

MEETING OF THE REGIONAL PLANNING COMMITTEE

TO THE CHAIRPERSON AND MEMBERS OF THE
COMMITTEE

MEMBERSHIP OF THE COMMITTEE

Cr R A Budd (Chairperson)

Cr T K Burke	Cr A G Neill
Cr A S Carroll	Cr M E Oldfield
Cr E H Cunningham	Cr J F Slee
Cr R H M Johnston	Cr N J Wagner
Cr R M Kirk	Cr J M Waters
Cr R I R Little	Cr W E Woods
Cr A R McKay	

A meeting of the Committee will be held on
Wednesday, 8 February 2006 at 9.30 a.m.

VENUE: Council Chamber
First Floor
Pegasus Building
Environment Canterbury
58 Kilmore Street
CHRISTCHURCH

BUSINESS: As per Order Paper attached

Dr Bryan Jenkins
CHIEF EXECUTIVE

**RECOMMENDATIONS IN REPORTS ARE NOT TO BE TAKEN
AS COUNCIL POLICY UNTIL ADOPTED BY COUNCIL**

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COMPLIANCE WITH LOCAL GOVERNMENT ACT 2002 DECISION-MAKING REQUIREMENTS

Except as below, a statement of compliance and a completed decision checklist is required for any agenda item on a council committee or the council recommending that a decision be made. This will be the responsibility of the person signing off the agenda item.

The compliance statement and checklist will not be used for:

- Recommendations that information be received or that the Council make a decision.
- Decisions taken under the Resource Management Act 1991 or the Biosecurity Act 1993 in relation to resource consents, decisions required when following the procedures set out in Schedule 1 of the Resource Management Act 1991, other permissions, submissions on plans, or references to the Environment Court.
- Decisions taken to proceed with enforcement procedures under various primary or secondary legislation or regulations, including procedures under the Resource Management Act 1991, the Biosecurity Act 1993, the Local Government Act 2002, and Environment Canterbury Bylaws.
- Administrative and personnel decisions that are entirely internal to Environment Canterbury.
- Other decisions where the procedures to be followed are set out in Legislation.

COMPLIANCE STATEMENT

The council committee (or the council) must formally certify that:

- (a) It is satisfied that it has sufficient information about the options and their benefits and costs, in terms of the region's social, economic, environmental and cultural well-being and the effects on community outcomes, bearing in mind the significance of the decisions.
- (b) It is satisfied that it knows enough about and has given adequate consideration to the views and preferences of affected and interested parties bearing in mind the significance of the decision.

INFORMATION CHECKLIST

(a)	A Statement of the Proposed Decision
(b)	A Statement of the Objective of the Proposed Decision and the Issue or Problem being addressed
(c)	A list of all reasonably practicable options, (including doing nothing).
(d)	For each option in (c): An evaluation of the Benefits and Costs, in terms of the region's social, economic, environmental and cultural well-being.
(e)	For each option in (c): A statement of the extent to which community outcomes would be promoted or achieved in an integrated and efficient manner.
(f)	For each option in (c): A statement of the Impact, if any, on Environment Canterbury's capacity to undertake its statutory responsibilities
(g)	If the Proposed Decision is a significant decision in relation to land or a body of water, a statement of how Maori values have been taken into account
(h)	A Statement of significant inconsistencies, if any, with any Existing Policy, Plan or Legislation arising from the Proposed Decision.
(i)	A statement how the views and preferences of affected or interested persons have been given adequate consideration during the definition of the problem or issue, the objective, the assessment of options and the development of the proposed decision, including the particular contribution of Maori to the decision-making process.

Notes:

The significance of proposals and decisions determines how much time, money and effort is put into exploring and evaluating options and obtaining the views of affected and interested parties. The significance of proposals and decisions is determined through reference to criteria contained in the policy on significance.

The policy on significance together with Section 76 of the Local Government Act 2002 set out the Council's requirements in relation to decisions. Some decisions can only be made through the Long-Term Council Community Plan, or after the Special Consultative Procedures set out in the Act have been used, (refer to the policy on significance and the Act).

All decisions of Environment Canterbury are subject to the decision-making requirements of section 76 of the Act unless inconsistent with specific requirements of other legislation.

ENVIRONMENT CANTERBURY
REGIONAL PLANNING COMMITTEE

ORDER PAPER

1. APOLOGIES
2. MINUTES OF MEETING – 6 DECEMBER 2005
3. MATTERS ARISING
4. DEPUTATIONS AND PETITIONS

MATTER FOR COUNCIL DECISION

5. PROPOSAL FOR NRRP VARIATION 3: CHRISTCHURCH GROUNDWATER RECHARGE ZONE 1 BOUNDARY
(A copy of the report presented to the 6 December 2005 meeting is attached. At the December meeting it was resolved to let this report lie on the table awaiting further information. This information will be circulated prior to the meeting.)
6. NOTICES OF MOTION
7. EXTRAORDINARY AND URGENT BUSINESS
8. QUESTIONS
9. NEXT MEETING – 8 MARCH 2006

AGENDA ITEM NO: 5	SUBJECT MATTER: PROPOSAL FOR NRRP VARIATION 3 – CHRISTCHURCH GROUNDWATER RECHARGE ZONE 1 BOUNDARY
REPORT: Regional Planning Committee	DATE OF MEETING: 8 February 2006
FILE REFERENCES: NAT/NRP/2002/Var3/GEN/1C	PORTFOLIO: Water PROJECT: Draft Variation 3 to the Proposed Natural Resources Regional Plan OUTPUT: Policy Paper
REPORT BY: Barry Loe, Loe Pearce and Associates Raymond Ford Senior Resource Management Planner	ENDORSED BY: John Talbot Director Policy and Planning

PURPOSE

To review the information on the hydrogeology of the Christchurch Groundwater Recharge Zone, and to explain the technical basis for the boundaries of the Recharge Zone. The information focuses on the boundary between Zone 1 and Zone 2, and additional information is provided on the hydrogeological conditions present in the vicinity of Coutts Island, and the “Yaldhurst-Masham block”. In addition, groundwater quality information is provided.

RECOMMENDATION

That the policy paper No. 5 be uplifted from the table.

