Auckland Council
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Official Height Standard Change

From 1 July 2024, Auckland Council adopts the official height standard for New Zealand called New Zealand Vertical Datum 2016 (NZVD2016).

This model was carried out prior to the height standard change.

All levels included in this modelling report are in Auckland Vertical Datum 1946 (AUK1946/AVD1946).

Levels in this report can be transformed from Auckland Vertical Datum 1946 into New Zealand Vertical Datum 2016 by applying an offset value of 0.264 m.

For example:

$$H_{NZVD2016} = H_{AVD1946} – \text{Offset Value}$$

A single offset value for the catchment has been taken from the Land Information New Zealand (LINZ) Auckland 1946 to NZVD2016 Conversion Raster therefore this offset should be taken as an approximation only for the catchment.

A more accurate height transformation value can be derived by downloading the conversion raster available on the LINZ website below:

https://data.linz.govt.nz/layer/103953-auckland-1946-to-nzvd2016-conversion-raster/

PAPAKURA STREAM CATCHMENT

CATCHMENT MANAGEMENT PLAN

Model Extents and Data Assessment Report

July 2012

DRAFT

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QUALITY RECORD SHEET

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Description

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DOCUMENT CONTROL

Distribution List

The following organisations shall receive a copy of this document on release:

Organisation
AC Stormwater Unit Catchment Planning South
AC Stormwater Hydraulic Modelling Team

Revision History

The following table outlines the revision history of this document:

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Draft	31 March 2012	**Larry Shui**
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Sign-off

The following persons have reviewed the document for its release:

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ABBREVIATIONS

AEP	Annual Exceedance Probability
ARI	Annual Reoccurrence Interval
BMP	Best Management Practices
BPO	Best Practicable Options
ERC	Environmental Response Criteria
HGL	Hydraulic grade lines
ICMP	Integrated Catchment Management Plan
LGA2002	Local Government Act 2002
LTP	Long term council community plan
MCA	Multi-criteria analysis
MHWS	Mean high water spring tide
MHWN	Mean high water neap tide
MLWN	Mean low water neap tide
MLWS	Mean low water spring tide
MSL	Mean seal level
MUL	Metropolitan Urban Limit – a statutory urban limit for the Auckland Region managed by ARC
NZBC	New Zealand Building Code
NZGD 2000	New Zealand Geodetic Datum 2000
NZTM	New Zealand Transverse Mercator – a kind of projection for definition of X and Y coordinates

DEFINITIONS

Astronomical Tide	Highest tide on record due to tidal movement with the coinciding of the Earth, Moon and Sun on line and occurs every 18.6 yearsDrainage System
Model	The mathematical representation of physical process involved in runoff and stream flow.
Floodplain	The portions of the low lying land or valley adjacent to a river or stream, which becomes inundated during floods. Although the actual flow velocity in the floodplain could be very low, but the storage volume serves the function of attenuating the peak discharge.
Flood Prone Area	Areas predicted to be prone to flooding due to blockage of culverts or bridges.
Floodway	The main channel of a river and the stream and the immediate fringe areas critical for conveyance of flood water. No encroachment should be allowed.
Flood Storages	Those parts of the floodplain that are important for the temporary storage of flood water during the passage of a flood.
Flood Attenuation	Reduction in peak discharge due to storage and lagging effects.
Habitable Floor	A building floor for human occupations such as a lounge room, rumpus room, kitchen and bedroom etc.
Hydraulic	A term given to the study of water flow, in particular, the prediction of flow depth, velocity, water surface profile, energy grade line and energy losses.
Hydrology	A term given to the study of rainfall and runoff process in a catchment taking into account parameters such as imperviousness, ground infiltration, depressional storage and evapotranspiration.
Model Calibration	The practice of adjusting a few hydrologic and hydraulic parameters (within reasonable bounds) to replicate the observed flows and stages in one or a few historic rainfall events.
Model Validation	The practice of running model simulations on one or a few historic events (not used in model calibration) for comparisons with observed flows and stages on a stream. This term sometime is used interchangeably with the term model verification.

EXECUTIVE SUMMARY

ES.1 Introduction

A few hydraulic models have been carried out for the Papakura Stream Catchment. However, after a review by the Auckland Council Modelling Team, significant shortcomings have been identified with these models, which will severely hinder the future ecatchment management practice in this catchment:

- The existing hydraulic models for the streams and urban drainage system were separate as such it prevents investigating solutions to flooding problems in urban drainage system adjoining the main stream channel in an integrated manner.
- The existing hydraulic models do not cover the tributary streams along which many flooding problems occurred in the past (82, 64 Ranfurly Road, etc).
- There is no reliable flood hazards data for the catchment area.
- Many existing structures, such as culverts and ponds, are not represented in the hydraulic model.
- There are many data gaps with the urban stormwater drainage system. Majority of the drainage assets in the former Manukau Council area, do not have invert information. But only very limited data was captured during previous studies.

Therefore there is an identified need to upgrade the existing drainage system model supported by newly captured data. This new model will provide a tool for investigating flood management planning in this catchment.

ES.2 Modelling Objectives

ICMP forms an important part of stormwater management strategy at Auckland Council. The following objectives have been identified for the Papakura Stream Catchment:

- Produce flood plain maps for the current and future land use scenarios
- To understand the catchment management implications from further land use changes in the catchment
- To understand the performance of the existing pipe network
- To provide a drainage system modelling toolset to enable future optioneering in dealing with various issues in the catchment.

ES.3 Previous Studies and Models Built

A comprehensive Flood Management Plan (FMP) was prepared for the Papakura Stream Catchment in 1993 by Beca for the former ARC. This FMP provides flood levels along the main channel of Papakura Stream, identified main flooding issues and possible management options.

In 2006, the former ARC initiated a new flood management study, and a parallel stream ecological assessment for the Papakura Stream Catchment. These studies have now been completed. Around the same time, the former Manukau City Council engaged GHD to prepare an ICMP for the Pahurehure Inlet receiving environment catchment area which falls inside the former Manukau City Council boundaries. The subcatchment areas included in the MCC Pahurehure Inlet ICMP but also falling within the Papakura Stream Catchment cover Clayton, Nield Road, Manurewa East, Lincoln and Greenmeadows. .

Comprehensive flood management plans were prepared for the Greenmeadow, Nield Road and Clayton subcatchment areas in the early 1990s, with discharge permits still valid for the Greenmeadow and Nield Road areas. For the Clayton subcatchment, only a Mahia Stage 1 subdivision (33ha) has a current discharge consent, and the former MCC has applied for new discharge consent in 2001 for the Clayton subcatchment area. Although, there has been no record for a discharge consent for the Manurewa East subcatchment at Manukau, the Auckland Council network consent team has informed that the discharge consent for this area has expired.

GHD Model – A mouse model covers a few subcatchments in the Papakura Stream Catchment (Manurewa East, Nields Road and Greenmeadow) and subcatchments in Waimahia Creek Catchment. Data capture is poor with a few hundreds of manholes still no lid levels, and pipes with missing or wrong sizes. Built using Model B.

DHI Model – Mike Flood (Mike 11 and Mike 21 coupled model) with 10m grids for the main stream channel only. No hydrologic modelling, inflow time series boundaries were applied. Hydraulic model with 40 crosssections covering approximately 10 major bridge crossings and 21 km stream channels. Main concerns with this model include the following:

- No tributary stream was included in the model.
- Can not model interactions between the urban pipe systems with the stream channel. The extent of the model doesn't cover flooding issues on major tributaries (e.g. Ranfurly Road).
- Unable to test solutions involving drainage upgrade in subcatchment, or checking the implications on the subcatchment overland drainage from stopbanking at main stream channel.

ES.4 Data Sources and Data Gap Analysis

The following table summarises the data types, existing data sources investigated and data gaps identified.

Table ES1: Data Sources and Data Gap Analysis Summary

DATA DESCRIPTION	DATA SOURCES INVESTIGATED	DATA GAPS IDENTIFIED
Drainage network assets data – manholes	Auckland Council GIS Data	**~852 manholes with various attributes missing**
Drainage network assets data – pipes and connectivity	Auckland Council GIS Data, historic as-builts (limited)	**31 pipes with no diameter**
Drainage network assets – inlet and outlet	Auckland Council GIS Data	**151 inlet and outlet structures with no invert levels**
Drainage network – ponds and wetlands	Papakura Pond Manual, Papakura pond as-built and Manukau as-builts.	**4 ponds with no data records**
Stream Cross sections	LiDAR, previous survey data	**69**
Stream crossing structures – bridges and culverts	Previous survey data	**30**
Hydrometric data - rainfall	Auckland Council rain gauge records	**Existing AC Rain Gauges will suffice**
Flow and water level	Auckland Council flow and water level gauge records	**One existing flow and water level monitoring at Great South Road Bridge. No new monitoring proposed.**
Flooding issues	Complaints database, knowledge of operational staff	**No new residents' survey planned at this stage. This decision will be reviewed after the completion of flood hazards mapping.**

ES.5 Data Capture Methods

The following methods and specifications are suggested:

Table ES2: Data Capture Methods Summary

DATA DESCRIPTION	DATA CAPTURE METHOD	SPECIFICATION
Drainage network assets data – manholes	Field survey	Section 5.1.2
Drainage network assets data – pipes and connectivity	Field manhole inspection and CCTV survey	Sections 5.1.4 and 5.1.5
Drainage network – ponds and wetlands	Field survey	Section 5.1.6

DATA DESCRIPTION	DATA CAPTURE METHOD	SPECIFICATION
Stream Cross sections	Field survey	Sections 5.2.1 and 5.2.2
Stream crossing structures – bridges and culverts	Field survey	Section 5.2.3
Hydrometric data - rainfall	N/A	N/A
Flow and water level	No new data capture suggested	N/A
Flooding issues	Residents questionnaires, on-line forms and residents interviews	Auckland Council residents communication protocol

ES.6 Recommendations

Considerable data gaps have been identified at the Papakura Stream Catchment for the purpose of building a hydraulic model of the drainage system. The captured data can also enhance the stormwater drainage asset records in this catchment.

