POKENO STORMWATER CATCHMENT MANAGEMENT PLAN

September 2010

FDC Reference: D450/06

FRANKLIN DISTRICT COUNCIL

Pokeno Stormwater Catchment Management Plan

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EXECUTIVE SUMMARY

This Pokeno Catchment Management Plan outlines stormwater management options and measures (planning controls, physical works and operation and maintenance strategies) to manage the effects on the stormwater environment resulting from the proposed development for Pokeno.

The purpose of the CMP is to: identify stormwater issues within the catchment; identify potential options to address these issues; and set out recommendations for the long-term stormwater management within the catchment which would form a basis for a stormwater discharge consent and to support rezoning and development.

A Structure Plan proposes a future Pokeno growth area of around 440 hectares. The stormwater catchment area which drains to this proposed development area is around 1,500 hectares, consisting of two sub-catchments the Tanitewhiora catchment (1,270 hectares) and Helenslee catchment (230 hectares).

The key findings associated with stormwater management within the catchment are:

- Envisaged land uses will not significantly alter the peak flood flows through the Tanitewhiora stream compared to the existing or pre-development scenario, as a result of the timing of peak flows from the development areas. Hence no flood mitigations measures are proposed, only water quality improvement measures.

- Without mitigation there will be a significant increase in the peak flood flows from proposed land use changes in the upper Helenslee stream catchment from pre-development to post-development. Hence mitigation measures are proposed which will reduce the flood flows from the proposed Helenslee Block developments to well less than pre-development levels. Water quality improvement measures are also proposed.

- Both the Tanitewhiora and Helenslee streams have waterfalls approximately 4 m in height, effectively separating the Mangatawhiri swamp/wetland and the Waikato River further downstream hydraulically from the Pokeno catchment.

- There do not appear to be any significant terrestrial ecosystems in the catchment.

- Indices of macro invertebrate community structure indicate that the Tanitewhiora and Helenslee streams both upstream and downstream of the proposed developments are generally moderately polluted and in some cases severely polluted. There is an opportunity to enhance the immediate receiving environment as a part of the development process.

- The receiving environment downstream of Pokeno catchment and the Waikato River is recognised as an area of ecological significance. The runoff from the proposed development areas will have to be treated to ensure that the receiving waters stormwater quality is not adversely affected.

Recommended Stormwater Management Works

The stormwater management concept is shown in Drawing 121412-SW103 "Recommended CMP outcomes". The plan shows:

- The location of a number of stormwater treatment and attenuation ponds that are recommended to mitigate the effects of development within the structure plan area. It also shows the extent of the existing 1% AEP flood plain
- Streams to be protected and riparian planting areas
- Recommended system upgrades
- Areas of fringe floodplain filling allowed for in the CMP
- Infill development within the existing urban area is to be evaluated and stormwater treatment provided on a site by site basis.

Further specifications for stormwater management are detailed in Section 9 and grouped under:

- Flooding considerations
- Ecological considerations
- Erosion and water quality
- Climate Change
- Land development rules
- Operation, maintenance, and monitoring strategies
- Council implementation plan using District Plan provisions and education initiatives

1.0 INTRODUCTION

1.1 BACKGROUND

Franklin District Council (FDC) completed a Pokeno Stormwater Catchment Management Plan (CMP) in December 2002 that focussed on the existing zoned township and the two main waterways that pass through the township. This was provided as supporting information to obtain a comprehensive stormwater discharge consent from Environment Waikato (EW). The Long Term Council Community Plan (LTCCP) 2006-2016 indicates that FDC is planning to commence a review of the present CMP in 2010/2011.

The initiative for a new Structure Plan for a greater Pokeno development area led to an agreement between FDC and the Pokeno Landowner Consortium to work together to develop a Pokeno Stormwater Catchment Management Plan (CMP) to establish a long term and sustainable stormwater management strategy considering the whole of the contributing catchment area.

To progress the CMP the Pokeno Landowner Consortium engaged Harrison Grierson Consultants Limited in August 2006 to prepare a draft CMP to support a Structure Plan and proposed Plan Change for the future Pokeno growth area of 440 hectares. Preparation of this CMP was carried out in parallel with the finalisation of FDC's Comprehensive Stormwater Discharge Consent and hence it also became a purpose of the CMP to meet FDC's obligations under that consent.

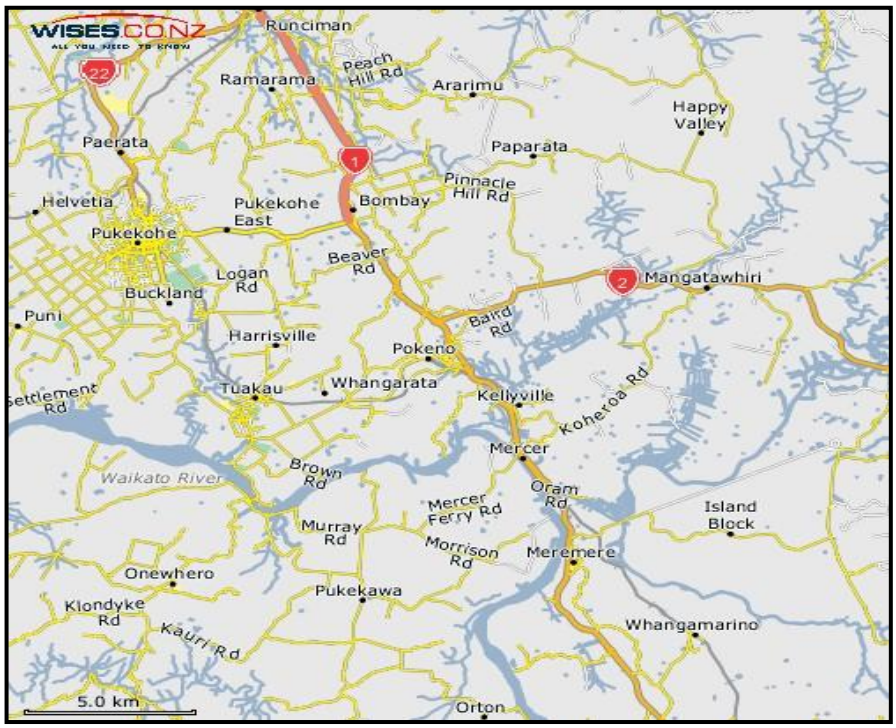

Fig 1.1 Pokeno Location Map

Over the next two years the Consortium and its Consultants progressively developed the CMP including consultation with key stakeholders. Consultation included formal and informal meetings and discussions between the Consortium, its consultants and the Franklin District Council, Waikato Regional Council and Iwi. Preparation of the detailed CMP included the commissioning by the Consortium of specialist reports, such as ecological, for the Assessment of Environmental Effects (AEE). The CMP was finalised for adoption by the FDC in September 2008 as the Stormwater Catchment Management Plan for Pokeno.

The stormwater catchment, which drains the proposed development area, is around 1,500 ha in extent and lies within the jurisdiction of FDC and EW.

1.2 PURPOSE

The purpose of the Stormwater CMP is to achieve the best practicable stormwater management of the effects of development, such that adverse effects are avoided, remedied or mitigated, and positive effects are optimised and assured, within the Pokeno catchment.

The objectives of the Stormwater CMP are to:

- Provide information to be incorporated into a plan change to the District Plan for the Structure Plan area.
- Provide alignment with the draft FDC Comprehensive Stormwater Discharge Consent (CSDC) for Pokeno and to support future municipal stormwater diversion and discharge activities in the greater Pokeno Catchment.
- Guide the stormwater management regime for the Pokeno Catchment and to support developer consent applications at subdivision stage.
- Specify appropriate stormwater measures available to guide the mitigation of the effects of subdivision or development, within the catchment.

1.3 SCOPE

The scope of this report is set out below:

1. Identify and review the existing stormwater issues within the catchment;
2. Study the potential impacts or effects of development within the proposed Structure Plan on:
    i. Stormwater flooding and stream erosion
    ii. Stormwater quality, and
    iii. Ecology of the receiving environment;

3. Analyse stormwater management options for existing stormwater issues and potential effects of development;

4. Recommend the best practicable option for flood management, stream management and stormwater treatment, without jeopardising environmental values. These management measures can be broadly categorised as:

    i. Physical works

    ii. Planning controls

    iii. Operation and Maintenance strategies

The following matters have been considered in the preparation of the draft CMP:

1. Alignment with EW's regional policies and FDC's district policies;

2. Compliance with EW's draft CMP related conditions of Comprehensive Stormwater Discharge Consent requirements;

3. Dialogue with relevant Council staff at EW and FDC;

4. Envisaged landuses within the study area.

This CMP will be used for the proposed Structure Plan consultations which began in 2007 and will continue through 2008.

1. Consultation with and identification of issues of concern to relevant iwi;

2. Consultation with key landowners, affected by the stormwater management outcomes and recommendations;

3. General public consultation;

4. Reporting back to FDC, on the results of the consultation, with final recommendations.

2.0 STRATEGIC PLANNING LINKS

2.1 CENTRAL AND REGIONAL GOVERNMENT POLICIES AND PLANS

2.1.1 Resource Management Act (1991)

The Resource Management Act (RMA) came into effect in 1991, and is an effects-based legislation, superseding a number of other rules and statutes previously governing water management. Section 5 of the RMA outlines the purpose of the Act, which is to promote the sustainable management of natural and physical resources.

> *"…Managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural; well being and for their health and safety."*

The purpose of the Act is also to safeguard the life-supporting capacity of these resources while avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Section 6 of the Act outlines matters of national importance, which includes:

> *"The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development."*

Section 15 of the RMA places restrictions on the discharge of contaminants into the environment. Those parts of Section 15 which relate to stormwater are reproduced below:

Discharge of contaminants into environment:

No person may discharge any:

a) Contaminant or water into water; or

b) Contaminant onto or into land in circumstances, which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water.

In relation to stormwater, the Act therefore deals with:

a) The control of the use of land for the purpose of the maintenance and enhancement of the quality of water in water bodies and coastal water;

b) The control of discharges, contaminants, and water into water;

c) The control of the taking, use, damming and diversion of water, and the control of the quantity, level and flow of water in any water body, including:

- The settling of any maximum or minimum levels or flows of water;
- The control of the range, or rate of change, of levels or flows of water.

2.1.2 Waikato Regional Policy Statement

The Regional Policy Statement (RPS) provides an overview of resource management issues in the Waikato Region.

Where resource quality is high, it is the intention of objectives and policies to retain high resource quality.

Section 3 sets out the significant resource management issues, objectives, policies and methods associated with the RPS. The purpose of Part 3 is to:

"*Provide resource management issues, objectives, policies, methods, principal reasons for adopting and environmental results anticipated for the Region."*

In particular Section 3.4.5 has the objective of:

"Net improvement of water quality across the Region"

2.1.3 Waikato Regional Plan

Relevant objectives, policies and rules in the operative Regional Plan (RP) are set out below.

Stormwater Discharge

The discharge of stormwater is identified as a Discretionary Activity under the PRP. Objective 3.1.2 of the PRP seeks to manage water bodies in a way, which ensures:

c) "The avoidance of significant adverse effects on aquatic ecosystems

k) The management of non-point source discharges of nutrients, faecal coliforms and sediment to levels that are consistent with identified purpose and values for which the water body is being managed

l) The natural character of the coastal environment, wetlands, and lakes and rivers and their margins, (including caves) is preserved and protected from inappropriate use and development

o) Concentrations of contaminants leaching from land use activities and non-point source discharges to shallow ground water and surface waters do not reach levels that present significant risks to human health or aquatic ecosystems".

Policy 7 states:

"Encourage reduction at source and treatment of stormwater discharges to reduce contamination and flooding effects of discharges on the receiving water body, particularly sensitive receiving environments in urban catchments."

Policy 7 refers to statutory and non-statutory means by which Environment Waikato can encourage methods of managing stormwater at its source, and treating stormwater prior to its discharge to receiving waters. These methods include the resource consent process and the development and implementation of stormwater management plans. Stormwater management plans are to include details on the way in which stormwater networks are operated and include methods to avoid, remedy or mitigate the adverse effects of stormwater discharge.

The discharge policies in section 3.5.3 encourage land based treatment of discharges, the re-use of nutrients and water contained in the discharge, and minimising effects on ground water.

2.1.4 Comprehensive Stormwater Discharge Consent Conditions

Draft CMP related conditions of Comprehensive Stormwater Discharge Consents (CSDC) and municipal stormwater systems are given below. Please note that these draft conditions prepared by EW are currently being worked through and discussed with territorial authorities with reference to municipal stormwater systems and pending CSDCs. They are not intended for any other purpose. However, the outlined conditions are relatively standard ones that are placed on CSDCs.

New municipal stormwater diversion and discharge activities

All new municipal stormwater diversion and discharge activities commenced after the granting of this consent shall be authorised by this consent when the consent holder is notified in writing by the Waikato Regional Council to this effect. Such notification shall be provided on receipt of information showing to the satisfaction of the Waikato Regional Council acting in a technical certification capacity, that:

a) The new diversion or discharge is consistent with all conditions of this consent; and

b) For new diversion or discharge activities in developed urban catchments – the new diversion or discharge does not increase peak discharge rates to, or flow volumes in, receiving waters above those that would occur at the time of granting this consent, unless it is demonstrated that there shall be no additional adverse effects on the environment or downstream properties as a result of such increase; or

c) For new diversion or discharge activities in undeveloped catchments - the new diversion or discharge is consistent with a Catchment Management Plan, prepared in accordance with Condition 32 of this consent, and approved by the Waikato Regional Council acting in a technical certification capacity prior to any new diversion or discharge activities occurring within the catchment.

Catchment Management Plans

In accordance with this consent, Catchment Management Plans that are prepared to enable municipal stormwater diversion and discharge activities in developing catchments shall be approved by the Waikato Regional Council prior to the undertaking of these activities. To this end, Catchment Management Plans shall be prepared in consultation with the Waikato Regional Council and other key stakeholders and, as a minimum, Catchment Management Plans shall detail the following information:

a) Catchment maps / drawings of the catchment, delineating the catchment boundary, catchment topography, receiving environment and existing land uses within the catchment;

b) Social, economic, ecological, amenity and cultural objectives being sought for the catchment;

c) Identification of the key stakeholders within the catchment, and details of the consultation initiatives undertaken with key stakeholders;

d) Classification of the receiving waters within the catchment in accordance with the Waikato Regional Plan;

e) An assessment of the current status of the catchment and receiving environment, and the provision of detailed baseline information of the geological, hydrological, and ecological characteristics of the catchment;

f) Identification of potential urban growth, development and land use intensification within the catchment;

g) An assessment of the potential effects of stormwater diversion and discharge activities on the catchment and receiving environment, including but not limited to effects on:

- Sites of cultural and/or historical significance
- Public health
- Flooding hazards
- Receiving water hydrology, including base flows in rivers and streams and long-term aquifer levels
- Receiving water sediment and water quality
- Receiving water habitat, ecology and ecosystem health
- The natural and amenity values of receiving waters
- Receiving water riparian vegetation
- The extent and quality of open stream channels
- Fish passage for indigenous and trout fisheries
- Erosion and sedimentation of receiving waters
- The discharge and accumulation of litter

h) The cumulative effects of stormwater diversion and discharge activities within the catchment, the range of general management options available and the Best Practicable Option to prevent and minimise the adverse effects of stormwater diversion and discharge activities, and to mitigate or offset any significant unavoidable adverse effects.

i) The effectiveness of District Plan provisions to implement the management approach adopted by the CMP and, where necessary, the changes or variations to relevant District Plan provisions that will be initiated or advocated to achieve the objectives of the CMP.

j) Education initiatives to support the catchment management objectives.

k) The methods by which all stormwater diversion and discharge activities will be managed.

l) A description of all infrastructure works scheduled by Franklin District Council, which may significantly affect stormwater management within the catchment.

2.2 FRANKLIN DISTRICT COUNCIL POLICIES AND PLANS

2.2.1 Long Term Council Community Plan 2006-2016

The Franklin District Council (FDC) District Growth Strategy reiterates the strategic importance of Pokeno. It states that future growth planning and infrastructure provision be consistent with Regional and District Strategic Planning, and to be undertaken in collaboration with private developers, incorporating contributions for successful implementation of the Strategy.

The LTCCP notes the requirement from EW to develop integrated Catchment Plans for all stormwater catchments.

2.2.2 District Plan

The operative Franklin District Plan sets out the Council's objectives, policies and rules for managing the District's natural and physical resources. These rules exist to manage and protect the District's diverse and unique environment. Plan Change 14, also known as *"The Rural Plan Change"* proposed a comprehensive replacement of the existing sections relating to rural areas in the Operative District Plan.

The purpose was to provide a regime of strategies, objectives, policies and rules that better address the current issues facing the rural and coastal areas of the District, particularly in relation to the management of growth. Plan Change 14 seeks to provide a clear direction for District growth, while fulfilling the responsibility of sustaining and enhancing the valuable natural and physical resources of the District, to ensure future economic, environmental, social and cultural well being.

A copy of the current provisions under the FDC District plan specific to stormwater is included for reference, in Appendix 2.

It covers policies in the following areas:

- Stormwater management – volume control
- Setback from water
- Open drains

Envisaged landuse changes contemplated as part of the Pokeno Development are covered in the Pokeno Structure Plan Report.

