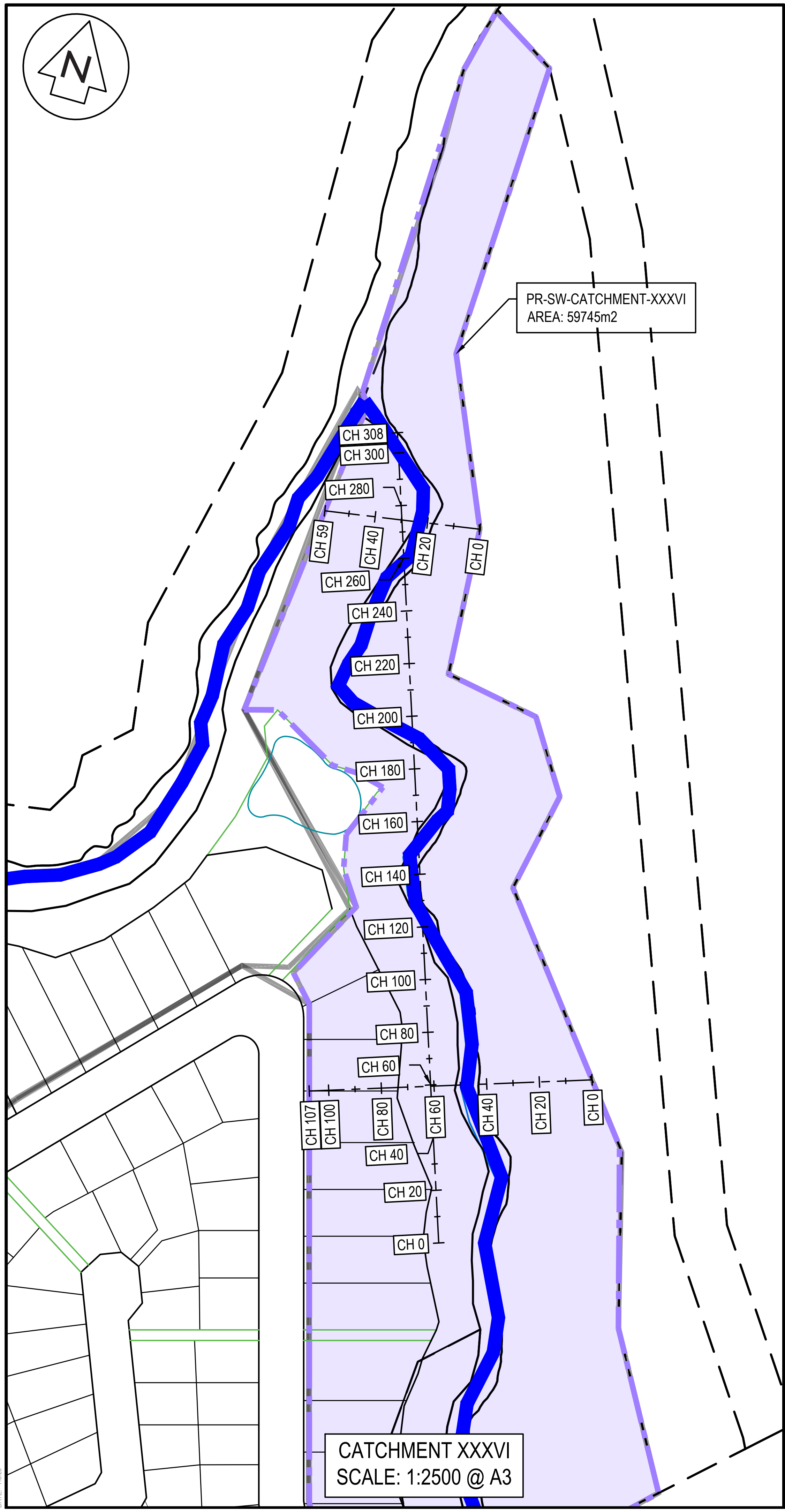
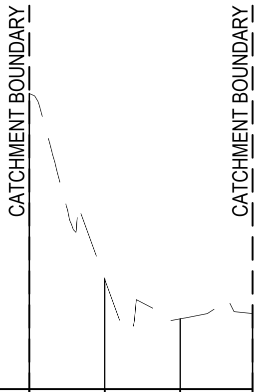
Title
POST DEVELOPMENT CATCHMENT XXXV PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-35
Rev	A

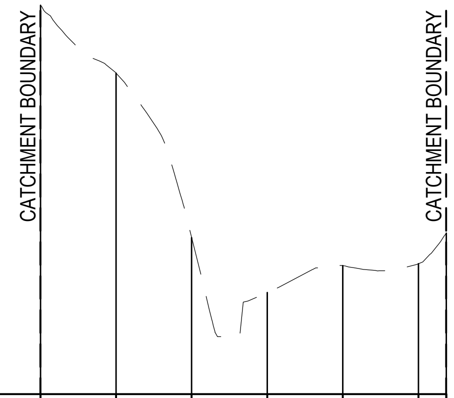




DATUM 20.00m

EXISTING LEVELS	35.64	25.82	23.72	24.00
CHAINAGE	0.00	20.00	40.00	59.21

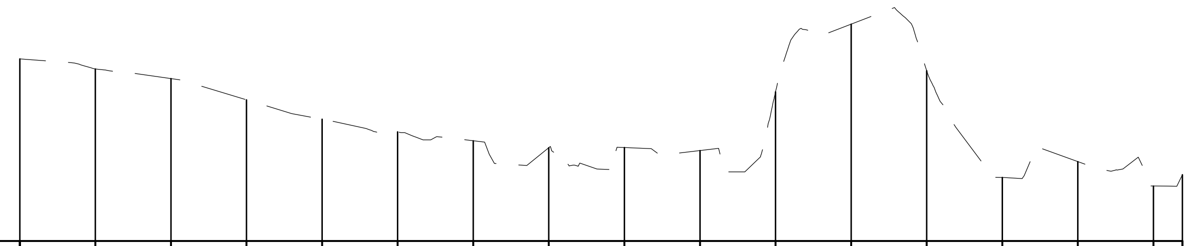
CS-CATCHMENT XXXVI-1
SCALE: HORI 1:2000 VERT 1:400



DATUM 22.00m

EXISTING LEVELS	42.58	38.99	30.28	27.38	28.80	28.90	30.52
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	107.36

C-CARTCHMENT XXXVI-2
SCALE: HORI 1:2000 VERT 1:400



DATUM 20.00m

EXISTING LEVELS	29.63	29.10	28.59	27.46	26.44	25.78	25.30	24.93	24.94	24.78	27.89	31.47	29.01	23.36	24.20	22.91	23.51
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	120.00	140.00	160.00	180.00	200.00	220.00	240.00	260.00	280.00	300.00	307.66

LS-CATCHMENT XXXVI
SCALE: HORI 1:2000 VERT 1:400

Notes
1. All works to be in accordance with Auckland council standards.

Legend

- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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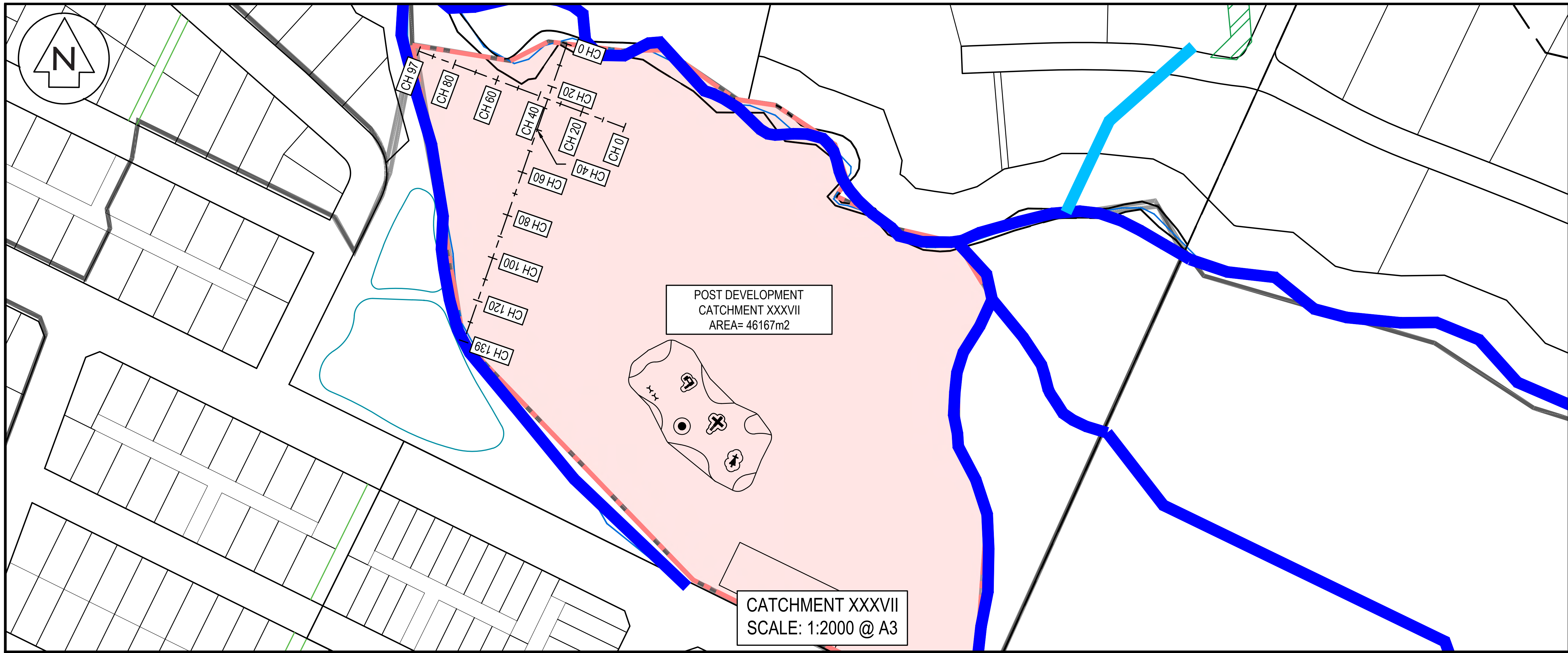
Title
POST DEVELOPMENT CATCHMENT XXXVI PLAN

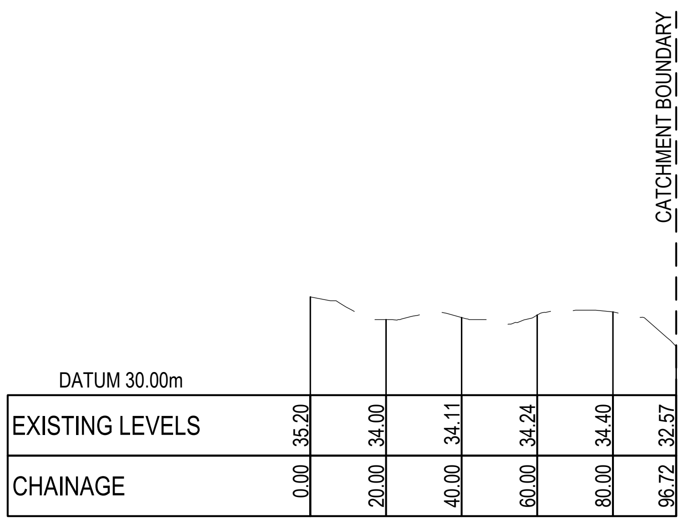
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-36 Rev A



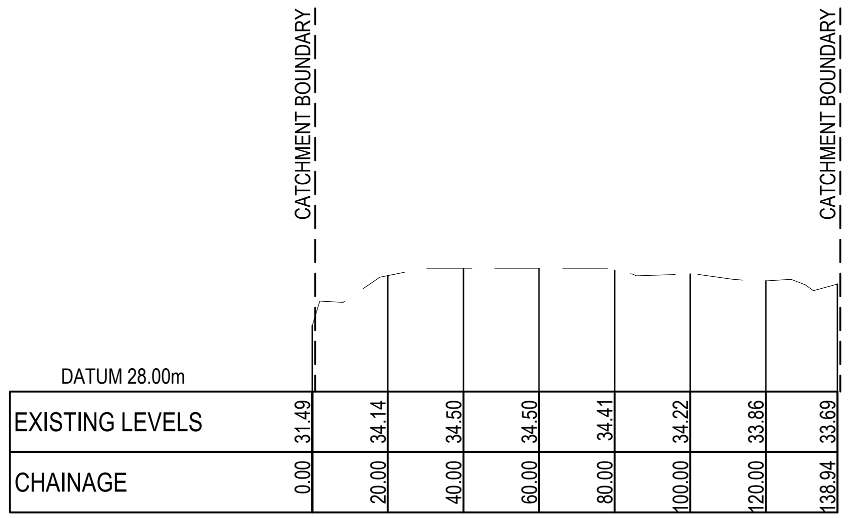
CATCHMENT XXXVII
SCALE: 1:2000 @ A3

Notes
1. All works to be in accordance with Auckland council standards.

Legend
EX BDY
EX PERM. STREAM
EX INTER. STREAM
EX WETLAND



CS-CATCHMENT XXXVII
SCALE: HORI 1:2000 VERT 1:400



LS-CATCHMENT XXXVII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

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Design	KH	05/2023
Drawn	LCH	06/2023
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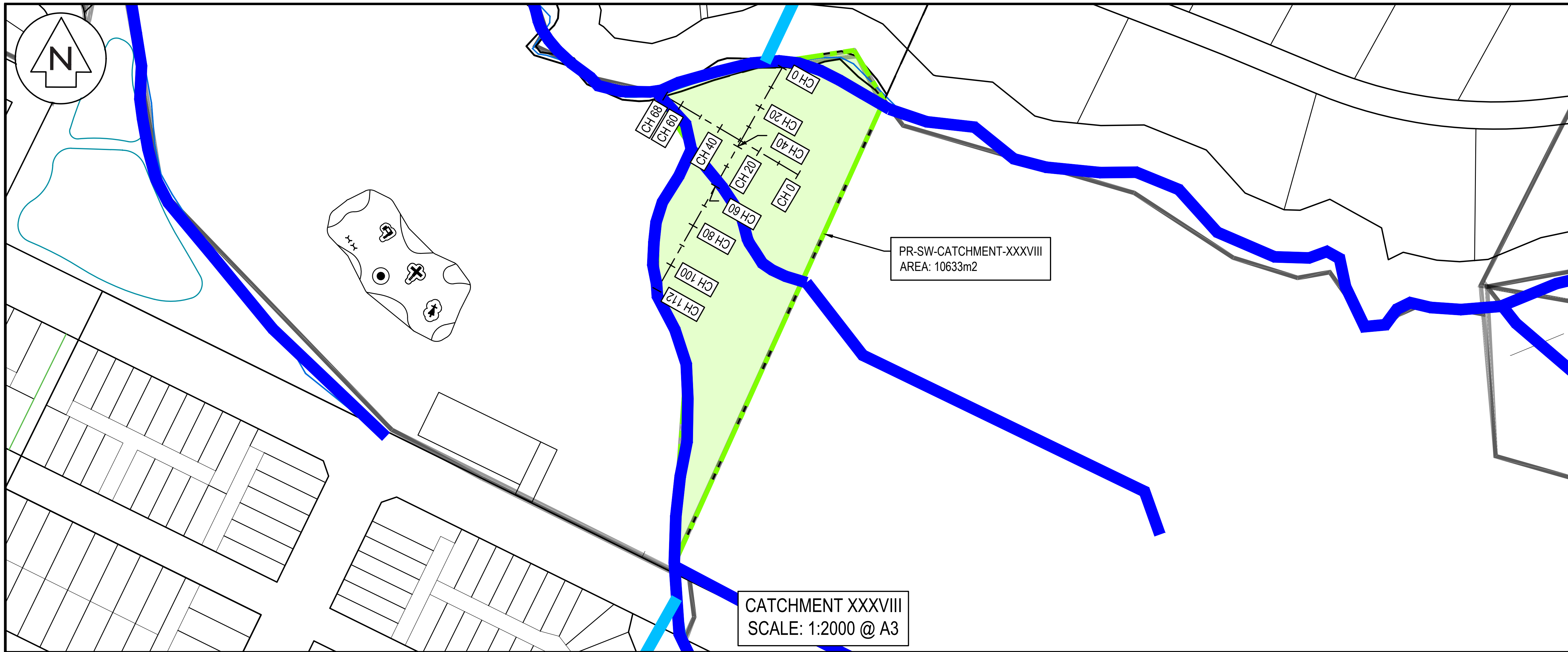
Title
POST DEVELOPMENT CATCHMENT XXXVII PLAN

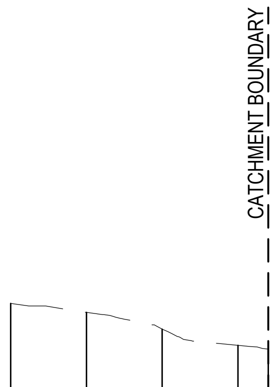
Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-37
Rev	A

DATE: 7/3/23



Notes
1. All works to be in accordance with Auckland council standards.

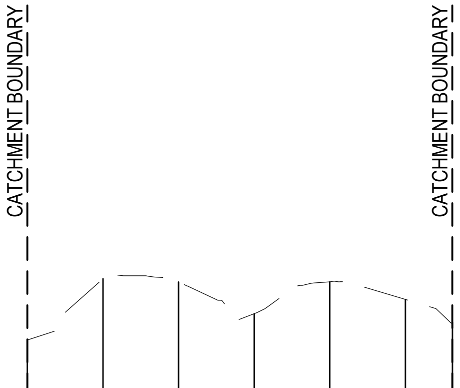
Legend
- EX BDY
- EX PERM. STREAM
- EX INTER. STREAM
- EX WETLAND



DATUM 32.00m

EXISTING LEVELS	36.64	36.17	35.28	34.42	34.22
CHAINAGE	0.00	20.00	40.00	60.00	68.03

CS-CATCHMENT XXXVIII
SCALE: HORI 1:2000 VERT 1:400



DATUM 30.00m

EXISTING LEVELS	32.61	35.85	35.67	34.00	35.68	34.75	33.55
CHAINAGE	0.00	20.00	40.00	60.00	80.00	100.00	112.45

LS-CATCHMENT XXXVIII
SCALE: HORI 1:2000 VERT 1:400

Rev	Description	By	Date
A	PPC RFI	LCH	06/2023

	By	Date
Survey	MH	03/2021
Design	KH	05/2023
Drawn	LCH	06/2023
Checked	LC	06/2023

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Title
POST DEVELOPMENT CATCHMENT XXXVIII PLAN

Project no.	211001
Scale	AS SHOWN
Cad file	203001- WETLAND ANALYSIS 2.DWG
Drawing no.	C470-38 Rev A

APPENDIX B – ENGINEERING CALCULATION

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 7/06/2023	Checked LC

Catchment	Area	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXVII	19887	277	298	24.56m(w)*54.56m(L)
Total	19887	277	298	1340 (m2)

F:\MAVEN\Projects\211001\Excel\pond sizing for whole catchment\221213 wetland 1.xlsx

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	1.9887	147.16
* from Appendix B		Totals =	1.9887	147.16

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{147.16}{1.989}$ = 74.0

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 1.9887}{1.989}$ 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{74.0}{200- \quad 74.0}$ = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.71 1.34 3.28 = 0.44 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.29 hrs

17.68 mins

OK

use

0.44 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.019887 km2(100ha =1km2)

   Runoff curve number CN= 74.0 (from worksheet 1)

   Initial abstraction Ia= 5.0 mm (from worksheet 1)

   Time of concentration tc= 0.44 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.033	0.022	0.091		
7. Peak flow rate, q_p=q*A*P_{24}	**0.028**	**0.013**	**0.348**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})$+S	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	215.66	108.80	2525.29		(m3)

Worksheet 2: Graphical Peak Flow Rate

F:\MAVEN\Projects\211001\Excel\pond sizing for whole catchment\221213 wetland 1.xlsx

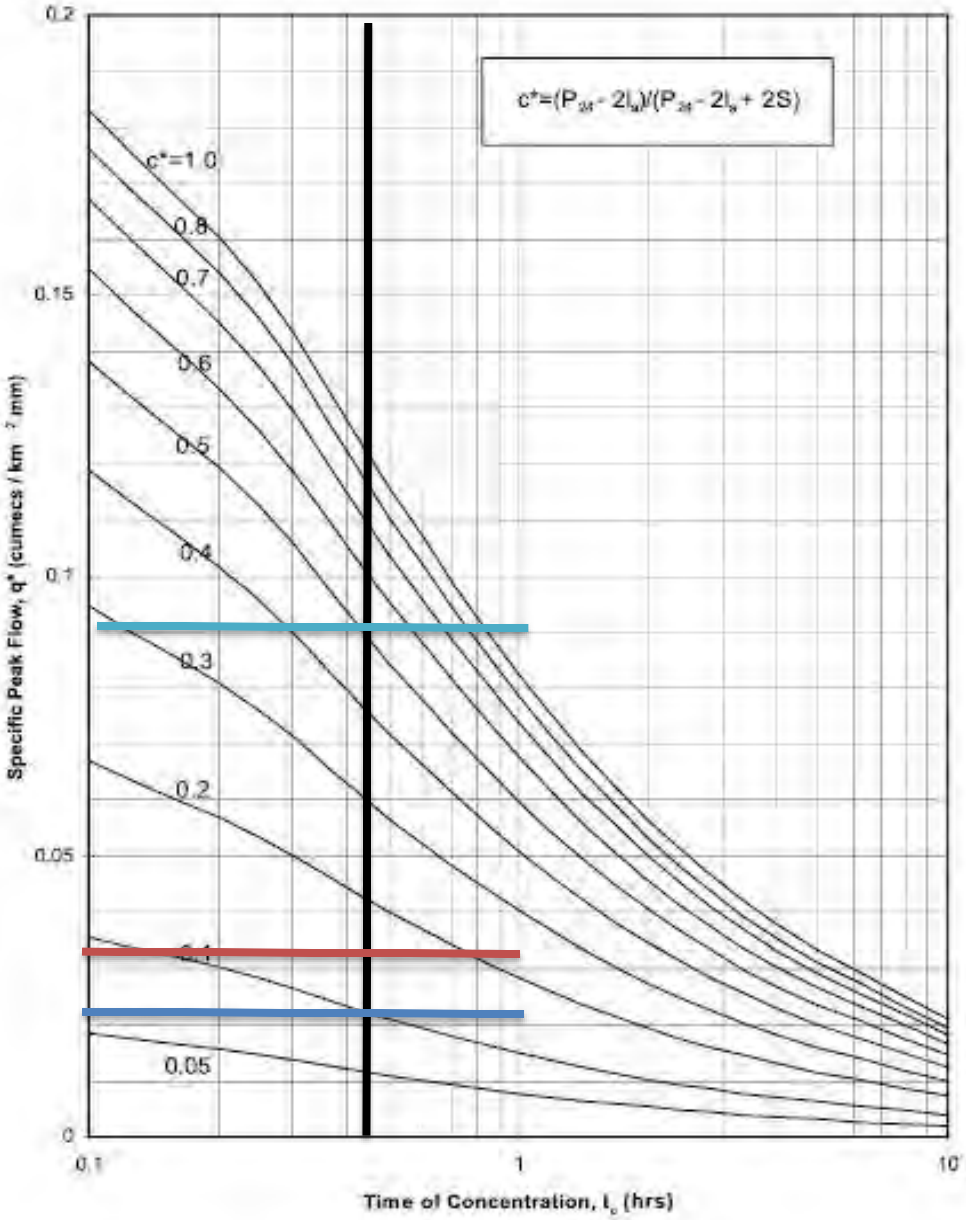

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001 0	Sheet 1	Rev A
Job Title WARKWORTH SOUTH PCA Calc Title WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	1.3921	136.42
C	Grass (landscape and gardens)	74	0.5966	44.15
* from Appendix B		Totals =	1.9887	180.57

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{180.57}{1.989} = 90.8$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 0.5966}{1.989}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.4 km (along drainage path)

Catchment Slope Sc= 0.025 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{90.8}{200 - 90.8} = 0.83$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.55 1.11 3.02 = 0.15 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.10 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 1 CATCHMENT XXVII	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.019887	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.110	0.091	0.155		
7. Peak flow rate, q_p=q*A*P_{24}	0.092	0.054	0.593		m3/s
PEAK FLOW RATE PRE DEV=	0.028	0.013	0.348		
PRE TO POST FLOW RATE=	**0.064**	**0.041**	**0.245**		
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	492.48	297.83	3346.21		(m3)
RUNOFF VOLUME PRE DEV=	215.66	108.80	2525.29		
PRE TO POST VOLUME=	**276.82**	**189.04**	**820.92**		

SMAF 1 retention volume =	**69.6**	m3	
SMAF 1 Detention volume =	**207.2**	m3	
Total SMAF 1 mitigation volume=	**276.8**	m3	
SMAF 2 post development run-off volume=	**297.8**	m3	= WQV
Wetland Based requirement is=	595.7	m2	= QWV/0.5m of maximum death storage depth
Wetand base measuremetn (1 in 3 shape)	15mx 45m= 675	m2	= width * length
SMAF 1 storage height=	0.41	m	= SMAF 1/ 675m2
Additonal space for SMAF 1 storage=	1.28	m	= side slope at 32% grade
additional space for maintanace track=	3.5	m	
final wetland size =	24.56m*54.56m= 1340m2		= (width+1.28*2+3.5*2)*(length+1.28*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXIX	56216	783	842	33.84m(w)*81.84m(L)
Total	56216	783	842	2769.5m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.6216	416.00
* from Appendix B		Totals =	5.6216	416.00

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{416.00}{5.622} = 74.0$

Ia (average) = $\frac{5 \text{ x pervious area}}{\text{total area}} = \frac{5 \text{ x } 5.6216}{5.622}$ = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.65 km (along drainage path)

Catchment Slope Sc= 0.013 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.0}{200 - 74.0} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.75 1.34 3.68 = 0.52 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.35 hrs

20.88 mins

OK

use

0.52 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area A= 0.056216 km2(100ha =1km2)

Runoff curve number CN= 74.0 (from worksheet 1)

Initial abstraction Ia= 5.0 mm (from worksheet 1)

Time of concentration tc= 0.52 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.030	0.020	0.084		
7. Peak flow rate, q_p=q*A*P_{24}	**0.071**	**0.034**	**0.909**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	609.61	307.55	7138.41		(m3)

Worksheet 2: Graphical Peak Flow Rate

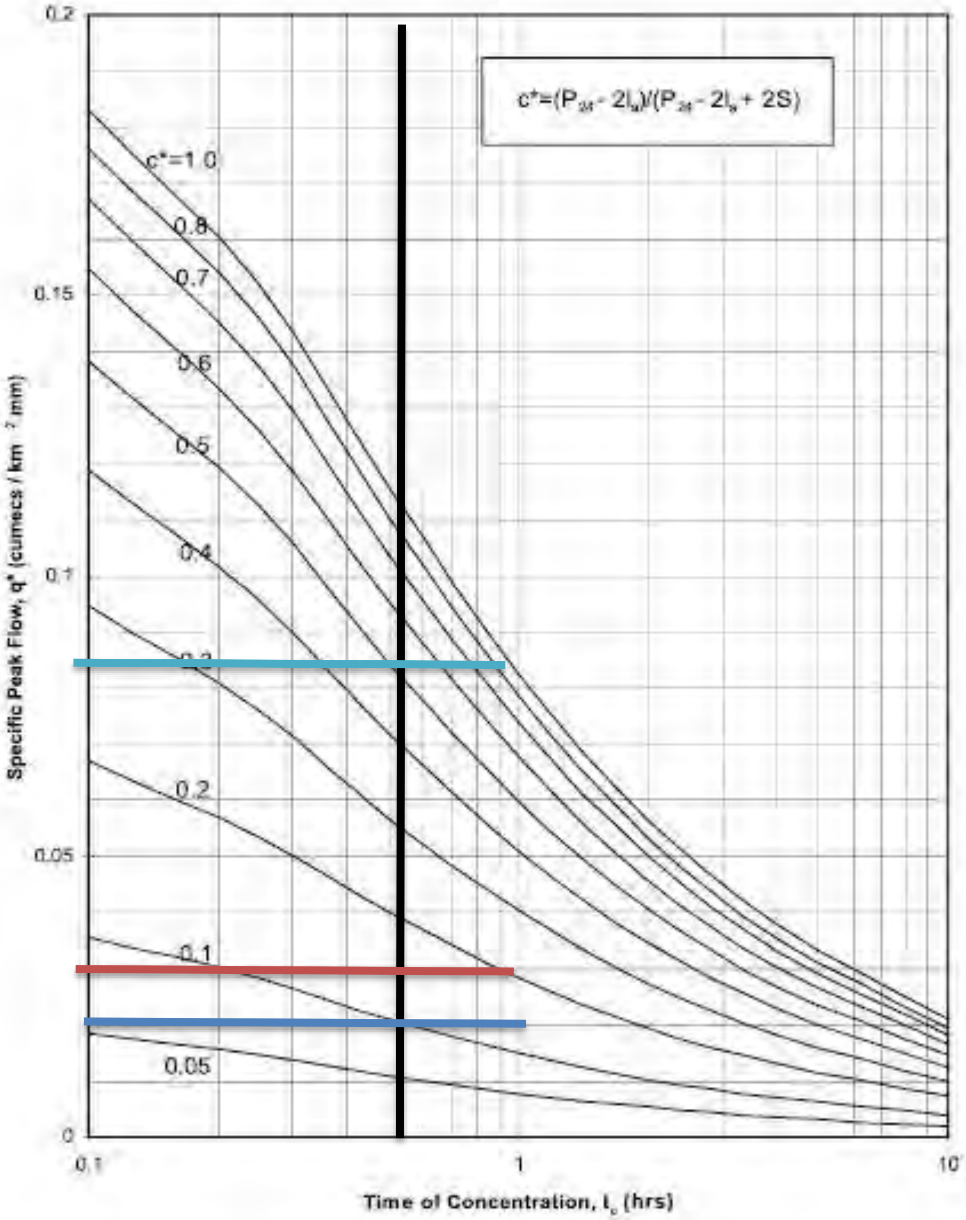

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	3.9351	385.64
C	Grass (landscape and gardens)	74	1.6865	124.80
* from Appendix B		Totals =	5.6216	510.44

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{510.44}{5.622} = 90.8$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 1.6865}{5.622}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.45 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{90.8}{200- 90.8} = 0.83$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.59 1.11 3.19 = 0.17 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.12 hrs

4.26 mins

OK

use

0.1749077 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 2 CATCHMENT XXIX	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.056216	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.109	0.091	0.155		
7. Peak flow rate, q_p=q*A*P_{24}	0.257	0.153	1.677		m3/s
PEAK FLOW RATE PRE DEV=	0.071	0.034	0.909		
PRE TO POST FLOW RATE=	**0.187**	**0.120**	**0.768**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	1392.12	841.91	9458.96		(m3)
RUNOFF VOLUME PRE DEV=	609.61	307.55	7138.41		
PRE TO POST VOLUME=	**782.51**	**534.36**	**2320.55**		

SMAF 1 retention volume =	**196.8** m3		
SMAF 1 Detention volume =	**585.8** m3		
Total SMAF 1 mitigation volume=	**782.5** m3		
SMAF 2 post development run-off volume=	**841.9** m3	=	WQV
Wetland Based requirement is=	1683.8 m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	24mx 72m= 1728 m2	=	width * length
SMAF 1 storage height=	0.45 m	=	SMAF 1/ 1728m2
Additonal space for SMAF 1 storage=	1.42 m	=	side slope at 32% grade
additional space for maintanace track=	3.5 m		
final wetland size =	33.84m*81.84m= 2769.5m2	=	(width+1.42*2+3.5*2)* (length+1.42*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

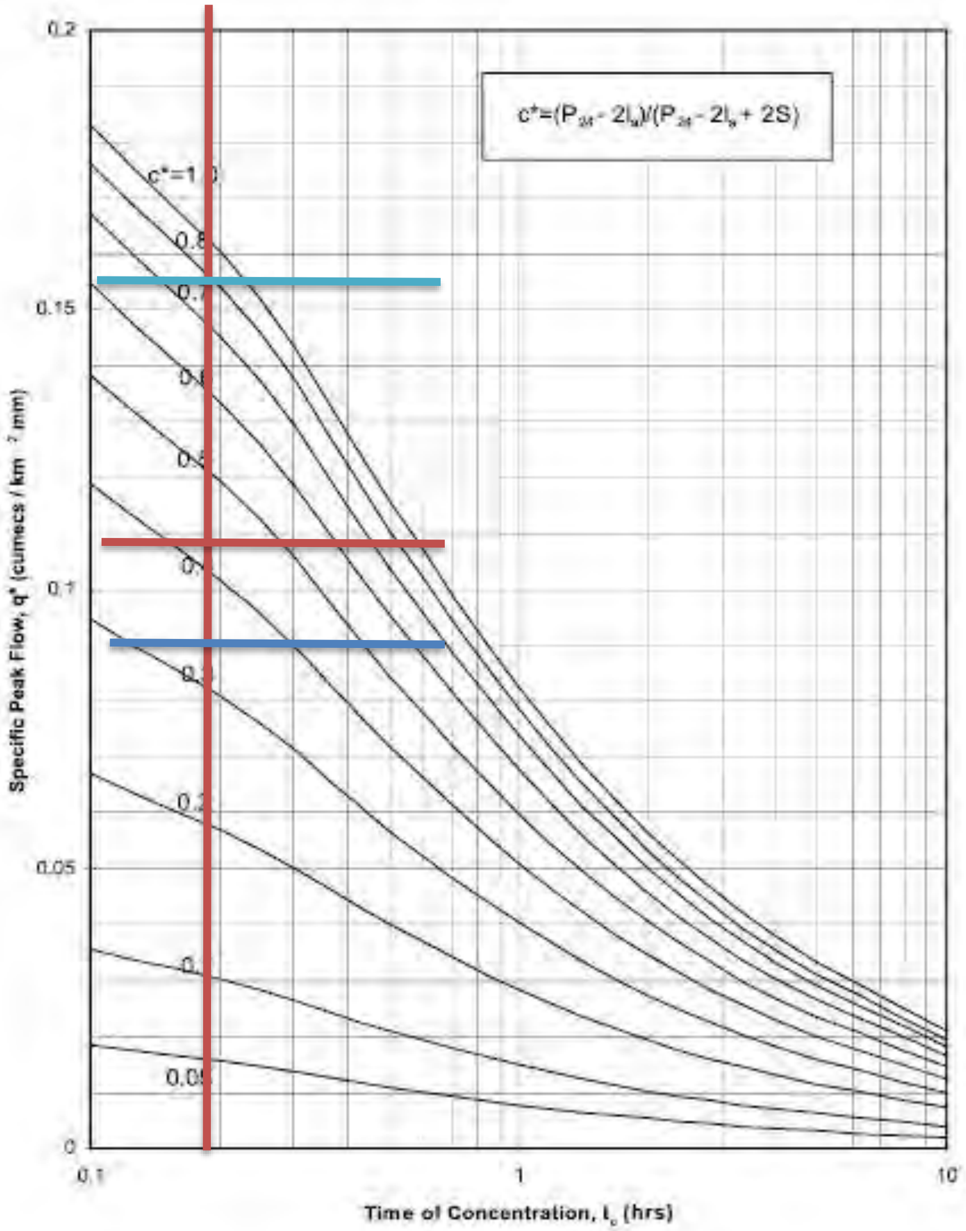

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXI	218388	3040	3271	56.86m (W)*150.86m(L)
Total	218388	3040	3271	8577.9m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	21.8388	1616.07
* from Appendix B		Totals =	21.8388	1616.07

CN (weighted) = total product / total area = 1616.07 / 21.839 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 21.8388 / 21.839 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.5 km (along drainage path)

Catchment Slope Sc= 0.012 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.31 1.34 3.77 = 0.92 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.62 hrs

37.15 mins

OK

use

0.92 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

1. Data
   - Catchment Area A= 0.218388 km2(100ha =1km2)
   - Runoff curve number CN= 74.0 (from worksheet 1)
   - Initial abstraction Ia= 5.0 mm (from worksheet 1)
   - Time of concentration tc= 0.92 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.024	0.015	0.064		
7. Peak flow rate, q_p=q*A*P_{24}	**0.220**	**0.098**	**2.690**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	2368.23	1194.75	27731.32		(m3)

Worksheet 2: Graphical Peak Flow Rate

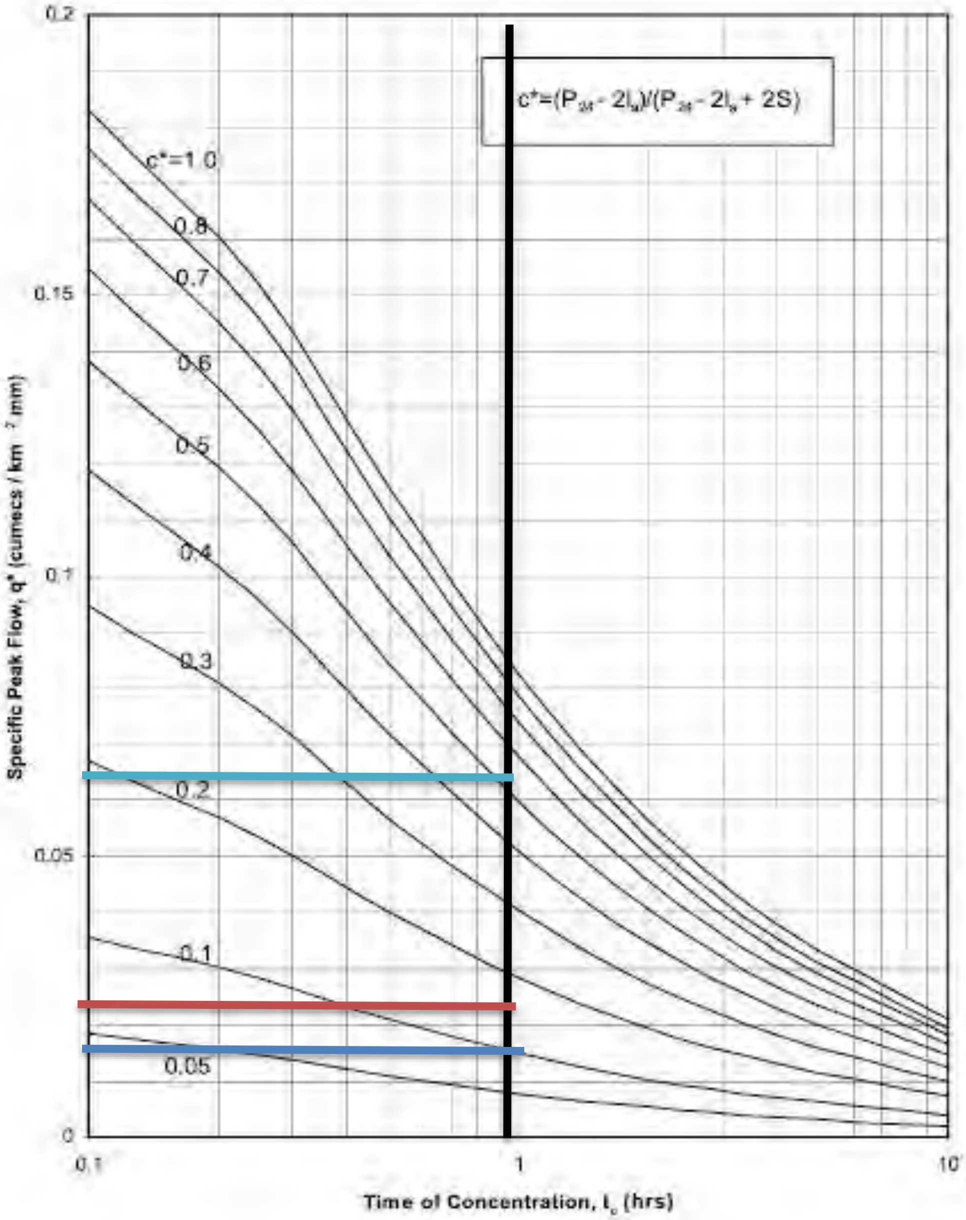

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	15.2872	1498.14
C	Grass (landscape and gardens)	74	6.5516	484.82
* from Appendix B		Totals =	21.8388	1982.96

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1982.96}{21.839} = 90.8$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 6.5516}{21.839}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{90.8}{200 - 90.8} = 0.83$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 1.00 1.11 3.28 = 0.31 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.20 hrs

4.26 mins

OK

use

0.3053012 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 3 CATCHMENT XXXI	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.218388	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.31	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.095	0.078	0.135		
7. Peak flow rate, q_p=q*A*P_{24}	0.871	0.511	5.674		m3/s
PEAK FLOW RATE PRE DEV=	0.220	0.098	2.690		
PRE TO POST FLOW RATE=	**0.651**	**0.413**	**2.984**		
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})$+S	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	5408.13	3270.64	36746.20		(m3)
RUNOFF VOLUME PRE DEV=	2368.23	1194.75	27731.32		
PRE TO POST VOLUME=	**3039.89**	**2075.89**	**9014.88**		

SMAF 1 retention volume =	**764.4**	m3		
SMAF 1 Detention volume =	**2275.5**	m3		
Total SMAF 1 mitigation volume=	**3039.9**	m3		
SMAF 2 post development run-off volume=	**3270.6**	m3		
Wetland Based requirement is=	6541.3	m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	47mx 141m= 6627	m2	=	width * length
SMAF 1 storage height=	0.46	m	=	SMAF 1/ 6627m2
Additonal space for SMAF 1 storage=	1.43	m	=	side slope at 32% grade
additional space for maintanace track=	3.5	m		
final wetland size =	56.86m*150.86m= 8577.9r		=	(width+1.43*2+3.5*2)* (length+1.43*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

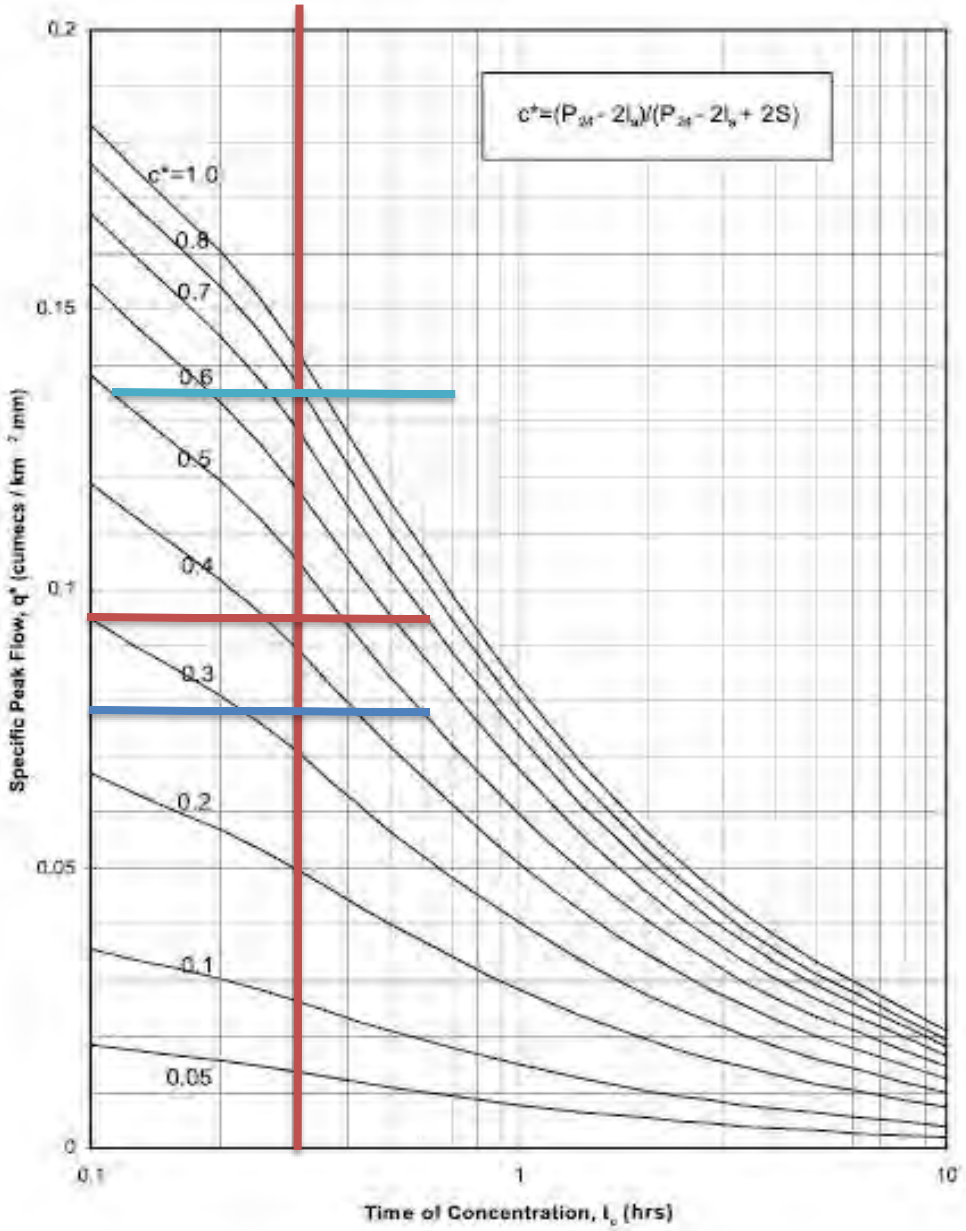

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title Calc Title WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXIV	57295	798	858	33.84m(w)*81.84m(L)
Total	57295	798	858	2769.5m2

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MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.7295	423.98
* from Appendix B		Totals =	5.7295	423.98

CN (weighted) = total product / total area = 423.98 / 5.730 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.7295 / 5.730 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.7 km (along drainage path)

Catchment Slope Sc= 0.032 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.79 1.34 2.81 = 0.42 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.28 hrs

16.74 mins

OK

use

0.42 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA / WETLAND SIZING CALCULATION / WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area A= 0.057295 km2(100ha =1km2)

Runoff curve number CN= 74.0 (from worksheet 1)

Initial abstraction Ia= 5.0 mm (from worksheet 1)

Time of concentration tc= 0.42 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.035	0.022	0.094		
7. Peak flow rate, q_p=q*A*P_{24}	**0.084**	**0.038**	**1.036**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	621.32	313.45	7275.43		(m3)

Worksheet 2: Graphical Peak Flow Rate

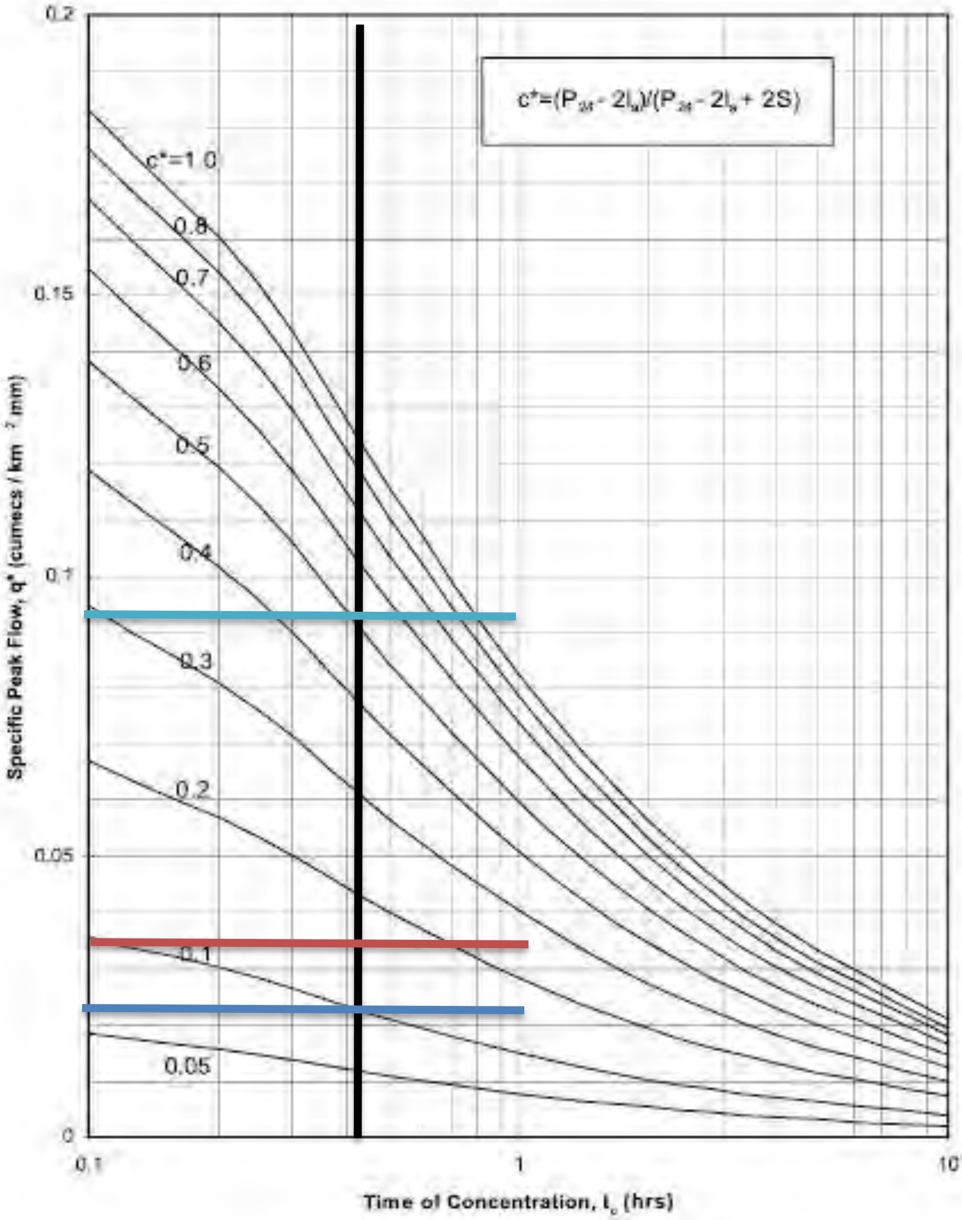

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	4.0107	393.04
C	Grass (landscape and gardens)	74	1.7189	127.19
* from Appendix B		Totals =	5.7295	520.24

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{520.24}{5.730}$ = 90.8

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 1.7189}{5.730}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.45 km (along drainage path)

Catchment Slope Sc= 0.049 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{90.8}{200-90.8}$ = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.59 1.11 2.47 = 0.14 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.09 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 4 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.057295	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.110	0.090	0.156		
7. Peak flow rate, q_p=q*A*P_{24}	0.265	0.155	1.720		m3/s
PEAK FLOW RATE PRE DEV=	0.084	0.038	1.036		
PRE TO POST FLOW RATE=	**0.180**	**0.117**	**0.684**		
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	1418.84	858.07	9640.52		(m3)
RUNOFF VOLUME PRE DEV=	621.32	313.45	7275.43		
PRE TO POST VOLUME=	**797.53**	**544.62**	**2365.09**		

SMAF 1 retention volume =	**200.5**	m3		
SMAF 1 Detention volume =	**597.0**	m3		
Total SMAF 1 mitigation volume=	**797.5**	m3		
SMAF 2 post development run-off volume=	**858.1**	m3		
Wetland Based requirement is=	1716.1	m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	24mx72m = 1728	m2	=	width * length
SMAF 1 storage height=	0.46	m	=	SMAF 1/ 1728m2
Additonal space for SMAF 1 storage=	1.44	m	=	side slope at 32% grade
additional space for maintanace track=	3.5	m		
final wetland size =	33.84m*81.84m= 2769.5m		=	(length+1.42*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

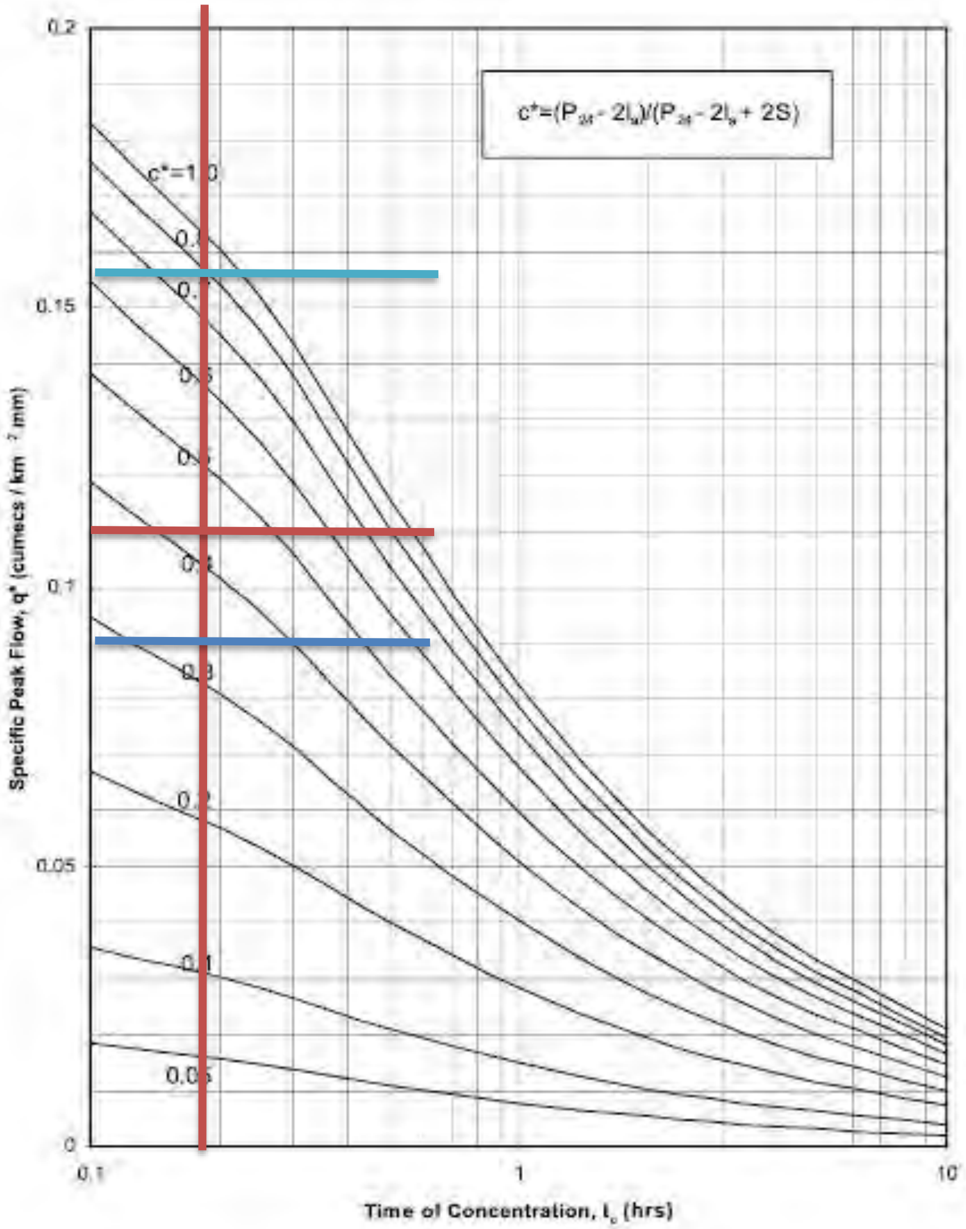

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXIV	38062	530	570	29.76m(w)*69.76m(L)
Total	38062	530	570	2076m2

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	3.8062	281.66
* from Appendix B		Totals =	3.8062	281.66

CN (weighted) = total product = / total area = 281.66 / 3.806 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 3.8062 / 3.806 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.65 km (along drainage path)

Catchment Slope Sc= 0.0165 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.0 / 200- 74.0 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.75 1.34 3.43 = 0.48 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.32 hrs

19.44 mins

OK
use
0.48 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

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MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data
   - Catchment Area A= 0.038062 km2(100ha =1km2)
   - Runoff curve number CN= 74.0 (from worksheet 1)
   - Initial abstraction Ia= 5.0 mm (from worksheet 1)
   - Time of concentration tc= 0.48 hrs (from worksheet 1)
2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.032	0.022	0.087		
7. Peak flow rate, q_p=q*A*P_{24}	**0.051**	**0.025**	**0.637**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	412.75	208.23	4833.18		(m3)

Worksheet 2: Graphical Peak Flow Rate

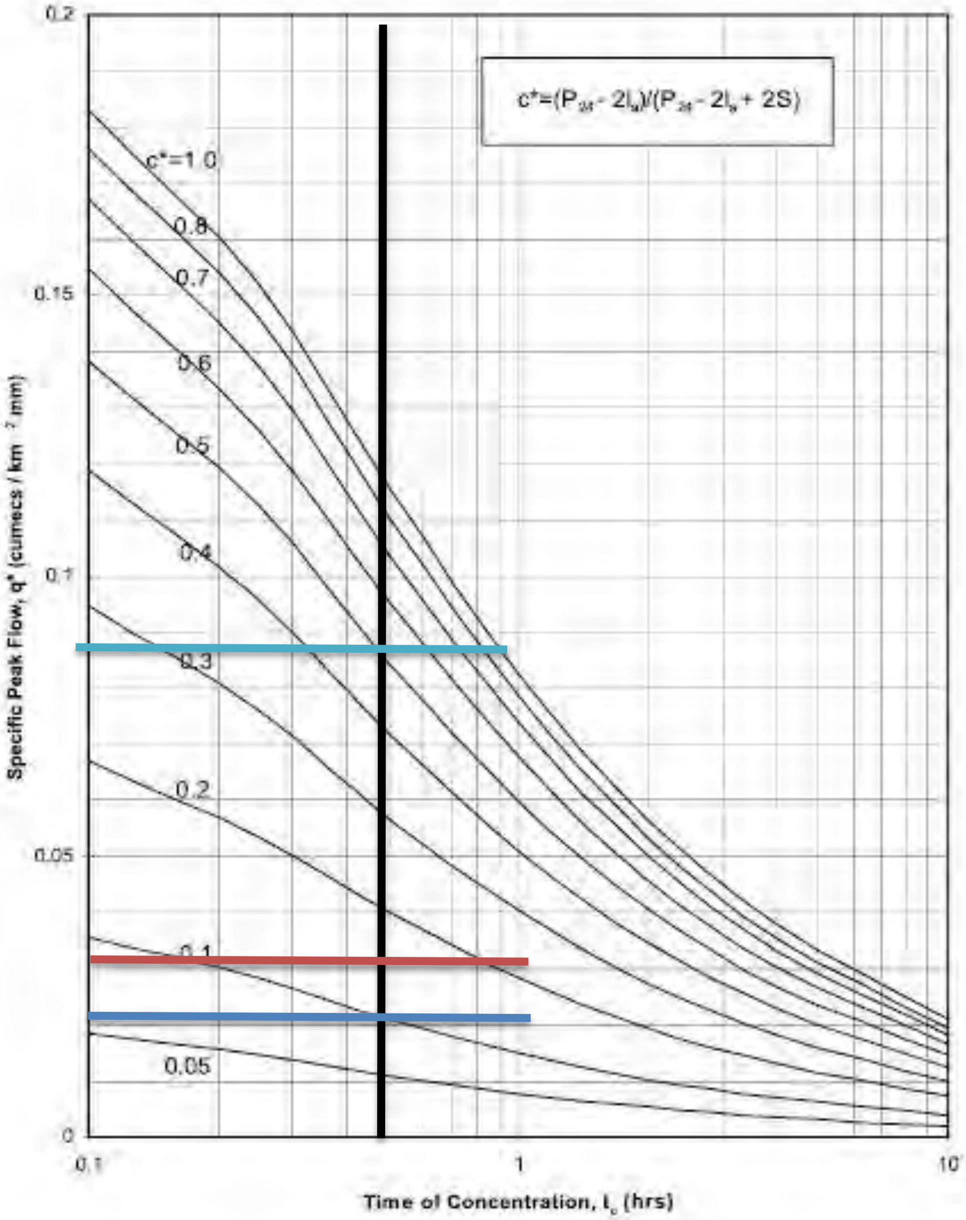

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	2.6643	261.11
C	Grass (landscape and gardens)	74	1.1419	84.50
* from Appendix B		Totals =	3.8062	345.60

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{345.60}{3.806}$ = 90.8

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}}$ = $\frac{5 \times 1.1419}{3.806}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.02 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{90.8}{200-90.8}$ = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.71 1.11 3.23 = 0.21 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.14 hrs

4.26 mins

OK

use

0.2145978 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 5 CATCHMENT XXXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.038062	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.21	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.105	0.088	0.152		
7. Peak flow rate, q_p=q*A*P_{24}	0.168	0.100	1.113		m3/s
PEAK FLOW RATE PRE DEV=	0.051	0.025	0.637		
PRE TO POST FLOW RATE=	**0.117**	**0.075**	**0.476**		
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	942.56	570.03	6404.35		(m3)
RUNOFF VOLUME PRE DEV=	412.75	208.23	4833.18		
PRE TO POST VOLUME=	**529.81**	**361.80**	**1571.17**		

SMAF 1 retention volume =	**133.2**	m3		
SMAF 1 Detention volume =	**396.6**	m3		
Total SMAF 1 mitigation volume=	**529.8**	m3		
SMAF 2 post development run-off volume=	**570.0**	m3		
Wetland Based requirement is=	1140.1	m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	20mx60m = 1200	m2	=	width * length
SMAF 1 storage height=	0.44	m	=	SMAF 1/ 1200m2
Additonal space for SMAF 1 storage=	1.38	m	=	side slope at 32% grade
additional space for maintanace track=	3.5	m		
final wetland size =	29.76m*69.76m= 2076m2		=	(length+1.38*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

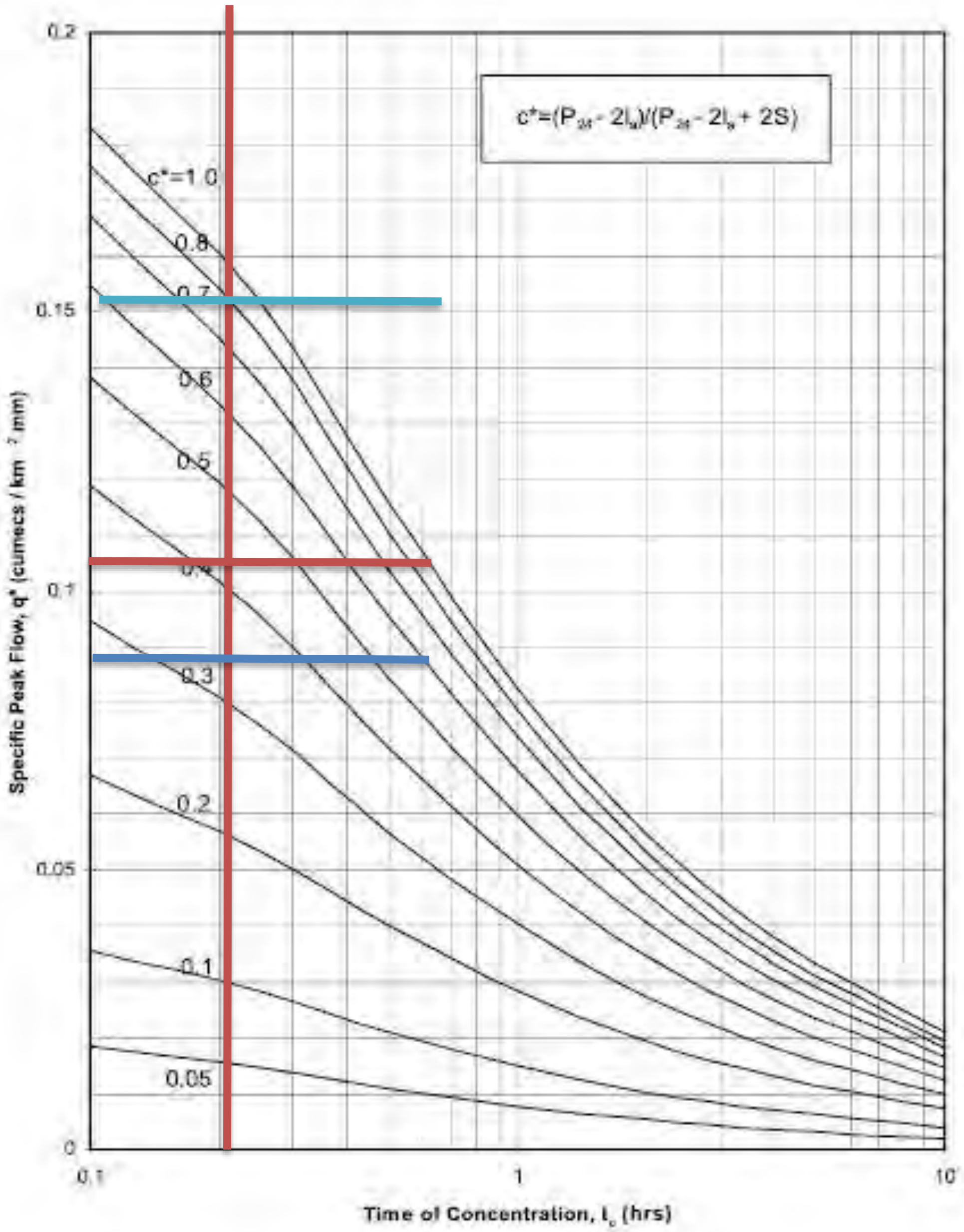

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXXV	44614	621	668	30.94m(w)*72.94m(L)
Total	44614	621	668	2256.8m2

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MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	4.4614	330.14
* from Appendix B		Totals =	4.4614	330.14

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{330.14}{4.461} = 74.0$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 4.4614}{4.461}$ 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.75 km (along drainage path)

Catchment Slope Sc= 0.012 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.0}{200- 74.0} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.83 1.34 3.77 = 0.58 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.39 hrs

23.51 mins

OK
use
0.58 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

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MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.044614	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.58	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.030	0.020	0.081		
7. Peak flow rate, q_p=q*A*P_{24}	**0.056**	**0.027**	**0.695**		m3/s
8. Runoff depth, $Q_{24} = (P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, $V_{24} = 1000xQ_{24}A$	483.80	244.07	5665.17		(m3)

Worksheet 2: Graphical Peak Flow Rate

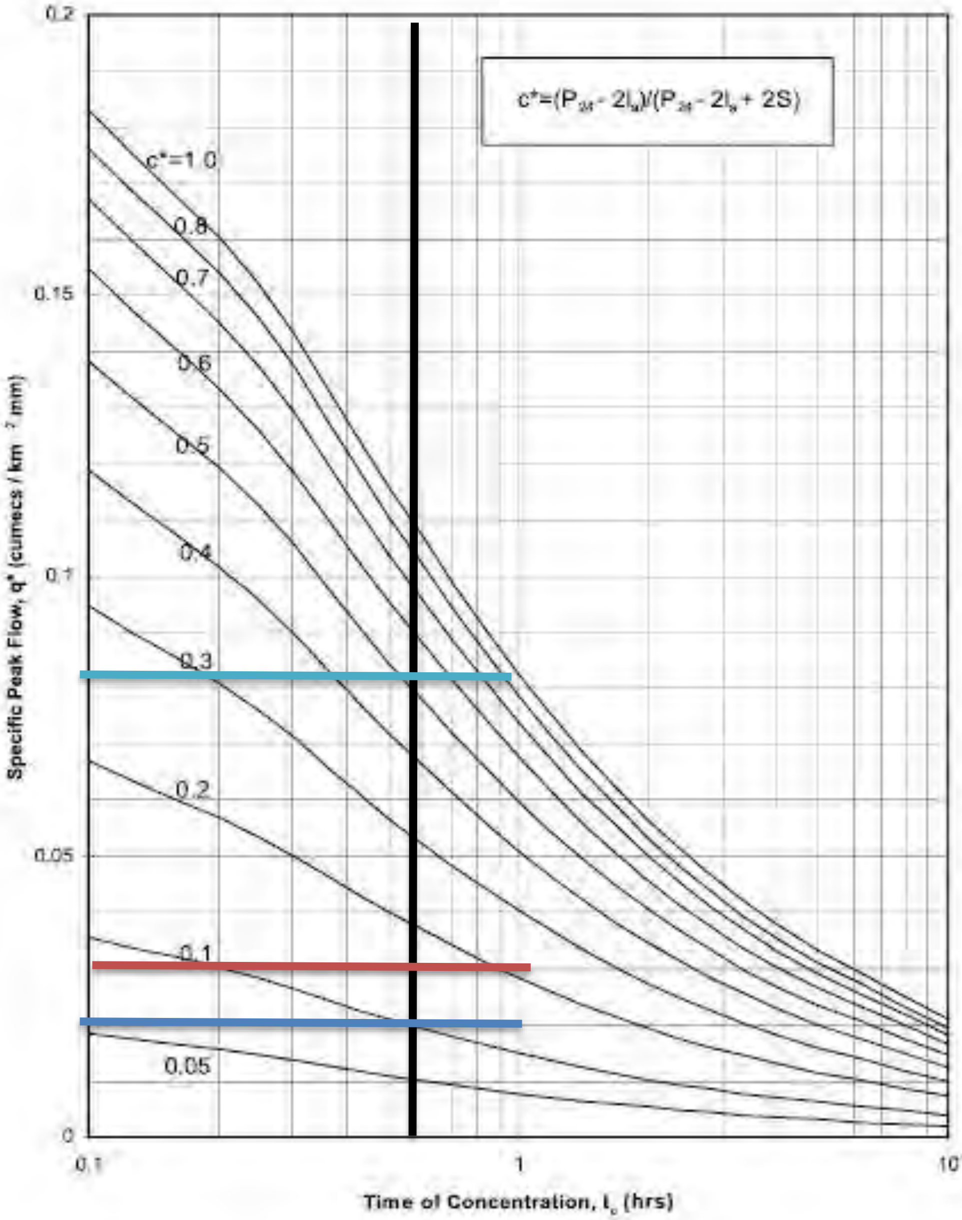

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	3.1230	306.05
C	Grass (landscape and gardens)	74	1.3384	99.04
* from Appendix B		Totals =	4.4614	405.10

CN (weighted) = total product / total area = 405.10 / 4.461 = 90.8

Ia (average) = 5 x pervious area / total area = 5 x 1.3384 / 4.461 = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.55 km (along drainage path)

Catchment Slope Sc= 0.0193 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 90.8 / 200- 90.8 = 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.67 1.11 3.27 = 0.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.14 hrs

4.26 mins

OK

use

0.2047985 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 6 CATCHMENT XXXV	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.044614 km2(100ha =1km2)

   Runoff curve number CN= 90.8 (from worksheet 1)

   Initial abstraction Ia= 1.5 mm (from worksheet 1)

   Time of concentration tc= 0.20 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.119	0.090	0.153		
7. Peak flow rate, q_p=q*A*P_{24}	0.223	0.120	1.314		m3/s
PEAK FLOW RATE PRE DEV=	0.056	0.027	0.695		
PRE TO POST FLOW RATE=	**0.167**	**0.094**	**0.618**		
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	1104.81	668.15	7506.80		(m3)
RUNOFF VOLUME PRE DEV=	483.80	244.07	5665.17		
PRE TO POST VOLUME=	**621.01**	**424.08**	**1841.63**		

