Land Development Report

Warkworth North Plan Change

Prepared For:
Turnstone Capital

Chester Job Number:
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Revision History

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Action	Name	Signed	Date
Prepared by	N. Jull		03/05/2019
Reviewed by	S. Rankin		03/05/2019
Approved by	S. Rankin		03/05/2019

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SECTION A: INTRODUCTION

1 Introduction

This report has been prepared to inform the Warkworth North Structure Plan and Plan Change on behalf of SF Estate Limited. The boundaries for the Structure Plan and Plan Change are shown in Figure 1 below. The specific components undertaken by Chester include flood hazard mapping, preparation of a stormwater catchment management plan, water supply servicing design, wastewater servicing design, bulk earthwork design and investigation into utilities.

2 Proposal

The Warkworth North Structure Plan area includes the Future Urban zoned land bounded by the proposed Puhoi to Warkworth motorway extension in the north-west, the Viv Davie-Martin Drive lifestyle development to the west, the Mahurangi River to the south, and Hudson Road and State Highway 1 to the east and north-east.

The Structure Plan Area as well as the areas to be rezoned as part of the Plan Change is shown on Figure 1 below;

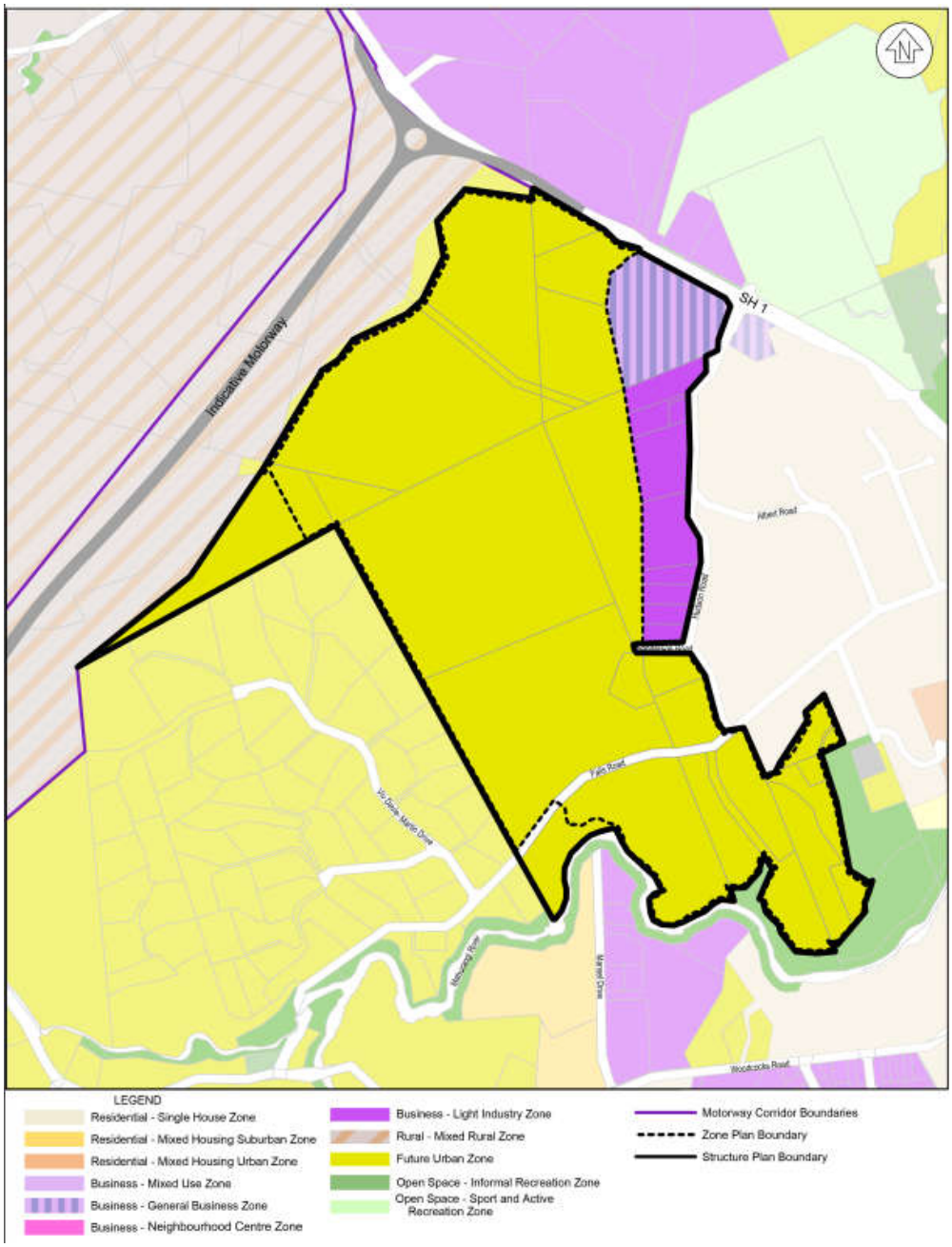

Figure 1 – Structure Plan and Proposed Zoning Boundaries

The structure plan area is 119 hectares and is made up of 32 separate parcels of land. The legal descriptions and current zone designations of these separate parcels are set out in Table 1 below.

Table 1 - Legal Descriptions within the Warkworth North Structure Plan area

Address	Legal Description	Zone (Unitary Plan – Operative in part)	Area (ha)
Lot 18 DP 9212, Sanderson Road Warkworth 0984	Lot 18 DP 9212, Allot 96F Psh Of Mahurangi SO 3434	Future Urban	6.76
12 Sanderson Road Warkworth 0984	Pt Allot 52 Psh Of Mahurangi	Future Urban	20.46
220 Falls Road Warkworth 0984	Lot 2 DP 355193	Future Urban	15.23
102 Hudson Road Warkworth 0984	Lot 16 DP 9212	Future Urban	1.6
223 Falls Road Warkworth 0984	Lot 2 DP 210933	Future Urban	9.2
null	Section 20 SO 495251	Rural - Mixed Rural / Future Urban	4.33
null	Section 24 SO 495251	Future Urban	2.42
null	Section 17 SO 495251	Future Urban	14.63
14 Hudson Road Warkworth 0984	Lot 1 DP 102732	Business - Light Industry	1.08
24 Hudson Road Warkworth 0984	Lot 2 DP 149967	Business - Light Industry	0.57
26 Hudson Road Warkworth 0984	Lot 1 DP 149967	Business - Light Industry	0.23
30 Hudson Road Warkworth 0984	Lot 21 DP 9212	Business - Light Industry	1.83
60 Hudson Road Warkworth 0984	Lot 20 DP 9212	Business - Light Industry	1.84
66 Hudson Road Warkworth 0984	Lot 1 DP 166853	Business - Light Industry	0.51
74 Hudson Road Warkworth 0984	Lot 2 DP 166853	Business - Light Industry	0.53
76 Hudson Road Warkworth 0984	Lot 2 DP 402541	Business - Light Industry	0.48
78 Hudson Road Warkworth 0984	Lot 1 DP 402541	Business - Light Industry	0.44
11 Sanderson Road Warkworth 0984	Lot 2 DP 375015	Future Urban	0.83
86 Hudson Road Warkworth 0984	Lot 1 DP 375015	Future Urban	0.95
Lot 3 DP 209013, Falls Road Warkworth 0984	Lot 3 DP 209013	Future Urban	2.1
Lot 2 DP 209013, Falls Road Warkworth 0984	Lot 2 DP 209013	Future Urban	2.72
215 Falls Road Warkworth 0984	Lot 1 DP 209013	Future Urban	2.22
93 Falls Road Warkworth	Lot 1 DP 336399	Future Urban	2.31
91 Falls Road Warkworth 0984	Lot 2 DP 336399	Future Urban	2.07
20 View Road Warkworth 0910	Lot 1 DP 62696	Residential - Single House / Future Urban	0.42
16 View Road Warkworth 0910	Lot 1 DP 204539	Residential - Single House / Future Urban	0.96
1 Hudson Road Warkworth 0984	Sec 3 SO 436198	Business - General Business	0.72
Sec 4 SO 476652, Hudson Road Warkworth 0984	Sec 4 SO 476652	Business - General Business / Future Urban	9.27
27 State Highway 1 Warkworth 0984	Lot 1 DP 405448	Future Urban	2.31
Pt Lot 1 DP 180823, State Highway 1 Warkworth 0984	Pt Lot 1 DP 180823, Pt Lot 2 DP 180823	Future Urban	1.25
null	Section 15 SO 495251	Future Urban	7.76
null	Section 16 SO 495251	Future Urban	0.7

3 Background and Context

The Future Urban Land Supply Strategy (FULSS), in line with the Auckland Unitary Plan, sets out Auckland Council's program to sequence future urban land to accommodate Auckland's future growth, which at 2015 was predicted at an additional 1 million people over the next 30 years. The program specifically helps to inform Council's infrastructure asset planning and management and its infrastructure funding priorities and sequencing, as well as private sector infrastructure planning and investment decisions to support development of future urban land.

Warkworth North is one of the areas programmed in the FULSS, and is currently zoned Future Urban. The FULSS states "Warkworth's growth is constrained by water and wastewater. However, some growth could occur in the north and north east of Warkworth in the shorter term". Watercare and Auckland Transport are aligned with this strategy, having actioned parts of the Strategy already in various upgrade programs. Details of some of the significant infrastructure upgrades occurring in line with the Future Urban Land Supply Strategy are summarised in the following section. The effects of these projects on the proposed development site have been accounted for, and are described in more detail later in this report.

3.1 Ara Tuhono - Puhoi to Warkworth Road of National Significance

The Ara Tūhono – Pūhoi to Wellsford road of national significance runs approximately 38 kilometres through the Rodney area north of Auckland on State Highway 1. The project aims to extend the Northern Motorway (SH1) from the Johnstone's Hill tunnels just south of Pūhoi to a point north of Wellsford. Figure 2 shows an overview of the proposed alignment.

3.2 Warkworth Western Collector

The Warkworth Western Collector project is a three-stage plan to improve road connections to the west of the state highway developed to support the future urbanisation of the Warkworth area. The new road will help alleviate pressure within the township by providing a strong north-south alternative route to the existing SH1 between the northern end of Warkworth. It will also improve access to nearby employment areas and the new residential growth areas in the west and south. The proposed alignment of the Western Collector is shown in Figure 2.

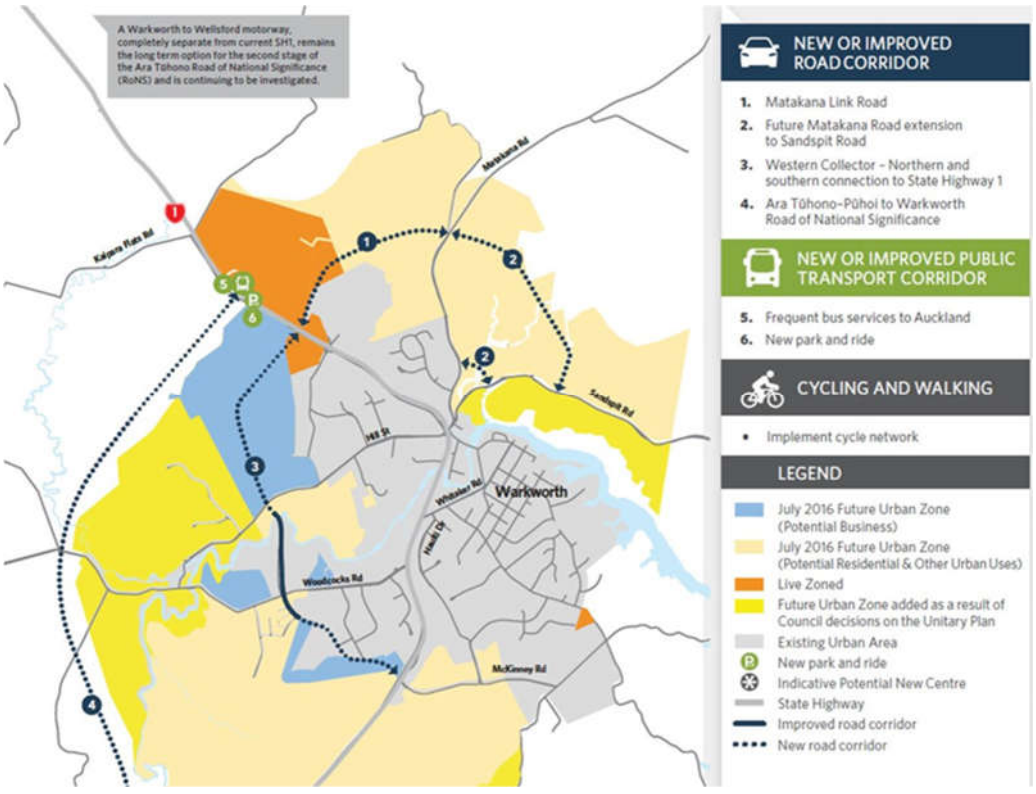

Figure 2 - Map of the transport network for Warkworth (accessed 16/03/2017)

3.3 Water Supply and Wastewater Upgrades

Existing infrastructure for the provision of water supply to the Warkworth area is currently at capacity. As a result, Watercare has a program of upgrades to augment the water supply system over the next two to five years. These include:

- Construction of Sanderson Road water treatment plant, sourcing water from groundwater bores;
- Providing new connections to View Road Reservoir;
- Network upgrade to increase capacity and improved supply to the Thompson Road Reservoir;
- Upgrade of the existing water treatment plant in Browns Road.

Similarly, Warkworth's Wastewater Treatment Plant is undersized compared to the growth area and the existing consent to discharge has expired. The wastewater network in Warkworth is close to capacity, with a mix of gravity and low-pressure systems. Watercare has a program of works for upgrading the wastewater system to handle future growth in the area which includes:

- Short term:
    - upgrade of the existing Warkworth wastewater treatment plant, permitting additional connections.
- Longer term:
    - construction of a wastewater transfer station and rising main to direct wastewater flows from Warkworth to Snells Beach Wastewater Treatment Plant
    - upgrade of existing Snells Beach WWTP by 2021.

Further detail on the proposed upgrades to the water and wastewater systems is provided later in this report.

4 Warkworth North Structure Plan

As outlined in the FULSS, for areas designated future urban, zone changes can only be made through a plan change application. To ensure the effects of development are addressed in advance of development occurring, plan changes require detailed planning to support their application, which is presented in the form of a Structure Plan.

The Warkworth North Structure Plan submission which this report forms part of, is intended to support a private plan change application to Auckland Council to provide for a change in zoning and land use to Urban zoning, with residential & business type activities within the proposed catchment. The plan change application will provide for a change in zoning to Mixed Use zoning, allowing a mix of residential and business activities.

5 Initial Development Sites

Within the area described in the Structure Plan, there are three distinct development sites, which lie on either side of Falls Road.

The following names have been given to these development sites, and will be used throughout this report:

Falls Road: approximately 50-lot subdivision, south of Falls Rd

Stubbs Farm: approximately 500-lot subdivision, north of Falls Rd including 102 Hudson Road.

Staging of these developments is proposed to be generally south to north, such that Falls Road would be developed and released in the first year, with Stubbs Farm, sequentially developed/released from south to north over the following 3 years.

Schemes have been developed for these development sites as it is intended that Resource Consent applications be submitted shortly after, and processed in parallel with, this private plan change. They have

been referred to in this report for information purposes only, primarily to demonstrate how the area can be developed.

An overview of the Structure Plan area showing these developments is shown in Figure 3 below and the areas and legal descriptions are shown in Table 2.

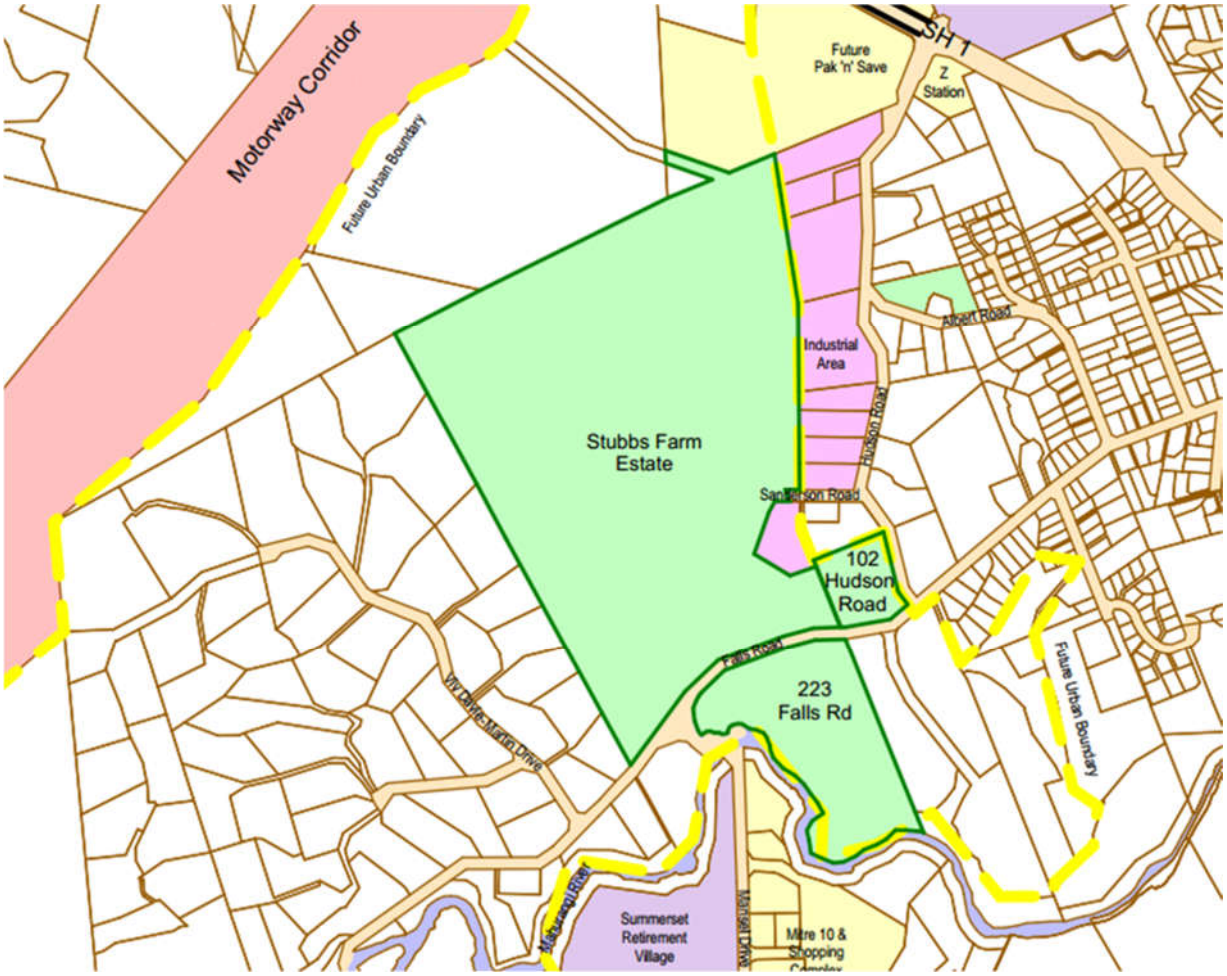

Figure 3 - Wider context plan showing proposed development sites (Buckton's)

Table 2 - Legal Descriptions within Stubbs Farm and Falls Road development sites

Address	Legal Description	Zone (Unitary Plan – Operative in part)	Area (ha)
Stubbs Farm			
Lot 18 DP 9212, Sanderson Road Warkworth 0984	Lot 18 DP 9212, Allot 96F Psh Of Mahurangi SO 3434	Future Urban	6.76
12 Sanderson Road Warkworth 0984	Pt Allot 52 Psh Of Mahurangi	Future Urban	20.46
220 Falls Road Warkworth 0984	Lot 2 DP 355193	Future Urban	15.23
102 Hudson Road			
102 Hudson Road Warkworth 0984	Lot 16 DP 9212	Future Urban	1.6
223 Falls Road			
223 Falls Road Warkworth 0984	Lot 2 DP 210933	Future Urban	9.2

6 Proposal

To support the zone changes proposed within the Structure Plan, this report investigates the civil engineering opportunities and constraints relating to the development of the existing greenfield site, currently designated Future Urban.

In line with the Auckland Unitary Plan – Operative in part, this report addresses civil engineering matters relating to the following:

- Natural resources:
    - protection, maintenance and enhancement of natural resources;
    - how the proposed subdivision, use, and development will protect, maintain and enhance the values of the natural resources;
    - The integration of green networks (such as freshwater and coastal water systems, and ecological corridors);
    - Measures to manage natural hazards and contamination
- Identifies key infrastructure requirements to support the proposed land uses and the wider community:
    - The location and protection of existing and planned infrastructure, including network infrastructure corridors.
    - The location, scale and capacity of existing and new infrastructure to serve the structure plan area.
    - The location, scale and function of stormwater management facilities based on the principles of an integrated stormwater management approach, including the retention of natural water systems and the primary use of onsite flow and quality controls (and related impervious area limits) to manage stormwater runoff from proposed sites and roads.

It should be noted that this report forms just one part of the overall Structure Plan submission being prepared by a team of various specialist consultants. The objectives set out above are not necessarily addressed in their entirety by this report. Aspects of some of these objectives will also be addressed in reports prepared by others.

7 Framework

7.1 Legislation

a) New Zealand Building Act; 2004 – Section 71 – 73

b) New Zealand Resource Management Act; 1991 – Part 4 – Section 30 - 31

7.2 Compliance and or Guidance Documents

c) Auckland Unitary Plan – Operative in Part; March 2017 – Appendix 1 – Structure Plan Guidelines

d) Auckland Unitary Plan Operative in Part

e) Future Urban Land Supply Strategy – July 2017

f) Watercare - Water and Wastewater Code of Practice for Land Development and Subdivision; May 2015

g) Auckland Council: Code of Practice for Land Development and Subdivision: Chapter 4 - Stormwater

h) ARC TP108 - Auckland Regional Council, Technical Publication 108, Guidelines for Stormwater Runoff Modelling in the Auckland Region (1999);

i) Auckland Council – Stormwater Flood Modelling Specifications; November 2011

j) Stormwater Management Devices in the Auckland Region (GD01) – Auckland Council, GD2017/001;

k) Water Sensitive Design, Volume 1: Principles (GD04) - Auckland Council, GD2013/04, 2013

l) Water Sensitive Design, Volume 2: Guidelines (GD04) - Auckland Council, GD2013/04, 2013

8 Limitations

- This assessment contains the professional opinion of Chester Consultants as to the matters set out herein, in light of the information available to it during the preparation, using its professional judgement and acting in accordance with the standard 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.
- We have prepared this report in accordance with the brief as provided and our terms of engagement. The information contained in this report has been prepared by Chester Consultants at the request of SF Estate Ltd and is exclusively for its client use and reliance. It is not possible to make a proper assessment of this assessment without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to and the assumptions made by Chester Consultants Ltd. The assessment will not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this assessment by any third party.
- The assessment is also based on information that has been provided to Chester Consultants Ltd from other sources or by other parties. The assessment has been prepared strictly on the basis that the information that has been provided is accurate, completed, and adequate. To the extent that any information is inaccurate, incomplete or inadequate, Chester Consultants Ltd takes no responsibility and disclaims all liability whatsoever for any loss or damage that results from any conclusions based on information that has been provided to Chester Consultants Ltd

SECTION B: LAND FORMATION

1 Land Formation

This section of the report briefly introduces the preliminary civil engineering design undertaken by Chester to produce bulk earthwork and roading plans to inform proposed zoning as well as scheme plan development for the Falls Road and Stubbs Farm developments. The reason these plans are included in this report is to demonstrate that development within the Structure Plan area can be undertaken whilst working with the existing topography.