2.2.3 Code of Practice for Development of Land

The FDC Code of Practice for Development of Land outlines Council requirements for design and construction of stormwater systems. The Code of Practice also

goes through design methods for 'on site' disposal of stormwater. It sets out the requirements for stormwater drainage under the following headings:

401 Definition of Public Stormwater System

401.1 General

401.2 Water Permits

401.3 Design requirements

401.4 Open watercourses

401.5 The hydraulic design of pipelines

401.6 Location of pipelines

401.7 Pipes

401.8 Joints

401.9 Structural strength of pipes and bedding

401.10 Pipeline construction

401.11 Minimum cover over pipes

401.12 Manholes

401.13 Connections

401.14 Ramped risers

401.15 Connections to deep lines

401.16 Inlet and outlet structures

401.17 Testing

401.18 Secondary Flow Paths

401.19 Counterfort and bored drains

401.20 Acceptance and As Builts

The Codes of Practice provides guidance for:

a) Acceptance and passage of discharges from the entire catchment upstream of that portion being developed.

b) Collection and disposal of discharges from each separate site by:

- Connection to a reticulated system;
- Disposal within the boundaries of the site.

c) Meeting the requirements of the Regional Council in respect of:

- Discharges onto or into land or water;

- Damming or diverting of natural water;
- Bridge or culvert waterway areas.

Overall the CoP ensures developments have appropriate engineering design to manage effects on the physical environment, whether that be urban or rural in nature.

2.2.4 District Growth Management Strategy

FDC adopted *"The Franklin District Growth Management Approach" (DGMA) in response to the Auckland Regional Growth Strategy: 2050, identifying issues and priority outcomes for Franklin District".*

FDC is currently preparing a growth management strategy for the Franklin District, which was not available at the time of writing the CMP report.

2.2.5 Stormwater Discharge Consents

EW is currently processing a CSDC application by FDC, for the Municipal Stormwater System in the Pokeno Township area.

There are no current (nor expired) resource consents held by the Franklin District Council for stormwater discharge activities or related activities in the Pokeno Urban area.

2.2.6 Council Maintenance

Council maintenance is currently carried out on an 'as-required' basis. At risk structures such as inlets and culverts are inspected prior to and post storm events.

2.3 PROPOSED POKENO STRUCTURE PLAN

2.3.1 Background and Key Socio-Economic Objectives

In 1999, FDC identified the strategic importance of Pokeno and the need for further investigations for the development of Pokeno. A proposed Structure Plan prepared in 2000 identified the need for a higher level of amenity and the potential for growth, but noted infrastructural constraints. The proposed rural plan change in 2003 identified Pokeno for residential development.

The FDC LTCCP (2006 to 2016) reiterated the strategic importance of Pokeno. The Hearings Panel of Plan Change 14 noted *"… Pokeno and its surrounding hinterland are of considerable strategic importance in providing for growth, given its proximity to major transportation routes. It is suitable as a major growth node to serve the southern area of the District."*

The Pokeno Landowner Consortium, in consultation with FDC, is advancing a Structure Plan, which aspires to transform FDC's vision to reality.

The Consortium are landowners in the Pokeno area with significant development aspirations to:

- Work in partnership with Council;
- Achieve community goals;
- Respond to community needs;
- Advance the economic, social, environmental and cultural growth and development of Pokeno and Franklin District.

The envisioned planning outcome is the development and revitalisation of Pokeno as a significant rural settlement accommodating a broader range of residential and business uses with a design (additional) population of circa 6,000 people.

It is the Consortium's strong desire to work with the respective Councils so as to support the strategic direction *"To achieve a built environment within the region's metropolitan area and rural and coastal settlements that has a sense of identity and character, has a range of densities and uses, is visually pleasant, functionally efficient, environmentally sustainable and economically vibrant".*[1]

Pokeno is strategically located at the entrance to the Region, at the confluence of State Highways 1 and 2 and adjacent to the North Island Main Trunk Railway (NIMTR). It therefore provides significant locational qualities to support and sustain extensive business/employment areas and a larger residential population building on the character of the village. The village could represent an important "gateway" to the District.

Franklin faces significant development pressures inherently as a result of decentralisation from Metropolitan Auckland. More affordable housing and business land is required to support a range of social and economic needs and lifestyle changes. These are strong motivators to provide settlement choice.

The Consortium's aspirations for Pokeno are to provide significant capacity and a range of land uses that complement the Franklin District hierarchy of centres, integrating with the existing village, building community and meeting Southern Sector Agreement (SSA) obligations.

The Consortium's desired planning approach is to integrate with Council's District Growth Strategy, to further advance technical studies to support

[1] Auckland Regional Policy Statement
Proposed Change 6
Clause 2.6.1.5 Strategic Objectives

comprehensive rezoning within an integrated structure plan and stormwater catchment management plan (and related discharge consents). By necessity this requires the planning for physical and social infrastructure.

The Pokeno Development Plan envisages creating an enlarged township in Pokeno consisting of a variety of land uses. These may include a range of residential zones and business zones.

2.3.2 Structure Plan Layout

For the purposes of this CMP, the development area is considered as four distinct blocks as shown in Drawing 121412-SW100. These blocks have been named as:

- Helenslee block, 120 hectares
- School block, 32 hectares
- Pokeno township, 56 hectares
- Hitchen block, 235 hectares

2.3.3 Proposed Land Use Changes

The proposed development area is currently rural land in most areas, apart from some urban development (commercial and residential) in the Pokeno Township, and some industrial land use at the southeastern end of the Hitchen block.

The proposed land use changes would accommodate a mix of residential, commercial, light industrial and industrial zones.

2.3.4 Proposed Staging of Land Development

The proposed staging of land development is not described in this report. Reference should be made to the Structure Plan Report, which outlines the proposed staging including maps showing the stages and timing of development. In general however stormwater mitigation should be in place prior to the effects being generated. This means that:

- Stormwater treatment/detention facilities should be in place prior to upstream impervious surfaces being constructed.
- Floodplain modifications in the industrial area need to start with removing restrictions prior to filling taking place.

3.0 CATCHMENT DESCRIPTION

3.1 CATCHMENT OVERVIEW

The Pokeno catchment study covers a land area of approximately 1,500 hectares largely comprised of farmland used for cropping and grazing. The catchment is bordered by Razorback Road to the northeast, Ridge Road to the north and west, Ewing Road and Potter Road to the south and Fraser Road to the east. The catchment is bisected east west by the Waikato Expressway and north south by the North Island Main Trunk Railway (NIMTR). Both transport routes have impacted on the natural topography of the catchment. The existing Pokeno Township lies entirely within the lower portion of the catchment.

The catchment termination point for this analysis has been chosen as the location where the Helenslee stream meets with the Tanitewhiora Stream (see stream names below). Both streams have waterfalls approximately 4m in height which effectively mean the streams are hydraulically separate from the backwater effects of flooding in the Mangitawhiri swamp/ wetland and Waikato River further downstream. The waterfalls also present a physical barrier to the passage of many fish species upstream.

3.2 SUBCATCHMENTS

There are two main sub catchments of interest within the Pokeno catchment (refer Drawing 121412-SW100), these are:

- The catchment (approximately 1,270 hectares), which contributes runoff into the Tanitewhiora stream (also referred to as the Pokeno stream). This subcatchment is separated from the Helenslee catchment (see below) by Helenslee Road and Great South Road. For the purposes of this report this catchment will be referred to as the Tanitewhiora Catchment.

- The catchment (approximately 230 hectares), which contributes runoff to the unnamed stream, which traverses through the Helenslee block and eastern area of the Pokeno Township (referred to in this report as the Helenslee Stream). For the purposes of this report this catchment will be referred to as the Helenslee Catchment.

These two sub catchments have been divided into smaller sub catchments where locations of particular interest have been identified. These include stream confluence points and stream crossings such as road and rail bridges. Drawing 121412-SW100 shows the contributing Pokeno catchment, sub catchments and nodes.

3.3 CATCHMENT BOUNDARY ASSUMPTION

Stormwater calculations in this report are based on the assumption that the southeastern boundary of sub-catchment K within the Tanitewhiora catchment coincides with the proposed structure plan development boundary.

We have assumed that the existing landscape will be re-worked to ensure that all stormwater run-off within this proposed development boundary will flow towards the Tanitewhiora stream.

3.4 PREVIOUS CATCHMENT STUDIES

Catchment investigations and studies of the Helenslee block area and part of Hitchen block (Winstone Quarry area) had been carried out by others in the past, following several development proposals in the Pokeno area. Appendix 4 lists the reports produced to date as a part of these studies, and which were made available to Harrison Grierson Consultants Limited. These reports have been examined and relevant information noted in the preparation of this draft CMP.

3.5 LANDSCAPE

3.5.1 Topography

The topography of the study area varies significantly with steep hill country in the upper parts of the catchment to the north and west and large expanses of flat areas within the valley floors lower down in the catchment. Ground levels within the catchment range from a reduced level (RL) of 240 at the highest point of the catchment (NZL&S datum) to RL 7 at the chosen termination point of the study area.

3.5.2 Vegetation

Vegetation is characteristic of the northern Waikato rural landscape in low-lying to lower hill country that had been developed for pastoral agriculture.

3.5.3 Streams

Two main streams drain the catchment. The Tanitewhiora stream and its tributaries drain around 1,270 hectares while the Helenslee stream drains around 230 hectares.

3.5.4 Climate and Rainfall

Rainfall charts provided by FDC have been used for modelling purposes. These charts compare well with ARC TP108 rainfall charts.

3.6 SOILS AND GEOLOGY

Reference to the Institute of Geological & Nuclear Sciences 1:250,000 scale Geological Map of Auckland (Map 3) shows the Pokeno catchment consists of three main soil classes, these are:

- South Auckland volcanic field - basalt lava, scoria, ash, lapilli and lithic tuff.
- Taupo Pumice Alluvium - alluvium/ colluvium.
- Mercer Sandstone - sandstones and mudstones.

3.7 EXISTING LAND USE AND POTENTIAL CONTAMINATED LANDS

A preliminary Site Contamination Investigation was undertaken by Harrison Grierson in November 2006. The report reviewed previous studies undertaken in the area as well as our own findings. A summary of the outcomes of that report is given below:

3.7.1 Previous Reports

Helenslee Block Area Soil and Land Evaluation, Chapman R, 19 May 2006

The Soil and Land Evaluation carried out by Soil and Land Evaluation Limited consisted of Preliminary and Detailed Site Inspection Reports for the area of land delineated by Helenslee and Pokeno Roads and Great South Road/State Highway 1. Soil and Land Evaluation identified that the land had historically been used for dairy farming and had most recently been used for grazing dry stock. Possible areas of soil contamination identified on the site included a farm rubbish dump on the northern part of the site and around a milking shed and barn near the western boundary.

Soil sampling was carried out at the two potential contamination hotspots, as well as composite samples across the whole site. Sample results indicate that zinc and cadmium are present at concentrations above the selected guideline values around the milking shed and barn near the western boundary, zinc contamination is also present in the farm rubbish dump on the northern part of the site.

The sampling methodology utilised by Soil and Land Evaluation (four composite sub-samples around the contamination hotspots and eighteen composite sub-samples across the remainder of the site) is likely to have prevented any other contamination hotspots, or contaminants of concern being identified on any other parts of the site. However, based on the site history provided by Soil and Land Evaluation, it is considered unlikely that contaminants are present elsewhere on the site.

Hellenslee Block Area Hydrogeology & Geotechnical Appraisal, SKM, 9 March 2004

Sinclair Knight Merz carried out a hydrogeological and geotechnical appraisal that included the area of the farm dump identified by Soil and Land Evaluation Limited. Sinclair Knight Merz estimated the farm dump to be 5m by 5m and 2m to 3m deep.

3.7.2 Preliminary Contamination Report

In addition to the review of available geotechnical and soil & land evaluation reports, site history investigation and site walkover were carried out. The site history was investigated by reviewing FDC and EW records and a historic land title search. A review of aerial photographs in 1942, 1961, 1975, 1981 and 2005 was also carried out, in addition to a site walkover and discussion with landowners.

A summary of findings and recommendations are given below:

(a) Identified land uses within the investigation area include:

- Dairy farming;
- Crops;
- Market gardening;
- School;
- Cattle farming;
- Automotive workshop;
- Emu farming.

These land uses have been identified based on aerial photographs, anecdotal evidence from property occupants; historic land titles and the presence of crops or milking sheds on some properties.

(b) A number of areas of potential contamination have been identified within the investigation area. These areas are:

- Farm dumps at 174 Helenslee Road, 62 Munro Road and 116 Hitchen Road;
- Farm sheds at Lot 4 DP 198258 (Helenslee Road), 71 Hitchen Road and 44 McDonald Road;
- A garage used for automotive repairs at 62 Munro Road;

- An area of rusted cars, car parts and oil drums at 45 Hitchen Road;
- Areas used to grow crops on Lot 1 DP 207629 (adjacent to State Highway 1), Lot 1 DP 189825 (Munro Road), Sect 1 SO 67606, Lot 2 DP 199998 and Lot 2 DP 184589 (properties circling 45 McDonald Road);
- A pond within Lot 2 DP 321866 (Hitchen Road);
- A pile of asbestos containing cement board at 44 McDonald Road;
- A small orchard at 47 McDonald Road.

(c) Recommended further contaminant investigation are:

A number of areas of potential soil contamination have been identified within the investigation area. It is recommended that further, more detailed, investigations be carried out in these areas to determine if contaminants are actually present in the soils prior to development of the site. In particular, soil sampling should be carried out in all identified areas, with sediment sampling within the pond on Lot 2 DP 321866.

If contaminants are found to be present in soils within the investigation area, it is recommended that sediment sampling be carried out in nearby streams to determine if contaminants have migrated into the streams. With regard to the area of asbestos containing cement board identified at 44 McDonald Road, this material should be removed from the site and disposed of appropriately.

3.8 EXISTING STORMWATER INFRASTRUCTURE

The main stormwater infrastructure maintained by FDC is a limited piped network within the Pokeno Township connected by open drains. Natural watercourses within the catchment are supplemented by overland flow paths. Culverts at the road and rail crossings of these watercourses and their sizes have been surveyed as a part of this CMP and shown in Drawing 121412 – SW104.

3.9 CLIMATE CHANGE

Climate change is an internationally recognised outcome of increased amounts of greenhouse gases in the atmosphere. It will have effects over the next decades that are predictable with some level of certainty, but which will vary from place to place and throughout New Zealand. Much research has been conducted in the area of climate change with numerous documents and publications produced by governmental bodies worldwide supporting both the evidence and significance of climate change.

The following publications were investigated during the development of this Catchment Management Plan:

- Intergovernmental Panel on Climate Change, Fourth Assessment Report, 2007. **Climate Change 2007: Synthesis Report.**
- Intergovernmental Panel on Climate Change, November 2007. Draft copy of the **Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report**
- Ministry for the Environment, May 2004. **Climate Change Effects and Impacts Assessment.**
- Ministry for the Environment, March 2005. **Incorporating climate change into stormwater design – Why and how?**
- Ministry for the Environment, June 2004. **Preparing for climate change – A guide for local government in New Zealand.**

The most significant and relevant publications for this catchment management plan include the Fourth Assessment Report produced by the Intergovernmental Panel on Climate Change (IPCC): **Climate Change 2007** and **Climate Change Effects and Impacts Assessment** produced by the Ministry for the Environment in May 2004.

Both reports go into detail on the reality of climate change and the need to consider its consequences, and present a broad range of climate change predictions. These documents do not offer much guidance as to what degree of climate change should be adopted. The **Climate Change Effects and Impacts Assessment** report does state however, that *…the extreme ends of the ranges may be slightly less likely than the central values, since they generally result from the one climate model which gives the most extreme projection, rather than reflecting agreement between a number of models.* These documents also detail the various significant factors that contribute to uncertainty in projected climate change values for New Zealand.

The New Zealand government has addressed climate change by the Resource Management Amendment Act, 2004, requiring local government and all persons exercising functions and powers under the principal Resource Management Act to have particular regard to the effects of climate change. Many Council's within New Zealand are currently working with the community and various industry groups to get their input towards climate change policy and most currently support industry taking a precautionary or mid-risk approach when considering climate change during the design of stormwater management practices.

4.0 STATUS OF RECEIVING ENVIRONMENT

4.1 DESCRIPTION OF RECEIVING ENVIRONMENT

The perennial streams in the catchment are the immediate receiving environments for stormwater runoff. The receiving environment for stormwater from the Pokeno Catchment is the Mangitawhiri swamp/ wetland and Waikato River.

Environment Waikato has stated that wetlands were once widespread throughout the Waikato but now they are some of New Zealand's rarest and most at-risk ecosystems. The Waikato River is also recognised as an area of ecological significance. These receiving environments will need to be protected from the potential adverse effects associated with land development.

4.2 ECOLOGICAL ASSESSMENT REPORTS

A preliminary ecological assessment was carried out by Bioresearches Group Limited, in September 2006. Their report was titled *"Pokeno Development Phase I Terrestrial Ecology and Freshwater Ecology"*. We have referred to this report hereinafter as the **Preliminary Ecology Report**. This report is included in Appendix 3 of this CMP.

A detailed ecological assessment of the catchment and receiving environment was carried out by Brian T. Coffey and Associates Limited, Environmental Consultants from December 2006 to February 2007. Their findings are detailed in a report titled *"Pokeno Catchment Management Plan - Ecological considerations, August 2008"* and is included in Appendix 3 of this CMP. It is referred to in this CMP as the "**Detailed Ecology Report**".

4.3 TERRESTRIAL ECOLOGY

The Preliminary Ecology Report summarises its findings of terrestrial ecology as follows:

"There would not appear to be any feature of the terrestrial ecology that would represent a major constraint to development of the site. Most of its area consists of grazed pasture and small, modified remnants of native forest, scrub and wetland. If those remnant habitats were found to have notable ecological values during the Phase II investigations, straightforward measures in mitigation are available."

