Annexure 3

Infrastructure Report

Consulting Engineers

ACENZ

Marsden Point-Ruakaka Structure Plan -2008 Water Infrastructure Report

For North Holdings Ltd

July 2008

REF: 10799

Executive Summary

The Structure Plan aims to enhance overall community wellbeing while achieving sound practice outcomes.

Open space areas will act as corridors for an overall water management strategy as well as providing buffering between differing land uses and areas where flooding and inundation presently occur.

Stormwater catchment management plans are required for the Takahiwai and Ruakaka catchments. Water quality and ecological improvements must be integrated into the system as well as flooding protection.

A catchment assessment is required to consider the energy efficiency of the sewerage network and positioning of major pump stations.

Consideration will need to be given to a variety of options to meet the predicted ultimate demand for water, including re-use of treated water, use of collected stormwater, and use of water saving devices.

Geotechnical constraints can be mitigated with standard engineering solutions. Consideration will need to be given to building on peat and sand, assessment of slope stability, coastal hazards, and infrastructure components.

Council's existing hazards maps for the district will need to be extended to include the newly zoned land.

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1. INTRODUCTION

1.1. INTRODUCTION

The current Marsden Point-Ruakaka Structure Plan (SP2000) adopted by Whangarei District Council in November 2000 states that:

> *"all identified future development areas are dependent on the availability of water supplies to the area, sewage disposal, and the assessment of stormwater impacts and flood hazard protection"*

The Marsden Point Ruakaka Structure Plan-2008 (the Structure Plan) has been prepared as the SP2000 was in need of review. This is due to developments over the past decade and the proposed developments in this area. There is a need to address the issues identified above by looking in more detail at the water resource management for the whole of Marsden Point-Ruakaka. Cook Costello Ltd has been briefed to prepare a water resource assessment and carry out supportive investigations to the Structure Plan for stormwater, wastewater and water for Marsden Point-Ruakaka. Particular consideration has been given to an overall strategy to complete the Structure Plan.

The recommendations and assessments are based on current regulatory documents and processes to ensure the subsequent plan changes can be effectively regulated.

1.2. RELEVANT DOCUMENTS AND REFERENCES

- Local Government Act 2002
- Auckland Regional Council – Technical Publication No. 108 – Guidelines for stormwater runoff modelling in the Auckland region
- Auckland Regional Council – Technical Publication No. 10 – Stormwater Treatment Devices
- Auckland Regional Council – Technical Publication No. 124 – Low Impact Design Manual for the Auckland Region
- Northland Regional Council – Regional Water And Soil Plan
- Northland Regional Council – State of the Environment (SOE) Report 2002
- Whangarei District Council – Ruakaka Stormwater Catchment Management Plan, 2002
- Whangarei District Council – One Tree Point Stormwater Catchment Management Plan, 2002

- Whangarei District Council – Marsden Point Stormwater Catchment Management Plan, 2002
- Whangarei District Council – Water Services Asset Management Plan
- Whangarei District Plan – Stormwater Asset Management Plan

1.3. LOCATION OF STUDY AREA

The study area is shown below.

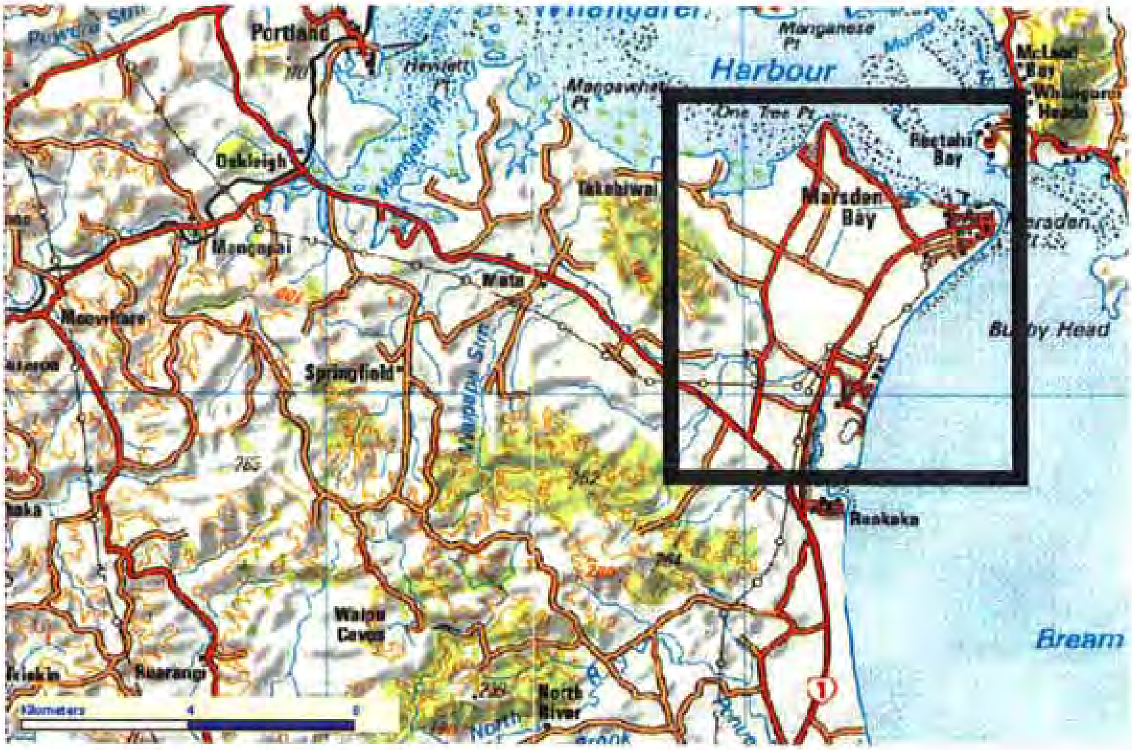


Figure 1 Study Area

1.4. TANGATA WHENUA

The Resource Management Act 1991 provides for tangata whenua involvement in resource management in a number of ways. With specific regard to water resources decision makers must:

- Recognise and provide for the relationship of Maori and their culture and traditions with their water resources (Section 6)
- Have particular regard to kaitiakitanga (the exercise of guardianship and stewardship of resources: Section 7)
- Consult with tangata whenua when formulating policy statements and plans (First Schedule)

Patuharakeke is recognised as the hapu having manu whenua (customary authority) within the rohe (area). In this respect Patuharakeke possess the responsibility and authority of kaitiaki for this rohe.

2. GEOLOGICAL AND GEOTECHNICAL

2.1. GEOLOGY

PEAT: C1 Peat: dark brown, fibrous carbonaceous deposits usually less than 5m thick unconsolidated, and SAND & SANDSTONE: Sand: felspathic with some quartz, minor dark minerals and clay forming fixed dunes, minor swamp deposits; unconsolidated to very soft. Unweathered to weathered to brown stained very soft clayey sand to depths of 5m.

New Zealand Land Inventory map NZMS 290 Sheet Q06/07 defines the pedology as soils of Coastal Sand Dune Complex: OT One Tree Point peaty SAND and RKd Ruakaka loamy peat.

The structure plan area is regionally placed as part of the Marsden Point barrier spit, a broad peninsula comprised of Quaternary coastal sand dunes, estuarine and alluvial sediments that partly encloses the Whangarei Harbour.

The harbour is an ancient river valley system drowned by a rise in sea level. At the Ruakaka River mouth the spit merges with a fringe of coastal sediments to form the distinctive arc of Bream Bay that extends from Marsden Point to Waipu Cove.

The spit has been built up by a prograding (seaward advancing) foreshore depositional process in the vicinity of the harbour entrance with sequences of aeolian influenced coastal sand dunes and alluvial and estuarine sediments. The investigated area is inland from the shoreline and has older 'stranded' dunes that have weathered to form surface soils and spread out to form a flat to gently undulating terrace. The dunes form a series of linear ridges and swales that generally have a relief in the vicinity of 5m.

Landward of the stranded dune system the near surface materials are mainly reworked sand and fine sediments (mud) deposited by the Ruakaka River in the protected lower energy environment behind the dune barrier. These sediments have covered a greywacke ridge that prior to sediment deposition connected the isolated hill at the corner of McCathie and Marsden Point Roads with the greywacke hills to the west. Surface peat is common in low-lying areas west of the dunes and at isolated locations within the poorly drained swales between dunes. Drainage courses are not well developed within the dunes due to the relatively high permeability of the sands. Poor drainage in swales, due to high groundwater level, has resulted in local ponding and the development of some small wetlands.

2.2. GEOTECHNICAL

The majority of the flat land is made up of PEAT, SAND and alluvial deposits with clay hill slopes surrounding. The appended Soils Plan taken from NZMG260 shows the soils in the area. Field investigations on a number of projects have found this to be substantially inaccurate and specific investigations are required on a site by site basis. This plan is shown in Appendix 4.

The SAND in the area has generally been found to have excellent load bearing capacity with, however, varying density due to the method of deposition. Lateral spreading and settlement from liquefaction should be considered in the recent and loose dune sands adjacent to the foredunes and deep excavations.

The PEAT is subject to consolidation and long term shrinkage. This needs to be taken into account in the development of future infrastructure and buildings. Common methods for treatment of PEAT to avoid differential settlement are to remove peat, pile structures, dynamic consolidation, preloading of infrastructure sites, groundwater controls to prevent oxidation and shrinkage and raft and spread footings for light structures. Tanked basements will be beneficial in some structures to utilise the buoyancy of the elevated groundwater.

The land is considered suitable for development and well established and standard engineering solutions are available for safe and stable construction of future infrastructure and buildings.

3. CURRENT WATER RESOURCES SITUATION ANALYSIS

This section investigates the current state of water resources in Marsden Point-Ruakaka, and highlights the issues that are currently facing these resources.

3.1. POTABLE WATER

The scheme has grown since inception in 1967 by the former Whangarei County Council. Bream Bay Water Supply Area (WSA) consists of approximately 5,400 people with 2,400-metered connections. It covers the areas of Takahiwai, One Tree Pt, Ruakaka, Waipu, Waipu Cove and Langs Beach together with the commercial and industrial areas of Marsden Point and Ruakaka.

Figure 2 on the following page map shows the Bream Bay water scheme.

The current system comprises three independent water supply sources treated at two WTPs. It has various historic supply sources that help maintain supply, but were very seldom used. The Takahiwai Dam and the Pohuenui stream take have not been used for several years and decommissioning is being investigated.

Wilson's Dam was completed in 2003 and Ruakaka WTP upgrade in 2007 will provide for the Bream Bay water supply system sustaining a 1 in 50 year return period drought. With the Wilson's Dam a full capacity daily abstraction of 21,000 m^3 (this would equate to a settlement of around 26,000 households) has been provided for and when combined with the existing sources provides for the 50 year security.