The following actions are recommended:

i That all manholes with missing attributes as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements in Section 5.1.2 of this report.

ii That pipes with missing attributes as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements in Section 5.1.4 of this report.

iii That all culverts including its inlets and outlets with missing attributes as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements in Sections 5.1.3 and 5.1.4 of this report.

iv That all ponds and wetlands with missing attributes as identified in **Table 8** of this report be field surveyed in accordance with requirements in Section 5.1.6 of this report.

v That all stormwater drainage network connectivity anomalies as shown on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be investigated initially by manhole inspection then CCTV survey if found necessary.

vi That all new stream cross-sections to be surveyed as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements set out in Section 5.2.1 of this report.

vii That all bridge structures as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements set out in Section 5.2.3 of this report.

viii That all survey data shall be presented in either Spreadsheet and/or GIS (geodatabase/shape) format, for easy incorporation into the Council asset management system.

1 INTRODUCTION

1.1 Background

The Papakura Stream Catchment comprises existing urban and rural areas with a total catchment area of 5325.8 hectares in the former MCC and PDC territories. The Papakura Stream is a fourth order significant open watercourse draining the catchment. The stream channels are mostly natural except for a section of engineered channel between Porchester Road and Great South Road and where interrupted by road and railway crossings.

The Papakura Stream Catchment encompasses subcatchment areas known as Clayton, Nield Road, Greenmeadows, Lincoln, Manurewa East, Manukau Golf Course, Takanini North, Alfriston, Porchester, Alfriston East, Ardmore and Papakura Stream Upper.

Papakura Stream discharges into Pahurehure Inlet at the edge of Manukau Golf Course. The former Auckland Regional Council has at least two regional discharge monitoring points at Pahurehure Inlet. At these two locations, a range of marine sediment quality parameters are monitored periodically to understand the trend of water and sediment quality.

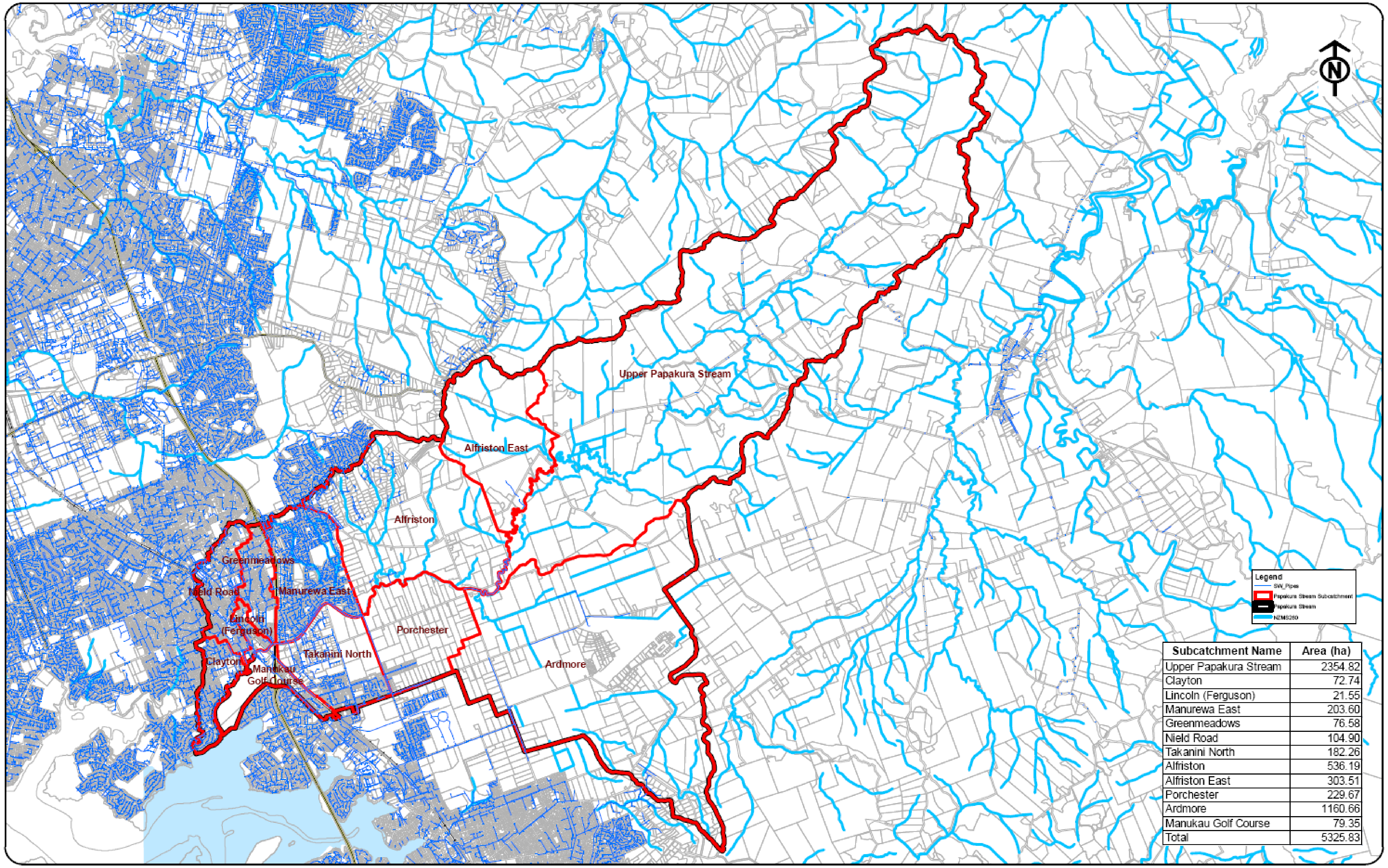
Flooding of properties, residential and commercial buildings occurred mainly in the lower portion of the overall catchment area – in the Clayton Catchment, Nield Road Catchment and Manurewa East subcatchment area. Significant flooding occurs along the main Papakura Stream Channel between NIMT railway bridge and the stream outfall where many industrial/commercial floors are predicted to be prone to flooding.

1.2 Study Objectives

The Papakura Stream modelling study objectives are:

- Produce flood plain maps for the current and future land use scenarios
- To understand the catchment management implications from further land use changes in the catchment
- To understand the performance of the existing pipe network
- To provide a drainage system modelling toolset to enable future optioneering in dealing with various issues in the catchment.

Figure 1: Papakura Stream Catchment Overview Map



Subcatchment Name	Area (ha)
Upper Papakura Stream	2354.82
Clayton	72.74
Lincoln (Ferguson)	21.55
Manurewa East	203.60
Greenmeadows	76.58
Nield Road	104.90
Takanini North	182.26
Alfriston	536.19
Alfriston East	303.51
Porchester	229.67
Ardmore	1160.66
Manukau Golf Course	79.35
Total	5325.83

REV	AMENDMENTS	BY	APV	DATE		NAME	DATE
					DRAWN		
					DESN'D		
					APRV'D		
FILE							

Papakura Stream ICMP Area
Subcatchment Boundaries Map

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1.3 Activities and Scope

The following overall tasks are suggested to progress towards an ICMP:

1. Review the current ICMP models and identify data gaps.
2. Rapid flood hazards mapping for the whole catchment to provide flood plain mapping for the rural areas and identify potential flood prone area in urban catchment areas.
3. Identify modelling data gaps, additional drainage system data capture and stream cross sections survey.
4. Review historic studies and prepare a list of issues and prioritisation.
5. Update drainage system models and stream models if found necessary.
6. Update catchment-wide flood hazards mapping.
7. Further options study to address the catchment issues.
8. Compiling structure measures (works programme) and non-structural (regulatory and preventative) measures and prepare an ICMP.

This report addresses the requirements in Task 3 above: identify modelling data gaps, and specify data capture requirements.

2 Available Information

2.1 Previous Studies

A comprehensive Flood Management Plan (FMP) was prepared for the Papakura Stream Catchment in 1993 by Beca for the former ARC. This FMP provides flood levels along the main channel of Papakura Stream, identified main flooding issues and possible management options.

In 2006, the former ARC initiated a new flood management study, and a parallel stream ecological assessment for the Papakura Stream Catchment. These studies have now been completed. Around the same time, the former Manukau City Council engaged GHD to prepare an ICMP for the Pahurehure Inlet receiving environment catchment area which falls inside the former Manukau City Council boundaries. The subcatchment areas included in the MCC Pahurehure Inlet ICMP but also falling within the Papakura Stream Catchment cover Clayton, Nield Road, Manurewa East, Lincoln and Greenmeadows. .

