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# STORMWATER MANAGEMENT PLAN

## WHENUAPAI EAST PRECINCT - CLARKS LANE & SINTON ROAD, WHENUAPAI

## Document Record

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# 1. Executive Summary

This stormwater management plan (SMP) has been prepared for Cabra Investments Limited in support of a Private Plan Change – Whenuapai East Precinct for 15, 17 and 17A Clarks Lane and 10, 12, 14 and 16 Sinton Road, Whenuapai.

The site is located on the northern side of Clarks Lane and Sinton Road and extends to the north down to the Waiarohia Inlet which drains to the Waitemata Harbour.

The site has several features including:

- Flat to mildly sloping topography.
- Geotechnical Conditions suitable for land development but not suitable for stormwater soakage.
- Existing hydrological conditions and drainage features including permanent and intermittent streams and a natural inland wetland.
- Isolated existing flooding along the permanent stream and natural inland wetland.
- Coastal vegetation with some pockets of native flora and salt marshes within the Waiarohia Inlet. An area of Significant Ecological Area which contains a mixture of exotic and native vegetation.
- A low risk of coastal hazards.

A comprehensive stormwater management approach has been recommended for the development consistent with the requirements under the Auckland Unitary Plan (AUP), Schedule 4 of the Auckland Council Regional Stormwater Network Discharge Consent and National Environmental Standards Freshwater. These are summarised as in Table 1 below and documented in Section 7 of this report.

| Component | Minimum Requirements | Recommended Approaches |
|---|---|---|
| Hydrological Mitigation | • Detention for the difference in the runoff volume from the predevelopment and post development 95$^{th}$ percentile 24-hour rainfall event, excluding any retention that is achieved.<br>• Retention of 5 mm runoff depth from all impervious areas, if practicable. | • Stormwater retention is achieved through rain tanks and bio-retention devices, where practicable.<br>• Detention is achieved through rain tanks and bioretention devices that have additional water quality benefits.<br>• If rain tanks are used the tanks are to be plumbed into the dwellings for internal non-potable reuse.<br>• Alternative approved GD01 devices, if required. |
| Water quality | • Stormwater management of runoff from all impervious surfaces before discharging into the receiving environment | • At source treatment.<br>• Treatment train approach.<br>• Bioretention devices with additional detention benefits are preferred.<br>• Alternative approved GD01 devices, if required.<br>• Roofs to be constructed from low contaminant generating building materials as detailed in Table 5 of the SMP. |
| Erosion protection | • Required at all stormwater outlets into the receiving environment | •Rock stabilised outlets to dissipate flows<br>•Minimise level drops at outlets to stream bed/base flow level.<br>•Avoid steep reticulation lines upstream of outlet and implement velocity reduction design elements, i.e. sumps in chambers.<br>• Bed protection as required at potential stream erosion areas. To be determined at detailed design stage. |
| Stormwater conveyance | • Convey runoff generated from the 10 % AEP flows through the stormwater network to the receiving environment.<br>• Allowance for runoff flows greater than the 10 % AEP flows should be made in overland flow paths | •Protection of overland flow paths |

It is envisaged that Auckland Council approve the Stormwater Management Plan under the Plan Change and adopt under the Auckland Council Network Discharge Consent (NDC)

# 2. Existing Site Appraisal

## 2.1 Summary of Data Sources

| Existing Site Appraisal Item | Source and Date of Data Used |
|---|---|
| Topography | • Topographical Survey – 10 Sinton Road & 15 Clarks Lane – Cato Bolam<br>• Creek Survey – 15 Clarks Lane – C&R Surveyors Ltd<br>• Topographical Survey – 14 & 16 Clarks Lane – Capture Land<br>• Auckland Council GeoMaps data, 2024 |
| Geotechnical / soil conditions | • ENGEO Geotechnical Assessment for Private Plan Change, dated 22nd April 2024<br>• ENGEO Geotechnical Investigation for 10 Sinton Road, Whenuapai dated 10th November 2023<br>• ENGEO Geotechnical Investigation for 15 Clarks Lane, Whenuapai dated 10th November 2023<br>• ENGEO Geotechnical Investigation for 16 Sinton Lane, Whenuapai dated 10th November 2023<br>• ENGEO Erosion Screening Assessment for 15 Clarks Lane, Whenuapai dated 19th June 2025 |
| Existing stormwater network | • Auckland Council GeoMaps data, 2024 |
| Existing hydrological features, including watercourses | • Auckland Council GeoMaps, 2024<br>• Viridis Ltd Ecological Assessment, August 2024 |
| Flooding and flowpaths | • Auckland Council GeoMaps, 2024 |
| Ecological / Environmental areas | • Viridis Ltd Ecological Assessment, August 2024 |
| Cultural & heritage sites | • Archaeology Solutions Limited Assessment, May 2024<br>• Mana whenua Consultation<br>• Te Kawerau Iwi Tiaki Trust Cultural Impact Assessment, Oct 2024 |
| Contaminated land | • ENGEO Contamination Assessment for Private Plan Change, dated 22nd April 2024 |
| Coastal Hazard | • SLR Coastal Hazard Assessment dated 19th April 2024 |

***Table 1 – Data Sources***

## 2.2 Location & General Information

| Existing site elements | Description |
|---|---|
| Site address | 15 Clarks Lane<br>17 Clarks Lane<br>17A Clarks Lane<br>10 Sinton Road<br>12 Sinton Road<br>14 Sinton Road<br>16 Sinton Road |
| Legal Description and Record of Title | Lot 2 DP 92753 - NA 49B/640<br>Section 2 SO 532984 - 895996<br>Section 1 SO 532984 - 895995<br>Lot 25 Allot 2 - NA 762/294<br>Lot 7 DP 57408 - NA 12C/167<br>Lot 8 DP 57408 - NA 12C/168<br>Lot 9 DP 57408 - NA 12C/169 |
| Site Area | Lot 2 DP 92753 - 3.3955 Ha<br>Section 2 SO 532984 - 2.4174 Ha<br>Section 1 SO 532984 - 0.4000 Ha<br>Lot 25 Allot 2 - 2.7291 Ha<br>Lot 7 DP 57408 - 2.4610 Ha<br>Lot 8 DP 57408 - 2.3674 Ha<br>Lot 9 DP 57408 - 2.8758 Ha |
| Current building coverage | Rural Residential. 17A Clarks Road has been acquired by Auckland Council for a Neighbourhood Park. |
| Historical land use | Agricultural |

***Table 2 – Existing Site Elements***


***Figure 1 – Plan Change Area - Yellow extent (Cabra land shown with orange infill)***

## 2.3 Topography

The topography of the site is relatively flat to mildly sloping in a southeast to northwest direction from the road to the coastal edge. There are embankments along the coastal edge of approximately 2m - 4m in height.

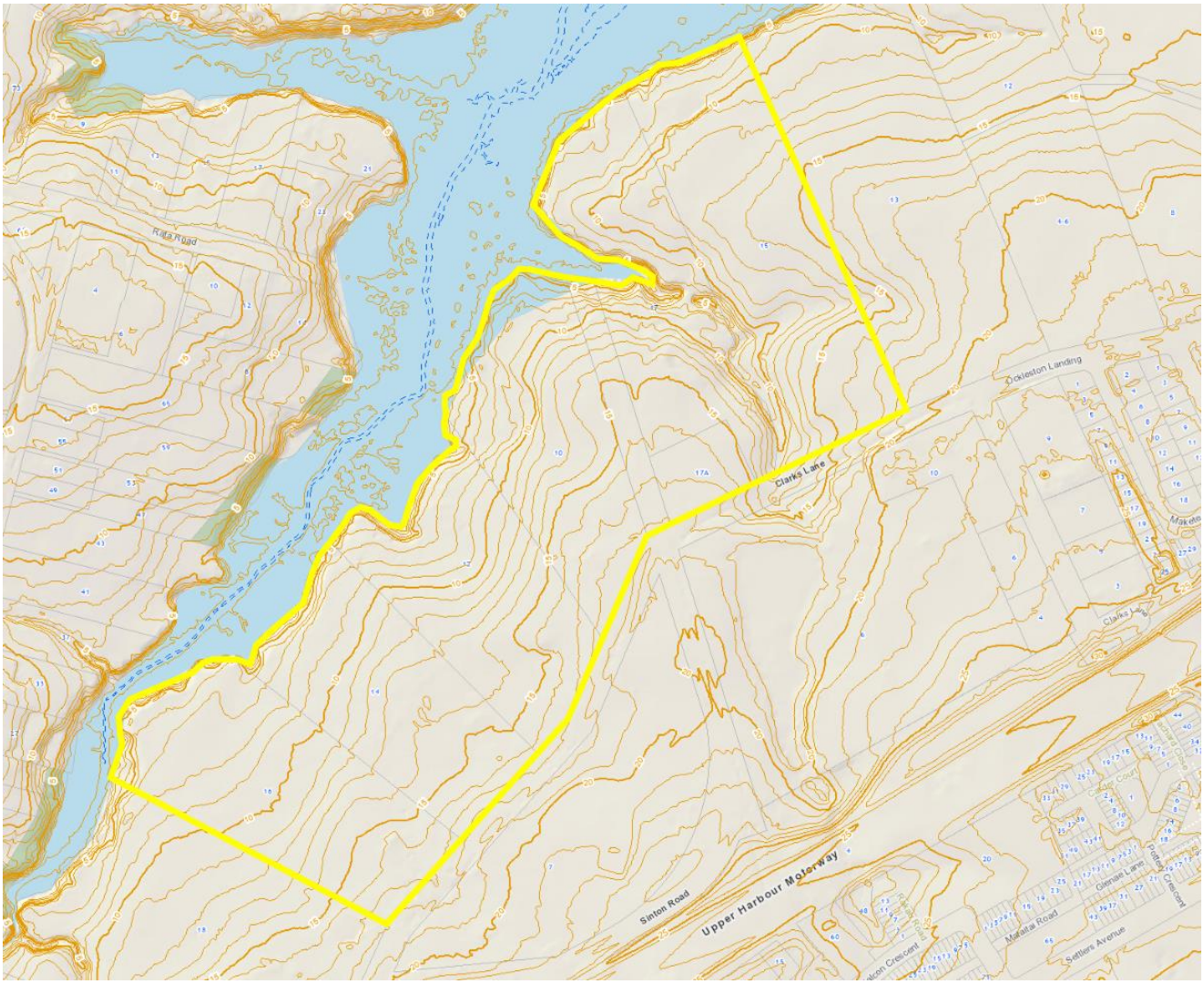


***Figure 2 – Auckland Council GIS Topography – Plan Change Area shown with yellow extent***

## 2.4 Geotechnical

Geotechnical investigations on 10, 14 and 16 Sinton Road and 15 Clarks Lane have been completed by ENGEO Limited.

The ENGEO investigation findings generally concur with the published geological mapping. East Coast Bays Formation residual soils were typically encountered over the northern portions of the sites investigated, with Takanini Formation (formerly named Puketoka Formation) alluvial soils encountered through the central and southern portions of the sites. The residual soils typically comprised stiff to hard silt and clay soils that generally increase in strength with depth, while the alluvial soils comprised interfingered layers of sands, silts and clays with occasional organic soil and peat lenses. Soil strengths within the alluvium were variable with depth but generally ranged from stiff to hard.

Groundwater was measured across the sites at hand auger borehole locations on the day of drilling, and during the CPT progression. The data indicates that groundwater levels vary across the area and are influenced by soil strata, proximity to overland flow paths or water courses, and proximity to the coastline. Groundwater may be expected within 5 m of the ground surface across much of the site area.

The investigations identified the following:

- **Soil Classification** – Class C – Shallow Soil Sites in line with NZS 1170.5.2004.
- **Seismic Hazards** – no known active faults located within the sites and based on topographic and lithologic data, risk from earthquake-induced regional subsidence / uplift, ground lurching, and seiches are considered negligible at the site.
- **Expensive Soils** – Classification of M (moderately) expansive with respect to NZS 3604.

In terms of soakage, ENGEO have stated:

For 10 Sinton Road: "*Due to the proximity of the steep and unstable slopes to the proposed development, we do not recommend in-ground soakage systems are adopted for the site. All stormwater collecting from hard standing areas and roofing should be collected and reticulated to council services."*

For 15 Clarks Lane and 16 Sinton Road: *"Based on the presence of near surface alluvial silt and clay material, we consider that soil infiltration rates at the site will be poor (i.e. less than 2 mm per hour). This should be verified by site specific soakage testing at the detailed design stage."*

Due to the consistent nature of the soils and slopes in the area these requirements for not utilising soakage shall be adopted across the plan change area.

ENGEO undertook an erosion screening assessment of the stream channels along the permanent watercourse within 15 Clarks Lane. The assessment was to determine baseline pre-development stream channel erosion potential and the effects that development of the site may have on future stream erosion. This erosion assessment was conducted utilising Auckland Council's Erosion Screen Tool (EST). There were some knickpoints identified in the assessment which are natural control points of weak rock, not a firm clay. These areas could potentially need bed protection to be determined at detailed design stage and to support this a 15m building setback from the stream is recommended (5m width for engineering stabilisation measures and the standard 10m riparian margin). The assessment overall concluded - Post-development scenarios represent the potential of increased erosion at all cross-sections, however this is considered by ENGEO to be no greater than minor.

ENGEO concluded, based on the findings of the existing ENGEO geotechnical reports for properties within the PPC area, as well as this desktop study of the wider peninsula area for context, we have not identified geohazards which would be likely to preclude future conversion of this area to residential land use provided that the normal geotechnical investigation, analysis and design process is followed. The geohazards identified in this assessment are typical of land development in the Auckland region and are able to be addressed through conventional engineering design approaches.

## 2.5 Existing Drainage Features and Stormwater Infrastructure

There are no existing public stormwater network within the site as it is a rural residential site. There is public drainage located at some points along Clarks Lane and Sinton Road which collects the stormwater discharge from the roads and upper catchments and directs them onto the plan change area.

