Silverdale West Dairy Flat Business Area Structure Plan

Stormwater Management Plan

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Executive Summary

Water is an important resource for all Aucklanders and the Auckland Unitary Plan Operative in Part (OiP) is a significant tool in managing the interaction and impacts between water and land use activities. The policies, objectives and rules in the Auckland Unitary Plan (OiP) incorporate the objectives of the National Policy Statement for Freshwater Management (NPSFM). Auckland's overall approach is to integrate stormwater infrastructure into the natural environment. This shift in the focus of stormwater management from removing or disposing of stormwater as fast as possible via built infrastructure, to recognising its value, close interrelationship with natural freshwater systems, and how it can enhance the liveability of our cities and communities is referred to as Water Sensitive Design. A water sensitive design approach will help deliver the Auckland Plan outcome to preserve, protect and care for the natural environment as our shared cultural heritage, for its intrinsic value and for the benefit of present and future generations.

There is greater opportunity in greenfield development to holistically integrate and manage stormwater as part of the future built environment. Notably, designing the si*te as a whole, considering the placement of infra*structure, *maintaining predevelopment hydrology, minimise the g*eneration and discharge of contaminants, reducing earthworks by utilising natural topography and using natural hydrological features as part of stormwater management.

The Silverdale West Dairy Flat Business Structure Plan Area covers approximately 600ha of Future Urban Zone located to the west of State Highway 1 and to the south-west of the Silverdale Township The Structure Plan Area is adjacent to further areas of Future Urban Zone for the wider Silverdale – Dairy Flat area. The Silverdale West Dairy Flat Structure Plan area has been identified as primarily for future business land uses.

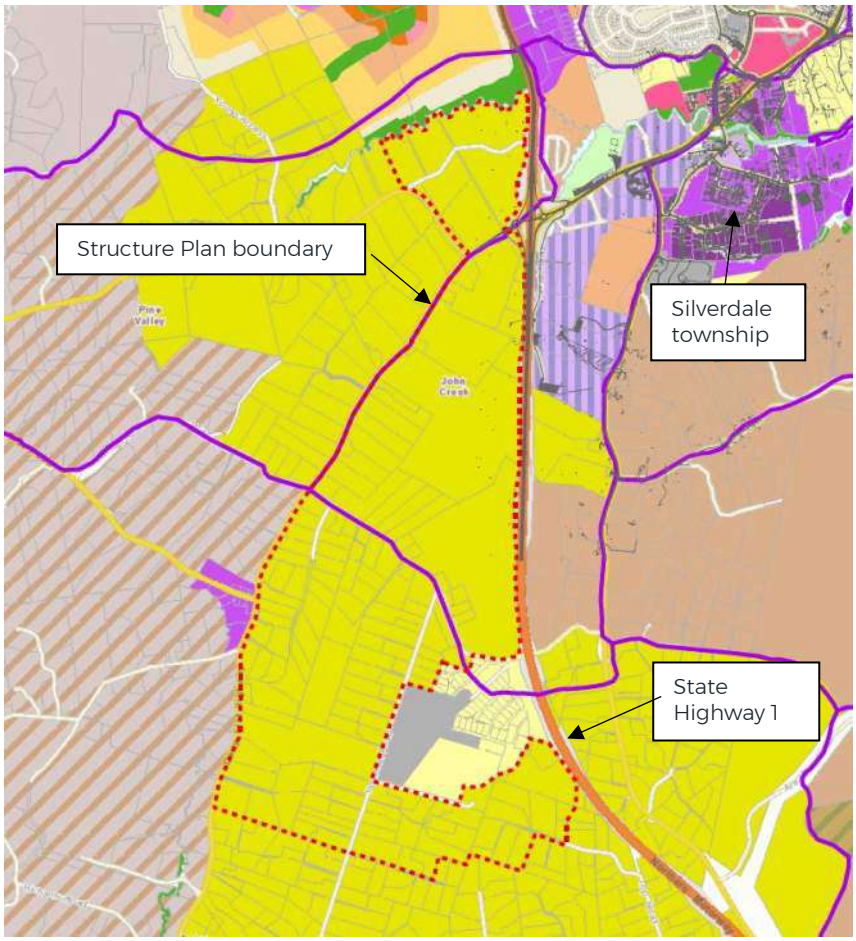

Figure 0-1: Silverdale West Dairy Flat Structure Plan Location

There are existing stormwater constraints to development across the Future Urban Zone, however some of these can **not only be mitigated, but improved upon, by delivering 'water sensitive' development that is fully integrated with the other urban design guidelines of the Auckland Design Manual**.

This Stormwater Management Plan (SMP) has been prepared to support the Structure Plan and as such considers the proposed land use and other outcomes proposed by the Structure Plan process. This document provides overall guidance on how water sensitive design can be applied to development in the Silverdale West Dairy Flat Business Area. The Future Urban Zone has been divided into a number of development subcatchments based on catchment boundaries, natural flowpaths, and discharge locations. More detailed responses to stormwater management will be identified in subsequent SMPs prepared for development (refer Table 1 below). The level of detail in each stage shall respond to the scale of development and complexity of integrated stormwater management required. In some cases it may be appropriate to develop a SMP that responds to the requirements across multiple tiers.

Table 1: Stormwater Management Planning for Growth

Tier	Development Planning Stage	Stormwater Management Plan Scope
1	Auckland Unitary Plan	Section E1, E3, E8, E9, E10, E36 of the AUP, Controls and Overlays
2	Structure Plan (Masterplanning)	Sets out high level catchment-based assessment to identify constraints, issues, opportunities, and stormwater management principles and guidelines. Identifies knowledge gaps and further work to required to inform next stages.
3	Precinct Plan or Private Plan Change (Live zoning)	Provides precinct level details informed by masterplan layout and detailed site assessments (e.g. watercourse assessments). Sets out how AUP rules and stormwater management principles in Structure Plan SMP will be delivered, including preferred options and identification of key communal stormwater management assets (e.g. wetlands, easements, structures, etc)
4	Subdivision (Land development)	Demonstrates how development design compiles with the Precinct SMP, Auckland Design Manual and relevant Codes of Practice.

In particular each subsequent SMP for the Silverdale West Dairy Flat Business Area will need to include further detail on:

- How development will address the generally poor stream ecology, erosion and water quality due to heavy modification through farming by restoring and enhancing streams so that they are resilient to both changing climate and an urbanised environment.
- How enhancement of existing permanent and intermittent streams and wetlands will be delivered to maximises environmental, social and cultural outcomes for the new communities.
- How developments will be designed around permanent and intermittent streams for primary and secondary stormwater conveyance. The stream systems need to sufficiently resilient to conveying future development flows.
- There is a high value and sensitive downstream receiving environment in the Hauraki Gulf and Upper Waitemata Harbour. Providing stormwater treatment to all roads and carparks in the

Future Urban Zone will assist in protecting, and enhancing, the downstream receiving environment.

- Commercial or industrial land uses that involve hazardous substances will require robust runoff management to ensure contaminants cannot enter the downstream environment.
- How hydrology mitigation requirements of the Structure Plan Area will be met in order to mitigate the effects of development on stream corridors within and downstream of the Future Urban Zone. A 'toolbox' of measures are available to meet this requirement.
- How infiltration will be maximised, even in low permeability soils to minimise the impact of development on stream baseflow and aquifers. Methods to support this include minimising and disconnecting impervious surfaces and soil compaction, as well as infiltration-based retention. Maintaining the discharge of clean base flows into the identified aquifers is important for its long-term sustainability.
- Provision of exemplar erosion and sediment control measures in accordance with GD05 during both bulk earthworks and individual lot construction will be delivered to protect the sensitive receiving environments.
- How sustainable and resilient development has avoided the floodplain, managed overland flowpaths, and considered residual flood risk (e.g. from culvert blockage) in accordance with the Auckland Unitary Plan (OiP).
- In some locations there is the opportunity to reduce floodplain extents in the Structure Plan Area through engineered interventions. There is potentially significant cost associated with delivering these engineered interventions to the floodplain. Subsequent SMPs will need to identify which interventions will be taken forward for further economic feasibility and funding assessment.

Contents

List of Figures

List of Tables

Document History and Status

Revision	Date	Author	Reviewed by	Approved by	Status
DRAFT 2	17/11/2017	Annise Raea	James Reddish	Annise Raea	Preliminary Plan
FINAL DRAFT 1	2/11/2018	Josh Irvine/ James Reddish	James Reddish	Annise Raea	Final
FINAL 1	29/11/18	James Reddish	Annise Raea	Annise Raea	Final

Revision Details

Revision	Details
DRAFT 2	Preliminary Plan – catchment characteristics and constraints
FINAL DRAFT 1	Stormwater Management Plan – updated to include further technical analysis completed and format consistent with other structure plan SMPs
FINAL 1	Stormwater Management Plan – minor amendments following feedback. Additions to Table 3-2. Addition of water quality section into Section 3.

Disclaimer

This Stormwater Management Plan ("Report") is has been prepared by WSP Opus exclusively for Auckland Council ('Client') solely in relation to informing the Silverdale West Dairy Flat Business Area Structure Plan land use zoning change. The findings in the Report are based on and subject to the assumptions specified in the Report, the scope of services and assumptions set out in WSP Opus's agreement with the Client dated 25th October 2017. The Report may not be used or relied upon by the Client for any use or purpose other than the Purpose and WSP Opus accepts no liability in relation to the same. WSP Opus accepts no liability or responsibility for any reliance on or use of the Report, in whole or in part, by any third party for any purpose whatsoever.

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1 Introduction

1.1 Purpose of this Stormwater Management Plan

The Silverdale West Dairy Flat Business Area Structure Plan area sits across three stormwater catchments in north Auckland (Figure 3.2):

1 The Pine Valley Catchment – draining to the Weiti Stream,
2 the Silverdale South Catchment – draining to the Weiti Stream; and
3 the Dairy Flat Catchment - part of the Rangitopuni Catchment draining to the Waitemata Harbour via Riverhead.

The purpose of this stormwater management plan is to:

- Identify water sensitive design measures to demonstrate how stormwater management in the Auckland Unitary Plan (Operative in Part) can be met.
- Promote water sensitive design principles during development for the creation of water sensitive communities.
- Support the Structure Planning process by providing a robust analysis of stormwater issues and management measures across the three catchments, based on current, best available information.
- Inform development of stormwater management obligations (i.e. minimum requirements).
- Inform the community of how stormwater management will be changing in the future.
- Become an adopted Stormwater Management Plan under the notified Regional Network Discharge Consent.

1.2 Scope of this Stormwater Management Plan

This document captures the current knowledge, thinking and best practice at this time. As intended land use becomes more certain and knowledge improves, the Stormwater Management Plan will be updated to reflect this and feedback from the community and mana whenua.

This Stormwater Management Plan provides a review of stormwater-related constraints and high-level guidance on water sensitive design and stormwater management requirements. The scope of this stormwater management plan covers:

- An appraisal of the current understanding of stormwater issues in the catchment, including opportunities and constraints to delivering stormwater solutions (Section 2);
- Stormwater management requirements and opportunities for development (Section 3)

1.3 Integrated Stormwater Management – the Auckland Context

Water is an important resource for all Aucklanders and the Auckland Unitary Plan Operative in Part (AUP OiP) is significant in managing the interaction and impacts between water and land use activities. Key objectives in B7.3 and B7.4 of the AU OiP for freshwater systems are summarised as:

- Safeguard the life-supporting capacity, ecosystem processes and indigenous species of freshwater and coastal environments.
- Improve the integrated management of fresh water and the use and development of land, including interactions between fresh water, land and coastal systems.

- Maintain the quality of freshwater and coastal water where it is excellent or good and progressively improved over time where it is degraded.
- Minimise, or if existing, progressively reduce, the adverse effects of point and non-point discharges, in particular stormwater runoff and wastewater discharges, on coastal waters, freshwater and geothermal water.
- The adverse effects from changes in or intensification of land use on coastal water and freshwater quality are avoided, remedied or mitigated.
- Mana Whenua values, mātauranga and tikanga associated with coastal water, freshwater and geothermal water are recognised and provided for, including their traditional and cultural uses and values.

A range of policies and rules support these region wide objectives and address specific aspects of water and stormwater management. The overall approach is to integrate stormwater into the environment and this approach draws heavily on Water Sensitive Design.

Using Auckland's growth to protect and enhance the environment is a key direction in the Auckland Plan 2050. This direction is supported by the focus areas including to *focus on restoring environments as Auckland grows and to account fully for the past and future impacts of growth*.

Protection of the environment and green space available for general recreation is expected to be major themes in public consultation on Auckland Plan 2050. The use of Water Sensitive Design including green infrastructure and the enhancement of freshwater habitats will help meet public expectation and deliver Auckland Plan outcomes.

1.4 Water Sensitive Design

The concept "Water Sensitivity" is a shift in the focus of stormwater management from removing or disposing of stormwater as fast as possible via built infrastructure, to recognising the value of stormwater, its close interrelationship with natural freshwater systems, and how it can enhance the liveability of our cities and communities. More guidance on this approach can be found in E1 of the AUP OiP and Water Sensitive Design – Guidance Document 04 (Auckland Council, 2015-1).

A water sensitive community will (Auckland Council, 2015-1):

4 Value our natural heritage

5 Sustainably manage natural resources

6 Treasure our coastline, harbours, islands and marine areas

7 Realise quality, compact urban environments

8 Demand good design in all development

9 Optimise, integrate and align network provision and planning

10 Protect, enable, align, integrate and provide social and community infrastructure for present and future generations.

The move to a water sensitive community is a significant change in approach and will take time. Built stormwater infrastructure has always been a primary component of stormwater management. Its on-going efficient and effective operation and renewal is fundamental to sustainable solutions, however built and natural assets need to be managed in an integrated way.

1.5 Development Context

There is greater opportunity in greenfield development to integrate and manage stormwater as part of the environment as a whole. Policies in E1.3.8 and E1.3.10 give guidance on how this is achieved, particularly:

- Designing the site as a whole, considering the placement of infrastructure including roads and reserves and the nature and sensitivity of the receiving environment.
- Maintaining predevelopment hydrology as much as possible to support stream health and groundwater recharge.
- Minimise the generation and discharge of contaminants and treat at source as much as possible.
- Providing for the management of gross pollutants, like litter, if they are likely to be an issue.
- Use natural hydrological features as part of stormwater management.

The Silverdale West Dairy Flat Business Structure Plan Area (Structure Plan Area) covers approximately 600ha of Future Urban Zone located to the west of State Highway 1 and to the south-west of the Silverdale Township (refer Figure 2-1). The Structure Plan Area is adjacent to further areas of Future Urban zone for the wider Silverdale – Dairy Flat area. The Structure Plan Area has been identified for future business land uses.

2 Stormwater Characteristics and Constraints

Stormwater characteristics and constraints are described through this section, supported by mapping. Key stormwater management messages to inform the Structure Plan are highlighted through this section and summarised in the Executive Summary. Appendix 1 includes mapping at a finer scale for reference.

The key stormwater constraints and opportunities for development within the Structure Plan Area are summarised below and described further in the following sections.