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On the Papakura side, a comprehensive stormwater discharge consent was granted for the Takanini North subcatchment following the completion of the Takanini North Catchment Management Plan in 2001.

The Ardmore Airport operates a private stormwater drainage network and has their own stormwater discharge consent. The stormwater drainage from the Ardmore Airport discharges into a heavily modified tributary of Papakura Stream.

The previous studies and reports can be summarised below:

1. Clayton Catchment Comprehensive Flood Management Study (Manukau Consultants, May 1994)
2. Clayton Catchment Comprehensive Flood Management Plan (Manukau Consultants, 1994)
3. Draft Integrated Catchment Management Plan for Pahurehure Inlet Catchment (GHD, Dec 2006)
4. Nield Road Catchment Comprehensive Flood Management Study (Manukau Technical Services / Babbage Consultants Ltd, Oct 1992)
5. Nield Road Catchment Comprehensive Flood Management Plan (Manukau Technical Services / Babbage Consultants Ltd, Oct 1992)
6. Greenmeadows Catchment Comprehensive Flood Management Study (Manukau Consultants/Babbage, June 1993)
7. Greenmeadows Catchment Comprehensive Flood Management Plan (Manukau Consultants/Babbage, June 1993)
8. Takanini North Catchment Management Plan (FTL, Sep 2004)
9. Papakura District Stormwater August 1992
10. Papakura Stream FHM Modelling Report (Opus/DHI, 2009)
11. Papakura Stream Flood Management Option (Opus/DHI, 2009)
12. Papakura Stream Assessment and Management Study (Boffa Miskell / ARC, 2008)

2.1.1 Previous Model Review

GHD Model – A mouse model covers a few subcatchments in the Papakura Stream Catchment (Manurewa East, Nields Road and Greenmeadow) and subcatchments in Waimahia Creek Catchment. Data capture is poor with a few hundreds of manholes still no lid levels, and pipes with missing or wrong sizes. Built using Model B.

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- No tributary stream was included in the model.
- Can not model interactions between the urban pipe systems with the stream channel. The extent of the model doesn't cover flooding issues on major tributaries (e.g. Ranfurly Road).
- Unable to test solutions involving drainage upgrade in subcatchment, or checking the implications on the subcatchment overland drainage from stopbanking at main stream channel.

Further issues may be identified through the detailed Papakura Stream modelling review currently being undertaken by the Auckland Council Modelling Team.

2.2 Drainage Network Data

2.2.1 Asset Data

Drainage network assets in the Papakura Stream Catchment including the following categories:

- Manholes
- Pipes
- Culverts
- Bridges
- Outlets
- Stormwater detention areas

- Stormwater treatment ponds
- Natural stream channel
- Overland flow paths

The asset data are largely maintained in the Auckland Council corporate GIS system. Hard copy as-built records are currently difficult to access; however, things may improve as the new Auckland Council integrates the legacy document management systems.

The quality of the asset data in terms of missing attribute values varies between two former TLAs involved in this catchment. The manholes on drainage network in the former MCC area generally have no lid levels or invert levels. Although depths to inverts at manholes are generally recorded for the Manukau drainage network. Pipe sizes are recorded but with anomalies, e.g. wrong pipe sizes compared with as-built plans, downstream pipe sizes less than upstream pipes, etc. Asset data for manholes and pipes in the former PDC area are generally of a better standard but still with a few gaps.

Data on culverts and bridges in both former TLAs are generally recorded in roading asset database, with rudimentary dimensions such as diameter or span width only. The RAMM data for culverts and bridges are often inadequate for hydraulic modelling purpose.

Stormwater detention areas and treatment ponds are generally recorded in the corporate GIS but often only the extents of the ponding areas. Specific details, such as outlet configurations, spillways, dam crest levels, stage/storage/discharge data, etc are only kept in hard copy as-built plans if available. For the former PDC area, the Pond Asset Data Manual and pond as built plans are the sources for specific details for ponds. For the former MCC area, all as-built data are kept in the Alchemy – a digital file archiving system, which can also been accessed via hyperlinks available on the Manukau web based GIS system.

There are very limited data on natural stream channels in the Papakura Stream Catchment. Approximately, 33 cross-sections were surveyed by Opus in 2007 as part of the Papakura Stream Flood Management Options study for the former ARC; and 19 cross-sections were surveyed in this catchment by GHD in 2006 as part of the Pahurehure Inlet ICMP work for the former MCC.

There has been no known survey undertaken on the overland flow paths in the Papakura Stream Catchment. An ArcHydro model was run for the southern area using the regional 2m grids to generate drainage lines for catchment at 2ha and 15ha respectively. These drainage lines can be used to approximate the overland flow path alignment.

The adoption of 2 dimensional DEM as a basis for overland flow modelling in recent time may also negate the needs of surveying overland flow paths in detail.

2.2.2 Topographical Data

The 2007 LiDAR data covers the whole catchment area. Contour lines with 0.5m intervals have been generated from the DTM derived from LiDAR data.

It is known some earthwork has occurred in this catchment post the LiDAR flight. A large industrial site (2-12 Great South Road) just upstream of the bridge at Great South Road was filled by an owner (before obtaining any consent) to create levelled buildable sites above the flood plain. A topographical survey was undertaken at this site by H&G for the developer to support a resource consent application.

There has been no other known major topographical survey for this catchment.

2.2.3 Drainage Operational Issues

The tributaries of the Papakura Stream have been scattered with private culverts, small dams and ponding area primarily on rural lifestyle or hobby farming lots. Many of the culverts and dam structures have been constructed of dubious material and standards, poorly maintained and prone to roots infiltration and other forms of blockage. Maintenance of these structures are the responsibility of the land owners but often the flooding suffering are with the upstream or downstream properties.

The practices of maintaining vegetation on the banks of the main channel differ between the former TLAs. Frequent grass mowing at the bank will assist with the conveyance of the flood flow but can have undesirable impact on water quality and ecological value. Streambank with minimal vegetation maintenance can have overgrown weeds and increased roughness for flood flow conveyance.

2.2.4 Reported Flooding Issues

Flooding issues identified through the recent completed Rapid Flood Hazards Mapping for the Papakura Stream Catchment and historic flood management plans for subcatchments are summarised in **Table 3**below:

Table 3: Historically Identified Flooding Issues at Papakura Stream Catchment

Road Name	Property Numbers	Subcatchment	Description of Issues
Holmes Road	3,5,9,19,17,14,21,23,25,27	Nield Road	Industry floors flooded from main Papakura Stream Channel
Great South Road	249,251,253,255,257,259,261	Nield Road	Flooding of residential property and basements due to ponding created by the NIMT railway embankment
Great South Road	256, 258, 260	Nield Road	Flooding of residential property and houses due to ponding behind Great South Road
Greenmeadow Road	Lower catchment adjacent to Papakura Stream	Greenmeadlow	Major overland flow path through private properties
Mahia Road	5,7,9,6,8,10,12	Nield Road	Overland flow path and ponding in road depression
Fields Road	4, 6, 8	Clayton Catchment	Overland flow, depressional ponding
Mahia Road	27, 29,31,33,35,37	Clayton Catchment	Overland flow and depressional ponding
Sheriff Place		Manurewa East	Potential flooding due to Papakura Stream overtopping Porchester Road at low point
Ranfurly Road	16, 82		Limited capacity at culverts on large tributary on Papakura stream
Airfield Road		Airfield Road	Under capacity at road crossings
Mill Road - upstream		Papakura Stream	Significant ponding area behing Mill Road. Serve as a flood detention area in the Papakura Stream Catchment, impact on peak discharge from the Middle and Upper Catchment areas.

Road Name	Property Numbers	Subcatchment	Description of Issues
Mill Road to Porchester Road			Rural properties flooding. Building situated in wide flood plain.
Spartan Road		Takanini North Catchment	Lack of overland flow path and flat topography.

2.3 Hydrometric Data

2.3.1 Rainfall Data

There is no known long-term rain gauge within the Papakura Stream Catchment. However, two long term rain gauges are located just outside the catchment boundary – one to the North at the Botanical Garden in the Puhinui Stream Catchment and one to the south at Longford Park in the Pahurehure Inlet North Catchment.

The Botanical Garden rain gauge has a history of approximately 30 years and is monitored by Auckland Council. The Longford Park rain gauge was established by the former Papakura District Council in 2004 and is now monitored by Auckland Council.

The modelling of stormwater runoff requires a selection of extreme rainfall events appropriate to the climatology of the local catchment areas. This information should preferably be based on analysis of records of rainfall measured within the catchment area. However, rainfall records in the PDC area are generally sparse, discrete and comparatively short in length of monitoring.

The ARC TP108 rainfall contour maps (Appendix B, TP108) cover the PDC Area. In this case, it is considered appropriate to use the ARC TP108 24hr design storms for the modelling and design of the proposed stormwater system.

