Auckland Regional Council
TE RAUHITANGA TAIAO

Auckland Water Resource Quantity Statement 2002 TP171

Surface water and groundwater resource information, availability and allocation.

Technical Publication Number 171, May 2002, ISSN 1175 205X

Prepared by Gillian Crowcroft & David Bowden

Contents

Appendices

Glossary

1 Introduction

Auckland is the smallest of New Zealand's 14 Regions and it has the largest population. Auckland has small short streams, small lakes, generally low-yielding aquifers and moderate rainfall. Auckland is a water short region and there is considerable stress on our water resources.

Water is essential to the social, economic, and cultural well being of the Auckland Region and is highly valued for both its 'instream qualities', and its 'out-of-stream' benefits for consumptive uses.

Water's essential 'in-stream' use is providing habitat for fish and other freshwater biota and for the relationship of the tangata whenua with the region's water bodies. Water may comprise or complement natural and landscape values and provide outdoor recreational opportunities like kayaking, swimming, fishing and picnicking, which often coincide with times of high abstractive demand.

The biggest 'out-of-stream' water use in the Auckland Region is for Auckland's municipal supply. Watercare Services Ltd, Auckland's largest bulk water supplier, account for 90% (~320,000 m^3/day) of total abstraction in the Auckland Region. Approximately 94% of Watercare Services Ltd.'s municipal supply water is currently taken from dams and 6% from groundwater. Even so Auckland needs to source water from outside the region in order to meet future water demand in the region. The horticultural sector accounts for the second highest water abstraction demand in the Auckland Region. Pukekohe produces over a quarter of the country's fresh vegetables and is irrigated using predominantly groundwater.

Other water uses include industrial processes, irrigation of recreational facilities like golf courses and sports fields, and community supplies. Many households outside the municipal supply area also rely on groundwater and surface water supplies, although they generally do not require resource consent to take water.

1.1 Scope

The RMA requires that local authorities collect and make available environmental monitoring information. In 1999 the ARC produced the State of Our Region Report, which broadly outlines regional environmental issues and challenges. This Statement is the first comprehensive document on the Region's water resources, in terms of quantity. The document provides a regional perspective on water resources and water resource management and is intended as a resource for existing and new water users, and anyone with an interest in water management in the Auckland Region.

This Water Resource Statement sets a baseline for information about Auckland's water resource quantity. It is an overview of the region's water resources, in terms of water quantity, 10 years after the implementation of the Resource Management Act (RMA).

While the Auckland Regional Council (ARC) has produced many reports and publications relating to water resources in the region there are few documents that consolidate water resource quantity knowledge. This report brings technical and management information for the whole region together. While technical information can stand alone it is difficult to understand water management without a basic understanding of the resource being managed. Resource information presented in this report is drawn principally from recent ARC investigations, reports undertaken by the Auckland Regional Water Board (predecessor of ARC), analysis and interpretation of site monitoring data and information provided as part of resource consent applications or consent conditions. Little information is presented about water quality or ecology unless there is a direct impact on water resource quantity management.

Water management information presented on Auckland's water resources is generally within the RMA timeframe. The RMA, Auckland Regional Policy Statement (ARPS) and Auckland Transitional Regional Plan have given water management direction. The Proposed Auckland Regional Plan: Air, Land and Water (PARP: ALW) was notified in October 2001. The plan outlines the water management approach that the ARC will use over the next 10 years and provides a clear framework against which policy effectiveness can be assessed. This report provides a benchmark of current policy and practice.

1.2 Report Structure

The objective of this Statement is to bring ARC technical, management, policy and monitoring information together in a regional overview document. The information presented relates to areas with past and/or present water management issues for which non-statutory water resource assessment reports (WRAR's) have been written or investigations undertaken.

Chapter 2 contains a regional overview of the region's climate, hydrology and hydrogeology.

Chapter 3 outlines the statutory framework within which the Auckland Regional Council manages water resources and Chapter 4 presents the water management approach used in the Auckland Region over the past 10 years.

This report separates the Auckland Region into 8 water resource areas (fig. 1.1) with a chapter devoted to each area (Chapters 5-12). The rainfall, surface water resource and groundwater resource of each area is discussed in more detail. Water management issues and water management specific to that area is discussed. Water availability figures, water allocations and consent numbers are to 31 May 2001, coincident with the end of the last hydrological year. Each of these chapters can be read independently but reference to chapters 1-4 may also be necessary.

The report concludes with a chapter looking forward to water management over the next 10 years. The chapter focuses on the direction for water management laid out in the PARP: ALW and how that may impact water management in the region.

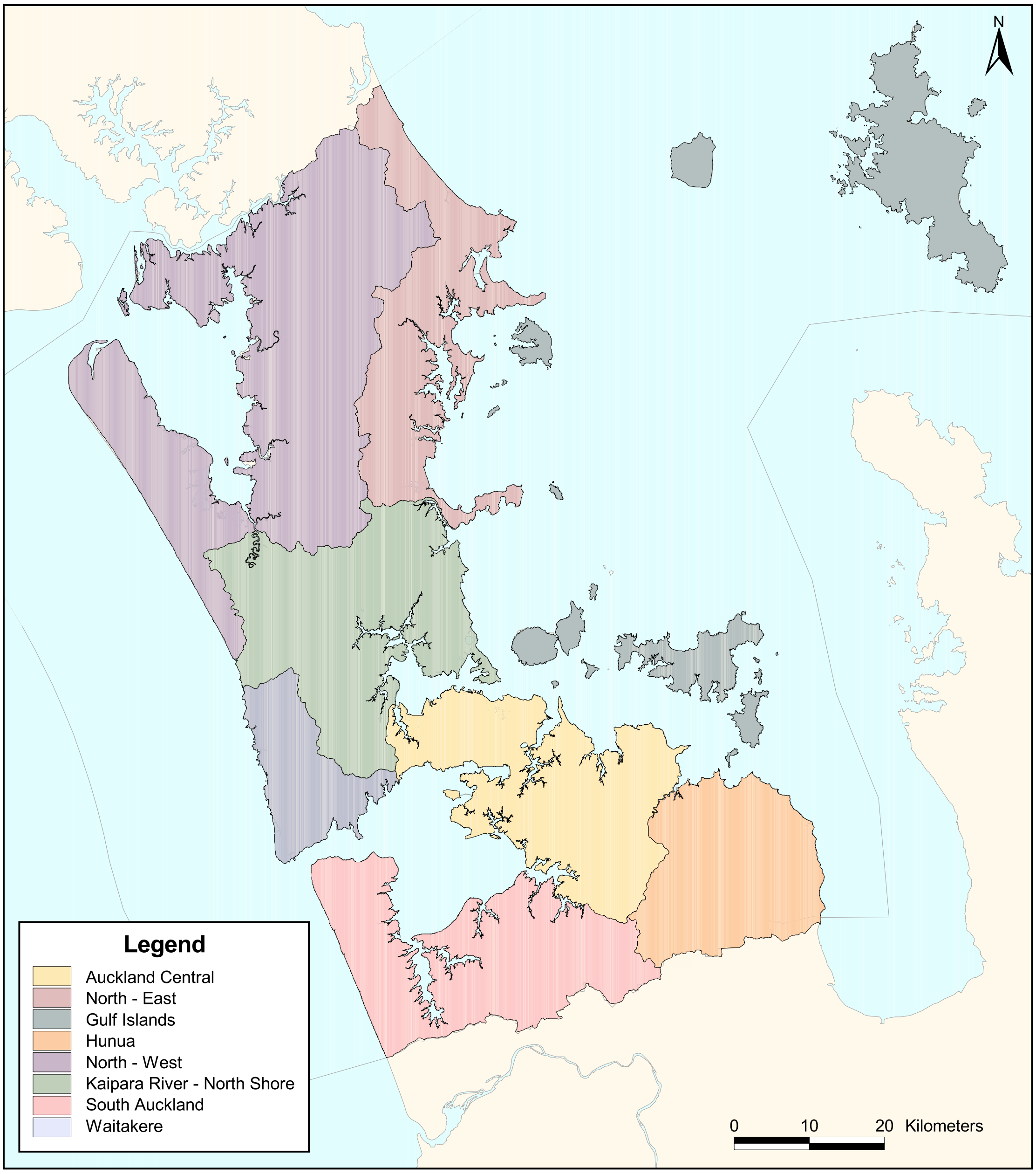

Figure 1.1: Location of water resource reporting areas.

2 Auckland's Water Resources

2.1 Introduction

The Auckland Region's fresh and geothermal water resources are fed principally by rainfall. Rain falling in the region feeds streams, rivers, lakes and wetlands (surface water) and infiltrates to recharge aquifers (groundwater). Surface water may also recharge groundwater and vice versa. During dry times of the year groundwater may be the only source of water to streams and may sustain flows for long dry periods. Runoff and infiltration rates are strongly linked with soils, geology and topography. Low permeability soils and rocks tend to result in a higher proportion of runoff than high permeability rocks and soils. Steep slopes also tend to increase runoff.

Streams and rivers in Auckland are typically soft bottomed due to the underlying clay material on which they are formed. Approximately 90% of the streams in the region are either first or second order streams (the fingertip tributaries at the head of the catchments), a considerably higher proportion than most other regions that have large gravel rivers or deeply incised rivers with considerably higher discharges. First order streams are more sensitive to abstraction and reduced runoff thereby requiring close monitoring to ensure adequate flow is retained to support their life giving capacity.

Most groundwater in the region is abstracted from aquifers in the Franklin and Bombay basalts, Waitemata sandstone, Auckland Isthmus basalts, Pleistocene sands and Kaawa shell beds. The region also has two well-developed geothermal fields, at Waiwera and Parakai. At a national scale Auckland aquifers are comparatively low yielding, save for the highly fractured basalt aquifers. Despite this groundwater resources are well developed and adequate supplies are gained for commercial enterprises. A simplified geology map for the Auckland Region is shown in figure 2.1. This illustrates the wide distribution of the Waitemata Group across the region and the location and extent of volcanic rocks. While there are large areas of Pleistocene deposits in the region it should be noted that in many areas these deposits (mainly sands) are too thin to provide reasonable water supplies. Principally the Waitemata Group or volcanics underlie sands.

The dependence of Auckland's groundwater and water resource on rainfall is discussed. While geology and soils impact hydrology, neither is discussed in detail here. However, geological units relevant to groundwater resources are outlined in the hydrogeology section of this chapter.

2.2 Climate

Auckland's climate is subtropical. Auckland enjoys mild winters and warm, if somewhat humid summers (Brook, 1979). The surrounding sea has a significant affect upon smaller scale weather systems in the region. In each of the prevailing wind directions, south-west and north-east, air passes over an extensive sea path before reaching a narrow strip of land, and thus air temperatures remain comparatively low in summer and mild in winter under windy conditions. Converging sea breezes in summer may cause heavy showers which remain very local, but that often alleviate the dry conditions associated with anticyclones. The Auckland Region is partly protected from climatic extremes because of its physical situation (Hessell, 1981).

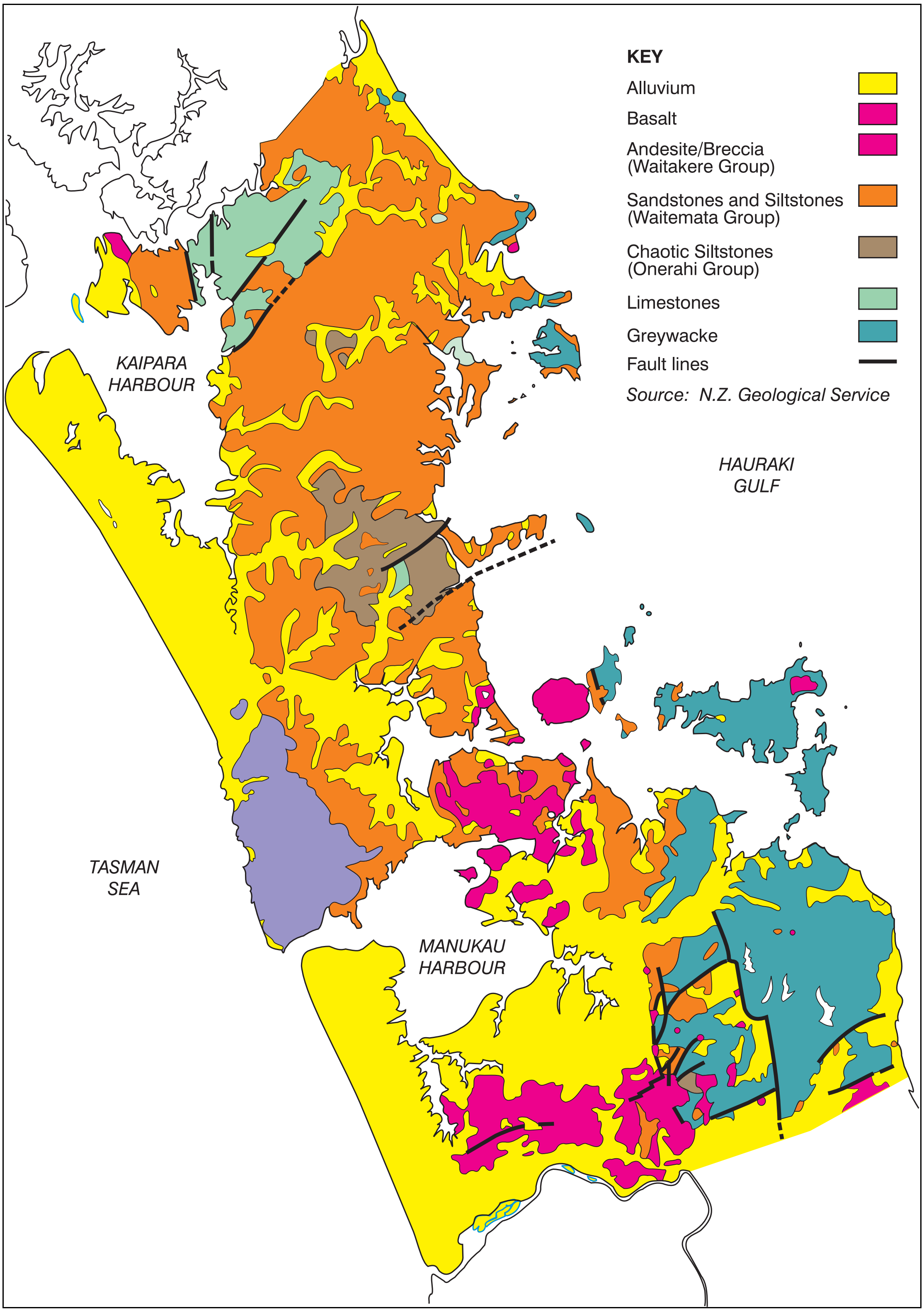

Figure 2.1: Simplified geology map of the Auckland Region (after NZ Geological Survey).

Approximately 325 rainfall monitoring sites are operational, or once operated within the Auckland Region. Long-term sites (greater than 20 years record) are generally operated, or were operated by either the New Zealand Meteorological Service (NZMS) or the National Institute for Water and Atmospheric Research (NIWA). Current ARC rainfall monitoring sites are listed in Appendix 1. The majority of these sites have less than ten years record.

Rainfall across the Auckland Region is predominantly governed by topography and air mass characteristics. Elevated areas of the Waitakere and Hunua Ranges, Hoteo Catchment and One Tree Hill, all receive high annual rainfall compared with other parts of the region. Areas of low rainfall occur over, and in close proximity to, the Kaipara and Manukau Harbours, and over the Hauraki Gulf. A low rainfall belt also extends across the Tamaki/Mt. Wellington area. Topographically influenced rainfall is evident from rainfall records. Annual average rainfall of 2,030mm occurs in the Waitakere Ranges at 380m above mean sea level (amsl) while Tiritiri Matangi Island receives 950mm at 70m amsl. In the central Hunua Ranges, average annual rainfall is approximately 1,657mm at 360m amsl. A short distance away on the Kaiaua Coast at Orere, annual rainfall is 1,283mm, at 10m amsl. An annual rainfall map for the period spanning 1980 to 1997 is shown in figure 2.2.