Urban design reports addressing the fundamental design principles that have been adopted to protect, maintain and enhance the natural environment have been completed by other and are included as part of the wider structure plan application. The main civil input feed to the urban design was to keep roads as parallel as possible to contours to enable terracing of building platforms up slopes and minimise steep roads. Additionally, guidance was provided to ensure schemes minimised stream crossings and enabled tying into green spaces whilst providing developable sites.

In regards to zoning, our opinion is that the majority of the higher steep land in the west of the structure plan area is more conducive to residential type development as opposed to light industrial uses. There is opportunity for light industrial or business uses in the east and north eastern portions of the structure plan area.

Figure 4 below is an extract from the "Proposed Site Plan – Overview" in Appendix B. The indicated sheets and a Cut and Fill plan are also included in Appendix B. A summary of the estimated earthworks quantities, retained heights and road gradients required to realise the development is on the following page.

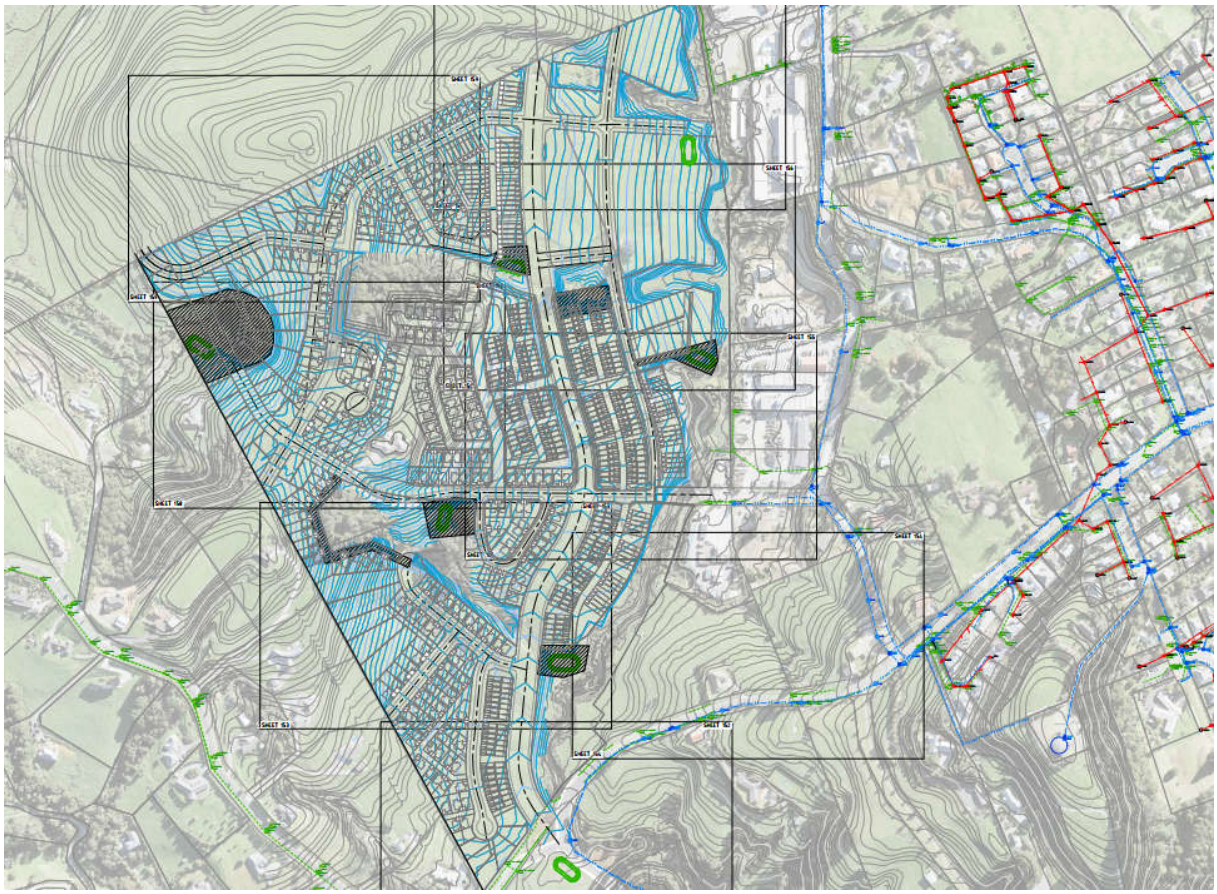

Figure 4 - Stubbs Farm - Preliminary Civil Engineering Design, Proposed Site Plan Overview

1.1 Earthworks - Cut & Fill

Bulk earthworks will be required over the Stubbs Farm and Falls Road Sites as well as throughout other areas in the structure plan area to create land suitable for development. In general, earthworks will mainly involve cutting off knolls and filling gullies in order to from road corridors and create uniform

slopes within development schemes. Some of the lower lying areas particularly in the northern portion of the structure plan area will need filling to lift ground levels above flooding hazards.

Within the Stubbs Farm and Falls Road developments this can be achieved with balanced earthworks. In general, the way this would be achieved whilst allowing for uncertainties such as unsuitable material being discovered is by completing the earthworks in stages. The sites will be broken into balanced stages with the lower areas worked first as they have highest risk of encountering unsuitable material. Stage by stage fill can be borrowed from the next stage to insure each stage is balanced. As the job progresses and uncertainty is reduced design levels for the higher areas in the last stage can be adjusted to balance the earthworks over the entire site. The following outlines the current bulk earthwork estimates based on the plans attached in appendix B;

Balanced Cut to Fill Volume: 410,000m3

Max Cut Depth: 7.5m

Max Fill Depth: 9.5m

Note; the numbers above have been produced from design only intended to inform scheme development and are not proposed as final. Actual earthwork volumes will be determined at resource consent.

1.2 Retaining

Retaining will be required throughout schemes in order to achieve level changes necessary to construct buildings and roads. In many cases such level changes would be incorporated into house designs considering both architectural and urban design principles. Actual retaining required to enable the subdivisions will be determined at resource consent. Figure 5 below is an example of how a 3m height difference could be achieved by a subdivision wall.

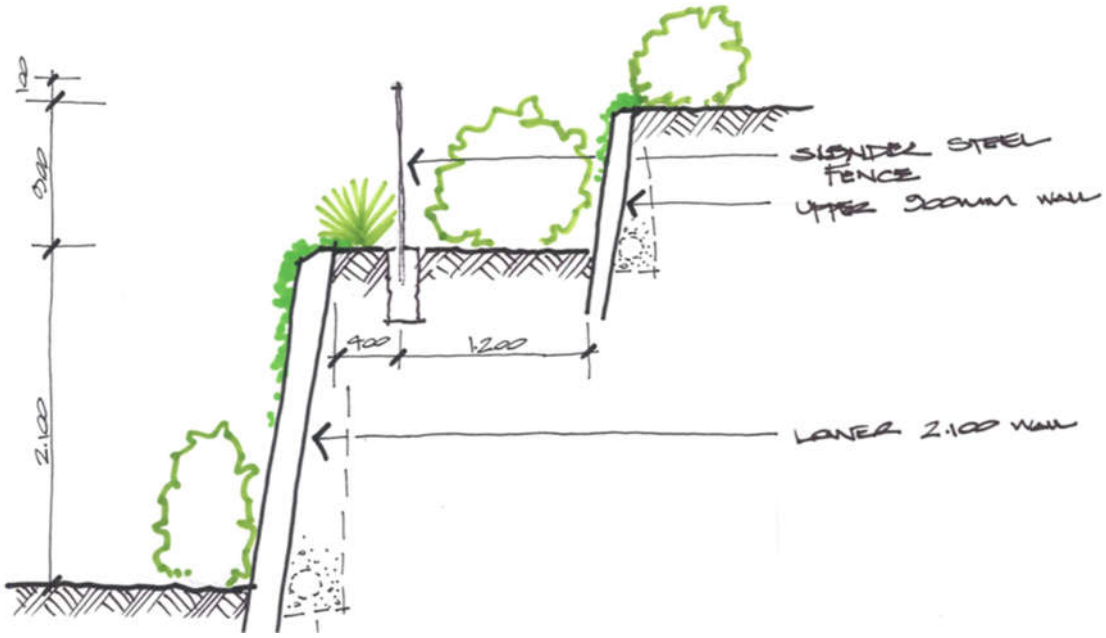

Figure 5 - Example of retaining for 3m level change (Littoralis Landscape Ahchitecture)

1.3 Road Gradients

The vertical geometry of roads is the main factor that influences earthworks when trying to work with existing topography. To develop the plans in appendix B we used the following parameters for road gradients;

Minimum Grade: 1%

Maximum Grade: 12.5%

Over the Falls Road and Stubbs Farm developments there will be circa 4.7km of road constructed at grades between 1-12.5%.

SECTION C: STORMWATER CATCHMENT MANAGEMENT PLAN

1 Purpose

This section of the report contains a Stormwater Catchment Management Plan (SWCMP) for the proposed Warkworth North Structure Plan area. It defines the existing stormwater context of the structure plan area and proposes an integrated stormwater management approach to suit the structure plan area. Figure 6 below provides an indicative plan of how the Stormwater Management Plan would be applied to sub-precinct A (Stubbs Farm Development Area).

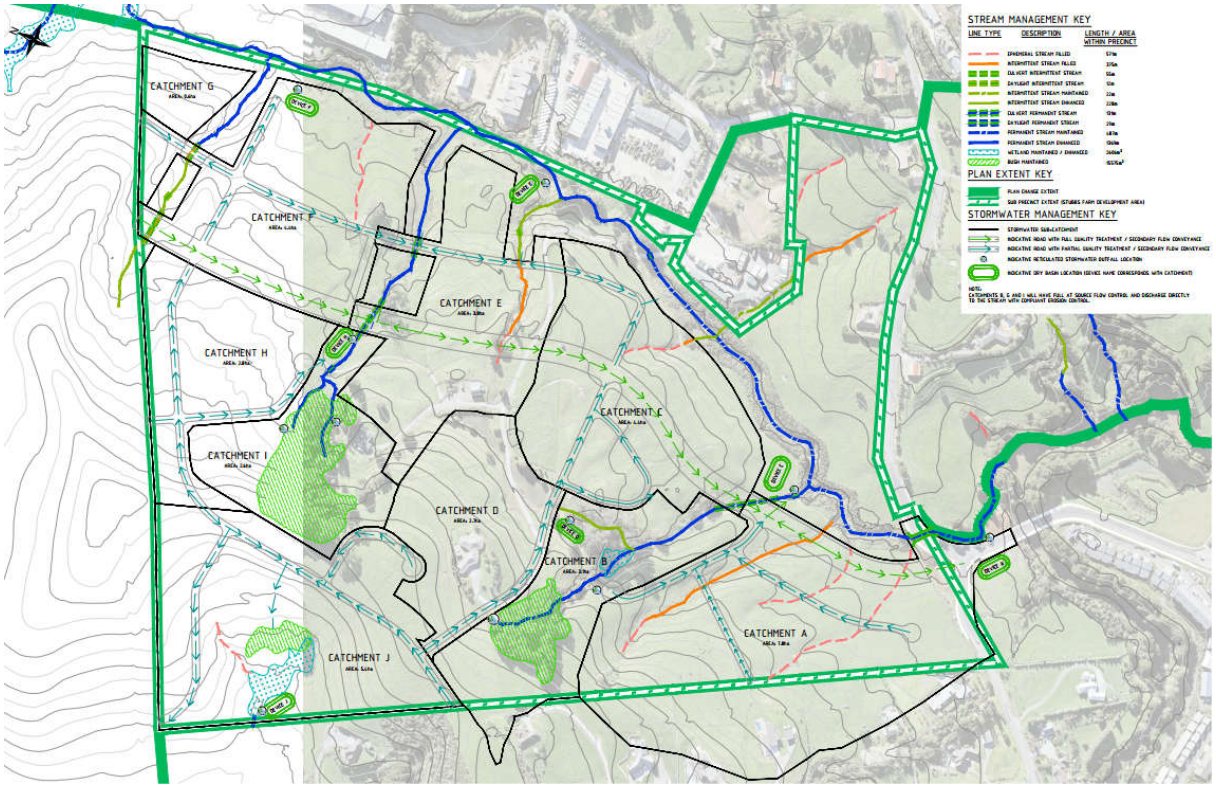

Figure 6 - Stormwater Management Plan Example – Sub-precinct A – Stubbs Farm Development

2 Catchment Definition

The proposed Structure Plan will change the catchment characteristics and constraints for the future development from the existing land use.

2.1 Catchment Location

The Warkworth North Structure Plan is located within the lower third of the Mahurangi River Catchment which has a total contributing catchment of approximately 4862 ha. The structure plan area is approximately 119 ha making up 2.5% of the total Mahurangi River Catchment. The structure plan area is bounded by the Mahurangi river to the south with an unnamed tributary of the Mahurangi River running north to south through the structure plan area. Other than the Mahurangi River this unnamed tributary is the main hydrologic feature within the catchment and in this report, is referred to as the Stubbs Stream. The entire structure plan area except land that is south of Falls Road is located within sub catchments that contribute to this stream. The land south of Falls Road is all within smaller sub catchments that discharge directly to the Mahurangi River. Figure 7 on the following page shows the structure plan area in relation to the wider Mahurangi River Catchment. Figure 8 & Figure 9 are enlargements of the structure plan area showing the smaller sub catchments and Figure 10 shows the Plan Change and Precinct extents.

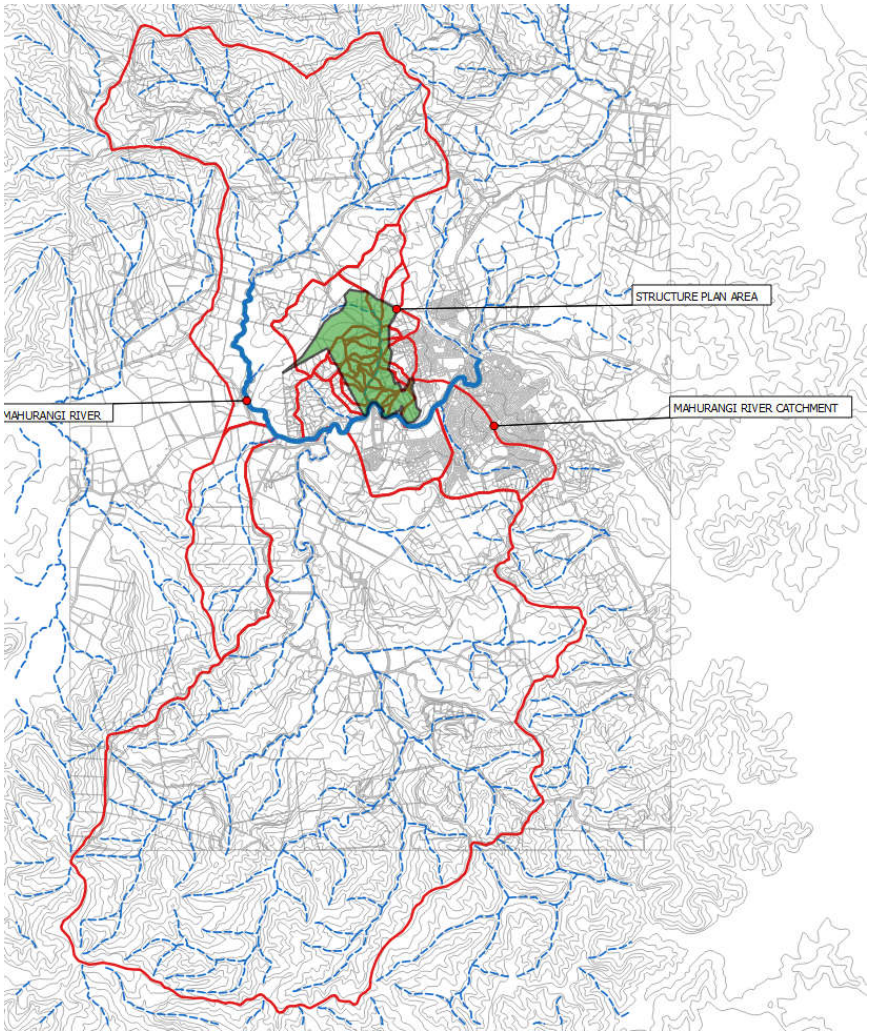

Figure 7 - Maurangi River Catchment and Structure Plan Extent

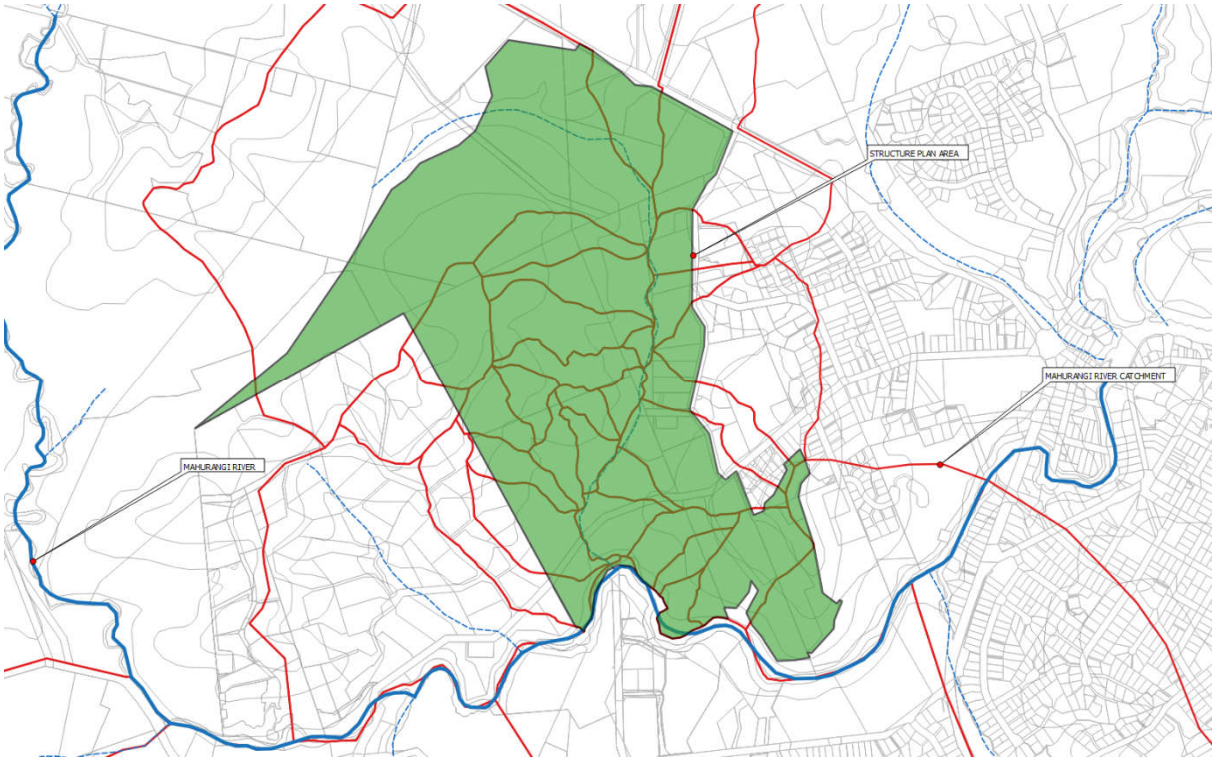

Figure 8 - Structure Plan Extent in Relation to Sub-catchments

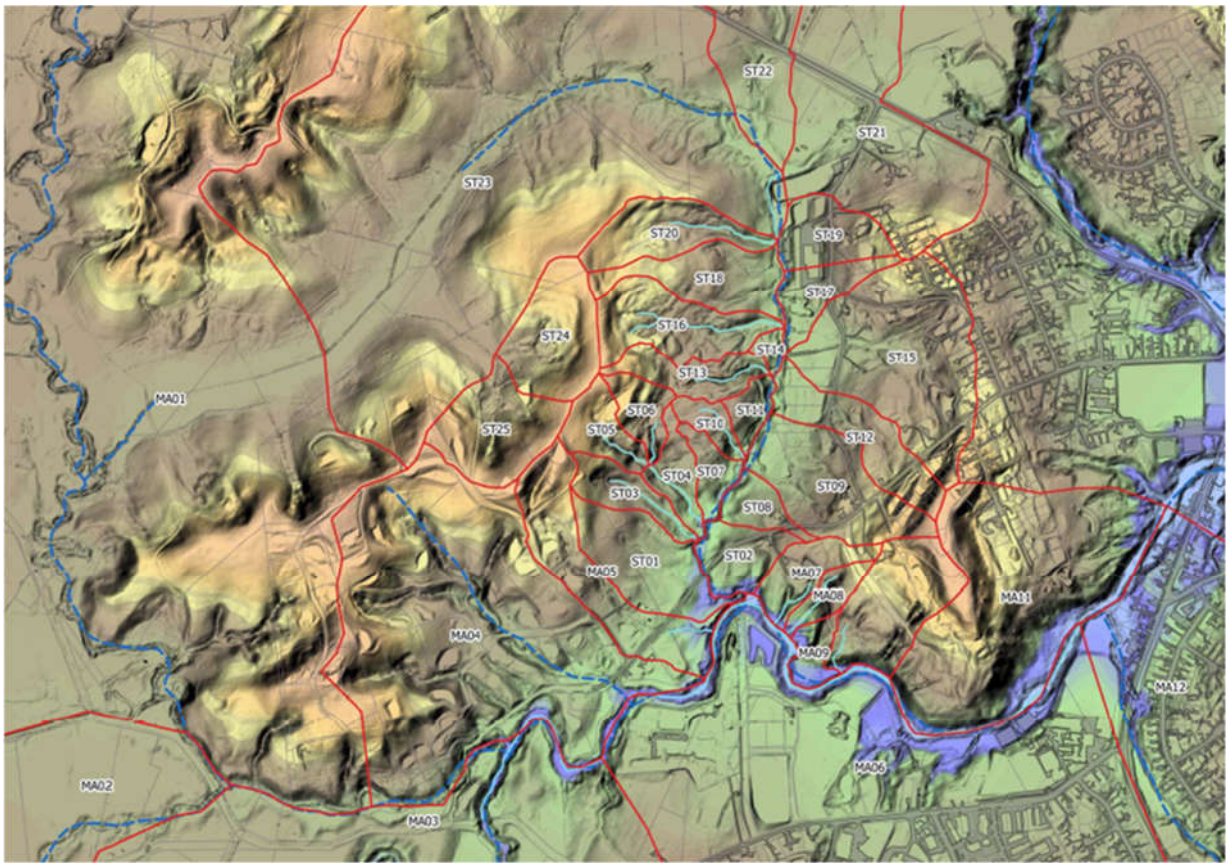

Figure 9 - Warkworth North Structure Plan Area Sub Catchments

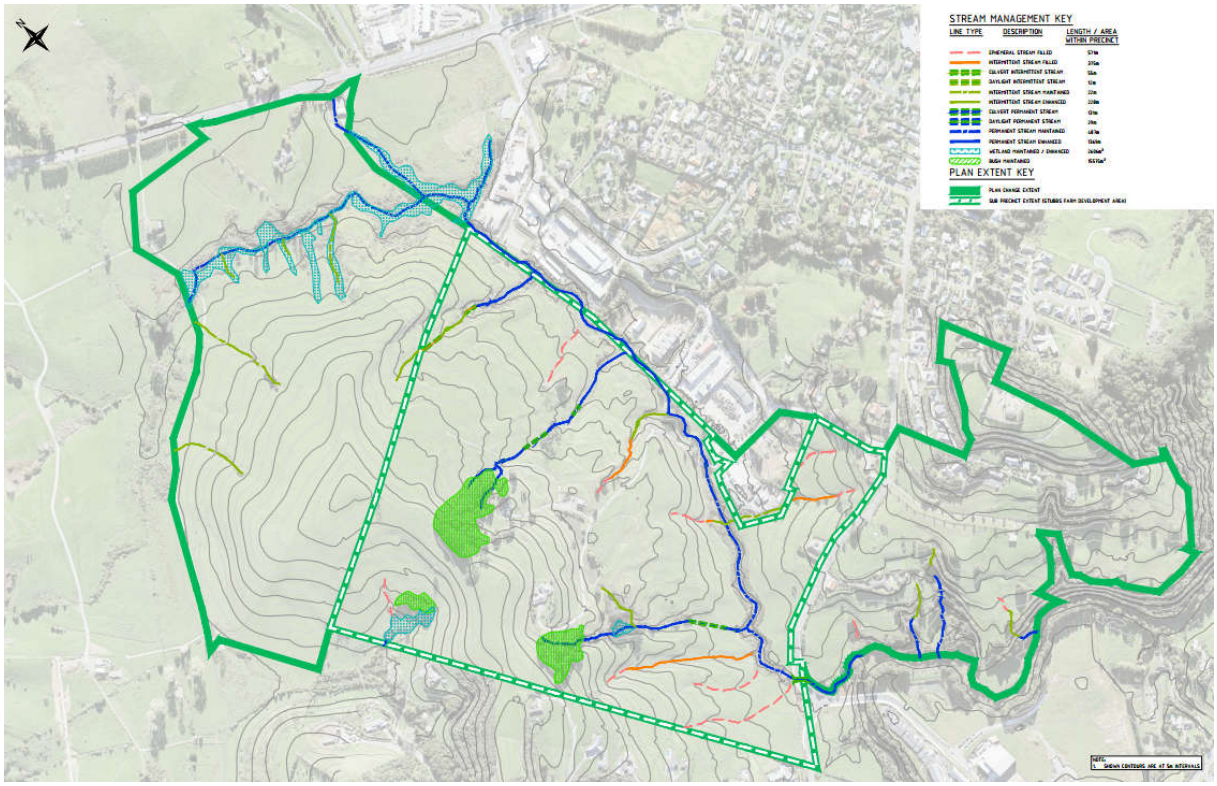

Figure 10 - Warkworth North Structure Plan Area and Precinct Plan Extents

2.2 Land Cover and Topography

The land cover within the catchment is predominantly undeveloped farmland containing numerous existing dwellings with the exception of a small industrial area off Hudson Road within the east of the catchment. The topography of the area varies throughout.