2.3.2 Flow and Water Level Data

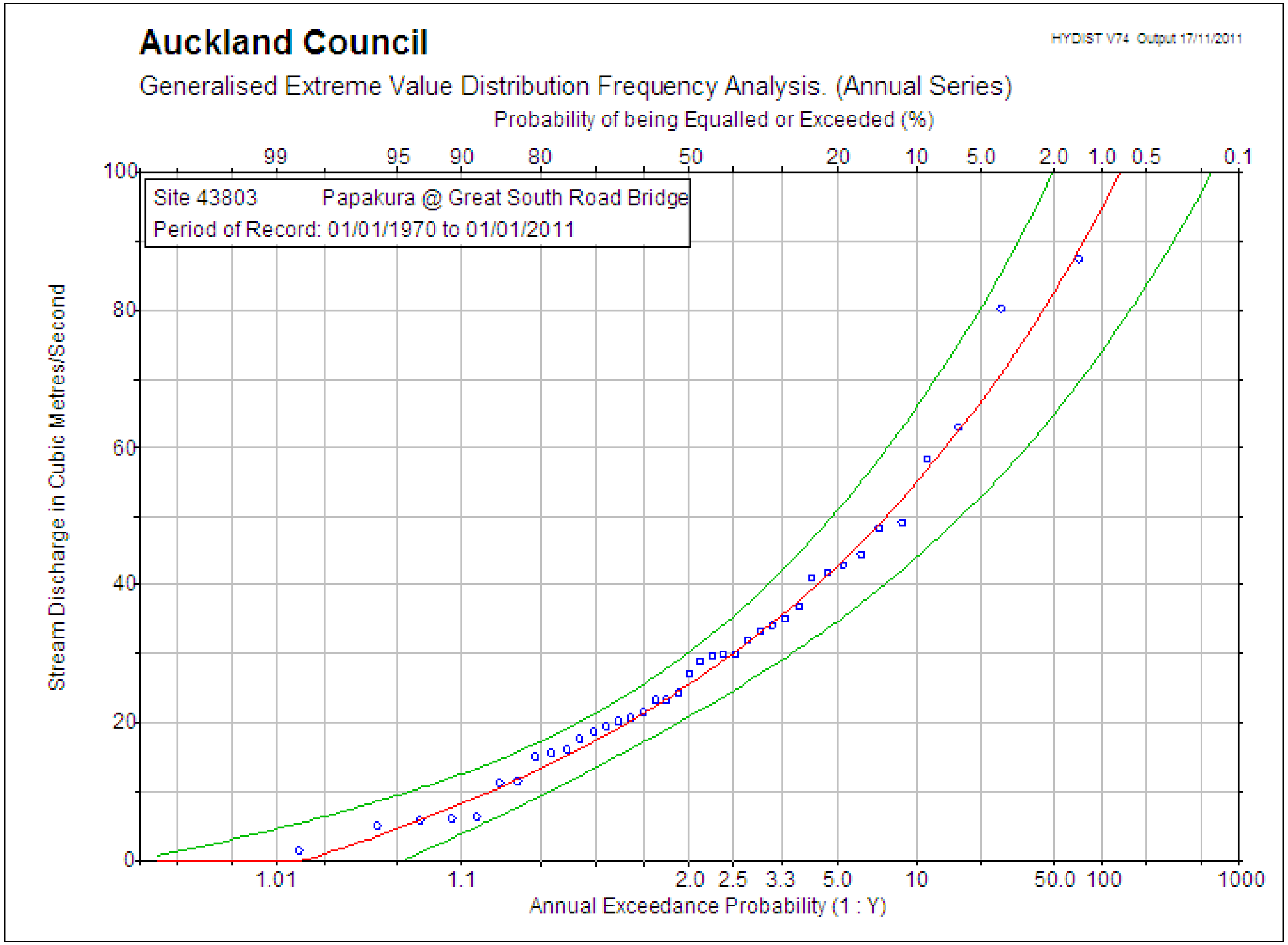
There is only one long term flow and water level gauge within the Papakura Stream Catchment. The automatic flow and water level gauge is located at the upstream side of the Great South Road bridge on the main Papakura Stream channel. This flow gauge has been in operation from mid-1960 to the present day with a small three month gap in early 1970 and another gap of nearly three years from 1982 to early 1985.

The former ARC developed a rating curve for the gauging location which has been used to translate water level monitoring into a flow rates time series. A rating curve from a hydraulic model at the gauging location was also developed as part of the Papakura Stream Flood Management Study (BECA, 1995).

It is understood that the rating is determined by downstream channel capacity, not by bridge control. The rating curve is unique for a specific set of conditions. If these conditions change, i.e. by increased weed growth, stream maintenance or by a reduced stream conveyance or storage downstream of the gauging site, the rating curve will subsequently change.

We are not certain when was the last time the rating curve at this flow gauge reviewed and verified.

Figure 2: Papakura Stream Flood Frequency Analysis – Great South Road Bridge Flow Gauge



2.3.3 Tidal Data

There is no tide level record at Pahurehure Inlet which the Papakura Stream discharges into. The table below is a summary of tides leveling data at Onehunga – Manukau Harbour based on the Auckland Harbour Board Datum published in 1973.

Table 4: Tides Levels at Onehunga – Manukau Harbour

Tides	**Levels (RL above L&S Datum 1946)**
Highest Recorded Tide 21-6-47	2.74 m
Mean High Water Springs	1.7 m
Mean High Water	1.49 m
Mean High Water Neaps	1.1 m
Mean Sea Level	0.10 m
L&S Auckland Datum 1946	0.00
Mean Low Water Neaps	-0.9 m
Mean Low Water	-1.5 m
Mean Low Water Springs	- 1.6 m
Lowest Recorded Tide	-2.68 m

If needed a tidal level time series can be generated at the stream outfall.

2.4 TP108 Design Rainfall

A TP108 daily rainfall depth isohyets map has been produced for the Papakura Stream Catchment to assist in visualizing the variation of design rainfall depths across this relatively large catchment area. The map is included in Appendix B.

2.5 Climate Change

Based on the publication "Preparing for climate change – A guide for local government in New Zealand" (MfE, 2008), the projected annual mean temperature change relative to 1990 is 2.1ºC. This is predicted to cause an increase of a 1%AEP 24hr rain depth by 16.8%.

The climate change will also likely cause a more intense peak therefore lead to change to the temporal pattern of design storm. **Table 5** below contains the recommended Future Climate Change TP108 storm temporal pattern in the Auckland Council Modelling Specification (Auckland Council, 2011).

Climate change will also cause sea level rises which can increase the coastal inundation and tailwater level for streams. MfE recommends that for planning and decision timeframe out to the 2090s:

1. a base value of sea-level rise of 0.5 m relative to the 1980-1999 average be used, along with
2. an assessment of potential consequences from a range of possible higher sea-level rise values. At very least, all assessments should consider the

consequences of a mean sea-level rise of at least 0.8m relative to the 1980-1999 range.

3. for longer planning and decision timeframes beyond the end of this century, an additional sea-level rise of 10 mm per year beyond 2100 should be allowed.

For coastal inundation analysis, the increases of sea-level due to storm surge, storm tide, wave set-up and wave run-up should also be taken into account.

Table 5: TP108 Rainfall Climate Change Temporal Pattern

Time (hrs:mins)	Time Interval (min)	ARC TP108 Normalised Rainfall Intensity (I/I_{24})	
		Existing Condition	Future Climate Change (2.1°C Increase in Temperature)
0:00 – 6:00	360	0.34	0.33
6:00 – 9:00	180	0.74	0.73
9:00 – 10:00	60	0.96	0.95
10:00 – 11:00	60	1.40	1.40
11:00 – 11:30	30	2.20	2.20
11:30 – 11:40	10	3.80	3.82
11:40 – 11:50	10	4.80	4.86
11:50 – 12:00	10	8.70	8.86
12:00 – 12:10	10	16.20	16.65
12:10 – 12:20	10	5.90	5.95
12:20 – 12:30	10	4.20	4.24
12:30 – 13:00	30	2.90	2.92
13:00 – 14:00	60	1.70	1.70
14:00 – 15:00	60	1.20	1.19
15:00 – 18:00	180	0.75	0.75
18:00 – 24:00	360	0.40	0.39

3 RAPID FLOOD HAZARD ASSESSMENT

3.1 Methodology

The rapid flood hazard assessment was undertaken adopting the approach known as “Rain on Grids” utilizing the MIKE21 overland flow model. The approach is as per the Auckland Council Stormwater Flood Modelling Specification (November 2011), unless otherwise specifically discussed below.

The flood hazard extent from the rapid flood hazard assessment is used to identify first cut flood sensitive areas and to determine the extent of the drainage system that needs to be included in the detailed hydraulic models.

3.1.1 Model Bathymetry

The Model Bathymetry has been built from the 2m grids resampled from the AC 1m grids derived from the most recent LiDAR data. The following bridges have been removed from the DEM:

1. Great South Road Bridge – Papakura Stream main stream channel
2. SH1 Bridge - Papakura Stream main stream channel
3. Railway Bridge - Papakura Stream main stream channel
4. Porchester Road Bridge - Papakura Stream main stream channel
5. Mill Road Bridge - Papakura Stream main stream channel
6. Philips Road Bridge - Papakura Stream main stream channel

The 2m grids were checked for accuracies at known prominent linear features, e.g. motorway embankment and railway embankment. The locations of linear features checked are shown on the Figure 3 below.