ATTACHMENTS

1. Working paper “ *Hydrogeology and boundaries of the Christchurch Groundwater Recharge Zone*” – Paper No. 5.
2. Power Point presentations on geology, hydrology, groundwater quality and the boundaries to Zone 1 and 2.
3. *Environment Canterbury Yaldhurst-Masham Review Stage 1* Prepared by Rob Potts, Glasson Potts Fowler Ltd

BACKGROUND

Christchurch City obtains high quality drinking water from the aquifer system below the city. The area to the west of Christchurch City, which comprises the recharge zone for the confined aquifer system, is coming under pressure from land use intensification and there is a significant risk of groundwater contamination.

Variation 1 of the Proposed Natural Resources Regional Plan (PNRRP) defined a protection zone (Zone 1) over the recharge area and required changes to the Selwyn District and Christchurch City plans to prohibit further subdivision for industrial, commercial or residential purposes in Zone 1. Both Selwyn District and Christchurch City believe that Environment Canterbury should implement this method rather than their respective Councils, although they support the outcome to maintain groundwater quality. There is also some legal uncertainty over the validity of the method, and staff have identified several areas where the provisions of the PNRRP could be improved.

On 7 April 2005, Council resolved to undertake work on a draft variation to Chapter 4 of the PNRRP and the provisions relating to the Christchurch Groundwater Recharge Zone.

The Regional Planning Committee has considered four working papers on the proposal for a variation. The Committee's recommendations were adopted by Council on the 27 October 2005.

The Committee sought further information on the relationship between the boundaries of the Christchurch Groundwater Recharge Zone and the hydrogeology of the aquifer system. This paper addresses that matter.

At the Regional Planning Committee meeting on 6 December 2005, no decisions were made on the recommendations of this report, pending further information on water quality impacts from urban land uses, and a review of information pertaining to the soils of the Yaldhurst Masham block had been completed.

THE PROPOSAL

The working paper contains a description of the Christchurch Groundwater Recharge Zone, and discusses the relationship between the hydrogeology of the groundwater system and the Zone boundaries. Information to be presented will include:

- An overview of the hydrogeology of the Christchurch Groundwater Recharge Zone;
- Report back on a meeting with Coutts Island residents;
- Description of groundwater quality in the Christchurch Groundwater Recharge Zone, which has been collected by Environment Canterbury and Christchurch City Council;
- A summary of the review of the currently available information regarding soil types and depths on the Yaldhurst- Masham block; and
- Options for the boundaries of the Christchurch Groundwater Recharge Zone.

CONSIDERATION OF THE OPTIONS

Alternative ways of defining the Christchurch Groundwater Recharge Zone boundaries are discussed in the attached working paper.

CONSISTENCY WITH EXISTING POLICY PLANS OR LEGISLATION

This paper forms part of a series of working papers on the proposal to vary the Proposed Natural Resources Regional Plan - a regional plan prepared under s. 65(1) of the Resource Management Act 1991.

VIEWS OF AFFECTED AND INTERESTED PARTIES

Staff have held meetings with a range of stakeholders, including Christchurch City Council and Selwyn District Council staff, representatives from Ngai Tahu, Department of Corrections, Community Public Health, quarry operators, Christchurch International Airport and Transit NZ.

Presentations were made to Christchurch City and Selwyn District Councils. Two public meetings were held at Yaldhurst Memorial Hall on 28 June 2005 and Environment Canterbury offices on the 29 June 2005. Both meetings were well attended.

A summary of the points arising from the meetings was reported to the Regional Planning Committee 13 July 2005.

Environment Canterbury staff continue to have regular meetings with Christchurch City Council and Selwyn District Council staff to discuss issues relating to the draft variation to the PNRRP.

A meeting was held with Coutts Island residents on 12 December 2005.

RECOMMENDATIONS

Two recommendations are incorporated within the attached paper:

- (a) That the proposed NRRP Zone 1 / Zone 2 boundary at Yaldhurst Rd – Masham Rd corner be altered to retain the land in Zone 1, because the position of this boundary will better reflect all of the factors upon which the location of this boundary is based.*
- (b) That a new zone – to be called Zone 3 - be added to the Christchurch Groundwater Recharge Zone to cover the area between Zone 2 and the coastline.*

In addition, two further recommendations are made:

- (c) That the boundary between Zone 1 and Zone 2 be located where the natural barriers to contamination comprising a layer of surface fine sediment more than 3 metres deep, and an upwards groundwater pressure, are both present.*
- (d) That the areas of Zone 1 that have an operative planning zone, which provides for urban development, be managed as subzones of Zone 1.*

**Natural Resources Regional Plan – Draft Variation 3 Working
Paper #5–**

**Hydrogeology and boundaries of the
Christchurch Groundwater Recharge Zone**

**Barry Loe
Loe Pearce & Associates**

**Raymond Ford
Senior Resource Management Planner**

6 December 2005

Executive Summary

The purpose of this paper is to:

1. provide an explanation of the hydrogeology of the groundwater system and relationship with the boundaries of the Christchurch Groundwater Recharge Zone (CGRZ).
2. define a new zone – Zone 3 – for the CGRZ
3. review the geological information for the Zone 1 – Zone 2 boundary in the vicinity of the Yaldhurst Masham area.
4. discuss the provisional boundaries of the subzones in Zone 2.

Key criteria for boundary identification

The key matters used to identify the Zone1/Zone 2 boundary are:

- having at least a three metre thickness of fine grained sediment between the ground surface and Aquifer 1.
- the presence an upwards pressure gradient within Aquifer 1.
- the location of existing urban development and areas zoned for such development.

Relationship between the boundaries of the Christchurch Groundwater Recharge Zone and the hydro-geology of the aquifer system

The CGRZ is a complex system resulting from the past and present interactions of the Waimakariri River with changing sea levels.

The land to the west of Christchurch overlies gravel, sand and silt deposited by the River. These free-draining sediments contain water that seeps from the river and rainfall that soaks through the ground (unconfined aquifer). Beneath and to the east of the city, fine sediments separate gravel deposits into water bearing layers (confined aquifers), where the groundwater is under pressure and will flow upwards to the surface. There is a gradual transition between the unconfined and confined aquifers.

The groundwater in the unconfined aquifers has very little natural protection from contamination, while the water in the confined aquifers is naturally protected by the fine sediments and the upwards groundwater pressure that prevent contaminants migrating down into the aquifers.