The area south of Falls Road is generally steep with short gullies falling down to the Mahurangi River.

The area north of Falls Road has the Stubbs Stream meandering up its eastern third until it exits the Stubbs Farm Estate. From here the stream veers west around the top the structure plan area ending in the future motorway corridor. The terrain within the Stubbs Farm Estate and Hudson Road Industrial Area rises steeply in either direction from the stream towards hills along the structure plan areas western boundary and Hudson Road. Several ridges project down from these hills towards the stream delineating the area into a number of small sub-catchments. Gullies within these sub-catchments convey flow towards the main stream via a variety of permanent and intermittent streams and overland flow paths.

The land in the northern portion of the structure plan area, west of the Stubbs Stream, falls at a generally moderate slope towards the stream from a knoll located adjacent to the central north boundary of Stubbs Farm Estate. The area east of Stubbs Stream extending to State Highway 1 is relatively flat with undulating wetlands and numerous overland flow paths.

Along the Stubbs Stream there are two existing hydrologic structures; one is the Falls Road bridge approximately 80m north of the junction with the Mahurangi River. The second is a culvert located at the end of Sanderson Road

Figure 11 below is an aerial photograph of the structure plan area. Figure 12 on the following page is a screen shot from GIS of existing overland flow paths within the Warkworth North Structure Plan Catchment as defined by Auckland Councils Rapid Flood Hazard Mapping (FHM). On the following pages Figure 13 to Figure 19 are images showing some of the areas significant topographical and hydrologic features/structures within the area.

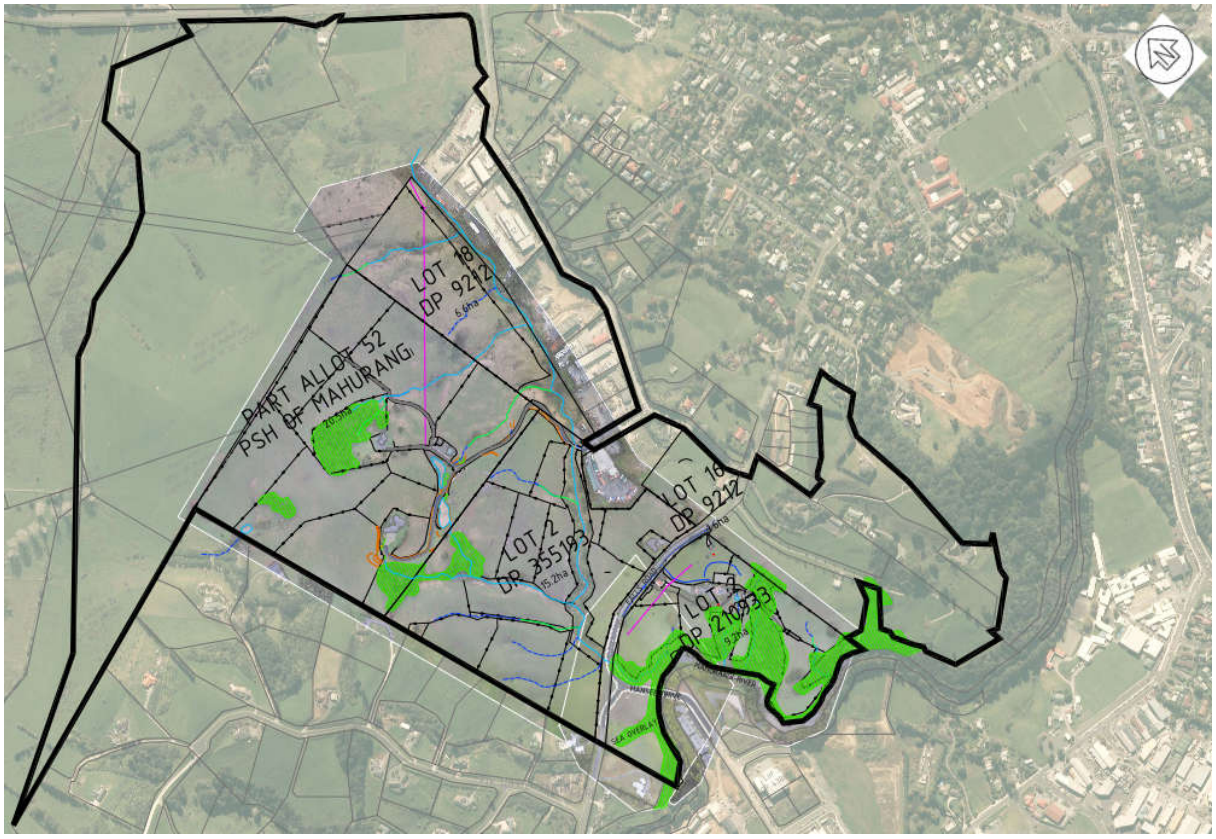

Figure 11: Aerial of Structure Plan Area

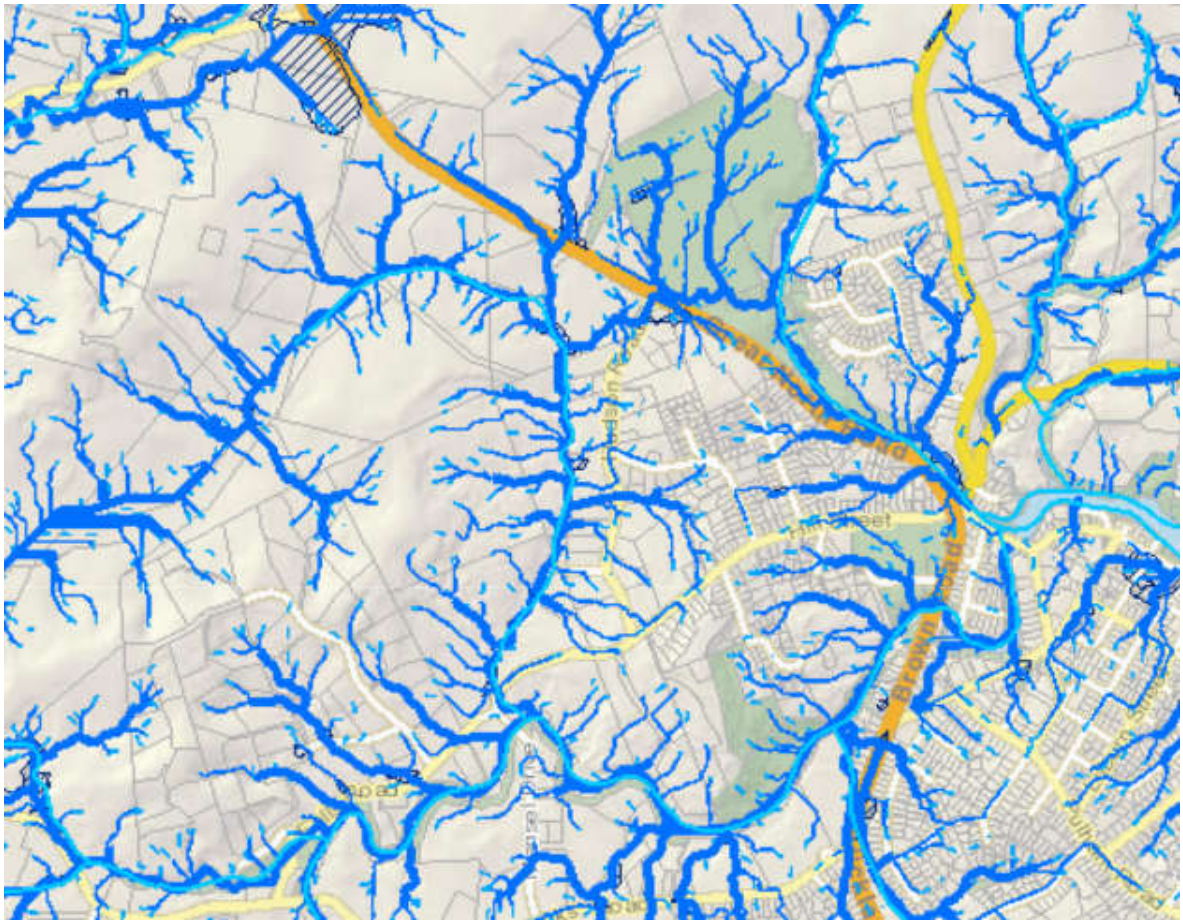

Figure 12 - Warkworth North Structure Plan overland flows (Accessed 14/10/2017)

Figure 13 – Falls Road Bridge (Taken by J Curtis 14.01.2017)

Figure 14 – Stream upstream of Falls Road Bridge (Taken by J Curtis 14.01.2017)

Figure 15 – Culvert at the end of Sanderson Road (Taken by J Curtis 14.01.2017)

Figure 16 – Gully looking west towards top of Stubbs Farm Estate (Taken by J Curtis 14.01.2017)

Figure 17 – Catchment above Stubbs Farm Estate looking West (Taken by J Curtis 14.01.2017)

Figure 18 – Looking north across Stubbs Farm Estate (Taken by J Curtis 14.01.2017)

Figure 19 - Image looking east across stream towards industrial lots on Hudson Road (Taken by J Curtis 14.01.2017)

2.3 Receiving Environment

An Ecological Assessment has been completed by Bioresearches for the Structure Plan Area. A summary of findings from this report in the context of this SWCMP is as follows.

The entire catchment discharges either to the Mahurangi River or to the Stubbs Stream via multiple smaller watercourses. The condition of these watercourses varies throughout the catchment. In some cases, they have high ecological value with well-defined channels and native tree cover and in others they are not well-defined and predominantly vegetated with exotic pasture and pest plants.

Additionally, The Mahurangi River and estuary has been defined by the Auckland Unitary Plan as a Significant Ecological Area - Marine 2 (SEA-M2). SEA-M2 areas are of regional, national or international significance which do not warrant a SEA-M1 identification as they are generally more robust.

Figure 20 below shows the SEA overlay. Figure 21 to Figure 23 on the following page are extracts from the report by Bioresearches identifying/classifying watercourses throughout the catchment and identifying areas for protection and enhancement.

Figure 20: Significant Ecological Area (SEA) Overlay (Auckland Council GEO Maps, Accessed 24.03.2017)

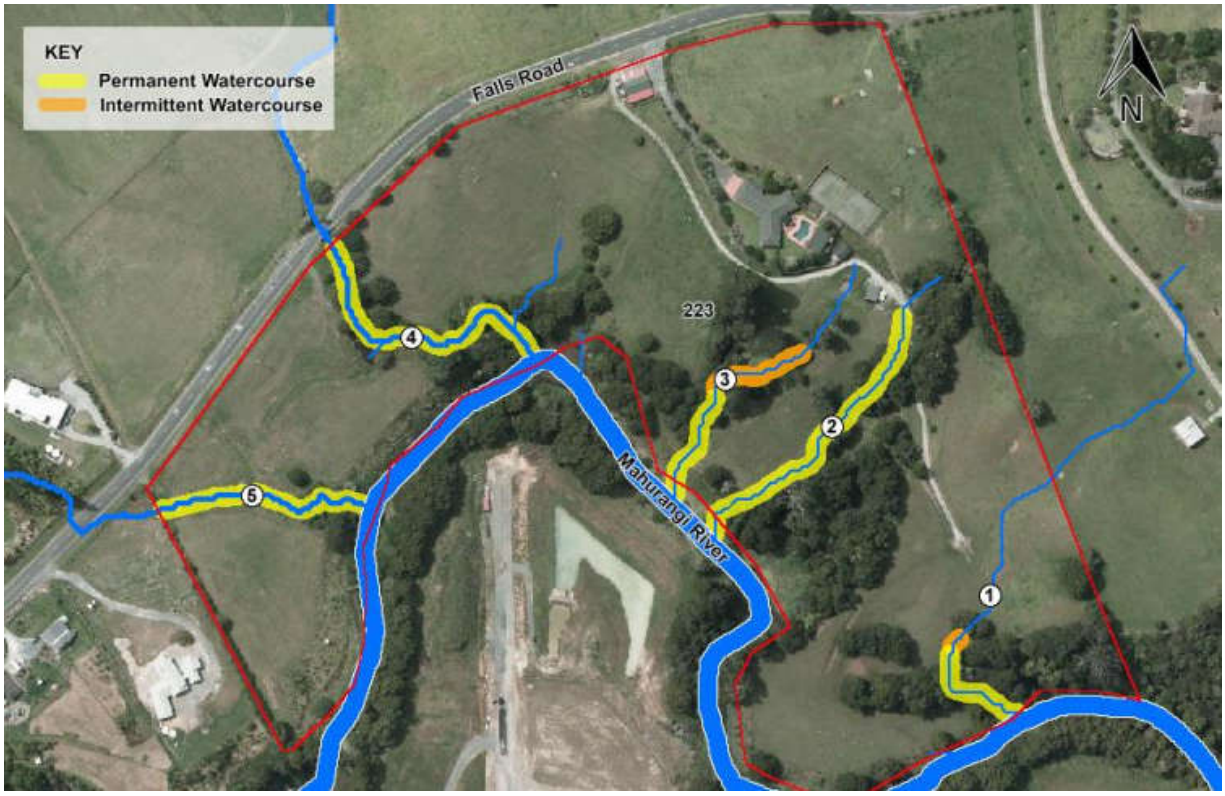

Figure 21: Watercourse Classifications within 223 Falls Road (Bioresearches 2017)

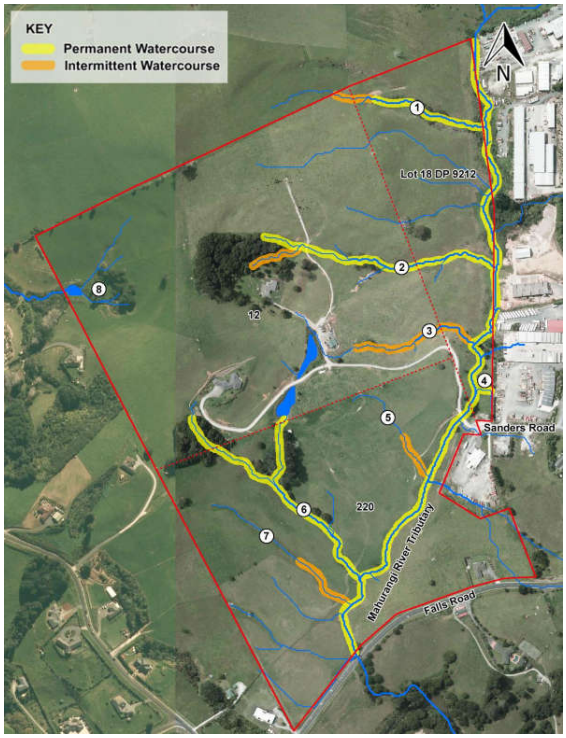

Figure 22: Watercourse Classifications within Stubbs Farm (Bioresearches 2017)

Figure 23 - Recommended Areas for vegetation riparian restoration / protection within catchment (Bioresearches 2017)

2.4 Geology

A Geotechnical Engineering Feasibility Assessment for the structure plan area has been completed by KGA Geotechnical which is included as part of the structure plan documentation. The following is an extract from the report by KGA regarding storm water soakage;

"The underlying allochthonous, alluvial, colluvial and residual soils over the subject area generally comprise silts and clays with a low permeability rate, and groundwater levels have been noted to be relatively high where recorded. Based on this, stormwater retention by ground recharge is not recommended from a geotechnical perspective. Site specific soakage assessments are to be carried out to confirm soakage capabilities of the different materials".

For further geotechnical information, refer to the report completed by KGA.

3 Future Development

The proposed Warkworth North Structure Plan provides for a change in land use from the existing future urban to a mixed use of residential status and general business.

The proposed catchment boundaries have been considered based on a fully developed scenario and envisages certain land uses, defined within the Auckland Unitary Plan within each sub catchment. The proposed zoning within the Structure Plan is shown on the proposed zoning plan completed by Chester Consultants Ltd attached in the appendix.

The land uses, with the corresponding impervious coverage (i.e. road pavement, roof areas and other impervious surfaces) proposed and allowed for under the Auckland Unitary Plan are summarised in Table 3 below.

Table 3 - Proposed Land Use and Impervious Area

Zone	Maximum impervious Coverage
Residential - Single House Zone	60%
Residential – Mixed Housing Urban Zone	60%
Business – Local Centre & General Business Zones	80%

4 Natural Hazards – Flooding

This section of the SWCMP outlines the flood model study we conducted for the structure plan catchment to evaluate its suitability for the proposed plan change in relation to the natural hazard; flooding. Section 4.1 below contains an overview of the flood modelling used. The following section, Section 4.2 contains our summary and recommendations in relation to the potential flooding risk.

4.1 Flood Modelling Study

In this section of the report, model input data and results are presented for both the 10%AEP and 1%AEP events, existing and future development scenarios. Please note that the model was primarily built to estimate the existing flooding risk within the catchment and then was used/re-run to assess the effects of the proposed land use change in the catchment. As such, this section of the report focuses on the flooding risk associated with the proposed land use. For information attaining to the estimated effects from the land use change and our recommendations for stormwater controls please refer subsequent sections of this report.

4.1.1 Auckland Council Flood Mapping

Auckland Council have now completed an extensive flood model study for the entire Mahurangi River Catchment which includes the proposed structure plan area.

At the time of preparing this assessment the Auckland Council study was not completed but we met with Auckland Council representatives Ken Tomkins and Nicholas Vigar on the 24/01/2017 to discuss this modelling and other stormwater issues relating to the structure plan catchment. In this meeting, it was confirmed that modelling is being completed by Auckland Council but it would not be complete in time for

this structure plan change application. Preliminary draft results from the modelling were provided to us, however, it was made explicit that the results were draft only and were not to be relied upon or referred to at this time. Subsequently we have undertaken our own first principle modelling to verify the preliminary results provided and have referred to them in this SWCMP, the following sections outline this modelling.

Chester's model results have been discussed with Ken Tomkins and Kevin Fan of Healthy Waters and it was accepted that the outputs were comparable with Council's Mahurangi Catchment model.

Chester confirms that the applicant is willing to adopt the results and outputs of the Mahurangi Catchment modelling completed by Auckland Council in 2017 (flood extents, modelled peak flows etc.) for subsequent design and consenting purposes.

The change in model basis does not in our opinion change the findings and or recommendations of this document.

4.1.2 Model Build Summary

4.1.2.1 Site & Catchment Walkover

Chester conducted a site and catchment walkover / assessment on 14th January 2017 to assess the potential for stream flows and overland flows throughout the catchment as indicated by the Auckland Council GIS (refer to Figure 12 on page 22).

4.1.2.2 Software & Guidance

A one-dimensional model of the development site has been built utilising HEC-HMS and HEC-RAS in combination with AutoCAD Civil3D in accordance with the Auckland Council Stormwater Flood Modelling Specifications.

4.1.2.3 Topography Data

Survey data provided by Buckton Consulting Surveyors Ltd was used as the basis of the terrain model within the development site boundary. Outside of the site boundaries contour information obtained from Auckland Council GIS and Lidar Data obtained from LINZ was utilised to build the wider terrain.

4.1.2.4 Modelled Rainfall Inputs

NIWA's high intensity rainfall design system has been used to estimate the rainfall intensity during all modelled 24-hour storm events. A 24-hour rainfall hyetograph has been generated using the factors provided in the Auckland Council – Stormwater Flood Modelling Specifications.

A 2.1°C temperature increase has been factored into the rainfall intensity to allow for climate change effects in accordance with the Auckland Council Code of Practice for Land Development and Subdivision – Stormwater (Version 1.0, 1 October 2013).

4.1.3 Catchment Hydrology & Peak Flows

4.1.3.1 Catchment Delineation

Flooding through the structure plan area has been considered in terms of flows through; defined over land flow paths and channels, the Stubbs Stream channel, and the section of the Mahurangi River at the southern extent of the structure plan area.

For the purposes of this assessment the catchment contributing to the Stubbs Stream has been defined as the Stubbs Farm Catchment with a total contributing area of 250 ha. The much larger catchment contributing to the Mahurangi River has been defined as the Mahurangi Catchment with a total contributing area of 4612 ha.

The Stubbs Farm Catchment has been delineated into 25 smaller sub-catchments, while the Mahurangi Catchment has been delineated into 12 sub-catchments. The sub-catchment delineation is shown in Figure 24 on the following page, for further details regarding catchment delineation please refer to drawing 900 attached in Appendix C of this report.

