Whenuapai 3 Precinct:

Stormwater Management Plan

September 2017

Healthy Waters

Infrastructure and Environmental Services

Auckland Council

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Whenuapai Stormwater Management Plan (SMP) Update – Final. Prepared for Healthy Waters by AECOM New Zealand Ltd (dated 10 July 2017)

Additional material relevant to the Whenuapai 3 Precinct area has also been utilised, as referenced in the summary.

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Whenuapai 3 Precinct: Stormwater Management Plan

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1. Introduction

1.1 Context

This document summarises the Whenuapai Stormwater Management Plan (SMP) Update - Final[1] (Whenuapai SMP) and outlines stormwater management requirements as they relate to the '***Whenuapai 3 Precinct***' (W3P) sub-catchment (refer Figure 1).

W3P is located approximately 23 kilometres northwest of central Auckland on either side of the Upper Harbour Motorway. The Waiarohia Inlet is to the northeast.

Figure 1: Whenuapai 3 Precinct location

1.2 Purpose

The W3P SMP has been produced to promote and support best practice sustainable urban development at Whenuapai for the Auckland Council led Whenuapai Structure Plan process. This is in accordance with the direction provided by the statutory framework (refer Section 3.4) that includes national and regional policy instruments including the New Zealand Coastal Policy Statement(NZCPS), the National Policy Statement for Freshwater Management (NPSFM, Hauraki Gulf Marine Park Act 2000 (HGMPA) and Auckland Unitary Plan (Operative in Part) (AUP (OP)).

The W3P SMP gives effect to the Auckland Stormwater Network Discharge Consent (NDC) application. This application seeks to authorise stormwater diversion and discharges from Auckland's existing and future urban areas. Once granted, the Auckland Stormwater NDC will authorise the diversion and discharge of stormwater from future development areas, provided specified stormwater management requirements are met or alternatively that development is undertaken in accordance with the requirements of an approved SMP.

The purpose of this SMP is to direct the stormwater management response in the context of the W3P catchment's receiving environments, proposed development and existing stormwater management issues/ opportunities. While

[1] AECOM New Zealand Ltd (dated 10 July 2017)

the W3P SMP provides overarching guidance for stormwater management across the precinct, it is anticipated that delivery will be undertaken by developers. Accordingly, the W3P SMP outlines the outcomes sought, minimum requirements and other considerations (such as environmental enhancement potential). However, there is flexibility for developers to determine how the requirements are met and the extent to which these are achieved on-site or through communal infrastructure and devices within and across developments.

The W3P SMP is in turn given effect to by the Whenuapai 3 Precinct Plan change, which includes the objectives, policies and rules that apply to the subdivision and development of W3P.

2. Catchment and Receiving Environments

2.1 Topography & Geology

WP3 is comprised of mainly flat to rolling land, with localised areas of steeper terrain around incised channels and low-level escarpments at the coastal margins. There are a few areas with steeper slopes associated with ridgelines towards the south of W3P, but the catchment is predominantly low-lying.

The geological units in the Whenuapai catchment area are largely composed of the East Coast Bays Formation (Waitematā Group) which forms the area's steeper slopes, and Puketoka Formation which forms the gently sloping and low-lying areas. Undifferentiated alluvium occurs within narrow gullies and flood plains around stream margins throughout the catchment. The soil types in the catchment area generally follow the make-up of the underlying geology, and are mostly poorly draining clays.

Testing suggests that soils in the catchment area are of 'low permeability' and considered of low soakage potential generally, but with isolated pockets of high soakage potential. Hence, the soils have limited ability to absorb large runoff volumes, but are likely to be able to provide for infiltration and stream baseflow.

2.2 Hydrology

2.2.1 Streams/Wetlands

The W3P catchment hydrology is dominated by the Waiarohia Stream, which is fed by a number of named (Trig and Rawiri) and unnamed tributaries that merge then generally drain north-east towards the Waiarohia Inlet and Upper Waitematā Harbour (refer Figure 2). In addition, a small sub-catchment in the south-western corner of W3P drains land from west of Trig Rd in a general north-west direction to the headwaters of Totara Creek (which largely sits outside W3P). This in turn discharges to the Upper Waitematā, further to the north east, at Brigham Creek.

The watercourses within W3P have been modified as a consequence of rural land use, including un-fenced stock access to riparian margins and directly through lower-order streams, stream culverting, plus the creation of irrigation and ornamental on-line ponds. Many of these changes have restricted fish passage up the W3P catchment. Livestock movements have resulted in direct contamination, stream bank erosion and resultant sedimentation of the harbour. Whilst these changes have not included the formation of lined channels, culverts have been constructed beneath roads and reclamation is likely to have occurred (Morphum Environmental, 2016)[2].

Overland flow paths are typically linked to narrow intermittent watercourses that drain into the permanent stream network described above. A number of remnant wetlands and artificial ponds are situated on tributaries of the Waiarohia Stream, most notably the 8,000m^2 Koenen Pond. Further to these, eight natural ponds have been identified within the catchment, indicative locations of which are also illustrated in Figure 2.

[2] Watercourse Assessment Report: Whenuapai Structure Plan Area. Morphum Environmental Ltd, September 2016.