SMAF 1 retention volume = **156.1** m3
SMAF 1 Detention volume = **464.9** m3
Total SMAF 1 mitigation volume= **621.0** m3
SMAF 2 post development run-off volume= **668.2** m2
Wetland Based requirement is= 1336.3 m2 = death storage depth
21mx63m
Wetand base measuremetn (1 in 3 shape) = 1323 m2 = width * length
SMAF 1 storage height= 0.47 m = SMAF 1/ 1728m2
Additonal space for SMAF 1 storage= 1.47 m = side slope at 32% grade
additional space for maintanace track= 3.5 m
final wetland size = 30.94m*72.94m= 2256.8m = (length+1.47*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

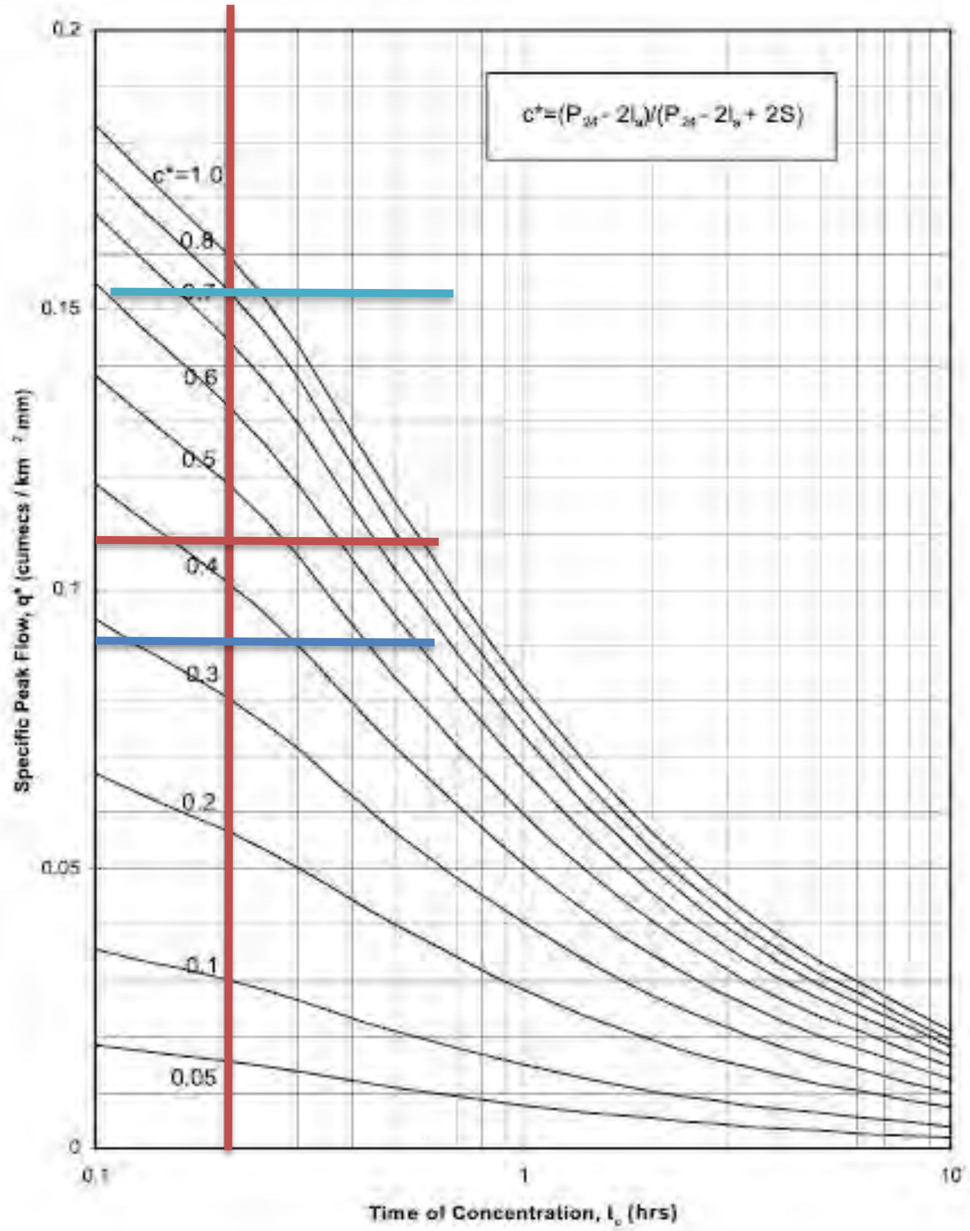

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XV	51346	715	769	32.82m(w)*78.82m(L)
Total	51346	715	769	2586.9m2

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.1346	379.96
* from Appendix B		Totals =	5.1346	379.96

CN (weighted) = total product / total area = 379.96 / 5.135 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.1346 / 5.135 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.75 km (along drainage path)

Catchment Slope Sc= 0.03 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.0 / (200- 74.0) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.83 1.34 2.86 = 0.44 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.30 hrs

17.86 mins

OK
use
0.44 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.051346	km2(100ha =1km2)
Runoff curve number	CN=	74.0	(from worksheet 1)
Initial abstraction	Ia=	5.0	mm (from worksheet 1)
Time of concentration	tc=	0.44	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.034	0.022	0.091		
7. Peak flow rate, q_p=q*A*P_{24}	**0.073**	**0.034**	**0.899**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}-Ia)^2/(P_{24}-Ia)+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	556.80	280.90	6520.01		(m3)

Worksheet 2: Graphical Peak Flow Rate

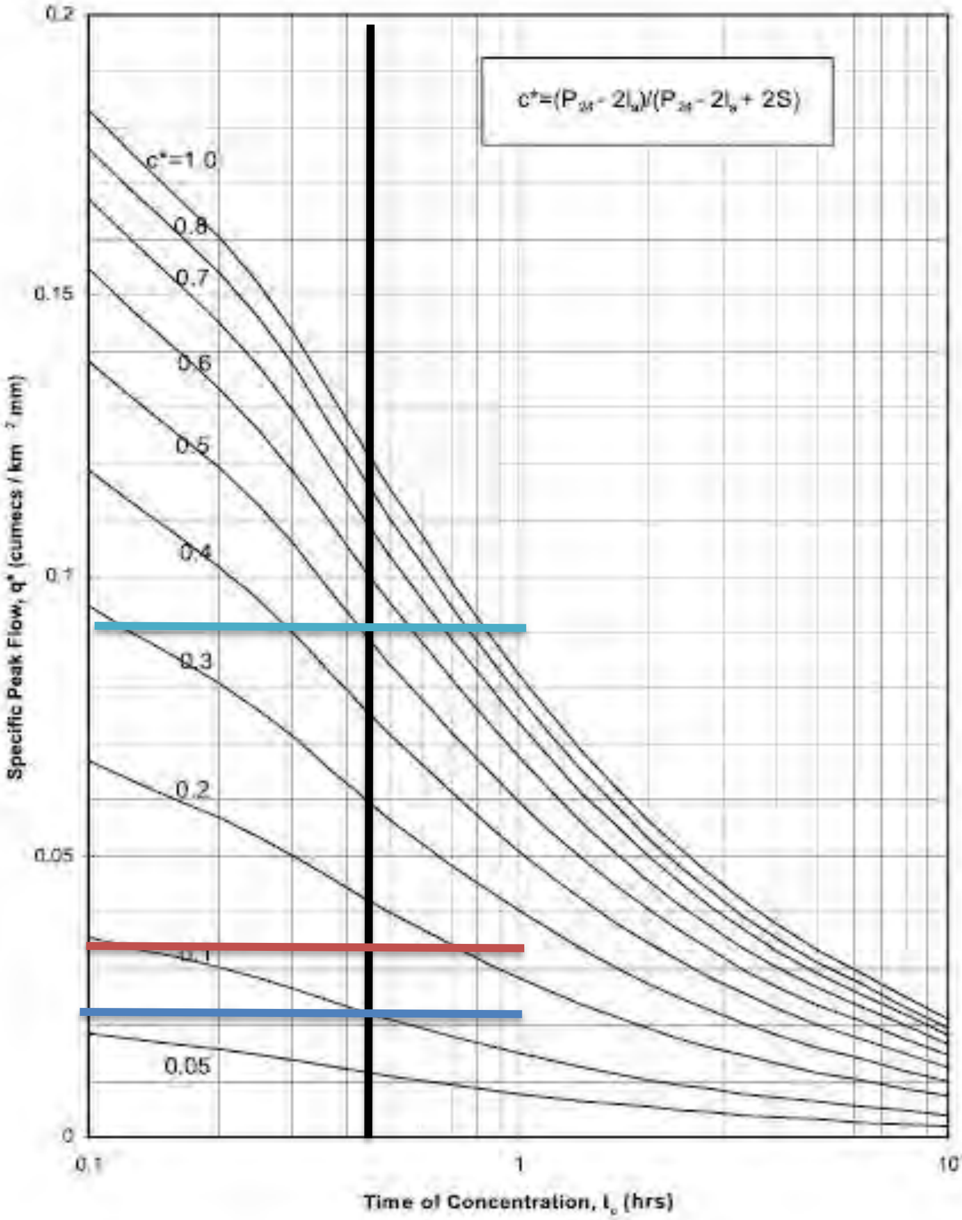

Figure 5.1 – Specific Peak Flow Rate

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MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title — WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	3.5942	352.23
C	Grass (landscape and gardens)	74	1.5404	113.99
* from Appendix B		Totals =	5.1346	466.22

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{466.22}{5.135} =$ 90.8

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 1.5404}{5.135}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.5 km (along drainage path)

Catchment Slope Sc= 0.043 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{90.8}{200- 90.8} =$ 0.83

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.63 1.11 2.57 = 0.15 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.10 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 7 CATCHMENT XV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.051346	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.17	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.109	0.089	0.156		
7. Peak flow rate, q_p=q*A*P_{24}	0.235	0.137	1.541		m3/s
PEAK FLOW RATE PRE DEV=	0.073	0.034	0.899		
PRE TO POST FLOW RATE=	**0.162**	**0.103**	**0.642**		
8. Runoff depth, $Q_{24} = (P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	1271.52	768.97	8639.53		(m3)
RUNOFF VOLUME PRE DEV=	556.80	280.90	6520.01		
PRE TO POST VOLUME=	**714.72**	**488.07**	**2119.52**		

SMAF 1 retention volume =	**179.7**	m3		
SMAF 1 Detention volume =	**535.0**	m3		
Total SMAF 1 mitigation volume=	**714.7**	m3		
SMAF 2 post development run-off volume=	**769.0**	m3		
Wetland Based requirement is=	1537.9	m2	=	death storage depth
	23mx69m			
Wetand base measuremetn (1 in 3 shape)	= 1587	m2	=	width * length
SMAF 1 storage height=	0.45	m	=	SMAF 1/ 1587m2
Additonal space for SMAF 1 storage=	1.41	m	=	side slope at 32% grade
additional space for maintanace track=	3.5	m		
final wetland size =	32.82m*78.82m= 2586.9m		=	(length+1.41*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

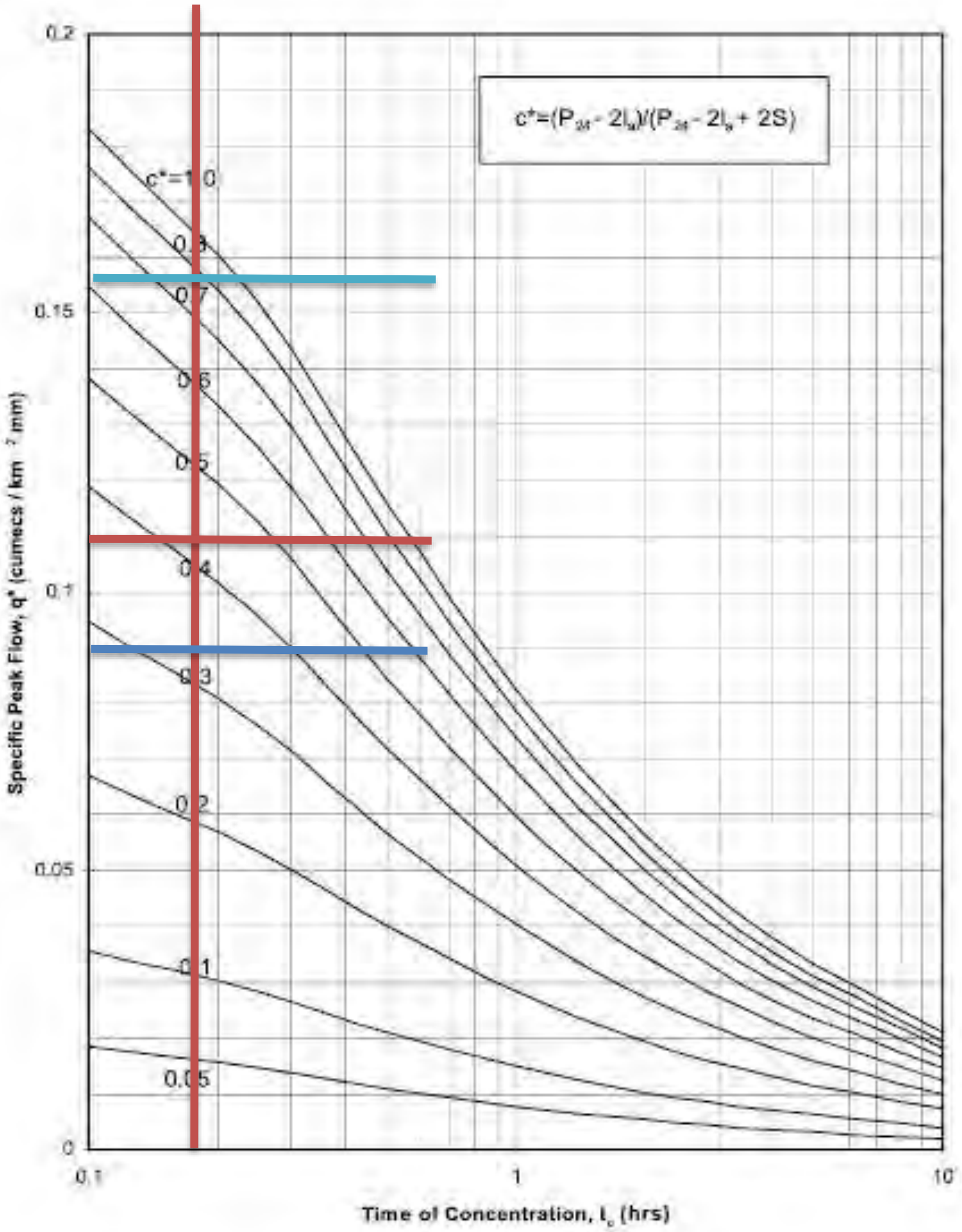

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XII	57015	794	854	33.88m(w)*81.88m(L)
Total	57015	794	854	2774.1m2

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MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.7015	421.91
* from Appendix B		Totals =	5.7015	421.91

CN (weighted) = total product = / total area = 421.91 / 5.702 = 74.0

Ia (average) = 5 x pervious area / total area = 5 x 5.7015 / 5.702 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.035 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.0 / 200- 74.0 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.34 2.73 = 0.51 hrs

SCS Lag for HEC-HMS.… $t_p = 2/3\ t_c$ = 0.34 hrs

20.62 mins

OK
use
0.51 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 3	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.057015 km2(100ha =1km2)

   Runoff curve number CN= 74.0 (from worksheet 1)

   Initial abstraction Ia= 5.0 mm (from worksheet 1)

   Time of concentration tc= 0.51 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. <u>24 hour rainfall depth</u>	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.030	0.021	0.083		
7. Peak flow rate, q_p=q*A*P_{24}	**0.072**	**0.036**	**0.911**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	618.28	311.92	7239.87		(m3)

Worksheet 2: Graphical Peak Flow Rate

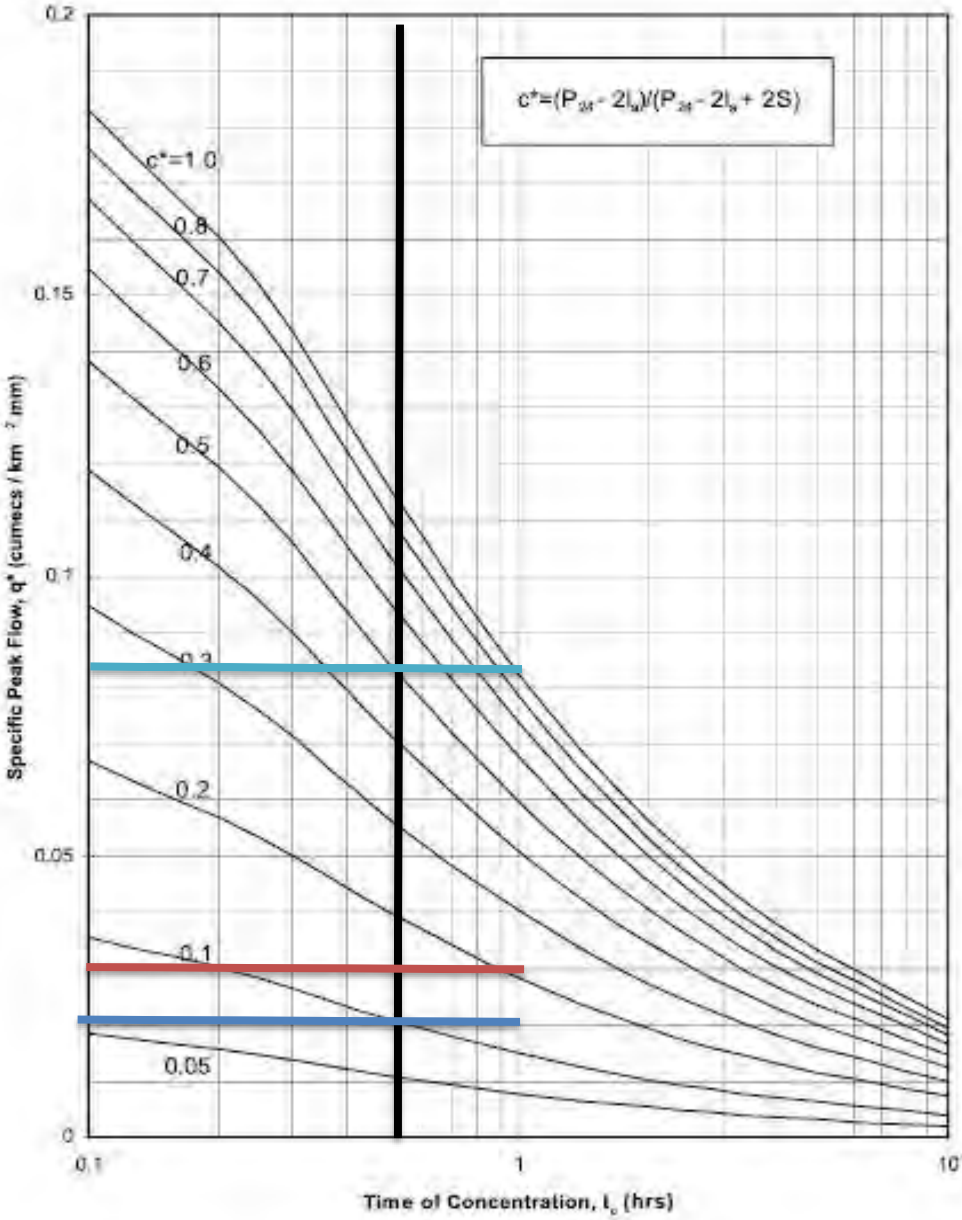

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	3.9911	391.12
C	Grass (landscape and gardens)	74	1.7105	126.57
* from Appendix B		Totals =	5.7015	517.70

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{517.70}{5.702} = 90.8$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 1.7105}{5.702}$ = 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.7 km (along drainage path)

Catchment Slope Sc= 0.029 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{90.8}{200 - 90.8} = 0.83$

$t_c = 0.14\, C\, L^{0.66}\, (CN/200-CN)^{-0.55}\, Sc^{-0.30}$

= 0.14 0.6 0.79 1.11 2.89 = 0.21 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\, t_c$ = 0.14 hrs

4.26 mins

OK

use

0.21252 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 2	Rev A
Job Title Calc Title	WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 8 CATCHMENT XII	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area	A=	0.057015	km2(100ha =1km2)
Runoff curve number	CN=	90.8	(from worksheet 1)
Initial abstraction	Ia=	1.5	mm (from worksheet 1)
Time of concentration	tc=	0.21	hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.108	0.089	0.153		
7. Peak flow rate, q_p=q*A*P_{24}	0.259	0.152	1.679		m3/s
PEAK FLOW RATE PRE DEV=	0.072	0.036	0.911		
PRE TO POST FLOW RATE=	**0.187**	**0.116**	**0.768**		
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})$+S	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	1411.91	853.87	9593.41		(m3)
RUNOFF VOLUME PRE DEV=	618.28	311.92	7239.87		
PRE TO POST VOLUME=	**793.63**	**541.96**	**2353.53**		

SMAF 1 retention volume =	**199.6** m3		
SMAF 1 Detention volume =	**594.1** m3		
Total SMAF 1 mitigation volume=	**793.6** m3		
SMAF 2 post development run-off volume=	**853.9** m3		
Wetland Based requirement is=	1707.7 m2	=	death storage depth
Wetand base measuremetn (1 in 3 shape)	24mx72m = 1728 m2	=	width * length
SMAF 1 storage height=	0.46 m	=	SMAF 1/ 1728m2
Additonal space for SMAF 1 storage=	1.44 m	=	side slope at 32% grade
additional space for maintanace track=	3.5 m		
final wetland size =	33.88m*81.88m=2774.1m2	=	(length+1.44*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

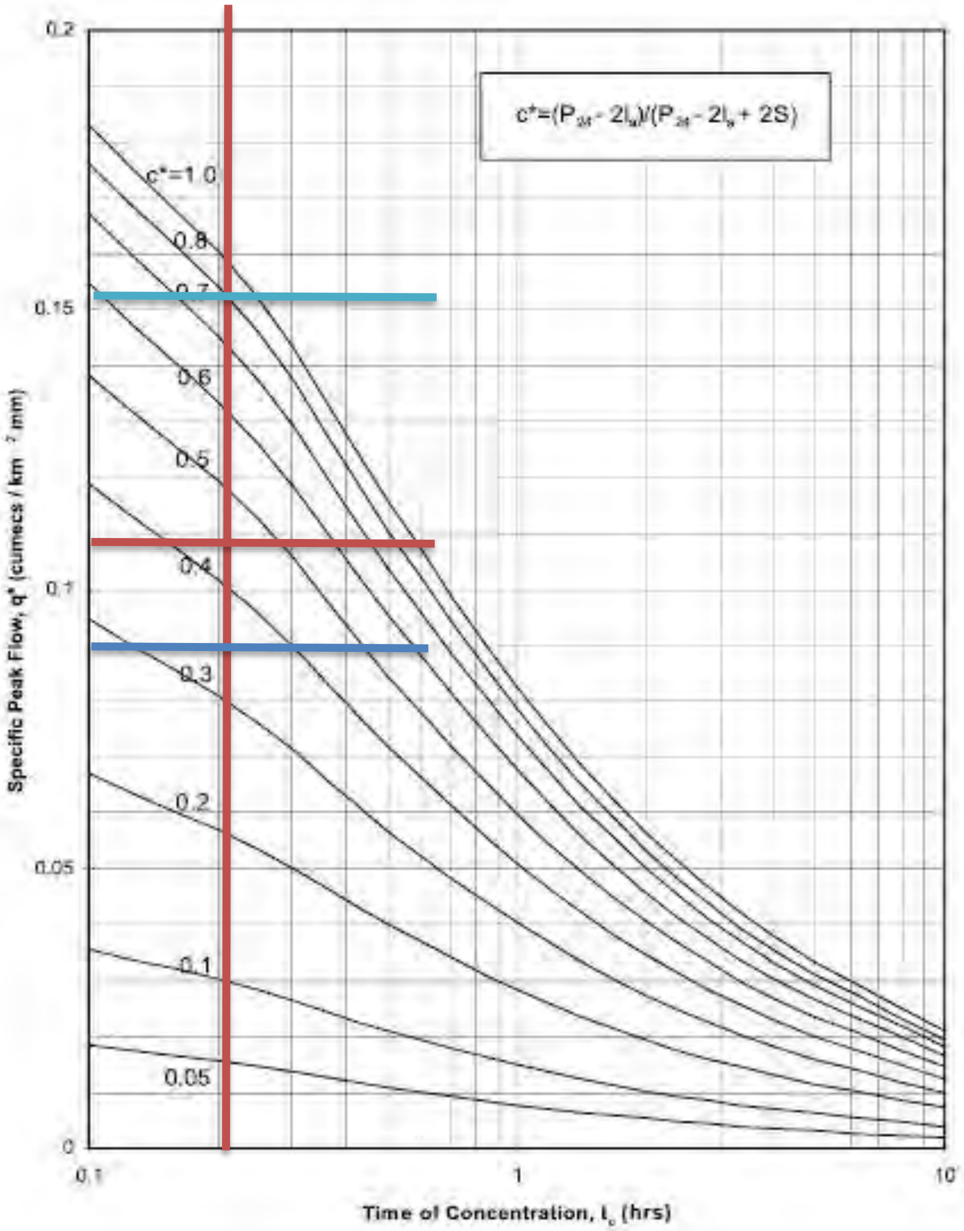

Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 7/06/2023	Checked LC

Catchment	Area*	SMAF1 Mitigation volume (m3)	SMAF2 Post Dev runoff volume (m3)	Wetland estimate size
XXIV	58004	807	869	33.88m(w)*81.88m(L)
Total	58004	807	869	2774.1m2

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MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: WARKWORTH SOUTH PCA WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	0.0000	0.00
C	Open space (Pervious)	74	5.8004	429.23
* from Appendix B		Totals =	5.8004	429.23

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{429.23}{5.800} = 74.0$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 5.8004}{5.800}$ = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 0.6 km (along drainage path)

Catchment Slope Sc= 0.049 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.0}{200- 74.0} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 0.71 1.34 2.47 = 0.33 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.22 hrs

13.30 mins

OK
use
0.33 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 3	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

1. Data
   Catchment Area A= 0.058004 km2(100ha =1km2)

   Runoff curve number CN= 74.0 (from worksheet 1)

   Initial abstraction Ia= 5.0 mm (from worksheet 1)

   Time of concentration tc= 0.33 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 89.2 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
Climate change %			13.2		
24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.15	0.10	0.51		
6. Specific peak flow rate q*	0.036	0.026	0.103		
7. Peak flow rate, q_p=q*A*P_{24}	**0.088**	**0.045**	**1.150**		m3/s
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	10.8	5.5	127.0		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	629.00	317.33	7365.46		(m3)

Worksheet 2: Graphical Peak Flow Rate

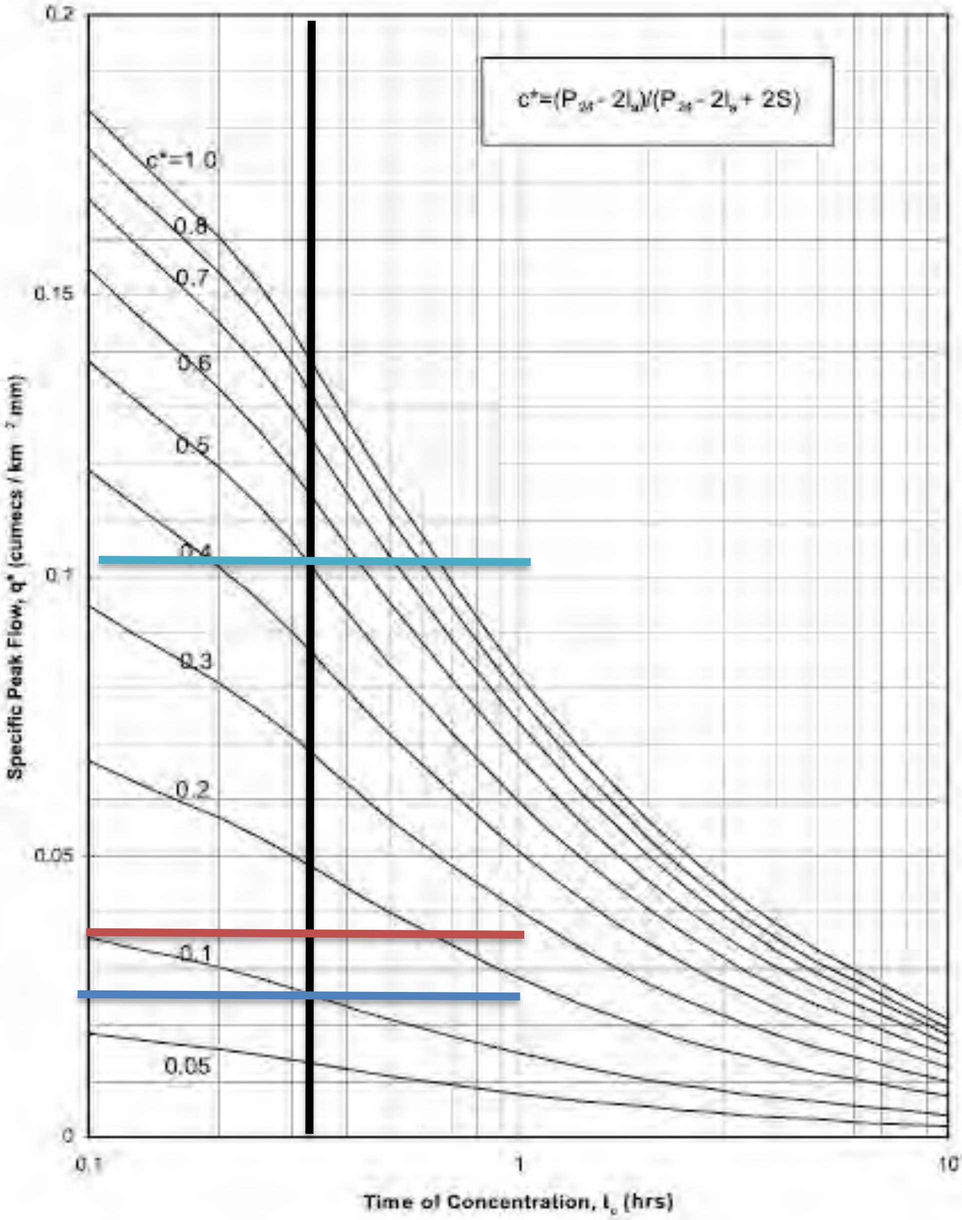


Figure 5.1 – Specific Peak Flow Rate

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Paved (concrete, gravel, metal, etc)	98	4.0603	397.91
C	Grass (landscape and gardens)	74	1.7401	128.77
* from Appendix B		Totals =	5.8004	526.68

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{526.68}{5.800} = 90.8$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 1.7401}{5.800}$ 1.5 mm

2. Time of Concentration

Channelisation factor C = 0.6 (From Table 4.2)

Catchment length L = 0.4 km (along drainage path)

Catchment Slope Sc= 0.065 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{90.8}{200-90.8} = 0.83$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 0.6 0.55 1.11 2.27 = 0.12 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.08 hrs

4.26 mins

NO GOOD

use

0.17 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 2	Rev A
Job Title: WARKWORTH SOUTH PCA Calc Title: WETLAND SIZING CALCULATION WETLAND 9 CATCHMENT XXIV	Author KH	Date 13/12/2022	Checked LC

1. Data

Catchment Area A= 0.058004 km2(100ha =1km2)

Runoff curve number CN= 90.8 (from worksheet 1)

Initial abstraction Ia= 1.5 mm (from worksheet 1)

Time of concentration tc= 0.17 hrs (from worksheet 1)

2. Calculate storage, S =(1000/CN - 10)25.4 = 25.7 mm

3. Average recurrence interval, ARI	95th %	90th %	10		(yr)
4. 24 hour rainfall depth	42	30	170		(mm)
P24			13.2		(%)
4. 24 hour rainfall depth, P24	42	30	192.44		(mm)
5. Compute c* = P24 - 2Ia/P24 - 2Ia+2S	0.43	0.34	0.79		
6. Specific peak flow rate q*	0.112	0.092	0.157		
7. Peak flow rate, q_p=q*A*P_{24}	0.273	0.160	1.752		m3/s
PEAK FLOW RATE PRE DEV=	0.088	0.045	1.150		
PRE TO POST FLOW RATE=	**0.185**	**0.115**	**0.603**		
8. Runoff depth, Q_{24} = $(P_{24}\text{-Ia})^2/(P_{24}\text{-Ia})+S$	24.8	15.0	168.3		mm
9. Runoff volume, V_{24} = 1000xQ_{24}A	1436.40	868.69	9759.82		(m3)
RUNOFF VOLUME PRE DEV=	629.00	317.33	7365.46		
PRE TO POST VOLUME=	**807.40**	**551.36**	**2394.36**		

SMAF 1 retention volume = **203.0** m3
SMAF 1 Detention volume = **604.4** m3
Total SMAF 1 mitigation volume= **807.4** m3
SMAF 2 post development run-off volume= **868.7** m3
Wetland Based requirement is= 1737.4 m2 = death storage depth
24mx72m
Wetand base measuremetn (1 in 3 shape) = 1728 m2 = width * length
SMAF 1 storage height= 0.47 m = SMAF 1/ 1728m2
Additonal space for SMAF 1 storage= 1.46 m = side slope at 32% grade
additional space for maintanace track= 3.5 m
final wetland size = 33.88m*81.88m=2774.1m2 = (length+1.46*2+3.5*2)

Worksheet 2: Graphical Peak Flow Rate

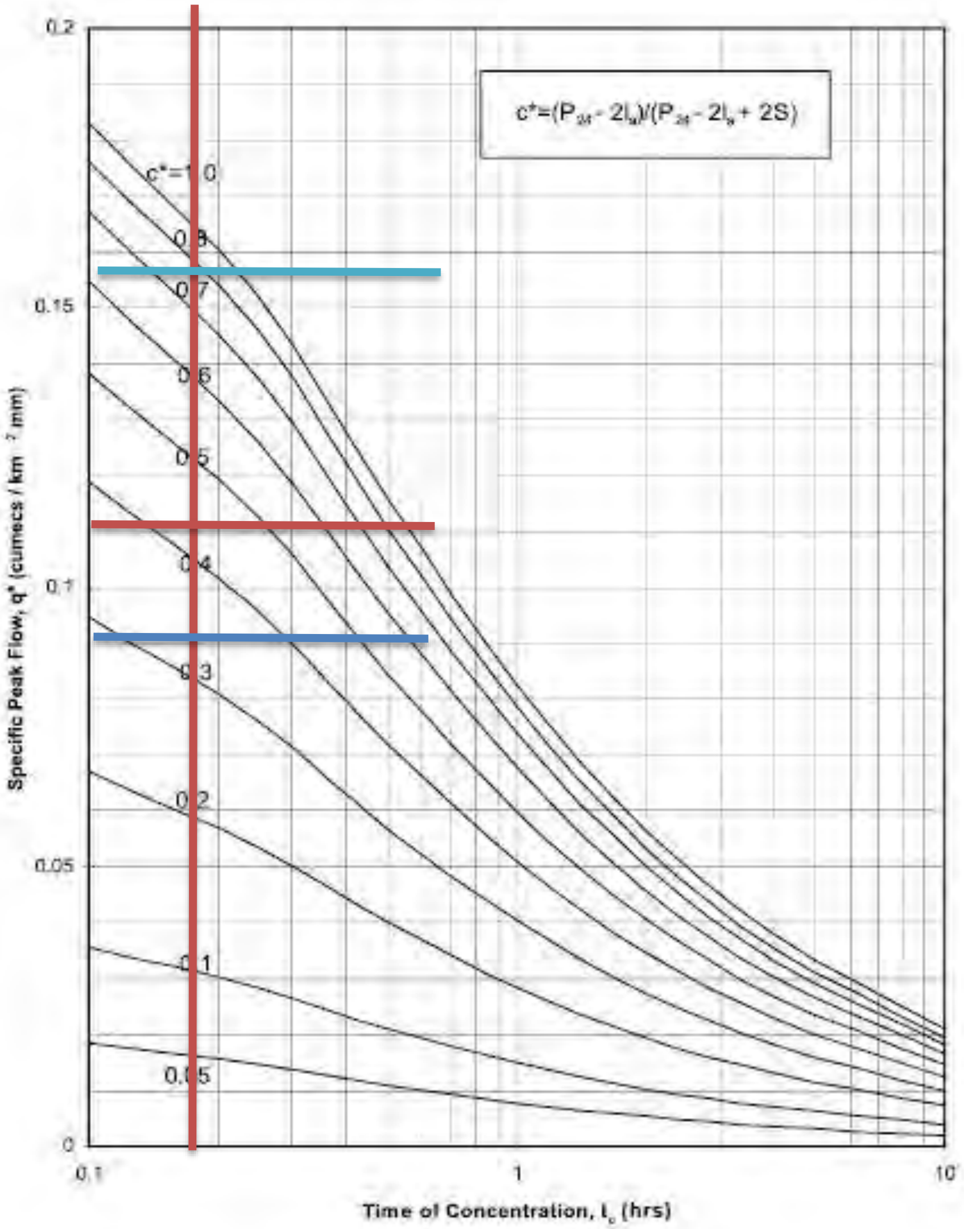
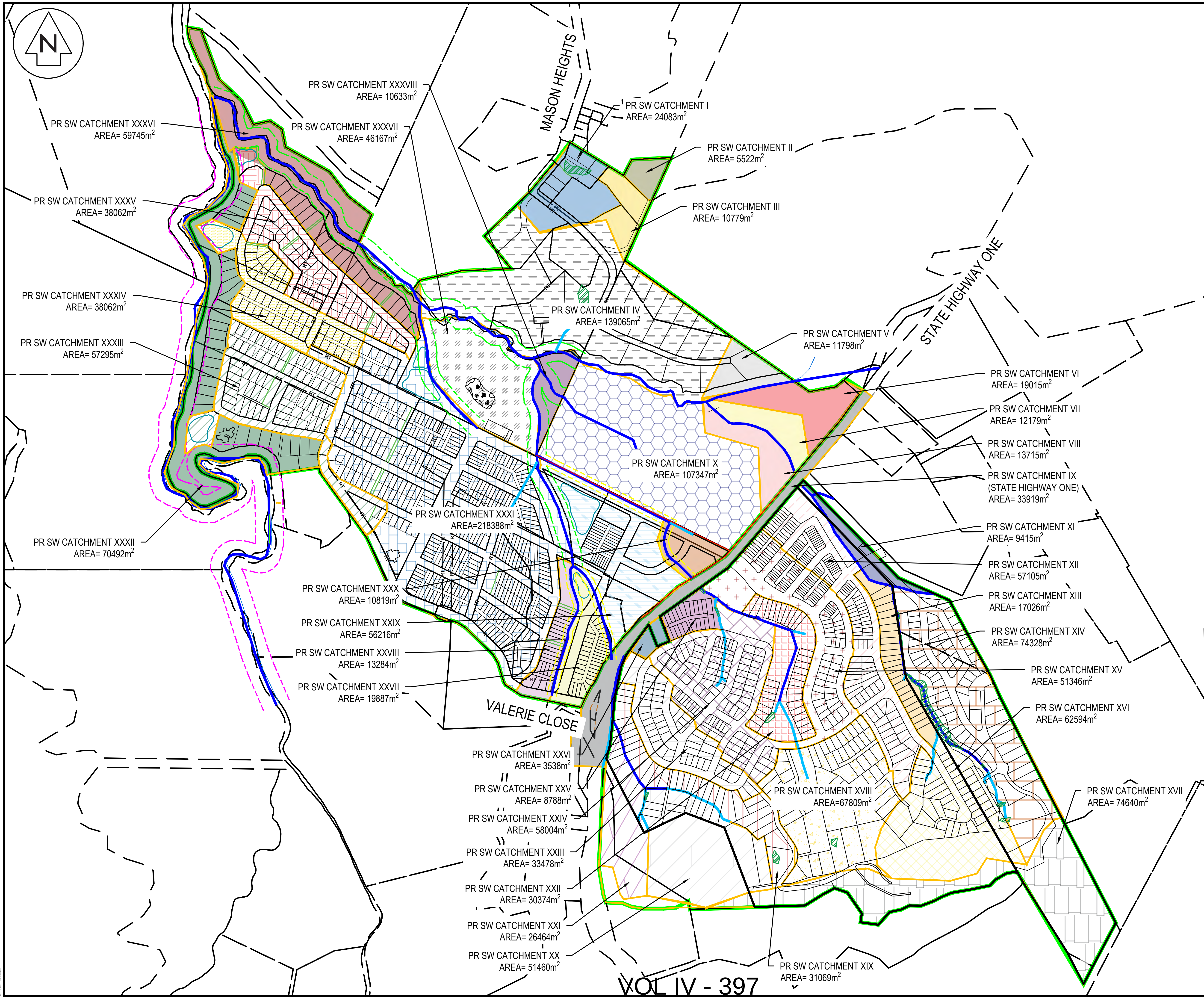


Figure 5.1 – Specific Peak Flow Rate



Notes
1. All works to be in accordance with Auckland council standards.
2. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Legend

EX BDY	
PLAN CHANGE BDY	
SW CATCHMENT	
SUB SW CATCHMENT	
EX PERM. STREAM	
EX INTER. STREAM	
EX WETLAND	

Rev	Description	By	Date
A	PPC	KH	08/22

	By	Date
Survey	PARALAX & MAVEN	03/21
Design		
Drawn	KH	08/22
Checked	GB	08/22

Maven Associates
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5 Owens Road, Epsom
Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
POST DEVELOPMENT STORMWATER CATCHMENT PLAN

Project no.	211001
Scale	1:10000 @ A3
Cad file	211001- C451 PRO DEV CATCHMENT.DWG
Drawing no.	C451
Rev	A

ATTACHMENT 19

APPENDIX 14

ARBORICULTURAL ASSESSMENT

Version 3 – RC Draft

CRAIG WEBB
Consultant Arborist

ARBORICULTURAL ASSESSMENT

OF THE PROPOSED PLAN CHANGE AT

WAIMANAWA WARKWORTH SOUTH

REPORT PREPARED BY: CRAIG WEBB

DATE: 9 June 2022

craig@cwca.co.nz

1 INTRODUCTION

1.1 I, Craig Webb (CWCA Limited) have been engaged by Classic Developments and Stepping Towards Far Limited to prepare this arboricultural report relating to the proposed Warkworth South Plan Change. The Plan Change affects land on both sides of State Highway 1 to the south of the town of Warkworth. To the northwest of State Highway 1 is the land collectively known as Waimanawa Valley, incorporating the Morrison Heritage Orchard. To the southeast of State Highway 1 is the land collectively known as Waimanawa Hills. The properties included in this plan change are listed in the planning report.

1.2 The purpose of this report is to provide an assessment of existing trees within the extent of the proposed plan change and to consider whether any of these trees warrant consideration of mandatory retention and protection.

1.3 This report is a combination of two previous report and one report addendum that were previously written for the various applicants that are party to the proposed Plan Change. No substantive changes have been made to the text of the reports when combining the previous reports.

2 BRIEF/BACKGROUND/PLANS PROVIDED

2.1 My brief was to survey the sites and assess all trees, with a view to informing the Plan Change process in regard to the trees present on both sites.

2.2 In addition, the brief includes assessing trees of standout qualities against the Auckland Unitary Plan criteria for inclusion in the schedule of notable trees. The AUP 'Guidelines for Nominating a Notable Tree for Evaluation' has been used in the compilation of this report.

2.3 I have been provided with a copy of the Masterplan – Urban Design Report, titled Wartworth South Plan Change – Waimanawa, dated April 2022, produced by Reset Urban Design and A Studio Architects.

3 ASSESSMENT METHODOLOGY

3.1 The methodology for this assessment was as follows:

- A desktop study of aerial photos was used to inform the assessment of the areas of the sites that contain trees of interest and to identify general tree types across the site.
- A walk-over of the sites was carried out to undertake a preliminary assessment of trees and tree groups.
- A tree survey app developed for similar surveys was used with a view to locating, identifying and ranking trees and their environmental qualities. . The app was also designed to collect data that meets the AUP 'Guidelines for Nominating a Notable Tree for Evaluation'.
- Trees were 'collected' as either single specimens, or in groups, where logical groups could be made according to species, location and/or function.

- The characteristics of trees that were ranked were: Landscape Amenity, Erosion Control, Stormwater Functions and Wildlife Habitat. Whether the trees may provide Forestry Products was also considered.
- More detailed assessments of trees were carried out where trees were awarded 'Excellent or Exceptional' rankings under any ranked criteria.
- For individually significant trees, height measurements were taken using a Nikon Forestry Pro laser rangefinder. Trunk diameter measurements were recorded using a Yamayo diameter tape. Crown spread radius was paced out on site.
- Data collected from the site visits was uploaded to QGIS for mapping purposes. The data was ordered and filtered to allow the characteristics of the tree resource on site to be classified and presented in various ways.

4 LIMITATIONS

4.1 The assessment of trees within the sites was undertaken using methods that aimed to collect data relevant to making an informed decision on the qualities and retention values of trees within the sites. The method for tree assessment was devised by the author of this report and is considered to be appropriate for the purposes of data collection to inform the plan change process on the relative merits of trees.

4.2 The assessment described in this report was undertaken by a qualified and experienced arborist. The assessment was completed with the arborist's expertise in the field of arboriculture as it relates to ecology/biosecurity, landscape amenity, agro-forestry and soil/water conservation. No experts in these fields were consulted to guide the preliminary assessment. It must therefore be acknowledged that the values ascribed to individual trees and groups of trees may be subject to review by other experts.

4.3 The tree survey did not locate every tree within the sites. Areas of the riparian margin and the large block of forest at 49 Mason Heights, which are protected by existing covenants and legislation were not surveyed. These area are assumed to be preserved during future development and not affected by future changes in land use. These areas were therefore not assessed for arboricultural quality.

4.4 Access limitations to the Morrisons Heritage Orchard site at 1773 State Highway 1 prevented full assessment of trees within that portion of the site. Where they could be assessed from proximate vantage points, tree groups were recorded for this property.

4.5 The extent of the Waimanawa Hills site was determined by the presence of fences in the approximate area of the property boundaries found on Auckland Council GeoMaps. It became apparent during the arboricultural survey that there are discrepancies between fence locations and the property boundary. Some of the trees in the tree inventory may be on the neighbouring properties, including the scenic reserve to the south of the site. It must be acknowledged that the overlay of property boundaries and aerial photographs contains inaccuracies that require the locations of trees and boundary lines to be confirmed through accurate surveying.

4.6 To my knowledge, the AUP 'Guidelines for Nominating a Notable Tree for Evaluation' has not been widely used or tested. The system contains criteria that are vague and unable to be accurately determined without significant amounts of further information relating to trees in the local and regional area, that is unavailable and/or unattainable. It is my opinion that the AUP 'Guidelines for Nominating a Notable Tree for Evaluation' is impractical, highly subjective and not supported by arboricultural best practices for tree evaluation. There are significant limitations in undertaking an assessment using this method, in my opinion.

5 SITE VISITS

5.1 The site visits involved traversing the site on foot to carry out a visual assessment of all trees and groups of trees. In particular, the site analysis involved looking for trees that stand out due to their size, species, visibility and specific qualities.

5.2 The site visit included collating an inventory of all major trees and tree groups within the extent of the site and logging data on a mobile GIS-capable device.

WAIMANAWA HILLS

5.3 Site visits to carry out assessments of trees within this site, at 1738 State Highway 1, were carried out on 9 and 17 December 2020.

5.4 An additional site visit to carry out assessments of trees within the adjacent property at 1768 State Highway 1 was carried out on 23 September 2021.

WAIMANAWA VALLEY

5.5 Site visits to carry out assessments of trees within the combined site, incorporating properties on State Highway 1, Valerie Close and Mason Heights, were carried out on 14 and 21 July 2021.

6 SITE DESCRIPTION

WAIMANAWA HILLS

6.1 The large site contains open farmland, a large number of shelter belts and agro-forestry plantings, native bush-clad areas, and centrally located homesteads surrounded by amenity plantings on each property. The site has gentle gradients over much of the area but rises steeply towards a ridgeline to the south.

6.2 The southern boundary of the site adjoins Avice Miller Scenic Reserve. The precise location of the boundary between the private property and the public reserve is not defined on site. A fence within the bush margin does not appear to follow the alignment of the property boundary shown on the Auckland Council GeoMaps. Groups of trees have been identified within the bush that have uncertain positions relative to the property boundary.

6.3 The ridge that defines the southern edge of the site is identified as part of an Outstanding Natural Landscape (ONL) overlay in the AUP. Small portions of the site contain a Significant Ecological Area (SEA) overlay, which more or less covers the extent of forest in the Avice Miller Scenic Reserve and parts of the southern aspect of the site. The eastern end of the Avice Miller Scenic

Reserve terminates adjacent to the western boundary of 1768 SH1. This site contains a large area of native forest that is contiguous with the forest of the scenic reserve.

6.4 The site contains a wetland and pond, within the property at 1768 SH1. The stream flowing from this area follows the boundary between the two properties, before joining the tributary on the 1738 SH1 site.

6.5 Large numbers of trees are present throughout the site. These include trees planted for agro-forestry purposes, amenity plantings and areas of undisturbed and regenerating, naturally occurring native forest.

WAIMANAWA VALLEY

6.6 The large site contains open farmland, orchards, a number of shelter belts, agro-forestry plantings, native bush-clad areas, amenity plantings around the several homesteads. The site has gentle gradients over much of the area but rises steeply towards a ridgeline in the northern aspect of the site (towards Mason Heights).

6.7 The southern boundary of the site adjoins Valerie Close, an existing public road that leads to a private road to nos. 46, 83, 123, 125 and 127 Valerie Close. The Western boundary is bordered by a convoluted section of the Mahurangi River. The northern boundary includes a tributary of the Mahurangi River and the external boundaries of 43 and 49 Mason Heights, Lot 6 DP 150976 and 1773 State Highway 1. The eastern boundary is bordered by State Highway 1.

6.8 Large numbers of trees are present throughout the site, particularly on riparian margins bordering the streams and existing forest areas at 49 Mason Heights. Other trees within the site include specimens and groups planted for agro-forestry purposes, amenity plantings, orchards and areas of undisturbed and regenerating, naturally occurring native forest.

7 ARBORICULTURAL ASSESSMENT – GENERAL

WAIMANAWA HILLS

7.1 The assessment has identified a total of approximately 1839 trees within the site.

7.2 A large proportion of the trees present on the site (approximately 45%) are part of the system of shelterbelts that define the edges of paddocks and the perimeter of much of the site. Species used in shelterbelt plantings include Yunnan poplar (*Populus yunnanensis*), black poplar (*Populus nigra*), radiata pine (*Pinus radiata*), Monterey cypress (*Cupressus macrocarpa*) and white willow (*Salix alba*). In addition to these exotic species, three rows of native totara (*Podocarpus totara*) that appear to represent an older shelterbelt system were identified.

7.3 As well as providing shelter in an agricultural system, many of the shelterbelt trees provide significant amenity value to the rural landscape, particularly where trees have been widely spaced in rows. Many of these trees are in excellent condition.

7.4 Poplar has also been planted on the steep land rising to the ridge near the southern margin of the site. These agro-forestry plantings appear to have been planted for land stabilization and/or wood-lots. Poplar may provide wood products for pulp and laminated sheet-boards. Wood products may also be obtained from pine and macrocarpa trees.

7.5 Native trees are represented by several groups and solitary specimens. Native trees comprise approximately one third of the trees on site. The majority of the native specimens are on the steep embankments of the southern ridge and the fringe of Avice Miller Scenic Reserve that borders the southern edge of the site. These are represented by significant totara and puriri (*Vitex lucens*) and kauri (*Agathis australis*).

7.6 A post and wire fence defines the southern edge of the area that is currently being used for agricultural purposes. Grazing land includes areas that are within native trees on the fringe of the substantial block of native forest that includes the scenic reserve land to the south. The actual property boundary relative to the fence line has not been determined at this stage. Stock grazing has had an adverse impact on the health of trees and the quality of the forest understory within the forested area at the southern margin of the site.

7.7 According to an assessment using the AUP 'Guidelines for Nominating a Notable Tree for Evaluation', one tree may be considered worthy of consideration for notable status. An assessment of this kawaka, *Libocedrus plumosa* is provided in Table 1, section 8.41 of this report.

WAIMANAWA VALLEY

7.8 The assessment has identified 93 groups and 7 solitary trees within the site. A large proportion of the trees present on the site are part of shelterbelts. Shelterbelts make up 21 of the 93 groups. Species used in shelterbelt plantings include Chinese poplar (*Populus yunnanensis*), black poplar (*Populus nigra*), radiata pine (*Pinus radiata*), Monterey cypress (*Cupressus macrocarpa*), gums (*Eucalyptus spp.*), Japanese cedar (, gums (*Eucalyptus spp.*), Japanese cedar (*Cryptomeria japonica*) and Tasmanian blackwood (*Acacia melanoxylon*). In addition, a block of Lawson cypress (*Chamaecyparis lawsoniana*) contributes to the agro-forestry plantings.

7.9 As well as providing shelter in an agricultural system, many of the shelterbelt trees provide significant amenity value to the rural landscape. A long row of poplar trees flanks the southern side of Valerie Close and the associated private road.

7.10 A wide range of common native and exotic species were identified as amenity plantings. Fifteen (15) out of 93 tree groups were identified as amenity plantings. These are solitary trees or small groups planted around existing homesteads, along with many fruit trees.

7.11 Native tree groups make up 18% of the tree groups identified on the site. A further 20% of identified tree groups include mixed native and exotic species. The native trees are primarily on the stream riparian margins or bush remnants on Mason Heights properties. Native tree groups of note include:

- A large number of totara on the sloping land south of the bush covenants on 49 Mason Heights
- Totara and mixed natives on Lot 6 DP 150976
- A mixed group, primarily totara at 43 Mason Heights

- Several small shelter belts
- Existing covenant areas planted in native revegetation.

7.12 It should be noted that the arboricultural assessment did not include all of the trees that are within the riparian margin of the Mahurangi River and the tributary along the northern edge of the plan change area. The arboricultural assessment did not include trees within existing covenant areas at 49 Mason Heights. These protected areas contain contiguous native forest canopy that are to be preserved and protected. Please refer to the Baseline Ecology assessment from Bioresearches for a description of the existing native forest areas.

8 ARBORICULTURAL ASSESSMENT – SPECIFIC

8.1 The arboricultural assessment across both sites has identified trees and groups of trees that are significant due to their native origin, their form and character and/or their contribution to amenity and ecological services.

8.2 Trees that have stand-out characteristics have been assessed using the AUP 'Guidelines for Nominating a Notable Tree for Evaluation', in Table 1, paragraph 8.41 of this report.

8.3 Please refer to the plans attached to this report for the locations of the listed trees and tree groups.

WAIMANAWA HILLS

8.4 The following paragraphs describe the trees and groups of trees that are recommended for mandatory retention.

8.5 Trees and tree groups No.1-9, 200 & 201

These individual trees and groups of trees are part of the native forest that covers Avice Miller Scenic Reserve, along the southern boundary of the site. This includes individual puriri trees of unusual and significant character, stands of totara, kahikatea and kauri and associated understory trees and ground plants in some places. The area surrounding the trees has been degraded by stock trampling. In order to protect these trees in perpetuity, a new boundary fence should be erected to define the forest margin, at the dripline edge of these trees. The location lends itself to enhancement planting if additional land were to be set aside in this area for mitigation purposes.

8.6 Tree groups No.10-12

These mixed groups contain trees of various species, origin and age-classes. This includes regenerating native scrub, established native trees, and self-seeded and planted exotic trees. The groups are growing on a very steep, north facing part of the ridgeline. Removal of the exotic species and retention/enhancement of the native species would allow the significant benefits of the native trees to be maintained and increase in the future.

8.7 Tree groups No.13, 14, 16-19

Significant native trees are included within these groups. The groups occupy a wide basin and the upper reaches of a watercourse on the steep, north-facing bank of the ridgeline. Central to tree group 13 is a massive puriri that is surrounded by dense canopy trees of totara, kahikatea, rimu and rewarewa. A large rata in group 17 and multiple nikau palms in group 14 are also features of the overall group. Tree group 15 is largely exotic trees (Monterey cypress, *Cupressus macrocarpa*) of poor health and structure that detract from the qualities of the native stand.

The location of groups 10-19 lends itself to enhancement planting, if vacant land between the groups were to be set aside to enable them to be linked together by a band of native restorative planting.

8.8 Tree group No.21

Growing around the perimeter of the former quarry, the principal trees in this group are pōhutukawa. The trees have roots extending down the rock face. Removal of exotic weeds and enhancement of the area could make this grove a significant feature of the site.

8.9 Tree No.50 & tree group No.214

This kawaka, *Libocedrus plumosa* tree has been singled out, due the relative rarity of the species and the size of this specimen. This is the largest tree of its species that I have encountered anywhere. Using the AUP Guidelines for Nominating a Notable Tree for Evaluation criteria, this tree scores 16 points. The tree is growing at the head of a basin and is surrounded by a mixed group of exotic trees, that includes large pines. The *Libocedrus* would benefit from staged reduction and gradual removal of the pine trees, to allow it to become a standalone specimen tree. The area surrounding the *Libocedrus* and wider group would require protection/ preservation from disturbance and earthworks to enable the specimen tree to be maintained.

8.10 Tree group No.114

Located against the road frontage in the northern corner of the site, is a stand of native trees that include rimu, totara, kauri and tanekaha. Due to their location, retention would be relatively simple, provided that earthworks was pulled back sufficiently from the corner of the site.

8.11 Tree group 1003

This group comprised mostly of native species covers an area of approximately 2,000m^2 and straddles the stream running through the property. Native species are represented by several large native podocarps, such as rimu (*Dacrydium cupressinum*) and kahikatea (*Dacrycarpus dacrydioides*). Kauri (*Agathis australis*) is also present. A range of understory and sub-canopy native species is also present. Exotic species are represented by gum (*Eucalyptus sp.*) and white monkey apple (*Syzygium smithii*) trees.

Due to the significant benefits of intact native tree canopy, the benefit of this to the watercourse and the size and quality of the trees present here, mandatory retention and preservation of the stand is recommended.

8.12 Tree group 1004

Upstream from group 1003 and surrounding the small dam in the watercourse, this mixed group contains one significant kauri and clusters of kanuka (*Kunzea robusta*). Exotic species are represented by commonly planted agro-forestry species, pine (*Pinus radiata*), Chinese poplar (*Populus yunnanensis*) and Japanese cedar (*Cryptomeria japonica*).

The kauri tree warrants mandatory retention, due to the size and threatened status of the species. Sufficient set-backs from this tree must be included in the planning of the site layout and development works, including any vegetation alteration. Selective and careful removal of exotic species as part of wetland, watercourse enhancements should be carefully managed to retain the kauri and other native species. Alteration to the land-from and hydrology could have adverse impacts on the kauri tree and must be carefully considered. All work in the vicinity must be carried out in accordance with controls against kauri dieback disease.

8.13 Tree group 1006

Along with tree group 1005, this stand of mixed species is located around the small wetland. This group includes native totara (*Podocarpus totara*) and exotic gum and Chinese poplar. Selective and controlled removal of exotic species and the adjacent pines in group 1005 could be undertaken with the objective of promoting native species around the watercourse. An ecological restoration plan should be developed and implemented prior to any site works occurring.

8.14 Tree group 1007

This group comprised mostly of native species covers an area of approximately 7,500m^2 and covers the upper catchment of the stream running through the property. Native species are represented by podocarps, such as totara and kahikatea, and mature broadleaves such as puriri (*Vitex lucens*). A wide range of understory and sub-canopy native species is also present. Gum trees contribute to the forest canopy along the western margin of the stand. Due to the significant benefits of intact native tree canopy, the benefit of this to the catchment and ecological values, and the size and quality of the native trees present here, mandatory retention and preservation of the stand is recommended.

8.15 Tree group 1008

Covering an area of approximately 38,000m^2 this is a significant area of regenerating native forest. A wide range of native species was observed, with relatively few exotic weeds. The forest has a variable density of canopy cover, with some open grassed areas. Regeneration of native species on the forest floor is profuse and this is attributable to recent cessation of stock grazing within the forest. As this stand of forest is linked to native forest and watercourses on adjoining land and scenic reserve, it is likely to play an important role in ecological function. Retention, preservation, and enhancement of this area is recommended.

8.16 In addition to the above trees that are recommended for mandatory retention, the following paragraphs describe good quality trees, or trees with significant amenity that could be considered for retention in the Waimanawa Hills.

8.17 Tree group No.22

This group of four black poplar, *Populus nigra* are on an elevated portion of the site, on the steep, north-facing side of the ridge. The tree's contribution to land stability and amenity make them worthy of consideration for retention.

8.18 Tree groups No.27 & 31

These rows of poplar, *Populus nigra* and *P. yunnanensis* are on the boundary between the two adjacent properties site and the neighbouring property at 1738A State Highway 1. The amenity that these trees provide in terms of visual screening between the two properties make them worthy of consideration for retention.

8.19 Tree group No.29

This group of swamp cypress, *Taxodium distichum* are growing around a hollow in the ground adjacent to a watercourse. The species is well-adapted to wet conditions and thrive in waterlogged soil. The trees' contribution to stormwater amelioration make them worthy of consideration for retention, particularly if a wetland were to be established in this area to accommodate stormwater treatment.

8.20 Tree No.36

This kahikatea, *Dacrycarpus dacrydioides* is a relatively small native tree that could be considered for retention in conjunction with Tree No.50 (kawaka, *Libocedrus*). Tree No.36 is at the lower end of the basin below the kawaka. Kahikatea are well-adapted to wet conditions and this tree may therefore be retained if the basin were to be used as a stormwater treatment device, with minimal alteration to the landform.

8.21 Tree group No.41

This row of totara, *Podocarpus totara* grows on the embankment of a drainage channel. This water feature has existed for a considerable time, as the close-planted totara have reached mature stature. The trees' contribution to stormwater amelioration and water quality make them worthy of consideration for retention.

8.22 Trees No.47-49

These are three individual specimen exotic species that have excellent form and health. They are swamp cypress, London plane and pin oak. The contribution of mature trees to the landscape makes these specimens worthy of consideration for retention, if adequate space is created to support the continued growth and development of these trees.

8.23 Tree groups No.110, 111

These two rows of totara appear to be remnants of an old shelterbelt system. While the trees are not in good condition due to the effects of stock trampling and rubbing, the trees, if retained and maintained could be a significant feature of the site.

These trees have been removed subsequent to the assessment.

8.24 Tree No.211

This individual specimen of English oak, *Quercus robur* has excellent form and health. The contribution of mature trees to the landscape makes this specimen worthy of consideration for retention if adequate space is created around the tree to support its continued growth and development.

WAIMANAWA VALLEY

8.25 The following paragraphs describe the trees and groups of trees that are recommended for mandatory retention. Note that many of these are within the 20m riparian margin of the streams.

8.26 Tree groups No.1, 13 & Tree No.9

These groups and solitary specimen of totara (*Podocarpus totara*) are significant representatives of the quality of native trees that inhabit the southern and eastern banks of the streams along the western and partial northern boundaries of the site. A number of other species of podocarp such as rimu (*Dacrydium cupressinum*), tanekaha (*Phyllocladus trichomanoides*) and kahikatea (*Dacrycarpus dacrydioides*) are also present, along with many native broadleaf species and subcanopy species. These areas should be protected, preserved and enhanced as part of future subdivision proposals.

8.27 Tree groups 25, 26

On a steep embankment above the stream that meanders through the southern aspect of 83 Valerie Close is these two groups containing kanuka (*Kunzea robusta*), mahoe (*Melicytus ramiflorus*), mapou (*Myrsine australis*) and emergent podocarps, tanekaha and totara. These groups are representative of other areas containing native revegetation that should be preserved and protected.

8.28 Tree group 84

A row of significant sized Monterey cypress trees growing from the top of a bank on the southern side of the stream tributary. The macrocarpa trees have significant character and contribute to stream bank stability. These trees should be retained and protected, with no earthworks within a 20m buffer from the base of the trees.

8.29 The following paragraphs describe the trees and groups of trees that are considered noteworthy but not recommended for mandatory retention in Waimanawa Valley. In many cases these trees are noteworthy due to arboricultural management practices required, or due to potential ownership issues.

8.30 Tree groups No.12, 14

These mixed groups contain trees of merit by virtue of their location close to the riparian margin. Removal of lesser quality trees and retention and protection of better-quality trees should be subject to arboricultural management as part of future development plans.

8.31 Tree groups 34, 36, 37

These group contain many good quality deciduous exotic trees, some of which may be suitable for retention or relocation as part of large-scale landscape projects. Such trees can provide instant mature tree effect to parks or avenues.

8.32 Tree group 38

A linear row of poplar follows the northern boundary of the properties on the southern side of Valerie Close. It was noted that portions of this row have been planted outside of the properties and may therefore be within the public road reserve or private road that is part of 83 Valerie Close. Any upgrade to Valerie Road may need to consider potential impacts on these trees.

8.33 Tree groups 43, 60

These shelterbelts of large Tasmanian blackwood and Japanese cedar are located on neighbouring properties at 50 Mason Heights and 81 Morrison Drive, respectively. Consideration of these trees may be required in relation to any future earthworks.

8.34 Tree 49, 63 & tree groups 50, 64

Various native tree specimens outside of the covenanted areas at 49 Mason Heights. Tree group 64 includes puriri, pōhutukawa, makomako and a number of exotic trees and shrubs growing at the top of a ridge. Rewarewa, rimu and totara specimen trees adjacent to the existing driveway and dwellings are also prominent trees on this site.

8.35 Tree groups 51-57, 59

These are groups of mostly native trees of variable quality growing within Lot 6 DP 150976. Group 52 includes exotic species (pines and gum). The majority of the trees are totara. Puriri, kahikatea, mapou, mahoe, ponga and ti kouka are also represented. Stock grazing has degraded the land compromising the undergrowth and damaging many of the trees. Tree group 51 is within the riparian margin of a small stream. Parts of groups 52 & 53 are within the riparian margin of the tributary of Mahurangi River.

8.36 Tree group 58

Large Monterey cypress (*Cupressus macrocarpa*) trees near the northern boundary of the plan change area and on top of the ridge, making them highly visible.

8.37 Tree groups 61, 62

Tree group 61 is at 43 Mason Heights and is a highly visible stand on the flanks of the ridge, when viewed from the existing urban extent on Mason Heights. This stand of trees includes some gum (*Eucalyptus sp.*) and has been degraded by stock grazing. Tree group 62 occupies the slopes of a basin on the northern side of the ridge at 49 Mason Heights. Both groups are dominated by totara, but also include rimu and smaller native trees and tree ferns.

8.38 Tree group 69

A prominent stand of English oak (*Quercus robur*) growing adjacent to State Highway 1. These trees, along with groups 67 and 70 are highly visible. The oak trees contain a heavy infestation of English ivy (*Hedera helix*) smothering their trunks.

8.39 Tree groups 77-82

Growing on the banks of the tributary of the Mahurangi River, within 40 Valerie Close and 49 Mason Heights, these groups of tree are within the riparian margin. The groups contain native and exotic trees. Careful extraction of the exotic species (poplar and coast banksia) should be carried out as part of the improvements to the riparian margin.

8.40 Tree groups 90, 91

These trees are associated with an existing covenant area and stream network at 40 Valerie Close.

8.41 The following table sets out specifications of trees that have been assessed using the criteria of the 'Guidelines for Nominating a Notable Tree for Evaluation' for the Auckland Unitary Plan.

Table 1 – assessment of trees against the Auckland Unitary Plan criteria in 'Guidelines for Nominating a Notable Tree for Evaluation'.

WAIMANAWA VALLEY										
Tree No.	**Species**		**Age and health**			**Character**	**Size**	**Visual contribution**	**Total score**	**Special factors**
	common name	botanical name	Age	Vigour and Vitality	subtotal					
1	totara	*Podocarpus totara*	41-60 (2-5)	High (2-5)	5	not exceptional	average (0)	in back yard or gully (2)	7	nil
9	totara	*Podocarpus totara*	81-100 (3-8)	Average (3-8)	6	not exceptional (0)	average (0)	in back yard or gully (2)	8	nil
65	gum	*Eucalyptus sp*	41-60 (2-5)	Average (2-5)	4	not exceptional (0)	average (0)	main road (10)	14	nil
67	black poplar	*Populus nigra*	41-60 (2-5)	High (2-5)	5	not exceptional (0)	average (0)	main road (10)	15	nil
69	English oak	*Quercus robur*	61-80 (2-6)	Average (2-6)	6	not exceptional (0)	average (0)	main road (10)	16	nil
84	Monterey cypress	*Cupressus macrocarpa*	81-100 (3-8)	Average (3-8)	6	exceptional example locally (5)	average (0)	in backyard or gully (2)	13	nil

WAIMANAWA HILLS								
	Species	**Dimensions**	**Age and health**	**Character**	**Size**			

Tree No.	common name	botanical name	height (m)	trunk dia. (mm)	crown spread	Age	Vigour and Vitality	subtotal			Visual contribution	Total score	Special factors
50	kawaka	*Libocedrus plumosa*	21.6	1058	6	61-80 (2)	low (2)	4	not exceptional (0)	> 25% larger than average (10)	in back yard or gully (2)	16	nil

Notes:

Age has been estimated based on size of the tree and expected growth rates.

Character and size ratings have been assumed without detailed assessment of other trees of the species in the local area or region.

9 RECOMMENDATIONS

9.1 Trees that warrant mandatory retention, and those that should be considered for retention and/or require arboricultural management are identified on the plans provided in Appendix A of this report.

9.2 Retention and protection of all substantial native trees and contiguous areas of native forest should occur as part of the plan change process.

9.3 The southern boundary fence line of Waimanawa Hills should be redefined to align with the dripline edge of the native trees at the margin of the forest that includes Avice Miller Scenic Reserve and the southern end of 1768 State Highway 1.

9.4 Retention of groups of native trees on the elevated ridgelines is recommended due to the contribution that these trees make to amenity, wildlife habitat, ground stability and other values.

9.5 Exclusion of stock from areas containing native trees is recommended to protect these important trees.

9.6 Wherever trees are to be retained on the site, sufficient space must be provided for them to ensure that they can be sustainably retained. Arboricultural input should be sought before any decisions are made in relation to the layout for land-use and development in the vicinity of the trees that are indicated as being worthy of retention, including those in covenant areas and riparian margins.

9.7 Safe and healthy retention of the trees that are to be retained requires that they are given adequate space in the design and layout of future subdivision schemes. The layout of the road network, lot boundaries, drainage systems and other network utilities, reserve areas and other features should be confirmed with arboricultural input where trees exist and are to be retained on site.

