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+64 9 303 1113
www.civix.co.nz
Level 8, 99 Albert St, Auckland

23/05/2024

SILVERDALE WEST PLAN CHANGE

STORMWATER MANAGEMENT PLAN

+64 9 303 1113
www.civix.co.nz
Level 1, 87 Albert Street, Auckland
PO Box 5204 Wellesley St, Auckland 1141

Development of Silverdale West Plan Change | Stormwater Management Plan

Dear Hamish,

Thank you for the opportunity for Civix Limited to provide an Stormwater Management Plan for the Proposed Plan change for Silverdale West.

The report and drawings contained in this document show infrastructure details for the Development of Silverdale West Plan Change.

Please do not hesitate to contact us if you have any questions on this report,

Written By:

Marcus Oliveira
Civil Engineer
027 455 0934
marcus@civix.co.nz

Civix Limited

Reviewed By:

Sam Blackbourn
Senior Engineer (CPENG 1002456)
021908524
sam@civix.co.nz

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Link to above documents: SMP Supporting Documents

References

Auckland Council. (2017, December). *Geotechnical Topic Report: Silverdale West Dairy Flat Business Area Structure Plan*.

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Brierley, G. J., & Fryirs, K. A. (2013). *Geomorphology and River Management: Applications of the River Styles Framework*. [Publisher if known].

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1. Executive Summary

The purpose of the Stormwater Management Plan is to inform the proposed Private Plan Change for Silverdale West and provide guidance on how the stormwater and existing freshwater system are to be managed when developing within the plan change area. This Stormwater Plan has been developed to achieve consistency with the objectives and policies of the Auckland Unitary Plan as well as Auckland Council's Guideline Documents and industry best practice options.

The proposed Stormwater Management Plan is consistent with the Silverdale West Dairy Flat Industrial Area Structure Plan and the SMP written by WSP/Opus in November 2018 and the draft SMP prepare by Auckland Council dated 25/11/22.

The Plan Change Area is located within the Silverdale South Catchment, west of the Auckland Northern Motorway (SH1). The development is bounded by SH1 on the northeast, Wilks Road on the south Dairy Flat Highway Road on the West. The site ultimately drains to Karepiro Bay via Weiti River.

The Stormwater Management Plan seeks to establish a cohesive approach to the management of stormwater runoff by specifying controls on the quality and quantity of the runoff and requiring ecological enhancements including:

- Identify Best Practice Options for Stormwater treatment for the development area.
- Promote Water Sensitive Design to mitigate adverse effects of development on the receiving environment.
- Minimise discharge of contaminants into the receiving environment
- Protect and improve existing freshwater systems.
- Not worsen downstream flooding

Proposed methodologies to achieve the above outcomes include:

- Provide for stormwater treatment either at source or within artificially constructed wetlands (communal wetlands)
- Locating the natural wetlands to be retained upstream of the development area and treatment devices, thereby ensuring the hydrology of the existing natural wetlands will not be significantly affected by the development.
- Provide for SMAF-1 equivalent hydrology treatment for all impervious areas.

Civix have been engaged to undertake civil design for the proposed plan change for Silverdale West. The proposed industrial zoning area of 107ha includes new public local and collector roads. The stormwater management strategy for the site has been developed to meet the requirements in the Auckland Unitary Plan, specifically the provisions set out in the following sections:

- Section E1 – Water quality and integrated management,
- Section E8 – Stormwater discharge and diversion
- Section E9 – High contaminant generating carparks and high use roads.
- Section E10 – Stormwater management area – Flow 1 and Flow 2
- Section E36 – Natural hazards and flooding

This report also outlines the management approach / key elements of the catchment and provides an assessment, which includes such detail on the scale and significance of the effects of the proposal, of how an Integrated Stormwater Management Approach has been adopted in the design and associated stormwater management in

accordance with the policies in the AUP Sections E1.3, B7 and B8 (See Annexure 1). This assessment shows how the SMP seeks to:

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

A summary of the stormwater management strategy for the site is summarised in Table 1-1 below.

Table 1-1 Stormwater Management Summary

Requirement	**Design response**
Water Quality	Communal artificially constructed wetlands are proposed for site runoff. The artificially constructed wetlands will be designed and constructed in accordance with GD01.
SMAF1 - Retention (5 mm) and reuse on site	Public Road Corridors: Impervious areas along public road corridors will undergo retention measures utilising GD01 recommended devices. These devices may include Infiltration devices, Bioretention Swales, Rain Gardens, Stormwater Tree Pits, or Planter Boxes wherever practicable. Private Lots: Retention of runoff from impervious areas within private lots will be achieved through the installation of rainwater tanks which will collect roof water, and then be reused for non-potable purposes. Considering the future transition of the site into a light industrial zone, any retained water not utilised within a 24-hour period will be added to the detention volume in Communal Wetland to augment overall stormwater management capacity. Note, in cases where these devices are not practical, then these areas will be integrated into a communal wetland as additional detention.
SMAF1 – Detention (95th percentile)	Detention for the site is provided via communal artificially constructed wetlands which meet the NDC objectives.
Stream hydrology	No direct discharge to stream and natural wetlands is permitted. Stormwater discharge into the stream only occurs once the runoff is treated within the artificially constructed communal wetlands. See section 6.2.2. The communal wetlands are designed to provide extended detention for stream protection, 2 year and 10 year peak flow mitigation.
Stream Erosion	Determine erosive flow levels and hold back flows on site for as long as practicable below these values to mitigate effects of development on downstream erosion. Provide riparian planting along stream length to reinforce banks and provide a buffer from the development.
Primary Drainage Network	The underground drainage network will be sized for 10% Annual Exceedance Probability (AEP) design storm. The design ensures that there is sufficient capacity within the pipe network downstream of the connection point to cater for the stormwater runoff associated with the development in a 10% AEP event including incorporating flows from contributing catchments at maximum probable development with expected mitigation for upstream areas. See section 6.2.3.

Requirement	Design response
Flood Hazard Management	TuFlow modelling has been carried out on the development and found that the design of the development safely conveys flows through the site. The modelling also found increases in flood levels downstream in the 1% AEP event from the development if no mitigation is included in the design. To maintain existing flow properties flood storage is provided onsite as the mitigation to ensure no adverse effect to downstream and neighbouring properties.
Buildings 1% AEP event	No buildings are proposed within the 1% AEP and floor levels are set to provide the required freeboard in accordance with Auckland Council Stormwater Code of Practice (SWCoP). See section 6.2.4.

2. Existing Site Description

The Plan change area totals approximately 107 hectares and is located north of Wilks Road and bound between the Northern Motorway and Dairy Flat Highway. The area is characterised by John Creek running north-south with an associated low-lying floodplain area. John Creek flows northward through the site and exits via an existing culvert under the Northern Motorway.

The site comprises easy to moderate slopes from John Creek up to Dairy Flat Highway and Wilks Road which sit around 30-50m higher than the stream. Slopes are steepest closer to the ridgelines where gradients are around 12.5 – 20%. Some steeper areas (up to 20% grade) are present to the north of the plan change area, however this area is limited in extent, and indicative 3D modelling shows these areas can be modified in order to create lot platforms and roads with suitable grades.

The proposed Plan Change seeks to rezone a 107ha of land between State Highway 1 and Dairy Flat Highway from Future Urban zone to light industry zone. Figure 1 below shows the indicative extent of plan change area, stream channel, existing wetlands, indigenous vegetation and the associated buffers.

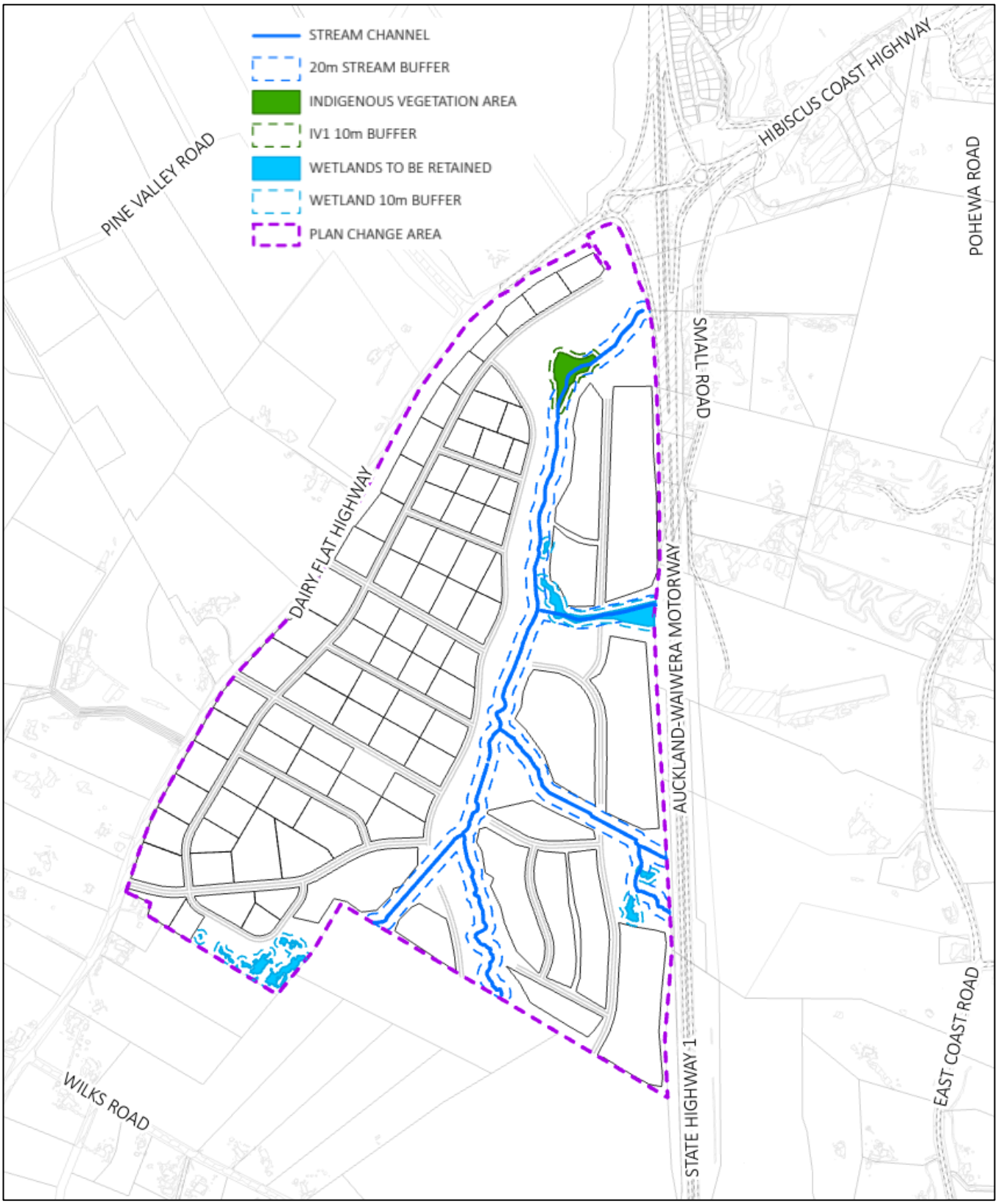

Figure 1: Silverdale West Plan change area *(Refer to Appendix E for more details)*