Two Zones are identified in the CGRZ: Zone 1 is the area of unconfined aquifer in the west and Zone 2 is the transitional zone between the unconfined aquifer and the confined aquifers system. Groundwater in both of these Zones is vulnerable to contamination as the natural features that protect the water quality are either not present or not strongly developed in these zones.

Proposed new zone – “Zone 3”

East of Zone 2, the natural features are sufficiently well developed to protect groundwater quality from activities on the land surface. Identifying the area of the CGRZ, where this protection is present provides a context for the other two zones.

Zone 1 – Zone 2 Boundary – Yaldhurst Masham area

The boundary between Zone 1 and Zone 2 is based on several factors, including; the change between the unconfined aquifer (Zone 1) and the confined aquifers (Zone 2), and the extent of the city that is identified for urban use. The assumption in the PNRRP is that where development has already occurred or is already zoned for development in the

Christchurch City Plan, the risk to groundwater quality must be managed, but in Zone 1 the risk can be avoided because development has not occurred, and it is not yet zoned for development.

At present, the boundary between Zone 1 and Zone 2 at the corner of Yaldhurst and Masham Roads extends into land that is zoned rural in the City Plan, but with a deferred residential zoning. Altering the Zone 1 boundary to include the land zoned rural would be consistent with the boundary position throughout the rest of the CGRZ. The groundwater in this area is not naturally protected from activities on the land surface.

Zone 2 Subzones

Former flood channels of the Waimakariri River extend into Zone 2. The Islington, Russley and Belfast channels are areas where the river has eroded the fine surface sediments exposing the gravels beneath. The groundwater pressure beneath these channels appears to vary between and within the channels. The vulnerability of groundwater in areas of these channels where there is no natural protection present is similar to that of Zone 1. These highly vulnerable areas need to be identified and management practices adopted to protect the groundwater quality.

Recommendations

1. The proposed NRRP Zone 1 / Zone 2 boundary at Yaldhurst Rd – Masham Rd corner be altered to retain the land in Zone 1, because the position of this boundary will better reflect all of the factors upon which the location of this boundary is based.
2. That a new zone – to be called Zone 3 - be added to the Christchurch Groundwater Recharge Zone to cover the area between Zone 2 and the coastline.

1. Introduction

The Proposed Natural Resources Regional Plan (PNRRP) has established a groundwater protection zone – the Christchurch Groundwater Recharge Zone (CGRZ) – to safeguard the source of Christchurch City’s drinking water. The CGRZ is divided into two management zones, reflecting present land uses and the relative vulnerability of groundwater in the Zone to contamination (Figure 1). The plan contains objectives, policies and methods to reduce the risk of groundwater contamination from land use activities.

The Council has decided that further work should be undertaken to determine whether a draft variation is required to control commercial, residential and industrial activities in Zone 1 of the CGRZ¹. A series of working papers containing recommendations to amend the PNRRP have been discussed and adopted by the Council². The Council decisions include defining the former Waimakariri River flood channels in Zone 2 as subzones. The Council has asked for further clarification of the hydrogeology of the groundwater system, and in particular, the technical basis for the CGRZ boundaries.

As a result of this review, it has become apparent that the reasons for dividing the CGRZ into Zone 1 and Zone 2 would be clearer, if a new zone, “Zone 3” is added to the CGRZ to cover the area where the confining layer is sufficiently thick and a strong upwards groundwater pressure means there is a low risk of groundwater contamination.

The purpose of this paper is to:

1. provide an explanation of the hydro-geological and planning matters that underpin the location of the boundaries of the CGRZ.
2. define a new zone – Zone 3 – for the CGRZ
3. review the geological information for the Zone 1 – Zone 2 boundary in the vicinity of the Yaldhurst /Masham area.
4. discuss the provisional boundaries of the subzones in Zone 2.

2. Hydro-geological setting of the Christchurch Groundwater Recharge Zone

The CGRZ is situated on a recent alluvial fan of the Waimakariri River³. During glacial periods, sea level was substantially lower than today and the Waimakariri River deposited gravel over a

¹ Environment Canterbury Council meeting 7 April 2005. Staff working paper “ Variation 3: Proposed Natural Resources Regional Plan – Control of land use in the Christchurch Groundwater Recharge Zone”

² Environment Canterbury Council Meeting 27 October 2005

³ Basher et al (1988)

plain extending many kilometres further east than the current coastline. During warmer interglacial periods, sea level was much higher than today and the coastline was on the western margins of the city. During these warmer periods, fine sediments were deposited on top of the gravel. The succession of glacial and interglacial periods has built a complex series of alternating aquifers and confining layers. In addition, periodic changes in the course of the Waimakariri River have created a series of gravel-filled flood channels across the alluvial fan (Figure 2).

East of a line running approximately along Johns Road and Russley Road, the gravel deposits become separated by beds of fine sediments (aquitards). These fine sediments separate the water bearing gravel layers into five confined aquifers, and together, the aquifers form the confined portion of the CGRZ.

This simple picture of a series of alternating layers of gravel and fine sediments is complicated by the presence of former flood channels where all or parts of the upper layer of fine sediments has been eroded away and beds of permeable gravel and have been deposited in the confining layer⁴ (Figure 4). These flood channels extend into the CGRZ as far as Wigram in the south, Fendalton in the centre of the Zone and Redwood in the north.

The groundwater system is recharged by both rainfall and a constant outflow of water from the bed of the Waimakariri River⁵. Groundwater flows generally east or south east towards the coast. Piezometric contours⁶ show that the groundwater flow divides around Banks Peninsula, flowing around the western side towards Lake Ellesmere/Te Waihora, or around the northern side towards Christchurch where it emerges as springs or enters the confined aquifer system⁷.

2.1 Natural barriers in the Christchurch groundwater system that protect groundwater from contamination.

The confined aquifer system has features that naturally protect groundwater quality from contaminants which may be released as a result of activities occurring on the land surface.

These features are:

- (a) the existence of low permeability layers of sediment (aquitards) at the surface and between the various aquifers in the confined system; and
- (b) an upwards groundwater (artesian) pressure gradient, resulting from the groundwater being confined between the impermeable beds of sediment.