Figure 3: Locations of Linear Features Verified

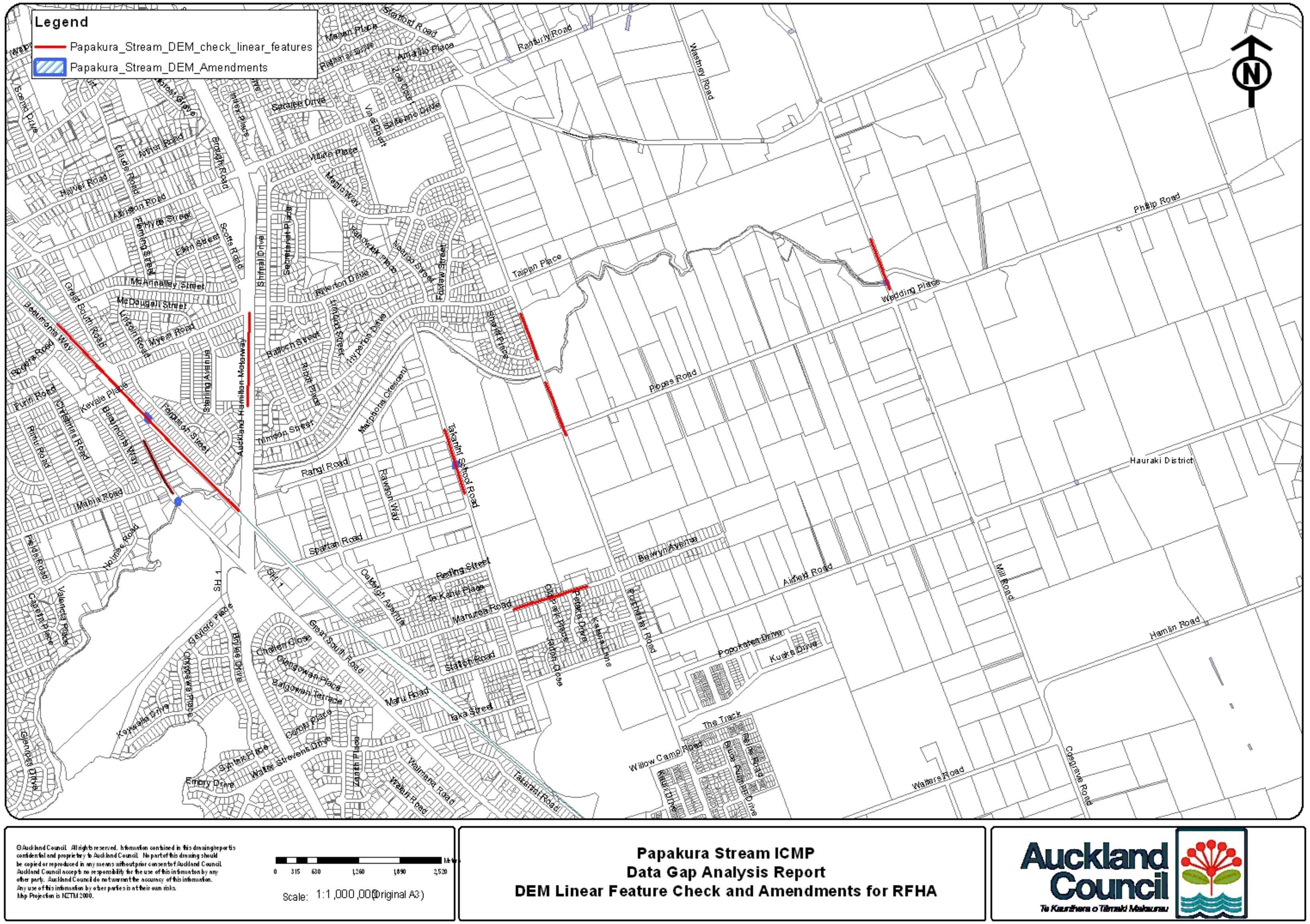
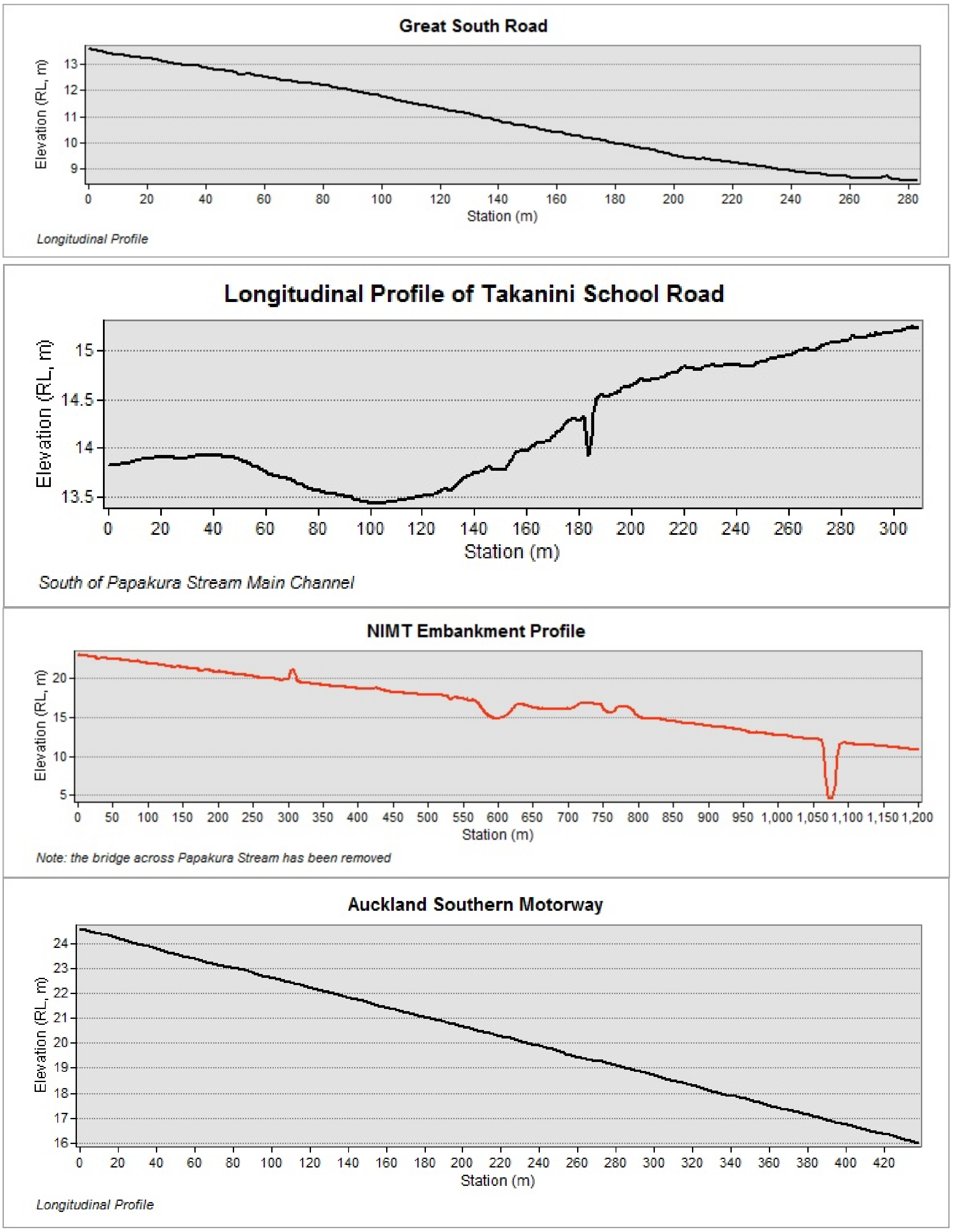
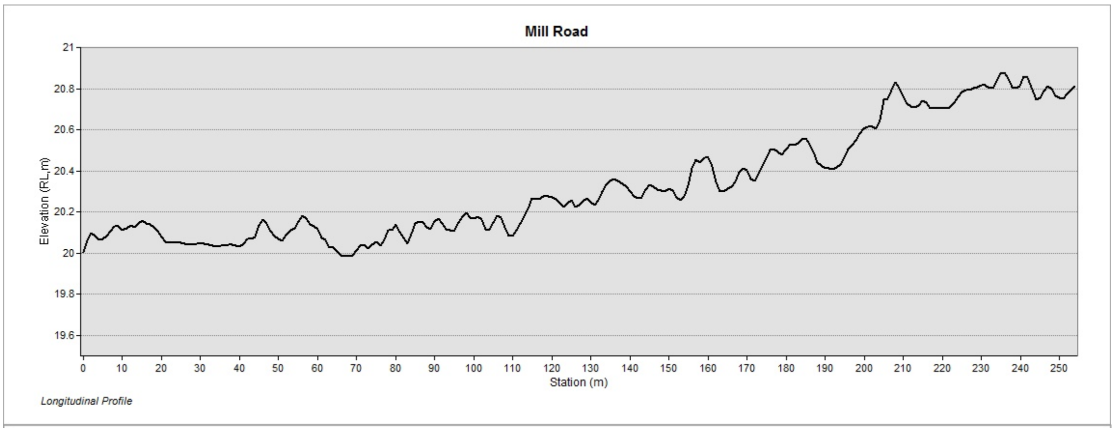
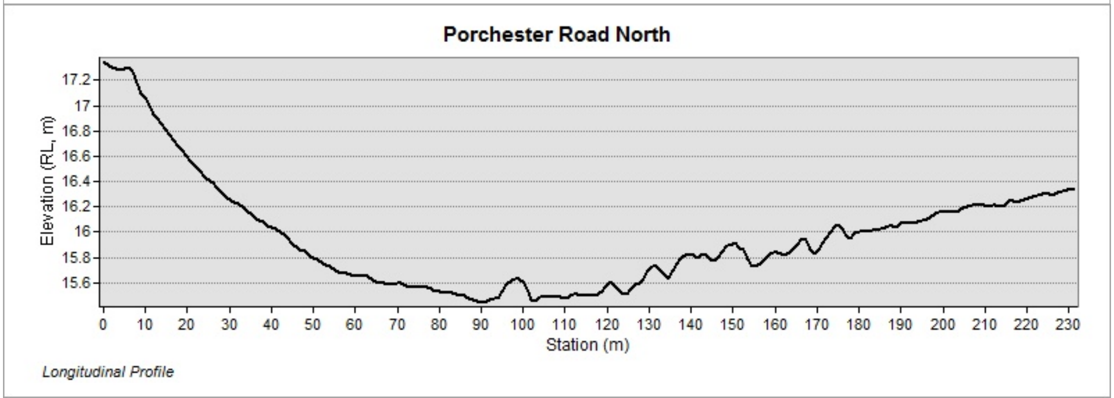
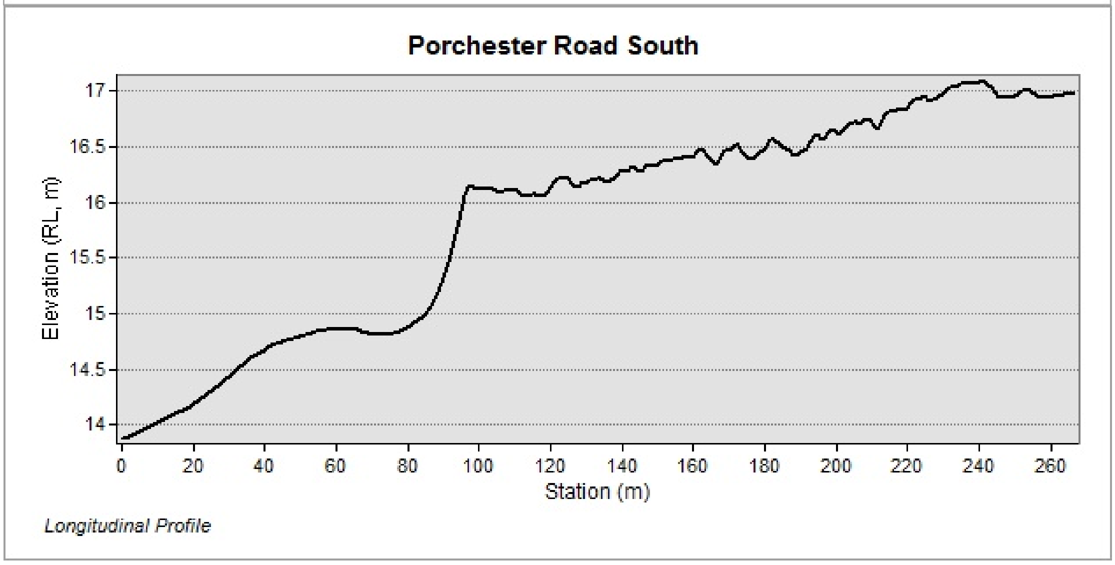