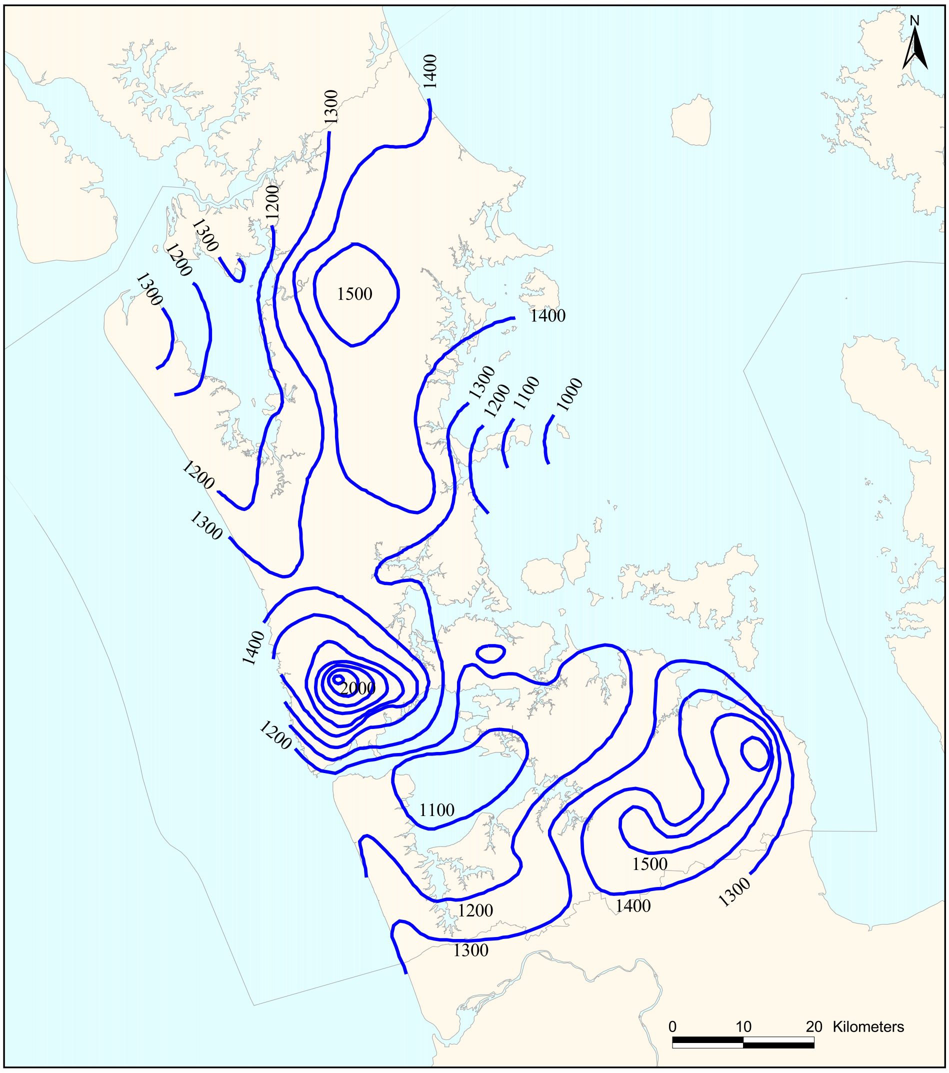

Figure 2.2: Mean annual rainfall isohyets (mm) (1980-1997) for the Auckland Region.

Like most of New Zealand, Auckland's rainfall is seasonal with more rainfall over winter and spring than summer and autumn. Figure 2.3 illustrates the seasonal pattern of rainfall at 2 sites, Pakuranga (740815)[1] and Puhinui (649820). Air temperature also ranges through the year. At Auckland International Airport mean monthly temperatures fall to a minimum of 10.7°C in July and climb to a maximum of 19.9°C in February. Mean annual temperatures fluctuate between 14.5°C and 16.5°C.

Evaporation fluctuates from season to season and year to year in response to factors such as wind, solar radiation and air temperature. Maximum open pan evaporation occurs during December with a daily average of 13.7mm decreasing to a minimum of 5.1mm during August.

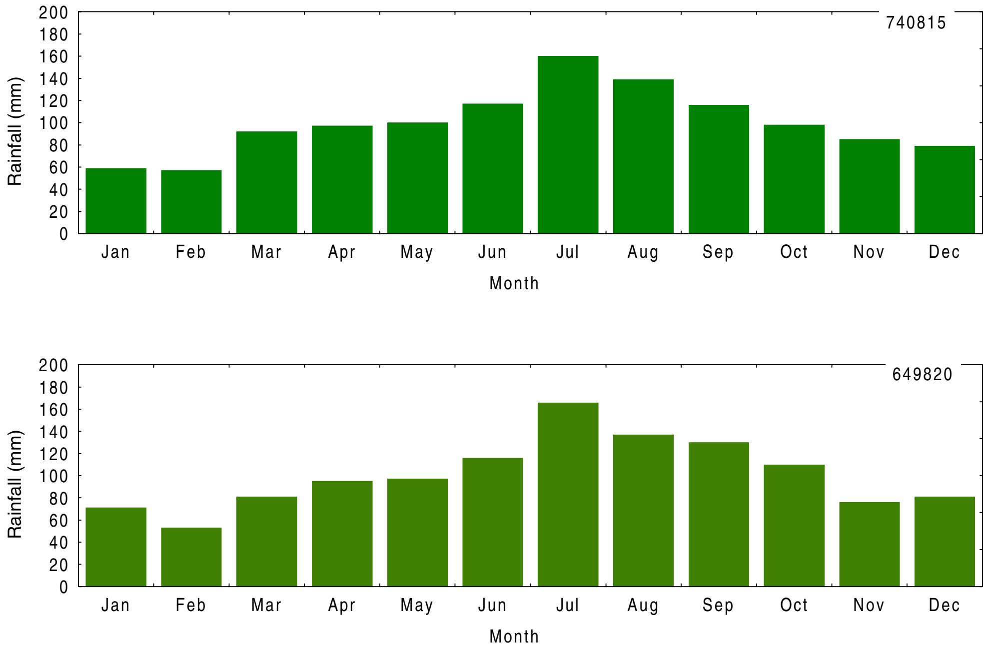

Figure 2.3: Mean monthly rainfall distribution at Puhinui (740815) and Pakuranga (649820) monitoring sites.

2.3 Surface Water

The ARC has a network of flow recorder sites that measure lake, river and stream levels at 15-minute intervals. A list of all ARC automatic flow recorder sites and site information is provided in Appendix 2. Water levels are converted to water flow using a 'rating curve' specific to that site. Approximately 40 sites are manually monitored over summer to supplement the automated network data. Statistical relationships are calculated between automated and manual sites so that flows can be extrapolated to remote locations within stream catchments. Typically this information is used to estimate flows during extreme low flow events of known frequency and duration. Low flow frequency analysis is commonly used. This analysis involves fitting a statistical distribution to a plot of annual low flows of a given duration (e.g. daily or weekly average flows[2]).

[1] ARC monitoring site numbers are given in brackets after site names
[2] An in-depth description of low flow frequency analysis is available from David Maidment's *Handbook of Hydrology* 1993, Chapter18.

Until recently the ARC assessed water available for allocation (water availability) using the one in five year one day duration low flow, or Q_5, as a key low flow. This flow was considered to have a recurrence interval of five years and duration of one day. Up to 70 percent of the Q_5 was allocated for out of stream water use. A list of Q_5 flows for automatic flow sites are presented in Appendix 3. Surface geology influences the specific discharge (measured in $l/s/km^2$) of catchments or sub-catchments above and between gauging sites. The surface geology of the Franklin lowlands comprises volcanic material in the Bombay, Pukekohe and Glenbrook to Patumahoe area, with Pleistocene alluvial sediments in the lower parts of most catchments. Alluvial sediments produce lower specific discharges than volcanic rock in the Auckland Region. Therefore specific discharges of upper catchments on basalt are expected to be higher than that from lower catchments on alluvial sediments.

Underlying geology also has a significant affect on baseflow recession. The hydrology of the South Auckland and Auckland Central hydrological areas is dominated by volcanic basalt geology, which rapidly release groundwater to surface water via springs and seepage zones. At the other extreme, catchments such as the Rangitopuni and Orewa reflect low permeability geology and the slow release of groundwater into streams.

Dams have the ability to significantly reduce peak stream discharges by storing large volumes of water. Dams create a physical barrier to the flow of water and sediment. There is growing concern that dams in the Auckland Region are having a detrimental impact upon stream hydrology, morphology and ecology. The ARC has records for close to 750 dams with some type of authorisation. However, there are estimated to be more than 5,000 dams in the region. Large numbers of dams are located within the Kaipara, Rangitopuni, and South Auckland catchments in localised areas where sufficient water is available for dam storage, such as downstream of springs and seepage zones.

The ARC has a well-established surface water quality monitoring programme. The programme includes numerous river, stream and lake sites and is reported on an annual basis (Wilcock & Kemp, 2001). Surface water quality is variable across the region. The primary influence on surface water quality is catchment land use, particularly land adjacent to stream and river banks and lake edges.

2.4 Groundwater

Aquifers in the Auckland Region are low yielding compared with other parts of New Zealand. However, they are an important source of water in many rural areas and for some industry within the municipal water supply area. Approximately 200 new, mostly water supply bores are drilled in the region each year.

Most groundwater is abstracted from sandstone, basalt, shell and sand aquifers (Crowcroft & Smaill, 2001). The region also has two small well-developed geothermal fields, at Waiwera and Parakai. The primary aquifer types that have been developed and used in the Auckland Region are discussed in the following sections. Local aquifer parameters, groundwater availability and management issues are discussed in more length in chapters 5-13 of this report. Groundwater availability is generally determined as a proportion of average annual aquifer recharge. The proportion is dependent on site-specific factors such as proximity to the coast and surface water-groundwater interaction.

Aquifer groundwater levels are measured in dedicated monitoring bores. Details of these groundwater-monitoring sites are provided in Appendix 4. Groundwater level monitoring data is used for long term aquifer monitoring or to meet specific management objectives. The data is also used for aquifer investigations.

2.4.1 *Waitemata Aquifers*

The Waitemata Group is comprised of flysch sequences (alternating sandstone and mudstone), conglomerate and grit. Apart from a few locations, such as the Hunua Ranges, some Hauraki Gulf Islands and areas of Onerahi rocks in the north of the Auckland Region the Waitemata Group forms the local basement. The Waitemata Aquifer is variable across the Auckland Region, particularly in the thickness of sandstone and mudstone beds and the amount of jointing and fracturing. Total thickness varies from several metres to greater than 1,000m and most groundwater movement is through fractured zones. Bores are generally drilled to depths of 200-400m and cased to 100-200m depth. Bore yields range from a few cubic metres per day to over 1,000 m^3/day.

The chemical composition of groundwater in the Waitemata Aquifer can be broadly classified into two types based on total hardness/total alkalinity ratio (TH/TA), pH, silica and total iron concentrations. Shallow groundwaters (<200m depth) commonly have a high TH/TA ratio, are hard calcium carbonate waters with near neutral pH, high total iron (>1.0 g/m^3), and silica concentrations greater than 40 g/m^3. Deeper groundwaters commonly have a low TH/TA ratio, are soft sodium bicarbonate waters with pH >8.5, have low total iron (<0.2 g/m^3) and silica concentrations (<40 g/m^3). Groundwater from some deep Waitemata Aquifer bores may contain boron at concentrations above the New Zealand drinking water standard (DWSNZ) and above tolerance levels for some crops.

Groundwater levels in Waitemata Aquifers respond to seasonal fluctuations in rainfall and, to a lesser extent, seasonal pumping. The water level plot illustrated in figure 2.4 is from an ARC groundwater monitoring bore at Quintal Road (6437005), Omaha. Water levels fluctuate seasonally with highest water levels around October and lowest water levels around May. This site was automatically monitored until 1998 but is now manually monitored monthly. This accounts for the less spiky water level record since 1998. Most aquifer recharge occurs during autumn and winter resulting in peak groundwater levels in September-October.

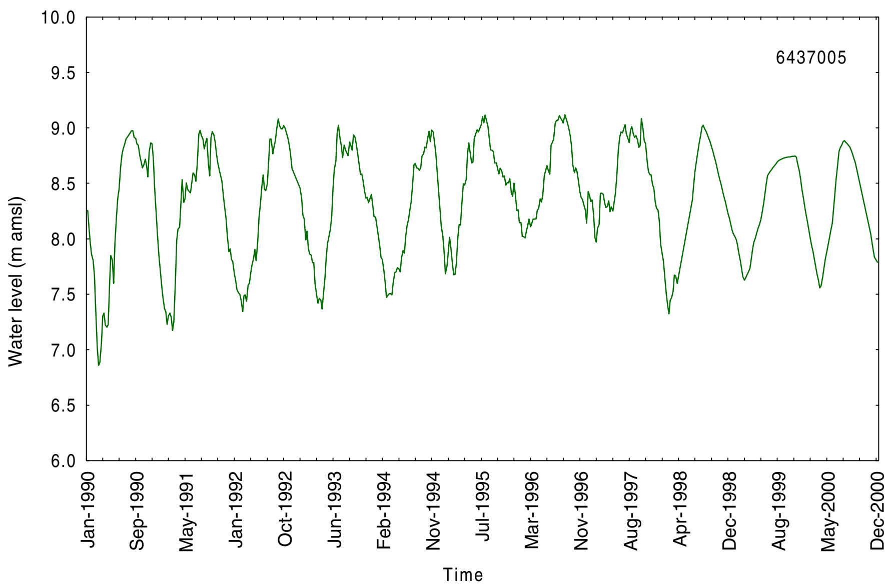

Figure 2.4: Quintal Road (6437005) monitoring bore groundwater level record, 1990-2000.

The “Onerahi Chaos” is an informal term used for dominantly limestones and mudstones that are part of the Northland Allocthon (Isaac et al., 1994). These rocks are older than the Waitemata Group but, due to tectonic thrusting, are interbedded with, and in places overlies, Waitemata Group sediments. Within the Auckland Region they occur mainly in the Orewa-Silverdale area and are not considered aquifers.

2.4.2 Basaltic Volcanics

There are two basaltic volcanic fields in the Auckland Region: Auckland Volcanic Field and South Auckland Volcanic Field. Both fields are important sources of groundwater, one for municipal and industrial supply, and the other for municipal and irrigation supply. Water supply bores are typically drilled to depths of 20-150m and intercept fractured basalt and/or scoria. Groundwater movement is dominantly fracture flow and aquifer properties vary considerably over short distances, both horizontally and vertically.

Volcanism in the Auckland Volcanic field started about 150,000 years ago (Homer et al., 2000). While it is relatively easy to recognise the remaining volcanic cones (e.g. Mt Eden and One Tree Hill), other features such as lava flows and tuff rings are less visible, being obscured by urban development. Pyroclastic material from volcanic centres has coalesced, resulting in hydraulic connection between basalt flows.

The 0.51-1.59 million year old year old South Auckland Volcanic Field extends from Papakura to Pukekawa and west across the Manukau lowlands to Waiuku. The field is predominantly comprised of lava flows, scoria cones and tuff rings formed from at least 97 centres (Briggs et al. 1994).

The basalt aquifers are recharged through rainfall recharge and groundwater levels respond quickly to rainfall events. The urban aquifers are also recharged through stormwater soakage, which further increases the magnitude of recharge “spikes” in groundwater hydrographs during rainfall events. Figure 2.5 illustrates the rapid groundwater recharge and recession in an ARC groundwater monitoring bore in Onehunga.

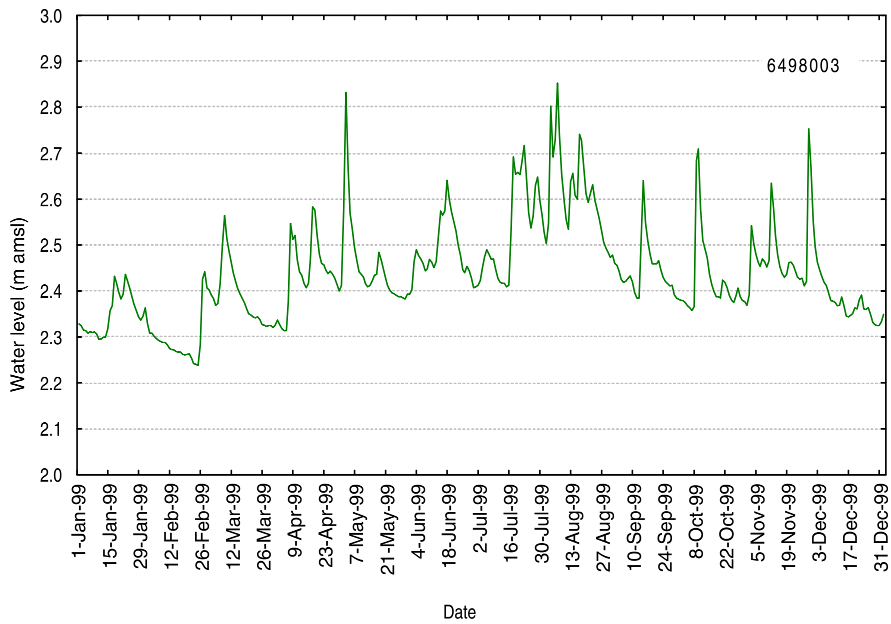

Figure 2.5: 1999 groundwater levels in Angle Street bore (6498003), Onehunga.