The subjected site comprises of 14 parcels of land and is predominantly covered in grassed pasture with existing buildings located on all the addresses listed in Table 2-1. except for 1738, Sec 6 SO 308591 and Lot 2 DP 480626 Dairy Flat Highway.

Table 2-1 - Properties affected by the proposed private plan change

Property Address	Legal Description	RT Number	Title Area	Registered Owner(s)
193 Wilks Road	Lot 1 DP 433431	527370	56.0419	Wilks Road 2014 Ltd
1636 Dairy Flat Highway	Lot 1 DP 208687	NA136D/722	59.245	Wilks Road 2014 Limited
1638 Dairy Flat Highway	Lot 1 DP 46158	NA1698/16	0.3703	Robert George Woolley, Rong Everlyne Woolley
1646 Dairy Flat Highway	Lot 1 DP 74321	NA30B/736	0.7802	Geok Mui Law, Huiping Sun
1660 Dairy Flat Highway	Lot 2 DP 74321	NA30B/737	20.2365	Fletcher Development Ltd
1686 Dairy Flat Highway	Lot 1 DP 69561	NA25C/412	0.7809	Stephen Rodney Wagstaff and Beth Rose Wagstaff
1700 Dairy Flat Highway	Pt Lot 1 DP 68886	NA25A/502	2.6999	Elaine Alice Butler-Stoney
1732 Dairy Flat Highway	Pt Lot 2 DP 68886	NA25A/503	16.3822	YJs Holding Limited
1738 Dairy Flat Highway	Lot 1 DP 480626	672036	0.5481	Mammoth Ventures Ltd
1744 Dairy Flat Highway	Sec 9 SO 308591, Sec 10 SO 308591	65588	2.1924	DP Boocock No 2 Trustee Ltd
1748 Dairy Flat Highway	Pt Allot 210 Psh Of Okura SO 18072, Sec 19 SO 308591	111842	2.7781	DP Boocock No 2 Trustee Ltd
1748A Dairy Flat Highway	Sec 1 SO 308831	72678	3.4377	Evan Lance Kemp and Tracey Michelle Soffe
Dairy Flat Highway	Sec 6 SO 308591	65593	0.99	Papanui Station House Limited
Dairy Flat Highway	Lot 2 DP 480626	672037	0.5345	DP Boocock No 2 Trustee Ltd

There is an existing area of indigenous vegetation located in the centre north of the site which meets the criteria for identification as a Significant Ecological Area, and is considered to be an area of significant indigenous vegetation. Therefore, it is proposed to retain this area and include a 10m buffer margin, zoning approximately 4,830m^2 as Special Ecological Area. The width of John Creek also indicates that a 20 m Esplanade Reserve setback may be triggered under the RMA when consents for development of the site are sought. Refer to the Ecological Values Assessment prepared by RMA Ecology for further details.

The Plan Change Area comprises soft soils which are potentially subject to load induced settlements and unstable slopes. Careful remediation and management will be required to ensure stability across the site and that future lots can be created with any risk minimised.

2.1. Topography

The Silverdale South catchment and has a total area of 557 ha which drains to the Weiti River. The plan change area is located within this catchment, consisting of 107 ha. The topography generally slopes down toward a north draining gully which runs through the approximate centre of the site and exits the site near the northeast corner underneath SH1. The east has a slight gradient towards the centre of the site, whereas the west of the site is moderately steep.

2.2. Geotechnical

Geotechnical assessment for the site has been completed by CMW Geosciences (CMW).

Geological ground modelling revealed three distinct landforms across the site, which likely reflects different geological units. These areas are predominately underlain with Mangakahia complex, Mahurangi Limestone and Tauranga Group Alluvium respectively. Minor earthworks and fills have been carried out in the past across the site to form farms, drainage channels and to level building platforms. The geomorphology of the site was mapped by examination of aerial photography stereo pairs, and during a site walkover, and is shown in the Geomorphology Plan in Figure 2 below.

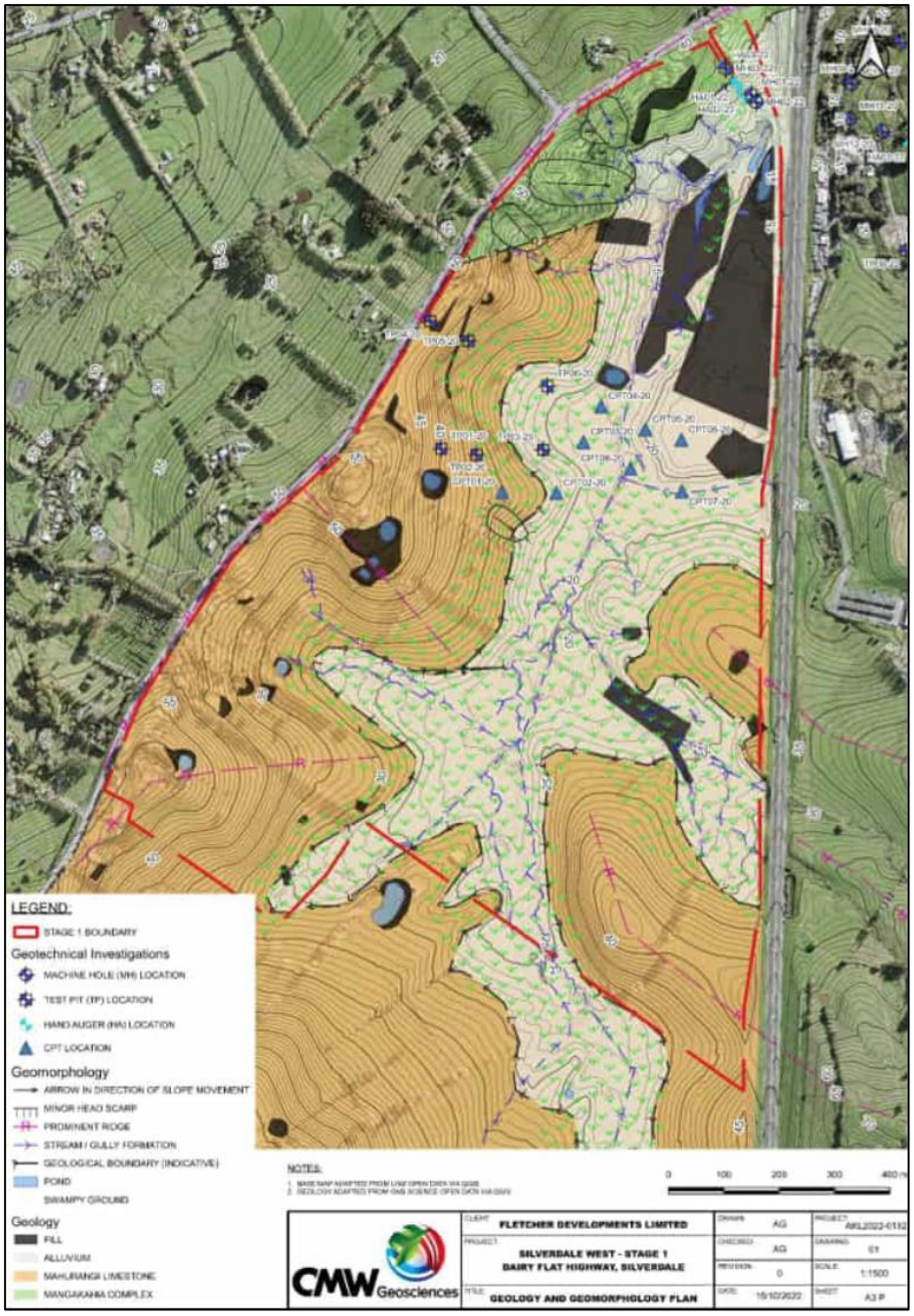

Figure 2: CMW Geology and Geomorphology Plan *(Refer to Appendix E for more details)*

Results after detailed hazard assessment indicate that the land is suitable for creating stable building platforms and infrastructure. Key considerations from the geotechnical hazards should be incorporated into the Master Planning (Please refer to CMW Geosciences Silverdale West Geotechnical Assessment Report).

The Plan Change Area's geological structure is predominantly composed of the Northland Allochthon, underlain by the Mahurangi Formation, characterized by its moderately dense, fractured, muddy limestone with occasional layers of glauconitic sandstone. The Northland Allochthon presents as soft, low shear strength clays near the surface, extending to depths of approximately 5 meters, the rock itself shows a high frequency of rock mass defects and often appearing shattered with millimeter-scale laminations.

