



Water and Sanitary Services Assessments



WASTEWATER

Adopted By Council 13 October 2005

Contents

1. Executive Summary	1
1.1 Methods Used to Dispose of Wastewater	1
1.2 Risk Assessment	1
1.3 Quality and Quantity of Discharged Wastewater	2
1.4 Current and Estimated Future Demands	2
1.5 Options to Meet the Demands	3
1.6 Christchurch City Council's Role in Meeting the Demands	4
1.7 Proposals for Meeting the Demands	4
1.8 Consultation with Medical Officer of Health	4
2. Introduction	5
2.1 Purpose and Scope	5
2.2 Project Methodology	5
2.3 Reference Documents	6
2.4 Community Definitions	6
2.5 Consultation Outcomes	7
2.6 Territorial Authority Area	7
2.7 Timeframe Considered	8
3. Description of Wastewater Services	9
3.1 Introduction	9
4. Urban Wastewater Collection, Treatment and Disposal	10
4.1 Introduction	10
4.2 Wastewater Flow Projections	11
4.3 Urban Wastewater Treatment Process	11
4.4 Urban Wastewater Disposal	12
4.5 Untreated Sewage Overflows	12
5. Urban Fringe Wastewater Treatment and Disposal	15
5.1 Northeast Fringe Wastewater Treatment and Disposal	15
5.2 Northwest Fringe Wastewater Treatment and Disposal	18
5.3 Southeast Fringe Wastewater Treatment and Disposal	23
5.4 Southwest Fringe Wastewater Treatment and Disposal	24
6. Urban Area Risk Assessment	26
6.1 Urban Area Risk Assessment Methodology	26
6.2 Christchurch Treatment Plant Risk Assessment	27
6.3 Urban Sewage Overflow Risk Assessment	31
7. Urban Fringe Risk Assessment	36
7.1 Risk Assessment Methodology	36
7.2 Wastewater Treatment Scheme Risk Factors	37
7.3 Northeast Fringe Risk Assessment	38

7.4	Northwest Fringe Risk Assessment	38
7.5	Southeast Fringe Risk Assessment	41
7.6	Southwest Fringe Risk Assessment	41
8.	Options to Meet Demand	42
8.1	Existing Plans	42
8.2	Options to Meet the Demands	43
8.3	Proposed Action Plan	44
	Appendix A Risk Assessment Methodology	1
	Appendix B Risk Assessment Spreadsheet	1

1. Executive Summary

This assessment of Wastewater services has been undertaken as required under Part 7 Section 125 of the Local Government Act 2002. The following paragraphs are the summary of the Wastewater Services Assessment (Statement of Proposal) to be used as part of the Councils Assessment of Water and Sanitary Services.

1.1 Methods Used to Dispose of Wastewater

For the purpose of making the assessment the City has been broken up into two separate communities, the urban community and the urban fringe community. The urban community includes the Council provided collection and disposal schemes for the City and Belfast. The urban fringe community includes the areas bordering the Christchurch metropolitan area and within the city boundaries but not served by the reticulated network.

Wastewater from Christchurch City is treated at the Christchurch Wastewater Treatment Plant (CWTP) and the treated effluent is currently discharged into the Avon-Heathcote Estuary. The Christchurch City Council is planning to replace the estuary discharge with an ocean outfall by 2009.

Wastewater from the Belfast township is treated through oxidation ponds and the effluent is currently discharged to Otukaikino Creek, a tributary of the Waimakariri River. The discharge from the ponds will be pumped to the CWTP by the end of 2006.

The urban fringe area utilises stand-alone schemes for wastewater treatment and disposal. These schemes mostly consist of single chamber septic tanks with gravity disposal trenches. It is estimated that there are 800 to 1,300 such properties within the Christchurch boundary.

1.2 Risk Assessment

The discharge of effluent from the Christchurch Wastewater Treatment Plant contributes to the health risk for users of the estuary. The risk zone is assessed as being very small and centred around the point of discharge.

The wet weather overflows to the Avon and Heathcote rivers significantly increase the levels of contaminants in the rivers while the overflow is occurring and for a period of time afterwards. These present a public health risk to users of the rivers. A significant mitigating factor is the prevalence of low-contact water related activities that are generally discouraged by the poor weather or high river flow conditions that coincide with the sewer overflows.

The effluent from the Belfast Oxidation Ponds is of inconsistent quality and currently presents a public health risk to users of the receiving stream.

The main risks associated with septic tanks are summarised below:

- Treatment plant or disposal field poorly designed leading to a low level of treatment.

- Treatment plant or disposal field poorly maintained leading to uneven distribution of effluent.
- Shallow groundwater leading to contamination of groundwater.
- Poor quality or hydraulically limited soils leading to surface ponding or shallow groundwater contamination.

The higher risk area is the Marshlands area owing to its shallow groundwater and peaty soils.

There is a potential health risk for properties on night soil collection because of the untreated wastewater being held on site for up to a week.

1.3 Quality and Quantity of Discharged Wastewater

The Christchurch wastewater system collects approximately 55 million cubic metres of wastewater each year, transporting it through a series of sewers and pump stations to the treatment plant at Bromley. The advanced secondary treatment process produces a very high quality effluent which is discharged to the Avon-Heathcote Estuary. There are also 12 consented locations where diluted untreated effluent is occasionally discharged, during periods of high rainfall, to the Avon and Heathcote Rivers.

Approximately 0.4 million cubic metres annually are collected from the Belfast area, treated in oxidation ponds and discharged into a tributary of the Waimakariri River. The effluent from the Belfast Treatment Plant is of inconsistent quality and has occasionally failed to comply with resource consent conditions.

There are approximately 800-1,300 domestic septic tank systems in operation on the fringe areas of Christchurch. These systems consist mainly of single chamber septic tanks with gravity disposal trenches. The estimated volume of effluent associated with this number of tanks is 500-800 cubic metres a day. The effluent quality of these systems is highly variable and dependant on design, construction and maintenance standards adopted by the owners.

There are currently 11 properties in the northeast fringe area that are served by a night soil collection. Untreated effluent is kept in a holding tank which is emptied out and taken to the Christchurch Wastewater Treatment Plant. Four of these properties are currently being connected to the city reticulation, five of them are being collected on a weekly basis and two only occasionally.

The Christchurch and Belfast wastewater collection and treatment systems are operated by appropriately trained and qualified staff. It is assumed that the domestic tank systems are operated by property owners who have limited knowledge of wastewater treatment systems.

1.4 Current and Estimated Future Demands

Future demand for the Council operated supplies are assessed in detail in the Wastewater Asset Management Plan. Wastewater flows are projected to increase as a result of:

- Increased population (approximately seven percent in the next ten years).

- Intensification of development of fringe areas meaning septic tank effluent disposal fields are less acceptable from a public health perspective.
- Increases in inflow and infiltration into the system. This has been estimated to increase by 10% over the next 40 years as the collection network ages.
- The connection of Belfast to the Christchurch Wastewater Treatment Plant (additional 0.4m cubic metres in 2007).

The upgrades to the CWTP have been designed to provide sufficient system capacity for future planned demands up to the year 2050. The reticulation upgrades are also being to cater for projected flows at this time.

The demands are also projected to increase as a result of environmental concerns regarding the wet weather overflows to the Rivers, the current discharge of treated effluent to the estuary and the discharge of Belfast's effluent to the Otukaikino Creek.

There is also demand to get properties currently served by night soil collection onto alternative methods of wastewater collection, treatment and disposal.

1.5 Options to Meet the Demands

Options to meet demand resulting from population growth:

- Construction of additional pumping stations and pipelines to increase capacity to help meet peak demands (Major Sewer Upgrade Project).
- Inflow and infiltration reduction programmes (ongoing maintenance programme).
- Increase capacity of treatment plant (CWTP Upgrade Project).
- Wastewater system modelling to identify operational changes to increase system efficiencies, monitor effectiveness of capital works and rehabilitation programmes, assist with pipe sizing and capacities required.
- Investigate alternative systems such as storage or decentralised treatment systems to help cater for peak flows and cater for growth above the current CWTP Upgrade.

Options to meet demand related to environmental issues:

- Inflow and Infiltration reduction programmes.
- Capital works to reduce wet weather overflows.
- Diversion of Belfast's wastewater flow from the Otukaikino Creek.
- Construction of ocean outfall to replace the current estuary discharge.

Options to meet demand related to night soil collection:

- Investigate options to get properties off night cart collection.
- Investigate reticulated septic tank options (STEP/STEG systems).

- Extend city reticulation to service the properties.

1.6 Christchurch City Council's Role in Meeting the Demands

In general the Christchurch City Council will play the role of facilitator in meeting the demands for wastewater services. It is expected that any new infrastructure for growth will be ultimately funded by developers and Council may assist in setting up cost share areas to recover funds from future developments. The Council may also consider assistance with funding of the service where there are significant public health issues. This would be assessed on a case by case basis.

1.7 Proposals for Meeting the Demands

The Christchurch City Council is already implementing its plans to meet the future demands. This includes:

- Upgrade of Christchurch wastewater treatment plant to increase capacity and effluent quality.
- A major sewer upgrade programme for new sewers to cater for projected growth and pipeline rehabilitation, some of these works are also aimed at reducing the wet weather overflows to the rivers.
- Construction of an ocean outfall to divert all treated wastewater from the estuary and discharge offshore via a 3 kilometre pipeline.
- Construction of a pipeline to take wastewater from Belfast to the Christchurch Wastewater Treatment Plant.
- Inflow and Infiltration reduction programmes.
- Capital works to reduce wet weather overflows.
- Diversion of Belfast's wastewater flow from the Otukaikino Creek.
- Construction of ocean outfall to replace estuary discharge.

The Christchurch City Council also proposes to investigate options to get the remaining properties off night cart collection.

1.8 Consultation with Medical Officer of Health

The Medical Officer of Health has been consulted in the process of making the assessment. Meetings were held with relevant staff and a draft copy of the assessment was provided for review. Comments received on the first draft have been incorporated into the assessment.

1.9 Assessment of Options

Various options to meet the demands are detailed in the draft assessment. The preferred options for addressing the issues identified have been considered as part of the Special Consultative Procedure.