The Detailed Ecology Report indicates the following with respect to vegetation within the catchment:

"Improved pasture was the dominant vegetation type throughout…

Wetlands in the School Block were dominated by reed sweet grass (Glyceria maxima); wetlands in the Helenslee Block were dominated by rushes (Juncus spp.) and willow weed (Persicaria [Polgonum] persicaria). Wetlands in the Pokeno Township and Hitchen Blocks were dominated by a combination of twin cress (Apium nodiflorum) and reed sweet grass".

Three sites of significant vegetation were identified. They are shown in Figure 4 of the Detailed Ecology Report.

- *"Totara (Dacrycarpus dacrydioides) occurred in all four blocks but tree lots of this native tree were a particular feature of the Helenslee block. The best-developed stand of mature totara occurred on the mid northeastern boundary of the Helenslee block.*

- *The other remnant native tree of special interest in the study area was the Kahikatea (Dacrycarpus dacrydioides) that was once widespread on the lower Waikato floodplain. A group of some 25 mature Kahikatea was present adjacent to the Totara referred to above on the mid northeastern boundary of Helenslee block. Another two smaller groups of Kahikatea occurred in the School block.*

- *Oak trees (Quercus spp.) in excess of 6 m tall were a feature of the town centre and were also recognised as a site of significant vegetation".*

4.4 STREAM CLASSIFICATION

A number of the watercourses within the catchment have been heavily modified in previous years in order to maximise available farmland. These watercourses are easily identified by their straight channelised alignment and general lack of riparian vegetation. Reference to aerial photos taken in the 1970's shows that a number of these watercourses have been modified since this time. Informal discussions with landowners in the area suggest that the process used to modify watercourses often involved heavy spraying of chemical herbicides and significant realignment earthworks.

The catchment also has a large number of ephemeral watercourses and upper reaches of streams, which may dry up during, summer months. It is considered that there is good opportunity to pipe some of these modified and ephemeral watercourses in order to provide larger areas for development. Some areas of the Development Concept Plan have been designed with this premise in mind.

The Detailed Ecology Report comments *"In general, all but the penultimate headwaters of the mainstream of both Tanitewhiora and Helenslee streams were perennial streams between early December 2006 and early February 2007".*

Figure 28 in page 28 of the Detailed Ecology report gives a map showing the Perennial and Ephemeral streams in the Pokeno catchment.

4.5 HYDROLOGY AND FLOODING HISTORY

Hydrological analysis of the current status of the catchment is detailed in Section 5. Existing flood plains are plotted using the results of modelling and shown in Drawing No. 121412 – SW102.

A 2000 OPUS Consultants Report prepared for Franklin District Council entitled 'Pokeno Growth Study report' noted that there are extensive flat areas in the area generally between Helenslee Road and Pokeno Road that are subject to flooding. The report also noted that the area west of the Pokeno main street experienced some flooding problems that may be due to culvert sizing. The report noted that the area south of McDonald Road might be subject to inundation. Apart from this, there is no written record of flooding in the study area on FDC's hazard register.

4.6 FRESHWATER AQUATIC ECOLOGY

The Preliminary Ecology Report summarises its findings on freshwater aquatic ecology as follows:

"The freshwater habitats within the development area appear to be modified as a result of present and historic land use practices, with the majority of the area used for agriculture, including cattle and sheep grazing. Riparian cover appears to be highly modified in most places, or limited to pasture grasses. The ecological assessments previously undertaken in the area indicate the small farm pasture streams are likely to have reduced ecological values with greater values recorded within the larger mainstream channels.

The Phase II investigations would be used to determine the actual values of streams in the area, and the extent of ephemeral/perennial habitats. Both Environment Waikato and Auckland Regional Council allow infilling of ephemeral stream channels, however proposed infilling of perennial streams would need to be deemed as unavoidable. Suitable measures in mitigation would be required for the infilling of any perennial streams, and the remaining streams within the development area would provide ample opportunity for restoration measures".

The Detailed Ecology Report indicates the following with respect to the streams within the catchment:

"Indices of macro invertebrate community structure indicate that the Tanitewhiora and Helenslee stream within, upstream and downstream of the proposed development are generally moderately polluted and in some cases probably severely polluted.

The mainstream of both the Tanitewhiora and Helenslee streams did have fisheries values to climbing native eel proportions and to resident landlocked common bully populations during the summer period.

The pH of stream water and its dissolved oxygen concentration appears to be related to the presence or absence of emergent plant cover in the stream upstream of any given sampling point. Where an open stream channel was present upstream of any given sampling site, dissolved oxygen saturation and pH values were higher at both dawn and maximum daylight than when a closed cover of emergent plants was upstream of any given sampling site".

"It appears that dissolved oxygen in a number of reaches of the Tanitewhiora and Helenslee streams falls below the threshold of concern for aquatic life as a result of:

- *Poor physical in stream habitat quality associated with the overgrowth of many sections of the stream channel with emergent macrophytes,*
- *Dense growth of iron bacteria associated with anoxic ground water seeps into tributary headwaters,*
- *Unfenced riparian stream margins; Agricultural and horticultural land use in the catchment*
- *Low or lack of tributary inflows during the summer flows,*
- *Probable moderate to severe pollution of water quality in the study area (as indicated by indices of macro invertebrate community structure)".*

5.0 STORMWATER MODELLING

5.1 HYDROLOGICAL MODEL

The hydrological modelling of the catchment was carried out using HEC-HMS version 2.2.1 (USACE, 2001) in accordance with the methodology detailed in the Auckland Regional Council Guideline Technical Publication 108 (ARC 1999a) (henceforth referred to as TP108). This publication uses the United States Soil Conservation Service's (USSCS) "Curve Number" approach and outlines methodologies for defining the parameters specified by this method. These parameters include curve numbers, initial losses, and time of concentration.

TP-108 is suitable for assessing the effects of land-use change in catchments and simulating natural and engineered systems. The key features of TP108 are described below:

- A standard 24-hour temporal rainfall pattern is used, having peak rainfall intensities at mid duration. This "Chicago Storm" rainfall hyetograph includes design rainfall bursts with durations ranging from 10 minutes to 24 hours nested within one another.
- Rainfall depths for given Annual Exceedence Probabilities (AEP) are presented for the Auckland Region.
- Runoff depth is calculated using USSCS rainfall-runoff curves. Curve Numbers are calculated based on Auckland soil types and USSCS guidelines relating to land use.
- The runoff hydrograph is calculated using the standard USSCS synthetic unit hydrograph.
- The time of concentration is estimated from an empirical lag equation derived from a regression analysis of data for the Auckland Region.
- Pervious and impervious components of urban catchments can be calculated separately.

5.2 SELECTION OF MODEL PARAMETERS

The HEC-HMS model package requires values for parameters that describe the soil properties and response properties of the catchment. The following parameters describe both pre-development and post-development scenarios for the Pokeno Catchment Study Area.

5.2.1 Rainfall

The design rainfall for the structure plan area has been obtained using the criteria outlined in ARC TP108. This includes the Chicago Storm hyetograph

shape applied to rainfall depths for chosen storm events. Rainfall events of 1% AEP, 10% AEP, 20% AEP and 50% AEP were chosen, as recommended by the ARC's "Guidelines for Comprehensive Catchment Stormwater Discharge Consents" (ARC 2001a) and as requested by the FDC. A further rainfall event was analysed for the Climate Change event at the request of EW which included a 28% increase on the 1% AEP event.

Table 5.2: Rainfall Depths for Selected Storm Events

Storm Event (AEP)	24-Hour Design Rainfall Depth (mm)
1% + Climate change 28%	300
1% AEP	242
10% AEP	152
20% AEP	123
50% AEP	78

5.2.2 Areal Reduction Factor

It is recognised that Depth, Duration, Frequency relates to rainfall at a specific point. The ARC TP108 recommends that for catchments greater than 10km² in size an Areal Reduction Factor (ARF) be applied to reduce the depth of rainfall falling on the catchment. The Pokeno catchment is approximately 15km² in area. The rainfall figure stated above for the climate change event have been reduced by a factor of 0.97.

5.2.3 Climate Change

Pokeno is situated in the northern Waikato area, just south of the Auckland Region. It could be argued that the climate in Pokeno is similar to that encountered in the Auckland Region, more so than the Waikato. Notwithstanding this, Pokeno is within the boundaries of the Waikato region, and as such, climate change predictions for the Waikato region have been employed.

There is no specific literature currently available on climate change predictions in the Pokeno catchment area, however the **Climate Change Effects and Impacts Assessment (CCEIA)** produced by the Ministry for the Environment in May 2004, does give a prediction range for the Waikato Region as a whole. The climate change variables of most concern with regards to stormwater management include rainfall and sea level. Pokeno is situated approximately 20km in-land and does not contain any tidally affected watercourses, sea level variations were therefore not considered as part of this assessment. The frequency of extreme daily rainfalls is generally expected to increase, so is likely to have an effect on stormwater management practices within the Pokeno catchment.

The CCEIA reports (Table 2.3) the projected annual mean temperature change to 2080 to be in the range of 0.4 to 3.8°C. The mid range value is shown in Figure 2.2 as being 2.0°C. While this change may either decrease or increase

the annual or seasonal rainfall depths, Table 5.2 (of the CCEIA) provides data for deriving extreme rainfall for various storm events per degree of temperature increase. These range from 5.4 % for the 50% AEP event to 6.7% for the 1% AEP event (24 hour duration).

Multiplying the high range temperature increase from Table 2.3 by the percentage increase in rainfall depths in Table 5.2 yields a value of 25.5% for a 1% AEP event. Based on the mid range temperature increase a value of 13.4% is derived for a 1% AEP event.

For the purposes of this CMP, scenarios were modelled by adding both 15% and 28% to the rainfall depths to the 1% AEP rainfall to confirm the sensitivity of the catchment runoff to these changes.

5.2.4 Curve Numbers (CN)

The Curve Numbers describe the soil's infiltration potential. They represent a non-linear relationship between rainfall and runoff depth. The Curve Numbers are related to the ground cover and underlying soil. TP108 uses four categories to describe the soils in the Auckland region.

Geological maps indicate that the catchment is underlain by three dominant soil classes (refer Drawing 121412-SW110). Various CN numbers have been assigned to each soil type, as follows:

Table 5.3: SCS Curve Number (CN) for Hydrological Soil Groups

Soil Type	CN	
South Auckland Volcanic Field Basalt Lava, Scoria, Ash, Lapilli and Lithic Tuff	**Type A-B Soil**	
	Pasture and Grassed Areas	CN = 50
	Bush Areas	CN = 43
	Impervious Areas	CN = 98
Taupo Pumice Alluvium Alluvium/ Colluvium	**Type B Soil**	
	Pasture and Grassed Areas	CN = 61
	Impervious Areas	CN = 98
Mercer Sandstone Sandstones and Mudstones	**Type C Soil**	
	Pasture and Grassed Areas	CN = 74
	Impervious Areas	CN = 98

South Auckland Volcanic Field soils were considered to belong in between Hydrological Soil Group A and B (soils with moderate to high infiltration rates), based on observations made in the field and from studies previously undertaken within the catchment. Therefore CN values for this soil type are the average value of Group A and B.

5.2.5 Initial Abstraction

The initial abstraction can be considered as the amount of rainfall that soaks into the ground before surface runoff begins. In accordance with ARC TP10, a value of 0 has been used for all impervious areas and a value of 5 has been used for all pervious areas.

5.2.6 Channel Routing

The Muskingham Cunge 8 point method was used to route peak stormwater flowrates down stream reaches. This method takes into account channel profile, length, average slope and Mannings roughness.

5.2.7 Percentage Impervious

The catchment study area was divided up into areas of various land uses for both the existing and post-development catchment scenarios. Drawing 121412-SW111 shows the Pre-development land use assumptions and Drawing 121412-SW112 shows the Post-development land use assumptions.

Each area was measured and assumptions were made for the amount of impervious areas (such as roads, driveways, footpaths and roofs) would be associated with each landuse. A summary of the impervious percentages chosen is given in Table 5.4.

Table 5.4: Percentage Impervious (PI)

Pre-Developed Landuse Type	PI (%)	Area (Ha)	Post Developed Landuse Type	PI (%)	Area (Ha)
Pasture	1	1320.8	Pasture	1	1003.0
School	50	2.4	School	50	3.7
Cemetery	20	1.5	Cemetery	20	1.5
Existing Roading	75	51.6	Roading	75	108.5
Railway	80	23.1	Railway	80	22.4
SH1 Waikato Expressway	75	34.4	SH1 Waikato Expressway	75	34.4
Bush	0	14.0	Bush	0	14.0
Reserves	0	25.0	Reserves	0	75.4
Existing Residential & Commercial	50	22.2	Residential	70	150.1
			Neighbourhood Centre	85	0.9
			Retirement Village	80	4.8
			Mixed Use	85	7.3
			Light Industry	85	24.3
			Industry	90	31.1
			Town Centre	100	2.9
			Town Centre Mixed Use	85	6.8
			Town Hall	70	0.4
			Commercial	85	3.1
			Railway Station	85	0.5

5.3 DATA SOURCES

LIDAR - LIDAR information was obtained by NZ Aerial Mapping for virtually the entire Pokeno catchment area. The LIDAR provides contour information at 0.5m intervals and with a vertical accuracy of approximately +/- 0.3m..

Field Survey Data - Additional field survey was undertaken by Harrison Grierson Consultants Limited. An initial survey of the major bridges and culverts in the catchment was undertaken to obtain suitable data for insertion into the HEC-RAS hydraulic model. A second survey was undertaken to more accurately determine streambed and bank levels where the LIDAR survey did not provide suitable information. The typical vertical accuracy of the field survey is +/- 0.1m.

FDC Data - GIS data from Franklin District Council was obtained. The data includes the layout of existing stormwater reticulation system (where known) as well as road culverts and stormwater outfall locations.

Transit NZ and On-Track Data - The location and diameter of culverts underneath SH1 Waikato Expressway and the North Island Main Trunk Railway were obtained from Transit NZ and On-Track rail.

Previous Studies and Reports - refer to Appendix 4 for a list of previous reports and studies that have been referred to in the CMP report.

5.4 HEC-HMS MODEL CALIBRATION

Accurate calibration of the HEC-HMS model has not been possible as no stream flow or storm event records exist for this catchment. Comparison to other studies conducted within the area suggests that the peak flow at Node 10 of 84.5 m^3/s is similar to the value of 80.1 m^3/s predicted by Search Consulting Limited in the December 2005 report.

5.5 HYDRAULIC MODEL

Given the largely undeveloped nature of the catchment and relatively small and isolated network of piped stormwater reticulation within the catchment it was considered that a typical drainage network analysis model such as MOUSE would not be suitable for modelling this catchment. The catchment is comprised largely of small streams with a number of road and rail crossings in the form of bridges and culverts. The use of a river modelling software package such as HEC-RAS (River Analysis Software, USACE 2001) that better takes into account flood plains, the backwater effects of bridges and culvert structures and the shape of the actual drainage path was used in this instance. Peak flowrates derived using HEC-HMS were input into the HEC-RAS model to determine flood levels for various storm events and development scenarios within the catchment.

5.6 SELECTION OF MODEL PARAMETERS

The HEC-RAS model package requires values for parameters that describe the stream channel, flood plain, bridge and culvert properties of the catchment. The following parameters describe both pre-development and post-development scenarios for the Pokeno Catchment Study Area.

5.6.1 Topography

The cross-sections of the hydraulic model were constructed using LIDAR Survey data of the catchment, to identify the extents of the natural floodplain on each over-bank.

As has been stated in section 5.3 although very detailed, LIDAR data does not often pick up channel details or smaller watercourses. Level data is also affected by substantial vegetation growth that cannot be filtered out completely. For this reason each cross section was supplemented by physical topographic survey information of the channel itself. Due to errors in the LIDAR data and also the positioning of the channel survey, some channels could not easily be reconciled with the LIDAR contours, leading to large steps in the cross section at the junction of the channel and the floodplain. In these instances the knowledge of the existing situation gained through site walkovers was applied to ensure that a realistic situation was achieved.

Two main models have been constructed and these relate to the pre-development and post development scenarios and included the bridges and culverts that were considered likely to create hydraulic restrictions within the channel.

5.6.2 Roughness Values

The roughness of the channels and associated floodplains was modelled using Manning's 'n' values. The roughness values were altered for the pre and post development scenarios to reflect riparian the planting that is recommended to be carried out in the post development scenario.

In the pre-development scenario the Manning's value used for most stream channels and the floodplain were set at 0.035, representing relatively clean, winding channels with some shoals and pools present. For selected stream sections a Manning's value of 0.06 was used to represent the dense vegetation present. A Manning's of 0.035 was applied to the floodplain areas to represent the relatively smooth pastoral land use that exists.

In the post development scenario the Manning's value used for the channel was increased to 0.06 to better represent the effects of riparian planting that would occur following development. For the floodplain areas, either side of the main channel, the Manning's remained at 0.035. This was allowed to reflect the construction of 'smoother' surfaces within the floodplain, (such as roading, footpaths playing fields and car park areas), whilst still allowing for occasional obstructions to the natural flowpath from buildings, specimen trees or other obstructions.

5.6.3 Steady State Modelling

The hydraulic modelling was carried out using steady state modelling and has, therefore, only generated flood levels for the peak flows generated from the HEC-HMS hydrologic model.

The peak flows from the HEC-HMS hydrologic modelling were entered as point inflows at relevant points in the hydraulic model.