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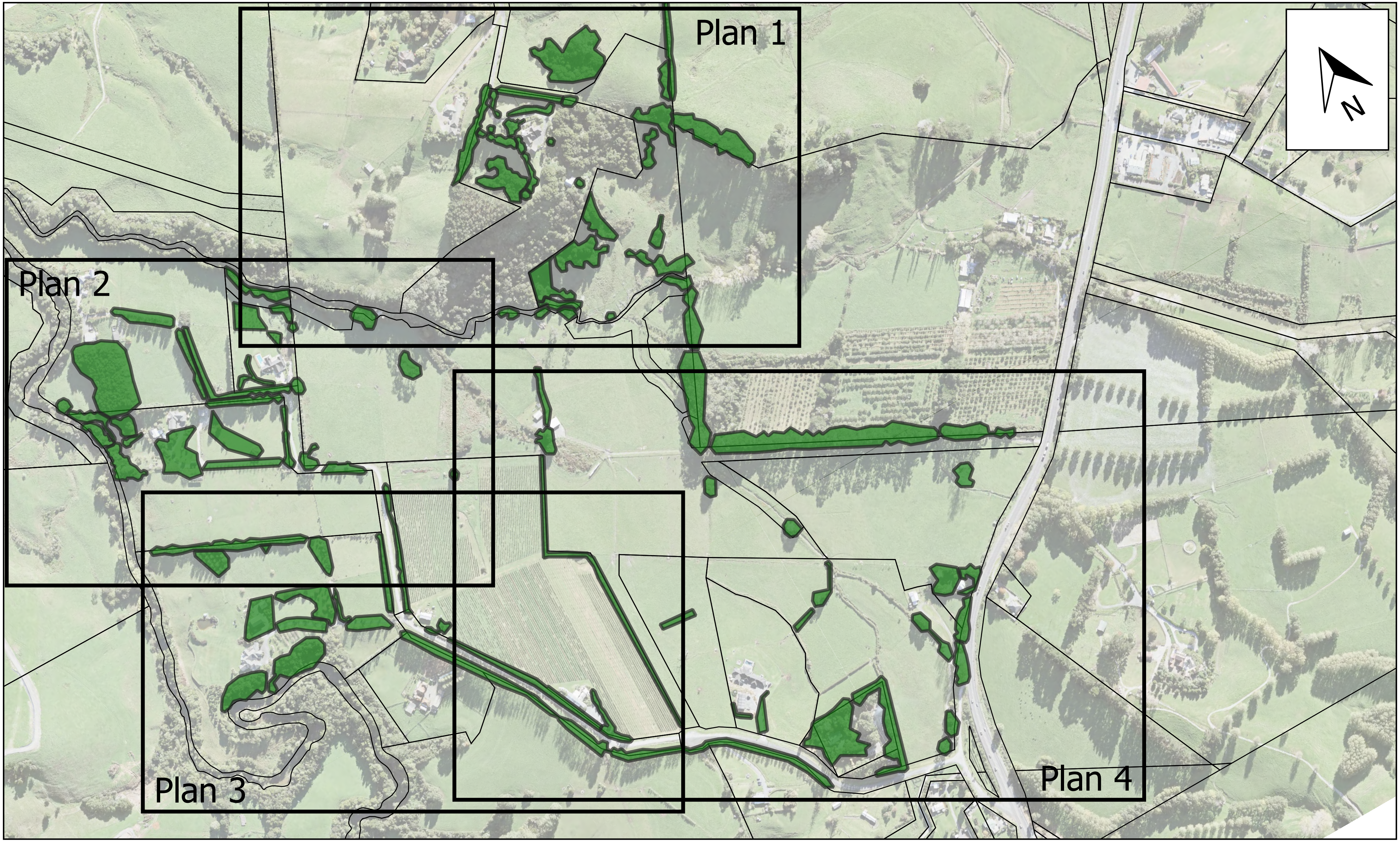


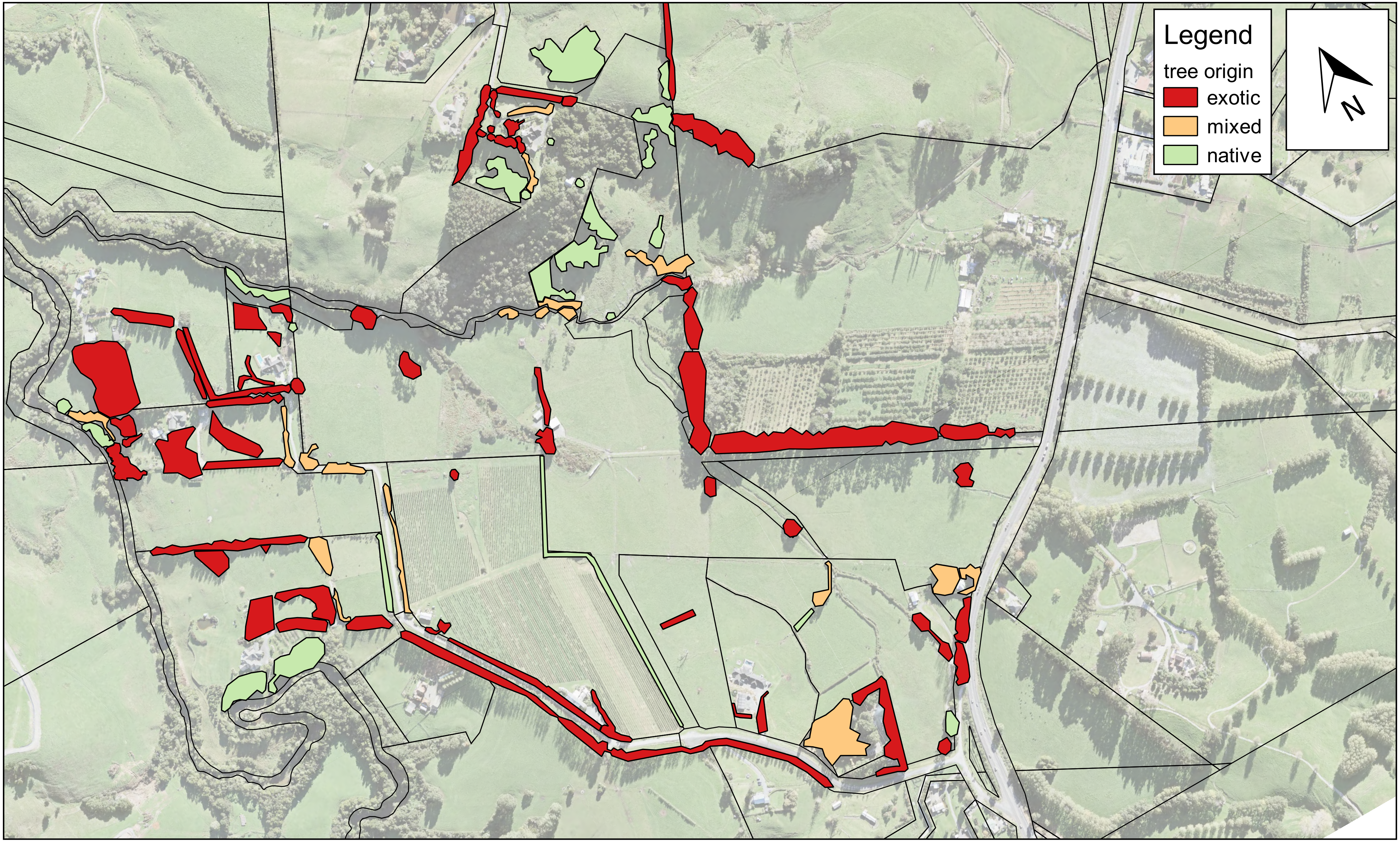
CRAIG WEBB
Consultant Arborist

Title: Overview and key to Plans 1-4
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-01



CRAIG WEBB
Consultant Arborist

Title: Tree Origin Plan - Overview
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-02

CRAIG WEBB
Consultant Arborist

Title: Plan 1 - Tree retention status - Mason Heights
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P12

CRAIG WEBB
Consultant Arborist

Title: Plan 1 - Tree classification - Mason Heights
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P11

CRAIG WEBB
Consultant Arborist

Title: Plan 2 - Tree classification - Valerie Close (123-127)
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P21

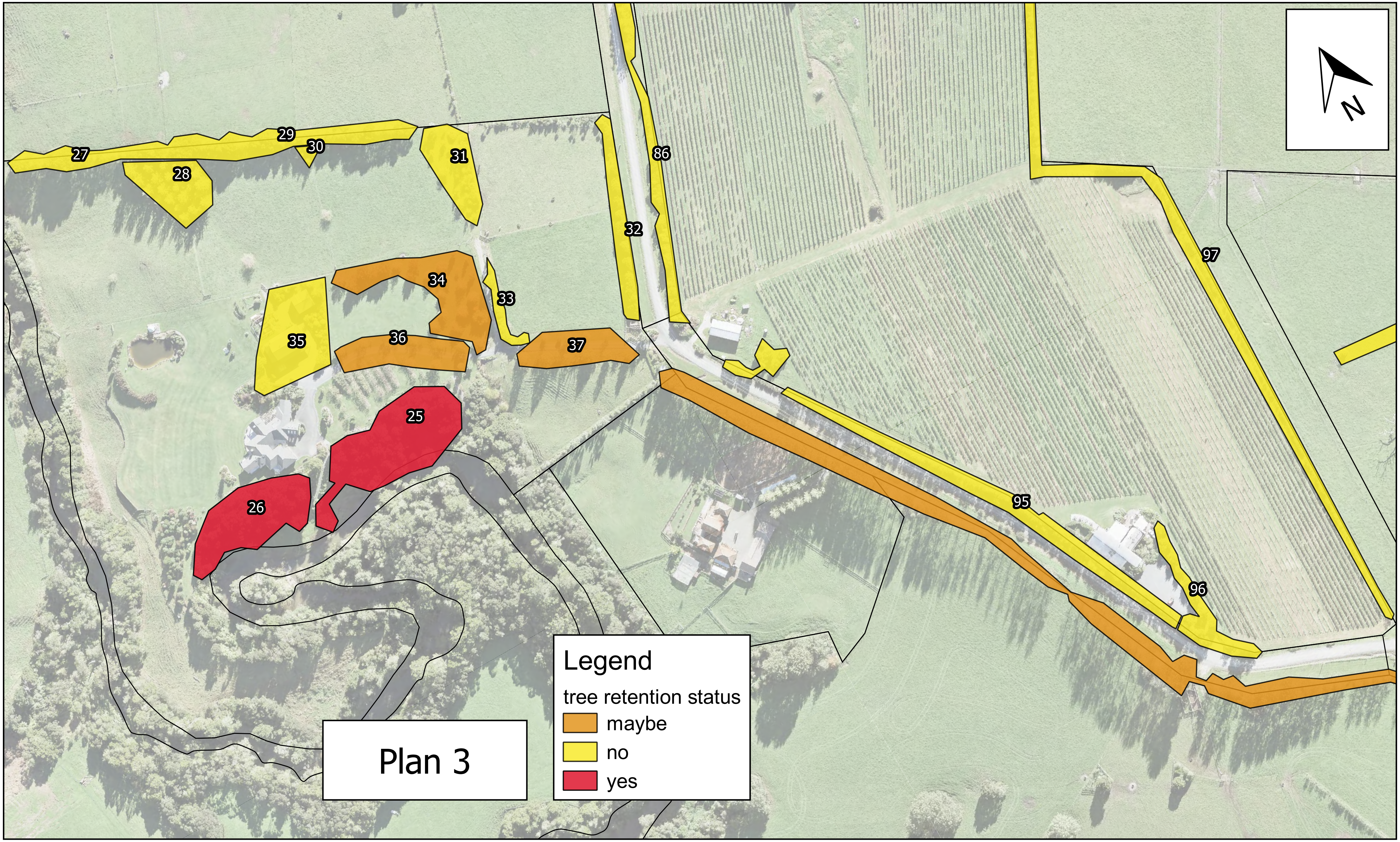
CRAIG WEBB
Consultant Arborist

Title: Plan 2 - Tree retention status - Valerie Close (123-127)
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P22



![CRAIG WEBB Consultant Arborist]

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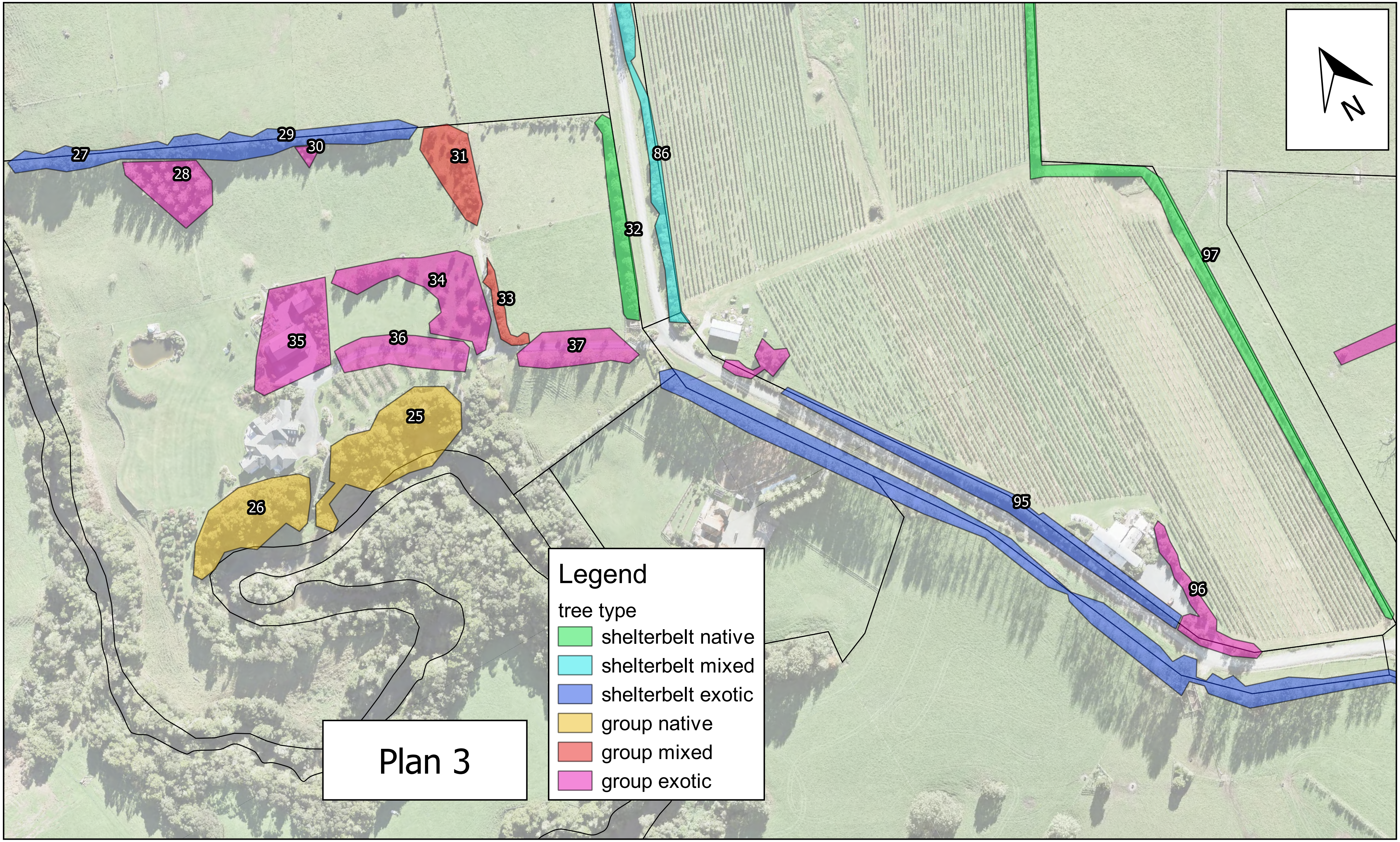
Consultant Arborist

Title: Plan 3 - Tree retention status - Valerie Close (46, 83)
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P32



CRAIG WEBB
Consultant Arborist

Title: Plan 3 - Tree classification - Valerie Close (46, 83)
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P31

CRAIG WEBB
Consultant Arborist

Title: Plan 4 - Tree retention status - Valerie Close and SH1
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P42

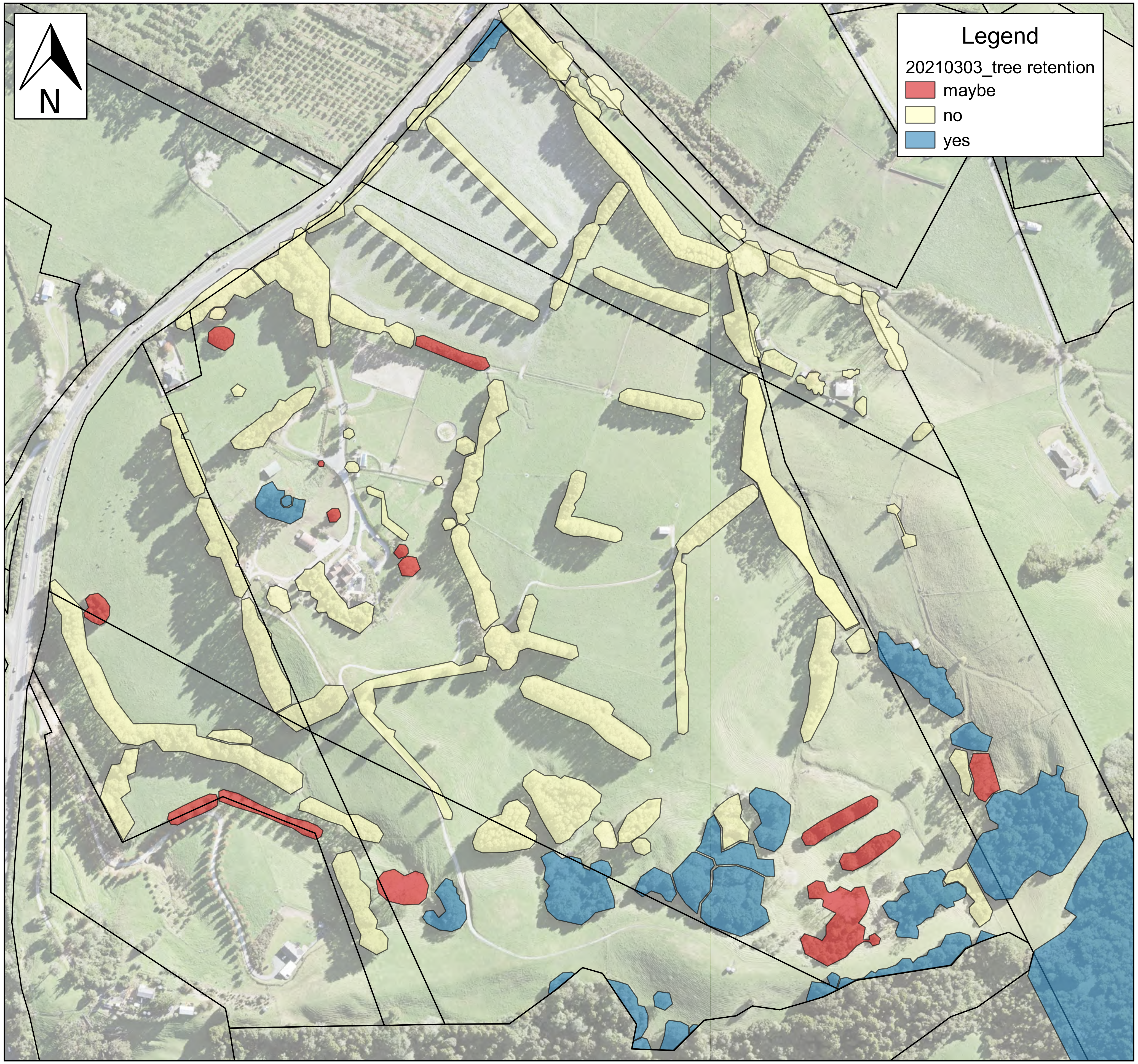
CRAIG WEBB
Consultant Arborist

Title: Plan 4 - Tree classification - Valerie Close and SH1
Project: Warkworth South - Waimanawa Valley
Client: OsborneHay

Date: 15 June 2022

Version: 03

Plan No.: J2400-03-P41



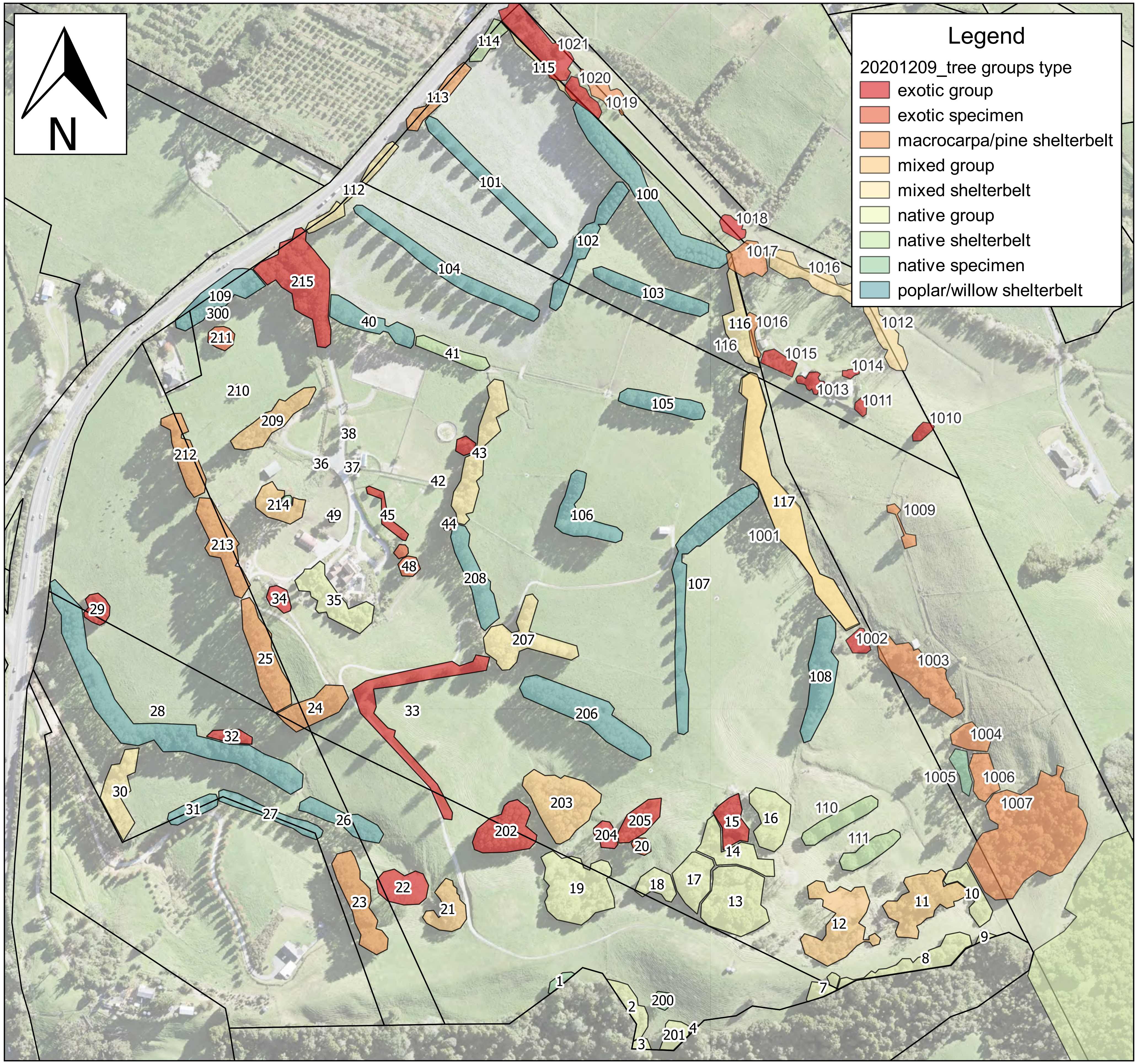
CRAIG WEBB
Consultant Arborist

Title: Overview Tree retention classification
Project: Warkworth South - Waimanawa Hills
Client: Tattico

Date: 15 June 2022

Version: 02

Plan No.: J2351-02-02



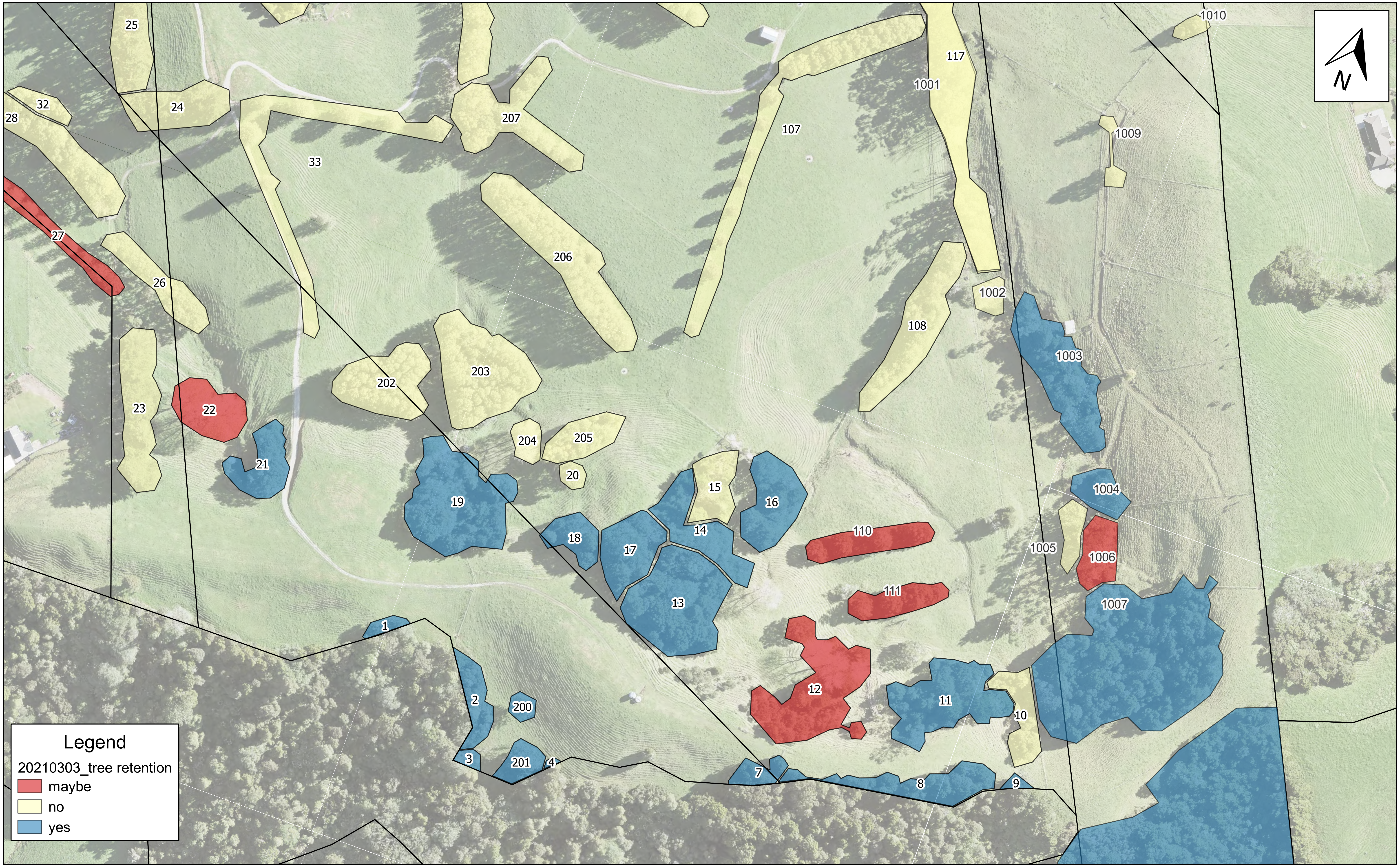
Title: Tree classification - Overview
Project: Warkworth South - Waimanawa Hills
Client: Tattico

CRAIG WEBB
Consultant Arborist

Date: 15 June 2022

Version: 02

Plan No.: J2351-02-01



Title: Tree retention classification - southern
Project: Warkworth South - Waimanawa Hills
Client: Tattico

Date: 15 June 2022

Version: 02

Plan No.: J2351-02-N2

CRAIG WEBB
Consultant Arborist

Title: Tree classification - southern
Project: Warkworth South - Waimanawa Hills
Client: Tattico

Date:15 June 2022

Version: 02

Plan No.: J2351-02-S1

Title: Tree classification - northern
Project: Warkworth South - Waimanawa Hills
Client: Tattico

Date: 15 June 2022

Version: 02

Plan No.: J2315-02-N1

CRAIG WEBB
Consultant Arborist

Title: Tree retention classification - northern
Project: Warkworth South - Waimanawa Hills
Client: Tattico

CRAIG WEBB
Consultant Arborist

Date: 15 June 2022

Version: 02

Plan No.: J2351-02-N2

ATTACHMENT 20

APPENDIX 15

STORMWATER MODELLING REPORT

STORMWATER MODELLING REPORT

FOR

PROPOSED WARKWORTH SOUTH

PLAN CHANGE AREA

Maven Associates	Job Number 211001		Rev E
Job Title 1711 & 1723 State Highway 1, Warkworth Plan Change Area **Title** Stormwater Modelling Report	**Author** YW	**Date** 18.01.23	**Checked** AO

CONTENTS

1 INTRODUCTION

1.1 PROJECT

Maven Associates have been engaged to assist in the development of a plan change application including determining setting baseline scenarios for predevelopment scenarios in various storm events and assessing the effects of development specific to the proposed plan change area (PCA) at 1711 & 1723 State Highway 1, Warkworth. Figure 1.1 shows the study area.

The objective of this report is to provide a preliminary analysis of the overland flowpaths in terms of peak flows and water level constraints. This will enable the assessment of mitigation measures required to ensure the proposal does not result in any adverse effect on the downstream properties. The analysis will be for a range of annual return period storms and include rainfall increases due to climate change.

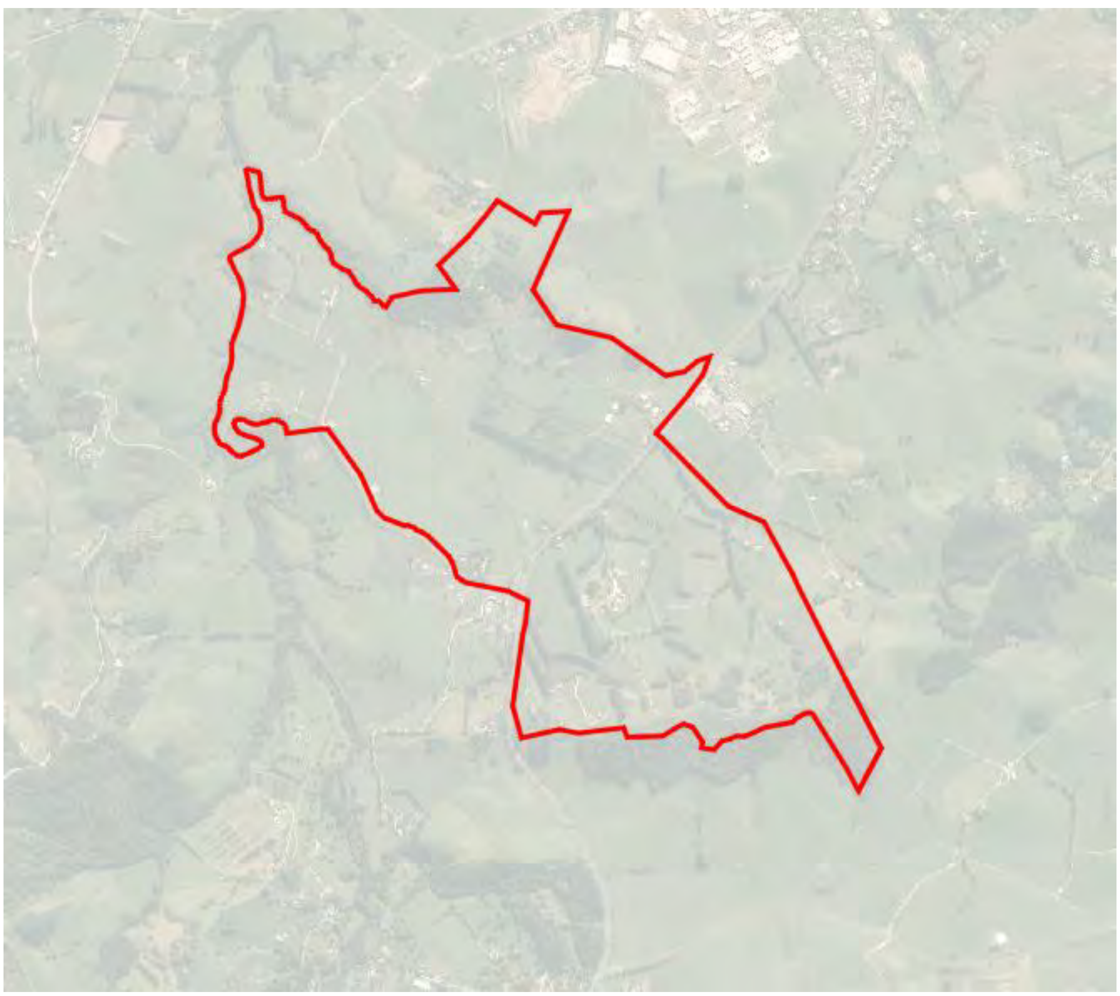


Figure 1.1 – Catchment Delineation

1.2 PREVIOUS STUDY

A Rapid Flood Hazard Assessment was undertaken by DHI in 2009. This was done on a 10m grid. This assessment did not include either climate change or land development changes.

1.3 PROPOSED STRATEGY

A 2D model will be used in the area around the Scheme Plan boundary. This will enable the identification of all overland flowpaths. The upper catchment area will be modelled as individual catchments to provide boundary inflows. All analyses will be done using TP108, HEC-HMS and HEC-RAS in accordance with guidelines of the Auckland Council Stormwater Code of Practice.

1.4 SCENARIOS MODELLED

Table 1.1 shows the scenarios modelled. Scenarios will indicate the difference between today's existing flow environment and the future.

Scenario	**Return period**	**Land-use**	**Rainfall**
1	100-year	Existing	Existing - historical
2	100-year	Existing	Climate change
3	100-year	Developed	Climate change
4	50-year	Developed	Climate change
5	20-year	Developed	Climate change
7	10-year	Developed	Climate change

Table 1.1 – Scenarios modelled

1.5 SOURCES OF DATA

Attribute	**Organisation**
Catchment Plans	Auckland Council Geomaps
Contours	LINZ DEM 1m. The Terrain datum is New Zealand Vertical Datum. LiDAR/Site Survey by Parrallax Ltd. LiDAR/Site Survey by Maven Associates.
Flow & WL data	Healthywaters
Flood level evidence	None

Table 1.2 – Source of Data

1.6 REFERENCE TECHNICAL DOCUMENTS

- AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION. CHAPTER4 – STORMWATER, VERSION 3.00
- ACCEPTABLE SOLUTIONS AND VERIFIABLE METHODS, DOCUMENT E1 SURFACE WATER, MINISTRYOF BUSINESS, INNOVATION AND EMPLOYMENT,
- AUCKLAND COUNCIL TP108

2 HYDROLOGICAL MODELLING WITH HEC-HMS

2.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the catchments,
2. Use Tp108 to calculate parameters,
3. Use HEC-HMS to create a rainfall hyetograph and flow hydrographs,

2.2 RAINFALL DATA

TP108 gives the following rainfall depths which are then adjusted for climate change as shown in Table 2.2. Climate change factor have been applied in accordance with Auckland Council code of practice (Version 3) assuming a 2.1°C increase in temperature as shown below;

Annual Exceedance probability exceedance	**Percentage Increase in 24-hour design rainfall depth due to future climate change***
50%	9.0%
10%	13.2%
5%	15.1%
2%	16.8%
1%	16.8%

* Assuming 2.1°C increase in temperature

Table 2.1 - Climate change factors

In accordance with TP108 section 2.3 an areal reduction factor (ARF) has been applies as the catchment has an area above 10 km2. ARF adjusted rainfalls are also shown in table 2.2. An ARF factor of 0.92 was used per TP108 table 2.2.

	TP108	**Climate change**	**ARF adjusted**
2-year	112	122	112
10-year	170	192	176
20-year	208	239	220
50-year	238	278	256
100-year	270	315	290

Table 2.2 – Rain depths

2.3 CATCHMENT SIZE

Figure 2.1 shows the catchment area modelled. Naming conventions of the subcatchments have been split between upstream and downstream of the PCA. The upper catchments are named upstream A to F and downstream catchments, downstream A to H. The yellow area (including the red boundary) is the 2D grid with the excess *Rain*. The catchment outflow of the Mahurangi River is at the northern edge. The Scheme Plan boundary is blue. The total area is 49km^2.

2.4 LAND-USE AND SOILS

The soil is assumed to be Group C with a curve number of 74. The land cover for the existing scenario has been obtained via delineation of impervious areas shown on the Auckland Council GIS aerial. The land-use is predominantly Rural-production and Rural-coastal with a small area of conservation, according to the AUP, see Figure 2.2. For the proposed scenario, the MPD (maximum probable development) of the proposed zoning has been used as well as MPD for the yellow designated FutureUrban. The FutureUrban zoning included in the developed scenarios assumes an average impervious area of 60%. The combined curve numbers and initial abstractions have been calculated according to TP108 and may be found in appendix D based on existing and developed land-use. Only catchments *Rain* and upstream catchment *F* will have a change in impervious area.

The full TP108 details to calculate the peak flows and times of concentration may be found in Appendix D. The total catchment area and the time of concentration suggests an area reduction factor of 0.92. This has been applied to the rainfall as per Table 2.2. This data can now be inserted into a HEC-HMS model.

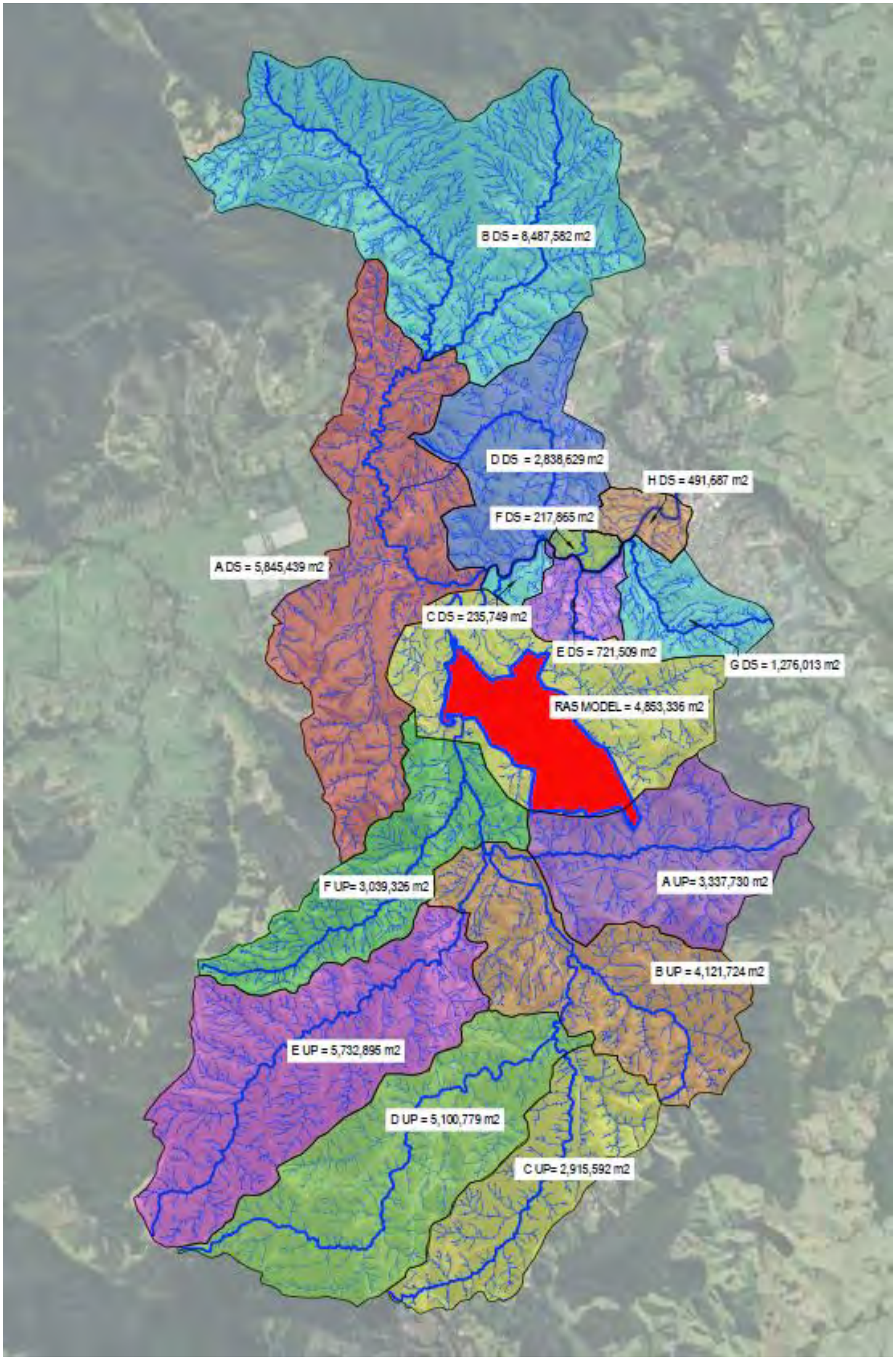


Figure 2.1 – Catchment Boundary

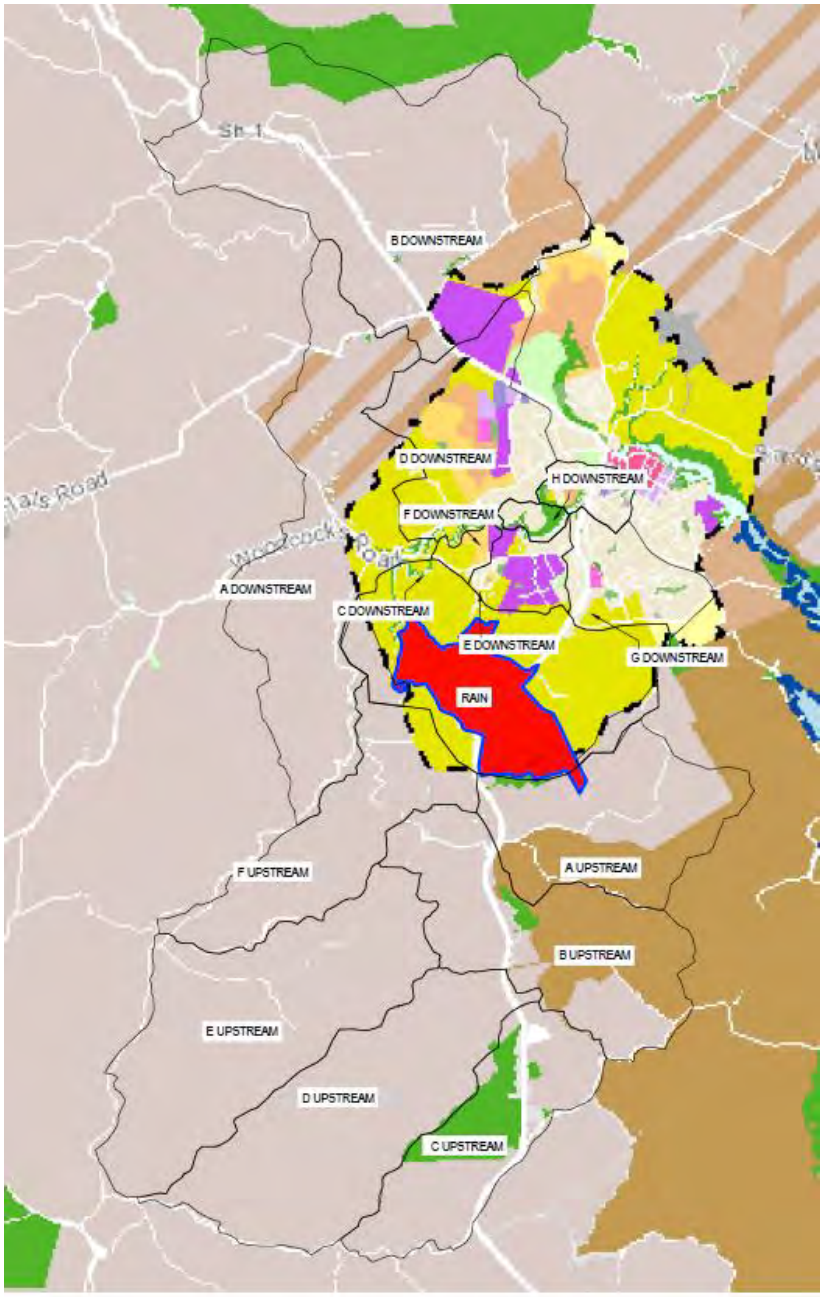


Figure 2.2 – Land-use zones

		Upstream of PCA							Downstream of PCA							
	Impervious %	Rain	A	B	C	D	E	F	A	B	C	D	E	F	G	H
Total		485	334	412	292	510	573	304	585	849	24	284	72	22	128	49
Rural / Vegetated area	1%	471	331	405	291	481	572	302	581	845	12	276	27	22	15	10
Urban MPD	60%	0	0	0	0	0	0	0	0	0	12	5	0	0	113	39
Open Space - Conservation	1%	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transort Corridor	90%	13	3	7	1	0	0	2	4	4	0	3	0	0	0	0
Residential - Large Lot	35%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Single House	60%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Mixed Housing Urban	60%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Terrace & Apartment	70%	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Business - Local Centre Zone	100%	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Impervious		16.42	6.01	10.35	3.81	4.81	5.72	4.82	9.41	12.05	7.32	8.46	45.27	0.22	67.71	23.60
Pervious		468.91	327.76	401.82	287.75	505.27	567.57	299.11	575.13	836.71	16.25	275.40	26.88	21.57	59.89	25.57

Figure 2.3 – Existing land use calculations

		Upstream of PCA							Downstream of PCA							
	Impervious %	Rain	A	B	C	D	E	F	A	B	C	D	E	F	G	H
Total		485	334	412	292	510	573	304	585	849	24	284	72	22	128	49
Rural / Vegetated area	1%	51	331	405	291	481	572	285	581	845	12	276	27	22	15	10
Urban MPD to	60%	276	0	0	0	0	0	17	0	0	12	5	0	0	113	39
Open Space - Conservation	1%	5.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transort Corridor	90%	13.0	3	7	1	0	0	2	4	4	0	3	0	0	0	0
Residential - Large Lot	35%	13.9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Single House	60%	22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Mixed Housing Urban	60%	74.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Residential - Terrace & Apartment	70%	25.4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Business - Local Centre Zone	100%	3.4	0	0	0	0	0	0	0	0	0	0	45	0	0	0
Impervious		261.76	6.01	10.35	3.81	4.81	5.72	15.10	9.41	12.05	7.32	8.46	45.27	0.22	67.71	23.60
Pervious		223.57	327.76	401.82	287.75	505.27	567.57	288.83	575.13	836.71	16.25	275.40	26.88	21.57	59.89	25.57

Figure 2.4 – Developed land use calculations

2.5 HEC-HMS MODEL

The data was then transferred to HEC-HMS. Figure 2.5 shows the model set-up. Calculations for the time of concentration of the reaches may be found in Appendix D. The reaches between junctions have been incorporated respectively to set the time it would take to arrive at the downstream connection.

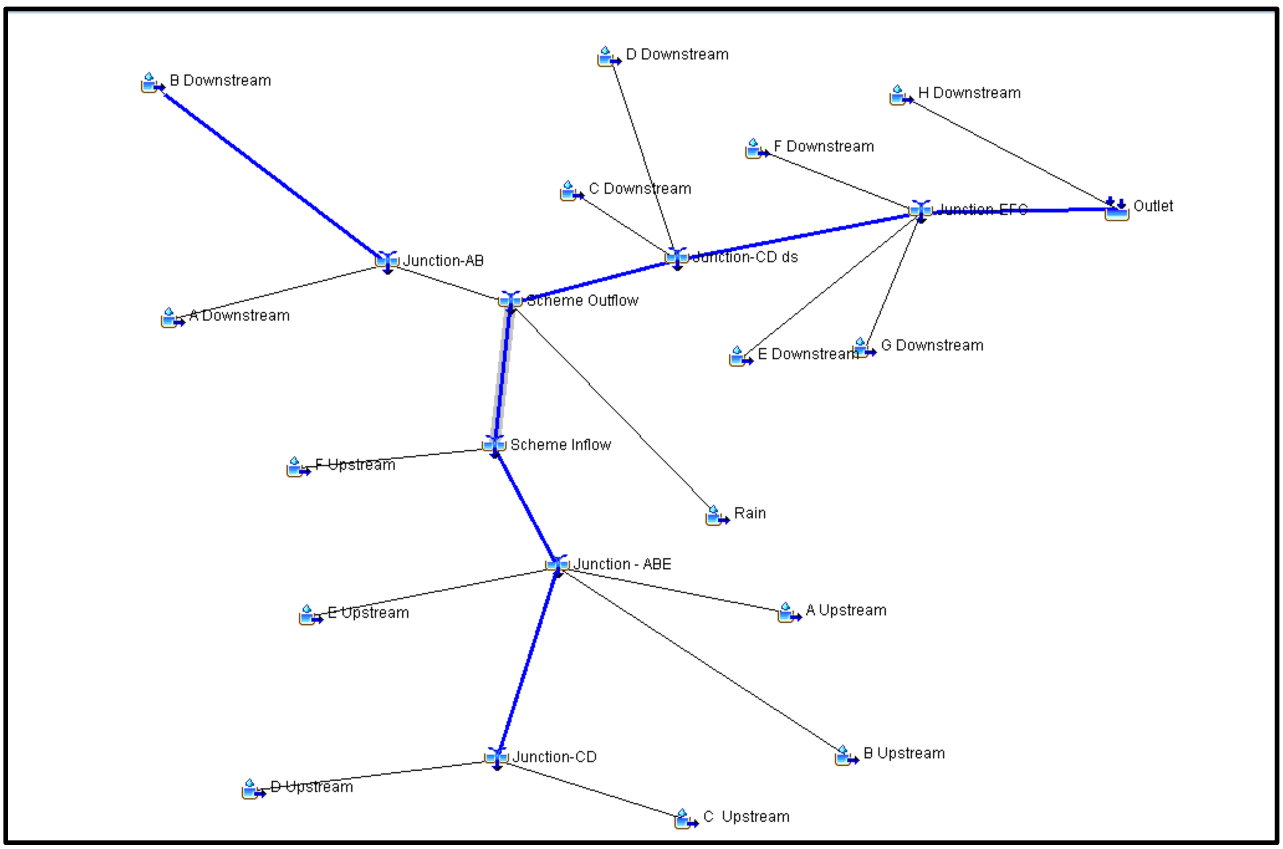


Figure 2.5 – HEC-HMS model set-up

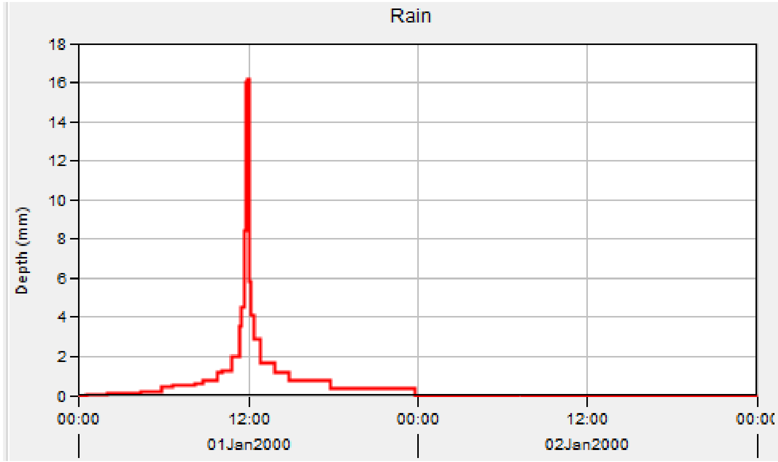


Figure 2.6 shows the 100-year developed land-use rainfall hyetograph for the grid.

Figure 2.6 – Rainfall excess, 100-year, climate change, developed

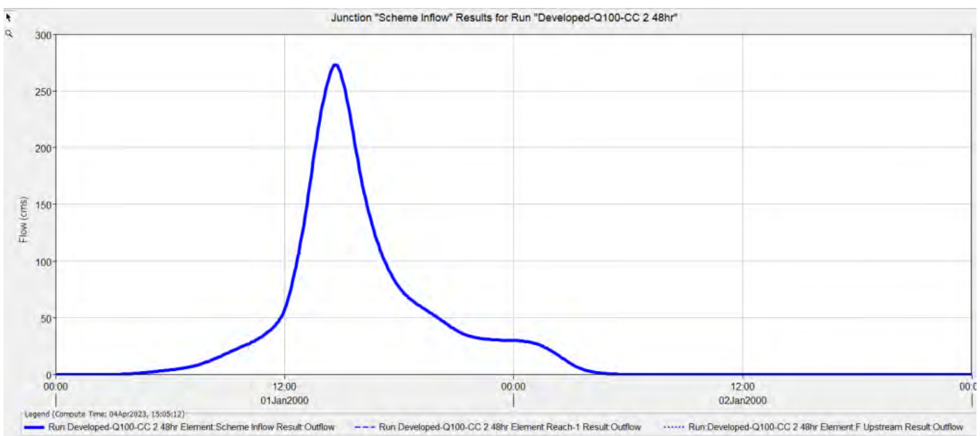


Figure 2.7 shows the hydrograph for scheme inflow for the 100-year storm with climate change rain and developed.

Figure 2.7 – Flow hydrograph, 100-year, climate change, developed

2.5.1 Effects of climate change

Figure 2.8 shows the global summary of the existing catchment flows against those that are expected to occur due to climate change and development. The scheme inflow has increased from 224m^3/s to 273m^3/s. Most of the 49m^3/s increase is due to climate change. The volume increase is almost 0.91 million m^3.

At the scheme outflow the changes are 347m^3/s to 421m^3/s. Thus, the catchment is expected to yield 74m^3/s, (this entire increase is due to climate change as explained in section 2.5.2). This increase is 17%. The volume increase is 1.6 million m^3.

Figure 2.8 – Global summary of flows and volumes for the 100-year storm (historical rain, existing land-use vs climate change rain and existing land-use vs. historical rain, proposed land-use vs climate changed rain and developed)

Global Summary Results for Run "Existing-Q100-existing 3"

Project: Warkworth South   Simulation Run: Existing-Q100-existing 3

Start of Run: 01Jan2000, 00:00   Basin Model: Existing Land-Use
End of Run: 02Jan2000, 00:00   Meteorologic Model: 100yr-existing-existing-land
Compute Time: 04Apr2023, 11:34:28   Control Specifications: 24hr (Maven)

Show Elements: All Elements   Volume Units: MM (•) 1000 M3   Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.8454	55.71354	01Jan2000, 13:50	999.18175
A Upstream	3.3380	36.86217	01Jan2000, 13:20	576.96580
B Downstream	8.4876	91.34174	01Jan2000, 13:25	1462.51227
B Upstream	4.1220	46.67449	01Jan2000, 13:20	715.49697
C Downstream	0.2357	5.01350	01Jan2000, 12:25	46.24902
C Upstream	2.9156	35.38431	01Jan2000, 13:10	506.20497
D Downstream	2.8386	36.46248	01Jan2000, 13:00	496.99865
D Upstream	5.1008	56.15127	01Jan2000, 13:20	878.69326
E Downstream	0.7215	16.17126	01Jan2000, 12:25	156.27172
E Upstream	5.7329	58.75500	01Jan2000, 13:35	982.55892
F Downstream	0.2179	4.58160	01Jan2000, 12:20	38.57723
F Upstream	3.0393	38.64703	01Jan2000, 13:00	529.75106
G Downstream	1.2760	25.09295	01Jan2000, 12:30	267.38809
H Downstream	0.4917	11.32758	01Jan2000, 12:20	101.86108
Junction - ABE	21.2093	208.34781	01Jan2000, 13:55	3628.33498
Junction-AB	14.3330	132.15756	01Jan2000, 14:50	2411.57944
Junction-CD	8.0164	90.79421	01Jan2000, 13:15	1384.89822
Junction-CD ds	46.5092	354.71174	01Jan2000, 16:05	7668.43491
Junction-EFG	48.7246	359.38568	01Jan2000, 16:45	8008.70568
Outlet	49.2163	360.41859	01Jan2000, 17:25	7969.16268
Rain	4.8533	54.41783	01Jan2000, 13:20	844.55754
Reach-1	21.2093	208.07416	01Jan2000, 14:45	3564.45241
Reach-2	8.0164	90.70163	01Jan2000, 14:20	1353.31328
Reach-3	8.4876	91.30646	01Jan2000, 15:00	1412.39769
Reach-4	24.2486	224.27160	01Jan2000, 15:55	3978.68919
Reach-5	43.4349	346.41930	01Jan2000, 16:10	7125.18723
Reach-6	46.5092	354.68892	01Jan2000, 16:45	7546.46865
Reach-7	48.7246	359.38568	01Jan2000, 17:25	7867.30160
Scheme Inflow	24.2486	224.27160	01Jan2000, 14:40	4094.20347
Scheme Outflow	43.4349	346.50079	01Jan2000, 15:30	7234.82617

Global Summary Results for Run "Existing-Q100-existing-CC 3"

Project: Warkworth South Simulation Run: Existing-Q100-existing-CC 3

Start of Run: 01Jan2000, 00:00 Basin Model: Existing Land-Use
End of Run: 02Jan2000, 00:00 Meteorologic Model: 100yr-CC-existing-land-use
Compute Time: 04Apr2023, 11:25:23 Control Specifications: 24hr (Maven)

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.8454	67.89074	01Jan2000, 13:50	1220.76543
A Upstream	3.3380	44.93661	01Jan2000, 13:20	704.70863
B Downstream	8.4876	111.35746	01Jan2000, 13:25	1786.68282
B Upstream	4.1220	56.84513	01Jan2000, 13:20	873.60158
C Downstream	0.2357	6.01131	01Jan2000, 12:25	55.75929
C Upstream	2.9156	43.11220	01Jan2000, 13:10	618.28270
D Downstream	2.8386	44.41328	01Jan2000, 13:00	606.60934
D Upstream	5.1008	68.48363	01Jan2000, 13:20	1073.67741
E Downstream	0.7215	19.12037	01Jan2000, 12:25	186.00455
E Upstream	5.7329	71.63279	01Jan2000, 13:35	1200.75451
F Downstream	0.2179	5.57805	01Jan2000, 12:20	47.09980
F Upstream	3.0393	47.10883	01Jan2000, 13:00	646.89674
G Downstream	1.2760	29.80892	01Jan2000, 12:30	319.54365
H Downstream	0.4917	13.48195	01Jan2000, 12:20	121.97268
Junction - ABE	21.2093	253.81225	01Jan2000, 13:55	4433.46367
Junction-AB	14.3330	160.93311	01Jan2000, 14:45	2947.84554
Junction-CD	8.0164	110.71134	01Jan2000, 13:15	1691.96012
Junction-CD ds	46.5092	431.66357	01Jan2000, 16:05	9377.50515
Junction-EFG	48.7246	437.12556	01Jan2000, 16:45	9785.00179
Outlet	49.2163	438.34159	01Jan2000, 17:25	9738.70730
Rain	4.8533	66.26538	01Jan2000, 13:20	1030.78437
Reach-1	21.2093	253.46225	01Jan2000, 14:40	4357.48934
Reach-2	8.0164	110.56449	01Jan2000, 14:20	1654.39895
Reach-3	8.4876	111.29836	01Jan2000, 15:00	1727.08011
Reach-4	24.2486	273.06652	01Jan2000, 15:55	4866.95901
Reach-5	43.4349	421.57056	01Jan2000, 16:05	8715.13652
Reach-6	46.5092	431.59631	01Jan2000, 16:45	9232.35379
Reach-7	48.7246	437.12556	01Jan2000, 17:25	9616.73461
Scheme Inflow	24.2486	273.06652	01Jan2000, 14:40	5004.38608
Scheme Outflow	43.4349	421.69390	01Jan2000, 15:30	8845.58892

Global Summary Results for Run "Developed-Q100"

Project: Warkworth South   Simulation Run: Developed-Q100

Start of Run: 01Jan2000, 00:00   Basin Model: Developed Land-Use
End of Run: 02Jan2000, 00:00   Meteorologic Model: 100yr-existing-existing-land
Compute Time: 05Apr2023, 15:26:21   Control Specifications: 24hr (Maven)

Show Elements: All Elements   Volume Units: MM   1000 M3   Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.8454	55.71354	01Jan2000, 13:50	999.18175
A Upstream	3.3380	36.86217	01Jan2000, 13:20	576.96580
B Downstream	8.4876	91.34174	01Jan2000, 13:25	1462.51227
B Upstream	4.1220	46.67449	01Jan2000, 13:20	715.49697
C Downstream	0.2357	5.01350	01Jan2000, 12:25	46.24902
C Upstream	2.9156	35.38431	01Jan2000, 13:10	506.20497
D Downstream	2.8386	36.46248	01Jan2000, 13:00	496.99865
D Upstream	5.1008	56.15127	01Jan2000, 13:20	878.69326
E Downstream	0.7215	16.17126	01Jan2000, 12:25	156.27172
E Upstream	5.7329	58.75500	01Jan2000, 13:35	982.55892
F Downstream	0.2179	4.58160	01Jan2000, 12:20	38.57723
F Upstream	3.0393	39.32813	01Jan2000, 13:00	536.15710
G Downstream	1.2760	25.09295	01Jan2000, 12:30	267.38809
H Downstream	0.4917	11.32758	01Jan2000, 12:20	101.86108
Junction - ABE	21.2093	208.34781	01Jan2000, 13:55	3628.33498
Junction-AB	14.3330	132.15756	01Jan2000, 14:50	2411.57944
Junction-CD	8.0164	90.79421	01Jan2000, 13:15	1384.89822
Junction-CD ds	46.5092	354.24160	01Jan2000, 16:05	7835.33315
Junction-EFG ds	48.7246	358.90511	01Jan2000, 16:45	8174.93964
Outlet	49.2163	359.93801	01Jan2000, 17:25	8134.74845
Rain	4.8533	68.19996	01Jan2000, 13:10	1005.79512
Reach-1	21.2093	208.07416	01Jan2000, 14:45	3564.45241
Reach-2	8.0164	90.70163	01Jan2000, 14:20	1353.31328
Reach-3	8.4876	91.30646	01Jan2000, 15:00	1412.39769
Reach-4	24.2486	224.28327	01Jan2000, 15:55	3985.02675
Reach-5	43.4349	345.89698	01Jan2000, 16:10	7292.08547
Reach-6	46.5092	354.20834	01Jan2000, 16:45	7712.70260
Reach-7	48.7246	358.90511	01Jan2000, 17:25	8032.88737
Scheme Inflow	24.2486	224.28327	01Jan2000, 14:40	4100.60950
Scheme Outflow	43.4349	345.98777	01Jan2000, 15:30	7402.40131

Global Summary Results for Run "Developed-Q100-CC 2"

Project: Warkworth South   Simulation Run: Developed-Q100-CC 2

Start of Run: 01Jan2000, 00:00   Basin Model: Developed Land-Use
End of Run: 02Jan2000, 00:00   Meteorologic Model: 100yr-CC-developed-land-use
Compute Time: 04Apr2023, 11:34:07   Control Specifications: 24hr (Maven)

Show Elements: All Elements   Volume Units: MM (•) 1000 M3   Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
A Downstream	5.8454	67.89074	01Jan2000, 13:50	1220.76543
A Upstream	3.3380	44.93661	01Jan2000, 13:20	704.70863
B Downstream	8.4876	111.35746	01Jan2000, 13:25	1786.68282
B Upstream	4.1220	56.84513	01Jan2000, 13:20	873.60158
C Downstream	0.2357	6.01131	01Jan2000, 12:25	55.75929
C Upstream	2.9156	43.11220	01Jan2000, 13:10	618.28270
D Downstream	2.8386	44.41328	01Jan2000, 13:00	606.60934
D Upstream	5.1008	68.48363	01Jan2000, 13:20	1073.67741
E Downstream	0.7215	19.12037	01Jan2000, 12:25	186.00455
E Upstream	5.7329	71.63279	01Jan2000, 13:35	1200.75451
F Downstream	0.2179	5.57805	01Jan2000, 12:20	47.09980
F Upstream	3.0393	47.85160	01Jan2000, 13:00	653.82898
G Downstream	1.2760	29.80892	01Jan2000, 12:30	319.54365
H Downstream	0.4917	13.48195	01Jan2000, 12:20	121.97268
Junction - ABE	21.2093	253.81225	01Jan2000, 13:55	4433.46367
Junction-AB	14.3330	160.93311	01Jan2000, 14:45	2947.84554
Junction-CD	8.0164	110.71134	01Jan2000, 13:15	1691.96012
Junction-CD ds	46.5092	430.57852	01Jan2000, 16:05	9554.84443
Junction-EFG	48.7246	436.03322	01Jan2000, 16:45	9961.73207
Outlet	49.2163	437.24925	01Jan2000, 17:25	9914.85577
Rain	4.8533	80.98906	01Jan2000, 13:10	1201.88354
Reach-1	21.2093	253.46225	01Jan2000, 14:40	4357.48934
Reach-2	8.0164	110.56449	01Jan2000, 14:20	1654.39895
Reach-3	8.4876	111.29836	01Jan2000, 15:00	1727.08011
Reach-4	24.2486	273.05174	01Jan2000, 15:55	4873.82581
Reach-5	43.4349	420.48551	01Jan2000, 16:05	8892.47580
Reach-6	46.5092	430.50396	01Jan2000, 16:45	9409.08407
Reach-7	48.7246	436.03322	01Jan2000, 17:25	9792.88309
Scheme Inflow	24.2486	273.05174	01Jan2000, 14:40	5011.31833
Scheme Outflow	43.4349	420.57851	01Jan2000, 15:30	9023.55489

2.5.3 Effects of the proposed development

A graph of the flows at the scheme outflow of the existing catchment flow with climate change against flow of the developed catchment with climate change can be found in the appendix A, the table below summaries the findings.

Rain event	Land-use	Climate change	Catchments A-F (m3/s)	Rain (m3/s)	Downstream Catchment A & B (m3/s) outflow	Scheme Outflow (m3/s)
100yr	Existing	No	224.3	54.4	132.2	346.5
100yr	Existing	Yes	273.1	66.3	160.9	421.7
100yr	Developed	No	224.6	68.2	132.2	344.2
100yr	Developed	Yes	273.1	81.0	160.9	420.6

Table 2.3 – Peak flow comparison, 100-year, climate change, existing vs developed

Table 2.3 shows that the peak flow for 100year storm events exiting the scheme area (Scheme outflow) decreases by 0.9m^3/s , even though there is an increase in impervious area of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F). As shown in figure 2.8, for the developed catchment, the 100year time of peak flow of the *Rain* catchment is 13:10 and for the upstream catchments, *A to F* (Reach 4) is 15:55. This demonstrates the peak flow from the *Rain* catchment exits the catchment boundary 2 hour 45 min prior to the arrival of upper catchment peak flow.

Downstream effects

Table 2.4 below shows the peak 100year stormwater events at the catchment junctions downstream of the site. Similarly to the effects described above the it is noted that the peak flows decrease as a result of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F).

Rain event	Land-use	Climate change	Downstream Junction CD (m3/s)	Downstream Junction EFG (m3/s)
100yr	Existing	No	354.7	359.4
100yr	Existing	Yes	431.7	437.1
100yr	Developed	No	352.3	358.9
100yr	Developed	Yes	430.6	436.0

Table 2.4 Peak 100yr flows at junctions downstream of the proposed development

2.5.3 Localised event scenario

A localised event scenario has been modelled which includes an Upstream PCA 2yr event and a 100yr event within the PCA (rain catchment) and downstream catchments of the PCA 100yr ARI for before and post development, no climate change. These runs are considered necessary to understand the effects of the development on the existing scenarios.

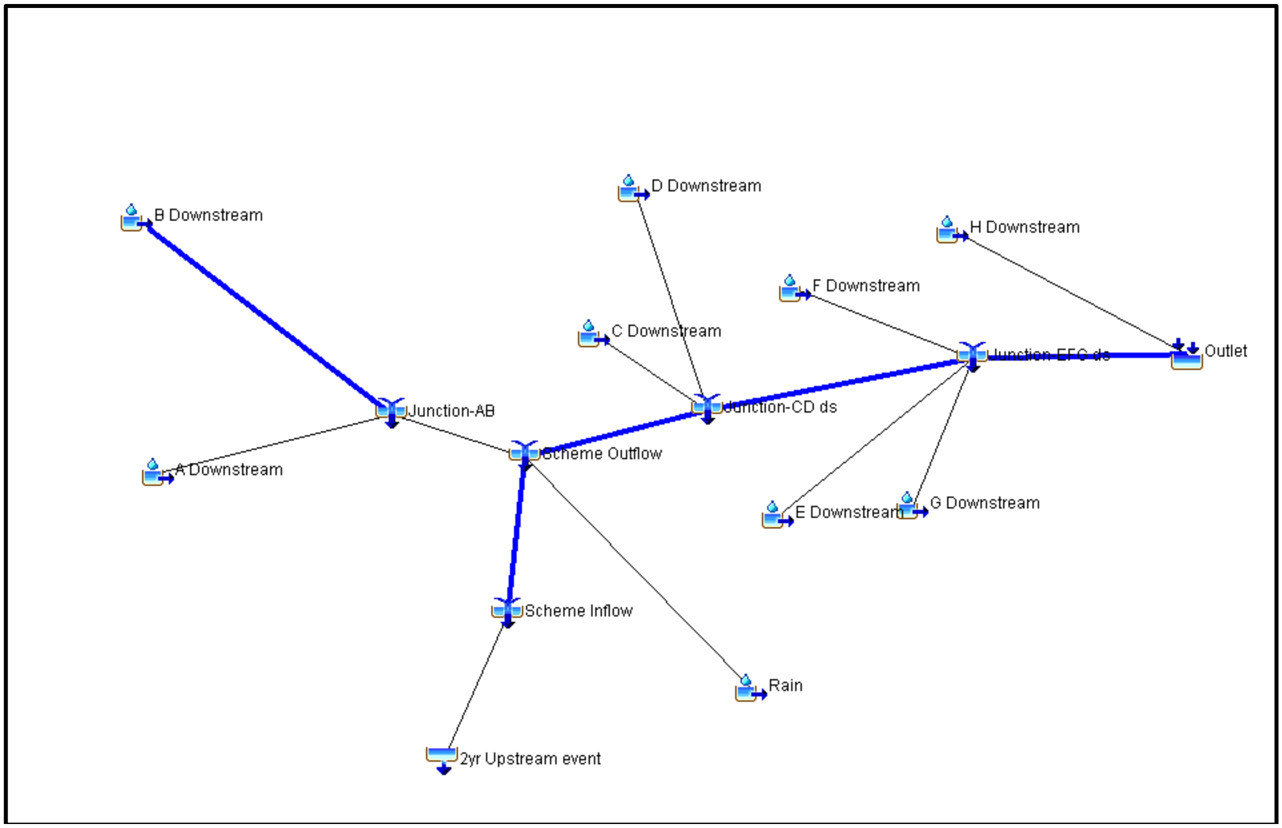


Figure 2.-9 Localised Event Scenario

Rain event	Land-use	Climate change	Scheme Outflow (m3 /s)	Downstream Junction CD (m3/s)	Downstream Junction EFG (m3/s)
100yr	Existing	No	212.6	222.8	227.6
100yr	Developed	No	212.4	222.6	227.4

Table 2.5 Peak 100yr flows at junctions downstream of the proposed development for a localised 100yr event scenario without climate change

Table 2.5 above shows the 100yr peak stormwater event for a localised 100yr event for the PCA area and downstream PCA area. Similarly to the effects described above the it is noted that the peak flows slightly decrease as a result of the development. This is explained by the decrease in time of concentration of the developed Rain catchment, which results in the runoff from the catchment reaching the Scheme outflow before the runoff from the upstream catchments (A-F).