The recent sedimentary deposits in the floodplain areas are associated with the site's stream network and are chiefly composed of modern alluvial and colluvial soils. These valley terraces are layered with unconsolidated materials including very soft muds, sands, gravels, interspersed with muddy peat and pumice silt strata. These deposits, which are commonly weathered into extremely soft clays at the surface, are projected to vary in depth from 1.5 meters to nearly 5 meters across the site. Such characteristics suggest that these regions may present challenges related to ground settlement, particularly influencing the design and implementation of stormwater infrastructure.

While the majority of the site is not prone to slope instability, areas of focus should be near steeper gradients and adjacent to stream banks where ground liquefaction may pose a risk.

Remediation strategies may include the application of shear keys, excavation and replacement of existing soils, and enhancement of subsoil drainage to improve stability. For constructions within a 100-meter proximity to unsupported soil banks, such as stream edges, a tailored lateral spread analysis is likely required. (Adapted from the Silverdale West Dairy Flat Business Area Structure Plan Geotechnical Topic Report by Auckland Council, 2017, and related studies by Tonkin & Taylor, 2013.

2.2.1. Hydro Geology

Subsurface water levels across the site are anticipated to lie between 2 to 4 meters beneath the ground surface, groundwater levels should be considered in the design of stormwater management systems, especially in low-lying parts of the site, Tonkin & Taylor (2013).

While the presence of natural springs within the site is probable, their specific locations remain undetermined. The conservation of these springs, along with their integration into the safeguarding and enhancement of perennial and episodic stream networks, is crucial for sustaining consistent stream flows.

The geological constitution of the site suggests that the permeability rates of the rock mass are expected to span from 10^-7 to 10^-11 meters per second, indicative of an overall low infiltration capability. The Mahurangi Limestone's propensity for exfiltration, is mitigated by the highly sheared condition of the limestone, which limits exfiltration by interrupting the continuity of fractures. Nevertheless, subterranean water flows within the rock, coupled with the shallow groundwater in depressions, are anticipated to provide a significant contribution to the stream baseflows.

The site's low permeability and the possibility of voids within the Mahurangi Limestone means the use of soakage methods for stormwater discharge is not recommended. Stormwater retention strategies that involve infiltration are still potentially suitable, dependant upon detailed site-specific geotechnical evaluations to ascertain the actual infiltration rates and soil conditions.

The design of groundwater control measures, such as cut-off or subsoil drainage systems for development platforms, should incorporate strategies for discharging into stream networks to bolster baseflow. This approach is aimed at addressing the potential adverse effects associated with the concentration of flows into streams, thereby mitigating the intensification of erosion issues.

In summary, groundwater management systems are to be optimized by discharging directly into nearby streams, aligning discharge points as close to the source as possible. This strategy is essential to minimize the impact of flow concentration and also to support stream baseflow.

2.3. Existing Drainage Features and Stormwater Infrastructure

Auckland Council's Geomaps service indicates no existing public stormwater infrastructure within the site. The stormwater runoff within the Silverdale South Stormwater Catchment is mostly channelled via streams through Johns 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 some stream modification works (mainly in the upper Silverdale South Catchment area) carried out in the smaller tributaries to form drainage channels with the straightening of natural drainage patterns. The presence of John Creek through the centre of the subject site allows new stormwater outfalls to be constructed in the future. Outfalls scour and erosion protection should be designed and constructed in accordance with Auckland Council Technical Report:2013/018.

Culverts located beneath State Highway 1, provide drainage to the highway's east side from the Plan Change Area on the west. These culverts are integral to the stormwater management system, ensuring the controlled passage and flow within the Plan Change Area.

The network of culverts under the motorway, erected in the 1990s, was not constructed in compliance with current design criteria established by Waka Kotahi NZTA.

The culverts downstream are essential for the reliability of SH1. Detailed analysis of culvert capacity and performance has been conducted through the TuFlow flood modelling.

2.4. Receiving environment

There are several intermittent and ephemeral watercourses within the Silverdale West Precinct and the primary watercourse, John Creek, is categorized as a permanent stream and flows through the center of the property.

The current watercourses have undergone examinations, been classified as permanent, and had their ecological significance evaluated. Based on ecological values, the site is classified as having low to moderate ecological values overall.

As the main stream, John Creek is supplied with water from several other intermittent and ephemeral watercourses. The John Creek outflow is routed via a 4 m diameter culvert beneath State Highway 1 (the Silverdale off ramp). The only outflow (exit) for the site is the 4 m diameter culvert. This ultimately drains to Karepiro Bay via Weiti River.

Because of this culvert constraint, the culvert's capacity limits the flows that can leave the location.

Figure 3 displays the position of John Creek, the other contributing watercourses. While Figure 4 displays a summary of the site inflows and outflows.

Figure 3: Wetlands (turquoise/ orange polygons) at the site, and site boundary (turquoise line) and ponds at the site.

Source: Ecological Values Assessment dated August 2023, prepared by RMA Ecology Ltd (Refer to Appendix E for details).

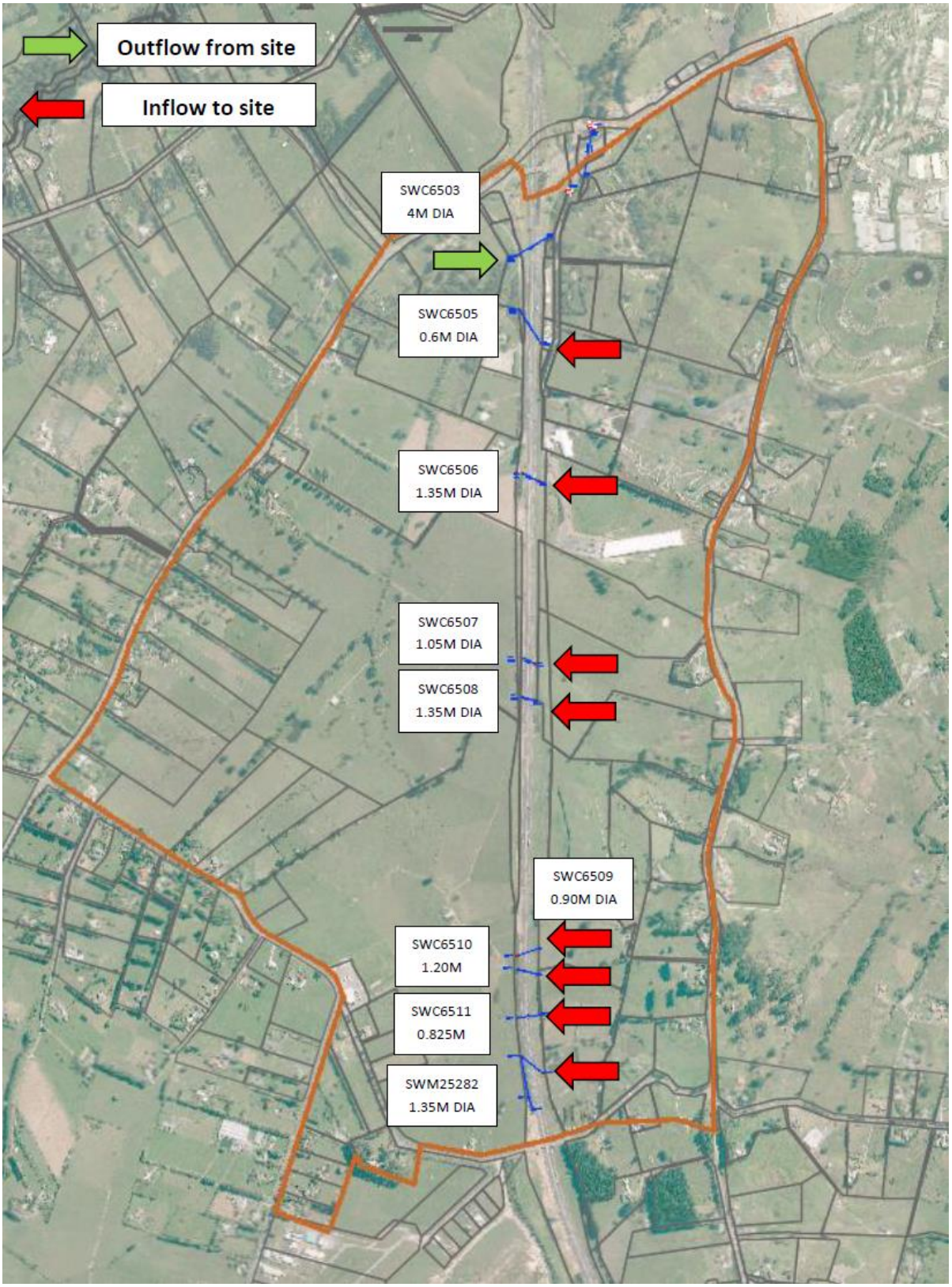

Figure 4: Inflows and Outflows

The information provided indicates a clear need for careful and strategic planning to protect the natural and ecological value of the Wēiti Stream and the larger ecosystems it supports, including the Long Bay Marine Reserve and the Hauraki Gulf Marine Park. Given the designation of the area as a Natural Stream Management Area with high natural character and ecological values, development within the Plan Change Area must adhere to stringent standards to preserve these qualities.

The Auckland Unitary Plan (AUP) outlines rules that aim to protect areas like the Wēiti Stream with unmodified beds and indigenous riparian vegetation indicative of high water quality and ecological value. The connection between the stream, the marine reserve, and the larger marine park underscores the importance of an integrated management approach that considers not only the immediate area but also the downstream effects on sensitive ecological zones.

With the identification of the Long Bay Marine Reserve and the Hauraki Gulf Marine Park as areas of significant conservation value, it is imperative that any construction or development activities include plans for stormwater management that prevent sedimentation and pollution. This includes during the construction phase and afterwards, when increased runoff and potential erosion from developed lands could pose new risks.