5.7 HEC-RAS MODEL CALIBRATION

Accurate calibration of the HEC-RAS model has not been possible as no flood level or storm event records exist for this catchment. Comparison to other studies conducted within the area suggests that the flood level at Node 10 is similar to the flood level shown in the report by Search Consulting Limited in their report dated December 2005. However, an exact comparison can not be made as the Search Consulting Limited report used an assumed datum in their study. A further comparison to the Pokeno Township Stormwater modelling and Flood Mapping Report dated April 2008 by Hydroanalytics, enabled cross section information below SH1 to be updated by lowering previously assumed bed levels.

5.8 MODEL SCENARIOS

Three main scenarios have been modelled:

- Existing Scenario (using Pre-development hydrological model);
- Future Scenario without mitigation (using Post-development hydrological model);
- Future Scenario with mitigation (using Post-development hydrological model and Post-developed hydraulic model).

5.9 OPTION EVALUATION

Within the Post-Developed Mitigated scenario a number of additional scenarios have been explored, these include:

- The possibility of merging the two upper Pokeno stream channels into one channel at a point near Munroe Road;
- Upgrading of selected bridges and culverts throughout the catchment;
- Modification of stream channels to determine the change in flood level resulting from proposed floodplain modifications.

5.10 MODELLING NODES

Modelling nodes represent points of interest within the catchment. We have positioned nodes at the various road and rail bridges and culverts as well as the confluence points of key streams.

5.11 PRE-DEVELOPMENT MODEL

The Pokeno catchment characteristics and HEC-HMS parameters for the pre-development scenario are summarised in Appendix 1 for the modelling nodes shown in Drawing 121412 – SW100.

The flood attenuation effect of the existing ponds was ignored, as these dams are not necessarily a permanent feature of the farmed catchments, nor is there any information to indicate that they were designed with flood mitigation as a feature.

5.12 POST DEVELOPMENT MODEL

Post development modelling has been carried out based on 9 November 2006 revision of the proposed Pokeno Structure Plan. This has subsequently been checked against the August 2008 Structure Plan maps to confirm that the development assumptions are still valid.

The TP108/HEC-HMS parameters for the post-development scenario are shown in Appendix 1 for the catchments shown in Drawing 121412 – SW100.

5.13 FLOOD PLAIN ANALYSIS AND FLOOD HAZARD MAPPING

To safeguard life and property, floodways to pass the 1% AEP flows should be reserved from development. Riparian margins are to be reserved for other reasons, but their flood-carrying capacity needs to be checked in case wider floodways need to be provided for.

Drawing 121412 – SW102 shows the provided 1% AEP flood extents based on the outcomes of the HEC-RAS modelling. The drawing details calculated flood levels for the 50%, 20%, 10%, 1% and 1% plus 28% AEP events at key locations.

5.13.1 Terminology

For the purposes of this report the following terms will be used as listed in Table 5.13 below:

Table 5.13: Terminology	
Term used in CMP	**Meaning**
1% AEP (15%)	The 1% AEP flood level or flowrate resulting from the 1% AEP storm event with the rainfall increased by 15%.
1% AEP (28%)	The 1% AEP flood level or flowrate resulting from the 1% AEP storm event with the rainfall increased by 28%.
True left bank	The left bank of the stream when looking downstream
True right bank	The right bank of the stream when looking downstream

5.13.2 Stream Sections

An exercise was undertaken to determine a typical stream section profile that should be adopted in the HEC-RAS model that would best represent the proposed modified streambank section in areas where filling may be allowed. It was found in the analysis that a 1 in 3 slope that started above the 50% AEP flood level and extended for 10m away from the stream was not overtopped by the climate change flood event. Typical drawings of the modified stream channels are shown in Drawing-121412-SW115. Not all stream sections required the use of this developed section and the way in which it was used varied as follows:

Between State Highway 1 and Great South Road

Existing (pre-developed) sections were used in the model with the exception of a small alteration around the entry to the SH1 culvert (see other changes modelled below)

Between Great South Road and the North Island Main Trunk Railway

No modification of the stream banks was modelled.

Between the North Island Main Trunk Railway and McDonald Road Bridge.

No modification was made to the true left bank of the stream. The true right bank was modified at the existing 50% AEP flood level depending on the width of the stream bank at that level. Where the distance from bank to bank at the 50% AEP level was less than 10m then a benched cut into the bank was adopted until the 10m width was reached, and then the developed section was used above this location. Where the distance from bank to bank at the 50% AEP level was greater than 10m then the developed bank section started from that level.

Between McDonald Road and Hitchen Road Bridges.

The true left bank was modified to allow for filling of the flood plain from the top of the channel for approximately 100m upstream of the MacDonald Road Bridge. This allows for the construction of flood free building platforms on existing urban zoned land.

The true right bank was modified at a distance of 40m from the true left bank before the developed bank section was applied. These changes were made to stream sections located upstream of the Node 10 (McDonald Bridge) for a distance of 270m at which point the developed bank section was applied at the 10m distance once again.

5.13.3 School Block/Sports Park

Modelling of the proposed stream diversion for the School Block/Sports Park was undertaken to incorporate stormwater aspects of the diversion including creating a "natural" route, containing flood flows and maximising land (sports field use) above the 1% AEP flood level. The best practical option, including filling a small flooding arm to the south of the proposed sports park, is shown on drawing 121412-SW103 and has been achieved without significant increases in upstream flood levels. Detailed design of riparian planting will maximise the shading and habitat enhancement of the single and double channel sections of the stream. This riparian planting will have an effect on raising the flood levels over this reach.

5.13.4 Other Changes Modelled

Initial stormwater modelling highlighted a number of areas along the Tanitewhiora Stream where stream flow was backing up behind culvert and bridge structures. It was considered that any post-development modelling being undertaken should also study what effects would result if improvements were made to allow streamflow to pass through these constrictions in a more efficient manner and to meet the FDC's design criteria for roads.

SH1 Culvert

One of the more significant locations where heading up of stream flow was evident was the SH1 culvert and the Tanitewhiora Stream. The increase in water level here was is in the order of 1.5 metres and lead to higher stream flood levels upstream.

The original modelling was undertaken using sections derived from LIDAR survey and a physical survey undertaken by HGCL. These sections compare reasonably well with the shape of the stream banks as they were viewed during site visits and which were used in the pre-developed HEC-RAS model. The modelling highlighted that the sections immediately upstream of the culvert formed a constraint on flows as they hinder the ability for streamflow to enter

the arch culvert in an efficient manner. Modelling was undertaken to determine what the effect would be if localised stream bank modifications were undertaken to ease the transition from stream bank section to the SH1 culvert both immediately upstream and downstream of the culvert. The post development modeling scenario assumes that these transitional clearing works are done.

Great South Road Bridge

A site inspection of the Great South Road Bridge has shown that flood flow is constrained as it passes underneath the Great South Road Bridge. This is due mainly to what appears to be the abutments of an older bridge located underneath the current bridge. These old abutments are significantly narrower than the width of the existing bridge abutments (Refer photo on drawing 121412-SW104). The post development modeling scenario assumes that these abutments are removed.

McDonald Road Bridge

Since the draft CMP was originally penned the proposed roading layout of the industrial zone has gone through a number of design iterations. The current proposal is that the existing McDonald Road Bridge no longer be retained. The McDonald Road Bridge was therefore removed from the post-development model. A new bridge to be constructed downstream of the current bridge location has been modelled as providing no restriction to flows.

Hitchen Road Bridge

The Hitchen Road Bridge has been shown to be inundated in regular events and impedes flows. It is proposed that the existing Hitchen Road Bridge will therefore not be retained. The bridge has therefore been excluded from the post-developed model. Any new bridge will be designed to avoid any impact on flood hydraulics.

Pokeno Road Bridge

The Pokeno Road Bridge has been shown to be inundated during the 1% AEP storm event. It is proposed that a new bridge be constructed clear of the 1% AEP flood level (including an allowance for climate change) to avoid any impact on flood hydraulics.

Channel Roughness

As stated in section 5.6.2 the roughness value of the stream channel was modified between the pre-development model and post-development model to represent the effect of the riparian planting that is proposed as part of the stream bank modification works. This change in roughness value will typically result in slightly impeded flood flows.

5.14 STREAM EROSION

Erosion of the existing stream channels should be prevented by the preservation of existing stream bank riparian vegetation. Areas under specific threat will need special attention to reduce the likelihood of sediment generation and transport to the downstream receiving environment. Erosion within streams can lead to bank stability problems, channel capacity problems and increased flood levels. It can also smother aquatic habitat and increase the turbidity of stream waters.

Suitable solutions for controlling stream erosion include planting of stream banks, provision of suitable erosion protection headwalls and rock rip-rap aprons around new stormwater outfalls, armouring of channels with rock or other similar non-erosive material and provision of riparian margins.

Observations of the channels and discussions with landowners in the area suggest that erosion of streams is not a significant problem within the Pokeno catchment.

5.14.1 Stream Erosion Monitoring

It is proposed that a stream erosion monitoring programme be established in order to determine whether proposed development in the catchment leads to increased stream channel erosion. The monitoring programme should initially focus on establishing baseline data to determine the existing pre-developed stream channel characteristics and then as development proceeds the monitoring would be used to determine whether there are any adverse effects on channel instability resulting from the development.

This section outlines the nature of the monitoring proposed for the Helenslee Stream and Tanitewhiora Stream.

Monitoring Objectives

Monitoring may include inspection of:

- Stream bank stability
- Stream bed sedimentation
- Stream bank vegetation
- Aquatic habitat condition
- Stormwater outfalls
- Stormwater Culverts
- Bridge abutment structures

Types of Monitoring

Stream Profiles

A number of stream sections are to be set up so that all significant changes in channel topography are captured such as top of bank, bottom of bank and stream invert. The key to stream profiles is establishing a section that can be repeatedly surveyed for a number of years so that any changes to channel profile can be accurately measured. Survey markers should be installed to aid in this effort. Stream profiles can be surveyed using either a straightforward chainage versus depth method of measurement or by total station or other survey equipment.

Photo Records

In conjunction with the stream profiles above, photographs of the stream channels should also be undertaken so that a visual history of the channel is obtained. Again the key with this type of record is to take photos from a consistent viewpoint so that changes can be readily identifiable.

Visual Inspection

Visual inspection of stream channels should be undertaken to look for signs of stream bank instability, slumping, increased stream bed sedimentation, and areas where there is an absence of vegetation that may be prone to erosion.

Asset Survey

There are many existing stormwater outfalls, culverts and bridge abutment structures in the Pokeno catchment and the proposed development will result in many more. In order to maintain the effectiveness of these structures it is recommended that a periodic asset survey program be initiated so that any damage can be identified prior to failure occurring.

5.15 RESULTS AND DISCUSSION

The attached Appendices and Drawings summarise the results from the HEC-RAS model for the existing pre-development and post-development scenario. The requirements for water quality and development mitigation are presented in Section 8.

The proposed zoning for the catchment allows for a mixture of development densities (See Section 1.3.4) and the exact roading and reserve configuration is not finalised. Therefore the floodplain widths and stormwater treatment and attenuation devices have been conservatively sized. However development specific flowpath widths and device requirements will need to be reassessed at the time of subdivision.

5.15.1 Tanitewhiora Catchment

5.15.2 School Block

The results of the HEC-HMS modelling indicate that stormwater peak flowrates through the School Block remain unchanged at Nodes 1, 2 and 3 as there is no development proposed within the structure plan for Catchments A, B and C. Nodes 4 and 5 have a slight decrease in peak flowrate for the 1% event and small increase for the 10% and 50% events as a result of a faster time of concentration from the proposed development within the eastern part of Catchment D. Due to timing effects the 1% AEP peak flowrate at Node 6 just downstream of the confluence point of the two upper tributaries of the Tanitewhiora Stream increases from a pre-development value of 80.5m³/s to 81.4m³/s (a 1.1% increase). The 50% and 10% AEP events increase by 6.5% and 2.7% respectively.

The results of the HEC-RAS modelling indicate that stormwater flood levels through the School Block increase by approximately 0.26m at the narrowest point of the stream realignment between the pre-development and post-development model scenarios. Flood levels upstream of the school block remain largely unchanged. When a Manning's value is increased from 0.035 to 0.06 representing a planted channel the flood levels increase by another approximately 0.2m at the narrowest point of the stream alignment proposal. The flood level upstream at Node 5 increases by approximately 0.13m.

The results show that the Pokeno Road Bridge is expected to overtop during the 1% AEP event. Specific modelling was undertaken to determine whether this bridge was impeding flood flow during the 1% AEP event. It was determined that flood waters would be reduced immediately upstream of the Pokeno Road Bridge if the bridge was removed and a new bridge was constructed clear of the flood plain. Flood levels further upstream at Node 3 do not change.

5.15.3 Hitchen Block

The marginal increase in peak flowrates encountered at Node 6 is further reflected in all the Nodes through the Hitchen Block and further down the Tanitewhiora Stream to Node 14 (State Highway 1 culvert). While there are large areas of development proposed in Catchments G, H, I, J and K, the increase in the 'time of concentration' (a term used to describe how long it takes a drop of rain falling at the furthermost point of the catchment boundary to flow to the point of interest) from developed catchments effectively means that peak flowrates from these lower catchments discharge to the Tanitewhiora Stream before the peak flow from the upper catchment (catchments upstream of, and including the school block) reaches this area of the Hitchen Block.

The pre-development flood plain extent shown on Drawing 121412-SW102 shows large areas of Catchments I, J and K on the western bank of the

Tanitewhiora Stream are prone to flooding during the 1% AEP event. The pre-development modelling results also show that the Hitchen Road Bridge overtops during the 20% AEP event and the McDonald Road Bridge overtops during the 1% AEP event.

Post-Developed modelling results showed that the effect of easing the transition around the State Highway 1 culvert resulted in a 0.8m decrease to the 1% AEP flood level at the arch culvert location. A reduction in flood level continues upstream to roughly the location of the McDonald Road Bridge.

The model shows that flood levels through the section of stream between the North Island Main Trunk Railway and just upstream of the Hitchen Road Bridge where modified bank sections are proposed result in post-developed 1% AEP flood levels that are virtually unchanged and marginally lower than pre-development levels (refer to HEC-RAS flood flow profiles attached in Appendix 1 and Drawing 121412-SW102).

Reference to aerial maps shows that the property at No. 14 Great South Road may flood during the pre-developed 1% AEP event. With the changes proposed as part of the post development works this property is shown to be clear of the post developed 1% AEP flood plain. The properties located between No. 15 Hitchen Road and the McDonald Road Bridge are likely to flood during the predeveloped 1% AEP event. The CMP modelling has specifically allowed for the filling of these properties to enable flood free building platforms to be provided for them.

5.15.4 Pokeno Township West

Peak flow discharge from the western Pokeno township catchments (Catchments L and M) will increase for all storm events modelled. The post-development increase will be roughly twice the peak flow for the 50% AEP, 1.6 times the peak flow for the 10% AEP and 1.5 times the pre-development flow for the 1% AEP event.

The modeling shows that the flood level during the 1% AEP will decrease from RL 19.6m for pre-development flows to RL 19.0 for post-development flows. This is a result of the upgrade works proposed in the lower Tanitewhiora Stream.

Reference to aerial maps shows that the properties at No. 14 Hitchen Road and No. 33 Great South Road are likely to be at risk of flooding during the pre-development 1% AEP plus 28% event.

A 50% blockage scenario was modelled at the Hitchen Road culvert. Occupiable floor levels upstream of this culvert should be set 0.5m above the 1% AEP event plus 28% climate change allowance plus blockage allowance which is approximately RL 20.4m.

5.15.5 Pokeno Township South

Analysis of Catchments N, O and P suggests that Great South Road will likely overtop during the 1% AEP event. The modelling indicates a peak flood level of 19.4m for the pre-developed scenario can be expected. Survey information shows that Great South Road has a low point of 18.0m near the underpass of the Waikato Expressway (SH1). The Great South Road Bridge has a surface level of approximately 19.5m.

5.15.6 Helenslee Catchment

5.15.7 Helenslee Block

Management of stormwater within the Helenslee catchment differs markedly from the Tanitewhiora catchment as the structure plan proposes development throughout most of the catchment, including most of the upper part of the catchment being the Helenslee Block. As such the increase in stormwater flows between a pre-developed (existing) landuse scenario and a post-developed (structure plan) scenario is significant. If stormwater from a developed Helenslee Block was not managed through the provision of a flow attenuation device(s) then the resulting increases at Node 15 would increase from 1.6m³/s to 4.7m³/s for the 50% AEP, 6.0m³/s to 11.0m³/s for the 10% AEP and 13.2m³/s to 20.4m³/s for the 1% AEP storm event. Node 16 located at Ford Street / Great South Rd and roughly the lower boundary of the Helenslee Block shows similar increases within the hydrological model. These results clearly show that stormwater attenuation will need to be provided within the Helenslee Block to manage flows from this area.

Drawing 121412-SW102 shows the 1% AEP pre-development flood plain extents within the Helenslee Block. The drawing shows that stormwater backs up behind the culverts under Ford Street and Great South Road and overtops Ford Street during a 10% AEP event. The flood level during a 1% AEP event is approximately 20.3m, which is about 0.5m above the crest level of Ford Street.

The two stormwater management wetlands (Pond Q and R) attenuate post-development stormwater runoff emanating from the Helenslee Block to below pre-development levels. At Node 15 the peak flowrate decreases from 1.6m³/s to 0.1m³/s for the 50% AEP, 6.0m³ to 2.1m³/s for the 10% AEP and 13.2m³/s to 12.1m³/s for the 1% AEP storm event. At Node 16 the post development peak flowrate is also below pre-development levels. The two stormwater management wetlands also result in lower flood levels for the section of Helenslee Stream between Great South Road and Market Road for the smaller flood events.