Groundwater in the basalt aquifers is generally low in dissolved constituents, as shown by conductivities below 30 mS/m with low total alkalinity and silica concentrations, and slightly acidic pH (~6.5). They contain some of the highest quality groundwater in the region. Contamination from urban stormwater may show as elevated concentrations of sulphate, potassium, bicarbonate and total hardness. Elevated nitrate, in the order of 2-4 g/m^3, is a result of leaky sewers, stormwater input or landuse practices e.g. horticultural or pastoral.

2.4.3 Kaihu Group

The Kaihu Group rests unconformably on the Waitemata Group. The older sediments are comprised of pumiceous shell and sandy shell beds, sands, and fine to medium sandstone. These sediments, Kaawa Formation, comprise a good aquifer, particularly the shell and sandy shell beds. Kaawa shellbed is a locally used name that refers to the shelly beds (0.5-6m thick) within the Kaawa Formation (ARWB, 1989). The younger and shallower deposits of the Kaihu Group, comprised of dune bedded sands and clayey sands, are generally poor aquifers.

The Kaawa Aquifer is defined here as the Kaawa Formation; specifically the water bearing zones, which are the shell beds, shelly sands and sands. The Kaawa Aquifer is an important aquifer in the Manukau lowlands, from Waiuku and Glenbrook and east towards Pukekohe and Paerata. Corresponding shell beds have been encountered in the Auckland Airport area north to the Mangere lagoon and in the Middlemore area.

Groundwater chemistry of the Kaawa Aquifer is typically characterised by a moderate pH of 8 due to moderate levels of carbon dioxide (4g/m^3), total alkalinity (130 g/m^3) and silica (50 g/m^3) and low total iron (0.5 g/m^3). The water composition is not unique to the aquifer but typical of other deep sedimentary and volcanic aquifers elsewhere in the region (ARWB, 1989).

2.4.4 Geothermal Groundwater

Auckland's geothermal waters are low temperature fracture related systems. The best known and developed resources are at Parakai, near Helensville and Waiwera, north of Orewa. Other geothermal waters have been encountered via drilling at Whitford and East Tamaki and evidenced as springs on Great Barrier Island.

Both Waiwera and Parakai geothermal waters rise from faults in greywacke rocks to be stored in Waitemata Group rocks. Maximum bore production temperatures at the centre of the geothermal fields are 53°C at Waiwera and 65°C at Parakai. Groundwater pressures in the Waiwera field stand below the water table in the overlying cold sand aquifer (Crane, 1999). At Parakai the gradients are reversed, with geothermal pressures greater than the water table aquifer since 1985.

Geothermal water is characterised by concentrations of boron, lithium and fluoride significantly greater than for non-geothermal fresh groundwater. The geothermal constituents are derived from reaction of rock-forming minerals with groundwater at depths where temperatures are sufficient to bring these elements into solution (ARWB, 1986). Parakai and Waiwera geothermal groundwater also have naturally high sodium and chloride while East Tamaki and Whitford geothermal waters more closely resemble non-geothermal water.

2.4.5 Quaternary sediments

Low-lying parts of the Auckland Region are mantled with generally less than 60m of Quaternary sediments. These typically sandy alluvial sediments occur throughout the low-lying areas of the Manukau lowlands and along many valley floors, and have been an important source of small water supply for farm holdings and rural domestic supply. Water bores drilled into these sediments are comparatively low yielding and of poor quality due to elevated iron concentrations. The bores are also prone to rural runoff, septic tank and saltwater contamination.

2.4.6 Greywacke

Greywacke, which comprises much of the south-eastern part of the region, including the Hunua Ranges and some Hauraki Gulf Islands, is a hard grey sandstone that is a comparatively poor aquifer. This is because the sedimentary rock is sufficiently fine-grained and indurated that water movement through the rock matrix is very low. Most groundwater movement in greywacke rocks is through fractured zones.

2.5 Regional Groundwater Quality

The Auckland Regional Council undertakes a regional baseline-monitoring program for groundwater quality. Twenty-three sites, representative of the aquifers across the region, are sampled at least annually. Groundwater across the region is of variable but generally good quality.

The most significant groundwater contamination issues in the Auckland Region at present are nitrate and from stormwater. Elevated nitrate concentrations occur in shallow volcanic aquifers in South Auckland and on the Auckland Isthmus. Elevated nitrate in South Auckland groundwater is from soil leaching as a result of land use practices. On the Auckland Isthmus, nitrate in groundwater is sourced from leakage from an ageing sewage reticulation system and stormwater (Viljevac & Smaill, 1999).

On the Auckland Isthmus stormwater is disposed of into basalt aquifers. Stormwater includes not only water but particulate matter in suspension and chemical pollutants. Groundwater quality has been compromised in some parts of the isthmus, in particular the Penrose industrial area (Rosen et al., 2000). Stormwater from road run-off is thought to contribute the greatest load of contaminants to the aquifer. The present stormwater management practice is for continued ground soakage, but with pre-treatment of stormwater. This should see a reduction in the volume of sediment, usually containing bound pollutants, entering aquifers.

The Auckland Region has a considerable length of coastline and many coastal aquifers. High water demand in coastal settlements increases the potential for saltwater contamination of these coastal aquifers.

2.6 References

ARWB, 1986: Investigation of factors controlling boron concentrations in groundwater in the Auckland Region TP. 34. ARWB.

ARWB, 1989: A study of the Kaawa formation aquifer system in the Manukau Lowlands 1989. TP. 85. ARWB.

Balance, P.F. 1976: Stratigraphy and Bibliography of the Waitemata Group of Auckland. New Zealand Journal of Geology and Geophysics. Vol. 19. Pp. 897-932.

Briggs, R.M., Okada, T, Itaya, T., Shibuya, H., Smith, I.E.M., 1994: K-Ar ages, paleomagnetism, and geochemistry of the South Auckland volcanic field, North Island, New Zealand. New Zealand Journal of Geology and Geophysics, Vol. 37: 143-153.

Brook, P.J.. 1979: Natural history of Auckland : an introduction. Auckland Institute & Museum.

Crane, S. G. 1999: He Kaupapa Tiaki i nga Wai Puia : draft Waiwera geothermal groundwater water resource assessment report. Auckland Regional Council.

Crowcroft, G. & Smaill, A., 2001: Auckland. *In* Groundwaters of New Zealand, M.R. Rosen & P.A. White (*eds*.) New Zealand Hydrological Society Inc., Wellington. P303-313.

Hessell, J.W.D. 1981: The climate and weather of the Auckland Region. New Zealand Meteorological Service Miscellaneous Publication 115 (20) Wellington, New Zealand.

Homer, L., Moore, P. & Kermode, L. 2000: Lava and Strata. A guide to the volcanoes and rock formations of the Auckland Region. Institute of Geological and Nuclear Science, Wellington, New Zealand.

Isaac, M J., Herzer, R.H., Brook, F.J., Hayward, B.W., 1994: Cretaceous and Cenozoic sedimentary basins of Northland, New Zealand Institute of Geological and Nuclear Sciences, Lower Hutt.

Maidment, D. 1993: Handbook of Hydrology. McGraw Hill, New York.

Rosen, M.R., Hong, Y.S., Sheppard, D., Roberts, K., Viljevac, Z., Smaill, A., & Reeves, R. 2000: Final report for the IAEA Urban aquifers RCA: Determining the Effects of storm water infiltration on groundwater quality in an urban fractured basalt aquifer, Auckland, New Zealand. Institute of Geological & Nuclear Sciences Ltd. science report 2000/20. .

Viljevac, Z.V., Smaill, A.S., 1999: The impact of stormwater disposal on groundwater resources, an example of shallow volcanic aquifers in Auckland, New Zealand. Proceedings of the Comprehensive stormwater and aquatic ecosystem management conference, Vol. 2.

Wilcock, R.J. , Kemp, C.L.S., 2001: Baseline water quality survey of the Auckland Region. TP 150. Auckland Regional Council.

3 Statutory Framework for Water Management

3.1 Introduction

The Resource Management Act 1991 sets out, amongst other matters, the functions of regional and territorial authorities, documents they are required to prepare to assist in carrying out those functions, and the need for monitoring how well they are carrying out the functions. These matters provide the statutory context for reporting on the state of Auckland's natural resources.

3.2 Resource Management Act

This Statement focuses specifically on the ARC water allocation function set out under section 30(1)(e) of the RMA, namely

> *"the control of the taking, use, damming, diversion of water, and the control of the quantity, level, and flow of water in any water body, including –*
>
> *(i) the setting of any maximum or minimum levels or flows of water:*
> *(ii) the control of the range, or rate of change, of levels or flows of water:*
> *(iii) the control of the taking or use of geothermal energy:"*

and section 30(1)(c), namely,

> *"the control of the use of land for the purpose of the maintenance of the quantity of water in water bodies ….." (excluding coastal).*

Section 9 governing the use of land, which is relevant to drilling activities and Section 14 relating to taking and use of water provide more detail on water quantity/allocation management.

3.2.1 Auckland Regional Policy Statement (ARPS)

Regional Councils are required to prepare a Regional Policy Statement as per section 60 of the RMA. Chapter 9 (Water Conservation and Allocation) of the ARPS

(i) identifies water allocation issues and sets out objectives, policies, and methods to be used in addressing those issues;
(ii) specifies environmental results that may be anticipated from implementation of the policies and methods and the monitoring that is necessary to evaluate the suitability and effectiveness of the policies and methods.

Appendix 5 lists the issues, objectives and policies of Chapter 9

One of the major water management methods described in the ARPS is the use of WRARs. These non-statutory documents have been prepared for specific surface or groundwater management areas and have provided the basis for and guidance on the day-to-day management of those areas. WRARs:

(i) describe the area and water resource to which the assessment report applies;
(ii) identify issues that affect the use, development or protection of the natural and physical resources;
(iii) provide information on water availability, including minimum water levels or flow regimes;
(iv) evaluate strategies for allocation priorities, economic instruments, and assessment of efficient use;
(v) propose ongoing monitoring or investigation of the resource;
(vi) specify a review or expiry date of the report.

3.2.2 Auckland Transitional Regional Plan 1991 (ATRP)

The Auckland Transitional Regional Plan, 1991, contains General Authorisations (now referred to as Permitted Activities) and Discretionary Activities that were developed under the Water and Soil Conservation Act 1967 and other legislation prior to the RMA. Minor water takes, small dams, minor diversions of groundwater, drilling, geothermal water management and efficient use of water are covered by this plan. These provisions will be eventually superceded by the Proposed Auckland Regional Plan: Air Land and Water

3.2.3 Environmental Reporting Requirements

Section 35(2)(a) of the RMA requires local authorities to monitor

> "*the state of the whole or any part of the environment of its region …… to the extent that is appropriate to enable the local authority to effectively carry out its functions under this* (RMA) *Act*".

The ARC has a well-established water resource monitoring programme and resource consent compliance monitoring strategy. This information assists in managing the region's water resources. Environmental reporting of water resource information has been integrated with State of the environment reporting for the whole region or through catchment specific reports. This Statement is the first document to report monitoring and resource information for the whole region.

4 Water Management Approach

4.1 Introduction

A number of Acts of parliament governing water resources in NZ have influenced water management in Auckland. The Soil Conservation & Rivers Control Act, 1941, established Catchment Boards, who administered that Act at a District level. The Act focused on soil erosion, hydro-electric power and flooding. It was not until the Water and Soil Conservation Act, 1967 was enacted that water allocation issues were addressed (Roche, 1994).

In Auckland the Ministry of Works and Development was initially responsible for the implementation of the Water and Soil Conservation Act. The Auckland Regional Water Board, a division of the Auckland Regional Authority (ARA), took over this role in the 1970's. Water rights were issued under the Act and management area plans developed in high demand areas. The format and content of the plans is highly variable, some cover technical information only and others include technical information and management guidance. Many reports were revised and updated as more monitoring data was collected.

The enactment of the Resource Management Act in 1991 and dissolution of the Auckland Regional Water Board (now subsumed into the Auckland Regional Council) heralded a different approach to water management. The RMA's focus on the development of Regional Policy Statements and Regional Plans shifted the focus from catchment or aquifer management plans to regional resource planning. The ARPS and the PARP: ALW state the issues, objectives, policies and anticipated outcomes for water management in the Auckland Region.

The ARC uses a variety of methods for water management in the region. These include water allocation through the resource consent process, a water conservation strategy, water education strategy, resource consent compliance monitoring and Water Resource Assessment Reports.

4.2 Water & Soil Conservation Act 1967

One of the most significant changes brought about by the Water and Soil Conservation Act was the replacement of riparian rights to water use with a system whereby the Crown vested in itself the rights to use natural water (Roche, 1994). This provided a means by which the Crown could grant the taking of water for specific purposes. The administration of the Act was vested in the new central agencies and regional boards.

The Auckland Regional Water Board implemented the Water & Soil Conservation Act 1967 in the Auckland Region. This included processing water right applications for stream and groundwater takes. Water rights were issued with conditions that controlled the rate and/or volume of abstraction, and enabled other conditions to be imposed if required. Water metering was required of most large abstractions toward the end of the 1980's.

Established existing water users were required to provide notice of their abstractions under the provisions of the Act. However the notification forms requested hourly pumping rates and annual quantities. While this is generally sufficient for groundwater management it meant that it was difficult to provide for takes from stream flow. Often quantities notified were estimates and well in excess of actual use and those existing authorities had no expiry date. Little water use information was available to allow realistic daily allocations to be estimated for existing authorities to take from streams. At times a daily quantity equivalent to the then ARA irrigation guidelines of 35 m^3/ha/day for market garden irrigation was applied where irrigation areas were unknown.

In 1988 the ARA introduced annual consent administration charges based on the authorised daily quantity. Charges provided sufficient incentive for some existing authority holders to reduce their quantity to artificially low levels. Since use was difficult to monitor the compliance with allocations could not be checked.

In 1989, as part of local government reform, the functions of water boards were incorporated into Regional Councils (Roche, 1994). The Auckland Regional Water Board was retained until 1991 when the Resource Management Act was implemented. Existing authorities were generally given a ten-year term (expiry October 2001) under the RMA.

4.3 Water management approach 1991-2001

Over the past 10 years the management of Auckland's water resources has been guided by objectives and policies in the ARPS and by the ATRP. The policies have been largely implemented through the resource consent process, although an education strategy and a water conservation strategy are additional methods.

WRAR's (formerly management plans) contain resource information and guidance for processing of resource consents but are non-statutory and therefore do not 'regulate' water management. This can only be done through resource consents or a regional plan. WRAR's and management plans have been developed for areas of high water demand and are generally catchment of aquifer specific. For management purposes the entire Auckland Region is split into 31 groundwater management areas and 24 surface water management areas. Aquifer or geographical area defines groundwater management boundaries and surface water management areas are defined by catchment boundaries. This method helps to ensure consistent water management in the region and assists in monitoring, investigation programmes and consent reviews and renewals.

4.3.1 Surface Water Management

Surface water management has been based on allocating a total quantity of water from a stream equivalent to some proportion of the Q_5 low flow. This approach was developed under the Water and Soil Act and was not changed when the RMA came into effect. WRAR's have been produced for many catchments with high surface water demand and have typically suggested retaining 30% of Q_5 low flow for that stream.

Recent investigations have shown that allowing abstraction at these low flows is likely to cause adverse environmental effects. It is likely that taking any water from Auckland streams has the potential for adverse effects in mid-summer. Changed flow regimes can affect the functioning of aquatic ecosystems. A reduction in low flows, or an increase in their duration, has the potential to result in reduced dissolved oxygen levels, elevated temperatures and reduced habitat availability. The abstraction of water can prolong the period over which streams would normally be subject to low flows or, in the case of ephemeral streams, cease flowing.

WRAR's for surface water have also provided some guidance on the damming of the water. This has included construction, low flow bypasses, fish passage and spillways. Auckland has a considerable number of dams on perennial rivers and streams, and these can have adverse environmental effects, particularly cumulative effects. Consents are required for dams under the RMA. Regulation of dams will also be governed by the Auckland Regional Plan: Air, Land and Water when it becomes operative.

The ARC has also produced Dam Safety Guidelines (TP109, June 2001), which gives guidance to dam owners, consultants and ARC officers on the design, construction, monitoring and maintenance of dams.

4.3.2 Groundwater Management

Most areas of intensive groundwater use have had resource investigations undertaken and WRAR's written to give guidance for water allocation. Most WRAR's present groundwater availability estimates including the methods used to determine availability, and make recommendations about how the resource should be allocated.