The Bream Bay area is unique in terms of its water supply, given that approximately 78% of the metered consumption is by the New Zealand Refinery Company (74%); the Carter Holt Harvey LVL plant (3%) and the Northland Port Corporation (1%).These customers dominate the consumption for the area.

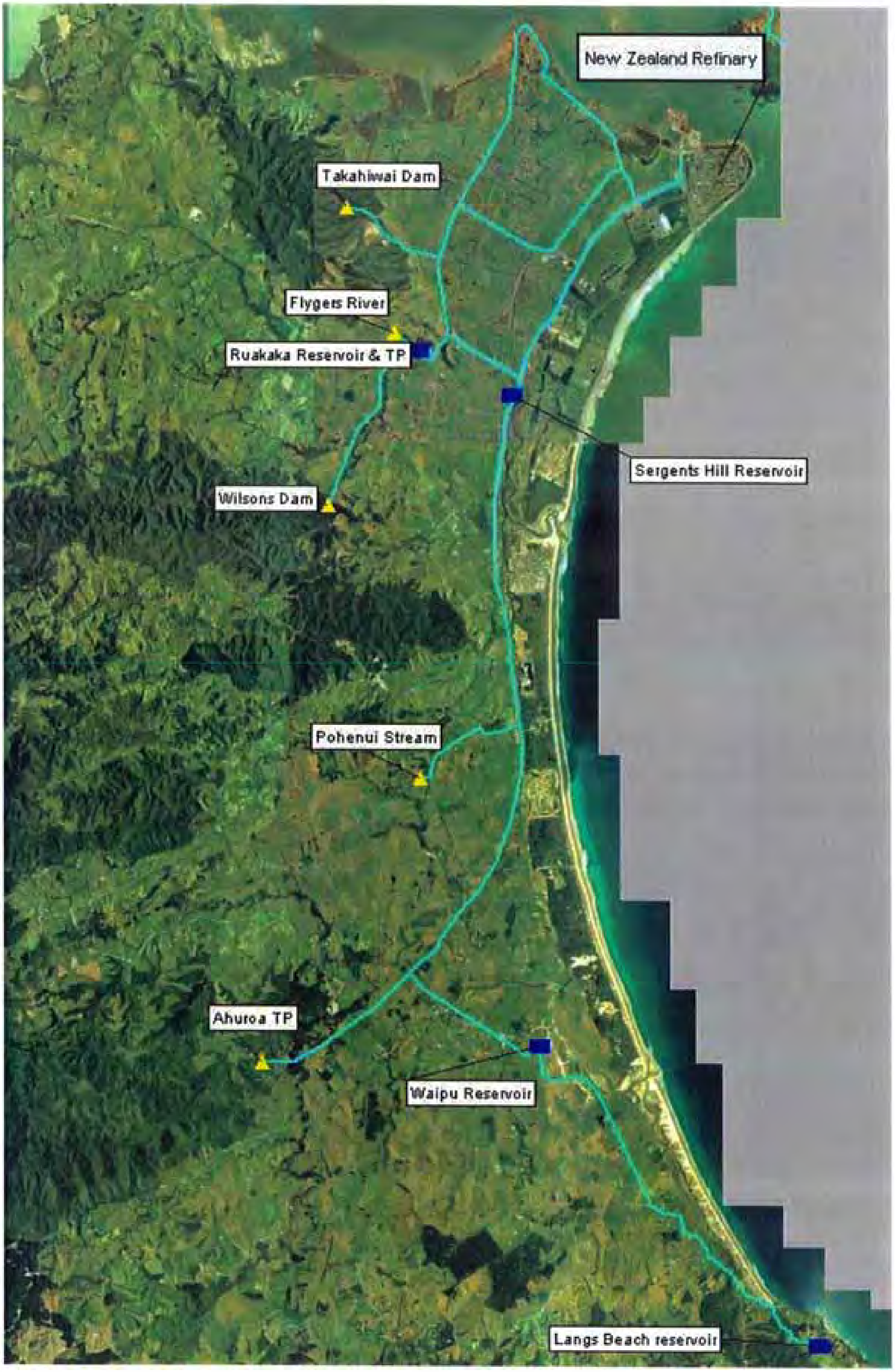


Figure 2 Bream Bay Water Scheme (Source: Whangarei District Council)

3.2. WASTE WATER

The Ruakaka/One Tree Point Wastewater Treatment Plant utilises two facultative lagoons followed by wetlands to stabilise the wastewater. At present effluent from the wetlands is discharged to ground via infiltration basins. The plant currently has resource consent for treating 685 m^3/day. The existing resource consent expired on 31 May 2005.

The consent for the temporary 1800m^3/day (approximately 3000 households) upgrade option has been granted and work will commence on the treatment plant shortly. The WDC and BBLOA are currently working through programming and construction.

Council has approved a Phase 1 plant upgrade for 3000m^3/day which is expected will be triggered when 80% of the temporary plant upgrade is utilized.

A study is currently underway to investigate the long term options available for treatment and disposal of wastewater for the community of approximately 24,000m^3/day (including Waipu in future). Four possible options have been identified and are being reviewed for acceptability and feasibility, with a view to obtaining a Resource Consent for a discharge based on predicted ultimate development.

Council has commenced community consultation and public meetings with future options for terrestrial or ocean outfall.

The possible future reticulation network is appended.

3.3. SURFACE WATER

3.3.1. Catchment and Drainage

The existing residential and industrial areas are primarily serviced by a piped network and open channels. Agricultural areas are drained by a network of open drains broadly running either north or south. The main catchments within the current SP2000 area are indicated in Appendix 2 and outlined below.

OTP - One Tree Point –Catchment Management Plan in place.

R -Ruakaka - Catchment Management Plan in place.

B – Berich Drain – Part of the Ruakaka Catchment Management Plan.

BC - Blacksmiths Creek – Consented Catchment Management Plan in place

The remaining area is generally agriculture drains and was covered by the Whangarei County Council One Tree Point Rural Drainage Provisional Scheme surveyed in 1978-1979. This area has now been divided into the following suggested catchments

T - Takahiwai River in the northwest,

RR - Ruakaka River.

U – Uretiti Wetland in the Southwest

The majority of the Marsden Point-Ruakaka area is flat with the exception of minor coastal cliffs and sand dune areas.

3.3.2. Flood Susceptible Areas

The Appendix 2 Plan also shows the current flood susceptible areas as given in the Whangarei District Council Hazard Maps. These are primarily a result of undercapacity agricultural drains overflowing onto the surrounding flat land during heavy rain. In addition, surface water ponds on flat topography during extreme events.

These flood areas are shown on the appended existing stormwater plan.

3.3.3. Surface Water Quality

The key pressures affecting water quality in Northland are point source discharges, non-point (diffuse) source discharges and agricultural land use.

Agricultural runoff from farmland can have a significant effect on the quality of stormwater and it is considered that if correct mitigation measures are implemented with the change in land use from agricultural to residential and commercial, that there can be a net improvement in the quality of stormwater discharging from the site.

The water quality of the area is considered important by the community and achieving a high water quality for recreation contact and food sources is essential.

4. THE STRUCTURE PLAN ASSESSMENT

The following calculations and modelling are based in the Structure Plan proposals.

4.1. POPULATION AND AREA CALCULATIONS

The population and areas used in the calculations for water and wastewater demand are from the Structure Plan. The summary statistics are as follows:

Table 1: Population and Area

Land Use	Population	Area (ha)	Population Assumptions
Residential		-	
Medium Density	28,757		Medium density: 35 persons/ha
High Density	5,743		High density: 70 persons/ha
Rural Residential	650		Rural Residential: 5 persons/ha
Rural	575		
Total Residential	35,725		
Retail / Commercial	2,280	63.3	50 persons/ha
Industry A	3,060	102	30 persons/ha
Industry B	1960	115	20 persons/ha
Industry C	6286	623	10 persons/ha

Source: Land Use Capacity Measurements: REVISION H (26 May 2008)

4.2. IMPLICATIONS FOR WATER

The current situation, where 74% of the potable water is used by one industry, the refinery, demonstrates that with 700 ha zoned for heavy industry it is impossible to predict what the future water use will be with any degree of accuracy. Some guidance can be given for what the likely scenarios will be.

The Bream Bay area has been modelled by the Whangarei District Council Water Services Department. A model was constructed based on rainfall records from 1910 to 1999 and this was tested against an assumed peak 2047 demand of 12,600 m^3/day. This was determined to be close to the maximum that existing Resource Consents would allow.

Two demand scenarios are presented: one labelled "Low Water Use" based on using water saving devices plus industrial reuse where possible; and a second labelled "High Water Use" based on business as usual for water use with no industrial reuse or water saving devices in domestic situations. The assumptions for each scenario are given below:

Table 2: Demand Scenarios

Land Use	Population	Area (ha)	Low Water Use	High Water Use
Residential	35,725	-	150L/person/day	300L/person/day
Retail/Commercial	1,835	36.7	100L/person/day	150L/person/day
Industry A + B	5,020	200	250L/person/day	500L/person/day
Industry C	6,286	629	3800 m³/day Marsden Point reusing 4000m³/day	7800 m³/day

Heavy industrial water use was approximated as 50% of existing industrial water use.

Using the above assumptions, the daily volume required for each scenario is as follows (rounded to nearest 100m³):

Table 3: Daily Volume Requirements

Land Use	Low Water Use m³/day	High Water Use m³/day	Expected m³/day
Residential	5359	10718	8,931
Retail/Commercial	3573	5359	82
Light Industry	8931	17863	6,528
Heavy Industry	3800	7800	20,518
TOTAL	**21663**	**41739**	**36,076**

Figures show that the low water use scenario fits within the existing raw water capacity in the Bream Bay area. The high water use scenario exceeds existing capacity by approximately 100%.

These figures are approximate, as the largest water user could potentially be a currently unknown heavy industry. The figures show that future efficiency of water usage may be essential to delay the need for finding another source.

4.3. IMPLICATIONS FOR WASTEWATER

A study has been commissioned by WDC Waste Services to investigate the future wastewater loads within the study catchment (Task 2A Report, Future Wastewater Quantity and Quality Projections). This has been based on the SP2000. A comparison between the figures that result from the Structure Plan and the SP2000 document is described below.