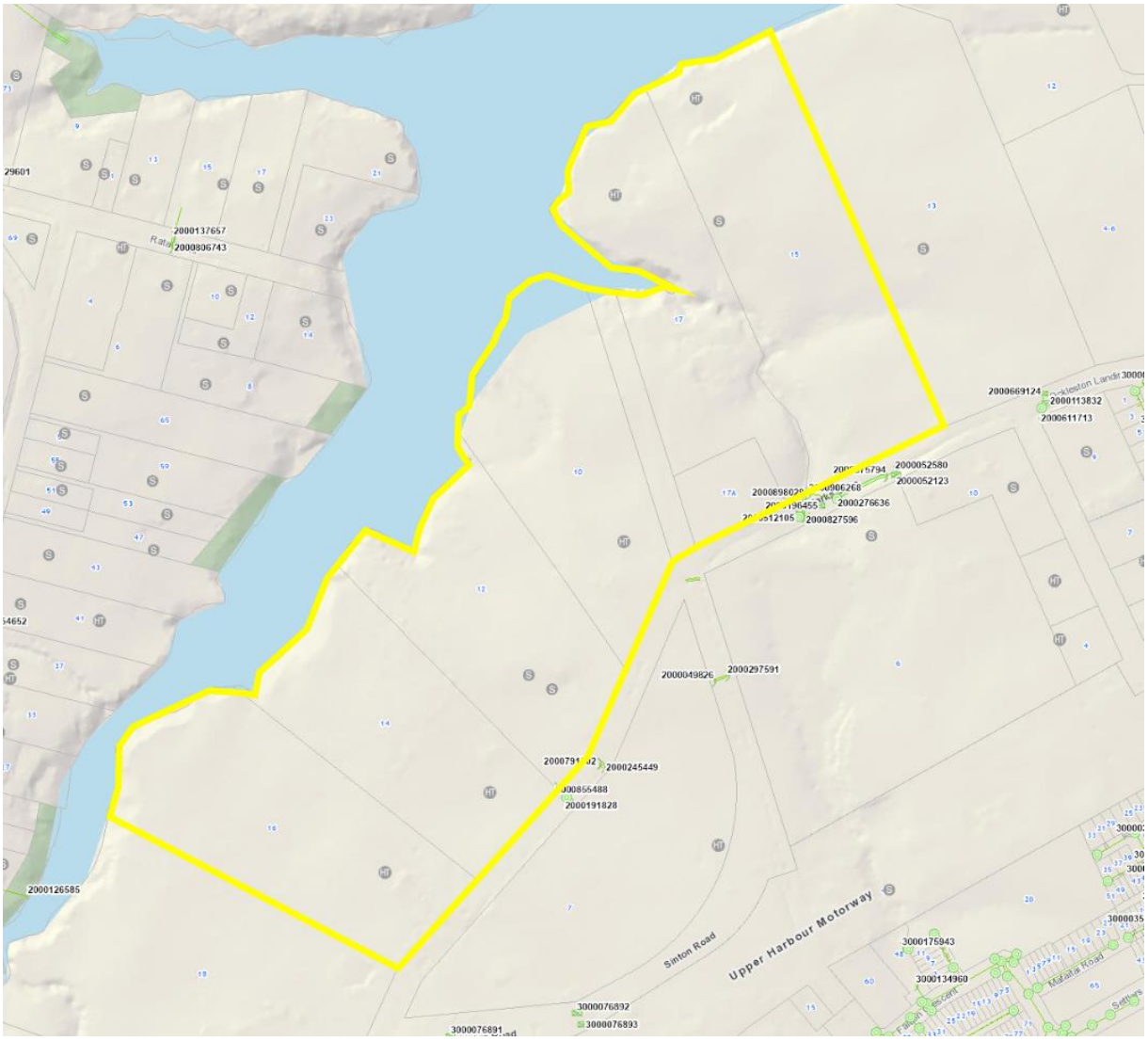


***Figure 3 – Auckland Council GIS Public Drainage – Plan Change Area shown with yellow extent***

The majority of the plan change area drains overland to the coastal Waiarohia Inlet. The upper catchment boundary for the stormwater catchment is SH18, apart from the permanent watercourse which extends to the southeastern side of SH18 via a culvert under the motorway.

## 2.6 Hydrological features

There are existing hydrological features within the site that have been identified in the Ecological Assessment completed by Viridis Environmental Consultants. These include intermittent and permanent streams, modified intermittent streams, artificial drains and natural inland wetlands as shown in Figure 4 below.


***Figure 4 – Viridis Environmental Consultants - Existing Hydrological Features***

## 2.7 Receiving Environment

As outlined above, the receiving environment for the plan change area is:

- The natural inland wetland and permanent watercourse running through the middle of 15 and 17 Clarks Lane.
- The intermittent stream in the north-eastern corner of 16 Sinton Road.
- The intermittent stream in the north-eastern corner of 12 Sinton Road.
- The Waiarohia Inlet (Coastal area).

The watercourses within the site have been classified and mapped according to the definitions within the AUP.

Below is a summary of the ecological values of the receiving environment as determined by the ecological assessment undertaken by Viridis.

*The natural inland wetland and intermittent streams present are of low value due to the exotic species present, lack of aquatic habitat and hydrological variation and the effects of agricultural land uses such as sedimentation. However, the permanent stream likely provides habitat for At Risk fish species and has been assessed as moderate value.*

*The adjacent coastal area is of high ecological significance, despite not being identified as marine SEA under the AUP-OP, it is expected to support At Risk/Threatened species.*

## 2.8 Flooding and Flowpaths

Due to the small upper catchment area, there is limited flooding within the plan change area with the only area identified, being confined to the permanent watercourse as shown in Figure 5.

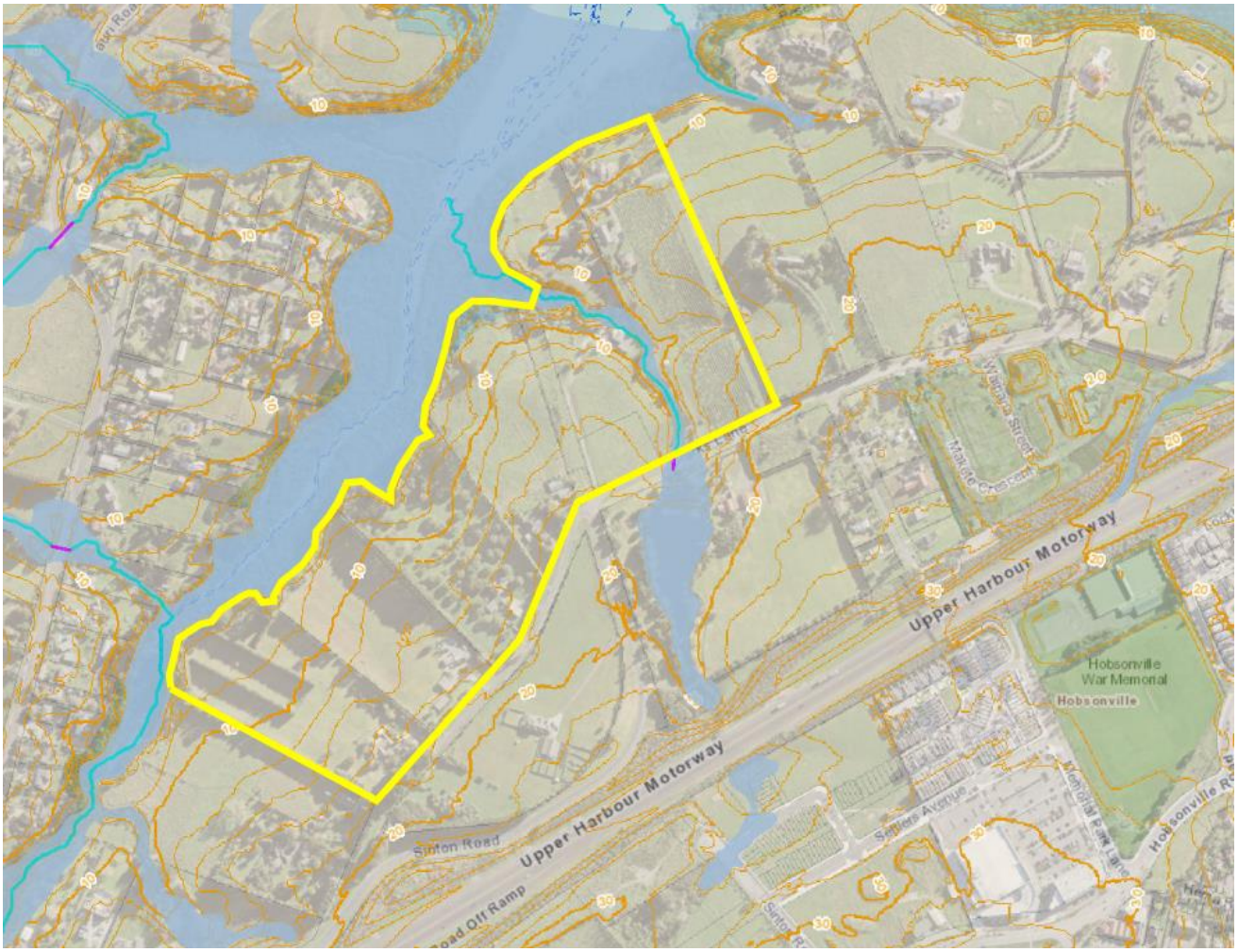


***Figure 5 – Auckland Council GIS Floodplain – Plan Change Area shown with yellow extent***

The Stormwater Management Plan prepared for underlying Plan Change 5 by 4Sight Consulting Ltd states that *"The existing flood hazard is in W3P is generally low, flood hazard is not a key constraint in the catchment provided an approximate approach to development and the management of flood plains and overland flow paths is implemented."*

## 2.9 Coastal Inundation

A Coastal Hazard Assessment has been prepared by SLR Consulting New Zealand for the proposed Plan Change area. Key recommendations being:

- Coastal inundation resulting from extreme storm tides is not generally considered to be an issue with regard to the project area, under both current day and future sea level rise scenarios over the next 100+ years.
- The risk to the project area from a tsunami is considered to be very low.
- Site-specific calculations of shoreline retreat undertaken as part of this assessment have identified a current day slope settlement distance of approximately 4-10m. Future maximum cliff regression potential was found to be in the order of 14.6m (Site A), 17.1m (Site B), 17.9m (Site D) and 16.2m (Site C) measured inland from the slope toe over the 100-year planning horizon. It is recognised that based on this very conservative cliff regression scenario (i.e. 1% exceedance probability), erosion is not expected to encroach within the area of the future residential development as a result of the plan change.

The assessment concluded the overall risk to the subject site from coastal hazards is considered low.

## 2.10 Biodiversity

The Plan Change land has been deforested and has very limited native flora and weed species are dominating. There coastal vegetation has some small pockets of native flora that remain, and these provide relatively good diversity and structure considering the disturbed nature of the surrounding landscape. Patches of salt marsh where also observed along the coast line of the Waiarohia Inlet.

There is a small area of Significant Ecological Area located along the north western boundary of 14 and 16 Sinton Road as shown on Figure 4 above. This area contains a mixture of exotic and native vegetation.

## 2.11 Cultural and Heritage Sites

The Archaeological Assessment prepared by Archaeology Solutions Limited identifies cultural sites along the coastal edge, which will be incorporated in future esplanade reserves measuring 20m from the MWHS. Refer to Figure 6. Coastal stormwater outlets and erosion protection measures are to be located outside the vicinity of the three identified midden sites referred to in the Archaeological Report.

A Cultural Impact Assessment (CIA) has been prepared by Te Kawerua Iwi Tiaki Trust for the proposed Whenuapai East Precinct Plan Change. The CIA concluded all potential cultural impacts will have either negligible or minor effects based on adopting proposed mitigation measures – refer to Section 4.2.

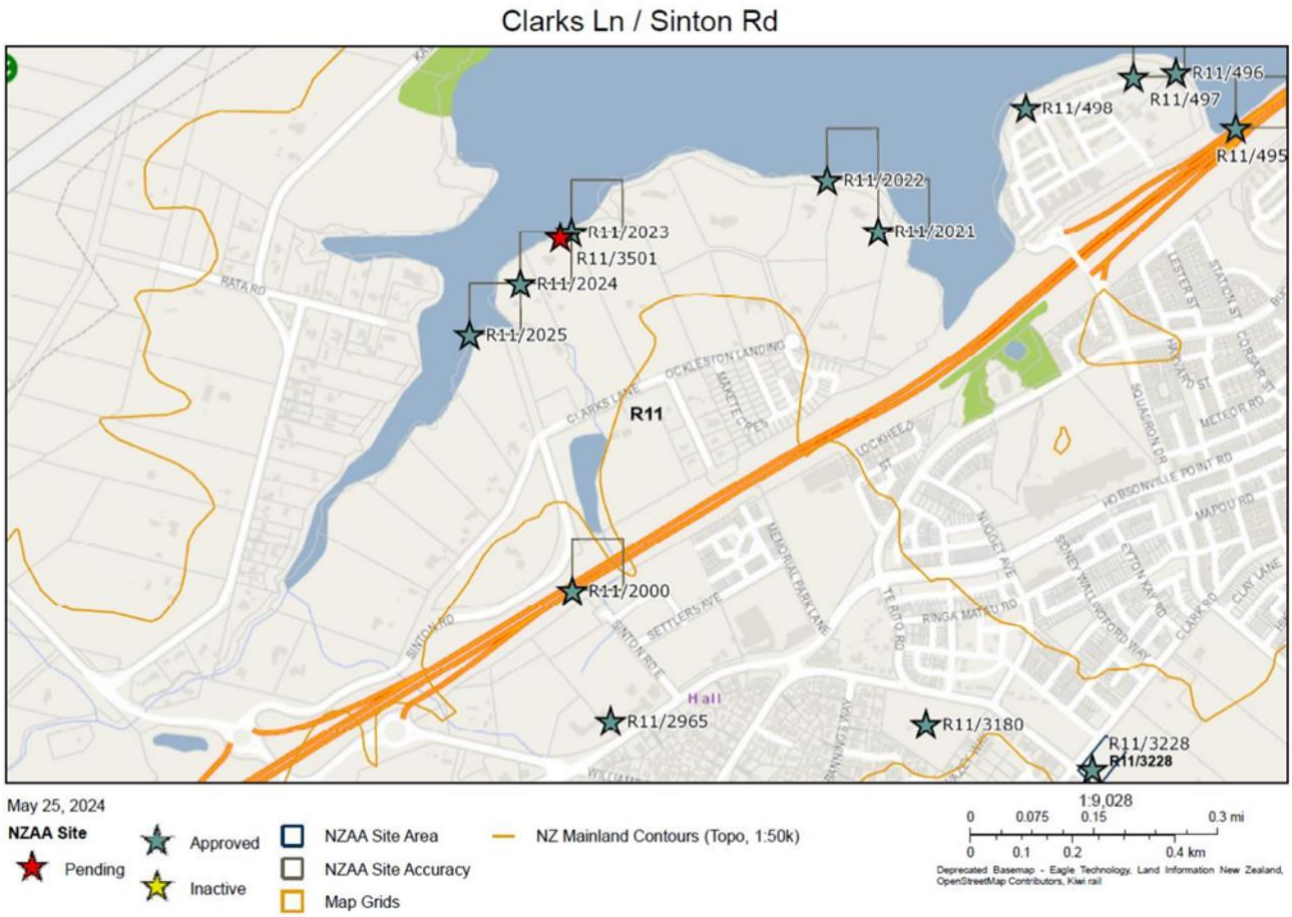


***Figure 6 – Archaeological Features***

## 2.12 Contaminated Land

ENGEO has undertaken environmental assessments of the properties at 10, 14 and 16 Sinton Road and 15 Clarks Lane in 2023 and 2024.

The report identified the following potential activities which are included on the Hazardous Activities and Industries List (HAIL1). The following activities are considered potentially have occurred on all or some of the sites and Remediation Action Plan's (RAP) were prepared for each lot:

- HAIL ID A10: Persistent pesticide bulk storage or use including sports turfs, market gardens, orchards, glass houses or spray sheds. Areas of cropping / vineyard.
- HAIL ID G5: Waste disposal to land. Areas where dumping of domestic waste was identified.
- HAIL ID 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. Use of lead-based paints and asbestos on buildings. Burn piles. Use of small volumes of fuel / oil.

ENGEO have concluded that, the Plan Change assessment is not intended to replace the need for a PSI and / or DSI for 12 Sinton Road and 17 / 17A Clarks Lane during future redevelopment.

ENGEO did not identify historic activities which would be likely to preclude future conversion of this area to residential land use from a contamination perspective, provided that the relevant provisions of the NESCS and the Auckland Unitary Plan are followed when the change in land use occurs.