The ARC regulates bore drilling in order to protect groundwater resources from degradation. Bores provide an access to groundwater resources but also create potential pathways for contamination from the surface or from other geological formations. The drilling of a bore is a landuse activity under Section 9 of the RMA and not a water abstraction activity. ARC recognises that the two activities are linked and therefore bore drilling is managed together with water management. Many bores drilled in the region are drilled for domestic supply and generally do not need a resource consent to take groundwater. The ARC currently has records for over 7,000 bores in the Auckland Region, although many other old bores exist that are not on ARC databases.

Groundwater abstraction is managed to ensure that the resource is not depleted (or mined), saline intrusion is avoided and aquifer discharges to wetlands, springs and streams are not adversely impacted. The proximity of bores and their respective abstraction volumes is also a consideration as aquifers can undergo localised mining of the resource resulting in localised adverse effects.

4.3.3 Water Efficiency & Conservation

The ARC is preparing a water conservation strategy with aims to develop major elements of the strategy in consultation with key stakeholders. The ARC has several water conservation initiatives under way, as do several other organisations in the Auckland Region. Bringing these programmes together in a coherent way will provide a framework for a more co-ordinated and cost-effective approach. The ARC is the Region's overall water manager, but does not directly manage all end users serviced by utility suppliers. As well as these suppliers, other stakeholders have an interest in water conservation.

The model proposed for this strategy is a collaborative one of:

- consultation with key stakeholders;
- review of iwi management plan policies on water management;
- a suggested dual approach that comprises a high level strategy followed up by practical action plans;
- developing criteria for work priorities and processes for long term implementation of this strategy by way of a consensus process with stakeholders; and,
- ongoing consultation and peer review.

Because a water conservation strategy for the Auckland Region would be a non-statutory document that aims to support and encourage the efforts of a range of `players', the active involvement of key stakeholders is vital.

4.3.4 Water Education

To heighten community awareness of environmental issues, an ARC water education strategy was developed in 1997. Its objective is sustainable management of the Region's water resources through increased community and client awareness of their responsibilities as resource users.

The strategy has identified and prioritised the key client groups, both internal and external to the ARC, to be targeted by initiatives designed to achieve this broad objective. As the main client group is resource consent holders, a key outcome is an improved level of compliance with consent conditions. Programmes have been identified which aim to provide resource users with information to facilitate responsible water use. This supports other ARC projects such as Consent Compliance Monitoring, Water Conservation and Environmental Reporting, as well as other initiatives like Water User and Care Groups.

The strategy recognises the value of different mechanisms to deliver information, including public meetings, fact sheets, reports, newsletters, and electronic media. Ensuring desired outcomes are achieved requires feedback from members of the community on what information they need and how they wish to receive it, as well as on the overall effectiveness of the Strategy.

Feedback received from resource consent holders in the Water Resources Customer Survey in autumn 2000, indicates they are prepared to take some responsibility in the management of the resources they use. There is, however, a lack of understanding of what some these responsibilities are, and what the ARC does with the information it collects. Water users would like to receive more information on the state of resources in their area, and they felt this would be best achieved through regular newsletters, reports or email and the Internet.

Overall the Strategy is considered to be effective. With limited time and resources available for Strategy initiatives, however, the focus must remain on consent holders information needs, and the environmental effects of activities such as building dams.

4.3.5 Water Resource Consent Compliance Monitoring Plan

The Water Resource Compliance Monitoring Plan gives strategic direction for water resource compliance monitoring (Allcock, 1999). Consent compliance issues and strategies to overcome them are identified. Monitoring is incorporated into water resource management for four main purposes:

1. Statutory requirements (under section 35 (2) of the RMA)
2. Water resource planning and investigations
3. Evaluation of regional objectives and policies
4. Community expectations

The plan outlines a method for grouping consents that assists in prioritising compliance monitoring of individual consents. Most resource consents to take water issued since 1994 have a condition of consent requiring that a water meter is fitted and read at regular intervals. In general groundwater and dam users are required to read their water meters weekly, while stream water users are required to read their meters daily. Water meter return forms are returned to the ARC quarterly basis. Meter readings, and the calculated use from those readings are used for the following purposes:

- ensuring compliance with consent conditions.
- consent reviews and renewals
- input to WRAR preparation and reviews
- water resource projects
- determining areas of increasing water demand and future investigation needs.

The status of consent compliance monitoring at 31 May 2001 indicated that 70% of consent holders required to return water meter returns were submitting them promptly. Approximately 12% of consent holders were exceeding their daily and/or annual allocations.

In the Auckland Region there are many resource consent allocations that are for a small proportion of the resource water availability. A review of the water resource allocation compliance strategy in 2001 indicated a need to prioritise compliance monitoring to fit a smaller monitoring budget than previously provided. Consent compliance monitoring now focuses on the 20% of allocations that are for large abstractions or in sensitive resources, although randomly audits the remaining 80% of consents. Enforcement action is a priority and both abatement notices and environmental infringement notices are issued to non-complying consent holders.

4.4 References

Allcock, N, 1999: Water Resources Compliance Monitoring Plan (unpublished internal report). Auckland Regional Council.

ARC, 2000: Dam safety: guidelines for construction, maintenance and monitoring. ARC.

Roche, M: 1994: Land and Water. Water & Soil Conservation and Central Government in New Zealand 1941-1988. Department of Internal Affairs, Wellington, New Zealand.

5 North-West Water Resource Area

5.1 Introduction

The North-west area drains 1,330 km^2 of land to the Kaipara Harbour and Tasman Sea (fig 5.1). The area is comparatively hilly with Waitemata Group rocks rising to 400m in the North-east (NZGS, 1961). Most of the area from west of Warkworth through to Kaukapakapa ranges in elevation from 50-200m amsl, with some lower lying alluvial areas along valley floors. Low-lying areas are also found along the coast, particularly around Tapora and the inner Kaipara Harbour. The South Kaipara Peninsula is formed predominantly of consolidated Pleistocene sand dunes overlying Waitemata Group sediments. The peninsula is low-lying to rolling hills ranging in elevation from sea level to 160m amsl. A north-west to south-east ridge is aligned along the western side of the peninsula. This ridge causes westerly moisture laden air to rise resulting in higher rainfall in this area than across the Kaipara Harbour. Small streams drain the eastern flanks of the ridge to the Kaipara Harbour. The western side of the ridge has numerous small dune lakes fed by rainfall and shallow groundwater.

Most of the North-west area is rural farmland used for dairying and drystock. Forestry is also a key land use in the area, with large pine forests in the eastern elevated areas and along the western South Kaipara Peninsula. Horticultural activities are scattered across the area e.g. in Kaukapakapa and Kaipara South Head.

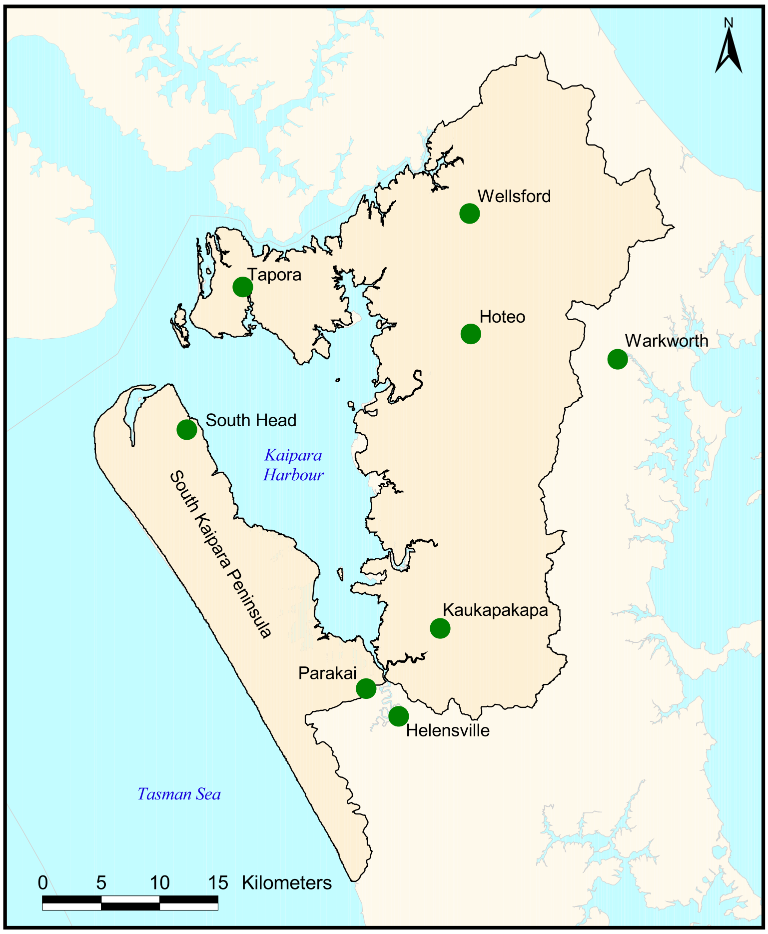

Figure 5.1: Location map for the North-west water resource reporting area.

Wellsford is the main community centre in the area, although there are numerous small communities throughout the North-west. The settlement of Parakai has developed around the geothermal groundwater resource, which is used to supply thermal pools complexes, accommodation complexes and private spa pools. Several quarries are operated within the North-west, providing building and roading aggregate for the Auckland Region. Water use in these activities is generally for dust suppression and/or quarry dewatering.

5.2 Rainfall

Within the North-west area are two elevated areas: the South Kaipara Peninsula to the west; and the eastern inland hills. The Kaipara Harbour lies between these two areas and is partially protected from westerly moisture-laden air masses by the Kaipara Peninsula. Mean annual rainfall ranges from approximately 1,100mm near the Harbour perimeter to 1,376mm near Kaipara South Head. Inland mean annual rainfall ranges between 1,300mm and 1,500mm (fig. 5.2).

The ARC operates two automatic rainfall sites. Oldfields (643510), in the Hoteo River Catchment, commissioned in 1978 and Kaipara South Head (644211) installed in March 1999. Three manual rainfall sites provide data that is used to assess spatial rainfall variability across the North-west. Manual rainfall sites include Busbridge (642611), Kaipara Hills (644410) and Kaipara Flats (644511) (fig. 5.2).

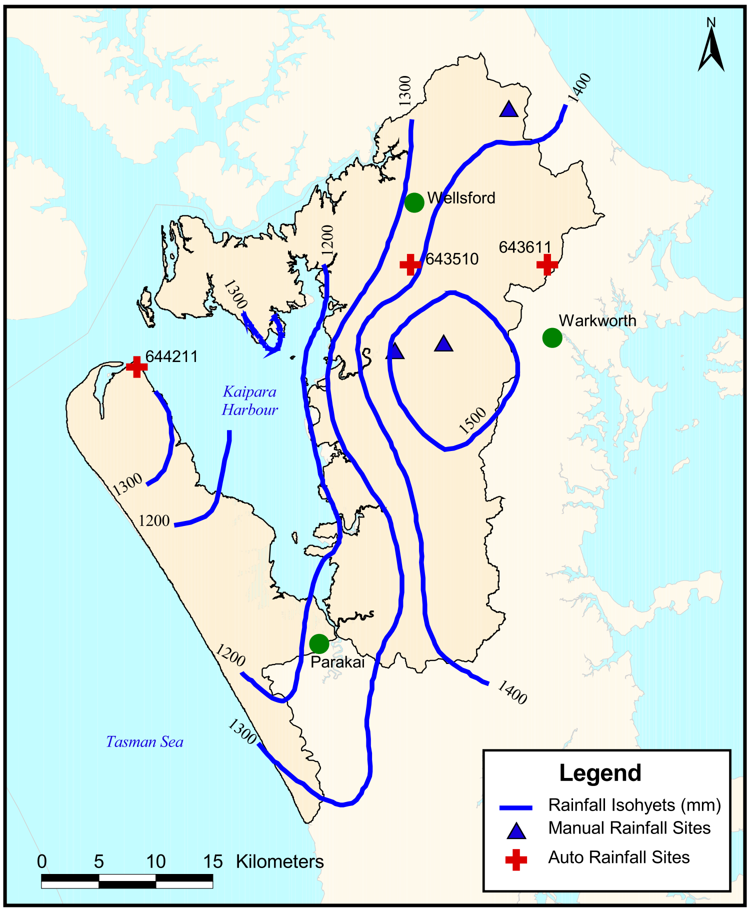

Figure 5.2: North-west area rainfall monitoring sites and mean annual rainfall isohyets.

Mean monthly rainfall for Oldfield's (643510), in the Hoteo River Catchment is shown in figure 5.3. The mean monthly totals are based on rainfall between 1979 and 1998 but excludes 1980, 1981, 1986, 1988, 1991 rainfall due to missing data. July is the wettest month with an average of 172mm and February is the driest month, with an average of 72.5mm. The mean wet day frequency is 179 days i.e. the number of days in the year that rainfall is received.

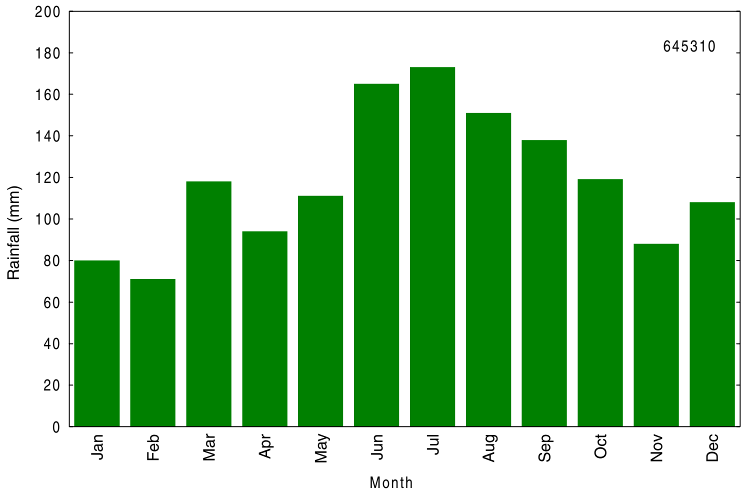

Figure 5.3: Mean monthly rainfall at Oldfields (643510).

5.3 Hydrology

Surface water catchments in the North-west area are variable in size, shape and orientation (fig. 5.4). Small catchments drain the South Kaipara Peninsula from west to east, whilst larger catchments lie on the eastern side of the Kaipara Harbour. The Hoteo River Catchment is the largest catchment in the Auckland Region with a catchment size of 405 km^2. Stream flows are proportionally higher than flows from catchments of lesser size such as Kaukapakapa, Araparera and the Makarau. These catchments lie along the eastern fringe of the Kaipara Harbour (fig. 5.4).

ARC has 3 automatic flow recorder sites in the North-west: Hoteo River at Gubbs (45703), Waiteitei at Sandersons (45705), and Kaukapakapa at Oak Hill (45407). Gubbs is located on the lower reach of the Hoteo River. This site commenced operation in 1977 and has provided data for water allocation, quality and flood flow investigations.

In the Kaukapakapa Catchment stream baseflows are inconsistent during summer months. Evidence of very low baseflows is seen when the flow duration curve for Oak Hill is compared against the Hoteo River at Gubbs (fig. 5.5). The curve is relatively steep, and tapers off at the higher percentile or low flow end. The Q_5 at Oak Hill is estimated at 3 l/s, or 0.04 l/s/km^2, which is considerably lower than flows at Gubbs of 244 l/s or 0.91 l/s/km^2 (see Appendix 3).

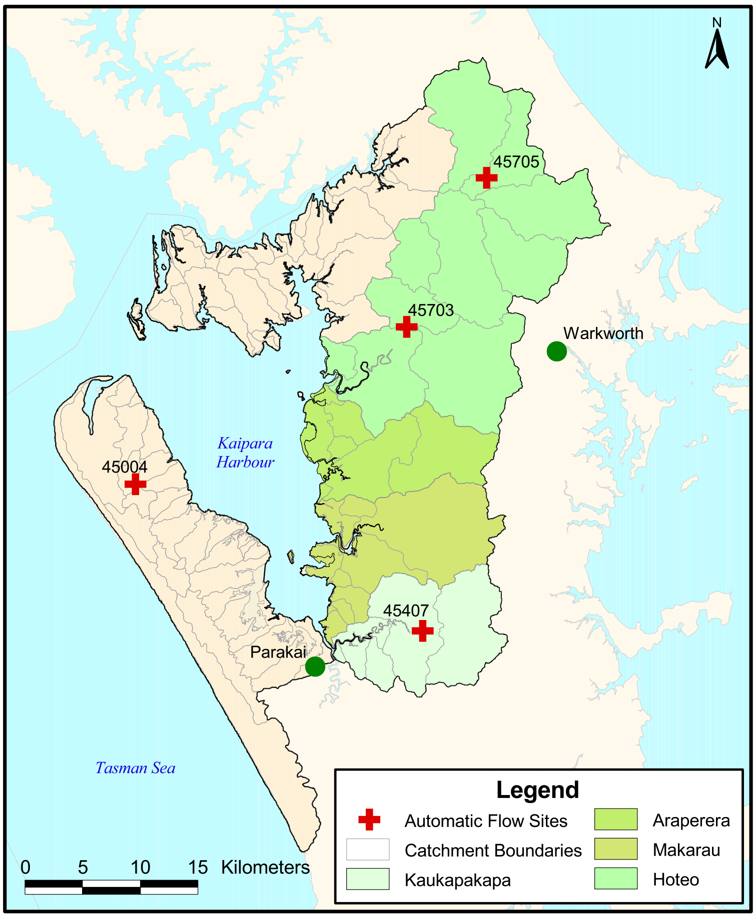

Figure 5.4: Surface water catchments and flow monitoring sites in the North-west area.