Constraints:

- Significant flood plains in future urban areas.
- Erosive nature of soils and limitations for soakage and infiltration.
- Potential silt loadings from earthworks, particularly to upper catchment streams.
- Potential capacity constraints at culverts and major structures.
- Sensitive receiving environments.

Opportunities:

- Protection of flood plain and controlling or mitigating the adverse impacts of flooding to protect health and safety of the public and ensure future resilience to flooding.
- Hydrology mitigation to reduce potential stream erosion, improve water quality and maintain/enhance stream health by maintain stream base flows and groundwater recharge.
- Protect and maintain overland flow paths as directed in AUP (OiP) as part of flood management
- Protect and enhance existing stream network through protection of permanent and intermittent streams, removal of on line farm ponds and riparian planting and fish barrier removal.
- Use of stream corridors for green infrastructure, ecological linkages within the catchments, and public amenity.

2.1 Location and Existing Land Use

The Structure Plan Area is predominantly rural. It comprises of farmed pasture with some residential and commercial properties and lifestyle blocks as indicated in Figure 2.1. The Structure Plan Area is adjacent to the North Shore Airport and Aero Park residential development, although this area is not within the Structure Plan Area. The area is bounded by SH1 motorway to the east and is located across three Stormwater catchments as described in Section 2.2.

The land within the Structure Plan Area was previously zoned General Rural under the Rodney District Council Proposed District Plan. A draft structure plan was completed in 2010 for the Silverdale West Area (Draft Silverdale West Structure Plan, October 2010).

Table 2-1: Existing Land Use

Land Use	Area (ha)
High Producing Exotic Grassland	584.0
Built-up Area	1.1
Indigenous Forest	3.5
Lake and Pond	0.4
Other Exotic Forest	9.8
Short-rotation Cropland	5.8
TOTAL	604.5

2.2 Topography and Catchments

The Structure Plan Area is located across three Stormwater catchments as shown on Figure 2.2. The area to the north of Dairy Flat Highway is contained within the **Pine Valley Catchment**, the central area is within the **Silverdale South Catchment** and the southern part of the Structure Plan Area is within the **Dairy Flat Catchment**. The Structure Plan Area has a significant number of permanent and intermittent watercourses and some existing natural wetland features.

The Silverdale South catchment is in the Silverdale South Integrated Catchment Management Plan (ICMP) area (URS, 2010). The Silverdale South Catchment has a Network Discharge Consent granted in June 2013 (No. 28908) based on the Silverdale South ICMP.

2.2.1 Pine Valley Catchment

The Pine Valley catchment has a total area of 1,036ha and drains east to the Weiti River. The Structure Plan Area includes approximately 65ha of the downstream section of Pine Valley Catchment area that is bounded by the Weiti Stream to the north and SH1 to the east, as shown on Figure 2.2. Upstream areas within the wider Pine Valley Stormwater Catchment are also zoned Future Urban – subcatchment 1, 2, and 3 on Figure 2.2.

The structure plan area within the catchment slopes from the Dairy Flat Highway to a predominantly flat area towards the Weiti Stream.

2.2.2 Silverdale South Catchment

The Silverdale South catchment covers approximately 230ha of the Structure Plan Area. The area is flat to undulating, with the embankment formed by State Highway 1 as well as the land from Wilks Road and Dairy Flat Highway all sloping towards John's Creek. The runoff from this catchment discharges to John's Creek and into the Weiti Stream at a similar location as the Pine Valley Catchment.

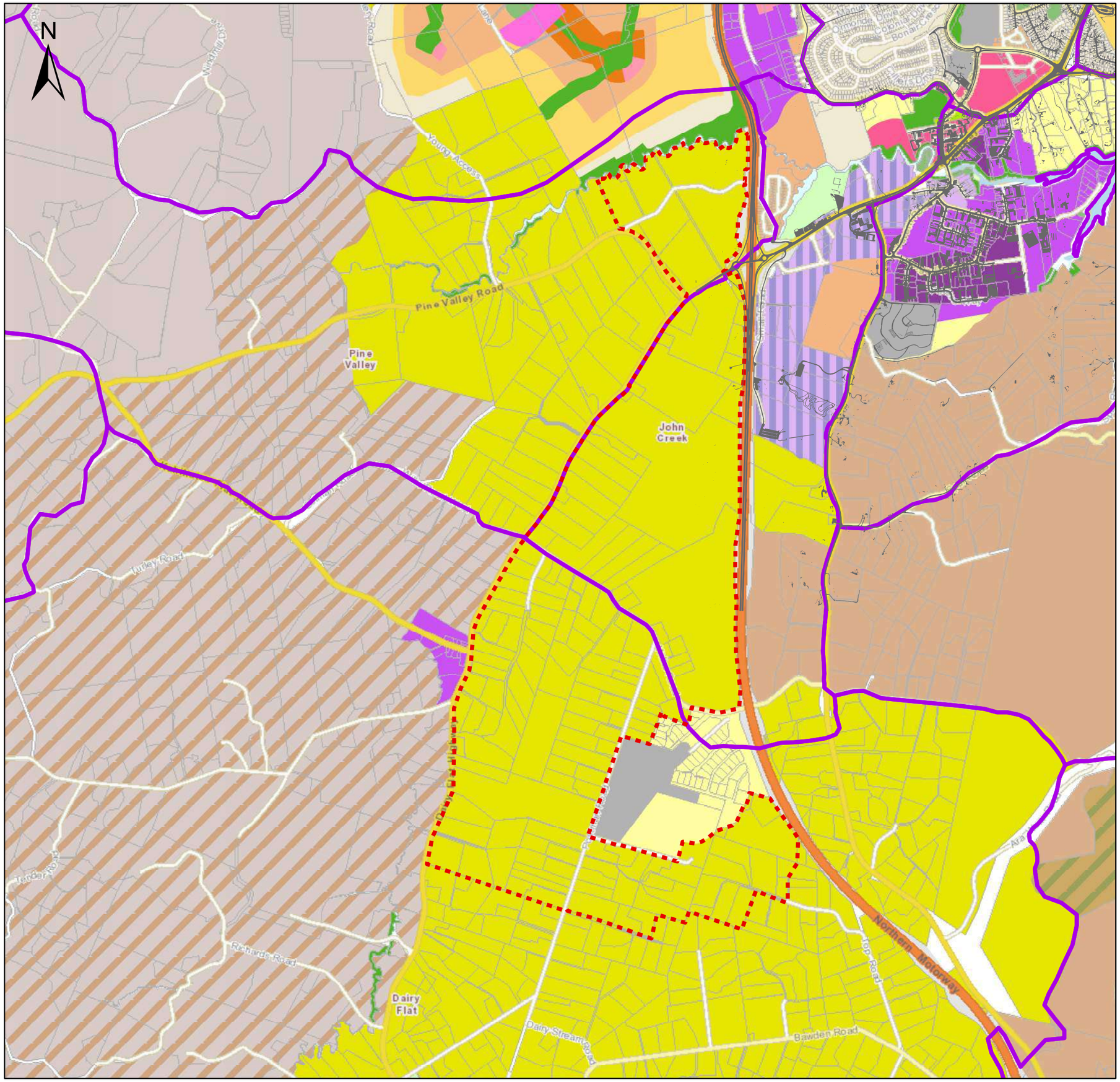
Subcatchment 5 within **the Structure Plan Area receives flows from the east of SH1 into the Structure Plan Area via a series of motorway culverts** as illustrated on Figure 2.2. A large part of this land is expected to be developed in the future (Figure 2.1).

2.2.3 Dairy Flat Catchment

The Dairy Flat Catchment area covers approximately 310ha of the Structure Plan Area. North Shore airport is located upstream of three subcatchments within the Structure Plan Area – subcatchments 5, 7 and 8. The northern area has two natural gullies lying between Postman Road and Dairy Flat Highway. The two tributaries confluent a short distance before a main culvert under Dairy Flat Highway, in a flat floodplain area. The southern part of the area general drains south into other small tributaries of Dairy Stream. The Dairy Stream flows into the Rangitopuni Stream.

Photo 1: Silverdale South Catchment Looking North

Photo 2: Silverdale South Catchment Looking West



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Silverdale West Stormwater Management Plan

Figure 2.1 Land Use

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Legend

- Silverdale Dairy Flat Business Area Structure Plan
- Existing Impervious Area
- Stormwater Catchments Boundaries

Zones (All)

- Residential - Large Lot Zone
- Residential - Rural and Coastal Settlement Zone
- Residential - Single House Zone
- Residential - Mixed Housing Suburban Zone
- Residential - Mixed Housing Urban Zone
- Residential -Terrace Housing and Apartment Buildings Zone
- Open Space - Conservation Zone
- Open Space - Informal Recreation Zone
- Open Space - Sport and Active Recreation Zone
- Open Space - Civic Spaces Zone
- Open Space - Community Zone
- Business - City Centre Zone
- Business - Metropolitan Centre Zone
- Business - Town Centre Zone
- Business - Local Centre Zone
- Business - Neighbourhood Centre Zone
- Business - Mixed Use Zone
- Business - General Business Zone
- Business - Business Park Zone
- Business - Heavy Industry Zone
- Business - Light Industry Zone
- Future Urban Zone
- Green Infrastructure Corridor (Operative in some Special Housing Areas)
- Rural - Rural Production Zone
- Rural - Mixed Rural Zone
- Rural - Rural Coastal Zone
- Rural - Rural Conservation Zone
- Rural - Countryside Living Zone
- Rural - Waitakere Foothills Zone
- Rural - Waitakere Ranges Zone
- Strategic Transport Corridor Zone
- Special Purpose Zone
- Coastal - General Coastal Marine Zone [rcp]
- Coastal - Marina Zone [rcp/dp]
- Coastal - Mooring Zone [rcp]
- Coastal - Minor Port Zone [rcp/dp]
- Coastal - Ferry Terminal Zone [rcp/dp]
- Coastal - Defence Zone [rcp]
- Coastal - Coastal Transition Zone
- Water [i]
- Hauraki Gulf Islands
- Road [i]

Silverdale West Stormwater Management Plan

Figure 2.2 Topography

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Legend

- Subcatchments Discharge Locations
- Permanent/Intermittent Stream
- 20m Contours
- Existing Urban Zone
- Subcatchments within the Structure Plan Area
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.

2.3 Geology and Soils

2.3.1 Geology

The geology of the Structure Plan Area is the Northland Allochthon, with recent alluvial / colluvial soils present in flood plain areas associated with the stream network (Figure 2.3).

1 Northland Allocthon: The project area is primarily underlain by Mahurangi Formation, a moderately hard, shattered, muddy limestone locally interbedded with thin beds of glauconitic sandstone. In the northern portion of the Structure Plan Area, there is a small portion of Hukerenui Formation, a soft, highly-sheared, multi-coloured mudstone with rare sandstone beds (Edbrooke, 2001).

2 The near surface residual Northland Allocthon materials are typically encountered as soft to very soft, low shear strength clays to depths of about 5m (Edbrooke, 2001). Also, the Northland Allochthon rock itself has high densities of rock mass defects and is typically shattered and with millimetre laminations.

3 Recent Alluvial / Colluvial Soils: The stream floodplain areas are indicated to be underlain by recent locally derived alluvium. Across the region the valley terrace deposits can consist of up to 20m of unconsolidated muds (very soft), sands and gravel with local muddy peat and pumice silt beds. The upper few metres are commonly weathered to very soft clays. Across this site, these deposits are anticipated to range in thickness from 1.5 m to 4.8 m (URS, 2010).

2.3.2 Hydro-Geology

Piezometric head typically increases with increasing depth and is commonly “artesian” at a depth of 10 to 20 metres. The piezometric head does not appear to be related to local infiltration or influences of local topography. It is not unusual to find artesian groundwater levels at the top of ridges during periods of dry weather.

High piezometric heads are more likely related to confined water bearing fractures, (some with high flows) within the rock mass material and the low permeability of the rock mass. Typical rates of permeability for this site geology rock mass are likely to range from 10-7 m/s to 10-11 m/s. This equates to generally low infiltration potential.

The calcareous nature of the Mahurangi Limestone means that it is susceptible to local dissolution. This can result in the development of underground streams, hollows, voids / tomos but it is noted that the limestone is typically so sheared that dissolution is restricted due to a lack of continuous defects. Given the likely artesian nature of groundwater within the bedrock, and shallow groundwater levels in low lying areas, these will be contributing baseflow for the stream networks.

In general terms soils soakage capacity will be limited. Where water is discharged to ground, consideration of Mahurangi Limestone is needed. Site specific data on soil properties will be important in refining stormwater management as development planning and design is progressed.

Groundwater management (e.g. cut off or subsoil drains) required as part of development platforms means a need to discharge water to stream networks away from development zones. The knock-on effect of concentrating flows to streams, exacerbating erosion issues described in Section 2.5.

Groundwater management systems need to discharge to streams as close to source as possible to minimise the effects of concentrating flow.

Silverdale West Stormwater Management Plan

Figure 2.3 Geology

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Legend

- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone

Soil Type

- Northland Allochthon (Kkh/ Hukerenui Mudstone)
- Northland Allochthon (Omm/ Mahurangi Limestone)
- Recent Alluvial/ Colluvial Soils
- Waitemata Group Sandstone and Mudstone (Mwe)

Data Source: Auckland Council Geomaps

2.4 Existing Hydrological and Stormwater Network

The Stormwater drainage network within the Structure Plan Area is predominantly natural channels with minimal existing infrastructure other than culverts under roads and the SH1 motorway as shown on Figure 2.4. There is an existing network of catchpits and reticulated stormwater drainage that forms part of the SH1 motorway owned and operated by NZTA. The motorway stormwater network includes several ponds adjacent to the motorway to manage runoff (water quality and extended detention) from the motorway area. A stream assessment has been completed to confirm the presence of permanent and intermittent streams and other hydrological features such as wetlands and ponds in the area.

2.4.1 Pine Valley Catchment

The Structure Plan Area within the Pine Valley Catchment includes three main stream channels that drain into the Weiti Stream.

The Structure Plan Area conveys flows from a significant area of the Pine Valley Catchment outside of the Structure Plan Area, also zoned Future Urban. Future management of stormwater upstream of the Structure Plan Area will need to be carefully managed to be in line with management controls within the current Structure Plan Area.

Stormwater management within the Structure Plan area needs to consider maximum probable development in the upstream catchment, including the Future Urban Zone outside of the Structure Plan Area.

2.4.2 Silverdale South Catchment

Stormwater in the catchment is conveyed via a number of streams and open channel systems to John's Creek. Johns Creek drains to the Weiti Stream. This drains in a northerly direction and beneath SH1 via a motorway culvert that connects to a secondary culvert located under Small Road and the Hibiscus Coast Highway which drains to the Weiti Stream. Culverts diameter and associated asset performance is set out in Table 3.2 and are critical existing stormwater asset within the area.

A number of culverts pass under SH1 to convey water from the eastern side of the motorway into the Structure Plan Area to the west of SH1 as shown on Figure 2.4. The capacity and performance of these culverts has been assessed using results from catchment hydraulic modelling, as described in Section 3.5.