Figure 4: Longitudinal Profiles at Linear Features Checked









The plot of longitudinal profiles at these linear features show that the LiDAR derived DEM generally reflect the true vertical alignment at these linear features and only minor amendments to the DEM are considered necessary at NIMT embankment where a potential impact on flow path is identified.

Minor errors caused by different flight paths or mixing of LiDAR data from different years, can also show up in the DEM. However, this errors are generally minor and very difficult to ractify. This data errors should be more properly dealt with when processing the raw LiDAR data.

3.1.2 Model Parameters

Model parameters are generally as per the AC Flood Modelling Specification (November 2011). The key parameters are summarised below:

- Software Used: MIKE 21 (V2011)
- DEM grid size: 2m x 2m
- Simulation Time Step: 0.2 second
- Eddy viscosity calculated based on 0.02 dx^2/dt = 0.4, flux based
- Manning's roughness for all paved surface: 0.02
- Manning's roughness for all urban and rural building footprints: 0.5
- Manning's roughness for pervious surface: 0.05

3.1.3 Model Initial Conditions

A short heavy rainfall event was used to fill all depressions on the bathymetry and the simulation result is used as the initial surface.

3.1.4 Boundary Conditions

The TP108 1%AEP future (2090) climate change rainfall scenario has been used for the rapid flood hazard assessment.

The 2090 climate change rainfall depth was derived from the standard TP108 100yr ARI rainfall depth increased by 16.8% as per the AC Flood Modelling Specification (Section 7.1.1).

- Incorporate rainfall losses (initial losses from the rainfall and applying correction for the continuing losses).

The effective rainfall should be calculated based on TP108 (ARC, 1999). A weighted curve number should be used for the entire catchment. A weighted CN is calculated from:

- CN (impervious) = 98
- CN (pervious) - various values for different soil types
- Percentage of impervious for the entire catchment = 70%

Since the whole natural catchment is included in the model, no external inflow into the model domain has been identified.

The water level of the most downstream boundary at the sea has been taken as 0.5m as per the ASFMS.

3.1.5 Model Simulations

The model simulation will not cover the full 24hr rainfall duration due to the run time required. The model simulation started at 10 am and finishes at 4 pm which covers the most severe period of rainfall centered around 12:10pm.

3.1.6 Mass Balance Check

Mass balance checks have been carried out to ensure that the total water mass unaccounted for (continuity balance) is small compared to the total inflow volume to the model. Usually a continuity error less than about 5% is acceptable.

The mass balance is the difference between the volume of water entering the model and the total volume of water existing the model as well as the volume of water stored in the model.

Volume = (M21 Start–M21 End) + (M21 In – M21 Out) = 0
<u>M21 Start, M21 End:</u> Start and end volume in MIKE 21. Open the results file, go into Tools->Statistics. To calculate the volume, multiply the Number of Points * Grid Size ^2 *Mean Value.
<u>M21 In:</u> Calculate the volume of the inflows, source points and flux boundaries.
<u>M21 Out:</u> At any outflow boundaries use the M21 toolbox to extract discharge across a boundary. Accumulated volume is given in the output from this.

The mass balance continuity for the Papakura Stream RFHA model is 4% which is less than acceptable threshold at 5%.

3.2 Results and Discussions

3.2.1 Post Processing of Model Results

Results from the RFHA are based on a grid, the results were processed to the following two sets of GIS polygon shape files

- Maximum Flood Extent and Depth

Small depth (< 0.05m) flooding area was filtered out.

- Maximum Flood Extent and Hazard

3.2.2 Flood Hazard Classification

Hazards have been determined in accordance with the hazard classification set specified in Table 7.5 of the Flood Hazard Classification Category from Auckland Council Flood Modelling Specification.

Table 6: Flood Hazard Classification Category

Hazard Classification	Description	Depth – Velocity Criteria
1	Potential Hazard	0.05 m < Depth < 0.1 m
2	Minor Hazard	0.1 m ≤ Depth < 0.3 m and Velocity < 2.0 m/s
3	Significant Hazard	Depth ≥ 0.3 m and Depth ≥ 0.1 m & Velocity ≥ 2.0 m/s

3.2.3 Buildings in Significant Flood Hazards Area

Buildings located in significant flood hazards areas have been identified on maps in Appendix C. The habitable floor levels of these buildings together with natural ground level adjacent to the entries will be surveyed.

4 MODEL EXTENTS

4.1 Hydrological Model Extents

4.1.1 Catchment Boundary

The catchment boundary for the Papakura Stream Catchment was defined based on existing topography and drainage patterns of the land. The artificial drainage infrastructure, e.g. stormwater drainage pipes, has also been taken into account under some circumstances. A 2m space raster grids (Digital Terrain Model) was extracted from the Auckland regional dataset based on the 2006/2008 LiDAR data. ArcHydro package was used to process the drainage lines and contributing catchment boundaries from the DTM. The final catchment boundary was smoothened manually with reference to the 0.5m interval contour lines.

The catchment boundary is in GIS format and a map showing the overall Papakura Stream Catchment is included in Appendix A.

4.1.2 Sub-Catchment Delineation

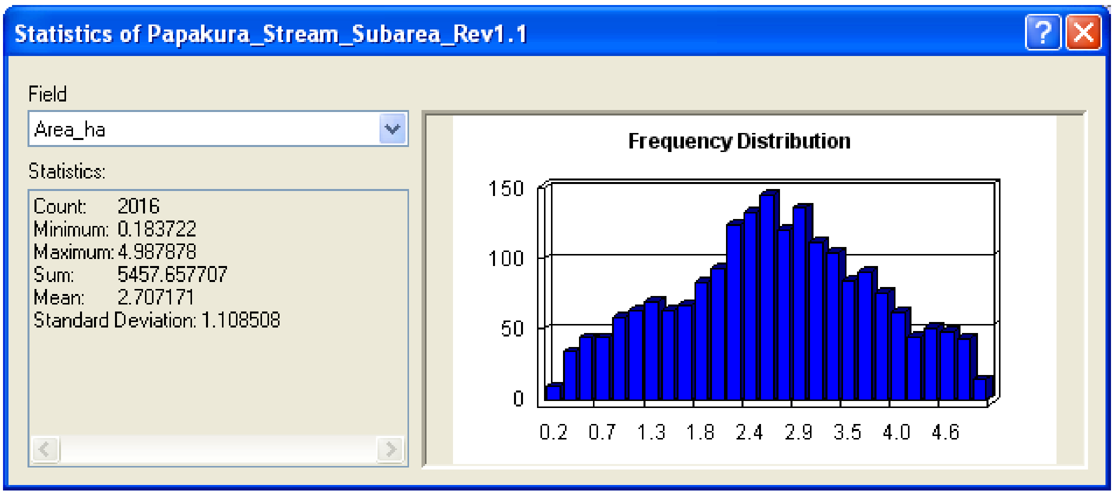
The subcatchment boundaries for drainage lines with 2ha contributing areas generated from ArcHydro process provided a good base for sub-catchment delineation.