2. Introduction

2.1 Purpose and Scope

This document is an assessment of all wastewater discharges in the geographical area under the jurisdiction of the Christchurch City Council. It considers the wastewater services provided by the Council as well as those services provided by others independent of the Council. Non-council service providers include the following:

- Marshland School.
- Ouruhia School.
- Yaldhurst School.
- McKenzie School.
- Paparua Youth Justice Facility.
- Christchurch International Airport.
- Canterbury Kennel Association.
- Leisure Club.
- Isaac Construction Company Limited.

The Local Government Act 2002 requires all territorial authorities throughout New Zealand to prepare assessments of water and sanitary services, with the primary purpose to safeguard public health. The first such assessment must be completed by 30 June 2005. The term “water and sanitary services” includes:

- Water supply (drinking water).
- Sewerage works and works for the disposal of sewage (including disposal of night soil).
- Stormwater.
- Cemeteries.
- Crematoria.
- Public toilets.
- Waste disposal.

Part 1 of this document considers water supply only and Part 2 considers sewerage. These are the first two categories listed above. The remaining categories are covered by separate documents that are being prepared by others.

2.2 Project Methodology

The methods used to prepare this assessment as a requirement of the Local Government Act 2002 have incorporated the following:

- Identification of services, to identify all water supply and sewage services provided by the Council and significant services not provided by the Council, eg. schools, hospitals, Christchurch Airport, prisons, camps, etc.

- Collection of data. All necessary data has been collected from available publications, reference documents, and discussions with service providers and regulatory authorities.
- Identification of population projections. All necessary data on population projections and new developments proposed within the territorial authority area has been obtained from Christchurch City Council to enable assessments of future demands.
- Consultation with Council personnel and other agencies including Community and Public Health has been conducted to obtain information on problems within the territorial authority area with respect to public health specifically related to sewerage services.
- Identify the risks to the communities of no adequate water supply or sewerage service particularly with respect to public health and environmental issues. Existing risks have been identified, analysed and evaluated using methods set out in NZS 4360:1999 Australian and New Zealand Standard for Risk management and HB203:2000 Australian and New Zealand Standard for Environmental Risk Management. - Principles and Process
- Review Policy Implications. To afford the Council opportunity to develop and / or review policy implications. Council personnel were consulted to determine the response that Council needs to take and this response has been included in the assessment documents.
- Prepare Initial Assessment

2.3 Reference Documents

In undertaking this assessment, reference has been made to a number of other documents, Council plans and reports. Where this has been done, endnotes are provided referencing these. Important reference documents for this assessment of wastewater services are:

- Christchurch City Wastewater Management Plan, Part 1 – Strategic Issues (2004).
- Christchurch City Wastewater Management Plan, Part 2 – Asset Management Overview (2004).
- Christchurch City Council Wastewater Treatment Plant Asset Management Plan (2003).
- Christchurch City Council website <http://www.ccc.govt.nz/consultation/wastewater>.
- Christchurch City Council Wet Weather Sewer Overflow Response Plan.
- CWTP Environmental Management Plan

2.4 Community Definitions

For the purpose of this sanitary services assessment, two community groups have been identified and are defined in Table 1:

■ **Table 1: Definition of Communities**

Community	Location
Urban	<ul style="list-style-type: none"> ■ Christchurch City. ■ Belfast.
Urban Fringe	<ul style="list-style-type: none"> ■ Northeast fringe (Marshland and Ouruhia). ■ Northwest fringe (Yaldhurst, Harewood, McLeans Island). ■ Southeast fringe (Mount Pleasant, Scarborough -Taylors Mistake) ■ Southwest fringe (Halswell and Westmorland).

The urban area is defined as the high-density metropolitan area containing Christchurch City and associated high-density satellite townships. Treatment schemes within this area include Christchurch and Belfast, which accept domestic effluent as part of a council provided reticulation and treatment scheme.

The urban fringe area includes varying density residential areas, and small towns, subdivisions, prisons and other institutional facilities bordering the Christchurch metropolitan area and other specific sites within the Christchurch City district boundary.

This assessment has been limited to include only those properties discharging not less than 1 m³/day and some groups of properties that have concentrated discharges though individually discharge less than 1 m³/day. The Special Consultative Procedure to be undertaken by the Council as part of this assessment may identify further properties and schemes.

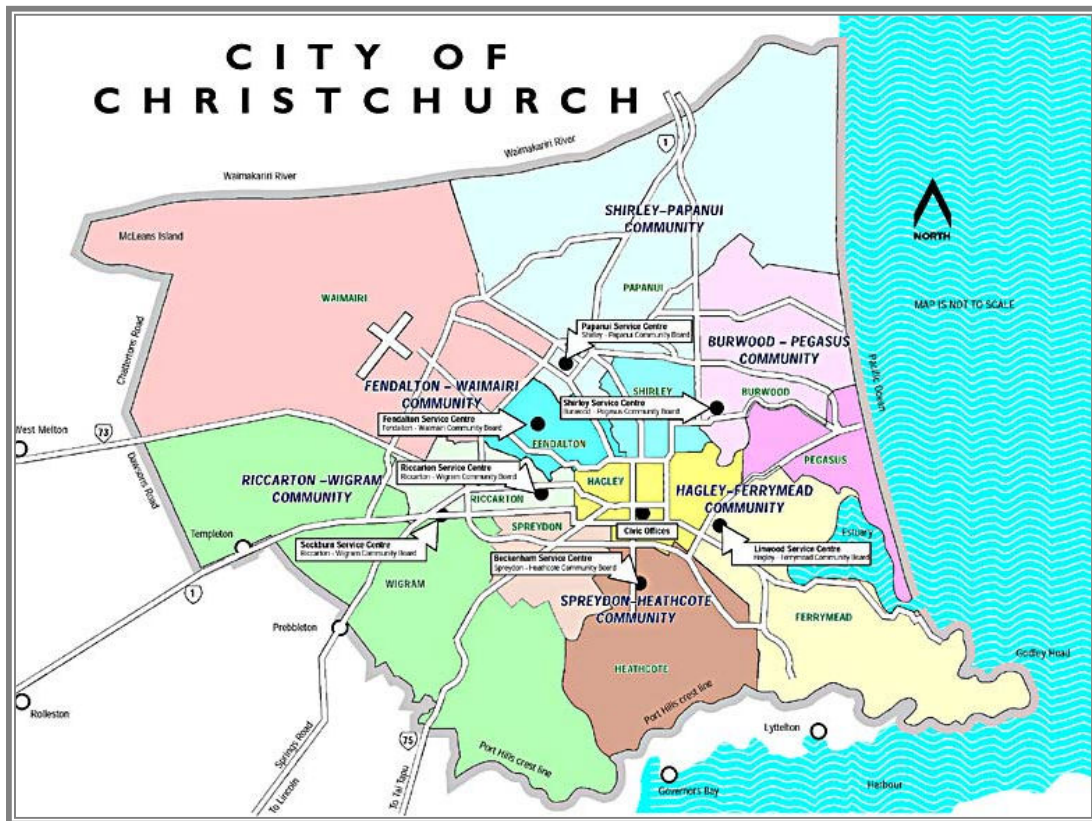
2.5 Consultation Outcomes

In undertaking this assessment, the Council wants to provide its customers with an opportunity to comment on the findings and proposals forming the assessment. The Local Government Act 2002 provides for the Council to undertake a Special Consultative Procedure that will give customers that opportunity through making a submission on the assessment. A public notice will provide details of how and when a submission can be made.

2.6 Territorial Authority Area

The Christchurch territorial authority area is bounded to the east by the Pacific Ocean and the estuary of the Avon and Heathcote rivers, to the south and southeast by the Port Hills and in the north by the Waimakariri River. The area is shown in Figure 1.

■ Figure 1: Territorial Authority Area



2.7 Timeframe Considered

The next ten year period has been considered in the preparation of these assessments. Forecasting information has been obtained from Statistics New Zealand population growth forecasts, areas zoned or indicated for development, current demand trends and existing reports.

3. Description of Wastewater Services

3.1 Introduction

The assessment of wastewater services has been divided into two groups based on geographical areas as defined in Section 2.4:

- Urban.
- Urban fringe.

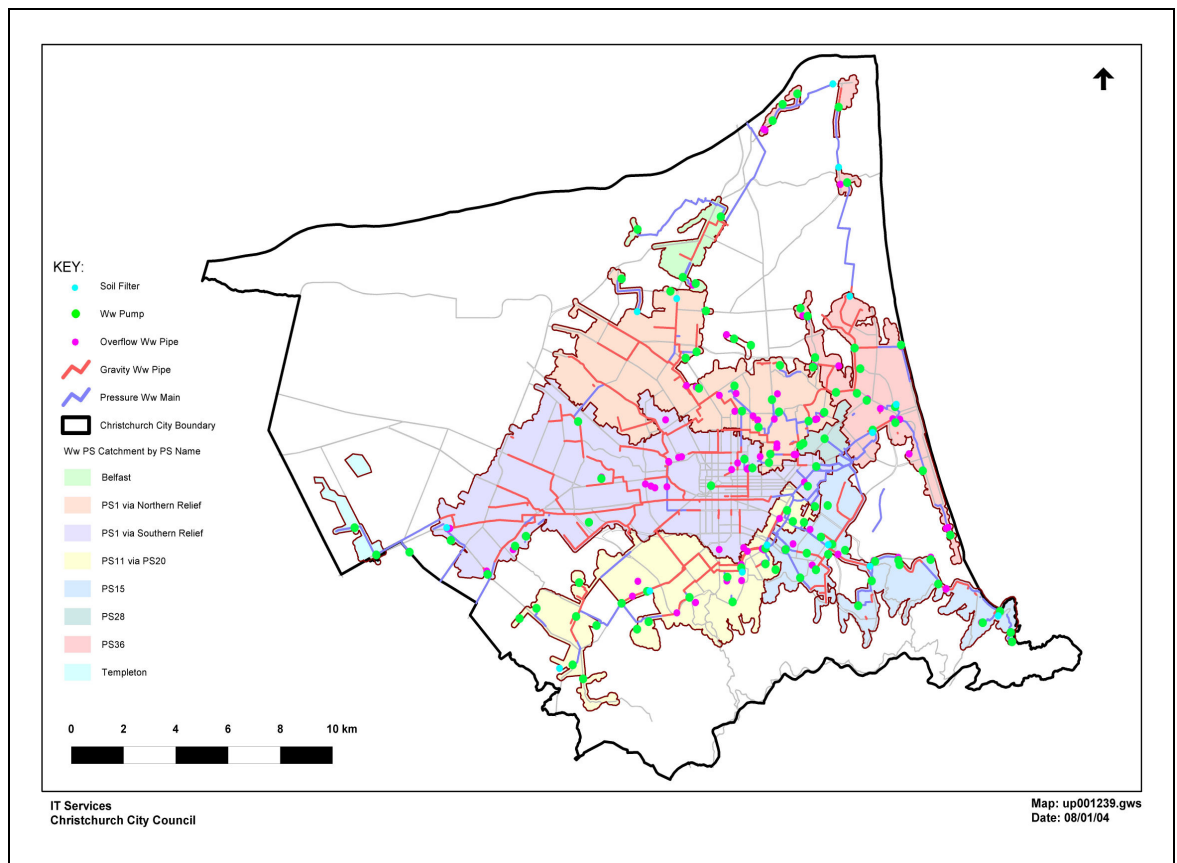
The groups are arranged geographically to take account of several factors. Each group represents a particular density of development and as such may be better suited to some types of wastewater collection and disposal schemes than others. Urban communities are likely to be served best by a centralised treatment plant connected to an integrated collection network. Communities located in the urban fringe area may be served by stand-alone small treatment schemes, but also have potential to be connected to the urban network.