The raised road embankment of Great South Road has the potential to cause large areas of ponding should the culvert underneath the road become blocked with debris. To determine the extent of this possible flooding modelling has

been undertaken of the Great South Road culvert. The modelling indicates that were the Great South Road culvert to be partially blocked (50% blockage modelled) during a 1% AEP event this would cause the flood level to increase from a predicted level of 20.2 to a level of 21.0, which is approximately the crest level of Great South Road. As discussed in Section 5.13.3 the inclusion of a climate change allowance further increases the flood level

5.15.8 Upstream of Ford Street and Great South Road Culverts

Both culverts are 1.2m diameter. A 50% blockage scenario was modelled at these culverts which yields a flood level of approximately RL 21.6m. Occupiable floor levels should be set 0.5m above the 1% AEP event + 28% climate change allowance + partial blockage, that is at 22.1m. Aerial maps show that the properties at No.8 and No. 10 Ford Street are at risk of flooding during the pre-development 1% AEP event. Survey confirms that the occupiable floor at 8 Ford Street will flood in a 1% AEP event (possibly in a 10% AEP event). While the floor at 10 Ford Street will flood in a 1% AEP event. The property at No. 12 Ford Street is also be at risk of flooding, however the house floor level is well above anticipated flood levels. At this stage it is not proposed to upgrade either the Great South Road or Ford Street culverts as this will increase flows and flood levels downstream of them.

5.15.9 Pokeno Township East

Development is also allowed for within the eastern part of the Pokeno Township. The modelling shows that infill housing and intensification in this area results in increased peak runoff at Nodes 17 and 18. It is considered that this catchment is not well suited to the use of stormwater attenuation ponds to manage increased runoff. To do so would require overland flowpaths to be setup that direct runoff from larger stormwater events into the pond and given the existing development and roading layouts this will be difficult to achieve. In terms of the 50% AEP no allowance has been made in the hydrological model to consider the effects of soakage that any proposed development within the Pokeno Township East area would need to comply with under the FDC Code of Practice. Treatment from new development in the Pokeno township east area will be managed at source through the use of low impact design, stormwater soakage devices, planning controls or the use of proprietary treatment devices. Additional modelling could also be undertaken to determine whether Ponds Q and R could be optimized to further attenuate the larger 10% and 1% AEP storm events.

The raised road embankment of the State Highway 1 expressway has the potential to cause large areas of ponding should the twin culverts underneath the expressway become blocked with debris. To determine the extent of this possible flooding modelling has been undertaken of the twin State Highway 1 culverts. The modelling shows that should the twin culverts become partially blocked (50% blockage) during a 1% AEP event this would cause the flood level

to increase from a predicted level of RL 15.7 to a level of RL 16.2. As discussed in Section 5.13.3 the inclusion of a climate change allowance further increases flood levels.

Between Great South Road and Market Street culverts occupiable floor levels should be set 0.5m above the 1% AEP event + 28% climate change allowance which is approximately RL 18.5m. Market Street culvert is to be upgraded, possibly via a new road access to the east of the watercourse, coupled with removing the hydraulic constraint of the culvert.

Between Market Street and State Highway 1 occupiable floor levels should be set 0.5m above the 1% AEP event plus 28% climate change allowance with a 50% blockage allowance. This yields a level of approximately RL 17.2m.

Drawing 121412-SW102 shows that the 1% AEP pre-development flood plain extents within Catchments T, U and V. As can be seen Market Road overtops during the 1% AEP event potentially blocking off the only access to houses along the end of this street. The restriction at the Market Road culvert results in higher flood levels upstream. Filling of floodplains outside the main channel in the lower Helenslee stream could be permitted in the area immediately upstream of SH1. Minimum occupiable floor levels are to be based on the 1% AEP flood plus 28% climate change allowance plus 50% blockage of culverts. Any filling proposals are to be incorporated with detailed analysis to confirm that effects on possibly affected parties have been managed.

5.15.10 Climate Change

The climate change scenarios modelled for the post development mitigated case increase the water level in the Tanitewhiora Stream in a range from 100mm to 700mm with the rainfall depths increased by 28% and 50mm to 350mm in the scenario where the rainfall depth is increased by 15%. Typically the maximum increases are around the upper NIMTR crossing are in the order of 600mm in the proposed industrial zone.

The potential effects of climate change on the catchment and extent of potential inundation on the existing topography are shown on Drawing 121413-SW103. The effect on the post development flood plain extent will be minimal beyond the 1% AEP extent. This is also shown on Drawing 121413-SW103 attached and also on the profiles in Appendix 1.

In the Helenslee Catchment the increases in flood depth range from 30 mm to 800mm with the 1% AEP rainfall depth increased by 28% and 20mm to 400mm with the rainfall depth increased by 15%.

The greatest effects from the climate change scenarios in the Helenslee catchment are felt upstream of Great South Road, where the restriction caused

by the small culvert and road embankment increase levels by around 800mm. Upstream of the motorway this increase is in the order of 200mm.

Based on the above results and the CCEIA recommendations discussed in Section 3.9 an allowance should be made for increases in rainfall intensities in future development planning in Pokeno.

Table 5.4: HEC-HMS - Modelling Results

Node	Node Description	Peak Flowrates (m^3/s)												Bridge/ Culvert Capacity
		50% AEP			20% AEP			10% AEP			1% AEP			
		Pre-Dev	Post w/o	Post with	Pre-Dev	Post w/o	Post with	Pre-Dev	Post w/o	Post with	Pre-Dev	Post w/o	Post with	
Tanitewhiora Stream (including upper tributaries)														
1	Discharge point-Catchment A	4.8	4.8	4.8	11.0	11.0	11.0	15.8	15.8	15.8	33.0	33.0	33.0	-
2	Discharge point-Catchments A and B	6.9	6.9	6.9	16.5	16.5	16.5	23.7	23.7	23.7	49.8	49.8	49.8	-
3.	Bridge crossing – Munro Road	7.8	7.8	7.8	18.5	18.5	18.5	26.9	26.9	26.9	59.4	59.4	59.4	>1% AEP
4	Culvert crossing-Pokeno Road	3.0	3.0	3.0	6.8	6.8	6.8	9.8	9.7	9.7	20.6	20.2	20.2	-
5	Culvert crossing-Munro Road	4.3	5.2	5.2	10.0	9.9	9.9	14.4	13.7	13.7	30.4	28.4	28.4	<1% AEP
6	Bridge crossing-Pokeno Road	10.6	11.4	11.4	25.1	26.2	26.2	37.0	38.0	38.0	80.5	81.4	81.4	<1% AEP
7	Bridge crossing-NIMT Railway	10.7	11.6	11.6	25.4	26.6	26.6	37.5	38.6	38.6	81.5	82.5	82.5	>1% AEP
8	Bridge crossing-Hitchen Road	10.8	11.8	11.8	25.5	26.8	26.8	37.7	38.8	38.8	82.0	83.1	83.1	<10% AEP
9	Confluence point-with unnamed stream	10.9	12.0	12.0	25.9	27.2	27.2	38.4	39.6	39.6	84.2	84.9	84.9	-
10	Bridge crossing-McDonald Road	10.9	12.1	12.1	26.0	27.3	27.3	38.5	39.7	39.7	84.5	85.2	85.2	<1% AEP
12	Bridge crossing-NIMT Railway	11.5	12.8	12.8	27.3	28.7	28.7	40.5	41.7	41.7	89.1	89.5	89.5	>1% AEP
13	Bridge crossing - Great South Road Bridge	11.5	12.8	12.8	27.3	28.8	28.8	40.5	41.8	41.8	89.1	89.5	89.5	>1% AEP
14	Culvert crossing-SH1 Culvert	11.5	12.8	12.8	27.3	28.8	28.8	40.4	41.7	41.7	89.1	89.4	89.4	>1% AEP
Helenslee Stream (including upper tributaries)														
15	Confluence - Two streams in Helenslee Block	1.6	4.7	0.1	4.0	8.3	0.6	6.0	11.0	2.1	13.2	20.4	12.1	-
16	Culvert crossing - Ford Street & Gt South Rd	1.6	3.5	0.8	3.3	4.4	1.4	3.9	4.8	2.2	5.2	5.8	5.0	Ford Street <10% AEP Great South Rd >1% AEP
17	Culvert crossing - Market Street	1.8	3.9	2.0	3.6	5.6	3.5	4.3	6.5	4.5	7.4	9.6	7.6	<1% AEP
18	Twin Culvert crossing-SH1 Expressway	2.4	5.5	3.6	5.0	8.3	6.2	6.9	9.6	8.0	11.4	13.7	12.0	>1% AEP
Unnamed stream through Pokeno township														
11	Culvert outfall-Pokeno township (west)	0.7	1.4	1.4	1.4	2.3	2.3	1.8	2.9	2.9	3.3	4.8	4.8	-
Confluence point of both the Tanitewhiora Stream and Helenslee Stream														
19	Catchment Termination Point	12.7	16.9	15.1	31.0	33.9	30.0	45.5	47.8	44.6	97.2	98.3	97.4	-

Abbreviations:
Pre-Dev = Pre-Developed (existing) scenario, **Post w/o** = Post-Developed scenario without mitigation measures, **Post with** = Post-Developed scenario with mitigation measures

Table 5.5: HEC-RAS - Modelling Results

Node	Peak Flood Levels (m)																								Road Over tops (y/n)
	50% AEP						20% AEP						10% AEP						1% AEP						
	Pre-Dev		Post w/o		Post with		Pre-Dev		Post w/o		Post with		Pre-Dev		Post w/o		Post with		Pre-Dev		Post w/o		Post with		
	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	U/S	D/S	
Tanitewhiora Stream (including upper tributaries)																									
1	32.8		32.8		32.8		33.1		33.1		33.1		33.2		33.2		33.2		33.6		33.6		33.6		-
2	28.9		28.9		28.9		29.1		29.1		29.1		29.2		29.2		29.2		29.4		29.4		29.4		-
3	26.2	25.8	26.2	25.8	26.2	25.8	26.8	26.2	26.8	26.2	26.8	26.2	27.1	26.4	27.1	26.4	27.1	26.4	28.0	27.1	28.0	27.1	28.0	27.1	No
4	-		-		-		-		-		-		-		-		-		-		-		-		-
5	26.0	25.9	26.0	25.9	26.2	25.8	26.4	26.3	26.7	26.3	26.7	26.3	27.0	26.4	27.0	26.3	26.8	26.2	26.9	26.8	26.9	26.8	27.0	26.9	Yes
6	24.5	24.5	24.6	24.6	24.8	24.7	25.0	25.1	25.1	25.1	25.2	25.1	25.3	25.3	25.3	25.3	25.4	25.3	26.2	25.8	26.2	25.8	25.9	25.8	Yes
7	22.4	22.4	22.4	22.4	22.6	22.5	23.0	23.0	23.1	23.0	23.5	23.5	23.5	23.5	23.5	23.5	23.7	23.6	24.9	24.8	24.9	24.8	25.0	24.8	No
8	18.5	18.5	18.5	18.5	18.6	18.6	19.2	19.2	19.2	19.2	19.2	19.2	19.5	19.5	19.6	19.6	19.5	19.6	20.2	20.2	20.2	20.2	20.0	20.1	Yes
9	17.7		17.8		18.2		18.5		18.5		18.5		18.9		18.9		18.8		19.7		19.8		19.6		-
10	16.9	17.0	17.0	17.1	17.3	17.3	17.7	17.7	17.7	17.7	17.9	17.9	18.0	18.1	18.1	18.1	18.3	18.3	19.5	19.5	19.5	19.5	19.2	19.3	Yes
12	16.6	16.5	16.7	16.6	17.0	16.9	17.3	17.3	17.3	17.3	17.5	17.4	17.7	17.7	17.8	17.7	17.7	17.7	19.5	19.4	19.5	19.4	18.6	18.5	No
13	16.1	16.1	16.2	16.1	16.4	16.4	16.8	16.7	16.9	16.8	17.1	17.1	17.3	17.2	17.3	17.2	17.4	17.4	19.4	18.9	19.4	18.9	18.3	18.3	No
14	15.4	15.5	15.5	15.5	15.0	14.9	16.0	16.1	16.1	16.2	15.7	15.6	16.5	16.5	16.6	16.5	16.2	16.0	18.3	17.6	18.3	17.6	17.4	16.9	No
Helenslee Stream (including upper tributaries)																									
15	20.7		20.5		20.4		20.9		20.6		20.6		20.9		20.8		20.8		21.1		21.2		21.2		-
16	18.1	17.2	19.8	18.0	17.5	17.1	19.8	17.9	19.9	18.0	17.7	17.6	19.8	18.0	19.9	18.0	18.1	17.3	20.2	18.0	20.8	18.0	20.1	17.6	Yes
17	17.0	15.9	18.0	16.2	16.1	16.1	17.9	16.1	18.0	16.4	16.4	16.3	18.0	16.2	18.0	16.4	16.6	16.4	18.0	16.5	18.0	16.6	17.3	16.6	Yes
18	14.5	14.5	15.1	15.0	15.1	15.1	15.0	15.0	15.3	15.3	15.4	15.3	15.2	15.2	15.4	15.3	15.5	15.4	15.5	15.4	15.7	15.5	15.8	15.6	No
Unnamed stream through Pokeno township																									
11	17.3		17.5		17.7		17.5		17.7		17.9		17.8		18.0		18.0		19.6		19.9		19.0		-
Confluence point of both the Tanitewhiora Stream and Helenslee Stream																									
19	7.4		7.5		7.5		7.7		7.8		7.7		7.9		7.9		7.9		8.4		8.5		8.4		-

U/S = Upstream of Node location, **D/S** = Downstream of Node location

6.0 ENVIRONMENTAL EFFECTS OF DEVELOPMENT

6.1 ENVIRONMENTAL IMPLICATIONS

The Pokeno Development Concept Plan envisages creating an enlarged township in Pokeno consisting of a variety of mixed land uses. This will include high to low density residential areas, business areas and a new industrial zone.

"A change in land use from existing rural farmland used for cropping and grazing to residential and industrial development is expected to have the following broad environmental implications: See the Detailed Ecological Report (Appendix 3).

- *An increased area of impervious surfaces associated with buildings, roads and industrial sites is expected to alter the quantity, quality and flow rates of stormwater discharged to the Mangitawhiri swamp/wetland and the Waikato River.*

- *There is the potential for a loss of connectivity between existing remnants of tree lots and wetlands within the footprint of the development.*

- *There will be a proportional reduction in the numbers of plants and animals associated with a modified rural environment and a proportional increase in the numbers of plants and animals associated with residential and industrial environments within the footprint of the proposed development.*

- *Residential and industrial stormwater systems have the potential to create barriers to the upstream and downstream migration of fish and other aquatic organisms.*

- *There will be an increased demand for infrastructural services such as potable water supplies, wastewater treatment and solid waste disposal within the footprint of the proposed development".*

The CMP is intended to provide baseline catchment information, assess these potential effects of development and to propose management options to mitigate these effects. It is intended to allow for the economic development of the area without compromising the environmental values. Where possible effort should be made to enhance the current status of the environment.

FDC has stated that it is desirable that, where possible, riparian vegetation protection areas are linked through corridors along riparian margins. The protection and enhancement of riparian vegetation will also achieve environmental results to enhance terrestrial and aquatic habitats, reduce water quality degradation and help address run-off issues.

6.2 LIKELY EFFECTS ON TERRESTRIAL ECOLOGY

The Detailed Ecology Report summarises the findings as follows:

"There do not appear to be any significant ecological issues in the proposed development in terms of terrestrial ecology." However, four particular tree lots were considered worthy of protection.

Totara (Dacrycarpus dacrydioides) occurred in all four Blocks but tree lots of this native tree were a particular feature of the Helenslee Block. A well-developed stand of mature totara was present on the mid northeastern boundary of the Helenslee Block.

Another remnant native tree of special interest in the study area was the kahikatea (Dacrycarpus dacrydioides) that was once widespread on the lower Waikato floodplain. A group of some 25 mature kahikatea was present adjacent to the totara referred to above on the mid north-eastern boundary of Helenslee Block. Another two smaller groups of kahikatea occurred in the School Block.

Oak trees (Quercus spp.) in excess of 6m tall were a feature of the town centre and were recognised as a site of significant vegetation.

A small pocket of native trees (tawa taraire, puriri, kahikatea and rewarewa) on the southwestern boundary of the Hitchen Block was also recognised as an area of significant vegetation.

Provided industry standards for dust suppression are adopted during earthworks, no direct or indirect effects of the proposed development are expected on terrestrial vegetation in the upstream section of the Pokeno catchment or in downstream catchments.

"…There would be a net loss of productive pasture as a result of the proposed development and a consequent reduction in sheep and cattle production within the footprint of the proposed development.

However, provided that parks, residential and commercial gardens within the proposed development contain suitable food supplies and they are relatively predator free, a diverse range of bird life could also be expected within the footprint of the proposed development."

6.3 LIKELY EFFECTS ON AQUATIC ECOLOGY

The Detailed Ecology Report and Section 4.6 Freshwater Aquatic Ecology summarise the values of and likely effects on aquatic ecology as follows:

"Notwithstanding the question of the migration of aquatic organisms through new and modified stormwater systems, no other upstream effects are expected to be associated with the development".