3 HYDRAULIC MODELLING WITH HEC-RAS

3.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the perimeter for the grid,
2. Create a grid and sub-grid areas,
3. Input flow hydrographs and other boundaries
4. Input structures,
5. Run scenarios.

3.2 HEC-RAS MODEL LAYOUT

HEC-RAS software was used to generate water levels throughout the catchment. A 2D model was developed using a combination of LINZ Terrain data and site-specific LiDAR and topographical survey. A Manning's n of 0.1 was used in the grid.A 5m x 5m grid was used. Figure 3.1 shows the grid and its boundary conditions. Appendix B shows culvert details used in the model.

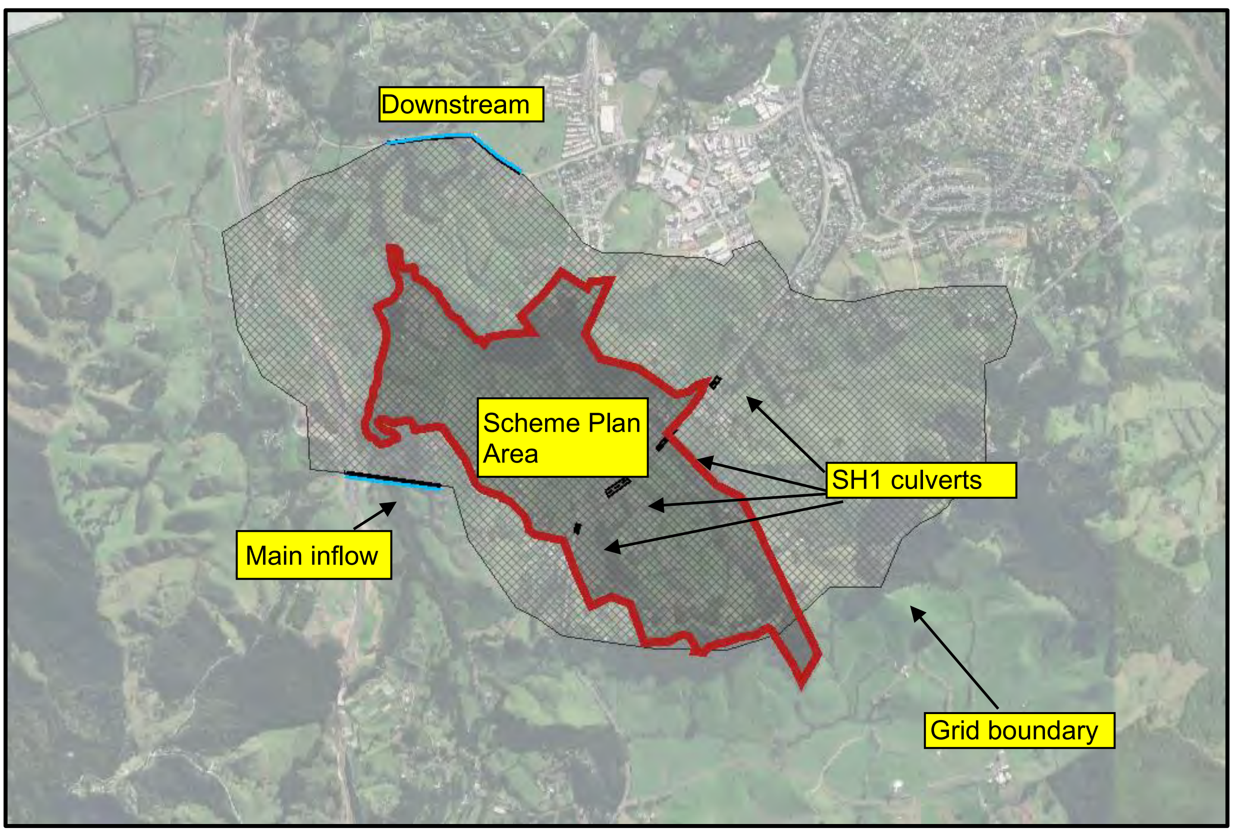


Figure 3.1 – HEC-RAS model set-up

3.3 BOUNDARIES

There are three boundaries. These are:

- Rain on grid – as per figure 3.1.
- Main inflow for mahurangi river
- Downstream boundary using a normal depth method with a gradient of 0.002.

3.4 FLOODPLAIN COMPARISON

Figure 3.2 compares the Geomaps floodplain against the 100-year storm for developed land and climate change rainfall. The patterns are similar. The flow at critical pinch points in the north-east at the confluence have similar widths.

The only difference of note is in the central scheme area, area A. Geomaps shows more flooding while the new model is more defined in the channels due to a specific site survey of the stream being modelled. In general, the new model appears to replicate the Geomaps floodplain.

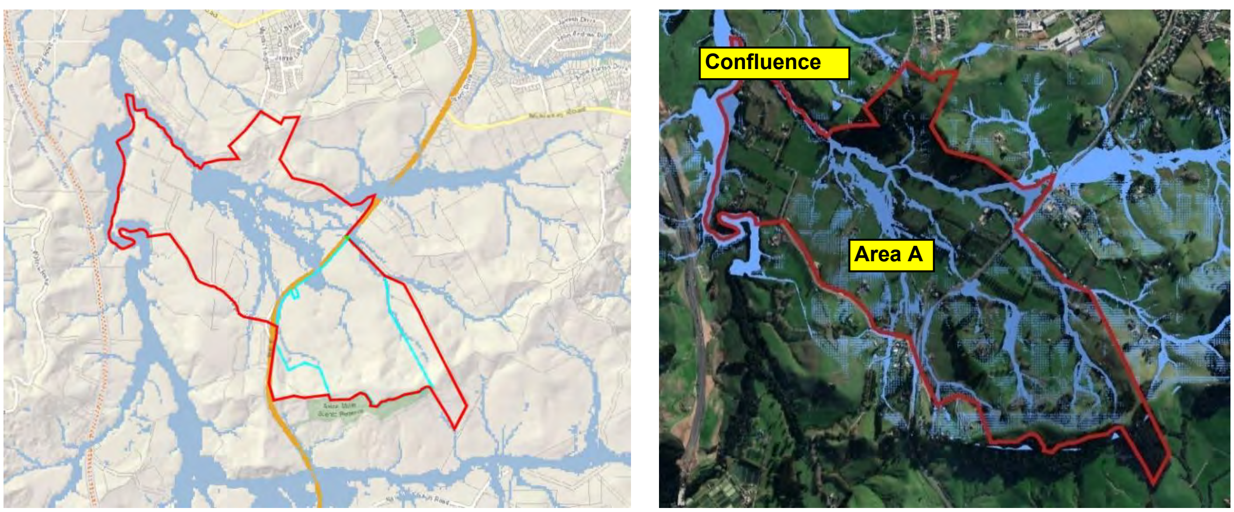


Figure 3.2 – Floodplain comparison – 100yr-storm

3.5 FLOW CHECK

All watercourse arrive at the point of confluence from the east making up about 332ha. The estimate TP108 graphical method 100-year peak flow is estimated at 47m^3/s. This is the existing rainfall and land-use. The modelled peak flow at this point is 53m^3/s. The model is higher than what TP108 estimates catchment run-off should be. However, the 2D terrain model uses a Manning's n of 0.1 which might be smoother than reality, but it also encourages higher flows. Importantly the model gives reasonable peak flows even though the finite volume method in HEC-RAS has pockets of water "stuck in hollows" inside the 5m grid. However, this does not affect the peak flow.

3.6 HYDRAULIC GRADE LINE

Figures 3.3 shows the HGL along the Mahurangi River on the west boundary of the scheme plan. The 100-year developed scenario ranges from RL32.4m to RL26.6m NZVD at a grade of 1 in 240. The range of water levels from 10-year to 100-year is about 1.3m.

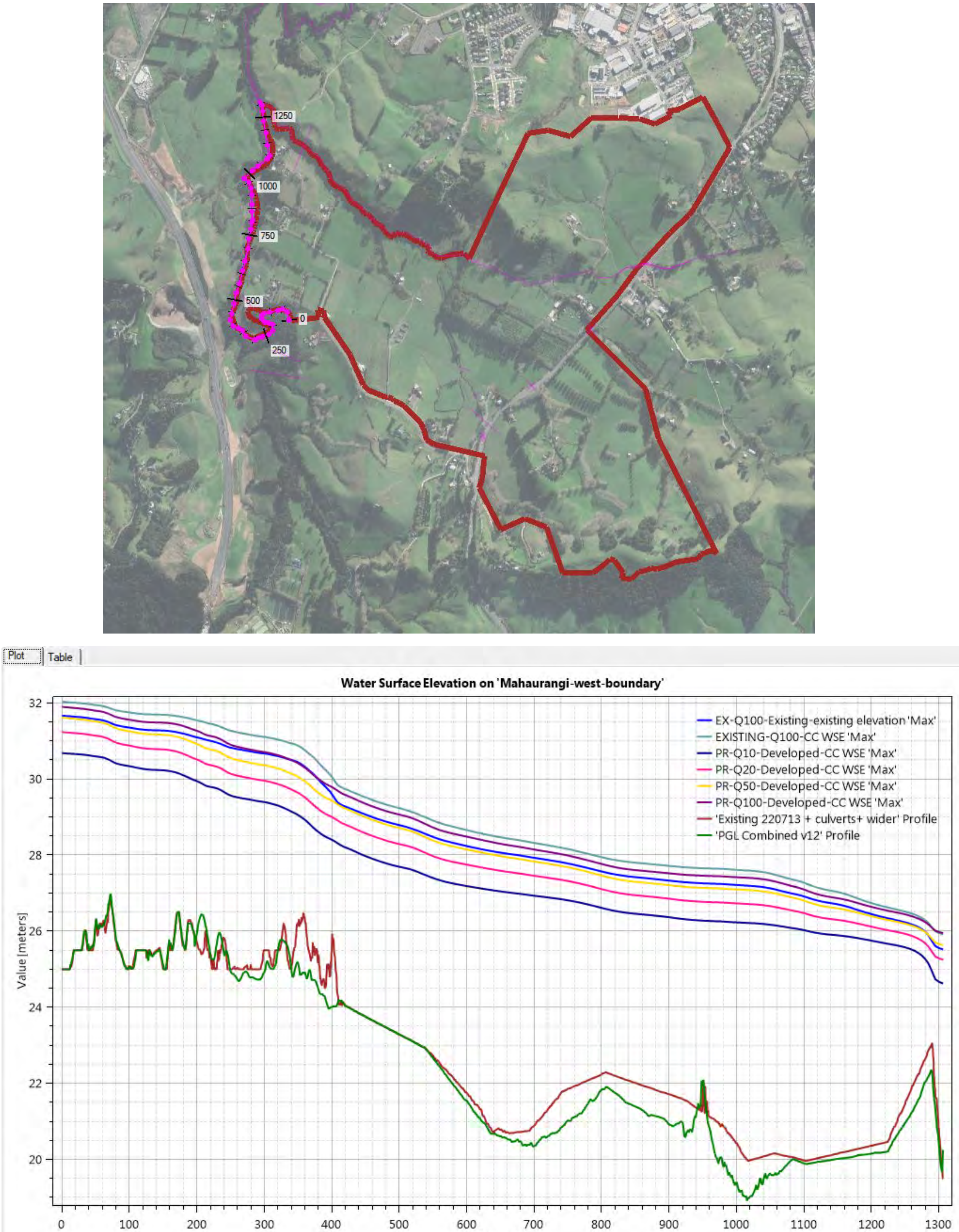
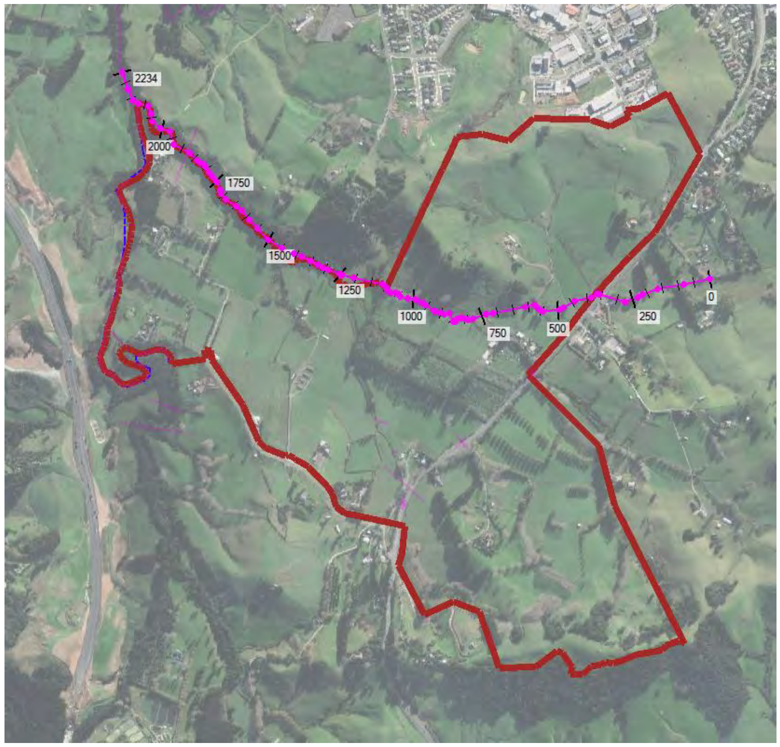


Figure 3.3 – HGL– Mahurangi River boundary (NZVD)

Figure 3.4 shows the HGL along the main scheme stream from east of the SH1 culverts across to the confluence with the Mahurangi River. The SH1 Culverts will cause a pond that is 200m long and 135m wide.



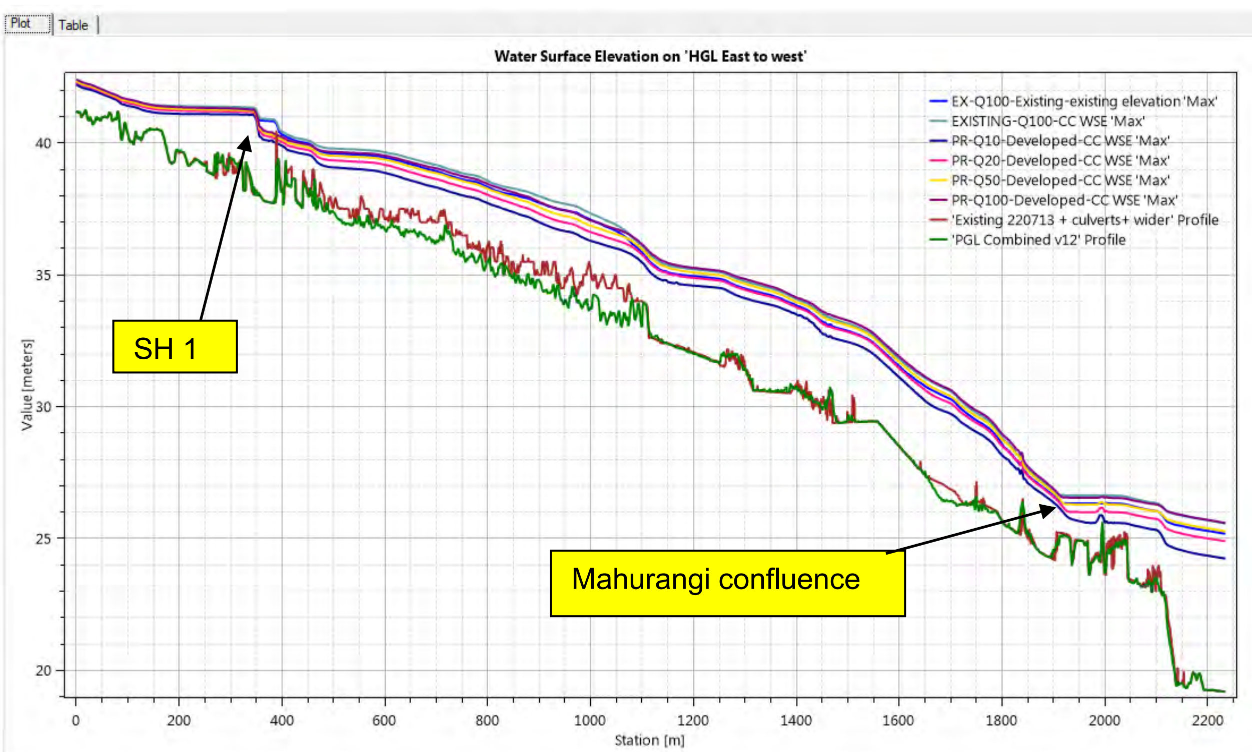


Figure 3.4 – HGL– Main east to west stream (NZVD)

3.7 FLOW HYDROGRAPHS

Figure 3.5 shows the flow hydrographs in the east-west stream just before the connection to the Mahurangi River. The existing 100-year storm without climate change flows (blue) is approximately equivalent to a 20-year storm with climate change flow (yellow) due to the development. And the existing 100-year storm with climate change is approximately equivalent to a 50-year storm post development.

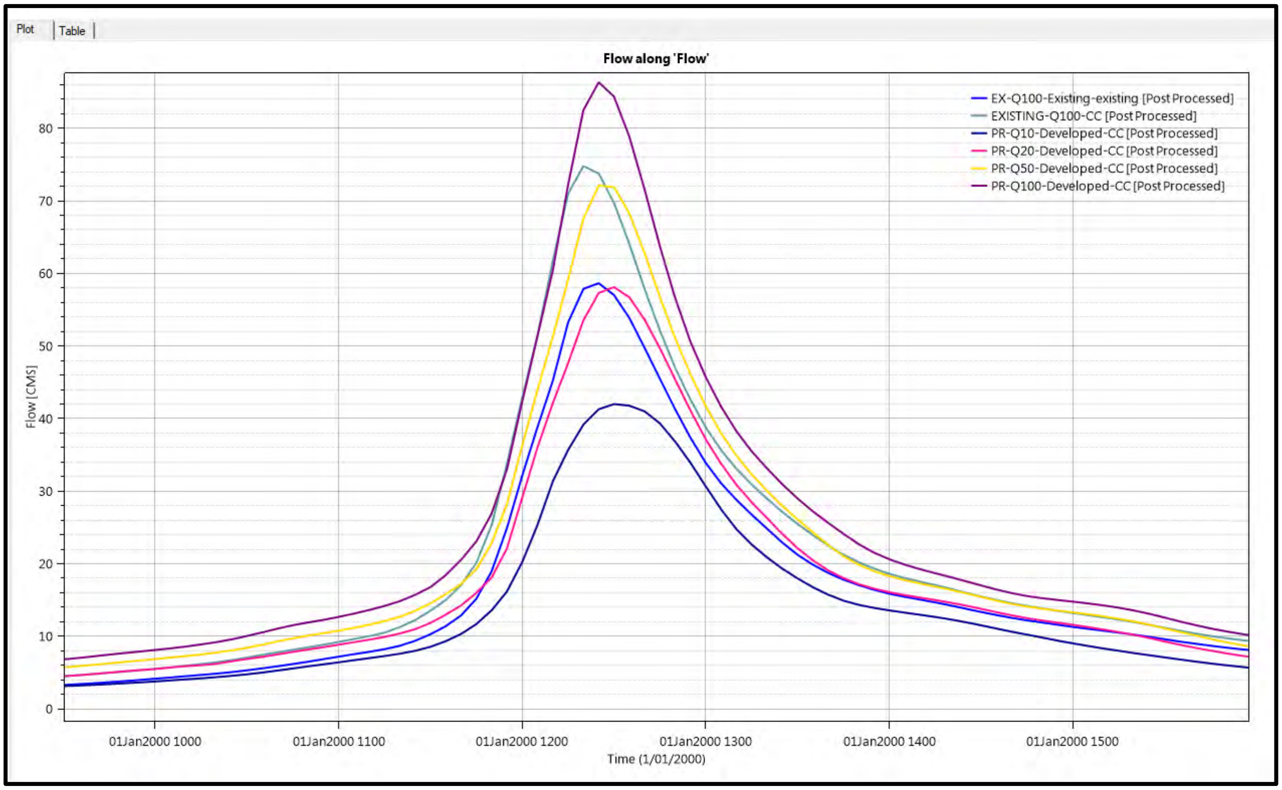


Figure 3.5 – Flow hydrograph for east-west stream outlet

3.8 CHECK ON DOWNSTREAM LEVEL

The model grid stops at Woodcocks Road bridge. The road deck of the bridge has been surveyed to be RL23.75. The peak 1% AEP event with climate change flow level at this location has been calculated to be RL 22.17 and 22.16 for the existing and proposed scenario respectively.

The manning calculation may be found in appendix E. It is noted that the contours used for the mannings calculation have been obtained from Auckland Council Geomaps. As the Lidar contours indicate the water surface elevation (rather than the streambed) of the stream baseflow it is noted that the flow depth may be considered conservative. Therefore, the bridge is not impeding flow.

3.9 CULVERTS CAPACITY ASSESSMENT

Cross sections showing water surface elevations across the four culverts through SH 1 maybe found in appendix B.

Cross sections indicate the two northern culverts (names Culvert north and Culvert mid) are under capacity and are overtopped for all modelled storm events (10yr through to 100yr). The next adjacent culvert to the south (culvert south) is show to only overtop during a 100yr event for the developed scenario. The southern most culvert is shown to have sufficient capacity for the developed scenario.

It is noted that the entire section of SH1 which is shown to be have under capacity culvert is proposed to be upgraded in the future by Auckland Transport once the road is eventually repurposed as an arterial road and the opening of Ara Tūhono – Pūhoi to Warkworth statehighway.

3.10 OUTFLOW VOLUME VALIDATION

HEC-RAS uses an Implicit Finite Volume Algorithm. The consequence of this is to have small volumes of water in the base of a cell that does not escape. A method to remove the potential holding back of water is to run the models with low flows in the initial stages to fill the hollows. The main storm run-off can then flow over the top. This is not a problem as long as there is volume continuity.

Figure 3.6 shows the volume generated in HEC-HMS for the existing land-use and 100- year historical rainfall. The volume is 4,942,000m^3. Figure 3.7 shows the volume accumulated at the HEC-RAS downstream boundary after 36 hours of simulation. The volume is 4,908,000m^3. This is an error of 0.0007% which is extremely small. The volume integrity is excellent.

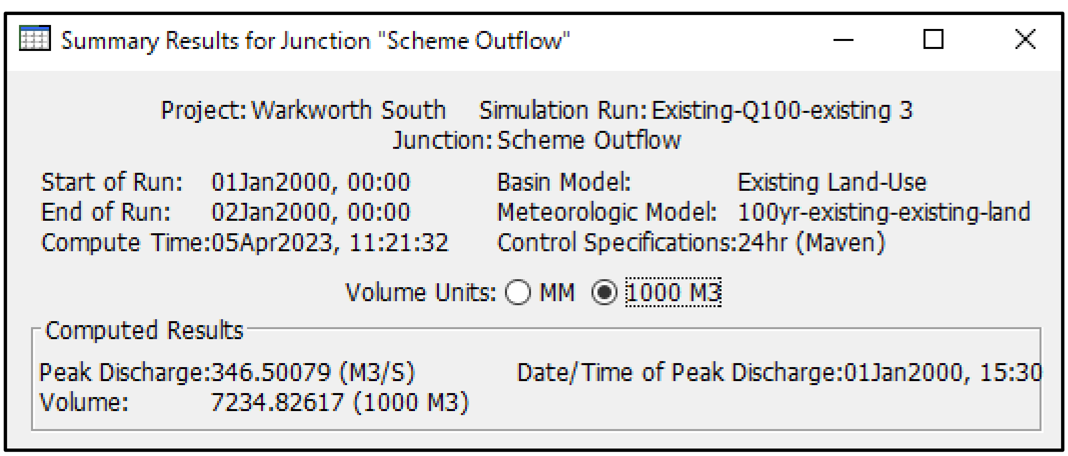


Figure 3.6 – HEC-HMS volume of run-off

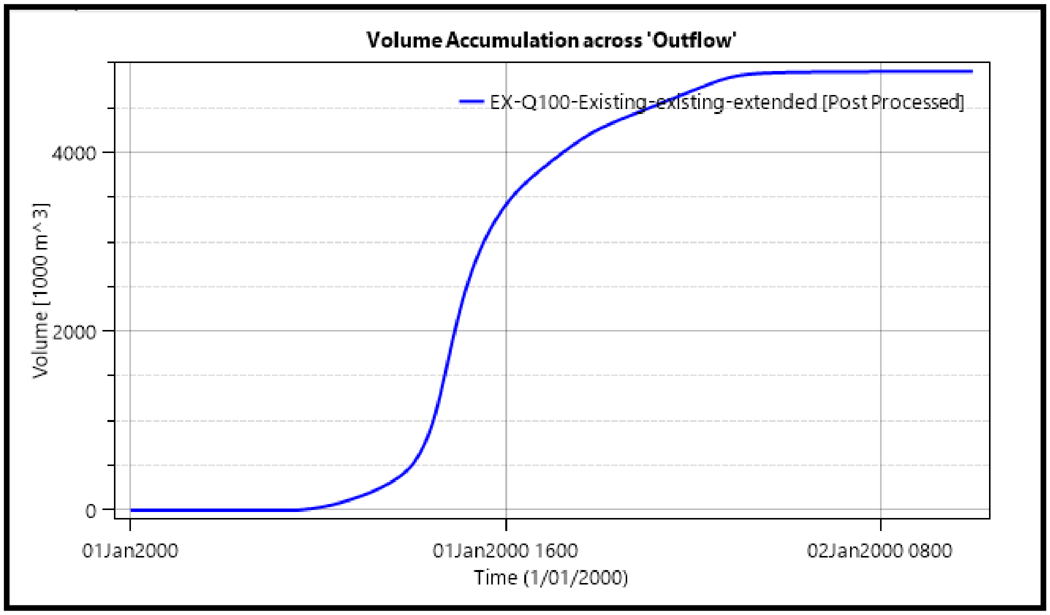


Figure 3.7 – HEC-RAS outflow boundary cumulative volume

3.11 HEALTHY WATERS MODELLING

Auckland Council HealthyWaters have supplied flow data of their modelling of the Warkworth catchment, for Mahurangi River. A comparison of this reports results and Healthywaters are summarised in the table below;

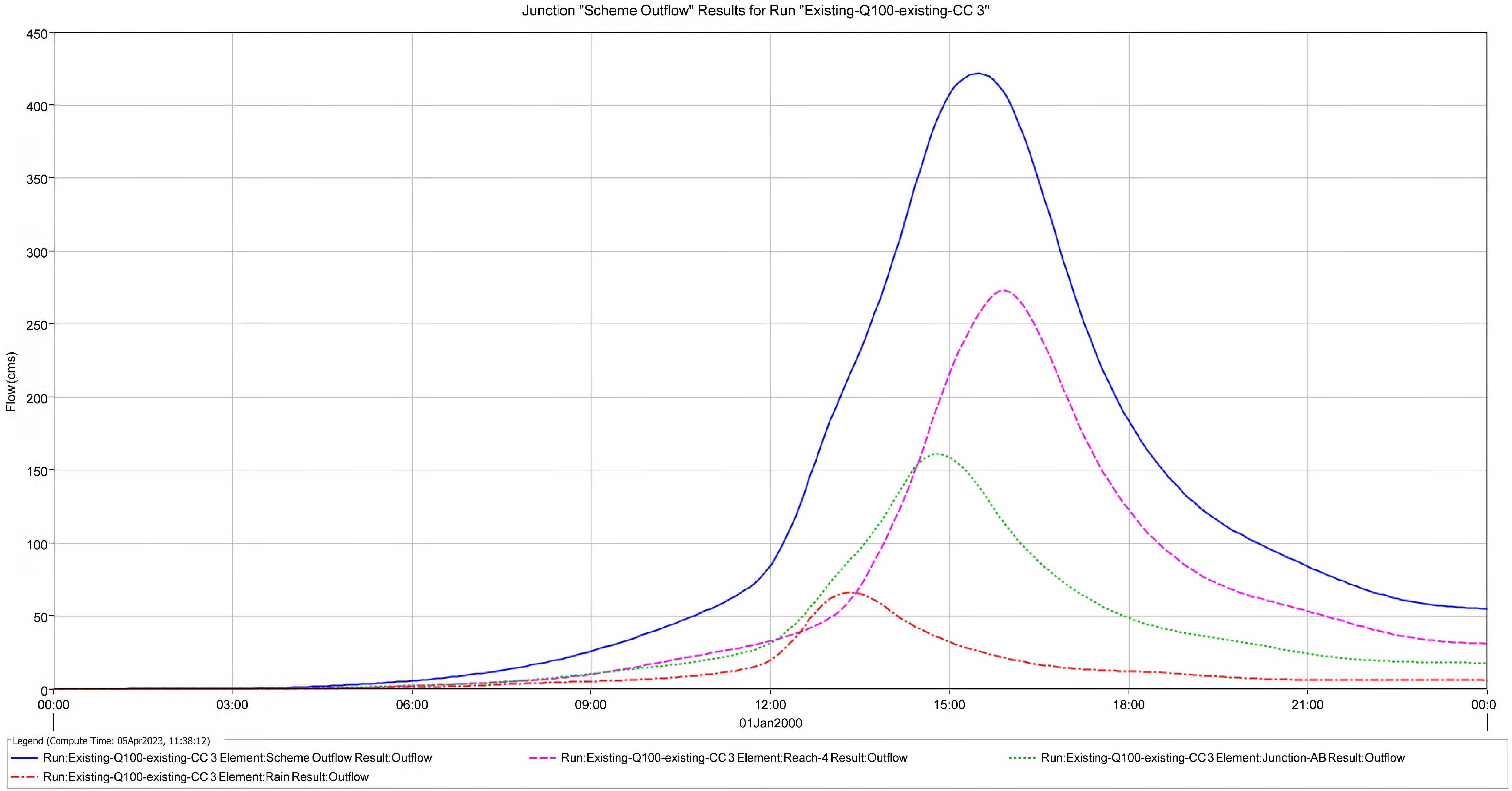
	XS 95 - SCHEME INFLOW (m3/s)					
	10yr Developed CC			100yr Developed CC		
Scenario	Peak Time	Peak Flow	Water level	Peak Time	Peak Flow	Water level
Healthy waters	13:40	199	31.34	13:40	340	32.88
Maven	14:45	142	31.78	14:40	273	33.05

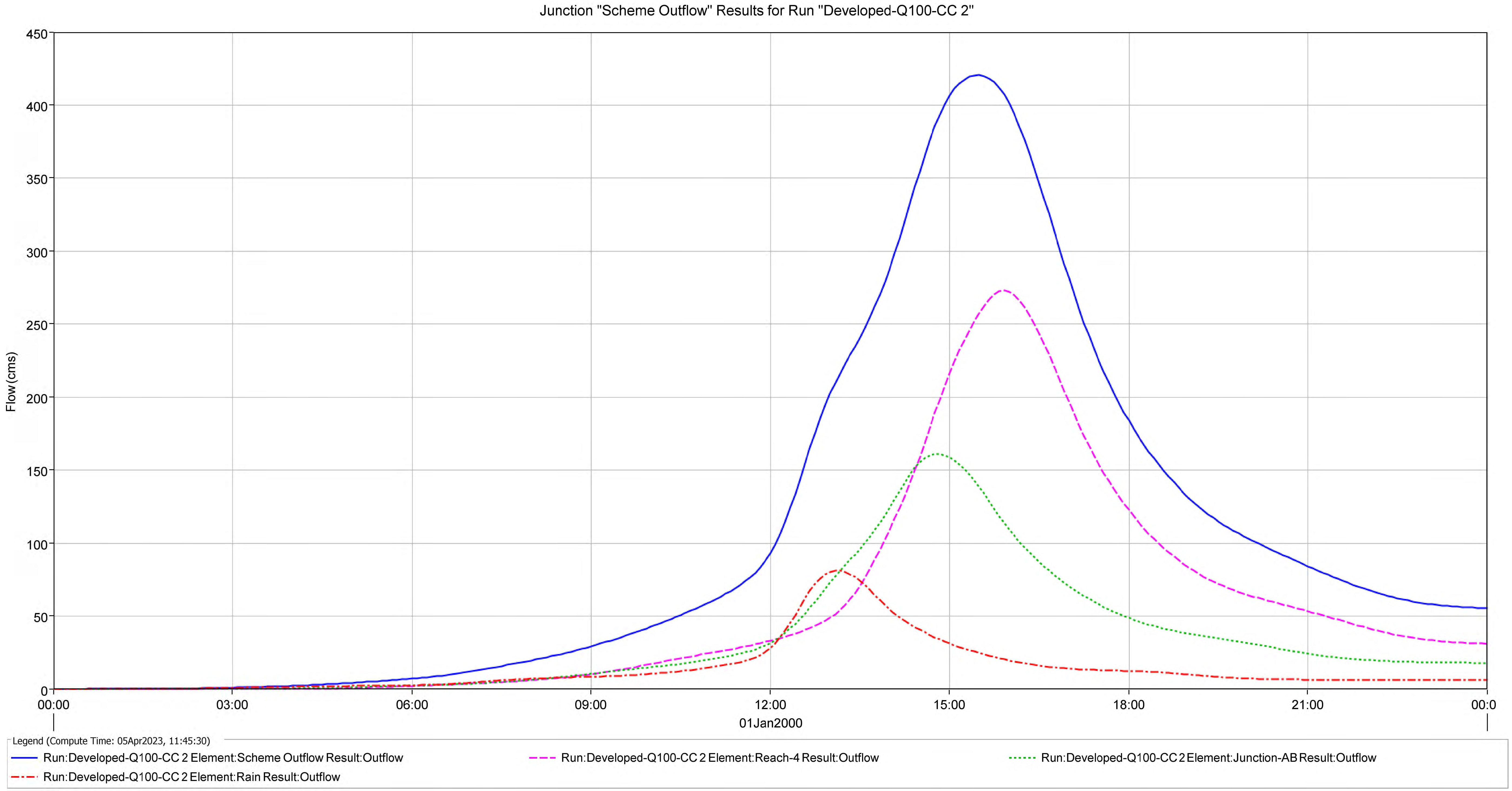
	XS87 - SCHEME OUTFLOW (m3/s)					
	10yr Developed CC			100yr Developed CC		
Scenario	Peak Time	Peak Flow	Water level	Peak Time	Peak Flow	Water Level
Healthy waters	14:10	223	22.16	14:15	326	23.74
Maven	15:10	151	22.12	15:15	285	23.89

Figure 3.8 MPD Modelling results comparison to Healthy waters model

Two notable points of comparison of modelling results are the times of peak flows and the water levels. The peak flow times produced in the model are generally 1 hour later than that from the Healthywaters model. A comparison of the water levels show similar peak flood levels with a difference of upto to 0.32m. This discrepancy is likely a result of the difference in terrain model used. As the terrain used in this reports model uses a combination of site survey and drone data, it has a higher degree of accuracy in comparison to the Lidar survey used in the Healthwaters model.

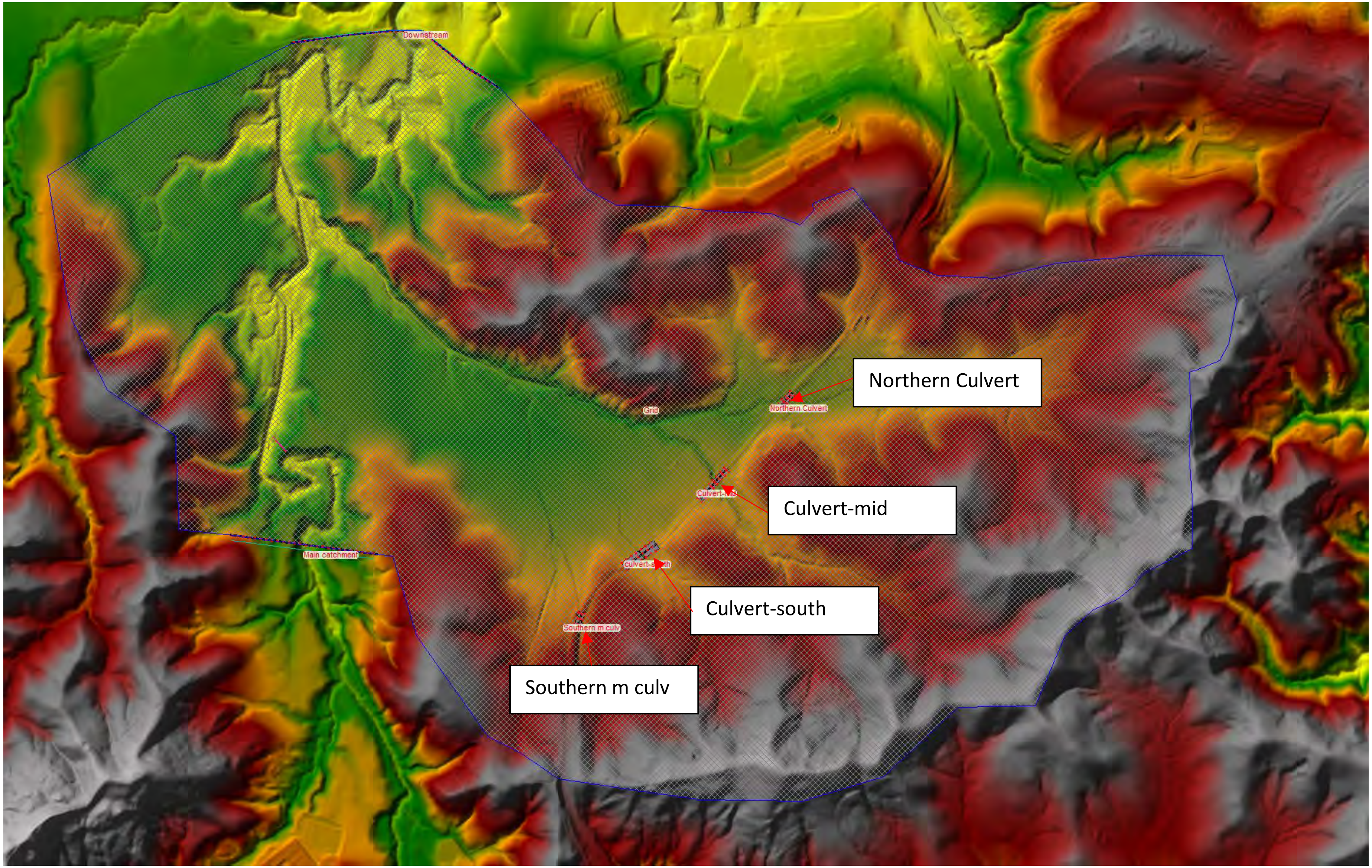
APPENDIX A – 100YR YEAR FLOW HYDROGRAPH


Junction "Scheme Outflow" Results for Run "Existing-Q100-existing-CC 3"
Flow (cms)
450
400
350
300
250
200
150
100
50
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:0
01Jan2000
Legend (Compute Time: 05Apr2023, 11:38:12)
Run:Existing-Q100-existing-CC 3 Element:Scheme Outflow Result:Outflow
Run:Existing-Q100-existing-CC 3 Element:Reach-4 Result:Outflow
Run:Existing-Q100-existing-CC 3 Element:Junction-AB Result:Outflow
Run:Existing-Q100-existing-CC 3 Element:Rain Result:Outflow

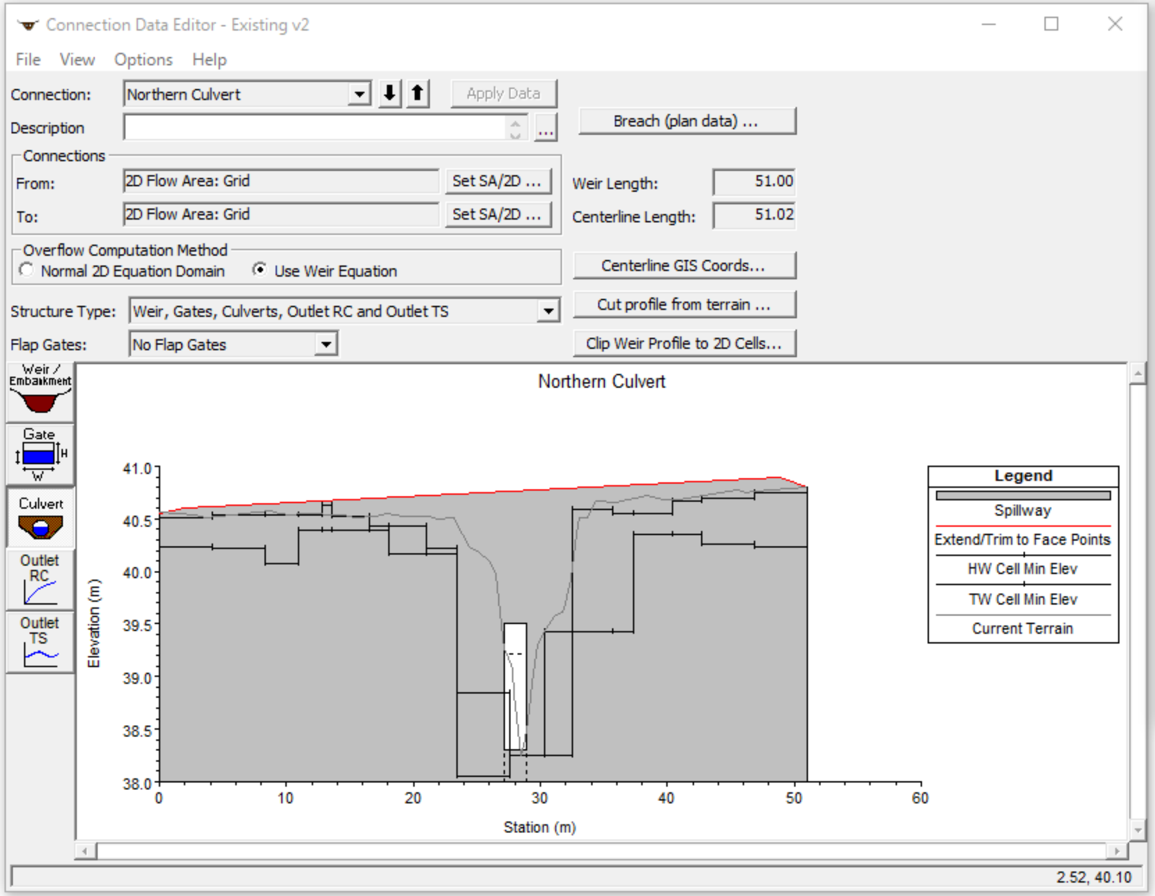


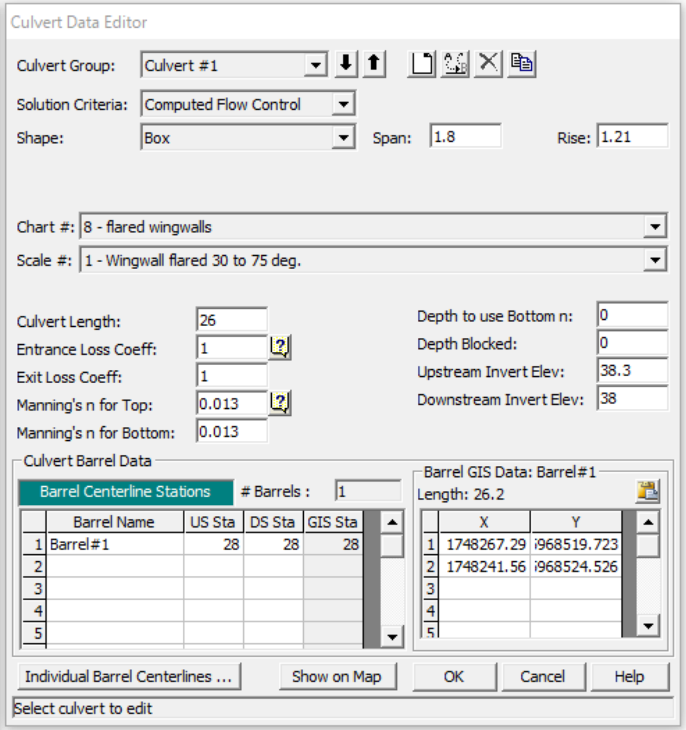
Junction "Scheme Outflow" Results for Run "Developed-Q100-CC 2"
Flow (cms)
450
400
350
300
250
200
150
100
50
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:0
01Jan2000
Legend (Compute Time: 05Apr2023, 11:45:30)
Run:Developed-Q100-CC 2 Element:Scheme Outflow Result:Outflow
Run:Developed-Q100-CC 2 Element:Reach-4 Result:Outflow
Run:Developed-Q100-CC 2 Element:Junction-AB Result:Outflow
Run:Developed-Q100-CC 2 Element:Rain Result:Outflow

APPENDIX B – HEC RAS CULVERT DETAIL

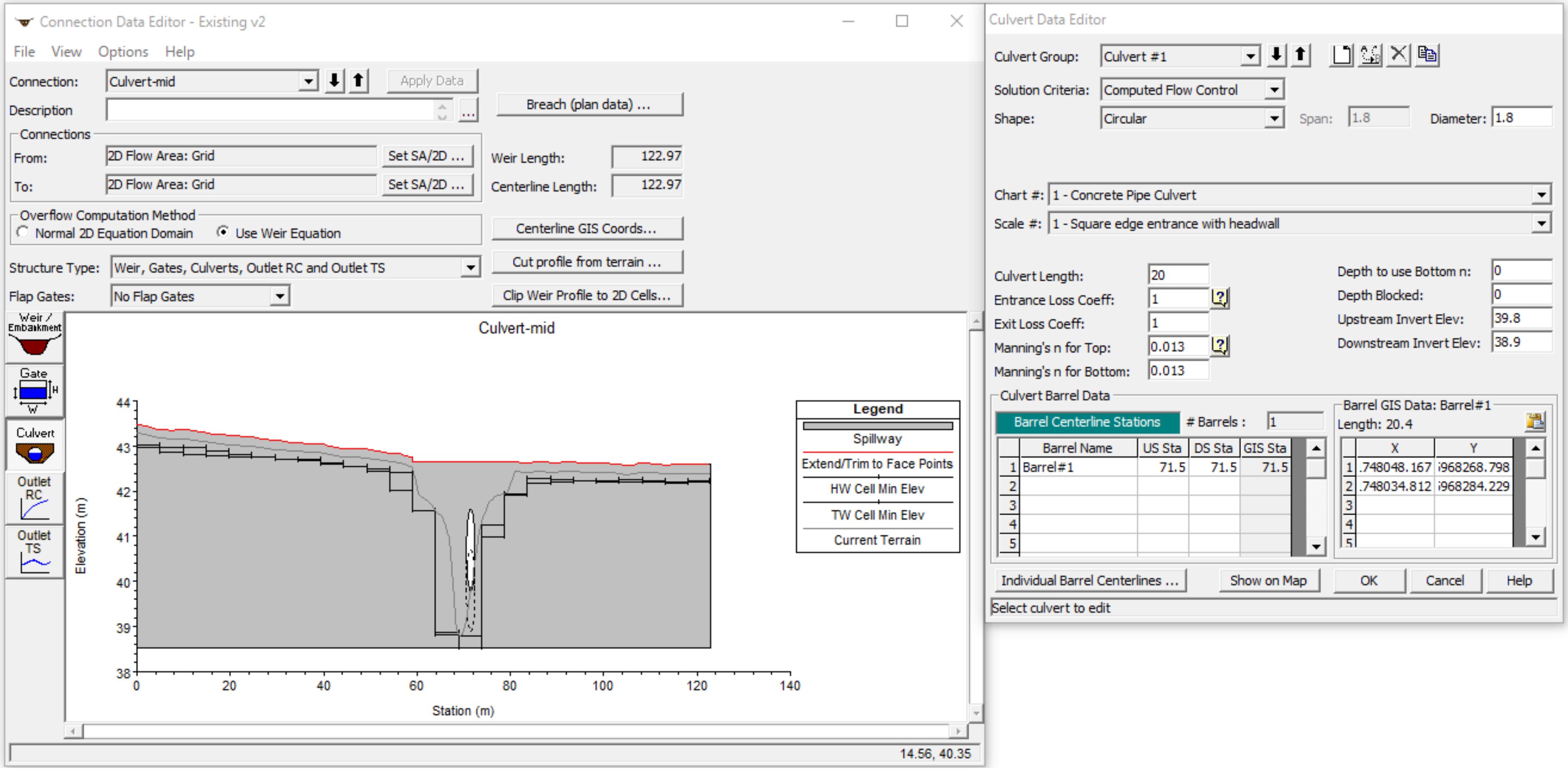

Downstream
Northern Culvert
Grid
Northern Culvert
Culvert-mid
Culvert-mid
Main catchment
culvert-south
Culvert-south
Southern m culv
Southern m culv

Northern Culvert - Details

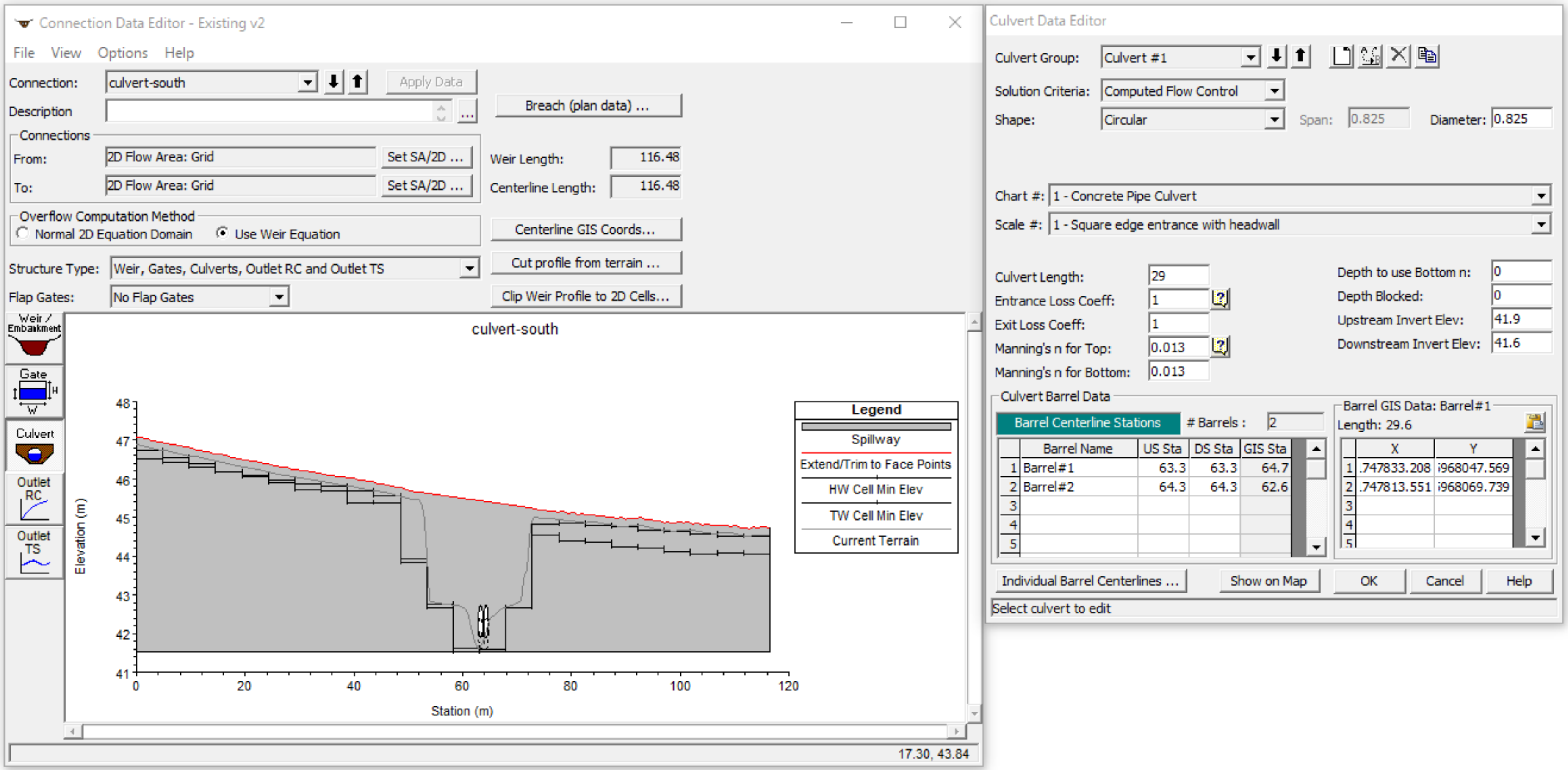




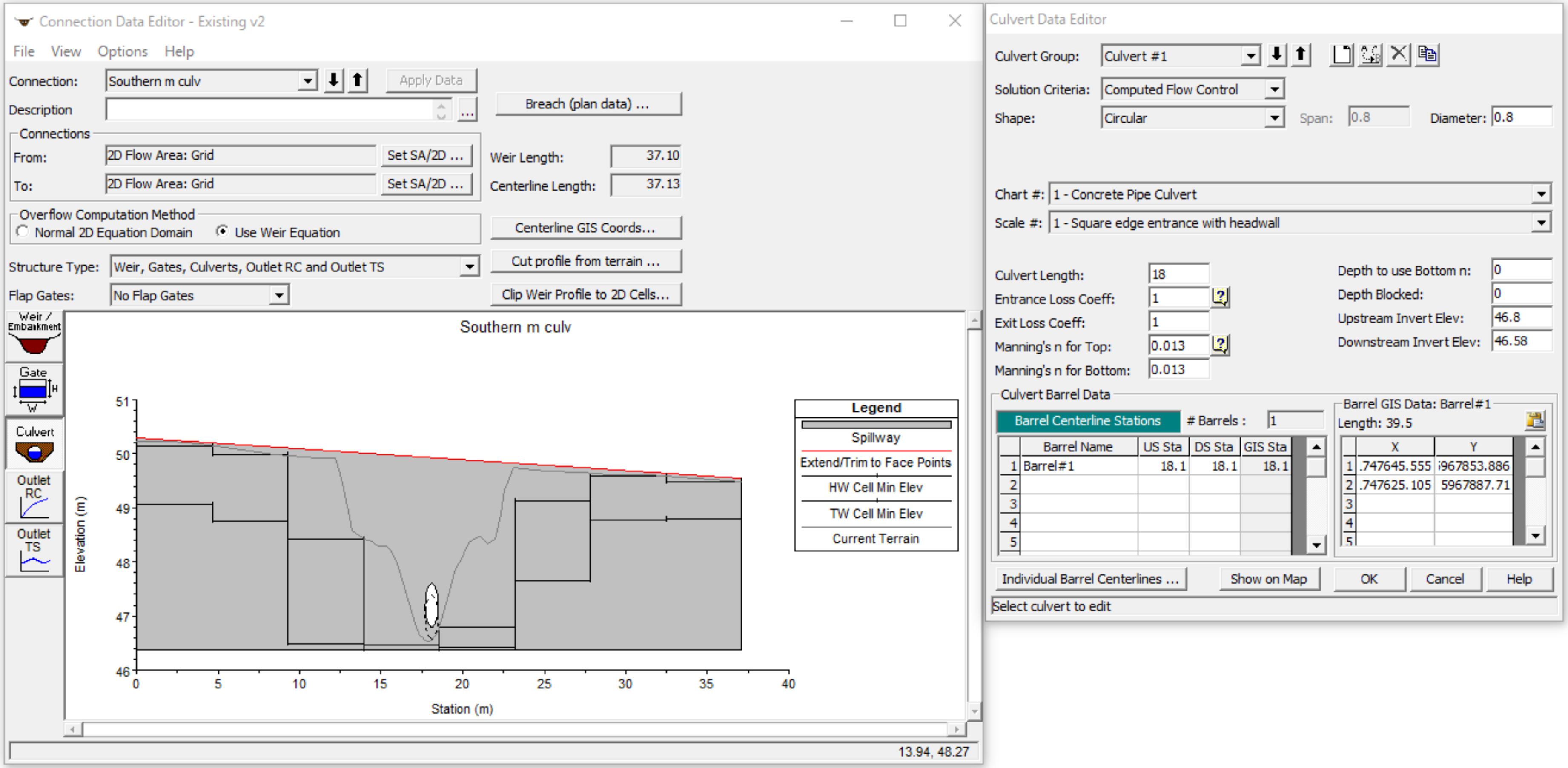
Culvert mid - Details



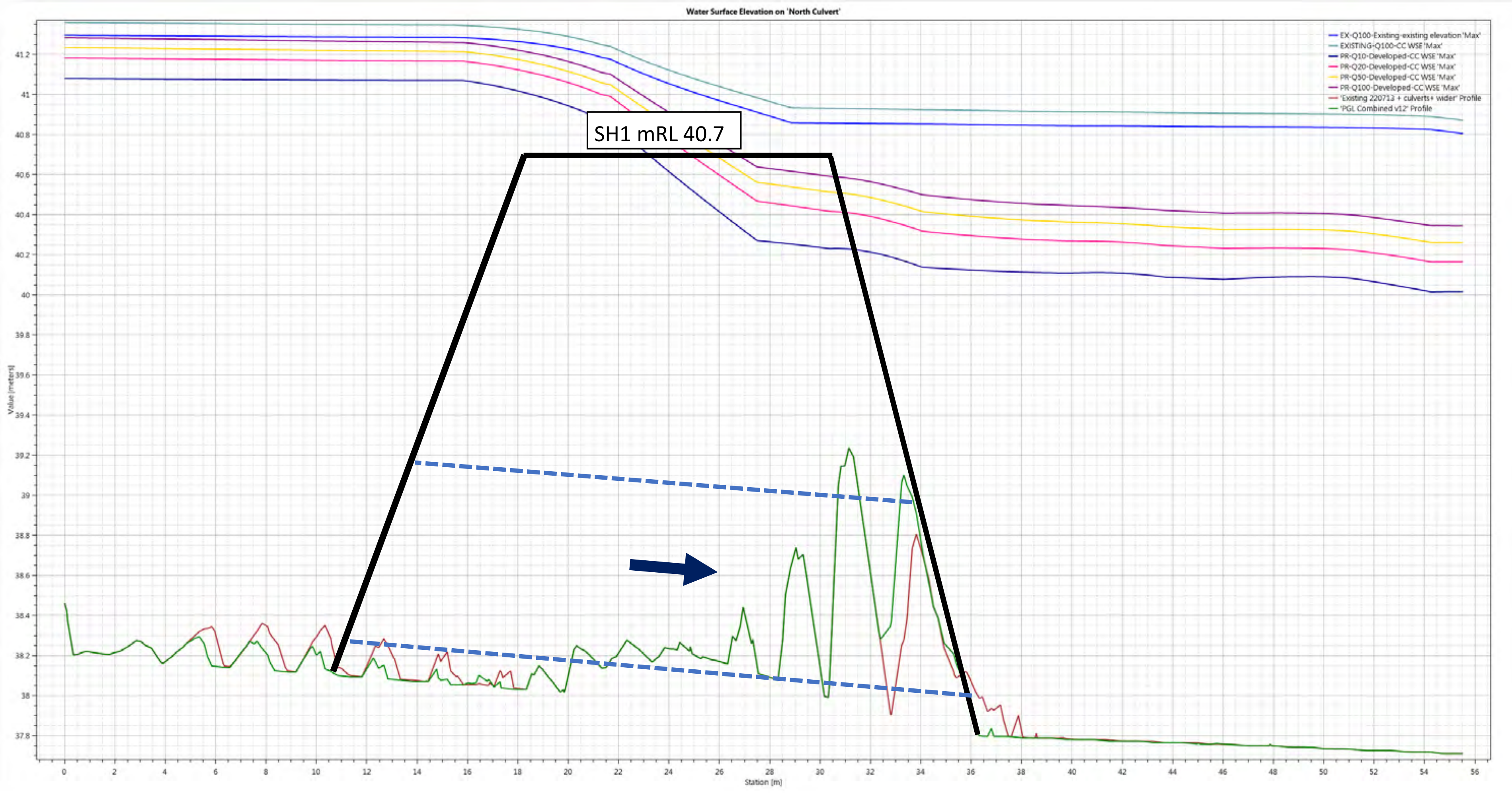
Culvert south - Details



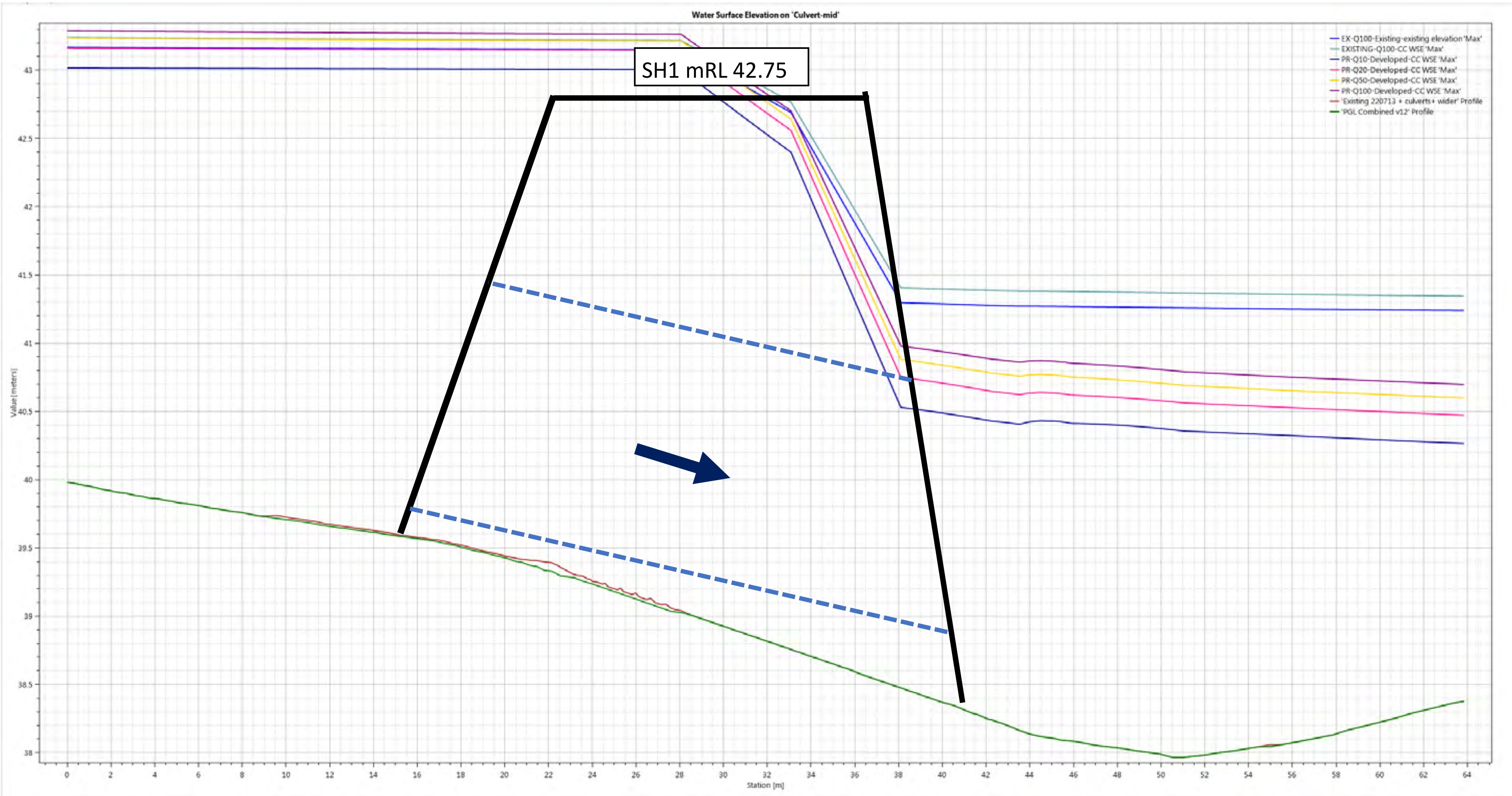
Culvert m south - Details



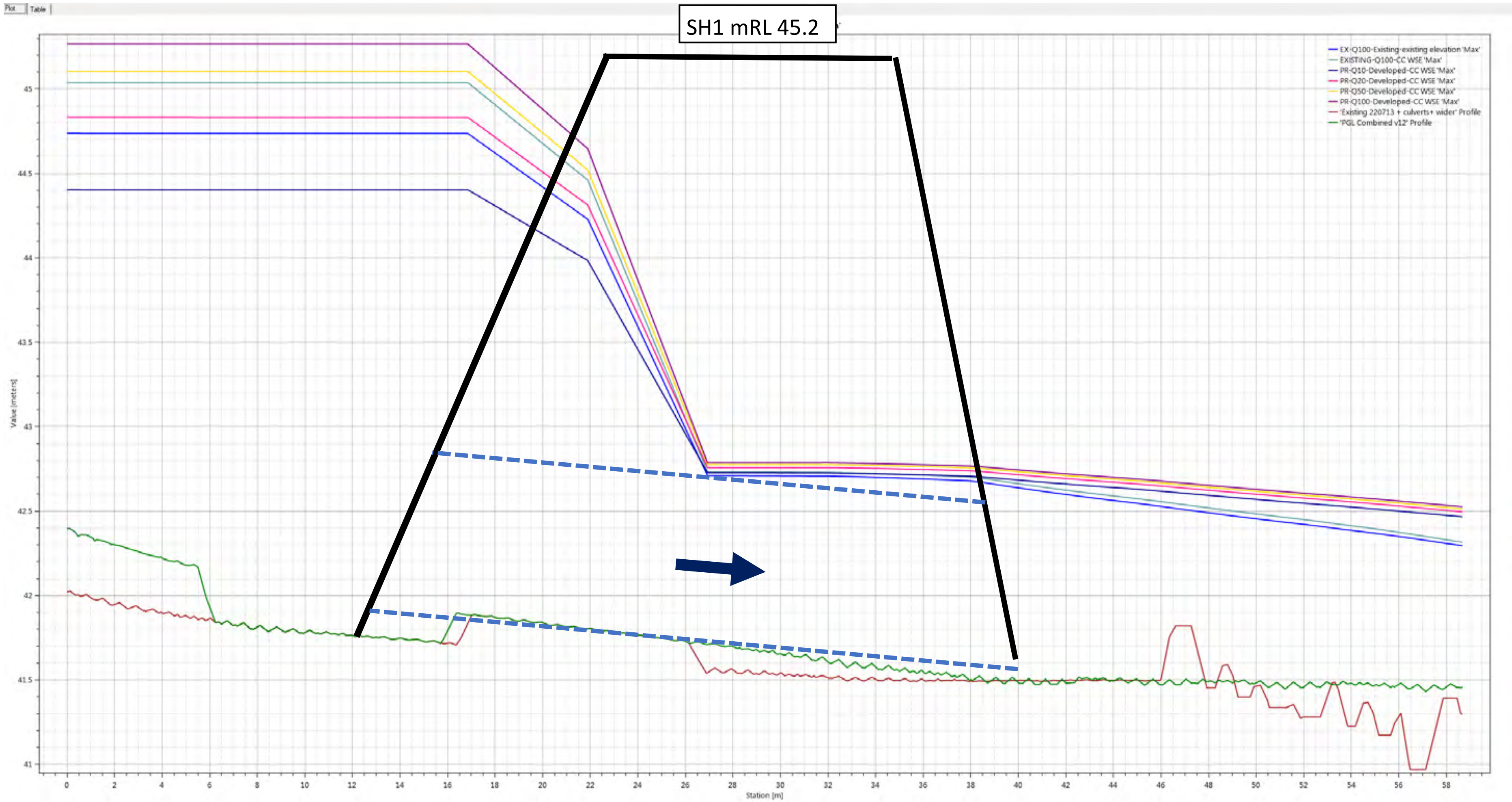
Northern Culvert (1800mm x 1200mm box)



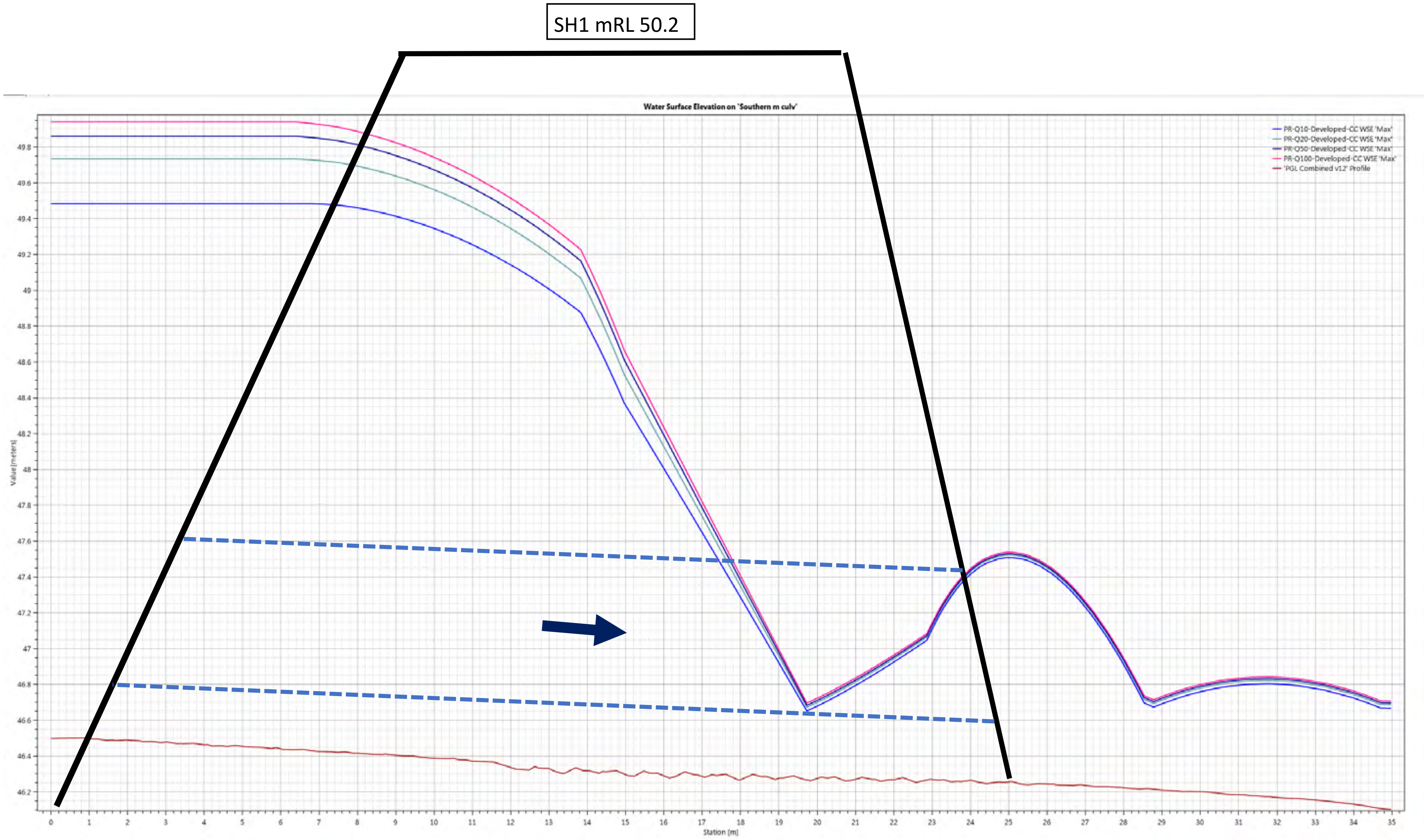
Mid Culvert (1800mm circular)



Culvert South (825mm circular x 2)