# 3. Development Summary and Planning Context

## 3.1 Regulatory and Design Requirements

| Requirement | Relevant regulatory / design to follow |
|---|---|
| AUP Chapter E8 Diversion and Discharge | AUP Chapter E8, Table E8.4.1 (A10) All other diversion and discharge of stormwater runoff from impervious areas not otherwise provided for.<br>Stormwater management devices must be provided to reduce or remove contaminants from stormwater runoff. |
| AUP Chapter E9 High Contaminant Generating Areas (HCGA) | AUP Chapter E9, clause E9.6.1.3 as follows:<br>Development of a new or redevelopment of an existing high contaminant generating car park greater than 1,000m2 and up to 5,000m2;<br>(1) The development of a new or redevelopment of an existing high contaminant generating car park must not be located in an industrial or trade activity area.<br>(2) Stormwater management device(s) must meet the following standards:<br>(a) the device or system must be sized and designed in accordance with GD01; or (b) where alternative devices are proposed, the device must demonstrate it is designed to achieve an equivalent level of contaminant or sediment removal performance to that GD01.<br>(3) Stormwater runoff from the impervious area used for the high contaminant generating car park is treated by stormwater management device(s) meeting Standard E9.6.1.3(2) above.<br>(4) Where the car park is more than 50 per cent of the total impervious area of the site, stormwater runoff from the total impervious area on the site must be treated by stormwater management devices. |
| AUP Chapter E10 SMAF hydrology mitigation | AUP Chapter E10, Table E10.6.3.1.1, SMAF 1 hydrological mitigation requirements have been adopted due to the receiving environment in respect of locations where stormwater will discharge to streams. These are:<br>• Retention (volume reduction) of at least 5 mm of runoff depth from impervious surfaces.<br>• Detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from impervious surfaces in the 95th percentile, 24hours rainfall event minus the achieved retention volume. |

| Requirement | Relevant regulatory / design to follow |
|---|---|
| AUP Chapter E36 Natural Hazards | Section E36 sets out the policies relating to management of natural hazards and flooding. The relevant policies are summarised briefly below:<br>• Avoid locating buildings in the 100-year ARI floodplain (Policy E36.3.17).<br>• Earthworks within the 100-year ARI floodplain should not permanently reduce floodplain conveyance or exacerbate flooding experienced by other sites upstream or downstream (Policy E36.3.20).<br>• Ensure all development in the 100-year floodplain does not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site (Policy E36.3.21).<br>• Maintain the function and capacity of overland flowpaths to convey stormwater runoff safely and without damage to the receiving environment (Policy E36.3.29) and Policy E36.3.30). |
| AUP Precinct | Whenuapai East Precinct Rules, summarised briefly below:<br>• Require subdivision and development to be consistent with any approved stormwater management plan.<br>• To manage effects on freshwater and coastal water quality.<br>• To manage reverse sensitivity effects on RNZAF Base Auckland, including in relation to bird strike.<br>• To ensure that there is sufficient stormwater infrastructure capacity in place at the time of development. |
| Existing Catchment Management Plan | N/A |
| Auckland Council regionwide Network Discharge Consent (NDC) | Schedule 4 of the NDC requires Greenfields Future Urban developments to have an Integrated Stormwater Management Approach to:<br>Minimise the stormwater related effects of development.<br>Retain/restore natural hydrology as far as practicable.<br>Minimise the generation and discharge of contaminants.<br>• Enhance freshwater systems including streams and riparian margins.<br>• Minimise the location of engineered structures in streams.<br>Protect the values of Significant Ecological Areas as identified in the AUP. |

***Table 3 – Regulatory and Design Requirements***

# 4. Mana Whenua: Tea o Maori and Matauranga

## 4.1 Identification and incorporation of mana whenua values

The Plan Change area is proposed to be developed to provide a water sensitive outcome incorporating the stormwater management principles.

The Auckland Council Guidance Document 01 – Stormwater Management Devices for the Auckland Region details how to design to reflect Mana Whenua Values:

> *'Mana whenua values are intrinsic to the design, construction and management of stormwater devices in the Auckland region.*
>
> *As kaitiaki, mana whenua have the responsibility of ensuring that the spiritual and cultural aspects of resources are maintained for future generations. This involves the on-going protection of mauri from damage, destruction or modification Mauri is a concept recognised by mana whenua as the connection between spiritual, physical and temporal realms. Loosely translated as the life force or life essence which exists within all matter, mauri sits at the very core of sustainable design for mana whenua and Te Ao Māori – the Māori worldview. A key concern to mana whenua is the effect on the mauri of water caused by pollution of a stream, river, estuary, catchment or harbour. This can be due to sediment entering waterways, loss of riparian margins and the loss of native habitat to support native flora and fauna. Degradation of freshwater quality can also affect the ability for customary harvest and manāki due to depletion in, or in some cases the absence of, traditional mahinga kai resources. Modification or destruction of wāhi tapu and wāhi taonga is another potential effect*
> *of freshwater degradation.*
>
> *The revival and enhancement of mauri should be a focus during the design and construction phases through:*
>
> - *A holistic approach to resource management*
> - *Protection of habitats of edible plants and native aquatic life which are traditional sources of food for local Māori*
> - *Restoring a buffer of native vegetation alongside waterways*
> - *Water conservation*
> - *Avoiding mixing waters from different sources.'*

## 4.2 Consultation with Mana Whenua

The Applicant has contacted all iwi listed on Council's website over a period of 18 months, including:

- Te Kawerau ā Maki
- Ngāti Manuhiri
- Ngāti Maru
- Ngāti Pāoa
- Ngāti Tamaterā
- Ngāti Te Ata

- Ngāti Whātua o Kaipara
- Ngāti Whātua Ōrākei
- Te Ākitai Waiohua
- Te Rūnanga o Ngāti Whātua

Te Kawerau ā Maki are the only listed party to actively engage in on-going engagement, including iterative discussions with Edward Ashby and Ashleigh McDonald over this period, including a site visit in July 2024, multiple meetings and preparation of a Cultural Impact Assessment (**CIA**), received in October 2024.

Ms McDonald confirmed at the site visit, that Te Kawerau ā Maki support the proposed approach to stormwater, coastal access and planting, and wishes to be consulted at resource consent stage regarding the design of the riparian planting and pedestrian access within the coastal and stream esplanade reserves. The proposed precinct provisions require demonstration of this further engagement via the Special Information Requirement for the riparian planting plan.

The CIA states that Te Kawerau ā Maki do not oppose the proposal provided that the mitigations discussed in the CIA are incorporated – we desire notice of the outcome of the application and the final consent conditions. The CIA mitigation measures are summarised below.

- Setbacks and planting from Waiarohia Inlet and waterways.
- Adoption of on-site treatment devices to develop a secondary or tertiary stormwater treatment process.
- Preserve as far as practicable the productive capacity or mauri of the soil by achieving a cut-fill balance.
- Work with us on ecologically sensitive design i.e. eco-sourced native planting, habitat enhancement etc.
- Work with us on water sensitive design that incorporates our tikanga.
- That a native fauna management plan be prepared to address the construction and long-term protection of native birds, bats, lizards and freshwater species.
- If archaeological material is encountered obtain a HNZPTA authority and include TKaM in cultural monitoring – any cultural material found on site should be reinterred into the Site.
- Work with Te Kawerau ā Maki on incorporating our wāhi tohu and history into the development.
- Te Kawerau ā Maki are afforded the opportunity (and resourced) to undertake a site visit during the construction phase to examine controls.
- Opportunity for cultural ceremonies (e.g. sod-turning).
- Given this is a plan change we require engagement on the formulation of any precinct provisions or introductory text.
- We have identified that Waiarohia ō Ngariki is a site of significance that should be scheduled.

# 5. Stakeholder Engagement and Consultation

| Stakeholders | What is the reason for interest? | What engagement has been completed? | Feedback and response |
|---|---|---|---|
| Mana whenua | To assess effects on cultural values. | Refer to section 4.2 above. | Refer to section 4.2 above. CIA received from Te Kawerau ā Maki. |
| Auckland Transport | Existing road upgrades and new roading network | Multiple meetings | Development of an Integrated Transport Assessment by Commute and road upgrade requirements. |
| Auckland Council - Healthy Waters | Guidance regarding stormwater consenting and mitigation for the development | Meetings<br>• 8th of July 2024<br>• 19th of July 2024 | • SMP to be adopted under NDC if approved as part of the plan change process.<br>• SMAF 1 overlay to be applied to development area.<br>• Streambed erosion assessment of permanent stream between 15 & 17 Clarks Lane to be undertaken.<br>• Assessment and recommendation of stormwater devices to be included in SMP. |

***Table 4 – Stakeholder Engagement and Consultation***

# 6. Proposed Development

## 6.1 Location and Area

The location of the proposed development is 15, 17 and 17A Clarks Lane and 10, 12, 14 and 16 Sinton Road, Whenuapai. The development area is 16.6462 hectares. See Figure 1 which show the Plan Change area.

## 6.2 Proposed Development

The proposed Plan Change is to rezone the area currently from Future Urban Zone (**FUZ**) under the Auckland Unitary Plan (**AUP**) to Residential, as shown in Figure 7. The anticipated yield from the plan change area is around 500 to 600 dwellings.

- Mixed Housing Urban
- Mixed Housing Suburban along the coastal edge
- Esplanade Reserve 20m along the MHWS and permanent stream
- Open Space – Informal Recreation zone (17A Clarks Lane has already been acquired by Auckland Council)

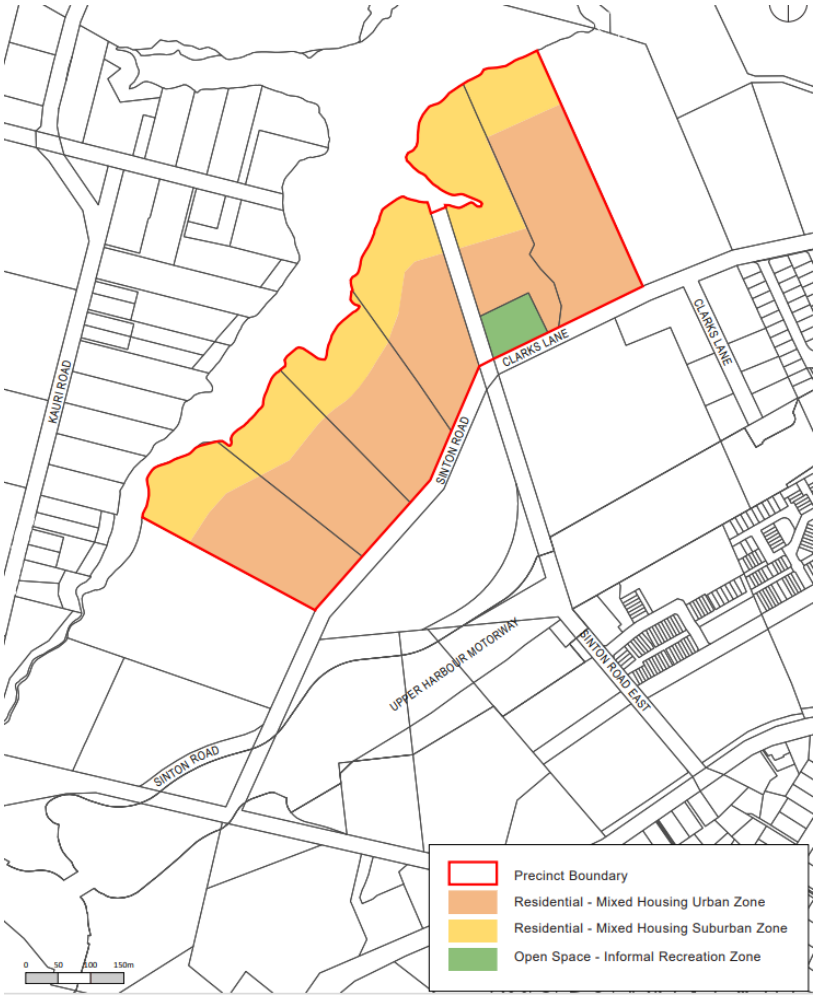


***Figure 7 – Whenuapai East Zone Map – Plan Change Area shown with red extent***

## 6.3 Earthworks

It is anticipated earthworks will be required over the extent of the proposed residential areas to create suitable gradients over the site, to facilitate access, infrastructure servicing and building platforms.

Based on the flat to moderate sloping topography of the area, we do not anticipate large scale land modification with maximum cuts and fills expected to be generally less than 1m.

The extent and volume of earthworks will be determined in the future when each site is designed, and Resource Consents applied for. It is anticipated both District and Regional Land-use Consents will be required when each development site is undertaken in the future.

The proposed site levels are to be designed to ensure the exit point for the existing overland flow paths will be retained. Earthworks are not proposed within a floodplain.

# 7. Stormwater Management

## 7.1 Principals of Stormwater management

The site is classified as a Greenfields site under the Schedule 4 of the Auckland Wide Network Discharge Consent and therefore stormwater management must include water quality, stream hydrology, flooding and assets as shown in Figure 8.

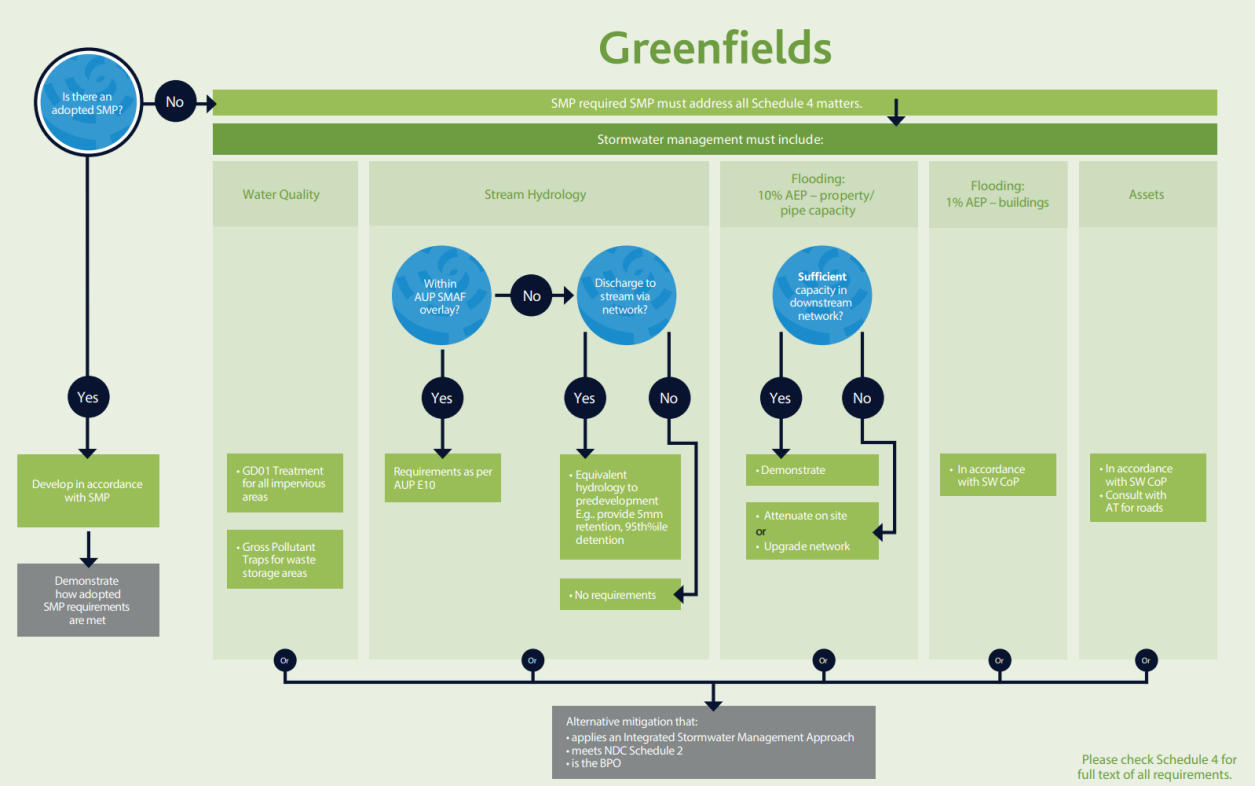


***Figure 8 – Regionwide Stormwater Network Discharge Consent – Greenfield Sites Requirements***

### 7.1.1 Regionwide Stormwater Discharge Consent Requirements

A high-level stormwater management strategy has been developed in accordance with the Regionwide Network Discharge Consent requirements and objectives. The proposed stormwater strategy is summarized as shown in Table 5.