The mainstream of both the Pokeno and Helenslee Streams had fisheries values to climbing native eel populations and to resident landlocked commonbully populations during the summer period. It is recommended therefore, that stormwater systems associated with the proposed development are user-friendly to both the upstream and downstream migrations of eels.

Low oxygen levels and high stream temperatures are stressful to fish and other aquatic life and reduced flows potentially exacerbate these levels.

Whilst a dissolved oxygen threshold of $5g/m^3$ is a critical level for some sensitive invertebrate and fish species such as trout, it is not an issue in these streams. Eels and common bully are highly tolerant of lower dissolved oxygen levels and, with the exception of instream cover, existing conditions are not likely to be severely limiting for these native species.

The creation of ornamental lakes and ponds within the proposed development is not recommended as eutrophic conditions are expected to prevail in such environs.

Mitigation or offset works for stormwater control works might include the fencing of the riparian zone of the Pokeno and Helenslee Stream and a systematic weed control programme for introduced emergent weeds such as willows, reed sweet grass and twin cress in the vicinity of the proposed development.

Given the perennial nature of both the mainstem of the Helenslee and Pokeno Streams as they flow through the proposed development blocks, it is recommended these mainstem channels should remain as open stream channels rather than incorporated into a reticulated stormwater system.

6.4 LIKELY EFFECTS OF STORMWATER STRUCTURES

Proposed stormwater dams as a part of attenuation or treatment ponds may have downstream safety issues. Management procedures should be put in place dependent on the level of risk associated with the dam structures.

6.5 PIPING OF PERENNIAL STREAMS

Helenslee Block spring-fed tributary, streams

There are several sites identified in the Detailed Ecological Report as H1 through H4 on streams in the Helenslee catchment of potentially high ongoing value due to their spring fed source. As a general rule piping of these perennial streams is to be avoided and uncontrolled stormwater excluded if possible. If required mitigation options would include riparian planting and instream habitat enhancement.

School Block Tanitewhiora tributary, Stream

An early design for the sports field proposed that an existing lower tributary of the Tanitewhiora Stream be piped, between the location where it currently enters the school block to the point where it currently merges with an upper tributary, in order to create a larger level area for sports fields. From discussions with Environment Waikato it was made clear that piping of this stream and its associated loss of function is not looked upon favourably by Council officers, therefore alternative methods of achieving the space needed for the sports fields would need to be investigated. This has now been done and is reported on in Section 5.13.2 Stream Sections. This includes the re-alignment of this tributary to the north proposed in this CMP.

7.0 CONSULTATION AND ISSUES

7.1 KEY STAKEHOLDERS

To date formal and informal meetings and discussions have taken place between the Pokeno Landowner Consortium, its consultants HGCL and the Franklin District and Waikato Regional Councils. This has included circulation of draft versions of the CMP for comment and progressive iterations of the CMP to arrive at a final draft CMP that is acceptable to the statutory approving authorities and aligned with the Structure Plan.

Key milestones in the process to date have been:

July 2007: Draft CMP circulated to FDC and EW for review. EW provided written comments with FDC commenting verbally.

March 2008: Summary of responses and proposed changes to draft CMP sent to EW.

April 2008: Progress meeting with EW to seek "general agreement" to CMP.

April 2008: Written comments from EW.

April 2008: Specialist comments from EW on ecology, engineering and wider planning aspects.

April 2008: Second draft CMP sent for EW/FDC comment.

June 2008: Feedback from MWH and FDC relating to peer review of CMP.

June 2008: Meeting with FDC and MWH to discuss peer review.

July 2008: Final comment from EW on technical, ecological and completeness aspects.

July 2008: Further comments discussed at a meeting with FDC.

September 2008: Final review comments discussed with FDC prior to Council adoption to support proposed Structure Plan Consultation.

The following key stakeholders groups have been identified for consultation and discussion, using the final CMP dated August 2008 as the basis for stakeholder consultation.

- Iwi
- Landowners
- Interested parties

- General public

A complete list of key stakeholders is available in the Structure Plan Report.

7.2 CONSULTATION INITIATIVES

Pokeno Landowner Consortium has held several discussions with key stakeholders including presentations to FDC. A public presentation in the form of an open day was held in May 2007.

Correspondence related to these consultation initiatives are reported in the Structure Plan Report.

8.0 STORMWATER MANAGEMENT OUTCOMES

This section explains the overarching considerations that were used to develop the elements of the preferred stormwater management regime and its implementation through the recommendations that follow in Section 9. The section also discusses the main elements and desired outcomes of the management regime under the headings of stormwater quantity and quality, climate change, infrastructure and riparian planting.

8.1 STORMWATER MANAGEMENT PHILOSOPHY

The preferred stormwater management outcomes in the Pokeno catchment have been developed giving consideration to a series of guiding philosophies. These guiding philosophies have not been viewed as dogma but used to assist and guide decision making in the catchments.

1. Maintain Peak Flows/Levels Post Development to Less Than or Equal to Pre-Development

   The purpose of this philosophy is to not create or worsen flooding problems for any particular landowner. This includes the principal of managing effects where they are created, as far as possible. It is acknowledged however, that in a total catchment assessment there will always be a certain amount of win/loss.

2. Existing Crossings Upgraded to Meet Current Service Criteria.

   This philosophy acknowledges that some of the historical structures will not be appropriately sized to meet current urban engineering design standards and allows for their upgrading, generally for safety or access reasons.

3. Modifications of Floodplain Allowed Where Impact (Flood Level) can be managed.

   This philosophy allows for the examination of options and mitigation, in particular for flood-plain fringe areas. It is not envisaged that it will lead to wholesale filling and segregation of floodplains, 'natural' solutions are envisaged. It also allows for suitable freeboards to be set and for erosion of stream channels to be monitored.

4. Potential Climate Change Managed by Freeboard Allowance.

   While there is little argument now that climate change effects will be felt, there is still considerable uncertainty of the extent of those affects. It is envisaged that these will be largely accommodated by the provision of extra freeboard allowance in the final design to pass the flows from the

1% AEP rainfall event plus a 28% increase in rainfall intensity to allow for climate change predictions.

5. Permanently Flowing Waterways, Streams Take Priority over the Built Environment and are Enhanced.

   Currently the watercourses in the Pokeno Catchment are highly impacted by past and existing agricultural practises. This philosophy envisages these waterways are enhanced to improve their ecology and amenity. Generally piping or artificial modifications of these waterways is to be avoided. As well as providing an improved ecological and amenity outcome for these perennial waterways, this enhancement will offset some of the negative impacts of development.

6. Non Permanently Flowing Waterways – Higher Emphasis on Built Environment, May be Modified.

   These ephemeral or dry waterways act as overland flowpaths and this function needs to be protected. However, modification of these may occur to enable the efficient use of land. This philosophy does not preclude these waterways from also being enhanced where appropriate.

7. Contaminant Removal via a few Public Devices to Protect Downstream Environments.

   The philosophy does not preclude the use of smaller site specific devices (and it is envisaged that these will be appropriate in some areas) however, it acknowledges the economies of scale for both construction and operation of fewer larger public devices.

8. Stormwater Management Devices Off-Line, Except Where Existing Features can be Enhanced.

   This philosophy is envisaged to be enforced over the whole catchment with the exception of the Helenslee Block. In this area the existing highly impacted wetlands form the natural location for stormwater management. The natural function and form of these wetlands can be enhanced through stock exclusion, some structural modification planting and weed control to provide for both stormwater management and improved amenity and aesthetics.

9. Integration of Uban Form and Stormwater Management/Create Amenity Rather than just Engineered Solutions.

   This philosophy is about achieving multiple outcomes and getting the mix right for the proposed landuse. It seeks to integrate urban design and stormwater management in for example, the location of devices and

reserves, stream corridors, protected areas and the open space network while providing for public safety.

The above philosophies have been used to guide the stormwater management options considered in the following sections and are consistent with the guiding principals promulgated by EW including the recognition of:

- The role that natural river systems provide in the conveyance of water and sediment.
- The residual flood risks that remain after flood risk reduction works.
- The benefits of hazard avoidance rather than hazard mitigation.
- The importance of preparing a flood risk management plan that concludes with a recommended and sustainable flood risk management strategy.

8.2 STORMWATER QUANTITY

8.2.1 Tanitewhiora Catchment

The modelling results indicate that the development proposed under the structure plan will result in virtually unchanged stormwater flood levels throughout the Tanitewhiora Catchment compared to that, which would currently occur. As such it is considered that stormwater attenuation of post-development flows is not required unless it is deemed that existing flood levels are unacceptable.

Typically stormwater management ponds are located at the bottom of the catchment where they can service as much catchment area as possible. However, the arrangement of development within the Tanitewhiora catchment makes the approach to attenuation management slightly different, as attenuation of flood flows from lower catchments tends to increase the likelihood of peaks coinciding with flow emanating from the upper catchment. It is considered that the most suitable location for stream attenuation if deemed necessary, be upstream of the School Block. Additionally if any development is proposed upstream of Nodes 3 and 5 then site specific management will be required.

Analysis of stormwater attenuation options was undertaken within Catchment C to determine whether a stormwater attenuation device would reduce the degree of flooding downstream, in particular to the school block itself. The analysis determined that with the flat topography of the land just upstream of Node 3, any form of stormwater attenuation pond would impact a vast area of land creating a very large pond. Analysis determined that reducing the peak discharge from the upper catchments from an existing value of approximately 60m³/s to around 40m³/s resulted in a flood level reduction within the school block of about 0.4m, and a corresponding gain in land area of 2.7 hectares.

However this required a 1.0m increase in water level upstream of the Munroe Road Bridge (above the existing flood level) and results in a loss of approximately 5.2 hectares of land in Catchment 3.

In order to maximise development potential within the school block the realignment of the stream flow from Catchment E into the stream flowing from Catchment C at a location approximately 150m upstream of Node 6 was considered. The modelling did not indicate any issues with this diversion, should it be undertaken. The new twin stream channel in the north of the School Block could be designed to pass the 50% AEP event before overlapping to form a single channel in less frequent events. The existing southern School Block stream channel would then become redundant.

The modelling shows that for the filling shown on 121412-SW103 a maximum increase in flood level of 260mm would result within the school block and that flood levels upstream of the school block would remain largely unchanged. When the existing Manning's value of 0.035 is increased to 0.06 representing a planted channel, the flood levels increase by another approximately 0.2m at the narrowest point of the stream alignment proposal. The flood level upstream at Node 5 also increases by approximately 0.13m.

The modelling shows that modification of the flood plain within the Industrial zone of the Hitchen Block, can be managed to ensure there is no increase in flood levels including the extreme1% AEP events with allowance for climate change.

8.2.2 Helenslee Catchment

The difference between pre-development and post-development stormwater discharge rates is significant within and from the Helenslee catchment. Accordingly it is proposed that a stormwater attenuation pond be constructed to control runoff from this catchment. Looking at the Helenslee catchment, as it currently appears, there is an obvious location where a management pond could be sited within the valley area at the confluence point of the two streams through the site (just upstream of Node 15). This area already consists of a highly impacted wetland and the use of this for stormwater management purposes enables the enhancement of this area in general. A management pond in this location would be on-line and would effectively flood part of the two existing streams during extreme events. It is considered that the road crossings being proposed within the structure plan could also double as pond embankments and that a pond could be created relatively easily in this location. The analysis indicates that two ponds (Pond Q and Pond R) would be needed, as shown in Drawing 121412-SW103.

Within the Pokeno Township there are no obvious locations for stormwater attenuation ponds to be provided, as these usually mean a deeper pond than regular treatment ponds and can make the entry and exit of stormwater to and

from the ponds difficult. With this constraint it was considered that the two ponds within the Helenslee Block should provide over-attenuation of flood flows emanating from the upper catchment so that stormwater emanating from the Pokeno Township does not require the use of large ponds to attenuate peak runoff from large storm events. Ponds Q and R successfully mitigate stormwater peak runoff at Nodes 15 and 16 for the 50% AEP event but proposed landuse intensification within the township gives rise to small increases in peak runoff at Nodes 17, 18 and 19. It should be noted that the modelling represents a worst-case level of percentage imperviousness and does not take into account the effects of soakage trenches and stormwater treatment devices that incorporate soakage as a function. This will lead to over reporting of the 50% AEP flows in particular.

Specific erosion protection for new stormwater outfalls is discussed in section 5.14. Table 5.4 and Drawing 121412-SW101 show the peak flowrate results.

Ponds Q and R have also been designed to provide a water quality component thus treating stormwater runoff from catchments Q and R.

8.3 STORMWATER WATER QUALITY

A number of stormwater treatment wetlands are proposed within the structure plan area. At this stage preliminary sizing has been undertaken to illustrate approximate sizes based on assumed contributing catchments and drainage paths. These are of course subject to change during detailed subdivision design. It should also be noted that some areas may not be able to be made to physically drain to the wetland locations proposed and therefore some other form of treatment may be required. A summary of the wetland sizes, depths and contributing catchments is tabulated below in Table 8.1. Drawing 121412-SW103 shows the location of the wetlands, their relative size and catchment areas being serviced.

8.3.1 Tanitewhiora Catchment

A number of stormwater treatment wetlands are proposed within the Tanitewhiora Catchment. Wetlands D, E1, E2 and G2 will service the largely residential areas adjacent to the North Island Main Trunk Railway in the Hitchen Block. Wetlands F1 and F2 are sized to treat stormwater emanating from proposed residential areas and school zones either side of the Tanitewhiora stream and upper tributaries in the School Block. These will be subject to the final landuse of this land. Pond G1 is sized to service the proposed retirement village zone and some parts of the Pokeno Township to the northwest. Wetland J will service the proposed residential, mixed use and light industrial zones in Catchments H, I and J. Wetland K will service the Industrial zone in Catchment K. There is limited scope for treatment wetlands to be situated within catchments L, M, N and O. These catchments will require other devices in the form of swales, rain gardens, sand filters or proprietary treatment devices and

are envisaged to be applied as part of specific development proposals, and possibly be part of the private stormwater systems servicing those specific developments.

8.3.2 Helenslee Catchment

Additional wetlands to Q and R discussed above are proposed within the Helenslee Catchment. Wetlands S1 and S2 around Node 16 (Ford Street) are proposed to provide treatment for the local area downstream of and unable to drain to Pond R.

Below Node 16 (Ford Street) treatment from new development downstream of Ford Street in the Pokeno township area will be managed at source through the use of Low Impact Design, stormwater soakage devices, planning controls or the use of proprietary treatment devices. These may be part of the private stormwater systems servicing those specific developments.

Table 8.1: Summary of Stormwater Management Ponds

Pond No.	Management Type	Catchment Area (ha)	Water Quality Component			Flood Attenuation Component								
						50% AEP Event			10% AEP Event			1% AEP Event		
			Depth (m)	Area (m^2)	Volume (m^3)	Depth (m)	Area (m^2)	Volume (m^3)	Depth (m)	Area (m^2)	Volume (m^3)	Depth (m)	Area (m^2)	Volume (m^3)
Pond Q	Treatment and Attenuation	38.9	0.5	15600	7400	1.2	18100	20300	1.9	20600	33500	2.6	23100	48000
Pond R	Treatment and Attenuation	65.6	0.5	24200	11500	2.0	32000	53500	2.3	33700	62500	2.4	35000	68500
Pond D	Treatment	17.3	1.5	2300	2400	-	-	-	-	-	-	-	-	-
Pond E1	Treatment	12.6	1.5	1700	1700	-	-	-	-	-	-	-	-	-
Pond E2	Treatment	8.4	1.5	1300	1200	-	-	-	-	-	-	-	-	-
Pond F1	Treatment	5.5	1.5	900	800	-	-	-	-	-	-	-	-	-
Pond F2	Treatment	10.3	1.5	1600	1500	-	-	-	-	-	-	-	-	-
Pond G1	Treatment	12.3	1.5	1700	1700	-	-	-	-	-	-	-	-	-
Pond G2	Treatment	22.6	1.5	2800	3100	-	-	-	-	-	-	-	-	-
Pond J	Treatment	106.2	1.5	13800	18200	-	-	-	-	-	-	-	-	-
Pond K	Treatment	36.8	1.5	5200	6300	-	-	-	-	-	-	-		
Pond S1	Treatment	6.4	1.5	1600	900									
Pond S2	Treatment	6.4	1.5	1600	900								-	-

Notes:

1. Pond volumes and areas listed in this table are based on preliminary catchment boundary definitions and landuses. Final sizing and design must be confirmed at the detailed design stage to take into account actual proposed landuses, catchment areas and on-site constraints.
2. Alternative pond arrangements are permitted provided the same outcomes recommended by the CMP are achieved.

8.4 CLIMATE CHANGE

8.4.1 Tanitewhiora Catchment

In the Tanitewhiora stream catchment the opportunities for flow control by detention are limited and given that the development is in the lower reaches, probably self defeating. As such in this catchment the most appropriate management mechanism for these potential increases in flowrate are via landuse controls.

Historically, the FDC has used a freeboard allowance of 500mm above the 1% AEP flood level for the setting of minimum occupiable floor levels and 300mm for commercial premises. Having regard for the effects of climate change as modelled above it is suggested here that it would be good practice in this case to provide a freeboard of +500mm over and above the flood levels calculated for the agreed climate change scenario for minimum occupiable floor levels, and based on the following considerations:

- Recent changes to the District Plan has resulted in linking commercial premises to the same freeboard of 500mm above the known 1% AEP flood level as residential properties.
- Currently EW advocates for the "worst-case" scenario (that is, a 28% increase in rainfall depth) to be adopted when incorporating the effects of climate change into rainfall calculations.
- The recommendation of freeboard allowances is discussed in Section 9.