4.3.1. Residential Capacity

Effective Ruakaka Wastewater Population in 2056

Table 4: Residential Capacity

	Task 2A Report		2007 Structure Plan	
	Medium Growth (includes Waipu)	**High Growth(includes Waipu)**	**Including Waipu**	Excluding Waipu
Usually Resident	40,962	**49,962**	**52,000**	39,500
Peak Holiday Season	58,026	**72,426**	**75,700**	63,170

Note that Waipu is predicted to be included in Ruakaka wastewater flows from 2026.

The comparison above shows that the difference in population predicted in 50 years time between the high growth scenario and the Structure Plan is minimal (approximately 2000 people in the usually resident population). It is concluded that for residential wastewater flows the current WDC study on future wastewater quantities are consistent with the SP2000, *providing the high growth scenario is used.*

4.3.2. Commercial/Industrial Wastewater

A comparison was made between the *total* area available for commercial and industrial subdivisions (excluding the Refinery site) in 2056. In the Task 2A report, the total figure quoted is 911ha, and in the Structure Plan the total arrived at is 828ha. These two figures are considered close enough to not make any significant difference in planning.

As for water use, it is difficult to predict wastewater flows from commercial/industrial sites without knowing what the industries will be producing.

It is estimated the future ADWF (Average Dry Weather Flow) wastewater flows will be 31,577m^3/day. Calculations are included in Appendix 1.

Options for use and discharge will be required in the future.

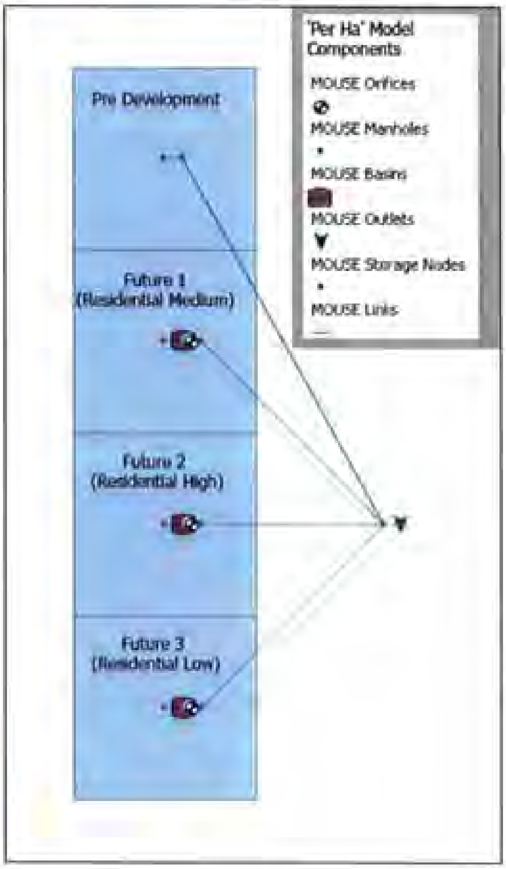
4.4. IMPLICATIONS FOR STORMWATER

Investigations have identified existence of under capacity drainage networks, low grades and on site ponding as a result. It is considered that there are high ecological and recreational values within the adjacent river, estuary and coastal areas.

To obtain an idea of the potential attenuation to mirror the existing situation required for some future development areas, a 1 hectare area of land was assessed. This was done using a dynamic software program called Mike Urban which uses MOUSE software.

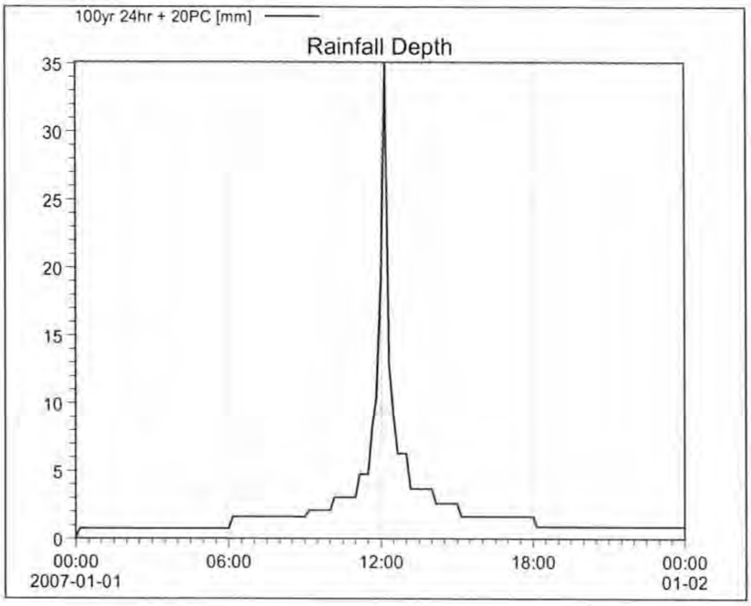
A schematic of this model is shown below in Figure 3.

Figure 3: Per Hectare Model



The design rainfall hyetograph is shown in Figure 4 below:

Figure 4: Design Rainfall Event (100 year ARI plus 20% for climate change)



The zone areas and runoff parameters are shown in Table 5 below:

Table 5 - Catchment Parameters

Zone	Area	% Imperv.	Area per Lot	CN	Ia	TOC
	Ha		m²		mm	min
Pre Development	-	0%	-	50	5.0	18
Residential Medium	28	35%	500	81	3.2	10
Residential High	32	45%	350	85	2.7	10
Residential Low	19	25%	2000	62	3.7	10

Note 1: CN is curve number as per TP108

Note 2: Ia is initial abstraction depth as per TP108

Note 3: TOC is time of concentration as per TP108

Storage requirements for each land zone were assessed on a 1.0 hectare basis. Two metre high tanks are assumed; however, the volume of storage is the main consideration. The storage tank and outlet were calibrated to determine the base area of storage per hectare required. The calibration of tank maximum water level and discharge flow rate are shown in *Table 6* and *Table 7* below.

Table 6 - Water Level in 2.0 high Storage Tanks

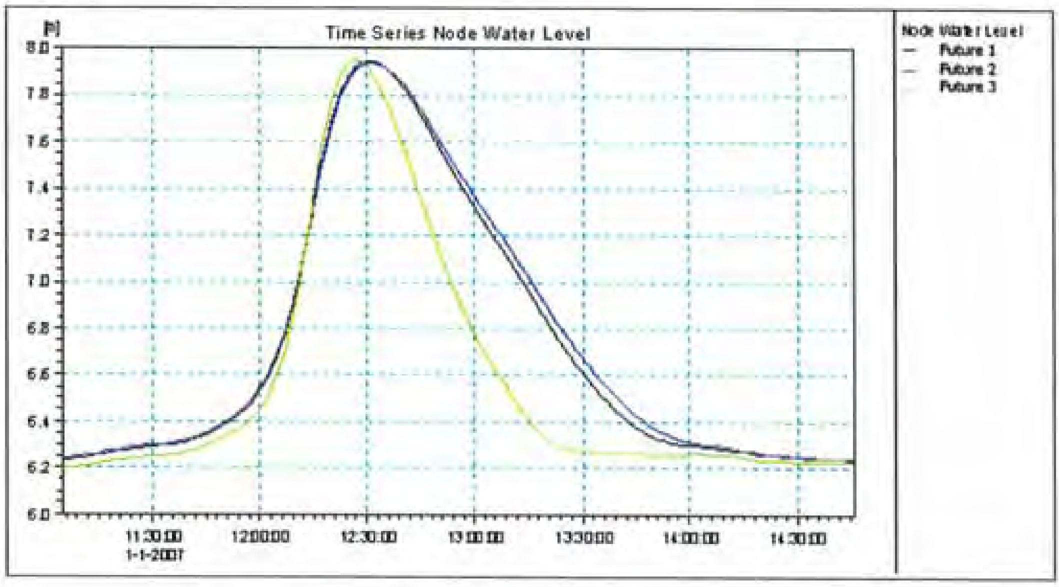
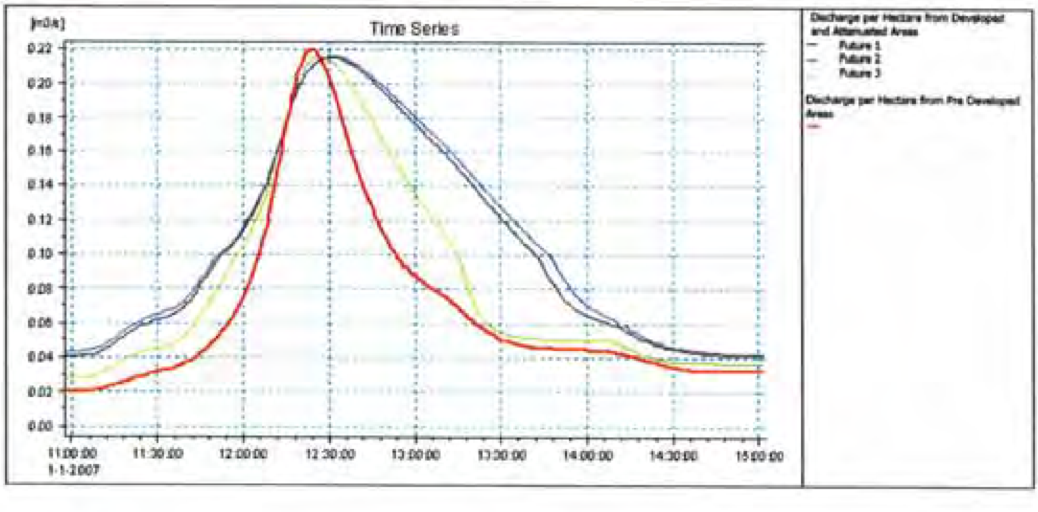


Table 7 - Discharge per Hectare



The tank base areas required to attenuate the future runoff to pre development flow rates are shown in Table 8 below:

Table 8 - Storage area per Hectare

Zone	Area	Tank Height	Tank Base Area	Tank Vol	Orifice ∅	Discharge
	Ha	m	m^2	m^3	mm	m^3/s
Pre Development	1	-	-	-	-	0.219
Residential Medium	1	2	185	370	350	0.215
Residential High	1	2	200	400	350	0.215
Residential Low	1	2	100	200	350	0.215

Note 1: A tank depth of 2.0 m is assumed

Note 2: A circular orifice plate is assumed, however outlet attenuation will depend on pond / tank configuration.

The results indicate that for low, medium and high density residential areas a minimum of 20mm, 37mm and 40mm of rainfall will need to be retained to attenuate the 100yr flows. This recognises the Climate Change Effects and Impacts Assessment which indicates in 2100 a 50yr return period storm will be a 7yr return period storm.

Assessment of the agricultural drains confirms the limited outlet capacity and applying a discharge of $0.22m^3/ha$ confirms that a combination of retention, detention and improved channel capacity will be required for each catchment.