| Stormwater Requirement | Stormwater Proposal |
|---|---|
| Water Quality | Roofs must be constructed from low contaminant generating building materials which:<br>(i) have exposed surface(s) or surface coating of metallic zinc or any alloy containing less than 10% zinc; and<br>(ii) have exposed surface(s) or surface coating of metallic copper or any alloy containing less than 10% copper; and<br>(iii) avoid exposed treated timber surface(s); and<br>(iv) avoid any roof material with a copper containing or zinc-containing algaecide.<br><br>Water Quality Treatment (90$^{th}$ Percentile Storm) for all impervious surfaces to minimise contaminants entering the receiving environment. Section 7.2.3 below sets out appropriate options for delivering this outcome. |
| Hydrological Mitigation | SMAF 1 Retention (5mm) for all Impervious Surfaces draining to a stream to mimic pre-development flows and maintain stream /natural wetland base flows.<br><br>SMAF 1 Detention (95$^{th}$ Percentile Runoff minus Retention Volume) for all Impervious Surfaces draining to a stream receiving environment to reduce the velocities of frequent storm events. |
| Flood Attenuation | Attenuation is not recommended for the Plan Change area due to the discharge being to a coastal environment with no flooding issues downstream of the site. |
| Flood Conveyance | Primary Network for up to 10% AEP peak flows (with 2.1 degree climate change).<br>Secondary Network for up to 1% AEP peak flows (with 3.8 degree climate change). |
| Assets | Discharge Outlets will be fitted with erosion protection and energy dissipation to minimise scour at these locations. Discharges will be to stream environments to retain baseflows, as far as practicable.<br><br>Assets will be in accordance with SWCOP and TR2013/018 as far as practicable and a dispensation from the standards will be sought as required.<br><br>Auckland Transport will be consulted with regard to road requirements prior to submission of Resource Consent applications. |

***Table 5 – Stormwater Proposal to meet Regionwide Stormwater Network Discharge Consent***

## 7.2 Proposed Stormwater Management

### 7.2.1 Constraints

The following constraints have been identified for this Plan Change Area.

| Constraint | Limitation | Recommendation |
|---|---|---|
| Infiltration | Infiltration is not recommended for the site based on the Geotechnical recommendations in relation to reduced infiltration rates and stability effects. | Infiltration is not recommended for this Plan Change Area. |
| Whenuapai Airport | Stormwater devices at attract birds - potential bird strike. | Large stormwater devices such as wetlands or wet ponds are not recommended for this Plan Change Area. |

***Table 6 – Constraints***

### 7.2.2 Proposed Stormwater Catchments

The proposed stormwater catchment areas for the development are shown in Figure 9 and included in Appendix A. The final catchment areas will be determined at Resource Consent stage.

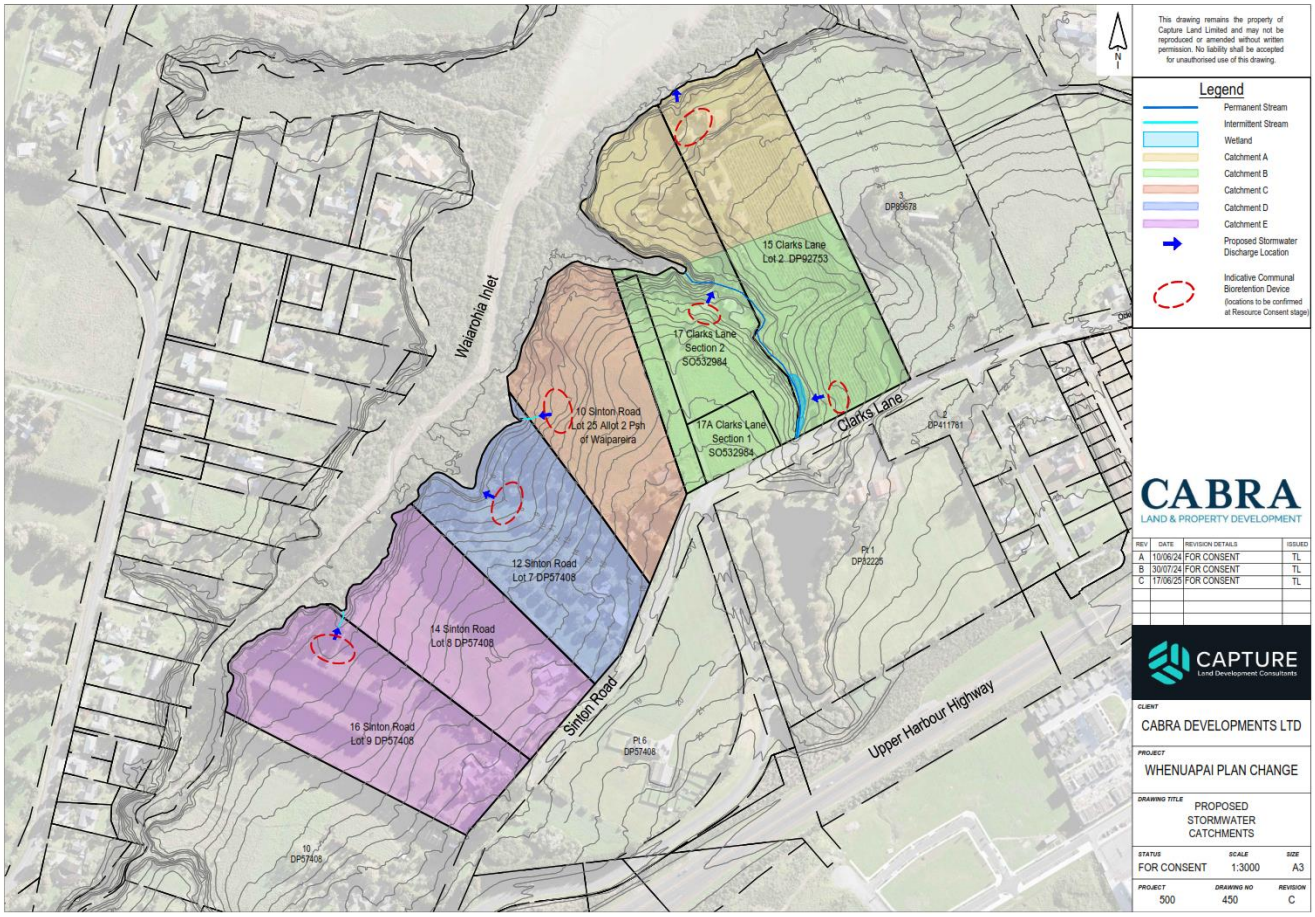


***Figure 9 – Proposed Stormwater Catchments***

Catchment A is located to the north of 15 and 17 Clarks Lane. This area will discharge directly to the Waiarohia Inlet.

Catchment B is located to the south of 15, 17 and 17A Clarks Lane. This area will discharge directly to the Permanent Stream and Wetland to recharge base flows in these features.

Catchment C contains 10 Sinton Road. This area will discharge directly to the Intermittent Stream to the north-west of the site to recharge the base flows in the stream.

Catchment D contains 12 Sinton Road. This area will discharge directly to the Waiarohia Inlet.

Catchment E contains 14 and 16 Sinton Road. This area will discharge directly to the Intermittent Stream located centrally to the north of the site to recharge the base flows in the stream.

Proposed discharge locations are determined based on the following:

- Site levels and natural discharge points of the existing catchments
- Retain baseflows to wetland and streams
- Site constraints i.e. gradients, access, middens, vegetation etc.
- Ecology aspects

The hydrological effects on the stream and natural wetland are to mimic the pre-development scenario as much as possible by retaining baseflows and limiting significant increases in post development peak flows. The stream stability assessment identifies potential impacts and suspectable areas that need further consideration and assessment at detailed design stage.

The locations shown Figure 9 are indicative and will be assessed in more detail and finalised at detailed design stage. These indicative locations do not intersect the location of the middens.

### 7.2.3 Water Quality Treatment Device Options

The stormwater quality treatment options that are proposed for the Plan Change area are summarized in Table 7.

| Development Area | GD01 Water Quality Mitigation Options | Recommended Devices |
|---|---|---|
| Public Road | • Bioretention device<br>• Swales | • Public (communal) bioretention devices located throughout the catchment where required to provide treatment and SMAF mitigation and/or separate bioretention (eg rain gardens) to treat public road areas only, subject to AT approval.<br>• Any assets proposed to be vested to AT require separate approval from AT. |
| Accessways and COALS | • Bioretention<br>• Swales<br>• Proprietary devices to GD01 requirements | • Public (communal) bioretention devices; or<br>• Private bioretention or proprietary devices located prior to the point of discharge to the public stormwater reticulation to provide treatment and SMAF mitigation.<br>*Devices to be designed in accordance with GD01 requirements.* |
| Lots | • Bioretention device<br>• Proprietary devices<br>• Living Roofs<br>• Pervious Pavements (lined where soakage is not feasible)<br>• Roofs to be constructed from low contaminant generating building materials | Impervious trafficable areas:<br>• Public (communal) bioretention devices; or<br>• Private bioretention, proprietary devices or pervious pavement (lined where soakage is not feasible) to provide treatment prior to discharge to the public stormwater network. Devices to be designed in accordance with GD01 requirements. |

***Table 7 – Water Quality Treatment Device Options***

The recommended stormwater devices outlined above have been assessed based on mitigation requirements, site constraints, asset lifecycle and ownership, maintenance requirements and effectiveness to achieve the best practical solution for the site.

The implementation of one single large stormwater device, such as, wetlands or wet ponds are not suitable for the site due to the potential of attracting birds, which pose an increased risk of bird strike to the Whenuapai Airport.

Communal bioretention devices are proposed as shown on plan SW450 in Appendix A. The number of devices should be minimised and life cycle costs will be assessed at Resource Consent stage.

### 7.2.4 Hydrological Mitigation Device Options

The development of the site into a residential development will result in a significant increase in impervious area and subsequently larger runoff volumes discharging to the receiving environment. Increased runoff can have adverse effects on streams, including accelerating erosion and bank instability, and creating hydrological conditions that do not support healthy aquatic ecosystems. There is one permanent stream within the development area and in this case, the stream also contains a wetland at its southern end (on the northern side

of the Clarks Lane culvert). SMAF-1 is proposed to apply site-wide to manage the effects of stormwater when discharge is to a stream.

A Stream Stability Assessment for the permanent stream has been undertaken by ENGEO in accordance with Erosion Screening Tool (EST) developed by Healthy Waters. A site walkover was carried out by ENGEO to assess the existing condition of the stream and determine the position of the EST sections. Stream-bed step changes (shallow waterfalls) were observed in two locations, with weak rock exposed across the head of the waterfall. The area is inferred to be underlain by weak rock at comparatively shallow depth. The presence of weak rock will limit the potential for ongoing incision of the water course and associated horizontal erosion of the adjacent streambanks.

The assessment is included in Appendix C and concludes, post-development scenarios represent potential for increased erosion at all cross-sections, however this is considered by ENGEO to be no greater than minor.

Recommendations include:

- 15m minimum building setback from the stream channel allowing 5m for engineering stabilisation measures and the standard 10m riparian margin.
- To aid in reducing stream widening and mobilisation, recommend appropriate erosion protection measures are designed during the detailed design phase.
- Detailed design assessments will need to consider not only horizontal erosion away from the stream, but also vertical changes due to the presence of knick-points in the watercourse. In particular, the northern-most knick-point (between Section 3 and Section 4), with a head cut of approximately 1-2 m, will require consideration of 'stepped' engineering stabilisation measures in sympathy to both the existing stream bed change and potential vertical changes from ongoing erosion. This will be undertaken at Resource Consent stage to support the design of appropriate erosion protection measures in identified erosion susceptible locations. This will be required at the time of subdivision of 15 and 17 Clarks Lane.

The following SMAF Flow 1 mitigation options are proposed to protect the downstream natural wetland and permanent stream within Catchment B, as summarised in Table 8. A SMAF Flow 1 overlay map for the Plan Change area is included in Appendix D.

A detailed site investigation of the streams will be required at Resource Consent stage to inform design consideration and mitigation measures.

| Development Area | GD01 SMAF Flow 1 Mitigation Options | Recommended Devices |
|---|---|---|
| Public Road | • Bioretention device<br>• Infiltration device | Public bioretention devices located throughout the development where required to provide mitigation. Devices to be designed in accordance with GD01 and Auckland Transport requirements. |
| Accessways | • Bioretention device<br>• Infiltration device | Private bioretention or proprietary devices located prior to the point of discharge to the public stormwater reticulation to provide mitigation. Devices to be designed in accordance with GD01 requirements. |
| Lots | • Bioretention device<br>• Rainwater Tank<br>• Pervious Pavements (lined where soakage is not feasible) | Impervious trafficable areas - Private bioretention or pervious pavement (lined where soakage is not feasible)located on each lot to provide treatment prior to discharge to the public stormwater network. Devices to be designed in accordance with GD01 requirements.<br><br>Roof Areas – Private on-lot rainwater tanks |

***Table 8 – Hydrological Mitigation Device Options***

The recommended stormwater devices outlined above have been assessed based on mitigation requirements, site constraints, asset lifecycle and ownership, maintenance requirements and effectiveness to achieve the best practical solution for the site. The location and design will be assessed and determined at resource consent stage.

Indicative locations of communal bioretention devices are shown on plan 1100-DR-C-SW450 in Appendix A and final locations of devices are to be determined at Resource Consent stage. The number of devices should be minimised and life cycle costs will be assessed at Resource Consent stage.

### 7.2.5 Flood Conveyance

There is no existing public stormwater reticulation within the development site.

New public stormwater networks are proposed to convey the 10% AEP primary flows from the development, with allowance for climate change for a temperature increase of 2.1 degrees in accordance with section 4.2.11 of the Auckland Council SWCOP Version 4. The publicly vested reticulation will discharge to a coastal outlet or overland flowpath within the Plan Change Area under the region-wide NDC consent held by Healthy Waters.

The secondary networks are proposed to convey the 1% AEP secondary flows from the development, with allowance for climate change for a temperature increase of 3.8 degrees in accordance with section 4.2.11 of the Auckland Council SWCOP Version 4. The secondary network will discharge via defined overland flowpaths to the coastal environment.

The subject development area is adjacent to the coastal area, and therefore no property downstream is affected by this development.

The existing isolated flooding through the development area, as shown in Figure 5, is confined to the permanent stream and will be situated within the future 20m esplanade reserve vested either side of the stream. Therefore, it will not be impacted by developing the area.

### 7.2.6 Development Staging

The residential development of each property will be progressed as Resource Consent is issued. The stormwater proposal will therefore be implemented as these developments progress.

## 7.3 Hydraulic Connectivity

The hydraulic connectivity with the receiving environment for the development will be similar to the existing situation. The discharge locations will remain the same, however the mechanisms to discharge the stormwater will alter with the implementation of piped networks and mitigation devices.

## 7.4 Asset Ownership

It is anticipated the stormwater devices and network required to manage stormwater from the new public road will be vested to Auckland Council, along with the primary network extended along the public road to provide connections to each new lot that is created.

The stormwater devices and networks required on each individual lot and accessways, will remain in the ownership of the lot owner.

## 7.5 Ongoing maintenance requirements

Operation and Maintenance plans for stormwater devices will be required and submitted to Auckland Council prior to being operational. It is anticipated this will be a condition of Resource Consent.

## 7.6 Implementation of Stormwater Network

The primary stormwater network for the development will be constructed as part of the subdivision works, including the required treatment and hydrological devices. Strict sediment and erosion control devices will be implemented during the construction phase and remain operational until the site is fully stabilised.