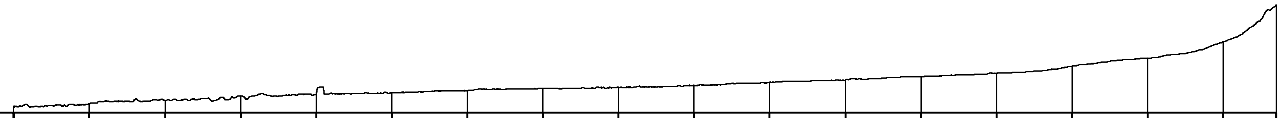


Culvert m south (800mm circular)



APPENDIX C – Preliminary Pre & Post Development Flood Extent Plan

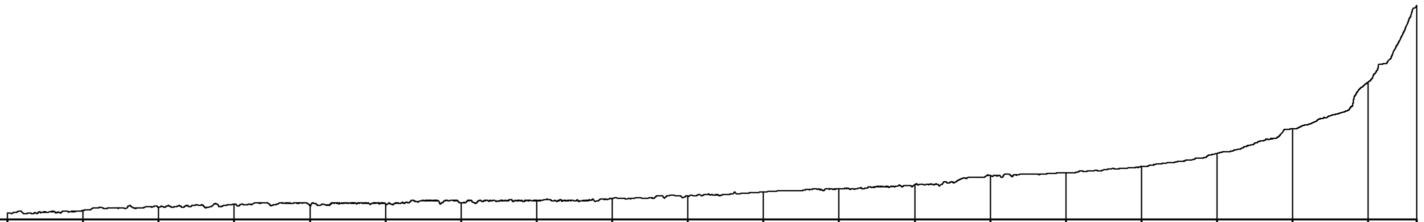
Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	39.17	40.12	41.28	42.75	44.24	44.70	46.13	48.24	49.61	51.99	54.17	58.84	64.00	75.19	99.44
DESIGN LEVELS	32.28	34.00	36.25	39.17	40.12	41.28	42.75	44.24	44.70	46.13	48.24	49.61	51.99	54.17	58.84	64.00	75.19	99.44
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4175.47

Upstream A Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.75	43.25	46.24	48.25	50.92	57.29	58.86	63.00	71.78	88.16	119.12	169.78
DESIGN LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.75	43.25	46.24	48.25	50.92	57.29	58.86	63.00	71.78	88.16	119.12	169.78
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4659.46

Upstream B Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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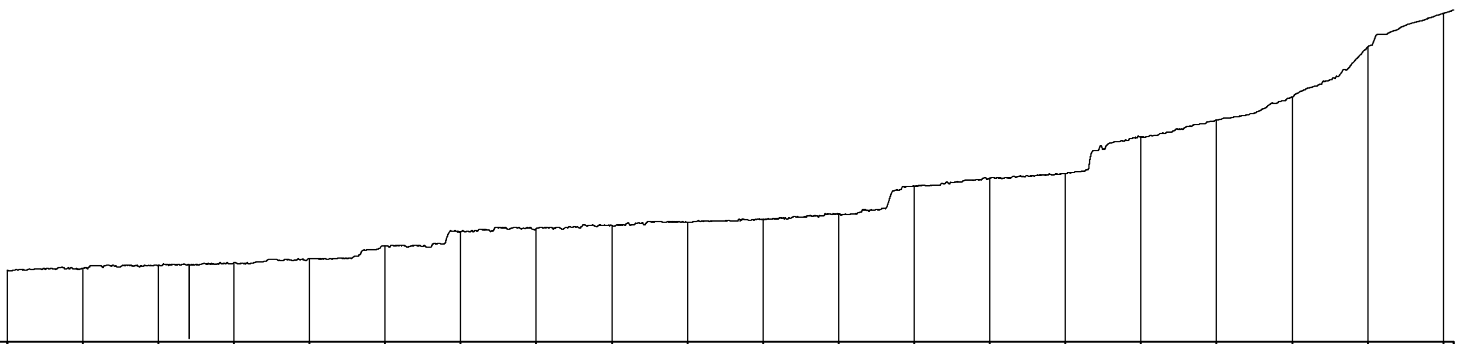
Auckland 1023

Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK001
Rev	A

DRAFT FOR REVIEW

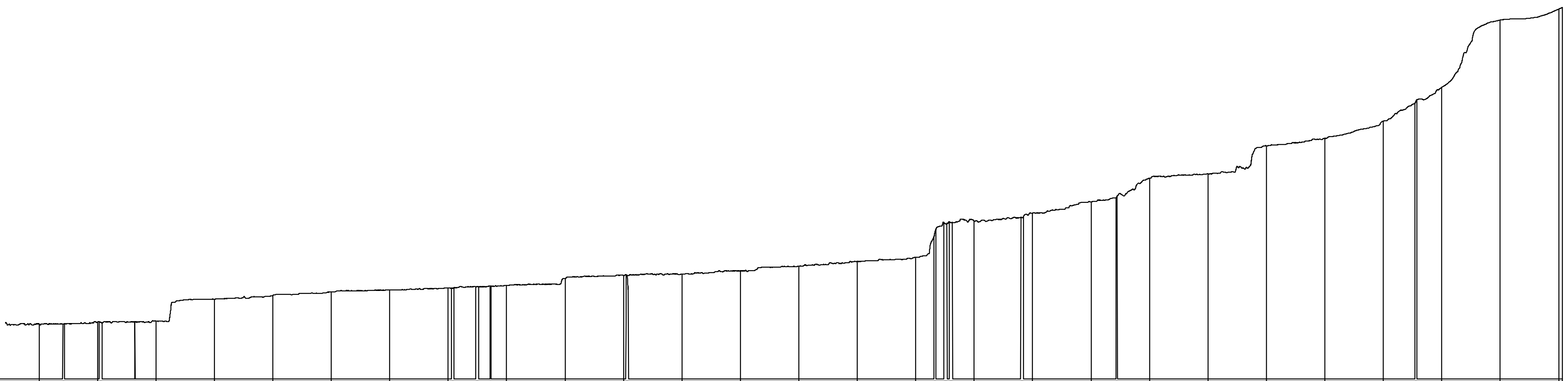


DATUM -2.00m

EXISTING LEVELS	45.50	46.62	48.65	50.35	53.20	61.68	70.62	73.09	74.95	77.25	79.02	82.58	101.03	106.38	109.38	133.64	144.97	160.00	193.31	215.51
DESIGN LEVELS	45.50	46.62	48.65	50.35	53.20	61.68	70.62	73.09	74.95	77.25	79.02	82.58	101.03	106.38	109.38	133.64	144.97	160.00	193.31	215.51
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00 4764.22

Upstream C Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM -2.00m

EXISTING LEVELS		46.95	48.59	49.62	68.25	71.28	74.24	76.00	78.00	80.00	86.00	88.56	89.51	92.54	96.42	100.66	104.05	134.95	141.95	151.52	171.50	175.39	199.50	205.84	220.55	249.44	307.01	316.43 [illegible]
DESIGN LEVELS		46.95	48.59	49.62	68.25	71.28	74.24	76.00	78.00	80.00	86.00	88.56	89.51	92.54	96.42	100.66	104.05	134.95	141.95	151.52	171.50	175.39	199.50	205.84	220.55	249.44	307.01	316.43 [illegible]
CUT/FILL		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00 0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	5000.00	5250.00	5500.00	5750.00	6000.00	6250.00	6500.00	6750.00 [illegible]

Upstream D Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

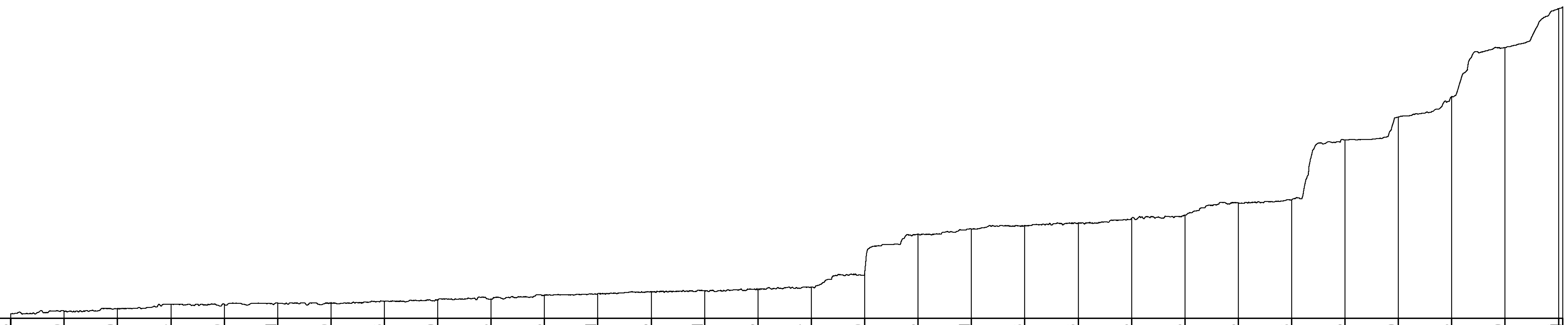
Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK002
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

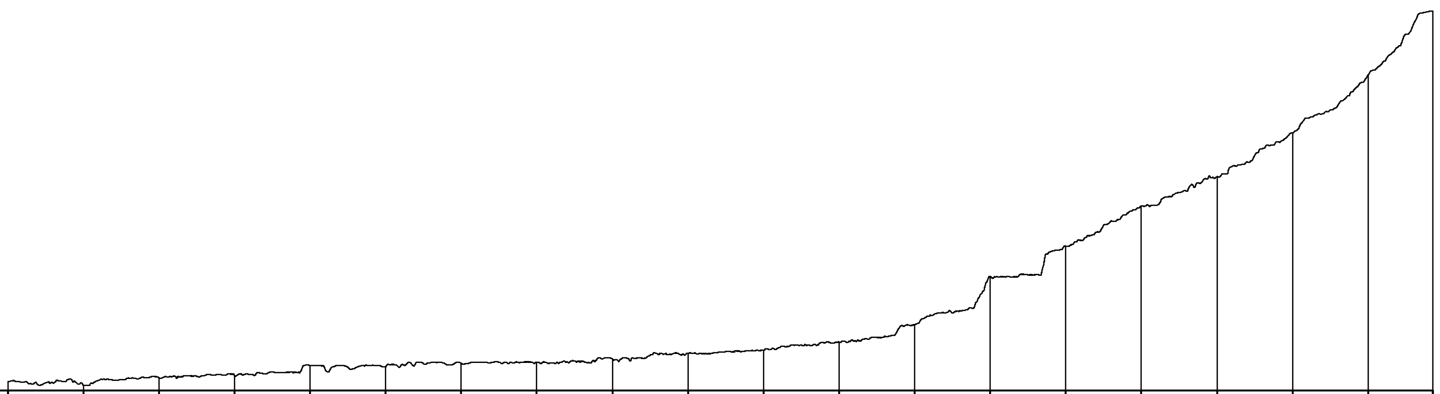


DATUM 28.00m

EXISTING LEVELS	32.28	34.30	36.89	40.94	41.10	42.21	42.20	43.56	45.09	45.93	49.28	50.91	52.65	53.91	54.75	57.17	70.10	106.58	111.41	114.56	117.06	121.38	124.48	135.68	138.56	194.75	216.09	235.23	280.99	317.36	[illegible]
DESIGN LEVELS	32.28	34.30	36.89	40.94	41.10	42.21	42.20	43.56	45.09	45.93	49.28	50.91	52.65	53.91	54.75	57.17	70.10	106.58	111.41	114.56	117.06	121.38	124.48	135.68	138.56	194.75	216.09	235.23	280.99	317.36	[illegible]
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	5000.00	5250.00	5500.00	5750.00	6000.00	6250.00	6500.00	6750.00	7000.00	7250.00	[illegible]

Upstream E Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM 24.00m

EXISTING LEVELS	29.95	27.50	32.26	33.64	40.50	39.50	41.91	42.75	44.86	48.59	50.50	55.91	67.32	99.25	119.28	145.68	165.10	194.00	232.28	274.71
DESIGN LEVELS	29.95	27.50	32.26	33.64	40.50	39.50	41.91	42.75	44.86	48.59	50.50	55.91	67.32	99.25	119.28	145.68	165.10	194.00	232.28	274.71
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4714.37

Upstream F Longsection

HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK003
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 24.00m

EXISTING LEVELS	29.95	27.50	31.89	32.02	32.01	32.28
DESIGN LEVELS	29.95	27.50	31.89	32.02	32.01	32.28
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1186.53

Upstream Reach ABE to Inflow

HORIZONTAL SCALE 1:25000 @ A3

VERTICAL SCALE 1:5000 @ A3

DATUM 28.00m

EXISTING LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.67	42.07			
DESIGN LEVELS	32.28	34.00	36.25	38.23	37.17	38.27	39.08	40.57	41.67	42.07			
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	2864.59

Upstream Reach CD TO ABE

HORIZONTAL SCALE 1:25000 @ A3

VERTICAL SCALE 1:5000 @ A3

A	FOR INFORMATION	YW	03/2023
Rev	Description	By	Date

	By	Date
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Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001		
Scale			
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG		
Drawing no.	SK004	Rev	A

DRAFT FOR REVIEW

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 22.00m

EXISTING LEVELS				27.00	29.21	29.97	29.94	30.28	32.47	32.26	33.04	32.75	33.50	34.33	36.28	37.86	37.42	38.05	39.90	40.55	45.00	52.27	58.22	67.56	97.30	140.02
DESIGN LEVELS				27.00	29.21	29.97	29.94	30.28	32.47	32.26	33.04	32.75	33.50	34.33	36.28	37.86	37.42	38.05	39.90	40.55	45.00	52.27	58.22	67.56	97.30	140.02
CUT/FILL				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	5000.00	5250.00	5500.00	5750.00	6000.00	6121.08

Downstream A Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 36.00m

EXISTING LEVELS	40.68	42.00	43.75	45.80	48.87	49.50	53.82	56.49	62.25	94.33	148.64	288.82
DESIGN LEVELS	40.68	42.00	43.75	45.80	48.87	49.50	53.82	56.49	62.25	94.33	148.64	288.82
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	500.00	1000.00	1500.00	2000.00	2500.00	3000.00	3500.00	4000.00	4500.00	5000.00	5305.61

Downstream B Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
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Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

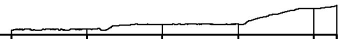
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK005
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



DATUM 8.00m

EXISTING LEVELS	11.10	12.01	15.07	15.32	25.65	27.77
DESIGN LEVELS	11.10	12.01	15.07	15.32	25.65	27.77
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1077.43

Downstream C Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 8.00m

EXISTING LEVELS	11.10	15.39	16.50	18.89	20.21	21.24	23.25	26.41	29.58	31.42	32.24	33.74	43.47	79.73	
DESIGN LEVELS	11.10	15.39	16.50	18.89	20.21	21.24	23.25	26.41	29.58	31.42	32.24	33.74	43.47	79.73	
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3331.05

Downstream D Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	8.98	11.99	10.36	18.24	26.47	34.17	44.66	57.08
DESIGN LEVELS	8.98	11.99	10.36	18.24	26.47	34.17	44.66	57.08
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1695.06

Downstream E Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

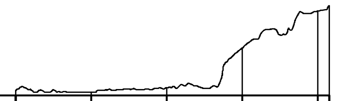
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK006
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.



DATUM 6.00m

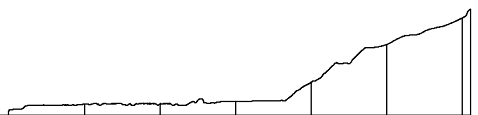
EXISTING LEVELS	8.98	8.25	10.88	37.35	61.78	[illegible]
DESIGN LEVELS	8.98	8.25	10.88	37.35	61.78	[illegible]
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	[illegible]

Downstream F Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	9.39	13.78	16.27	20.00	27.46	31.75	35.09	38.48	42.35	51.20	67.66	71.51
DESIGN LEVELS	9.39	13.78	16.27	20.00	27.46	31.75	35.09	38.48	42.35	51.20	67.66	71.51
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2553.95

Downstream G Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3



DATUM -4.00m

EXISTING LEVELS	-0.75	3.75	3.58	5.25	18.08	43.07	60.60	[illegible]
DESIGN LEVELS	-0.75	3.75	3.58	5.25	18.08	43.07	60.60	[illegible]
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	[illegible]

Downstream H Longsection
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

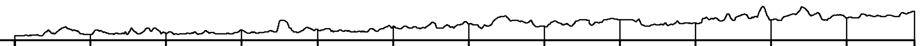
Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK007
Rev	A

DRAFT FOR REVIEW

Notes
1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

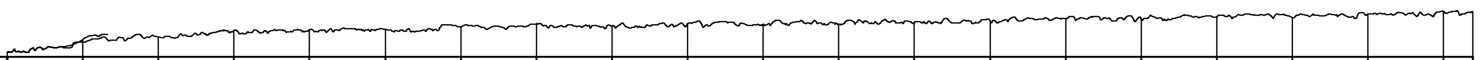
DATUM 12.00m



EXISTING LEVELS	15.00	16.00	16.25	18.76	19.25	21.21	22.75	21.19	25.66	23.47	25.60	26.79	31.12
DESIGN LEVELS	15.00	16.00	16.25	18.76	19.25	21.21	22.75	21.19	25.66	23.47	25.60	26.79	31.12
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	2873.05

Reach Scheme In to Scheme Out
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

DATUM 12.00m



EXISTING LEVELS				29.43	29.86	30.15	31.76	33.75	32.25	33.75	33.58	33.34	34.85	35.73	37.29	37.03	38.50	37.84	40.12	42.08	41.68
DESIGN LEVELS	15.02	23.42																			
CUT/FILL																					
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1500.00	1750.00	2000.00	2250.00	2500.00	2750.00	3000.00	3250.00	3500.00	3750.00	4000.00	4250.00	4500.00	4750.00	4847.70

Downstream Reach B to A Scheme Out
HORIZONTAL SCALE 1:25000 @ A3
VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
Checked	##	####

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Project
WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title
FLOOD MODELLING CATCHMENT LONGSECTION PLAN

Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK008
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

Notes

1. Co-ordinates in terms of NZ Geodetic Datum Mt Eden 2000. Levels in terms of the Auckland Vertical Datum 1946.

DATUM 8.00m

EXISTING LEVELS	11.10	11.77	15.05	15.33	15.00	15.00
DESIGN LEVELS	11.10	11.77	15.05	15.33	15.00	15.00
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1006.09

Downstream Reach Scheme Out B to CD

HORIZONTAL SCALE 1:25000 @ A3

VERTICAL SCALE 1:5000 @ A3

DATUM 6.00m

EXISTING LEVELS	9.38	9.81	9.88	11.71	11.00	11.02	11.11
DESIGN LEVELS	9.38	9.81	9.88	11.71	11.00	11.02	11.11
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1250.00	1303.55

Downstream Reach CD to EFG

HORIZONTAL SCALE 1:25000 @ A3

VERTICAL SCALE 1:5000 @ A3

DATUM 0.00m

EXISTING LEVELS	2.75	3.92	3.45	5.74	8.00	9.41
DESIGN LEVELS	2.75	3.92	3.45	5.74	8.00	9.41
CUT/FILL	0.00	0.00	0.00	0.00	0.00	0.00
CHAINAGE	0.00	250.00	500.00	750.00	1000.00	1078.37

Downstream Reach EFH to Out

HORIZONTAL SCALE 1:25000 @ A3

VERTICAL SCALE 1:5000 @ A3

Rev	Description	By	Date
A	FOR INFORMATION	YW	03/2023

	By	Date
Survey	##	MM/YYYY
Design	##	MM/YYYY
Drawn	BY	MM/YYY
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Project

WARKWORTH SOUTH PLAN CHANGE FOR KA WAIMANAWA LP & STEPPING TOWARDS FAR LTD

Title

FLOOD MODELLING CATCHMENT LONGSECTION PLAN

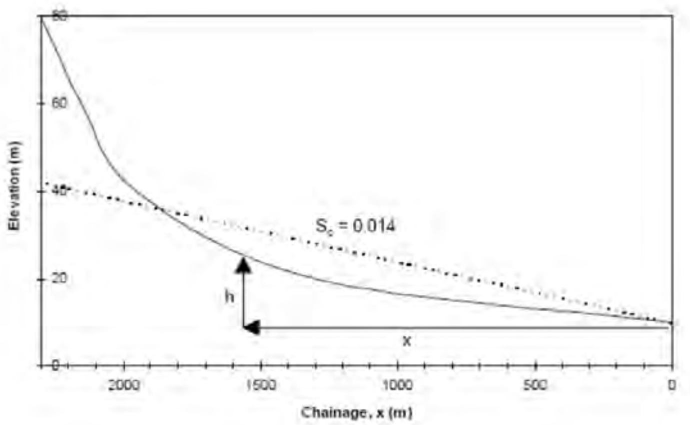
Project no.	211001
Scale	
Cad file	CATCHMENT BDYS & LENGTHS EDEN2K.DWG
Drawing no.	SK009
Rev	A

DRAFT FOR REVIEW

DATE: 4/6/23

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment A	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	32.3	0	0			
2	42.75	10.45	1500	1500	5.225	7837.5
3	52	19.7	3000	1500	15.075	22612.5
4	64	31.7	3750	750	25.7	19275
5	99.4	67.1	4175	425	49.4	20995
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4175	TOTAL =	70720

S_c = 0.008

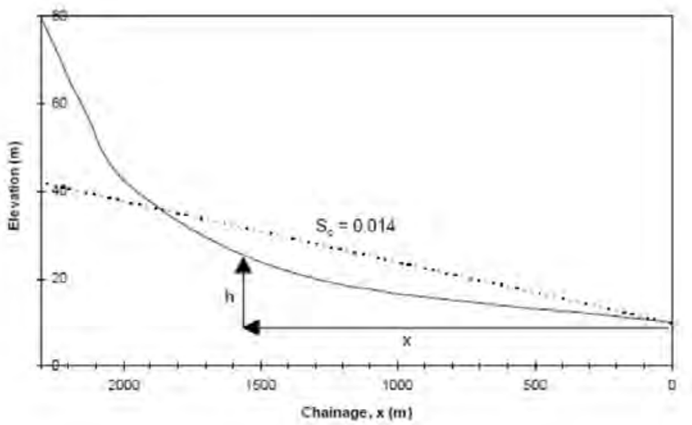
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment B	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	32.3	0	0			
2	40.6	8.3	1750	1750	4.15	7262.5
3	50.9	18.6	3000	1250	13.45	16812.5
4	57.3	25	3250	250	21.8	5450
5	88	55.7	4250	1000	40.35	40350
6	169.8	137.5	4660	410	96.6	39606
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4660	**TOTAL =**	109481

S_c = 0.010

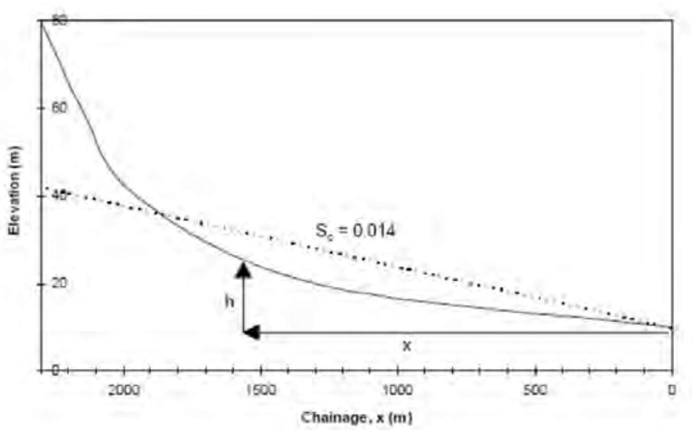
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment C	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A(=\overline{h}\Delta x)$
1	45.5	0	0			
2	70.6	25.1	1500	1500	12.55	18825
3	82.6	37.1	2750	1250	31.1	38875
4	101	55.5	3500	750	46.3	34725
5	133.6	88.1	3750	250	71.8	17950
6	215.5	170	4750	1000	129.05	129050
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4750	TOTAL =	239425

S_c = 0.021

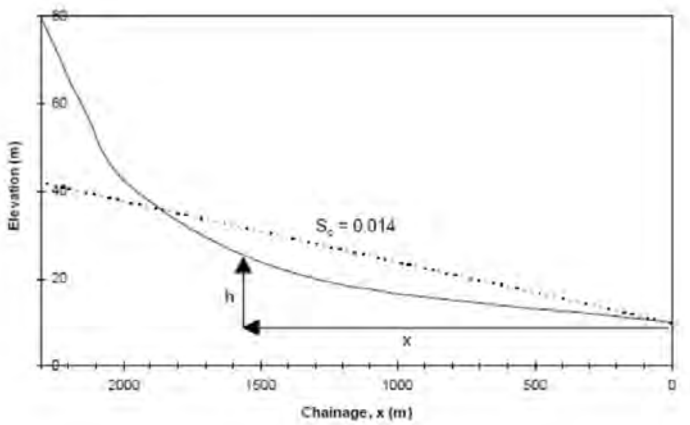
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A(=\overline{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment D	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	46.95	0	0			
2	76	29.05	1750	1750	14.525	25418.75
3	92.5	45.55	3250	1500	37.3	55950
4	142	95.05	4500	1250	70.3	87875
5	205.84	158.89	5750	1250	126.97	158712.5
6	317	270.05	6750	1000	214.47	214470
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	6750	**TOTAL =**	542426.25

S_c = 0.024

Post-development

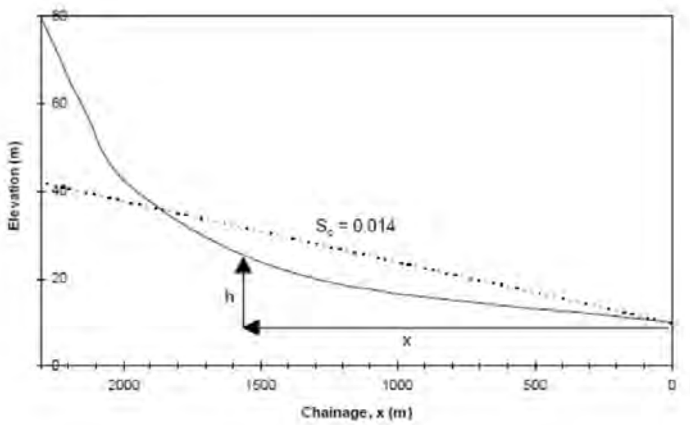
Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

D

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment E	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	45.1	12.8	2000	2000	6.4	12800
3	57.2	24.9	3750	1750	18.85	32987.5
4	111.4	79.1	4500	750	52	39000
5	135.7	103.4	5750	1250	91.25	114062.5
6	194.8	162.5	6250	500	132.95	66475
7	317	284.7	7250	1000	223.6	223600
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	7250	**TOTAL =**	488925

S_c = 0.019

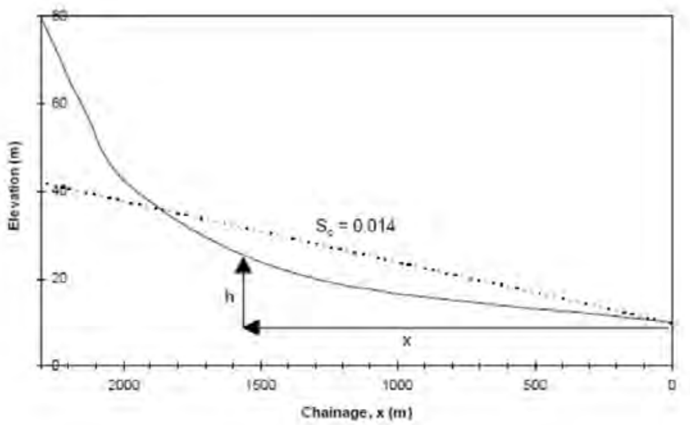
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Catchment F	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1	29.95	0	0			
2	44.86	14.91	2000	2000	7.455	14910
3	55.91	25.96	2750	750	20.435	15326.25
4	99.25	69.3	3250	500	47.63	23815
5	165.1	135.15	4000	750	102.225	76668.75
6	274.7	244.75	4714.4	714.4	189.95	135700.28
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4714.4	**TOTAL =**	266420.28

S_c = 0.024

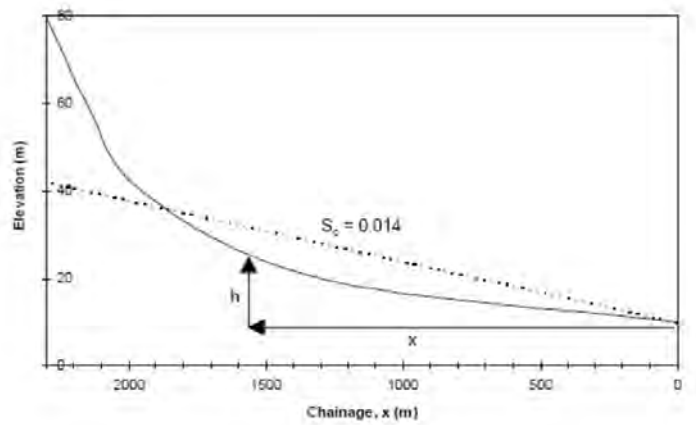
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Reach ABE to Scheme Inflow	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells	
Result cells	

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	29.95	0	0			
2	31.9	1.95	500	500	0.975	487.5
3	32.01	2.06	750	250	2.005	501.25
4	32.28	2.33	1186	436	2.195	957.02
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1186	**TOTAL =**	1945.77

S_c = 0.003

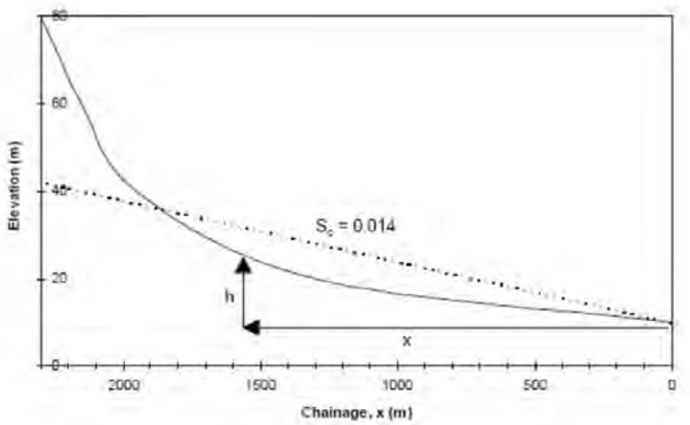
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Upstream Reach CD to ABE	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	32.3	0	0			
2	37.2	4.9	1000	1000	2.45	2450
3	39.1	6.8	1500	500	5.85	2925
4	42.1	9.8	2250	750	8.3	6225
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	2250	**TOTAL =**	11600

S_c = 0.005

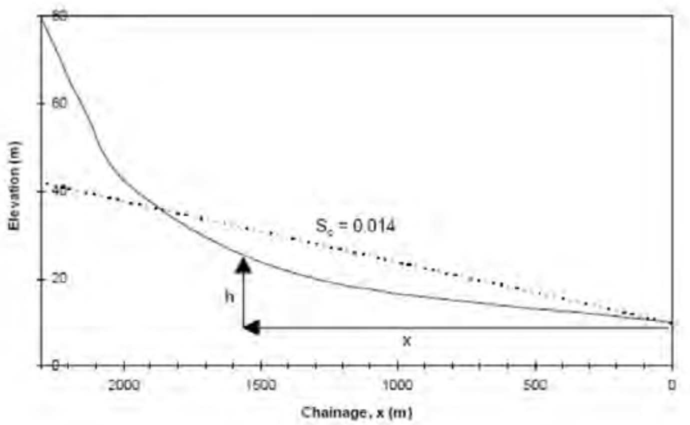
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream A	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	27	0	0			
2	33.5	6.5	3000	3000	3.25	9750
3	39.9	12.9	4500	1500	9.7	14550
4	67.56	40.56	5750	1250	26.73	33412.5
5	140	113	6120	370	76.78	28408.6
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	6120	**TOTAL =**	86121.1

S_c = 0.005

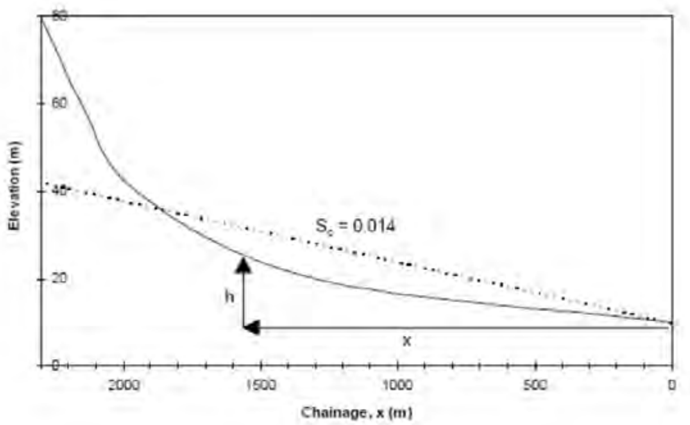
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream B	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1	40.7	0	0			
2	48.87	8.17	2000	2000	4.085	8170
3	56.5	15.8	3500	1500	11.985	17977.5
4	94.3	53.6	4500	1000	34.7	34700
5	148.64	107.94	5000	500	80.77	40385
6	288.82	248.12	5306	306	178.03	54477.18
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	5306	TOTAL =	155709.68

S_c = 0.011

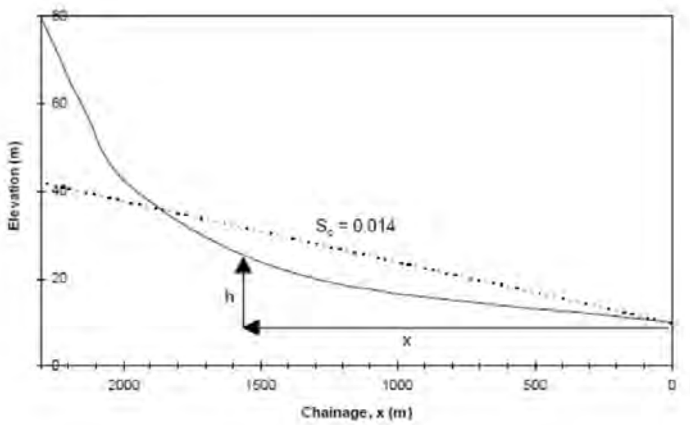
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h} \Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream C	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A(=\overline{h}\Delta x)$
1	11.1	0	0			
2	15.07	3.97	500	500	1.985	992.5
3	15.3	4.2	750	250	4.085	1021.25
4	25.67	14.57	1000	250	9.385	2346.25
5	27.77	16.67	1077	77	15.62	1202.74
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1077	TOTAL =	5562.74

S_c = 0.010

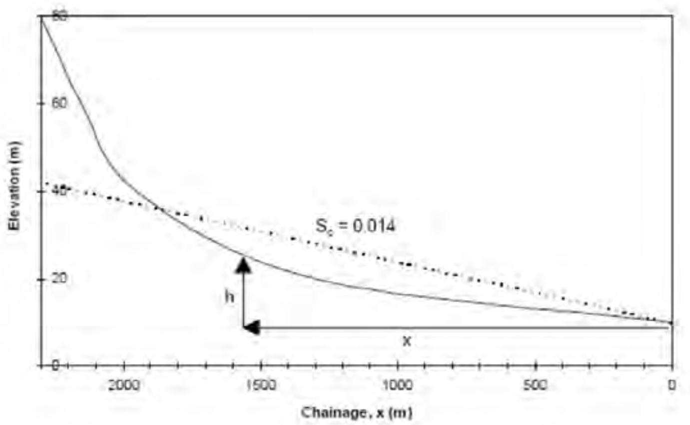
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A(=\overline{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream D	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h}\Delta x)$
1	11.1	0	0			
2	20.2	9.1	1000	1000	4.55	4550
3	29.6	18.5	2000	1000	13.8	13800
4	33.74	22.64	2750	750	20.57	15427.5
5	43.5	32.4	3000	250	27.52	6880
6	79.7	68.6	3250	250	50.5	12625
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	3250	**TOTAL =**	53282.5

S_c = 0.010

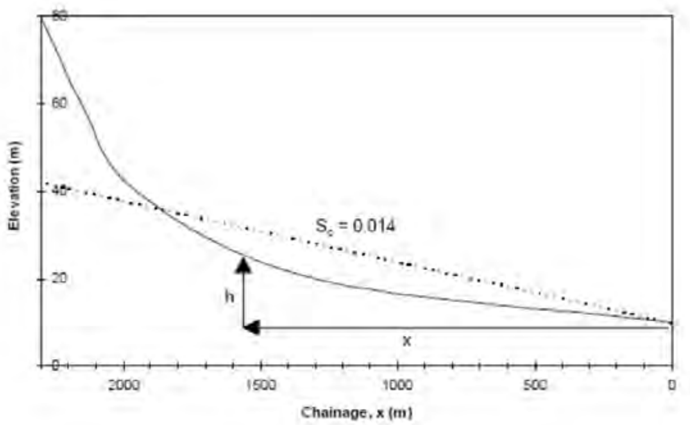
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream E	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h}\Delta x)$
1	8.9	0	0			
2	10.36	1.46	500	500	0.73	365
3	18.24	9.34	750	250	5.4	1350
4	34.2	25.3	1250	500	17.32	8660
5	57.1	48.2	1695	445	36.75	16353.75
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1695	**TOTAL =**	26728.75

S_c = 0.019

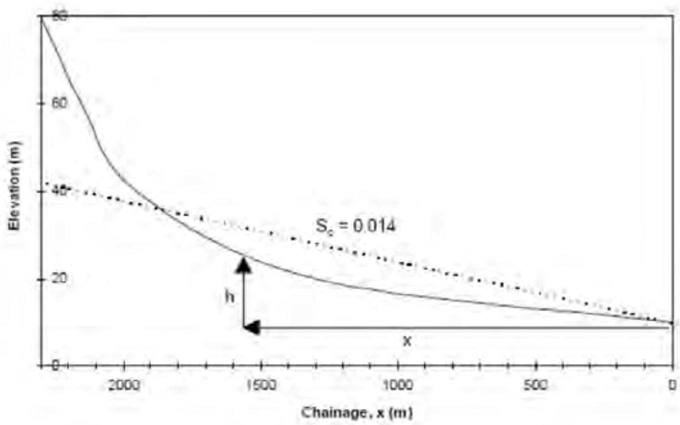
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\overline{h}$	$\Delta A (= \overline{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream F	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	8.98	0	0			
2	10.88	1.9	500	500	0.95	475
3	37.35	28.37	750	250	15.135	3783.75
4	65	56.02	1036	286	42.195	12067.77
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1036	**TOTAL =**	16326.52

S_c = 0.030

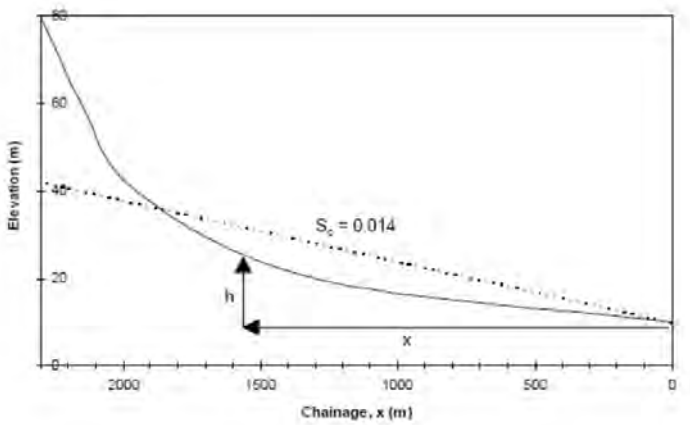
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	DATE:	30/03/2023
JOB NO:	211001	DES BY:	YW
SUBJECT:	Downstream G	CHKD BY:	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	9.4	0	0			
2	27.5	18.1	1000	1000	9.05	9050
3	38.5	29.1	1750	750	23.6	17700
4	71.5	62.1	2553	803	45.6	36616.8
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	2553	TOTAL =	63366.8

S_c = 0.019

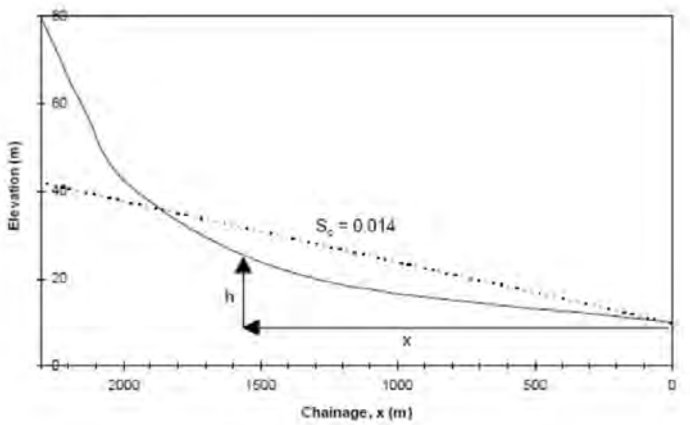
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream H	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	0	0	0			
2	3.75	3.75	250	250	1.875	468.75
3	5.25	5.25	750	500	4.5	2250
4	18.1	18.1	1000	250	11.675	2918.75
5	43.1	43.1	1250	250	30.6	7650
6	60	60	1520	270	51.55	13918.5
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1520	TOTAL =	27206

S_c = 0.024

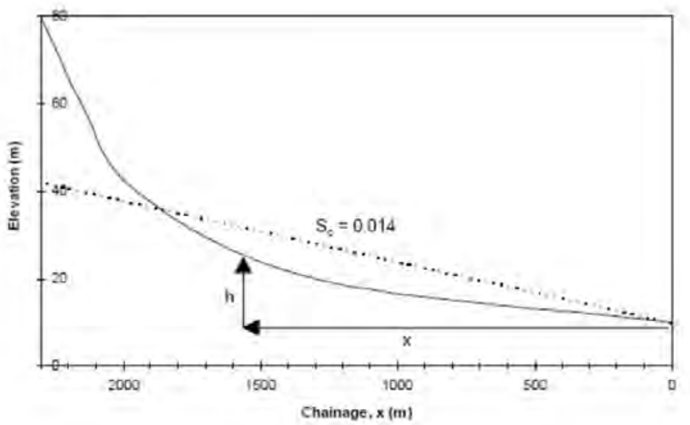
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Scheme In to Out	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	15	0	0			
2	19.25	4.25	1000	1000	2.125	2125
3	25.66	10.66	2000	1000	7.455	7455
4	31.1	16.1	2973	973	13.38	13018.74
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	2973	TOTAL =	22598.74

S_c = 0.005

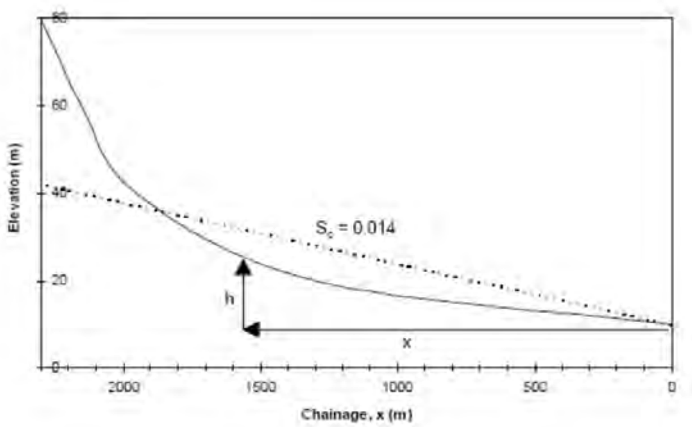
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	TOTAL =	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Bto Scheme Out	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells

Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	15	0	0			
2	29.43	14.43	750	750	7.215	5411.25
3	32.25	17.25	2000	1250	15.84	19800
4	35.73	20.73	3250	1250	18.99	23737.5
5	41.7	26.7	4850	1600	23.715	37944
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	4850	**TOTAL =**	86892.75

S_c = 0.007

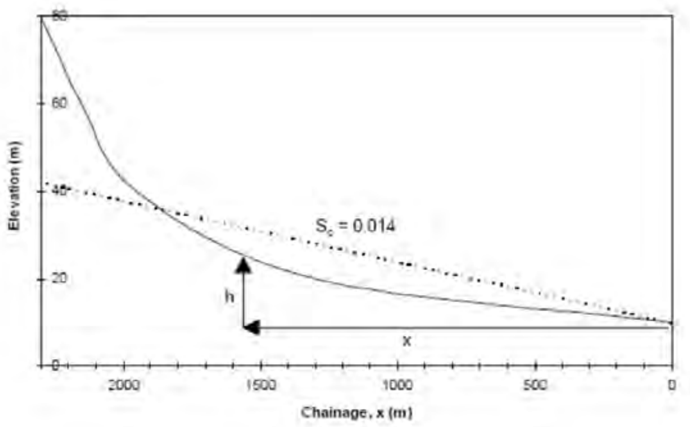
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach Scheme Out B to CD	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1	11.1	0	0			
2	11.77	0.67	250	250	0.335	83.75
3	15	3.9	1000	750	2.285	1713.75
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1000	**TOTAL =**	1797.5

S_c = 0.004

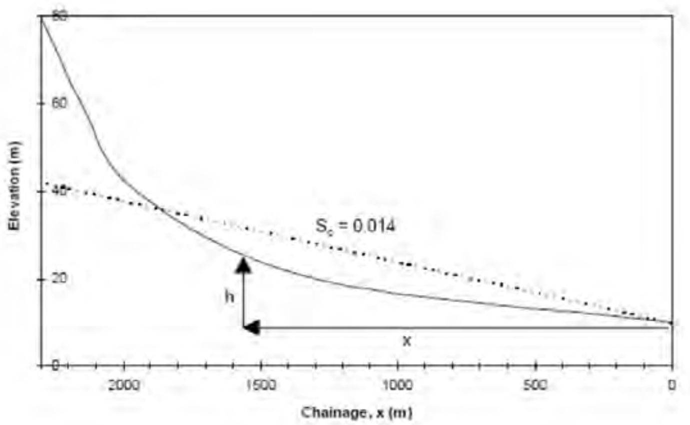
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A (= \bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach CD to EFG	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

(This graph is from the ARC TP 108, April 1999, pg.14)

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	9.38	0	0			
2	9.8	0.42	250	250	0.21	52.5
3	11	1.62	1000	750	1.02	765
4	11.11	1.73	1303	303	1.675	507.525
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1303	**TOTAL =**	1325.025

S_c = 0.002

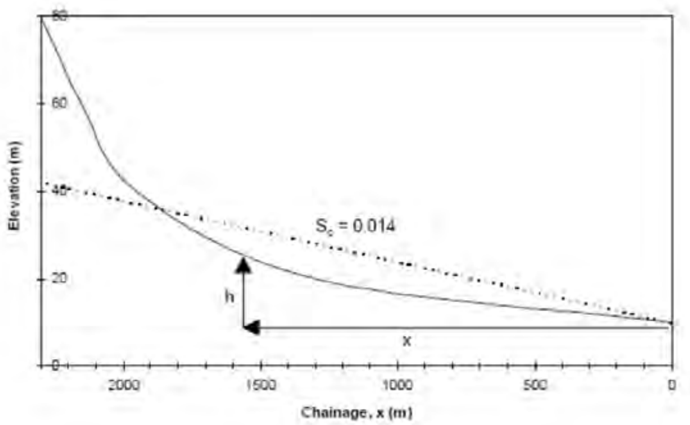
Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

JOB NAME:	Warkwork South Plan Change	**DATE:**	30/03/2023
JOB NO:	211001	**DES BY:**	YW
SUBJECT:	Downstream Reach EFG TO OUT	**CHKD BY:**	

Catchment Slope **(Calculating the Slope (Sc) using the equal area method)**



(This graph is from the ARC TP 108, April 1999, pg.14)

$$S_c = \frac{2A}{L^2}$$

Data Entry Cells
Result cells

Pre-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1	2.75	0	0			
2	3.45	0.7	500	500	0.35	175
3	8	5.25	1000	500	2.975	1487.5
4	9.41	6.66	1080	80	5.955	476.4
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	1080	**TOTAL =**	2138.9

S_c = 0.004

Post-development

Point	RL (m)	(m) h	(m) x	(m) Δx	(m) $\bar{h}$	$\Delta A(=\bar{h}\Delta x)$
1		0				
2		0		0	0	0
3		0		0	0	0
4		0		0	0	0
5		0		0	0	0
6		0		0	0	0
7		0		0	0	0
8		0		0	0	0
9		0		0	0	0
10		0		0	0	0
11		0		0	0	0
12		0		0	0	0
			TOTAL =	0	**TOTAL =**	0

S_c = #DIV/0!

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment A	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	6.0077	588.75
C	Total Pervious	74	327.7623	24254.41
* from Appendix B		Totals =	333.770	24843.16

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 327.7623 / 333.770 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.117 km (along drainage path)

Catchment Slope Sc= 0.008 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.54 1.33 4.26 = 2.02 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0218088 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment B	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	10.3517	1014.47
C	Total Pervious	74	401.8183	29734.55
* from Appendix B		Totals =	412.170	30749.02

CN (weighted) = total product / total area = ###### / ###### = 74.6

Ia (average) = 5 x pervious area / total area = 5 x 401.8183 / 412.170 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.29 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.6 / (200- 74.6) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.61 1.33 3.98 = 1.94 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.30 hrs

OK
use
1.939068 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES

		Job Number	Sheet	Rev
		211001	1	A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Upstream Catchment C	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	3.8056	372.95
C	Total Pervious	74	287.7544	21293.83
* from Appendix B		Totals =	291.560	21666.77

CN (weighted) = total product = ###### = 74.3
total area ######

Ia (average) = 5 x pervious area = 5 x 287.7544 4.9 mm
total area 291.560

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.89 km (along drainage path)

Catchment Slope Sc= 0.021 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.3 / 200- 74.3 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.85 1.34 3.19 = 1.70 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.14 hrs

OK
use
1.6979653 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment D	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	4.8100	471.38
C	Total Pervious	74	505.2700	37389.98
* from Appendix B		Totals =	510.080	37861.36

CN (weighted) = total product / total area = 37861.36 / 510.080 = 74.2

Ia (average) = 5 x pervious area / total area = 5 x 505.2700 / 510.080 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 6.687 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.50 1.34 3.06 = 2.01 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.35 hrs

OK
use
2.0076355 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\TP108 Upstream Catchment D.xlsx

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Catchment E	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	5.7200	560.56
C	Total Pervious	74	567.5700	42000.18
* from Appendix B		Totals =	573.290	42560.74

CN (weighted) = total product = / total area = 42560.74 / 573.290 = 74.2

Ia (average) = 5 x pervious area = / total area = 5 x 567.5700 / 573.290 = 5.0 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 7.153 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.2 / (200- 74.2) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 3.66 1.34 3.28 = 2.25 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.51 hrs

OK
use
2.2509428 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Upstream Catchment F	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	4.8193	472.29
C	Total Pervious	74	299.1107	22134.19
* from Appendix B		Totals =	303.930	22606.48

CN (weighted) = total product = / total area = 22606.48 / 303.930 = 74.4

Ia (average) = 5 x pervious area = / total area = 5 x 299.1107 / 303.930 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.4 / 200- 74.4 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.33 3.06 = 1.56 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5646387 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\TP108 Upstream Catchment F.xlsx

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Post Development Upstream Catchment F	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	15.1030	1480.09
C	Total Pervious	74	288.8270	21373.20
* from Appendix B		Totals =	303.930	22853.29

CN (weighted) = total product / total area = 22853.29 / 303.930 = 75.2

Ia (average) = 5 x pervious area / total area = 5 x 288.8270 / 303.930 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.596 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.2 / (200- 75.2) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.74 1.32 3.06 = 1.55 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.04 hrs

OK
use
1.5497843 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development pstream Reach Catchment ABE - Inflow	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	22.0794	2163.78
C	Total Pervious	74	1297.1506	95989.14
* from Appendix B		Totals =	1319.230	98152.93

CN (weighted) = total product / total area = ###### / ###### = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 1297.1506 / 1319.230 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.186 km (along drainage path)

Catchment Slope Sc= 0.003 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.12 1.33 5.71 = 1.19 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.80 hrs

OK
use
1.193873089 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\TP108 Upstream Reach Catchment ABE - Inflow.xlsx

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Upstream Reach CD to ABE	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	8.6156	844.33
C	Total Pervious	74	793.0244	58683.81
* from Appendix B		Totals =	801.640	59528.13

CN (weighted) = total product / total area = ###### / ###### = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 793.0244 / 801.640 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.25 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.71 1.34 4.90 = 1.57 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.05 hrs

OK
use
1.5656087 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment A	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	9.4054	921.73
C	Total Pervious	74	575.1346	42559.96
* from Appendix B		Totals =	584.540	43481.69

CN (weighted) = total product / total area = 43481.69 / 584.540 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 575.1346 / 584.540 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.848 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.83 1.33 4.90 = 2.59 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.74 hrs

OK
use
2.5945274 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

F:\MAVEN\Projects\211001\HEC\230328 RFI\TP108\TP108 Catchment G.xlsx

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Catchment B	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 5.031 km (along drainage path)

Catchment Slope Sc= 0.011 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.3}{200- 74.3} = 0.59$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.90 1.33 3.87 = 2.10 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.41 hrs

OK
use
2.0998325 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment C	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	7.3200	717.36
C	Total Pervious	74	16.2500	1202.50
* from Appendix B		Totals =	23.570	1919.86

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = $\frac{1919.86}{23.570}$ = 81.5

Ia (average) = $\frac{\text{5 x pervious area}}{\text{total area}}$ = $\frac{5 \times 16.2500}{23.570}$ 3.4 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.018 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN}$ = $\frac{81.5}{200- \quad 81.5}$ = 0.69

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.01 1.23 3.98 = 0.69 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.46 hrs

OK
use
0.6932339 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development TP108 Downstream Catchment D	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	8.4586	828.94
C	Total Pervious	74	275.4014	20379.70
* from Appendix B		Totals =	283.860	21208.65

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{21208.65}{283.860} =$ 74.7

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 275.4014}{283.860}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 3.056 km (along drainage path)

Catchment Slope Sc= 0.01 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.7}{200- 74.7} =$ 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.09 1.33 3.98 = 1.55 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.04 hrs

OK
use
1.5480986 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Down Catchment E	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	45.2715	4436.61
C	Total Pervious	74	26.8785	1989.01
* from Appendix B		Totals =	72.150	6425.62

CN (weighted) = total product / total area = 6425.62 / 72.150 = 89.1

Ia (average) = 5 x pervious area / total area = 5 x 26.8785 / 72.150 = 1.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.665 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 89.1 / (200- 89.1) = 0.80

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.40 1.13 3.28 = 0.73 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.49 hrs

OK
use
0.7262942 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment F	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	0.2200	21.56
C	Total Pervious	74	21.5700	1596.18
* from Appendix B		Totals =	21.790	1617.74

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1617.74}{21.790} =$ 74.2

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 21.5700}{21.790}$ 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.076 km (along drainage path)

Catchment Slope Sc= 0.03 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{74.2}{200- \quad 74.2} =$ 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.34 2.86 = 0.56 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.38 hrs

OK
use
0.5621775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Downstream Catchment G	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	67.7100	6635.58
C	Total Pervious	74	59.8900	4431.86
* from Appendix B		Totals =	127.600	11067.44

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{11067.44}{127.600} = 86.7$

Ia (average) = $\frac{5 \times \text{pervious area}}{\text{total area}} = \frac{5 \times 59.8900}{127.600}$ 2.3 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.412 km (along drainage path)

Catchment Slope Sc= 0.019 m/m (by equal area method)

Runoff factor, $\frac{CN}{200 - CN} = \frac{86.7}{200- 86.7} = 0.77$

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.79 1.16 3.28 = 0.95 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.64 hrs

OK
use
0.9519511 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Catchment H	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	23.6020	2313.00
C	Total Pervious	74	25.5680	1892.03
* from Appendix B		Totals =	49.170	4205.03

CN (weighted) = total product / total area = 4205.03 / 49.170 = 85.5

Ia (average) = 5 x pervious area / total area = 5 x 25.5680 / 49.170 = 2.6 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.471 km (along drainage path)

Catchment Slope Sc= 0.024 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 85.5 / (200- 85.5) = 0.75

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.29 1.17 3.06 = 0.65 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.43 hrs

OK
use
0.6491606 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change Calc Title: TP108 Calculation - Pre-Development Reach Scheme in to out	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	30.9143	3029.60
C	Total Pervious	74	2111.7450	156269.13
* from Appendix B		Totals =	2142.659	159298.73

CN (weighted) = total product / total area = ####### / 2142.659 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 2111.7450 / 2142.659 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 2.973 km (along drainage path)

Catchment Slope Sc= 0.005 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.3 / 200- 74.3 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.05 1.33 4.90 = 1.88 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 1.26 hrs

OK
use
1.87974775 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title: Warkworth South Plan Change TP108 Calc Title: Calculation - Pre-Development Downstream Reach B to SCHEME OUT	Author YW	Date 30/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2= 1ha	Product of CN x area
C	Total Impervious	98	12.0476	1180.66
C	Total Pervious	74	836.7124	61916.72
* from Appendix B		Totals =	848.760	63097.38

CN (weighted) = total product / total area = 63097.38 / 848.760 = 74.3

Ia (average) = 5 x pervious area / total area = 5 x 836.7124 / 848.760 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 4.85 km (along drainage path)

Catchment Slope Sc= 0.007 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.3 / (200- 74.3) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 2.84 1.33 4.43 = 2.35 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 1.57 hrs

OK
use
2.3473116 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES	Job Number 211001	Sheet 1	Rev A
Job Title / Calc Title: Warkworth South Plan Change, TP108 Calculation - Pre-Development Downstream Reach Scheme out to CD	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	68.7906	6741.48
C	Total Pervious	74	3992.4987	295444.90
* from Appendix B		Totals =	4061.289	302186.38

CN (weighted) = total product / total area = ####### / 4061.289 = 74.4

Ia (average) = 5 x pervious area / total area = 5 x 3992.4987 / 4061.289 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 74.4 / (200- 74.4) = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200-CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 5.24 = 0.98 hrs

SCS Lag for HEC-HMS…. $t_p = 2/3\ t_c$ = 0.66 hrs

OK
use
0.97848894 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Reach CD to EFG	Author YW	Date 18/01/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	84.5692	8287.78
C	Total Pervious	74	4284.1501	317027.11
* from Appendix B		Totals =	4368.719	325314.89

CN (weighted) = total product / total area = ####### / 4368.719 = 74.5

Ia (average) = 5 x pervious area / total area = 5 x 4284.1501 / 4368.719 = 4.9 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1 km (along drainage path)

Catchment Slope Sc= 0.002 m/m (by equal area method)

Runoff factor, CN / 200 - CN = 74.5 / 200- 74.5 = 0.59

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.00 1.33 6.45 = 1.20 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.81 hrs

OK
use
1.2038381 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

MAVEN ASSOCIATES		Job Number 211001	Sheet 1	Rev A
Job Title Calc Title	Warkworth South Plan Change TP108 Calculation - Pre-Development Downstream Reach EFG to Outlet	Author YW	Date 31/03/2023	Checked

1. Runoff Curve Number (CN) and initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number CN*	Area (ha) 10000m2=1ha	Product of CN x area
C	Total Impervious	98	197.7707	19381.53
C	Total Pervious	74	4392.4886	325044.16
* from Appendix B		Totals =	4590.259	344425.69

CN (weighted) = total product / total area = ####### / 4590.259 = 75.0

Ia (average) = 5 x pervious area / total area = 5 x 4392.4886 / 4590.259 = 4.8 mm

2. Time of Concentration

Channelisation factor C = 1 (From Table 4.2)

Catchment length L = 1.08 km (along drainage path)

Catchment Slope Sc= 0.004 m/m (by equal area method)

Runoff factor, CN / (200 - CN) = 75.0 / (200- 75.0) = 0.60

$t_c = 0.14\ C\ L^{0.66}\ (CN/200\text{-}CN)^{-0.55}\ Sc^{-0.30}$

= 0.14 1 1.05 1.32 5.24 = 1.02 hrs

SCS Lag for HEC-HMS.... $t_p = 2/3\ t_c$ = 0.68 hrs

OK
use
1.02191107 hrs

Worksheet 1: Runoff Parameters and Time of Concentration

APPENDIX D – TP108 and Time of concentration calculations

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Apr 5 2023

WOODCOCK BRIDGE (Existing scenario 100yr no Climate Change)

User-defined

Invert Elev (m)	=	16.0500
Slope (%)	=	0.2000
N-Value	=	0.030

Calculations

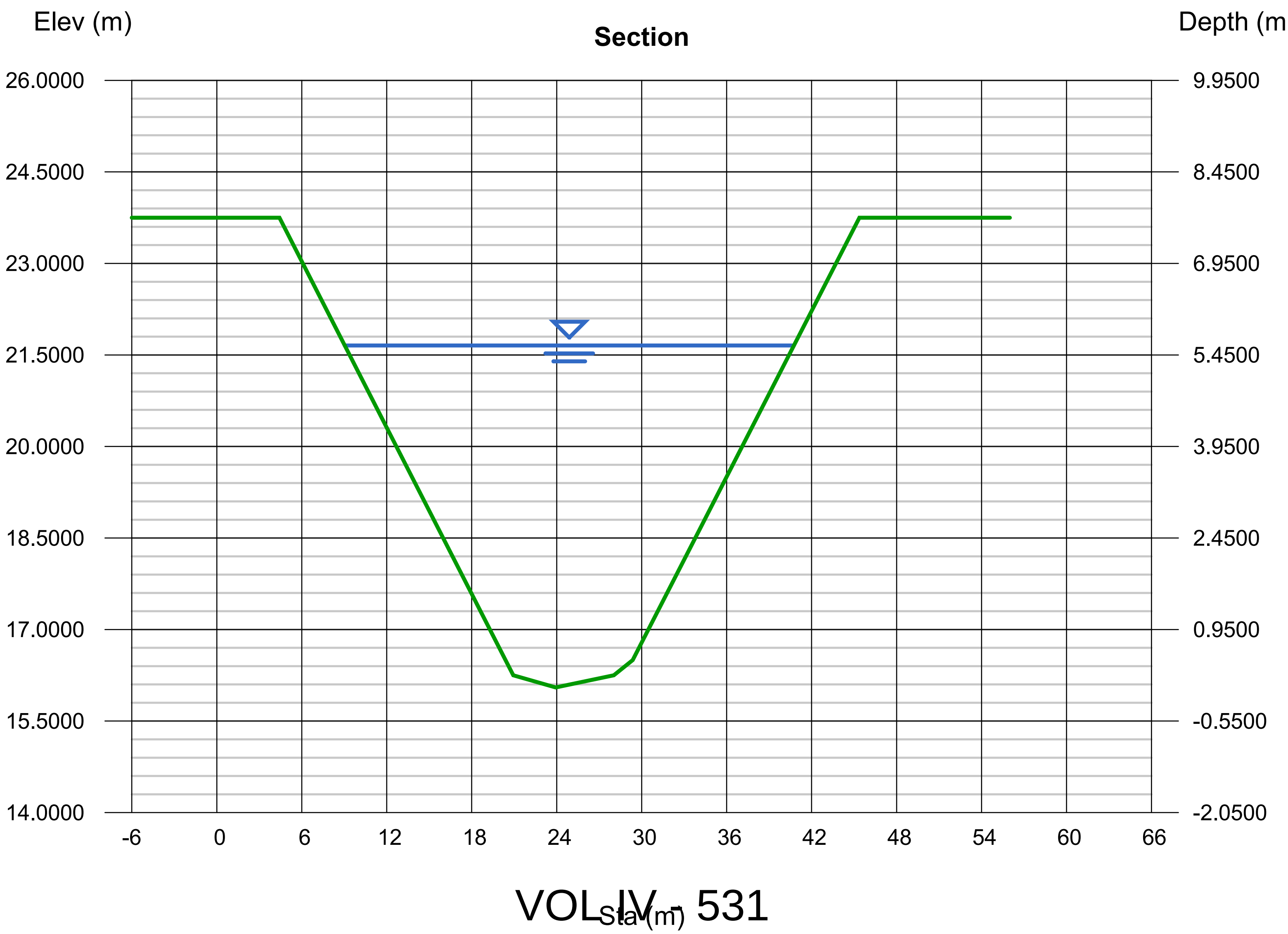
Compute by:		Known Q
Known Q (cms)	=	346.5000

Highlighted

Depth (m)	=	5.6054
Q (cms)	=	347
Area (sqm)	=	107.6504
Velocity (m/s)	=	3.2187
Wetted Perim (m)	=	34.0348
Crit Depth, Yc (m)	=	4.2215
Top Width (m)	=	31.7164
EGL (m)	=	6.1338

(Sta, El, n)-(Sta, El, n)...

(0.0000, 23.7500)-(4.4200, 23.7500, 0.030)-(20.9300, 16.2500, 0.030)-(23.9300, 16.0500, 0.030)-(28.0300, 16.2500, 0.030)-(29.3700, 16.5000, 0.030)-(45.3700, 23
-(50.0000, 23.7500, 0.030)



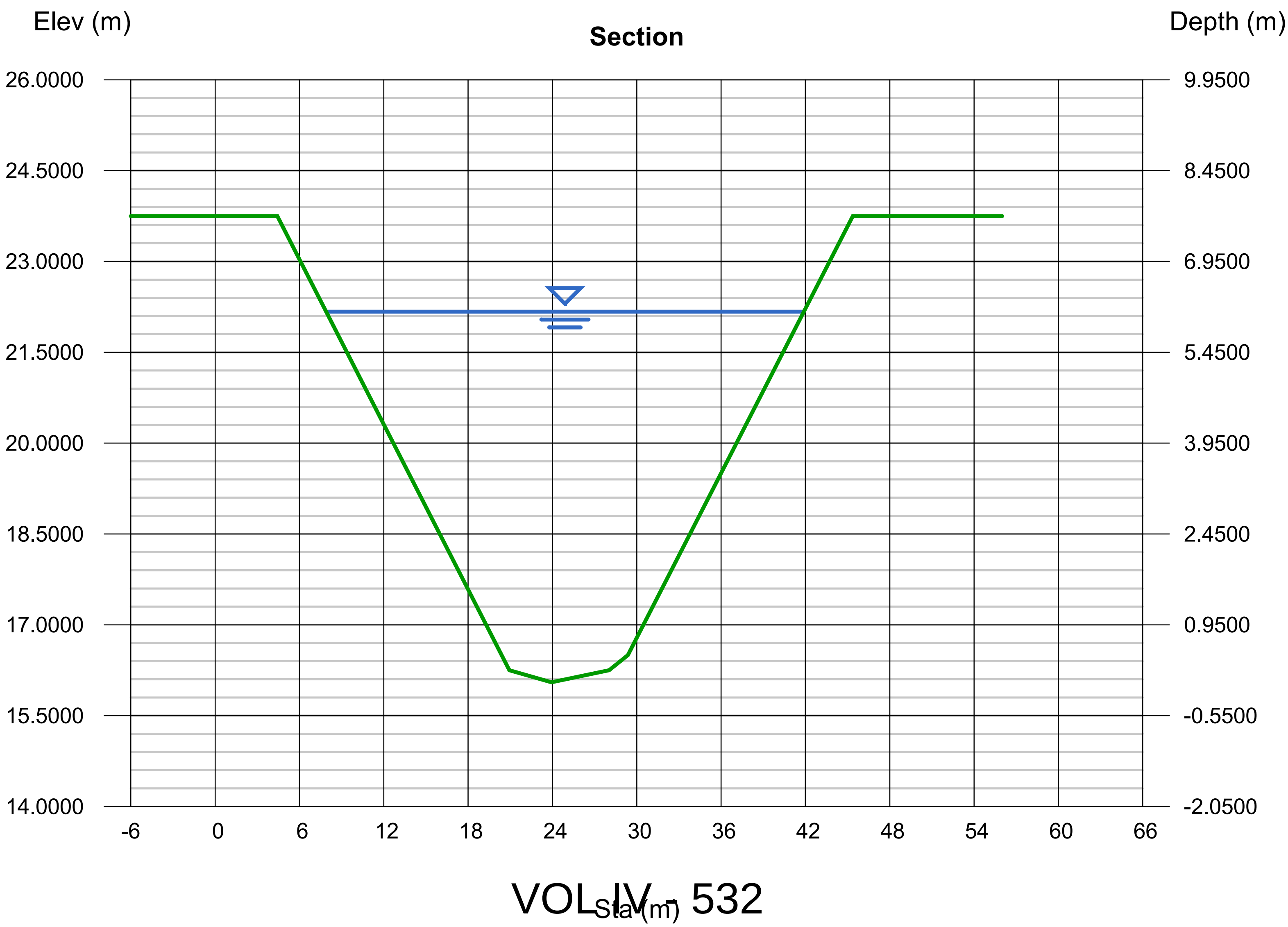
Channel Report

WOODCOCK BRIDGE (Existing scenario 100yr + Climate Change)

User-defined		**Highlighted**	
Invert Elev (m)	= 16.0500	Depth (m)	= 6.1205
Slope (%)	= 0.2000	Q (cms)	= 422
N-Value	= 0.030	Area (sqm)	= 124.5731
		Velocity (m/s)	= 3.3851
Calculations		Wetted Perim (m)	= 36.5283
Compute by:	Known Q	Crit Depth, Yc (m)	= 4.6483
Known Q (cms)	= 421.7000	Top Width (m)	= 33.9872
		EGL (m)	= 6.7050

(Sta, El, n)-(Sta, El, n)...