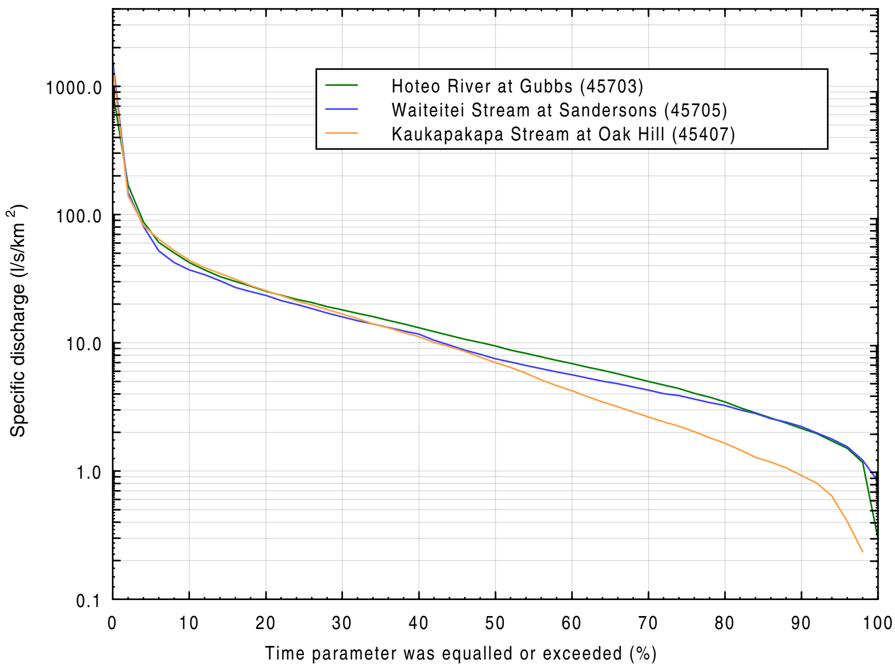

Figure 5.5: Flow duration curves for three North-west area surface water catchments.

A low flow frequency curve for Gubbs is shown in figure 5.6. This shows the Q_5 as approximately 75% of the mean annual low flow and approximately twice the Q_{10}. Minimum stream flows generally occur during February, and maximum flows occur during July. A typical seasonal flow pattern at the Gubbs site is shown in figure 5.7.

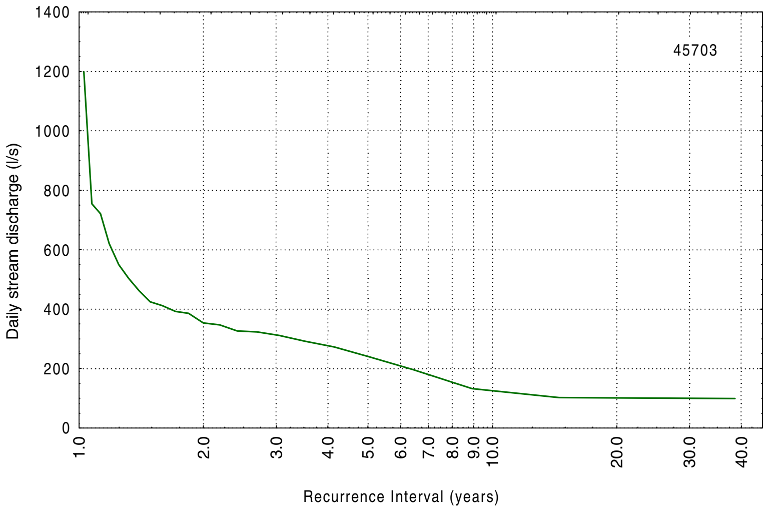

Figure 5.6: Low flow frequency plot at Gubbs (45703) flow monitoring site.

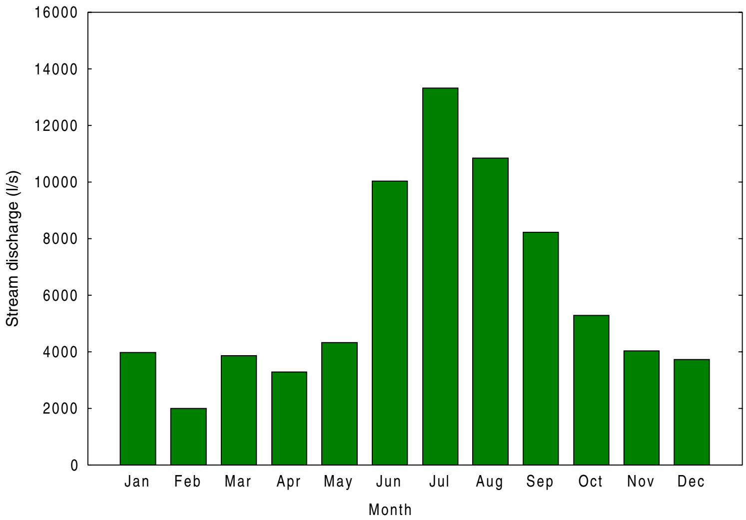

Figure 5.7: Mean total monthly stream flows at Gubbs (45703) flow monitoring site.

The South Kaipara Peninsula yields more consistent baseflows than elsewhere in this area reflecting the geological differences described in section 5.1. There is little information available to describe the character of Kaipara Peninsula streams, although here is a recorder site on the shoreline of Lake Ototoa (45004). Lake levels typically vary between 0.5m and 0.8m per year. Maximum lake levels occur during October and minimum levels in May reflecting the seasonal variation of inputs (rainfall, stream flow and groundwater) and losses (evaporation and abstraction) from the lake.

5.4 Hydrogeology

There are two main aquifer types in the North-west, Waitemata Group and Pliocene/Pleistocene sands. In the South Kaipara and Okahukura Peninsulas dune and alluvial sands overlie Waitemata Group rocks. Alluvial sediments are also found along valley floors. In the north, around Wellsford and Hoteo mudstones and limestones overlie Waitemata Group. The siltstones and limestones are not considered aquifers and bore yields are extremely low. The Waitemata Group Aquifer is not only a source of cold freshwater in the North-west but is also a reservoir for geothermal water at Parakai.

5.4.1 Waitemata Aquifer

Three pumping tests have been carried out on Waitemata Aquifer bores in the North-west obtaining transmissivities of 1-13 m^2/day. Most bores are 100mm in diameter and drilled to depths of between 120-300m. Typical bore yields range from 10-200 m^3/day, although there are higher producing bores in some places. Highly fractured zones and fault zones may yield considerably higher volumes of water.

5.4.2 Parakai Geothermal Aquifer

At Parakai groundwater warmed by the natural geothermal gradient rises from depths in excess of 2,000m to be stored in the Waitemata Aquifer. The geothermal field is small at approximately ~30 hectares and temperatures range from 40-65°C (ARC, 1993). Piezometric heads in the aquifer at the centre of the field stand above ground level and above levels in the overlying cold sand aquifer. Springs are a natural discharge for geothermal water, however geothermal bores are significant discharge points. The Parakai Geothermal Aquifer responds strongly to pumping and, to a lesser extent, rainfall recharge (fig. 5.8). The ARC monitors water levels in two groundwater monitoring bores at Parakai. In 1984 Parakai groundwater levels were below sea level. At this time conditions were suitable for cold water, either fresh or saline, to enter the aquifer. Currently groundwater levels fluctuate from about 2m amsl in winter to 3m amsl in summer. The seasonal trend is the reverse of most Waitemata Aquifers because most water use in the geothermal field is in winter while freshwater demand is generally in summer.

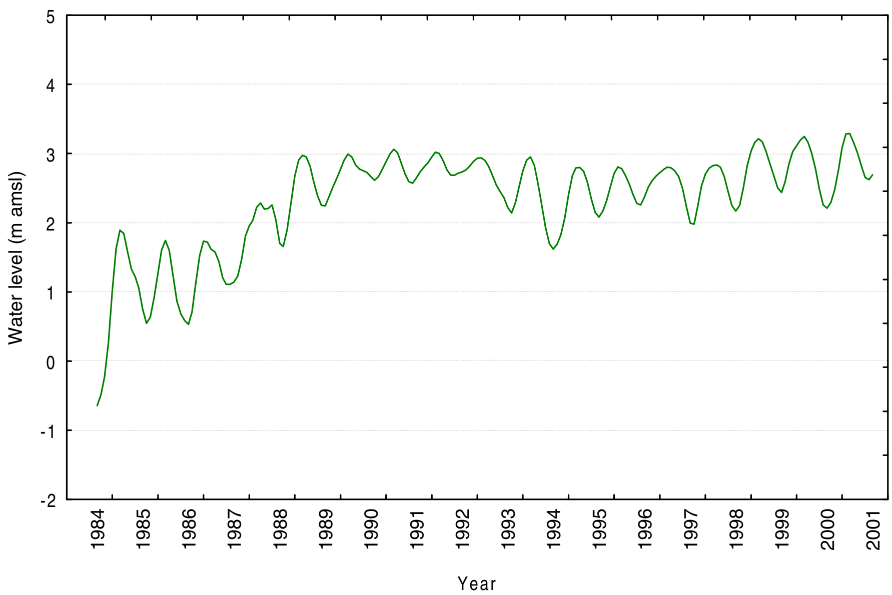

Figure 5.8: Groundwater level record at Parakai geothermal bore No. 86 (6464007).

5.4.3 Kaipara Sand Aquifer

The South Kaipara Peninsula comprises dune sands over Waitemata Group rocks. In places these sands are 120m thick and comprise a useful source of groundwater. Most bores drilled in the Kaipara Sand Aquifer are drilled to depths of up to 100m and are cased and screened. Screens are required in these bores because the aquifer is insufficiently consolidated for drilled holes to stand open. Bore yields range from 30-300 m^3/day. Data on aquifer characteristics (thickness, transmissivity and storativity) are limited due to the relatively few reliable aquifer tests. The water chemistry is characterised by high chloride concentrations around 180 g/m^3 Cl, probably due to salt spray in rainfall recharge. Shallow groundwater is an important source of baseflow to South Kaipara Peninsula Lakes e.g. Ototoa.

5.5 Water Management

5.5.1 Surface Water

The North-west area comprises five surface water management areas (fig. 5.9). The numbers of consents and total daily allocation in each management area are shown in table 5.1.

Consented surface water use in the North-west area is dominated by water taken for pasture irrigation in the Hoteo River Catchment and the neighbouring Okahukura Peninsula (covered by the Upper Kaipara Streams management area). Whilst some water is taken directly from the Hoteo River, the majority of it is from relatively large dams constructed in response to the inability of smaller streams being able to meet the summer water demand of irrigation for intensive dairying operations. Rodney District Council have a permit (AR945872) to take up to 1,300 m^3/day of water from the Hoteo River for Wellsford municipal water supply, the largest stream take in the North-west area.

The ARC commenced the preparation of a catchment management plan for the Hoteo River Catchment in the mid-1990's in response to projections of a significant increase in demand for pasture irrigation. The pasture irrigation 'explosion' did not eventuate and the catchment management plan remains at the draft stage. Elsewhere in the North-west area, water demand is greatest in the Kaukapakapa River Catchment, specifically on the Waikahikatea and Waitoki Streams and main river. Water is abstracted primarily for horticulture, although a golf course and quarry operations also hold water permits.

Table 5.1: Surface water consent allocations and numbers in the North-west area.

Surface Water Management area	Number of take consents		Maximum allocation m^3/day		Total surface water allocation
	Stream	Dam	Stream	Dam	m^3/d
Hoteo River	8	5	7,040	9,355	16,285
Upper Kaipara Streams	0	6	0	3,998	3,998
Kaukapakapa	8	4	908	500	1,288
South Kaipara Head	3	1	357	120	789
Araperera, Makarau	3	1	18	95	113
TOTAL	29	18	8,305	13,973	22,472

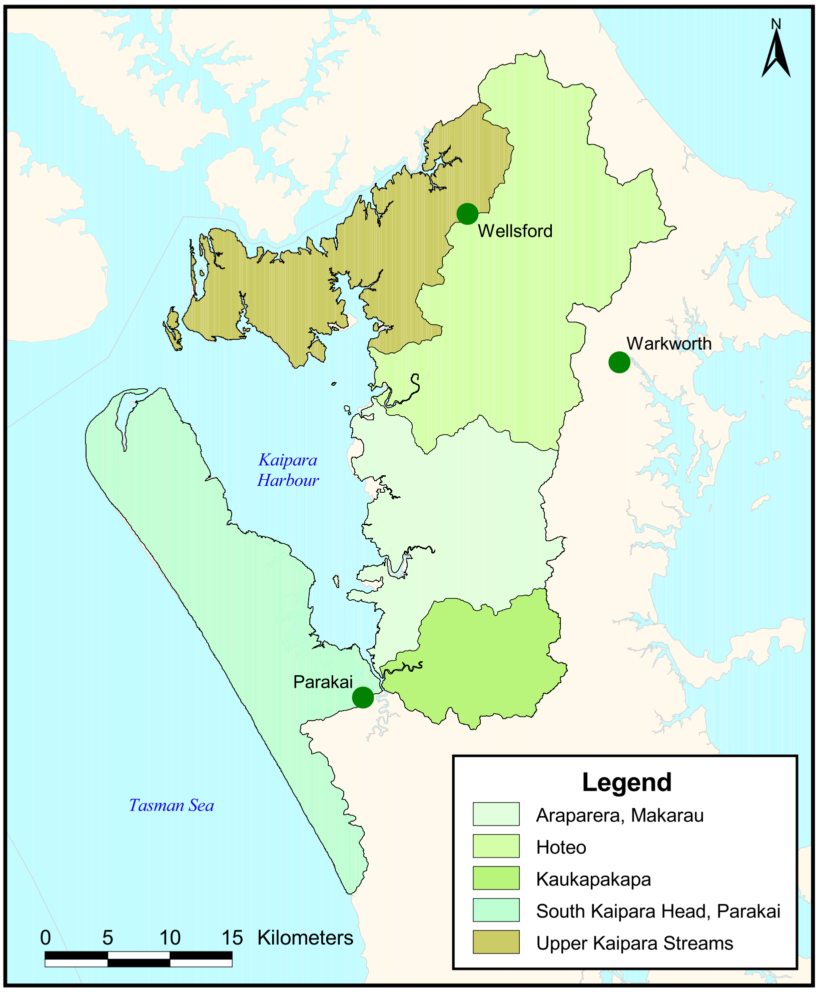

Figure 5.9: Surface water management areas in the North-west

The dune lakes of the Kaipara Peninsula also provide a water supply, mainly for stock drinking water. These lakes are also valued for their non-consumptive values, although many of them have significantly degraded water quality due to neighbouring land uses. Lake Ototoa is the least modified of these lakes and is reasonably well protected by a buffer of remnant native vegetation. The lake contains a reasonably diverse ecology, including some landlocked native fish species and introduced trout, which add to the lake's recreational value.

5.5.2 Groundwater

Groundwater resources have not been developed at a large scale in the North-west. This is principally due to accessibility to relatively plentiful surface water resources within the South Head, Kaipara and Hoteo catchments. Groundwater is generally abstracted from the Waitemata Aquifer, Parakai Geothermal Aquifer, or Kaipara Sand Aquifer. The largest single user of groundwater in the Northwest is Hoteo Farms Ltd, which uses water for pasture irrigation (dairying) (a combined annual allocation of 500,000 m^3 from groundwater and surface water). Tapora Farming Community Water Supply has consent to take water from up to 6 bores to supply a number of farms in the Okahukura Peninsula.