For the Papakura Stream Catchment the modelling sub-catchments have been defined and shown in Maps in Appendix A. The preliminary boundaries from ArcHydro will be manually altered in accordance with the AC Modelling Specification (Nov 2011), taking into account the following:

- topography, i.e. elevation, contours and natural drainage pattern,
- stormwater drainage network, i.e. underground pipes, engineered channels and dams,
- property boundaries,
- overland flow paths, and
- known flooding issues.

There is a total of 2016 subcatchments proposed for the Papakura Stream Catchment. The majority of the subcatchments fall below 3.0 ha with largest at 4.98 ha and smallest one at 0.18 ha. The average subcatchment size is 2.7 ha.

Figure 5: Subcatchment Size Statistics



4.1.3 Sub-Catchment Loading Nodes Selection

The loading nodes are the modelling nodes on the drainage network which takes the inflows from the sub-catchments or sub-areas. The loading node should generally be the modelling node closest to the centroid of the sub-catchment or sub-area.

For the Papakura Stream Catchment, a GIS layer which contains the centroids of all sub-areas will be generated automatically, and spatially joined with the closest modelling nodes. The process will also report on the distance between the centroid of the sub-area and the spatially joined model node.

A map of sub-areas, the loading nodes and the modelled hydraulic network will be produced to enable visual examination of the appropriateness of the selected loading nodes.

Unmodelled storage for flat sub-catchment may be added to the loading nodes to avoid hydraulic shock only with prior agreement with the Auckland Council modelling team.

4.2 Hydraulic Model Extents

4.2.1 Modelled Manholes, Inlets and Outlets

All manholes that fall within a buffer distance (20m) from the flood prone area identified through rapid flood hazard mapping, or on public drainage pipes with a diameter larger than and equal to 300mm in size, are included in the hydraulic model. For some large stormwater drains under private ownership, e.g. stormwater drains within the motorway corridor, there may be no data at Auckland Council. All stormwater outlets are included in the model.

Maps showing all modelled nodes are included in Appendix A.

4.2.2 Modelled Pipes and Culverts

Similar to modelled manholes, pipes and culverts within a 20m buffer distance from the RFHM flood prone area, or with equivalent sizes equal to or larger than 300mm in diameter, are included in the model.

Maps showing all modelled pipes are included in Appendix A.

4.2.3 Modelled Ponds, Wetlands and Other Storage Areas

All stormwater ponds with or without flood management function are included in the model. Many stormwater ponds are located either in low lying area or along major drainage paths, will have hydraulic implications during flooding.

Cares should be taken to avoid double counting flood storages in ponds, wetlands and other storage areas.

4.2.4 Modelled Control Structure

Except for pond outlets and spillways, there is no other known control structure on the stormwater drainage network in Papakura Stream Catchment.

4.2.5 1D MIKE11 Stream Model

It is considered that the all stream channels and tributaries in the urban and rural life style residential development area (Ranfurly Road area) will be included in the MIKE11 stream model. All main bridges and culverts will be modeled also in MIKE 11 as structures. All other stream channels including open drains will be modeled in 2D. Small open channels not shown in DEM and vegetation obstructions in stream channel will be identified and burnt into the DEM.

The extent of the MIKE 11 stream model is shown on the Map in Appendix A.

4.2.6 2D Model Extent

It is proposed to develop a 2m DEM covering the whole catchment area. This DEM will be modeled in MIKE 21 and linked with the MIKE Urban model representing the overland flow paths in urban area, open drains and streams in rural areas.

5 DATA QAULITY ASSESSMENT

5.1 Asset Data Assessment

5.1.1 Missing Manholes, Inlets and Outlets Attribute Data

The following tables summarise the number of manholes, inlets and outlets with missing attribute data.

Table 7: Summary of Manholes, Inlets and Outlets with Missing Attribute Data

ATTRIBUTES MISSING	MANHOLES	INLETS/OUTLETS
Missing Lid Level	784	N/A
Missing Lid Level and Invert Levels	227	N/A
Missing Diameter or Dimension	819	N/A
Missing Invert Level		151
Benching	N/A	N/A
Asset ID (Unique)	N/A	N/A

All manholes, inlets and outlets with missing attributes are summarised in a spread sheet titled "Papakura Stream Manholes, Inlets and Outlets with Missing Attributes" in Appendix D. A3 maps showing manholes, inlets and outlets with missing attributes are also included in Appendix D to assist the surveying team to locate these structures.

5.1.2 Missing Pipes and Culverts Attribute Data

Pipes and Culverts in the Papakura Stream Catchment with missing attributes are summarised in Table 7 below:

Table 8: Summary of Manholes, Inlets and Outlets with Missing Attribute Data

ATTRIBUTES MISSING	PIPES	CULVERTS
Unique ID		
Upstream Manhole/Inlet ID	N/A	N/A
Downstream Manhole/Inlet ID	N/A	N/A
Diameter/Size	31	0
Upstream Invert Level	N/A	N/A

ATTRIBUTES MISSING	PIPES	CULVERTS
Downstream Invert Level	N/A	N/A
Culvert Inlet Shape*	N/A	N/A
Material	0	0

Culvert inlet shapes, e.g. socket end with wing wall, projected from embankment, presence of debris arrestor, etc are essential in determining inlet head losses.

All pipes and culverts with missing attributes are summarised in a spread sheet titled "Papakura Stream Pipes and Culverts with Missing Attributes" in Appendix D. A3 maps showing pipes and culverts with missing attributes are also included in Appendix D to assist the surveying team to locate these structures.

5.1.3 Missing Ponds and Wetlands Outlets Attribute Data

There are a few stormwater wetlands and ponds in the Papakura Stream Catchment, including some illegal ponds along tributaries in the rural area. Most of these ponds/wetlands have permanent pools and are for stormwater quality treatment purpose. However, there are also dry detention area (Beaumont Reserve) and live storages incorporated into treatment ponds for flood peak discharge attenuation.

Ponds and wetlands in the Papakura Stream Catchment with missing attributes are summarised in Table 8 below:

Table 9: Summary of Stormwater Ponds/Wetlands with Missing Attribute Data

POND/WETLAND NAME	ID	INVERT LEVEL	PERMANENT POOL LEVEL	ELEVATION-SURFACE AREA DATA	ELEVATION-DISCHARGE DATA	OUTLET DIMENSIONS/ SPILLWAY
Beaumont Reserve Detention Dam		N	N	N	N	N
Beaumont Reserve Wetland		N	N	N	N	N
Alfriston Pond		N	N	N	N	N
Takanini North Pond		N	N	N	N	N

5.1.4 Missing Control Structures Attribute Data

There are no known control structures on the public stormwater drainage network in the Papakura Stream Catchment.

5.1.5 Drainage Network Connectivity Issues

The connectivity of the stormwater drainage network has been examined to identify anomalies or suspicious locations for site verification.

The connectivity anomalies and suspicious locations are shown a map included in Appendix D. These will be checked as part of field manhole inspections. If field inspections are inconclusive, then a CCTV pipe inspection may be undertaken as the next step.

5.1.6 Downstream Reduction in Pipe Diameter

Using a GIS process, all stormwater drains have been displayed using symbols proportionally scaled based their diameters.

Pipes with diameters less than the upstream pipes (constrictions) have been shown on map in Appendix B for further site verifications.

5.1.7 Negative Grade Pipes

Pipes with negative grades have not been examined due to the following reasons:

- Pipes in the corporate GIS don't have the upstream invert and downstream invert levels;
- A large number of manholes are still missing lid levels and invert levels.

Once the pipe network has been imported into the modelling package, invert levels at upstream and downstream nodes can be assumed as the same as for the connected pipes. The gradients can then be calculated for pipes and pipes with negative grades will be identified afterwards.

5.1.8 Reverse Orientation Pipes

Using ArcView GIS, all drainage pipe lines can be displayed with a direction arrow at the ending node ("to" node). All pipes with wrong flow directions have been selected and corrected in GIS. The pipes with the wrong flow directions have been shown on a map in Appendix B.

5.1.9 Inconsistent Manhole invert Levels, Depths and Ground Levels

The manhole ground levels have been compared the closest LiDAR point level. Where the difference between LiDAR point and manhole lid level exceeds 0.3m, the manhole lid level will be recommended for re-check on site.

For manholes with invert levels creating humps along the longitudinal section of the pipe line, the manhole depths or invert levels will require checking on site. The longitudinal section of the modelled pipes can be examined once the pipe network has been imported into the model.