The implications are that if the Structure Plan including industrial land is developed into an average of 65% impermeable surfaces then around 10% subject to storage depth will need to be set aside for detention storage.

5. SUSTAINABLE WATER MANAGEMENT PHILOSOPHY

5.1. INTRODUCTION

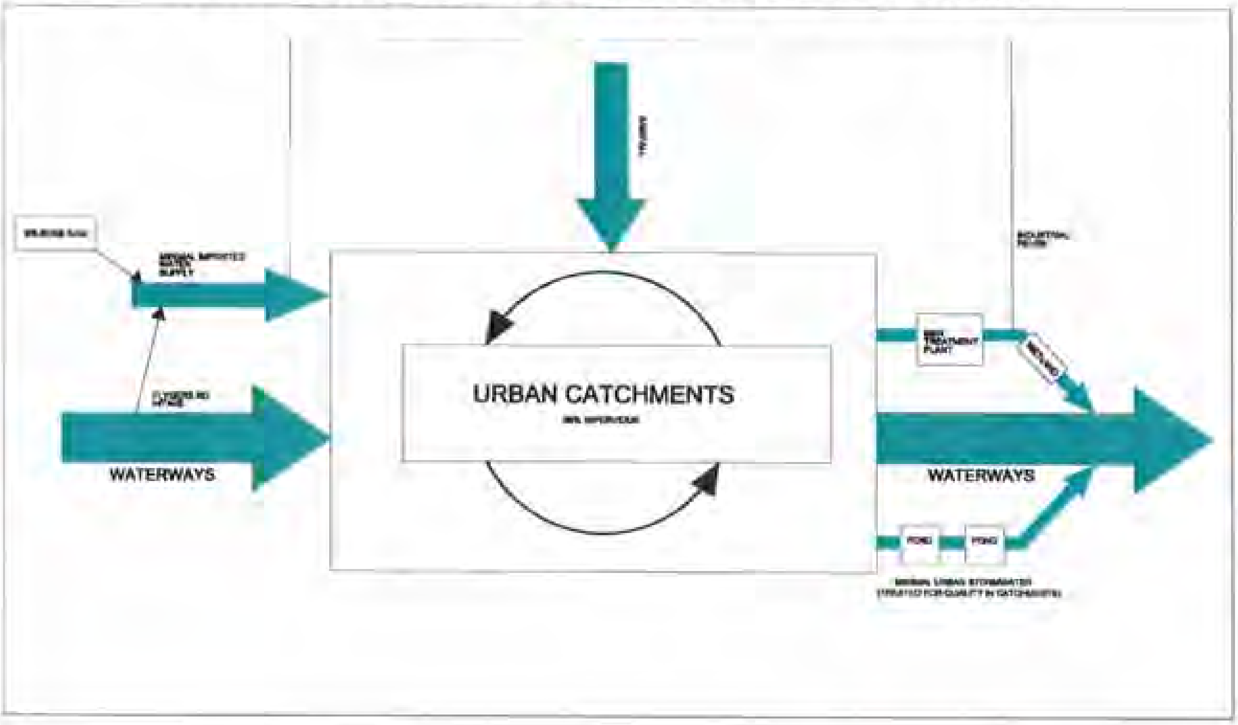
Water management philosophy has changed greatly in the past 50 years, and will continue to evolve as new challenges and opportunities develop. This section examines some of the likely changes that will occur and ways to ensure that there is opportunity to incorporate them as they become available.

5.2. WATER MANAGEMENT CYCLE

Rather than viewing different 'types' of water separately it is far more helpful to examine them as part of a whole water management cycle. The diagram below begins to do this with the Ruakaka proposal. It begins to consider the importance to avoid waste and use water for enhancement of ecological values of the area.

The best practice thinking recognises the life values of water and this is identified in the urban catchments placed centrally in the diagram below. Water within this urban catchment is essential for supporting human life, flora and fauna.

CURRENT BEST PRACTICE THINKING
WATER IS A PRECIOUS RESOURCE - NOT WASTE



It is used in the health and wellbeing of the community, for cleaning, waste transportation and normal everyday activities. It has substantial recreational value from kids playing and spraying with a hose, swimming, cooling, irrigation and other recreational activities. It is used for gardening, growing food, and habitat for insects and animals within the environment. The list continues on and every person in the community would easily identify and define a subject of importance.

The source of this life supporting water is rainfall, waterways, rivers and creeks which are either direct intakes or stored in dams for periods of dry weather.

Desalination was considered; however, there is not a source in the urban area and the need is not identified as required under this Structure Plan.

The outlet and discharges of the "used water" are considered to drain to waterways and eventually the coast. The stormwater and wastewater is considered to be treated to an acceptable quality in ponds and wastewater in treatment plants and wetlands to enhance the environment and ecological values of the community.

There is a loop directing recycled/harvested acceptably treated wastewater and possibly stormwater back into the source to be used within the urban catchments. It may be used for activities where a lower quality of water is acceptable, for example, irrigation for growing plants, transportation of waste, and industry.

The size and riparian zones of the waterways and ponds are determined to prevent 100yr flooding of critical infrastructure and personal properties as well as allowing for the ecological values of the community to be supported. This includes the consideration of spawning areas for fish and the neighbouring coastal habitat.

The Structure Plan recognizes this importance with the identification of open space. This open space shows essential links along the Ruakaka, Takahiwai Rivers and main waterways, the old Ruakaka Lake and has identified a network of internal open space with the zoned land.

5.3. POTABLE WATER

5.3.1. Whangarei District Council Standards

The Whangarei District Council prepared a Water Supply Asset Management Plan in 2005 as part of the 2006 Long Term Council Community Plan (LTCCP) in accordance with Schedule 10 of the Local Government Act 2002. In it the Water Services Division made a commitment to: *encourage the sustainable use of the limited water resources for agricultural, horticultural, commercial, industrial and domestic purposes and to discourage waste.*

5.3.2. Local Government Act 2002

It is stated in the Local Government Act 2002:

Section 128:(2) In making an assessment of current and future demands for water services and options to meet those demands, a territorial authority must consider—

(a) the full range of options and their environmental and public health impacts, including (but not limited to)—

(i) on-site collection and disposal; and

(ii) grey water and stormwater reuse or recycling; and

(iii) demand-reduction strategies, including public education, information, promotion of appropriate technologies, pricing, and regulation; and

(iv) the full range of technologies available…

5.3.3. Sustainable Use of Potable Water

The peak supply from the current water sources available to the Ruakaka area is 14,000m³/day. Using the proposed zoning plan for Ruakaka, the peak demand will be between 11,400 and 36,078m³/day.

Climate change projects indicate that the projected changes in precipitation (in %) are tabulated below.

Table 9: Projected changes in precipitation

	Low Change (%)	Average Change (%)	Upper Change (%)
Annual Change in precipitation 1990 – 2040	-16	-4	7
Annual Change in precipitation 1990 - 2090	-28	-7	2

It is clear that water resources are limited for future development and so water conservation measures will need to be incorporated from the beginning, such as:

- Requiring water saving appliances and devices to be used in all new building consent applications
- Pursuing wastewater reuse for industries as far as possible
- Investigating grey-water recycling devices for garden irrigation during summer dry periods
- Public education on waste use reduction
- Encouraging planting of low-water requirement plants
- Collecting and using individual rain harvesting methods where appropriate
- Identification of new sustainable sources.

5.3.4. Industrial Water Use

Industrial water use is an unknown since different industries require different amounts of water. Security of water supply is increasingly a competitive advantage when attracting investment. Therefore maximising the amount of water available to be used efficiently by industry by reducing inefficient use of water for domestic purposes is considered a future benefit.

5.4. WASTEWATER

Wastewater treatment and disposal for the completely developed situation for Ruakaka is currently the subject of a study by WDC. Ultimate capacity is likely to be around 31,577m^3/day. Calculations are attached in Appendix 1.

This study will set the direction for wastewater treatment and disposal well into the future. It considered that over the next 50 years re-use will become more common and that wastewater will change from being a 'waste' to a resource for use in the improving the environment and reuse in industry. This thinking should be encouraged now.

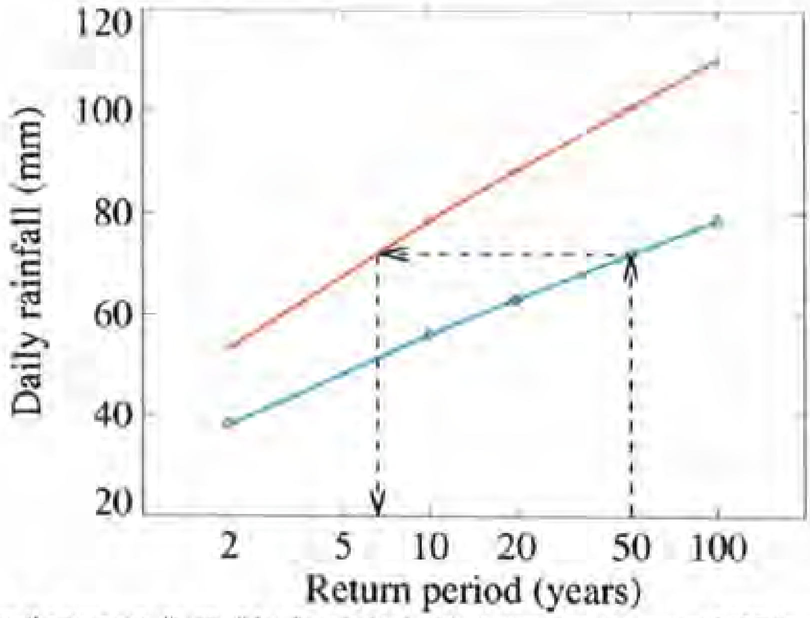
The proposed layout for wastewater attached as Appendix 2 indicates the low points in the catchment. The flat nature of the catchments identifies that pipe grades will be as low as 0.25% and pumping may be required at around 1km radius. Planning of the ultimate sewerage layout to maximise energy efficiency should be encouraged.

5.5. STORMWATER

The limited agriculture drains and limited gradients within the area significantly affect the ability for impervious development without effective solutions including retention and detention. These are shown on the Stormwater Drawing in Appendix 2.

The recent Ministry of the Environment Climate Change Effects and Impacts Assessment "A Guidance Manual for Local Government in New Zealand" 2nd Edition identifies that climate change has significant potential impacts and is sobering reading. The graph below could apply to the Structure Plan Area and future considerations of increasing flooding should be allowed for.

Figure A3.13: Effect on return period of extreme daily winter rainfall at Auckland for an increase in the beta parameter of the gamma distribution, but no change in the alpha parameter.