⁴ Weeber (2002)

⁵ ECan (2001)

⁶ Piezometric contours are lines of equal piezometric pressure. They mark the height of the static water level above an aquifer. In an unconfined aquifer, the piezometric contours would coincide with the water table

⁷ Brown and Weeber (2002)

In the coastal Christchurch area, these low permeability layers are composed of fine and very fine grained materials of marine/ estuarine origin, such as sand, silt, peat, and clay. Their ability to prevent downwards movement of contaminants increases as the thickness of the sediment layer increases. Where the thickness of the fine sediment layer is less than three metres, the sediment layer can vary in thickness from nothing to three metres over short distances, and therefore not provide adequate protection from land use activities. To provide a sufficient level of certainty that the uppermost confining layer will be thick enough to provide an effective barrier, the three metre thickness line has been chosen as one of the criteria to define where the natural barrier exists.

The combination of low permeability sediment layers inhibiting the downward movement of contaminants, and the upwards water pressure working against gravity, prevents the migration from the surface of most types of contaminants into Aquifer 1 and limits the movement of groundwater between the aquifers.

The removal of either of these natural features, for example through excavation of the surface confining layer, or excessive pumping of groundwater that reduces groundwater pressures and may reverse the hydraulic gradient between the aquifers, renders the groundwater vulnerable to the downwards migration of contaminants from the surface.

2.2 How does the risk of groundwater contamination vary across the CGRZ?

The risk of groundwater contamination varies across the CGRZ. Zone 1 and parts of Zone 2 are the most vulnerable portions of the CGRZ⁸. The risk of contamination reduces towards the coast, as both the upwards groundwater pressures increase and the beds of confining sediments thicken towards the coast (Figures 3 & 4).

Zone 1

Zone 1 comprises the area of the CGRZ, west of Johns Road-Russley Road and the present urban area of Christchurch City. The groundwater in Zone 1 is situated within an unconfined aquifer, where it is particularly vulnerable to contamination from discharges and land use activities because:

- groundwater is present at shallow depths, from less than 3 metres to 20 metres below the ground surface, depending on the location within the Zone.
- the groundwater is “young” i.e. newly recharged, and therefore the effects of recent land use activities may affect water quality.
- the soil layer is generally less than 1 metre thick and comprises sandy and stony loams with little organic matter or fine material so there is little capacity or opportunity for contaminants to be assimilated by the soil.

⁸ Barber et al (2005)

- the gravels and sands overlying the groundwater are highly permeable, and comprise inert greywacke sediments that have very low capacity to remove contaminants from water or fluids as they percolate downwards through the gravels⁹

Zone 1 currently has only a low to moderate level of land use intensification compared with Zone 2.

Zone 2:

Zone 2 is the transitional zone between the unconfined aquifer system (Zone 1) and the fully confined aquifer system (Zone 3)¹⁰. Zone 2 is an area of complex geology containing elements of both the unconfined aquifer system and the confined aquifer system. In parts of Zone 2, principally the former flood channels of the Waimakariri River known as the Islington, Russley and Belfast channels, where all or most of the upper layer of fine sediments has been eroded, the aquifer resembles the unconfined aquifer of Zone 1, and is as vulnerable to contamination as the groundwater in Zone 1 (Figures 3 & 4) . The groundwater beneath all or parts of these areas of Zone 2 may be at greater risk of contamination than Zone 1 due to the existing urban development in Zone 2.

The two features that provide natural protection to the confined groundwater system, the upwards groundwater pressure and low permeability layer of fine sediments, only begin to develop across Zone 2. These protective features are not present in some areas of Zone 2, especially in the western part of the Zone (Figure 3).

Going from west to east, the groundwater system begins to change from an unconfined system, where the height of the water table fluctuates according to the amount of recharge and abstraction, to a confined system where the groundwater is under pressure between the confining layers. The area where the groundwater changes from an unconfined system to a confined system with an upwards pressure will vary depending on such factors such as the amount of the recharge, and abstraction. Because this is not a fixed point, this area has been portrayed as a blue band in Figure 3.

The natural barriers to contaminants entering the groundwater system are only weakly present in the central area of the Zone¹¹, and are interspersed with areas where at least one of the features is not present. The upper confining layer becomes a continuous layer in the central part of Zone 2, but in this area it may contain deposits of permeable gravels and sands, and not provide a complete barrier to contaminants.

⁹ Field testing has shown that surface gravels in the CGRZ have high infiltration rates (Griffiths 1991; Williams 2004). These highly permeable gravels form a natural defence against flooding from the Waimakariri River, as it has been estimated that if an outflow of floodwaters from the river occurred, a substantial portion of the outflow would soak into the ground before reaching Christchurch.

¹⁰ Weeber (2002)

¹¹ Ibid

These protective features do not become fully developed until towards the eastern part of Zone 2, where an extensive low permeability confining layer overlies Aquifer 1, and there is a consistent and strong upwards groundwater pressure.

Zone 3 (new):

Staff propose that a new zone – to be called Zone 3 – be established in the CGRZ. This zone would comprise the area between Zone 2 and the coast where the confining material is sufficiently thick that there is a low risk of downwards movement of contaminants and there is a strong consistent upwards groundwater pressure. The reason for establishing a new zone is to show that the Christchurch Groundwater System extends beyond the eastern boundary of the Zone 2 to the coastline, and to emphasise that Zone 2 is a transitional zone, between the unconfined and confined aquifers, where there is still a significant risk of groundwater contamination from land use activities.

In Zone 3, the thickness of low permeability fine sediments overlying Aquifer 1, increases from 5 metres in the vicinity of the Zone 2 and Zone 3 boundary, to about 40 metres deep at the coast (Figure 3). It is only in this Zone that the depth of overlying sediments and the upward groundwater pressure together provide complete protection to groundwater quality from activities at or near the land surface.

3. The boundaries of the Christchurch Groundwater Recharge Zone

The CGRZ encompasses the recharge area of the confined aquifer system that is the source of the water used in Christchurch City's reticulated water supply network¹².

The extent of the CGRZ is based primarily on the following hydro-geological conditions:

- the south western extent of the Zone is the groundwater flow direction divide between groundwater flowing into the Christchurch groundwater system and that flowing into the Lake Ellesmere system;
- the southern extent of the zone is limited by Banks Peninsula which forms a hydraulic barrier to the south;
- the eastern limit is defined by a north-south line in the vicinity of Marshlands Rd where the confining layer above Aquifer 1 forms a thick (> 5 metres) low permeability barrier with no lenses or layers of gravels;
- the northern extent is the Waimakariri River which is the predominant source of recharge to the upper aquifers.