A stormwater management plan should be developed that includes:

- Sediment control during construction to prevent runoff into the estuary and marine park.
- Long-term infrastructure to manage increased runoff from developed areas to prevent erosion and pollution.
- Restoration initiatives that may include replanting indigenous riparian vegetation, streambank stabilization, and habitat enhancement for the local fauna. See Section 6.2.3 below for details.
- Monitoring and adaptive management strategies to ensure the effectiveness of mitigation measures and to respond to unforeseen impacts.

2.5. Existing Hydrological Features

There are 15 existing natural inland wetlands as defined by the NPS-FM, located within the proposed plan change area. The Masterplan layout anticipates that many of the smaller mid and upper slope seepage wetlands may be removed to enable the road network and efficient lot sizes. All of these wetlands are of very low ecological value as they are exotic rush dominated and intensively grazed. Where wetland removals may require ecological redress, there are substantial opportunities on the site where offsetting could be applied. Offsetting at off-site locations is also possible and can be undertaken in accordance with the AUP. The mitigation hierarchy will be applied as per the NPS-FM, including efforts to mitigate and offset on site, especially around W9-W10 where there are opportunities for wetland recreation and restoration. Where offsets cannot be located within the plan change site, wetland enhancement and recreation will be located elsewhere in line with Council's accepted practice. See Figure 5 below for reference.

Figure 5: Wetlands W9 – W10 (*Source: Ecological Values Assessment dated August 2023, prepared by RMA Ecology Ltd.)*

The natural wetlands to be retained are located upstream of the development area and treatment devices and are fed by existing flow paths/stream channels. Therefore, it is not anticipated that the hydrology of the existing natural wetlands will be significantly affected by the development.

John Creek is located through the centre of the site. Riparian planting is proposed for a minimum of 10 meters on each side of the stream for widths less than 3 meters, and a minimum of 20 meters for widths greater than 3 meters. Additionally, a 20m building offset will be established to protect this feature. Other hydrological features include overland flow paths across the site.

Refer to the Ecological Values Assessment prepared by RMA ecology for further details.

2.6. Existing Infrastructure

See Sections 2.3 & 2.4 above.

2.7. Flooding and Flow Paths

As indicated on Auckland Council Geomaps, numerous overland flow paths (OLFP) are present across the extent of the site and converge at John Creek as shown in Figure 6 below. Floodplains associated with these flow paths and John Creek are also present, predominantly in the low lying areas to the north of the site.

John Creek is a permanent stream which runs through the site, with a width varies between 1.5m and 4.98m. Where the width of this stream is greater than 3m, esplanade reserve requirements are triggered which in turn results in minimum setbacks of 20m each side with riparian planting margins.

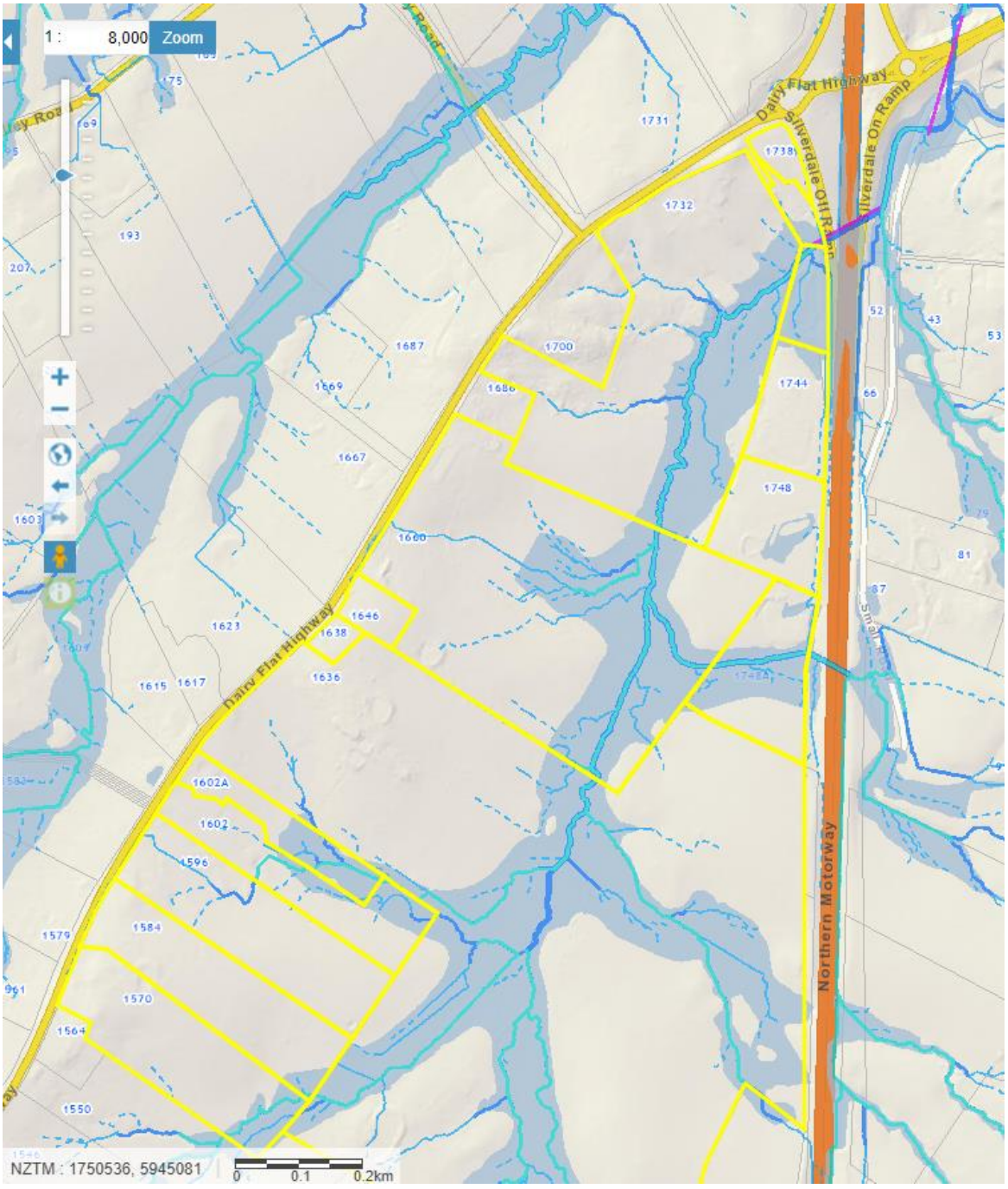

Figure 6: Existing OLFP & Flood plain associated with John Creek *(Source: Council Geomaps dated 22/05/2024)*

To meet the esplanade reserve requirement, all lot areas have been set back at least a minimum 20m from the stream edge (i.e., the top of the stream bank on either side as the edge of the stream), with most lots extending more than 30m and others more than 50m away from the stream edge to facilitate room for the existing wetland areas to the east, new wetland area to the west and formation of gentle earthworks batters and landscaping/greenway along the length of John Creek. A minimum of 20m each side of the permanent stream would be proposed to be planted with Riparian planting, with potential for other uses within the floodplain area for either future planting, landscaping, park, cycleways, or additional yield.

While, where the width of the stream is lesser than 3m, a minimum of 10m riparian margin and planting will be provided on each side.

The assessment confirms that the stormwater flows generated by additional impervious area based on the proposed masterplan will have negligible effect on the flood plain. Please refer to Section 6.2.7 Flooding details for this development.

2.8. Coastal Inundation

The lowest elevation within the site is approximately 11m RL, therefore site is not subjected to risk of Coastal Inundation.

2.9. Biodiversity

Biodiversity Assessment of the site has been undertaken by RMA Ecology Ltd, regarding aquatic and terrestrial ecology.

There are key ecological features on site, which can be summarised by the main stem of John Creek and its tributaries, riparian margins surrounding the John Creek catchment, mosaic of wetlands within low lying areas, possible copper skinks in some parts of the site and the existing indigenous forest site (IV1 – Refer to RMA Ecological report). There is no remnant native forest on this site, no significant ecological areas are listed at the site in the AUP.

The assessment of the site concludes a highly modified landform that has lost most of its original indigenous value. Although most native components are absent, and key ecological features such as streams and wetlands are highly degraded, there is substantial opportunity to improve on this and return biodiversity and ecological function to the site.

2.10. Cultural and Heritage Sites

Archaeological assessment of the site has been carried out as part of the plan change application process. Refer to Proposed Plan Change – Silverdale West, Auckland: Archaeological Assessment Report.

2.11. Contaminated Land

Contaminated Land assessment of the site has been carried out by Groundwater and Environmental Services as part of the preliminary site investigation.

Current Auckland Council contaminated site databases do not contain records of actual or potential contamination within the property and no activities considered likely to cause significant contamination were identified in the surrounding area.

There is low risk potential for contamination of the ground within identified areas in the north-west and south-west of the property, as well as within sediment and a small stream in the east of the property. These areas of potential contamination are a relatively small portion when measured against the whole subject site.

2.12. Stream Bank Erosion

The development of the catchment and its related increase in impermeable surfaces will, unless mitigated, intensify the volume of water discharging through stream networks, increasing the potential for erosion. The scouring of stream banks and the alteration of channel shapes negatively impact stream morphology and ecological integrity. Such stream erosion is intimately tied to the alterations in flow delivery rates that accompany land cover modifications, which in turn escalate hydraulic loads. This sequence of events triggers rapid adjustments within stream systems, especially during recurrent flows that exceed the 2-year Average Recurrence Interval (ARI) rainfall event, as per Auckland Council Technical Report 2013/035.

Nested within a gently sloping valley, the Silverdale South have experienced a vertical accumulation of fine, highly erodible sediments over time, facilitated by geological uplift, slope erosion, and the spillover of floodwaters. The gentle gradient of the catchment gives a limited ability to channel water efficiently through its naturally established conduits, leading instead to the formation of marshlands and wetlands. However, anthropogenic agricultural practices have significantly altered this landscape, manifesting in the channelization and drainage of natural wetlands and the deforestation of areas. This change has had the effect of streamlining the flow of water through the catchments. This change has induced pronounced erosion, particularly at the lower reaches of the Silverdale South Catchment, heightening the risk of continued erosion as the system seeks a new state of balance.