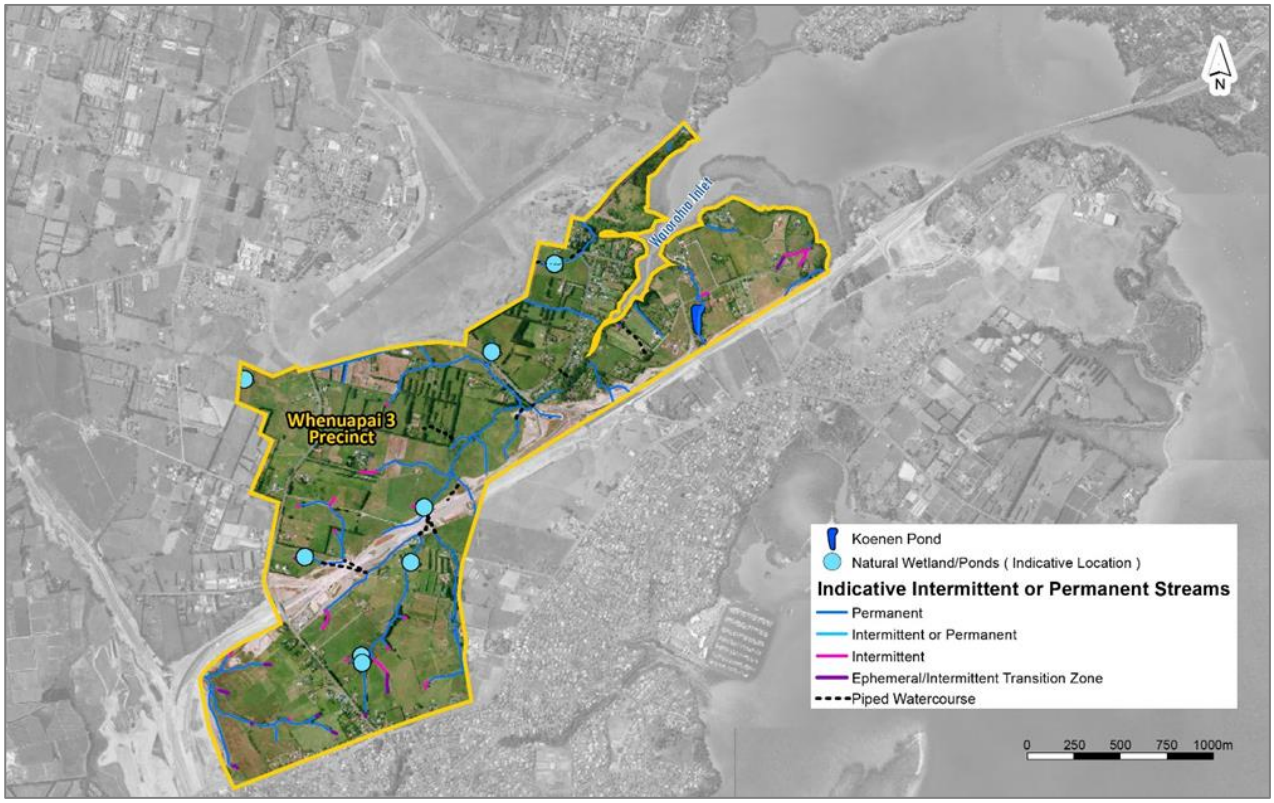

Figure 2: Whenuapai 3 Precinct Stream Network
(from Morphum Environmental, 2016)

A detailed description of the stream network is provided in Morphum Environmental (2016). Overall, sites within the Waiarohia Stream (and tributaries) are identified as being within the 'moderate' ecological value range (stream ecological valuation (SEV) score 0.3-0.7) for fish and macroinvertebrates. Existing water quality was also assessed as generally being 'poor'. Table 1 provides a summary of stream quality within the Waiarohia Stream catchment and tributaries.

Table 1: Summary of Existing Waiarohia Catchment Stream Quality
(from Morphum Environmental, 2016)

Stream Name	General Condition	Water Quality	Biological Quality	Native Fish	Reaches with widths 3m+
Waiarohia Stream	Modified with fine sediment loading Poor quality habitat	Low dissolved oxygen Elevated heavy metals	SEV Moderate	Observed	Yes – defined banks evident
Trig Stream	Slow flowing, intermittent in places	Poor	SEV Moderate	No information	Yes – heavily modified by pugging
Rawiri Stream	Slow flowing, intermittent in places	Poor	SEV Moderate	No information	No information

The Macroinvertebrate Community Index (MCI) is an index of stream health based on the type and number of macroinvertebrates (animals such as insects, crustaceans, snails and worms) that live in rivers. Macroinvertebrates have been used extensively for the assessment of river health and the MCI has been adopted in the AUP(OP) as a guideline for freshwater ecosystem health. Hence it is presented in more detail here.

Macroinvertebrate Community Index scores for the Waiarohia Stream Catchment, collected over a range of surveys, are presented in Table 2. They display variability, but generally range between 60 and 72. MCI values of less than 80 indicate 'poor' quality (Stark and Maxted, 2007[3]). Comparison with the AUP (OP) MCI guideline value for rural land use adopted for the Auckland region (MCI of 94), also indicates that the Waiarohia Stream and tributaries are degraded below that typically associated with rural land uses in Auckland. In the circumstance where the current stream condition is below guideline values, the AUP (OP) directs that water quality, flows, stream channels and their margins and other freshwater values should be enhanced.

Table 2: MCI Scores for the Waiarohia Stream Network
(from Morphum Environmental, 2016 - see this report for the source of the individual MCI values)

Stream	Year	MCI Score
Upper Waiarohia (W1)	1997	60
Upper Waiarohia (W2)	1997	100
Mid-Waiarohia (W3)	1997	72
Mid-Waiarohia (W4)	1997	60
Mid Waiarohia (SEV 4)	2009	64
Mid-Waiarohia	2000	69
Lower Waiarohia (W5)	1997	70
Lower Waiarohia (W6)	1997	65
Lower Rawiri Stream	2009	72
Upper Rawiri Stream	2009	110

In addition to poor water quality and stream health, barriers to fish passage have also been identified and these contribute to limiting the native aquafauna populations. Introduced/pest species of fish have been sighted within W3P.

Overall the Waiarohia Stream and its tributaries are degraded as a result of current land uses. However, Morphum Environmental Ltd (2016, pg 35) note that "*…due to the spatial scale of historical impacts from agricultural land use drainage within the catchment, Enhancement Opportunities are abundant. Particularly common potential Enhancement Opportunities within the catchment includes fencing and planting riparian margins; enhancement of wetland areas; removal of online farm ponds, and, daylighting piped sections of streams*". The existing wetlands at 23-25 Trig Road and 167 Brigham Creek Road are specifically identified as key improvement opportunities within W3P with respect to amenity, ecology, conveyance and water quality values.

2.2.2 Groundwater Aquifers

The Whenuapai catchment is located entirely upon the Kumeu-Waitematā Aquifer, with some evidence of an additional aquifer system potentially occurring within younger volcanic rock formations. The Kumeu-Waitematā Aquifer is identified as a "High Use Aquifer Management Area" under the AUP (OP), recognising its importance as a direct source of water supply for domestic, industrial and rural use. However, the Auckland Water Quantity

[3] Stark JD, Maxted JR 2007. A user guide for the Macroinvertebrate Community Index. Prepared for the Ministry for the Environment. Cawthron Report No.1166.

Statement (2012/2013) (Table 2 Page 10)[4], indicates that this aquifer is not fully allocated, with water allocation being approximately 55% of total availability.