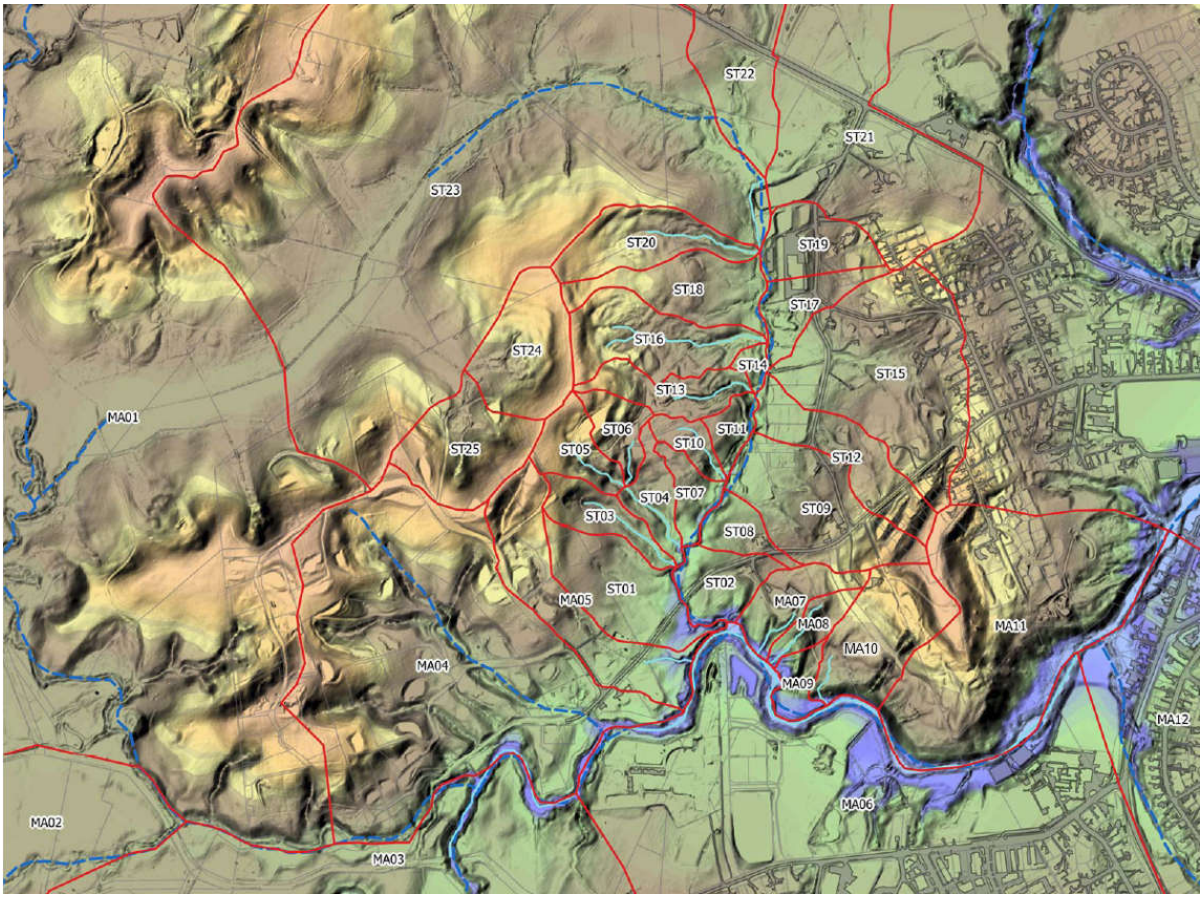

Figure 24 - Sub-catchment delineation (Drawn: J Curtis accessed 03.08.2017)

4.1.3.2 Catchment Run-off Parameters

The SCS curve number method has been utilised to estimate direct runoff and infiltration rates from each sub-catchment during all modelled storm events.

The Auckland Council TP108 method has been utilised to calculate a time of concentration for each sub-catchment.

In the pre-development state the sub-catchments surrounding the development site are characterised as primarily grazing farmland and forestry blocks with small areas of sub-urban residential and light industrial. The land use for each sub-catchment was broken into impervious areas, forested areas, urban lawn areas and pasture areas. Impervious areas were attributed an SCS curve number of 98. A composite curve number for the pervious areas within each sub-catchment were calculated using the curve numbers given in Table 4 below.

Table 4 - SCS Curve Numbers

Land Use	SCS Curve Number
Forested	70
Urban Lawn	79
Pasture	74
Impervious	98

4.1.3.3 Hydrological Model Summary

HEC-HMS was used in accordance TP108 to estimate the peak flow from each sub-catchment. A summary of the hydrological model inputs for the modelled scenarios are included in Table 5 below, for further details and results from other modelled scenarios please refer to the Hydrological Model Summary in Appendix C.

Table 5 - Hydrological Model Summary

CATCH_ID	Area (ha)	Length (m)	Slope (m/m)	CN_Imp	CN_Perv	TC_IMP (min)	TC_PERV (min)	ED Imp Area (ha)	ED Perv Area (ha)	MPD Imp Area (ha)	MPD Perv Area (ha)
MA01	1134.0	9600	0.005	98	72.2	153.8	205.9	56.7	1077.3	56.7	1077.3
MA02	218.1	3700	0.012	98	73.3	61.7	81.5	10.9	207.2	10.9	207.2
MA03	2944.6	10800	0.010	98	71.7	130.9	176.3	147.2	2797.3	147.2	2797.3
MA04	41.3	900	0.044	98	74.0	16.4	21.5	4.1	37.1	4.1	37.1
MA05	7.8	760	0.079	98	74.2	12.3	16.1	0.8	7.0	0.8	7.0
MA06	106.6	1080	0.041	98	78.1	18.9	23.5	63.9	42.6	63.9	42.6
MA07	2.8	340	0.148	98	73.3	10	10	0.1	2.7	0.1	2.7
MA08	1.5	300	0.151	98	72.6	10	10	0.1	1.4	0.1	1.4
MA09	1.4	220	0.134	98	72.2	10	10	0.1	1.4	0.1	1.4
MA10	6.5	360	0.225	98	73.2	10	10	0.3	6.2	0.3	6.2
MA11	23.8	480	0.161	98	72.6	10	10	3.6	20.3	3.6	20.3
MA12	123.6	2000	0.033	98	77.0	30.3	38.3	61.8	61.8	61.8	61.8
ST01	6.1	560	0.068	98	74.0	10.5	13.7	0.3	5.8	4.0	2.1
ST02	3.0	220	0.159	98	74.0	10	10	0.3	2.7	2.0	1.1
ST03	2.6	360	0.098	98	73.9	10	10	0.1	2.4	1.7	0.9
ST04	2.1	200	0.063	98	73.8	10	10	0.1	2.0	1.4	0.7
ST05	2.6	300	0.163	98	73.0	10	10	0.1	2.5	1.7	0.9
ST06	2.0	280	0.146	98	73.6	10	10	0.1	1.9	1.3	0.7
ST07	1.7	220	0.124	98	74.0	10	10	0.1	1.6	1.1	0.6
ST08	1.8	260	0.126	98	74.0	10	10	0.1	1.7	1.2	0.6
ST09	7.9	500	0.114	98	74.0	10	10.9	2.4	5.5	5.1	2.8
ST10	1.3	220	0.137	98	74.0	10	10	0.1	1.2	0.9	0.5
ST11	1.3	120	0.208	98	74.0	10	10	0.1	1.2	0.9	0.5
ST12	5.0	480	0.085	98	74.0	10	11.6	3.0	2.0	3.3	1.8
ST13	3.0	460	0.102	98	74.0	10	10.7	0.2	2.9	2.0	1.1
ST14	0.6	100	0.117	98	74.0	10	10	0.0	0.5	0.4	0.2
ST15	14.8	560	0.052	98	79.0	11.4	14.1	8.9	5.9	9.6	5.2
ST16	5.9	480	0.078	98	73.2	10	12	0.3	5.6	3.8	2.1
ST17	2.693	300	0.110	98	79.0	10	10	1.6	1.1	1.8	0.9
ST18	4.9	480	0.101	98	74.0	10	11.1	0.2	4.7	3.2	1.7
ST19	3.568	300	0.123	98	79.0	10	10	2.1	1.4	2.3	1.2
ST20	4.6	500	0.090	98	74.0	10	11.7	0.2	4.4	3.0	1.6

4.1.3.4 Reach Routing - Lag Times

The sub-catchments were grouped at junctions and linked with reaches, in order to estimate the flows at points of interest within the development site and the Mahurangi River. A schematic of the HEC-HMS hydrological model is given in Figure 25 below.

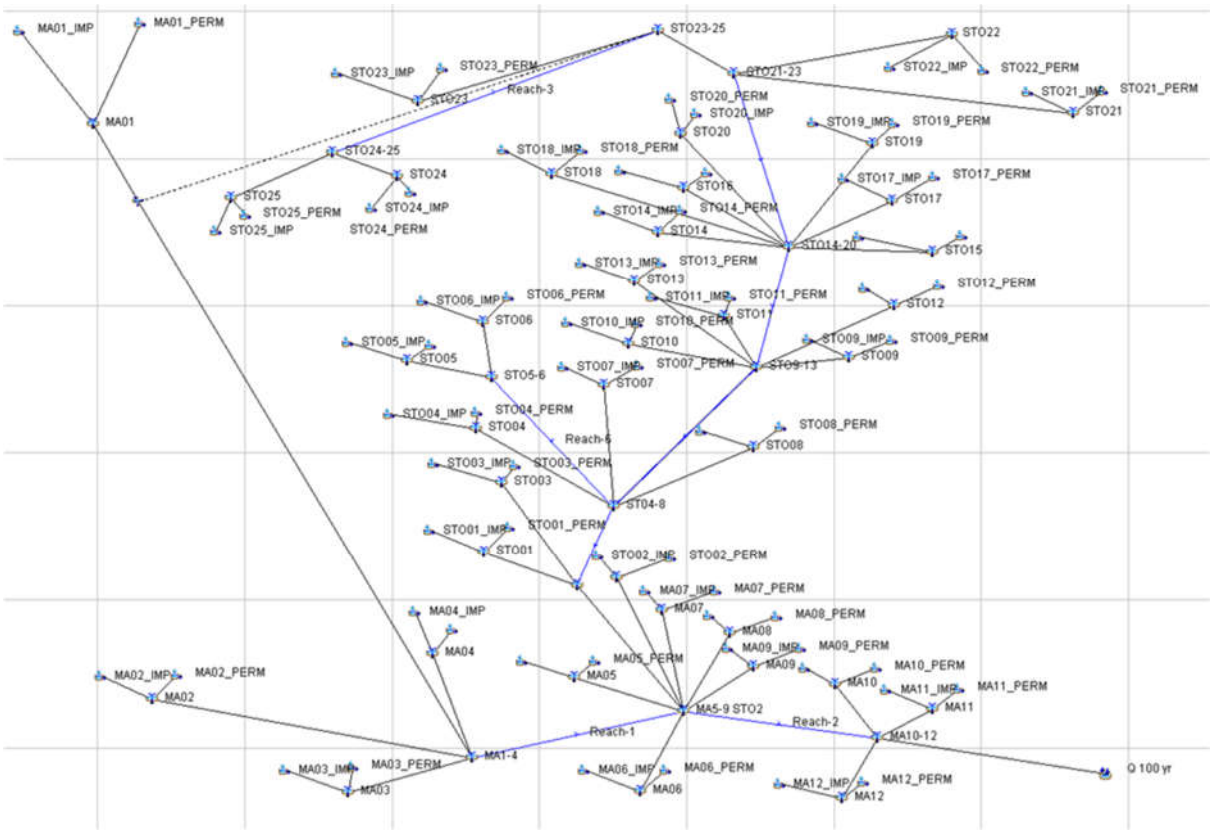

Figure 25 - HEC-HMS model schematic

A preliminary hydrologic model was built utilising HEC-RAS in order to estimate the channel velocities and subsequently refine the reach lag times in the hydrological model.

4.1.3.5 Catchment Interaction and Flow Diversion

Preliminary model results from Auckland Council's flood hazard mapping exercise for the Mahurangi River catchment highlighted significant interactions between the Mahurangi River Catchment and the Stubbs Farm Catchment. Most notably, it is expected that during extreme rain events the western branch of the Mahurangi River will spill east into the low-lying flood plain area indicated in Figure 26 on the following page. The increased head water level in the flood plain has the effect of driving flood waters further east diverting flows from the Mahurangi River Catchment into the Stubbs Farm Catchment. This amounts to a significant increase in peak flowrates through the development site from outside of the catchment.

Complete results from Auckland Council's flood hazard mapping were not available at the time of this initial report, subsequently Chester undertook a first principle assessment to quantify the peak flow diverted into the head of the Stubbs Farm Catchment.

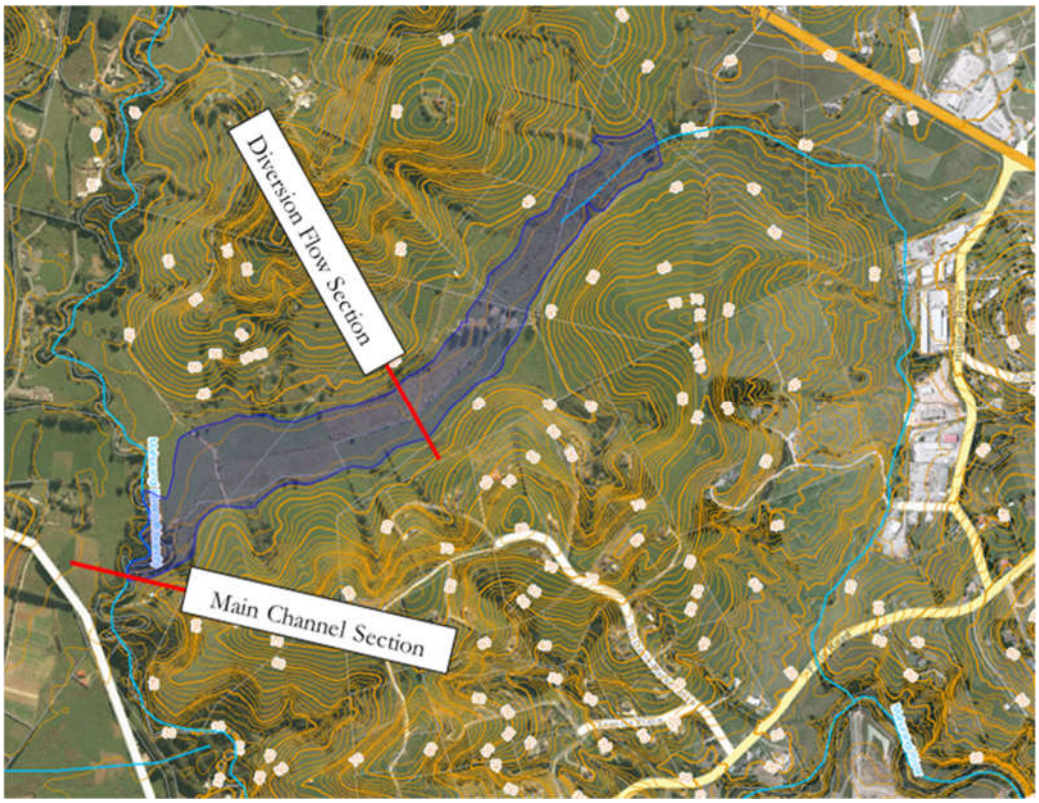

Figure 26 - Flood plain interaction area (Auckland Council GIS Accessed: J Curtis accessed 09.03.2017)

Lidar data obtained from LINZ was analysed to determine the location of the saddle point between the Mahurangi River Catchment and the Stubbs Farm catchment. A section through this location was extracted from the terrain and analysed using Manning's open channel flow equations to establish a discharge / head water elevation relationship for the saddle point. The same process was undertaken for a representative section of the Mahurangi River at a location adjacent to the floodplain.

Utilising the two discharge / head water elevation curves a relationship between flow in the Mahurangi River and flow diverted to the Stubbs Farm Stream was established refer Table 6.

The relationship was then input back into the HEC-HMS hydrological model as an inflow function-controlled diversion.

Table 6 - Mahurangi River and Diversion flow relationship

Elevation* RL (m)	Main Channel Flow (m^3/s)	Diversion Flow (m^3/s)
31.5	0	0
33	7	0
33.5	13.5	1.5
34	19	4.3
34.3	31.5	12.5
34.5	45.5	18.5
34.8	76.5	34
35	105	47.5
35.09	121.01	55

*Elevations given are in NZ2009 Vertical Datum

4.1.4 Hydrology – Modelled Flood Flow Extent

4.1.4.1 Hydrology Model Build Summary

Using Hec-Ras in combination with Autocad Civil 3D we have modelled the flood flow throughout the structure plan area to estimate its extents and the associated flood levels. The Stubbs Farm catchment has been modelled including the Stubbs Stream channel and 13 minor reaches. We also modelled the section of the Mahurangi River along the southern extent of the structure plan area. The model uses a mixed flow regime. The model schematisation is shown in Figure 27 below.

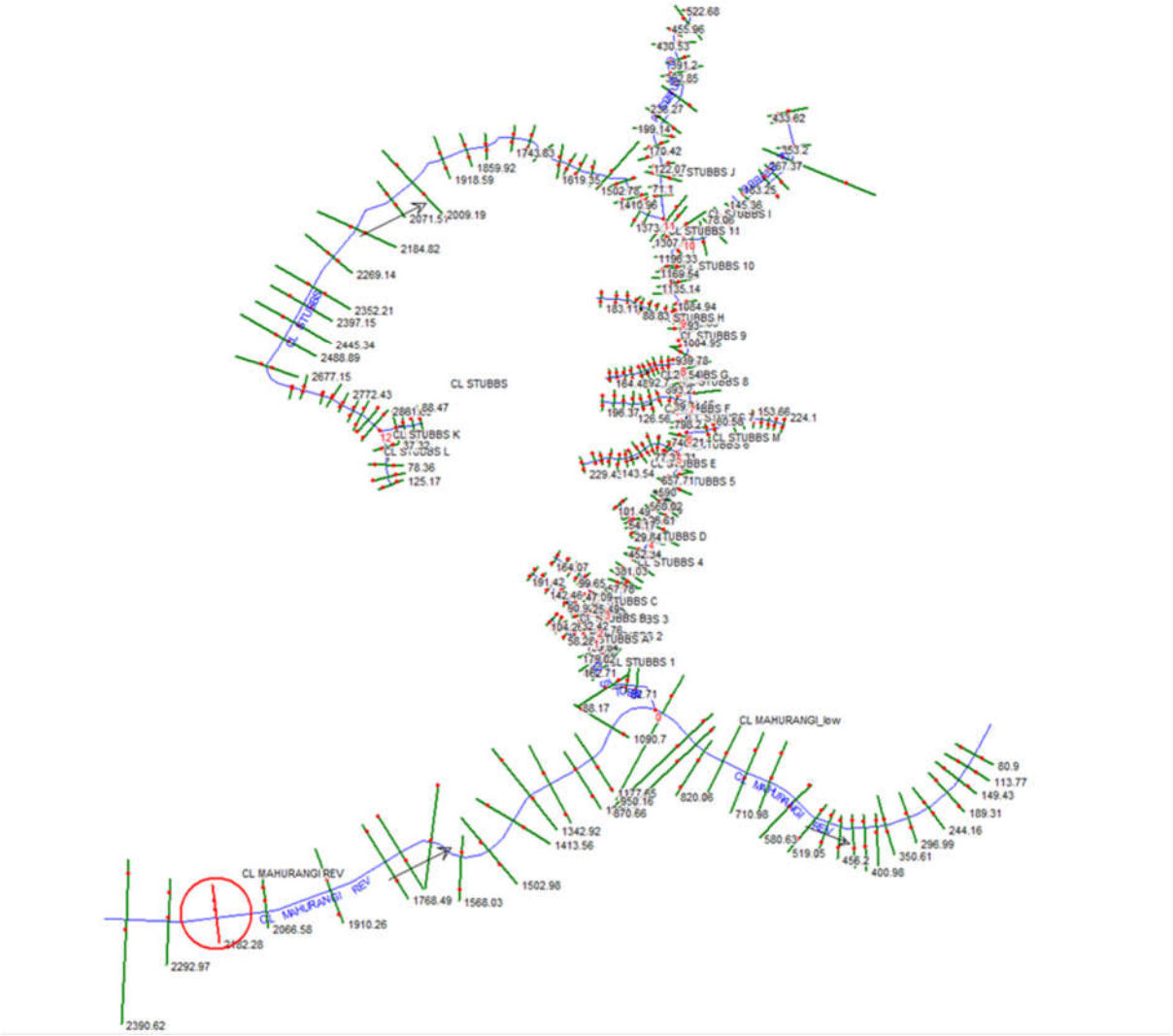

Figure 27 - HEC-RAS Hydrologic Model Schematisation

4.1.4.2 Flow Change Locations

Flows from the HEC-HMS hydrological model have been input at the top of all reaches and junctions.

4.1.4.3 Boundary Conditions

Normal depths based on channel slopes have been computed for the boundary conditions at the upstream and downstream boundaries of all reaches.

4.1.4.4 Roughness Values

Stream channels have been modelled with a Manning's roughness of 0.06 to represent sluggish reaches with weeds (Chow, 1959). Flood plains have been modelled with a Manning's roughness of 0.03 to represent pasture (Chow, 1959).

4.1.4.5 Structures

Two bridge/culvert structures have been included in the hydrologic model. The spill crests/ deck levels for these structures has been based upon survey data and observations made on site.

4.1.5 Hydrologic Model Results

The model results indicate that flooding within the Warkworth North Structure Plan catchment are largely confined to the channel and riparian margins of the Stubbs Stream and Mahurangi River. Steep sided gullies confine overland flows from the smaller contributing catchments to narrow extents which broaden at the junctions with the main watercourses.

Below is a summary of the estimated flood velocities for the 1%AEP existing development scenario within the structure plan area. The estimated flood plain extents throughout the catchment and section details including peak flood elevations at critical points are included in Appendix C on Chester drawings 901 and 902.

Max Velocities within the structure plan area (By Reach):

- Main Channel: 3.39 m/s at CH1084.9
- Stubbs A: 2.12 m/s at CH58.28
- Stubbs B: 1.72 m/s at CH168.2
- Stubbs C: 2.06 m/s at CH137.69
- Stubbs D: 2.18 m/s at CH42.97
- Stubbs E: 2.92 m/s at CH92.66
- Stubbs F: 2.00 m/s at CH196.37
- Stubbs G: 2.58 m/s at CH147.77
- Stubbs H: 2.46 m/s at CH69.46

4.2 Natural Hazards – Flooding: Development Recommendations

In our opinion the structure plan area is suitable for the proposed plan change in relation to natural hazards - flooding. The existing flooding is generally confined to the gullies and streams enabling the majority of the structure plan area to be clear of any flooding risk at all. In the lower areas where flooding is present, it is our opinion that new development can be achieved providing the stormwater management practices outlined in this SWCMP are followed.

5 Stormwater Management

This section of the SWCMP outlines the assessment undertaken and then the proposed provisions to meet the Auckland Council requirements based on the proposed land use and the receiving environment.

5.1 Conveyance

As part of stormwater management, the extent of public stormwater infrastructure and hydrologic connectivity and conveyance of the primary and secondary drainage networks must be considered and accounted for.

As such, Stormwater flows within the developed Warkworth North Structure Plan will need to meet the criteria of the Auckland Council Stormwater Code of Practise for stormwater conveyance and flood management. The Warkworth North Structure Plan will have to convey stormwater through a combination of piped networks and swales within the urban area and discharge to the existing streams identified. Overland flows will need to be conveyed to the identified streams by formed, unobstructed, overland flow paths and roads for the large rainfall events (>10% AEP CC).

5.2 Flooding

The proposed change in land use within the Warkworth North catchment must not result or increase; flooding of other properties in rainfall events up to the 10% AEP or; inundation of buildings on other properties in rainfall events up to the 1% AEP event.

Therefore, in order to determine the stormwater management requirements for the 10% AEP and 1% AEP events within the catchment, we have conducted a flood modelling study to estimate the actual or potential risk of increased flooding and inundation on downstream properties and buildings. For the Warkworth North catchment the main consideration in respect to this was the ability of the Stubbs Stream, unnamed tributaries and the Maurangi River to provide adequate levels of conveyance for these events whilst accounting for the catchments proposed land use change.

Pre-development and post-development peak flow flood elevations and widths have been estimated for the 10% CC AEP and the 1% CC AEP; the complete modelling results and the drawings are contained in the Appendix but are summarised below.