During future development on the individual lots, private stormwater devices will be installed to provide the required mitigation and treatment appropriate for the residential development that is being proposed.

## 7.7 Dependencies

Not applicable to this SMP.

## 7.8 Risks

| 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? |
|---|---|---|---|---|
| Stormwater Management Devices are not maintained by Auckland Council | Vesting devices in Auckland Council and providing an Operation and Maintenance Plan | Auckland Council recording the asset on their register | During the maintenance period. | Low |
| Stormwater Management Devices are not maintained by individual lot owners | Adding Consent Notices on the Record of Title referencing the Operation and Maintenance Plan | Auckland Council to review the title documents at the time of issuing building consents | During the construction phase for building dwellings and the ongoing maintenance period. | Low |
| Soil Erosion | Adequate design to reduce the risk of erosion due to overland and piped stormwater flows. | Erosion and Outlet Protection installed during construction | During the design and construction phase | Moderate |
| Overland Flow Paths | Full design of Overland Flow Paths to include Climate Change with 3.8 degrees increase. | Freeboard added as required by SWCOP Version 4. | During the design and construction phase | Moderate |
| Stream instability | Detailed hydraulic assessment of stream velocities and field testing of bank and bed parameters at resource consent stage to identify at risk areas.<br><br>The final outlet locations and any stream mitigation measures will be determined at Resource Consent stage as part of the further detailed stormwater design and stream assessments for each catchment. This will include consideration of downstream locations for the outfalls. | Riparian planting and setbacks.<br><br>Erosion protection measures at outlets.<br><br>Bank stabilisation at risk areas.<br><br>Stream bed protection/stabilisation at risk areas. | During the design and construction phase | Low |

***Table 9 – Risks***

# 8. Departures

Not applicable.

# 9. Conclusions

The design of this development will be completed to meet the requirements of the various regulatory and design requirements. The detailed design will be confirmed through a consultative process with Auckland Council, Healthy Waters, Mana Whenua and client representatives to ensure the proposal is the appropriate for use on this site.

With the proposed implementation of detention, retention and treatment, there will be less than minor adverse effects on the downstream environment. The principles of stormwater management for the development and suitable approaches for water quality, hydrological mitigation, erosion risk and flooding were addressed in Section 7 of this report. A summary is indicated in Table 10.

| Component | Minimum Requirements | Recommended Approaches |
|---|---|---|
| Hydrological Mitigation | • Detention for the difference in the runoff volume from the predevelopment and post development 95$^{th}$ percentile 24-hour rainfall event, excluding any retention that is achieved.<br>• Retention of 5 mm runoff depth from all impervious areas, if practicable. | • Stormwater retention is achieved through rain tanks and bio-retention devices, where practicable.<br>• Detention is achieved through rain tanks and bioretention devices that have additional water quality benefits.<br>• If rain tanks are used the tanks are to be plumbed into the dwellings for internal non-potable reuse.<br>• Alternative approved GD01 devices, if required. |
| Water quality | • Stormwater management of runoff from all impervious surfaces before discharging into the receiving environment | • At source treatment.<br>• Treatment train approach.<br>• Bioretention devices with additional detention benefits are preferred.<br>• Alternative approved GD01 devices, if required.<br>• Roofs to be constructed from low contaminant generating building materials as detailed in Table 5 of the SMP. |
| Erosion protection | • Required at all stormwater outlets into the receiving environment | •Rock stabilised outlets to dissipate flows<br>•Minimise level drops at outlets to stream bed/base flow level.<br>•Avoid steep reticulation lines upstream of outlet and implement velocity reduction design elements, i.e. sumps in chambers.<br>• Bed protection as required at potential stream erosion areas. To be determined at Resource Consent stage. |
| Stormwater conveyance | • Convey runoff generated from the 10 % AEP flows through the stormwater network to the receiving environment.<br>• Allowance for runoff flows greater than the 10 % AEP flows should be made in overland flow paths | •Protection of overland flow paths |

***Table 10 – Stormwater Management Summary***

# 10. Whenuapai East Precinct Provisions

The proposed stormwater management for the development are outlined in the Whenuapai East Precinct Provisions, which are consistent with the recommendations detailed in this Stormwater Management Plan.

The provisions require subdivision and development to be consistent with any approved stormwater management plan, which aligns with Auckland Council's NDC and Schedule 4 for greenfield developments.

Adoption of this stormwater management plan under the NDC and implementation under the precinct provisions will achieve appropriate stormwater outcomes that are consistent with Auckland Council requirements and standards.

The Whenuapai East Precinct stormwater provisions are summarised below.

- *Objective 5 - Subdivision and development are integrated and sequenced with the upgrade and delivery of infrastructure.*
- *Objective 7 - Avoid, as far as practicable or otherwise remedy or mitigate the effects of subdivision, use and development, including stormwater management, on the operation and activities of RNZAF Base Auckland.*
- *Policy 5 - Require publicly reticulated stormwater, water and wastewater infrastructure to be available to service new residential lots.*
- *Policy 8. Require subdivision and development to be consistent with any approved stormwater management plan including by:*
    - *requiring management of runoff from all impervious surfaces to minimise effects on water quality and protect the health of the receiving environment;*
    - *promoting treatment at-source to achieve water quality and hydrology mitigation; and*
    - *requiring appropriate design, sizing and location of all stormwater outfalls, including having regard to the location of archaeological sites in the coastal environment.*
- *Policy 9. Require subdivision, use and development including stormwater management to avoid, remedy or mitigate adverse effects, including reverse sensitivity effects and safety risks relating to bird strike, lighting and glare on the operation and activities of RNZAF Base Auckland.*

***IX.6.8 Stormwater management***

*Purpose:*

- *To ensure that there is sufficient stormwater infrastructure capacity in place at the time of*

*development.*

- *To ensure that stormwater in the Precinct is managed and treated, to ensure flood risk is not increased, and the health and ecological values of the streams and coastal environments are improved or maintained.*
- *To manage reverse sensitivity effects on RNZAF Base Auckland, including in relation to bird strike.*

*(1) All land use and development shall be managed in accordance with approved Stormwater Management Plan certified by the Stormwater network utility operator.*

*(2) The discharge of stormwater runoff from subdivision and development cannot occur until the necessary stormwater infrastructure as determined by the Stormwater Management Plan required by sub-clause (1) is in place.*

*(3) Stormwater runoff from all impervious areas other than roofs must be either:*

*a. treated at-source by a stormwater management device or system that is sized and designed in accordance with 'Guidance Document 2017/001 Stormwater Management Devices in the Auckland Region (GD01)'; or*

*b. treated by a communal stormwater management device or system that is sized and designed in accordance with 'Guidance Document 2017/001 Stormwater Management Devices in the Auckland Region (GD01)' that is designed and authorised to accommodate and treat stormwater from the site.*

*(4) Stormwater runoff from roofs must be from inert building materials.*

# 11. Recommendations

The stormwater principles outlined in this report are adopted for the Plan Change area.

We recommend that Auckland Council approve the Stormwater Management Plan under the Plan Change and adopt under the Auckland Council Network Discharge Consent (NDC)

# Appendices

Appendix A – Proposed Stormwater Catchments


N



## Legend

- Permanent Stream
- Intermittent Stream
- Wetland
- Catchment A
- Catchment B
- Catchment C
- Catchment D
- Catchment E
- Proposed Stormwater Discharge Location
- Indicative Communal Bioretention Device (locations to be confirmed at Resource Consent stage)

CABRA
LAND & PROPERTY DEVELOPMENT

| REV | DATE | REVISION DETAILS | ISSUED |
|---|---|---|---|
| A | 10/06/24 | FOR CONSENT | TL |
| B | 30/07/24 | FOR CONSENT | TL |
| C | 17/06/25 | FOR CONSENT | TL |

CAPTURE
Land Development Consultants

CLIENT
CABRA DEVELOPMENTS LTD

PROJECT
WHENUAPAI PLAN CHANGE

DRAWING TITLE
PROPOSED STORMWATER CATCHMENTS

| STATUS | SCALE | SIZE |
|---|---|---|
| FOR CONSENT | 1:3000 | A3 |

| PROJECT | DRAWING NO | REVISION |
|---|---|---|
| 500 | 450 | C |

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## Appendix B – Flood Hazard Risk Assessment

## AUP Chapter E36.9 OLFP/Flood Hazard Risk Assessment

**Prepared by** Capture Land Ltd

**Site Address:** 15, 17 and 17A Clarks Lane and 10, 12, 14 and 16 Sinton Road
**Application No:**

| | Risk |
|---|---|
| **(a) The frequency, duration and scale of the flooding hazard;** | |
| *The site is identified on Auckland Council's Geomaps as being partially within a 1% AEP flood plain through the central portion of 15 and 17 Clarks Lane. This overland flowpath extends from Clarks Lane through the plan change area to Waiarohia Inlet. This overland flowpath is shown on plan 1100-450-A in Appendix A of the Stormwater Management Plan prepared by Capture Land Ltd. An assessment of the flooding hazard has been completed by AECOM and Auckland Council Ltd and published on the Auckland Council GIS - Whenuapai RFHA Model Update 2023. This model has been updated in 2023 to use a constant tideal boundary conditoin of 2.89m R.L. (Auckland Vertical Datum 1946) and Climate Change at 3.8 degrees. The extent of this flooding event is minor and will be temporary in nature.* | low |
| **(b) The type of activity being undertaken and its vulnerability to flooding events;** | |
| *The proposed activity use for the site is for residential activity including platforms, roads and driveways. The design will be completed in order to minimise the flood depth and ensure the upper catchment is conveyed through the site without impacting the residential activity. The existing flood plain will be contained within a protected Riparian Covenant Area. Building platforms and vehicle parking areas will be designed so that they are not impacted by flooding.* | low |
| **(c) The consequences of a flooding event in relation to the proposed activity and the people likely to be involved in that activity** | |
| *The activity will manage and control the flooding overland flowpaths to avoid flood water entering habitable spaces by raising the levels at least 500mm above flood levels.* | low |
| **(d) The potential effects on public safety and on other property;** | |
| *The activity will manage and control the flooding overland flowpaths to ensure flood levels that travel along roads and driveways have been designed to ensure they are at a minimal depth and velocity to still allow for traffic and pedestrian manoeuvring to and from the residential lots. The upstream properties are not affected by the development as the upper catchment continues to be conveyed through the site.* | medium |
| **(e) Any exacerbation of an existing flooding hazard risks or creation of a new flooding hazard risk;** | |
| *The activity does not change any overland flowpaths or the general function of the flood plain. The existing vertical profile of the overland flowpaths are maintained as they were prior to the development. No change to the flooding on neighbouring properites is intended and the proposal does not create any new natural hazards.* | low |
| **(f) Whether any building, structure or activity located on land subject to natural hazards near the coast can be relocated in the event of severe coastal erosion, coastal storm inundation or shoreline retreat;** | |
| *The proposed zoning of Residential - Mixed Housing Suburban along the coastal environment will ensure that the proposed buildings on the new lots will be separated from the coastline. Stormwater Outlet Structures will be located at the head of Intermittent streams or discharging into permanent streams or natural inland wetlands where possible. This will ensure they will have minimal effect during natural hazards.* | low |
| **(g) The ability to use of non-structural solutions, such as planting or the retention or enhancement of natural landform buffers to avoid, remedy or mitigate the hazard, rather than hard engineering solutions or protection structures** | |
| *The planted riparian areas on the site to enhance the natural form to provide a soft barrier between the overland flowpath and the residential activity of the subdivision.* | low |
| **(h) The design and construction of buildings and structures to mitigate the effects of natural hazards;** | |
| *The finished floor level of all residential buildings will be raised at least 500mm above the 1% AEP flood levels.* | low |
| **(i) The effect of structures used to mitigate hazards on landscape values and public access;** | |
| *The riparian areas on the site will add landscape values of the overland flowpaths and surround stormwater structures to discourage public access. Public Access to Esplanade Reserves will be incorporated into the detailed design.* | low |
| **(j) Site layout and management to avoid or mitigate the adverse effects of natural hazards, including access and exit during a natural hazard event;** | |
| *The proposed activity will be designed to tie into the existing overland flowpaths and minimise the effect of the flood events on the surrounding residential subdivision. All residential lots are at least 500mm above adjacent flood levels. There are no properties downstream of the site which will be affected by flood levels.* | low |
| **(k) The duration of consent and how this may limit the exposure for more or less vulnerable activities to the effects of natural hazards including the effects of climate change; and** | |
| *The potential impact of climate change will be provided for in the stormwater design in accordance with AC SW CoP Version 4.* | low |
| **(l) Any measures and/ or plans proposed to mitigate the natural hazard or the effects of the natural hazard.** | |
| *Stormwater treatment and hydrological mitigation using the SMAF 1 rules are proposed.* | low |

## Appendix C – Stream Stability Assessment

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**Project Number 23849.000.004**

# Erosion Screening Assessment

15 Clarks Lane, Hobsonville, Auckland

Submitted to:
Cabra Consulting Ltd
Unit 9B
30 Foundry Road
Silverdale, Auckland 0932

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Figure 7: Cross-Section 4 Peak Flow Excess Shear

**ENGEO Document Control:**

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| 19/06/2025 | 2 | Revision Issued to Client | FS/SB | PF | JT |

# 1 Introduction

ENGEO Ltd was requested by Cabra Consulting Ltd to undertake an erosion screening assessment of the property at 15 Clarks Lane, Hobsonville, Auckland (herein referred to as 'the site'). The purpose of the assessment was to determine baseline pre-development stream channel erosion potential and the effects that development of the site may have on future stream erosion. This erosion assessment was conducted utilising Auckland Council's own Erosion Screen Tool (EST).

An erosion screening assessment was requested by Council in order to understand the susceptibility of the stream to hydraulic erosion and to anticipate the potential for stream incision and bank undercutting. This assessment will help to inform future planning and developments on the site. This work has been carried out in accordance with our signed agreement dated 30 July 2024.

Our scope of works includes:

- Completion of Erosion Screen Tool (EST) workbook calculations.
- Preparation of a technical memo for provision to Auckland Council to support a proposed plan change.

# 2 Site Description

The site comprises a 4.41 ha section of future urban zoned land accessed via Clarks Lane as seen in Figure 1. A permanent stream extends across the southwest corner of the site. Existing high-level mapping commissioned by Auckland Council (*Whenuapai Structure Plan Area WAR*; Morphum, 2016) indicates elevated erosion potential associated with the stream.

**Figure 1: Aerial Site Map**


*Aerial image of the site outlined in blue taken from Auckland Council GeoMaps.*

## 3 Site Walkover

A site walkover was carried out by ENGEO on 31 July 2024, and included observations of the water course section from the Clarks Lane culvert to immediately upstream of the private vehicle bridge at 17A Clarks Lane. Stream-bed step changes (shallow waterfalls) were observed in two locations, with weak rock exposed across the head of the waterfall. The area is inferred to be underlain by weak rock at comparatively shallow depth. The presence of weak rock will limit the potential for ongoing incision of the water course, and associated horizontal erosion of the adjacent streambanks.

Observations from the walkover were used as the basis for determining the positions of the EST sections presented in Section 4:

- Section 1: Upstream 'Headwater' Baseline.
- Section 2: Upstream of stream knick-point where low-lobe extends from within 15 Clarks Lane.
- Section 3: Downstream side of knick-point downstream of Section 2.
- Section 4: Downstream of knick-point and identified erosion potential area.

Site notes and selected photographs are presented in the Site Note Memo attached to this report.