Much of the groundwater within the catchment area is obtained from the Tauranga and Waitematā Group sandstones, with groundwater recharge and near surface flows generally resulting from surface infiltration. These flows mainly occur within more permeable layers and minor fractures. As a result, groundwater movement is generally relatively slow, with an estimated mean soakage rate of approximately 13.6mm per day, or 1% of mean annual rainfall. Groundwater levels range between 0.5m and 2.5m below ground level (during wet conditions), suggesting that a perched water table may exist in the area.

2.2.3 Existing Flood Risk

The extent of existing 1% AEP (100yr ARI) floodplains within the W3P catchment are primarily located around coastal inlets and streams. Generally speaking, the flood hazard in W3P is considered low, with only two buildings within the W3P catchment identified by flood hazard modelling as being susceptible to habitable floor flooding in the 100yr ARI event. These are located in the vicinity of Brigham Creek Road.

2.3 Terrestrial Ecology

The Whenuapai Structure Plan advises that historic rural activities have resulted in a poorly defined and poorly linked network of natural systems with little habitat or connective corridors for biota. The majority of W3P is composed of pasture and horticultural ground/planting, which has largely cleared natural vegetation.

Variable coverage of exotic and native vegetation is found mainly along riparian margins or as shelter belts, with the notable exception of extensive native plantings integrated along the State Highway that forms an important ecological corridor. Only one small pocket of land at the terminus of the Waiarohia Stream Inlet is recorded as a terrestrial Significant Ecological Area under the AUP (OP). However, the Northern Strategic Growth Area (NGSA) maps identify Environmentally Sensitive Areas centred around riparian margins throughout W3P.

2.4 Coastal Environment

2.4.1 Coastal Interface

W3P is amongst the upper-most reaches of the Waitematā Harbour. Its interface with the coastal marine area (CMA) primarily consists of the relatively narrow Waiarohia Inlet, which is a low-energy mangrove-dominated estuarine system surrounded by approximately 4.5km of cliffed coastline.

The Boffa Miskell 2010 Landscape Restoration Plan identifies that areas within the Upper Waitematā Harbour surrounding the wider Whenuapai catchment are considered of regional, national and international significance, largely due to the presence of salt marsh, mud flat systems and mangrove swamps that provide habitat and resources for a variety of plant and animal species.

Much of the W3P coastal margin is protected from direct wave erosion by the extensive mangrove swamps and shell banks, and because of the low wave energy environment experienced[5]. However, general slope instability at coastal margins remain.

2.4.2 Estuarine Environment

AECOM's 2017 Coastal Habitat Assessment[6] concluded that coastline vegetation comprised a mix of native and exotic species. There are small pockets of indigenous flora that remain and these provide relatively good diversity and structure considering the disturbed nature of the surrounding landscape. Patches of saltmarsh were also observed along the coast, particularly around Waiarohia Inlet and to a lesser extent, Brigham Creek.

[4] Stansfield, B and Holwerda, N (2015). State of the environment monitoring: Auckland water quantity statement 2012/2013. Prepared by EIA Ltd for Auckland Council. Auckland Council technical report, TR2015/005
[5] Tonkin + Taylor (2017). Coastal Hazard Assessment Whenuapai Plan Change Stage1. Prepared for Auckland Council
[6] AECOM (2017). Coastal Habitat Assessment, Whenuapai Structure Plan Area. Prepared for Auckland Council

The SMP notes that the intertidal mudflats are recognised for their ecological value as a habitat for wading birds, in particular the South Island pied oystercatcher, pied stilt, wrybill, lesser knot and reef heron. The mangrove and salt-marsh vegetation provides habitat for threatened species such as the banded rail. Shell banks are used by species such as the Northern New Zealand dotterel, variable oystercatchers, Caspian tern and banded dotterel.

2.4.3 Contamination

Heavy metal contamination of nearshore seabed sediments is associated with urban areas. Estuarine areas, such as the Waiarohia Inlet and Brigham Creek to the north, are particularly susceptible to the accumulation of metals and other contaminants due to their often narrow width and low tidal energy which encourages deposition rather than dispersion of contaminants carried in stormwater discharge. Auckland Council operates a marine sediment contamination monitoring programme across Auckland's harbours and estuaries.

Analysis of contaminant concentrations in coastal sediments across 16 sites within the Upper Waitematā Harbour are reported in "*The Upper Waitematā Harbour Reporting Area: 2014 Marine Report Card*" by Auckland Council. The Environmental Response Criteria (ERC) monitoring locations of relevance to W3P are the sediment quality site on the southern bank of the Waiarohia Inlet and the chemistry / ecology site further into the harbour just to the south of Herald Island. The saline water quality and chemistry water quality sites within the Brigham Creek Inlet are also of some relevance as a small portion of W3P drains to this receiving environment via Totara Creek.

Results indicate that contamination concentrations within the Upper Waitematā harbour are generally below the ERC amber (some contaminant elevation) threshold for heavy metals. Despite this, the contamination levels observed are higher than would be expected for a mostly rural catchment, particularly for copper, which indicate a potential for broad-scale impacts on benthic ecology.

Figure B7.4.2.1 of the AUP (OP) identifies areas of coastal water that have been degraded by human activities. It classifies the Upper Waitematā Harbour area as being Marine Degraded 1. Degraded 1 areas are those areas where monitoring data shows a high level of degradation (to marine water quality, sediment contamination and benthic health) and are likely to show significant adverse effects on ecosystems and natural habitats (Carbines, 2014[7]).

2.5 Land Contamination

Past application of horticultural pesticides and agricultural fertilisers presents potential for elevated levels of contamination in soils. In addition, an historic landfill site has been identified to the east of the Whenuapai Air base on the northern bank of the Waiarohia Inlet.

2.6 Heritage Sites

W3P contains several historic structures and recorded archaeological sites, as well as a historic heritage 'place'. As these features have little relevance to stormwater management, they have not been considered further.

2.7 Cultural

The Whenuapai Structure Plan reports that Te Kawerau ā Maki and Ngāti Whātua o Kaipara have indicated that they each have a spiritual and cultural connection to the area of Whenuapai and its surrounds. Both iwi are mana whenua of the area and, as such, have kaitiaki and other obligations and responsibilities to the land and its cultural and natural resources.

2.8 Existing Development

Existing development in the W3P catchment is predominantly rural (horticulture, agriculture and lifestyle blocks), with small pockets of low-intensity residential areas around the Waiarohia Inlet and the southern extent of Trig Road. The Upper Harbour Motorway dissects the western half of W3P. The New Zealand Defence Force (NZDF) Whenuapai Air Base is located to the immediate north of W3P. The catchment is currently zoned 'Future Urban' under the AUP (OP).