5.2.1 10% AEP Event

Table 7 - Estimated peak flows within the Mahurangi River Tributaries – 10% CC AEP

Cross Section Number	HEC-RAS River Station	Pre-Development			Post-Development		
		Flow (m3/s)	Water Level RL (m)	Flood Plain Width (m)	Flow (m3/s)	Water Level RL (m)	Flood Plain Width (m)
1	950.16	253.52	16.85	151.22	253.79	16.85	151.29
2a	138.12	32.23	16.80	22.10	35.13	16.74	18.66
2b	162.71	32.23	17.86	55.46	35.13	17.92	56.55
3	511.93	32.02	19.05	26.11	34.55	19.13	28.72
4	740.21	32.02	20.84	22.43	34.55	20.90	22.79
5	981.21	31.80	21.93	23.19	33.71	21.99	23.65
6	1196.33	31.37	23.77	19.65	32.31	23.79	19.69
7	2184.82	20.72	33.25	49.17	28.80	33.25	49.20
8	2772.43	2.74	37.71	6.77	3.020	37.73	7.01

Note: 1) Falls Road Bridge / Spill way is located at Cross Section 2b

2) Falls Road Spillway level 17.42mRL

The effect of the 10% CC AEP flow from the fully developed Warkworth North Structure Plan is estimated to result in a maximum increased depth of 0.08m at the lower reaches of the catchment. The increased flows remain contained within the existing stream corridor width.

5.2.2 1% AEP Event

Table 8 - Estimated peak flows within the Mahurangi River Tributaries – 1% CC AEP

Cross Section Number	HEC-RAS River Station	Pre-Development			Post-Development		
		Flow (m3/s)	Water Level RL (m)	Flood Plain Width (m)	Flow (m3/s)	Water Level RL (m)	Flood Plain Width (m)
1	950.16	511.03	18.03	243.42	511.12	18.03	243.44
2a	138.12	71.64	18.08	48.87	74.88	18.08	48.85
2b	162.71	71.64	18.44	65.54	74.88	18.46	65.86
3	511.93	70.64	19.76	40.37	73.83	19.80	40.81
4	740.21	70.64	21.48	26.60	73.83	21.53	26.94
5	981.21	69.34	22.71	32.17	72.39	22.77	32.72
6	1196.33	67.00	24.31	22.27	69.82	24.35	22.46
7	2184.82	60.89	33.65	57.52	60.87	33.65	57.52
8	2772.43	5.43	37.88	10.26	5.70	37.90	11.23

Note: 1) Falls Road Bridge / Spill way is located at Cross Section 2b

2) Falls Road Spillway level 17.42mRL

The effect of the 1% CC AEP flow from the fully developed Warkworth North Structure Plan is estimated to result in a maximum increased depth of 0.06m at the lower reaches of the catchment. The increased flows remain contained within the existing stream corridor width.

The results from the assessment estimate that the change in land use does not increase downstream flooding as described above; with the exception of the Falls Road Bridge.

5.2.3 Falls Road Bridge

The Falls Road Bridge was assessed in detail through a Request for Information with Auckland Council's Healthy Waters Team; the assessment / reply is contained in the Appendix. Through this assessment it was determined to be under capacity for the existing stormwater flows greater than the 20% AEP; and as such any additional flows through this structure will worsen the overtopping frequency, duration and depth. Stormwater mitigation was investigated to determine if the development flows could be sufficiently reduced to suit the capacity of the existing stream crossing.

Mitigation was assessed by limiting the post development discharge from each sub-catchment in the model to never exceed pre-development levels using a storage-discharge restriction. The effect of hydrology on the peak flows upstream of Falls Road Bridge was variable across the 4 rainfall events modelled.

Figure 28 - Location of Falls Road Bridge

Table 9 - Peak Flow Comparisons Upstream of Falls Road Bridge

Model Scenario	Peak Flow (m^3/s)	Time
2yr ARI ED	14.41	12:43
2yr ARI MPD	20.86	12:43
2yr ARI MPD with Mitigation	21.11	12:29
5yr ARI ED	21.63	12:53
5yr ARI MPD	31	12:37
5yr ARI MPD with Mitigation	30.06	12:30
10yr ARI ED	27.52	12:47
10yr ARI MPD	39.26	14:59
10yr ARI MPD with Mitigation	39.31	14:59
20yr ARI ED	35.37	15:06
20yr ARI MPD	53.47	14:48
20yr ARI MPD with Mitigation	53.47	14:48

Note: 1) Falls Road Bridge Capacity estimated at 23.13m3/s

When applied to the 50% AEP rainfall event, mitigation measures resulted in an increased peak flow upstream of the Falls Road Bridge. Hydrological mitigation detains peak flows for an extended period, decreasing the magnitude but increasing the duration of the peak. The model results for the 50% AEP storm scenario suggest that despite the reduction in peak flows, the increased duration allows for the peaks from a larger number of sub-catchments to coincide resulting in a slight increase in flow upstream of the Stubbs Farm Bridge.

When applied to the 20% AEP rainfall event, mitigation measures resulted in a slight decrease in peak flow upstream of the Falls Road Bridge approximately 3%.

When applied to the 10% AEP year and 5% AEP year rainfall events, mitigation measures have a negligible effect as MPD flows through the Stubbs Farm Stream are dictated by flows from the Mahurangi River.

Based on the results of the assessment undertaken it is our opinion that peak flow mitigation within the Stubbs Farm Development Area has limited potential to reduce peak flows upstream of the Falls Road Bridge. For some storm events, peak flow mitigation may actually increase peak flows at the Falls Road Bridge by extending the duration of peak flows allowing for peak flows from a larger number of sub-catchments to coincide.

At source peak flow mitigation is not considered suitable to mitigate the issues associated with the Falls Road Bridge and as such it is our opinion that this structure is replaced and suitably designed structure to flow the 1% AEP.

With the absence of flooding issues, the upgrade of the Falls Road Bridge, the potential to coincide sub-catchment peak flows and that the Warkworth North catchment is located in the lower third of the wider Mahurangi river catchment; we have concluded that detention for the 50% AEP, 20% AEP, 10% AEP and 1% AEP events is not required.

5.3 Flow

5.3.1 Stream Protection

The visual inspection and subsequent ecological assessments of the development site's existing streams noted some stream(s) of high value which are suited for preservation and enhancement. Given the quality and opportunity for enhancement hydrologic mitigation targeting stream protection was considered appropriate. The following best practise hydrologic controls were considered for stream protection and are summarised below:

Peak Flow Control

- Extended Detention Volume (EDV),
- Peak flow control 50% AEP (1 in 2 year)
- Peak flow control 90th percentile storm
- Peak flow control 95th percentile storm

Volume Reduction

- Rainwater harvesting
- Stormwater retention

These controls are explained in more detail below.

Extended Detention Volume (EDV)

Extended detention has been historically used to meet stream channel protection objectives; in summary this approach requires the first 34.5mm of rainfall to be captured and then released over 24 hours. The primary purpose of extended detention is to align the post-development discharge flow rate and time of concentration to that of the natural or pre-development hydrologic regime.

Peak Flow Control 50% AEP

Peak flow control for the 50% AEP has historically been used either as standalone or in combination with extended detention to meet stream channel protection objectives. Generally, by providing EDV, the peak flow control requirement would be satisfied through the resulting attenuation device. The primary purpose of peak flow control is to simply control the peak flow to the pre-development flow without consideration of the time series associated to convey the rainfall event.

Peak Flow Control 90/95th Percentile Storm

Peak flow control for the more frequent 90th and 95th percentile storms is now considered to be best practise for stream channel protection objectives through the provision of flow control (detention) with volume reduction (retention).

Stormwater Retention

Stormwater retention seeks to reduce peak flows for small frequent storm events and align the developments run-off volumes with that of the pre-development run-off volumes. This can be done through the provision of rainwater harvesting and ground water soakage. Stormwater retention is considered to be best practise for stream channel protection objectives in combination with a form of peak flow control of either the 90th or 95th percentile storms.

5.3.2 Stormwater Mitigation Approach

The proposed stream has sufficient capacity to convey flows with a less than minor adverse effect on the receiving environment. We believe the effect of the development to the receiving environment is stream channel erosion as a result of small / frequent rainfall events. Therefore, hydrologic mitigation to SMAF1 is proposed to address the stream channel protection objectives for the following reasons;

a) Detention of the 95th percentile storm is considered the most effective peak flow control to prevent / mitigate stream channel erosion.

b) Retention through the provision of rainwater harvesting and soakage of the 5mm rainfall is critical to reduce flow during small frequent rainfall events, which results in stream erosion.

The specific SMAF1 controls are shown in Table 10 below;

Table 10 - Auckland Unitary Plan E10.6.3.1.1 Hydrology mitigation requirements

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

5.3.2.1 Precluded Mitigation Controls

The controls mentioned but not proposed as mitigation have known limitations which has precluded them from being considered suitable for this development, the specific limitations are:

a) Peak flow control of the 50% AEP and EDV does not reduce the stormwater volume rather maintains pre-development peak flows over a longer duration, extending the duration at which erosive flows occur.
b) The majority of storm events that result in stream channel erosion is now considered to take place during the smaller more frequent storms thus the shift to the 90th and 95th percentile storms rather than the 50% AEP.
c) In order to achieve extended detention (EDV) requirements and or peak flow of the 50% AEP within a catchment end of pipe type devices are generally required. These devices can have adverse environmental effect beyond the hydrologic functions, specifically
    i. Temperature changes – detention basins for EDV and, or peak flow control have the potential to have increased water temperatures due to their surface area exposure to direct sunlight. The discharge from these devices can shock the receiving environment which will be at a cooler temperate potentially impacting flora and fauna.

ii. Larger open devices lose water to evaporation, where baseflow parameters have not been carefully considered devices can reduce stream baseflow during dry periods as small storms are captured within the device without any discharge, thus adversely impacting the receiving environment.

5.4 Quality

The Auckland Unitary Plan focuses on treatment of stormwater contaminants generated by the land use and the nature of the receiving environment.

5.4.1 High Contaminant Generating Car Parks and High Use Roads

Full stormwater quality treatment is proposed on high contaminant generating car parks and high use roads (5000VPD) in accordance with the Auckland Council Guideline Document GD2017:001 *Stormwater Management Devices in the Auckland Region* (referred to as GD01).

5.4.2 Low-Use Local Roads

Partial stormwater quality treatment will be provided at source for the low-use local roads where treatment is not specifically required by E9 of the Unitary Plan in order to achieve the objectives of the Auckland Council Unitary Plan E1.

Partial treatment would be achieved through bioretention devices such as tree pits where the primary function would be to provide retention for volume reduction.

5.5 Stormwater Management Summary

Based on the above information it is our opinion that with the provision of SMAF 1 and the DEQR with the addition of partial treatment of the local roads at source is the best most optimal option to mitigate the development's effects with respect to stormwater management, flooding, water quality and protection of the streams from stream channel erosion; the approach is summarised in Table 11 below.

Table 11 - Indicative Stormwater Management

Location	Quality Treatment (DEQR)	Retention (SMAF1)	Detention (SMAF1)
High-use Road	Yes (at source) via Raingarden or similar	Yes (at source)	Yes (downstream device)
Low-use Road	Partial (at source) via Tree Pit	Yes (at source)	Yes (downstream device)
Lots	N/a	Yes (at source)	Yes (downstream device)

The proposed hydrologic mitigation and stormwater quality treatment is in accordance with E9 and E10 of the Auckland Council Unitary Plan.

Each stormwater sub catchment will have a small detention device to provide detention volume for the road and the lots impervious surface.

The application of the controls in accordance with E9 and E10 of the Auckland Unitary Plan over the plan change area will ensure the stormwater outcomes within the plan change area will be aligned with the objectives and policies of the Auckland Unitary Plan E1.

SECTION D: WATER SUPPLY SERVICING

1 Existing Network

Currently, water supplied to Warkworth is drawn from the Mahurangi River and treated at the existing treatment plant off Brown Road. Treated river water is pumped up to a water supply reservoir in View Road, with a supply elevation of RL 86.0m. The reservoir feeds into a bulk supply main which delivers water to the Warkworth area. Refer to Figure 29 below and Drawing 500 entitled "Water Supply – Existing Network Overview" (in appendix) for more detail.

Figure 29 - Warkworth Water Supply Schematic

1.1 Public Water Projects

Watercare is currently undertaking improvement works to the Warkworth water supply network to ensure supply for growth in the area.

Our understanding is that there is a shortage in the treatment capacity of the existing plant and it will be unable to meet predicted demand. This is due in part to the Mahurangi River being the only source. The Mahurangi River is prone to flooding and discolouration due to high sediment loads in wetter months and low flow in dryer months. This is often cause for more vigorous treatment requirements. As a result of this recurrent problem, Watercare have proposed long term improvements as well as undertaking temporary measures to supplement immediate demand in the short term.

Watercare's general plan to improve Warkworth's water security long term is to install a new treatment plant located on Sanderson Road, which will source water from groundwater bores. In the short term, a 'pilot' plant has been installed at the site which is being monitored to ensure viability of the full upgrade, as well as serve to supply additional water to the View Road reservoir in the meantime. The water take for the long term option has been consented and the treatment plan construction is well underway.

Other related network upgrades include the following:

- New network connections into the View Road reservoir
- Upgrades to the network providing improved supply to the Thompson Road reservoir
- Upgrade the existing water treatment plant at Brown Road Pump station and treatment plant.

Table 12 below outlines our understanding of the timeframes associated with the Warkworth Water Supply Upgrades both completed and proposed. The Structure Plan proposal is dependent on the timing of these upgrades.

Table 12 - Water Supply upgrade projects for Warkworth North

Date	Upgrade/Milestone Description	Status
2014	Gain Resource consent for the pilot plant and install two water bores.	Complete
2015	Install pilot plant	Complete
2016	Design and consenting of the new treatment plant and network upgrades	Complete
2017	Construction of water treatment plant and network upgrades	Complete
2018	New Water Supply Available	Complete

1.2 Water Supply Capacity Assessment

Assessment and modelling has been undertaken as described in the following section to determine infrastructure sizing requirements to service the proposed development. The assessment assumes there are no constraints on the volume of water supply available from the Mahurangi River and future groundwater bore. Therefore, because our understanding is that the water take from the ground water bore is sufficient to service the future growth needs of Warkworth, an assessment of source water supply capacity has not been undertaken by Chester.

2 Proposed Development

The Structure Plan for the proposed development relates to a 120 ha area that is currently zoned a mix of Future Urban, Light Industry and General Business usages. The proposed development would involve zone changes to create both Residential and Business zoned areas. Proposed zoning as well as potential development staging plans are attached in appendix A.

Table 13 below outlines the projected number of houses to be added in each projected development stage.

Table 13 - Proposed Development Staging

Stage	No. of Houses	224c Timing
Stage 1 (223 Falls Rd)	51	March 2020
Stages 2 through to 8B	1060+	2022 onwards

3 Water Supply Servicing Options

This section of the report outlines the possible options for servicing the proposed Structure Plan area for water supply. It includes a high-level assessment of the catchment serviceability in relation to existing and planned infrastructure as well as identifying estimated demand and timing within the catchment.

3.1 Water Supply Requirements

Water supply networks must be able to maintain appropriate nominated pressures for both peak demand and firefighting scenarios. The following outlines the requirements we have adopted to assess the Structure Plan area's serviceability for water supply. These requirements have been obtained from Watercare Services Limited's Water and Wastewater Code of Practice and SNZ PAS 4509 (WSL CoP).

The minimum flow shall be the greater of:

- 25L/min at the property meter
- the peak water demand in L/s or
- the hydrant fire flow targets set out in table 2 of SNZ PAS 4509, dependent on the areas fire water classification.

Residual pressures within the network must exceed 250kPa (25m head) at all times, excluding under fire flow conditions. Minimum residual pressures during fire flow must exceed 100kPa.

3.1.1 Peak Water Demands

Table 14 below shows the estimated peak water demands throughout the Structure Plan area over time as stages progress through to completion. Demands have been calculated in accordance with the Watercare Code of Practice, Section 6. This table outlines the timing, at which the Warkworth water supply network must be able to supply additional volume throughout the Structure Plan area.

Table 14 - Estimated Peak Demands for Structure Plan Area

Estimated Structure Plan Area Cumulative Peak Water Demands Over Time				
Area/Stage Name	**Cumulative Lots**	**Average Daily Demand (m^3)**	**Peak Daily Demand (m^3)**	**224c Timing**
Stage 1 (223 Falls Rd)	50	38	75	March 2020
Stages 2 through to 8B	1060+	1188	2375	2022 onwards

3.1.2 Fire Fighting Water Supply

Table 15 below outlines the required flow for firefighting in accordance with SNZ PAS 4509 dependent of fire water classifications.

Table 15 - Flow Requirements for Firefighting

Fire Water Classification	Reticulated Water Flow Required
FW1	7.5L/s
FW2	25L/s
FW3	50L/s
FW4	100L/s
FW5	150L/s
FW6	200L/s

3.2 Proposed Network Layout

The area to which this Structure Plan change relates is to be serviced for water supply by the View Road Reservoir. From a network layout perspective, the existing View Road Reservoir is well situated to service the Structure Plan area. The reservoir has a fixed head of approximately RL 86.0m, the majority of the Structure Plan area is located below RL 50.0m.

The highest portion of the Structure Plan area (excluding the location of the reservoir itself) is sited at RL 74.00m. Due to constraints on the head available from the View Road reservoir, the Structure Plan will need to include a pressure boosted zone in order to meet minimum levels of service for properties above the 50m contour.

The entire Structure Plan area is located within a 1.5km radius of the reservoir and all areas of the Structure Plan can be serviced by mains located within the road reserve. Worst case pipe lengths are less than 2.5 km long from reservoir to point of supply, dependent on final road alignments.

3.3 Preliminary Water Supply Trunk Model

A preliminary water supply model has been developed in order to indicatively size the trunk mains required to service the Structure Plan area for both peak hour demands and fire flow requirements.

EPAnet 2 was utilised to build the hydraulic model.

The network was divided into 14 zones. Peak demand for each zone was calculated based on the land use. Peak flow for residential zones was established based on an average per capita consumption of 250 L/p/d with an hourly peaking factor of 5. Peak demand for business zones was calculated based on an average usage of 17.5m³/d/ha. For the purpose of this analysis it was assumed that the draw from businesses was constant over a typical 10 hour work day.

Fire flows were determined as per the New Zealand Fire Service Firefighting Water Supplies Code of Practice SNZ PAS 4509:2008.

Calculated peak flows are provided in Table 16 below;

Table 16 - EPANet Model Input/Output

Zone Number	Zone Name & Description	Area (ha)	Lots	Population	Demand (L/s)	Fire Hazard	Fire Flow (L/s)
1	South East Structure Plan Area (Low Pressure)	12	120	360	5.21	FW2	25.00
2	Falls Road Development (Low Pressure)		46	138	2.00	FW2	25.00
3	Stubbs East (Low Pressure)		46	138	2.00	FW2	25.00
4	East Structure Plan Area South of Sanderson Rd Business (Low Pressure)	0.8		0	0.41	FW4	100.00
5	East Structure Plan Area North of Sanderson Rd Business (Low Pressure)	7.5		0	3.80	FW4	100.00
6	North Structure Plan Area B Business (Low Pressure)	26		0	13.17	FW6*	200.00
7	North Structure Plan Area A Residential Residential (Low Pressure)	8.4	84	252	3.65	FW2	25.00
8	Stubbs South (Low Pressure)		65	195	2.82	FW2	25.00
9	Stubbs Central (Low Pressure)		151	453	6.55	FW2	25.00
10	Stubbs Upper West (High Pressure)		97	291	4.21	FW2	25.00
11	North Structure Plan Area A Residential (High Pressure)	10	100	300	4.34	FW2	25.00
12	Stubbs East Mixed Use (Low Pressure)	4.6		0	2.33	FW2	25.00
	Totals:		709	2127	50.47		

** The reason for this assumption is because the northern part of the structure plan area adjacent to SH1 (EPANet Model Zone 6) is currently zoned Business – General Business Zone which is proposed to be extended as part of the proposed plan change. Within this zone we understand that there is a proposal for a foodstuff's supermarket. As such with referral to SNZ PAS 4509:2008 we have assumed the fire water classification possible to be FW6 (i.e. supermarket with bulk display over 3m with a firecell floor area of 800m2+) which has a required fire flow of 200L/s. We understand that this assumption is conservative from a network design point of view and note that the purpose of this model is only to prove reticulation can be achieved across the structure plan area.*

Peak hourly demand was distributed around the network, mains were sized indicatively to ensure minimum residual pressures could be supplied at all locations throughout the trunk model.

Fire flows were then applied to each zone sequentially, with peak hourly demands still in place. This represents the worst-case scenario for network operation. Mains were upsized as required to ensure a minimum residual pressure of 100kPa was achieved at nodes where fire flows were applied.

Drawing 502 in Appendix D of this report shows an example bulk main layout based on EPANet model.

4 Proposed Water Servicing Plan

The completion of the water treatment plant at Sanderson Road and network upgrades scheduled for 2018 will enable development in the Structure Plan area, in line with development staging. We believe the majority of the Structure Plan area can be served by a gravity reticulation network supplied by the View Road reservoir (Elevation RL 86m). Due to the head constraints at the View Road Reservoir, a boosted pressure zone at elevations above the RL 50m contour within the Structure Plan area, will be required in order to ensure minimum levels of service are met.

Refer to CCL Drawing 502 "Water Supply – Example Bulk Main Plan" in Appendix for the water supply zones and an indicative bulk main plan to service the Structure Plan area for water supply.

5 Funding Proposal

The installation of new water supply infrastructure as set out in the Water Servicing Plan for the purpose of servicing Falls Road and Stubbs Farm developments will be funded entirely by the developer. These assets will subsequently be vested to Auckland Council as public assets.

SECTION E: WASTEWATER SERVICING PLAN

1 Existing Network

The existing wastewater network in Warkworth is a combination of gravity sewer and a pressurised waste collector system. The network consists of approximately 40.9km of pipeline, two pump stations (Palmer Street WWPS and Lilburn Street WWPS), and a Wastewater Treatment Plant (WWTP) located off Alnwick Street beside the Mahurangi River.

Around the Warkworth town centre and the area to the northeast, the network is primarily a gravity system; the portion to the south of Warkworth is a gravity system that flows down to the Palmer Street WWPS into the pressure network; and the portion to the southwest is a low-pressure network that is pumped to the Warkworth WWTP. An overview of the existing wastewater network is shown in Figure 30 below.