Horticultural supplies are generally for small-scale developments although some large (5 ha.) glass and plastic house developments have been established in the last 5 years. There are 5 groundwater management areas in the North-west (fig. 5.10), with a combined total of 60 issued consents to take groundwater in May 2001 (table 5.2). The combined annual allocation of all consents, including the Hoteo Farms Ltd combined groundwater/surface water allocation of, was 944,029 m^3 and daily allocations ranged from 1-5,000 m^3/day. After pastoral irrigation the largest groundwater use is from the Parakai Geothermal Aquifer.

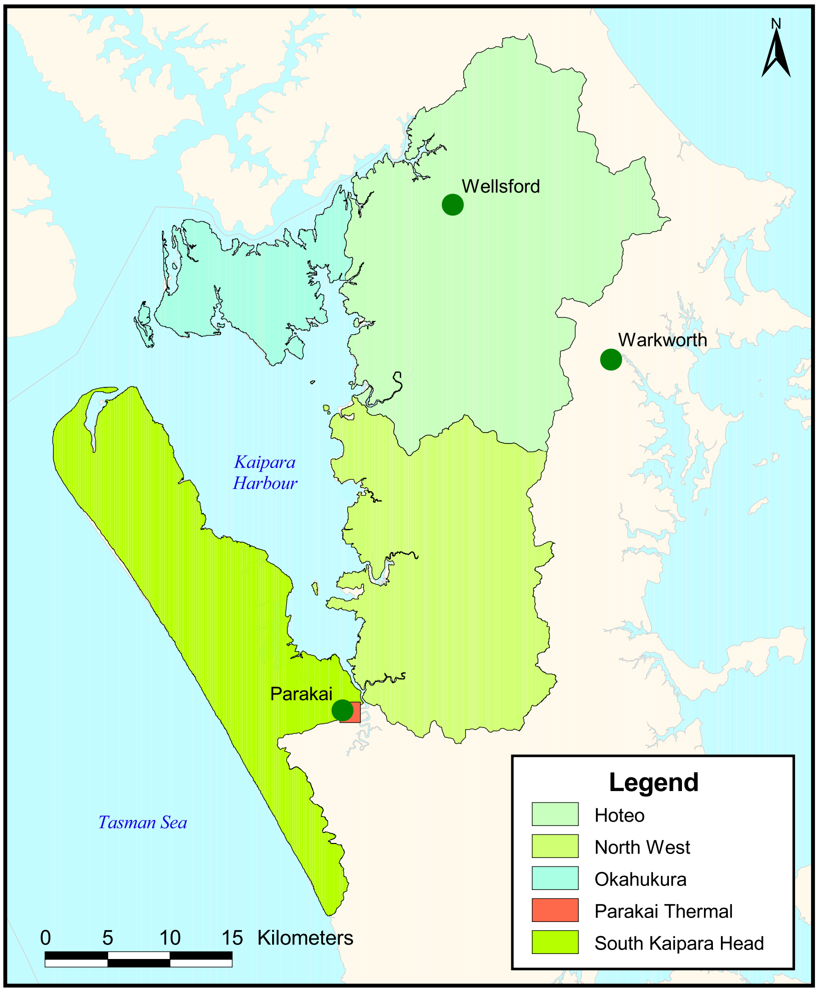

Figure 5.10: Groundwater management areas in the North-west

Table 5.2: Groundwater consent allocations and numbers in the North-west.

Groundwater Management Area	Water allocation m^3/year	Number of consents
Hoteo Groundwater	9,200	6
North west Groundwater	36,914	6
Okahukura	20,100	8
Parakai Thermal	254,405	26
South Kaipara Head	123,410	14
TOTAL	444,029	60

Parakai Geothermal Management

The ARC management objective for the Parakai geothermal field is to avoid cold groundwater or seawater intrusion which could result in a reduction in aquifer temperatures (ARC, 1993). The management regime to achieve this is to maintain a mean groundwater level in the ARC geothermal groundwater monitoring bore No. 86 (6464007) of at least 2.5m amsl. This will ensure that the water level over much of the geothermal aquifer should remain above that of the overlying cold aquifer and hence minimise cold water inflow to the geothermal aquifer for much of the year. In 1992 availability of an average of 700 m^3/day was determined based on maintaining a minimum 2.5m amsl water level in the ARC bore No. 86.

There are 26 geothermal groundwater consent holders who are collectively allocated 254,405 m^3 annually. The largest average daily allocations of geothermal water at Parakai are the three public pool complexes: Parakai Springs Trust (Aquatic Park), Rex Swensson (Palm Springs) and Parkhurst Corporation totalling on average 505 m^3/day. Smaller allocations are granted for motels, a proposed resort and a home for the elderly (total 131 m^3/day). The balance of geothermal groundwater allocation at Parakai is mostly for domestic users. Usage for the larger allocations is 55-95% of allocated quantities.

5.6 References

Auckland Regional Council, 1993: Draft Parakai geothermal groundwater resource statement and management plan. Auckland Regional Council

Crowcroft, G.M. & Scoble, R.G. 1999: Drilling Report Rimmer Road, Helensville monitoring bore. TP 120. P6-7. Auckland Regional Council.

NZ Geological Survey, 1961: Whangarei map 1:250,000 DSIR, Wellington, New Zealand.

6 North East Water Resource Area

6.1 Introduction

The North-east area is a long narrow strip of land that generally drains from the western hills to the east coast (fig. 6.1). Coastal areas are low lying, with elevations less than 40m amsl. Further inland gentle hills give way to hilly areas of greater than 300m elevation. The more elevated areas in the North-east are around Omaha State Forest (Tamahunga, 436m), Dome State Forest (The Dome, 336m) and Moirs Hill (358m). The underlying geology is predominantly Waitemata Group, "Onerahi Chaos", and limestone. Thin sands occur in low-lying coastal areas and along some valley floors.

The dominant land uses within the North-east are farming, horticulture and forestry. The main urban centres are in Warkworth, Orewa and Whangaparaoa. Water demand in the North-east is primarily for municipal supply and horticulture. Five Waitemata Aquifer management areas have been defined where demand for groundwater resources approaches water availability estimates (Fig.6.1). Omaha is dominantly a horticultural area and Tomarata is a dairying area. At Orewa and Whangaparaoa water demand was for municipal supply until 1995, but has since declined, and Waiwera geothermal groundwater is used for recreational purposes.

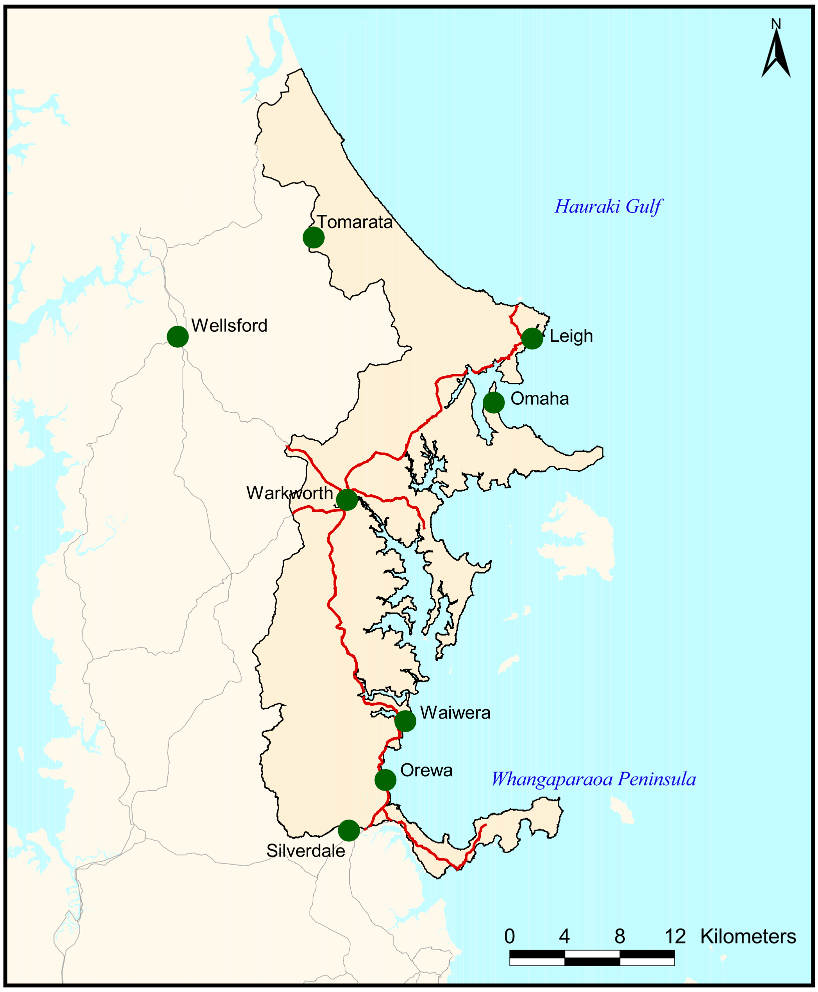

Figure 6.1: Location map for the North-east water resource reporting area.

The North-east of the Auckland Region is a popular summer destination for many Aucklander's. The area has many sandy beaches that are safe for swimming and good parkland areas for camping and picnicking. The influx of people to these areas over summer increases the demand for water supplies over summer weekends and particularly during the Christmas/New Year holiday. The area is not well endowed with water supplies and seasonal pressure on existing supplies causes water shortages in some areas.

6.2 Rainfall

The North-east area is generally drier than the North-west. This is due to the elevated area dividing the two areas that acts as a barrier to prevailing moist westerly air masses from the Tasman Sea. Mean annual rainfall varies from just over 1,500mm across the upper Hoteo Catchment, to 1,100mm on the Whangaparaoa Peninsula. Six automated, and 5 manual rainfall recorder sites measure rainfall across the North-east and show the spatial variability in rainfall (fig. 6.2). At Omaha Flats (640704), mean annual rainfall is approximately 1,450mm and there are on average 189 wet days per year. To the south at Rosedale ponds (647727), just outside the southern boundary, mean annual rainfall is 1,200mm and an average of 159 wet days per year is measured. The rainfall record for Omaha Flats is illustrated in figure 6.3.

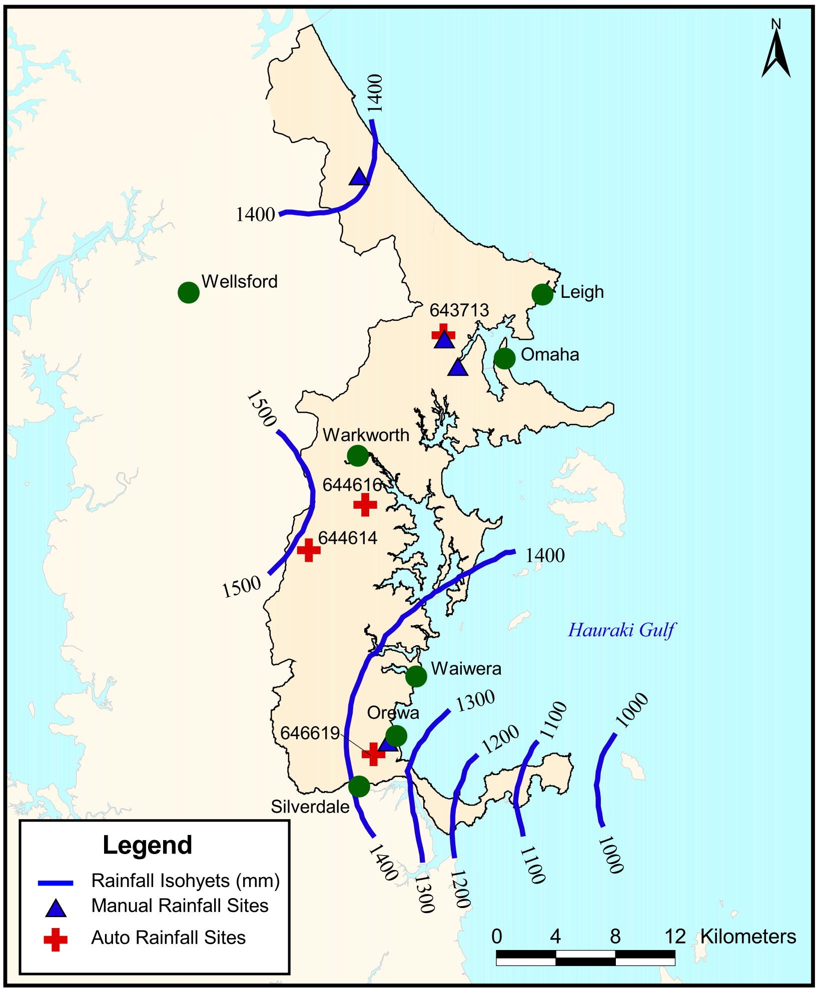

Figure 6.2: North-east area rainfall monitoring sites and mean annual rainfall isohyets.

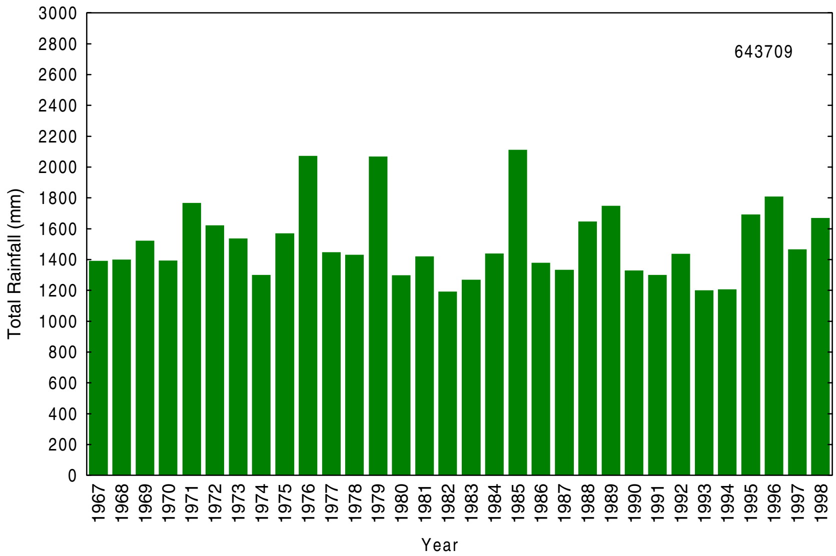

Figure 6.3: Annual rainfall record at Omaha Flats (643709).

6.3 Hydrology

The Auckland Regional Council operate 4 flow monitoring sites in the North-east; Orewa Stream (7202), Mahurangi Stream (6806), Slipper Lake (6302), which measures lake discharge and Tamahunga Stream (6501) (fig. 6.4). Manual gauging has been carried out at numerous locations in the area to supplement the automatic flow records.

North-east catchments are small and generally drain from west to east. The upper reaches of streams are often in areas of steep terrain. These catchments are 'flashy' with flood peaks that propagate and disperse rapidly. The flashy nature indicates that during extended dry periods, stream flows are likely to fall to extreme low flows. The local geology has a controlling influence on low flows. Catchments that are dominated by alluvial deposits and limestone experience poor base flow. The Orewa Catchment is a good example with a Q_5 low flow of 0 l/s near the outlet. By comparison the Mahurangi Catchment, which is underlain by Waitemata Group rocks, has Q_5 low flow of 45 l/s or 0.96 l/s/km^2. Flow duration curves, shown in figure 6.5, illustrate the impact underlying geology has on flow.

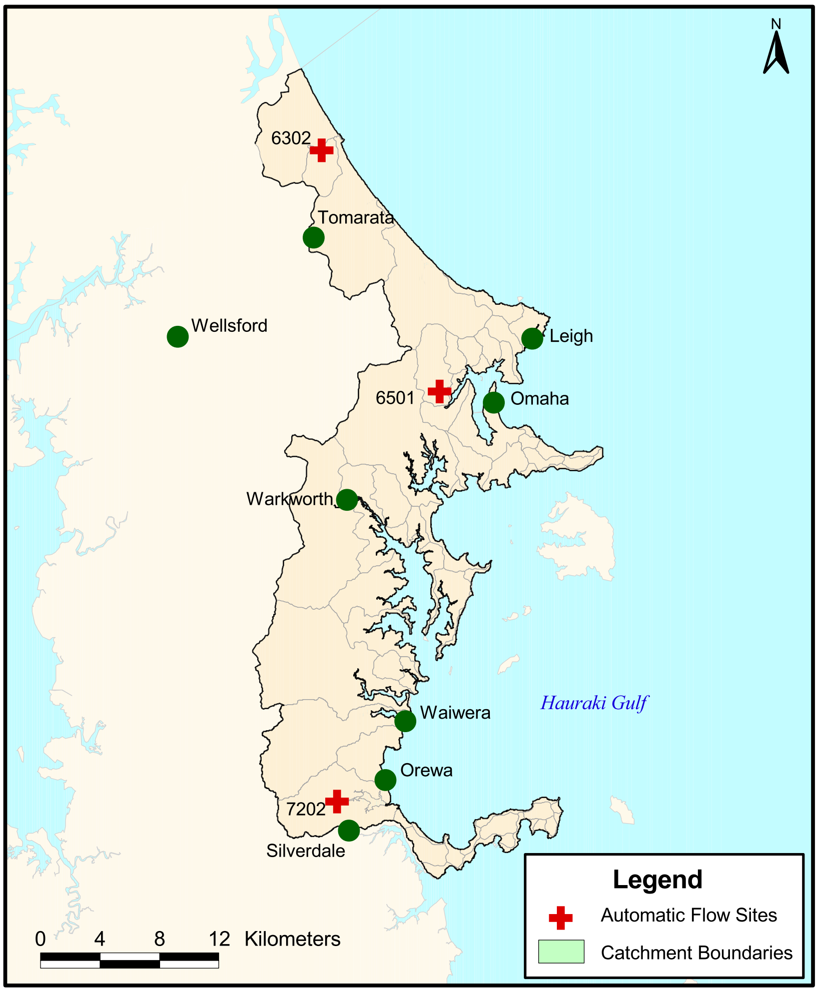

Figure 6.4: Surface water catchments and flow monitoring sites in the North-east area.