Note: Comparing the present climate (blue line, below) with the extreme change at 2100 (red line, above), as inferred from the gamma distributions changes of Semenov and Bengtsson (2002). The dotted lines show how the 50-year return period under the present climate, associated with a rainfall amount of about 72 mm, changes to a return period of about 7 years for this worst case scenario.

The projected changes in seasonal and annual mean temperatures (in °C) with resulting increase in rainfall intensity for the greater than ARI 30yr storms are tabulated below for Northland for a lower average and upper climate change scenario

Table 10: Projected Temperature Changes

	Low Change (°C)	Average Change (°C)	Upper Change (°C)	% increase in heavy rainfall per 1°C in temperature
Annual Temperature Increase 1990 - 2040	0.2	0.9	2.6	8%
Annual Temperature Increase 1990 - 2090	0.6	2.1	5.9	8%

For example in 2040 a (2.6 x 8 =) 20.8% increase in rainfall intensity may occur under the upper climate change scenario.

The best practicable option for on-site stormwater disposal shall be identified and incorporated into the stormwater management design to avoid or minimise changes to stormwater flows resulting from development.

This can be achieved by giving consideration to utilizing a combination of:

- Infiltration facilities in permeable soil types;
- The retention of natural stream channels (where property boundaries permit);
- Minimising areas of impermeable surfaces (unnecessary parking, turning and hardstand areas);
- Stormwater detention (concrete tanks with limited outlet device or similar) before dispersal into waterways.
- Design of systems to imitate and integrate into the performance of natural systems which will provide high ecological values.

This can further be achieved by the implementation of on-site volume control practices as contained in "Technical Publication 124, Low Impact Design Manual for the Auckland Region", Auckland Regional Council, 2000.

The quality of discharge from development should be at acceptable levels so as to not have any adverse effects downstream. Although some stormwater from industrial and commercial premises can contain significant quantities of contaminants, a high level of dilution is usually available and the stormwater can usually be discharged into water or onto or into land without significant adverse effects. In any event it is inappropriate to allow stormwater discharge from hazardous substances storage areas or contaminated sites without subjecting the discharges to full scrutiny.

The extent of low impact design will need to be defined after public consultation and preparation of Catchment Management Plans prior to the issue of subdivision consents. These plans should have a significant ecological consideration and the hydraulics modelled to sustain the environment.

5.5.1. Stormwater Effects and Mitigation

5.5.1.1. Stormwater Quality

The object of providing stormwater treatment devices as stated in ARC TP10 is *"to remove 75% of total suspended sediment on a long term average basis. Removal of sediment will remove many of the contaminants of concern, including particulate trace metals, particulate nutrients, oil and grease on sediments and bacteria on sediments."*

Detention ponds can be used to improve the quality of stormwater discharge from developed sites. Ponds detain stormwater inflows to allow suspended solids to settle, while aerobic decomposition and absorption of contaminants onto plants provide secondary treatment benefits. The sizing of the stormwater treatment ponds will need to achieve the required level of suspended solids removal. This is assessed as the water quality volume that will achieve the water quality objective. This volume is generally exceeded by the requirements for on site storage.

In addition to this it is recommended that the stormwater runoff from individual industrial sites be treated to improve stormwater quality to acceptable levels prior to discharge. In the first instance, it is preferable that pollutants such as sediment, fuel, grease and oils do not become mixed with stormwater.

The stormwater quality management can further be enhanced with the installation of proprietary stormwater treatment systems such as in line Humeceptors or similar.

ARC TP10 lists additional suitable stormwater management practices for improving the quality of stormwater discharge from the site, including extended detention, swales, filtration, infiltration and vegetative filters. It is considered that biofiltration (swales, filter strips and raingardens) and infiltration mechanisms can easily be incorporated into the design to provide suitable treatment devices.

5.5.1.2. Industrial On-site Stormwater Management System

On-site stormwater management systems have been considered. The basic design philosophy is to provide pre-treatment of paved area runoff (all runoff from non-roof impervious areas plus pervious areas) prior to discharging to detention and infiltration structures. The provision of pre-treatment can be carried out using filter strips, rock swales/trenches, catchpit filters or sand filters. Rock swales/trenches are those in which the swale system runs along the downslope edge of the paved area. Swales are typically formed with gravel and planted with a variety of trees, shrubs and ground covers. A rock filled trench typically underlies the swale, and under low flow conditions, runoff seeps into the underlying gravel while at higher flows it flows along the swale.

Pollutants are removed by filtration and sedimentation, and the vegetation also removes further contaminants by filtration, adsorption and biological uptake.

Due to the permeable nature of the SAND care must be taken to prevent infiltration of contaminants in the underlying unconfined aquifer.

6. PROPOSED WATER MANAGEMENT STRATEGY

Water is a valuable LIFE resource and not a waste. It is integrated and holistic and demand for it and its importance will increase in the future. Treating it from source through its use to discharge is considered critical to the health and wellbeing of the community.

The Structure Plan provides open space areas for multiple use functions to achieve this. Part of this function is to allow for service corridors for water power, telephone, roading, water wastewater and stormwater.

These corridors can be used for the primary stormwater conveyance of floods, retention and water quality treatment. Flora can be established to enhance the ecological values along these zones. Not only can they be used for conveyance, treatment and retention of stormwater, they can be used for potential irrigation or discharge of wastewater. They may be wet or dry and form community areas. The ponds and retention may also be used for water harvesting.

This open space clearly establishes the corridors for the overall water management strategy as well as providing potential buffering between incompatible land uses and areas where flooding and inundation presently occur, including the Old Ruakaka Lake. Extensive areas will be required for stormwater treatment and retention.

Low future water demand may be achieved with the present sources as indicated by the calculations and may require a combination of water saving appliances and devices to be used in all new building consent applications, pursuing wastewater reuse for industries as far as possible, investigating grey-water recycling devices for garden irrigation during summer dry periods, use of rain harvesting for garden watering, public education on water use reduction and encouraging planting of low-water requirement plants.

For higher use and specific industry new water sources may be required.

The restrictions of the existing agricultural drainage system and flat nature of the land which causes localized ponding requires that future stormwater has a combined solution based assessment.

Floods spill out of drainage channels and pond in areas of the catchments now. In the future large areas will need to be made available for stormwater solutions. This includes protection of the main drainage channels with adequate freeboard depth and width to allow for increasing capacity if required. Stormwater detention areas will retain floodwaters and enhance ecological habitats. This is a feature of the open space corridors.

It is recommended that new catchment management plans include but not be limited to

- LIDAR survey and flood modeling using MIKE FLOOD or similar.
- Integration of the ecological features of the water system.
- Specification of the maximum impervious area per site.
- On-site or local area storage within the open space of peak stormwater in new subdivisions through consent conditions.
- Budgeting for personnel for more frequent maintenance and repair of stormwater systems.
- Be modelled on full urban development scenarios for each catchment

7. CONCLUSION AND RECOMMENDATIONS

The Structure Plan provides extensive areas of open space for multiple use functions which are considered to enhance the overall community wellbeing while achieving sound, sensible and good practice outcomes.

The open space establishes corridors for an overall water management strategy as well as providing buffering to the differing land uses and areas where flooding and inundation presently occur including the Old Ruakaka Lake.

There are appropriate stormwater solutions for the proposed rezoning of land. Stormwater catchment management plans should be updated and prepared for the Takahiwai and Ruakaka catchments. These should consider 3 potential options to effectively attenuate, treat, and convey stormwater as well as enhancing ecology. They must be holistic, and water quality and ecological improvements must be integrated into the system as well as flooding protection.

- subdivisions and developments in the floodplain areas and which are close to rivers will need specific assessment for long term flood levels and to ensure maximum long term clear river channel flow is maintained.
- subdivisions and developments close to or within the coastal area (cliffs, beaches or low-lying areas)

The solution may be either or a combination of the following

1. Maintain existing limited drainage capacity and create on site retention and storage within each development area
2. Increase the capacity of drainage channels using pipes or channels.
3. Allow for average intensities of development to occur with the density of development offset by open space and storage areas.

Wastewater can be effectively collected and pumped to a suitable location for treatment of the proposed ultimate flows.

A catchment assessment is required to consider the energy efficiency of the sewerage network and positioning of major pump stations.

Water can be sourced from the present water sources. Consideration will need to be given to re-use to meet the predicted ultimate demand. This can be provided from treated water, collected stormwater and a mixture of low flow devices.

- encourage or require on-site collection and storage of rainwater (specify storage capacity in engineering standards) in all new developments.
- commence education programmes on water conservation and sustainable gardening.
- allow for staff time and budget for the consent process, the design and the construction of enhanced supply.
- budget to monitor the use and effectiveness of on-site storage, and the effectiveness of water conservation education programmes. Budget to continue the education programmes.
- Evaluate the available precipitation and storage requirements for subdivision and developments that rely on rain water supply.

Geotechnical constraints can be mitigated with standard engineering solutions. Consideration will need to be given to:

- Appropriate solutions for building and infrastructure foundations on PEAT and SAND,
- Subdivision and developments on and close to steep hillsides shall have specific assessment of slope stability.
- Coastal Hazards particularly in the vicinity of One Tree Point sandstone cliff edge and Bream Bay will need to be carefully considered.
- Specific consideration of lifeline infrastructure components in the above locations.
- Extension of council's existing hazards mapping for the district to include the newly zoned land.

8. LIMITATION AND QUALIFICATION

This report has been prepared for the benefit of North Holdings Ltd as our client with respect to Structure Plan assessment and for Whangarei District Council. It shall not be relied upon for any other purpose. The reliance by other parties on the information or opinions contained in this report shall, without our prior review and agreement in writing, be at such parties' sole risk.

Opinions and judgments expressed herein are based on our understanding and interpretation of current regulatory standards, and should not be construed as legal opinions. Where opinions or judgments are to be relied on they should be independently verified with appropriate legal advice

Cook Costello Ltd is pleased to provide this service to North Holdings Ltd and believe that the community would benefit from the project's continuity. In any event it is essential that Cook Costello Ltd is contacted if there is any variation in conditions from those described in the report as it may affect the parameters recommended in the report.

Cook Costello Ltd. has performed the services for this project in accordance with the standard agreement for consulting services and current professional standards. No guarantees are either expressed or implied.