# 4 Erosion Screening Assessment

## 4.1 Stream Sections

Four preliminary stream cross-sections were chosen based on aerial analysis and site observations undertaken by ENGEO and Capture Land Development Consultants (Capture; Client's appointed Civil engineers). These sections have been refined and entered into the EST. The location of these critical sections is shown in Figure 2. Figure 3 shows the approximate cross-section profiles.

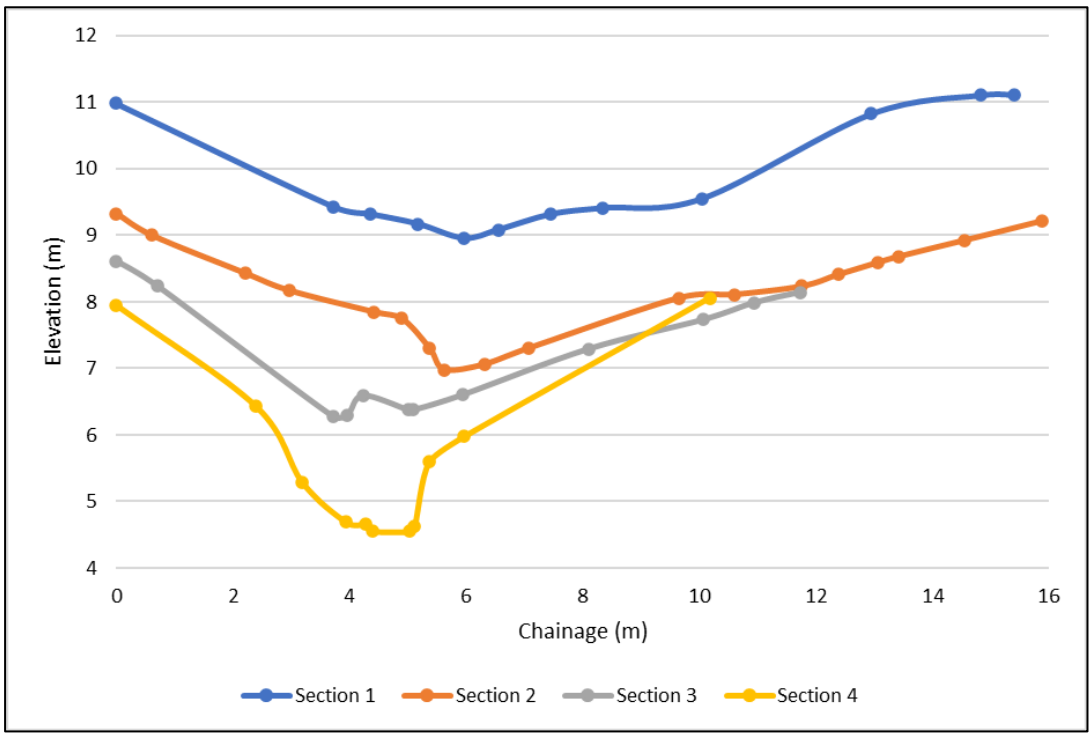
Capture have provided the contributing catchments pre and post development impervious and pervious areas used in the EST as shown in Table 1. The model includes a proposed reduction in catchment area post-development compared to existing conditions in Sections 2, 3, and 4 (Table 1). The post-development reduction in total catchment area is due to the civil design redirecting runoff from portions of the site directly to the coast in order to minimise onsite stormwater attenuation infrastructure.

No field testing of soil characteristics has been completed, therefore, a global default critical shear stress value of 20 Pa has been used in this study (Carno, 2017 as cited in Irvine et al., 2019). The adopted value is considered suitably conservative for the purpose of the desktop screening assessment in relation to a plan change.

**Figure 2: Approximate Cross-Section Locations**


Aerial image of the site with the concept plan overlain. The stream cross-sections are lined in red and numbered, identified overland flow paths from Auckland Council GeoMaps are lined in blue and the approximate 10 m stream setback is shown as a black dashed line.

**Figure 3: Cross-Section Profiles**




*Cross-Section profiles NZVD.*

There appears to be a potential knickpoint in the channel between cross-section 3 & 4 as observed in Figure 3. This indicates that there may be upstream channel bed erosion from the knickpoint during flooding events. This may cause downcutting and subsequent widening of the channel. However, as indicated in Section 3 the weak rock noted in the base of the stream channel may reduce the potential upstream erosion from the knickpoint.

**Table 1: Catchment Area Inputs**

| Pre-development | | Post Development | Pre-development | | | Post Development | | |
|---|---|---|---|---|---|---|---|---|
| **Cross Section 1** | | | Impervious Area | Pervious Area | % of Pervious | Impervious Area | Pervious Area | % of Pervious |
| | Total Area | Total Area | | | | | | |
| Catchment 1 | 87700 | 87700 | 35416 | 52284 | 60% | 35416 | 52284 | 60% |
| Catchment 2 | 102050 | 102050 | 19521 | 82529 | 81% | 20539 | 81511 | 80% |
| Catchment 3 | 5400 | 7014 | 0 | 5400 | 100% | 2431.1 | 4582.9 | 65% |
| Total m2 | 195150 | 196764 | | | | | | |
| Total km2 | **0.19515** | **0.196764** | **0.054937** | **0.140213** | **0.72** | **0.0583861** | **0.1383779** | **0.70** |
| **Cross Section 2** | | | Impervious Area | Pervious Area | % of Pervious | Impervious Area | Pervious Area | % of Pervious |
| | Total Area | Total Area | | | | | | |
| Catchment 1 | 87700 | 87700 | 35416 | 52284 | 60% | 35416 | 52284 | 60% |
| Catchment 2 | 102050 | 102050 | 19521 | 82529 | 81% | 19521 | 82529 | 81% |
| Catchment 3 | 5400 | 7014 | 0 | 5400 | 100% | 2431.1 | 4582.9 | 65% |
| Catchment 4 | 6800 | 3850 | 0 | 6800 | 100% | 254 | 3596 | 93% |
| Total m2 | 201950 | 200614 | | | | | | |
| Total km2 | **0.20195** | **0.200614** | **0.054937** | **0.147013** | **0.73** | **0.0576221** | **0.1429919** | **0.71** |
| **Cross Section 3** | | | Impervious Area | Pervious Area | % of Pervious | Impervious Area | Pervious Area | % of Pervious |
| | Total Area | Total Area | | | | | | |
| Catchment 1 | 87700 | 87700 | 35416 | 52284 | 60% | 35416 | 52284 | 60% |
| Catchment 2 | 102050 | 102050 | 19521 | 82529 | 81% | 19521 | 82529 | 81% |
| Catchment 3 | 5400 | 7014 | 0 | 5400 | 100% | 2431.1 | 4582.9 | 65% |
| Catchment 4 | 6800 | 3850 | 0 | 6800 | 100% | 254 | 3596 | 93% |
| Catchment 5 | 2100 | 1030 | 0 | 2100 | 100% | 0 | 1030 | 100% |
| Total m2 | 204050 | 201644 | | | | | | |
| Total km2 | **0.20405** | **0.201644** | **0.054937** | **0.149113** | **0.73** | **0.0576221** | **0.1440219** | **0.71** |
| **Cross Section 4** | | | Impervious Area | Pervious Area | % of Pervious | Impervious Area | Pervious Area | % of Pervious |
| | Total Area | Total Area | | | | | | |
| Catchment 1 | 87700 | 87700 | 35416 | 52284 | 60% | 35416 | 52284 | 60% |
| Catchment 2 | 102050 | 102050 | 19521 | 82529 | 81% | 19521 | 82529 | 81% |
| Catchment 3 | 5400 | 7014 | 0 | 5400 | 100% | 2431.1 | 4582.9 | 65% |
| Catchment 4 | 6800 | 3850 | 0 | 6800 | 100% | 254 | 3596 | 93% |
| Catchment 5 | 2100 | 1030 | 0 | 2100 | 100% | 0 | 1030 | 100% |
| Catchment 6 | 32000 | 32195 | 1913 | 30087 | 94% | 7870 | 24325 | 76% |
| Total m2 | 236050 | 233839 | | | | | | |
| Total km2 | **0.23605** | **0.233839** | **0.05685** | **0.1792** | **0.76** | **0.0654921** | **0.1683469** | **0.72** |

*Cross-Section contributing catchment and impervious area calculations provided by Capture Land Development Consultants.*

## 4.2 Hydrological Calculation

Hydrological calculations have been conducted using the EST from Auckland Council and design TP108 rainfall depths for a range of Average Return Intervals (ARI). TP108 design rainfall depths have been provided by Capture, with smaller ARI depths calculated using the smaller AEP calculation function in the EST as seen in Table 2.

**Table 2: Rainfall Depths**

| Rainfall Depth (P24) | Current Climate Rainfall Depth (mm) | RCP 8.5 Future Climate Rainfall Depth (mm) |
|---|---|---|
| 3month (400% ARI) * | 16 | 14 |
| 6month (200% ARI) * | 42 | 49 |
| 1year (100% ARI) * | 68 | 84 |
| 2 YEAR (50% ARI) | 92.7 | 118 |
| 5 YEAR (20% ARI) | 128.0 | 166 |
| 10 YEAR (10% ARI) | 158.5 | 207 |
| 100 YEAR (1% ARI) | 239.5 | 318 |
| * value calculated by using smaller AEP calculation table. | | |

*TP108 derived rainfall depths for the site provided by Capture Land Development Consultants.*

## 4.3 Excess Shear Stress

The EST uses excess shear stress as a metric (ratio) representing how much the hydraulic forces applied by the stream flow differ from the resisting forces provided by the bed and banks. Excess shear stress is estimated using boundary shear stress divided by the critical shear stress.

The values obtained are then categorised and displayed in four threshold colour categories, as seen in Table 3. Stream reaches with an excess shear stress of between 0 – 1 are predicted to be stable, 1 – 2 is considered a potential for some erosion to occur, 2 – 10 erosion is predicted to be occurring, and > 10 significant and widespread erosion is predicted (Cardno, 2017, as cited in Irvine et al., 2019).

**Table 3: Excess Shear Stress**

| Threshold | Excess Shear | Description |
|---|---|---|
| Green | <1.0 | Indicates no erosion predicted to occur |
| Yellow | >1.0 <2.0 | Indicates the potential for some erosion of the channel |
| Orange | >2.0 <10.0 | Indicates the potential for channel to be mobile, (likely active erosion) |
| Red | >10.0 | Indicates potential rapid rates of erosion and incision of channel |

*Range of excess shear causing erosion (Fluvial erosion risk)*

## 4.4 Results and Findings

The results from the Erosion Screening Tool suggest that there is erosion potential of the stream at all four cross-sections. All cross-sections show increased erosion potential as a result of predicted climate change effects. Cross-sections 2 & 3 represent the greatest potential for erosion.

Post-development scenarios represent discernable impact on increasing erosion potential at all cross-sections, however this is considered by ENGEO to be no greater than minor. This is primarily due to the development of onsite stormwater management reducing the contributing catchment sizes and directing on-site stormwater into the nearby estuary.

The greatest potential for increased erosion is related to anticipated climate change effects.

### 4.4.1 Cross-Section 1

Table 4 and Figure 4 show the results of excess shear stress pre- and post-development at Cross-Section 1 with existing climate and RCP8.5 future climate change design rainfall values. Model results indicate that there is the potential for some erosion of the channel under existing conditions.

Modelling of pre- and post-development cases under current climate and future climate change scenarios indicates that development of the site will slightly increase erosion risk based on altered site hydrology. There is an increase in the erosion potential at Cross-Section 1 when current climate is compared with future climate modelled values. The EST indicates that there is the for the channel to be mobile (likely active erosion).

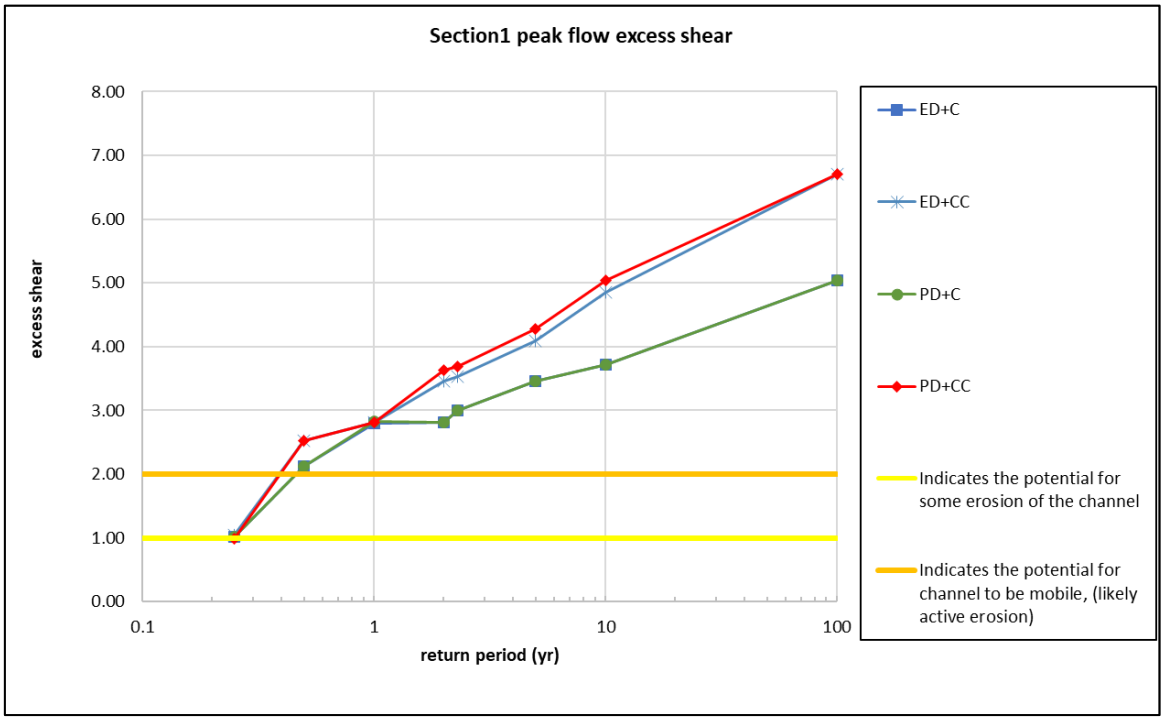
Table 4, 5, 6, and 7 all present the period of time (in minutes) over a 24-hour design storm period that the relevant Cross-Section is subject to each excess shear threshold.