[7] Statement of Evidence of Megan Carbines on Behalf of Auckland Council to the Auckland Unitary Plan Independent Hearings Panel on Topic 008 – RPS Coastal, 9 October 2014

Very little existing public stormwater infrastructure has been built within W3P. Stormwater needs are mostly met by private systems of piped culverts, open drains and ponds/modified wetlands and road drainage.

3. Future development

3.1 Proposed Zones

The Whenuapai Structure Plan and the W3P Plan provide for the development of urban landuse in the W3P catchment, as illustrated in Figure 3 below. The Precinct Plan allows for establishment of light industry to the north west of the State Highway and a variety of residential intensities in the south and north-eastern areas of W3P.

Under the W3P Plan, it is proposed to comprehensively develop W3P in a sequential manner (named Staging 1A to 1E), which includes the creation of esplanade reserves and open space land amongst arterial and collector roads.

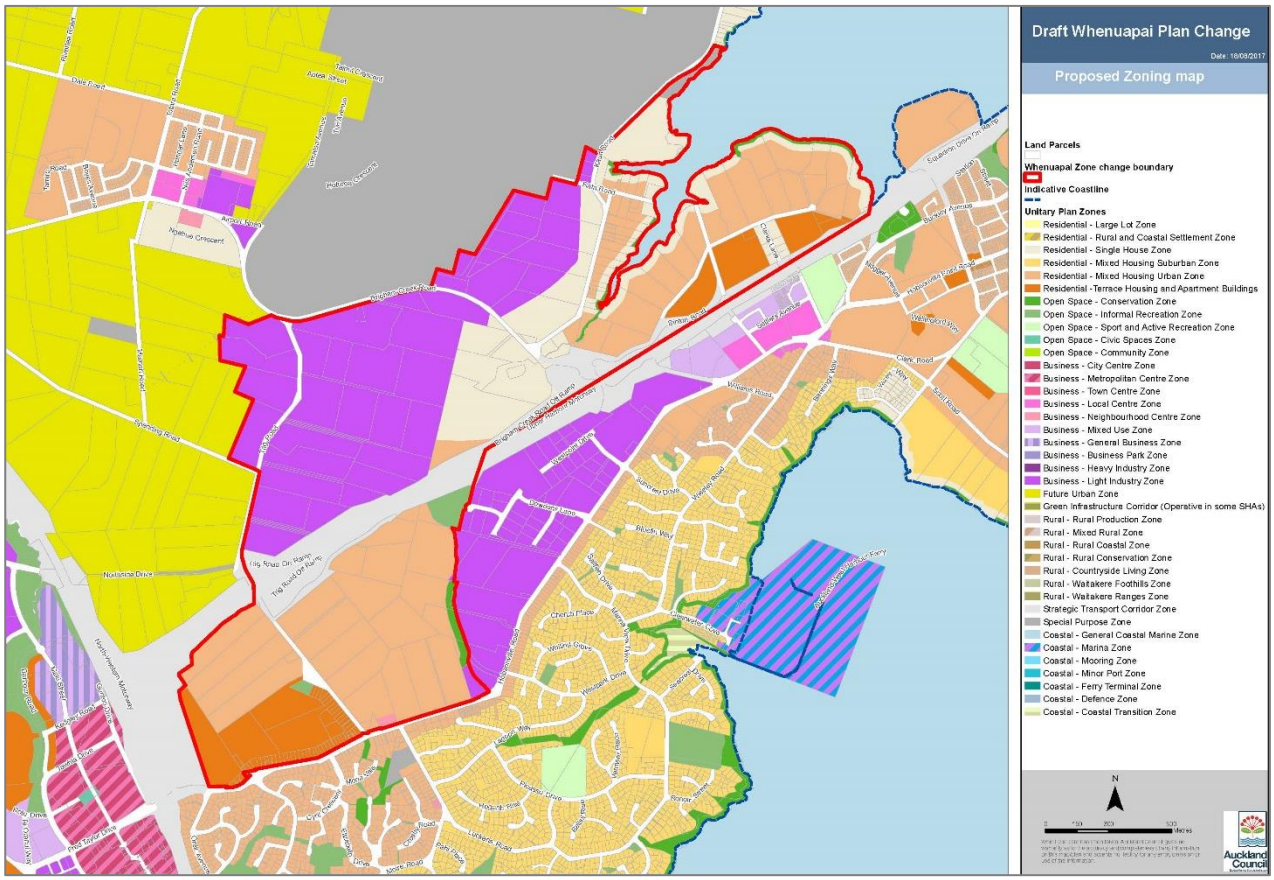

Figure 3: Map of Future Development of W3P (September 2017)

Under the AUP (OP), maximum impervious area is not limited for the Business - Light Industry Zone (although other requirements such as landscaping may apply), while the Residential - Mixed Housing Urban and Terrace Housing and Apartment Zones are limited to 60% and 70% respectively. Under the W3P Plan, light industry and higher density residential development have been located away from the main channel of the Waiarohia Stream and its tributaries. Residential development, which generally has more flexibility to work around existing hydrology and offers greater ability for (and ultimately amenity from) enhancement of streams, has been located in upper catchment areas and around the coastal margins. This zone layout is generally consistent with an integrated stormwater management approach/water sensitive design (WSD).

3.2 Key Stormwater Management Issues

As discussed above, W3P is a predominantly rural catchment where previous agricultural and horticultural activities have removed native vegetation and modified watercourses and hydrology. These activities have resulted in degraded streams and negatively impacted coastal marine environment quality.

Urbanisation has the potential to create and exacerbate flood risks and degradation of receiving environments. At the same time, well-designed urban development offers the opportunity to reduce existing adverse effects and enhance and revive degraded freshwater and marine environments.

3.2.1 Flood Hazard

The existing flood hazard in W3P is generally low. Only two buildings within the W3P catchment were identified by flood hazard modelling as being susceptible to habitable floor flooding in the 100yr ARI event. Additionally, flood modelling of future development indicated only a minor increase in risk and inundation of buildings.

Accordingly, flood hazard is not a key constraint in the catchment provided an appropriate approach to development and the management of flood plains and overland flow paths is implemented. This includes locating buildings and other activities that are vulnerable to flooding outside of flood plains, ensuring that the stormwater network (including the pipe network and overland flow paths) are of sufficient capacity and appropriately located to safely convey stormwater and to reduce existing flooding where possible. For development to the southwest of the State Highway, consideration should be given to the capacity of the culverts under the State Highway to ensure that flood flows do not affect the operation of the State Highway or cause ponding that affects new development.