5.2 Hydrometric Data Assessment

5.2.1 Rainfall Monitoring Data

There are three known Auckland Council long term rain gauges in the proximity of the Papakura Stream Catchment Area:

- Puhinui – within Auckland Botanical Garden
- Longford Park – within the Council reserve adjacent to the Longford Park wetland

Two other rain gauges managed by Watercare Services Ltd may also provide useful data especially for the upper catchment area, being at a similar higher altitude comparing to the two AC long term gauges.

5.2.2 Identification of Suitable Events for Model Validation

The long term rainfall records for these gauges have not been obtained at this stage. Known major flooding events in the catchment include:

- 28th to 29th Jan 2011 – 91.5mm in 4 hrs and 136.5mm in 12 hrs at Hunua Rain Gauge, approximate a 50yr return period rainfall event.
- 22nd to 25th May 1985 – 162mm in 33 hrs, approximate a 50yr rainfall event.
- 16th to 19th Feb 1985 – 173mm in 8 hrs, approximate a 100yr rainfall event.
- 16th to 18th July 1988 – 102mm in 15 hrs, approximate a 20yr rainfall event.
- 27th to 29th Feb 2004 – 129mm in 40 hrs, a 10 ~ 20yr rainfall event.

The above extreme rainfall events are considered appropriate to combine with the long term flow gauge record at Great South Road Bridge to be used for calibration and validation of the hydrologic and hydraulic model.

5.2.3 Flow and Water Level Monitoring Data

The only flow and water level monitoring data available for the Papakura Stream catchment is the Council long term flow gauge at Great South Road Bridge.

5.2.4 Flow-Depth Relationship Assessment

There is flow-depth rating curve developed at the Great South Road bridge flow gauge. This can be assessed using the future hydraulic model.

5.2.5 Gauge Mass Balance Analysis

No gauge mass balance analysis has been undertaken at this stage.

5.2.6 Rainfall-Runoff Volume Relationship Assessment

The rainfall-runoff volume has not been analysed at this stage.

6 DATA COLLECTION AND SURVEY REQUIREMENTS

6.1 Asset Data Survey Requirements

6.1.1 Assumptions Made to Reduce Survey Requirements

It is considered that all asset data gaps identified will be surveyed on site for not only the benefit of model building but also improving the asset data records.

Assumptions will be made if further data gaps are identified post the site survey work to facilitate model building. Any assumed asset attributes will be recorded in the model or GIS metadata. The following general assumptions will be made:

- Manhole lid levels are assumed to be identical to the closest LiDAR point level.
- The incoming pipe invert level is the same as the outgoing pipe invert level at a manhole.
- Manhole invert level can be interpolated based on the immediate upstream and downstream manholes invert levels and distances in between the manholes.
- Pipe diameters will generally increase as moving downstream along a pipe reach. Pipe diameter will be assumed as the same as the upstream pipe on a single pipe run, or the same as the downstream pipe if the pipe with missing size is immediately downstream a confluence manhole (with more than one branch joining in).

6.1.2 Manholes Depth and Lid Level Survey

All manholes with missing depths and lid levels have been identified and shown on a map in Appendix D. The following requirements should be followed when capturing manhole depths and lid levels:

- The manhole lid level shall be surveyed at the centre of the lid using the closest survey bench mark. Any structure defects with the cover and frame should be noted. The manhole lid level survey shall achieve an accuracy of ±15mm.
- The manhole depths shall be captured at at least three locations: depth to invert of every incoming pipe, depth to invert of the out-going pipe, and depth to invert of the manhole. The depth shall be measured from the top using a survey staff or a measuring rod assisted by a bright torch, or a laser tape measure.
- The manhole depth measurement shall achieve an accuracy of ±15mm.
- All survey data shall be recorded in a spreadsheet with the manhole asset ID clearly identified.

6.1.3 Culvert Inlets and Outlets Invert Level Survey

All culvert inlets and outlets with missing invert levels have been identified and shown on a map in Appendix D. The following requirements should be followed when capturing culvert inlets and outlets invert levels:

- The culvert invert levels measurement shall achieve an accuracy of ±15mm.
- All survey data shall be recorded in a spreadsheet with the culvert asset ID clearly identified.

6.1.4 Pipes and Culverts Diameter Survey

All modelled pipes and culverts with missing sizes are shown on a Map in Appendix D. The pipes and culverts sizes should be measured by using measuring tape, a survey staff (from top of the manhole), or a laser measuring device. The pipes and culverts sizes shall be reported in millimeters, and generally following the metric pipe size series.

6.1.5 CCTV Survey for Network Connectivity Issues

Anomalies with network connectivity have been identified and shown on a map in Appendix D. These anomalies will be initially investigated by field manhole inspections, then followed by CCTV survey if found necessary.

6.1.6 Ponds and Wetlands Oultet Size and Invert Level Survey

All ponds and wetlands with missing attribute data have been identified in Appendix D. The following data will be needed for all ponds and wetlands:

- Pond outlets details – low flow orifice size, invert levels, flood control outlets sizes and invert levels(e.g. vertical slot), low level spillway dimension (drop inlet crest level, size, etc), emergency spillway dimension, and dam crest level.
- Pond topography – topographical survey of the pond area below the maximum flood level including bathymetry survey of area below the permanent water level. Islands within the pond should be surveyed. Vegetated areas should be identified on the survey plan.

All pond outlets dimensions and levels survey should achieve an accuracy of ±15mm. All topographical survey should achieve an accuracy of ± 50mm.

6.1.7 Control Structures Size and Invert Level Survey

There is no known control structure on the stormwater drainage system in this catchment.

6.2 Topographical Data Survey Requirements

6.2.1 Stream Cross-Section Survey

All new stream cross-sections to be surveyed have been shown on the maps in Appendix D. The following requirements shall be followed when surveying the stream cross-sections:

- All stream cross-sections shall be aligned to be perpendicular to the flood flow direction.
- The stream cross-section should extend beyond the stream bank edges.
- No two stream cross-sections should intersect each other.
- All survey points should be provided in spreadsheet tabular format with X and Y coordinates, levels and cross-section ID. The thalweg point and bank edge points should be marked in the spreadsheet.
- All X and Y coordinates shall achieve an accuracy of ± 100mm. All levels should achieve an accuracy of ± 50mm.
- A digital photo should be provided for each cross-section and named after the cross-section ID.

6.2.2 Stream Long Profile Survey

No specific stream long profile survey will be undertaken. The thalweg point at each surveyed cross-section can be linked to create a stream longitudinal profile.

6.2.3 Bridge Cross-Section Survey

All new bridge cross-sections to be surveyed have been identified in Appendix D.

The following requirements are to be followed when surveying bridges:

- For each bridge at least three cross-sections shall be surveyed: a cross-section through the middle of the bridge, a cross-section immediately upstream the bridge (~5m to 10m from the bridge upstream edge) and a cross-section immediately downstream the bridge (~5m to 10m from the bridge downstream edge).
- The bridge abutments, piers should be included in the bridge cross-section survey.
- Bridge deck level should be surveyed along the centre line of the bridge to the extent of possible overtopping flood flow. If the levels of bridge deck at the upstream side and downstream side are different from the centre line levels then longitudinal profiles of the bridge deck along the upstream and downstream edges should be surveyed as well. Guiderail heights should be surveyed; a photo of the guardrail should be taken to show its permeability.
- The cross-sections should extend beyond the stream bank edges.
- All survey points should be provided in spreadsheet tabular format with X and Y coordinates, levels and cross-section ID. The thalweg point and bank edge points should be marked in the spreadsheet.
- All X and Y coordinates shall achieve an accuracy of ± 100mm. All levels should achieve an accuracy of ± 50mm.
- Digital photos should be provided for each bridge structure and named after the bridge ID.

7 CONCLUSIONS AND RECOMMENDATIONS

Considerable data gaps have been identified at the Papakura Stream Catchment for the purpose of building a hydraulic model of the drainage system. The captured data can also enhance the stormwater drainage asset records in this catchment.

The following actions are recommended:

- ix That all manholes with missing attributes as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements in Section 5.1.2 of this report.
- x That pipes with missing attributes as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements in Section 5.1.4 of this report.
- xi That all culverts including its inlets and outlets with missing attributes as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements in Sections 5.1.3 and 5.1.4 of this report.
- xii That all ponds and wetlands with missing attributes as identified in **Table 8** of this report be field surveyed in accordance with requirements in Section 5.1.6 of this report.
- xiii That all stormwater drainage network connectivity anomalies as shown on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be investigated initially by manhole inspection then CCTV survey if found necessary.
- xiv That all new stream cross-sections to be surveyed as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements set out in Section 5.2.1 of this report.
- xv That all bridge structures as identified on Map "SW Pipe and Inlet/Outlet with Missing Attributes Map" in Appendix D be field surveyed in accordance with requirements set out in Section 5.2.3 of this report.
- xvi That all survey data shall be presented in either Spreadsheet and/or GIS (geodatabase/shape) format, for easy incorporation into the Council asset management system.

8 REFERENCES

Stormwater Flood Modelling Specification, Auckland Council, November 2011

Papakura Flood Management Study Volume 1, Opus/DHI/ARC, May 2009

Pahurehure Inlet ICMP, GHD/MCC, May 2006

Appendix A: Hydrological and Hydraulic Model Extent

Appendix B: Rainfall and Flow Monitoring Gauge Locations Map

Appendix C: Stormwater Drainage Asset Data Survey Location Map

Appendix D: Stream Cross Sections, Bridges and Culverts Survey Location Map