### Table 4: Cross-Section 1 Excess Shear Exceedance

| return period (yr) | 0.25 | 0.5 | 1 | 2 | 2.30 | 5 | 10 | 100 |
|---|---|---|---|---|---|---|---|---|
| Cross Section 1 - Existing Development Current Climate | | | | | | | | |
| boundary shear stress at peak (N/m2) | 20.45 | 42.39 | 56.09 | 56.32 | 60.11 | 69.25 | 74.43 | 100.67 |
| excess shear at peak | 1.02 | 2.12 | 2.80 | 2.82 | 3.01 | 3.46 | 3.72 | 5.03 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1420 | 1170 | 570 | 470 | 430 | 370 | 320 | 190 |
| >1 & <2 (min) | 20 | 250 | 800 | 870 | 890 | 880 | 870 | 720 |
| >2 & <10 (min) | 0 | 20 | 70 | 100 | 120 | 190 | 250 | 530 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cross Section 1 - Existing Development Climate Change | | | | | | | | |
| boundary shear stress at peak (N/m2) | 20.82 | 50.51 | 56.32 | 69.25 | 70.57 | 81.94 | 96.93 | 134.11 |
| excess shear at peak | 1.04 | 2.53 | 2.82 | 3.46 | 3.53 | 4.10 | 4.85 | 6.71 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1430 | 970 | 540 | 440 | 410 | 350 | 300 | 190 |
| >1 & <2 (min) | 10 | 440 | 810 | 830 | 840 | 830 | 820 | 700 |
| >2 & <10 (min) | 0 | 30 | 90 | 170 | 190 | 260 | 320 | 550 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cross Section 1 - Post Development Current Climate | | | | | | | | |
| boundary shear stress at peak (N/m2) | 20.45 | 42.39 | 56.41 | 56.32 | 60.11 | 69.25 | 74.43 | 100.67 |
| excess shear at peak | 1.02 | 2.12 | 2.82 | 2.82 | 3.01 | 3.46 | 3.72 | 5.03 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1420 | 1160 | 570 | 460 | 430 | 360 | 310 | 190 |
| >1 & <2 (min) | 20 | 260 | 800 | 880 | 890 | 890 | 870 | 710 |
| >2 & <10 (min) | 0 | 20 | 70 | 100 | 120 | 190 | 260 | 540 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cross Section 1 - Post Development Climate Change | | | | | | | | |
| boundary shear stress at peak (N/m2) | 19.90 | 50.51 | 56.32 | 72.72 | 73.79 | 85.69 | 100.67 | 134.11 |
| excess shear at peak | 1.00 | 2.53 | 2.82 | 3.64 | 3.69 | 4.28 | 5.03 | 6.71 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1420 | 970 | 520 | 430 | 400 | 350 | 290 | 170 |
| >1 & <2 (min) | 20 | 430 | 830 | 840 | 850 | 820 | 820 | 710 |
| >2 & <10 (min) | 0 | 40 | 90 | 170 | 190 | 270 | 330 | 560 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Cross-Section 1 excess shear exceedance (min) for all four development and climate scenarios.*

**Figure 4: Cross-Section 1 Peak Flow Excess Shear**




*Cross-Section 1 peak flow excess shear for all four development and climate scenarios. ED refers to Existing Development, PD refers to Post Development, C refers to Current climate and CC refers to Climate Change.*

### 4.4.2 Cross-Section 2

Table 5 and Figure 5 show the results of excess shear stress pre- and post-development at Cross-Section 2 with existing climate and climate change design rainfall values. Model results indicate that there is a higher potential for channel erosion under pre-development scenarios when compared with upstream Cross-Section 1. Modelling of pre- and post-development cases under current climate and future climate change scenarios indicates that development on the site will slightly increase erosion risk through altered site hydrology.

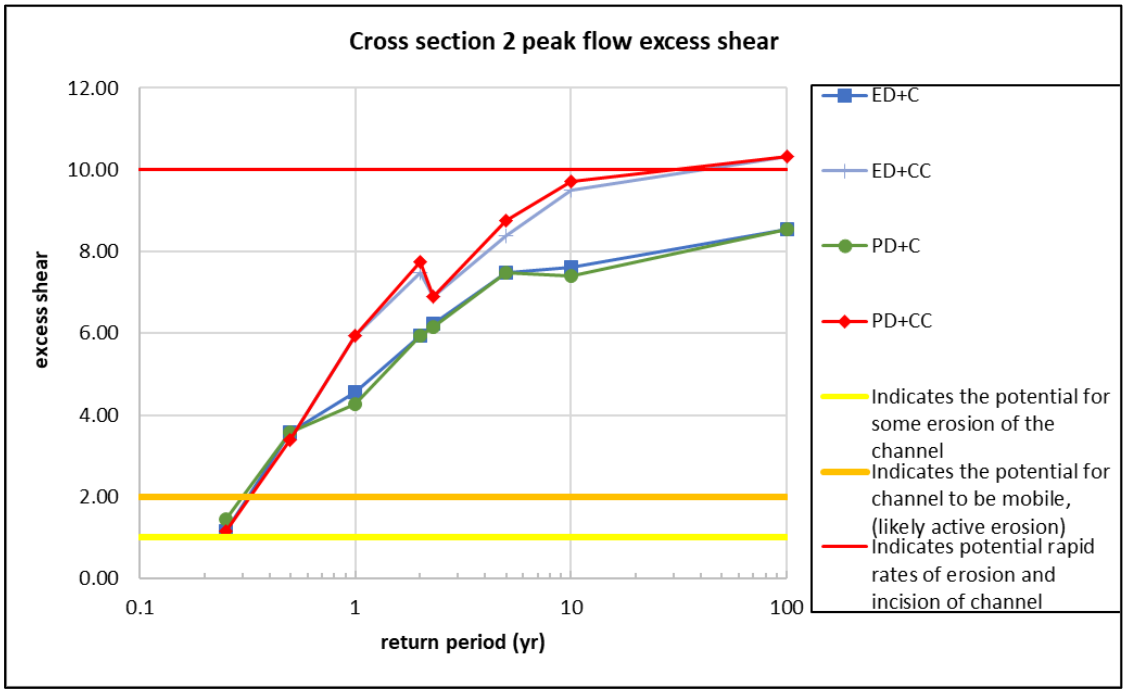
Modelling of pre- and post-development cases under current and future climate change scenarios indicates that climate change will increase erosion risk (based on altered site hydrology), to exceed the red threshold. This indicates the potential for rapid rates of erosion and incision of the channel during 100 yr future climate flooding. Development on the site will slightly impact the erosion potential, as seen in Figure 5 with climate change factors having the greater impact on erosion potential.

### Table 5: Cross-Section 2 Excess Shear Exceedance

| return period (yr) | 0.25 | 0.5 | 1 | 2 | 2.30 | 5 | 10 | 100 |
|---|---|---|---|---|---|---|---|---|
| Section 2 Existing Development Current Climate | | | | | | | | |
| boundary shear stress at peak (N/m2) | 23.16 | 71.60 | 91.04 | 118.98 | 124.42 | 149.67 | 152.01 | 170.73 |
| excess shear at peak | 1.16 | 3.58 | 4.55 | 5.95 | 6.22 | 7.48 | 7.60 | 8.54 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1410 | 1020 | 550 | 440 | 410 | 360 | 350 | 180 |
| >1 & <2 (min) | 30 | 330 | 650 | 570 | 550 | 190 | 90 | 180 |
| >2 & <10 (min) | 0 | 90 | 240 | 430 | 480 | 890 | 1000 | 1080 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Section 2 Existing Development Climate Change | | | | | | | | |
| boundary shear stress at peak (N/m2) | #N/A | 67.89 | 118.98 | 149.67 | 137.75 | 167.60 | 190.15 | 206.54 |
| excess shear at peak | #N/A | 3.39 | 5.95 | 7.48 | 6.89 | 8.38 | 9.51 | 10.33 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1430 | 990 | 540 | 410 | 390 | 360 | 350 | 170 |
| >1 & <2 (min) | 10 | 300 | 470 | 580 | 520 | 150 | 50 | 190 |
| >2 & <10 (min) | 0 | 150 | 430 | 450 | 530 | 930 | 1040 | 1070 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| Section 2 Post Development Current Climate | | | | | | | | |
| boundary shear stress at peak (N/m2) | 28.88 | 71.60 | 85.31 | 118.98 | 123.27 | 149.67 | 148.02 | 170.73 |
| excess shear at peak | 1.44 | 3.58 | 4.27 | 5.95 | 6.16 | 7.48 | 7.40 | 8.54 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1410 | 1010 | 540 | 440 | 400 | 360 | 350 | 170 |
| >1 & <2 (min) | 30 | 340 | 660 | 570 | 560 | 190 | 100 | 190 |
| >2 & <10 (min) | 0 | 90 | 240 | 430 | 480 | 890 | 990 | 1080 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Section 2 Post Development Climate Change | | | | | | | | |
| boundary shear stress at peak (N/m2) | 23.16 | 67.89 | 118.98 | 154.78 | 137.75 | 175.16 | 194.42 | 206.54 |
| excess shear at peak | 1.16 | 3.39 | 5.95 | 7.74 | 6.89 | 8.76 | 9.72 | 10.33 |
| excess shear exceedance (min) | | | | | | | | |
| <1 (min) | 1430 | 1000 | 530 | 400 | 380 | 360 | 350 | 160 |
| >1 & <2 (min) | 10 | 300 | 480 | 590 | 530 | 150 | 40 | 190 |
| >2 & <10 (min) | 0 | 140 | 430 | 450 | 530 | 930 | 1050 | 1080 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |

*Cross-Section 2 excess shear exceedance (min) for all four development and climate scenarios.*

**Figure 5: Cross-Section 2 Peak Flow Excess Shear**




Cross-Section 2 peak flow excess shear for all four development and climate scenarios.

### 4.4.3 Cross-Section 3

Table 6 and Figure 6 show the results of excess shear stress pre- and post-development at Cross-Section 3 considering both existing climate and climate change design rainfall values.

Model results indicate that there is the potential for erosion of the channel under pre-development scenarios. The model also indicates that Cross-Section 3 has a higher likelihood of erosion than upstream Cross-Sections 1 and 2. Modelling of pre- and post-development cases under current and future climate scenarios indicates that future climate change will increase erosion risk (based on altered site hydrology), to exceed the red threshold.

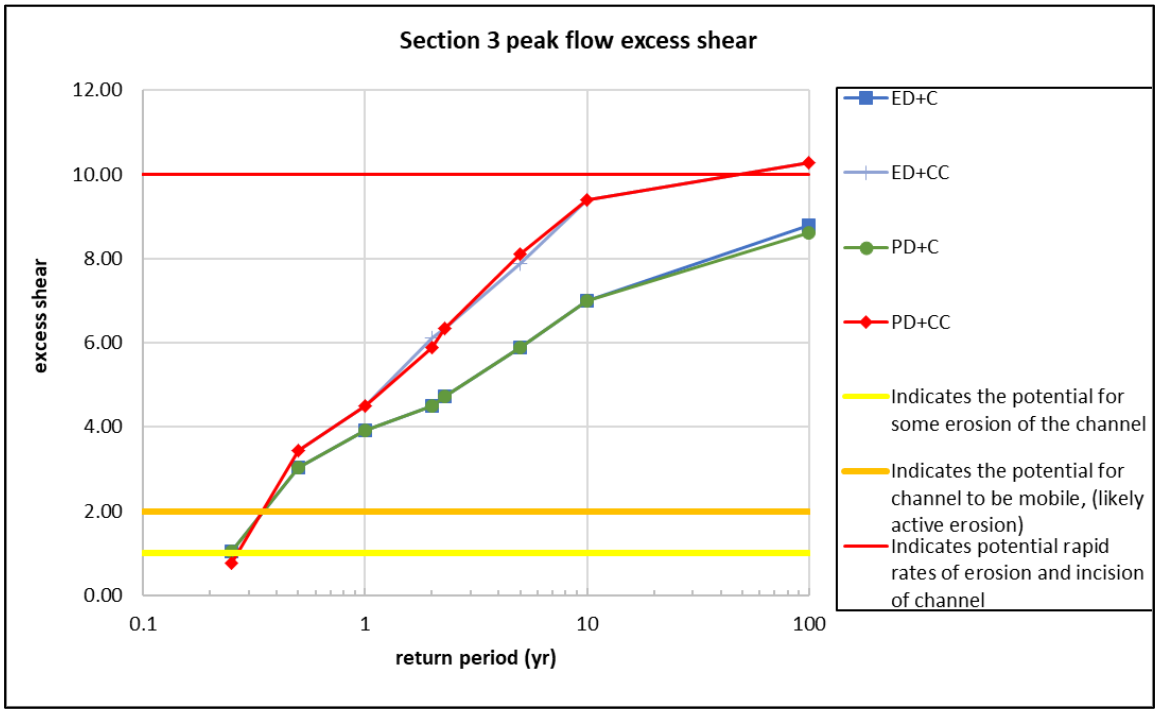
This indicates the potential for rapid rates of erosion and incision of the channel during 100 yr future climate flooding. Development on the site will likely have a slight impact on erosion potential, with climate change factors having the greater impact on erosion potential as seen in Figure 6.

### Table 6: Cross-Section 3 Excess Shear Exceedance

| return period (yr) | 0.25 | 0.5 | 1 | 2 | 2.30 | 5 | 10 | 100 |
|---|---|---|---|---|---|---|---|---|
| Scenario 1 ED+C | | | | | | | | |
| boundary shear stress at peak (N/m2) | 20.96 | 60.77 | 78.21 | 90.16 | 94.76 | 117.58 | 140.04 | 175.83 |
| excess shear at peak | 1.05 | 3.04 | 3.91 | 4.51 | 4.74 | 5.88 | 7.00 | 8.79 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1420 | 1020 | 580 | 480 | 440 | 370 | 350 | 200 |
| >1 & <2 (min) | 20 | 340 | 650 | 690 | 550 | 560 | 190 | 170 |
| >2 & <10 (min) | 0 | 80 | 210 | 270 | 450 | 510 | 900 | 1070 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 2 ED+CC | | | | | | | | |
| boundary shear stress at peak (N/m2) | #N/A | 68.72 | 90.16 | 122.11 | 126.61 | 157.71 | 187.90 | 205.80 |
| excess shear at peak | #N/A | 3.44 | 4.51 | 6.11 | 6.33 | 7.89 | 9.39 | 10.29 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1440 | 1010 | 540 | 430 | 410 | 360 | 350 | 190 |
| >1 & <2 (min) | 0 | 340 | 660 | 580 | 550 | 520 | 120 | 170 |
| >2 & <10 (min) | 0 | 90 | 240 | 430 | 480 | 560 | 970 | 1070 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |
| Scenario 3 PD+C | | | | | | | | |
| boundary shear stress at peak (N/m2) | 20.96 | 60.77 | 78.21 | 90.16 | 94.76 | 117.58 | 140.04 | 172.11 |
| excess shear at peak | 1.05 | 3.04 | 3.91 | 4.51 | 4.74 | 5.88 | 7.00 | 8.61 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1410 | 1030 | 580 | 480 | 430 | 360 | 350 | 200 |
| >1 & <2 (min) | 30 | 340 | 670 | 690 | 560 | 580 | 270 | 160 |
| >2 & <10 (min) | 0 | 70 | 190 | 270 | 450 | 500 | 820 | 1080 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 4 PD+CC | | | | | | | | |
| boundary shear stress at peak (N/m2) | 15.26 | 68.72 | 90.16 | 117.58 | 126.61 | 162.08 | 187.90 | 205.80 |
| excess shear at peak | 0.76 | 3.44 | 4.51 | 5.88 | 6.33 | 8.10 | 9.39 | 10.29 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1440 | 1010 | 550 | 440 | 400 | 360 | 350 | 190 |
| >1 & <2 (min) | 0 | 330 | 650 | 560 | 550 | 530 | 120 | 170 |
| >2 & <10 (min) | 0 | 100 | 240 | 440 | 490 | 550 | 970 | 1070 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |

*Cross-Section 3 excess shear exceedance (min) for all four development and climate scenarios.*

**Figure 6: Cross-Section 3 Peak Flow Excess Shear**




*Cross-Section 3 peak flow excess shear for all four development and climate scenarios.*

### 4.4.4 Cross-Section 4

Table 7 and Figure 7 show the results of excess shear stress pre- and post-development at Cross-Section 4 under both existing climate and climate change scenarios. Model results indicate potential for erosion of the channel under pre-development conditions. When compared to upstream Cross-Sections 2 and 3, Section 4 has a lower erosion potential.