The Northland Allochthon soils, prevalent within the area, are highly susceptible to erosion under the impact of water discharge. Conversely, alluvial soils in the flatter regions are somewhat more resistant to erosion but are vulnerable to being scoured away as stream connectivity enhances and shear forces intensify with changes in flow patterns, as identified by URS (2010).

Without mitigation, further development is poised to intensify stream erosion and sediment flow into downstream environments. Consequently, measures to offset the hydrological detriments from erosive flows will become imperative, ensuring the stability of stream banks and the preservation of aquatic habitats and downstream water quality.

2.12.1. Existing Erosion Assessment

The Watercourse Assessment Report by Morphum Environmental Ltd in 2020 observed that within the Plan Change Area, a significant portion of the banks of permanent and intermittent streams and tributaries were experiencing erosion, with 20-40% of the banks affected. Localized areas displayed varying degrees of erosion severity.

Subsequent efforts have aimed at pinpointing regions currently undergoing erosion or at risk of future erosion in light of evolving boundary conditions. For this purpose, a preliminary geomorphic assessment was carried out, employing the first stage of the River Styles Framework—a method that supplies river managers with tailored, catchment-specific resources to discern the characteristics and dynamics of streams (Brierley & Fryirs, 2013). This assessment, dubbed the "Silverdale River Styles – Initial Desktop Analysis," was prepared by Auckland Council in 2021. Refer to Appendix B for Erosion Assessment Memo – Silverdale River Styles.

Within the Plan Change Area, two stream sections have been identified as erosion hotspots by the River Styles Framework:

1. Johns Creek (downstream/outside Plan Change Area): This section is categorized as "Partly Confined, Terrace Margin Controlled, Incised, Low Sinuosity Channel" with a medium sensitivity to erosion. It is currently experiencing vertical incision exacerbated by flow concentration during significant storms, funnelled through a culvert from an upstream highway. The surrounding fine-grained floodplain material is highly erodible, leading to over-steepened banks and significant geotechnical failures.
2. Johns Creek (downstream margin of Plan Change Area): Here, the channel is defined as "Partly Confined, Bedrock Margin Controlled, Incised Channel." This stretch has a low to moderate sensitivity to change since it has already gone through incision and widening. Although lateral adjustments are limited by bedrock margins, ongoing incision could propagate upstream, impacting less sensitive areas.

Most streams within the Plan Change Area are considered to have low to moderate sensitivity to change. However, without intervention, current erosion is likely to extend upstream, potentially affecting areas that are currently stable, particularly due to human-induced changes like artificial channel modifications and altered flow regimes.

Given the context of moderately sensitive downstream areas, stormwater management strategies must include measures to mitigate erosive forces, accounting for hydrological effects.

2.12.2. Future Erosion Considerations

The dynamics of erosional processes in the Plan Change Area (PCA) are heavily dependent on the balance between the natural channel-forming capacity of streams and the modifications that have been made to their flow paths, primarily through human activities.

The upstream extents of streams along Johns Creek, where natural sediment transport and channel formation begin, are categorized using the River Styles Framework as "Partly Confined, Bedrock Margin Controlled, Discontinuous Floodplain, Meandering, Discontinuous Channel". These segments are integral to the natural geomorphology of the watercourse, where the stream actively engages with its floodplain and forms meandering patterns.

However, these natural patterns are interrupted by reaches that have been artificially modified ("Partly Confined, Bedrock Margin Controlled, Channelised Fill"). Such areas were historically swamps or wetlands but have been transformed into straightened channels to facilitate agricultural land use, thereby increasing the connectivity and flow speed through these once disconnected wetlands.

While these upstream reaches are not currently experiencing high erosion rates, they possess inherent vulnerabilities to erosive processes. The introduction of headcuts (a sudden break in the stream profile often caused by an abrupt change in channel slope) can initiate a chain reaction of erosion through both the artificially straightened and the naturally meandering sections.

To prevent the degradation of these watercourses, mitigation measures for hydrology changes should be implemented as development progresses within the PCA. In additional, a focus on areas identified as hotspots to prevent continued erosion and its spread to stable streams. Remedial and rehabilitative efforts should be considered to halt any ongoing degradation resulting from past landuse changes in the catchment.

3. Development Summary and Planning Context

A review of the relevant stormwater guidelines and policies were carried out to determine the appropriate stormwater and flooding requirements to adopt in the Stormwater Management Plan for this development. The relevant requirements are summarised in Table 3-1.

Table 3-1 Regulatory and design requirements

Requirement	Design response
Unitary Plan – SMAF hydrology mitigation	5mm retention to be achieved via tanks with non-potable water reuse for all buildings. In cases where these devices are not practical, then these areas will be integrated into a communal wetland as additional detention. Detention Volume for stream protection via artificially constructed wetlands for all paved surfaces
High Contaminant Generating Areas	Treatment for the site to be provided via artificially constructed wetlands prior to discharging into the natural stream.
Natural Hazards	Flood modelling and assessment. Design of the site to ensure safe access and that floor levels are not at risk of flooding.
Auckland Unitary Plan Precinct	(N/A)
Existing Catchment Management Plan	(N/A)
Auckland Council Regionwide Network Discharge Consent	Measures proposed comply with the NDC: • Natural hydrology is restored and protected as far as practicable, utilising SMAF-1 requirements. • Discharge of contaminants and temperature related effects are managed using engineered wetlands. • Engineered structures are located outside of stream extents and 1% AEP floodplain. • Water quality treatment is proposed for all impervious surfaces • Flooding is contained within the stream extent, and downstream flooding is not exacerbated by the proposed development. • All assets to be vested as public are to be designed in accordance with relevant guidelines

4. Mana Whenua Values

Mana Whenua values are intrinsic to the design, construction, and management of stormwater devices in the Auckland region. A review been completed to ensure the stormwater design for the site aligns with relevant Mana Whenua values. In particular the principles of Taiao and Mauri Tū feed into the design of the stormwater system and works relating to the existing streams and wetlands.

The Mana Whenua value of Taiao guides design consideration of the stream and wetlands to protect, restore and enhance these aspects of the natural environment. The proposed plan change seeks to establish a 20m buffer around John Creek, and a 10m minimum buffer around wetlands and areas of indigenous vegetation to protect these features from any deleterious effects of intensification in the plan change area. The proposal also provides an opportunity for restoration of the severely degraded wetlands and stream by native restorative planting and limiting further degradation. Detailed planting and restoration plans can be developed as part of the detailed design and should include local species as much as possible. The indicative wastewater design proposes multiple wastewater crossing points over John Creek. Ongoing consultation with Iwi is recommended to ensure that the wastewater design is sensitive to Mana Whenua values of protecting environments.

The stormwater system is also designed to protect the environmental health of the plan change area into the future, in line with Mauri Tū principles. This is accomplished by sensitive management and treatment of stormwater flows to minimise temperature related effects, excess runoff volume, contaminated water, and sediment from entering the stream network. Managing these effects restores and protects the habitat for aquatic fauna (such as waterfowl, fish, eels, and macroinvertebrate communities), thus contributing to the long-term health of the environment. This is accomplished using the requirement for roof areas to utilise retention and detention tanks, and for all paved areas including roadways to be detailed to avoid effects of increased

imperviousness on downstream hydrology. Additionally, stormwater outfalls are proposed to lead to new communal artificially created wetlands prior to discharging to stream. Refer to section 6 of this report for details on the stormwater management devices proposed for the site.

5. Proposed Development

5.1. Location and Area

The site proposal seeks for a plan change to rezone a 107ha of land between State Highway 1 and Dairy Flat Highway. Refer to Section 2 of this report for details of the site.

5.2. Purpose of the Development

The site proposal seeks for a plan change to rezone 107ha of land from Future Urban zone to light industry zone. In addition to the industrial aspect, the plan change request identifies wetlands, streams and associated riparian areas along with the enhancement of the existing stream channel incorporated into the landscape design.

5.3. Site layout and urban form

Refer to the Concept Development Masterplan for details on the proposed layout of the plan change area.

The full extent of the proposed Plan Change Area has been modelled in 3d to ensure compliant road grades are achievable across the development and ensure levels and grades for the proposed lots are feasible.

There are two proposed bridges with culverts along the stream that will require work within the stream margin, but no other works are proposed within the stream or riparian margin.

5.4. Earthworks

Earthworks will be consented with Council after obtaining approval for plan change application.

Earthworks are required for recontouring across the site to improve contours to satisfy the design and layout requirements, in addition for the proposed roading network and to provide suitable building platforms.

Due to the size of the development, earthworks will likely be staged, with completed areas progressively stabilised through the earthworks phase, which prevents a large area of exposed land at once.

Further geotechnical investigation will be required to identify specific retaining wall, and ground stabilisation requirements.

6. Stormwater management

A review of the relevant stormwater guidelines and policies was carried out to determine the appropriate stormwater and flooding requirements to adopt as part of this SMP. The relevant documents are as follows:

The general provisions set out in the Auckland Unitary Plan – Operative in Part:

- Section E1 – Water quality and integrated management,
- Section E8 – Stormwater discharge and diversion
- Section E9 – High contaminant generating carparks and high use roads.
- Section E10 – Stormwater management area – Flow 1 and Flow 2

- Section E36 – Natural hazards and flooding

Under section E8 of the Auckland Unitary Plan, Auckland Council's assessment criteria includes whether the relevant network discharge consent has been considered (clause E.8.7.2.1.b) as part of the stormwater management strategy.

Per Auckland Council's regionwide network discharge consent, the development is classified as Greenfield.

6.1. Principles of stormwater management

The following principles will guide the management of stormwater for the site.