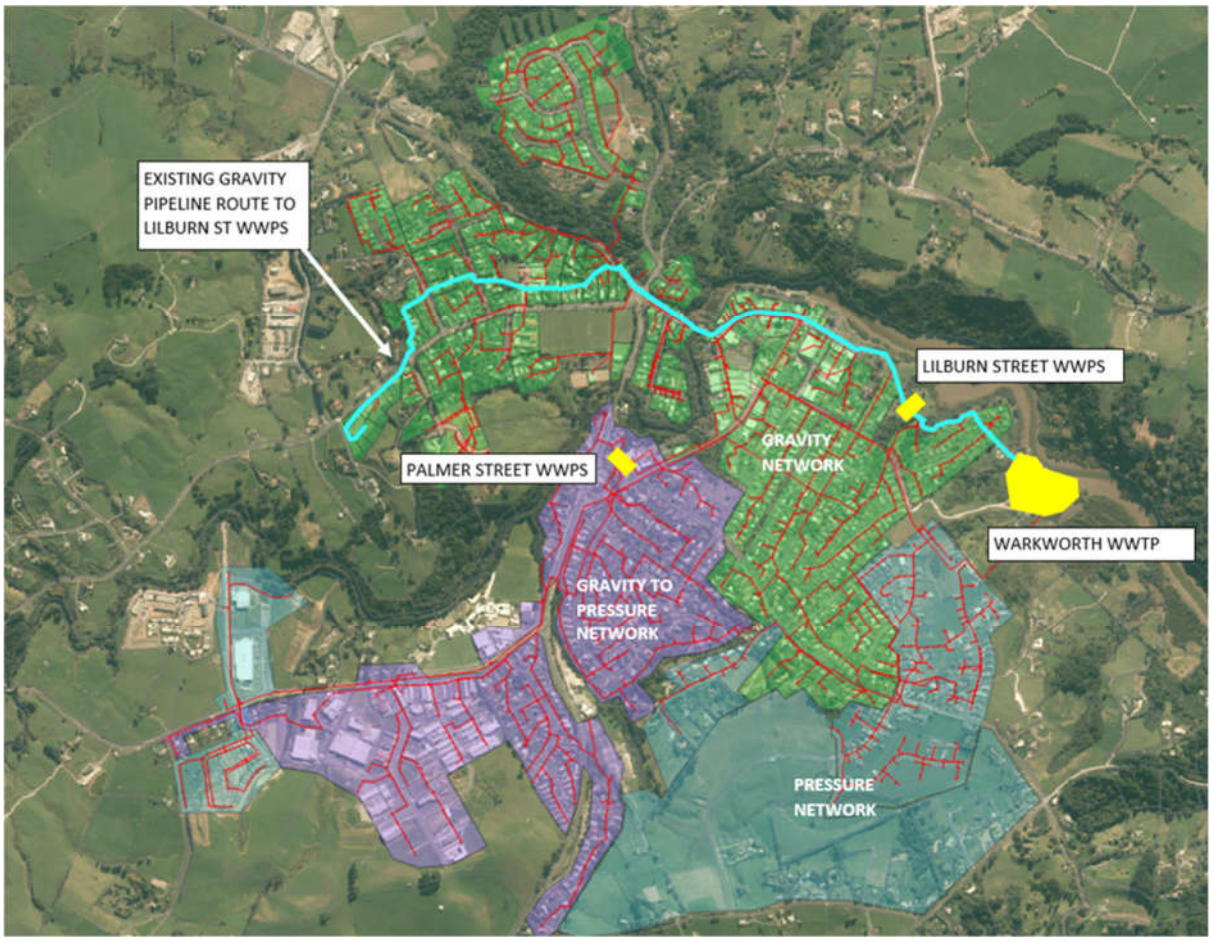

Figure 30 - Existing Wastewater Network Overview

An existing pipeline route from the proposed development site (local top of catchment) to the Warkworth WWTP (bottom of catchment) was identified as the most likely route that new wastewater flows from the proposed development would take if passed into the current network. The majority of this pipeline route is a gravity system flowing west adjacent to Hill Street towards the Warkworth Town Centre, across to the Lilburn St WWPS. The location of this pipeline route is shown above in Figure 30, and a detailed set of plans is included in the Appendix.

1.1 Public Wastewater Projects

The Warkworth wastewater treatment plant was built in 1979, and commissioned in 1980 to service the Warkworth region. Due to population growth and an increase in the level of treatment required, the treatment plant has become inadequate for its catchment. At the time of writing this report, the plant is scheduled to be decommissioned by 2021. The plant's original Discharge Consent expired so a short-term consent to continue treating wastewater from now till then has been obtained. As part of that consent, a number of small upgrades to the plant were permitted, to allow for some immediate growth within the catchment i.e. to service consented and some zoned development.

In June 2016, Watercare completed a report identifying the preferred option for providing wastewater services for the Warkworth and Snells Beach / Algies Bay areas, given that they have been identified as areas of significant population growth. The purpose of the report was to select the Best Practicable Option for servicing the Warkworth and Snells-Algies communities up to 2051 with the ultimate capacity to service a population of 30,000, and to provide a level of service that will meet the future needs of the area.

The preferred option in the Watercare report was a combined treatment facility located at the existing Snells / Algies WWTP close to the Snells Beach township, discharging to the Hauraki Gulf via a marine outfall. Under this option, wastewater from Warkworth will be collected at a new pump station and transferred via a new conveyance pipeline to the existing Snells/Algies WWTP site. A new WWTP will be constructed at the existing Snells-Algies WWTP site with sufficient capacity for servicing both townships. The conveyance route will include 3-4 underground pump stations in series with the pipeline route, which will be located within the road reserve and public land areas.

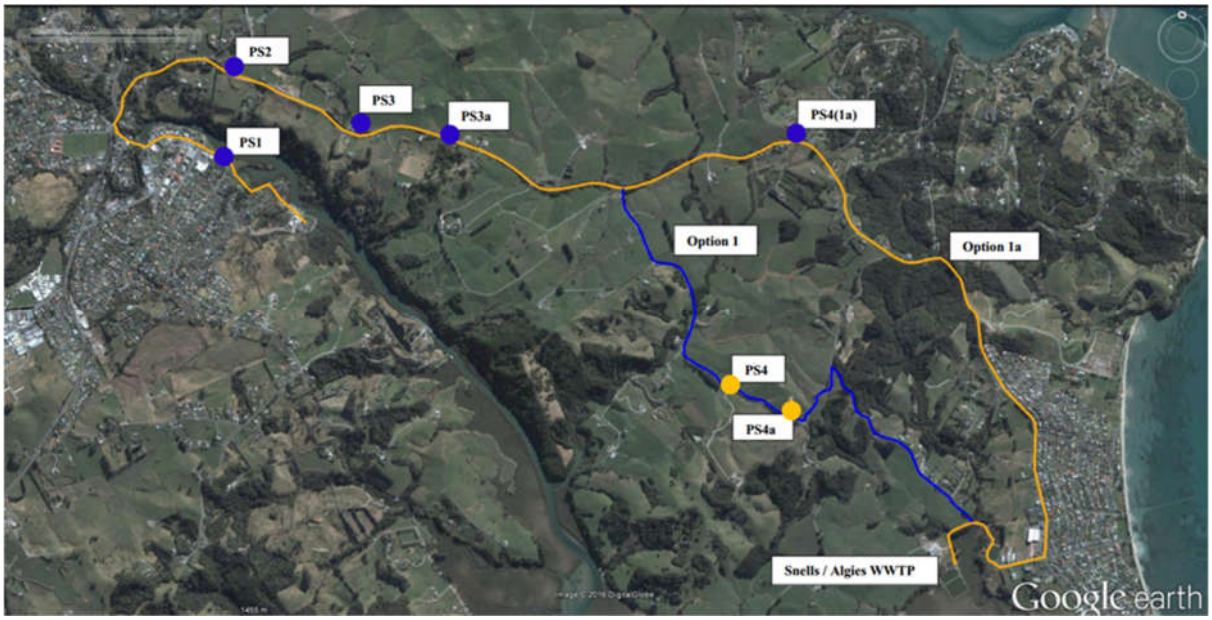

Figure 31 - Indicative Conveyance Pipeline to New WWTP

1.2 Wastewater Capacity Assessment

A capacity assessment of the existing gravity pipeline route was undertaken to determine the current pre-development pipe capacity and identify parts of the network that may be undersized and/or become critical with the introduction of new connections. The general approach to this assessment was to quantify the wastewater flows added to each pipe in the route, and use the physical pipe properties to calculate the reserve capacity.

Data on pipe locations, diameters, materials, invert levels, and pipe were obtained from the Auckland Council GeoMaps GIS Viewer.

The network was assessed using the following criteria, according to the Residential Flow parameters specified in Section 5.3.5.1(a) of the Watercare "Water and Wastewater Code of Practice for Land Development and Subdivision", May 2015:

- Average Dry Weather Flow: 225 litres/day/person
- Dry Weather Diurnal Peak Factor: 3.0
- Peak Wet Weather Flow: 1,500 litres/day/person
- No. people per dwelling: 3.0 people
- Pipe Flow Condition: 100% Full

The number of dwellings associated with each pipe in the route was obtained by using a combination of Auckland Council's wastewater GIS layer, aerial imagery and property boundaries. Using the parameters shown above, a population size was calculated, with a corresponding flow for Dry Weather and Wet Weather scenarios.

A summary of the results of the capacity assessment for the existing network are shown below in Figure 32. For the full tabulated results, refer to Appendix E.

PIPE											PRE-DEVELOPMENT								
											LOAD		DRY WEATHER			WET WEATHER			
Ref no.	Upstream SSMH ID	Dowstream SSMH ID	Pipe Dia (mm)	US Level	DS Level	Length	Pipe Grade (%)	Pipe Material	Pipe Velocity (m/s)	Pipe Capacity (L/s)	No. of Houses	Population	ADWF (L/s)	Cumul. ADWF (L/s)	Pipe Res. Capacity (L/s)	PWWF (L/s)	Cumul. PWWF (L/s)	Pipe Reserve Capacity (L/s)
100	3001259	3001255	100	67.09	64.56	44.3	5.71	PVC	1.86	14.59	2	6	0.047	0.047	14.54	0.104	0.104	14.48
101	3001255	3001252	150	64.6	62.43	14.46	15.01	PVC	3.95	69.72	1	3	0.023	0.070	69.65	0.052	0.156	69.57
102	3001252	3001249	150	62.43	56.51	33.1	17.89	PVC	4.31	76.12	1	3	0.023	0.094	76.02	0.052	0.208	75.91
103	3001249	2700595	150	56.51	55.56	73	1.30	PVC	1.16	20.53	3	9	0.070	0.164	20.37	0.156	0.365	20.17
104	2700595	2700644	150	55.56	55	51.54	1.09	PVC	1.06	18.76	2	6	0.047	0.211	18.55	0.104	0.469	18.29
105	2700644	2670059	150	55	54.52	40.912	1.17	PVC	1.10	19.50	4	12	0.094	0.305	19.19	0.208	0.677	18.82
106	2670059	2670743	150	54.52	53.29	61.372	2.00	PVC	1.44	25.48	3	9	0.070	0.375	25.11	0.156	0.833	24.65
107	2670743	2658858	150	53.29	52.89	59.15	0.68	PVC	0.84	14.80	7	21	0.164	0.539	14.26	0.365	1.198	13.60
-	2658858	2666178	150	52.89	52.69	17.6	1.14	PVC	1.09	19.19	0	0	0.000	0.539	18.65	0.000	1.198	17.99
108	2666178	2663617	150	52.69	52.42	28.11	0.96	PVC	1.00	17.64	1	3	0.023	0.563	17.08	0.052	1.250	16.39
109	2663617	2662644	150	52.42	51.6	24.3	3.37	PVC	1.87	33.06	1	3	0.023	0.586	32.48	0.052	1.302	31.76
110	2662644	2700021	150	52.5	49.5	42.075	7.13	PVC	2.72	48.06	4	12	0.094	0.680	47.38	0.208	1.510	46.55
111	2700021	2664734	150	49.5	46	37.5	9.33	PVC	3.11	54.99	3	9	0.070	0.750	54.24	0.156	1.667	53.32
112	2664734	2667167	150	44.9	43.14	69.42	2.54	PVC	1.62	28.66	2	6	0.047	0.797	27.86	0.104	1.771	26.89
113	2667167	2667814	150	43.14	42.54	24.14	2.49	PVC	1.61	28.38	8	24	0.188	0.984	27.39	0.417	2.188	26.19
114	2667814	2663501	150	42.54	41.75	19.74	4.00	PVC	2.04	36.01	27	81	0.633	1.617	34.39	1.406	3.594	32.41
115	2663501	2667372	150	41.75	32.74	53.58	16.82	PVC	4.18	73.81	2	6	0.047	1.664	72.14	0.104	3.698	70.11
116	2667372	2660121	150	32.74	28.68	60.5	6.71	PVC	2.64	46.63	2	6	0.047	1.711	44.91	0.104	3.802	42.82
117	2660121	2665599	150	28.68	27.49	21.56	5.52	PVC	2.39	42.28	8	24	0.188	1.898	40.39	0.417	4.219	38.07
118	2665599	2661939	150	27.49	23.87	46.85	7.73	PVC	2.83	50.03	5	15	0.117	2.016	48.01	0.260	4.479	45.55
119	2661939	2667242	150	23.87	23.16	33.79	2.10	PVC	1.48	26.09	3	9	0.070	2.086	24.00	0.156	4.635	21.45
120	2667242	2670701	150	23.16	20.69	68.89	3.59	PVC	1.93	34.08	6	18	0.141	2.227	31.85	0.313	4.948	29.13
121-126	2670701	2666310	150	20.69	18.89	62.36	2.89	PVC	1.73	30.58	65	195	1.523	3.750	26.83	3.385	8.333	22.25
127	2666310	2658376	150	18.89	17.94	31.9	2.98	PVC	1.76	31.06	18	54	0.422	4.172	26.89	0.938	9.271	21.79
128	2658376	2669653	150	17.94	16.58	68.45	1.99	PVC	1.44	25.37	5	15	0.117	4.289	21.08	0.260	9.531	15.84
129	2669653	2660918	150	16.58	15.17	41.94	3.36	PVC	1.87	33.00	5	15	0.117	4.406	28.59	0.260	9.792	23.21
130	2660918	2665833	150	16	13.5	37.27	6.71	PVC	2.64	46.61	3	9	0.070	4.477	42.14	0.156	9.948	36.67
131	2665833	2665609	150	13.5	11.5	31.625	6.32	PVC	2.56	45.26	2	6	0.047	4.523	40.74	0.104	10.052	35.21
132	2665609	2660388	150	9.66	9.46	13.14	1.52	PVC	1.26	22.21	3	9	0.070	4.594	17.61	0.156	10.208	12.00
133-141	2660388	2663991	150	9.46	8.87	70.56	0.84	PVC	0.93	16.46	140	420	3.281	7.875	8.58	7.292	17.500	-1.04
142-143	2663991	2660756	150	8.87	8.14	73.94	0.99	PVC	1.01	17.88	15	45	0.352	8.227	9.66	0.781	18.281	-0.40
144-146	2660756	2658275	150	8.14	7.46	68.56	0.99	PVC	1.01	17.92	16	48	0.375	8.602	9.32	0.833	19.115	-1.19
147-149	2658275	2671309	150	7.46	7.22	23	1.04	PVC	1.04	18.39	24	72	0.563	9.164	9.22	1.250	20.365	-1.98
150	2671309	2671730	150	7.22	7.01	56.33	0.37	PVC	0.62	10.99	1	3	0.023	9.188	1.80	0.052	20.417	-9.43
-	2671730	2669302	150	7.01	6.87	8.16	1.72	PVC	1.33	23.58	0	0	0.000	9.188	14.39	0.000	20.417	3.16
151-152	2669302	2661210	150	6.87	6.81	54.55	0.11	PVC	0.34	5.97	4	12	0.094	9.281	-3.31	0.208	20.625	-14.66
-	2661210	3000712	175	8.41	8.16	4.9	5.10	PVC	2.55	61.32	0	0	0.000	9.281	52.04	0.000	20.625	40.70
-	3000712	3000707	355	8.16	7.02	87.4	1.30	PE	2.27	224.92	0	0	0.000	9.281	215.64	0.000	20.625	204.29
153-154	3000707	3000714	355	7.02	4	180.1	1.68	PE	2.58	255.02	4	12	0.094	9.375	245.64	0.208	20.833	234.19
155	3000714	2665823	355	4.02	4	16.4	0.12	PVC	0.63	62.52	34	102	0.797	10.172	52.35	1.771	22.604	39.92
156-158	2665823	2661420	450	4.02	3.85	83.4	0.20	C	0.88	139.45	72	216	1.688	11.859	127.59	3.750	26.354	113.09
159	2661420	2663919	150	3.85	3.71	62.5	0.22	C	0.44	7.81	6	18	0.141	12.000	-4.19	0.313	26.667	-18.86
160	2663919	2672243	225	3.71	3.54	37	0.46	C	0.83	32.97	7	21	0.164	12.164	20.81	0.365	27.031	5.94
161	2672243	2658412	450	3.54	3.42	13.6	0.88	C	1.82	290.13	18	54	0.422	12.586	277.54	0.938	27.969	262.16
-	2658412	2672852	450	3.42	3.11	70.7	0.44	C	1.29	204.52	0	0	0.000	12.586	191.94	0.000	27.969	176.55
-	2672852	2672588	375	3.11	2.96	46.18	0.32	C	0.98	108.25	0	0	0.000	12.586	95.67	0.000	27.969	80.28
162	2672588	2668353	375	2.96	2.82	69.6	0.20	C	0.77	85.19	310	930	7.266	19.852	65.34	16.146	44.115	41.07
-	2668353	2667998	300	2.82	2.62	45.8	0.44	C	0.98	69.23	0	0	0.000	19.852	49.38	0.000	44.115	25.11
-	2667998	2660150	375	2.62	2.5	37.58	0.32	C	0.97	107.33	0	0	0.000	19.852	87.48	0.000	44.115	63.22
-	2660150	2659205	375	2.5	2.499	23	0.00	C	0.11	12.52	0	0	0.000	19.852	-7.33	0.000	44.115	-31.59
163	2659205	2669096	225	2.5	2.49	6.5	0.15	PVC	0.52	20.81	50	150	1.172	21.023	-0.21	2.604	46.719	-25.90

*Insufficient Invert Level info on GIS, grade determined from contours/interpolation.

Figure 32 - Existing wastewater line capacity assessment

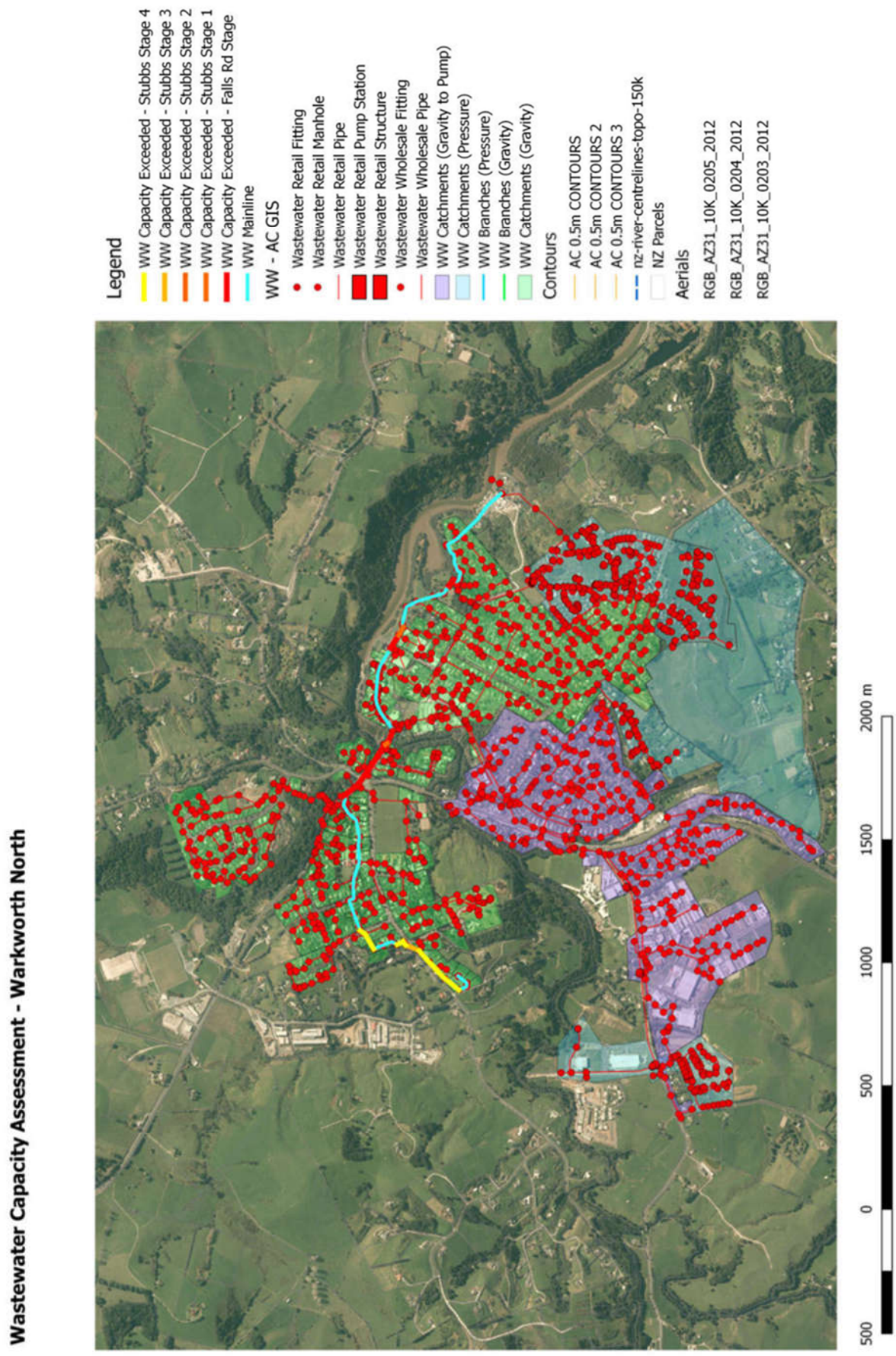

Figure 33 - Wastewater Capacity Assessment Results

The results of this assessment show that the existing gravity pipeline route to the Lilburn St WWPS has under-capacity pipes in both the Dry Weather and Wet Weather scenarios (4 pipes and 9 pipes respectively). The critical pipe sections are located along Elizabeth Street adjacent to the Warkworth Town Centre, and further downstream on Baxter Street. A diagram of the under-capacity pipe locations is shown above in Figure 33.

Because the existing gravity pipeline route is at capacity in the pre-development scenario, it is not desirable for it to convey additional post-development wastewater flows without carrying out upgrades to the network, or installing an alternative route for wastewater to reach a treatment facility. Recommendations for development options are presented in the following section.

2 Proposed Development

The Structure Plan for the proposed development relates to a 120 ha area that is currently zoned a mix of Future Urban, Light Industry and General Business usages. The proposed development would involve zone changes to create both Residential and Business zoned areas. Proposed zoning as well as potential development staging plans are attached in appendix A.

The larger Structure Plan area has been delineated into several potential development stages of which construction may be sequenced (refer to appendix A). In Table 17 below, Stage 1 (Falls Rd) approximately contains 50 Lots and is intended to be complete by March 2020. The remaining stages are all not intended be completed until early 2022 and onwards which is in line with Watercare Services Limited's intended timing for the Snells / Algies WWTP and associated infrastructure upgrades.

Table 17 - Proposed Development Stages

Stage	No. of Houses	Daily Wet Weather Wastewater Volume (m^3)	Peak Wet Weather Flow (L/s)	224c Timing
Stage 1 (223 Falls Rd)	50	75	2.60	March 2020
Stages 2 through to 8B	1060+	1833	63.64	2022 onwards

Since 223 Falls Road will need to be serviced before the 2022 an interim solution utilizing the existing WWTP's capacity as well as manging the existing reticulation networks capacity shortfalls will be required for stage 1 alone, unless the planned upgrades are completed sooner.

3 Wastewater Servicing Options

From our analysis of the existing Warkworth wastewater network and the proposed development site, several wastewater servicing options were identified and are described below. These options are to be read in conjunction with the Wastewater Servicing Plan, which is included in the Appendix E. A brief discussion of each option is included to provide background on the considerations taken in developing the proposed wastewater servicing plan and determining the best and most practicable option.

3.1 Wastewater Network Type

3.1.1 Low Pressure Sewer Option

Part of the wastewater network in the southeast part of Warkworth runs on a Low-Pressure system to pump flows to the existing wastewater treatment plant. This system requires each household to have a small local pumping station at the connection into the network. One of the primary benefits of a pressurised system is that the pipe alignments are less constrained by topography (compared to a gravity sewer), so crests and rising levels can be navigated while maintaining flow. There are also benefits in ease of construction and initial costs to developer, as the pipes are relatively small and easy to install.