P J Cook
Chartered Professional Engineer
BE(hons),Dip Ag, MIPENZ, CPEng, IntPE(NZ), MACENZ, MIOD

9. APPENDIX 1: WATER AND WASTEWATER CALCULATIONS FOR ULTIMATE DEVELOPMENT AND STRUCTURE PLAN

Marsden Point - Ruakaka Structure Plan: 2008 (Revision H)
Land Use Capacity Measurements

cook | costello **11 June 2008**

	Wastewater Production	Water Demand	Units
residential	0.200	0.250	l/p/day
retail / commercial	0.040	0.044	l/p/day
industrial	0.34	0.38	l/s/ha

Residential - Medium Intensity (@ 14 units / gross ha and 2.5persons per site)

Type	Land Unit	Number of Sites			Total Capacity		Wastewater Production	Water Demand
		Developed	Vacant		Sites	Population	m³ per day	m³ per day
Existing Areas	OTP West	219	65		284	710	142	178
	OTP	110	191		301	752	150	188
	OTP East	141	57		198	495	99	124
	Ruakaka East	312	17		329	823	165	206
	Ruakaka South	300	128		428	1145	229	286
	Ruakaka West Bank	256	44		300	750	150	188
Total		1338	502		1840	4675	935	1,169

	Land Unit	Land Unit Size (ha)	Total capacity		Wastewater Production	Water Demand
			Sites	Population	m³ per day	m³ per day
Undevelolped Zoned and/or Proposed	St Just		311	777	155	194
	WHF/Kowi Lakes		550	1375	275	344
	Marsden Cove		770	1925	385	481
	Ruakaka East		680	1700	340	425
	Ruakaka West Bank		77	193	39	48
	OTP 1	191	2674	6685	1,337	1,671
	OTP 2	99	1386	3465	693	866
	OTP 3	70	980	2450	490	613
	McCathie North	26	364	910	182	228
	McCathie South	17	238	595	119	149
	Ruakaka West 1	86.5	1211	3027	605	757
	Ruakaka West 2	28	392	980	196	245
Total		517.5	9633	24082	4,816	6,021

	Land Unit	Land Unit Size (ha)	Total capacity		Wastewater Production	Water Demand
			Sites	Population	m³ per day	m³ per day
Undevelolped Zoned and/or Proposed	Town Centre West	22.2	622	1555	311	389
	Town Centre North	37.2	1042	2605	521	651
	Town Centre East	6.5	182	455	91	114
	Ruakaka	7.7	216	540	108	135
	McCathie	8.4	235	588	118	147
Total		82	2297	5743	1,149	1,436

Type	Land Unit	Area (ha)	Number of Sites		Total Capacity		Wastewater Production	Water Demand
			Developed	Vacant	Sites	Population	m³ per day	m³ per day
Existing and proposed Ar	Rural Res	38			76	190	38	48
	Rural Res	92			184	460	92	115
Total		130			260	650	130	163

Rural

	Sites	Population	Wastewater Production	Water Demand
General Rural Assume 230 households @ 2.5 persons each =	230	575	115	144
TOTAL STUDY AREA RESIDENTIAL		35725	7,145	8,931

Retail / Commercial (Local Centres @ 50 persons employed / ha)

Type	Land Unit	Size (ha)			Employment Capacity	Wastewater Production	Water Demand
		Developed	Vacant	ha		m³ per day	m³ per day
Existing Areas	OTP	0	1.2	1.2	60	2	3
	Ruakaka	3.7	4	7.7	385	15	17
Proposed	OTP	0	1.2	1.2	60	2	3
Total		3.7	6.4	10.1	505	20	22

Mixed Retail / Commercial/ Other (Town Centre @ average ± 124 persons employed / ha)

Type	Land Unit	Size (ha)			Employment Capacity	Wastewater Production	Water Demand
		Developed	Vacant	ha		m³ per day	m³ per day
Proposed	Town Centre (Retail)	0	35.5	35.5	2150	86	96
	Town Centre (Other)				2240	90	100
Total		0	35.5	35.5	*1 4390	176	195

*1 Based on specific Town Centre detailed demand study

Industry (@ 30 persons employed / ha)

Type	Land Unit	Size (ha)			Employment Capacity	Wastewater Production	Water Demand
		Developed	Vacant	ha		m³ per day	m³ per day
Proposed	Northgate/ Port Marsden	0	102	102	3060	2,996	3,329
Total		0	102	102	3060	2,996	3,329

Industry (@ 20 persons employed / ha)

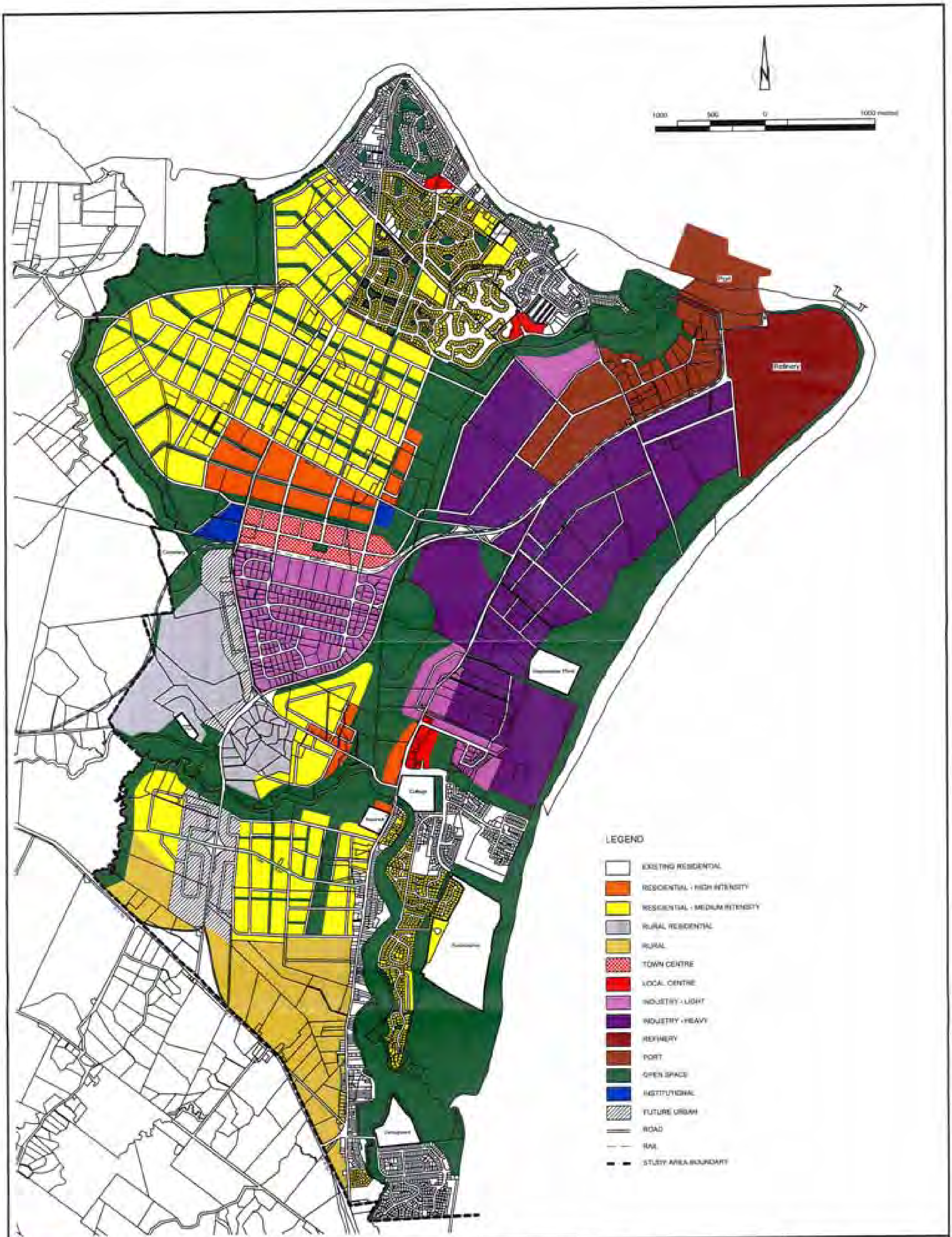
Type	Land Unit	Size (ha)			Employment Capacity	Wastewater Production	Water Demand
		Developed	Vacant	ha		m³ per day	m³ per day
Existing Areas	I 3	0	48.1	48.1	962	1,413	1,570
	I 4	0	16	16	320	470	522
	I 5	0	13.9	13.9	278	408	454
	I 6	20	0	20	400	588	653
Total		20	78	98	1960	2,879	3,199

Industry (@ 10 persons employed / ha)

Type	Land Unit	Size (ha)			Employment Capacity	Wastewater Production	Water Demand
		Developed	Vacant	ha		m³ per day	m³ per day
Existing Areas	I 1	25	212.5	237.5	2375	6,977	7,752
	I 2	0	93	93	930	2,732	3,036
	Refinery	107	12	119	1190	3,496	3,884
	Northland Port	15	117	132	1320	3,878	4,308
	Power Station	0	47	47	470	1,381	1,534
Total		147	481.5	628.5	6285	18,463	20,514

	Employment Capacity	Wastewater Production	Water Demand
TOTAL STUDY AREA EMPLOYMENT	16,200	24,534	27,260
OVERALL TOTAL		31,679	36,191

Note :
1. Residential demand and production based on population
2. Commercial demand and production based on employment
3. Industrial demand and production based on area of land