4. Urban Wastewater Collection, Treatment and Disposal

4.1 Introduction

The communities identified in this group are Christchurch City and Belfast. The Christchurch City Council collection system is shown in Figure 2 below.

■ Figure 2: Christchurch City (including Belfast) Collection System



According to the Environment Canterbury resource consent register, there are no discharges of human sewage within the Christchurch City network other than from the municipal treatment plants at Bromley and Belfast and from sewage overflows within the network. As a result, there are no separate communities to consider within the Christchurch City network.

The Christchurch wastewater system collects approximately 55 million cubic metres of wastewater each year, transporting it through a series of sewers and pump stations to the Christchurch Wastewater Treatment Plant (CWTP) at Bromley. In addition, approximately 0.4 million cubic metres annually are collected from the Belfast area, treated in oxidation ponds and discharged into the Otukaikino Stream, a tributary of the Waimakariri River. The collection system includes 86 pump stations, 1,600 km of sewer mains and 950 km of laterals in public roadways.

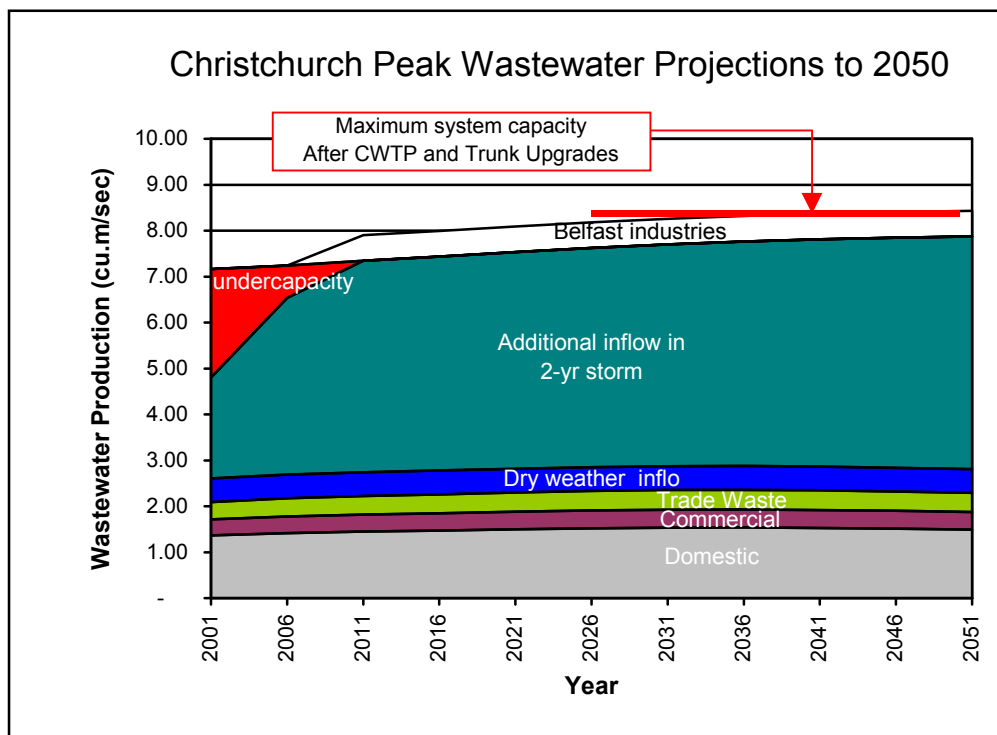
4.2 Wastewater Flow Projections

Christchurch wastewater flow projections to 2050 are shown in Figure 3. Forecast increases in wastewater flow are used by the Council in planning the future capacity of the CWTP.

A number of assumptions have been made by the Council in assessing future flows at the CWTP, including the following:

- Overflows from storm events will occur once every two years after trunk sewer upgrades are completed in 2013.
- Belfast sewage will be pumped to the CWTP system from 2006.
- Inflow and infiltration due to any given rainfall event are assumed (conservatively) to increase by approximately 10% overall over the next four decades as the system ages, despite an expected flow reduction in rehabilitated catchments.

■ Figure 3: Wastewater Flow Projections



4.3 Urban Wastewater Treatment Process

Urban wastewater treatment is provided in two treatment plants at Bromley and Belfast. The CWTP at Bromley is by far the larger of the two and treats between 130,000 m³/day and 160,000 m³/day¹ of wastewater. The Bromley treatment plant and long term Christchurch wastewater strategy are described in detail in the Christchurch City Council Wastewater Management Plan 2003, Part 1² the Wastewater Management Plan 2004, Part 2³ and also on the council website (www.ccc.govt.nz/consultation/wastewater).⁴

The CWTP employs the following treatment sequence⁵:

- Preliminary treatment to remove debris and grit.
- Aeration to minimise odours.
- Primary sedimentation to remove settleable organic matter and suspended solids.
- Biological treatment in trickling filters and an activated sludge process to reduce.
- Oxidation pond treatment to reduce pathogen content.

The CWTP has recently been upgraded to increase capacity and improve treatment. The upgrade works include reconfiguration of the oxidation ponds and new outfall pipe into the estuary. The upgrade works, completed in May 2004 at a cost of \$4M, have improved wastewater quality by increasing the residence time in the ponds allowing more effective natural ultraviolet (UV) disinfection. Further improvements are planned by Christchurch City for the wastewater treatment systems including:

- An ocean outfall to divert all treated wastewater from the estuary and discharge offshore via a 3 km pipeline by 2009 at a cost of approximately \$50M
- A major sewer upgrade project to run for 10 years until 2014 involving \$36M spending on new sewers and rehabilitation of existing sewer pipelines

The Belfast Sewage Treatment Plant consists of two oxidation ponds operated in series. The treatment plant discharges to Otukaikino Creek, a tributary of the Waimakariri River. In recent years the discharge has failed to comply with consent conditions for a range of contaminants including faecal coliforms (Environment Canterbury consent CR990558.1), and the wastewater discharge from the ponds will be pumped to the CWTP by the end of 2006. From this time onwards there will be no further sewage discharges into Otukaikino Creek.

4.4 Urban Wastewater Disposal

The Bromley wastewater treatment plant discharges to the Avon-Heathcote Estuary twice daily from several outfall pipes along the western edge of the estuary. The discharge occurs for two to three hours after each high tide every day. Christchurch City Council is planning to replace the estuary discharge with an ocean outfall to discharge treated wastewater 3 km out to sea by 2009⁵.

The Belfast wastewater treatment plant discharges to the Otukaikino Stream, a tributary of the Waimakariri River.

4.5 Untreated Sewage Overflows

During periods of heavy rainfall, stormwater infiltrates through the ground and inflows through pipes into the sewer network. In extreme rainfall events the extent of inflow and infiltration that occurs may be sufficient to overwhelm sewage pumping stations, causing overflows of untreated dilute sewage into the receiving environment. Within the Christchurch City network there are 12 overflow locations as shown in Table 2 below.

■ **Table 2: Sewer Overflow Locations**

Reference code	Location	Receiving waters
PS1/15	St Andrews Square	Upper Avon
PS1/16-1	Fendalton Road Bridge	Upper Avon
PS1/16-2	Fendalton Road Bridge	Upper Avon
PS1/11	River Road	Lower Avon
PS7/1	Slater Road	Lower Avon (via Dudley Creek)
PS1/21	Grassmere Street	Lower Avon (Via Horseshoe Lake)
PS23/1	Sandwich Road	Heathcote
PS22/2	Bowenvale Ave Bridge	Heathcote
PS20/4	Fisher Avenue	Heathcote
PS20/3	Tennyson St Bridge	Heathcote (via stormwater pipeline)
PS20/2	Waltham Road Bridge	Heathcote (via stormwater pipeline)
PS19/1	Beckford Road Bridge	Heathcote

The overflows are authorised by resource consent CRC991222 granted in 2002 with a 15-year duration. The consent authorisation is for stormwater, groundwater and sewage from the Christchurch City network that occurs “as a result of wet weather overloading the sewerage system”. The consent also requires an overflow response plan to be lodged with Environment Canterbury. Overflows at the 12 specified sites trigger alarms that initiate the City Council overflow response plan. The alarm system also records the start time, finish time, flow and duration of each overflow event. The overflow response plan incorporates the following action sequence:

- Site callout within two hours to verify the overflow.
- Erection of signage within two hours at the overflow site.
- Confirmation of cause of overflow and remedy if not caused by wet weather.
- Notification of affected parties and laboratory.
- Water samples taken within 10 hours and repeated daily until contaminant levels recede.
- Overflow stop alarm is recorded and initiates further site call out.
- Once overflow has stopped for 24 hours, affected parties are renotified.
- City Council provides a full report to Regional Council within one month of the overflow event.

Since 17 September 2002 there have been three reported incidences of sewage overflows, as described in Table 3 below.