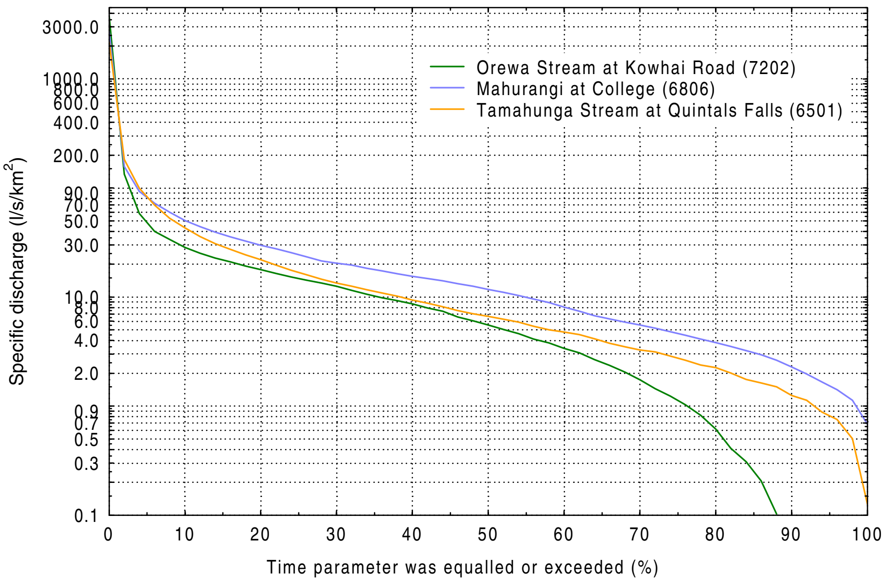

Figure 6.5: Flow duration curves for three North-east area surface water catchments.

The Mahurangi low flow frequency curve in figure 6.6 shows an inflection point at the about 68-70 l/s. This point is used to differentiate between normal and drought flows. That is, flows below 68-70 l/s are considered `drought' flows. The occurrence of drought flows is associated with extended periods of below normal rainfall, which generally coincides with summer months. A typical seasonal pattern of flows in the Mahurangi Catchment is illustrated in figure 6.7. Mean monthly stream flows at Mahurangi College (6806) reach a maximum of 2,642 l/s during July and a minimum flow of 362 l/s during February.

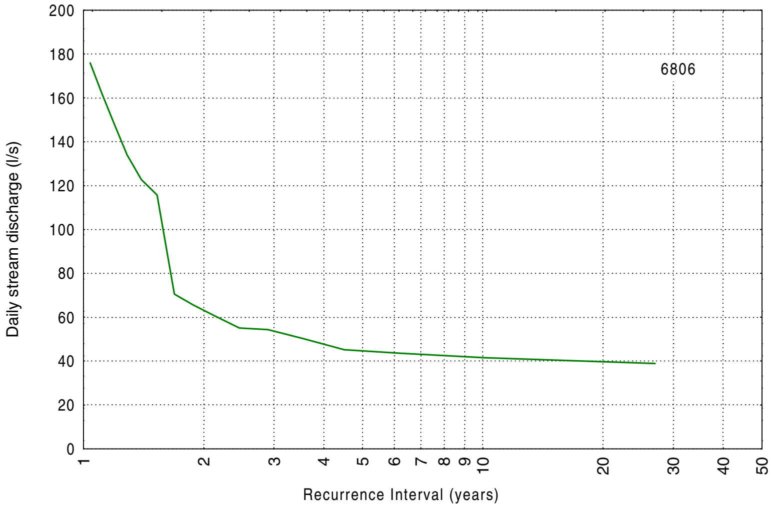

Figure 6.6: Low flow frequency plot at Mahurangi Stream (6806) flow monitoring site.

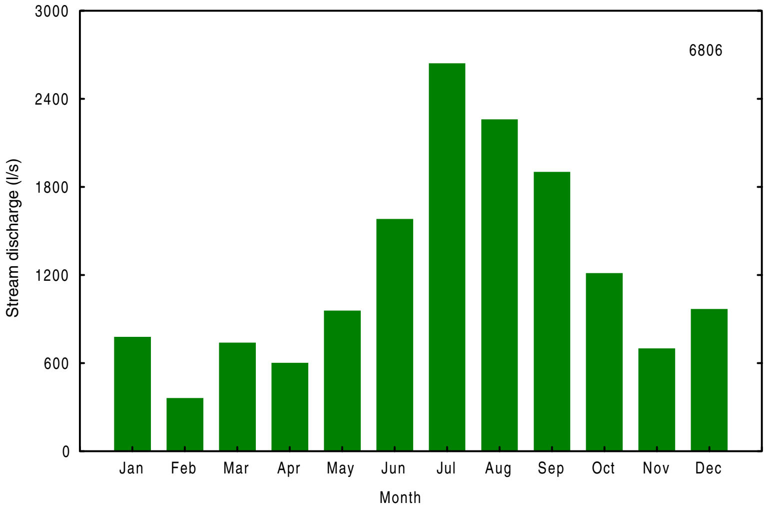

Figure 6.7: Mean monthly stream flows at Mahurangi Stream (6806) flow monitoring site.

6.4 Hydrogeology

The most developed aquifer in the North-east is the Waitemata Aquifer. The Waitemata aquifer is used principally as a source of freshwater but is also a source of geothermal groundwater at Waiwera. Limestones and Onerahi Chaos rocks in the area are low yielding and not considered aquifers here. Small volumes of groundwater are abstracted from thin sand deposits in coastal areas and along valley floors.

6.4.1 Waitemata Aquifer

The Waitemata Aquifer is highly variable across the North-east. Aquifer thickness varies from less than 100m to 800m and transmissivities range from 4 to 250 m^2/day. The Waitemata Aquifer is comparatively high yielding at Orewa, Whangaparaoa and Omaha, lower yielding at Mahurangi and Warkworth and very low yielding in the Kahikatea Flats area. ARC has 10 groundwater monitoring sites in the North-east, the location of these is shown in figure 6.8. Most sites are monitored monthly, although many sites were monitored automatically prior to 2000.

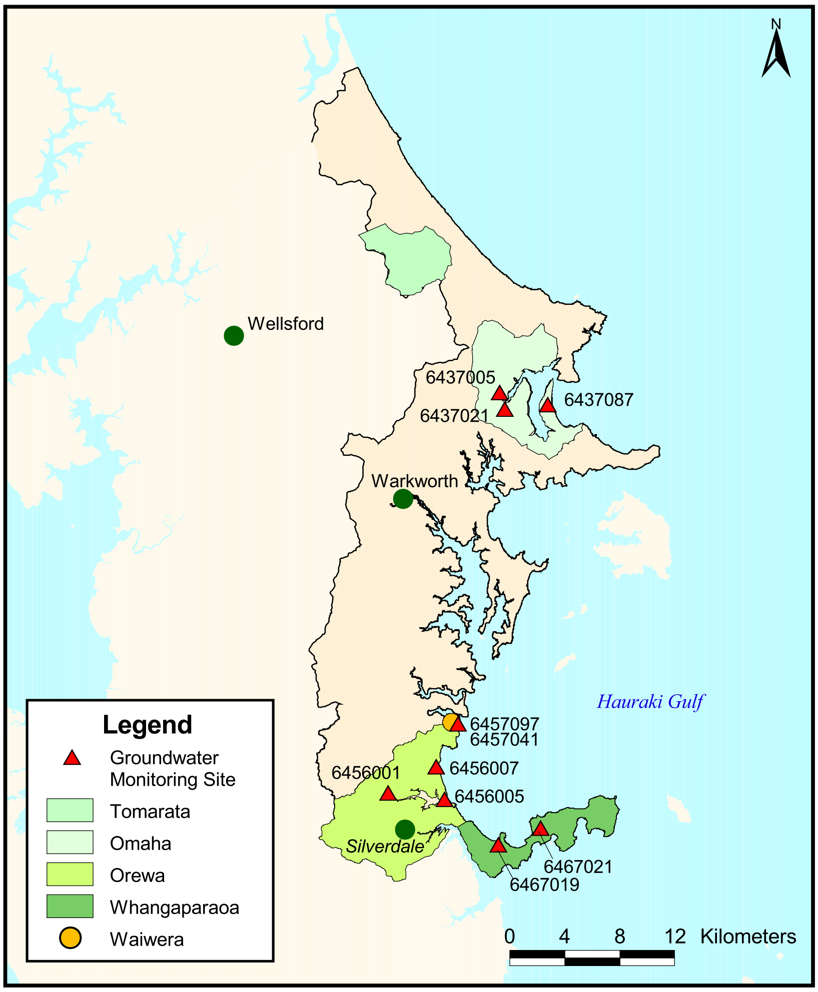

Figure 6.8: Location of groundwater monitoring sites and groundwater management plan areas.

Omaha

Omaha is situated in a low-lying basin of dune and alluvial deposits surrounded by hills formed of Waitemata Group and minor volcanic intrusions. Greywacke rocks, which are exposed at the northern edge of the Whangateau Harbour, Leigh and Cape Rodney and at the base of the Omaha Spit and Tawharanui Peninsula form the geological basement in the area. The Waitemata aquifer sits on top of an eroded greywacke surface and is between 150m and 400m thick across most of the Omaha groundwater management area. Most bores drilled in to the Waitemata Aquifer are drilled to depths of between 80m and 220m and cased with 100-150mm diameter casing.

Groundwater levels for two Omaha sites are shown in figure 6.9. While the record shows the typical seasonal trend of water level fluctuation, pumping increases the magnitude of variance between winter and summer groundwater levels. The effect of pumping was particularly pronounced in the summers of 1982-83 and 1986-87. While groundwater levels do not peak as high as they did at the start of the records they have stabilised over the last decade.

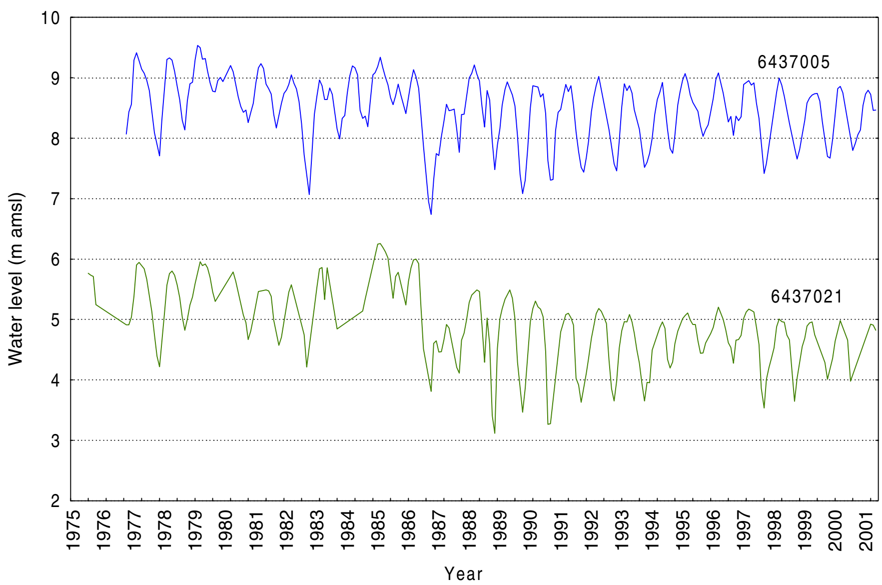

Figure 6.9: Groundwater level records at Quintal Road (6437005) and Omaha Flats (6437021) monitoring bores.

Orewa/Whangaparaoa

The main physical characteristics are Orewa sandspit, Orewa/Weiti River estuaries and the headlands and coastal cliffs of the Whangaparaoa Peninsula. Topographic elevations range up to 120m in the southern area and 0 to 140m amsl north of the Orewa River. Recharge is via direct infiltration of rainfall where the Waitemata Group outcrops. The major recharge area to the Orewa aquifer is the zone of higher topography to the north-west of Orewa Township. Recharge to the Whangaparaoa Peninsula area also occurs in areas of high topography – Red Beach and parts of the Peninsula.

The Orewa Waitemata Aquifer was developed rapidly in the 1970's and 1980's, in line with urban development. The Rodney District Council provided water to many parts of the area via a network of bores drilled from across the Orewa, Silverdale and Whangaparaoa area. The effect of such large abstractions on the aquifer was rapidly declining water levels. In many places groundwater levels dipped below sea level and saline intrusion became a problem, especially on the Whangaparaoa Peninsula. In 1995 RDC switched off its pumps and decommissioned most of the production bores in favour of water supply from Watercare Services Ltd. Figure 6.10 shows the response of the aquifer, at Orewa South, to the cessation of pumping. As yet groundwater levels have not stabilised and continue to rise.

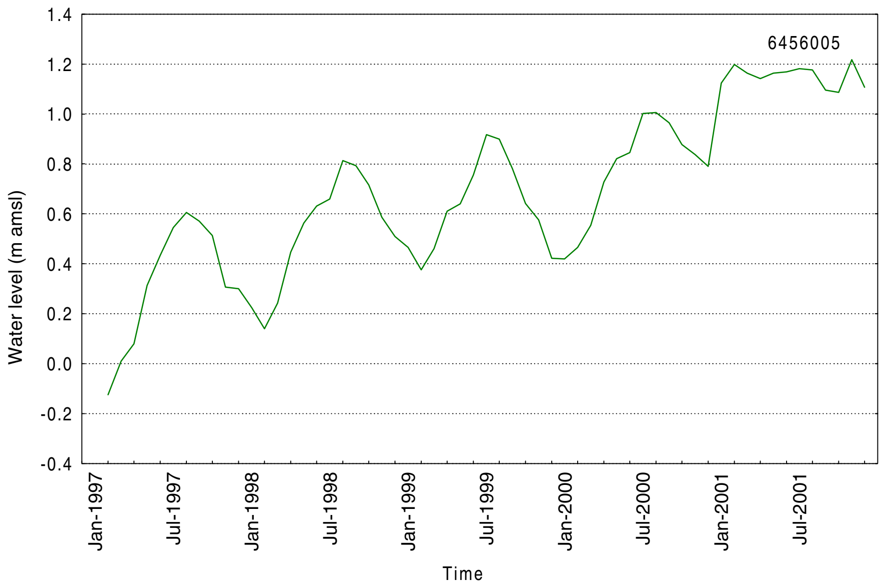

Figure 6.10: Groundwater level record at Orewa South (6456005) monitoring bore since January 1997.

Tomarata

The Tomarata Valley is located north- east of Wellsford and is approximately 18km^2 in area. Waitemata Group sediments form a basin surrounded by hills. Alluvial sediments 8-15m thick cover the bottom of the valley. The Poutawa Stream drains the valley into the Pacific Ocean.

The Waitemata Aquifer encompasses a number of layers of bedded sandstone (predominantly), silty sandstone, silt and occasionally mudstones. The average aquifer thickness is 100-150m but does reach 200m thick in some places. Groundwater occurrence is related to fractured thickly bedded coarse sandstone. Pumping test results and groundwater levels indicate the aquifer is a confined to semi-confined leaky aquifer, thick alluvial deposits with clay layers are likely to be the major confining layer. Transmissivities within the aquifer are calculated in a range from 44.5 m^2/d to 278.5 m^2/d and storativities range from 1.0x10^{-4} to 1.7x10^{-5}.

Annual groundwater recharge is estimated to be around 640,000 m^3 from the immediate catchment area. It is assumed that no recharge occurs in the areas covered by alluvium. Groundwater levels measured in a number of bores across the valley show typical seasonal variation especially in the recharge area (Waitemata hills) and a relatively flat gradient from the periphery of the catchment towards the bottom of the valley. A number of bores in the central catchment area (at the bottom of the valley) demonstrate artesian water levels. Average groundwater levels within the valley are between 70 and 95m amsl.