3.2.2 Stream Environments

Stream quality issues currently facing W3P can be summarised as:

- **Morphology**: Modifications of streams have restricted fish passage up the catchment, and creation of wetlands or ponds to support agricultural activities affect stream ecological values through increased water temperatures and reduced oxygen levels.
- **Contamination**: Unrestricted stock access and removal of streamside vegetation has resulted in direct contamination, stream bank erosion and subsequent sedimentation of the harbour.
- **Biodiversity/habitat value**: The land has been largely deforested, and exhibits a very limited extent of native flora generally. Weed species often dominate. The lack of riparian vegetation has negative flow-on effects for terrestrial and aquatic ecological values.
- **Retention of stream base flows**: The creation of ponds to support agricultural activities have been observed to reduce the base flow of streams during summer months.
- **Controlling stream flood flows**: High-volume and high-speed flood flows have potential to create erosion and subsequent sedimentation effects.

If not appropriately managed or mitigated, urbanisation of W3P may lead to further stream degradation such as:

- **Changes to hydrology:** Urbanisation will significantly increase impermeable surface area, leading to greater stormwater runoff rates and volumes that in turn increase peak stream flows, flood risk, erosion potential and sediment discharge. The widespread establishment of impervious areas reduces infiltration, which may further reduce stream base flows (particularly in upper and mid catchment stream reaches) and reduce recharge to the underlying groundwater aquifer.
- **Further habitat loss/fragmentation**: This may result from the removal of remaining vegetation and piping/culverting of watercourses for creation of developable land.
- **Water quality**: A change to the source and composition of contaminants, with potential to result in the increase in urban-type contaminants (e.g. heavy metals and hydrocarbons) poses a threat to water (and sediment) quality in streams. This in turn may increase impacts on the ecosystem health of freshwater environments.

3.2.3 Coastal Environment

The primary issues currently facing the coastal environment at W3P are:

- **Water quality:** The Waiarohia Inlet and Brigham Creek, which will receive stormwater from the future development of W3P, and the wider Upper Waitematā Harbours are identified as being degraded in the AUP (OP). The narrow, low energy estuaries are valued marine environments that are susceptible and sensitive to contaminant accumulation.
- **Erosion:** General slope instability at coastal margins, and the amplification of coastal hazards stemming from sea-level rise.

Urbanisation of W3P has the potential to lead to further degradation of the coastal environment. While a potentially positive consequence of the establishment of impervious areas is a reduction in sediment runoff from rural land/stock access to streams, this is replaced by the introduction of urban development and the generation, discharge and accumulation of 'urban' contaminants such as gross stormwater pollutants (litter), heavy metals and hydrocarbons. Accumulation and an increasing concentration of metals is likely to occur in the narrow estuaries of the Waiarohia Inlet and Brigham Creek. While this can be mitigated to some extent, stormwater treatment is only partially effective[8] and consequently a comprehensive approach that reduces the generation of contaminants at source and applies treatment is required to effectively minimise contaminant increases in coastal waters and sediment.

Given the nature of the catchment hydrology, it is likely that the stormwater from most of the future development will be piped to the Waiarohia Stream and its tributaries. However, coastal stormwater discharges will likely occur in those areas where the natural topography falls to the coast. This will increase the risk of coastal erosion and a proliferation of costal discharge structures may impact on the natural character of, and public access to and around, the coast. However, this should be able to be adequately mitigated through appropriate design and location of outfalls.

3.2.4 Aquifer Systems

Potential impacts to the underlying Kumeu-Waitematā aquifer are related to the reduction in filtration, which is a component of aquifer recharge. As with preservation of stream base flows, maintaining a sustainable hydrology, including through infiltration, is required to avoid significant impacts on the supply of water to the aquifer system at W3P.

It is noted that the Kumeu-Waitematā aquifer is currently not fully allocated and urbanisation is likely to reduce water demand further with the change from agriculture/horticulture to urban land uses. However, consideration should be given to providing infiltration to sustain the aquifer system.

3.2.5 Mana Whenua Values

The environmental health issues discussed above are expected to mirror iwi cultural concerns. A Cultural Values Assessment (CVA) was completed by Ngāti Whātua o Kaipara in May 2017 to identify potential effects on their values at W3P. The CVA identified that development provides opportunities for the spiritual values of Mana Whenua to be recognised and enhanced. Te Kawerau ā Maki also hold mana whenua at Whenuapai, and provided input to the Whenuapai Structure Plan, with particular focus on the sustainable management of taonga such as waterbodies, native flora and indigenous fauna.

3.3 Enhancement Opportunities

While urbanisation of W3P has the potential to give rise to, or exacerbate, the adverse effects identified above, the change in land use also offers significant opportunities to enhance the currently degraded environments through appropriately designed and managed subdivision and development. The AUP (OP) recognises the opportunity that greenfield development planning presents to identify and implement enhancement opportunities, in addition to minimising new adverse effects. As discussed below, objectives and policies of the plan, particularly in E1, seek an

[8] A stormwater treatment device that is designed to remove 75% of suspended sediment typically removes 35% to 50% or metal contaminant

integrated stormwater management approach and the progressive reduction in existing adverse effects on/enhancement of degraded freshwater and coastal systems.

Opportunities include:

- **Hydrologic mitigation:** Maintaining sustainable hydrology, consistent with pre-development hydrology, is an essential component of the future development of W3P. Reducing stormwater runoff through retention (volume loss) and detention (temporary storage and slow release) mitigate the increased stormwater runoff from extensive impervious areas. This is essential to minimise further erosion of the Waiarohia Stream and its tributaries. Furthermore, retention that is achieved through infiltration assists in maintaining stream baseflow and aquifer recharge. When combined with the riparian enhancement measures, maintaining suitable hydrology will improve ecological, biodiversity and amenity values within stream environments.
- **Protection of streams**: Identification of permanent and intermittent streams at development design stages; creation of riparian margins through development setbacks (including vesting esplanade reserves to Council); and appropriate design or set back of outfall structures from the stream and the use of green infrastructure/soft engineering (where appropriate) can assist in mitigating the necessary establishment of structures such as culverts and outfalls. The establishment of stream riparian margins also plays an important role of protecting important flood plains from development.
- **Enhancement of streams**: The removal of existing fish passage barriers and artificial on-line ponds within the beds of permanent or intermittent streams, and reinstating stream beds will promote ecological and biodiversity values. Riparian planting and management will assist in providing bank stability and improving aquatic habitat, provide filtration of surface runoff to assist with the reduction of contaminants and sediment entering waterways and shading streams will also assist in both enhancing streams and mitigating the adverse effects of stormwater runoff from urban areas. Planting will also provide enhanced habitat quality for wildlife. Protection of potential inanga spawning habitat has been identified in the vicinity of stream mouths.