■ **Table 3: Reported Incidences of Sewage Overflows in Christchurch**

Date	Overflow location	Rainfall event	Duration	Total volume (m ³)
13/10/2003	PS20/4 Fisher Avenue	unknown	unknown	unknown
6-8/8/2004	PS20/4 Fisher Avenue	1:3 yr event	43 hrs	13802
	PS1/16-1 Fendalton South		7 hrs	168
	PS1/16-2 Fendalton North		18 hrs	7917
	PS7/1 Slater Road		7 hrs	992
	PS1/21 Grassmere Street		17 hrs	604
	PS1/11 River Road		23 hrs	16289
27-29/8/2004	PS20/4 Fisher Avenue	<1:2 yr event	30.5 hrs	5441

Microbiological analysis of sewer overflows is summarised in Table 4 below.

■ **Table 4: Microbiological Quality of Sewer Overflows in Christchurch**

Overflow event	PS20/4 Fisher Avenue 6-12/8/04 E.coli Monitoring (cfu/100mL)						
Time (hrs after start)	2.5	12	36	60	87	106	130
Weather	rain	rain	fine	fine	fine	rain	fine
Upstream	2400	3200	4400	4400	7400	12000	8600
Discharge point	61000	49000	2700	6500	6700	11000	7700
Downstream	5800	8700	5200	6200	7300	13000	10000
Overflow event	PS20/4 Fisher Avenue 27-31/8/04 E.coli Monitoring (cfu/100mL)						
Time (hrs after start)	1	66	87.5				
Weather	rain	fine	fine				
Upstream	3300	7300	5300				
Discharge point							
Downstream	5200	6100	3700				

5. Urban Fringe Wastewater Treatment and Disposal

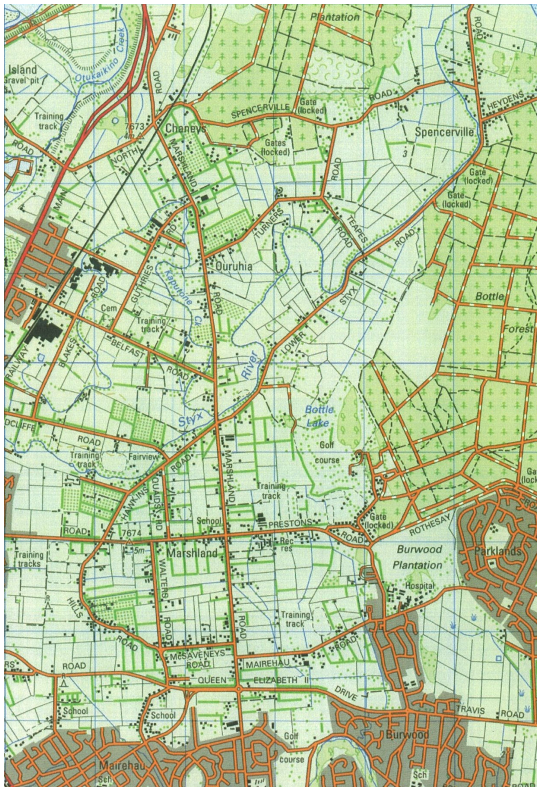
Beyond the metropolitan area of Christchurch is an urban fringe that is rapidly developing and supports an increasingly dense population on lifestyle blocks or semi-rural subdivisions. The majority of the urban fringe area is not connected to the Christchurch City sewerage network, and utilises stand-alone wastewater schemes for wastewater treatment and disposal. For the purposes of assessing potential public health risks from small stand-alone treatment schemes the Christchurch fringe has been divided into three areas:

- Northeast (Marshland).
- Northwest (Yaldhurst and Harewood).
- Southeast (Mount Pleasant, Scarborough -Taylors Mistake).
- Southwest (Halswell and Westmorland).

5.1 Northeast Fringe Wastewater Treatment and Disposal

The area northeast of Christchurch includes Marshland, Spencerville and land stretching to the Waimakariri River, as shown in Figure 4.

- **Figure 4: Northeast Fringe Location Map**



Marshland is a semi-rural community occupying approximately 20 km² on the northern perimeter of Christchurch. The locality received its name from the peaty marsh and swampland⁶ that is a feature of the area. The centre of the Marshland area is 2 km from the Christchurch sewerage

reticulation boundary with most of the population located in ribbon development pattern along Marshland Road, Hills Road, Prestons Road and McSaveney's Road, and stretching north to Ouruhia and Chaney's. The population of Marshland recorded at the 2001 census was 5,088, an increase of 16% from 1996⁷. The population is distributed amongst 1728 households with an average household occupancy rate of 2.9⁷.

The Environment Canterbury consent database shows a total of six resource consents are held for wastewater discharges in the Marshland area, including five consents for domestic users and one consent for Marshland School. A number of other residential properties in this area are also served by septic tanks that were authorised prior to 1991 by the City Council drainage unit. Septic tank drainage contractors provide anecdotal information that between 500 and 1000 septic tanks are currently operated on the northeast fringe of Christchurch⁸. This number has reduced in recent years as a consequence of part of Hills Road, Spencerville and parts of Prestons Road being connected to Christchurch City reticulation. The remaining areas are not reticulated and all wastewater is discharged to land.

As of February 2005, 11 properties in the rural northern area of Christchurch were not served by either septic tanks or reticulation. These properties are served by a weekly "night soil" collection. Septic tanks have not been installed because on-site effluent disposal is not viable. Of these 11 properties four are in the process of being connected to the City Council system, five are collected weekly and two occasionally. The number of properties using this system of disposal is decreasing (104 in 1993; 35 in 2001, 17 in March 2004).

5.1.1 Domestic Septic Tanks

As only five of the domestic septic tank schemes in this area hold Resource Management Act consents it is assumed that the majority of these septic tank schemes were installed prior to 1991, and are not consented. Anecdotal information from septic tank contractors suggests there are likely to be between 500 and 1000 septic tank schemes operating in the Marshland area. This is consistent with the progressive development of the Marshland area since the 1950s and is confirmed by Christchurch City Council staff who approve disposal of septic tank sludge from this area into the Bromley treatment plant.

The wastewater generated by 500 septic tank systems, assuming a household (and therefore septic tank) occupancy rate of 2.9, is approximately 260 m³/day based on standard wastewater production rates per person⁹.

Since most of these systems are more than 13 years old, it is assumed that they will mainly consist of single chamber septic tanks with gravity disposal trenches. These systems can be subject to a range of operational problems including poor treatment performance and creeping disposal field failure, depending on their design and operation. Early septic tank disposal fields were also designed based on hydraulic loadings that resulted in relatively high areal loadings of contaminants.

This introduces some risk of groundwater and surface water contamination particularly in areas where groundwater is relatively shallow. Depth to groundwater in the Marshland area is typically 1 - 2 m below ground level¹⁰ and the area is known for peaty soils with low infiltration rates likely in the winter due to soil saturation and shallow groundwater. The areas at greatest risk of surface water or shallow groundwater contamination are those subject to highest population density. Using NZMS 260:M35 as a reference guide the areas of highest population density are Marshland Road, Prestons Road, and Walters Road in the Marshland area; and Turners Road, Guthries Road and North Marshland Road at Ouruhia.

Surface water also has potential to become contaminated in areas such as Marshland particularly during the winter, when high groundwater levels combined with high soil moisture content could lead to surface ponding if disposal field hydraulic loading rates are high. There is some anecdotal evidence of surface ponding in low lying areas of Marshland during winter, with known instances of surface water septage contamination at several sites near the intersection of Marshland Road and Prestons Road¹¹. Specific domestic resource consent holders in Marshland are listed in Table 5.

■ **Table 5: Marshland Domestic Wastewater Consent Holders**

Consent holder	Address	Flow (m ³ /day)	Treatment system
Private Individual	40 Walters Road	1	aerated plant with subsurface irrigation
Private Individual	852 Hills Road	1	septic tank
Private Individual	394 Prestons Road	1	septic tank
Friends Holding Limited	390 Prestons Road	1	septic tank
Rejang Investments Limited	Turners Road	unknown	unspecified

The Environment Canterbury groundwater database indicates approximately 450 known groundwater bores within a 2 km radius around Marshland and Ouruhia settlements as located on NZMS260: M35. Environment Canterbury suggests that there are likely to be a significant number of unknown bores given that the area has been in development for up to 100 years. Nearly all of the recorded wells are 25 to 50 m deep, with a small proportion (3%) less than 10 m deep (excluding observation bores). The deeper bores will be extracting water from confined layers that are under positive pressure near the coast. As the bores themselves will also be at positive pressure in relation to shallow groundwater, they are unlikely to become contaminated in the event that the shallow groundwater becomes contaminated.

The majority of the shallow bores are used for observation purposes, with a small number of bores in productive use for domestic supply.

5.1.2 Marshland School

Marshland School discharges up to 2.5 m³/day of sewage effluent to land via a 5 m³ septic tank, designed in accordance with AS/NZS 1547:2000, as authorised by discharge consent CRC970914.2. The discharge is disposed via a 120 m² disposal trench type soakage field. The disposal trenches are fed via a low pressure dosing system to ensure that the wastewater is evenly

distributed. A contractor maintains the septic disposal system every 18 months. Conservative horizontal buffer distances to surrounding groundwater bores are also specified in the resource consent. A routine compliance monitoring visit by Environment Canterbury on 4 July 2003, confirmed that the plant was built and is operated in accordance with recommended design and operating guidelines and also that no surface ponding of effluent was occurring.

5.1.3 Ouruhia School

Ouruhia School discharges 4.8 m³/day of sewage effluent to land via in-series septic tanks, clarified effluent filters, and sand filled disposal trenches as authorised by discharge consent CRC021582. The treatment plant was commissioned in 2002 and serves 120 people. It is serviced every two years under an ongoing maintenance contract. A site inspection on 4 July 2003 by Environment Canterbury found the system functioning well with no surface ponding observed in the disposal field.

5.2 Northwest Fringe Wastewater Treatment and Disposal

The northwest fringe of Christchurch includes Yaldhurst, the Old West Coast Road and Papanui Prison land, Christchurch International Airport and land stretching to McLeans Island on the south bank of the Waimakariri River and to the Selwyn District Boundary to the east and south. The area is shown in Figure 5.