- Water Quality – Treatment of all impervious pavement areas is to be provided by a water quality device that removes contaminants and is approved by Auckland Council prior to discharge into the stream.
- Stream Hydrology – As this discharge is to a stream outside a SMAF area, equivalent hydrology requirement will apply. This can be completed using artificially constructed wetlands or other treatment methods such as wetlands and proprietary devices.
- Flooding – There is flooding within the proposed development area particular in the vicinity of John Creek. Flooding risk is mitigated by providing attenuation on site up to the 100-year ARI event to pre-development peak flow. Setbacks from the creek have been considered to avoid the 1% AEP floodplain. Reticulated public stormwater network discharging to new outfalls will be provided to convey the 10% AEP event safely through the development. Setback extents are shown in the stream setback drawing attached to this report.
- Assets – All new private and public assets proposed as part of SMP will be designed to comply with the relevant local and national standards to ensure they are durable and last the design life with suitable maintenance.
- SMAF1 Provisions.
    - Retention (volume reduction) for the first 5mm of runoff for all impervious areas. In cases where these devices are not practical, then these areas will be integrated into a communal wetland as additional detention.
    - Detention (temporary storage) with a drain down period of 24 hours for the difference between the pre-development (grassed state) and post development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume for all impervious areas.
- Ensure that there is sufficient capacity within the pipe network downstream of the connection point to cater for the additional stormwater runoff associated with the development in a 10% AEP event; or
- Demonstrate that flows more than the pipe capacity in a 10% AEP event within the pipe network downstream of the connection point will not increase flooding of any other property; or
- Demonstrate through an assessment that flows more than the pipe capacity in the 10% AEP event within the pipe network downstream of the connection point will not increase adverse effects on any other property.

6.2. Proposed stormwater management

The proposed stormwater management strategy for the site is described in the following sections. The proposed Stormwater Management approach is consistent with the Silverdale West Dairy Flat Business Area Structure Plan SMP prepared by WSP/Opus in November 2018 and Draft Silverdale West Industrial Plan Change SMP prepared for Auckland Council by WSP dated 25/11/2022.

Table 6-2-1 Comparison with other SMPs

Other SMPs	Key elements	Design response
Silverdale West Dairy Flat Business Area Structure Plan SMP prepared by WSP/Opus in November 2018	Flood Risk Management Hierarchy is recommended. Water Sensitive Design Toolbox	It has been adopted and the following has been proposed: - Any development has been set aside from the floodplains. - Riparian planting has been proposed along the stream within the floodplain. - Engineering interventions such as Stream crossing culverts/bridge, land raising, and flood storage have been proposed to attenuate the 1% AEP event within the site. - All finished floor levels for the proposed buildings shall meet the freeboard requirements for the 1% AEP flood plain in accordance with Table 5 of the SW CoP Guidance. Proposed hydrological mitigation and treatment devices are consistent with the options listed.
Draft Silverdale West Industrial Plan Change SMP prepared for Auckland Council by WSP dated 25/11/2022	Preferred Flood Mitigation option is to attenuate on-site up to the 100-year ARI event. Preferred option for Stormwater Management Implementation is via providing Water quality treatment 'at source', detention and attenuation in communal devices downstream, enhance existing streams.	Same approach is adopted as it would not increase the flooding risk for key infrastructure including SH1 Johns Creek Culvert No. 2 and Small Road Culvert and buildings at 2 and 4 Blue Gum Avenue further downstream. Similar approach is adapted where retention is provided 'at source', while treatment & detention is provided 'at subcatchment-level communal devices' (such as wetlands) at downstream and with riparian planting along the stream. This approach provides more certainty on the treatment as the communal wetlands will be operated and maintained by Auckland Council and therefore, less likely to miss-out on the treatment prior to discharging to the stream.

The following Table 6-2-2 provides a summary of implementing options considered similar to the Silverdale West Industrial Plan Change SMP:

Table 6-2-2 Summary of options on how to implement the stormwater management principles

Option	1 All at Source	2 All sub-catchment (Communal Wetlands only)	3 Combination (At-source retention + Communal Wetlands for treatment & detention)
Water Quality	Private Lots Good treatment, however, O&M may not be carried out correctly by private lot owners. Public Roads Good treatment but will results in a large number of small devices that are not preferred by Healthy Waters or Auckland Transport.	Good treatment and O&M by council less likely to be missed. However, will require larger land and higher O&M costs for Council.	Same as option 2

Option	1 All at Source	2 All sub-catchment (Communal Wetlands only)	3 Combination (At-source retention + Communal Wetlands for treatment & detention)
Stream Hydrology	Private Lots Good for mitigation, however, opportunity to incorporate reuse into an industrial development will be dependent on the activity. Public Roads Providing attenuation within roads will results in larger devices and complicates the O&M.	No retention viable and O&M more robust with council running O&M.	Similar to Option 1. Most preferred as retention provided earlier where possible and O&M robust.
Stream Erosion	2-year detention on site requires more complex system	Centralising detention control in wetlands easier to design and operate	Same as option 2
Network Capacity	Good	Good	Good
Flooding	Not a viable option to mitigate within the private lots and public roads	Good	Good
Life Cycle Cost	Most expensive, based on prior projects at least 2 x cost of alternatives	Cheapest option as centralised devices and cheaper to build and maintain	Good value for money, on-lot retention adds some expense.

Best Practicable Option (BPO) Discussion

Option 3 Combination (At-source retention where practicable + Communal Wetlands for treatment & detention) is considered to be the best practicable option for the Plan Change Area as it:

- Delivers a treatment via Communal Wetlands operated and maintained by Auckland Council. Therefore, less likely to be missed.
- Retention is provided at source wherever possible provides resilience against single device failure. However, in cases where these devices are not practical, then these areas will be integrated into a communal wetland as additional detention.
- Requires slightly smaller communal devices than Option 2 reducing the overall O&M burden for Auckland Council.
- Reduces the loss of developable land while achieving required performance criteria.
- Avoids the need for separate pipe network for roads compared to lots so that discharge attenuated 'on lot' isn't combined within road runoff still requiring attenuation.

6.2.1. Water quality

Treatment recommendations from previous SMP's for this catchment have recommended treatment to GD01 standards for building roofs, driveways, waste storage (high contaminant generating areas) and roadways. Given the scale of the catchment these SMP's recommend treatment to be provided via communal wetlands which also aligns with the recommendations of the other SMPs, particularly Draft Silverdale West Industrial Plan Change SMP dated 25/11/2022.

Communal Wetlands are proposed to treat all the impervious areas including roadways prior to slowly discharging the runoff into the natural stream.

Communal Wetland – BPO Discussion for treatment

If individual discrete devices such as on-lot raingardens or proprietary devices were to be used this would result in higher lifecycle costs vs communal wetlands, due to this high cost it's likely that some areas would be excluded from treatment to ensure reasonable stormwater management costs for the catchment. This means that utilising individual on lot treatment devices would have a higher cost with poorer environmental outcomes vs centralising the treatment devices in wetlands which are sized to treat all impervious areas. For this reason, wetlands are proposed as the best practicable option for treatment from a life cycle cost and environmental outcomes standpoint.

In addition to the Communal Wetlands, as per Schedule 4 of the NDC, gross pollutant traps are required for runoff from (communal) waste storage areas located within the private lots. Hence, a LittaTrap is proposed to be placed in the catchpit capturing runoff from these waste storage areas. The purpose of LittaTrap is to capture and retain plastic and litter before they enter the drainage system and therefore before they can reach the wetland and streams. The maintenance of this system will be within the private lot owner.

6.2.2. Stream hydrology

The proposed development is to ensure that there is no direct discharge to the stream. All runoffs from the development will be conveyed to the proposed communal wetlands where the treatment and detention are provided to mimic up to the 10-year pre-development flow into the stream.

In accordance with AUP E10, SMAF-1 are for those catchments which discharge to sensitive or high value streams that have relatively low levels of existing impervious area. While SMAF-2 areas typically discharge to streams with moderate to high values and sensitivity to stormwater, but generally with higher levels of existing impervious area within the catchment. Although this plan change area is not identified to be within the stormwater management area controls, we have taken a conservative approach to adopt SMAF-1 for the entire plan change area. Furthermore, the area downstream of the plan change site has been already identified as the SMAF-1 control area. Additionally, it is also in consistent with Silverdale West Industrial Plan Change SMP dated 25/11/2022 which identified that SMAF1 retention and detention are to be applied for hydrology mitigation.

Hence, to protect stream hydrology, the following SMAF1 hydrology mitigation is proposed for the site:

- Retention (volume reduction) of at least 5mm runoff depth for the impervious area is to be provided via reuse tanks for the private lots while utilising GD01 recommended devices for public roadways wherever practicable.
- Detention (temporary storage) with a drain down period of 24 hours for the difference between the pre-

development (grassed state) and post development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume for all impervious areas. SMAF-1 detention for the plan change area will be provided via communal wetlands which will also act as a detention for stream protection and will be in accordance with GD01.

Communal Wetland – BPO Discussion for detention

Based on life cycle costing analysis prepared for other projects, we know that wetlands have total life cycle costs roughly half that of smaller site based devices. Wetlands are also assessed as having the best environmental outcomes for the site with bulk treatment of flows. Consolidating wetland locations was considered however the extra network required increases the life cycle cost of this proposal offsetting any benefits from fewer devices and the environmental outcomes of this proposal are considered inferior due to centralised discharge points to the waterways causing higher fluctuations in stream hydrology. Also, in accordance with GD01 Table 15 & Table 16, the wetlands are considered as the most effective and have significant benefits on the Social, cultural, and environmental values compared to any other devices.

6.2.3. Stream Erosion

As mentioned in section 2.12 of this report, significant existing erosion of stream networks on the site and downstream of the development site were observed. To mitigate the effects of proposed development on these systems, it is recommended that erosive flows for these downstream waterways are quantified via a shear analysis of the stream banks and then detention controls should be implemented into the proposed wetlands as far as practicable to reduce the flow duration of these erosive flows as much as practicable.