The culverts that pass under the motorway were designed and constructed in the 1990's. These existing assets were not designed to meet NZTA's current design standards. The legacy Rodney District Council design standards were used at that time. Hydraulic modelling indicates that although the design standards are not met, flooding of the motorway is not predicted to occur during the current 1% AEP (existing development, excluding climate change) event.

Photo 3: SH1 Culvert (downstream end) at Silverdale Interchange

There are a large number of ponds and wetland within this area including management ponds for the motorway and private ponds (Figure 2.4).

Photo 4: SH1 water quality pond at Silverdale Interchange, within Structure Plan Area

2.4.3 Dairy Flat Catchment

The Dairy Flat catchment area is relatively flat with less defined stream channels. The area is drained via a combination of engineered channels along public roads and driveways and natural stream channels. Many of the shallow channels that drain the land are not picked up in the LiDAR information and overland flow path details on the Auckland Council GIS data. There is also evidence from the aerial photography of many ponds in private properties. There are several culverts that transfer flow beneath roads and driveways. Further assessment of these assets is required and will be assessed through a stream assessment and further detailed hydraulic modelling.

The runoff from this area discharges into the Rangitopuni Stream that continues through Riverhead into the Waitemata Harbour.

Silverdale West Stormwater Management Plan

Figure 2.4 Network

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N

OREWA RIVER WEST
PINE VALLEY
KAUKAPAKAPA
SILVERDALE NORTH
RED BEACH
WEITI RIVER NORTH
SILVERDALE WADE
SILVERDALE SOUTH
WEITI SOUTH
DAIRY FLAT
OKURA NORTH

Legend

- Motorway Ponds/Wetlands
- Known Private Culverts/Bridges
- Public Culverts/Bridges
- Stormwater network
- Permanent/Intermittent Stream
- Private Ponds/Wetlands
- Furture Urban Zone
- Existing Urban Zone
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.

2.5 Ecology, Erosion and Water Quality

The National Policy Statement for Freshwater Management, the New Zealand Coastal Policy Statement and the Auckland Unitary Plan (OiP) emphasise the importance of managing and improving the condition of Auckland's streams. Auckland Council's three strategic objectives for the management of freshwater (E1.2 of the Auckland Unitary Plan (OiP) are:

- Freshwater and sediment quality is maintained where it is excellent or good and progressively improved over time in degraded areas.
- The mauri of freshwater is maintained or progressively improved over time enabling traditional and cultural use of this resource by mana whenua.
- Stormwater and wastewater networks are managed to protect public health and safety and to prevent or minimise adverse effects of contaminants on freshwater and coastal water quality.

These objectives recognise that stormwater is an integral part of the hydrological cycle and that the quality of stormwater impacts on the mauri of water in the receiving environments.

There are a number of streams within and downstream of the Structure Plan Area. Streams are critical assets for both the transportation and storage of stormwater, as well as providing ecological, cultural (the mauri of water) and amenity value within the catchments. Where ephemeral streams become intermittent/permanent streams has been identified within the Structure Plan Area (Morphum, 2017), as shown on Figure 2.5.

Assessments of streams have been completed for parts of Johns Creek within the Silverdale South Catchment (URS, 2010 & Golder Associates 2009). These included comprehensive stream surveys, including physical attributes, water quality, habitat/ vegetation, structures, and fish. At the time of completing this report there is no readily available watercourse assessment data for the streams within the Pine Valley and Dairy Flat Catchments. This represents a gap in understanding that will inform management measures for the riparian margins, as well as support ecology, water quality and erosion objectives.

Watercourse assessments are required for all three catchments that form part of the Structure Plan area to verify the baseline condition of the existing stream environment and confirm the scope of on site and downstream watercourse works.

Increased stormwater runoff generated by development can adversely affect streams through impacting ecology, contamination of water and soils and erosion, however also offer a significant opportunity to deliver stream enhancement to avoid the further adverse effects that development would create.

2.5.1 Ecology

2.5.1.1 Silverdale South Catchment

The stormwater runoff within the Silverdale South Catchment is mostly channelled through John's Creek and its small tributaries. Due to the predominantly rural nature of the catchment many of the streams and tributaries are exposed to stock. By assessing aerial photos and from site visits there has also been stream modification works carried out in the smaller tributaries to form drainage channels with the straightening of natural drainage patterns.

In addition, catchment stream assessments have been completed for areas of John Creek including:

- Morphum 2018 (Watercourse Assessment Report – Silverdale Structure Plan Area: Concept Management Zones and Enhancement Opportunities. This report provides initial high-level evidence and guidance to inform this SMP ahead of completion of the watercourse assessment.
- URS 2010 (Silverdale South ICMP) - walkovers to visually assess in-stream issues including fish passage. The ephemeral and perennial parts of the streams were determined with respect to the requirements of the updated Proposed Auckland Regional Plan; Air, Land and Water (PALWP, ARC, 2004).
- URS 2010 (Silverdale South ICMP) – Physical habitat assessment (PHA) of the streams which was carried out against factors related to riparian vegetation integrity, bank stability, aquatic ability, hydrologic heterogeneity and aquatic diversity (ARC, 2006, USHA, 1998). The investigation was undertaken to evaluate the general morphological characteristics and habitat opportunities that are present in the receiving environment.
- Golder Associates 2009 (Silverdale West Structure Plan – Ecological Constraints Analysis) – undertook a constraints analysis of the aquatic and terrestrial resources within the Silverdale West site. The constraints analysis was to determine baseline aquatic and terrestrial ecological values and identify areas of significance or sensitivity to future development within the catchment.

Photo 5: John's Creek immediately upstream of SH1 culvert

These previous studies provide useful information on stream issues, however some are 10 years old and will be superseded once the watercourse assessment is complete. The studies indicate:

- Many ponds were recorded within the Structure Plan Area – Three of these are related to stormwater treatment and receive runoff from SH1. All ponds were man-made structures, and with the exception of the SH1 ponds, had riparian margins that generally consist of pasture grasses and occasional willow trees. A small natural wetland was observed by the north eastern end of Johns Creek.

Ponds and wetlands within the site are of low ecological value and generally provide poor aquatic habitat. Removal of many of the man-made ponds (or moving to offline ponds) could enhance water flow and improve water quality in many of the intermittent tributaries (Golder, 2009).

- Johns Creek and its tributaries are highly modified and impacted by unrestricted stock damage to streambanks and channels. Streams within the area should be retained and enhanced through riparian planting and stock exclusion, with emphasis given to the willow lined section of Johns Creek. (Golder 2009).

- Aquatic resources within the upper Johns Creek catchment are of poor quality and not considered to be significant in terms of habitat or biological communities present. Fish passage within the area is restricted by damaged culverts and debris. (Golder 2009).

2.5.1.2 Pine Valley Catchment

Limited information is currently available regarding the ecology within the Pine Valley catchment area. This area of the catchment discharges directly to the Weiti Stream. The AUP (OiP) has identified the area in around the Weiti Stream as a "Significant Ecological Area – Terrestrial (SEA-T)" as shown on Figure 3.6. "Significant Ecological Areas – Terrestrial are identified areas of significant indigenous vegetation or significant habitats of indigenous fauna located either on land or in freshwater environments. In order to maintain indigenous biodiversity these areas are protected from the adverse effects of subdivision, use and development" (AUP (OiP)).

The Pine Valley Catchment area discharges to the Weiti Stream in the location of a "Natural Stream Management Area" as shown on Figure 3.6.

The Natural Stream Management Area as defined in the AUP (OiP) "identifies river and stream reaches with high natural character and high ecological values. They generally have an unmodified river or stream bed with existing indigenous riparian vegetation on both sides. The presence of indigenous riparian vegetation indicates that the river or stream has high ecological values and water quality." There are rules in the AUP (OiP) that apply to this area in order to provide a high level of protection.

2.5.1.3 Dairy Flat Catchment

No ecological information was readily available for the Dairy Flat Catchment within the Structure Plan Area at the time of completing this report.

2.5.2 Erosion

Erosion of stream banks and channel forms have obvious negative effects on stream ecological and aesthetic values and is directly affected by increasing stream flows, particularly the smaller more frequent flows of less than the 2 year ARI rainfall event (Auckland Council TR 2013/035).

The nature of the soils in the Structure Plan Area, areas, particularly in the steeper parts of the catchments, are prone to erosion. With particular regard to potential development on the slopes of the catchment, the Northland Allocthon soils in this area are prone to erosion when subject to discharges of water (URS, 2010). The alluvial soils in the flatter areas are less susceptible to erosion (URS 2010).

Development in the Structure Plan Area will exacerbate stream erosion if unmitigated. Mitigation of hydrological adverse effects from erosive flows will be needed to provide stream bank stability, as well as associated effects on stream habitat and receiving environments.

2.5.2.1 Silverdale South and Pine Valley Catchments

Velocity is the driving force for stream bank erosion, although only part of the equation in assessing the risk of erosion. The resistance of the stream bank – soil type/cohesion and bank strength through vegetation root sand coverage are also important.

Hydraulic modelling predicts that in-stream velocities will increase if development occurs without mitigation. In the 50% AEP (1 in 2 Year ARI) event **average in stream velocities in the Weiti Stream downstream of the Structure Plan Area are predicted to increase between 50-100%** - from a range of 0.4-1 m/s to 0.75-1.6 m/s. It is important to note that this is the cumulative increase in velocity for the entire Future Urban Zone within the catchment, not just the Silverdale West Dairy Flat Business Area.

Although erosive flow effects are assessed and mitigated at more frequent storm events in Auckland (e.g. the 90th-95th percentile storm events), the 2 Year ARI storm event gives a strong indication of negative effects from development in the Structure Plan Area, that will require mitigation.

Increased velocities also have the potential to effect downstream infrastructure, including at culvert inlets and outlets under the motorway and roads, motorway embankments and bridges within Silverdale. This erosion can affect asset performance and residual life if its leads to undermining, removal of existing erosion protection and in severe circumstances collapse of culverts or bridges.

Initial outputs from the watercourse assessment (Morphum, 2018 – 2) indicate bank erosion susceptibility across the Silverdale South and Pine Valley catchments having an impact on the local and downstream environment.

A Rapid Geomorphic Assessment has recently been completed for approximately 2km of the Weiti River downstream of the Hibiscus Coast Highway. Initial results (Morphum, 2018) indicate *considerable instability* of the stream banks, based on the Auckland Council's Rapid Geomorphic Assessment methodology. There are no existing erosion protection measures within the stream corridor.

NZTA and Auckland Transport will be consulted on measures to mitigate potential erosion effects on downstream transport infrastructure.

2.5.2.1 Dairy Flat Catchment

Auckland Council are currently undertaking a pilot study in the Rangitopuni catchment (including the Dairy Flat catchment) to:

- Understand the existing stream bank erosion potential through in situ testing;
- Quantifying the volume the sediment currently generated through stream bank erosion;
- Quantify how this may change with the effects of development and assess the environmental impact; and
- Quantify the potential benefit on site hydrological mitigation could make to this environmental impact through continuous simulation modelling of conceptual hydrological mitigation methods.

The study will inform specific requirements for hydrological mitigation within the wider Future Urban Zone, as well as provide initial information on whether further works are required within the stream corridor to mitigate the effects of development.

Preliminary results show that the maximum probable development flow scenario results in a significant increase in bank-generated sediment loads within the downstream catchment, if unmitigated. The outcome from this study is expected in early 2019.

Even without development, erosion is likely to continue, therefore stream enhancement to avoid further adverse effects as part of development will be critical to delivering the objectives of the Auckland Unitary Plan (OiP).

Photo 6: Dairy Stream viewed from Dairy Flat Highway showing stream bank erosion/slumping within the Structure Plan Area

2.5.3 Water Quality

The current rural nature of the land within the Structure Plan Area is likely to generate contaminants including additional nutrients (e.g. from animal excreta and fertilisers), micro-organisms and sediment. Stock currently have access to waterways in parts of the Structure Plan Area. There is no wastewater system in the catchment and current properties will have on site wastewater treatment facilities, however sewage fungus has been noted upstream near Snow Planet. Other sources of contaminants into the stormwater network could include discharge from roads and discharges from other commercial activities.

The current stream network in John's Creek and Dairy Flat is reported to have limited riparian vegetation where the stream is largely surrounded by open pasture and receives high levels of sunlight (URS, 2010 & Morphum, 2018).

The change in land use from rural to commercial will generate different stormwater contaminants. Effects are due to additional roads and other impervious surfaces within the catchment. There is also a risk of additional sediment runoff during earthworks during the development of the area.

It is recommended that baseline water quality testing is carried out within the Structure Plan Area to determine the current water quality.

Silverdale West Stormwater Management Plan

Figure 2.5 Ecology

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Legend

- Esplanade Reserve Classification
- Permanent/Intermittent Stream
- Natural Stream Management Areas Overlay [rp]
- Enhancement Opportunity
- Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Significant Ecological Areas Overlay Terrestrial [rp/dp]

Stormwater Management Area Control

- Flow 1 [rp]
- Flow 2 [rp]
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.

2.6 Flooding

2.6.1 Floodplain

In Auckland, the floodplain is defined as a 1% annual exceedance probability (AEP) event, including allowance for climate change and maximum probable development (MPD). Development should be located outside of the floodplain and particularly the highest flood risk areas.

Even with the introduction of infrastructure to reduce the extent of the floodplain there will remain a residual risk of infrastructure failure (e.g. culvert blockage) that can lead to flooding of low-lying properties. Residual flood risk will need to be considered as part of development design. Auckland Council's flood prone area dataset can be used as a guide to identify these areas.

Sustainable and resilient development should avoid the floodplain, in accordance with the Auckland Unitary Plan (OiP).

Figure 2.6 shows the floodplain within the Structure Plan Area that has been developed through computational hydraulic modelling, as described in Table 2-2. . All hydraulic modelling has been undertaken in accordance with Auckland Council's Stormwater Modelling Specification (2011), considers maximum probable development land use and the predicted effects of climate change on rainfall and sea level rise. **Importantly, the climate change allowances are based on the Ministry for the Environment 2008 Climate Change and Effects and Impacts Assessment. Consideration will need to be given to the latest climate change prediction allowances from Auckland Council, as development is brought forward.** Uncertainty means a precautionary approach shall be adopted. The hydraulic models represent a useful tool to inform development on flood risk and system performance.

Table 2-2: Floodplain Data and Limitations

Catchment	Hydraulic Modelling Technique	Key Limitations	Outcome
Pine Valley & Silverdale South (John's Creek)	Rain-on-grid – MIKE 11/21 coupled MIKE FLOOD model, including key culvert structures	Effective rainfall hyetograph (after losses due to abstractions and infiltration) has been used in the model which results in direct surface runoff hydrograph. 15 major culverts are included in model on streams crossing SH1 as well as culverts crossing Small Road and Hibiscus Coast Highway. Wade bridge assumed to not provide a restriction.	Small watercourses in the structure plan area have not been explicitly included in the model. All depressions are filled in the model. The floodplain is based on the current terrain, and the actual extent may be smaller.
Dairy Stream	Rain-on-grid – MIKE 11/21 coupled MIKE FLOOD model,	Only covers Structure Plan Area of the catchment.	Existing channels and farm drains in the structure plan area have not been explicitly included in the model.