This area of land comprises part of the recharge zone that is the source of the City's drinking water. The groundwater is particularly susceptible to contamination. A substantial portion of the recharge area has very thin soils and is underlain by shallow groundwater. Contaminants can enter groundwater by a number of pathways:

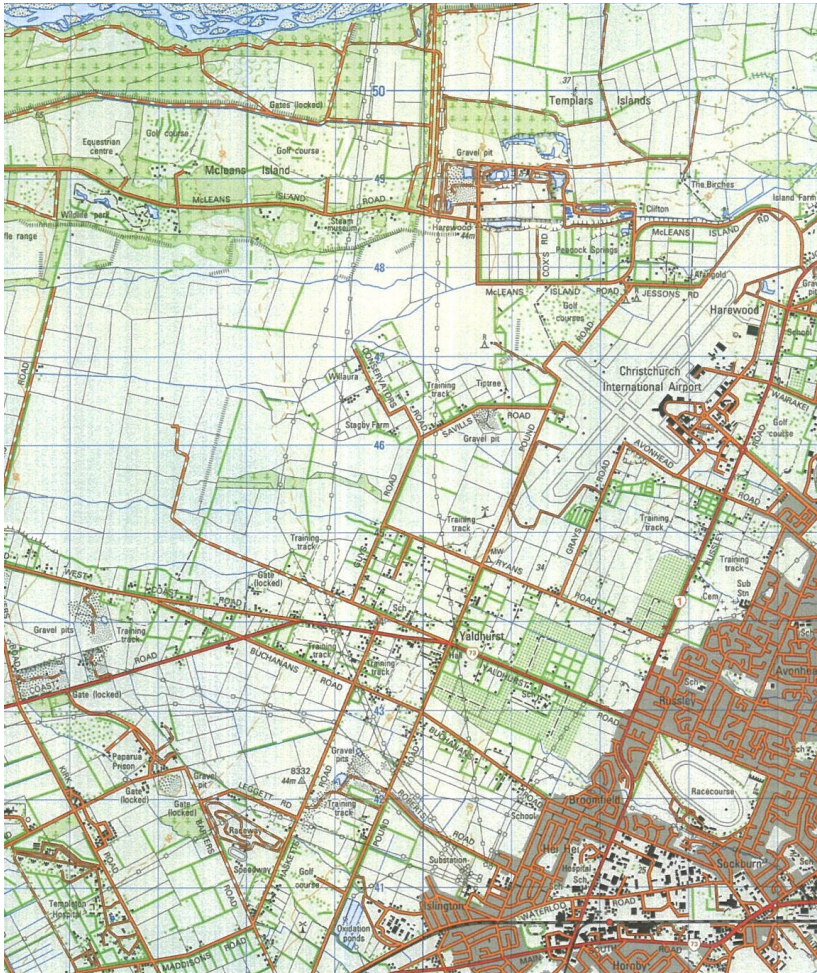
- routine discharges to land e.g. stormwater from roads or hard surfaces.
- accidental spills or discharges
- uncontrolled backfilling of existing open pits, or the uncontrolled burial of debris following a major natural event e.g. an earthquake
- inadequate or poorly maintained containment or treatment systems, e.g. leaking pipeline networks, oil water separators, storage tanks,
- catastrophic release of contaminants e.g. rupturing of storage tanks or pipeline networks during an earthquake or flood from the Waimakariri River.

There is increasing pressure to develop land in the recharge area. The intensification of land uses in this area, such as the spread of industrial development, will increase the risk of groundwater contamination. While the effects of individual land use activities may have relatively little impact on groundwater quality, their cumulative effect may result in a decline in groundwater quality.

The installation of a wastewater network in this area would reduce the risk of groundwater contamination but this will be offset by more pressure to develop the land to take advantage of the network, increasing the risk of contamination from leakage or failure of the system. Once groundwater becomes contaminated the water supply may need to be treated or alternative sources

of drinking water. Either of these options would involve considerable costs to the community. Experience from overseas has shown that preventing contamination of groundwater is the only viable, and most cost effective, approach of protecting drinking water sources.

■ **Figure 5: Christchurch Northwest Fringe**



5.2.1 Northwest Domestic Septic Tanks

An unspecified number of domestic septic tanks are located on the northwestern fringe of Christchurch serving semi-rural properties in Yaldhurst and Harewood. The majority of these, which are not consented, are centred around Yaldhurst and the Old West Coast Road.

Yaldhurst is a small agricultural service centre 3 km from the western outskirts of Christchurch. The Christchurch City reticulation network does not serve it although some specific sites beyond Yaldhurst, including Papanui Prison and Templeton township, are connected onto the Christchurch reticulation. The 2001 census population of Yaldhurst is 621 distributed amongst 210 households, a reduction of 5.0% since 1996. The average household occupancy rate is 2.8. As Yaldhurst is not connected onto the City reticulation scheme it is assumed that wastewater from all 210 households is discharged to land. This equates to a domestic wastewater flow of 105 m³/day. Other activities in Yaldhurst that discharge wastewater to ground include three large hotels (at Yaldhurst and Templeton), a gun club, boy scout camp, and community hall.

The Environment Canterbury consent database shows that a total of six resource consents are held for wastewater discharges in the Yaldhurst area, including five consents for domestic users and one consent for Yaldhurst School.

Wastewater from 210 households and several commercial and institutional facilities in Yaldhurst is all disposed to ground in the absence of any reticulation. As only six of these discharges hold Resource Management Act consents it is assumed that the majority of these schemes were installed prior to 1991. The wastewater generated by 210 septic tank systems, assuming a household (and therefore septic tank) occupancy rate of 2.8, is approximately 105 m³/day based on standard wastewater production rates per person¹².

Since most of the septic systems are more than 13 years old, it is assumed that they will mainly consist of single chamber septic tanks with gravity disposal trenches. These systems can be subject to a range of operational problems including poor treatment performance and creeping disposal field failure, depending on their design and operation.

The risk to groundwater from septic tank discharges is primarily related to the depth to groundwater and soil conditions at the site. Early septic tank disposal fields, described in Section 5.1.1, feature relatively high areal nitrogen loadings. This introduces some potential for groundwater contamination on a minor scale compared to that from agricultural or large-scale wastewater disposal activities. As the depth to groundwater in the Yaldhurst area is quite considerable, typically 15 m to 30 m,¹³ and soils in the area have good capacity to treat the wastewater, the risk of significant groundwater nitrate contamination is relatively low.

Also, as the soils are freely draining the likelihood of surface ponding due to septic wastewater disposal is also considered to be low. Providing no surface ponding occurs there are no obvious pathways for local residents or visitors to come into contact with the wastewater.

Specific domestic resource consent holders in northwest Christchurch are listed in Table 6.

■ **Table 6: Northwest Domestic Wastewater Consent Holders**

Consent holder	Address	Flow (m³/day)	Treatment system
Canterbury Kennel Association	McLeans Island Road	10	Septic tank
Fendalton Properties Limited	Johns Road	1	Septic tank
Private Individual	541 Johns Road	2	Septic tank
Private Individual	353 Gardiners Road	1	Septic tank
Private Individual	Pound Road	1	Septic tank

5.2.2 Yaldhurst School

Yaldhurst School is located in Yaldhurst township 2 km from the western suburban boundary of Christchurch. Sewage discharges of up to 6.4 m³/day to land via a septic tank and disposal trench type soakage field are authorised by discharge consent CRC011551. The system services 160 people. A Contractor inspects and maintains the septic disposal system annually.

Appropriate horizontal buffer distances to surrounding groundwater bores are also specified in the resource consent. An Environment Canterbury review of the system design documentation in August 2002 found the system conforms to approved plans and specifications. The disposal trench is 80 m from the nearest building.

The school reports that the disposal system is working well and that there are no odours. It also reports that there is no likelihood of people coming into contact with effluent near the disposal point.

5.2.3 McKenzie School

McKenzie School, located on Yaldhurst Road 1 km from the western suburban boundary, discharges up to 7.4 m³/day of sewage effluent to land via a septic tank and 148 m² disposal trench type soakage field as authorised by discharge consent CRC010329. The number of people serviced by this system is 50. The soakage field is 100 m from the nearest building. Septic disposal trenches are filled with graded sand and are fed via a low pressure dosing system to ensure that the wastewater is evenly distributed. The septic disposal system is inspected and maintained every two years under a maintenance contract.

Appropriate horizontal buffer distances to surrounding groundwater bores are also specified in the resource consent. An Environment Canterbury review of the system design documentation in May 2002 found the system conforms to approved plans and specifications.

The school reports that the treatment plant works well, no surface ponding at the site has been observed, and that the likelihood of any person coming into contact with the wastewater is low.

5.2.4 Papanui Youth Justice Facility

The Crown operates a youth justice facility on Leggett Road less than 1 km from Papanui Prison. The scheme consists of a septic tank, intermittent sand filter and sub-surface irrigation. Wastewater discharges from the treatment plant are estimated at 6.2 m³/day¹⁴, in excess of the consent limit of 5 m³/day. The discharge from the treatment process has high faecal coliform counts, which is typical of small enclosed treatment processes with no UV disinfection.

Appropriate horizontal buffer distances to surrounding groundwater bores are also specified in the resource consent. The septic disposal system is inspected and maintained every two years under a maintenance contract.

5.2.5 Clearwater Resort

Clearwater Resort holds consent CRC650452 to discharge 200 m³/day of wastewater to land within the resort boundary northwest of Johns Road. This consent has not been exercised and is effectively redundant as the wastewater is piped to the Belfast Sewage Treatment Plant. At this stage the wastewater is ultimately discharged with Belfast domestic wastewater to Otukaikino Stream, but will be reticulated to Christchurch from the end of 2006. Clearwater Resort has indicated that it is unlikely to exercise this consent in future.

5.2.6 Isaac Construction Company

The Isaac Construction Company is authorised to discharge up to 4 m³/day of wastewater to land under consent CRC040268. The treatment system consists of an aerated septic tank system (Oasis Clearwater Limited) with outlet filters and sub-surface irrigation pipes. The treatment plant produces high quality effluent that is discharged “onto gardens surrounding the office”(consent condition 7) with a faecal coliform standard set at 1000 cfu/100mL. Appropriate groundwater abstraction buffer distances are specified in the consent.