The following ecological protection and restoration initiatives are expressed in the Structure/Masterplan:

1. A central south-north, green corridor centred on John Creek which will provide a central focal point, connectivity, and integration of ecological services through stormwater management, conveyance, and treatment, as well as opportunities for ecological restoration, and connectivity to indigenous vegetation patches across the site;
2. Improve aquatic habitat, function, and biodiversity values of John Creek as a natural outcome of the revegetation and enhancement of the margins of the Creek and the restoration of the main wetland clusters at either end of the site. This will improve in-stream habitat, riparian margin revegetation and improvements to water quality, both within the site, and, therefore, improvements to the northern receiving area of John Creek and Weiti Stream and the nearby estuary.
3. Where riparian enhancement is included, this provides opportunities for not only revegetation planting, but also including created habitat for lizards, bats, and invertebrates (for example, by including logs, refuge stacks, and including specific forest trees within riparian margin management).

The above ecological protection and restoration initiatives are to be provided either side of the waterway to provide a buffer between the development and the waterway and to restore the bank stability and ecological functions. These are also reflected in the draft Precinct Provisions. For further details, refer to Ecological Values Assessment prepared by RMA Ecology Limited.

The proposed development is divided into sub-catchments such that the runoff from each sub-catchments will convey into the communal wetland which provides SMAF mitigation and 10-year detention to mimic the pre-development flow into the stream. Furthermore, the proposed riparian yards and plantings will improve the water temperature and minimises stream erosion.

Whilst the above mitigations mitigate the impact of development on the downstream watercourses and improve the condition of the existing watercourses, it is still anticipated that stream erosion will continue due to the existing modified nature of the catchment. There is an opportunity for enhancement both within the plan change area and downstream. These opportunities would be most effective via a partnership between the developers and council to improve and enhance the waterways on site prior to significant development taking place. The cost of enhancing these waterways prior to development will be much lower than trying to restore these waterways post development.

6.2.4. Network Capacity

The primary stormwater network for the development will be designed to have sufficient capacity to meet the requirements of the SWCoP, i.e., the 10% AEP. While the secondary system will be designed to accommodate the 1% AEP design storm event. The drainage reserve for the site has been sized to utilise the culverts as hydraulic controls to maintain downstream flows and water levels at pre-development conditions (i.e., existing being greenfield or grassed state). The TuFlow flood modelling for the 100-year scenario shows an unchanged scenario in water levels downstream so the development proposed is mitigating the 100-year event within the site.

6.2.5. Proposed Wetlands

The site is divided into 14 distinct sub catchments, each requiring specific design and grading to accommodate the masterplan. Therefore, implementing a communal device (such as a wetland) in each sub catchment is deemed essential. These communal devices serve multiple purposes, including hydrology and flood mitigation for all land uses within the sub catchments. This compares to approximately 10 wetlands shown in the draft Silverdale West Private Plan Change SMP. The increase in wetland count is due to specific design and grading required to support the masterplan. These wetlands will be found inside the designated open area next to John Creek. The idea is to build wetlands next to streams wherever the outfalls are in order to capture the stormwater mains along the roads. These "offline" features will help reduce the amount of stormwater runoff by acting as buffers. Refer to Drawing 30001 for Proposed Communal Wetland locations and catchments.

Existing natural wetlands on site are largely preserved in the development proposal. Any modifications to these existing natural wetlands should follow an appropriate consenting process to ensure effects are appropriately managed.

Based on life cycle costing analysis prepared for other projects, we know that wetlands have total life cycle costs roughly half that of smaller site based devices. Wetlands are also assessed as having the best environmental outcomes for the site with bulk treatment of flows. Consolidating wetland locations was considered however the extra network required increases the life cycle cost of this proposal offsetting any benefits from fewer devices and the environmental outcomes of this proposal are considered inferior due to centralised discharge points to the waterways causing higher fluctuations in stream hydrology. Lifecycle costing should be provided for proposed stormwater management devices at the time of Resource Consent application.

The following benefits are anticipated from the wetlands for this development:

- Natural habitat
- Stormwater treatment
- Detention (95th percentile)
- Wetlands are proposed to use GD01, the design of the wetlands will include a bathymetric and forebay.

The wetlands are also proposed to provide 2 year and 10 year peak flow mitigation for the development to mitigate the effects of new impervious areas on downstream erosion. Further discussions with Healthy Waters are being held on this approach to inform the SMP.

Catchment areas for each Wetland are shown in the Wetland Catchment Area drawing 30001 attached to this SMP.

All proposed communal wetlands are sized in accordance with Council Guideline Document 2017/001 (GD01). Refer to Appendix D for the Wetland Sizing Calculations for details.

Table 3-2-5: Summary of Sub-Catchments and Wetland Areas

Wetland	Sub-Catchment Area (m2)	Required Area (m2)	Allocated Area (m2)
1	221900	8161	9120
2	115900	4621	4935
3	66600	2509	2835
4	15900	650	865
5	16500	650	1180
6	31300	1186	1475
7	27600	1037	1215
8	16200	650	790
9	40500	1514	1740
10	28300	1186	1585
11	37800	1693	1745
12	59400	2290	2365
13	42900	1514	1815
14	40100	1345	2065
		29000	33730

Further details and calculations for Wetlands are to be provided at Resource Consent Stage.

Access to Wetlands

All communal wetlands are to be located such that they can access from the public road corridor.

6.2.6. Outfalls

New outfalls will be required as part of the new wetland system and overall stormwater management for the site. To minimise the impact all new outfalls should be designed as ‘green’ outfalls that integrate into the natural landscape around them such as Scruffy dome outlet with smaller orifice catering for detention for stream protection will be provided in the wetland and the downstream of the outlet will be a wingwall culvert with rip-rap protection to ensure the flow does not trigger any stream erosion.

Each wetland will have a separate outfall to convey water into the stream. The wetland and outfall locations have been selected to fit with layout of the sub catchments and also to provide regular points of discharge into the stream network, maintaining stream baseflows. Refer to drawing 30001 for a layout of proposed communal wetlands for the plan change area.

6.2.7. Flooding

Rainfall

Existing rainfall depths do not include allowances for climate change. Future rainfall depths allow for a projected average temperature increase of 2.1°C, per the Ministry for Environment's Guidance Manual for Local Government in New Zealand (2008). Rainfall depths used for modelling are:

Table 6-2-4 Rainfall depths used for flood modelling:

	24 hr – TP108 Rainfall Depth (mm)	% increase (based on 2.1°C)	24 hr – Rainfall Depth incl. Climate Change (mm)	% increase (based on 3.8°C)	24 hr – Rainfall Depth incl. Climate Change (mm)
Rainfall 2 year – 50% AEP	85.5	9.0%	93.2	27.4%	108.9
Rainfall 5 year – 20% AEP	119.4	11.3%	132.9	29.6%	154.7
Rainfall 10 year – 10% AEP	142.0	13.2%	160.7	30.8%	185.7
Rainfall 20 year – 5% AEP	162.0	15.1%	186.4	31.2%	212.5
Rainfall 50 year – 2% AEP	180.0	16.8%	210.2	31.9%	237.4
Rainfall 100 year – 1% AEP	212.3	16.8%	248.0	32.7%	281.7

We have also completed a model run using (3.8°C climate change) for comparison purposes.

Curve Numbers

A curve number of 98 was used for all impervious areas. A curve number of 74 was used for pervious areas.

Upstream Catchment Inflows

Site characteristics for the TuFlow modelling are determined based on a Citywide overlay of rainfall depths and soil classifications. The rainfall depths have been found through a linear interpolation for each storm based on the rainfall contour plots in TP108. Rainfall depths are then adjusted for Climate Change to give rainfall depths used in the modelling.

The upstream catchment areas are set based on the area accumulation model in the Citywide GIS layer. Catchment lengths are determined via the OLFP layer which is then draped on the Citywide LIDAR layer and the equal area slope calculated to give the upstream catchment slope. The channelisation factor is set based on the nature of the upstream catchment and using TP108.

The catchment factors are then used to calculate inflow Hydrographs using the SCS Curve runoff method, as recommended in TP108.

Catchment inflow data is shown in the model data.

Impervious Coverages

Existing impervious coverages were calculated specific to delineated catchments based on known impervious coverages in the catchment. This includes road kerbs, building footprints and North Shore City Council's GIS impervious surface data.

Proposed impervious coverages have been modelled at 85% of the catchment area. The following table provide the calculation for the site impervious coverages under proposed development:

Table 6-2-4 Site Impervious Coverage for the proposed development:

	Area (ha)	Area (%)
Proposed Development Area (100% impervious)	78 ha	73%
Proposed Open Space Area (0% impervious)	29 ha	27%
Total	107 ha	100%

Refer to Drawing 30001 for catchment areas.

While the estimated impervious percentage of the site stands at approximately 73%, a conservative approach has been adopted for flood modelling. Consequently, the proposed site imperviousness has been modelled at 85%.

To meet the esplanade reserve requirement, all lot areas have been set back at least a minimum 20m from the stream edge (i.e., the top of the stream bank on either side as the edge of the stream), with most lots extending more than 30m and others more than 50m away from the stream edge to facilitate room for the existing wetland areas to the east, new wetland area to the west and formation of gentle earthworks batters and landscaping/ greenway along the length of John Creek. A minimum of 20m each side of the stream where the width is greater than 3m would be proposed to be planted with Riparian planting, with potential for other uses within the floodplain area for either future planting, landscaping, park, cycleways, or additional yield. While a minimum of 10m each side of the stream where the width is lesser than 3m would be proposed with Riparian planting.

Results

As indicated on Auckland Council Geomaps, several OLFP are located across the extent of the site. Flood plains associated with these OLFP are also present.