The cost of the local pumping stations at each lot are typically passed on to the end user. The additional cost may be prohibitive depending on the developer's financial approach and market intentions. In the case of this development site in Warkworth, the developer has expressed a preference for affordable

housing, in response to shifts in the housing market and anticipated future demand. This may make the Low-Pressure Sewer option less desirable for the developer.

The Low-Pressure Sewer Option may also have limitations when designing for future growth, as it can be difficult to build in excess capacity while maintaining the required velocity.

For these reasons this is not a favourable option.

3.1.2 Gravity to Pump Station Option

A combination of gravity and pressure network could be achieved by constructing a simple gravity network to a local pumping station. Although the initial installation cost would be higher than a low-pressure network, there is greater ability to accommodate future growth by building in extra capacity while meeting velocity requirements. There is already precedent for this kind of arrangement with the Palmer Street WWPS, which is fed by gravity network by the surrounding lots.

There is a potential site for a new WWPS in the southwest corner of the development site, on the south of Falls Road. The 1.3 ha lot is owned by Auckland Council, and is currently under discussion for its proposed usage. A new WWPS in this location could service the development site, as well as future developments and the nearby Future Urban zones.

This is the favourable option because it will be a final outcome that will contribute to the full future upgrade.

3.2 Possible Connection Points

Several options for connecting into the existing or planned wastewater network were identified, taking into account the network capacity, topography, and timing of planned works.

3.2.1 Possible Connection Point 1: Intersection of Falls Rd and View Rd

There is a possible connection point near the intersection of Falls Road and View Road, which is near the top of the existing gravity pipeline route that was assessed in the capacity assessment. This connection point is the closest to the development site of the four connection points evaluated. However, the capacity assessment showed that the existing network downstream would not have the reserve capacity to accommodate the post-development wastewater flows, so upgrades may be required. The pipe sections potentially requiring upgrades would be located in a mixture of private property (e.g. Falls Road and Albert Road) and public land (e.g. Elizabeth Street and Queen Street), so the success of this option would be dependent on landowner consent and local government approval if an upgrade was required.

3.2.2 Possible Connection Point 2: Albert Road Crossing

The existing network crosses Albert Road perpendicular to the road corridor, between 12 and 14 Albert Road. This is another possible connection point for a gravity to pump station system that is relatively close to the development site (approximately 250m further than Possible Connection Point 1). This route would avoid some of the private properties that might require upgrades in Possible Connection Point 1, which would potentially make it a more feasible option. The same downstream capacity issues would exist, so mitigation measures may need to be implemented to manage reticulation capacity issues in the downstream network. (e.g. Elizabeth Street and Queen Street).

3.2.3 Possible Connection Point 3: Snells/Algies Conveyance Pipeline

Watercare's proposed wastewater conveyance route along Sandspit Road includes several pumping stations, to maintain the pressure required to reach the planned Snells/Algies WWTP. There are numerous connection points along this proposed line. Connecting directly to the conveyance line has long term benefits, as it ties directly into Watercare's future design intentions and bypasses the existing network and its capacity issues. Input from Watercare would be required regarding feasibility, capacity, and pumping requirements.

From initial consultation with Watercare, we understand that a new wastewater pump station (WWPS) is planned to be constructed in the vicinity of the Warkworth Show Grounds by 2022. This would then pump to the conveyance line. A WWPS in this location could not service the entire structure plan area via gravity but it could be used as the long-term connection point if pumped to from another WWPS.

3.2.4 Possible Connection Point 4: Existing Pressure Sewer to Warkworth WWTP

There is an existing pressure network that extends into Mansel Drive, to the south of the development site. This is a possible connection point for a pressure sewer that would then flow on to the existing Warkworth WWTP. The current capacity of the pressure network downstream of Mansel Drive is unknown, and it is assumed that since the network has not been designed for the additional sites, it is likely that upgrades would be required. It is our understanding that when the planned Snells/Algies WWTP is operational, the flows arriving at the current Warkworth WWTP will be pumped back through the town centre and up Sandspit Road. While connecting the development site to this network may be convenient in the short term, it appears to be inefficient in the long term, unnecessarily increasing the distance that wastewater needs to be pumped.

4 Proposed Wastewater Servicing Plan

After reviewing the above options, a proposed Wastewater Servicing Plan was developed, which is included in Appendix E of this report.

It is proposed to use the Gravity to Pump Station Option for wastewater servicing of the new developments. The new lots in the Stubbs Farm and Falls Road areas would be serviced by a local gravity reticulation system flowing to WWPS-1 proposed on the section of land in the southeast corner of the Structure Plan area. In the Interim WWPS-1 would pump wastewater via a rising main up Falls Road and along Albert Road to Possible Connection Point 2; Albert Road Crossing (PCP2). Then in 2022 once the conveyance pipeline is operational, either;

1. a rising main directly from WWPS-1 to “Possible Connection Point 3: Snells/Algies conveyance pipeline” will be installed, or;
2. If WWPS-2 is operational/preferred by watercare, a new gravity main down Albert Road and Hudson Road can be installed taking the wastewater flows from PCP2 to WWPS-2 which would then pump it to the conveyance pipeline.

As discussed earlier, the existing gravity reticulation network is at capacity so mitigation measures to manage additional wastewater loads in the interim may be required. This and other key issues around the proposed servicing plan are summarised in the following sections.

4.1 WWPS Location - 1

The preferred location for the new WWPS is the 1.0 ha lot in the southwest corner of the Structure Plan Area, south of Falls Rd. The topography of the site would allow the Stubbs Farm area and the majority of the Falls Rd area to flow to the WWPS via a simple gravity reticulation system. The only exceptions are some local low points in the southeast corner of the Falls Rd area, which could be incorporated into the network by using small localised pumping up to a nearby gravity main.

Another benefit of this WWPS location is that gravity reticulation could be achieved for the surrounding Future Urban areas, including the West Catchment A (71 ha), and South Catchment (477 ha) shown on the Wastewater Servicing Plan. Although there may be some geographical features that require extra design to circumvent, the local topography would allow gravity drainage for this extended area. The WWPS could be designed with capacity to accept wastewater from these regions, should they undergo a similar process of zone changes. The northernmost catchments, North Catchment C (64 ha) and North Catchment D (100 ha), would be able to flow by gravity to the east towards the Warkworth Town Centre, and either connect to the existing network, or tie into the new conveyance line towards the Snells/Algies WWTP.

Due to the proximity of this WWPS location with the Mahurangi River, there is a known flood risk with the site. Because of the size and grade of the lot, it is our opinion that it would be achievable to construct an adequately sized WWPS outside of the flood plain. An existing site plan of the potential site is attached in Appendix D, Figure 34 on the following page is an image of the site taken from Falls Road.

Figure 34 - Image of potential WWPS site (Taken by N. Jull 31/03/2017)

4.1.1 Current Ownership Status

Figure 35 below is a proposed subdivision plan for 223 Falls Road in Warkworth which has been approved by Environment Court consent order. Proposed Lot 8 is the relevant parcel of land. Lots 7, 8, 9 and 10 on Figure 35 are land areas for which there is a compensation certificate registered against the title to the land holding (Lot 2 DP 210933) that the land owner at the time the land take was negotiated, will be compensated for the land. The following is our understanding of the current intended future use of the land;

Lot 7 is to be vested as road for the Mansel Drive extension which has been constructed and that new road is open. The remainder of the land (Lot 8, 9 & 10) is to be vested to Auckland Council for an unknown use or as Esplanade Reserve. We understand that Auckland Transport has engaged Warkworth Surveyors to undertake the surveying work and the developer is in communications with Auckland Transport road legalisation staff regarding the implementation of the road legalisation process to ensure that process does not compromise the developer's subdivision and future development of that land holding.

Figure 35 - Proposed Subdivision of 223 Falls Road, Warkworth (Buckton's)

4.1.2 Alternate Location for WWPS-1

An alternative location for WWPS-1 would be in the Stubbs Farm area, adjacent to Falls Road on the north side. Construction of a WWPS here would replace several lots that are part of the proposed development. This is a feasible option, but has a negative economic impact for the developer, and complicates the issues of ownership and cost-sharing between the developer and Watercare.

4.2 Interim Connection into Existing Network

Until the completion of the new conveyance line towards the Snells/Algies WWTP (expected in 2022), it is proposed to connect the pumped wastewater flows into Possible Connection Point 2: Albert Street Crossing, which flows to the Warkworth WWTP. The indicative alignment is shown on the Wastewater Servicing Plan in Appendix E.

Because the existing network is at capacity, as detailed in the Wastewater Capacity Assessment in Appendix E, mitigation measures may be required. Therefore, we suggest that WWPS-1 be designed to allow for off-peak pumping. In a meeting between Chester and Watercare on 22/03/2017, it was discussed that a flow monitoring system could be installed to monitor the existing network and utilise its capacity during off-peak times and use the excess storage within WWPS-1 when the existing network is receiving peak flows. This removes the need for any upgrades in the existing network. Because WWPS-1 would be constructed to service the entire structure plan area but in the interim would only need to service the 51 Lots from stage 1, there would be plenty of excess storage available to allow for off peak pumping.

4.3 Connection into New Conveyance Line

It is proposed to connect into Watercare's new conveyance line towards the Snells/Algies WWTP. Because the design of this conveyance line has not been finalised yet, there is an opportunity to incorporate this connection into the design of the pumping stations. The proposed connection point is Possible Connection Point 3: "Pump Station 2" Towards Snells/Algies WWTP, and the indicative alignment is shown on the Wastewater Servicing Plan in the Appendix.

4.4 WWPS-2 Location

As shown on the Wastewater Servicing Plan in the Appendix an additional wastewater pump station location is indicated in the vicinity of the Warkworth Show Grounds, north east of the structure plan area. We have been advised by Watercare that this is a likely location for a new WWPS. As such we have included this in our servicing plan as another option to drain wastewater to.

To date we have been provided limited information regarding this WWPS but assume it would be operational by 2021-2022 and would pump to the conveyance pipe line. It is practical to drain the northern half of the structure plan area to this location via gravity. However, the southern half would still need to either gravity down to WWPS-1 or be reticulated with a low-pressure sewer network (LPS).

In our opinion, the best practical option whilst accounting for WWPS-2 would be to install WWPS-1 sized to service the structure plan area and pump to Proposed Connection Point 2 (PCP2). In the interim wastewater can go into the existing gravity network at PCP2 then when WWPS-2 is operational a new gravity main can be extended up Hudson Road and Albert Road linking PCP2 to WWPS-2.

5 Funding Proposal

The proposed developer contributions towards the capital cost of new public assets / upgrade of existing assets in order to service the Stubbs Farm and Falls Road developments is as per Table 18. The costs are provided solely for the purpose of supporting the Structure Plan submission. They are indicative only and subject to further discussion and negotiation with Watercare.

Table 18 - Proposed developer contributions for public wastewater upgrades

Capital Upgrade	Developer Contribution	Estimated Contribution	Comment
New WWPS	100%	$ 1,200,000	Cost estimate based on WWPS sized for the Future Urban areas north of the Mahurangi River. This will allow for capacity to balance short term peaks to protect the gravity network. Upgrade costs for future growth in the Warkworth south catchment excluded.
Rising Main to PCP3	100%	$1,800,000	Cost estimate based on construction of new rising main to service entire area, from WWPS to PCP3.
Flow management	100%	$ 500,000	Cost estimate based on provision of flow monitoring and telemetry required to manage flows into the existing gravity network, until future transfer pipeline to Snells Beach WWTP is constructed. Cost of increased holding capacity at WWPS included in estimate above.
TOTAL		$3,500,000	

5.1 New Wastewater Pump Station

The cost to design and construct a new wastewater pump station sized to service the Future Urban growth area north of the Mahurangi River is estimated at $1.2m. The pump station should be designed to enable future capacity upgrades to service future growth as required. As the pump station is required exclusively to service the Warkworth North Structure Plan area in the short term, it is proposed the developer funds 100% of the construction cost of this asset. Watercare will need to acquire the 1.3 hectares of land from Auckland Council as indicated on the Servicing Plan, which could potentially be used for locating the WWPS.

5.2 Wastewater Rising Main

As per the Wastewater Servicing Plan, an indicative alignment for a rising main to service the Structure Plan area is shown with an interim connection point (PCP2) to the existing gravity main and a long-term connection point (PCP3) into the future transfer main. The future transfer main is scheduled for completion in 2022 at the latest and will convey wastewater flows from the Warkworth area to Snells Beach / Algies Bay Wastewater Treatment Plant. It is proposed the developer funds the entire length of the rising main from WWPS to PCP3, including the temporary connection at PCP2.

5.3 Gravity Main Flow Management

As outlined earlier in this report, the interim servicing solution involves connecting the new rising main into the existing gravity network at PCP2, to direct wastewater flows to the Warkworth Wastewater Treatment Plant. The existing gravity main is currently undersized to accommodate the full development (as highlighted in the capacity assessment). Two options have been considered for managing flows through the gravity main:

- Option 1 – upgrade main to cater for future flows. Cost estimate $600,000 (based on 1.2 km of main ranging from DN225 to DN750).

- Option 2 – Size the new WWPS and install downstream flow monitoring system to balance peak flows into the gravity network.

As this work is required to service interim development only (ie. prior to the Snells Beach transfer main), it is proposed the developer contributes 100% to the construction cost of flow monitoring to manage flows through the gravity main.

5.4 Benefits to Greater Area

As indicated above and in the Wastewater Servicing Plan (CCL Drawing 500 in the Appendix), the proposed wastewater pump station and rising main will not only serve developments within the proposed Structure Plan area, but also have the potential to service the wider Warkworth North area currently designated Future Urban. Table 19 outlines the areas that could benefit from the proposed public works, and their relative flow contributions, which equate to 83% of total flows.

Table 19 - Wastewater Catchment Areas serviced by Proposed Public Works

	Catchment	Area (ha)	PWWF (m3/d)
Structure Plan	Falls/Stubbs developments	54	795
	North Catchment A	19	290
	North Catchment B	24	420
	East Catchment A	7	123
	SE catchment	12	183
	Sub-total	116	1811
Other developments	West Catchment B	18	275
	West Catchment A	71	1085
	South Catchment	477	7272
	Sub-total	566	8632

SECTION F: UTILITIES

1 Utilities

1.1 Telecommunications

We have liaised with Chorus Network planning staff and service team in regard to provision of telecommunications reticulation infrastructure to the proposed developments in Stubbs Farm and Falls Road Estate.

We have been informed that the existing telecommunications infrastructure in the area is large capacity fibre-optic cable running along Falls Rd & Hudson Rd, with ducting in place to install more if/when required.

Chorus have also confirmed:

- The proposed development can be serviced with reticulated telecommunications infrastructure
- Chorus would provide ABF (air blown fibre) telephone reticulation to the proposed development
- There are no issues or constraints in the provision of telecommunication services to the development
- No overhead infrastructure would be required

A preliminary offer of service has been provided for the provision of reticulated telecommunications services to the proposed development. A copy of the offer of service is provided in the Appendix.

Records of correspondence with Chorus and offer of service are also provided in Appendix G.

1.2 Power

By other

SECTION G: SUMMARY AND CONCLUTION

1 Summary

This report was prepared to inform the Warkworth North Structure Plan and Plan Change on behalf of SF Estate Limited. This report investigated the civil engineering opportunities and constraints relating to the land and infrastructure in the structure plan area. The specific components undertaken by Chester included bulk earthwork design, flood hazard mapping, preparation of a stormwater catchment management plan, water supply servicing design, wastewater servicing design and investigation into utilities. Each section of the report is summarised below.

1.1 Land Formation

The existing land formation over the structure plan area is mostly steep with some flat lower lying areas to the east and northeast. In our opinion the proposed zoning over the structure plan area is what is most appropriate for the topography. The built form/earthworks required to enable the proposed land use is considered consistent and in keeping with the natural topography.

1.2 Stormwater Catchment Management Plan

Flood hazard mapping of the structure plan area indicates that the majority of the structure plan area is not likely affected by flooding apart from some lower lying areas along stream. The flood risk in these lower areas are managed by the proposed zoning through green belts which will enable the flood flows to be conveyed clear of development.

The structure plan area itself is located in the lower portion of the Mahurangi river catchment and is relatively small compared to the wider Mahurangi catchment. Our assessment indicated that development in line with the proposed zoning will have a less than minor effects on flooding within the Mahurangi catchment therefore attenuation for the 1% AEP and 10% AEP storm events is not considered necessary.

The receiving environment from the catchment contains streams which warrant stream management. We have recommended that the Stormwater Management Area – Flow 1 (SMAF1) requirements of the Auckland Unitary Plan be implemented over the structure plan area to provide the required mitigation. We have demonstrated that this will be achievable within the proposed zoning. However, we do note that some of the retention specific requirements of SMAF1 will not be possible in certain areas due to topographic and geological constraints. In these areas detention can be provided in place of retention which is in line with SMAF1 requirements. We have recommended a variety of tools that can be implemented to achieve SMAF1 requirements.

In summary, stormwater can be managed in the catchment whilst allowing for the development associated with the proposed zoning to occur.

1.3 Water Supply Servicing Plan

The structure plan area with the proposed zoning can be serviced for water supply once infrastructure upgrades which are already underway are completed. Distribution networks subject to specific design will be required.

1.4 Wastewater Servicing Plan

The structure plan area with the proposed zoning can be serviced for wastewater. There are short term options that can allow for interim development to occur and Watercare have major upgrades proposed which will allow full development to occur by 2022. Reticulation networks subject to specific design will be required.

1.5 Utilities

Our understanding is that there are no major constraints restricting telecommunications or power infrastructure from being installed to service the structure plan area.

1.6 Conclusion

In relation to the civil engineering constraints and opportunities we support the structure plan application and recommend that the zone change is implemented.

APPENDIX

APPENDIX A: GENERAL

Proposed Warkworth North Plan Change

Date: 02/04/2019

Proposed Zoning Map

Plan Change Extent

Land Parcels

Unitary Plan Zones

- Residential - Large Lot Zone
- Residential - Single House Zone
- Residential - Mixed Housing Suburban Zone
- Residential - Mixed Housing Urban Zone
- Open Space - Conservation
- Open Space - Informal Recreation
- Open Space - Sport and Active Recreation
- Business - Neighbourhood Centre Zone
- Business - General Business Zone
- Business - Light Industry Zone
- Future Urban Zone
- Rural - Rural Production Zone
- Rural - Mixed Rural Zone
- Special Purpose - Healthcare Facility and Hospital Zone

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REVISION	DATE	COMMENT	CHECK
5	20/12/2018	ZONE BOUNDARIES	NJ
6	11/01/2019	NEIGHBOURHOOD ZONE	NJ
7	18/01/2019	ZONE BOUNDARIES	NJ
8	22/03/2019	LEGEND	NJ
9	2/04/2019	LEGEND	NJ

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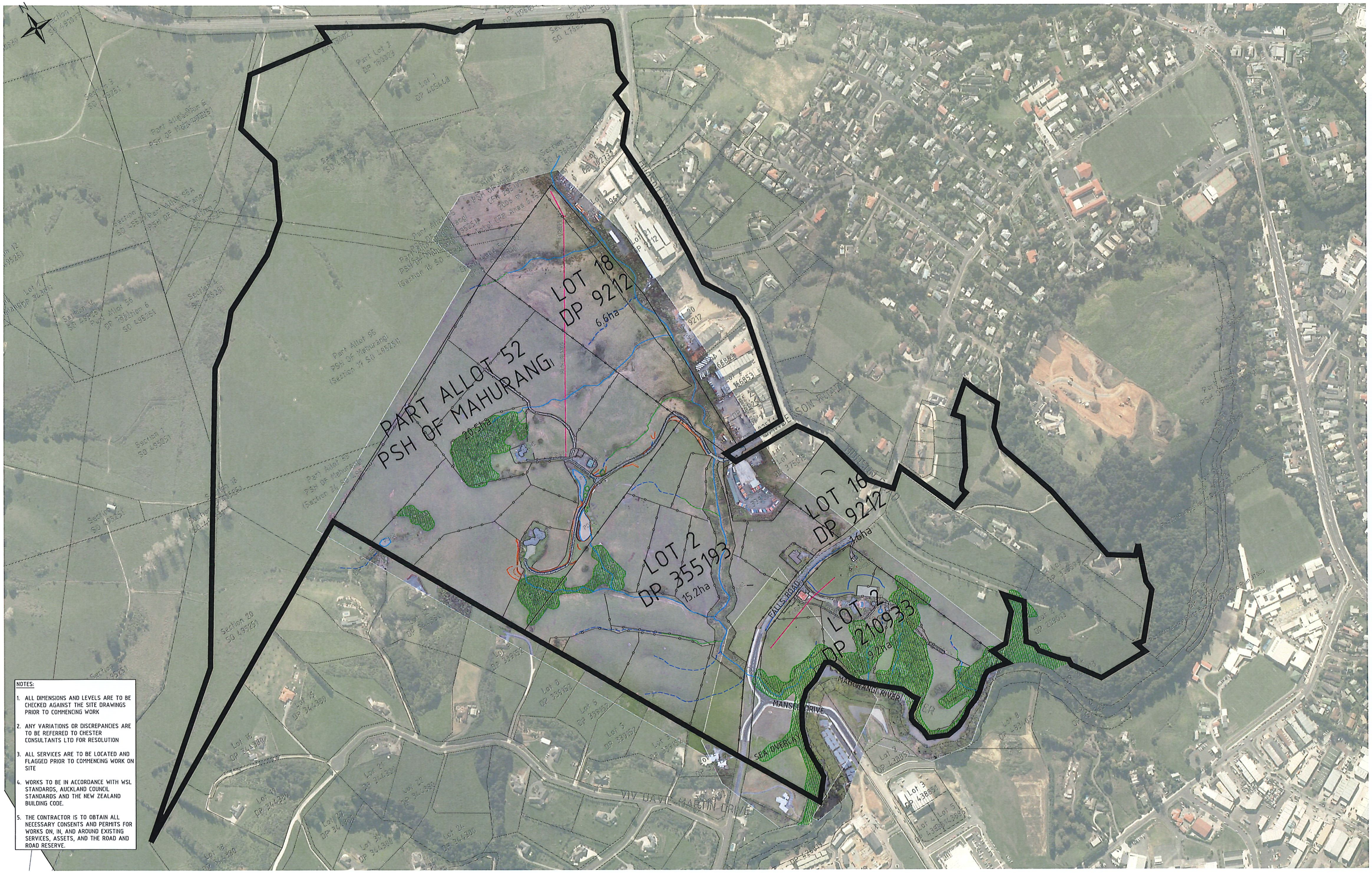

NOTES:

1. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED AGAINST THE SITE DRAWINGS PRIOR TO COMMENCING WORK
2. ANY VARIATIONS OR DISCREPANCIES ARE TO BE REFERRED TO CHESTER CONSULTANTS LTD FOR RESOLUTION
3. ALL SERVICES ARE TO BE LOCATED AND FLAGGED PRIOR TO COMMENCING WORK ON SITE
4. WORKS TO BE IN ACCORDANCE WITH WSL STANDARDS, AUCKLAND COUNCIL STANDARDS AND THE NEW ZEALAND BUILDING CODE.
5. THE CONTRACTOR IS TO OBTAIN ALL NECESSARY CONSENTS AND PERMITS FOR WORKS ON, IN, AND AROUND EXISTING SERVICES, ASSETS, AND THE ROAD AND ROAD RESERVE.