5.2.7 Christchurch International Airport

Christchurch International Airport is authorised to discharge wastewater to land at the Aviation Park and Aero Club area under resource consents as follows:

■ Christchurch Airport Discharge Consents

Consent No.	Discharge location	Flow (m ³ /day)
CRC962291	M35:7207-4695	5 m ³ /day
CRC990183	M35:7209-4703	2.3 m ³ /day

CRC962291 consent authorises discharge of 5 m³/day of wastewater to land from facilities servicing 50 people. The treatment plant consists of a septic tank and low pressure pumped dosing system to 54 m² disposal trenches. The system is maintained under an annual service contract and no operational problems have been experienced. Appropriate buffer distances to groundwater users are specified. The disposal field is 30 m from the nearest building, 130 m to the site boundary and 520 m to the site groundwater bore. Compliance monitoring reports show that some information about the design and installation of the treatment plant is yet to be submitted to Environment Canterbury following a written request in 2002.

CRC990183 consent authorises discharge of 2.3 m³/day to land from facilities servicing 15 people. The treatment plant consists of a septic tank with disposal trenches 40 m² in area. Appropriate buffer distances to groundwater users are specified. The disposal field is 20 m from the nearest building, 87 m to the site boundary and 300 m to the site groundwater bore.

5.2.8 The Leisure Club

The Leisure Club NZ Limited is authorised to discharge up to 14.6 m³/day of wastewater to land via a septic tank and 300 m² sand disposal trench. The septic tank is in conformance with AS/NZS 1547:2000. Wastewater is dose-loaded to ensure even distribution across the disposal bed. The system is regularly inspected and maintained (annually) and no operational problems have been reported. Appropriate buffer distances to surrounding groundwater users are also specific in the consent.

5.2.9 Canterbury Kennel Association Inc.

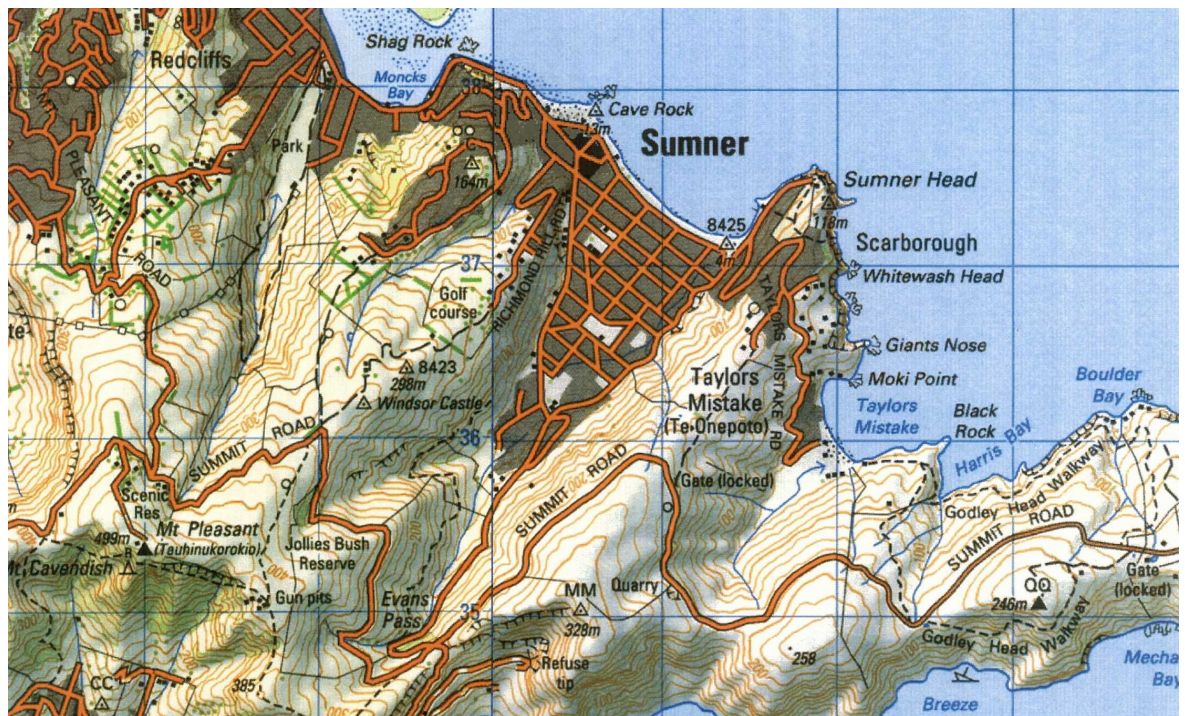
The Canterbury Kennel Association has been authorised to discharge up to 10 m³/day of wastewater to land after septic tank treatment under consent CRC916790. The septic system was

certified by a registered engineer in 1997. According to Environment Canterbury records the discharge consent expired on 30 April 1999. The Kennel Association has confirmed that the system remains in operation and functions without any significant operational problems, with wastewater disposed to a trench disposal field. No surface ponding has ever been observed. The disposal field is located 20 m from the boundary and 100 m from the site groundwater bore.

5.3 Southeast Fringe Wastewater Treatment and Disposal

The southeast Christchurch fringe includes rural land of the Port Hills as shown in Figure 6.

■ Figure 6: Christchurch Southeast Fringe

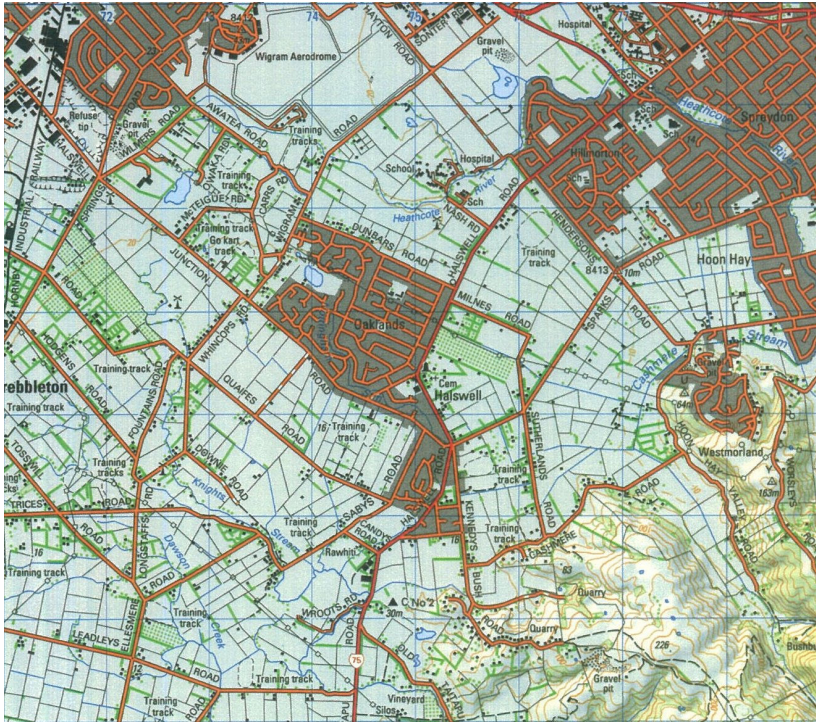


The population in this area is mainly in the areas of Mount Pleasant and from Scarborough to Taylor's Mistake. Some properties in this fringe area may still discharge wastewater directly to land though by far the majority of properties are now on reticulated service. The serviced properties were connected at times of nearby subdivision and during the servicing of the Scarborough – Taylor's Mistake area. ECan holds no records of any properties consented for discharging wastewater to land.

5.4 Southwest Fringe Wastewater Treatment and Disposal

The southwest Christchurch fringe includes rural land at the foot of the Port Hills, Westmorland and Worsley Spur, as shown in Figure 7.

■ Figure 7: Christchurch Southwest Fringe



The population in this area is mainly confined to reticulated areas of Halswell, Westmorland, and Tai Tapu. However, some semi-rural residential properties and Worsley Spur properties are not reticulated and hence discharge wastewater directly to land.

5.4.1 Southwest Domestic Septic Tanks

Authorised discharges from small treatment schemes in this area are summarised in Table 7.

■ Table 7: Southeast Domestic Wastewater Consent Holders

Consent holder	Address	Flow (m ³ /day)	Treatment system
Private Individual	22 Fountain Road	1	Multi-chamber septic tank
Private Individual	Worsleys Road	1.5	Septic tank
Private Individual	Worsleys Road	1.5	Septic tank
Private Individual	Worsleys Road	1.5	Septic tank
Private Individual	Fountain Road	1.1	Septic tank
Private Individual	Fountain Road	1.1	Septic tank
Private Individual	315 Worsleys Road	2.8	Septic tank
Grange Trustees Limited	Marshs Road	1.1	Aerated package plant
Private Individual	Marshs Road	1.5	Aerated package plant
Thorncroft Ltd	335 Worsleys Road	1.0	Aerated package plant

There are 10 discharge consents held for discharges of domestic wastewater in this area. Septic tank operators advise that there are a relatively small number of un-consented discharges (up to 50) in the area⁸. The area includes a zone around the base of the Port Hills and several small hill-zone housing areas. The flat zone at the base of the hills is relatively low lying and features hydraulically limited soils and high groundwater during the winter months.

Development in the Halswell area is being provided for by planned construction of new reticulation and through developers' contribution.

6. Urban Area Risk Assessment

6.1 Urban Area Risk Assessment Methodology

The potential health risks from the discharge of untreated or treated sewage is characterised by combining the risks of each of the following:

- Population Characteristics - The vulnerability of the Christchurch population to health problems.
- Hazardous Nature of the Discharge - The presence and concentration of hazardous substances in the discharge, the location and size of the discharge risk zones, and assessment of these zones against New Zealand guidelines for acceptable exposure.
- Exposure Assessment - The location of the risk zone and the duration and frequency of exposure of people to the health hazard.