Catchment	Hydraulic Modelling Technique	Key Limitations	Outcome
	including key culvert structures	Assumed all rain that fall on the ground turns into runoff.	Floodplain is based on the current terrain, and the extent may be slightly reduced if the current drainage system are better represented.
Rangitopuni Stream	MIKE 21/M11 coupled MIKE FLOOD Model with full hydrological model in M11 for ED and MPD Scenarios	Covers wider catchment, including Dairy Stream catchment, down to Riverhead. Only main tributary channels and structures are included in the model	Floodplain extent limited to main channel. Tributary channels are not included in the model. 10m grid terrain data used and it is very coarse and likely based on the 2006 LiDAR.

The floodplains on Figure 2.6 have been developed by applying Auckland Council's Rapid Flood Hazard Assessment (rain-on-grid) modelling specification. The Silverdale South and Pine Valley floodplain was created using an existing Mike11-MIKE21 1D-2D coupled model completed by AECOM (November 2017). The Dairy Stream floodplain assessment was created using a Mike-21 model completed by Municipal Design Ltd (November 2017). Rain-on-grid modelling assumes no pipe network is available and is based on a digital terrain model developed from LiDAR data. In urban areas it therefore represents a precautionary estimate of the floodplain. In rural areas like the Silverdale West Structure Plan area, the rain-on-grid modelling is likely to be less precautionary, particularly where existing infrastructure such as culverts have been included.

The floodplain in Auckland is considered to begin when flow reach $2m^3/s$. Flows less than $2m^3/s$ are usually represented as overland flowpaths. The modelled flood extents within the Structure Plan Area have been edited to conform to floodplain criteria. Outside the Structure Plan area the modelled flood extents have not yet been edited, however are provided for context.

The following subsections summarise the floodplain constraints with the Structure Plan Area. Assessment of flood risk downstream as a result of development, and associated flood risk management is discussed further in Section 3.3.

2.6.1.1 Silverdale South and Pine Valley Catchments Floodplain

The main floodplain in the Structure Plan Area is along Johns Creek and its tributaries between Wilks Road and SH1. The low-lying land adjacent to the stream in this area is reasonably flat with the flood plain extent up to approximately 100m wide.

Johns Creek is piped beneath SH1 via a culvert and there are several culvert structures downstream of the Structure Plan Area between SH1 and the Weiti Stream beneath Small Road. Increased flow as a result of development is predicted to impact the system performance of downstream culvert and bridge infrastructure (refer Section 3.3).

2.6.1.2 Dairy Stream Catchment Floodplain

Large areas of the Structure Plan Area are at risk of flooding in the 1% AEP (1 in 100 year) storm event. The area within the Structure Plan Area is predominantly low gradient areas with some undefined stream channels and farm drains. The floodplain is large, however

much of it is shallow sheet flow and the extent of flooding can potentially be reduced through controlled overland flow from the existing urban area through the growth area. The floodplain in this area may also be influenced by structures on the watercourse such as road culverts (Dairy Flat Highway) – exacerbating flooding of low lying areas. Further assessment of the floodplain is required for these low gradient areas.

2.6.2 Flood Prone Areas

Flood prone areas are topographical depressions that can fill rapidly during a storm event due to a lack of capacity or blockage. They can be natural low points, or man-made (e.g. due to road embankments). Auckland Council have mapped flood prone areas using LiDAR data across the region (Figure 2.6).

Resilient development should avoid flood prone areas, providing a buffer to flooding hazards as described in the Auckland Unitary Plan E36 objectives. Where this is not practicable, design must consider how to manage this residual risk in accordance with the Building Code.

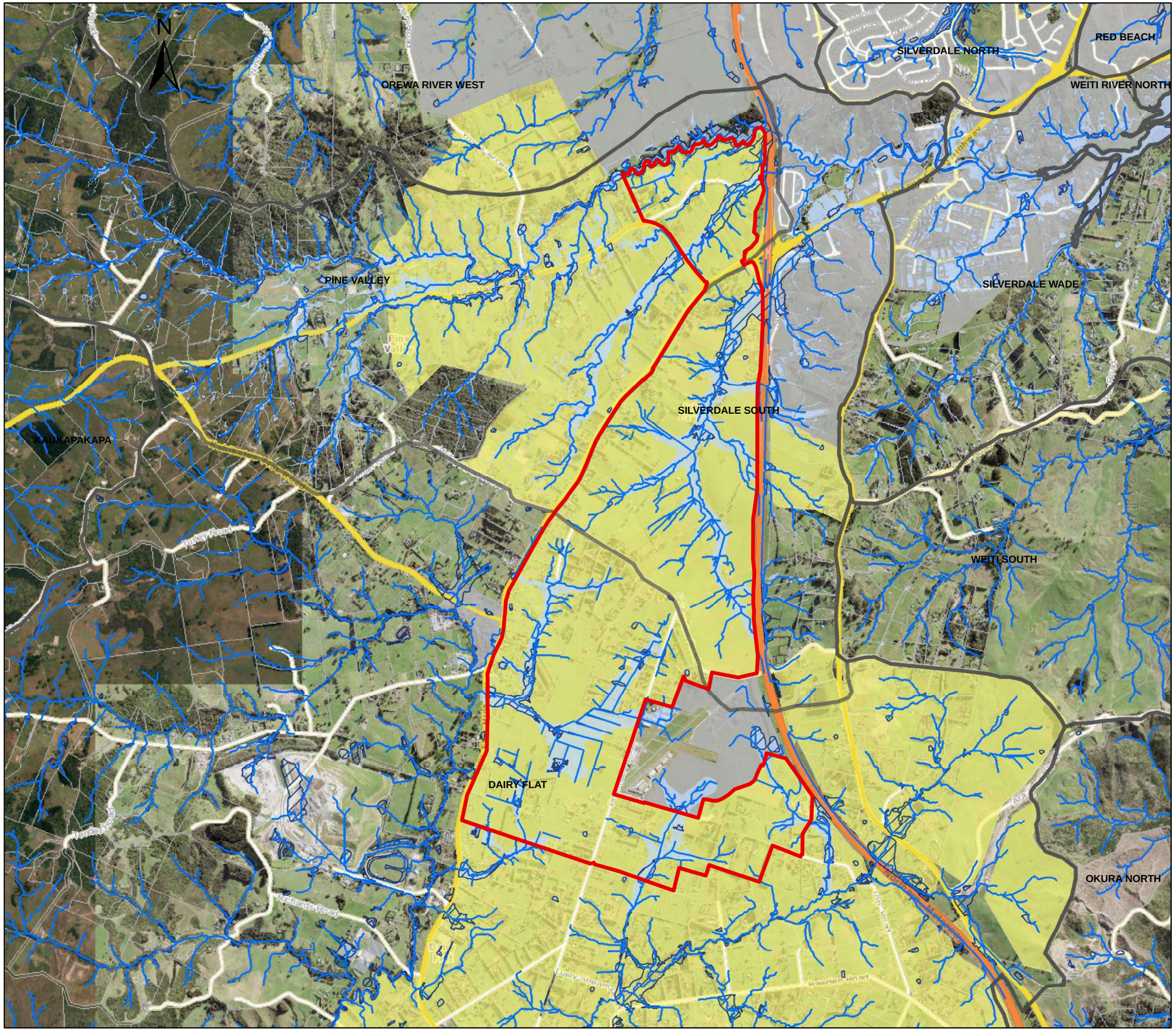
2.6.3 Overland Flow Paths

An overland flow path is a low point in the terrain, excluding permanent or intermittent streams, where surface runoff flows. They have a contributing catchment of greater than 4000m^2. Auckland Council have mapped overland flow paths using LiDAR data across the region (Figure 2.6).

There is limited pipe infrastructure within the Structure Plan Area, therefore overland flow paths currently act as the primary flow route for surface water upstream of intermittent streams.

In some cases the 'natural' topographical stream or overland flow path has been modified to form farm drains. It may be appropriate to modify farm drain locations as part of development, however overland flowpaths need to be accommodated as an integrated part of development, with consideration of permanent and intermittent streams, topography and road layout.

Overland flowpaths need to be integrated as part of development proposals in accordance with the Auckland Unitary Plan (OiP), Stormwater Code of Practice and Building Code.



Auckland Council | wsp | OPUS

Silverdale West Stormwater Management Plan

Figure 2.6 Flooding

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Legend

- Overland Flow Path
- Flood Prone Areas
- Silverdale Flood Plain
- Furture Urban Zone
- Existing Urban Zone
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

Note:

The modelled flood extents within the Silverdale Dairy Flat Business Area Stucture Plan have been edited to confirm with the AUP(OiP) flood Plain definition. The flood extent shown outside the structure plan area is incomplete and has not undergone this editing. Therefore where shown the flood extent outside the structure plan area should be treated as indicative only.

2.7 Receiving Environment

Runoff from the Structure Plan Area enters two separate receiving environments as shown on Figure 3.7. The northern area including the Silverdale South and Pine Valley Catchments (approximately 295ha) drains to the Weiti Stream, Weiti Stream Estuary and ultimately into the Hauraki Gulf. The southern area of the Dairy Flat catchment (approximately 310ha) drains to the Rangitopuni Stream and into the Waitemata Harbour.

2.7.1 Weiti Stream Estuary and Hauraki Gulf

The Weiti Stream drains a catchment of approximately 2,130 hectares, including the Silverdale South catchment and Pine Valley Catchment. The river is tidal from Karepiro Bay to Silverdale, upstream of which the river and its tributaries are essentially small freshwater streams (URS, 2010). It is also an Area of Significant Conservation Value identified by the Department of Conservation.

The Weiti Estuary location is classified as a Significant Ecological Area (SEA) under the AUP (OiP) as shown on Figure 3.6. The Weiti Estuary comprises three SEA including SEA-M2_65a; SEA-M1 65b and SEA-M1-65c.

- SEA-M2-65a – Weiti Estuary Intertidal

  Wading birds feed in the adjacent Wading birds feed in the adjacent intertidal areas to the south of the shell spits. The estuary also provides a good habitat for the coastal birds. There are also intact ecological sequences from mangroves and saline vegetation grading into coastal forest on the northern slopes of the Wade River. Here coastal broadleaved forest and shrubland forms a narrow continuous corridor from the mouth of the river to the upper reaches.

- SEA-M2-65b – Weiti Estuary Shell Spits

  The most notable feature of this small estuary is the series of cheniertype shell spits which have formed within the estuary. These have been used to derive a sea level curve for the last 10,000 years and are considered to be internationally significant landforms. The shellspits are a good high tide roosting site for the wading birds that feed in the adjacent intertidal areas to the south and for the coastal birds that use the estuary itself. The most seaward shellbank is particularly important as it is one of the key breeding grounds in the region for the threatened New Zealand Dotterel.

- SEA-M2-65c – Weiti Estuary

  Saline vegetation in the estuary grades into manukakanuka shrubland on hills, significant within the ecological district.

The Weiti Stream in the location of the Structure Plan Area is also a "Natural Stream Management Area" as shown on Figure 3.6.

The Natural Stream Management Area as defined in the AUP (OiP) "identifies river and stream reaches with high natural character and high ecological values. They generally have an unmodified river or stream bed with existing indigenous riparian vegetation on both sides. The presence of indigenous riparian vegetation indicates that the river or stream has high ecological values and water quality." There are rules in the AUP (OiP) that apply to this area in order to provide a high level of protection.

The Weiti Stream estuary discharges into the Long Bay Marine Reserve, and ultimately feeds into the Hauraki Gulf to the south of Whangaparaoa Peninsula at Karepiro Bay. **These are highly sensitive and regionally important receiving environments.**

2.7.2 Rangitopuni Stream

Approximately 310ha drains into the Dairy Stream catchment that includes the Dairy Stream and the Rangitopuni Stream. The ultimate receiving environment is into an upper reach of the Upper Waitemata Harbour at Riverhead via the Rangitopuni Stream.

The catchment draining to the Rangitopuni Stream is predominantly rural land use. The Structure Plan Area is located within the upper catchment of the Rangitopuni Stream as shown on Figure 3.8.

The Auckland Council "State of Auckland Freshwater Report Card" for the Dairy Flat Reporting Area, including the Rangitopuni Stream, has an overall grade of "C" (August 2016). This overall grade is made up of five indicators: water quality, flow patterns, nutrient cycling, habitat quality and biodiversity.

Further assessment of the receiving environment of the Rangitopuni Stream and assessment of impact from the Structure Plan Area is required. This assessment should also take into account the wider impact of further areas zoned Future Urban with the adjacent area as shown on Figure 2.7. This assessment need to impacts of development including stream erosion, flooding, water quality and ecological impacts.

The receiving environment is an area of the Waitemata Harbour classified under the AUP (OiP) as a Significant Ecological Area – (SEA M2-57b Marine 2). This SEA is the best example of the muddy, mangrove-lined inlets of the inner Waitemata Harbour. The diversity and productivity of the flora and fauna is generally large with extensive beds of shellfish and abundances of birds and fish".

N

OREWA RIVER WEST
SILVERDALE NORTH
RED BEACH
PUAWAI
WEITI RIVER NORTH
STANMORE BAY
Weiti Stream
PINE VALLEY
SILVERDALE WADE
DUCK CREEK
KAUKAPAKAPA
SILVERDALE SOUTH
STILLWATER
WEITI SOUTH
KAREPIRO
DAIRY FLAT
OKURA
OKURA NORTH
LONG BAY
CENTRAL KAIPARA
AWARUKU
COATESVILLE
WAYSIDE
LUCAS CREEK
TAIAOTEA
RANGITOPUNI
Rangitopuni Stream
PAREMOREMO
RIVERHEAD
PAREMOREMO
ATTWOOD
KUMEU HUAPAI

Legend

- Catchment Discharge Location
- Permanent/Intermittent Stream within Sturcture Plan Area
- Auckland_Council_Classified_River
- Stormwater Catchments Boundaries
- Silverdale Dairy Flat Business Area Structure Plan
- Furture Urban Zone
- Existing Urban Zone

Auckland Council

WSP | OPUS

Silverdale West Stormwater Management Plan

Figure 2.7 Receiving Environment

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3 Integrated Stormwater Management

3.1 Introduction

The Auckland Unitary Plan (OiP), particularly in E1.3(10) Integrated Stormwater Management, requires greenfield development to take an integrated stormwater management approach.

In taking an integrated stormwater management approach have regard to all of the following:

a. *the nature and scale of the development and practical and cost considerations, recognising:*

   i. *greenfield and comprehensive brownfield development generally offer greater opportunity than intensification and small-scale redevelopment of existing areas;*

   ii. *intensive land uses such as high-intensity residential, business, industrial and roads generally have greater constraints; and*

   iii. *site operational and use requirements may preclude the use of an integrated stormwater management approach.*

b. *the location, design, capacity, intensity and integration of sites/development and infrastructure, including roads and reserves, to protect significant site features and hydrology and minimise adverse effects on receiving environments;*

c. *the nature and sensitivity of receiving environments to the adverse effects of development, including fragmentation and loss of connectivity of rivers and streams, hydrological effects and contaminant discharges and how these can be minimised and mitigated, including opportunities to enhance degraded environments;*

d. *reducing stormwater flows and contaminants at source prior to the consideration of mitigation measures and the optimisation of on-site and larger communal devices where these are required; and*

e. *the use and enhancement of natural hydrological features and green infrastructure for stormwater management where practicable.*

These requirements are reflected in Auckland Council's Water Sensitive Design guideline (GD04), which sets out a process for delivering water sensitive design in the Auckland Region.