¹² ECan (2001), CCC (2005)

3.1 Why are the CGRZ boundaries located in their present position?

A precautionary approach was taken to defining the perimeter of the CGRZ in the PNRRP. For the following reasons the boundary of the CGRZ encompasses the maximum source area of groundwater that recharges the confined aquifers:

- The subsurface geology within the CGRZ is very complex. It is thought that groundwater does not flow in a uniform direction or rate towards the coast, but that groundwater moves along preferential flow paths where there are zones of more permeable gravels. The distribution of surface sediments on the Waimakariri River, as shown on geological maps (Figures 2 & 3), is the result of the most recent outflows of the Waimakariri River. The deeper sediments may exhibit a different pattern of channels and fine sediments.
- The direction of groundwater flow is based on regional piezometric contours. The shape of the contours can vary depending on the seasonal recharge and groundwater abstraction.
- Once a management zone is established in a plan, it will generally be more difficult to expand the size of zone as land uses become established. It will usually be easier to reduce the size of a zone as new information becomes available.

The boundaries of the CGRZ could be based solely on hydro-geological criteria. If this boundary was to follow a geological feature, such as the edge of the three metre layer of fine sediments, the result would be a convoluted line or series of lines that would wend their way across the CRGZ, cutting across properties, roads, and zone boundaries in the Christchurch City Plan. The administration of this type of boundary would create some practical problems because:

- parts of the Christchurch urban area have already expanded beyond the geological boundary and developed over the more vulnerable parts of Zone 2 (Figure 5) . Therefore, a boundary in this position would have little practical effect.
- the position of the boundary would reflect subsurface geological features that have no surface expression. To locate the line on the land surface would require reference to a large scale planning map or to interpolate its position from nearby boreholes, if they are present.
- the position of the boundary line is inferred from boreholes, and because the subsurface geology is highly variable, the boundary of the line may change as new bores provide additional information. As the density of boreholes increases, the uncertainty about the position of the line is reduced. This problem could be overcome to some extent by defining a zone of uncertainty and using the most conservative line to define the boundary of CGRZ.
- where planning boundaries have been based purely on a natural feature which has variable properties, e.g. Class 1 soils, the boundary line has resulted in litigation over the extent to which an application is “in” or “out” of the zone. By contrast, a planning zone with

boundaries based on distinct physical features offers much clearer guidance and reduces the scope for ambiguity and debate.

For these reasons, it was proposed that the boundaries of the CGRZ should be a planning zone with boundaries that are based on a number of factors including; hydro-geology, administrative boundaries from district plans, the present urban area, and roads

3.2 The boundary between Zone 1 and Zone 2

The position of the Zone 1 and Zone 2 boundary, which runs along Johns Rd/ Russley Rd and on to Waterloo Road, is based on the following factors:

- It represents the approximate boundary between the unconfined aquifer to the west and the transitional zone to the east;
- It includes the extent of the existing urban development of the city;
- It follows the Christchurch City Council Plan boundaries between land currently zoned for urban purposes and land zoned for rural purposes;
- It is along an obvious physical feature, a road, for much of its length.

3.3. The boundaries of the former flood channels in Zone 2

Within Zone 2, former flood channels of the Waimakariri River are present. (Figures 2 & 3)

These are the Islington Channel in the south-west, the Russley Channel in the centre of Zone 2 and the Belfast Channel in the north. In these channels, the groundwater pressure in Aquifer 1 beneath these former flood channels areas appears to vary from channel to channel (Figure 3).

In the Islington Channel, neither of the factors that provide natural protection to groundwater quality are present. The groundwater beneath this area is particularly vulnerable to contamination as the upper layer of fine sediments has been eroded away and there is no upwards pressure to prevent contaminants moving into groundwater. The land and groundwater in this area has the same vulnerability characteristics as in Zone 1 of the Recharge Zone.

While the groundwater in Aquifer 1 beneath the Russley and Belfast Channels, at least in the eastern part of the channels, exhibits an upwards groundwater pressure.

The areas of land within the former flood channels have been progressively developed for urban purposes¹³ or are identified in the Christchurch City Plan for urban expansion. The Islington Channel includes the former Wigram Aerodrome, and industrial and residential land in the Hornby area. In the past, this area was used for a variety of industrial activities, such as quarries, freezing works and a tannery that discharged wastes into the ground¹⁴. The detection

¹³ Ford & Loe (2005a)

¹⁴ Bennett (1982)

of contaminants in groundwater in this area¹⁵ is likely to reflect the lack of natural protection for groundwater.

The area of the Russley Channel has been developed for primarily residential purposes, with some commercial and industrial use in the western areas. Historically, the western areas of the channel were used for quarries which subsequently have been back-filled¹⁶. While the surface fine sediments are not present in this area, the groundwater in Aquifer 1 appears to be exerting an upwards pressure at least over part of the area.

The Belfast Channel, while a smaller incursion into Zone 2, has not yet been fully developed for urban use. It is likely that an upwards groundwater presence exists over part of the channel but, as with the Russley Channel, further technical assessment is required.

These areas of former river channels in Zone 2 are shown on Figure 3. Because of the vulnerability of groundwater to contamination in these areas, it is proposed to create management zones to manage the risk. In a previous working paper to the Regional Planning Committee, it was recommended that management of these areas to protect groundwater quality be undertaken in collaboration with the Christchurch City Council¹⁷.

In determining the position of the planning boundaries of these subzones, several factors need to be considered:

- the location of the area where an upwards aquifer pressure begins varies according to factors such as the amount of groundwater recharge and abstraction. The eastern edge of the band defines the area where the upwards groundwater pressure is consistently present.
- the uppermost confining layer of fine sediments needs to be more than three metres thick and to form a continuous layer to provide adequate protection for the underlying aquifer.
- the identification on maps of the fine sediment layer will vary as more wells are drilled and information is collected. The position of the three metre line can be defined by an error band. To minimize, any uncertainty over the location of the line, the subzone boundary should follow the most conservative line i.e. where the sediment is thickest.