This requirement will be based on the calculated levels including any channel or floodplain modification.

8.4.2 Helenslee Catchment

In the Helenslee catchment greenfields development is occurring in the upper and mid catchment areas and infill development is likely to occur in the lower catchment areas.

The development in the upper catchment areas already includes for significant detention. There is scope for this detention to be increased in volume to allow for attenuation of flows brought about by increased rainfall intensities. Such allowances for climate change can be provided for at the construction stage or allowance can be mode in the design of the pond so that modification can easily be made at some future date when the affects of climate change is better understood.

The development in the lower catchment areas is more difficult to manage by flow attenuation due to the limitation of suitable available sites. In this area landuse control is the most appropriate management measure. While the

calculated potential level increases in this area are not as great as in the Tanitewhiora stream catchment, it is appropriate that the same control be set. That is, occupiable floor levels be set at 500mm above the calculated 1% AEP flood level for the climate change scenario with mitigation in place.

8.5 INFRASTRUCTURE UPGRADE WORKS

It is proposed that infrastructure upgrade works be undertaken:

- Upgrade the culvert on the eastern section of Market Street to convey the 1% AEP flow with a maximum head up behind the culvert of 0.5m below road level. This may require dual culverts to be installed.

- Upgrade the existing stormwater system in catchments L and M, either by replacing the existing 900mm pipeline or providing an additional stormwater pipeline to meet the increased development proposed up to a 20% AEP event. Overland flowpaths for the 1% AEP event modified for increased rainfall intensities will also need to be provided.

- Replace the MacDonald Road Bridge with a bridge out of the floodway.

- Widen the waterway under the Great South Road Bridge to remove the constriction to flow.

- Upgrade the Pokeno Road Bridge clear of the 1% AEP floodplain, and provide a double span bridge.

- Upgrade Tanitewhiora Stream transition entry and exit to the SH1 culvert.

8.6 RIPARIAN PLANTING

A core philosophy of the CMP is to enhance the ecological character of the perennial streams within the Structure Plan area. The riparian planting will be a mix of native plant species ranging from water tolerant grasses/sedges and perennials through to native herbs, herbaceous plants, shrubs and trees. The plants selected will assist to significantly improve the ecological diversity and health of the stream condition. The plants will also provide shading of the stream channel, assist with stabilising the banks, provide habitat for desirable fauna, insects and aquatic life and improve the visual appearance of the existing weedy and degraded stream corridors.

In accordance with the ARC's Technical Publication No. 148 "Riparian Zone Management." minimum 10m wide planted riparian strip either side of the stream channel is recommended. In some instances the riparian margin may be more dependent on topography and adjacent wet or boggy areas than the minimum requirement of TP148.

The stream riparian planting will generally consist of four categories of planting; water margin planting, lower bank planting, upper bank planting and specimen trees. The water margin planting will primarily consist of water tolerant grasses, sedges and rushes. The lower bank will primarily comprise of herbaceous plants, ferns and shrubs. Where erosive forces due to increased stormflows threaten stream bank stability, trees with good bank stabilisation properties can also be made part of the water margin/lower bank planting plan. The upper banks will primarily comprise of shrubs and small trees. The specimen trees will be located accordingly within the three planting zones to provide shade and habitat. Drawing 121412-SW115 shows a concept layout of the proposed planting.

The detailed Ecological Report notes that if channels with no dry weather flow or where dry weather flows are reduced to seepages are incorporated into the stormwater reticulation, there will still be a large number of ephemeral channels left intact following development. Taking this into account, then mitigation for any loss of function from reticulation of these channels and effects of any stormwater inputs to perennial streams should focus on the riparian planting already proposed above.

9.0 RECOMMENDATIONS

The following recommendations represent the actions required to implement the preferred stormwater outcomes for the Pokeno Catchment. Compliance with these is required to comply with this Catchment Management Plan. Key elements of these recommendations are summarised on drawing 121412-SW103. The plan shows:

- The location of a number of stormwater treatment and attenuation ponds that are recommended to mitigate the effects of development within the structure plan area. It also shows the extent of the existing, and proposed 1% AEP flood plain
- Streams to be protected and riparian planting areas
- Recommended system upgrades
- Areas of fringe floodplain filling allowed for in the CMP

Further specifications for stormwater management are given below.

9.1 FLOODING CONSIDERATIONS:

1. Stormwater treatment and attenuation ponds be constructed as located in the above drawing to manage stormwater discharge from the proposed structure plan development. Design of devices is to be carried out in accordance with the ARC's TP10. An indicative sizing for the devices is included within Table 8.1, this may be modified once detailed design is carried out.

2. The bridges at Pokeno Road (Node 6), Hitchen Road (Node 8) and McDonald Road (Node 10) be upgraded to accommodate the 1% AEP peak flood flow without overtopping the carriageways and to provide a structure clear of the 1% AEP flood level.

3. The stream channels immediately upstream and downstream of the large State Highway 1 arch culvert on the Tanitewhiora Stream are to be widened to ease the transition from stream channel to culvert and improve flood hydraulics upstream.

4. The Great South Road Bridge opening on the Tanitewhiora Stream is to be widened underneath to improve flood hydraulics upstream.

5. The management of stormwater from infill development in the Pokeno Township east and west areas shall be done at source using low impact design, stormwater soakage devices, planning controls or the use of

proprietary treatment devices. Attenuation of flows from this area is not recommended.

6. Occupiable floor levels upstream of the Hitchen Road culvert in subcatchment M should be set above RL 20.4m.

7. The culvert under Market Street be upgraded to accommodate the 1% AEP peak flow without overtopping the carriageway.

8. Upgrade the stormwater reticulation network that drains catchment L in the western part of the existing Pokeno Township to convey the 20% AEP event with suitable provision of an overland flowpath for the 1% AEP event, modified for increased rainfall intensities.

9. Flows and flood levels presented in this CMP are to be confirmed at detailed design stage of the adjacent development or the relevant hydraulic upgrade.

10. The draft floodway extents and levels in this report be entered into FDC's hazard database and updated once confirmed with adjacent developments and upgrades.

11. Detailed design of developments shall incorporate overland flowpaths through public land wherever possible, otherwise protected by easement. This applies particularly where development includes the piping of existing (ephemeral or perennial) watercourses.

9.2 ECOLOGICAL CONSIDERATIONS:

12. The three areas of significant vegetation (Figure 4 of the Detailed Ecological Report) are to be protected from development.

13. Retain the existing natural character of both the mainstream of Tanitewhiora and Helenslee streams.

14. Provide riparian planting to the mainstream of the Tanitewhiora and Helenslee Streams for a minimum width of 10m either side of the stream to provide shading and bank stabilisation. A concept plan for the planting is included as drawing 121412-SW115. The extent of the planting is to tie in with urban design parameters and is generally as shown on Drawing 121412-SW103.

15. The proposed stormwater management devices such as ponds/wetlands to be made user-friendly to taxa such as Bittern, Fernbird and Banded Rail.

16. The proposed stormwater management systems (particularly on-line systems) and culverts are to be user-friendly for migration of eels.

17. Exclude piping of spring-fed perennial streams in the Helenslee catchment and exclude stormwater discharges from development discharging uncontrolled into these streams where possible. Use riparian planting and increase instream habitat cover for mitigation and enhancement of ecological values of the Helenslee catchment upstream of SH1.

18. Exclude piping of the tributary of the Tanitewhiora Stream that passes through the School Block. Use riparian planting and increase upstream habitat cover for mitigation and enhancement of ecological values for the tributary stream. Redirection of this tributary to the north is specifically envisaged in this CMP.

9.3 EROSION AND WATER QUALITY:

19. Channel scour protection be incorporated where piped flow is discharged into the streams or earth drains, and around culverts. A programme to monitor stream channel erosion to be established.

20. Water quality (or treatment) ponds including detention where detailed should be placed at suitable locations within the catchments as development takes place in the contributing catchment and generally as shown on drawing 121412-SW103 and in Table 8.1.

21. Specific stormwater management devices may be moved and catchments draining to them modified with the prior written consent of the FDC. This consent will be assessed on the same or similar outcomes being achieved by the modified devices. This includes the potential diversion of undeveloped catchments around proposed devices.

22. Where appropriate, alternative stormwater management techniques may be implemented with the prior written permission of the FDC. This permission will be assessed on the same or similar outcomes being achieved and FDC being satisfied that maintenance regimes are appropriately accommodated and costed.

9.4 CLIMATE CHANGE

23. Potential climate change effects on peak flows is to be allowed for in the design of the Helenslee detention dams. The design of these dams is therefore currently expected to allow for an increase of up to 28% of the 1% AEP rainfall depths.

24. Freeboard allowances to occupiable floor levels be set at 500mm above the calculated flood level (proposed development and mitigated flows) allowing for a 28% climate change increase on the rainfall depths for the 1% AEP event.

9.5 LAND DEVELOPMENT RULES:

25. Developments shall proceed in accordance with the FDC subdivision provisions for stormwater volume control, stream setbacks and open drains. Local differences may occur only with the written permission of FDC.

26. Land development densities and coverage shall not generally exceed those detailed in Table 5.3 of this CMP. Where the stated assumptions are exceeded, the effects of this are to be re-modelled to confirm that they can be incorporated into the CMP.

27. For sites with high risk landuse activities such as those referred to in EW's Regional Plan, Rule 3.5, additional source control measures for stormwater discharges appropriate for that activity shall be utilised.

28. Development of land upstream of the railway embankment has the potential to increase flows to the existing culverts. In these areas a detailed assessment of culvert capacity should be carried out, by the developer, to confirm what mitigation measures are required to ensure the long-term stability of the embankment and railway assets.

29. In the following areas the minimum occupiable floor level should be set 0.5m above the 1% AEP event + 28% climate change and allowing for 50% partial blockage of the downstream culverts:

    - Upstream of Great South Road (node 16).
    - Between Great South Road and Market Street.
    - Between Market Street and State Highway 1.
    - Upstream of Hitchen Road.

9.6 OPERATION, MAINTENANCE, AND MONITORING STRATEGIES:

30. A systematic weed control programme, for introduced emergent weeds such as reed, sweet grass and twin cress in the vicinity of the proposed development, be implemented.

31. Regular monitoring and maintenance of the vegetation and the streams and drains to be carried out.

32. Prepare and adopt a Monitoring Programme for baseline assessment and subsequent periodic assessment of stream ecology in accordance with EW guidelines for monitoring freshwater ecosystems:

- Biological sampling for assessment of the health, diversity and extent of in-stream biota (in general accordance with EW invertebrate monitoring protocols)
- Sediment monitoring
- Water quality sampling and physio-chemical analysis for TSS, BCOD5, TP, TRP, TN, NH4-n, E.coli, Faecal coliforms, TPHs, pH, water temperature, total Zn and total Cu
- Routine visual clarity checks and checks for oil or grease film, scums or foams and unacceptable odours in stream water

31. An Operation and Maintenance Plan shall be prepared and handed over to the asset owner upon completion of construction of each stormwater management device constructed. The Plan shall cover but not be limited to, the following areas as appropriate for the type of device:

(a) Operations manual for installed devices and components

(b) General maintenance

- Routine inspections for blockages and structural integrity
- Cleaning of litter, vegetation, gross pollutants and blockages
- Routine maintenance of vegetation around ponds, to a height of 150 mm
- Sediment removal and safe disposal
- Minor repair works

(c) Emergency maintenance

- Emergency Action Plan (EAP) including safety measures and checks in the case of small dams
- Emergency Response Plan following severe storm event, including repair of erosion caused by such storms
- Monitoring of potentially high risk contaminant discharge sites
- Incident Response Plan following hazardous spill or contaminant discharge.

9.7 DISTRICT COUNCIL IMPLEMENTATION PLAN

It is recommended that an Implementation Plan is prepared once the CMP is finalised and adopted by the FDC to ensure:

32. Implementation of stormwater mitigation should be in place prior to the effects being generated. This means that:

    - Stormwater treatment/detention facilities should be in place prior to upstream impervious surfaces being constructed.

    - Flood plain modifications in the industrial area need to start with removal of restrictions prior to filling taking place.

33. District Plan Changes: Rules and regulations are to be incorporated within the District Plan for the Pokeno Structure Plan area, so that stormwater infrastructure is constructed and maintained to standards assumed in the development of the management outcomes recommended in this CMP.

34. Education Initiatives: The FDC is to put in place education initiatives that would assist stakeholders to understand the need for compliance with the rules and regulations.

10.0 LIMITATIONS

This report was originally prepared by Harrison Grierson Consultants Limited (September 2008) and subsequently updated by MWH NZ Limited in September 2010. It has been prepared for the particular project described to the consultants and its extent is limited to the scope of work agreed between the client and consultants. No responsibility is accepted by the consultants or their directors, servants, agents, staff or employees for the accuracy of information provided by third parties and/or the use of any part of this report in any other context or for any other purposes.This report is for the use by FRANKLIN DISTRICT COUNCIL only, and should not be used or relied upon by any other person or entity or for any other project

APPENDIX 1

Hydrologic and Hydraulic Modelling Input Data
Longitudinal Sections Showing Flood Levels

- **2yr, 10yr, 100yr and Climate Change –Tanitewhiora Stream**
- **2yr, 10yr, 100yr and Climate Change - Helenslee Stream**
- **2yr, 10yr, 100yr and Climate Change – Pokeno Township West**

Pre-Development HEC-HMS Input Parameters													
Catchment	Total Area (ha)	Length (m)	Slope (m/m)	Percentage Impervious (%)	Combined			Impervious			Pervious		
					CN	Ia	Time to Peak (mins)	CN	Ia	Time to Peak (mins)	CN	Ia	Time to Peak (mins)
A	298.3	3437	0.085	6.2	56.9	4.7	44.0	-	-	-	-	-	-
B	146.8	2064	0.026	2.2	60.1	4.9	43.0	-	-	-	-	-	-
C	151.4	2269	0.025	2.9	52.5	4.9	51.4	-	-	-	-	-	-
D	262.1	3432	0.013	7.9	55.8	4.6	78.4	-	-	-	-	-	-
E	125.0	2344	0.011	6.1	54.4	4.7	65.4	-	-	-	-	-	-
F	32.7	1238	0.001	12.3	55.9	4.4	86.2	-	-	-	-	-	-
G	29.6	1170	0.014	7.8	54.1	4.6	38.6	-	-	-	-	-	-
H	18.6	781	0.03	10.3	58.7	4.5	22.1	-	-	-	-	-	-
I	85.9	1837	0.024	3.4	52.0	4.8	45.5	-	-	-	-	-	-
J	9.0	754	0.014	19.5	67.4	4.0	24.3	-	-	-	-	-	-
K	77.4	2096	0.028	2.1	60.8	4.9	42.1	-	-	-	-	-	-
L	16.2	700	0.01	35.2	-	-	-	98.0	0.0	18.0	52.9	5.0	18.6
M	5.6	444	0.018	34.0	-	-	-	98.0	0.0	11.2	60.2	5.0	10.4
N	6.1	406	0.016	22.7	-	-	-	98.0	0.0	10.9	54.4	5.0	11.0
O	2.1	215	0.028	30.4	68.4	3.5	8.5	-	-	-	-	-	-
P	6.0	440	0.044	26.3	62.6	3.7	12.8	-	-	-	-	-	-
Q	62.4	1800	0.041	14.4	56.9	4.3	35.7	-	-	-	-	-	-
R	65.4	1800	0.026	0.0	51.7	4.8	44.1	-	-	-	-	-	-
S	12.8	300	0.017	0.0	56.8	4.3	14.3	-	-	-	-	-	-
T	24.5	991	0.002	27.5	-	-	-	98.0	0.0	18.4	50.0	5.0	19.8
U	28.8	757	0.002	25.8	-	-	-	98.0	0.0	15.4	50.0	5.0	16.5
V	28.6	1082	0.018	4.5	52.1	4.8	34.9	-	-	-	-	-	-
TOTAL	**1495**			**7.3**									

Post-Development HEC-HMS Input Parameters													
Catchment	Total Area (ha)	Length (m)	Slope (m/m)	Percentage Impervious (%)	Combined			Impervious			Pervious		
					CN	Ia	Time to Peak (mins)	CN	Ia	Time to Peak (mins)	CN	Ia	Time to Peak (mins)
A	298.3	3437	0.085	6.2	56.9	4.7	44.0						
B	146.8	2064	0.026	2.2	60.1	4.9	53.0						
C	151.4	2269	0.025	2.9	52.5	4.9	51.4						
D1	244.8	3432	0.013	8.3	56.1	4.6	78.1						
D2	17.3	850	0.020	70.3				98.0	0.0	10.0	50.0	5.0	17.9
E	125.0	2344	0.011	19.0				98.0	0.0	23.3	51.8	5.0	40.7
F	32.7	1238	0.001	34.9				98.0	0.0	31.4	50.0	5.0	56.2
G	29.6	1170	0.014	63.4				98.0	0.0	13.7	50.5	5.0	24.4
H	18.6	781	0.030	63.2				98.0	0.0	8.7	55.6	5.0	13.8
I	85.9	1837	0.027	30.3				98.0	0.0	15.7	49.2	5.0	28.5
J	9.0	754	0.014	59.5				98.0	0.0	10.3	60.7	5.0	15.9
K	77.4	2096	0.028	41.7				98.0	0.0	16.4	50.6	5.0	29.1
L	16.2	700	0.010	75.4				98.0	0.0	10.8	53.4	5.0	18.4
M	5.6	444	0.018	76.5				98.0	0.0	6.7	55.3	5.0	11.1
N	6.1	406	0.016	54.2				98.0	0.0	6.7	54.8	5.0	11.0
O	2.1	215	0.028	65.0				98.0	0.0	6.7	54.3	5.0	6.7
P	6.0	440	0.044	26.3				98.0	0.0	6.7	50.0	5.0	9.1
Q	62.4	1800	0.041	48.7				98.0	0.0	13.2	50.0	5.0	23.6
R	65.4	1800	0.026	59.7				98.0	0.0	15.1	50.0	5.0	27.1
S	12.8	300	0.017	59.0				98.0	0.0	5.3	50.0	5.0	9.4
T	24.5	991	0.020	46.9				98.0	0.0	11.0	50.0	5.0	19.8
U	28.8	757	0.020	46.3				98.0	0.0	9.2	50.0	5.0	16.5
V	28.6	1082	0.018	4.5				98.0	0.0	12.1	50.0	5.0	21.6
TOTAL	**1495**			**21.0**									

APPENDIX 2

District Plan Provisions

Franklin District Plan - Activity Status

Rule 26: Urban Subdivision Provisions (applies to residential, rural-residential and business zones of the plan unless the plan specifically states otherwise)

26.6.12 Stormwater Management - Volume Control:

Each new lot or site within the subdivision intended for individual ownership shall provide for a stormwater management system deemed by Council to be effective and appropriate. Regional Council discharge consents may be required to accommodate stormwater discharges from some developments. The landowner shall be responsible for the ongoing maintenance of the private on site stormwater system upon its implementation.