(0.0000, 23.7500)-(4.4200, 23.7500, 0.030)-(20.9300, 16.2500, 0.030)-(23.9300, 16.0500, 0.030)-(28.0300, 16.2500, 0.030)-(29.3700, 16.5000, 0.030)-(45.3700, 23
-(50.0000, 23.7500, 0.030)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Apr 5 2023

WOODCOCK BRIDGE (Proposed scenario 100yr + Climate Change)

User-defined

Invert Elev (m)	=	16.0500
Slope (%)	=	0.2000
N-Value	=	0.030

Calculations

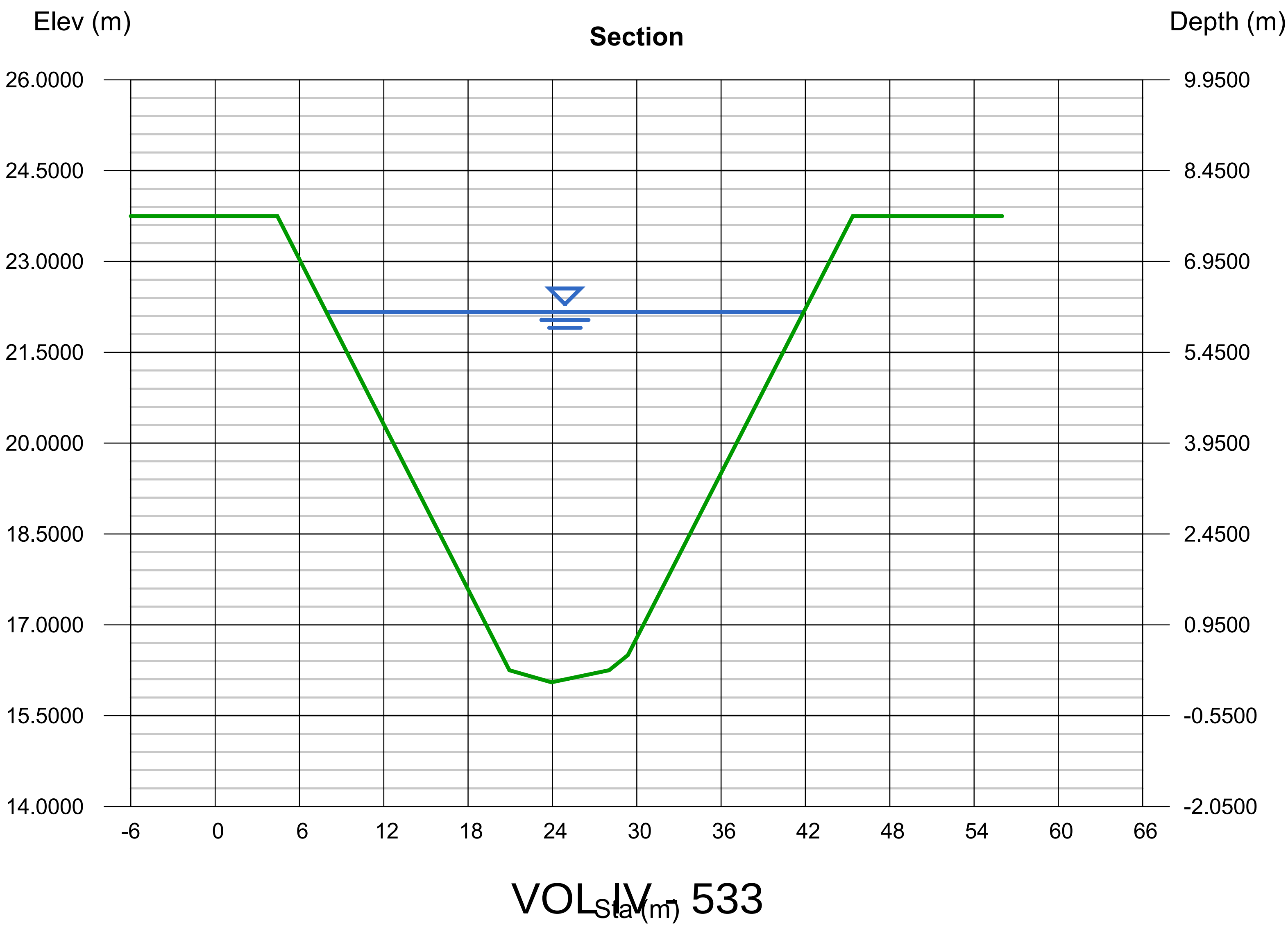
Compute by:		Known Q
Known Q (cms)	=	420.6000

Highlighted

Depth (m)	=	6.1144
Q (cms)	=	421
Area (sqm)	=	124.3660
Velocity (m/s)	=	3.3819
Wetted Perim (m)	=	36.4988
Crit Depth, Yc (m)	=	4.6422
Top Width (m)	=	33.9603
EGL (m)	=	6.6978

(Sta, El, n)-(Sta, El, n)...

(0.0000, 23.7500)-(4.4200, 23.7500, 0.030)-(20.9300, 16.2500, 0.030)-(23.9300, 16.0500, 0.030)-(28.0300, 16.2500, 0.030)-(29.3700, 16.5000, 0.030)-(45.3700, 23
-(50.0000, 23.7500, 0.030)



ATTACHMENT 21

APPENDIX 16
SOIL AND RESOURCE REPORT

Soil and Resource Report for Warkworth South.

Prepared By: Ian Hanmore

Prepared For: KA-Waimanawa Limited Partnership and Stepping Towards Far Limited

25th October 2022

Hanmore
Land Management

TABLE OF CONTENTS

1.0 INTRODUCTION

This report has been prepared at the request of the client to assess the soils on a potential rezoning site either side of State Highway 1 south of Warkworth. The purpose of the report is to identify any prime or elite soils located at the proposed site, as defined by the Auckland Council and any highly productive land as defined by the National Policy Statement on highly productive land (NPS-HPL). To achieve this, a site visit was carried out to map the soils and land use classes present and assess them in relation to the Auckland Council soil class definitions and the NPS-HPL. This report presents the description of each of the soil types identified on the proposed site as well as descriptions of each of the Land Use Capability units mapped. This information is then used to determine and quantify any prime or elite soil and any highly productive land present on the proposed site. This information is accompanied by soil, LUC, prime and elite soil and highly productive land classification maps.

2.0 MAPPING METHOD

A site visit was carried out on the 11th of October 2022 to evaluate and describe the soil types and the Land Use Capability (LUC) units present. The site of interest was mapped at a scale of less than 1:5,000. LUC mapping was carried out in accordance with the methods described in the 3rd Edition of the Land Use Capability Survey Handbook (Lynn et al 2009). This process involves making a land resource inventory (LRI) of the property in which soil types, soil parent materials, land slopes, erosion type and severity and land cover are recorded. Whenever any of these land features changes a new unit is made. Specific field work activities include digging and describing soil profiles on each landform with supporting holes dug or profiles observed on bank/drain cuttings to establishing soil boundaries, measuring slopes with a clinometer, and gathering any other data that may be of assistance in assessing the suitability of the land for primary production such as erosion, susceptibility of the land to flooding, winter wetness and/or cold, high temperatures, exposure to salt winds, aspect, and accessibility. This information is then used to determine the specific LUC units, as described in the Land Use Capability Classifications of the Northland Region (Harmsworth, 1996) for the area. At times when mapping at a scale finer than Harmsworth (1996) of 1:50,000, new LUC units are recorded and are noted with an * in the LUC description table.

3.0 SITE DESCRIPTION

The proposed site is located just south of Warkworth township and includes land on the north western and south eastern sides of SH1 covering a total of 134.9ha. It is bordered by lifestyle and residential blocks, farm land and Morrisons Heritage Orchard. The topography of the site to the northwest is dominated by alluvial flats with a lesser area of rolling hills. To the southeast topography climbs from undulating to rolling hills close to the road to steep hills on the southern most boundary. The alluvial flats have poorly drained alluvial clay soils while the hills on both sides of the road have imperfectly drained clay soils. At the time of the site visit the properties were being used for grazing beef cattle and horses.

3.1 Soil Profiles and Descriptions

The soils identified on the proposed site are presented and described in the table below with an accompanying soil map located in section five.

Soil Profile	Soil Profile Description
	**Soil Name:** Waipuna clay (WU) **Soil classification:** Strongly leached to weakly podzolised yellow-brown earths from the Whareora suite **Parent material:** Alluvium mainly from sedimentary rocks. **Soil description:** 0-200mm: Friable, strongly developed, 5-15mm nut, sticky, plastic, dark grey (2.5y 4/1) clay. 200-250mm: Friable, strongly developed, 5-15mm nut, sticky, plastic, grey (2.5y 5/1) clay with rusting round plant roots. 250-400mm: Friable to firm, strongly developed, predominantly 10-30mm blocky structure, sticky, plastic, grey (5y 6/1) slightly sandy clay with yellowish brown (10yr 5/8) mottles. **Overall drainage:** Poorly drained
	**Soil Name:** Albany silt loam (AB) **Soil classification:** Weakly to moderately podzolised yellow-brown earths from the Whareora suite **Parent material:** Alluvium mainly from sedimentary rocks. **Soil description:** This soil varies from the WU profile above in that the topsoil has a less clay and a more silt loam texture, there was a distinct podzolised silica layer forming at approximately 200mm depth and increased mottling in the subsoil. **Overall drainage:** Poorly drained

	**Soil Name:** Warkworth clay and sandy clay loam (WA) **Soil classification:** Strongly leached to weakly podzolized yellow-brown earths from the Puhoi suite **Parent material:** Banded sandstone **Soil description:** 0-200mm: Friable, strongly developed, 1-5mm nut, sticky, plastic, very dark greyish brown (2.5y 3/2) clay. 200-400mm: Soil deforms under pressure, blocky structure, sticky, plastic, olive yellow (2.5y 6/8) clay with strong brown (7.5yr 5/8) mottling. **Overall drainage:** Moderately well to imperfectly drained.
	**Soil Name:** Whangaripo clay loam (WR) **Soil classification:** Moderately to strongly leached yellow-brown earths from the Puhoi suite. **Parent material:** Banded sandstone. **Soil description:** 0-200mm: Friable, strongly developed, 2-5mm nut, slightly sticky, slightly plastic, dark brown (10yr 3/3) clay loam. 200-500mm: Very friable, strongly developed, 2-3mm nut, sticky, plastic, olive (5y 4/3) clay loam with strong brown (7.5yr 5/8) mottles. **Overall drainage:** Moderately well to imperfectly drained.

3.2 Land Use Capability Descriptions

Land use capability classifications categorizes land into eight classes according to its long-term capability to sustain one or more productive uses. Classes one to four have arable potential with limitations to this land use moving from class one being the most versatile, multi-use land with minimal physical limitations for arable use and increasing to severe limitations under class four land. These classes are also suitable to viticulture, berry production, pastoralism, tree crops and production forestry. Classes five to seven are suitable for pastoral farming and production forestry with class eight land having no productive use and is rather managed for catchment protection and conservation purposes. The table below presents the LUC units mapped on the proposed site with an accompanying LUC map located in section five.

Resource information	Luc unit	Total area (ha)	Parent material	Dominant soil type	Slope (degree)	Land Cover	Erosion degree & severity		Landuse suitability	Stock carrying capacity (su/ha) Forestry site index (FSI)
							Actual	Potential		
3e 3 Gently rolling to rolling slopes on deeply weathered interbedded sandstones and mudstones with occasional massive sandstones and mudstones.		See table in section 4.0 for area information	Interbedded sandstones and mudstones, massive sandstones, and mudstones	Yellow-brown earths on stratified and massive sandstones and mudstones	4-15º	Pasture Viticulture	Nil	Slight sheet, rill, gully. Slight to moderate sheet, rill and gully when cultivating	Root green fodder crops. Horticulture. Intensive grazing. Forestry Now have crop (maize) in rotation	Average: 13 Top: 15 Potential:18 FSI: 29-32 **Revised** Average: 13 Top: 18 Potential:20
4e 5 Rolling and strong rolling slopes within a subdued rolling to hilly landscape on strongly weathered interbedded and occasionally massive sandstones and mudstones.			Bedded sandstone and mudstone, less extensive areas of massive sandstone and mudstone.	Yellow-brown earths on stratified and massive sandstones and mudstones	8-20^0	Pasture Viticulture	Nil	Slight to moderate sheet, soil slip, tunnel gully, earthflow, and rill. Slight to moderate rill and gully and moderate to severe sheet when cultivated.	Grazing Horticulture Cereals Root and green fodder crops	Average: 17 Top: 20 Potential: 24 FSI: 19-29
4e12 Gently rolling to strong rolling slopes within subdued rolling landscape with podzolised soils.			Massive sandstone and mudstone, jointed mudstone, bedded sandstone and mudstone, argillite, crushed argillite, association of rocks, sheared lithologies, lavas and welded ignimbrites.	Podzols on various sedimentary lithologies.	8-20º	Pasture	Nil	Moderate sheet, gully, earthflow, soil slip and tunnel gully. Moderate to severe sheet, rill and gully when cultivated.	Pasture Root and green fodder crops. Forestry	Average: 13 Top: 15 Potential: 18 FSI: 28-32

Resource information	Luc unit	Total area (ha)	Parent material	Dominant soil type	Slope (degree)	Land Cover	Erosion degree & severity		Landuse suitability	Stock carrying capacity (su/ha) Forestry site index (FSI)
							Actual	Potential		
4w 1 Flat to undulating areas on floodplains, valley plains and low terraces with severe continuing wetness or flooding limitation.		See table in section 4.0 for area information	Fine alluvium.	Recent soils on sedimentary and volcanic alluvium.	0-7^0	Pasture	Nil	Moderate streambank and deposition.	Intensive grazing Root and green fodder crops. Forestry	Average: 17 Top: 20 Potential:24 FSI: 20-23 **Revised** Average: 13 Top: 15 Potential:18
4s 4 Flat to undulating slopes within a subdued rolling landscape with podzols and podzolised brown soils.			Fine alluvium or unconsolidated clays and silts and sheared mixed lithologies.	Podzols and podzolised brown soils.	0-15^0	Pasture	Nil	Moderate gully and tunnel gully under pasture. Slight to moderate sheet, rill and gully when cultivated.	Pasture Root and green fodder crops Forestry	Average: 13 Top: 15 Potential:18 FSI: 26-30
6e 1 Strongly rolling to moderately steep slopes forming hilly terrain on interbedded sandstone and mudstone.			Interbedded sandstone and mudstone, occasionally massive sandstone	Yellow-Brown earth hill soils on stratified sandstones and mudstones	16-25º	Pasture Trees	Nil	Moderate soil slip, earth slip, sheet, earthflow, and gully.	Pasture Forestry	Average:8 Top :10 Potential:12 FSI:31-34m **Revised** Average: 11 Top: 13 Potential:15
6e 8 Moderate to steep slopes forming hilly to steep land terrain.			Interbedded sandstone and mudstone	Yellow-Brown earth hill soils on stratified sandstones and mudstones	21-35º	Pasture Trees	Negligible gully	Moderate sheet, soil slip, gully and earthflow. Slight tunnel gully	Pasture Forestry	Average:7 Top farmer:8 Potential:9 FSI:31-34m **Revised** Average: 11 Top: 13 Potential:15

Land use capability unit descriptions are taken from field work and from Land use capability classification of the Northland region (Harmsworth, 1996).

4.0 PRIME AND ELITE SOIL AND HIGHLY PRODUCTIVE LAND CLASSIFICATIONS

4.1 Prime and Elite Soils

The Auckland Council has classified soils in LUC class 1, Bombay clay loam, Patumahoe clay loam, Patumahoe sandy clay loam, and Whatitiri soils as elite soils. Soils in LUC classes 2 and 3 are classified as prime soils. The regional plan has regulations in place that seek to protect the productivity potential of such soils by regulating non-productive land uses.

4.2 Highly Productive Land

The overall purpose of the proposed NPS-HPL is to improve the way highly productive land is managed under the Resource Management Act 1991 (RMA) to:

- recognise the full range of values and benefits associated with its use for primary production
- maintain its availability for primary production for future generations
- protect it from inappropriate subdivision, use, and development.

The current definition of highly productive land under the NPS-HPL is LUC classes 1-3 (https://www.mpi.govt.nz/dmsdocument/36621-Valuing-highly-productive-land-a-summary)

4.3 Warkworth South Soil, LUC and Highly Productive Land Classifications

When completing the field mapping for this report a number of sites were not accessible and as such could only be view from a distance. In some instances not all of the site was visible from neighbouring properties. These sites have been highlighted on the accompanying maps with results based on a visual assessment, aerial imagery, regional scale maps and the authors experience.

The Northland Soil Maps and the New Zealand Resource Inventory (NZLRI) show the alluvial flats on the north-western side of SH1 to be a combination of Whareora clay loam and Kara silt loam soils with the NZLRI giving the area a LUC classification of 3w 1. Detailed mapping of the site found that the soils were not dominated by Whareora clay loam but rather the more strongly leached Waipuna clay soils that are gleyed and have poorer drainage. The site mapping also failed to locate any true podzols (Kara soils) rather the soil profiles were seen to be at an intermediate stage of development between the strongly leached to weakly podzolised Waipuna soils and the podzolised Kara soils. These have been classified as weakly to moderately podzolised Albany silt loam soil. Images of both profiles are presented in the soil section of this report and are included below with the yellow lines indicating the formation of the silica layer in the Albany soil which is characteristic of podzolised soils.

Pictures of the Waipuna clay soil profile on the left and Albany silt loam on the right.

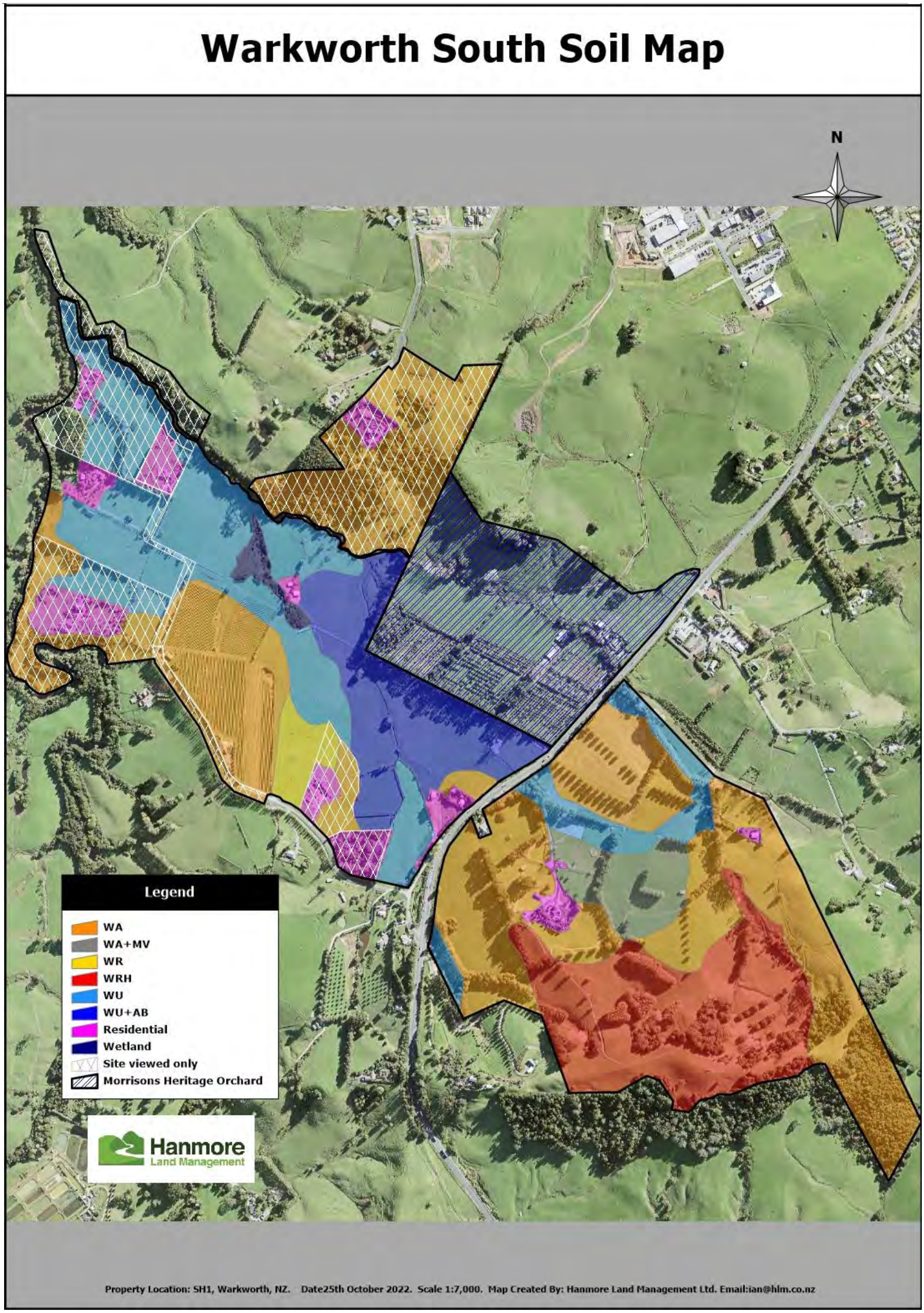
If Whareora and Kara soils had been present at the site as indicated by the regional scale Northland soil and NZLRI maps the correct LUC units would have been either 2w 1 or 3w 1 in the areas of Whareora soils and 4s 4 for the area of Kara soils (Harmsworth 1996). However, as the soils at the site are Waipuna clay with smaller areas of Albany soil the former LUC unit is changed to a 4w 1 (Harmsworth 1996) with 4s 4 remaining for the areas of Albany soil.

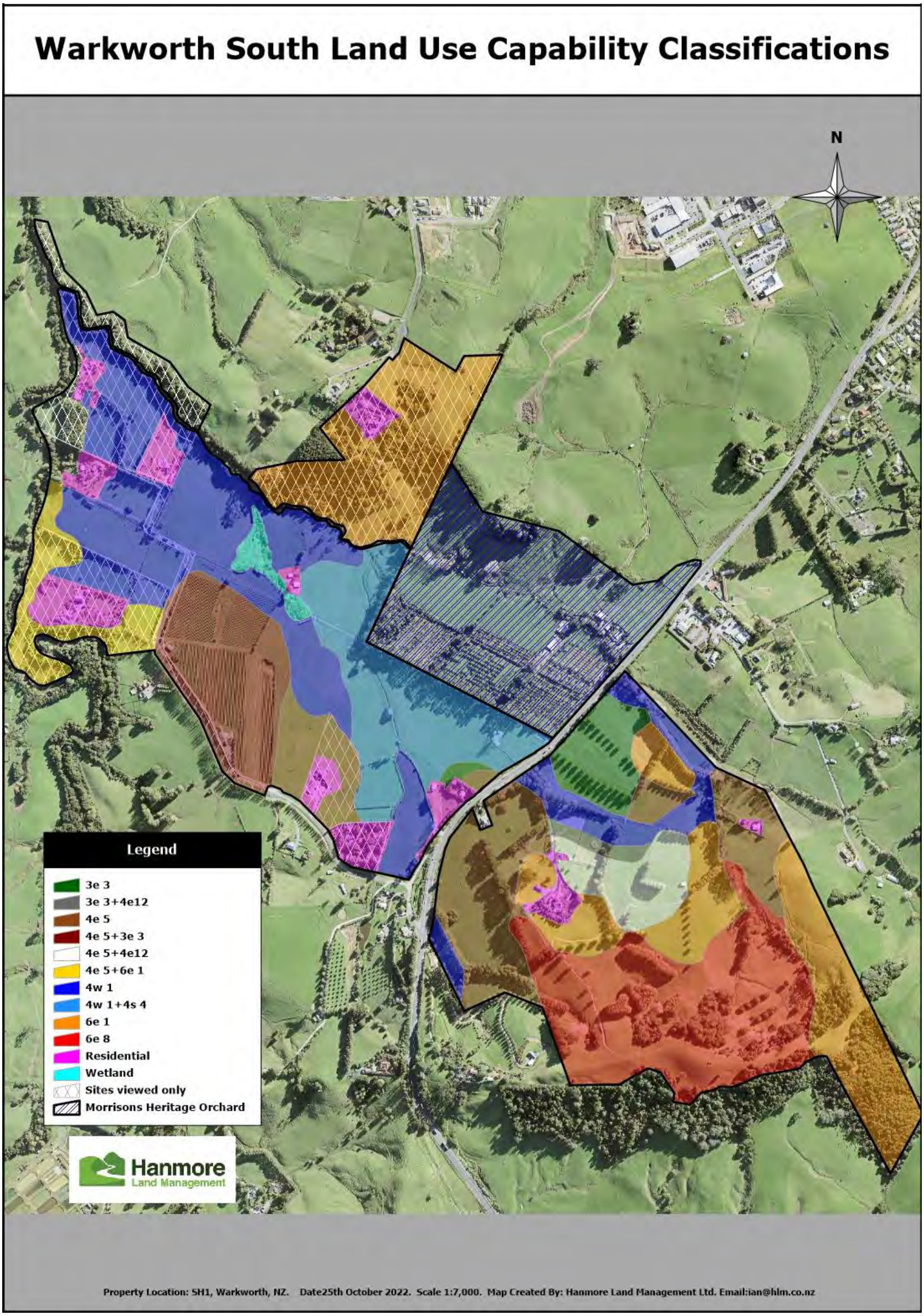
There are five areas on the property that have a combination of LUC units mapped in one polygon. This has been done as the areas are a mix of LUC classes that cannot be separated at the scale of mapping used in this report. The two LUC units are separated by a "+" indicating that the first unit is the dominant unit with smaller areas of the second unit also present. There are two combinations which include both prime soil and highly productive land classifications: 3e 3+4e12 and 4e 5+3e 3. Both of these areas have been given an overall classification of non-prime and non-highly productive land. This has been done as the greater limitations of the class four land determine the potential use of the areas when practically managing them. Further consideration must also be given to the size of the area. The 3e 3+4e12 area is dominated by the class three land but the total area covered is only 0.71ha (0.5%) which is of little productive use on its own. The other areas with combined LUC units are all outside of the prime and elite soils and HPL categories as they are class four and class six land..

The table below shows the area breakdown of LUC units for the proposed site as well as the percentage of prime and elite soils and highly productive land. This information is accompanied by a soil classification and highly productive land classification map in section five.

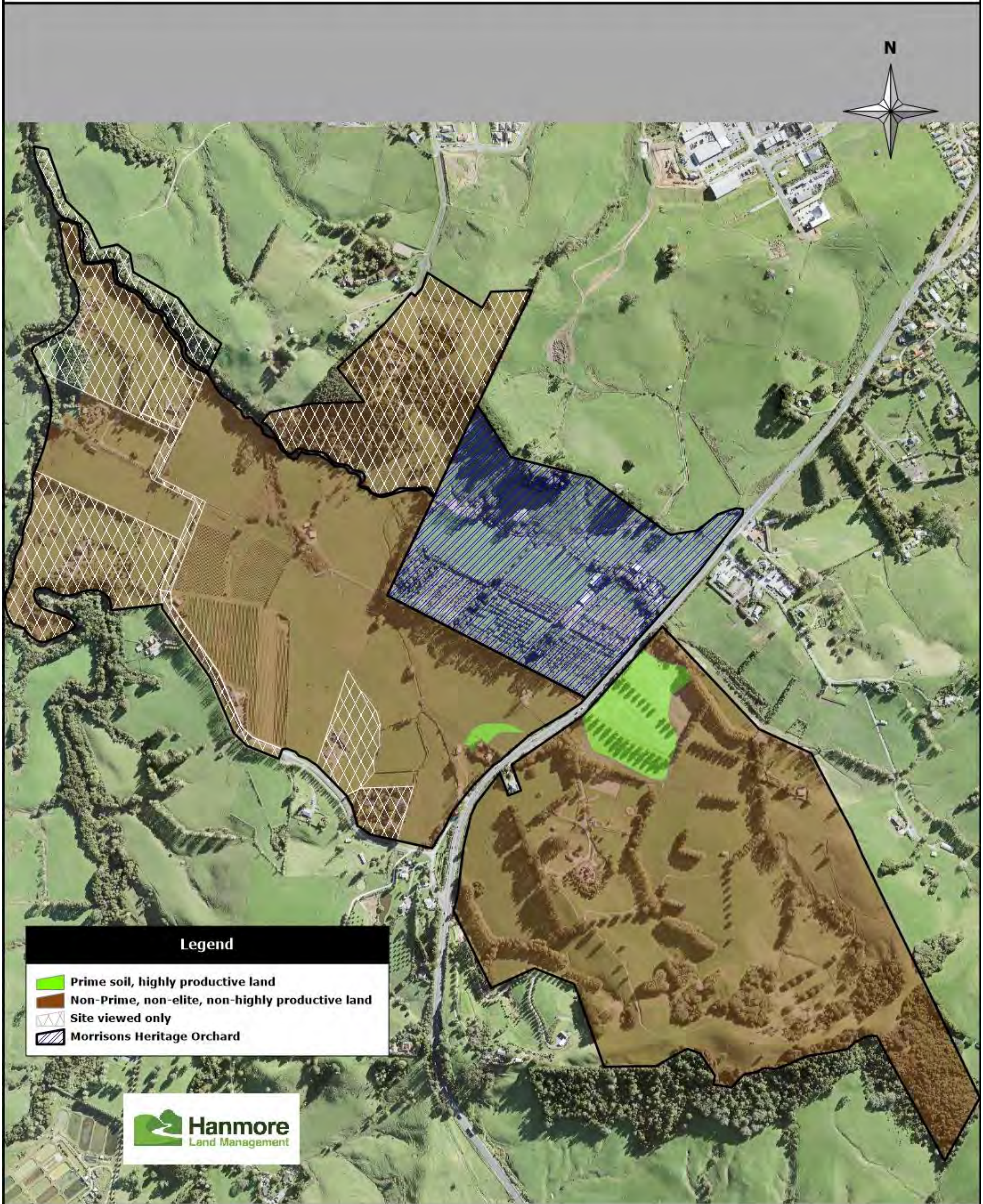
LUC, prime and elite soils and highly productive land for Warkworth South.

LUC Unit	Area (ha)	Soil Classification	Productivity classification	% of total Area
3e 3	3.92	Prime	HPL	3.0
3e 3+4e12	0.71	Non-prime. Non-elite	Non-highly productive land	0.5
4e 5	15.15	Non-prime. Non-elite	Non-highly productive land	11.6
4e 5+3e 3	9.23	Non-prime. Non-elite	Non-highly productive land	7.0
4e 5+4e12	4.05	Non-prime. Non-elite	Non-highly productive land	3.1
4e 5+6e 1	4.20	Non-prime. Non-elite	Non-highly productive land	3.2
4w 1	26.47	Non-prime. Non-elite	Non-highly productive land	20.2
4w 1+4s 4	12.44	Non-prime. Non-elite	Non-highly productive land	9.5
6e 1	26.20	Non-prime. Non-elite	Non-highly productive land	20.0
6e 8	19.11	Non-prime. Non-elite	Non-highly productive land	14.6
Residential	8.47	Non-prime. Non-elite	Non-highly productive land	6.5
Wetland	1.07	Non-prime. Non-elite	Non-highly productive land	0.8
Total Area	131.02			
	3.92	Prime soil and highly productive land		3.0
	127.10	Non-prime, non-elite soil and non-highly productive land		97.0


Warkworth South Soil Map
N
Legend
WA
WA+MV
WR
WRH
WU
WU+AB
Residential
Wetland
Site viewed only
Morrisons Heritage Orchard
Hanmore
Land Management
Property Location: SH1, Warkworth, NZ. Date25th October 2022. Scale 1:7,000. Map Created By: Hanmore Land Management Ltd. Email:ian@hlm.co.nz


Warkworth South Land Use Capability Classifications
N
Legend
3e 3
3e 3+4e12
4e 5
4e 5+3e 3
4e 5+4e12
4e 5+6e 1
4w 1
4w 1+4s 4
6e 1
6e 8
Residential
Wetland
Sites viewed only
Morrisons Heritage Orchard
Hanmore
Land Management
Property Location: SH1, Warkworth, NZ. Date25th October 2022. Scale 1:7,000. Map Created By: Hanmore Land Management Ltd. Email:ian@hlm.co.nz

Warkworth South Soil Classifications



Property Location: SH1, Warkworth, NZ. Date25th October 2022. Scale 1:7,000. Map Created By: Hanmore Land Management Ltd. Email:ian@hlm.co.nz

6.0 REFERENCES

Harmsworth, G.R. 1996. Land Use Capability classification of the Northland region. A report to accompany the second edition (1:50,000) NZLRI worksheets. Landcare Research Science Series 9. Lincoln, Manaaki Whenua Press.

Lynn IH, Manderson AK, Page MJ, Harmsworth GR, Eyles GO, Douglas GB, Mackay AD, Newsome PJF 2009. NZ Land Use Capability Survey Handbook – a New Zealand handbook for the classification of land 3rd Edition. Hamilton, AgResearch; Lincoln, Landcare Research; Lower Hutt, GNS Science.

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ATTACHMENT 22

BIORESEARCHES – JANUARY 2021 REPORT

Memorandum

Bioresearches
A Babbage Company

To:	**OsborneHay**	**Date:**	21 January 2021
Attention:	David Hay	**Ref:**	63967
Subject:	**Freshwater Ecology Classifications – Warkworth Plan Change Area**		

Background Information

Bioresearches was engaged by OsborneHay to undertake an analysis of the potential freshwater ecological features within the proposed Warkworth South Plan Change area ('the site' – 1711 and 1723 State Highway 1 and 36, 40, 46 and 123 Valerie Close, Warkworth). Multiple overland flow paths are indicated to flow through the site, all indicated to be tributaries of the Mahurangi River (Figure 1).

Figure 1. ***A map of the Warkworth South Plan Change site (yellow polygon) showing predicted overland flow paths (dark blue lines) and Terrestrial Significant Ecological Areas (SEA-T; green crosses) from Auckland Council's GIS viewer.***

Prior to the field survey, a map of the site was created from the Auckland Council GeoMaps GIS viewer, which defined the predicted overland flow paths, ecological overlays and contours of the properties (Figure 1). A site assessment was undertaken on 23rd November 2020, by a qualified freshwater ecologist. During the site assessment, the presence and extent of stream or wetland features within the properties were noted and the quality of any instream habitat was visually assessed.

Bioresearches
68 Beach Road, Auckland 1010
P O Box 2027, Auckland 1140
T 09 379-9417
Website: www.Bioresearches.co.nz

Overland flow paths were ground-truthed and classified under the definitions within the Auckland Unitary Plan – Operative in Part (AUP OP) as to their permanent, intermittent or ephemeral status. Areas that contained wetland vegetation were assessed, generally following the wetland delineation protocols[1].

Watercourse Classification

Definitions

Under the AUP OP, an **intermittent stream** is defined as:

'Stream reaches that cease to flow for periods of the year because the bed is periodically above the water table. This category is defined by those stream reaches that do not meet the definition of permanent river or stream and meet at least three of the following criteria:

- *a) it has natural pools;*
- *b) it has a well-defined channel, such that the bed and banks can be distinguished;*
- *c) it contains surface water more than 48 hours after a rain event which results in stream flow;*
- *d) rooted terrestrial vegetation is not established across the entire cross-sectional width of the channel;*
- *e) organic debris resulting from flood can be seen on the floodplain; or*
- *f) there is evidence of substrate sorting process, including scour and deposition.'*

Under the National Policy Statement for Freshwater Management 2020 (NPS-FM), a **natural wetland** is defined as:

'A wetland (as defined in the Act) that is not:

- *a) a wetland constructed by artificial means;*
- *b) a geothermal wetland;*
- *c) any area of improved pasture that, at the commencement date, is dominated by (that is more than 50% of) exotic pasture species and is subject to temporary rain-derived water pooling.'*

Improved pasture is defined as:

'An area of land where exotic pasture species have been deliberately sown or maintained for the purpose of pasture production, and species composition and growth has been modified and is being managed for livestock.'

Rainfall

One significant rainfall event (>25mm) occurred within the month prior to assessment. Rainfall in the week immediately preceding the site assessment was very low, with generally no rain falling with the exception of two rainfall events (0.5mm and 3mm). Due to the very large rain event approximately two weeks prior to the site visit (>60mm), the catchment was likely saturated. Approximately 3mm of rainfall

[1] Ministry for the Environment (2020). Wetland Delineation Protocols.

occurred within 48 hours of the site assessment (Auckland Council Environmental Monitoring Site: Mahurangi @ Satellite Dish) (Figure 2), which may have resulted in the flow of ephemeral streams.

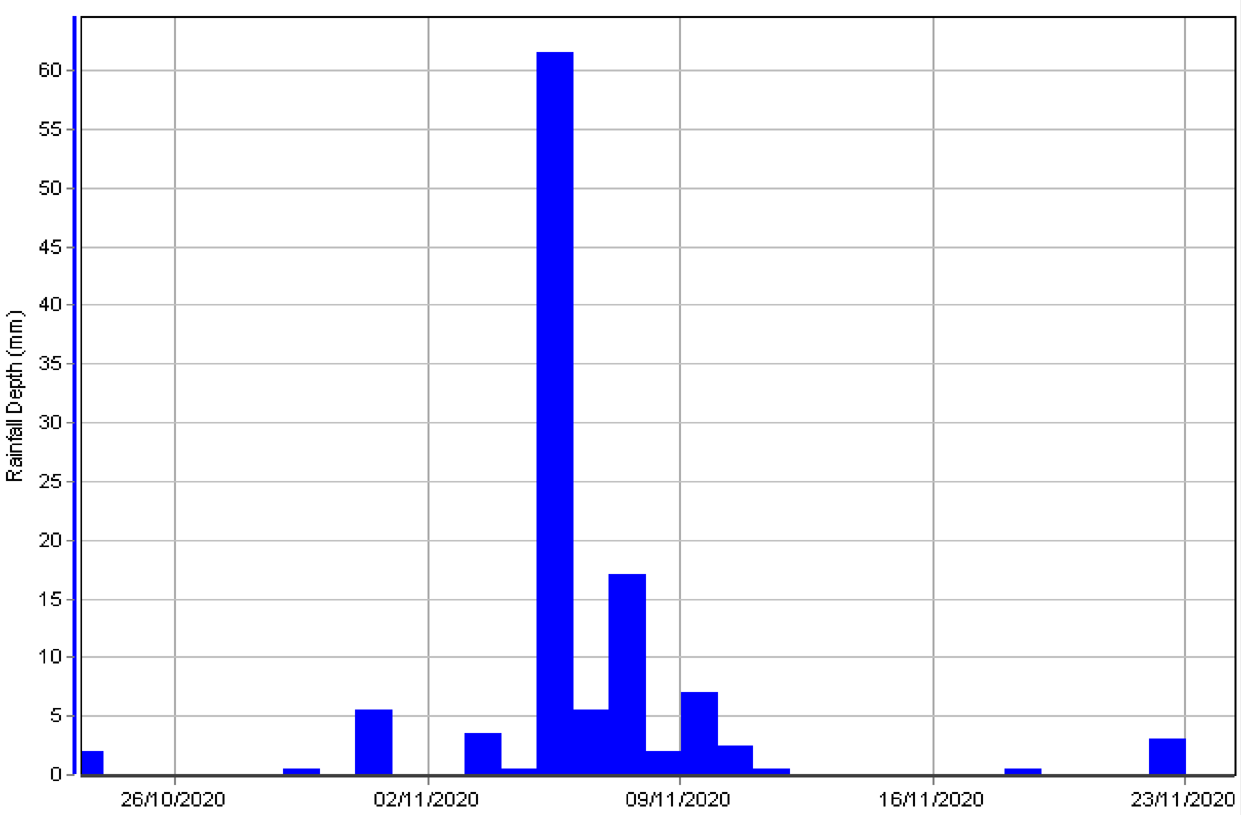

Figure 2. Totalled daily rainfall in the month preceding site assessment (23/10/2020 – 23/11/2020) from Auckland Council's environmental monitoring site at Mahurangi @ Satellite Dish.

Watercourse 1

A watercourse was predicted to flow through a southern portion of 1711 State Highway 1 in a south to north direction (Figure 1). Water exited a culvert running under Valerie Close and into a well-defined channel within the site (Photo 1). The culvert was not overhanging, however appeared undersized for the size of the stream and scour was evident immediately downstream of the culvert outlet.

Water was slow-flowing and contained predominantly in deep runs and pools, with shallow runs occasional (Photo 2). The wetted width of the upper reach was 0.5-1.5m wide and the deepest section was 0.38m. Water was present for the entire length of Watercourse 1 and, due to the consistently deep water and large catchment size (14.5ha), the watercourse was classified as a **permanent stream** (Figure 3). The stream was straight and may have been modified (through straightening and deepening) at some point in the last century, however has existed in its current state since at least 1963 (Figures 4 and 5).

Watercourse 2

Water exited a pipe on the eastern boundary of 1711 State Highway 1. A very large pool directly downstream of the pipe contained water more than 1m deep (Photos 3 and 4). Water then flowed through a well-defined channel in a south to north direction before joining watercourse 1. Watercourse 2 was classified as a **permanent stream** (Figure 3) due to the presence of deep, continuous flowing water.

Bioresearches
A Babbage Company

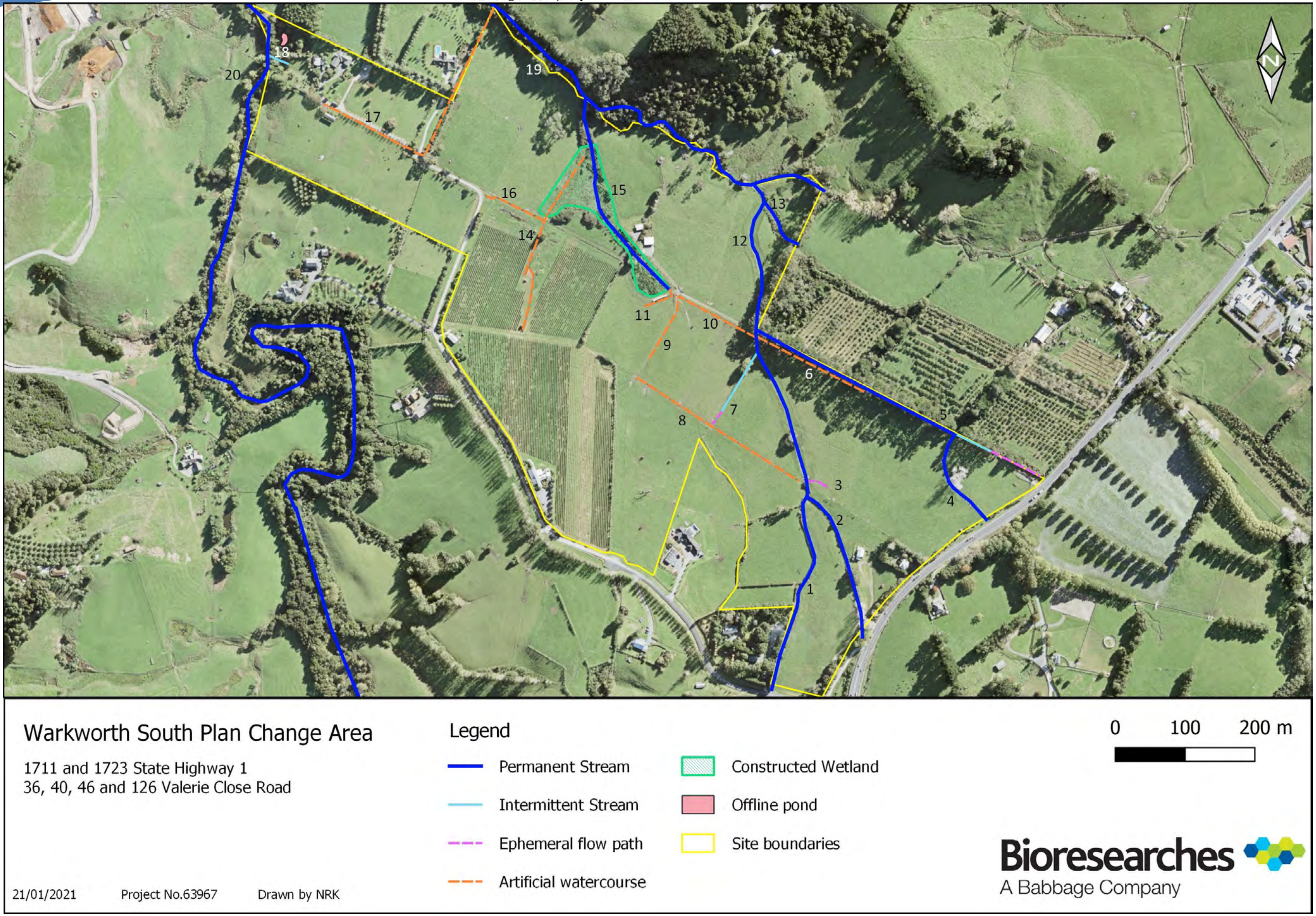

Figure 3. Ground-truthed and classified watercourses within the Warkworth South Plan Change area. Numbers correspond to Watercourse numbers in text and on photographs.

Photo 1. 1 – water entered via a culvert under Valerie Close.

Photo 2. 1 – the stream flowed along a straight path through deep runs and pools.

Photo 3. 2 – water entered via a culvert under SH1.

Photo 4. 2 – the stream was very deep near the culvert.

Photo 5. 1 & 2 – after the confluence of the watercourses.

Photo 6. 3 – no stream characteristics in the area.

Watercourse 3

An overland flow path was indicated to be in the Watercourse 3 area on Auckland Council's Geomaps. Within the area, there was a small depression however there was no well-defined channel, surface water or aquatic vegetation that would suggest a stream or wetland present in the area (Photo 6). Buttercup (*Ranunculus* sp.) grew occasionally throughout pasture grass within the area. This area was classified as an **ephemeral overland flow path** due to the lack of stream or wetland characteristics.

Watercourse 4

Water entered the site via a pipe under SH1. Water was shallow and the stream was often clogged with macrophytes such as parrot's feather (*Myriophyllum aquaticum*) (Photo 7). Further downstream, the stream narrowed and deeper sections were observed (Photo 8). Water then flowed through a culvert under the driveway and discharged into Watercourse 5. This watercourse was classified as a likely **permanent stream**, due to the continuous flowing water, presence of deeper reaches and large catchment size (approximately 37ha).

Watercourse 5

On the northern side of the driveway, a drainage channel had been constructed. The upper portion of this contained very little surface water, however a few still pools were present and there was no terrestrial vegetation growing throughout the channel width (Photo9). Whilst the channel had been clearly constructed, a flow path was likely naturally present through this area and it is expected that water has been diverted to this channel. As such, this upper portion of Watercourse 5 was considered a modified **intermittent stream**. After the confluence with Watercourse 4, water become deep and the channel was much wider (Photo 10). Banks were very steep and had been reinforced in places with wooden boards. From the confluence, the watercourse was classified as a **permanent stream**.

Photo 7. 4 – the upper reach was wide and clogged with macrophytes.

Photo 8. 4 – the lower reach was narrow and incised.

Photo 9. 5 – the upper intermittent reach had r small pools of water

Photo 10. 5 – the lower reach was wide and water was often deep.

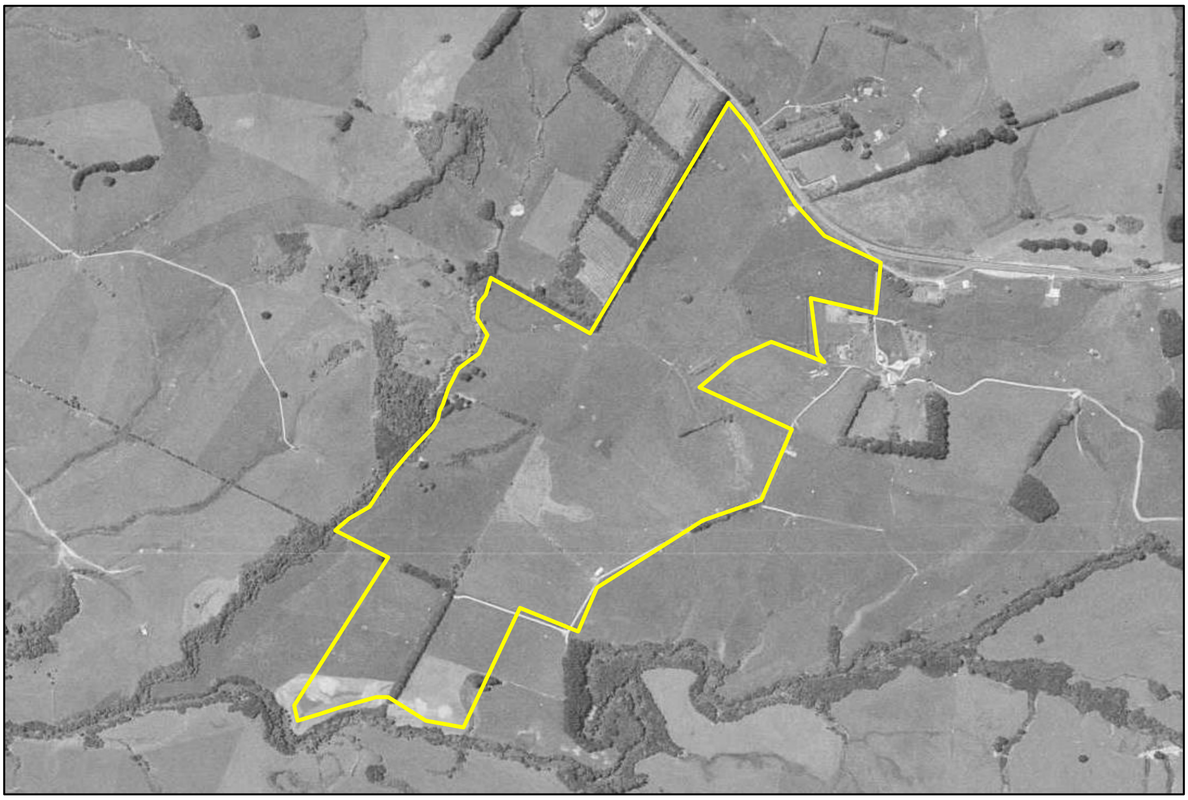

Figure 4. Historic aerial image of the site (yellow polygon) from 1966. Image from Retrolens.

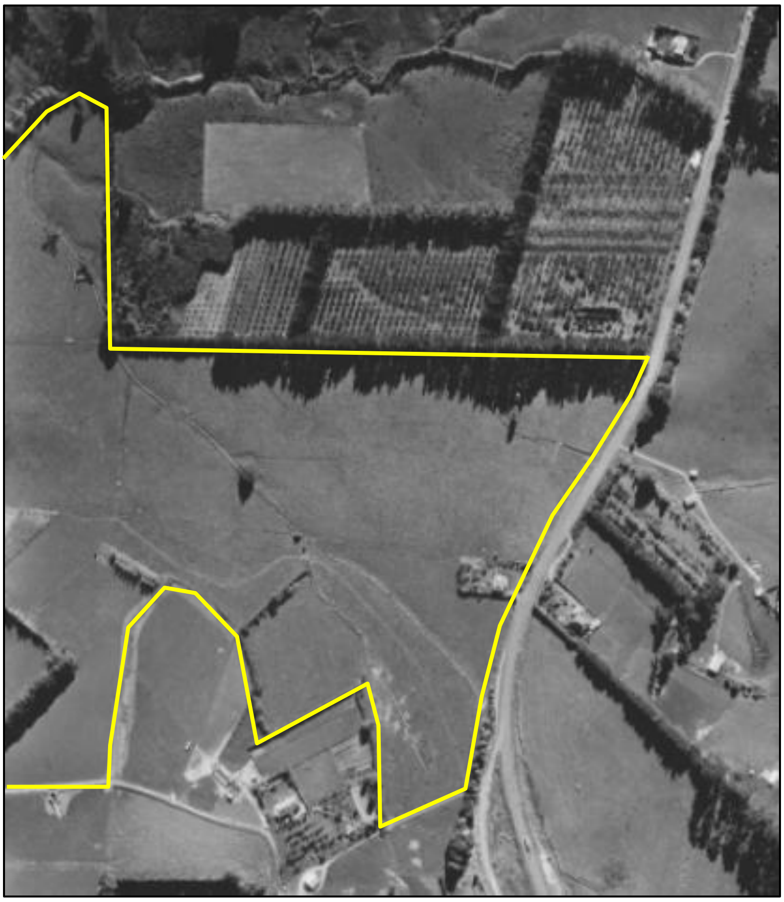

Figure 5. Historic aerial image of the eastern portion of the site (yellow polygon) from 1963. Image from Retrolens. State Highway 1 is the road running up the right-hand side of the figure.

Watercourse 6

On the southern side of the driveway a second, smaller drain was observed. There was no water within this drain and terrestrial pasture grass was rooted throughout (Photo 11). Further along the western portion of the drain, Yorkshire fog (*Holcus lanatus*) grew within the channel and the base of the drain was slightly boggy. A culvert connected this drain to the larger stream on the northern side of the driveway. This drain was classified as an **artificial watercourse** which has been constructed as a roadside drain to take water from the driveway. There were no natural portions of the drain from its headwaters (no natural intermittent or ephemeral streams fed into the drain) to its confluence.

Watercourse 7

A channel that had flattened banks was present within the Watercourse 7 area, and shallow surface water flowed between deeper pools along its length. Macrophytes such as starwort (*Callitriche stagnalis*), water pepper (*Persicaria hydropiper*) and watercress (*Nasturtium officianale*) often grew within the channel (Photos 12 and 13). The flow path was relatively straight, however did not appear to have been artificially created as it was very shallow (some modification may have occurred through straitening). Watercourse 7 was classified as an **intermittent stream** due to the presence of natural pools, flowing surface water and macrophytes. This transitioned into an **ephemeral overland flow path** within the upper reach, where the channel disappeared and surface water was not present.

Watercourse 8

A straight, deep drain had been created, running perpendicular to Watercourse 7 (Photo 14). There was no standing water or boggy ground within the base of the drain and terrestrial pasture vegetation was rooted throughout (Photo 15). Due to the lack of stream characteristics and lack of connectivity to natural watercourses, the drain did not appear to have been a modified natural freshwater system. As such, the drain was classified as an **artificial watercourse**.

Watercourse 9

Another straight watercourse was present along the edge of a driveway (Photo 16) (driveway not shown on map). Water entered the drain through a pipe (Photo 18) that appeared to be fed by stormwater from the surrounding area as no pipe inlet or channel was present within the area upstream. Water was present within a small pool, then the channel became dry for approximately 20m, before shallow, flowing water was observed for the rest of the channel length (Photo 17). The watercourse was clearly constructed and the surrounding flat catchment and lack of upstream freshwater habitat suggest that this watercourse was entirely artificial. As such, this watercourse was classified as an **artificial watercourse**.

Watercourse 10

Similar to the Watercourse 6 drain (artificial watercourse), a shallow drain was present along the edge of the farm track/driveway, with shallow water flowing through the base (Photos 19 and 20). Soft rush (*Juncus effusus*) grew along the edge of the drain. This watercourse had been constructed, did not appear to have natural headwaters and did not flow along a path that would be expected to have historically have a natural stream. Furthermore, historic aerial images do not show any signs of a flow path through this area. Watercourse 10 was classified as an **artificial watercourse**.

Photo 11. 6 – ditch on side of driveway

Photo 12. 7 – downstream reach clogged with water pepper

Photo 13. 7 – upstream reach had shallow pools, macrophytes and flowing water

Photo 14. 8 – an artificial drain

Photo 15. 8 – there was terrestrial vegetation rooted throughout and no water

Photo 16. 9 – an artificial watercourse next to a new driveway.

Photo 17. 9 – a pool upstream of a culvert

Photo 18. 9 – pipe feeding the partially dry drain

Photo 19. 10 – drainage channel adjacent to the farm track flowing opposite to contours

Photo 20. 10 – standing water present in some areas

Watercourse 11

A small, natural headwater tributary was present flowing toward the wetland area (see Watercourse 15). There was a well-defined channel (Photo 22), boggy ground (small puddles of surface water) (Photo 21), and aquatic vegetation growing within the base of the channel. Watercourse 11 then joined Watercourses 9 and 10 which flowed into the wetland. Watercourse 11 was classified as an **intermittent stream**.

Watercourse 12

After the confluence of Watercourses 1,5 and 7, a deep channel containing water flowed in a south to north direction (Photo 24). This reach was classified as a **permanent stream** due to the presence of continuous flowing water and large catchment size. The stream had been fenced from stock and regenerating native planting was present within the 10m riparian yard (Photo 23).

Watercourse 13

Water entered the site through a well-defined channel and flowed to the confluence of Watercourse 12. The watercourse had been fenced and the riparian yard was planted with native vegetation (Photo 25). Upstream of the site, the watercourse narrowed and was overgrown with vegetation (Photo 26). This watercourse was classified as a likely **permanent stream** due to the well-defined channel, flowing water and large catchment size.


Photo 21. 11 – a short intermittent stream had patches of standing water


Photo 22. 11 – a well-defined channel overgrown with vegetation; mercer grass throughout


Photo 23. 12 – riparian planting and fencing


Photo 24. 12 – the stream was deep and overgrown


Photo 25. 13 – water beneath overgrown buttercup


Photo 26. 13 – shallow water upstream of site

Watercourse 14

A large depression at the edge of a vineyard block marked the upper extent of Watercourse 4. A well-defined channel that lacked terrestrial vegetation within the base was present, with water occasionally observed in pools (Photo 27). Aquatic vegetation was also common within the base of the channel and scour and deposition was present within the few meanders along the watercourse. The watercourse was completely straight and very deep and did not appear to have any natural features along its length. Watercourse 14 was classified as an **artificial watercourse**.

Watercourse 15 (including constructed wetland)

A number of watercourses flow into deep channels within a fenced area dominated by a variety of wetland vegetation (Photo 28). Some of this appeared planted, while other areas (predominantly exotic vegetation) appeared to have established naturally. Vegetation included carex (*Carex* spp.), kahikatea (*Dacrycarpus dacrydioides*), flax (*Phormium tenax*), pampas grass (*Cortaderia selloana*), Yorkshire fog (*Holcus lanatus*), giant rush (*Juncus pallidus*), broom rush (*Juncus sarophorus*), water pepper (*Persicaria hydropiper*) and crack willow (*Salix fragilis*) (Photo 29). Very few upland or facultative upland plant species were observed and the percent cover of terrestrial vegetation was less than approximately 10-20% (formal delineation was not undertaken).

Discussions with the landowner have revealed that the area containing wetland vegetation historically consisted of two watercourses running through dry pasture. Approximately 15 years ago, he fenced the area and dammed these watercourses in order to slow the flow of water. He then planted wetland vegetation throughout the area. The purpose of damming this water and planting the vegetation was to create a wetland (pers. comms.). Historical aerial images also show that the wetland vegetation currently growing throughout the area was not present in 2001 (Figure 6). As the wetland has been purposefully constructed by artificial means, the area was not considered a natural wetland and was classified as a **constructed wetland**.

The western channel running through the area was considered a continuation of drain 14, an **artificial watercourse**. On historical aerials, it is clear the straight, deep channels have been constructed and do not appear to form part of a natural system, with no natural headwaters observed along its length.

The eastern channel is fed by three drains (9, 10 and 11). This watercourse appeared to have a small meander and contours show that this flow path is the low point of the surrounding area, suggesting water flow through here may be natural. Whilst there appeared to have been some straightening and/or deepening of the channel, the meander, contours and large catchment (approx. 5ha) suggest a natural flow path was likely present through this area prior to anthropogenic modification. As such, this watercourse was classified as a **modified permanent stream**. Water from these channels flow into a man-made pond (Photo 30), then into a narrow, well-defined channel (Photo 31). Below the constructed wetland, the narrow, well-defined watercourse was considered a continuation of the **permanent stream.** The banks and riparian yard of this channel consisted of predominantly terrestrial vegetation.

Figure 6. Historical aerial image from 2001, showing the constructed western drain (14) and the potentially modified eastern stream (15). The wetland vegetation growing throughout the area currently, was not present in 2001. Image from Auckland Council's Geomaps.

Photo 27. 14 – the watercourse was straight and deep

Photo 28. 15 – wetland vegetation grew throughout

Photo 29. 15 – the wetland vegetation included natives such a kahikatea

Photo 30. 15 – a pond at the downstream end of the constructed wetland

Photo 31. 15 – the stream reach below the constructed wetland had steep, incised banks

Photo 32. 16 – a shallow drain with grass growing though it

Watercourse 16

A shallow drain had been constructed along the edge of the farm track (Photo 32). This did not contain water, was ill-defined and terrestrial pasture grass was rooted throughout. This area was classified as an **artificial watercourse**.

Watercourse 17

Another shallow drain was present along the edge of a driveway in the north-west corner of the site (Photo 33). This did not contain water for its entire length and had been clearly constructed (Photos 34 and 35). The lack of water suggests that no natural flow path was historically present through the area that may have been modified. As such, Watercourse 17 was classified as an **artificial watercourse**.

Watercourse 18

A well-defined channel containing a large amount of water celery (*Apium nodiflorum*) was observed within the backyard of a property in the north-west corner of the site (Photo 36). There was no water within the channel, however the presence of a macrophyte rooted throughout suggests that this flow path contains water frequently. The channel joined the Mahurangi River at the western site boundary. Historic aerial images also show a natural flow path within the vicinity of Watercourse 18. The upper reaches of this appear to have been piped/reclaimed with just the current short downstream section left. Due to the well-defined channel, presence of macrophytes and evidence of a natural flow path, Watercourse 18 was considered an **intermittent stream**.

A large man-made pond was also present to the north of Watercourse 18 (Photo 37). This pond was lined with concrete/tiles and a pipe was present at its upper end. There was not natural inlet or outlet observed around the edges of the pond. This was considered an **offline, manmade pond** and not a natural freshwater feature.

Watercourse 19

A large river flowed along the northern boundary of the site (Photo 38). This **permanent river** is the receiving waters of Watercourses 1-17 on site and is a tributary of the Mahurangi River.

Photo 33. 17 – lower section of drain completely dry and straight suggesting artificial nature

Photo 34. 17 – mid-section of drain dry; grass and some exotic rushes grew throughout

Photo 35. 17 – upper section dry, under shade there was no terrestrial (or aquatic) vegetation

Photo 36. 18 – small stream containing water celery near western boundary

Photo 37. 18 – an off-line artificial pond was located in the area

Photo 38. 19 – the large river running along the northern boundary is a tributary of the Mahurangi River (right branch)

Constraints

Freshwater Ecological Constraints

Under the Auckland Unitary Plan Operative in Part (AUP OP), the National Policy Statement for Freshwater Management 2020 (NPSFM) and the National Environment Standards for Freshwater 2020 (NESFW) there are a number of constraints that apply to developing land near/in freshwater ecosystems. A number of natural/modified intermittent and permanent streams flow through the site along with artificial watercourses and one constructed wetland:

- 1 – permanent stream
- 2 – permanent stream
- 3 – ephemeral overland flow path
- 4 – permanent stream
- 5 – intermittent/permanent stream
- 6 – artificial watercourse
- 7 – intermittent stream
- 8 – artificial watercourse
- 9 – intermittent stream
- 10 – artificial watercourse
- 11 – intermittent stream
- 12 – permanent stream
- 13 – permanent stream
- 14 – intermittent stream
- 15 – natural wetland; permanent stream
- 16 – artificial watercourse
- 17 – artificial watercourse
- 18 – intermittent stream; offline pond
- 19 – permanent river

Activity Table E3.4.1 (E3; Lakes rivers, streams and wetlands) in the AUP OP apply to the potential works at the site. Where there are the same rules within the NES-FW and AUP OP, the more stringent of the two rules would apply. These rules apply to permanent and intermittent streams and wetlands:

- (A19) – Diversion of a river or stream to a new course and associated disturbance and sediment discharge is a discretionary activity.
- (A23) – Replacement, upgrading or extension of existing structures complying with the standards in E3.6.1.12 is a permitted activity.
- (A29) – Bridges or pipe bridges complying with the standards in E3.6.1.16 are a permitted activity.
- (A32) – New culverts or fords less than 30m in length when measured parallel to the direction of water flow, complying with the standards in E3.6.1.18 are a permitted activity.
- (A33) – New culverts or fords more than 30m in length are a discretionary activity.
- (A49) – New reclamation or drainage including filling over a piped stream is a **non-complying** activity.

The following rule in E3.4.1 in the AUP OP applies to ephemeral overland flow paths:

- (A53) – Any activity that is undertaken in, on, over or within the bed of an ephemeral river and stream complying with the standards in E3.6.1.1 is a permitted activity.

The following rules in the AUP OP, relating to vegetation removal near freshwater bodies (Activity Table E15.4.1; Vegetation Management and Biodiversity) may apply to the development of the site:

- (A6) – Pest plant removal is a permitted activity.
- (A18) – Vegetation alteration or removal within 20m of a natural wetland or in the bed of a river or stream (permanent or intermittent) is a restricted discretionary activity.

- (A19) – Vegetation alteration or removal within 10m of streams is a restricted discretionary activity.

The rules in relation to natural wetlands detailed within the NESFW and the AUP OP do not apply to constructed wetlands.

As far as practicable, any streamworks or works within the riparian yards of natural streams should be avoided, minimised, mitigated or offset appropriately. If reclamation of an intermittent or permanent stream is proposed, ecological offsetting through the restoration of 'like-for-like' freshwater ecosystems will highly likely be required.

Regards,

Bioresearches, Babbage Consultants Limited

Nicky Kerr

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ATTACHMENT 23

LETTER – WARKWORTH SOUTH
BULK INFRASTRUCTURE FUNDING

Classic Developments

P. 07 571 2761
W. classicdevelopments.co.nz

17 August 2023

Peter Vari
Planning Manager
Auckland Council

Peter.Vari@aucklandcouncil.govt.nz

RE: Warkworth South Private Plan Change Request – Bulk Infrastructure Funding

Dear Peter,

The purpose of this letter is to outline the bulk infrastructure required to service the Warkworth South plan change area and proposed funding mechanisms.

Background/Context

Classic Developments act as development managers for KA Waimanawa Limited Partnership, one of the co-applicants for the Warkworth South plan change. KA Waimanawa is a wholly owned subsidiary of Kaha Ake, a partnership between the NZ Super Fund (NZSF) and Classic Group.

NZSF and Classic Group have come together in partnership to form Kaha Ake, bringing together long-term financial support and experienced development capability to support the creation of homes at pace and scale around New Zealand. The partnership is based on a $300 million-dollar initial commitment, with NZSF having an 80% share in Kaha Ake and Classic Group owning the other 20%.

On 7 August 2022, a letter was provided to Auckland Council outlining a range of potential funding mechanisms for the required bulk infrastructure to enable development at Warkworth South. Following discussions with the Development Programme Office (DPO), the applicants have subsequently narrowed this down to two potential funding options, discussed further below.

Bulk Infrastructure Required for Warkworth South

Following consultation with various stakeholders, including Auckland Council, Auckland Transport, Watercare Services Limited and Supporting Growth Alliance over the last two years, we have established the required bulk infrastructure for the Warkworth South plan change area is as follows:

1. Upgrading Old State Highway 1 through the plan change area to urban arterial standard, including:
    - Construction of a shared footpath/cycle path from the plan change area to McKinney Road.

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W. classicdevelopments.co.nz

- Construction of a new roundabout at the intersection of Old State Highway 1 and the proposed Wider Western Link Road (WWLR).

2. Construction of a new two-lane urban arterial road, the WWLR, through KA Waimanawa LP's land, in accordance with Supporting Growth Alliance's recently lodged Notices of Requirement (NOR) and the Warkworth Structure Plan.

3. Provision of potable water supply, including:

    - Extension of new bulk water mains from the existing Warkworth urban area to the plan change area.

    - Vesting of sufficient land required for a water reservoir to service the wider Warkworth South catchment area.

    - Construction of a new water reservoir, sufficiently sized to service the plan change area.

4. Provision of wastewater services, including:

    - Vesting of sufficient land required for a wastewater transmission pump station to service the wider Warkworth South catchment area.

    - Construction of a wastewater transmission pump station, sufficiently sized to service the plan change area.

    - Construction of a wastewater rising main from the transmission pump station to the high point on McKinney Road.

    - Construction of a gravity main, future-proofed to service the wider Warkworth South catchment, from the high point on McKinney Road to the central Warkworth wastewater pump station in Lucy Moore Memorial Park.

5. Setting aside sufficient land for a future public transport hub, in accordance with the Warkworth Structure Plan.

6. Provision of a range of Open Spaces, including:

    - Construction of "green links" for pedestrians and cyclists throughout the plan change area.

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In addition to the above specified infrastructure, we note the following regional/sub-regional infrastructure either complete or well underway:

7. Ara Tūhono – Puhoi to Warkworth motorway, opened in June 2023.

8. Matakana Link Road, opened in June 2023.

9. Upgrading of the central wastewater pump station in Lucy Moore Memorial Park.

10. Warkworth to Snells Beach wastewater transfer pipeline.

11. Upgrading of the Snells Beach wastewater treatment plant.

The applicants have given an undertaking that no new dwellings will be connected to the wastewater network until such time as (9) – (11) above have been completed, currently anticipated in early 2025.

A range of triggers have been included within the plan change to ensure that development will not proceed until such time as the required bulk infrastructure has been provided.

Furthermore, in addition to the bulk infrastructure required to service the plan change area, we have identified several opportunities for Auckland Council and/or Council-Controlled Organisations to future-proof for development in the wider Warkworth South area, as outlined below:

12. Upgrading of the Old State Highway 1 pavement to urban arterial standard through the plan change area.

13. Upsizing of the proposed wastewater transmission pump station from the size required to service the plan change area, to the size required to service the wider Warkworth South catchment area.

14. Upsizing, or installation of, additional rising mains to service the wider Warkworth South catchment area.

15. Upsizing of the proposed water reservoir from the size required to service the plan change area, to the size required to service the wider Warkworth South catchment area.

We believe there are several advantages to completing (12) – (15) above in conjunction with the proposed plan change works. However, it is important to note the applicants would be seeking relief from future development contributions and/or infrastructure growth charges to the equivalent value for any works over and above what is required to service the plan change area.

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The applicants are seeking to formalise this arrangement via an Infrastructure Funding Agreement (IFA), facilitated by the DPO.

Proposed Infrastructure Funding Mechanisms

As mentioned above, the applicants propose to fund the required infrastructure through one of two mechanisms:

1. Developer Funded Option

The applicants will privately fund all required bulk infrastructure to service the plan change area.

2. Externally Funded Option

Bulk infrastructure to be funded through an external party, for example:

- Crown Infrastructure Partners (CIP), in accordance with the Infrastructure Funding and Financing Act 2020. Costs to be recovered via special levy, similar to Milldale. The applicants have been in discussions with CIP, who have indicated they are interested in funding the required bulk infrastructure for Warkworth South.

- NZ Super Fund. Costs to be recovered via one-off payment, special development contribution, or levy, collected at time of subdivision/s224c. Alternatively, the applicants are investigating cost recovery mechanisms similar to the targeted rate above, albeit in a private capacity (i.e. not administered by Council).

It is important to note that neither of the above options require any capital commitment from Council.

Conclusion

We believe Warkworth South is uniquely positioned to provide essential growth for Auckland, in a situation where all regional/sub-regional infrastructure is either complete or well underway; and all bulk infrastructure required to service the plan change area will be funded either by the developers or through an external party.

We welcome your feedback on this proposal and look forward to further discussions with the DPO in due course. Ideally, we would seek to have an Infrastructure Funding Agreement in place prior to the hearing, anticipated early 2024.

Yours sincerely,

Phillip Nicholson
Development Manager
Classic Developments
Phillip.nicholson@classicdevelopments.co.nz

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ATTACHMENT 24

RESPONSE TO CLAUSE 23 REQUEST
WITH TABLE OF RESPONSES – 19 APRIL 2023

April 19, 2023

Auckland Council
Attn. Mr David Wren
(by email)

Dear David

Re: Proposed Warkworth South Plan Change – Response to Cl 23 Request

This is the response to the Auckland Council request for information on the Proposed Warkworth South Plan Change.

Attached to this letter is the tabulated response to the full set of questions. In addition, please find attached the following reports which are to replace the corresponding documentation submitted previously to Council (except the Bioresearches January 2021 Report):

1 The updated Plan Change document.

2 The updated Plan Change Report.

3 The updated Appendix 5 – Infrastructure Report.

4 The updated Appendix 13 – Draft Stormwater Management Plan.

5 The updated Appendix 15 – Stormwater Modelling Report.

6 The Bioresearches January 2021 Report (which is referred to in one of the responses).

In addition, the revised cross-section for the Wider Western Link Road is attached and replaces the earlier version referred to in various reports. The key change is that the cross-section for that part of the Wider Western Link Road which adjoins Morrison Heritage Orchard now no longer includes the riparian margin (which will remain outside the road reserve). This reflects the preference of Auckland Transport.

The Appendix 2 – Urban Design Report is currently being updated and this should be supplied to you within the next week. In the interim we consider that the information providing in this letter can be distributed to the other Council staff involved.

As you are aware from our previous correspondence, the Supporting Growth Alliance has provided to some landowners plans showing the draft proposed designations for the Wider Western Link Road. The Supporting Growth Alliance has advised us that we cannot provide these plans to Auckland Council and Auckland Council has to request them from Supporting Growth. We understand that Auckland Council will now do that.