6.1.1 Population characteristics – The Christchurch Community

2001 Census data has been used to characterise the demographics in each community. These are summarised in Table 8.

■ Table 8: Demographic data for Christchurch and New Zealand

	Christchurch	New Zealand statistics
Resident Population:	152,238	
Percentage who are children (<5 years) ¹	6.5	7.5
Percentage who are young people (<15 years)	19.3	22.7
Percentage who are elderly (>65 years)	13.7	12.1
Percentage who are Māori	6.2	14.5

Notes 1. Based on 1999 MoH Health fact survey results for Canterbury

2. Based on 2001 census data

Individuals considered vulnerable to water-borne enteric diseases include the very young, the very elderly and those with immune deficiencies. The 2001 Census data indicates a slightly larger resident elderly population, and a slightly smaller child population under five years of age in Christchurch compared to New Zealand as a whole.

6.1.2 Notified enteric disease rates

The health profile of residents in Christchurch is a further indication of vulnerability to disease and a record of health problems that may be attributable to wastewater discharge. The numbers of notified cases of enteric disease illness for the townships from the ESR Communicable Disease Centre are shown in Table 9.

■ **Table 9: Notified enteric diseases for Christchurch and New Zealand 1999 – 2003**

Year	Total number of notified enteric diseases		Percentage of total population	
	Christchurch	National	Christchurch	National
1999	1600	14286	0.5	0.4
2000	1594	13954	0.5	0.4
2001	1377	16962	0.43	0.5
2002	1740	18611	0.55	0.5
2003	1913	20151	0.6	0.5

The incidence of notified enteric disease in Christchurch has been above the national average over the past five years with the exception of 2001. This could be attributed to a range of factors, such as higher rates of visits to doctors, diagnosis, or reporting. It is also possible that the Christchurch population has higher exposure or higher vulnerability to enteric disease.

6.1.3 Hazardous nature of the wastewater and the risk zone

The primary health hazard from wastewater discharges is pathogen content. The presence of pathogens is normally measured using a bacterial indicator species that is specific to humans, stable in the receiving environment and readily testable in the laboratory. The risk zone that relates to any wastewater discharge is defined as the area within a watercourse where indicator concentrations do not comply with public health guidelines. The current microbiological acceptance standards for water quality in New Zealand are summarised in Table 10.

■ **Table 10: Microbiological Water Quality Acceptance Criteria**

Freshwater ¹		Marine Waters ¹	
Contact recreation	260 <i>E.coli</i> / 100 mL 200 faecal coliforms/100 mL	Contact recreation	140 <i>Enterococci</i> / 100 mL 200 faecal coliforms/100 mL
Drinking water	<1 <i>E.coli</i> / 100 mL	Shellfish gathering	Median 14 faecal coliforms(MPN)/100 mL

Notes 1. Refer to Ministry for the Environment Microbiological Water Quality Guidelines, June 2003

6.2 Christchurch Treatment Plant Risk Assessment

Public health risk assessment for surface water catchments is prescribed in “*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*” (MfE, June 2003). The MfE guideline recommends a qualitative “risk grading” of the catchment supported by direct measurement of appropriate faecal indicators. The two components to provide a grading for a particular “beach” (or estuary in the case of Christchurch) are:

- The Sanitary Inspection Category (SIC) which generates a measure of the susceptibility of a water body to faecal contamination.
- Historical microbiological monitoring results, which generate a Microbiological Assessment Category (MAC) as a measure of the actual water quality over time.

Combination of the SIC and the MAC provides the overall “Suitability for Recreation Grade”. The SIC methodology clearly identifies that a municipal wastewater discharge of tertiary treated effluent (without disinfection) is a high risk factor for contact recreation. Applying the Guideline approach to the Avon-Heathcote Estuary identifies that the CWTP wastewater outfall risk factor is “High”¹⁵.

Set out below is an assessment of the following risk factors in relation to wastewater discharge to the Avon-Heathcote Estuary:

- **Hazardous Nature of the Discharge** - The presence and concentration of hazardous substances in the discharge, the location and size of the discharge risk zones, and assessment of these zones against New Zealand guidelines for acceptable exposure.
- **Exposure Assessment** - The location of the risk zone and the duration and frequency of people exposure to the health hazard.

Monitoring data for the CWTP discharge is summarised in Table 11 below.

■ **Table 11: Christchurch Treatment Plant Discharge Monitoring Results**

Site	Enterococci (cfu/100mL) ¹			Faecal coliforms (cfu/100mL) ¹		
	Median	90 th	Maximum	Median	90 th	Maximum
Pond 6 discharge	34	37	38	120	185	200

Notes 1. Statistical assessment based on a limited data set from 24 June 2004 to 29 July 2004

The range in faecal coliform concentrations in the wastewater treatment plant discharges (from Ponds 5 and 6) to the estuary between 1 October 2003 and 24 June 2004 is 17 – 13,000 cfu/100 mL. Following the completion of a pond upgrade in June 2004, the microbiological quality of the discharge (from Pond 6 only) has improved significantly, with current faecal coliform levels at 120 cfu/100 mL median and 200 cfu/100 mL maximum. However it should be noted that this observed improvement is based on a limited dataset over a period of 5 months.

Faecal coliforms are recognised as an indicator of the likely presence of pathogens in human wastewater. Monitoring results summarised in Table 11 show indicator levels in the CWTP discharge that are below the recommended maximum levels for contact recreation for most of the time.

6.2.1 Public health risk zone

The public health risk zone is defined as the area of discharge mixing within the receiving waters that does not comply with appropriate standards for public health as set out in Table 10. In the case of the CWTP, the wastewater is discharged into the Avon-Heathcote Estuary for several hours after each high tide. The mixing behaviour of the discharge plume is complex and variable depending on environmental conditions. A study by Lincoln Ventures in 1994¹⁶ found that typically 65% of the effluent leaves the estuary on the ebb tide after discharge and 35% is captured and retained on the next incoming tide. In terms of mixing, the effluent is typically diluted 30 times before it reaches Shag Rock at the mouth of the estuary, but is diluted to a lesser extent within the estuary

itself. Expert submissions to the Hearing Panel for the application for discharge consent renewal in 2002 identified that typical mixing within the estuary is between two and a half and five times, with 10 times achieved at some locations on some occasions¹⁷.

Assessment of the public health risks based on estuary mixing required to achieve public health standards is summarised in Table 12.

■ **Table 12: Bromley Treatment Plant Discharge Risk Zone**

Contaminant	Discharge Quality (cfu/100 mL)		Estuary Water Quality ¹ (cfu/100 mL)		Receiving Environment Standard
	Median	90 th	Median	90 th	
Enterococci (cfu/100mL)	34	37	7 - 14	7 - 15	Contact recreation 140 <i>Enterococci</i> / 100mL
Faecal Coliforms (cfu/100mL)	120	185	24 - 48	37 - 74	Contact recreation 200 faecal coliforms / 100mL Shellfish gathering Median 14 faecal coliforms(MPN) / 100mL

Notes 1. Based on 2.5 - 5 times mixing achieved in the estuary

The preliminary assessment presented above indicates that the zone of public health risk is likely to be very small and centred around the point of discharge. For most of the time the discharge will comply with receiving environment standards for contact recreation at the point of discharge. The shellfish gathering standard is not likely to be met within the estuary at any time.

Christchurch City Council is planning to construct an ocean outfall by 2009. More information on this plan is provided in Section 4.3. After the new ocean outfall is commissioned, minor contact recreational health risks associated with the wastewater discharge to the estuary will be reduced significantly. However, wet weather sewage spills into the Avon and Heathcote Rivers will still occur resulting in some contamination of the Estuary.

6.2.2 Health risk exposure pathways

Two most likely health risk exposure pathways that apply to the Avon-Heathcote Estuary are:

- Contact recreation.
- Shellfish gathering.

The Avon-Heathcote estuary is a significant social and recreational resource for the City of Christchurch¹⁸. The area provides sites for numerous recreational activities including fishing, kayaking, yachting, wind surfing, rowing, surfing and walking. The estuary is used by the public year round, with the summer months (September to May) the most popular for yachting and windsurfing.

Contact recreational users of the estuary are likely to be subject to minimal exposure to public health risks associated with the CWTP wastewater discharge, based on wastewater quality monitoring from 24 June to 29 July 2004. It is noted, however, that the risk may vary from day to day and is also dependent on the location of the user. Public health risks may have been previously

mitigated to some extent by the awareness of the public about the wastewater discharge, possibly acting as a deterrent to people wishing to recreate in the estuary. It is noted that this discharge is not the only influence on the quality of the water in the estuary.

Regarding shellfish gathering, signage is provided around the estuary to warn people about the potential risk from eating shellfish gathered in the estuary. A study of shellfish contamination in 1991 and 1992 found that pathogen contamination in the CWTP wastewater discharge may lead to contamination of estuary shellfish¹⁸. It is likely that the incidence of shellfish gathering in the estuary is lessened by the awareness of potential risks. However, the health risk from consumption of shellfish from the estuary still exists.

6.2.3 Duration and frequency of risk

The discharge to Avon-Heathcote Estuary occurs daily and therefore creates a continuous or very frequent health hazard in the defined risk zone.

The frequency of contact recreation is likely to increase over the summer months, with relatively large numbers (several hundred) of people likely to carry out recreation activities on the estuary. The high frequency of visits is due to the close proximity of the estuary to Christchurch and its inherent suitability for wind surfing, yachting and other similar activities.

6.2.4 Health risk summary

A summary of health risks associated with continued operation of the Bromley treatment plant for the next five years until the new ocean outfall is commissioned is as follows:

- Population Characteristics - The Christchurch population may be slightly more vulnerable to enteric disease compared to the national average (reference Table 9).
- The hazardous nature of the discharge is likely to be maintained at current levels for the next five years. Discharge wastewater will comply with the MfE guidelines for contact recreation for most of the time. As stated earlier, the low faecal coliform counts recorded in the discharges from Pond 6 of the Bromley treatment plant since the pond upgrade are based on a limited dataset of 5 months.
- The contact recreation risk zone is effectively a small zone centred around the point of discharge within the Avon-Heathcote Estuary. People involved in recreation activities at any point not in close proximity to the wastewater discharge point are unlikely to be exposed to risks associated with the wastewater contaminants.
- The duration of the discharge producing a risk zone in the Avon-Heathcote Estuary is described as continuous or very frequent (there may be short periods at some locations each day when the risk is low).
- The frequency of exposure to recreational users is low due to the small risk zone, despite the large number of users and the continuous/very frequent duration of the discharge.