An effective and appropriate stormwater management system in the Residential Zone shall be achieved by providing for either a, b, c, d or e following:

a) An independent connection to a public stormwater system, and on-site detention structure to contain a 20% AEP 10 min storm event before overflowing to the public stormwater system which is able to collect stormwater from the site equivalent to that generated by: 70% impervious surface covering for all sites between 425m2 and 1000m2 in area. The detention structure must be able to completely empty via an orifice controlled outlet over a 24-hour period. For sites over 1000m2 the stormwater system must be able to collect stormwater equivalent to 550m2 of impervious surface cover.

b) An independent connection to a public stormwater system, and on site soakage to contain a 20% AEP 10 min storm event before overflowing to the public stormwater system which is able to collect stormwater from the site equivalent to that generated by: 70% impervious surface covering for all sites less than 425m2 in area; and 55% impervious surface covering for all sites between 425m2 and 1000m2 in area. The soakage system must be able to completely empty via soakage within a 24-hour period. For sites over 1000m2 the stormwater system must be able to collect stormwater equivalent to 550m2 of impervious surface cover.

c) Where connection to a public system is not available, the applicant shall provide an on-site soakage system to contain a 5% AEP 10 min storm event without overflowing, which is able to collect stormwater from the site equivalent to that generated by: 70% impervious surface covering for all sites less than 425m2 in area; and 55% impervious surface covering for all sites between 425m2 and 1000m2 in area. The soakage system must empty within a 24 hour time period. For sites over 1000m2 the stormwater system must be able to collect stormwater equivalent to 550m2 of impervious surface cover.

d) An alternative method of stormwater management for the subdivision and/or site/s which achieves a standard of stormwater management equal

to or better than that achieved by compliance with A, B or C above, such that the adverse effects of stormwater are avoided, remedied or mitigated.

e) Where existing development has occurred in the Residential or Business Zone, the effective and appropriate stormwater management system provided for must be consistent with the method described in A, B, C or D but be able to collect stormwater from the site equivalent to that generated by 100% impervious surface covering.

The stormwater management system shall be maintained to achieve the standard of management provided for under A, B, C, D or E.

26.6.13 Open Drains

Any open drain within the site being subdivided shall be piped to the Councils relevant standards unless it can be demonstrated that leaving it (or them) open would produce a more sustainable outcome without compromising safety, health or amenity considerations.

Rule 27: Residential Zone: Planning Provisions

27.6.1.10 Setback from water:

For titles that existed prior to 31 May 1994, no building or part thereof may be sited within 20 metres of mean high water springs or within 10 metres of the edge of a river or stream, provided that:

- Where an intervening esplanade reserve of at least 3 metres already exists, or
- The plan does not require an esplanade in the particular locality (refer Part 11), or
- The Council has otherwise waived the taking of an esplanade reserve for the locality.

Then the required set back from the seaward boundary of the site shall be no less than one-seventh of the average depth of the site, such depth to be measured generally at right angles to the coastline.

For titles created since 31 May 1994, no building or part thereof may be sited within 30 metres of mean high water springs or within 10 metres of the edge of a river or stream provided that where an esplanade reserve of 20 metres or more is set aside the set back from it shall be required to comply with the height in relation to boundary standard.

No earthworks activity unrelated to a development which has resource consent or building consent and which is within 30 metres of mean high water springs or within 10 metres of a river or stream may exceed a total volume of $25m^3$ or a total area of $250m^2$.

27.6.1.18 Stormwater Management - Volume Control:

All activities shall have a stormwater management system that is deemed to be effective and appropriate by Council. The landowner shall be responsible for the ongoing maintenance of the private on site stormwater system upon its implementation.

Where the activity involves an alteration or addition to an existing activity, the applicant must show that the existing stormwater management system is effective and appropriate. An effective and appropriate stormwater management system shall be achieved by providing for either:

- An independent connection to a public stormwater system and an onsite detention structure to contain a 20% AEP 10 minute storm event before overflowing to the public stormwater system, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max 100% of the site). The detention structure must be able to completely empty via an orifice controlled outlet over a 24-hour period.

- An independent connection to a public stormwater system and an on site soakage system to contain a 20% AEP 10 minute storm event before overflowing to the Public Stormwater System, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max 100% of the site). The soakage system must be able to completely empty via soakage within a 24-hour period.

- Where connection to a public system is not available, the applicant shall provide an on site soakage system to contain a 5% AEP 10 minute storm event without overflowing, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max of 100% of the site). The soakage system must be able to completely empty via soakage within a 24-hour period.

- An alternative method of stormwater management of the site/s, which achieves a standard of stormwater management equal to or better than that achieved by compliance with the above, such that adverse effects of stormwater are avoided, remedied or mitigated.

The stormwater management system shall be maintained to achieve the standard of management provided for under the above.

Rule 29: Business Zone: Planning Provisions

29.5.14 Setback from water:

Subject to rule 29.6.5, no building shall be sited closer than 30m back from mean high water springs or 10m back from the edge of any stream or river, and earthworks within these set backs shall not exceed a total volume of $25m^3$ or a total area of $250m^2$.

29.5.17 SW Management - Volume Control:

All activities shall have a stormwater management system that is deemed to be effective and appropriate by Council. The landowner shall be responsible for the ongoing maintenance of the private on site stormwater system upon its implementation.

Where the activity involves an alteration or addition to an existing activity, the applicant must show that the existing stormwater management system is effective and appropriate. An effective and appropriate stormwater management system shall be achieved by providing for either:

- An independent connection to a public stormwater system and an onsite detention structure to contain a 20% AEP 10 minute storm event before overflowing to the public stormwater system, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max 100% of the site). The detention structure must be able to completely empty via an orifice controlled outlet over a 24-hour period.

- An independent connection to a public stormwater system and an on site soakage system to contain a 20% AEP 10 minute storm event before overflowing to the Public Stormwater System, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max 100% of the site). The soakage system must be able to completely empty via soakage within a 24-hour period.

- Where connection to a public system is not available, the applicant shall provide an on site soakage system to contain a 5% AEP 10 minute storm event without overflowing, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max of 100% of the site). The soakage system must empty within a 24-hour period.

- An alternative method of stormwater management of the site/s, which achieves a standard of stormwater management equal to or better than that achieved by compliance with the above, such that adverse effects of stormwater are avoided, remedied or mitigated.

The stormwater management system shall be maintained to achieve the standard of management provided for under the above.

Plan Change 14: Village Countryside Living Zone Lots

Rule 22: Subdivision Rural and Coastal Areas

Lots shall be sited or designed so that they would be capable of being served by an effective stormwater disposal system, as outlined in Rule 22.9.7.

Plan Change 14: Rural Village Zone

Rule 22.24: Rural and Coastal Village Zone General Performance Standards

Stormwater Management - Volume Control

Each new lot or site within the subdivision intended for individual ownership shall provide for a stormwater management system deemed by Council to be effective and appropriate. Regional Council discharge consents may be required to accommodate stormwater discharges from some developments. The landowner shall be responsible for the ongoing maintenance of the private on site stormwater system upon its implementation to its continuing hydrological neutrality. An effective and appropriate stormwater management system in the rural or coastal village zone shall be achieved by providing for either a, b, c, d or e:

a) An independent connection to a public stormwater system and an on—site detention structure to contain a 20% AEP 10min storm event before overflowing to the public stormwater system which is able to collect stormwater from the site equivalent to that generated by: 70% impervious surface covering for all sites less than 425m2 in area; and 55% impervious surface covering for all sites between 425m2 and 1000m2 in area. The detention structure must be able to completely empty via an orifice controlled outlet over a 24-hour period. For sites over 1000m2 the stormwater system must be able to collect stormwater equivalent to 550m2 of impervious surface cover.

b) An independent connection to a public stormwater system, and an on-site soakage system to contain a 20% AEP 10min storm event before overflowing to the public stormwater system which is able to collect stormwater from the site equivalent to that generated by: 70% impervious surface covering for all sites less than 425m2 in area; and 55% impervious surface covering for all sites between 425m2 and 1000m2 in area. The soakage system must be able to completely empty via soakage within a 24-hour period. For sites over 1000m2 the stormwater system must be able to collect stormwater equivalent to 550m2 of impervious surface cover.

c) Where connection to a public system is not available, the applicant shall provide an on-site soakage system to contain a 5% AEP 10min storm every without overflowing, which is able to collect stormwater from the site equivalent to that generated by: 70% impervious surface covering for

all sites less than 425m2 in area; and 55% impervious surface covering for all sites between 425m2 and 1000m2 in area. The soakage system must empty within a 24 hour time period. For sites over 1000m2 the stormwater system must be able to collect stormwater equivalent to 550m2 of impervious surface cover.

d) An alternative method of stormwater management for the subdivision and/or site/s which achieves a standard of stormwater management equal to or better than that achieved by compliance with A, B or C above, such that the adverse effects of stormwater are avoided, remedied or mitigated.

e) Where existing development has occurred in the Rural Village or Coastal Village Zone the on site stormwater management system shall be deemed to be effective and appropriate where it is found to be in compliance with Rule 23C.2.1(16) or Rule (23D.2.1(16).

The stormwater management system shall be maintained to achieve the standard of management provided for under A, B, C, D or E.

Open Drains

Any open drain within the site being subdivided shall be re-profiled and landscaped or piped, unless it can be demonstrated that leaving it (or them) open would produce a more sustainable outcome without compromising safety, health, village character or amenity value considerations.

Rule 23C.2: Performance and Development Standards: Rural Village Zone

Setback from water

For titles that existed prior to 31 May 194, no building or part thereof may be sited within 20 metres of mean high water springs or within 10 metres of the edge of a river, lake or wetland, watercourse, or stream provided that:

Where an intervening esplanade reserve of at least 3m already exists; or

This plan does not require an esplanade in the particular locality (refer Part 11); or

The council has otherwise waived the taking of an esplanade reserve for the locality.

Then the required setback from the seaward boundary of the site shall be no less than one-seventh of the average depth of the site, such depth to be measured generally at right angles to the coastline or river.

For titles created since 31 May 1994, no building, or part thereof may be sited within 30m of mean high water springs or within 10m of the edge of a river, lake or wetland, watercourse, or stream provided that where an esplanade reserve of 20m or more is set aside the set back fro it shall be as required to comply with the height in relation to boundary standard.

No earthworks activity shall be carried out within 30m of mean high water springs or within 10m of the edge of a river, lake or wetland, watercourse or stream, exceeding a total volume of 25m3 or a total area of 250m2 shall be carried out unless related to a development for which resource consent has been granted.

Stormwater Management - Volume Control

All activities shall have a stormwater management system that is deemed to be effective and appropriate by Council. The landowner shall be responsible for the ongoing maintenance of the private on-site stormwater system upon its implementation to ensure continuing hydrological neutrality.

Where the activity involves an alteration or addition to an existing activity, the applicant must show that the existing stormwater management system is effective and appropriate. An effective and appropriate stormwater management system shall be achieved by providing for either i, ii, iii, or iv:

i. An independent connection to a public stormwater system and an on-site detention structure to contain a 20% AEP 10min storm event before overflowing to the public stormwater system, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max of 100% of the site). The detention structure must be able to completely empty via an orifice controlled outlet over a 24-hour period.

ii. An independent connection to a public stormwater system and an on-site soakage system to contain a 20% AEP 10min storm event before overflowing to the public stormwater system, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces plus 10% of that (max of 100% of the site). The soakage system must be able to completely empty via soakage within a 24-hour period.

iii. Where connection to a public system is not available, the applicant shall provide an on-site soakage system to contain a 5% AEP 10min storm event without overflowing, which is able to collect stormwater from the site equivalent to that generated by actual and proposed impervious surfaces, plus 10% of that (max of 100% of the site). The soakage system must be able to completely empty via soakage within a 24-hour period.

iv. An alternative method of stormwater management of the site/s, which achieves a standard of stormwater management equal to or better than that achieved by compliance with the above, such that the adverse effects of stormwater are avoided, remedied, or mitigated.

v. The stormwater management system shall be maintained to achieve the standard of management provided for under I), II), III), or IV).

APPENDIX 3

Ecological Assessment Reports

APPENDIX 4

List of Previous Studies

List of previous studies

HELENSLEE BLOCK AREA

1. Hydraulic Modelling Services Limited, Pokeno Stormwater Management Plan dated December 2002

2. Fraser Thomas Limited, Stormwater Management Options for Helenslee Investments, Helenslee Road, Pokeno

3. Chapman, R, Soil and Land Evaluation dated 19th May 2006

4. Fraser Thomas Limited, Water Management Options Report

5. Sinclair Knight Merz Limited, Hydrogeology and Geotechnical Appraisal dated 9th of March 2004

6. Fraser Thomas Limited, Wastewater Management Options

7. Kingett Mitchell Limited, Ecological Assessment of Aquatic and Riparian Resources dated September 2005

FRANKLIN DISTRICT COUNCIL RECORDS

8. Railway Culvert Upgrade (Opus Dec 2002)

9. Cambridge Road (Michelsen) culvert correspondence

10. Opus, Franklin District Council, Pokeno Growth Study Report dated February 2000

11. Search Consulting Limited, Flood Assessment Report for 15 Hitchens Road, Pokeno dated December 2005

12. Franklin District Council, Requirements for Structure Plan dated February 2000

13. 1m contours for Pokeno greater-town area

14. RAMM culvert data

15. Franklin District Council, letter regarding Draft Long Term Community Plan 2006 - 2016 dated 19th July 2006

WINSTONE AGGREGATES

16. Riley Consultants Limited, Management of Water Quality and Flow Regimes dated April 1998

17. Woodward-Cylde, Assessment of Effects of Discharges to Air, Proposed Pokeno Quarry dated May 1998

18. Brian T. Coffey and Associates Limited, Proposed Quarry Development, Effects on Surface Water Ecology dated May 1998

19. Boffa Miskell Limited, Proposed Pokeno Quarry, Assessment of Terrestrial Ecological Effects dated February 1998

20. Tonkin & Taylor Limited, Proposed Pokeno Quarry, Geotechnical Assessment and Preliminary Slope Design dated May 1998

21. Riley Consultants Limited, Bluff Road Quarry Development, Natural Hazards Assessment of Effects dated April 1998

APPENDIX 5

Stormwater Infrastructure Upgrade Prioritisation Schedule

Stormwater Infrastructure Upgrade Prioritisation Schedule		
Priority	**Location**	**Upgrade Works**
1.	Market Street 1.2 m dia culvert	Upgrade existing 1.2m diameter culvert to convey the 1% AEP flow with a maximum head up behind the culvert of 0.5m below road level. This may require that dual culverts are installed, alternatively Market Street may be closed and the culvert removed if alternative access to properties is provided.
2	Catchments L and M	Upgrade the existing stormwater system in catchments L and M, either by replacing the existing 900 mm pipeline or by providing an additional stormwater pipeline to meet the increased development proposed up to a 10% AEP event. Overland flowpaths for the 1% AEP event modified for increased rainfall intensities will also need to be provided.
3	State Highway 1 culvert	Remedial works needed to ease the transition from stream channel to arch culvert and back. To be completed prior to filling upstream.
4	Great South Road Bridge	Widen the waterway under the Great South Road Bridge to remove the constriction to flow. To be completed prior to filling upstream.
5	Mc Donald Road Bridge	Replace the McDonald Road Bridge with a bridge out of the floodway.
6	Hitchen Road Bridge	Replace the Hitchen Road Bridge with a bridge out of the floodway.
7	Pokeno Road Bridge	Replace the Pokeno Road Bridge with a bridge out of the floodway.

DRAWINGS

121412-SW100	**Catchment Plan**
121412-SW101	**Calculated Peak Flowrates**
121412-SW102	**Calculated Peak Flood Levels**
121412-SW103	**Recommended CMP Outcomes**
121412-SW104	**Existing Stormwater Infrastructure**
121412-SW105	**Aerial Photo of Flood Extent**
121412-SW110	**Catchment Soil Type Plan**
121412-SW111	**Pre-development Land-use**
121412-SW112	**Post-development Land-use**
121412-SW113	**Land Set Aside for Stormwater Management Devices**
121412-SW114	**Typical Cross Section**
121412-SW115	**Concept Layout of Channel Cross-Sections**