Both Auckland Transport and the Supporting Growth Alliance have requested the Proposed Plan Change documentation submitted to Council. We will be providing them a link to this information shortly for their information.

A new title for Lot 1 DP 578389 (1768 State Highway One) and Lot 1 DP 568727 (1738 State Highway One) have been issued and these are attached.

If you wish to discuss any of the responses then please let us know and we can arrange a meeting.

As the next step is notification of the proposed plan change, could you please send us as soon as practical the draft notification notice for our review.

Osborne Hay (North) Limited

Postal Address: PO Box 16, Warkworth 0941
Email: david@osbornehay.co.nz

Sincerely,

David Hay

David Hay
Planning Consultant
Ph: *09 425-9844*
Mobile: *027 425-0234*

Copy to: KA – Waimanawa Limited Partnership, Attn. Mr Phill Nicholson (by email)
Stepping Towards Far Limited, Attn. Mr Victor Hao (by email)
Tattico, Attn. Mr John Duthie (by email)

Attachments: Response Table
The updated Plan Change document
The updated Plan Change Report
The updated Appendix 5 – Infrastructure Report
The updated Appendix 13 – Draft Stormwater Management Plan
The updated Appendix 15 – Stormwater Modelling Report
The Bioresearches January 2021 Report
WWLR Cross-Section
Records of Title for Lot 1 Deposited Plan 578389 and Lot 1 DP 568727

Warkworth South Plan Change : Clause 23 Responses.

Question No.	Question	Response by	Response
	Planning AEE/S32 Analysis		
	Precinct Provisions		
1.1	Please align the zones shown on the zone map (Map 1) with the zones provided elsewhere in the text. I note that the text does not include the Single House Zone, whereas the map does.	DH/JD	The terminology used in the PC has now been standardised so it refers to Residential – Low Density Residential.
1.2	Please notate on the Plan Change document which rules and standards are Qualifying Matters.	DH/JD	This notation has been included to the extent understood by the applicant as the current Council format practice for showing qualifying matters.
1.3	I consider that greater clarity is required in the provisions relating to the Morrison Orchard Precinct. This is particularly in respect of whether the rules allow one of the listed activities (i.e. Market) or many. While some effort has been made to clarify this I think that room for various interpretations remains.	SH/DH/JD	The submitted version of the Plan Change did not include all the proposed changes to the Morrison Heritage Orchard precinct to address the earlier questions raised by Council. The required changes have now been incorporated into the Plan Change. It is now clear that the activity table providing for each of the specified activities as permitted activities, subject to each meeting the applicable standards. When read in conjunction with the standards, the different activities and associated buildings and outdoor commercial areas are limited either in number or area or both.
1.4	On Table Ixxx.4.6 Business – Local Centre (A5) provides for the development of a public transport interchange. Should this also allow for the use of that facility?	DH/JD	The requested change has been made to the Plan Change.
1.5	Please explain whether it is proposed to stage the development. If so please explain those stages and whether it is desirable to include such staging within the plan provisions	DH/JD	No staging is proposed in the Plan Change.
1.6	Please show the RUB boundary on the zone map (i.e. Map 1)	DH/JD	The RUB boundary is now shown on Map 1.

	S32 Report		
1.7	While Qualifying Matters in reference to the application of the MDRS are referred to the s32 Report – it would helpful if these could be discussed in a dedicated section within the report. An assessment under s77J or 77L should be provided for each qualifying matter.	DH/JD	This evaluation has been completed and is included in pages 50-53 of the Planning Report.
1.8	Pages 20 and 21 include a discussion of the FULSS. Please explain whether going ahead with the development allowed in this plan change will have any impacts on other areas in Warkworth where development is likely.	DH/JD	The Planning Report has been updated on pages 20 and 21 to address this point.
1.9	On page 24 the s32 report discusses the south facing links to the new Ara Tuhono-Puhoi to Warkworth Motorway. The structure plan clearly shows that a potential link to these ramps should be provided within the plan change area. Please provide a further explanation of why this is not provided for with the proposed plan change.	DH/JD	Supporting Growth has confirmed that the south-facing ramps, if constructed, will be located on the land to the west of the Mahurangi River (ie not within the Plan Change area). The proposed WWLR is shown in the Plan Change to connect into the area which Supporting Growth has identified will be subject to a notice of requirement to designate to provide for the future WWLR over the watercourse and to the west of the plan change area.
1.10	Please update the reference on page 30 to a town centre to a local centre.	DH/JD	This correction has been made in the Planning Report (page 31).
1.11	Please provide a more fuller explanation of the area of Low Density Residential Zone that extends beyond the RUB and whether the Plan Change remains consistent with the RPS.	DH/JD	The following wording has been added on page 59 of the Planning Report: • Within the area outside the RUB, an estimated one additional residential lot will be created, although a small number of lots are likely to saddle the RUB. Taking account of the topography of the area, existing property boundaries and the presence of the Avice Miller Reserve, it is considered that the proposed extension of the urban extent over this RUB in this location will not impact on the integrity of the RUB and the proposed re-zoned of this area remains consistent with the RPS.
1.12	There appear to be very few north-south connections between the Plan Change area	DH/JD	Owing to the topography of this area there is very limited opportunities for further north-south connections.

	and areas to the north. Please provide a greater explanation why this is the case.		
1.13	Please provide comment on whether retaining the Morrison Heritage Orchard as self-servicing is sustainable in terms of the potential wide range of uses allowable on the land.	SH	On-site treatment and disposal would be assessed at building consent and or resource consent stage. In the event that on-site servicing is no longer feasible in the future then connections could be made to the wastewater and potable water networks which would installed in the general vicinity for the Waimanawa Precinct.
1.14	Please explain why the heading – purpose of the Act is located on page 40 when this refers to the NPS:UD.	DH/JD	This heading has been deleted in the Planning Report.
1.15	In respect of the Objective 6 of the NPS:UD there is a discussion concerning the timing of development. Please provide greater clarification as to how proceeding with this plan change now is strategic given there is land to the north that is yet to be zoned for urban development.	Reset	The proposal is well located within an area that has been identified as an important node for future urban growth in Warkworth by the Warkworth Structure Plan 2019. The northernmost part of the site does connect directly with the urban subdivisions and developments along Mason Heights, making a seamless extension to the current urban area. Following the planning of the Warkworth Structure Plan, the proposal provides a wide range of residential activities around a new local centre, and supports a self-sustaining community with walkable access to daily needs. The new local centre will provide convenience retail and services for the future Warkworth South community which will help reduce private vehicle trips to the Warkworth Town Centre. The proposed residential zones have been configured around the local centre and the transport hub with a network of convenient walking and cycling routes generously provided throughout the development. In addition, the proposed transport hub is located immediately adjacent to the local centre. The proposed transport hub will enable public transport routes from

		DH/JD	Warkworth South to the Warkworth Town Centre, the surrounding settlements and Auckland. Walking and cycling routes will also be provided alongside the existing SH1 which directly connects to Warkworth Town Centre. The following additional wording has been included on Page 46 of the Planning Report: "Given the necessity to provide this key infrastructure (ie the water reservoir and wastewater pump stations) along with the local centre and the public transportation hub all within Waimanawa, it is both appropriate and necessary for this area to be re-zoned first and to allow for that development to proceed before the land to the immediate north is re-zoned and developed. "
1.16	Please explain more fully how the proposed plan change will support reductions in greenhouse gases given its separation from the existing urban area of Warkworth.	Reset	The proposal is well located within an area that has been identified as an important node for future urban growth in Warkworth by the Warkworth Structure Plan 2019. The northernmost part of the site does connect directly with the urban subdivisions and developments along Mason Heights, making a seamless extension to the current urban area. Following the planning of the Warkworth Structure Plan, the proposal provides a wide range of residential activities around a new local centre, and supports a self-sustaining community with walkable access to daily needs. The new local centre will provide convenience retail and services for the future Warkworth South community which will help reduce private vehicle trips to the Warkworth Town Centre. The proposed residential zones have been configured around the local centre and the transport hub with a network of convenient walking and cycling routes generously provided throughout the development.

		DH/JD	In addition, the proposed transport hub is located immediately adjacent to the local centre. The proposed transport hub will enable public transport routes from Warkworth South to the Warkworth Town Centre, the surrounding settlements and Auckland. Walking and cycling routes will also be provided alongside the existing SH1 which directly connects to Warkworth Town Centre. It is considered that the proposal will positively contribute to the reduction of greenhouse gases with the provision of a series of walkable neighbourhoods with safe and accessible routes to the planned local centre and transport hub. The following wording has been added into the Planning Report (page 103): "In terms of s7(i) (climate change), this proposal proceeds from the premises that it is a good planning outcome to develop a local centre with its associated transportation hub, cycleways and walkways and develop the community around that centre. Any local centre relies on a walkable catchment. This Plan Change more quickly delivers this walkable catchment which will then allow for the development of the local centre and transportation hub. This means that for residents they good get access to standard local retail services and potential alternative transport connections. The contrary view is that Warkworth is expanded from the centre out. The difficulty with this approach is that key infrastructure such as the water reservoir and the wastewater pumping stations and assets such as the local centre would be constructed well after urbanisation of the northern Warkworth South area has commenced. This latter approach brings the risk of under development of the three-water services and places a focus on vehicular transport modes as the services of the local centre and transport hub would not be available.

			It is considered that in this circumstance, developing Waimanawa first and then enabling Warkworth to grow from the McKinney Road plan change area south to join Waimanawa is the appropriate planning strategy. This delivers better infrastructure, retail servicing and transportation infrastructure outcomes."
1.17	Given the Precinct provisions which modify the MDRS standards in different way please provide greater clarity around how it is considered that the plan change is fully consistent with the RMA Amendment Act.	DH/JD	With the changes made to the Plan Change provisions and the explanations providing in the Planning Report, it is considered that the Plan Change is fully consistent with the RMA Amendment Act. If Council forms the opinion that any of the proposed rules are not consistent with the RMA Amendment Act then it would be appreciated if Council could identify these so further consideration to the appropriateness of them can be given.
1.18	The notification assessment on page 157 seems at odds with the proposed rule in the Waimanama Precinct. Please clarify.	DH/JD	The assessment on Page 163 of the Planning Report has been updated and is now consistent with Proposed Plan Change 78.

	Healthy Waters		
2.1	Healthy Waters have reviewed the Stormwater Management Plan (SMP) submitted as part of the Warkworth South PPC in relation to stormwater effects against the plan change requirements and in relation to the Auckland Council Healthy Waters' Regionwide Network Discharge Consent (NDC). The Plan Change proponent has indicated that it wishes its stormwater discharges to be covered by the NDC and		No response required.

	intends to vest stormwater assets with Auckland Council. The table below outlines the further information requested by Healthy Waters pursuant to Clause 23 of the First Schedule to the RMA.		
	Water Quality		
2.2	Sections 7.2.1 and 7.2.3, and Table 7 in the SMP listed out many options for stormwater treatment but no preferred option is confirmed. Please confirm the preferred treatment option and/or device for the different areas and activities. Please also provide an assessment on how the preferred treatment options will achieve the required performance criteria (e.g. all impervious areas need to be treated to meet GD01 requirements). This information is required to enable a full assessment of water quality effects and to meet the requirements of the NDC authorisation process.	Maven	The section 7.2.1, 7.2.3 and Table 7 have been updated in the revised SMP rev C to show wetland as a preferred option for water quality treatment. An alternative option is also listed to provide a water quality treatment solution where the wetland option is not viable. An assessment of the effectiveness of the preferred treatment option to meet the performance criteria is deemed not necessary at this Plan Change stage as all listed water quality treatment devices listed in the SMP will be designed in accordance with GD01. GD01 has provided a detail assessment of each devices performance criteria for the target contaminant. See table below:

Key: ● Effective; ○ Partially effective; - Not effective	Quantity control					Quality control								
	1% AEP	Detention of 50% and 10% AEP	90th & 95th percentile detention	Groundwater recharge	Retention	Sediment	Gross pollutants	Heavy metals	Oils and grease	Nutrients	Organics	Hydrocarbons	Indicator bacteria	Temperature
Pervious pavement - unlined	-	-	●	○	●	●	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]
Pervious pavement - lined	-	-	●	-	-	●	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]	-[b]
Living roof	-	-	●[a]	-	●	○	NA	○	NA	○	○	NA	○	●
Rainwater tank (no reuse)	-	○	●	-	-	●	NA	○	NA	○	○	NA	○	○
Rainwater tank (with reuse)	-	○	●	-	●	●	NA	○	NA	○	○	NA	○	○
Infiltration device	-	○	●[a]	●	●	-	-	-	-	-	-	-	-	●
Swale (lined)	-	-	-	-	-	●	○	○	○	○	○	○	○	●
Bioretention swale (unlined)	-	-	●	●	●	●	●	●	●	●	●	●	●	●
Rain garden	-	-	●	●	●	●	●	●	●	●	●	●	●	●
Stormwater tree pit[c]	-	-	○	○	●	●	●	●	●	●	●	●	●	●
Planter box	-	-	○	○	●	●	●	●	●	●	●	●	●	●
Constructed wetland	-[d]	●	●	-	○	●	●	●	●	●	●	●	○	○
Wet pond	●	●	●	-	-	●	●	○	○	○	○	○	○	-
Dry pond (detention basin)	●	●	●	-	-	-	-	-	-	-	-	-	-	●

2.3	Please provide an assessment of and justification why the proposed treatment methods for high contaminant generating car parks, public local road and high use road as stated in Table 7 of the SMP are considered the Best Practicable Options (BPO). It should be noted that some of the proposed treatment methods do not comply with the requirements in Chapter E9 of the AUP (OP) Or the NDC's requirements.	Maven	The NDC and Chapter E9 only refer to water quality treatment as per GD01. We have not proposed any deviation devices outside the scope of GD01. All devices suggested in the SMP fall within the best practice scope.

2.4	Please provide information on how stormwater runoff from any communal waste storage areas in apartments and multi-unit developments is proposed to be managed and treated.	Maven DH/JD	The SMP has been updated to provide the adequate treatment provision for this area. This is a detailed design matter addressed through future resource consent applications rather than through the Plan Change.
2.5	Please provide an assessment of how the proposed SMP addresses stormwater quality in accordance with the policies under Section E1.3 of the AUP. This information is required to enable a full assessment of stormwater runoff effects and to meet the requirements of the NDC authorisation process.	DH/JD	The implementation over time of the stormwater management train will ensure that an adequate level of stormwater treatment is achieved prior to discharges to watercourses. As specific development is progressed, the relevant resource consent applications will need to identify that stormwater treatment is being provided in terms of the NDC. At the Plan Change level, specific designs are not provided for stormwater treatment as this is a matter which is addressed at the detailed design stage as subdivision and infrastructure are designed then consented. However, it is considered that there are no obvious reasons why the Policies under E1.3 could not or will not be achieved. In particular an integrated stormwater management approach is proposed and can be implemented over time in this catchment as development progresses. The proposed WW South SMP has adopted the framework from the Tonkin and Taylor's Structure Plan SMP to ensure that the receiving environment is protected and enhanced as it undergoes change from the current rural environment to an urban form. The stormwater management approach is considered to generally align with the outcomes of the NDC.
	<u>Hydrology</u>		
2.6	Please confirm the purpose of the calculations provided in Table 8 of the SMP. Where a decision has been made for passing flow forward, the increased runoff volume and rate become irrelevant. Additional	Maven	Table 8 removes any information beyond SMAF 1 event. The retention volume will be removed as indicated by the preliminary geotechnical report that there is limited infiltration available on this site. Hence the retention volume will be added on top of the detention volume. Please refer to the updated calculation in the revised SMP attached.

	assessment is needed to support the decision to pass flows forward. In addition, Healthy Waters notes that the calculations provided are confusing. Retention equals 0.5m³ for every 100sq of impervious area. Detention is approx. 34.5mm of rainfall depth between pre and post imperviousness difference. What is the actual meaning of this detention volume? It should be noted that all impervious area require mitigation as per the SMAF requirements. This information is required to enable a full assessment of stormwater runoff effects and to meet the requirements of the NDC authorisation process.		The supporting information to justify the passing forward arrangement has been provided in the chapter 7.2.5 and the flood modelling report. Please refer to the updated SMP and flood modelling report attached. All impervious area within the SMP area will be required to be mitigated as per NDC.
2.7	Bioretention devices are proposed as the BPO throughout the SMP. However, the Geotechnical assessment has indicated there is limited infiltration in the plan change area. Therefore, please provide a feasibility assessment and justification for this.	Maven	In accordance with GD01, bioretention devices will still be able to achieve the full water quality and hydrological mitigation required in areas where infiltration is limited. The use of bioretention devices in these areas will comply with the requirement of the NDC. No further feasibility assessment is required for the Plan Change.
2.8	Please provide information on the potential size/area of the proposed wetlands and confirm if the proposed wetlands (as indicated in Figure 16 of the SMP) will be located above the 10-year floodplains.	Maven	The indicative wetland location shown in the Figure 16 is only an indicative concept plan. The final location of these wetland will be determined at resource consent stage(s). All wetlands will be placed outside of the flood plain. This information will be provided at resource consent stage(s).
	<u>SMAP Implementation</u>		

2.9	Please provide information on how the proposed stormwater management methods outlined in the SMP are intended to be implemented. Please confirm and clarify at what stage of the development the proposed wetland and other public network/devices are intended to be constructed. If staging of development is proposed, please provide information on how the SMP will be implemented corresponding to each stage of development.	Maven	As stated in the SMP, the stormwater management devise will be implemented progressively as the site is development. This information will be provided at resources consent stage.
2.10	Rule A15 is proposed in the Precinct provisions to require subdivision to be consistent with the approved SMP. Please confirm and clarify how the precinct provision intends for any development that occurs before the subdivision stage to provide for the implementation of the proposed SMP. This information is required to enable a full assessment of adverse stormwater effects and to meet the requirements of the NDC authorisation process.	DH/JD	A new A9 has been added in this table in the Plan Change.
	<u>Flood Modelling</u>		
2.11	The naming conventions of the sub-catchment is confusing and unnecessary in the SMP. Healthy Waters considers that it would be better to identify the sub-catchments as Upstream of PCA (Plan Change Area) and Downstream of PCA.	Maven	Flood report amended with suggested naming convention.
2.12	This assessment is lacking an assessment of the capacity of the downstream infrastructure. Constraints such as the	Maven	Flood report had been updated to include assessment. The road level of the Woodcocks Road bridge has been surveyed at 23.75 mRL.

	Woodcocks Road bridge should be surveyed and assessed.		Existing scenario (with climate change) WSE at Woodcocks bridge have been calculated using to be 22.17 mRL providing 1.58m freeboard to the deck of the bridge. Proposed scenario (with climate change) WSE at the Woodcocks Road bridge have been calculated using to be 22.16 mRL providing 1.59m freeboard to the deck.
2.13	The current assessment has been done for the wider catchment by using HEC-HMS to assess the peak flow for 100yr pre-development, 100yr pre-development with climate change, and 100yr post-development with climate change. 1) Please add additional scenarios that include 100yr post development with no climate change. 2) Please include a localised event scenario, which includes an Upstream PCA 2yr event, within the PCA and downstream of the PCA 100yr ARI for before and post development, no climate change. These runs are considered necessary to understand the effects of the development on the existing scenarios. Please also assess the BPO for flood management. 3) Please also check the slope calculations provided. A sport review has been done that found errors in the sub-catchment A, C and E slope calculations.	Maven	1. Proposed scenario without climate change added to report. 2. Localised event scenario added to report (refer to section 2.5.3) 3 Please refer to appendix D for slope calculations and long-sections for each of the subcatchments which have also been included for reference.

2.14	In Section 3 of the Flood Modelling Report, please include an assessment of culvert capacity, whether they would be overtopped, and the period and frequency of such events.	Maven	Report updated. Please refer to section 3.9.
2.15	Please double check the boundary condition in Section 3.3 of the Flood Modelling Report. Auckland Council's regionwide model has a gradient of 0.002.	Maven	Boundary condition updated to be 0.002.
2.16	Please include a plan of the route of the HGL in Section 3.6 of the Flood Modelling Report, and explain why this should be shown.	Maven	Plan and explanation added to section 3.6. Plan shows an indication of the flood depths along Mahurangi River for different modelled scenarios.
2.17	Please revise Section 3.7 of the Flood Modelling Report. Peak flow and return period should be discussed respectively. Please clarify whether due to development, the post development flow during a 5% AEP would be equal to 1% AEP pre-development?	Maven	Peak flow from the existing 1% predevelopment (without climate change) is approximately equal to a 5% developed (with climate change).
2.18	Section 3.8 of the Flood Modelling Report – please clarify the rainfall event and AEP that gave a peak level of 21.9mRL. This information is required to enable a full assessment of flood risk and to meet the requirements of the NDC authorisation process.	Maven	Report updated. The peak flood level reference is a development scenario with a 1% AEP Flow.
	<u>SMP Approval</u>		
2.19	Please provide an amended SMP which includes the further information and assessment as requested above.	Maven	An updated draft SMP and Flood Report is attached.
2.20	Feedback on other sections of the SMP:	Maven	The devices listed on Table 7 and 9 are endorsed by GD01 which is appropriate to provide the specific stormwater quality and quantity target set out by the SMP and

	Section 7.4 – The SMP provides no guidance on devices to manage stormwater or provides information that the devices presented in Tables 7 and 9 could work. As such, there is no relevant information to support the statements made on asset ownership. Section 7.6 – There is no guidance provided I n the SMP on how any of the stormwater infrastructure could be implemented. Table 10 – The risks identified should be addressed in the SMP. The content of the SMP fails to adequately identify the impacts of development in relation to water quality, SMAF and flooding. Section 9.2 – The recommendation section seems incomplete and does not align with the content of the SMP. The SMP acts in the plan change process as an assessment of stormwater effects and forms part of the NDC authorisation process. An approved SMP is required for the authorisation of stormwater diversion/discharge under the NDC.		NDC. The specific design information and device location is generally provided at resources consent stage when the land development layout has been confirmed. This SMP is a high-level SMP which sets out the stormwater management framework for the plan change area. The final design is subject to future resource consent application(s) and at this stage the detail sought within Sections 7.4 and 7.6 will be expanded on. The statements within Section 7.4 and 7.6 remain correct, and all future SMPs in support of resource consents will abide by this high-level governance. The Table 10 has been updated to including risk with flooding, water quality and SMAF. These risk has been adequately address by the SMP. Section 9.2 has been updated to aligned with the content of the SMP. This SMP only provides a high-level framework for the PCA. Detail SMPs will be developed at resources consent stage to authorise the stormwater discharge & diversion under the NDC.

	Landscape		
3.1	Part A – Amendment to the maps within the Requested Plan Change document outlines the proposed zones, this includes THAB, Low Density, MHU, Large Lot, Local Centre, Open Space Conservation and Rural Mixed Rural and the standards and activity tables and labels an	DH/JD	This is the same as question as 1.1 All references to Residential - Single House have been changed to Residential – Low Density Residential.

	area Single House (eastern escarpment) and the response to Council's Soft Lodgement comments also notes that the eastern escarpment is zoned single house zone, but the precinct does not provide activity tables/standards titled single house. Please confirm the proposed zoning name/title for the eastern escarpment area and update the map and/or key to correctly label the area where required. *If the low-density zone proposed is 'Single House' consistent labelling or titles for plan zones, tables, standards etc should be provided rather than switching between single house and low-density zone.*		
3.2	The proposed plan change identifies two special height limit areas (within the Landscape Protection Area Eastern Escarpment); those being a special height area of 5m/single storey building area, and special height area 9m building area. However, these controls are only identified on the key of the 'Waimanawa Precinct Plan 1 Spatial Provisions plan'. These are in addition to the height control for the 'landscape protection area controls (Eastern Escarpment)' of 8m. The applicant is asked to consider how the controls could be better included and made clearer within the body of the precinct as they are not mentioned within the precinct	DH/JD	Special height limit rules have been included in the Plan Change to reflect the maps.

	standards/controls and may be missed where only noted on the one plan.		
3.3	Noting the sensitive landscape values within the eastern escarpment; its elevation, located adjacent to/on the boundary of an ONL, and the existing vegetation recommended for retention as noted within the Arboricultural report; it is recommended that the proposed external finishes control included within the 'landscape protection area control (northern escarpment)' be included within the 'landscape protection area controls (eastern escarpment)'.	DH/JD	This change has been made to the Plan Change.
3.4	The 'Waimanawa Precinct Plan 2 Environment plan', outlines areas of existing covenanted bush and areas of riparian planting and bush to be retained. Generally, this appears to capture the majority of vegetation noted as mandatory protection within the Arboricultural report. However, some trees or groups of trees do not appear to be included (e.g., Tree 50 and Group 214 within Waimanawa Hills). Please describe how the recommendations outlined within the Arboricultural report; such as the protection of mandatory trees, has been adopted (and or where this has not been possible) into the proposed plan change and Precinct Plan 2 – Environment.	DH/JD	The Plan Change is proceeding on the basis of the protection of the trees shown on Precinct Plan 2.
3.5	The objectives of the 'Morrisons Heritage Orchard Precinct' include maintaining a rural heritage character and appearance of the Morrison Heritage Orchard and providing for	SH	There is no maximum impervious area specified in the AUPOP for the Rural – Mixed Rural zone.

	the continued rural use/activities on site. However, a number of other activities; such as camping grounds, markets, garden centre, restaurant, visitor accommodation, residential sites; are permitted within Area A & B; which will also have to accommodate the rural use. Please demonstrate how the standards around the additional activities that are permitted on site will be able to retain a rural character (e.g., consideration of a maximum impervious/building coverage, retention/protection of open space or trees within this Precinct).		The front yard along SH1 is 20m, with other yards being 12m. It is also noted that this would apply to any future arterial road, including the proposed WWLR along the south-western boundary. An option to address this is to reduce the permitted activity GFA for buildings to $250m^2$, with buildings larger than that being restricted discretionary activities. In this way, larger buildings would be subject to the matters of discretion and assessment criteria in Rule H 19.12.1 and H 19.12.2 Rural zones. The relevant standards for building areas suggest a maximum GFA for all likely buildings of around 5000 m^2. Assuming areas A and B total 15 ha approximately, this is only 3.3% site coverage. So with a maximum GFR overall within areas A and be of around 5% at most, and combined with the option of a restricted discretionary activity status for any single building over 250 m^2, the overall rural open space landscape should be easily attainable and protected. In addition, the boundary setbacks will also provide for a low density and rural amenity compared to, for example, residential development with front yards of 3m were the land to be zoned for, and developed as, standard mixed housing suburban or higher-density
3.6	The proposed precinct plan outlines that the underlying overlays, zone and Auckland-wide provisions apply to the 'Morrison Heritage Orchard Precinct'; it is taken that this includes aspects such as setbacks from streams as required within the Rural Zone and protection of watercourses under the Auckland-wide chapter objectives.	SH	Yes. AUPOP objectives and policies apply, as do NPS/NES Freshwater. It is also noted that the standard riparian yard for permanent and intermittent streams applying in rural zones is 20 m (refer table H19.10.3.1).
3.7	However, noting the number of potential activities that could occur within the site, it is unclear how the protection of the landscape features such as the streams on site are equally expressed within the 'Morrison	SH	Yes. AUPOP objectives and policies apply, as does the NPS/NES Freshwater. Refer to the comment above regarding the 20m riparian setback.

	Heritage Orchard Precinct' as the streams on site are equally expressed within the 'Morrison Heritage Orchard Precinct' as being an important feature for protection and enhancement in balance with the proposed additional activities being provided for. (*Retention of streams is outlined in the 'Waimanawa Precinct' objectives and plans but not for the Orchard).*		
3.8	Please demonstrate how the proposed standards/controls appropriately balance between retention of watercourses (an Auckland-wide objective) and the potential scale of permitted activities and uses now provided for within the 'Morrison Heritage Orchard Precinct'.	SH	Yes. AUPOP objectives and policies apply, as does the NPS/NES Freshwater.
3.9	(a) The LVA notes that the paddock within the Orchard will be retained as open/rural (with planting along the road) as viewed from Twin Coast Discovery Highway/SH1. However, the Morrison Heritage Orchard Precinct outlines the ability within Section A & B of the site for camping, visitor accommodation units, restaurant facility and subdivision.	SH	The relevant standards for building areas suggest a maximum GFA for all likely buildings of around 5000 m². Assuming areas A and B total 15 ha approximately, this is only 3.3% site coverage. So with a maximum GFR overall within areas A and be of around 5% at most, and combined with the option of a restricted discretionary activity status for any single building over 250 m², the overall rural open space landscape should be easily attainable and protected. In addition, the boundary setbacks will also provide for a low density and rural amenity compared to, for example, residential development with front yards of 3m were the land to be zoned for, and developed as, standard mixed housing suburban or higher-density residential development.
	(b) Similarly in managing the effects as seen from intermediate views of the wider Waimanawa urban development, the LVA relies on the Morrisons Orchard vegetation being retained within the orchard to provide a	Reset	A shelter belt will continue to be required along the southern boundary of the Morrisons Orchard although the current shelter belt may be replaced over time owing to the age of the trees. As its name indicates the shelter belt provides needed shelter from the wind from the south and westerly directions. The shelter

	buffer of screening. However no Arboricultural report or precinct plan identifies trees/vegetation which are to be retained within the orchard precinct and the underlying zone would not automatically protect vegetation on site. Therefore, the retention of the open rural character to the road may not be retained along the road.		belt also provides screening to visually separate the orchard from the proposed development.
	(c) The response to Council Soft Lodgement Comments notes that the Rules about development in Morrisons Heritage Orchard have been strengthened to help achieve these outcomes. However there does not appear to be any significant changes to objectives, policies or standard wording. Therefore, please clearly identify how the objectives/policies/standards have been strengthened to specifically achieve the outcomes mentioned within the LVA.	SH/DH/JD	Policy 2 for the Precinct has been modified slightly. As outlined earlier, the standards have been modified to provide greater clarity.
3.10	(a) The proposed zoning for the Morrison Heritage Orchard area is Rural – Mixed Rural zone as identified on Map 1 – Zoning. However, Area C of the 'Morrison Heritage Orchard Precinct' outlines provisions for subdivision as a Large-Lot Residential Activity (XXX.6.11 Subdivision (3)). Please explain how the correlating zoning (Rural – Mixed Rural) and Large Lot Subdivision rules would work – e.g., do the underlying	SH	Activity Area C on the Precinct Plan is now proposed to have the underlying zoning of Residential – Large Lot.

	zone (rural) standards such as height and no impervious area apply, or do the Large Lot objectives, policies, and zone standards apply.		
	(b) Please update Map 1 – Zoning where required. *It is recommended that the Large Lot zone be applied to Area C on the planning maps, this zone also manages building height (slightly more restrictive than rural zone) but still aims for an open landscape character similar to that of the proposed precinct and rural zone. Large Lot zone could also be better respond to the physical landscape traits of this part of the site (ridgeline).*	SH	Yes this is agreed to.
3.11	The applicant is asked to clarify the area left out on the 'Morrison Orchard Precinct Plan (2)' which his left white; as this is not outlined as a different area within the 'Morrison Orchard Precinct Plan (2)'. *Area highlighted in yellow below.*	SH/DH/JD	There is no Morrison Orchard Precinct Plan 2 in the Plan Change.
3.12	(a) The author of the LVA in their conclusions relies on the ongoing management of the landscape to ensure that the landscape values will be maintained to a high quality and the overall impact of the zoning/future development will be appropriate. *"When considered collectively, it is concluded that even though the Private Plan Change will create a high level of change the Site can accommodate the proposed masterplans without significantly diminishing the landscape*	Reset	It is a standard expectation for high quality subdivisions that a comprehensive maintenance and management programme will be established to help maintain a high-quality visual landscape outcome. The conclusion in the LVA doesn't wholly rely on a maintenance and management plan for positive landscape values for public parks, open space, etc. Landscape management and maintenance is likely to be part of the development contracts, development design guidelines and/or resource consent conditions.

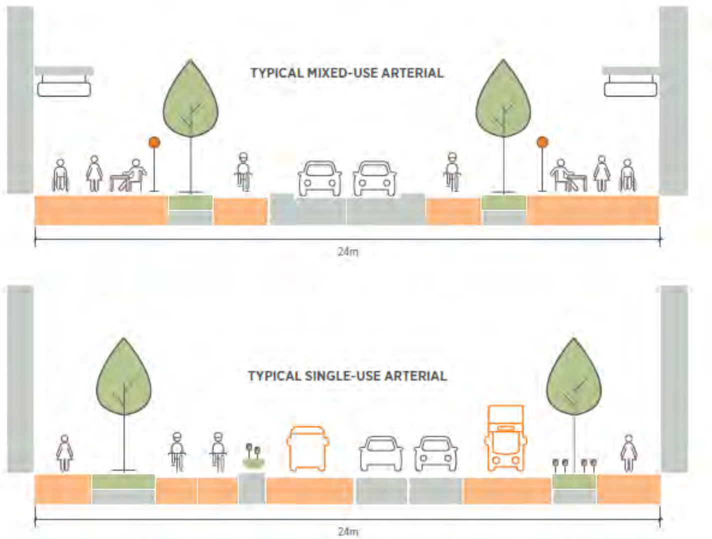
	values. The character of the landscape will be affected by the proposed development, but it is anticipated that future development within Warkworth South will reduce the overall impact of the scale of the proposal. With a comprehensive maintenance and management programme the landscape will be maintained to a high quality." (Summary of Effects, paragraph 11.9) While the Plan Change Precinct Plan 4 identifies indicative areas of open space and reserves, the precinct does not provide specifics for future development landscape treatment (e.g., planting within public roads, pocket parks) or the ongoing management of these spaces to ensure the above landscape outcomes concluded within the LVA. Therefore, the applicant is asked to consider how the outcomes conclude within the LVA can be achieved through the plan change. *In this instance could a landscape plan and landscape management & maintenance plan be required as part of future development to ensure appropriate open space, enhancement planting (such as that mentioned within the Arboricultural report), amenity planting and ongoing maintenance of public and private spaces is achieved.*		
3.13	Comment from Landscape Specialist – I hold concerns that the reduction in riparian/reserve	Reset	In respect to the section of stream that runs along the southern boundary of Morrison Orchard, a minimum 4m wide riparian planting will be provided with

	planting and/or setback to 4m and 10m in some places will directly impact the ability for walkways/cycleways along these spaces to be provided for in the future. I note the Proposed Greenways – Walking and Cycling Infrastructure section of the plan change requires minimum 2m width paths, but if Council does not want to or is unable to accept vesting then there is no requirement for the infrastructure to be put in. In my view, the initial narrowing of the stream's reserves could impact on paths being able to put in or being of an amenity level and quality that council would accept for vesting. Provision of walkways is positive and will create greater connectivity throughout the precinct and wider amenities and sites; therefore, further consideration should be given to narrowing the riparian setback. I do understand however that the applicant has been in conversation with Council Parks and Facilities in regards to the provision and location of public parks, and that this is to be an ongoing process with Council to determine where vested parks etc will be located. However reduced vegetation along riparian edges is generally not considered a positive landscape outcome.		thefootpath/cycleway located outside the riparian strip. Since Morrison Orchard sits immediately north of this section of the stream and interfaces the site with a densely planted shelter belt, the existing visual and physical connections through to the Morrison Orchard are limited and will remain to protect its rural character. The proposed riparian strip helps enhance the stream corridor and will provide effective buffer planting without creating further separation between the two precincts. In terms of the walkways/cycleways that could be possibly provided within the riparian strip, these are mostly provided along the 20m riparian strip except a section that is along Stream 1 and adjacent to the proposed collector road. The provision of riparian planting together with recreational walking/cycling paths along the stream corridors will help enhance the ecological values and offers additional transport and recreational opportunities throughout the development. In respect to the walkway/cycleway that could be located within the 10m riparian setback, it provides an additional off-road recreational route between the proposed local centre/transport hub and Valerie Close. This also aligns with the indicative greenway routes that are proposed in the Warkworth Structure Plan.

	Transport		
	<u>Future Traffic Flows</u>		
4.1	Please undertake an assessment for 2046 to demonstrate that the proposed Sh1/WWLR	TPC	As stated in Section 3.3 of the ITA report, the SGA have undertaken assessment of the road network required to accommodate the traffic generated by the full

	intersection operates satisfactorily in 2046, or whether upgrades to the intersection may be required. If upgrades are required, the precinct should ensure that those upgrades are no precluded. The ITA focuses on the short to medium term effects of the plan change. No assessment of the long term effects within the full build out of the plan change in considered in 2046, other than reliance on the previous work undertaken in the Warkworth Structure Plan (WSP). The assessment in the WSP was a high level assessment and there is now more detailed information available with regards to the development and the roading network for Warkworth South; for instance, the Wider Western Link Road now connects to SH1 as a cross-roads with a collector road to the east of SH1. Previously, this road was a T intersection. The assessment should ensure that the proposed intersection with SH1 which provides the main access to the plan change area would continue to operate satisfactorily in 2046 or identify whether an upgrade (or additional land) would be required.		development of Warkworth in 2046, and this work has not been repeated in the ITA report. SGA have verbally advised the applicant that a single lane roundabout would accommodate WWLR/SH1 traffic following the full development of FUZ land and a completed arterial road network. As shown below, SGA have recently shared their idea for a layout of the Western Link Road/SH1 intersection proposal to support their upcoming Notice of Requirement and which shows a single lane roundabout. 
	<u>Future Public Transport Accessibility</u>		
4.2	Please provide details as to how the precinct provisions ensure that interim bus stops are provided prior to the construction the public transport interchange.	DH/JD	The implementation of interim bus stops on roads is a permitted activity under Rule E26.2.3.2 (as a road network activity) and specific provisions therefore do not need to be included in the precinct rules to provide for such bus stops.

	The ITA states that bus stops will be provided to service the existing route 995 to provide public transport for the plan change area. Whilst the exact location may be a matter of detail, the precinct provisions do not require the provision of bus stops prior to the construction of the public transport interchange. As the timing of the interchange is not currently know, it is important that facilities for public transport users are provided in the interim period. The precinct should ensure these facilities are provided.		The provision of bus stops on the road network is the responsibility of Auckland Transport.
	<u>Future Pedestrian and cyclist Accessibility</u>		
4.3	(a) Please review the extent of the pedestrian/cycle path on the eastern side of SH1 so that it connects toa n existing facility.	TPC	The proposed precinct provisions rightly only take responsibility for providing pedestrian and cycle connections to the existing urban area of Warkworth. It is the responsibility of NZTA/AT/Council to provide adequate walking and cycling infrastructure on SH1 within the existing urban area, which is needed with or without the proposed plan change. There is a mixture of shoulder markings and footpaths provide between McKinney Road and Woodcocks Road that are existing available for active modes as well as the requirement for PC72 to provide a footpath north of McKinney Road.
	(b) Please review the need for a pedestrian crossing facility in the vicinity of the Morrison Orchard vehicle access across SH1.	TPC	See item 4.7
	(c) The Transportation Infrastructure Table IXXX6.15.1 (T3) and (T4) require the construction of a pedestrian/cycle path to connect to McKinney Road and the access to Morrison Orchard respectively. The termination of the facility at McKinney Road would stop short of connecting to an existing footpath cycle facility.	TPC	See response to 4.3(a) above. See item 4.7.

	The termination of the footpath at Morrison Orchard could lead pedestrians/cyclists having to cross SH1 when wanting to travel to the Warkworth urban area. This poses a safety risk to vulnerable road users.		
	<u>Road Hierarchy "Waimanawa Valley" – WWLR Cross-section</u>		
4.4	(a) Please provide justification for including the riparian margin within the road reserve width and for the provision of the cycle facilities only on the northern side as a two-way cycle lane.	DH/JD	The updated WWLR cross-section does not now include the riparian strip.
	(b) Please explain how the road could be upgraded by Auckland Transport to an arterial through this section, including the provision of a one-way cycle lane on the south side of the road.	TPC	Please note that the proposed cross sections of the WWLR as shown in Figures 19 and 20 of the ITA report are intended to be of arterial road standard. They are very similar to the arterial road cross-sections shown on page 27 of the AT "Urban Street and Road Design Guide" as below: 

			The AT design guide cross sections, and those proposed for the WWLR, provide off-road cycle paths, which is a safer option than on-road cycle lanes. The updated Plan Change includes a table of road widths and requirements and reflect this.
	(c) Figure 19 of the ITA shows a cross-section for the WWLR alongside the Morrison Orchard with a two-way cycle way only on the northern side of the road. This would force cyclists to cross the WWLR and would inconvenience cyclists travelling between the western and eastern sides of SH1, and compromise access to the Local Centre. Cycle facilities should be provided on both sides of the WWLR for its entire length. The figure also shows that the riparian planting is within the road reserve width (24m). The available width without the riparian planting (19.4m) would not enable Auckland Transport to upgrade this section of the WWLR to arterial standard with one-way cycle ways on each side.	TPC	Having a two-way cycle path on one side only of an arterial road corresponds to the cross-section for a typical single use arterial road shown on page 27 of the AT "Urban Street and Road Design Guide". As explained on page 29 of the ITA report: "An advantage of having the cycle path on the northern side of the road is that cyclists will not need to cross any intersections or vehicle crossings. (The Matakana Link Road is a local example of an arterial road with a cycle path on one side of the road only.) Cyclists travelling from the western section of the Wider Western Link Road to the Morrison Orchard section would need to cross the link road where the cycle lane on the southern side of the road terminates. A high-standard cycle crossing facility would need to be provided at this point.
	<u>Wider Western Link Road Alignment</u>		
4.5	Please provide details of what assessment has been undertaken that demonstrates that the WWLR is appropriately located to allow it to be extended west of the plan change area in both the horizontal and vertical alignments. The WWLR will be required to be extended to the west when this land is rezoned and	DH/JD	The Supporting Growth Alliance ("SG") (for Auckland Transport/Auckland Council/NZTA) has now distributed the plans showing the areas they intend to designate at the WWLR/SH1 and the western side of WW South. In terms of the western side of the WW South Plan Change area, the proposed WWLR alignment in the Plan Change aligns with the SG proposed designation area for the crossing of the watercourse.

	developed and/or the WWLR is constructed to connect to Woodcocks Road or the motorway interchange. It is therefore important that the alignment of the WWLR is provided for in an appropriate location to allow for it to be extended in terms of both horizontal and vertical geometry.	 Maven	In terms of the WWLR/SH1 designation position, the proposed area to be designated needs to be expanded to the north to appropriately provided for the proposed WWLR/SH1 intersection and discussions are being had with SG in respect to that. SG has confirmed that the indicative alignment of the WWLR within the Plan Change area which they have shown is indicative only and will be determined through the Plan Change process based on the alignment which has been included in the Plan Change. The WWLR alignment has been located based on the factors listed below: • Centrally located within the FUZ area which provided a good service to surrounding land • The proposed WWLR vertical alignment is generally flat with minimal requirement for batter • WWLR will need to be extended west via a bridge crossing Mahungari River. Given the topographical on site this bridge can be formed with minimal work needed for the abutment. • The intersection of WWLR with State Highway 1 (SH1) is located in a straight section of SH1 which has a better outcome in terms of traffic safety. • This intersection location also provides a safe access to the Waimanawa Hills area. • The WWLR is located next to the local center and large recreation park which generate high volume of traffic. This also promote the use of public transport and cycling which is provided as part of arterial facility.
	<u>Road Hierarchy “Waimanawa Hills”</u>		
4.6	(a) Please provide details of how cyclists using the collector road (Road 1) in Waimanawa Hills will be catered for east of Road 6 where traffic volumes are still likely to be high as vehicles access the wider Waimanawa Hills area.	TPC	See (b) below.

	(b) The proposal is for the collector road to be constructed along the western end of Road 1 before turning north along Road 6. Further consideration is required as to how the hierarchy of roads within this area provides for cycling and the movement of traffic through the "Hills" area. For instance, the continuation of separated cycle facilities along Road 1 would likely be desirable as traffic volumes would still be elevated as this road provides the main access to the southern parts of the development.	TPC	The extent of the Collector Roads within the "Hills" is consistent with the Warkworth Structure Plan. Traffic volumes to the east of the proposed collector roads are not anticipated to be greater than 3,000 vpd and therefore it is unlikely that separated facilities would be required beyond the collector road. The applicant does not consider that special provision is therefore required within the precincts and the design of cycle facilities, if any, can be dealt with a resource consent time.
	<u>Cycling and Walking</u>		
4.7	(a) Please detail how appropriate pedestrian and cycle crossing facilities across SH1 to meet likely demands for crossing this road will be provided in locations where the plan change is likely to result in desire lines across SH1. Advice Note: Consideration should be given to facilities in the vicinity of the pedestrian/cycle connection from the eastern area to SH1 south of the WWRL and at in the vicinity of the Morrison Orchard access (refer to item 3).	TPC	With the proposed rear-loading of development along SH1, the potential locations where pedestrian demand to cross SH1 might be expected are at the new WWLR intersection (which will have pedestrian crossing facilities), the vicinity of Valerie Close and the pedestrian-cycle connection from the eastern area to SH1 south of the WWLR (see next item). At the time of any upgrade to the Valerie Close intersection, pedestrian facilities will be considered and we do not believe any additional provisions are required within the precinct. Any pedestrian desire line between the "Hills" and the Morrison Orchard access will be via the WWLR intersection and a footpath along the Orchard frontage. No additional facilities are anticipated north of this intersection.
	(b) A pedestrian and cycle access indicated on the western boundary of the Waimanawa Hills area (circled in red in the image below) connects to SH1 and the proposed pedestrian and cycle paths. The location is located south of the SH1/WWLR intersection. This connection could create pedestrian demands across SH1 for residents to walk or cycle to the	TPC	See response to item 4.7(a) above. The appropriate time to address these detailed design matters is at the resource consent stage if the Valerie Close intersection is upgraded.

	southern areas of the Waimanawa Valley part of the precinct. Pedestrians are unlikely to deviate to cross the road at the proposed WWLR/SH1 intersection due to the distance between these two locations, and therefore this could result in safety risks for pedestrians and cyclists. ITA Section 7.1 states that "*regular and safe crossing opportunities on the arterial roads where pedestrian desire lines are evident*" will be provided. Desire lines such as that described above would not be currently evident as there is no development or pedestrian facilities along SH1, however, the provision of the connection to SH1 for pedestrians/cyclists, which is considered appropriate, is likely to be a location where crossing demand would exist.		
	<u>Traffic Generation of Proposed Warkworth South Plan Change Area</u>		
4.8	(a) Please confirm that the SGA has accepted the trip rate used in the ITA for the single house and THAB zones. If these rates have not been accepted, please review the trip rates used in light of the accessibility to public transport and connections to wider facilities by active modes and update the assessment of the SH1/WWLR intersection accordingly.	TPC	We confirm that, as stated in the ITA, the use of the trip rates used in the previous ITA reports for approved plan changes/subdivisions in Warkworth has been agreed with the SGA.

	ITA Section 6.3 presents forecast flows and trip rates in Table 4. The ITA states that the use of the trip rates used in the previous ITA reports for approved plan changes/subdivisions has been agreed with the SGA.		
	(b) However, the rates for single house zones shown in Table 3 had a rate of 0.85 trips per household, but a rate of 0.65 trips per household has been used.	TPC	That is an error. A rate of 0.85 trips per household should have been applied to the 41 dwellings of this category. Increasing the trip rate from 0.65 to 0.85 increases the peak hour trip generation by 8 vehicles per hour, a difference of 0.6% to the total predicted trip generation of the PPC area. Thus, the effect of this error is insignificant.
	(c) There were no trip rates for THAB zones in the other plan changes. The ITA assumes a trip rate of 0.5 for THAB, and it is therefore not clear if this has been accepted by SGA. Given the poor connectivity to public transport and connections for walking and cycling and the short to medium term (as noted in the ITA), this trip rate is considered low. A rate in the order of 0.65 trips/household is considered more appropriate. Higher trip rates will affect the assessment of the operation of the SH1/WWLR intersection	TPC	We do not agree that THAB households would have the same vehicle trip generation as single house sites. THAB households generally have fewer vehicles per household and less parking available than single house sites, and thus have lower trip rates. The 0.5 rate used is consistent with the rates of 0.4-0.65/dwelling for medium density residential flat buildings suggested in the RTA Guide to Traffic Generating Developments. The trip rate of 0.5 used for THAB households has been accepted by the SGA
	<u>Motor Vehicle Trips at the Morrisons Orchard Access on SH1</u>		
4.9	Please provide an assessment of the suitability for a simple site access (as proposed) for the Morrison Orchard taking into consideration the volume of traffic turning into and out of the access and volume of traffic on SH1. The assessment should consider the provision of a channelised right turn or improvements to the	TPC	As SH1 is an arterial road, a Vehicle Access Restriction applies under Standard E27.6.4.1 of the AUP, and any new activity or change of type of activity at the Morrison Orchard site would need to be assessed against the criteria specified in E27.8.2(11) of the AUP, including the effects of the location and design of the access on the safe and efficient operation of the adjacent transport network having regard to visibility and safe sight distances, existing and future traffic conditions including speed, volume, type, current accident rate, and the need for safe manoeuvring, proximity to and operation of intersections, existing pedestrian

	access as illustrated in the Waka Kotahi Planning Policy Manual. With the forecast turning movements and the volume of traffic on SH1, a channelised right turn or right turn bay may be required, or at least improvements to the access in accordance with the Planning Policy Manual SP/M/001 Appendix 5B – Accessway standards and guidelines. A new access onto the State Highway would need to be assessed against this document and would require approval from Waka Kotahi.		numbers, and estimated future pedestrian numbers having regard to the level of development provided for in this Plan. Thus, the appropriate design of the access to the Morrison Orchard site will be determined to Council's satisfaction when any new land use or change of land use is proposed at the site. Should any extra land be required for the access, this can be provided by the property owner if required as a condition of resource consent. In terms of the proposed Morrison Orchard precinct provisions, standard XXX.6(2) only allows for activities generating up to 100 vehicles per hour in any hour. The estimated turning volumes arising from this level of activity in the AM and PM peak hour are shown in Figure 32 of the ITA report. An evaluation of these peak hour turning volumes against the auxiliary lane warrants on page 53 of Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossing Management (2020) indicates that only a basic left turn (BAL) treatment is warranted to accommodate left turning traffic, while a full right turn bay (CHR) is warranted to accommodate right turning traffic. As the proposed SH1 cross section shown in Figure 18 of the ITA report indicates a central median island width of 2 metres, a reduction of the berm width or local widening would be required in the vicinity of the Morrison Orchard access to accommodate a right turn bay.
	<u>Morrison Heritage Orchard traffic generation standard IXXX6.1(2)</u>		
4.10	Please provide an explanation as to why the trip generation limit in Standard IXXX6.1(2) for the Morrison Orchard only applies to certain activities in Table IXXX.X.1 and not all activities. If the standard does not apply to the other activities in the Activity Table, please provide an assessment of the operation of the site access to demonstrate that this will operate satisfactorily without an upgrade.	DH/JD	The Plan Change has been updated so that the trip generation limited in Standard Ixxx6.1(2) applies to all activities.

	Morrison Orchard Precinct Standard IXXX6.1(2) General Access and Traffic Generation Standard proposes to limit the total number of vehicle movements to 100 veh/hour from the Morrison Orchard for activities A4 to A10 (excluding A7) listed in Table IXXX.X.1 for the Morrison Orchard. The trip limit is considered appropriate, however, it is not clear why the limit only applies to certain activities. If the limit is proposed to address an effect of development exceeding 100 vehicles per hour, then this should apply to all activities as the safety of the access will not be better just because the trips are generated by one of the activities not referenced in the standard.		
	<u>Activity Tables, including Activity Table IXXX4.4, 4.5 and 4.6</u>		
4.11	Please provide justification as to why non-compliance with IXXX6.15 Transport Infrastructure is Discretionary and not Non-Complying. Please review the consistency of how the non-compliance with Standards IXXX6.7, IXXX6.8 and XXXX6.15 in the Activity Tables has been applied, including consideration of these being applied to Table IXXX4. for all zones. The activity tables for the various zones list activities that do not comply with Standard IXXX6.7 Limited Access Restrictions and Pedestrian Connections, and IXXX6.8 Wider	DH/JD	It is not agreed that the activity status needs to be non-complying. It is possible that AT may change over time the road design requirements from those currently proposed. The discretionary activity status is therefore more appropriate and provides the opportunity for Council to assess the effects arising and taking into account any changes in the road design requirements by AT at that time.

	Western Link Road as Non Complying (NC), and those that do not comply with IXXX6.15 Transport Infrastructure as Discretionary (D). The inclusion of these varies across the zones in which they have been applied. It is not clear why non-compliance with all these standards does not apply to all zones. Furthermore, it is not clear why non-compliance with the IXXX6.15 is not non-complying.		
	<u>Standard IXXX6.7 – Limited Access Restrictions and Pedestrian Connections</u>		
4.12	Please explain why the access restrictions for roads with separated cycle facilities only apply to S1 and the WWLR and not all road with separated cycle facilities (such as the collector roads).	TPC	Recent practice with plan changes has sought not to prohibit vehicle access on Collector Roads, but there is an expressed desire to limit access. This recognises that it is not always practical or possible to provide rear lane access on both sides of a Collector Road. This is also recognised in AUP standards where limits are provided on a number of design features such as the number of crossings provided on a frontage, vehicle access width, separations, and level of use where reversing vehicles may be required. We consider that there is sufficient provision within the AUP to address any safety concerns for cycle paths on collector roads.
	Standard IXXX6.7(2) refers to the SH1, WWLR and Green Road. However, there are other roads which have separated cycle facilities. These roads should also have restricted access to provide for the safety of cyclists. Note that the Precinct Plans refer to Green Road as Green Avenue.	DH/JD	The terminology in the PC has been corrected so it refers to Green Avenue.
	<u>Standard IXXX6.8(1)(c) – Western Link Road</u>		
4.13	Please explain how the precinct allows for or protects the Wider Western Link Road for upgrading to arterial road standard.	DH/JD	The width of road being provided for allows for it to be converted to an arterial road standard in the future. This upgrading is likely to be a permitted activity and falls within the ambit of E26. Specific rules in the Plan Change are therefore not required.

	The precinct provisions do not allow for the future upgrading of the WWLR to arterial standard. Previous versions of the precinct provisions (IXXXX6.8(1)(c)) included such a provision but this has been deleted.		
	<u>Transportation Infrastructure Requirements Table IXXX6.15.1(T1)</u>		
4.14	Please review the detail of the trigger for IXXX6.15.1(T1) to ensure that the effect of <u>any</u> development using Valerie Close is appropriately addressed as is recommended in ITA Section 2.2.2. The Transportation Infrastructure Table IXXX6.15.1(T1) requires that an assessment of the Valerie Close intersection should be undertaken in the event of development fronting onto or having access to a Valerie Close. The ITA states in Section 2.2.2 that <u>*any*</u> additional traffic would require Valerie Close intersection to be upgraded. The standard therefore only requires an assessment to be undertaken not an upgrade itself, therefore the effect of the development on the safe operation of the intersection may not be addressed.	DH/JD	No change to the Plan Change wording is required and the required assessment will determine if the upgrading is required at that point.
	<u>Transportation Infrastructure Requirements Table IXXX6.15.1(T9)</u>		
4.15	Please detail how IXXX6.15.1(T9) would trigger upgrades to Mason Heights if development is accessed via a new road connection or an extension to Mason Heights rather than just	DH/JD	The Plan Change wording has been changed to: Any subdivision or development with frontage to that section of Mason Heights or in the event that Mason Heights is extended or a new road is connected to it within the Waimanawa Precinct.

	fronting onto Mason Heights as is currently stated in the table. The Transportation Infrastructure Table IXXX6.15.1(T9) relates to the upgrade of Mason Heights where development or subdivision has frontage on to Mason Heights. If Mason Heights is extended or a road connection is provided onto Mason Heights, then technically the threshold would not be met and no upgrade would be required. This would mean that residents would not be provided with appropriate pedestrian connections to the wider network.		
	<u>Standard IXXX6.15 – Transport Infrastructure</u>		
4.16	Please provide an explanation why the triggers for Table IXXX6.15.1 Transport Infrastructure Requirements (T2) and (T5) relate to the 20 residential lots and only relate to subdivision. The triggers included Table IXXX6.15.1 Transport Infrastructure Requirements (T2) to (T5) are for 20 residential lots. There is no justification provided for the use of 20 residential lots rather than for the first dwelling or not. Furthermore the trigger only refers to the "first subdivision". If a development for a retirement village or similar were to occur, this may not require subdivision and thus not trigger the requirement for the upgrade. The standard should refer to the first subdivision or development creatin more than 1 residential lot.	DH/JD/TPC	(T2) and (T5) have been updated so that any subdivision within the Business – Local Centre Zone or for a retirement village triggers the upgrades. In terms of the 20 residential lot trigger, this has been included as it reflects that there are a number of small lots not under the control of the applicants within the Plan Change area. This would allow very limited subdivision of these lots without them triggering the upgrading requirement if for any reason those landowners decided to progress the subdivision of their lots for residential purposes prior to the applicants progressing their subdivision.

	Standard IXXX6.15 – Transport Infrastructure		
4.17	To assess the adequacy of roading elements and functions, please include the Road Standards and Function Table in the precinct provisions. Reference should be made to the table in IXXX6.15 Transportation Infrastructure to require infrastructure to be provided in accordance with the table. The ITA recommends that a Road Standards and Function Table be included in the precinct provisions. The table would set out the function of each road and the key design elements of the road including number of lanes, pedestrian and cycle requirements, whether the road is to accommodate buses, the overall corridor width etc. This would provide clear guidance to developers and planners. However, the Precinct Provisions do not include the table. The table is referenced in IXXX8.2(1)(c)(vii) for the Assessment Criteria for Restricted Discretionary activities in relation to subdivision.	DH/JD	This requested table has been included in the Plan Change.
	General comment from Traffic Engineer XX.3(16) Policies		
4.18	Please amend policy 16 to read: *"Avoid direct vehicle access from individual sites on to the Wider Western Link Road, and State Highway One, and collector roads with separated cycle paths, while allowing direct pedestrian and cycle access."*	DH/JD	A new Policy 19 has been added to address collector roads.

	To provide safe cycling facilities and to provide priority for cycling, vehicle access should be avoided on roads with separated cycle facilities, including SH1, WWLR and the collector roads within the precinct. Policy 16 only refers to SH1 and the WWLR, but it should also refer to the collector roads.		
	<u>Standard IXXX6.7 – Limited Access Restrictions and Pedestrian Connections</u>		
4.19	Please amend IXXX6.7(3) to refer to Precinct Plan 3 rather than Precinct Plan 1. Standard IXXX6.7(3) refers to Precinct Plan 1 with regards to pedestrian connections. It is assumed that this should refer to Precinct Plan 3.	DH/JD	This correction has been made.
	<u>IXXX9.1 Special Information Requirements – Transport and Safety</u>		
4.20	Please review IXXX9.1 Special Information Requirements – Transport and Safety and include the purpose of the assessment in the special information requirement. IXXX9.1 Special Information Requirements do not provide sufficient guidance to developers as to the purpose of the transport assessment or safety audit. The purpose of the requirement should be clearly identified in the purpose of the requirements.	DH/JD	No changes are proposed.

	Urban Design		
	Pedestrian Connectivity		
5.1	The precinct description asserts 'that range of lot sizes for different typologies focused on open spaces and responding to the topography … will result in a walkable community with a high amenity urban area'. However, 'community' is driven by wider associations and affiliations relating to the wider Warkworth Area. Walkability is about enabling easy, safe and convenient pedestrian connections for all ages, genders and use during evening hours. Objective 2 in a broad sense reflects this wider need of community and pedestrian amenity, but that part of the objective "integrated walking and cycling connections internally and to the wider Warkworth urban area" and Policy 13 requires subdivision … to provide walking and cycling networks within the precinct while provided connections to the wider transportation network. My experience to date is if any pedestrian link is provided, however circuitous, with limited overlook and lighting and/or connections to the wider area through limited high-end connectors or arterials is considered as integrated. Please consider how the policy and other provisions of the precinct can address and make clear the needs for the development of street-based structure for the easy, safe, and	DH/JD	No changes are proposed.

	convenient pedestrian connections for all ages, genders and appropriate for use during evening hours to the wider or adjoining neighbourhood areas of Warkworth. Please demonstrate the dependence of open space pedestrian routes connecting northwards having limited length (i.e., less than 30m) and what provisions would support appropriate overlook.		
	<u>Cul-de-sac road grids</u>		
5.2	The creation of groups of connected street grides as indicated by the Master Plan work, accessed by a single-entry road create cul-de-sac neighbourhoods, with edges defined by streams and open spaces. The effect, even when stream side pedestrian paths and crossings are provided, is to drive inconvenient, and long pedestrian access between closer residential sites that act as a barrier to pedestrian activity and promotes more vehicle use. The applicant is asked to consider what provisions are necessary to avoid the impacts these small neighbourhood pods of connects streets that are poorly connected other similar pods and how these provisions to that outcome is better balanced against open space and typographical constraints.	DH/JD	No changes are proposed, and it is considered that adequate pedestrian and cycle access can be provided onto SH1.
	<u>Northern Esplanade Reserves</u>		
5.3	The provision of a continuous esplanade incorporating the recreational 'green route' with either further open space landscaped	DH/JD	No changes are proposed.

	protection or rear of properties that back onto these esplanade reserves undermines connections to the north which would be considered easy, safe, and convenient pedestrian connections for all ages, genders usable during evening hours. While changes to fencing have been made, all these properties can develop a landscape response which can screen and undermine the intentions behind the fencing provisions. The use of road frontage against the esplanade, open them to better overlook and positions roads closer to enable shorted pedestrian links across the stream. Please identify how objectives, policies and assessment criteria for subdivision would strengthen the ability for easy, safe, and convenient pedestrian connections for all ages, genders usable during evening hours.		In terms of the western edge of the Plan Change area it is considered inappropriate for a road to be formed within the area identified as a bat flight corridor.
	<u>Local Centre</u>		
5.4	(a) The precinct description identifies that the local centre is 'designed' to be a focal point for the community, and the centre is to be both accessible and functional within the notion of high amenity. However, there is a lack of policy or provisions which deal with the co-ordination of activities frontages and backs. Subdivision of the site and selling sites to be developed independently (an approach that is being adopted by developers) will result in case by case consenting and potential	DH/JD	The design of the local centre is a detailed design matter. No changes are proposed.

	conflicting outcomes based on some of the functional needs of businesses.		
	(b) The master plan depicts reasonable attempt at a new urbanist approach to the town centre, however the extent to which this has been assessed from a retail perspective is lacking in any supporting documents or the urban design report, where that would sit if not separated out. In particularly what the stream which bisects the site and its 10m riparian setback does to the functioning of the centre and its approach to developments fronts and backs.	DH/JD	The design of the local centre is a detailed design matter. No changes are proposed.
	(c) There is need to identify key frontages within the subdivision consenting process, and to describe the frontages performance. This centre could easily be developed on a site-by-site basis, in its own time with its own agenda activity. That raises some conflicts between assembling pedestrian supportive frontages, assembly of activities and the efficiency of a centre's layout. Below are some of the poor examples of development fronting key arterials and corner sites, which indicates how poorly planning is dealing with these locations. While there is a need to provide for a range of business activities, a piecemeal approach is unlikely to result in the envisaged community focal point, a functional shopping environment or an appropriate gateway address for the site.	DH/JD	The design of the local centre is a detailed design matter. No changes are proposed.
	(d) The applicant is asked to provide a retail assessment of the local centre, considering the	DH/JD	The Warkworth Structure Plan identifies the requirement for a local centre in Warkworth South (and close to the proposed location). It is considered that a

	implications of the stream and riparian protections, costs associated with bridging, and the co-ordination of frontages and backs to achieve a town centre based on urban design principles. The applicant to consider strengthening the subdivision policies and provisions for the local centre to manage and co-ordinated frontage conditions relating to the WWLR, State Highway 1, stream, and riparian, possibly utilising existing AUP-OP provisions such as identify commercial and retail frontages.		retail assessment for a local centre is not required particularly when the requirement for this local centre is already identified in the Structure Plan for the area.
	(e) The applicant consider implications of street on parking provisions in the design of the WWLR to support the early establishment of frontage conditions, and parking considerations when in the long-term the WWLR becomes an arterial route.	TPC	Standard Ixxx.6.7(2) requires that "sites that front onto the Wider Western Link Road, Green Avenue and State Highway One must not have direct vehicle access to the road and must be provided with access from a rear driveway, rear lanes (access lots) or side roads at the time of subdivision" so a very stringent frontage control is already proposed. The WWLR cross-sections do not provide on-street parking on the WWLR.

	Parks		
	<u>Stormwater Ponds</u>		
6.1	The masterplan shows that the indicative open spaces shown in Precinct Plan 4 double as stormwater ponds. This is not supported and does not meet the requirements of the Open Space Provision Policy 2016 for suburb, neighbourhood and pocket parks. Please clarify/confirm the provision of sufficient and appropriate open space and how this coordinates with green infrastructure.	Reset	The proposed open spaces within Warkworth South are provided primarily along the multiple stream corridors. These streams are an integral part of the existing site and will be essentially protected and enhanced by the provision of riparian yards. The approach to integrating the existing site features such as streams, natural landforms and vegetation into the proposed open space network helps create a rich sense of place. The various open spaces proposed along the stream corridors not only provide for a range of recreational activities but also combine stormwater management functions into the area. Integrating green infrastructure with open spaces to create multifunctional open spaces demonstrates good urban design practice and is encouraged by the Auckland Council's Open Space Provision Policy 2016.

	<u>Subdivision</u>		
6.2	IXXX.4 Activity table removes the application of the E38 activity table provisions for vacant site subdivision and replaces them with RD activity class for subdivision in the precinct. An assessment of open space provision is not provided for within the proposed matters of discretion, beyond a narrow consideration of "the extent to which green connections are provided". This means the normal consideration of open space provision within a subdivision consent application and its adequacy in terms of useable spaces etc. under E38 would be precluded. The Section 32 assessment considers that providing certainty over open space provision in preferred to the uncertainty of a resource consent process. This approach is not supported by Parks Planning as outlined in its pre-lodgement consultation feedback. There is no comment, response or further explanation is the section 32 report regarding Parks Planning's significant concern over the application of open space zones at the initial plan change stage, rather than post-subdivision. It is how the precinct plan provides suitable mechanisms to ensure the provision of sufficient and suitable open space in future	JD/DH	The original draft Plan Change included zoned areas for formal and informal recreation. During the soft lodgement process, the Council Officer feedback was that the preferred approach for Council was to zone future open space land as residential so that the detailed boundaries could be worked through at the resource consent stage. The applicants do not reconcile from the provision of open space as per the masterplan and this will feature with appropriate boundaries at the time of resource consent applications for staged subdivision. A new policy 20 has been added and a new matter of discretion (Ixxx.8.1(1)(h)) and assessment criteria (Ixxx.8.2(1)(f)) have also been included. These matter of discretion and assessment criteria are consistent with the E38 provisions.

	subdivision, and how this will be able to be assessed at subdivision consent stage.		
	<u>Numbers, sizes and types of parks</u>		
6.3	Precinct Plan 4 appears to conflate potential areas of future open space zones with open space provision in terms of the numbers, sizes and type of parks to be provided throughout the precinct. Please explain how Precinct Plan 4 provides the necessary guidance for future subdivision and development of the precinct in terms of numbers, sizes and type of parks to be provided, or how else this is specified and assessed in the proposed precinct provisions.	DH/JD	Auckland Council identified through the soft lodgement process that they did not want future open spaces defined at this stage as the exact location, size and function of open spaces will be determined through the future subdivision processes. For this reason, the final Plan Change submitted in January removed open space zonings (except for Open Space - Conservation).
	<u>Esplanade Reserves</u>		
6.4	Should the stated reason for IXXX6.16 refer to only esplanade reserves in the actual wording or should it refer to 'vested publicly accessible open space' to ensure land that may not be vested as esplanade reserve is also considered?	DH/JD	This change has been made in the Plan Change.

	Ecology		
7.1	Please confirm the proposed riparian yard widths and whether the proposed widths are shown as a measured whole width (i.e., 20m riparian yard width means 10m each side of the stream bank) or whether the proposed riparian yard widths are (as generally accepted) measured individually from the top of both stream banks (i.e., 20m riparian yard	DH/JD	The riparian widths shown on the plans to date are only indicative as detailed surveys and plans are prepared at the subdivision stage. The width will be from the top of stream banks.

	is measured as 20m from either side of the top of the streams bank). Please update Precinct Plan 1 as necessary.		
7.2	It is acknowledged that bat surveys have been undertaken on site and that records of bats using the area identified as the "Indicative Bat Flight Corridor" have been shown. However, it is my opinion that these surveys are lacking in sufficient detail or scope for the nature of the proposed application. The Bat surveys are very limited in area and appear to have been placed on the edge/boundaries of the site, outwardly focused. The applicant has not undertaken any formal surveys from within the centre areas of the site including around wetlands, stream and pasture areas within the site that are likely to be used as feeding areas/habitats for bats. The plan change proposes a large area of the site to be Open Space – Sports and Active Recreation (Suburban Park) which is located next to a significant area of stream and wetland. Sports and Active Recreations area are busy locations often associated with large flood lights and spotlights for sports at night. Without formal bat surveys over and around these it is difficult to determine and assess the effects of the proposed location and rezoning of these areas on bats. As such please provide further formal bat surveys over the site including the areas of potential bat habitat.	Bioresearches	The scope of the surveys, provided in the Ecology report, targeted key ecological features- being those that are linear and / or support potential roost habitat, such as: **Waimanawa Valley** The Mahurangi River (right arm) and associated riparian corridor along the western and northern site boundaries and including key vegetation fragments along the northern extents of the site. **Waimanawa Hills** Groves and fragments of large totara, puriri (areas 2 & 3, Figure 8 of ecology report) adjacent to the northern edge of Avice Miller Scenic Reserve. These areas are identified as being of important ecological value, including for potential bat use, and are protected under the proposal, including the provision of a dedicated bat corridor at Waimanawa Valley to support identified bat activity. It is acknowledged that further survey spread has potential to provide more insight into bat activity within and around the project areas, such areas within Waimanawa Valley are proposed to be open space under the proposed plan change, (e.g. areas of wetland and watercourse, connected to northern riparian corridor- which was surveyed and reported in the ecology assessment), and would be best suited to open space zoning, rather than the more regular anthropogenic activity (lighting, vehicle traffic noise) associated residential areas. Existing, repeated surveys to date indicate that any such activity beyond the Mahurangi River corridor would be low level (as identified from existing survey information) if at all, and because previous survey effort and bat database records indicate that the source of the identified activity is highly likely to be associated with the large area of forest (indigenous and exotic) to the south-west, which has

			more recently become bisected from Warkworth by the construction of SH1 (Puhoi to Warkworth) motorway.
7.3	The proposed provisions in the plan do not propose any specific lighting provisions around standards for lighting for areas of identified or potential Bat Habitat. Please provide comment as to why the recommendations of the ecologist have not been adhered to. Notwithstanding the above, it is recommended that further provisions addressing this matter, such as those previously approved under Plan Change 69 – Spedding Road be adopted.	DH/JD	Proposed lighting provisions within the Bat Flight Corridor have now been included in the Plan Change.
7.4	A wetland area (unlabelled) alongside watercourse 15 has been identified as a constructed wetland. Please revaluate this assessment. Whilst it is agreed there are elements of ground modification, Council has previously concurred this as a restored natural wetland (both prior to, and during review for subdivision consent SUB8007191 [RMA55271]).	Bioresearches	Page 28 of the Baseline Ecology Report discusses the wetland and the reasoning for classifying the wetland as a constructed wetland, including the history of the site as pasture (*15 years ago*) and construction of a dam across the watercourse to create a pond. The following are snips from the current Google Earth Imagery and 1963. The current wetland is located in the centre of the Google Earth Imagery and absent from the 1963 imagery:

			
7.5	Please update precinct plan 2 with all natural wetlands and streams on site irrespective of determined value. Wetlands and streams have been identified within the ecology report that have not been shown on precinct plan 2. Please provide a clear, detailed and labelled precinct plan that includes all natural features. For avoidance of doubt, it is not agreed that pre-determining potential wetland and/or stream reclamations are a matter for the Plan Change; this is contrary to	DH/JD	The Precinct Plan shows retained streams for planning reasons and there is no requirement under Appendix 1 of the AUPOP or the NES for Freshwater to show all watercourses.

	the Unitary Plan Appendix 1 and/or National Environment Standards for Freshwater.		
7.6	Please accurately identified the area proposed as 'Waimanawa Wetland' reserved on precinct plan 4.	DH/JD	This has not been included. Auckland Council made it clear during the soft lodgement process that future open spaces which may be vested in Council were not to be zoned Open space through the Plan Change process.
7.7	It is not considered that the streams shown as 'artificial watercourse' in Figure 5 of the Baseline Ecology Report prepared by Bioresearchers have been incorrectly identified. It is considered that these 'artificial watercourse' meet the definition of a modified stream as a modified element of a natural drainage system as determined under the AUP definition for streams. These streams are located within a natural floodplain that has been altered for farming and horticultural activities. Please provide an updated Figure 5 and a full assessment of these modified streams. All streams should be shown on Precinct Plan 2, should the Plan be used to act as a baseline for future Resource Consent applications.	Bioresearches	The detailed assessment of the watercourses is included in the January 2021 report which is attached. Figure 5 is based on this earlier report where all watercourses and potential watercourses were ground-truthed. It is considered that no updates to Figure 5 are required. Precinct Plan 2 only shows those streams which are to be retained and does not need to show all artificial watercourses or drains.
7.8	No formal Herpetofauna surveys have been undertaken on site. Please undertake formal surveys to identify if there are any areas on site that have high value habitat or value and should undertake habitat restoration and/or protection.	Bioresearches	Formal herpetofauna surveys are not considered necessary in the current instance. We acknowledge that the potential occurrence of indigenous lizards within parts of the site, beyond those we have identified for protection and enhancement, remains possible. However, such areas are localised and fragmented, and are currently maintained as pastures and exotic hedges. Our assessment has identified areas of indigenous vegetation, habitats and linkages on both blocks (Waimanawa Valley and Waimanawa Hills) that are worthy of further protection, enhancement and buffering with respect to their wider ecological representativeness, diversity and context, as well as their potential to support indigenous lizard communities. These locations are mapped

<table>
<tr><td></td><td></td><td></td><td>in Figures 4 and 8, and additionally include those areas that are afforded riparian yard protection. In the longer term, we anticipate that these identified areas could further provide support for additional enhancement of lizard habitat values as managed under future resource consents.</td></tr>
<tr><td>7.9</td><td>Table 4 within the ecology report shows NZ treat status for herpetofauna, please update this table to represent regional threat status for the Auckland region instead, as endorsed by the Department of Conservation.</td><td>Bio</td><td>The ecology report listed all native herpetofauna as “At Risk’. This has not changed. A revised version is produced below, as per Melzer et al. 2022.