PO Box 466
Orewa 0946

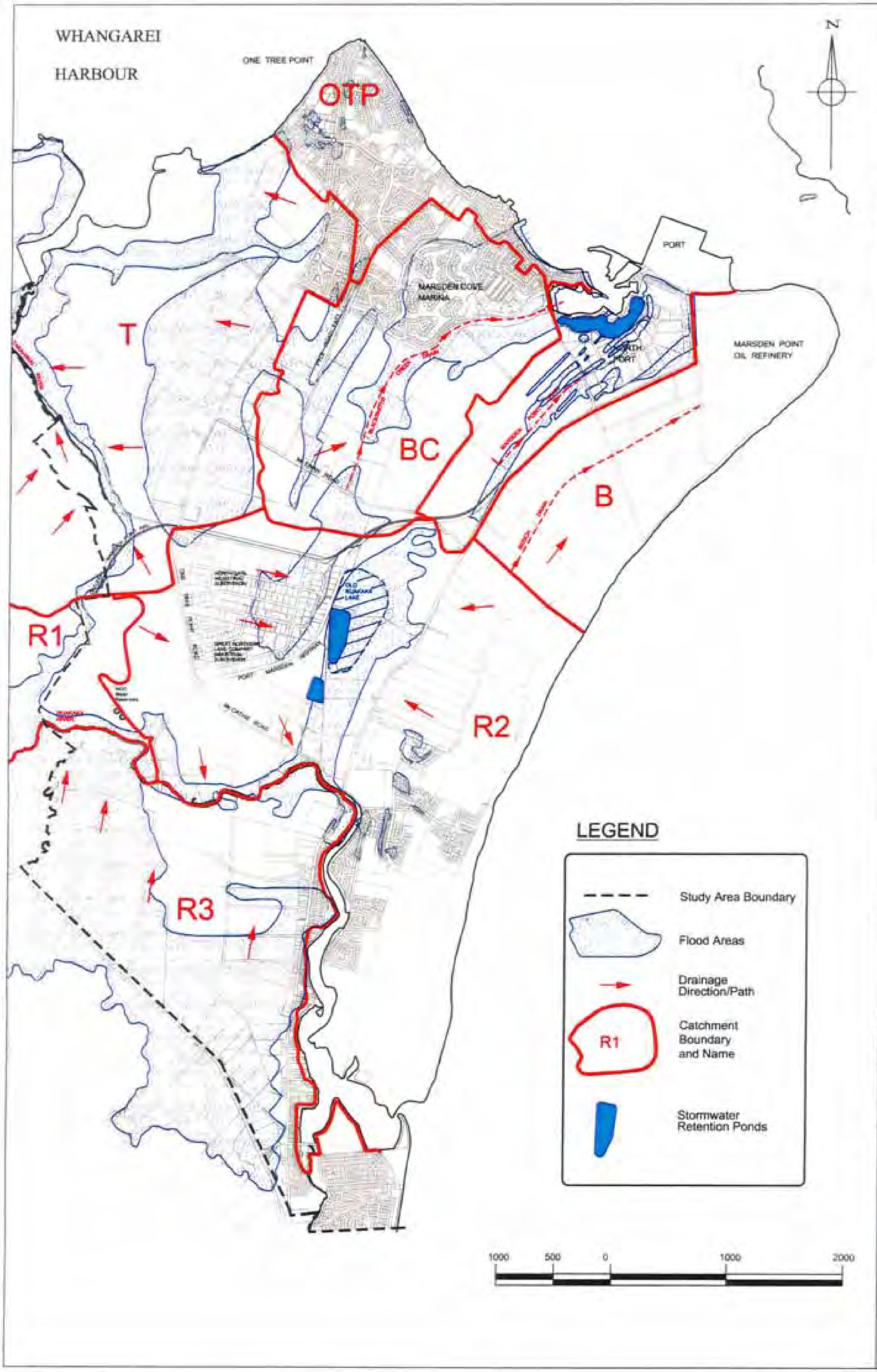
Marsden Point - Ruakaka Structure Plan: 2008

Plan 6: Land Use Proposals

Prepared for
Whangarei District Council

Date June 2008
Scale 1:30 000 @ A3 REV H

10. APPENDIX 2: FLOOD AREAS AND INDICATIVE STORMWATER CATCHMENT PLAN



MARSDEN POINT - RUAKAKA STRUCTURE PLAN 2008
MAIN STORMWATER CATCHMENTS

SURVEYED		REVISION	DATE
DESIGNED		SHEET	SWCP - 1
DRAWN		SERIES	
CHECKED		DATE	2007
APPROVED		SCALE	1:30000 - A3
REF	10799	SIZE	A3

CLIENT

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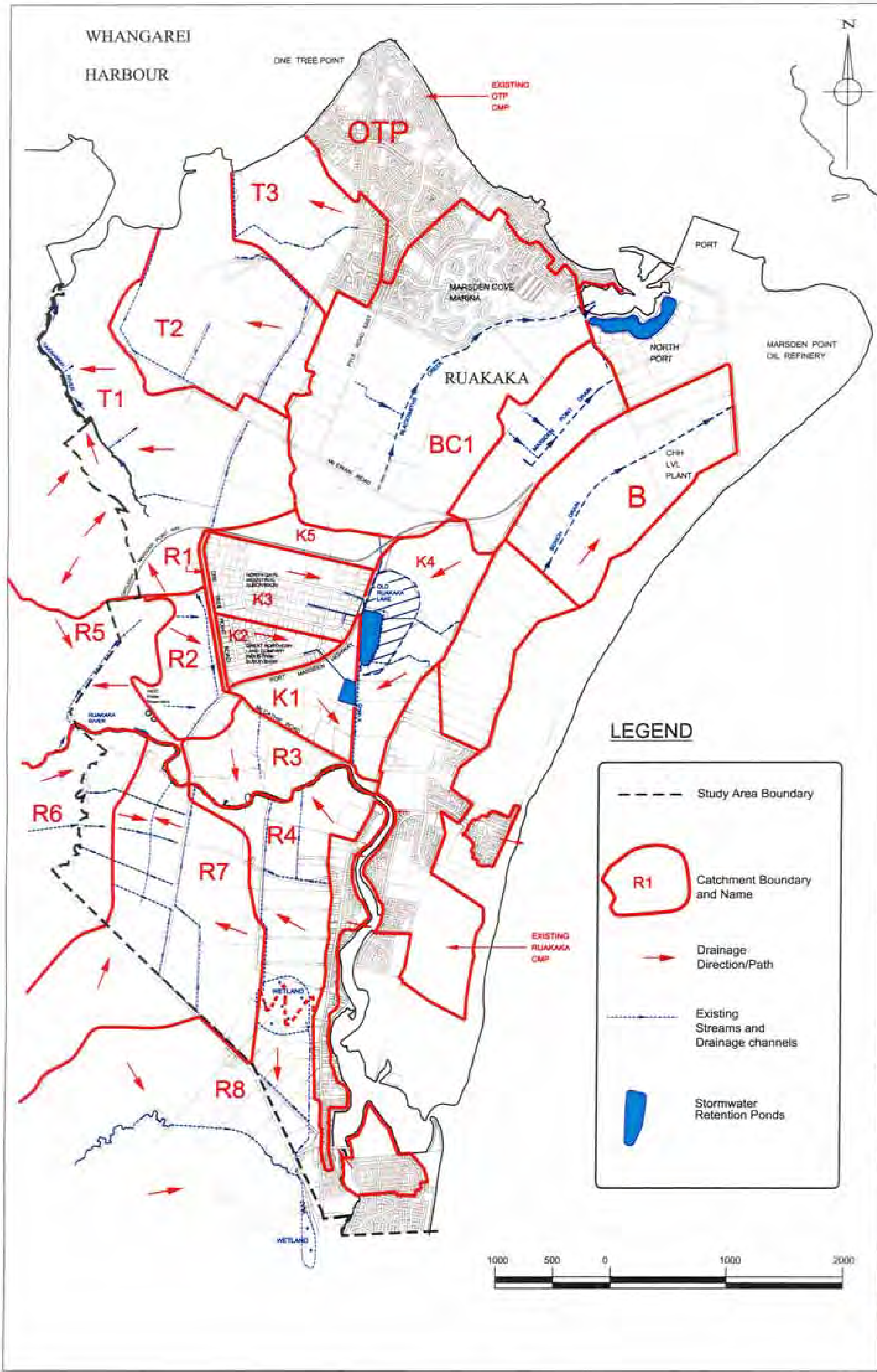
Consulting Engineers
Civil, Structural & Natural Resource Engineers
Norfolk House, 2 Norfolk Street, Whangarei



MARSDEN POINT - RUAKAKA STRUCTURE PLAN 2008
STORMWATER CATCHMENTS PLAN

REVISION	DATE	SHEET	SWCP - 2
SURVEYED			
DESIGNED		SERIES	
DRAWN	GB		
CHECKED	DATE	SCALE 1/30000 - A3	REF 10799
APPROVED			SIZE A3

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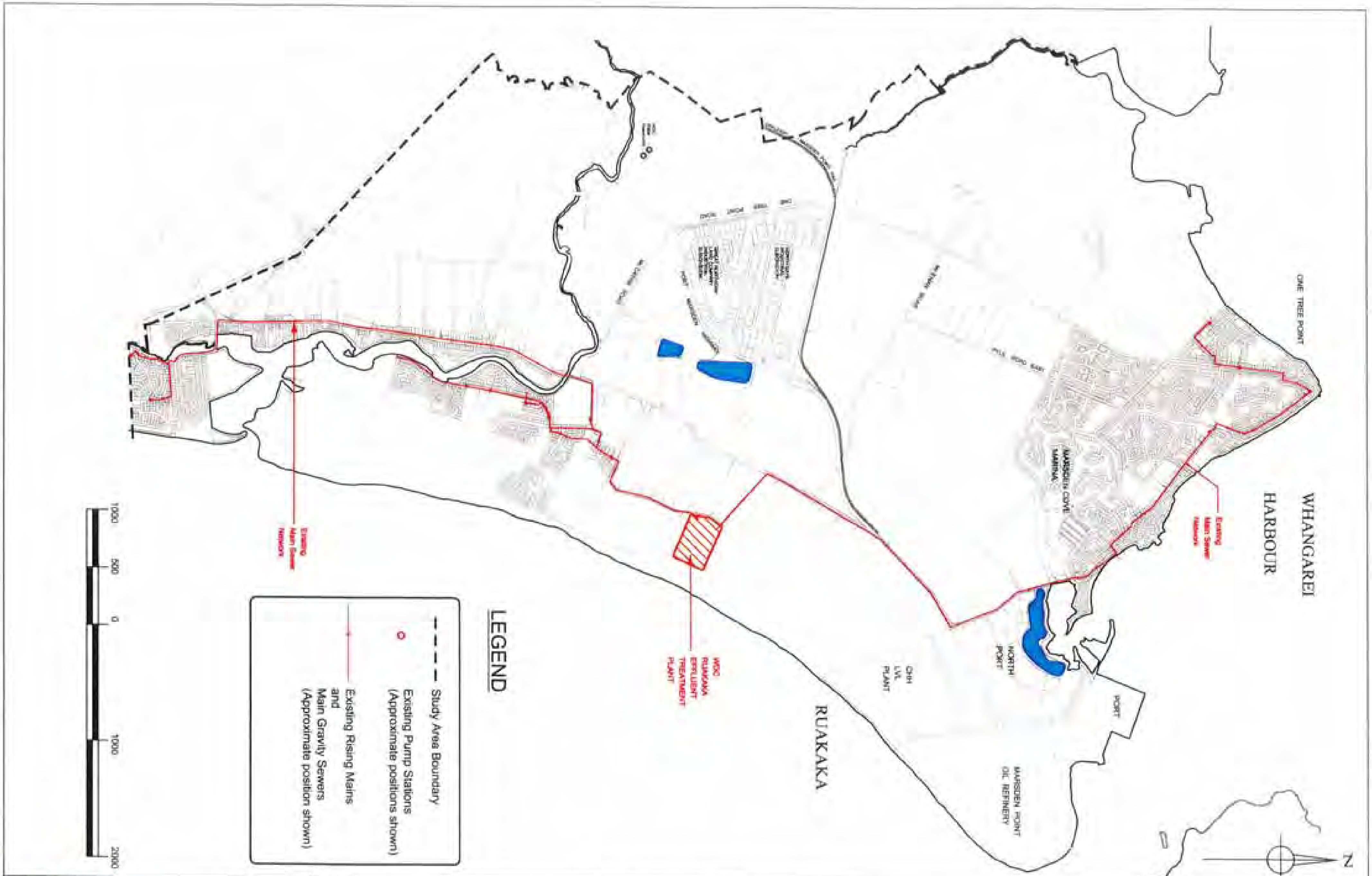
Civil, Structural & Natural Resource Engineers
Norfolk House, 2 Norfolk Street, Whangarei