3.4 Zone 1 / Zone 2 boundary at Yaldhurst Masham.

The boundary between Zone 1 and Zone 2 is located on the western edge of land zoned for residential purposes in the Proposed Christchurch City Plan. The boundary reflects the assumption in the PNRRP that in areas that are already used or are intended for residential and other urban purposes, the risk to groundwater quality must be managed. In areas where urban use has not yet been anticipated, this risk can be avoided.

¹⁵ Hayward (2002)

¹⁶ ECan (2001) Refer to Figure 5.1

¹⁷ Ford & Loe (2005b)

The current boundary runs along Johns Road and Russley Road until it meets Yaldhurst Road. South-west of Yaldhurst Road the boundary continues to follow this western perimeter of land zoned for residential or industrial use. West of the boundary the land is zoned rural.

The current position of the boundary passes through land known as the “Yaldhurst – Masham Block”. On the eastern side of the current boundary line the land is zoned rural, but has a deferred zoning of residential in the Christchurch City Plan.

In terms of geology, there is a localised area of fine river sediment, of varying thickness, on the gravels beneath the Yaldhurst Masham block, however the groundwater does not exhibit any positive pressure, so no upwards gradient is present. Therefore, both the natural features that are needed to protect groundwater quality are not present beneath this block. The groundwater in this area is in an unconfined aquifer, and is therefore vulnerable to contamination from activities on the land surface.

The alteration to the boundary, proposed in the earlier NRRP working paper¹⁸, is to include this land in Zone 1 as it is an area where, although the Christchurch City Plan indicates possible future residential use, it is not currently provided for in the City Plan. This change to the boundary to include all of this land in Zone 1 would ensure a consistent application of the location of the boundary – the divide between land that is provided for urban residential purposes and that which is zoned rural.

To conclude, all of the land in the Yaldhurst-Masham block should be included in Zone 1. The geological characteristics of Zone 1 are present over the whole site, and the land is not developed, or provided for in the City Plan for development for urban use.

4. Recommendations.

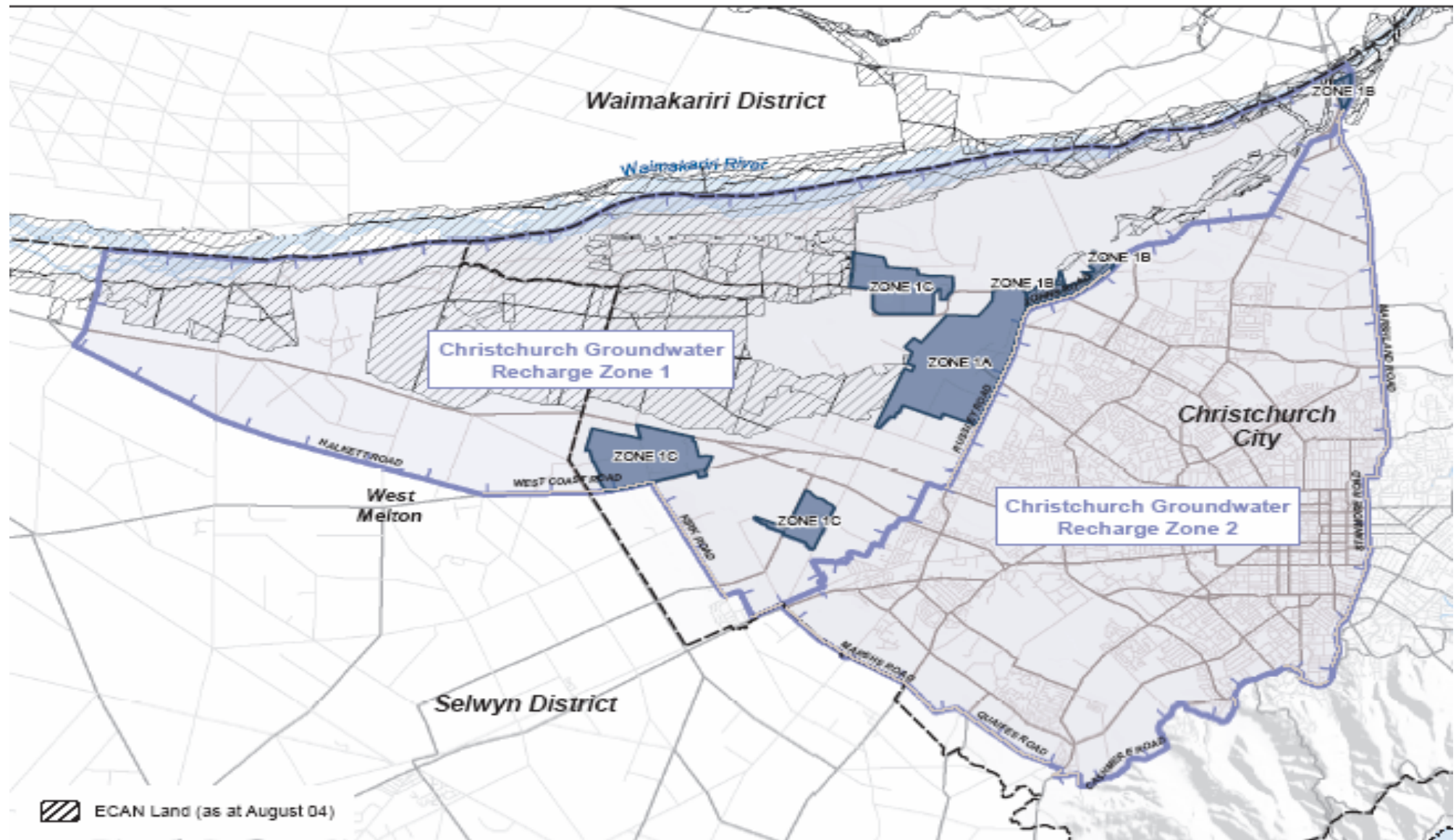
1. The proposed NRRP Zone 1 / Zone 2 boundary at Yaldhurst Rd – Masham Rd corner be altered to retain the land in Zone 1, because the position of this boundary will better reflect all of the factors upon which the location of this boundary is based.
2. That a new zone – to be called Zone 3 be added to the Christchurch Groundwater Recharge Zone to cover the area between Zone 2 and the coastline.