Table 1. Terrestrial herpetofauna of the Rodney Disctrict, corresponding NZ threat status (Hitchmough et al., 2016; Burns et al., 2018; Melzer et al. 2022) and occurrence within five kilometres of the site.

<table>
<tr><th></th><th>Common name</th><th>Species name</th><th>NZ threat status</th><th>Reported within 5 km of the sites</th><th>Habitat potential within Projects</th></tr>
<tr><td rowspan="9">Indigenous</td><td>Mokopirirakau granulatus</td><td>Forest gecko</td><td>At Risk – Declining</td><td>✓</td><td>✓</td></tr>
<tr><td>Naultinus elegans</td><td>Elegant gecko</td><td>At Risk – Declining</td><td>✓</td><td>✓</td></tr>
<tr><td>Dactylocnemis pacificus</td><td>Pacific gecko</td><td>At Risk – Declining</td><td></td><td>✓</td></tr>
<tr><td>Woodworthia ”Muriwai”</td><td>Muriwai gecko</td><td>Threatened- Critical</td><td></td><td></td></tr>
<tr><td>Oligosoma ornatum</td><td>Ornate skink</td><td>At Risk – Declining</td><td></td><td>✓</td></tr>
<tr><td>Oligosoma moco</td><td>Moko skink</td><td>At Risk – Relict</td><td></td><td>✓</td></tr>
<tr><td>Oligosoma smithi</td><td>Shore skink</td><td>At Risk – Naturally Uncommon</td><td></td><td></td></tr>
<tr><td>Oligosoma aenuem</td><td>Copper skink</td><td>At Risk – Declining</td><td>✓</td><td>✓</td></tr>
<tr><td>Leiopelma hochstetteri</td><td>Hochstetter’s frog</td><td>At Risk – Declining</td><td></td><td></td></tr>
<tr><td rowspan="3">Exotic</td><td>Lampropholis delicata</td><td>Plague skink</td><td>Introduced & Naturalised</td><td>✓</td><td>✓</td></tr>
<tr><td>Ranoidea aurea</td><td>Green and golden bell frog</td><td>Introduced & Naturalised</td><td></td><td>✓</td></tr>
<tr><td>Ranoidea raniformis</td><td>Southern bell frog</td><td>Introduced & Naturalised</td><td>✓</td><td>✓</td></tr>
</table></td></tr>
</table>

7.10	Precinct Plan 2 shows proposed areas of bush to be protected by covenant. These areas include the areas of mixed native exotic vegetation and indigenous tree land vegetation identified as areas 2 and 3 on the plan. These areas are connected by proposed covenant bush area identified as a dark green colour on the plan. These large areas proposed to be covenanted fall outside of the provision on chapter E38 of the AUP. No provisions are proposed under the proposed plan change to enhance, restored, and protect these areas. Please provide an assessment/propose provision as to how these areas will be enhanced to achieve the outcomes as identified in the AUP. The applicant may choose to include relevant standards within the Precinct to ensure these outcomes are met.	DH/JD	No changes are proposed.
	Further identified areas of concern that are likely to be raised through the application review process but not included in this s23 assessment.		
7.11	The proposed plan change and provisions frequently references back to 'Precinct Plan 1, 2, 3&4' however it is considered that the provisions should instead reference natural features 'identified on precinct plan or otherwise existing'.	DH/JD	No changes are proposed.

7.12	The riparian planting provisions under IXXX9.2 of the plan change provisions are inconsistent with what has been approved under other plan changes and those under appendix 16 of the AUP. Including the exclusion of walking tracks from within riparian buffers, especially those that are only 10m wide.	DH/JD	The provisions reflect those used in the Warkworth Clayden Road Precinct.
7.13	The proposed standard under table IXXX.4.1 (A7) allows for public walkway within a riparian yard or esplanade reserve as a permitted activity. It is not considered that this standard is appropriate in such a broad capacity as it fails to take ecological values of specific natural features into account. Furthermore the standard is more permissive that the Unitary Plan and has not been accompanied by appropriate justification or assessment of ecological effects.	DH/JD	The Plan Change has been amended to make this an RD activity.
7.14	A 4m riparian yard is proposed alongside watercourse 5 adjacent to the indicative location of the proposed local centre. It is not considered that this is acceptable in this instance for the following reasons: a. A width of 4m lacks the ability to provide adequate riparian yard functions, including terrestrial benefits. b. This area of riparian yard is an important ecological link between and through the site, reducing its width reduces the buffer and connectivity to other areas of terrestrial vegetation, including SEA's.	Reset Bioresearches	In respect to the section of stream that runs along the southern boundary of Morrison Orchard, a minimum 4m wide riparian planting will be provided with footpath/cycleway located outside the riparian strip. Since Morrison Orchard sits immediately north of this section of the stream and interfaces the site with a densely planted shelter belt, the existing visual and physical connections through to the Morrison Orchard are limited and will remain to protect its rural character. The proposed riparian strip helps enhance the stream corridor and will provide effective buffer planting without creating further separation between the two precincts. (a) Although 10m riparian yards are a general standard for Auckland, the Auckland Council guidance document TP148 allows for narrower riparian yards

	c. The plan changes provisions propose allowing walkways within riparian reserves as a permitted activity which would further significantly compromise the ecological integrity of this area. d. This watercourse would have originally linked further north with watercourse 13a by dissecting the orchard area to the north, this has been identified within the baseline ecology report. If full riparian yards cannot be achieved along watercourse 5, the applicant may like to consider modifying this stream to be located along its original drainage route therefore allowing for a full riparian yard and ecological corridor, however it is understood that this area is proposed to remain as an orchard and hence this may not be practical, whereas other solutions could be considered.		than the 10m 'general guideline'[1], and narrower yards provided for in rules are common elsewhere (e.g. GWRC). The primary reasoning for the wider yard is edge effects i.e. weed invasion from abutting pasture or vegetation (TP148). At this site, this is not the case as a formed cycleway/ footpath will be immediately adjacent to the yard. Other functions, such as shading, woody inputs, leaf litter will not be compromised by the narrower yard, particularly with the incised banks and tall trees on the opposite bank already providing for these functions. Functions such as filtration will not be compromised because the stormwater will be collected by roadside drains and be treated prior to discharge to the streams. (b) With the proposed 10m riparian yard either side of the other streams on site, connectivity through the site is assured. This straightened and highly modified stream has no direct connectivity upstream (broken by State Highway 1 and then connected to pasture) and downstream it will be provided by the riparian yards of Streams 2 and 12. There is no direct connection to SEAs with the closest SEA the riparian yard of the Mahurangi River, located over 700m to the west (or over 2km if the connection was through the riparian areas) and separated by the proposed development area. (c) With the proposed 10m riparian yard either side of the other streams on site, connectivity through the site is assured. This straightened and highly modified stream has no direct connectivity upstream (broken by State Highway 1 and then connected to pasture) and downstream it will be provided by the riparian yards of Streams 2 and 12. There is no direct connection to SEAs with the closest SEA the riparian yard of the Mahurangi River, located over 700m to the west (or over 2km if the connection was through the riparian areas) and separated by the proposed development area.

[1] **TP 148 p.15, 2.3 Width of sustainable riparian zones**, concluding statement: *In light of the above, a 10m minimum buffer width is therefore recommended as a general guideline for the purposes of this Strategy and Guideline, with narrower or wider options being considered appropriate as indicated by site constraints or opportunities.*

			(d) The original route of the stream was through the adjacent northern property (Orchard). The option of re-establishing the historic flow path was explored in the early design stages, but the landowner has clearly stated that re-routing the stream through his property is not an option.
	The proposed Arterial Road is currently shown on the plans to dissect the covenanted natural wetland; however no assessment of alternatives has been provided to avoid this impact, or remedies to offset being proposed in the ecological report.	DH/JD	The wetland area referred to is not covenanted. The title for this site has been provided to Council. That area impacted by the proposed WWLR is not a natural wetland as outlined above.
7.16	Areas of wetlands and watercourses that have been identified as having low value. Without acknowledging their existence the precinct would seem permissive to their removal, and therefore contrary to National Policy and /or relevant National Environment Standards.	DH/JD	No response required.
7.17	It is considered that the northern areas of the site proposed to be rezoned Open Space – Conservation Zone could be better connected to provide higher ecological connectivity value.	DH/JD	No response required.

	Development Engineering		
8.1	Please update the Maven report to refer to the correct opening date of the Puhoi to Warkworth motorway.	DH/JD	The exact date of the opening of the Puhoi to Warkworth Motorway has not been confirmed by NZTA but it is understood it will be around June 2023.
8.2	It is proposed to provide the necessary pipe infrastructure to the various pumpstations (Falls Rd, McKinny Rd) and the documentation refers to pump stations as far as pump station 2. Please check and confirm this is the case and	Maven	The infrastructural report has been updated to reflect the timing of this network to be completed by Watercare.

	verify along with estimated date for the completion of the Watercare Services limited rising man from Warkworth to Snells Beach, (Lucy Moore Park to Hamilton Road treatment facility). The current projection is 2025 (and we have requested information from WSL on this at the time of writing) the Maven report states 2024.		
8.3	Please confirm that there has been input from WSL on the infrastructure that may be required to implement a water supply for the Plan Change area.	Maven	On-going consultation has been carrying out regularly with Watercare representative regarding which infrastructure required for this Plan change.
8.4	Please provide an update on progress with Chorus and Vector on achieving the necessary power and telecommunication infrastructure to serve the Plan Change area.	Maven	On-going consultation has been carrying out with Chorus and Vector regarding extension of existing network extension to services this plan change.

Key:

DH/JD – David Hay/John Duthie (Planning Consultants for the Applicants)

SH – Shane Hartley (Planning Consultant for Morrison Heritage Orchard)

Reset – Reset Urban Design

Maven – Maven Engineers

TPC - Traffic Planning Consultants.

ATTACHMENT 25

CLAUSE 23 RESPONSE – JUNE 2023

osbornehay
Resource Management Practice

June 23, 2023

Auckland Council
Attn. Mr David Wren
(by email)

Dear David

Re: Proposed Warkworth South Plan Change – Response to Second Cl23 Request

I write on behalf of KA-Waimanawa Limited Partnership and Stepping Towards Far Limited.

The tabulated response to the second set of questions from Council is attached. Also attached is a response from Simpson Grierson in respect to the wetland matter. There has been a further meeting with Healthy Waters this week and we will respond to their questions in the next week or two as further progress was made in addressing their queries at this meeting and this needs to be reflected in the response.

The updated version of the proposed plan change provisions is attached. The only change is in xxx6.1(2) where (A4) has been changed to (A3). This was an error in the last version and addressed question 2.5.

Since our last meeting there are a couple of matters we have given further consideration to and which we now address further.

Flooding

The Plan Change documentation includes a Stormwater Modelling Report and I attach at the end of this letter the current flooding extent plan for the Precinct (which excludes any future changes resulting from bulk earthworks).

We have given further thought as to whether a precinct specific rule is required in respect to flooding matters. However, we consider that Section E36 (Natural Hazards and Flooding) adequately addresses the flooding risk and that no Precinct specific rules are required. In very simple terms, any new dwellings within a flood plain require resource consent under E36. The adequacy of E36 was demonstrated in the recent Auckland Anniversary flood events where new master planned subdivisions in Auckland were not significantly affected by the flood events.

This must be understood in the context where Maven have done extensive work on flooding and overland flow within the catchment. That has been worked through with Healthy Waters and, as noted above, we will be responding to their questions next week.

Overland flow is successfully managed through existing streams and on roads, to complying depths, as it typical in modern subdivisions in Auckland. All flood plains within the plan change area are to remain undeveloped for housing and will mostly remain as streams or open space.

As stated it would be possible to draft precinct assessment criteria to this effect. However, working on the principle of avoiding duplication, we instead are relying on E36. This is common practice elsewhere in precincts. However, if the Council considers this is material to the advancing of this plan change the applicants would accept duplicated provisions dealing with the flood plain and effectively repeating the relevant E36 criteria.

Separation to the Existing Warkworth Urban Area

The Plan Change is adjacent to the existing Warkworth urban area in the vicinity of Mason Heights and there is a separation distance of just over 400m between the northern edge of the WW South

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Plan Change area and the urban zoning just south of McKinney Drive (with this area being zoned Future Urban).

As outlined in the supporting Planning Report, the key infrastructure for the urban development of Warkworth South (ie the water reservoir, wastewater pump stations) along with the local centre and the public transportation hub for Warkworth South are all within the Waimanawa precinct. This area therefore needs to be developed prior to the area to the immediate north unless Council was to purchase the required land and install this infrastructure itself to then allow for urban development to proceed southwards from McKinney Drive. Given the significant financial constraints faced by Auckland Council, such an option is not feasible. Policy 8 of the NPS-Urban Development specifically provides for situations such as this.

A shared pedestrian path/cycleway is proposed between the Warkworth South Plan Change area and McKinney Drive to ensure there is a practical and usable connection between the two areas.

Funding of Infrastructure

As previously outlined, the required infrastructure is to be funded by the applicants and negotiations on this funding are continuing with the relevant Council Officers. Significant investment in infrastructure in Warkworth has and is continuing to be made by Auckland Council and its CCO's (including the upgrading of the water supply and the wastewater network), NZTA (the new Puhoi to Warkworth Motorway) and a range of network utility operators and private companies. It is important that Warkworth can continue to expand as proposed to ensure that this new infrastructure is appropriately used and a return is received on it in a timely manner.

This matter is addressed further in the response to the questions from the DPO.

Questions from the DPO

On the 22/06/2023 you sent us an email with some questions which the DPO had raised with you. Our response to these questions (given in italics below) are:

Watercare – mention is made of a water reservoir but this doesn't appear to be recognised in the proposed precinct plan?

This is incorrect. Precinct Plan 2 identifies the proposed water reservoir location. Rule Ixxx.4.3(A4) specifically provides for the provision of a water reservoir as a controlled activity.

AT – unclear when/how the WWLR would transition from collector to arterial. Also a lack of detail on the plans for a public transport interchange.

It is our understanding that the transition will occur in approximately 12 months. This transition of control of the current SH1 from NZTA to AT does not have a material effect on the Plan Change and we are working on the basis that by the time development proceeds that the current SH1 would be under the control of AT. The detailed planning of the transport interchange is the responsibility of AT. The Plan Change identifies a location for this public transport interchange.

DPO have been looking at the effectiveness of infrastructure triggers in precinct plans and are working up monitoring of the triggers in Drury precinct plan triggers as part of wider work on monitoring the development of Drury. The infrastructure triggers proposed by the applicant for Warkworth South are very poorly worded and will be ineffective in delivering the necessary infrastructure to support an increasingly urbanised environment.

We look forward to receiving from Council the suggested revised wording for these rules and this is a matter we assume will be addressed in your report. It is unfortunate that the DPO has not identified their specific concerns with the current wording.

We (DPO) have met Phillip Nicholson (Classic Developments) a few times as he is very keen to get some form of infrastructure funding agreement in place prior to the plan change. We have communicated to him that Warkworth South is not a priority area for the council. We also advised that we thought it was unlikely funding agreements would be in place prior to the plan change. We *have met with them and know they are progressing work with Crown Infrastructure Providers to scope out an arrangement and what kind of levy could be charged.*

The proposed plan change and the implementation programme resolves and funds all infrastructure for the plan change area, and futureproofs infrastructure for the wider Warkworth South area. The applicants have been very clear to Council from the start that it is their intent to fund the infrastructure required for Warkworth South and it is unclear why certain Council officers either don't understand this or are pushing back on this private funding initiative.

In particular, the proposal will fund:

(i) all local infrastructure within Warkworth South will be funded by the project in the normal manner.

(ii) the upgrading of the existing SH1 through the plan change area to urban road standards;

(iii) building a dedicated shared path walkway and cycleway from the plan change area to McKinney Road;

(iv) funding the construction of the roundabout at WWLR;

(v) funding a two lane strategic arterial road on the WWLR through the K A Waimanawa land;

(vi) funding the potable water supply line from Warkworth-to-Warkworth South;

(vii) vesting the land for the necessary water reservoir to service Warkworth South. Securing this land will futureproof either an extension or a duplicate reservoir for the rest of Warkworth South;

(viii) vesting the land necessary for the wastewater pump station necessary to service the plan change area;

(ix) construction of the pump station(s) to service the plan change area;

(x) construction of a rising main from the pump station to the top of McKinney Road, with the opportunity to place a second pipe in the trench to service other parts of Warkworth South if developed in the future;

(xi) construction of a gravity line, futureproofed for all of Warkworth South, from McKinney Road to the prime Warkworth pump station;

(xii) setting aside land for the transport hub identified in the Strategic Growth Alliance programme and in the Structure Plan; and

(xiii) setting aside land for future open spaces.

As you would be aware, there has been and there is on-going substantial investment in core sub regional infrastructure, which is either complete or well underway and this includes:

- rising main from Warkworth to the Mahurangi Treatment Plant;
- upgrade of the Snells Beach treatment plant;
- ocean outfall from the Snells Beach treatment plant;
- upgrade of the Warkworth water supply;
- completion of the Puhoi to Warkworth Expressway; and
- completion of the Matakana Link Road.

I am also a little concerned that the applicant's understanding of the infrastructure needed is underdeveloped. The Infrastructure Report isn't significantly different to what was presented during the soft lodgement and doesn't include updated estimate on costs which I understood Maven were to meet with WaterCare to understand how WaterCare cost out their projects for the purposes of estimating what the cost of providing that infrastructure would be.

The engineering reports provided to support a plan change does not include costings. These are provided separately to the DPO and the relevant CCO's through the discussions on infrastructure funding. We note that Maven have since provided updated costings to Watercare for review/approval.

The Next Stages

Upon receipt of this response, can Council please confirm when we can expect their recommendation to go to the Planning, Environment and Parks Committee. If the Councillors consider that a site visit would assist their understanding of the Proposed Plan Change then please let us know and we arrange this in coordination with yourself.

Sincerely,

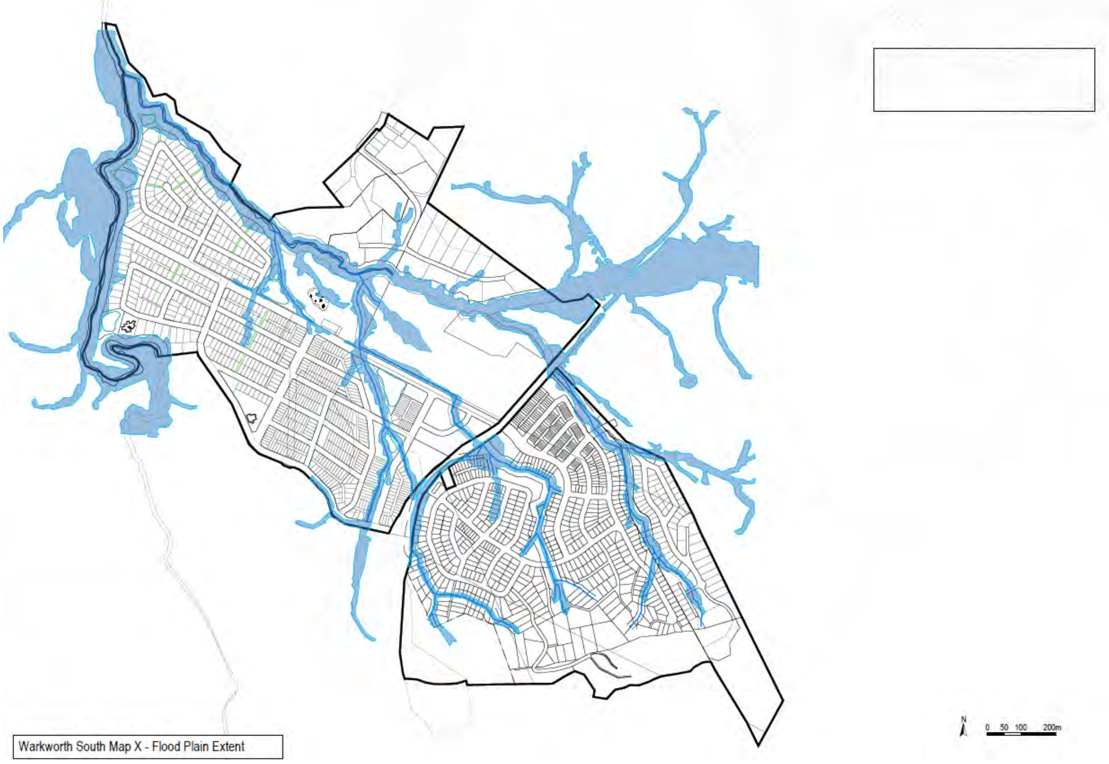
David Hay

David Hay
Planning Consultant
Ph: *09 425-9844*
Mobile: *027 425-0234*

Copy to:

Attachments:

Current Flood Model Plan



Response to Questions

Question No.	Question	Response By	Response
1. Landscape			
1.1	*The response to 3.9a – 39c of the original request notes a likely GFA of up to 5,000msq for areas A & B. Is a maximum GFA for the site (areas A & B combined) proposed? The response to point (b) notes that the shelter belt will continue to be required along the southern boundary.* *The Morrison Orchard: Precinct Plan does not identify this planting as having to be retained. Similarly, the locations and width of planting along the streams is not identified on the plan, so the planting could be removed if not protected.* *Please clarify how the retention of the existing shelterbelt or similar would be achieved in the long term (e.g., shown on the precinct maps and through standards?)*	SH	No maximum GFA is proposed within areas A and B combined. It is considered that the standard Mixed Rural Zone and other AUP standards are generally appropriate, other than where the proposed precinct provisions prevail. It is noted that buildings and additions over 250m² GFA are now proposed as a restricted discretionary activity, which is considered appropriate to assess and control any potential adverse effects arising from GFA. The assessment criteria applying relate to the following matters: • Noise • Design and location of buildings • Traffic effects • Stormwater management • Building height effects • Animal housing effects While the shelter belt is likely to be retained/replaced/maintained on an ongoing basis given the orchard activity requiring a shoulder belt is projected to continue, that requirement in itself is considered highly likely to ensure that any positive effects provided by the shelter belt are maintained. On the other hand, were the shelterbelt to be removed for any farm operational or plant health reasons, the rural landscape values offered by the property to urban development to the south-west would largely be retained by the ongoing orchard operation or any similar rural activities. Were the Council of the view that there were more than minor adverse effects likely to arise with the removal of the shelter belt, options that could be considered include:

			o the Precinct Plan being amended to identify the location of the shelter belt and a standard requiring its retention. o A new restricted discretionary activity included in Table XXX.X.1 under "Development" for: "Removal of all or part of the shelterbelt identified as X on the Precinct Plan map". o A new Matter of Discretion and Assessment criterion for consideration of the shelter belt alteration or permanent removal, including the option for replacement were all or part of the existing shelter belt required for orchard operation, plant health or maintenance purposes. (Potentially a permitted activity for removal and re-establishment for the latter reasons could also be considered to prevent the need for unnecessary resource consent applications).
1.2	*Section 3.11 of the original request was in relation to the plan below (which was included within the lodged documentation). The area in the middle with the highlighter green mark was left white and I was unsure of what this was indicating (e.g., an area excluded from the proposed areas A, B and C?). However, it appears that this map has been removed. Please confirm if this map is no longer proposed, or if it is confirm what the white area is.*	SH	This plan is no longer part of the Plan Change. Plan Ixxx.9.1 Morrison Orchard Precinct Plan in the Plan Change is the precinct plan to be referred to and covers this area shown in white in the now superseded plan.

			
2. Traffic and Transport			
2.1	*In respect of your 4.1 the extract from the SGA drawing shown in the response is for a 3-legged roundabout. The Plan Change proposes a 4-legged intersection. The addition of the fourth leg could impact on the performance of the intersection.* *An assessment of the performance of the intersection in 2046 as a four legged intersection should be provided to demonstrate the acceptable performance of the intersection.*	TPC	As stated in Section 3.3 of the ITA report, the SGA have undertaken assessment of the road network required to accommodate the traffic generated by the full development of Warkworth in 2046, and this work has not been repeated in the ITA report. SGA have verbally advised the applicant that a single lane roundabout would accommodate WWLR/SH1 traffic following the full development of FUZ land and a completed arterial road network. As shown below, SGA has recently shared their idea for a layout of the Western Link Road/SH1 intersection proposal to support their Notice of Requirement and which shows a single lane roundabout (although this is slightly to the south of the preferred option provided for in the proposed plan change).

			
2.2	*In respect of 4.3(a) and (b) please refer to item 4.7(b)*		Refer to 2.4 below.
2.3	*In respect of your 4.5 please provide details as to how the precinct responds to the SGA proposals for WWLR and the upgrades to SH1.*	DH/JD	The SGA's NoR application has been lodged for the State Highway 1 upgrades including the intersection with the WWLR. A submission is being made to the NOR to expand it to the north to allow for the WWLR/SH1 intersection to be slightly further to the north to more efficiently use the land resource and to avoid a wetland to the south on the eastern side of SH1. If SGA or AT has an issue with the precise SH1/WWLR location then that is a matter dealt with at the NOR hearing rather than being a requisite to the notification of this Plan Change. The precinct plan makes provision for the WWLR. The designation will be included in the general Auckland Unitary Plan maps and does not need to be repeated in the precinct provisions. The rules require protection of the WWLR corridor and set the timing for the implementation of the WWLR.
2.4	*In respect of your 4.7(b) it is not clear as to the relevance of the Valerie Close upgrade to the provision of a pedestrian/cycle connection between the ped/cycle access from the Waimanawa Hills area to SH1 and the eastern area of the plan change. The response does not sufficiently address the original request.*	TPC	If there is no development on Valerie Close, and no connection from Valerie Close to the Waimanawa Valley precinct, there would be no other connection to the west side of SH1 south of the SH1/WWLR intersection apart from Valerie Close, no attractors for pedestrians on the western side of SH1 south of the SH1/WWLR intersection, and thus no desire line for

			pedestrians from Waimanawa Hills to cross SH1 south of the SH1/WWLR intersection. Subdivision with frontage along Valerie Close or any road connection to Valerie Close might generate or attract pedestrians between the western side of SH1 and the pedestrian and cycle access from Waimanawa Hills connecting to SH1, and thus may create a pedestrian desire line to cross SH1 south of the SH1/WWLR intersection, however the precinct provisions require that "In the event of any subdivision with frontage along Valerie Close occurring or a new road connection to Valerie Close, an assessment is to be undertaken to confirm if any upgrading of the Intersection is required as part of that subdivision". Thus the appropriate time to assess if a pedestrian desire line has been created to cross SH1 south of the SH1/WWLR intersection, and to assess if crossing facilities are thus required, would be at the resource consent stage when there is any subdivision with frontage along Valerie Close or any new road connection to Valerie Close, as part of the assessment that would be undertaken to confirm if any upgrading of the SH1/Valerie Close intersection is required. The applicant does not envisage a pedestrian crossing across SH1 in this location but considers it is a matter that can be assessed in the future assessment at resource consent stage and this is not a matter that needs to be finalised prior to the notification of this Plan Change.
2.5	*In respect of your 4.10 it is noted that Standard Ixxx6.1(2) has been amended. However, please provide an explanation as to why camp grounds have been excluded from this standard.*	SH	This is an error and Ixxx6.1(2) has been amended so that it now includes campgrounds (A3).
3. Ecology			
3.1	*The following comments have been provided in respect of your numbered responses.*	-	N/A

3.2	*In respect of 7.2 The existing records of bats have not been carried out to a level necessary to understand bat activity in the area, being limited to snap shots in limited times frames. For a comprehensive understanding of bat activity multiple surveys throughout the year are necessary (not including winter dormancy). Please explain how The applicant is able to conclusively reach an opinion on activity being limited or" low level".* *The construction of the new SH1 Is not a limitation on bat movement. The proposal is to significantly increase urbanisation of the land, and the applicant has not demonstrated, even with the limited inclusion of lighting standards, that bats have been duly afforded protection from urbanisation, including noise effects.* *The bat flight corridor is therefore incomplete, especially for the southeast of the plan change area (opposite side of current SH1), where no formal bat surveys have occurred.*	Bioresearches	Existing, repeated surveys to date indicate that any such activity beyond the Mahurangi River corridor would be low level (as identified from existing survey information) if at all, and because previous survey effort and bat database records indicate that the source of the identified activity is highly likely to be associated with the large area of forest (indigenous and exotic) to the south-west, which has more recently become bisected from Warkworth by the construction of SH1 (Puhoi to Warkworth) motorway. With respect to how "the applicant is able to conclusively reach an opinion on activity being limited or" low level"- our assessment has not conclusively reached this opinion, and acknowledges that 'further survey spread has potential to provide more insight into bat activity'. However, the survey was undertaken in accordance with the Department of Conservation's bat inventory and monitoring module, (counting away from roosts- automatic bat detectors, Sedgeley 2012), noting that our study over November to January provided a much greater period of survey time than the minimum two weeks recommended in the DOC bat inventory and monitoring toolbox (Sedgeley 2012). We stated that the survey results 'indicated that 'any such activity beyond the Mahurangi River corridor would be low level (as identified from existing survey information (previous S92 response), based on the time spent within the study area (322 survey nights across the study, and 177 valid survey nights from three locations at the Waimanawa Valley site, west of SH1, in November 2021 to January 2022 inclusive), and targeting locations that would support the most likely flight paths into the study areas from known bat habitat. We have additionally reanalysed all data recorded from the survey period and confirmed that only two passes (15 less than the 17 originally reported) were recorded, both detected on one

			night (07 December 2021) at around 12.30 am. No other passes were recorded at this location (Mahurangi River, DW corner of Waimanawa Valley), or on any of the other recorders set over the survey period. The location of detected activity is consistent with expectations that bat activity would originate from sources to the SW of the site (being that nearest records (and area of known bat habitat) is to the south-west, and therefore the southern and western areas of the site were targeted for survey for this study. Further into Waimanawa Valley, two other recorders did not record any activity, where they were associated with forest fragment edges, comprising large trees and adjacent watercourses.
3.3	*In respect of 7.3 the applicant has only addressed lighting effects and not noise effects that are known to adversely effect bat behaviours. Please update*	Bioresearches	The effects of noise on bats is considered to be low. The following noise assessment is based on current knowledge of bat activity within the study sites, being at Waimanawa Valley- SW corner, Mahurangi River corridor. This location supports foraging, commuting and potential roosting habitat, and a 20 m setback / clearway buffer is proposed between the existing riparian edge and the proposed residential mixed housing suburban zone, where potential changes to baseline noise levels as a result of the proposed residential- suburban zone may cause disturbance to bats. The relationship between noise and longtailed bat activity remains unclear. Recent research in southern Hamilton found no clear relationship between long-tailed bat activity and noise (e.g., aircraft noise) (Wildlands Consultants, 2018), and current known bat roosts are present alongside major traffic routes in Hamilton-South. Despite this, other recent research has found that bats avoided motorway traffic sound, when played throughout consecutive nights (Hart, A. National Bat Hui, 2023) within bat habitat. While residential noise is likely to be substantially less intense, of a less frequent duration and

			frequency, particularly throughout the night, the operational effects of the Puhoi to Warkworth motorway, which is nearing construction completion and runs to the immediate south west of the study site, may further reduce existing indicatively low-level bat activity into the site in the long term. It remains difficult to determine whether noise alone is a significant deterrent to bat behaviour, the overall disturbance effects of urbanisation is often linked to increased lighting along road networks (night time, when bats are active), light spill and noise disturbance from residential houses (generally considered to be greater during the day, when bats are roosting). Noise levels are considered to be lowest during the evening and overnight in the proposed residential zone, and the potential effects of noise are expected to be minimised through provision of a 20 m dark space corridor alongside the existing Mahurangi River riparian edge. The overall level of effect of noise on bat activity is considered to be 'low'.
3.4	*In respect of 7.4 the response is considered inadequate. Repeated surveys and the existence of a covenant protecting a natural area (see 7.14), is not overridden by the presence of a 'dam'. The applicant has not provided any evidence of resource consent for the construction of a dam (dams have specific meaning), or earthworks that has 'created an artificial wetland'. The wetland would be considered a natural inland wetland under the NPS-FM & NES-FM as it has not been demonstrated the wetland was constructed for a specific purpose.* *Assessment under the AUP for Significant Ecological Areas would easily determine SEA factors have been met. Not only is the wetland natural, as previously determined by consent but meets SEA Factors and should be annotated as such.*	Bioresearches	As discussed under 3.3.4.7 of the Ecological Report, a small man-made pond was created by deliberately damming the flow of the intermittent flow paths to the area. This was done to create an amenity area. These works were carried out as a permitted activity under the ALWP (or possibly earlier), well prior to Nov 2016 when works in intermittent streams were no longer a permitted activity. The main point of discussion is whether the area was deliberately constructed or not. As discussed, the habitat was obviously created (as shown on the historical aerials and consultation from the previous landowner) and is part of a deliberately constructed waterbody and therefore does not meet the definition of a natural inland wetland (as per the NPS-FM as at February 2023). The exclusions are: (*b) a deliberately constructed wetland…. or*

			(c) a wetland that has developed around a deliberately constructed water body, since the construction of the water body. These exclusions would both apply to this area.
3.5	*In respect of 7.8 In order to understand how development protected, maintains and enhances biodiversity values formal fauna assessments are necessary. This goes to the very essence of the RMA and demonstrates the hierarchy of avoid, remedy, or mitigating adverse effects. Including where specific standards are required in the Precinct, noting the inclusion of bat standards for flight corridors (notwithstanding their current inadequacy).*	Bioresearches	As per our previous response, the areas with highest potential for lizard habitat throughout the site have been identified, avoided, protected (where they are currently not protected) and enhanced (e.g. SEA & Mahurangi River corridor, kanuka forest, mixed native exotic fragment; Waimanawa Hills- Rock face, indigenous tree land). Beyond these areas, any potential lizard occurrence has not been ruled out but are not considered to represent important habitat for native lizards. This is because these areas are generally maintained as pasture or exotic hedges. This approach ensures that key terrestrial biodiversity values, as represented by existing areas of least modified indigenous vegetation cover, are avoided, protected and enhanced. Additionally, riparian restoration would enhance / improve and connect potential lizard habitat values where they are currently negligible (e.g. currently grazed pasture edges).
3.6	*In respect of 7.9 ,because DOC have endorsed Auckland Regional threat categories, it would be worthwhile acknowledging the regional distinction, even if threat status may be unchanged.*	Bioresearches	Regional threat status acknowledged (note Pacific gecko, *Dactylocnemis pacificus*, is Nationally 'Not Threatened', however our assessment uses the Regional status of 'At Risk- declining').
3.7	*in respect of 7.10 it is considered that the response is inadequate because Appendix 1, section 1.4.2 is clear in that the applicant must identify natural resources and demonstrate how they will be protected, maintained and/or enhanced through development, including "opportunities for environmental restoration and biodiversity".*	DH/JD	Appendix 1 (and section 1.4.2 in particular) of the AUPOP relates to Structure Plan guidelines. The Warkworth Structure Plan was prepared by Council and is not being revisited as part of this Plan Change process. If Council Officers have a concern that the Warkworth Structure Plan was not prepared in accordance with Appendix 1 then this

			should have been raised internally at the time of the Structure Plan preparation rather than at this Plan Change stage.
3.8	*In respect of 7.14 it is considered that the response is inadequate because Council GeoMaps shows this wetland as subject to LINZ covenant. Further investigation is required as to the discrepancy with the CT title doc and the one that does show that the covenant was registered and issued at s224(c) 2011.*	DH/JD	Please refer to the attached response from Simpson Grierson.
4. Urban Design			
4.1	*Please provide an analysis and response to creation of a functional structure and urban area that addresses the relationships between the plan change area and land to the north and south noting that these connections appear to be lacking.*	Reset	The proposed plan change will essentially contribute to a functional urban area and promote integration with the surrounding area whilst providing protection to the existing special natural\rural characteristics. The key reasons are: · The proposal is well located within an area that has been identified as an important node for future urban growth in Warkworth by the Warkworth Structure Plan 2019. The urban structure and spatial arrangement of subdivisions, roading and open space networks have been comprehensively considered and laid out to create a functional urban area with high connectivity both within the site and to the wider area. Connection with the existing urban area of Warkworth · Fundamentally, the existing SH1 and further upgrade alongside part of this road corridor ensures that the proposal is well connected with the existing urban area of Warkworth including the town centre. Connection to the north · In terms of the plan change site to the west of SH1, there are multiple natural features and rural characters to be protected, including a primary tributary of the Mahurangi River, the northern escarpment north of the tributary and the special rural character of Morrisons orchard. These elements form physical barriers and land

			use constraints across that part of the land. The proposal provides a good level of protection to all of these special characters via the avoidance of unexpected and inappropriate urban developments (this reflects on the provision of only low intensity residential developments), maintaining the landform character and its landscape across the northern escarpment, and retaining the Morrisons orchard as a key rural feature. However, roading and pedestrian connections together with compatible activities are provided throughout the northeastern part of Waimanawa Valley which ensures the proposal is well integrated with the immediate urban neighbourhood around Mason Heights. · In terms of the plan change site to the east of SH1, the proposal provides a subdivision pattern with density transitioning down towards the northeastern boundary beyond which the immediate neighbours are predominant pastoral farms/ rural lifestyle blocks. A collector road connection linking to the further urban area north of the site is provided. The proposal will not exclude the possibilities for any future pedestrian/cycling connections to be further provided through to the northern neighbours as a large portion of the northern boundary contains public interfaces which are either esplanade reserves or bush reserves. Connection to the south · In terms of the plan change site to the west of SH1, the existing Valerie Close will continue to provide access to the properties immediately south of Waimanawa Valley. A series of north-south connections (for vehicles, pedestrians and cyclists) between Valerie Close and the proposed WWLR will be provided within the plan change area. These are envisaged to provide easy access for further developments south of Valerie Close to be connected with the new neighbourhood centre, the proposed recreational park and other amenities within the Waimanawa development.

			· In terms of the plan change site to the east of SH1, the proposal adjoins the Avice Miller Scenic Reserve almost to the full extent of the south boundary. The southernmost part of the site together with the wider area further to the south is currently rural zoned. The proposal essentially provides protection to the outstanding natural landscape and rural character across and beyond the Avice Miller Scenic Reserve by enhancing existing vegetation and avoiding inappropriate high intensity urban development. A pedestrian and cycle link is proposed from the southeastern end of the plan change area through to the adjacent Avice Miller Scenic Reserve. ·
4.2	*Please provide a commentary on the relative importance of principles and the management of tensions between delivering an overall functional and well-designed area that fits into the wider functional and well-designed urban area. This may include changes to the policies and objectives that focus on connections to adjoining land to the north and south.*	Reset	The indicative masterplan demonstrates a well-designed and functional urban area with a high level of connectivity and amenity throughout the plan change site and to the wider area. The proposal provides an appropriate transition and design approach to the immediate and surrounding neighbourhood regarding land use, urban form, transport connection and landscape. The proposal reflects the urban structure sought out in the Warkworth Structure Plan. The Plan Change provisions provide an appropriate framework that enables a functional urban area within the plan change site whilst addressing the integration with the immediate neighbourhood and the wider Warkworth urban area.
4.3	*Please provide a rationale for sites backing onto the reserve network to the extent shown.*	Reset	Waimanawa Valley · A bat flight corridor is proposed at the western boundary of Waimanawa Valley along the Mahurangi River. Larger residential lots with substantial yard setbacks are provided at this location to minimise potential disturbance associated with the urban subdivision. This approach is applied further along the tributary of the

			Mahurangi River along the northwestern boundary where the Kanuka forest dominates the riparian bank that may also be used by bats. The provision of residential lots backing onto this riparian corridor rather than urban standard roads would largely reduce the adverse impacts resulting from the associated urban developments. · There are a number of lots proposed adjacent to a section of a minor tributary on the southeastern corner of the Waimanawa Valley site. A north-south collector road is located immediately adjacent to this stream edge which provides a public interface with walking and cycling paths. It is considered that the approach proposed achieves an appropriate and practical outcome that balances public benefits and land use efficiency. Waimanawa Hills · The highly incised stream valleys intermixed with various escarpment faces/rolling hills often raise practical issues between construction feasibility and public/environmental benefits. A combination of public road edges, open spaces and lots adjoining riparian yards is proposed throughout the Waimanawa Hills site which provides fundamental protection to the stream corridors with a minimal impact on efficient subdivision layout and public amenity.
4.4	*There is a lack of information about the development of the local centre and the potential for subdivision and development to be conducted in a piecemeal manner.* *Please provide approaches and techniques that can be adopted to provide a clear framework for public and private investment at the time of subdivision.*	DH/JD	Rule Ixxx.9.3 Local Centre outlines the information requirements for future resource consents for buildings in the local centre. The information being sought by Council in this question delves well into the realm of detailed design which is not required to be covered by the proposed Plan Change provisions.

	These techniques would cover the use of a comprehensive framework for an integrated proposal which resolves access, frontage qualities, canopy provision, and servicing, an integrated public realm supporting a sense of place to enable the centre to be part of a livable, walkable, and connected neighbourhood. *A robust relationship needs to be established with the potential future transport hub, along with a framework of amenity spaces and block patterns so that centres become part of a livable walkable and connected neighbourhood.*		It is also considered inappropriate for a Plan Change to provide the framework for future public and private investment for the future town centre.
5. Healthy Waters			
5.1	*The additional information required in relation to matters raised by Healthy Waters is set out in the attached appendix to this letter.*		A separate response is being provided.
6. Planning			
6.1	*It has come to my attention that there may be an issue with the way the Morrison's Orchard precinct is zoned. The request is proposing a Mixed Rural zone with a precinct over the top. I acknowledge that a rural zone would likely be the most simple base zone from which to create the precinct. However, this is putting a rural zone inside the RUB. This is not something that occurs anywhere else in Auckland (as far as I am aware) and goes against the practice of council to date. I am not aware of anything official that says you can't do this, so it is perhaps an 'unwritten rule'. I understand that this was an issue during the PAUP and Council had to change the zoning of Rural Production areas in Kumeu near the centre (left in that zone due to flooding) to the Future Urban zone.*	SH/DH/JD	Our assessment of the objectives and policies for the Rural Urban Boundary (RUB) is that they do not necessarily exclude the proposed Mixed Rural Zone. Relevant parts supporting or at least not excluding this conclusion are highlighted in blue below for emphasis. We further note that the Future Urban Zone (FUZ) is <u>also a rural zone</u>, and although specifically identified to signal its <u>likely</u> suitability for urban purposes, there will clearly be properties that have different suitability for urbanisation and where not suitable for urbanisation, will be generally retained as open space or even in rural use if the location, extent and suitability of the land remains appropriate. The alternative of applying a FUZ, or even an active urban zone, to the subject property (other than for that part proposed as Residential - Large Lot Zone) does not provide the necessary signal about the long-term future for this land desired by the landowner. It may also introduce a level of uncertainty in

			planning terms that may compromise the specific orchard/open space of activities provided for – including in such areas as obtaining sufficient investment support if that is required in the future. It is possible to retain the land as FUZ, or to even apply a standard residential zone, and to apply a precinct over that land as is currently proposed. However, that approach introduces a higher level of complexity as the precinct provisions would need to assess and exclude a wide range of residential and other urban uses that could be incompatible with the present activity provisions, as well as to have a wider set of activity provisions to include not only the specific precinct activities but also those compatible activities currently provided for in the Mixed Rural Zone. In this respect, the proposed approach is considered to be the most efficient and effective method of providing for the range of activities, orchard protection, and open space/landscape protection sought by the landowner. Relevant sections of the AUPOP: *B2.2. Urban growth and form B2.2.1. Objectives* *(4) Urbanisation is contained within the Rural Urban Boundary, towns, and rural and coastal towns and villages.* *(5) The development of land within the Rural Urban Boundary, towns, and rural and coastal towns and villages is integrated with the provision of appropriate infrastructure.* *B2.2.2. Policies* *Development capacity and supply of land for urban development* *(1) Include sufficient land within the Rural Urban Boundary that is appropriately zoned to accommodate*

			at any one time a minimum of seven years' projected growth in terms of residential, commercial and industrial demand and corresponding requirements for social facilities, after allowing for any constraints on subdivision, use and development of land. *(2) Ensure the location or any relocation of the Rural Urban Boundary identifies land suitable for urbanisation in locations that:* *(a) promote the achievement of a quality compact urban form* *[new text to be inserted]* *(b) enable the efficient supply of land for residential, commercial and industrial activities and social facilities;* *(c) integrate land use and transport supporting a range of transport modes;* *(d) support the efficient provision of infrastructure;* *(e) provide choices that meet the needs of people and communities for a range of housing types and working environments; and* *(f) follow the structure plan guidelines as set out in Appendix 1;* *while:* *(g) protecting natural and physical resources that have been scheduled in the Unitary Plan in relation to natural heritage, Mana Whenua, natural resources, coastal environment, historic heritage and special character;* *(h) protecting the Waitākere Ranges Heritage Area and its heritage features;* *(i) ensuring that significant adverse effects from urban development on receiving waters in relation to natural resource and Mana Whenua values are avoided, remedied or mitigated;*

			(j) avoiding elite soils and avoiding where practicable prime soils which are significant for their ability to sustain food production; *(k) avoiding mineral resources that are commercially viable;* *(l) avoiding areas with significant natural hazard risks and where practicable avoiding areas prone to natural hazards including coastal hazards and flooding; and* *(m) aligning the Rural Urban Boundary with:* *(i) strong natural boundaries such as the coastal edge, rivers, natural catchments or watersheds, and prominent ridgelines; or* *(ii) where strong natural boundaries are not present, then other natural elements such as streams, wetlands, identified outstanding natural landscapes or features or significant ecological areas, or human elements such as property boundaries, open space, road or rail boundaries, electricity transmission corridors or airport flight paths.* *(7) Enable rezoning of land within the Rural Urban Boundary or other land zoned future urban to accommodate urban growth in ways that do all of the following:* *(a) support a quality compact urban form;* *(b) provide for a range of housing types and employment choices for the area;* *(c) integrate with the provision of infrastructure; and* *[new text to be inserted]* *(d) follow the structure plan guidelines as set out in Appendix 1.* *(8) Enable the use of land zoned future urban within the Rural Urban Boundary or other land zoned future urban for rural activities until urban zonings are applied, provided that the subdivision, use and development*

			does not hinder or prevent the future urban use of the land. *G1. Rural Urban Boundary* *G Rural Urban Boundary (RUB)* *The Rural Urban Boundary identifies land potentially suitable for urban development.* *The location of the Rural Urban Boundary is a district plan land use rule pursuant to section 9(3) of the Resource Management Act 1991, other than for Waiheke Island where it is an interim regional policy statement method until it is considered as part of a plan change to incorporate the Auckland Council District Plan – Operative Hauraki Gulf Islands Section into the Unitary Plan.* *The planning maps show the Rural Urban Boundary line.* *The only method for relocating the Rural Urban Boundary is by way of a plan change pursuant to Schedule 1 of the Resource Management Act 1991.* Any relocation of the Rural Urban Boundary must give effect to the objectives and policies of the regional policy statement which establish it.
6.2	*Please comment on this and provide an alternative solution if required.*		No further response required.

Auckland Transport RFI Response Table – Warkworth South Private Plan Change Request

Request No.	Request for information	Accountable Person	Response
AT – Stormwater Comments			

AT-1	*AT's stormwater consultant has provided the following comments:* *'We have reviewed the application documents and have the following comment:* • *Section 3.1.2 of the Draft SMP (NDC requirements) states that stormwater flows and volume will be attenuated on site such that there is no increase in peak flow in a 10% AEP event, however section 7.1.1 of the Draft SMP (principles of stormwater management) states that for flood mitigation a "'pass forward' approach with no hydrology mitigation proposed beyond SMAF 1" is proposed. Can the applicant please clarify what the effects of not attenuating the 10% AEP rainfall event are on existing stormwater networks and AT's road network?'*		Separate response being provided on stormwater matters.
AT – Transport Modelling			
AT-2	*Quick checks reveal they have added trip generated traffic through the proposed WWLR/ SH1 intersection however I have been unable to check how they got the SH1 flows (SATURN output would have been useful to append to the application). Instead I have to rely on their spreadsheets.*	TPC	These spreadsheets can be provided to AT if required.
AT-3	*Single lane roundabout works well in both peak hours. Ultimately however, while AT may be comfortable with a roundabout, the road is still controlled by Waka Kotahi and will require their approval.*		Noted.
AT-4	*The proposed designation around this intersection (Warkworth NoR3 https://www.aucklandcouncil.govt.nz/UnitaryPlanDocuments/08_wnor3-general-arrangement-plan-nor3-sh1-south-upgrade.pdf) will need to be in place to preserve long-term intersection options at this location i.e. no buildings or structures within the proposed NoR.*	TPC	Noted. The applicant will support the designation in this location as long as it is located slightly further to the north as outlined to Supporting Growth through the feedback phase.
AT-5	*We note there is a 100vph limit for activities on Morrisons Orchard site. As this has informed modelling, this condition must remain. Intersection can work appropriately.*		Noted.
AT-6	*Valerie Close intersection – not sure how much AT can comment on this as under Waka Kotahi control. Long terms seems reasonable to limit as many movements here as possible. Also unsure why they can't just have priority intersection with reduced urban speed limit i.e. threshold further south.*	TPC	It may well be that there can be a speed reduction threshold further south and just be a priority intersection at Valerie Close. This possibility can be investigated when there is any proposal

			that would increase activity on Valerie Close, as per the proposed precinct provisions.
AT – Public Transport			
AT-7	*Section 7.2 of ITA. Just check - Bus route 995 currently passes the site, but is unlikely to continue along SH1 in the future. My understanding is that they are likely to go on Ara Tuhono. As such, development is isolated from PT.* Any additional bus routes are funding dependant so no guarantee they will occur (no matter what Structure Plan says).	TPC	The structure plan and AT through the consultation to date, has requested the Plan Change specifically provide for a public transport hub. The Plan Change does this. While the applicant is aware that the bus route will likely go to Ara Tuhono, what was described to the applicant was that the bus would start and terminate at WW South and go through WW Central then the WW North PT Hub before entering Ara Tuhono. Regardless, it is accepted that it will be for AT to determine the final public transport routes and preferences.
AT – Walking and Cycling			
AT-8	*Section 5.0. New cycle facility and footpath along east side of SH1 to McKinney Road and new path along west side of road to Morrisons Orchard. There are space constraints on western side of road so difficult to extend path any further north on this side. As the proposed infrastructure doesn't connect to anything to the north, I'm not sure what the benefit of this infrastructure is. At the very least, I think they should have footpath on west side to Morrisons Orchard (local pedestrian movements), and a bi-directional cycle facility and pedestrian facility on the east side of the road extending north to northern side of Wech Drive. That would provide some connectivity to existing shops, Mahurangi College etc. Personally, I would be OK with a shared path. The problem with any facility on the east side is that there are a number of constraints that would prevent a safe pedestrian and cycling facility being established (there is some 300m immediately south of McKinney Drive with power poles etc which would mean any facility would be hard against a live traffic lane). I think more work is needed to demonstrate how the required*	TPC/DH/JD	Noted. The indication that AT is open to a shared path is appreciated and this will be confirmed through the future resource consenting processes. However, we reiterate our view that it is the responsibility of the Road Controlling Authority to provide pedestrian and cycle infrastructure within the already developed urban section of SH1.

	connectivity is provided (and unfortunately because space is so tight, they need to provide much greater detail). SH1 is still under Waka Kotahi control – how much say does AT have in this?		
AT-9	*I note that Mike has indicated that he would be comfortable with a shared path on SH1. A shared path wouldn't comply with AT standards, so would need a departure from standards. It may be acceptable as an interim arrangement if it is the only practicable option.*	TPC	Noted. These are matters that would be resolved through any future resource consent processes once the Plan Change is in effect.
AT - WWLR			
AT-10	*I haven't seen updated plans but we had concerns it was originally in the riparian margin. Is that still the case?*	DH/JD	There is currently no riparian margin. Maven have confirmed that the proposed WWLR route is acceptable from an engineering perspective.
AT – Other Matters			
AT-11	*The upgrade of Mason Heights Road should be described a bit more (is it a footpath upgrade, pavement upgrade etc)*	DH/JD	This is a resource consenting matter.
AT-12	*The construction of the WWLR needs to be triggered not just by frontage development but also any local road/collector road connection to it. The extent of upgrade only needs to be between the development frontage, or local/collector road connection and SH1.*	TPC	This rule can be amended if Council considers it makes a material difference because it would extremely unlikely that a local road or collector road connection would be formed prior to the construction of the WWLR when the WWLR is required for such a road to connect to it.

Key:

DH/JD – David Hay/John Duthie (Planning Consultants for the Applicants)

SH – Shane Hartley (Planning Consultant for Morrison Heritage Orchard)

Reset – Reset Urban Design

Maven – Maven Engineers

TPC - Traffic Planning Consultants.

Bioresearches – Chris Wedding or Treff Barnett

23 June 2023

Partner Reference
W S Loutit - Auckland

Auckland Council

For: David Wren

Writer's Details
Direct Dial: +64-9-977 5021
Email: rachel.abraham@simpsongrierson.com

Privileged and Confidential
Sent by Email

Dear David

Warkworth South Plan Change: Clause 23 Responses

We act for KA – Waimanawa Limited Partnership and Stepping Towards Far Limited, the requestors of the proposed 'Warkworth South Plan Change'. This letter addresses Question 7.14 of the Council's Clause 23 request relating to Council's claim that the proposed Arterial Road shown in the plan change material dissects a covenanted natural wetland. The relevant wetland area is shown in the plan change material as adjoining 'Watercourse 15'.

David Hay's Clause 23 response explains why the wetland area is not covenanted and is not a 'natural wetland' for the purposes of the National Policy Statement on Freshwater Management 2020 (**NPS-FM**). Council has advised that Mr Hay's response "*…is inadequate because Council GeoMaps shows this wetland as subject to LINZ covenant. Further investigation is required as to the discrepancy with the CT title doc and the one that does show that the covenant was registered and issued at s224(c) 2011."*

We have investigated the relevant history and background material. On the basis of these investigations, this letter outlines why:

1. There is no covenant relating to the wetland;
2. There is no live condition of any resource consent relating to the wetland; and
3. In our opinion, there is no ability for Council to have a covenant added to the title.

Reasons

We have reviewed the relevant titles, the applications for subdivision and boundary adjustment consents, and the consent decisions. This history is summarised below:

1. Subdivision consent was obtained from Council in 2010 to create an additional lot at two underlying sites Lot 1 DP408406 and Lot 2 DP411024 (RMA 55271). This subdivision consent contained Condition 4(a) providing for the protection of a wetland on a continuing basis under s221 of the RMA. As a result, it was to be dealt with in the consent notice issued by the Council (rather than a land covenant as is more common).

2. The survey plan for this subdivision was completed in 2010 (LT430487). The plan was approved by Land Information New Zealand and section 223 and 224c certifications were issued by the Council.

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Christchurch: Level 1, 151 Cambridge Terrace, PO Box 874, Christchurch, 8140, New Zealand. **T** +64 3 365 9914
www.simpsongrierson.com

3. However, the new records of title were not issued (it appears they were not applied for). As a result, consent R55271 (including Condition 4(a)) was never given effect to. This consent and s223 have now long expired and are no longer capable of being given effect to.

4. The lots were then adjusted by a boundary adjustment in 2011 (R58028). Although it was described as a boundary adjustment, the consent provided for the creation of additional lots. The survey plan for this adjustment was completed in 2012 (DP451512) and new records of title were issued.

5. While the survey plan for R58028 indicates a protected wetland area, there is no condition of consent R58028 requiring the protection of a wetland and the only consent notice required for the newly created titles related to Stormwater neutrality.

We have considered whether the boundary adjustment consent R58028 effectively 'gave effect to' consent R55271 and Condition 4(a). We do not consider this to be the case, because:

1. The first subdivision never occurred;
2. Consent R58028 did not incorporate the conditions of the first subdivision consent;
3. The subdivision provisions of the Resource Management Act 1991 do not operate in a way that would mean the conditions of a previous consent are automatically incorporated into a subsequent consent;
4. Council simply issued a s223 certificate for a plan that created 4 lots (i.e. an additional lot), despite being described as a boundary adjustment consent; and
5. It was clear that the consent notice with the wetland protection had not been registered, and Council failed to require a condition to ensure it was.

We also note that the official record of land rights in New Zealand is the LINZ registration system. Discrepancies with GIS systems do occur from time as GIS systems are updated from a range of sources and can be edited by the owner of the system manually. We do not know why the Auckland GIS shows the existence of a wetland covenant in this instance, particularly as the relevant protection to be used under the original consent was a consent notice rather than a covenant, but the notation on the GIS system does not override the LINZ register.

In summary, the wetland is not legally protected by covenant or any other mechanism.

Mr Hay's Clause 23 response also explains why, with reference to historical photographs, the wetland area is a constructed wetland and not a natural wetland. We do not repeat this reasoning and understand that a further question has not been raised on this point.

Please contact us if you have any further questions.

Kind regards

Bill Loutit / Rachel Abraham
Partner / Senior Associate

ATTACHMENT 26

TITLE FOR LOT 1 DP 568727

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier **1029181**
Land Registration District **North Auckland**
Date Issued 07 April 2022

Prior References
NA67B/483

Estate Fee Simple
Area 46.4767 hectares more or less
Legal Description Lot 1 Deposited Plan 568727
Registered Owners
Thriving Development Limited

Interests

Subject to Section 36 (4) Counties Amendment Act 1961

Subject to Section 59 Land Act 1948(affects part)

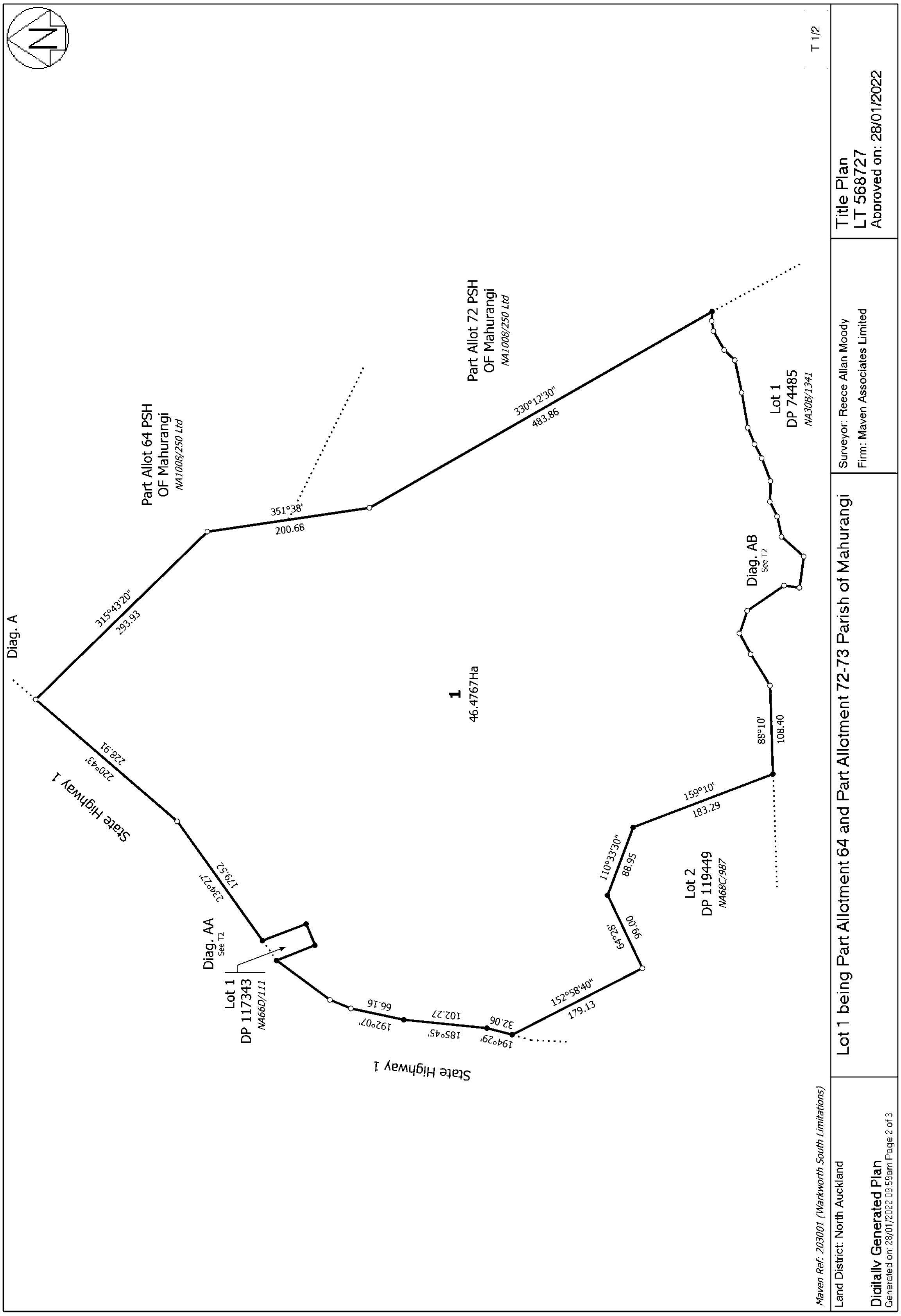
Subject to Section 8 Coal Mines Amendment Act 1950(affects part)

Appurtenant hereto is a right of way created by Conveyance 233624 (affects part Allotment 64 Parish of Mahurangi) - 17.8.1929 at 11:10 am

Appurtenant hereto is a right of way created by Transfer 191332.4 - 18.9.1975 at 2:11 pm

The easements created by Transfer 191332.4 are subject to Section 37 (1) (a) Counties Amendment Act 1961

464508.1 Gazette Notice (N.Z. Gazette No. 112 3.11.1877 2868) declaring the adjoining State Highway No:1 to be a limited access road - 28.11.1988 at 1.47 pm



Title Plan
LT 568727
Approved on: 28/01/2022
T 1/2
Surveyor: Reece Allan Moody
Firm: Maven Associates Limited
Lot 1 being Part Allotment 64 and Part Allotment 72-73 Parish of Mahurangi
Land District: North Auckland
Digitally Generated Plan
Generated on 28/01/2022 09:59am Page 2 of 3
Maven Ref: 203001 (Warkworth South Limitations)
Part Allot 72 PSH
OF Mahurangi
NA1008/250 Ltd
Part Allot 64 PSH
OF Mahurangi
NA1008/250 Ltd
Lot 1
DP 74485
NA30B/1341
Lot 2
DP 119449
NA68C/987
Lot 1
DP 117343
NA66D/111
Diag. A
Diag. AA
See T2
Diag. AB
See T2
1
46.4767Ha
State Highway 1
State Highway 1
330°12'30"
483.86
351°38'
200.68
315°43'20"
293.93
220°43'
228.91
234°27'
179.52
192°07'
66.16
185°45'
102.27
194°29'
32.06
152°58'40"
179.13
64°28'
99.00
110°33'30"
88.95
159°10'
183.29
88°10'
108.40

ATTACHMENT 27

TITLE FOR LOT 1 DP 578389

RECORD OF TITLE
UNDER LAND TRANSFER ACT 2017
FREEHOLD

Search Copy

R.W. Muir
Registrar-General
of Land

Identifier **1075364**
Land Registration District **North Auckland**
Date Issued 03 March 2023

Prior References
NA1008/250

Estate Fee Simple
Area 13.2558 hectares more or less
Legal Description Lot 1 Deposited Plan 578389
Registered Owners
Stefan Nigel Richardson and Karen Garland Richardson

Interests

Appurtenant hereto is a right of way created by Conveyance 233624 (R215/571)

464508.1 Gazette Notice (NZ Gazette 3 November 1977 p. 2868) pursuant to Section 4 Public Works Amendment Act 1963 declaring the adjoining State Highway to be a limited access road - 29.11.1977 at 1.47 pm

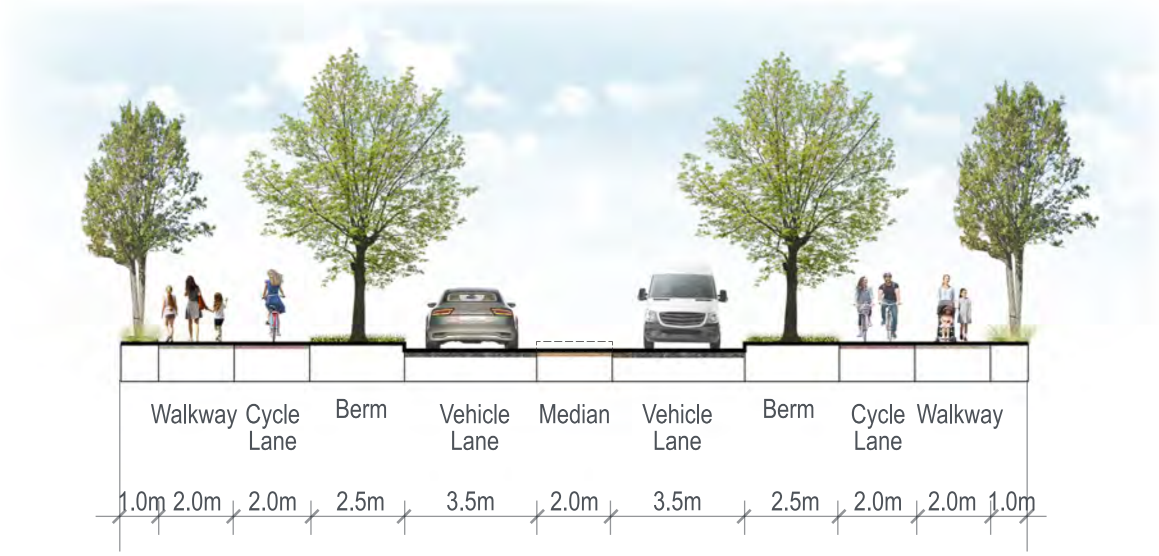
12056929.2 Mortgage to ASB Bank Limited - 14.4.2021 at 11:30 am

ATTACHMENT 28

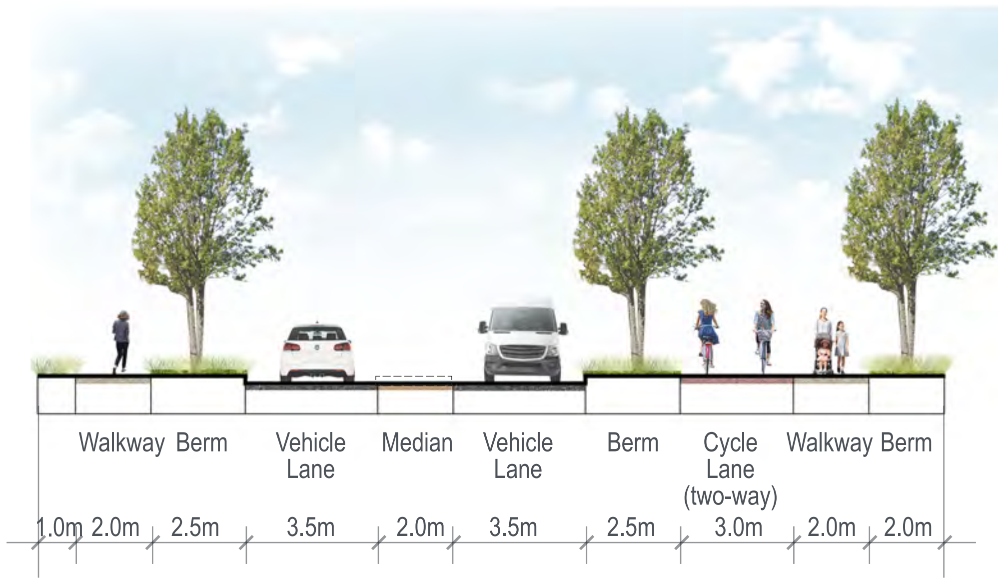
UPDATED WWLR CROSS-SECTION DIAGRAM
APRIL 2023

Indicative Road Cross-sections

State Highway 1 (24m-2 Lanes)



Wider Western Link Road (24m) -Morrison Orchard Section



Wider Western Link Road (24m) -Western Section