Waiwera

The geothermal field at Waiwera is a small low temperature fracture related system. Geothermal waters, heated by the natural geothermal gradient, rise along faults in the greywacke rocks from depths in excess of 1,200m. The geothermal water is stored in Waitemata Aquifer at depths of between about 50–400m (ARWB, 1980; ARC, 1991). Maximum bore production temperature at the centre of the Waiwera field is 53°C and groundwater pressures in the field stand below the water table in the overlying cold sand aquifer (Crane, 1999). Geothermal water is characterised by concentrations of boron, lithium and fluoride significantly greater than for non-geothermal fresh groundwater. At Waiwera geothermal groundwater also has naturally high sodium and chloride.

The ARC maintains a geothermal groundwater-monitoring site at Waiwera beachfront (6457041). The bore, drilled in 1980, is 407m deep and water levels are monitored automatically. In 1996 a shallow cold geothermal water bore was drilled adjacent to the hot geothermal bore. This site was established as part of the ARC long-term groundwater-quality baseline-monitoring programme. Water levels are measured coincident with water quality sampling.

Groundwater pressures in the coastal geothermal aquifer have fluctuated significantly over the last 100 years. Prior to development geothermal groundwater levels stood over 5m amsl. In the 1970's hot springs on the beach ceased to flow and by the 1980's water levels had fallen to 1m below sea level (fig. 6.11). At this time conditions existed for saline water to enter the aquifer at the coastal margin and at the landward margin. In 1979 monitoring of geothermal water quality in beachfront bores indicated up to 3.5% of the bore water was of seawater origin. Geothermal groundwater levels rose through the late 1980's then declined for several years before beginning to trend up again since 1994. In 1998 a new deep bore was drilled by the Waiwera Thermal Pools and most of their water requirements were taken from this bore rather than the existing 3 production bores. The upward trending water levels in the ARC monitoring bore supports the assertion that bore location, construction and amount of pumping have a large effect on the ARC monitoring bore water levels (Chapman, 1998; Crane, 1999)

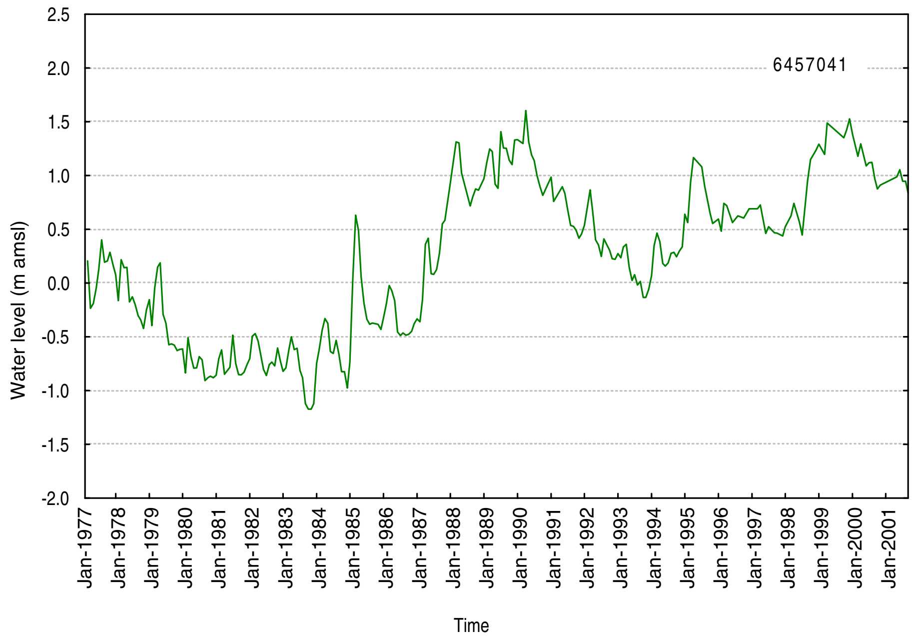

Figure 6.11: Groundwater level record at Waiwera geothermal (6457041) monitoring bore.

6.4.2 Sand Aquifers

Sand aquifers in the Northeast are not extensive. However, they are an important source of water for some small rural farms and homes. Coastal sand and alluvial aquifers are generally less than 40m thick and bores constructed into them are low yielding (1-2 m^3/day). Water quality is variable but tends to be high in iron. These shallow sand aquifers respond seasonally to both rainfall and pumping and are inclined to dry up toward the end of a dry summer. Shallow sand aquifers are also vulnerable to contamination from septic tanks discharge and, in coastal areas, saline intrusion.

6.5 Water Management

6.5.1 Surface Water

The North-east is split into two surface water management areas, North-east surface water and Orewa, Whangaparaoa, Waiwera (fig. 6.12). While there are relatively few consents to take surface water in this area (13) there are some large allocations. The largest run of stream allocation is granted to Rodney District Council to take water from the Mahurangi River for Warkworth municipal supply. RDC have applied to increase their take from 1,600 m^3/day to 2,765 m^3/day. The next largest allocation(s) is to R.H. Cooper, who has two consent allocations (605 m^3/day and 375 m^3/day) to take water from Eyres Point Stream for pasture irrigation.

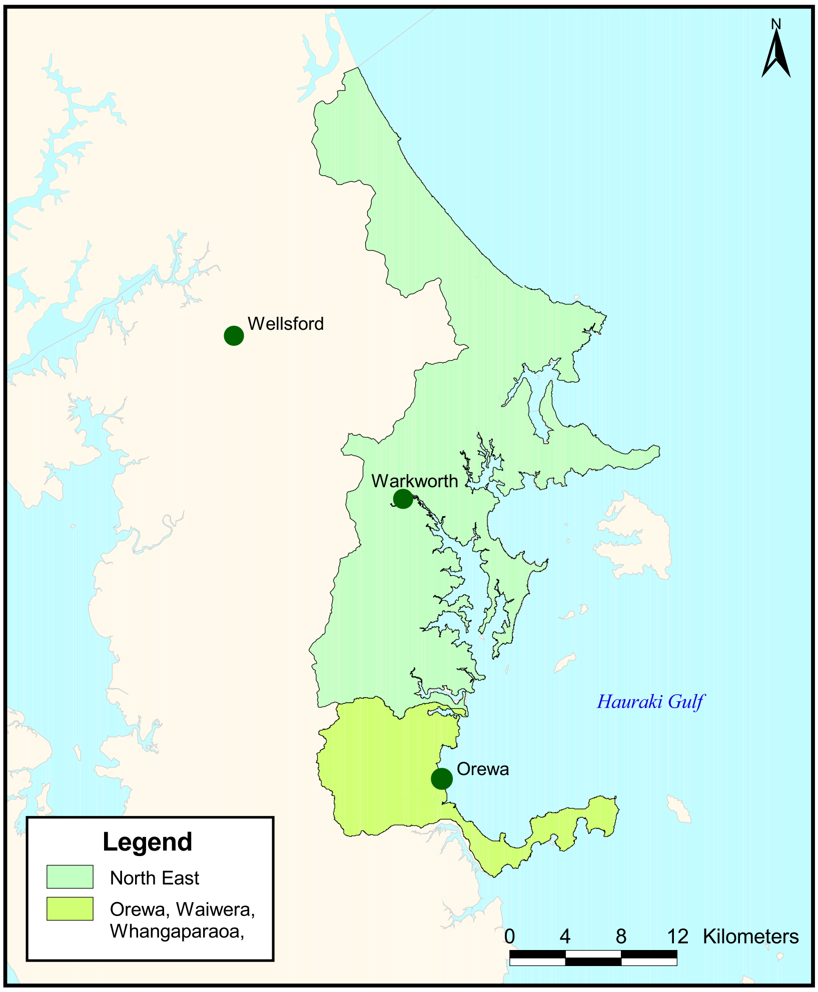

Figure 6.12: Surface water management areas in the North-east

All surface water abstractions in the Orewa, Whangaparaoa, Waiwera surface water management area are from dams. Water from dams is used for golf course irrigation at Gulf Harbour (1,500 m^3/day), Whangaparaoa (120 m^3/day) and Peninsula (240 m^3/day) Golf Courses. Allocations and consent numbers for surface water abstractions are presented in table 6.1.

Table 6.1: Surface water consent allocations and numbers in the North-east area.

Surface water management area	Number of take consents		Maximum allocation m^3/day		Total allocation from surface water m^3/d
	Stream	Dam	Stream	Dam	
North-east surface water	5	3	2,635	263	2,898
Orewa, Whangaparaoa, Waiwera	0	5	0	4,860	4,860
TOTAL	5	8	2,635	5,123	7,758

6.5.2 Groundwater

Waitemata Aquifer management in the North-east has focussed on high water demand areas, which include Omaha, Tomarata, Orewa/Whangaparaoa and Waiwera (fig. 6.13). Groundwater availability and allocation figures for the areas are listed in table 6.2.

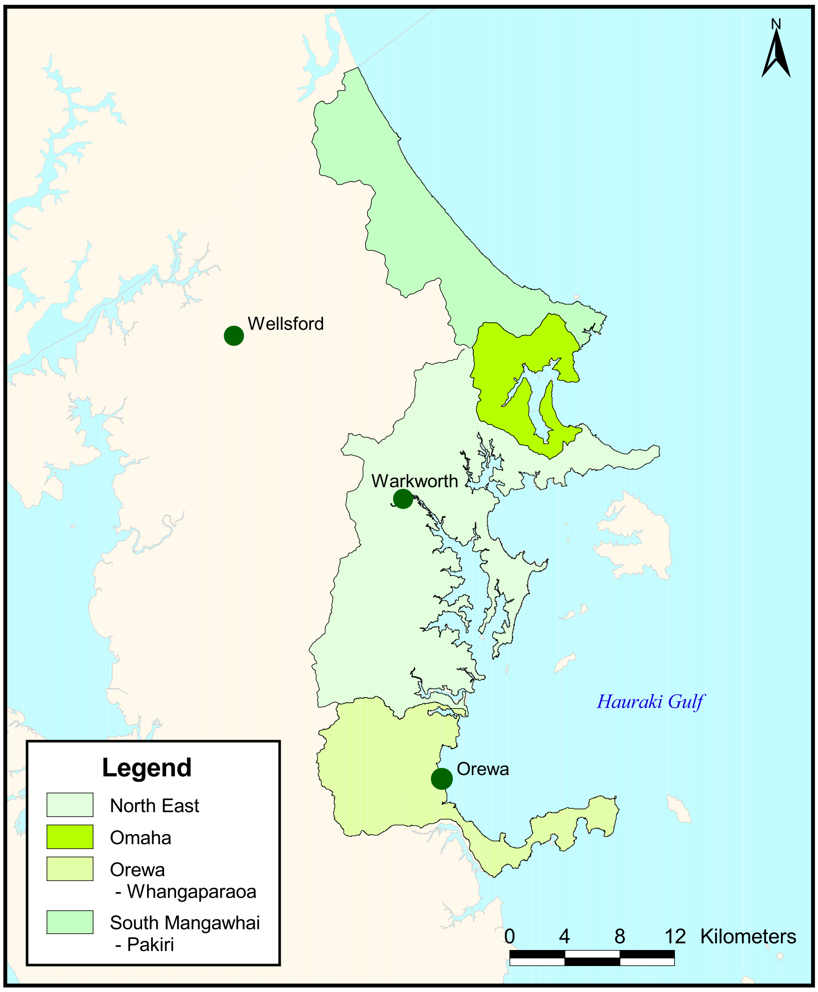

Figure 6.13: Groundwater management areas in the North-east

Table 6.2: Groundwater availability, consent allocations and consent numbers in the North-east area.

Management Area	Water availability m^3/year	Water allocation m^3/year	Number of consents
Omaha	105,000	76,891	37
Orewa	858,000	23,380	4
Whangaparaoa	528,000	97,160	12
Tomarata	638,000	135,000	1
North East groundwater	NA	531,795	33
South Mangawhai-Pakiri	NA	134,250	12
TOTAL		998,476	99

Omaha

The Waitemata Aquifer at Omaha has a long history of intensive development. Most groundwater demand has been for horticultural use, which is centred on the Omaha Flats area. In the late 1970's demand was sufficiently high that the ARA undertook extensive investigations to accurately define aquifer recharge and to determine water availability figures. Since 1980 both groundwater availability and allocation figures have been reviewed periodically (ARWB, 1982; ARWB, 1989) and water allocation rates set in conjunction with a local water users committee.

More recently the area has under gone landuse change with a move away from horticulture. Point Wells and Omaha have seen an increase in the number of both holiday and permanent homes built. The Omaha subdivision obtains its water from a thin sand aquifer overlying the Omaha Waitemata Aquifer. In Point Wells and Omaha Flats water is obtained for some lifestyle blocks and homes from private bores that penetrate the Waitemata Aquifer. An allowance for domestic use is made in determining groundwater availability figures for the Omaha Flats area.

Orewa/Whangaparaoa

The Orewa/Whangaparaoa Aquifer has been one of Auckland's most stressed aquifers. This was principally due to demand for municipal supply water. Rodney District Council operated borefields at Orewa, Whangaparaoa and Silverdale and had consent to take up to 2,990 m^3/day (1,091,350 m^3/year) to meet municipal water demand. In the 1990's it was evident that the increasing demand for water would exceed the safe yield of the aquifer (Carryer & Associates, 1990; ARC, 1992). A moratorium on new domestic supply bores had been placed in much of the Whangaparaoa Peninsula to reduce the potential for saline intrusion to the aquifer and to the municipal supply wells. In 1995 RDC turned off their pumps, surrendered most of the consents to take groundwater and connected to Watercare Service's Ltd. municipal supplies. Since that time groundwater levels in the aquifer have steadily risen and the restriction on new resource consent allocations lifted.

Tomarata

Groundwater in the Tomarata area is principally used for dairy farming and domestic supply. There is currently only one resource consent to take groundwater in the Tomarata area. That consent, issued to A. Day & G. Locke is for a maximum of 1,350 m^3/day and 135,000 m^3/year, is for pasture irrigation purposes.

Waiwera

The ARC management objectives for the Waiwera geothermal field are to maintain aquifer water levels sufficient to avoid cold groundwater or seawater intrusion, to prevent reduction in aquifer temperatures, to avoid long-term decline in aquifer water levels and to seek restoration of geothermal springs on Waiwera Beach (Crane, 1999). The management regime to achieve this is to maintain a mean groundwater level in the ARC deep geothermal groundwater monitoring bore No. 74 (6457041) of at least 0.5m amsl. This will ensure that the water level in the geothermal aquifer at the coastal margin will remain on average 0.2m amsl and hence avoid cold seawater intrusion (ARWB, 1986, ARC, 1991). Location and bore construction are almost as important as the quantity abstracted from a bore when assessing whether there will be an effect on the resource. Therefore a single value for aquifer availability, based on recharge to the aquifer as a whole is not appropriate.

There are 48 geothermal groundwater consents that are collectively allocated 466,105 m^3/year or an average of 1,277 m^3/day. The largest average daily allocation, 850 m^3/day, is the public pools complex Zentrum Holdings Ltd (Waiwera Thermal Resort). Other large allocations at Waiwera include the proposed hotel development Waiwera Resorts Ltd for 120 m^3/day, Waiwera Spa Apartments Body Corporate 60 m^3/day and the Caravan Park site redevelopment Waiwera Ltd for 50 m^3/day. Eight smaller allocations are for motels, private apartments, holiday complexes and large private pools totalling 117 m^3/day and the remaining 33 small private pool allocations total 78 m^3/day.

6.6 References

ARC, 1991: Draft Waiwera geothermal groundwater resource statement and allocation plan. ARC TP 112

ARC, 1992: Orewa/Whangaparaoa groundwater allocation and management plan 1992 Auckland Regional Council.

ARWB, 1980: Waiwera water resource survey: preliminary water allocation/Management plan ARWB.

ARWB, 1982: Omaha-Leigh Freshwater Resource Allocation/Management Plan. ARWB,

ARWB, 1986: Waiwera thermal groundwater allocation and management plan 1986 ARWB

ARWB, 1989: Omaha groundwater allocation and management plan. ARWB

Carryer & Associates Ltd, 1990: Report on the groundwater investigation in the Orewa area

Chapman, M.G, 1998: Investigation of the dynamics of the Waiwera geothermal groundwater system, New Zealand. Unpublished M.Sc thesis, University of Waikato.

Crane, S. G., 1999: He Kaupapa Tiaki i nga Wai Puia: draft Waiwera geothermal groundwater water resource assessment report. Auckland Regional Council.