In addition to the environmental and stormwater management benefits, provision of esplanade reserves affords the opportunity to incorporate walking and cycle ways, which will promote connectivity whilst supporting alternative transport methods around the area. Riparian planting provides aesthetic and amenity benefits to neighbourhoods and communities.

3.4 Statutory Direction

Stormwater management in W3P is guided by a suite of statutory provisions. Key considerations in this regard are summarised below:

National Policy Statements: New Zealand Coastal Policy Statement 2010 (NZCPS), National Policy Statement for Freshwater Management 2014 (NPSFM), Hauraki Gulf Marine Park Act 2000 (HGMPA)

The relevant National Policy Statements (NPSFM, NZCPS and HGMPA[9]) provide a generally consistent approach to the management of natural resources that may be affected by stormwater that are summarised as follows:

- Maintain the quality of fresh and coastal waters where it is high or meets objectives (including those that relate to compulsory national values for freshwater);
- Enhance the quality of freshwater where it has been degraded;
- Maintain/sustain the life-supporting capacity of ecosystems and enhance life supporting capacity where appropriate; and
- Protect and enhance the natural, historic, cultural and physical resources of the Hauraki Gulf and its catchments.

In addition, the NZCPS explicitly addresses the issue of stormwater discharges to the CMA to avoid significant adverse effects on ecosystems through the integrated management of stormwater including reducing contaminant loads and stormwater flows at source through design and controls on land use activities.

[9] Section 7 and 8 of the HGMPA are to be treated as a New Zealand Coastal Policy Statement, pursuant to section 10 of the HGMPA.

AUP (OP) – Regional Policy Statement (RPS)

The AUP (OP) RPS includes numerous provisions relating to urban growth and development. A key aim of the RPS and the AUP (OP) in general is to provide sufficient land capacity to meet the demand for urban growth – both residential and business. The W3P precinct is identified in the AUP (OP) as a future urban area. Other provisions that guide the development and management of stormwater infrastructure include:

B3.2 Infrastructure: Objectives and policies generally seek to recognise the benefits and operational needs of infrastructure and its efficient development and operation/maintenance while minimising adverse effects associated with its development and use. Integration of growth and infrastructure provision is sought, together with the protection of infrastructure from reverse sensitivity effects and incompatible subdivision and use.

B7.3 Freshwater Systems: The AUP (OP) provides a broad definition of freshwater systems, defining them not only in terms of the freshwater body itself but also the elements that contribute to its values and functions, including riparian margins and floodplains. Objectives and policies seek to minimise the permanent loss and significant modification of freshwater systems and to enhance them where they are degraded. Of relevance to stormwater management are the aims of minimising erosion and modification of streams and the establishment of structures within stream beds enhancing freshwater systems, including riparian margins, and taking the opportunity provided by development/subdivision to restore and enhance freshwater systems.

B7.4 Coastal Water and Fresh Water: The RPS seeks to maintain water quality where it is good and progressively improve it where it is degraded, including to progressively reduce the existing adverse effects of stormwater (and wastewater). Objectives also set the expectation that the adverse of land use change or intensification will be avoided, remedied or mitigated and that Mana Whenua values associated with freshwater are recognised and provided for. In respect of achieving the objectives relevant to stormwater management, the RPS directs the management of subdivision, use and development to minimise the generation and discharge of contaminants and adverse effects on fresh and costal water and the capacity of the stormwater network; and to adopt the best practicable option (BPO) for stormwater diversions and discharges. The RPS identifies coastal areas that are considered degraded – with the Upper Waitematā Harbour being identified as Degraded 1.

B10.2 Natural Hazards and Climate Change: Objectives seek that communities are more resilient to natural hazards and climate change and that risks from natural hazards are not increased in existing areas and are avoided in new subdivision and development. Additionally, the functions of natural systems in flood management (such as overland flow paths and flood plains) are to be protected in new development and otherwise maintained. Achieving this requires up-to-date information of hazards, mitigating effects in areas of natural hazards and strengthening natural systems in preference to engineered systems.

AUP (OP)

There are a large number of provisions that are of relevance to the management of stormwater and its interaction with communities and the natural environment. Of specific relevance include:

E1: Water quality and integrated management

Key objectives in this section are to maintain freshwater and sediment quality where it is good and progressively improve it where it is degraded; maintain or progressively improve the mauri of freshwater; and to manage stormwater networks to protect public health and safety and prevent or minimise adverse effects on fresh and coastal water.

A focus for greenfield development is to avoid adverse effects as far as practicable or otherwise minimise or mitigate them. Key methods of achieving this include applying an integrated stormwater management approach, which replaced the concept of water sensitive design in the AUP(OP); minimising the generation and discharge of contaminants into sensitive receiving environments; minimising or mitigating changes in hydrology; and managing gross pollutants. Key considerations also include the nature, quality, volume and peak flow of the stormwater runoff; the current state and sensitivity of freshwater systems and coastal waters; the potential for the diversion and discharge to create or exacerbate flood risks; options to manage stormwater on-site or the use of communal stormwater management measures; and practical limitations.

E36: Natural hazards and flooding

Most of the flooding provisions are focused on avoiding new development within floodplains in greenfield areas and managing subdivision and development/redevelopment so as not to increase, and where possible reduces, flood risk. A particular focus is on the management of "vulnerable activities", which are determined on their permanence of occupation and their limited resilience to flood related effects. Of particular note is the adoption of the 1% AEP floodplain as the primary scale of flood event when managing development and risk to life and properties, and policies relating to the maintenance of the function and capacity of overland flow paths in conveying stormwater from sites.

E38 Subdivision

The AUP (OP) recognises that subdivision is an important process in giving effect to stormwater management outcomes. While subdivision itself does not create/generate stormwater, it provides a process by which land is laid out for development including the provision of infrastructure and implementation of water sensitive design and other methods of mitigating the stormwater related adverse effects of (future) development.