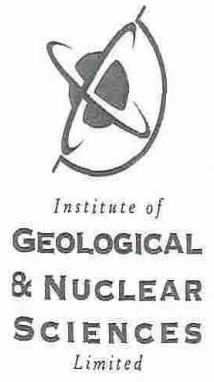
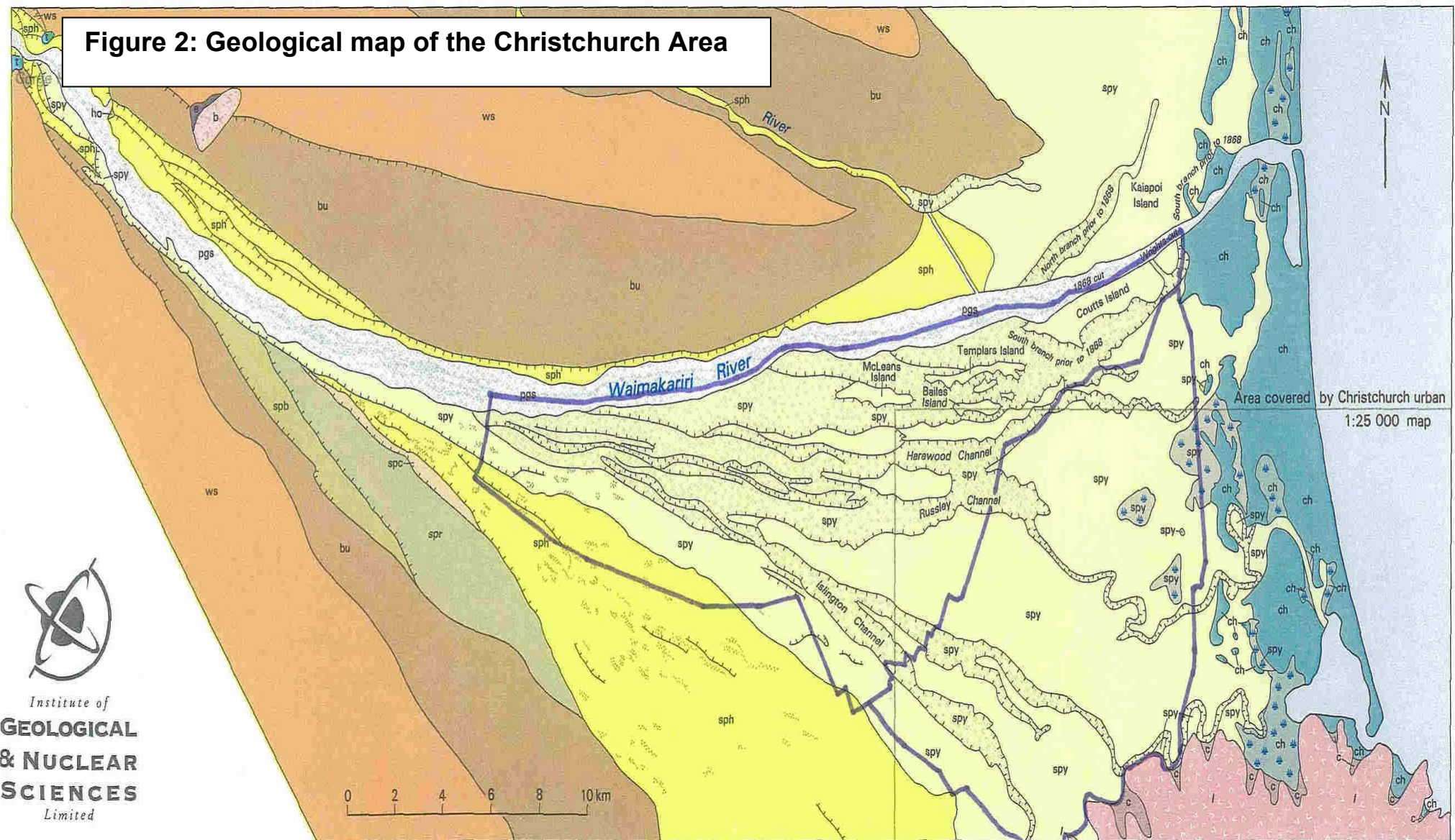
¹⁸ Ford & Loe(2005b)

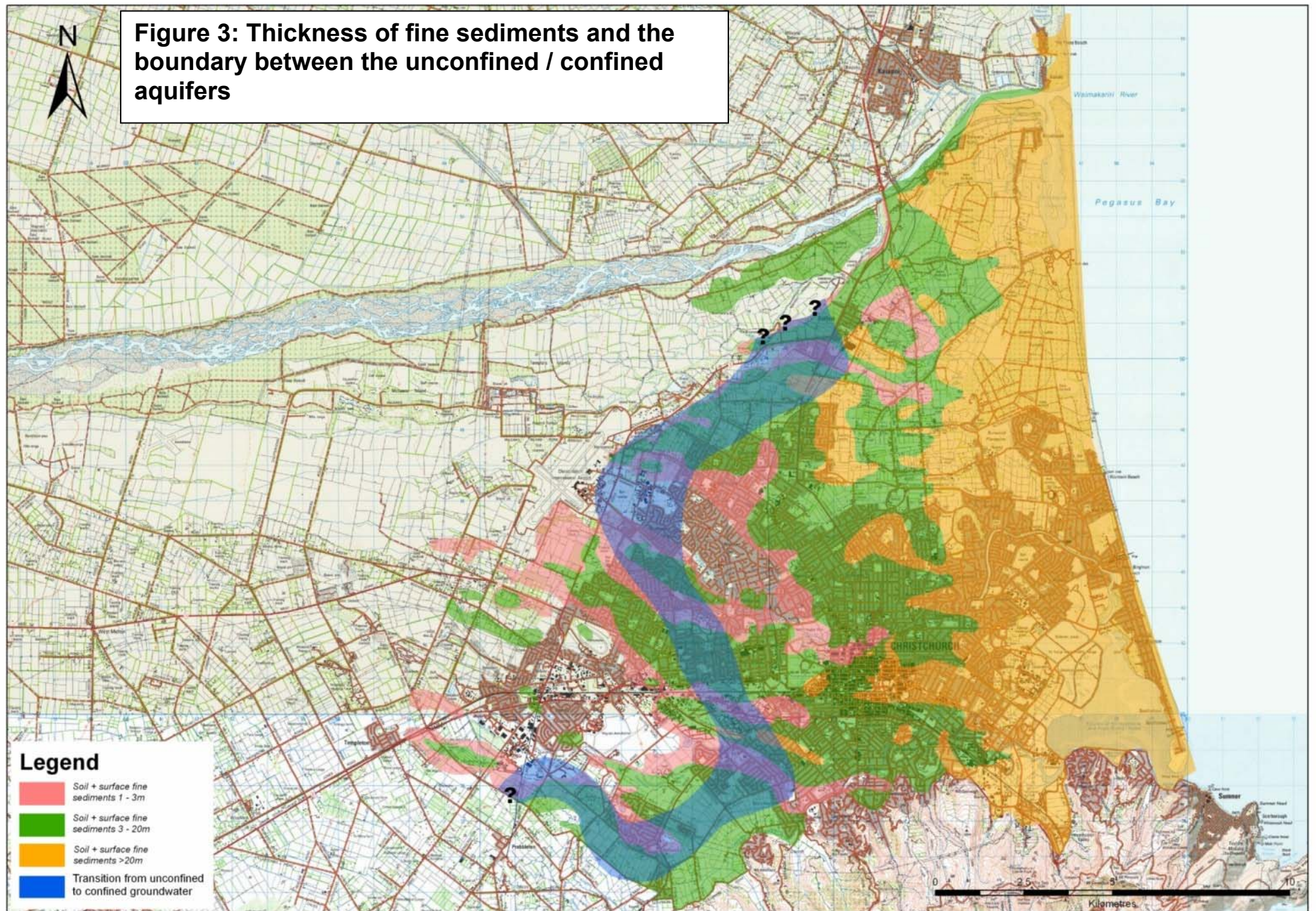
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Figure 1: Christchurch Groundwater Recharge Zone