11. APPENDIX 3: WASTEWATER EXISTING AND PROPOSED INDICATIVE CATCHMENT PLAN



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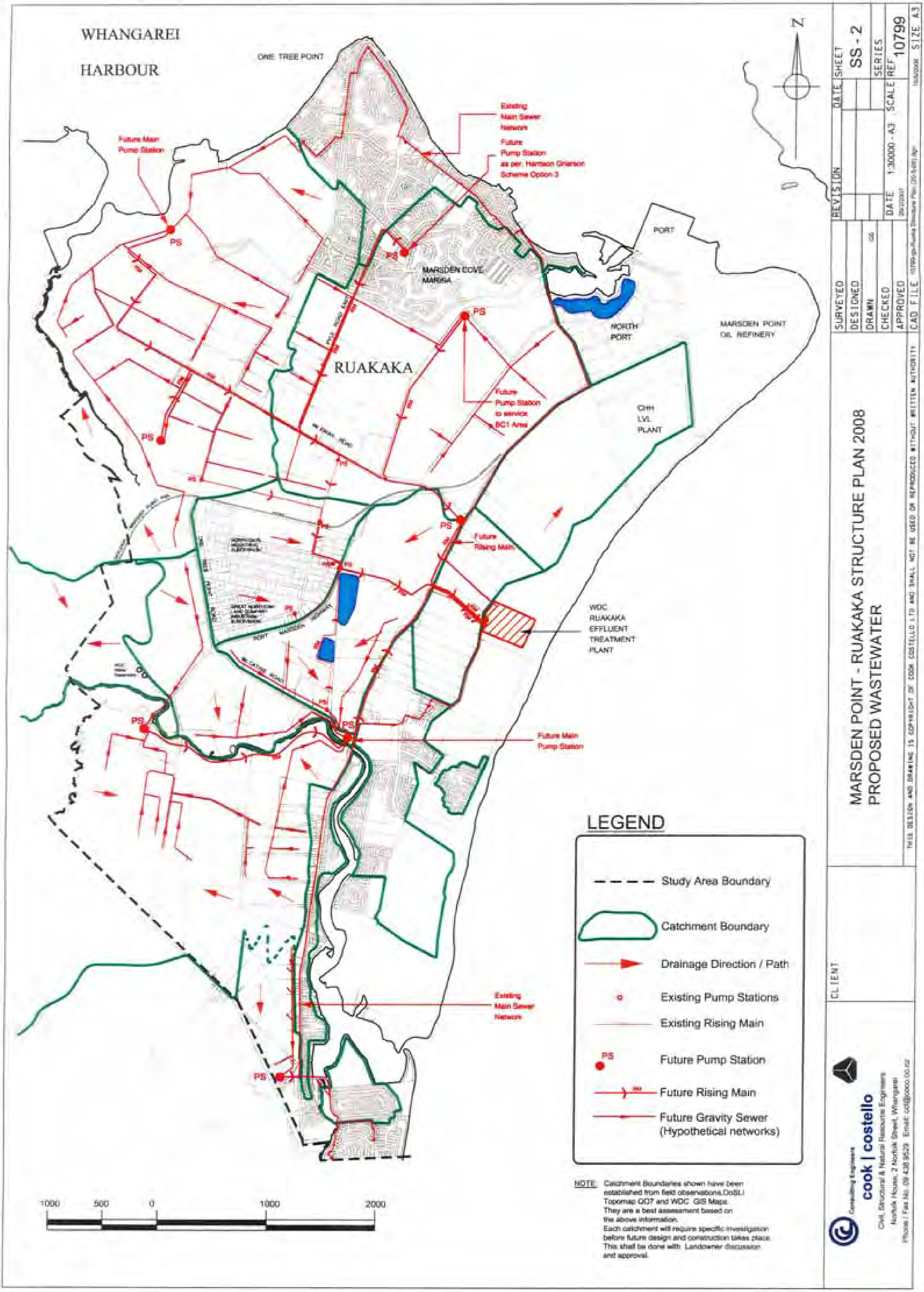
MARSDEN POINT - RUAKAKA STRUCTURE PLAN 2008
CURRENT WASTEWATER PLAN

SURVEYED		REVISION	DATE	SHEET SS - 1
DESIGNED				
DRAWN	GG			
CHECKED		DATE 1:30000 - A3	SCALE 1:1500	SERIES
APPROVED				REF 10799
CAD FILE				SIZE A3



WHANGAREI
HARBOUR
ONE TREE POINT
N
Existing Main Sewer Network
Future Pump Station as per. Harrison Grierson Scheme Option 3
Future Main Pump Station
PS
MARSDEN COVE MARINA
PORT
NORTH PORT
MARSDEN POINT OIL REFINERY
RUAKAKA
Future Pump Station to service BC1 Area
CHH LVL PLANT
Future Rising Main
WDC RUAKAKA EFFLUENT TREATMENT PLANT
Future Main Pump Station
Existing Main Sewer Network
LEGEND
Study Area Boundary
Catchment Boundary
Drainage Direction / Path
Existing Pump Stations
Existing Rising Main
Future Pump Station
Future Rising Main
Future Gravity Sewer (Hypothetical networks)
NOTE: Catchment Boundaries shown have been established from field observations, DoSLI Topomap Q07 and WDC GIS Maps. They are a best assessment based on the above information. Each catchment will require specific investigation before future design and construction takes place. This shall be done with Landowner discussion and approval.
1000 500 0 1000 2000
MARSDEN POINT - RUAKAKA STRUCTURE PLAN 2008
PROPOSED WASTEWATER
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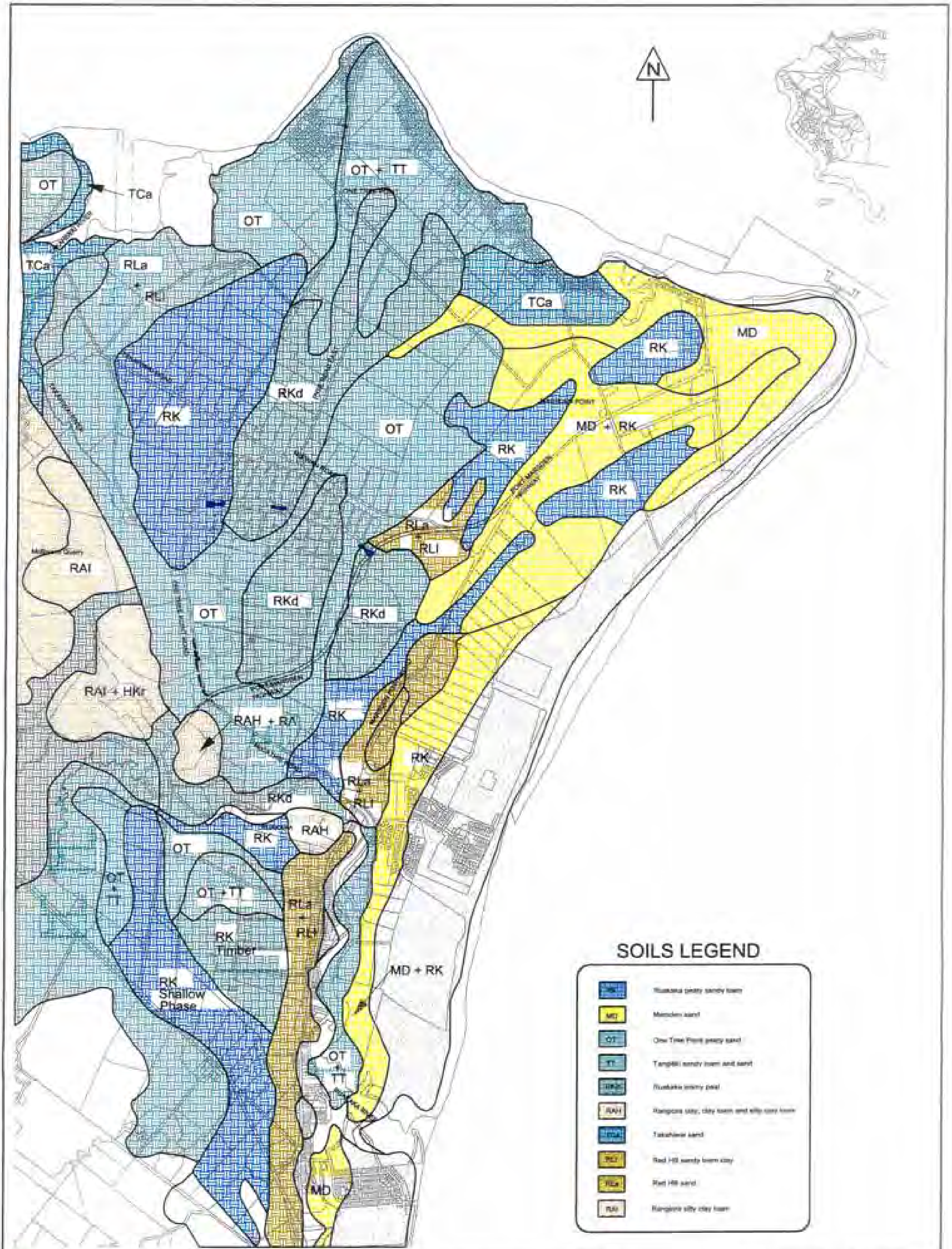
SHEET SS - 2
SCALE 1:30000 - A3
REF. 10799
SIZE A3

12. APPENDIX 4: RUAKAKA SOIL TYPES



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WHANGAREI DISTRICT COUNCIL
NORTH HOLDINGS LTD
SOIL TYPES

SURVEYED		REVISION		DATE	SHEET
DESIGNED					
DRAWN CG					SERIES
CHECKED		DATE	SCALE		
APPROVED		03/09/07	1:5000		REF 10799
CAD FILE		PLOT DATE 05/09/07			ORIG. SIZE A1