Water Sensitive Design is an inter-disciplinary design approach to urban planning and development which provides opportunities for integration of land use and freshwater management and aims to protect and enhance natural freshwater systems, by sustainably managing water sources and mimicking natural processes. (Auckland Council, 2015).

There are four key Water Sensitive Design principles in GD04:

Promote interdisciplinary planning and design.

Protect and enhance the values and functions of natural ecosystems.

Address stormwater effects as close to source as possible.

Mimic natural systems and processes for stormwater management.

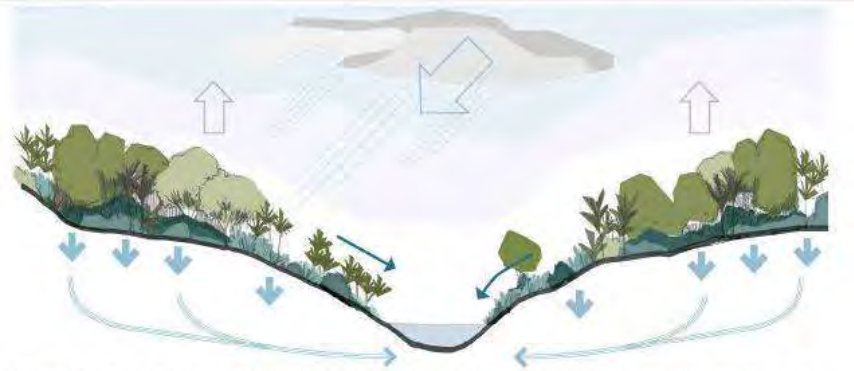

Figure 4: The water cycle interacts with plant and soil systems that capture, infiltrate and transpire rainwater and stormwater runoff.

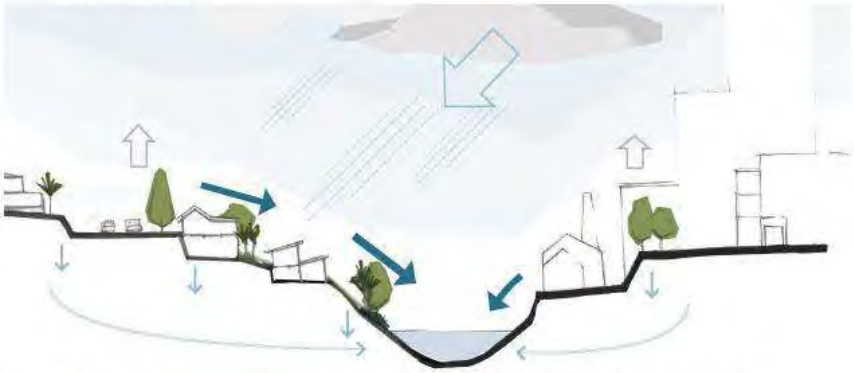

Figure 5: A developed catchment has increased overland and reticulated flows directed rapidly to receiving environments, bypassing natural systems and processes.

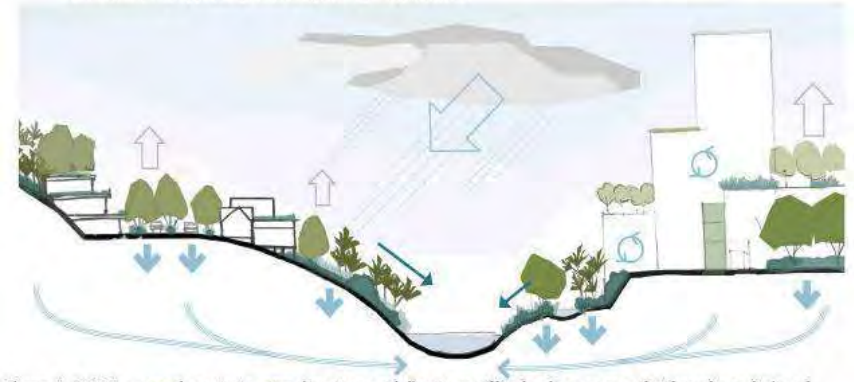

Figure 6: A WSD approach protects natural systems and directs runoff to landscape areas that have been designed to utilise natural processes to treat and retain runoff.

This SMP provides guidance on how water sensitive design can be applied to development brought forward in the Structure Plan Area to deliver the outcomes sought by the Auckland Unitary Plan (OiP), in the context of the issues identified in Section 2.

3.2 Stream Protection and Enhancement

3.2.1 Stream Corridors

The Auckland Unitary Plan (OiP) seeks a high level of protection for permanent and intermittent streams in the region, which recognises the range of values that streams have including hydrological function, ecological values and amenity value for community. Through the development of Future Urban Zones the existing stream corridors will be transformed from rural streams to functional urban waterway. The urbanisation of the contributing catchments to these streams presents a one off opportunity to implement practices that will result in resilient and ecologically functional urban streams in the future. With a co-ordinated approach, these corridors could form the building blocks for green corridors incorporating walking and cycling facilities and, where appropriate, provide a corridor for other utility provisions.

Section 0 summarises the current ecological, erosion and water quality issues in the streams associated with the Future Urban Zone. Permanent and intermittent streams have been mapped for the catchments on Figure 2.4. In addition to providing habitat and biodiversity streams provide an important hydrologic function – detaining and attenuating flows and reducing flood risk compared to pipe systems.

Protecting and enhancing permanent and intermittent streams forms a key feature of a water sensitive design approach in the Structure Plan Area.

Key principles required for stream corridors in the Structure Plan Area are described below, informed by GD04 (Auckland Council, 2013):

- Greenways (lineal parks) are to be incorporated to provide the framework to protect, conserve and link stream corridors as open spaces. These can provide important cycle and walkways, wildlife corridors and riverways linking natural, cultural and recreational areas. Greenways will need to be established early in the master planning process, in collaboration with landowners, Auckland Council, Auckland Transport and Local Boards.
- Where Greenways are not practical or appropriate, create Riparian Buffer Zone through private land on all permanent and intermittent streams that includes the extent of the floodplain. These can have a significant effect on water quality in the receiving environment. A minimum 10m riparian margin shall be provided either side of intermittent streams and a minimum 20m riparian margin either side of permanent streams. Guidance is available in the Auckland Regional Council Technical Publication TP148 Riparian Management Guideline (Becker et al., 2001).
- In combination with managing increased runoff preparing the stream corridor to receive flows from an urbanised catchment is critical to protect against erosion and to attenuate stormwater runoff. Depending on the size of the upstream catchment this may include enhancement planting around intermittent and permanent streams in headwater locations, or harder interventions such as rock armouring or bank shallowing where high flows are anticipated.
- Protect and enhance existing wetland areas of value (informed by Watercourse Assessments).
- Development layout must maintain, as far as practicable, the natural drainage pattern of the site. GD04 (Auckland Council, 2013) identifies this could be achieved through:

  (a) Adapting the urban street grid pattern in response to existing topography and landform, including stream crossings perpendicular to the direction of flow.

(b) Creating 'naturalised' drainage patterns to receive runoff from increased imperviousness, placed along boundaries and within streetscapes.
(c) Allowing flexibility for both road carriage width and riparian buffers.
(d) At strategic stream crossing points, favouring pedestrian and bike crossings over roads.
(e) Assisting vehicle movements by prioritising street connections and potential stream crossings based on neighbourhood density and travel distances.
(f) Creating streetscapes and street alignments which draw from and extend riparian open spaces.
(g) Increasing neighbourhood cycle/pedestrian connections through stormwater reserves.
(h) Mitigating the occupation of the floodplain by road crossings by enhancing stream habitats elsewhere (internal to blocks).
(i) Providing for wider stream corridors at road crossings to accommodate bridge abutments, landscape transitions, and habitat refuges above and below culverts.

3.2.2 Watercourse Management

The requirements set out in Section 2.5 and Section 3.2.1 will inform watercourse management, however specific watercourse management responses will be informed Watercourse Assessments, once completed. Initial concept management zones and enhancement opportunities (Morphum, 2018 – 2) for the Silverdale South catchment have been provided ahead of completion of the watercourse assessment, to help inform this Stormwater Management Plan.

Watercourse management responses are summarised below. The latest watercourse assessment should be referenced for further detail, once available.

Consider the effects of climate change on erosion and sediment loads and embed appropriate mechanisms and actions into planning decisions.

Enhancement Opportunities that would benefit both the structure plan area and wider catchment are described in Table 3-1.

Table 3-1: Enhancement Opportunities for the Silverdale West Dairy Flat Structure Plan Area

Enhancement Opportunity	Management Zone	Description	Linkage in this SMP
EO1	MZ4	Daylighting and erosion on lower Weiti River	Section 2.5.2.1 (outside Structure Plan area, but influenced by development in Structure Plan Area)
EO2	MZ4	Upper Weiti River ecological area	Section 2.5 and 3.2.1 (outside Structure Plan area, but influenced by development in Structure Plan Area)
EO3	MZ1	Attenuation of stormwater flows from John Creek to Weiti River	Section 3.4
EO4	MZ1	Restore historical hydrology	Section 3.2.1 and 3.2.3
EO5	MZ2	Snow Planet stormwater treatment	Section 2.5.3 (outside Structure Plan area, but impact within Structure Plan Area)

Enhancement Opportunity	Management Zone	Description	Linkage in this SMP
EO6	MZ6	Aeropark Drive wetland	Section 2.5.3 (outside Structure Plan area, but impact within Structure Plan Area)
EO7	MZ5	Esplanade Reserve – Weiti River Pine Valley	Section 2.5 and 3.2.1
EO8	MZ1	Esplanade Reserve – John Creek	Section 2.5 and 3.2.1

3.2.3 Hydrology Mitigation

In addition to Water Sensitive Design, the Auckland Unitary Plan (OiP) uses Hydrology Mitigation where stream environmental protection is required as part of development. This takes the form of at source retention and detention. Hydrology mitigation in the Auckland Unitary Plan (OiP) is applied using Stormwater Management Area – Flow (SMAF) rules. The SMAF overlay is focussed on urban areas and is applied to brownfield development. The need and level of hydrological mitigation in Future Urban Zones is informed by Stormwater Management Plans (i.e. this document).

The ongoing study in the Rangitopuni catchment (refer Section 2.7.2) will help inform the extent and parameters for hydrological mitigation. The majority of the Structure Plan Area within the Silverdale South and Dairy Stream catchments were classified as SMAF Zone 1 in the technical analysis (TR2013/035) that supported SMAF classification in the Proposed Auckland Unitary Plan (Auckland Council, 2013).

Application of hydrological mitigation is required for the Structure Plan Area to minimise hydrological impacts on streams within and downstream of the Future Urban Zone.

Development within the Structure Plan area will be required to apply hydrology mitigation, informed by the ongoing study in the Rangitopuni catchment. The requirements will align with the hydrological mitigation requirements in the Auckland Unitary Plan (OiP), however will be development specific, recognise the objectives of the Auckland Unitary Plan (OiP), opportunity afforded by greenfield development to apply the best practice approach set out in TR2013/035 (Auckland Council, 2013), and the site-specific conditions.

Guidance on how retention and detention requirements can be delivered is described in Section 4.4. As development planning and design occurs, assessment will be required to assess to confirm how hydrological mitigation is most appropriately achieved.

Although hydrological mitigation is an important part of managing stream bank erosion, it is likely that in stream erosion protection works may be required both within the Structure Plan

3.3 Stormwater Treatment

Development provides an opportunity to improve the water quality discharging into the sensitive receiving environment. Stormwater treatment is required in accordance with the Auckland Unitary Plan, and associated guidelines, as set out in Section 3-5.

Industrial and trade activities will also be required to meet the requirements of E33 in the Auckland Unitary Plan, where appropriate.

The significant value and sensitivity of the receiving environments downstream of the Structure Plan Area, mean that stormwater management systems needs resilience and contingency arrangements, either on-site or as part of a collective treat train approach to ensure water quality is not impacted.

3.4 Flood Risk Management

An integrated stormwater management approach means flood risk should be managed through applying the hierarchy in Table 3-2. This process is enshrined within the Unitary Plan, which directs that in greenfield areas building in the floodplain be avoided and flood tolerant activities only occur if there are no downstream or upstream effects. The flood risk management hierarchy should be considered through the structure planning process as well as when development areas are brought forward.

Table 3-2: Flood Risk Management Hierarchy

Step	Approach	Description	Example
1	Avoid	Locate development in areas at least risk of flooding.	Set aside floodplains free from any development.
2	Substitute	Where development has to be located in the floodplain, located the least vulnerable land uses there.	Prioritise public open space, or similar, within the floodplain.
3	Control	Implement interventions to reduce the impact of flooding. Where the need for vulnerable land uses or critical infrastructure outweighs flooding, engineering interventions could be brought forward to reduce flood extents.	Culvert/bridge upgrades Channel widening Land raising Flood storage
4	Mitigate	Implement interventions to reduce the residual risk of flooding	Property level flood protection or flood resilience measures.

Source: Planning Policy Statement 25 Practice Guide, CLG, December 2009

The flood risk management hierarchy will be applied through the structure planning process for the Silverdale West Dairy Flat Business Area, and as development is brought forward.

3.4.1 Mitigating the effects of increased flood risk to existing downstream properties

Development within the Structure Plan area is predicted to result in increased downstream water levels in events up to the 100 year ARI event. Although floor level surveys have not been undertaken, an assessment of relative changes in predicted flood levels has been undertaken.

Within the Silverdale South/Pine Valley catchment one property is predicted to be negatively affected as a result of upstream development.

Within the Dairy Flat/Rangitopuni catchment 17 properties, primarily in the Coatesville-Riverhead Highway area, are potentially negatively affected as a result of upstream development in the Structure Plan Area, with increases in water level of approximately 50-200mm. When development across the wider Future Urban Zone is considered the number of properties increases to 33 and the change in depth increases to up to approximately 370mm.

Floor level survey is required to confirm whether the increased risk of flooding meets the requirements of the Auckland Unitary Plan (OiP), however based on the currently available information mitigation is expected to be required. Potential mitigation options include:

- Attenuation of flows onsite (at source);
- Attenuation of flows in communal storage areas;
- Upgrading/upsizing of the culverts (pass flows forward);
- Raising of embankment between the properties and stream;
- Increasing the conveyance capacity of the streams main channel (e.g. widening)
- Property purchase.

The most appropriate option, or combination of options, to mitigate the effects of will need to be assessed.

3.4.2 Mitigating the effects of increased flood risk to existing infrastructure

A number of culverts under key road corridors (9 in Silverdale and Pine Valley Catchments and 4 in Dairy Flat Catchment) are likely to be affected by the increased flows from the development of the Silverdale West Dairy Flat Business Area.

Table 3-3 outlines the culverts located under SH1, whether they meet the freeboard requirements as set out in the NZTA Bridge Manual (current standard) and the predicted increase in flood levels from impervious development (including climate change effects). Culverts with a flow area greater than 3.4m^2 are classified as culverts. As indicated in Table 3-2, few of the culverts meet current design standards. Consultation with NZTA indicated network (road and stormwater infrastructure) performance, and how it would change as a result of development, is more important than existing assets meeting current design standards.