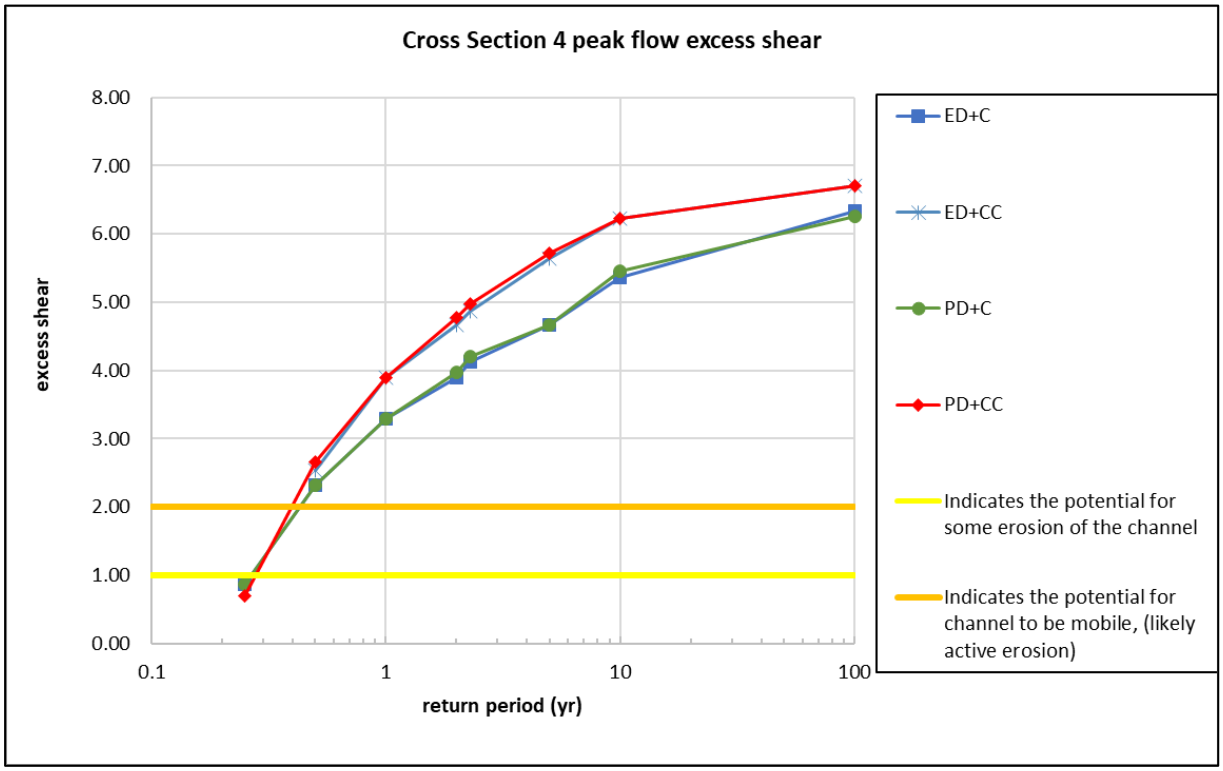
Modelling of pre- and post-development cases under current climate and future climate change scenarios indicates that climate change will increase erosion risk (based on altered site hydrology), more than development of the site will. Therefore, development of the site will likely have a slight impact on erosion potential, with climate change factors having the greater impact on erosion potential.

**Table 7: Cross-Section 4 Excess Shear Exceedance**

| return period (yr) | 0.25 | 0.5 | 1 | 2 | 2.30 | 5 | 10 | 100 |
|---|---|---|---|---|---|---|---|---|
| Scenario 1 ED+C | | | | | | | | |
| boundary shear stress at peak (N/m2) | 17.20 | 46.46 | 65.92 | 77.89 | 82.61 | 93.18 | 107.16 | 126.57 |
| excess shear at peak | 0.86 | 2.32 | 3.30 | 3.89 | 4.13 | 4.66 | 5.36 | 6.33 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1440 | 1360 | 1200 | 1010 | 960 | 870 | 470 | 360 |
| >1 & <2 (min) | 0 | 50 | 170 | 320 | 320 | 340 | 680 | 540 |
| >2 & <10 (min) | 0 | 30 | 70 | 110 | 160 | 230 | 290 | 540 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 2 ED+CC | | | | | | | | |
| boundary shear stress at peak (N/m2) | #N/A | 50.77 | 77.89 | 93.18 | 97.46 | 112.71 | 124.56 | 134.19 |
| excess shear at peak | #N/A | 2.54 | 3.89 | 4.66 | 4.87 | 5.64 | 6.23 | 6.71 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1440 | 1320 | 1110 | 990 | 940 | 540 | 410 | 360 |
| >1 & <2 (min) | 0 | 80 | 230 | 260 | 270 | 610 | 560 | 470 |
| >2 & <10 (min) | 0 | 40 | 100 | 190 | 230 | 290 | 470 | 610 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 3 PD+C | | | | | | | | |
| boundary shear stress at peak (N/m2) | 17.20 | 46.46 | 65.92 | 79.51 | 84.08 | 93.18 | 108.96 | 124.98 |
| excess shear at peak | 0.86 | 2.32 | 3.30 | 3.98 | 4.20 | 4.66 | 5.45 | 6.25 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1440 | 1360 | 1200 | 1010 | 960 | 870 | 460 | 360 |
| >1 & <2 (min) | 0 | 50 | 170 | 310 | 330 | 340 | 680 | 540 |
| >2 & <10 (min) | 0 | 30 | 70 | 120 | 150 | 230 | 300 | 540 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Scenario 4 PD+CC | | | | | | | | |
| boundary shear stress at peak (N/m2) | 13.90 | 53.31 | 77.89 | 95.35 | 99.51 | 114.27 | 124.56 | 134.19 |
| excess shear at peak | 0.70 | 2.67 | 3.89 | 4.77 | 4.98 | 5.71 | 6.23 | 6.71 |
| excess shear excedence (min) | | | | | | | | |
| <1 (min) | 1440 | 1300 | 1060 | 1000 | 930 | 530 | 400 | 350 |
| >1 & <2 (min) | 0 | 100 | 280 | 250 | 280 | 610 | 560 | 470 |
| >2 & <10 (min) | 0 | 40 | 100 | 190 | 230 | 300 | 480 | 620 |
| >10 (min) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

*Cross-Section 4 excess shear exceedance (min) for all four development and climate scenarios.*

**Figure 7: Cross-Section 4 Peak Flow Excess Shear**




*Cross-Section 4 peak flow excess shear for all four development and climate scenarios.*

## 4.5 Assumptions and Uncertainties

As specific testing for on-site critical yield stress values was not conducted, a default critical yield stress value of 20 N/m2 has been used for this assessment. This value relates to a soft soil stiffness and is considered low and conservative for a cohesive soil with high clay content (Irvine et al., 2019; Zhou, 2020).

Cross-Sections chosen are assumed to be representative of the majority of the stream channel and provide sufficient stream coverage to ensure erosion screening is representative for the stream channel.

Riparian vegetation cover on the stream banks has only been included in this assessment as Manning's n values. Riparian vegetation may mitigate potential erosion risk more than is expected from the EST modelling.

The current EST version is understood to be a beta version tool developed by Auckland Council. While efforts have been made to ensure all equations in the model are correct, ENGEO has taken the developers own QA/QC at face-value. ENGEO has not undertaken a holistic check of the models' code stability or analytical basis, nor the suitability of the level of parameterisation / simplification.

Notwithstanding, the use of the EST is considered a suitable tool for high-level review and identification of potential 'problem areas' at the conceptual development phase.

# 5 Analysis

Based on modelling results in Section 4.4, development of the site will likely have only a minor impact on the potential erosion risk of the stream channel. The potential for erosion stays within the same erosion threshold bands when considering development but jumps to a higher threshold band when climate change is considered. Therefore, future climate change factors will likely have more of an impact on the erosion risk than development will have. However, development of the site will cause a slight increase in erosion potential of the stream. It should be noted that pre-development screening demonstrates existing erosion potential, which needs to be considered as part of detailed design, to ensure appropriate setback of building from any potential erosion zone or erosion mitigation measures required at a later date.

The erosion screening tool suggests that climate change will likely increase the erosion potential and mobilisation of the stream. Climate change will cause larger flows in the stream, leading to widening and (nominally) deepening of the channel. The inferred presence of weak rock is anticipated to restrict the deepening of the stream channel. Erosion will likely occur regardless of development and therefore, design should take this into consideration by allowing sufficient stream setback.

In order to help mitigate effects, a minimum 15 m building setback should be implemented along the stream, and measures such as riparian planting, recontouring and toe armouring should be considered in the detailed design phase. Incorporation of toe armouring should consider the practicality of keying the armour-rock blanket into the underlying weak rock to mitigate against potential under-cutting.

It is considered that engineering solutions for stream bank stabilisation, such as toe armouring, can be achieved without the need for direct stream bed stabilisation, and in a manner that generally constrains the long-term considerations to within a 10 m margin. To support this, a 15 m setback is recommended to allow for a 5 m width in which engineering stabilisation measures can be constructed without intruding on the standard 10 m riparian margin (i.e. 15 m total setback)

Notwithstanding, the current concept design does not include any built structures within approximately 20 m of the stream channel, with the adjacent section of land scheduled as open space. Consequently the current layout allows for additional setback along the meander itself where the highest erosion potential is anticipated. Therefore, should the 15 m setback be insufficient (i.e. 5 m design width) at the detailed design stage, additional room is available for increased setback without necessitating intrusion into the 10 m riparian margin.

The area of exception to the above, (i.e. the area we consider to be more susceptible to erosion), is the knickpoint and channel bends between cross-sections 3 & 4 which will need additional consideration. It is noted that the scheduled open space area (Figure 2) extends perpendicular to Clarks Lane, and is therefore sub-parallel to the undulating stream. Adjacent to the knick-point, the furthest limit of the scheduled open space is in excess of 30 m from the stream channel. The riparian margin is not anticipated to strictly parallel the undulating stream channel, and adjacent to the knick-point will extend in a straight line. While in stream erosion protection measures such as woody weirs and rock lining may be considered during the detailed design phase, it is recommended that erosion protection measures be designed set back from the channel within the additional building setback space.

# 6 Recommendations

In order to help mitigate the potential erosion effects and stream channel movements it is recommended that there is a 15 m minimum setback from the stream channel to any developed buildings on the development side of the stream (eastern side). The current concept plan allows for the minimum 15 m setback as well as approximately 5 m of additional space (from 15 m to 20 m distance from the stream) to the nearest building should detailed design require more than the 5m design corridor (i.e. 10 m to 15 m distance from stream). To aid in reducing stream widening and mobilisation we recommend appropriate erosion protection measures are designed during the detailed design phase.

During detailed design we recommend that a more detailed hydraulic assessment of stream velocities and field testing of bank parameters such as shear stress is undertaken to support the design of appropriate erosion protection measures in identified erosion susceptible locations.

Detailed design assessments will need to consider not only horizontal erosion away from the stream, but also vertical changes due to the presence of knick-points in the watercourse. In particular, the northern-most knick-point (between Section 3 and Section 4), with a head cut of approximately 1-2 m, will require consideration of ‘stepped’ engineering stabilisation measures in sympathy to both the existing stream bed change and potential vertical changes from ongoing erosion.

# 7 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Cabra Consulting Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on qualitative site observations and information indicated from published sources as described in this report. Only a limited amount of information has been collected to meet the specific technical requirements of the client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between Cross-Section locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

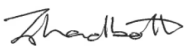
iii. This Limitation should be read in conjunction with the Engineering NZ/ACENZ Standard Terms of Engagement.

iv. This report is not to be reproduced either wholly or in part without our prior written permission.

v. This report has been produced with an unpublished version of the Erosion Screen Tool which is currently open to feedback and changes. Therefore, any errors or problems with the tool may not have been realised or fixed at the time of creating this report.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (09) 972 2205 if you require any further information.

Report prepared by



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Report reviewed by

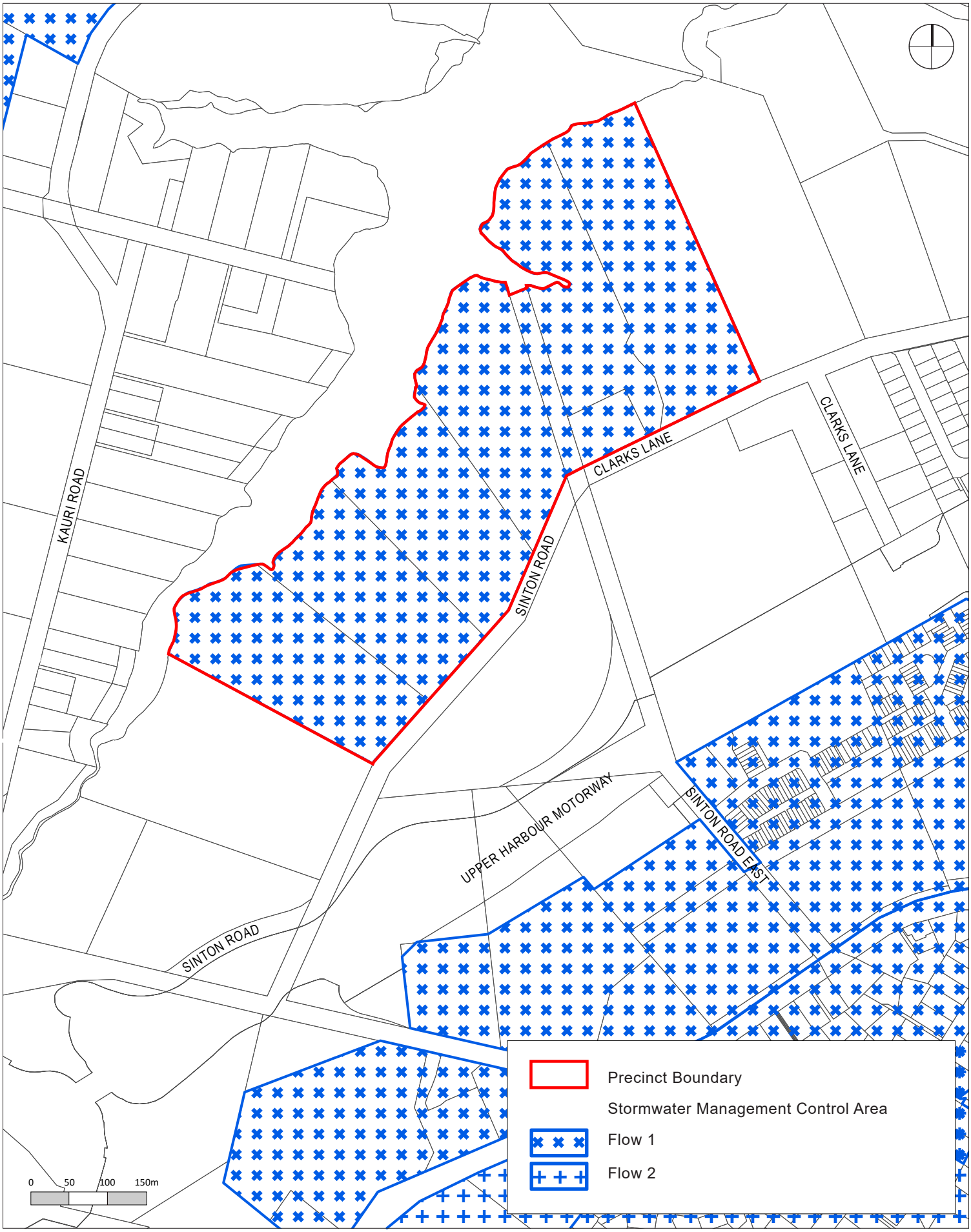
**Paul Fletcher, CMEngNZ (CPEng)**
Principal Geotechnical Engineer

# 8 References

Irvine, J., Brown, N., Speed, S., & Simon, A. (2019). *Auckland's Approach to the Stream Erosion Problem.* Stormwater Conference and Expo.

Zhou, J. (2020). Assessment of Stream Erosion in Greenfield Development . *Memo*. Auckland Council.

## Appendix D – SMAF Flow 1 Overlay Map




# WHENUAPAI EAST STORMWATER MANAGEMENT CONTROL AREA