A flood assessment evaluation has been undertaken to assess the flows within the site and upstream/downstream of the site. Flood modelling has been undertaken using Tuflow. The model has been developed for the purpose of demonstrating that the mitigation measures included within the site mitigate the effects of the development. This means that the existing and proposed scenarios are only different in the ways that the development will affect the site, i.e. change in imperviousness within the site and increased efficiency of the drainage network in the site. Changes outside the effects of the development including Climate Change and development of upstream catchment areas are not legally required to be mitigated within the development, this was a principal established in the Queenstown-Lakes District Council v Hawthorn Estate Ltd (2006) 12 ELRNZ 299; [2006] NZRMA 424 (CA) decision.

The assessment calculations are based on maximum probable development for the site and are factored for climate change. The existing model included the existing state of the site (as 8% impervious). The proposed model included the proposed development on site (as 85% impervious), with the proposed stream crossing culverts and flood storage areas providing attenuation for the 1 in 100 year event.

The extent of the flooding in the existing and proposed development scenarios are shown in drawing series 55000 while the extent of drainage reserve, communal wetlands and riparian margin are shown in drawing series 30001. The preliminary afflux results indicate the proposed development will not significantly affect water levels on downstream properties in the 1% AEP design event with the proposed drainage reserve and artificially constructed wetlands.

The table below summarises the Peak outflow immediately outside the site on the downstream side, comparing both existing and proposed scenarios with the location shown in Figure 7:

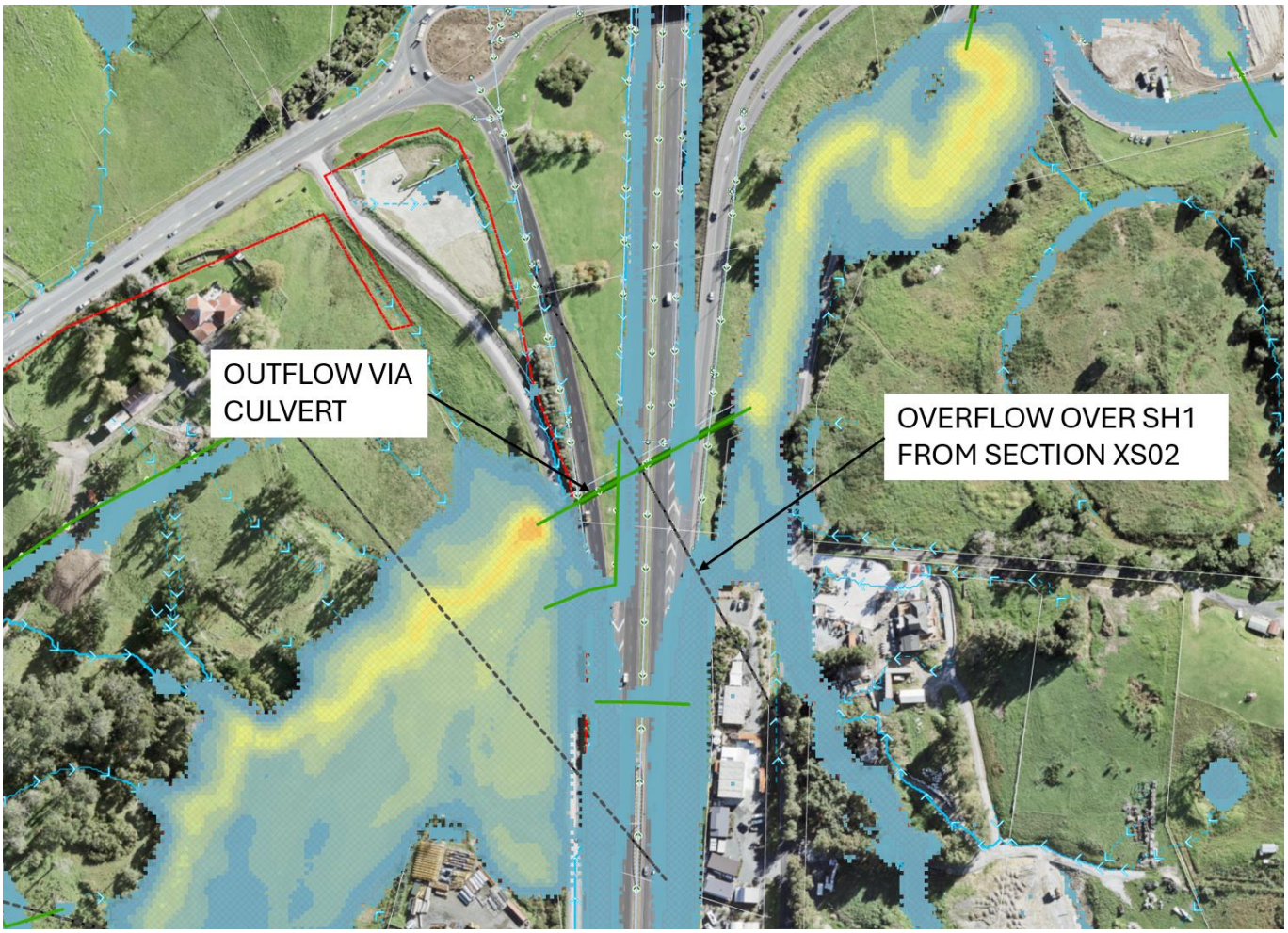

Figure 7: Silverdale West Site OLFP Outlet Location

Table 6-2-5 Peak Outflow summary results

I1 – 100 year (No Climate Change)			A5 - 100 year (2.1° Climate Change)				A6 - 100 year (3.8° Climate Change)			
	Existing		Existing		Proposed		Existing		Proposed	
Peak Outflow via Culvert	52.1	m3/s	64.9	m3/s	66.8	m3/s	68.2	m3/s	69.3	m3/s
Peak Overflow over SH1	6.0	m3/s	6.1	m3/s	6.1	m3/s	6.2	m3/s	8.0	m3/s
Total	**58.1**	m3/s	**71.0**	m3/s	**72.9**	m3/s	**74.4**	m3/s	**77.3**	m3/s
Difference			**1.9**			m3/s	**2.9**			m3/s

Both scenarios (2.1°C and 3.8°C) indicate no significant effects on downstream water levels from the proposed development. The slight increase in peak outflow can be mitigated by the proposed communal wetlands, which attenuate the 10-year event. Currently, these wetlands are not modelled. It is also important to note that the proposed scenario is modelled with 85% impervious surfaces, whereas the realistic figure is only 73%, making this a conservative approach.

According to the flood assessment results for the pre- and post-development scenarios, stormwater runoff is effectively contained in the post-development scenario. The pre-development scenario has a much wider flood extent, which is purely a result of the topography which is very flat and low lying.

Ponding along the eastern edge of State Highway 1 in the post development model has been noted. The model indicates the ponding is a result of inletting capacity into existing culverts that is resulting in these flows overtopping and traversing down the eastern edge of State Highway 1. John Creek will need to be throttled at the two proposed stream crossing locations in order to not increase flood water levels downstream. These throttled stream crossing structures will allow water to back up behind the structures to alleviate pressure downstream. No overtopping is intended at the throttled stream crossing locations. The road levels will be set higher to accommodate the required freeboard from the 100-year flood level. Inlet and outlet for the culverts will be proposed with rip-rap protection to prevent from stream erosion. The locations of stream crossing culverts are also shown on the catchment plan Drawing 30001. The stream crossings and actual calculated cross-sectional areas will be addressed via detailed design of the development levels at Resource Consent stage.

All finished floor levels for the proposed buildings shall meet the freeboard requirements for the 1% AEP flood plain in accordance with Table 5 of the SW CoP Guidance V3. Also, it's important to note that while V4 of the SW CoP hasn't been mandated for use, Table 5 remains unchanged.

The proposed flooding results also show no negative effects upstream of the development as well, demonstrating that the mitigations proposed for flooding are suitable.

In summary, the approaches outlined above demonstrate that stormwater can be managed in a way that meets the requirement to be included under the Auckland Council Regionwide Stormwater Network Discharge Consent for the proposed plan change area.

6.2.8. Development staging

Due to the size of the development, construction is intended to be staged, the details of which will be provided at Resource Consent stage. SMAF mitigation for buildings will be provided as they are constructed. The primary stormwater network will be developed to allow flexibility with staging.

6.3. Hydraulic connectivity

The development is connected hydraulically through new public stormwater network, which ties into outfalls leading to new wetlands and the stream running through the site.

6.4. Asset ownership

Mitigation systems such as reuse tanks located within the private lot will be privately owned.

Drainage assets that drain more than 1 title are proposed as public.

Any communal devices such as Communal Wetlands and Public SW pipe network will be vested to Council upon completion. The process as set in SW CoP guidance, particularly Section 4.3.6.2 shall be complied.

6.5. Ongoing maintenance requirements

Ongoing maintenance of the private drainage system and tanks on individually owned lots will be the responsibility of the private landowners.

Ongoing maintenance of the public drainage network and the wetlands will be the responsibility of council.

7. Conclusions

- SMAF mitigation requirements for the plan change are met via retention tank and extended detention in wetlands.
- Erosive flows for streams should be assessed and detention provided to keep flows below these levels for as long as practicable.
- The 10% AEP network design event can be safety conveyed through the site via a new public drainage network.
- The 1% AEP flood event can be safely conveyed through the site.
- The proposed plan change will not increase flood risk for surrounding properties through the mitigation of peaks flows by 1% AEP detention.
- Stormwater treatment can be provided at source via Littatrap (for waste storage areas) and at downstream via artificially constructed communal wetlands (for all impervious areas).
- Life cycle costings for new developments under this SMP should be provided with Resource Consent applications for development.

8. Limitations

- This assessment contains the professional opinion of Civix Limited Staff relating to this development. Civix Limited Staff used their professional judgement and acted in accordance with the standards of care and skill normally exercised by professional engineers providing similar services in similar circumstances. No other express or implied warranty is made as to the professional advice contained in this report.
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