The analysis in Table 3.2 includes the cumulative effects of development across the entire Future Urban Zone, not just the Structure Plan area in isolation. Peak flow runoff increase from the Future Urban Zone result in increased water levels at culverts.

Uncertainty in climate change predictions, the lack of validation possible of the model results, and uncertainty in future motorway upgrades means a precautionary approach or adaptive approach should be adopted in decision making with respect to the impact on these assets.

1. Culvert SWC6503 (beneath SH1 At the Silverdale off ramp) – Floodwater at the culvert inlet is already predicted to by 2.6m above the soffit in a 1 in 100 year ARI event. The effect of development means the water level is predicted to reach the edge of seal on the on ramp. There is the potential to affect the safety of people and the resilience of the road network. Although flooding is shown across the motorway on-ramp, this is runoff from the motorway swale running towards the stream, rather than from the Structure Plan Area.

2. Culvert 3 (beneath Small Road) – the culvert is predicted to overtop in the 10 Year ARI (include climate change) both now and following development. The frequency of overtopping will increase as a result of development. At present the road does not carry significant traffic, however future development (outside of the Structure Plan Area) means the culvert is likely to require upgrade to meet Auckland Transport design criteria.

3. Culvert SWC6504 (beneath Hibiscus Coast Highway) – water level increases are not predicted to result in overtopping of the Hibiscus Coast Highway, however the backwater effect is predicted to effect Small Road. Recent development works adjacent to the culvert, including the wetland and carpark area has not been considered in this assessment.

4. Culvert 1 and Culvert 2 (beneath SH1 on the Weiti Stream) – although water levels increase at the upstream end of these culverts, and strictly does not conform to current design standards, the water level is predicted to remain 5.1m and 1.2m respectively below the edge of seal of the motorway.

5. Dairy Flat Highway Culverts 1 and 2 – Road overtopping at Culvert 1 is predicted more regularly than during a 10% AEP storm event at present. Road overtopping at Culvert 2 is predicted between a 10% AEP and 100% AEP storm event at present. The frequency of overtopping will increase with development if not mitigated. These culverts do not currently meet Auckland Transport's Code of Practice criteria for culverts. The importance of Dairy Flat Highway as a key arterial road for the area means future upgrade to these structures is likely to be required, however this will need to be balanced against the requirements to manage downstream flood risk.

6. Culverts SWC6505, 6506, 6507 and 6508 are not directly affected by development in the Structure Plan Area, however future development will need to consider their capacity (or lack thereof). There is the potential that future upgrade of these culverts could lead to increased flow entering the Structure Plan Area.

Table 3-3: Details of stormwater culverts under SH1

Culvert	Diameter (m)	Meet Current NZTA Freeboard Requirements (ED)	Meet Current NZTA Freeboard Requirements (MPD)	Freeboard to Culvert Soffit in 100yr ARI MPD event (m)	Increase in upstream flood level in the 10yr ARI event considering MPD (m)	Increase in upstream flood level in the 100yr ARI event considering MPD (m)
SWC6503**	4*	No	No	-3.223	0.630	0.616
SWC6504**	4	No	No	-1.899	0.900	0.561
SWC6505**	0.6	No	No	-0.088	0.329	0.026
SWC6506	1.35	Yes	Yes	1.181	0.223	0.115
SWC6507	1.05	Yes	Yes	0.624	0.190	0.186
SWC6508**	1.35	No	No	-0.224	0.204	0.038
Culvert 1	2.5	No	No	-3.221	0.480	0.335
Culvert 2	4.6	No	No	-4.580	0.310	0.579
Culvert 3**	2.8	No	No	-1.378	0.320	0.484
Dairy Flat Highway Culvert 1	0.9	No	No	-4.046	0.602	0.210
Dairy Flat Highway Culvert 2	1.8	No	No	-1.361	0.523	0.439

*Considered a bridge as per NZTA Bridge Manual

**Culverts are predicted to overtop or inundate SH1 or road in a 100yr ARI considering MPD

Photo 7: Small Road culvert downstream of the Structure Plan Area

Any upgrade or upsizing of the culverts is likely to increase flows and velocities downstream. The effect of any upgrade (in terms of flooding, stream erosion or any other effect), will need to be assessed and mitigated appropriately. Decisions on mitigating the flooding effects will need to consider the residual life of the existing assets. For example, culvert SWC6503 has recently had a structural liner due to its deterioration.

Four stormwater ponds, located in the vicinity of the Silverdale Off-Ramp, are likely to be affected by development of the Silverdale West Dairy Flat Business Area. Preliminary modelling indicates that only the 1 in 10 year ARI existing development flows are able to be contained in the John's Creek stream channel, upstream of Culvert ID SWC6503. An increase in stream flow and flood levels from impervious development is likely to lead to regular overtopping of the stream into the ponds and will adversely affect the function and maintenance requirements of these ponds. In-depth analysis of these ponds and their freeboard to stream flows and levels will be required.

Mitigation of the identified effects on culverts and ponds could include:

- Attenuation of flows onsite (at source);
- Attenuation of flows in communal storage areas;
- Upgrading/upsizing of the culverts (pass flows forward);
- Raising of embankment between the ponds and stream, or other pond improvement options (pond mitigation only);
- Improvements to the pavement design to be resilient to flooding and traffic management on the off-ramp.

The most appropriate option, or combination of options, to mitigate the effects of will need to be assessed.

Options to mitigate the flooding effects of development in the Structure Plan Area will be required. This should be done in close collaboration with NZTA and AT so that solutions are resilient or adaptable for transport network improvements.

3.4.3 Managing the Floodplain

As identified in Section 2.5, the floodplain represents a constraint to development. A conceptual assessment of the potential to control the floodplain in the Dairy Flat catchment portion of the Structure Plan Area. The objective was to understand the scale of works required to reduce the extent the floodplain. Earthworks (cut and fill) to form a naturalised stream and floodplain could control the currently represented extent of floodplain. Where the Dairy Stream crosses Dairy Flat Highway this has the potential to reduce the floodplain from 150m wide to approximately 60m wide, if the associated downstream culvert was upgraded. Further upstream, where the floodplain is up to 250m wide, it may be possible to reduce the width to in the order of 35-60m wide. This hasn't considered the potential need to provide attenuation on site, which may reduce the extent of floodplain with on site attenuation, or increase it with communal attenuation.

Although a similar assessment has not been undertaken in the Silverdale South, some control of the floodplain may be possible with earthworks and stream naturalisation, however the effect is likely to be less pronounced due to the narrower extent of the current floodplain.

There is likely to be limited scope to significantly change the floodplain within the Pine Valley catchment.

There is potentially significant cost associated with delivering engineered interventions to the floodplain, which will be subject to economic feasibility and funding agreement before being taken forward. Some options will require collaboration across land ownership boundaries..

3.5 Applying Water Sensitive Design in the Future Urban Zone

Table 3-4 provides a 'toolbox' of options that can be applied by development to meet minimum stormwater management requirements. For primary and secondary conveyance, priority is given in Table 3-4 to the order in which options should be applied. For example, for secondary stormwater conveyance the preferred option is to retain and enhance permanent and intermittent streams. If there are practical reasons why this cannot be achieved, then swales and open channels can be considered. Finally, if swales are not suitable, the road network can then be considered for secondary conveyance.

As the Structure Plan is developed further, the appropriateness of particular devices or approaches can be further refined.

Guidance on applying water sensitive design at the development level can be found in the following documents.

- GD04: Water Sensitive Design for Stormwater, March 2015
- GD05: Erosion and Sediment Control Guide for Land Disturbing Activities in the Auckland Region, June 2016.
- SW CoP: Code of Practice for Land Development and Subdivision, Chapter 4 – Stormwater, November 2015
- Auckland Transport Code of Practice
- GD01: Stormwater management devices in the Auckland Region, December 2017. (Note this supersedes TP10).
- TR035: Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements, August 2013

3.6 Development Sub-catchments

The Future Urban Zone has been divided into development subcatchments (Figure 2.2) based on:

- Catchment boundaries and drainage flow paths;
- Future Urban Zone and proposed land use; and
- Discharge location and receiving environment.

As the Structure Plan develops, particular interventions or stormwater management approaches outlined in Table 3-3 will be developed for each area based on the needs of development, sub catchment constraints, such as soil type, and impact on the downstream receiving environment, and development sequencing/staging. If necessary, these areas may be further split or merged to suit.

Table 3-4: Water Sensitive Design Toolbox

GENERAL			
• MINIMISE IMPERVIOUS SURFACES AND LAND DISTURBANCE • APPLY EXEMPLAR EROSION AND SEDIMENT CONTROL MEASURES TO MINIMISE THE IMPACT ON THE DOWNSTREAM RECEIVING ENVIRONMENT • DISCONNECTION OF IMPERVIOUS SURFACES PRIOR TO DISCHARGE TO THE STORMWATER SYSTEM • AVOID SOIL COMPACTION OR UNDERTAKEN CULTIVATION TO INCLUDE ORGANICS AND RESTORE DAMAGE TO MAXIMISE PERMEABILITY • RE-VEGETATION/PLANTING TO REDUCE RUNOFF AND EROSION AND MAXIMISE BIODIVERSITY • REDUCE CONTAMINANT SOURCES BY AVOIDING ZINC/COPPER ROOF MATERIAL			
LAND USE	*Requirements*	*Options*	*Auckland Council Guidance Documents (refer Section 5.2)*
RESIDENTIAL	Hydrological Mitigation – Retention and Detention	• Above ground rainwater storage tanks • Rain gardens/planter boxes • Underground storage tanks, structural cells • Permeable pavement and porous concrete • Filter trenches/trench drains	TR035 GD04 GD01
	Primary Stormwater Conveyance	1. Soakholes (To be confirmed) 2. Retain and enhance permanent and intermittent streams 3. Swales 4. Pipe network	GD04 SW CoP GD01
	Secondary Stormwater Conveyance	1. Retain and enhance permanent and intermittent streams 2. Swales and open channels 3. Road corridors	GD04 SW CoP

ALL ROADS/ CARPARKING AND HIGH CONTAMINANT GENERATING ACTIVITIES (HCGAS)	Hydrological Mitigation - Retention and Detention	• Rain gardens • Tree pits • Filter trenches/trench drains • Permeable pavement and porous concrete	TR035 GD04 GD01
	Stormwater Treatment	• Rain gardens • Tree pits • Filter strips/swales • Wetlands	GD01
	Primary Stormwater Conveyance	1. Soakholes (To be confirmed) 2. Retain and enhance permanent and intermittent streams 3. Swales 4. Pipe network	GD04 SW CoP GD01
	Secondary Stormwater Conveyance	1. Retain and enhance permanent and intermittent streams 2. Swales and open channels 3. Road corridors	GD04 SW CoP
BUSINESS	Hydrological Mitigation - Retention and Detention	• Above ground rainwater storage tanks • Rain gardens/planter boxes • Underground storage tanks, structural cells • Permeable pavement and porous concrete • Filter trenches/trench drains • Detention basins	TR035 GD04 GD01
	Stormwater Treatment (where required by the AUP)	• Rain gardens • Tree pits • Filter strips/swales • Proprietary treatment devices • Wetlands	GD01

	Primary Stormwater Conveyance	1. Soakholes (To be confirmed) 2. Retain and enhance permanent and intermittent streams 3. Swales 4. Pipe network	GD04 SW CoP GD01
	Secondary Stormwater Conveyance	5. Retain and enhance permanent and intermittent streams 6. Swales and open channels 7. Road corridors	GD04 SW CoP
SPECIAL PURPOSE	Hydrological Mitigation - Retention and Detention	To be confirmed	
	Primary Stormwater Conveyance		
	Secondary Stormwater Conveyance		

4 Next Steps

This Stormwater Management Plan provides guidance on how development can be delivered in accordance with the objectives of national and regional policy and guidelines. It has considered the stormwater constraints within the Structure Plan Area, as well as how to manage potential impacts on the downstream receiving environment. Delivered following a water sensitive design approach, development offers significant opportunity to enhance the local water environment, addressing a number of existing stormwater issues.

This Stormwater Management Plan is a high-level document, reflecting the start of the development process. As development plans are brought forward it is expected that either this Stormwater Management Plan is updated, or more detailed Plans are prepared that comply with the requirements set out in Section 1 and Section 4.

Key next steps for informing the refinement of this stormwater management plan as specific areas are brought forward include:

1. Complete the Rangitopuni Erosion Assessment study and Weiti Stream Rapid Geomorphic Assessment to quantify the hydrological mitigation requirements within the Diary Flat catchment area of the Structure Plan, and its applicability to the Silverdale south and Pine Valley catchment areas.
2. Undertake watercourse assessments for both the watercourses within the Structure Plan Area, and downstream, to support the existing evidence based for mitigation measures, and provide site-specific information on issues and enhancement opportunities.

Undertake baseline water quality testing within the Structure Plan Area to determine the current water quality.

3. Undertake a flood risk options assessment study, in consultation with NZTA and AT, to identify the preferred options, costs and benefits for mitigating flooding effects to properties and transport infrastructure.
4. Engage early with Healthy Waters for large scale development to align expectations.
5. Apply Water Sensitive Design as the basis for development planning.
6. Development layout considers the extent of floodplain, flood prone, and overland flow paths so these areas are free from vulnerable land uses. Where development yield necessitates works within the floodplain, development could be sequentially located in the lowest hazard areas based on the benefits and costs of controlling the floodplain identified in this SMP. Development in these areas will be subject to economic feasibility and funding agreement before being taken forward.
7. Site specific geotechnical investigations, including infiltration testing to inform the potential for retention of stormwater to ground and the management of high groundwater levels.
8. Ensure watercourse enhancement opportunities are co-ordinated and integrated from the start of development planning to maximum benefits. Work with landowners in a collaborative manner to ensure sufficient land is set aside for greenways or riparian buffer zones, as appropriate.
9. Work with landowners in a collaborative manner to ensure multiple benefits (social, cultural and environmental) are achieved based on the need for flood risk attenuation (where required).

5 References

Auckland Council (2013) -1. TR2013/035 Auckland Unitary Plan stormwater management provisions: Technical basis of contaminant and volume management requirements.