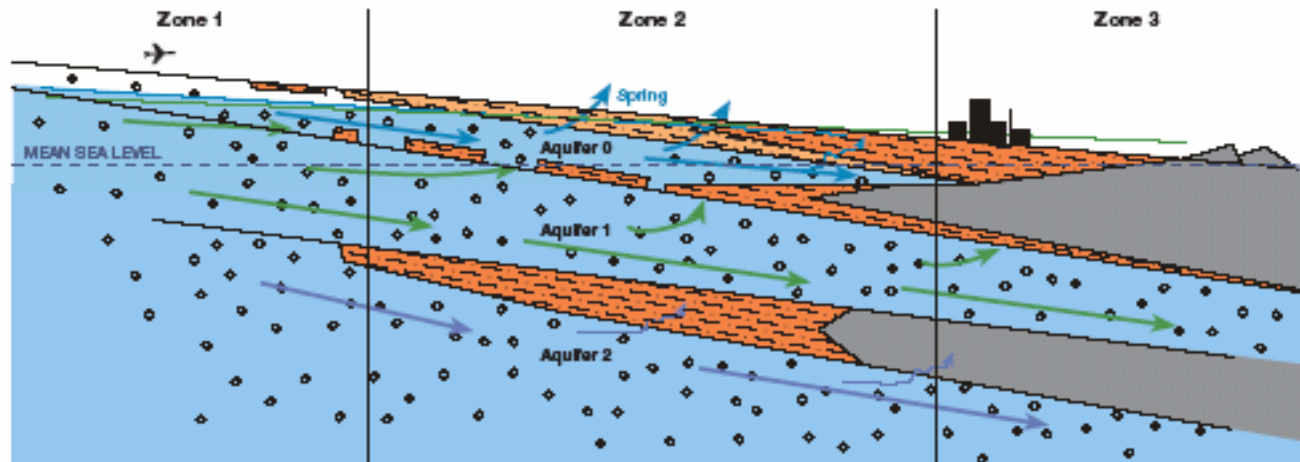




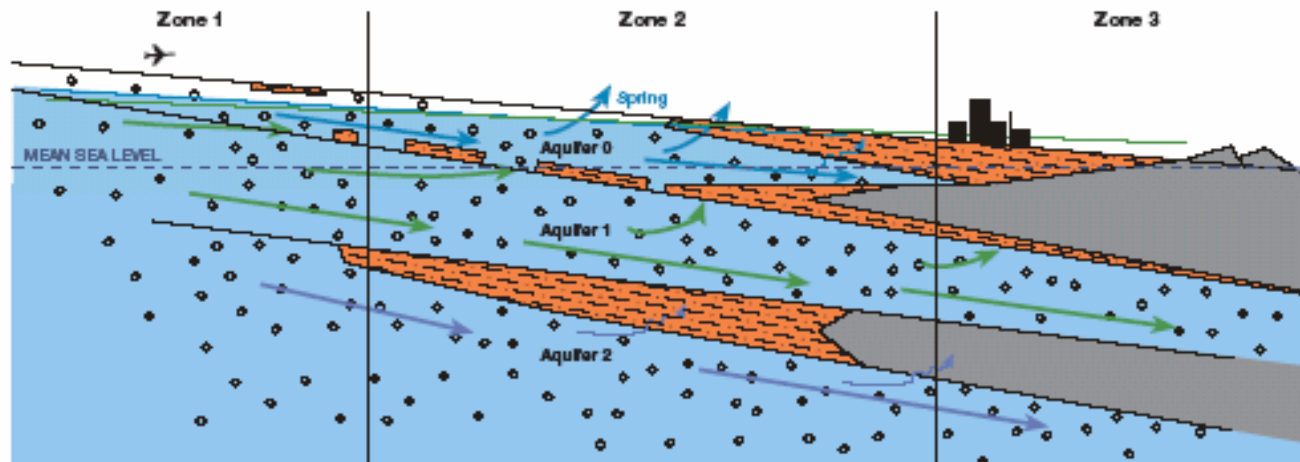
Generalised cross-sections of the Christchurch Groundwater Recharge Zone NB: Vertical scale exaggerated

Figure 4








A: Outside of former Waimakariri River flood channels



B: Across former Waimakariri River flood channels



LEGEND

-  Alluvial fine sediments
-  Estuarine/marine fine sediments
-  Alluvial gravel, sand, silt
-  Saturated alluvial gravel, sand, silt
-  Aquifer 0 groundwater flow
-  Aquifer 1 groundwater flow
-  Aquifer 2 groundwater flow