Objectives and policies seek an integrated approach to the provision of infrastructure supporting subdivision and that subdivision provides for communities while minimising future effects of development on the environment. Additionally, stormwater is to be managed in accordance with any granted network consent; be consistent with the policies for water quality and integrated management; apply an integrated stormwater management approach; protect natural streams and overland flow conveyance and maintain or progressively improve water quality. Subdivision is also to be manged to protect the operation and capacity of existing infrastructure.

F2.11 Coastal – General Coastal Marine Zone Discharges

Relevant objectives and policies are also located in the coastal discharges section. Consistent with the outcomes articulated in E1 Water Quality and Integrated Management, this section seeks to maintain coastal water and sediment quality where it is good and progressively improve it where it is degraded and to manage stormwater to prevent or minimise the adverse effects of contaminants. Key to this is the adoption of the BPO for the discharge of contaminants, encouraging source control of contaminants, and reducing litter discharges to the marine environment.

The above statutory direction is given effect to through a range of documents including the Whenuapai Structure Plan; the Auckland Stormwater NDC application, this W3P and the W3P Plan.

4. Stormwater Management Considerations and Requirements

In light of the above, the following stormwater management approach is adopted for the W3P area.

4.1 Integrated Stormwater Management Approach

An integrated stormwater management/water sensitive design approach is essential to enable high and moderate density development of greenfield sites while at the same time, enhancing degraded environments. This integrated approach is directed by Policies E1.3(8) and (10) of the AUP (OP) and guidance is provided by Auckland Council Guideline Document 2015/004 Water Sensitive Design for Stormwater (GD04).

It is important for subdivision and development to consider integrated stormwater management/water sensitive design principles from the outset, with an emphasis of avoiding the creation of new effects and taking opportunity to utilise and enhance natural systems. This overarching approach in a manner that is appropriate for the nature of the development and its location within W3P.

4.2 Flood Hazards

As discussed above, flood risk is not considered a significant issue in W3P. Hence the focus is managing subdivision and development to avoid creating new flood risks, while taking the opportunities to reduce existing flooding impacts. Key considerations and requirements include:

- Stormwater networks, floodplains an overland flow paths should be determined/designed on the basis of maximum probable development and climate change for the contributing catchment as set out in Auckland Council's Stormwater Code of Practice[10].
- The primary stormwater network should be designed to accommodate the 10% AEP flow, in accordance with Auckland Council's Stormwater Code of Practice.
- Overland flow paths should be provided to safely convey flows in excess of the 10% AEP so as not to pose a risk to property or people. Where these cannot be safely conveyed in the road corridor, dedicated overland flow paths will need to be provided.
- Creation of esplanade reserves and enhancements to riparian margins to enable the natural storage and conveyance function of the floodplains to provide flood resilience.
- Flood risk to existing properties should not be worsened, and opportunities to reduce flood risk to buildings and property should be taken where opportunity arises.
- Development within W3P should factor projected sea-level rise in to design calculations, requiring set-back of certain development from the coast, and requiring site-specific geotechnical investigation to inform developments within 100m of the coastal cliff toe[11] .

4.3 Streams

Holistic management is required to enable existing streams to receive and convey stormwater from urban development, while at the same time improve water quality, enhance stream systems and mitigate potential increases in stormwater volumes and flows. An integrated stormwater management approach, discussed above, is central to achieving these multiple outcomes. Other key considerations include:

- Retain intermittent and permanent streams as far as possible and minimise the establishment and proliferation of in-stream structures to those that are functionally required, in accordance with AUP (OP) 7.3.2(4). Daylight piped watercourses to restore hydrology where practicable.
- Utilise soft engineering/green infrastructure, including setting back discharge points from streams to promote diffuse stormwater flows and minimise erosion, where this feasible and suitable (recognising that hard engineering solutions will be preferred in some circumstances). The location of stormwater outlets should follow natural drainage paths flows where practical to reduce the risk of erosion and use of sheet flow will provide additional treatment and disconnect impervious surfaces from the receiving environment.
- Manage hydrology and reduce stormwater volumes and 'erosive' flows from impervious areas. The Stormwater Management Area – Flow (SMAF) 1 control has been applied to the W3P area to help maintain and enhance stream hydrology. Retention devices that promote infiltration (rather than re-use) should be utilised in upper and mid-catchment areas where possible to retain stream baseflow and recharge groundwater aquifers.
- Protect and restore waterways. Permanent and intermittent streams should be enhanced through riparian planting, development set-backs, remove/mitigate existing barriers to fish migration (and not creating new barriers), removing on-line dams and reinstating the stream bed.
- Establish a minimum planting width of 10m either side of the stream; however, 15m to 20m may be appropriate adjacent to the main reach of wider permanent streams.
- In combination with controls to restrict the generation of contaminants in the first instance, a high level of stormwater quality treatment is required to minimise contaminant discharges to the Waiarohia Stream and its tributaries. In line with the AUP (OP), the preferred stormwater management approach includes decentralised at-source control (or close-to-source treatment devices), particularly for high contaminant generating landuse activities.

[10] Auckland Council Code of Practice for Land Development and Subdivision, Chapter 4-Stormwater, Auckland Council, November 2015

[11] Coastal Hazard Assessment: Whenuapai Plan Change Stage 1. Prepared for Auckland Council by Tonkin & Taylor Ltd. August 2017

4.4 Coastal Environment

The Waiarohia Inlet and Brigham Creek and the wider Upper Waitematā Harbour are susceptible to the accumulation of contaminants derived from urban land uses and transported in stormwater and identified as being degraded. Key stormwater management considerations and requirements are:

- As for streams above, a high level of stormwater quality treatment is required to minimise the risk of contaminant accumulation and enhance degraded water and sediment quality.
- Effective management to reduce stream erosion, discussed for streams above, will also contribute to reducing sediment discharge into the marine environment. This will reduce potential smothering effects of sediment discharges, the rate of sedimentation of the estuaries and the acceleration of mangrove propagation.
- Stormwater outfalls within the coastal margin should be designed to prevent local and wider erosion. Where possible, outfalls should follow natural drain patterns.

4.5 Aquifer Recharge

Consideration should be given to the potential loss of aquifer infiltration as a result of the establishment of significant impervious areas. As indicated above, a SMAF 1 control has been applied to the W3P area. Retention required by the SMAF control should be achieved by infiltration where possible, particularly in upper and mid-catchment areas.

4.6 Stormwater Management Options

An integrated stormwater management/water sensitive design approach should be adopted to guide the design of subdivision and development. That is, it should guide the design, layout and form of development and its integration with the natural environment. Following that, stormwater management at a subdivision or development-level should consider both non-structural/green-infrastructure methods and structural (i.e. engineered management or devices). The combination of these two elements can effectively manage stormwater, promote the health of the receiving environment and facilitate opportunities for enhancement.