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Appendix 1 – Detailed Maps

Silverdale West Stormwater Management Plan

Figure 2.2A Topography

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

N

OREWA RIVER WEST

SILVERDALE NORTH

SILVERDALE SOUTH

SILVERDALE WADE

PINE VALLEY

1

2

3

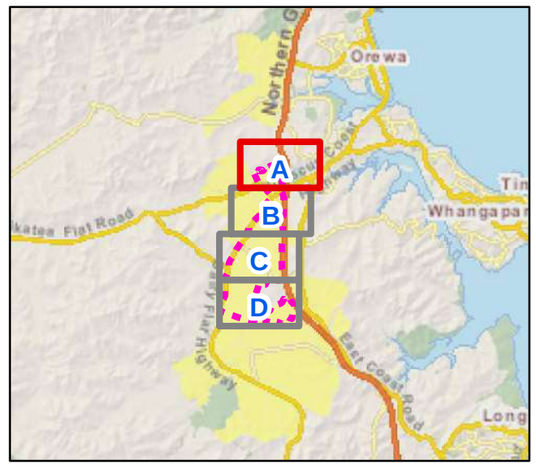
4

Legend

- Subcatchments Discharge Locations
- Permanent/Intermittent Stream
- 5m Contours
- Subcatchments within the Structure Plan Area
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.2B Topography

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

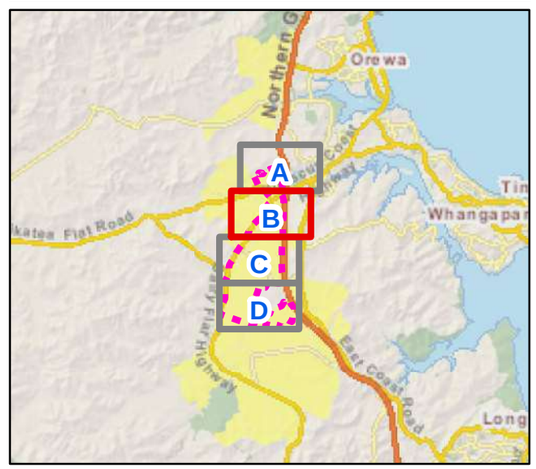
Drawn: NY
Checked: JR

Legend

- Subcatchments Discharge Locations
- Permanent/Intermittent Stream
- 5m Contours
- Subcatchments within the Structure Plan Area
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.2C Topography

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

PINE VALLEY

SILVERDALE WADE

SILVERDALE SOUTH

WEITI SOUTH

DAIRY FLAT

4

5

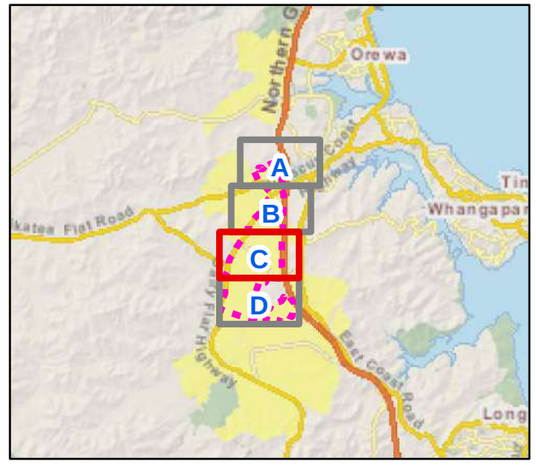
6

Legend

- Subcatchments Discharge Locations
- Permanent/Intermittent Stream
- 5m Contours
- Subcatchments within the Structure Plan Area
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.2D Topography

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

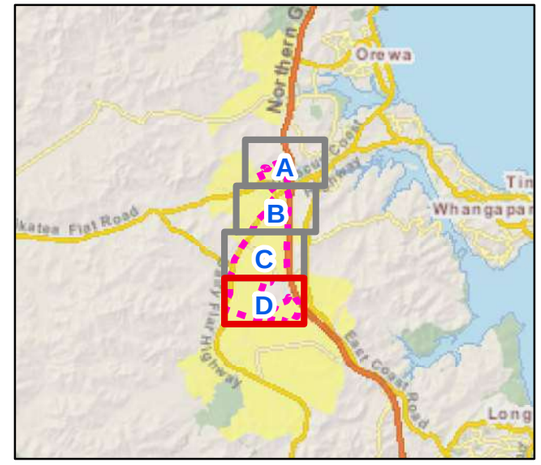
Drawn: NY
Checked: JR

Legend

- Subcatchments Discharge Locations
- Permanent/Intermittent Stream
- 5m Contours
- Subcatchments within the Structure Plan Area
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.4A Network

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
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Drawn: NY
Checked: JR

N

OREWA RIVER WEST

SILVERDALE NORTH

PINE VALLEY

SILVERDALE SOUTH

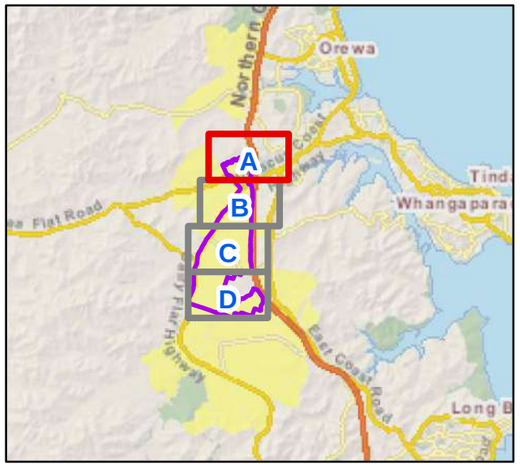
SILVERDALE WADE

Legend

- Motorway Ponds/Wetlands
- Known Private Culverts/Bridges
- Public Culverts/Bridges
- Permanent/Intermittent Stream
- Stormwater network
- Private Ponds/Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.4B Network

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

Legend

- Motorway Ponds/Wetlands
- Known Private Culverts/Bridges
- Public Culverts/Bridges
- Permanent/Intermittent Stream
- Stormwater network
- Private Ponds/Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

OREWA RIVER WEST

PINE VALLEY

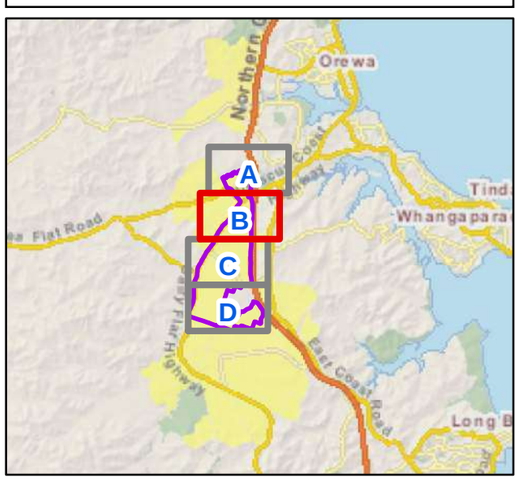
SILVERDALE SOUTH

SILVERDALE WADE

DAIRY FLAT

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.4C Network

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

PINE VALLEY

SILVERDALE SOUTH

SILVERDALE WADE

DAIRY FLAT

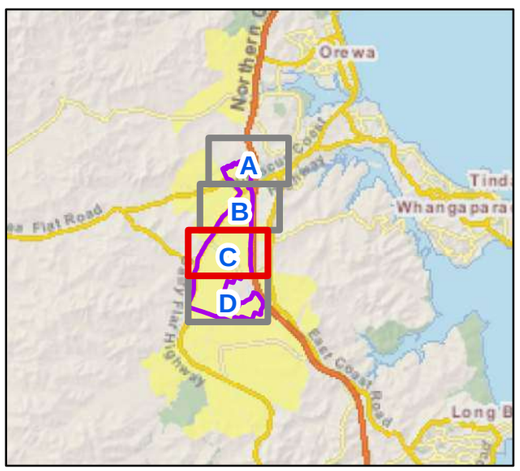
WEST SOUTH

Legend

- Motorway Ponds/Wetlands
- Known Private Culverts/Bridges
- Public Culverts/Bridges
- Permanent/Intermittent Stream
- Stormwater network
- Private Ponds/Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.4D Network

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

WEITI SOUTH

SILVERDALE SOUTH

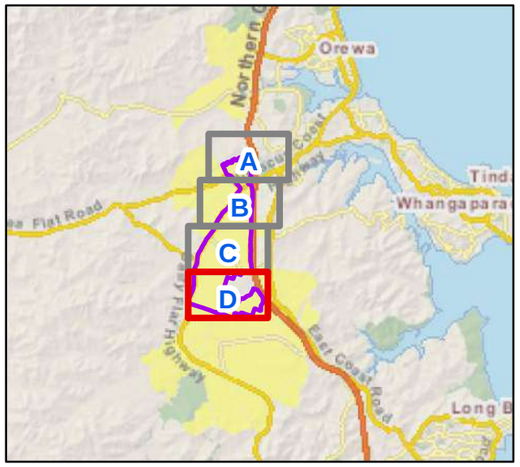
DAIRY FLAT

Legend

- Motorway Ponds/Wetlands
- Known Private Culverts/Bridges
- Public Culverts/Bridges
- Permanent/Intermittent Stream
- Stormwater network
- Private Ponds/Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Existing Urban Zone
- Stormwater Catchments Boundaries

Note:

Stream classification within the structure plan area is based on the Silverdale Stream Classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, permanent and intermittent stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.



Silverdale West Stormwater Management Plan

Figure 2.5A Ecology

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

13/12/2018
DRAFT

Drawn: NY
Checked: JR

Legend

- Esplanade Reserve
- Permanent/Intermittent Stream
- Natural Stream Management Areas Overlay [rp]
- Enhancement Opportunity
- Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Significant Ecological Areas Overlay Terrestrial [rp/dp]

Stormwater Management Area Control

- Flow 1 [rp]
- Flow 2 [rp]
- Existing Urban Zone
- Stormwater Catchments Boundaries

OREWA RIVER WEST

SILVERDALE NORTH

SILVERDALE SOUTH

SILVERDALE WADE

PINE VALLEY

Northern Motorway

EO1

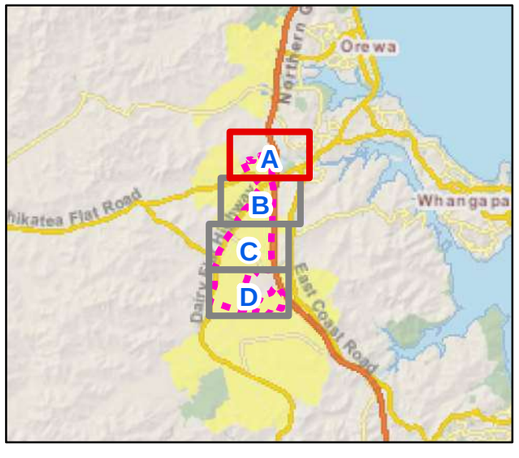
EO2

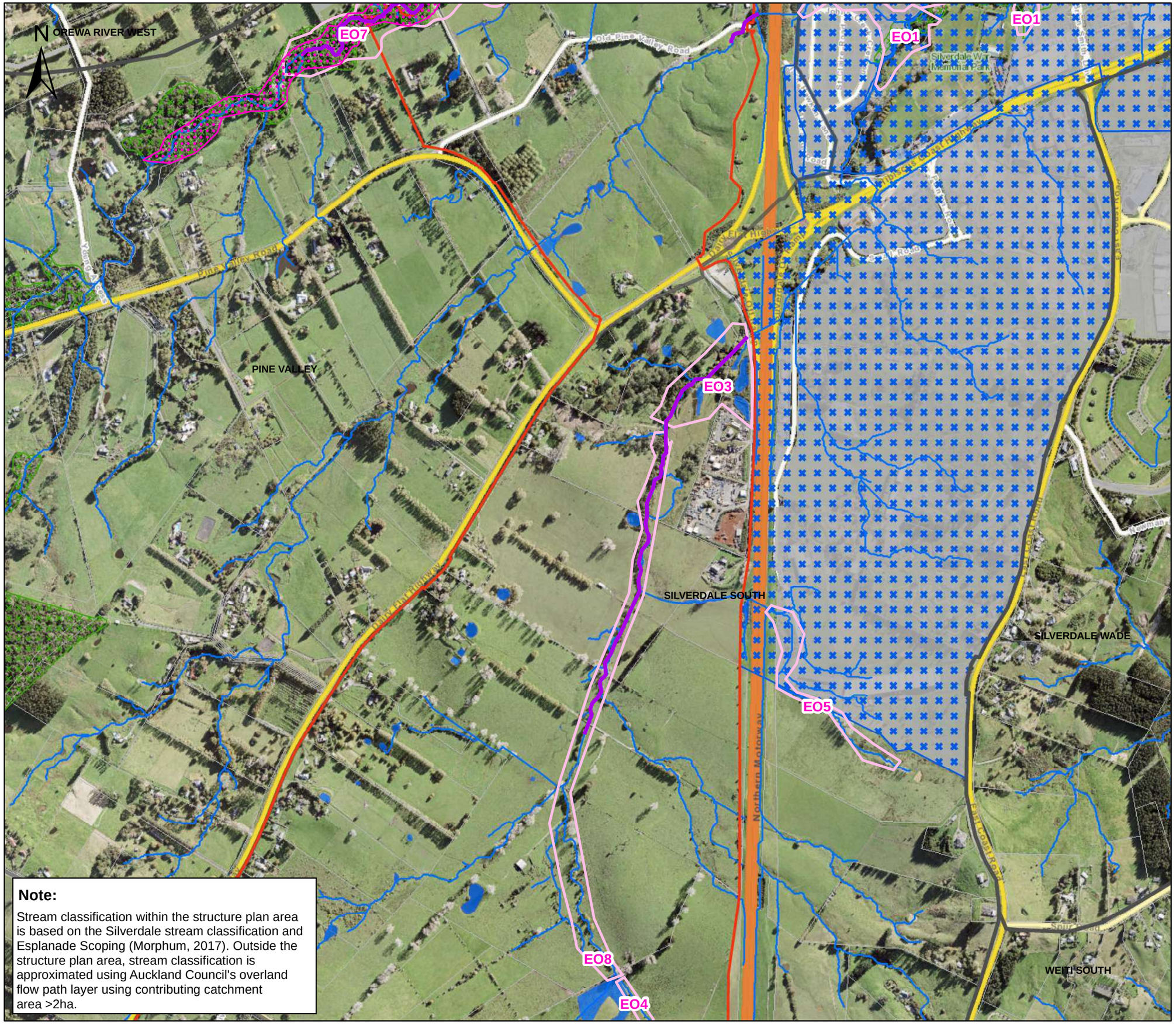
EO3

EO7

Note:

Stream classification within the structure plan area is based on the Silverdale stream classification and Esplanade Scoping (Morphum, 2017). Outside the structure plan area, stream classification is approximated using Auckland Council's overland flow path layer using contributing catchment area >2ha.