REV	DATE	AMENDMENTS	CHECKED

Design:	N. JULL
Date:	24.03.2017
Check:	S. RANKIN
Job No:	11085

Subject:	WARKWORTH NORTH - STRUCTURE PLAN
Client:	SF ESTATE LTD
Address:	NORTH WARKWORTH, AUCKLAND, NEW ZEALAND
Drawing Title:	STRUCTURE PLAN AREA EXTENT

Drawing No:	100
Revision No:	0
Scale:	1:3000 @ A1
Issued for:	PLAN CHANGE

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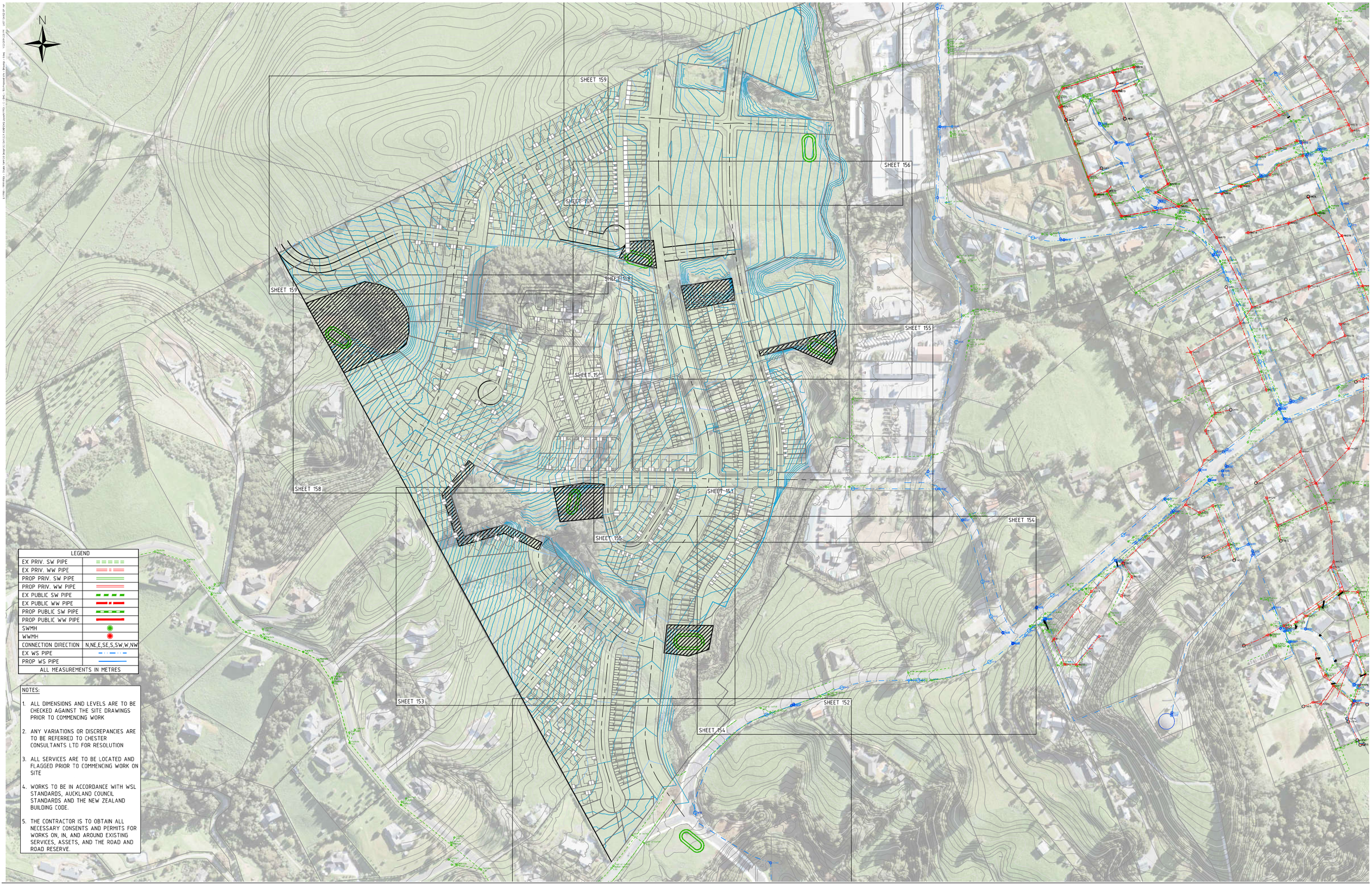
APPENDIX B: LAND FORMATION



REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN OVERVIEW

Drawing No:	151
Revision No:	1
Scale:	1:2000 @ A1
Issued for:	SP

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LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
PROP PRIV. WW PIPE	
EX PUBLIC SW PIPE	
EX PUBLIC WW PIPE	
PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

NOTES:

1. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED AGAINST THE SITE DRAWINGS PRIOR TO COMMENCING WORK
2. ANY VARIATIONS OR DISCREPANCIES ARE TO BE REFERRED TO CHESTER CONSULTANTS LTD FOR RESOLUTION
3. ALL SERVICES ARE TO BE LOCATED AND FLAGGED PRIOR TO COMMENCING WORK ON SITE
4. WORKS TO BE IN ACCORDANCE WITH WSL STANDARDS, AUCKLAND COUNCIL STANDARDS AND THE NEW ZEALAND BUILDING CODE.
5. THE CONTRACTOR IS TO OBTAIN ALL NECESSARY CONSENTS AND PERMITS FOR WORKS ON, IN, AND AROUND EXISTING SERVICES, ASSETS, AND THE ROAD AND ROAD RESERVE.

REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 102

Drawing No:	152
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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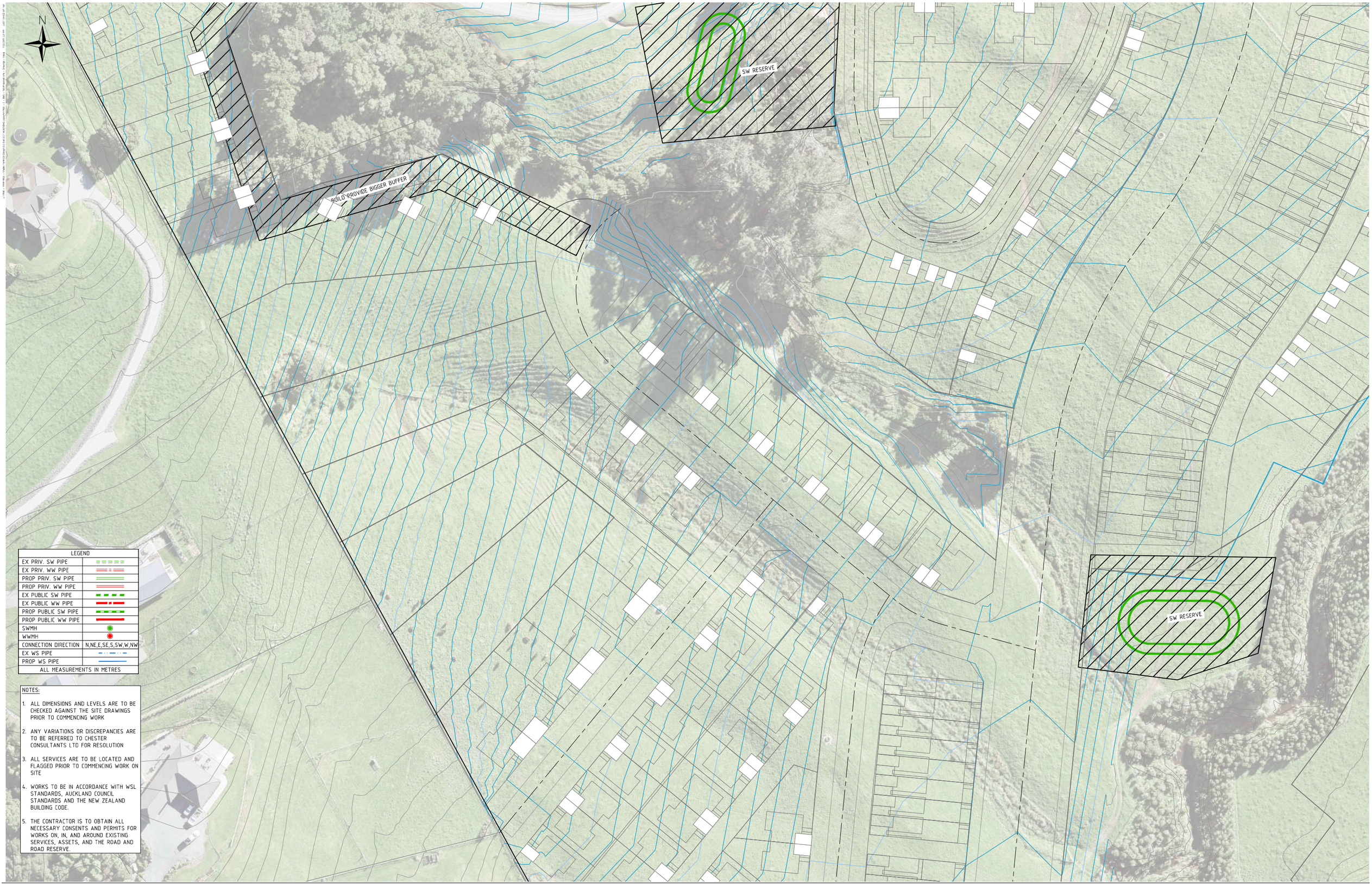

LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
PROP PRIV. WW PIPE	
EX PUBLIC SW PIPE	
EX PUBLIC WW PIPE	
PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

NOTES:

1. ALL DIMENSIONS AND LEVELS ARE TO BE CHECKED AGAINST THE SITE DRAWINGS PRIOR TO COMMENCING WORK
2. ANY VARIATIONS OR DISCREPANCIES ARE TO BE REFERRED TO CHESTER CONSULTANTS LTD FOR RESOLUTION
3. ALL SERVICES ARE TO BE LOCATED AND FLAGGED PRIOR TO COMMENCING WORK ON SITE
4. WORKS TO BE IN ACCORDANCE WITH WSL STANDARDS, AUCKLAND COUNCIL STANDARDS AND THE NEW ZEALAND BUILDING CODE.
5. THE CONTRACTOR IS TO OBTAIN ALL NECESSARY CONSENTS AND PERMITS FOR WORKS ON, IN, AND AROUND EXISTING SERVICES, ASSETS, AND THE ROAD AND ROAD RESERVE.

REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924
Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 103
Drawing No:	153
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
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EX PUBLIC SW PIPE	
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PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

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REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924
Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 104
Drawing No:	154
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
PROP PRIV. WW PIPE	
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PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

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REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM – PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN – SHEET 105

Drawing No:	155
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
PROP PRIV. WW PIPE	
EX PUBLIC SW PIPE	
EX PUBLIC WW PIPE	
PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

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REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 106

Drawing No:	156
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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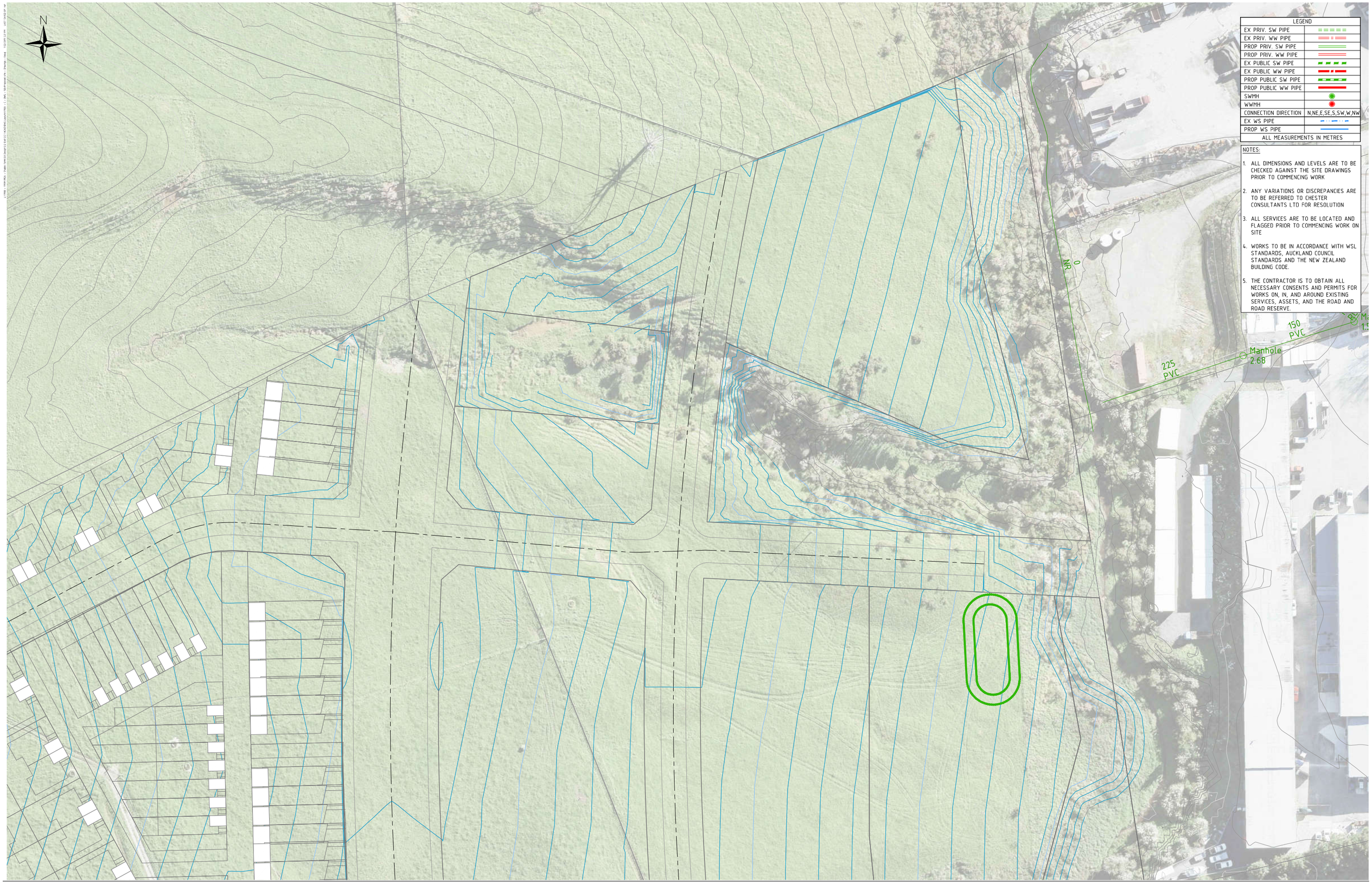

REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 107

Drawing No:	157
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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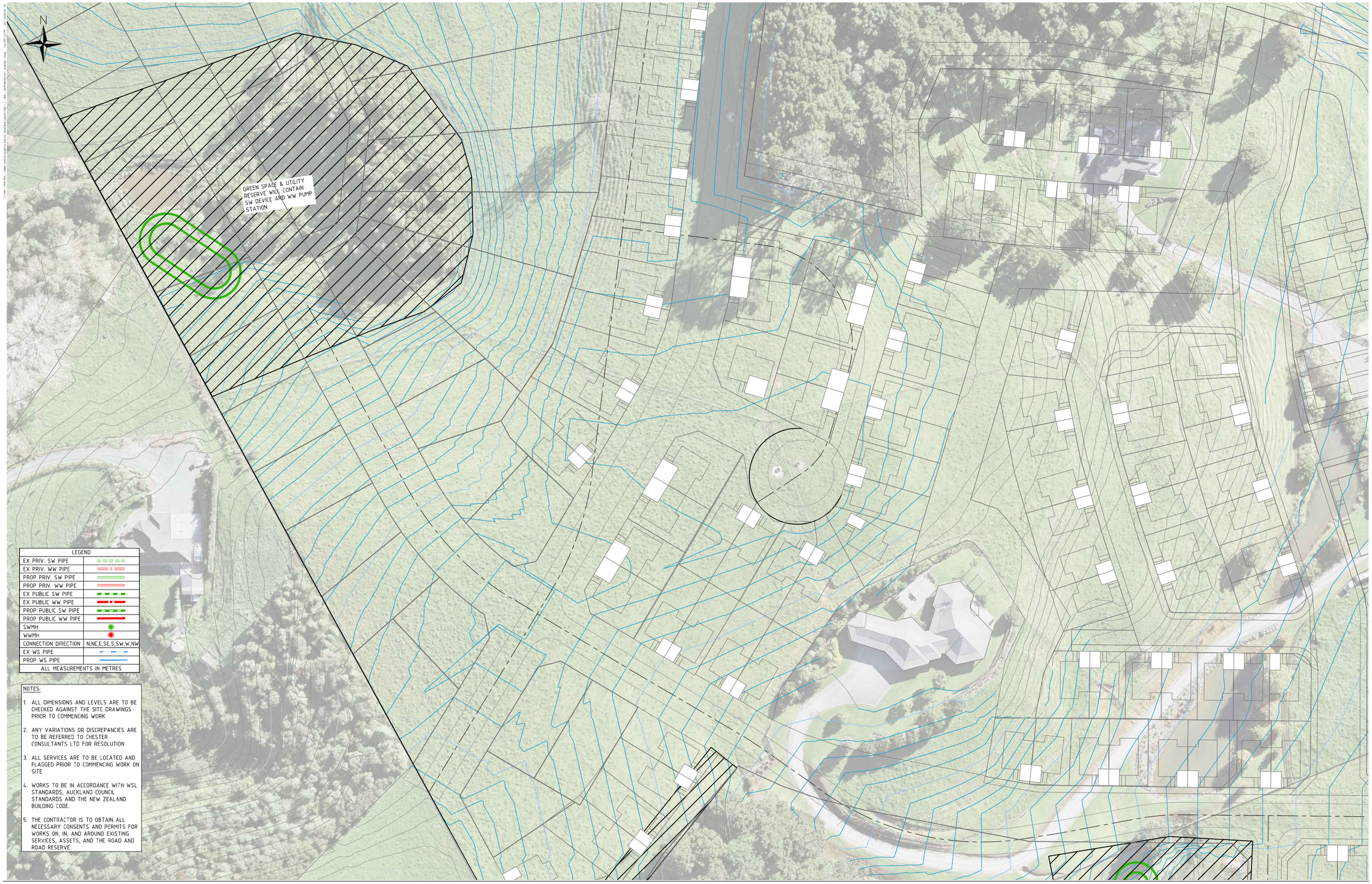

LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
PROP PRIV. WW PIPE	
EX PUBLIC SW PIPE	
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PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

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REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 108

Drawing No:	158
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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LEGEND	
EX PRIV. SW PIPE	
EX PRIV. WW PIPE	
PROP PRIV. SW PIPE	
PROP PRIV. WW PIPE	
EX PUBLIC SW PIPE	
EX PUBLIC WW PIPE	
PROP PUBLIC SW PIPE	
PROP PUBLIC WW PIPE	
SWMH	
WWMH	
CONNECTION DIRECTION	N,NE,E,SE,S,SW,W,NW
EX WS PIPE	
PROP WS PIPE	
ALL MEASUREMENTS IN METRES	

NOTES:

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REV	DATE	AMENDMENTS	CHECKED
1	22/01/2019	SECTION 32 ASSESSMENT UPDATE	S. RANKIN

Design:	S SHIPIN
Date:	22/01/2019
Check:	N JULL
Job No:	11924

Subject:	STUBBS FARM - PRELIMINARY CIVIL ENGINEERING DESIGN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH, PT ALLOT 52 PSH OF MAHURANGI, LOT2 DP355193, LOT16, 18 DP9212
Drawing Title:	PROPOSED SITE PLAN - SHEET 109

Drawing No:	159
Revision No:	1
Scale:	1:500 @ A1
Issued for:	SP

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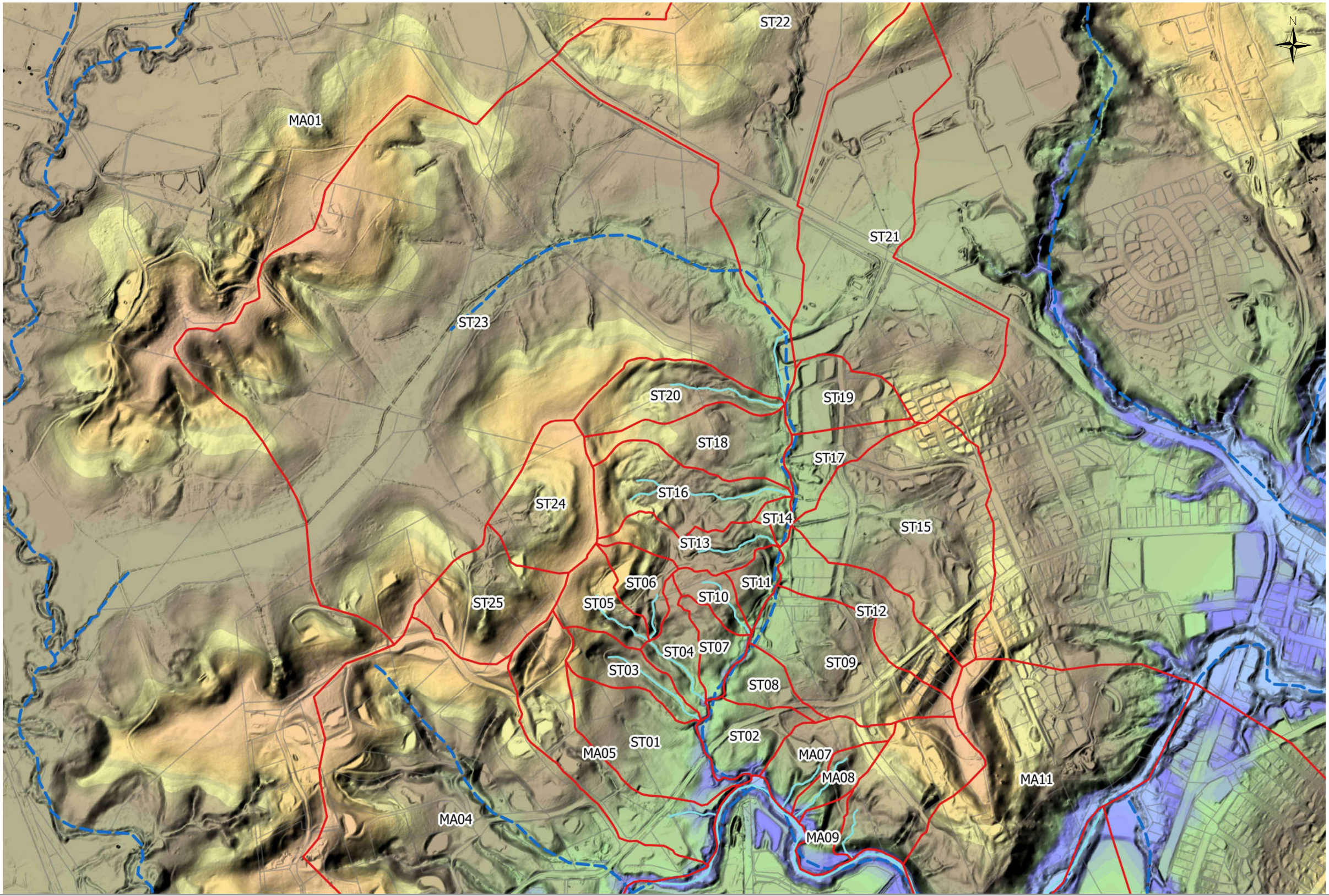
APPENDIX C: STORMWATER CATCHMENT MANAGEMENT PLAN



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#	#	#	#
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REV	DATE	AMENDMENTS	CHECKED

Design:	J CURTIS
Date:	15.03.2017
Check:	N JULL
Job No:	11875

Subject:	FLOOD RISK ASSESSMENT
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH
Drawing Title:	CATCHMENT PLAN

Drawing No:	900
Revision No:	0
Scale:	NTS
Issued for:	RC

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