4.6.1 Non-Structural Methods

Non-structural or green infrastructure stormwater management options can be used to promote sustainable development and resilience within the urban area. Potential non-structural options include:

- Retention/relocation of overland flow paths and hydrology;
- Restriction/exclusion of development within 1% AEP floodplains;
- Minimising earthwork areas and compaction, and re-establishment of infiltration in pervious areas following earthworks where possible;
- Protection and enhancement of streams and wetlands;
- Protection of fish passage along streams and removal of existing migration barriers;
- Provision of esplanade reserves and riparian margins to support stream health, provide amenity and connectivity and provide for flood storage; and
- At source reduction/control of contaminant generation.

4.6.2 Structural Methods

Structural methods include provision of treatment, retention and detention devices, as well as outfalls or erosion mitigation measures (where natural systems or buffers are not practicable). These may also include green infrastructure. Examples include:

- Permeable paving;
- Bio-retention (raingardens, bio-swales, living roofs and tree pits);
- Stormwater re-use tanks (plumbed into the toilet as a minimum);
- Swales; and
- Detention basins / infiltration basins and trenches.

The suitability for adopting any of the above devices must consider landuse (e.g. high contaminant generating activities) and desired hydrological outcome. Stormwater management devices must be designed in accordance with Auckland Council's technical publications, guidance documents and Codes of Practice that are relevant at the time of the development design. Road corridors should be sized to accommodate stormwater management, where this is applied 'on-site'. Finalisation of road design will occur through the approvals process in consultation with Auckland Transport and Auckland Council Healthy Waters.

Stormwater infrastructure such as pipe networks, outfalls and management devices are an element of most development. Where stormwater infrastructure is to be vested to Auckland Council, it will be required to be designed and constructed in accordance with Auckland Council's Stormwater Code of Practice and agreed with the Auckland Council Healthy Waters Department as the ultimate infrastructure owners.

4.7 Summary of Stormwater Management Requirements and Guidance

The above stormwater management approach is summarised in Table 3 below. Matters identified as 'Minimum Requirements' are expected to be met or alternative options approved by Auckland Council in accordance with the Stormwater Code of Practice requirements for vesting and to meet the requirements of the Auckland Stormwater NDC. Items that are identified as 'Desirable' should be achieved where it is practicable to do so. These latter considerations will be part of the assessment under the W3P Plan rules.

Table 3: Stormwater Management Requirements for Subdivision and development

Whenuapai Precinct 3: Stormwater Management Requirements

Component	Principle/Approach	Minimum Requirements	Desirable	Guidance
Design Approach	All subdivisions and development must apply an integrated stormwater management/water sensitive design approach through all phases of development, from planning through to construction	WSD is implemented to the extent practicable across the development		AUP (OP) Policy E1.3 (8) and (10); Auckland Council Guideline Document 2015/004 Water Sensitive Design for Stormwater (GD04)
Piped stormwater network and other public stormwater assets	All public stormwater assets shall be designed and constructed in accordance with best industry practice and to accommodate Maximum probable development (MPD) for the contributing catchment	All public stormwater pipes must be designed to accommodate the 10% AEP event for MPD for the development and any upstream contributing catchment areas MPD is to be determined in accordance with Auckland Council's Stormwater Code of Practice (SWCoP) All assets to be vested must be designed and constructed in accordance with the SWCoP	Green infrastructure is considered and utilised where it suitable and feasible to do so	SWCoP
Flooding	New flood risk is not created; and existing flood risk is not increased and where possible, is reduced	Development shall not create, or exacerbate existing, flooding of any habitable floor The 1 % AEP (incorporating climate change) MPD flood plains New buildings shall be located outside the 1% AEP (incorporating climate change) MPD flood plain; and any overland flow path[3] Overland flow paths shall be retained/provided to convey the 1% AEP (incorporating climate change)	Infrastructure and overland flow paths are designed to reduce existing habitable floor flooding flooding where possible Riparian margins provided and protected to safely convey flood flows	[3] An overland flow path is one where the upstream contributing catchment exceeds 4,000m²

		event from the contributing catchment (MPD) without creating flood risk All overland flow paths shall be mapped and provided to Council on GIS Overland flow paths on private property shall be protected from development		
Streams/natural wetlands	Intermittent and permanent streams and natural wetlands are retained, enhanced and protected from the adverse effects of development and stormwater runoff	The location of all intermittent and permanent streams and wetlands within a subdivision or development are to be mapped All intermittent and permanent streams are to be retained[1] Riparian planting is provided for all intermittent and permanent watercourses All outfalls into streams shall be protected against erosion and designed/constructed in accordance with the SWCoP	Existing barriers to fish migration are removed or mitigated in permanent watercourses Erosion protection incorporates green infrastructure where feasible Setback outfalls from edge of streams where appropriate and practicable	[1] It is recognised that this will not be possible in all circumstances. This requirement is waived where a resource consent to pipe/reclaim a watercourse is obtained under the AUP(OP)
Coastal Yards	The coastal environment is protected from erosion from stormwater discharges	All outfalls to the coast shall be designed/constructed to protect against erosion and in accordance with the SWCoP	Green infrastructure/soft engineering is used where it is feasible and practicable to do so	
Hydrology	Changes to natural hydrology are minimised in areas where developments discharge to permanent or intermittent streams Aquifer recharge and stream baseflows are retained	A SMAF control is applied to the W3P area	Stormwater retention is achieved by infiltration where it is feasible to do so	

Water quality	Water quality impacts on streams and the coastal environment are minimised and water quality is enhanced through development	All new impervious areas over 1,000m^2 shall be treated by a treatment device designed in accordance with TP10/GD01[2] Runoff from: • Commercial/industrial waste storage/handling or loading/unloading areas • Communal waste storage areas in apartments and multi-unit developments shall be treated by gross pollutant traps designed in accordance with GD01 unless otherwise treated by a stormwater device	The generation and discharge of contaminants is reduced at source as far as prcticable Low contaminant building products are utilised Water quality treatment shall be achieved on site unless there is a communal device, acceptable to Council	[2] Some hydrology mitigation devices may also achieve the required level of treatment. Devices that achieve both hydrology and treatment mitigation are acceptable, provided that the relevant performance requirements are met High contaminant generating land use activities are regulated by the AUP (OP)