Note:

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Silverdale West Stormwater Management Plan

Figure 2.5B Ecology

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

13/12/2018
DRAFT

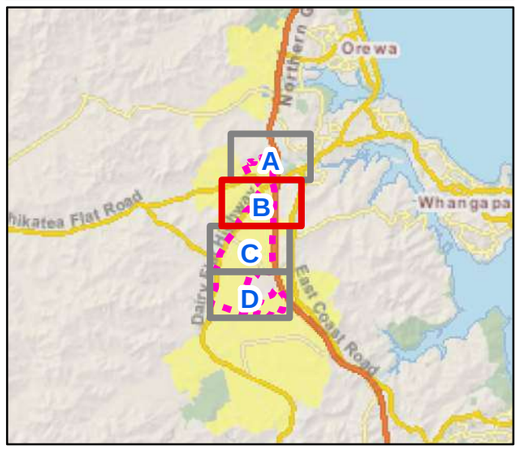
Drawn: NY
Checked: JR

Legend

- Esplanade Reserve
- Permanent/Intermittent Stream
- Natural Stream Management Areas Overlay [rp]
- Enhancement Opportunity
- Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Significant Ecological Areas Overlay Terrestrial [rp/dp]

Stormwater Management Area Control

- Flow 1 [rp]
- Flow 2 [rp]
- Existing Urban Zone
- Stormwater Catchments Boundaries



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Silverdale West Stormwater Management Plan

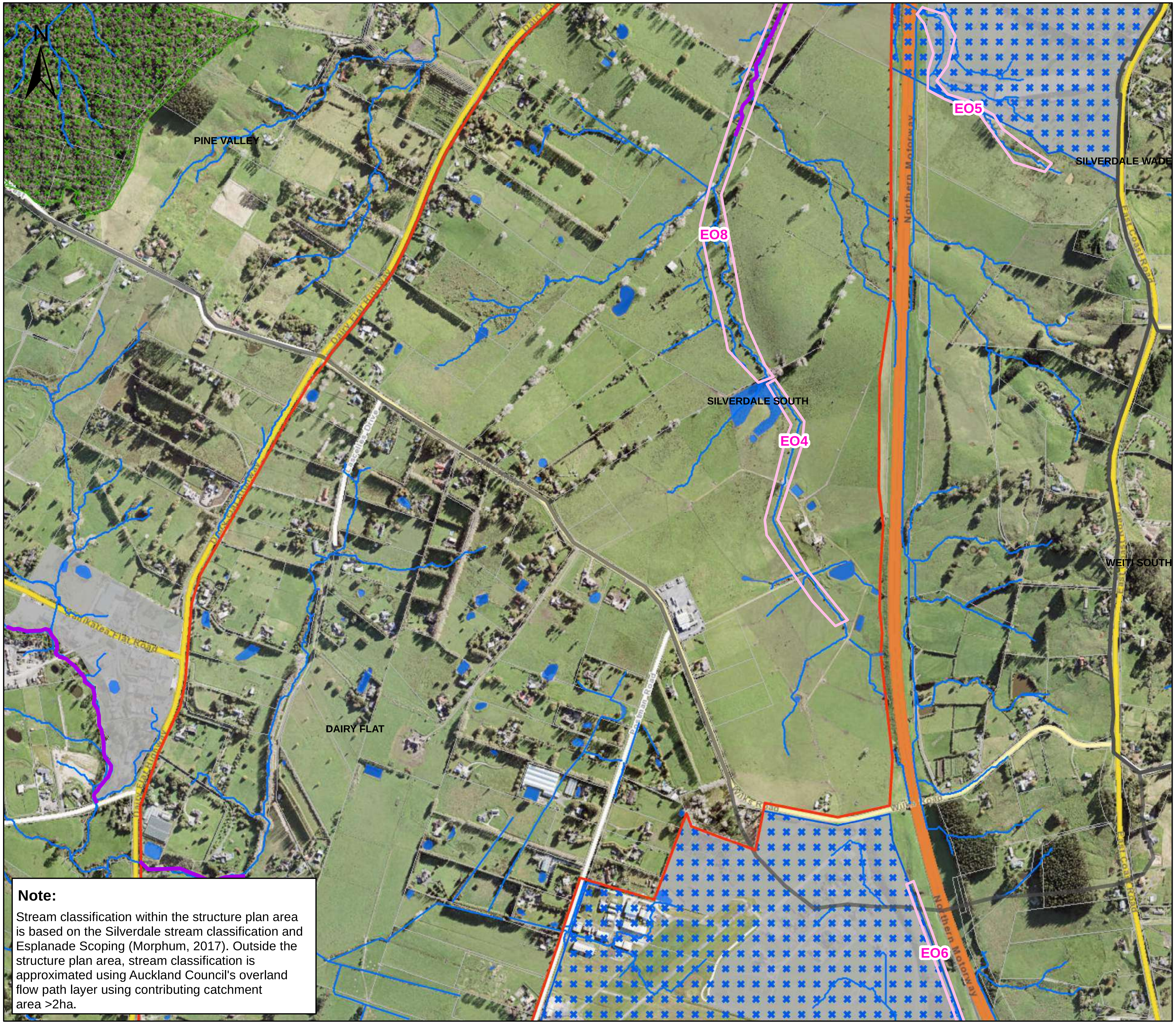
Figure 2.5C Ecology

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

13/12/2018
DRAFT

Drawn: NY
Checked: JR

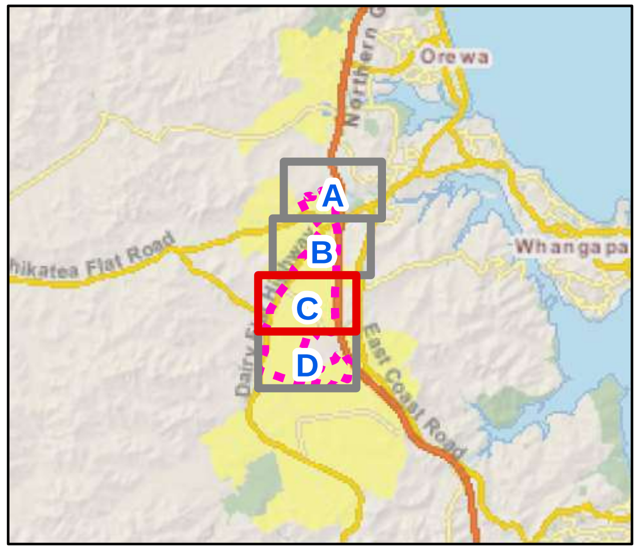


Legend

- Esplanade Reserve
- Permanent/Intermittent Stream
- Natural Stream Management Areas Overlay [rp]
- Enhancement Opportunity
- Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Significant Ecological Areas Overlay Terrestrial [rp/dp]

Stormwater Management Area Control

- Flow 1 [rp]
- Flow 2 [rp]
- Existing Urban Zone
- Stormwater Catchments Boundaries



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Silverdale West Stormwater Management Plan

Figure 2.5D Ecology

13/12/2018
DRAFT

Drawn: NY
Checked: JR

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

Legend

- Esplanade Reserve
- Permanent/Intermittent Stream
- Natural Stream Management Areas Overlay [rp]
- Enhancement Opportunity
- Wetlands
- Silverdale Dairy Flat Business Area Structure Plan
- Significant Ecological Areas Overlay Terrestrial [rp/dp]

Stormwater Management Area Control

- Flow 1 [rp]
- Flow 2 [rp]
- Existing Urban Zone
- Stormwater Catchments Boundaries

EO4

EO6

WEITI SOUTH

SILVERDALE SOUTH

DAIRY FLAT

Dairy Flat Highway

Postman Road

Wilks Road

Top Road

Northern Motorway

Pine Valley Road

Orewa

Whangapa

Dairy Flat Road

East Coast Road

A

B

C

D

Note:

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Silverdale West Stormwater Management Plan

Figure 2.6A Flooding

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

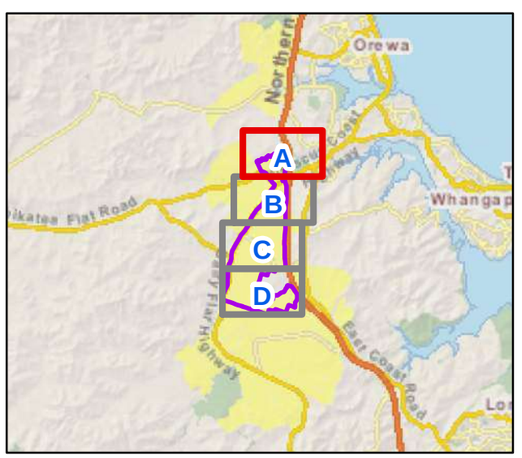
Drawn: NY
Checked: JR

Legend

- Overland Flow Path
- Flood Prone Areas
- Silverdale Flood Plain
- Furture Urban Zone
- Existing Urban Zone
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

Note:

The modelled flood extents within the Silverdale Dairy Flat Business Area Stucture Plan have been edited to confirm with the AUP(OiP) flood Plain definition. The flood extent shown outside the structure plan area is incomplete and has not undergone this editing. Therefore where shown the flood extent outside the structure plan area should be treated as indicative only.



Silverdale West Stormwater Management Plan

Figure 2.6B Flooding

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

Legend

- Overland Flow Path
- Flood Prone Areas
- Silverdale Flood Plain
- Furture Urban Zone
- Existing Urban Zone
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

Note:

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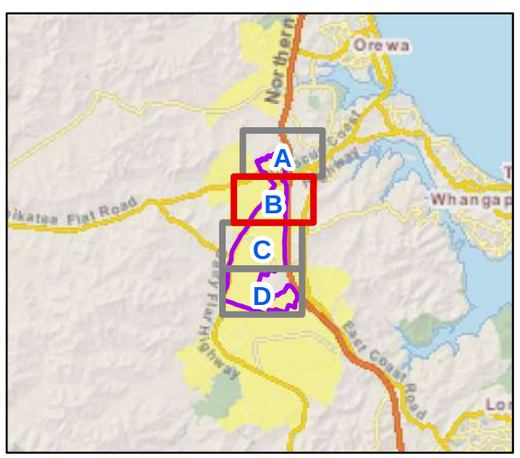

Silverdale West Stormwater Management Plan

Figure 2.6C Flooding

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

Legend

- Overland Flow Path
- Flood Prone Areas
- Silverdale Flood Plain
- Furture Urban Zone
- Existing Urban Zone
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

Note:

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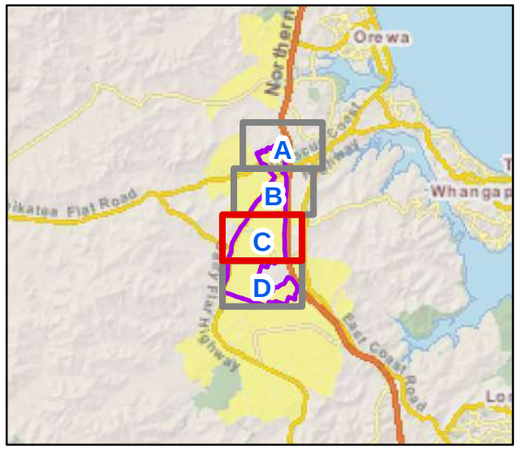

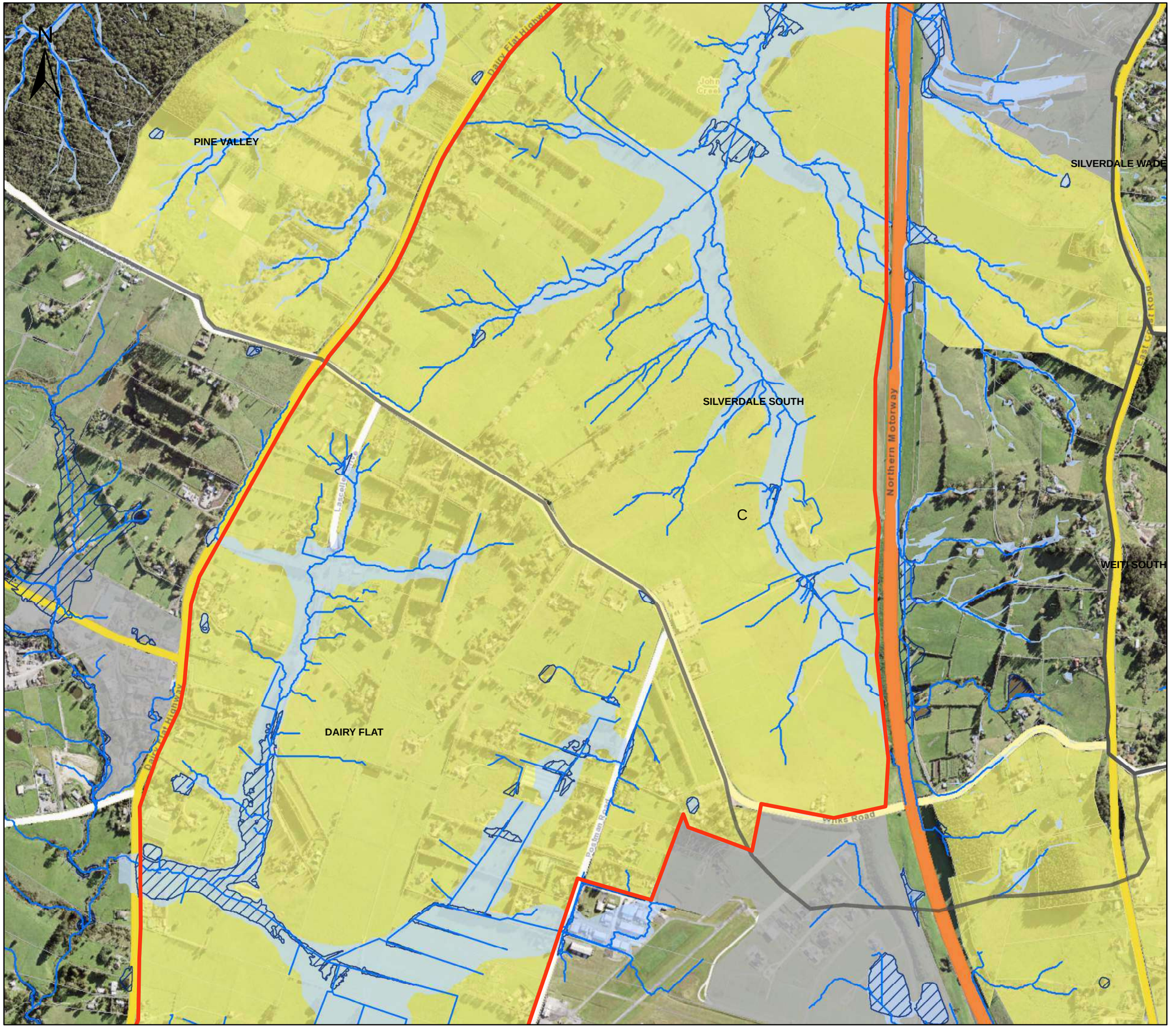

Silverdale West Stormwater Management Plan

Figure 2.6D Flooding

0 0.075 0.15 0.3 Kilometers

1:9,000 @A3

29/11/2018
DRAFT

Drawn: NY
Checked: JR

Legend

- Overland Flow Path
- Flood Prone Areas
- Silverdale Flood Plain
- Furture Urban Zone
- Existing Urban Zone
- Silverdale Dairy Flat Business Area Structure Plan
- Stormwater Catchments Boundaries

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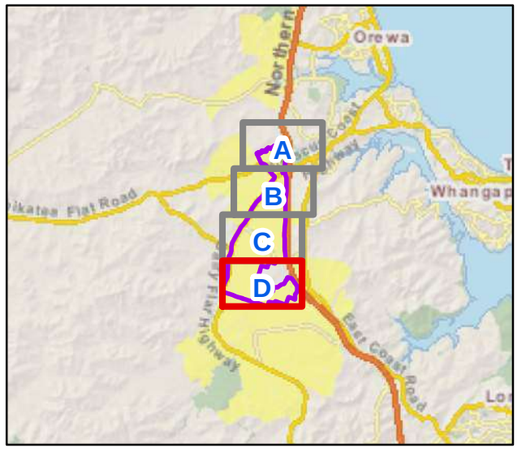

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