6.3 Urban Sewage Overflow Risk Assessment

The recently updated “*Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas*” (MfE, June 2003), prescribes a qualitative “risk grading” of the catchment supported by the direct measurement of appropriate faecal indicators. The two components to provide a grading for a particular “beach” (or river in the case of Christchurch sewer overflows) are:

- The Sanitary Inspection Category (SIC) which generates a measure of the susceptibility of a water body to faecal contamination.
- Historical microbiological monitoring results, which generate a Microbiological Assessment Category (MAC) as a measure of the actual water quality over time.

Combination of the SIC and the MAC provides the overall “Suitability for Recreation Grade”. The SIC methodology clearly identifies that an untreated or treated municipal wastewater discharge of tertiary treated effluent (without disinfection) is a high risk factor for contact recreation. Applying the Guideline approach to the Avon and Heathcote rivers identifies that the risk factor assigned to overflows of untreated sewage is “*High*”¹⁵. Limited monitoring data covering two sewer overflow events only is available. The most comprehensive data for an overflow at Fisher Avenue on 6 / 8 August 2004 is presented in Table 13 below.

■ Table 13: Sewer Overflow Monitoring Results

Overflow Event	PS20/4 Fisher Avenue <i>E.coli</i> Monitoring (cfu/100mL) 6-12/8/04						
Time (hours after start)	2.5	12	36	60	87	106	130
Weather	rain	rain	fine	fine	fine	rain	fine
Upstream (cfu/100mL)	2400	3200	4400	4400	7400	12000	8600
Discharge point (cfu/100mL)	61000	49000	2700	6500	6700	11000	7700
Downstream (cfu/100mL)	5800	8700	5200	6200	7300	13000	10000

Several observed trends from the monitoring data in Table 13 are set out below:

- The range of *E.coli* levels in the discharges, measured immediately downstream from the point of discharge in the Heathcote River, is 49,000 – 61,000 cfu/100 mL.
- Background *E.coli* levels exceeded public health standards on all occasions while monitoring was being conducted.
- Background *E.coli* levels in the Heathcote River appear to increase significantly during rainfall even when no sewer overflow occurs (see data for 10 August 2004). This may be due to animal wastes collected in surface water runoff. However, the very high levels of *E.coli* present in samples collected from 9 August to 12 August 2004 may be indicative of another source of faecal pollution, as the levels present have not reduced as would be expected on the falling limb of the flood.

Background water quality in the Heathcote River is reported as poor in the Christchurch City Environmental Trends Report 2003, with median historical faecal coliform count at 1000 cfu/100 mL²⁰.

6.3.1 Public health risk zone

The public health risk zone is defined as the area of discharge mixing within the receiving waters that does not comply with appropriate standards for public health as set out in Table 10. In the case of wet weather sewer overflows, the wastewater is discharged into the Avon and / or Heathcote Rivers at up to 12 locations for a period of time during heavy rainfall events. At the time that the discharge is occurring flows in the Avon and Heathcote Rivers are likely to be high due to heavy rain within the catchment. Background microbiological water quality is also likely to be diminished during the rising limb of a flood¹⁹ as the “first flush” of contaminants washed off roads and footpaths will include animal wastes laden with *E.coli* and other contaminants.

The dispersion and dilution behaviour of the discharge plume in the Avon and Heathcote rivers is likely to be affected by a number of factors including the following:

- High initial dilution due to relatively high river flow.
- Further downstream dilution due to non-human waste contaminated tributaries joining the main stem of the rivers.
- Possible die-off of *E.coli* in the lower reaches due to natural UV disinfection (weather and timing dependent).

Assessment of the public health risks based on observed river mixing and a comparison with public health standards is summarised in Table 14 below.

■ Table 14: Sewer Overflow Discharge Risk Zone Assessment

Overflow event	PS20/4 Fisher Avenue <i>E.coli</i> Monitoring 6-12/8/04	
Time (hours after start)	2.5	12
Upstream (cfu/100 mL)	2400	3200
Discharge point (cfu/100 mL)	61000	49000
Downstream (cfu/100 mL) ¹	5800	8700
Calculated dilutions	18	8.9
Receiving Environment Standard	Contact recreation 260 <i>E.coli</i> / 100mL Drinking water <1 <i>E.coli</i> / 100mL	

Notes 1. Samples collected 200m downstream from discharge point

The preliminary assessment presented above indicates that the zone of public health risk is likely to continue downstream for some distance below the discharge point. While wet weather sewer overflows are occurring, between 9 and 18 dilutions are observed at a point 200 m downstream from the discharge. The maximum measured sewer overflow rate at Fisher Ave of 212 L/s implies a flow in the Heathcote River of between 1.9 and 3.8 m³/s, which appears to be a reasonable assessment of likely flow during heavy rain. This implies that no additional mixing is likely to occur further downstream until the confluence with other tributaries is reached, and the effective risk zone may extend for some kilometres downstream.

Sewer overflow points are spatially distributed throughout the city. As sewage mixing zones extend for considerable distances downstream from the points of discharge, it is reasonable to

conclude that a large proportion of the length of Christchurch City waterways may contain *E.coli* at levels that represent a significant health risk during a heavy rainfall event (1:2 year event or larger). Insufficient information is available to confirm the specific location and extent of health risks for smaller events.

Overflows also occur in the event of pipe blockages. These occur predominantly in small diameter pipes. The volume of overflow is small and the resultant effect on the environment and public health is also small. Approximately 400 of this type of overflow occur annually.

6.3.2 Health risk exposure pathways

Human health risk exposure pathways that apply to the Avon and Heathcote Rivers are primarily associated with contact recreation. The waterways provide sites for numerous recreational activities including fishing, kayaking and walking. Christchurch City management objectives for the Avon and Heathcote Rivers including the following²⁰:

- Protection and improvement of natural character.
- Restoration of natural waterway function.
- Restoration of habitat for birds, fish and insects.
- Restoration of waterways for their value to local communities.

Significant community values include those associated with walking alongside the river and scenic interest. Contact recreation mainly consists of kayaking, but may also include educational contact involving children. For example, the Riccarton / Wigram Community Board Leisure, Parks and Waterway Study (2003)²¹ has identified supervised play for children as a river management objective, including “*more than simple river access.... but with larger areas where children can run and cycle beside rivers*”.

The rivers are used by the public year round, with the summer months (September to May) the most popular for rowing and kayaking. Swimming in the Avon or Heathcote Rivers appears to have limited status as a desirable recreational pursuit in community board waterway studies, and in Council policy documents. Anecdotal evidence of swimming by children “*in a creek or drain by Harrington Park*” is reported in the Riccarton / Wigram Leisure, Parks and Waterways Study²¹.

Contact recreational users of the Avon and Heathcote Rivers are likely to be exposed to public health risks associated with untreated sewage discharges along a considerable length of the two rivers at times of sewer overflow. A significant mitigating factor is the prevalence of low-contact water-related activities such as walking or kayaking over high-contact water sports such as swimming. Some of these activities may also be discouraged by poor weather and / or high river flows that coincide with sewer overflow. A further consideration is the use of warning signs and advisory messages to river users including the Antigua Boatsheds and rowing clubs in the lower reaches.

Chapter 4 of the Proposed Natural Resources Regional Plan establishes water quality objectives for rivers, lakes and aquifers in the region, and specific water quality standards and mixing zones for

point sources discharges to surface water bodies that will have to be complied with. The general policy approach in the Plan is to prohibit the discharge of human sewage and solid or hazardous waste to receiving waters, and to ensure that best practices are used to ensure to prevent or minimise the risk of accidental discharges. CCC employs best practice to minimise the risk of sewer overflows as a result of pipe blockages or pump failures. CCC also holds a resource consent permitting it to discharge sewage under wet weather conditions provided capital works are undertaken to reduce the frequency of overflow.

6.3.3 Duration and frequency of risk

Wet weather sewage overflows to the Avon and Heathcote Rivers occur infrequently. There are three recorded instances of overflow since September 2003, typically lasting for two to three days at a time. During each event, overflows may occur from any number of overflow points and the overflows may be intermittent. Monitoring data indicates that the background water quality is restored at the point of discharge within 24 hours after the overflow has ceased.

Dry weather sewage overflows caused by blockages in small diameter pipes occur approximately 400 times a year. These overflows are generally of short duration.

The frequency of contact recreation in the Avon and Heathcote Rivers is likely to increase over the summer months. Sewer overflows may occur at any time of the year but may be slightly more likely in winter as high groundwater levels enhance sewer inflow and infiltration.

6.3.4 Health risk summary

A summary of health risks associated with overflows of untreated sewage to the Avon and Heathcote Rivers is as follows:

- The hazardous nature of the discharge is likely to continue at current levels. Wastewater, at the point of discharge and downstream, does not comply with the MfE guidelines for contact recreation.
- The contact recreation risk zone is effectively the entire length of the Avon and Heathcote Rivers within the City boundary. Monitoring shows that acceptance standards are not likely to be met for considerable distances (greater than 1 km) downstream of the discharge points. People undertaking recreation activities at any point within the river network may be exposed to risks associated with the wastewater contaminants.
- The duration of the discharge producing a risk zone in the Avon and Heathcote Rivers is typically one to two days for each overflow event.
- The frequency of exposure to the discharge producing a risk zone in the Avon and Heathcote Rivers is described as very low (once per year typical) for wet weather overflows.

6.3.5 Belfast treatment plant risk assessment

The MfE “risk grading” for the Otukaikino catchment based on the methodology set out in Section 6.1 is “*Very High*”²². This risk will be eliminated when the discharge is removed at the end of 2006

and pumped to the CWTP. A summary of health risks associated with continued discharge from the Belfast treatment plant until the end of 2006 when the discharge will cease is as follows:

- Population Characteristics - The Christchurch population may be slightly more vulnerable to enteric disease compared to the national average (reference Table 9).
- The hazardous nature of the discharge is likely to be maintained at current levels until the end of 2006. Discharge wastewater will fail to comply with the MfE guidelines for contact recreation for most of the time.
- The contact recreation risk zone is the course of Otukaikino Stream from the point of discharge to the confluence with the Waimakariri River 2.5 km downstream. People coming into contact with the stream waters are likely to be exposed to health risks associated with wastewater contaminants.
- The duration of the discharge producing a risk zone in the Otukaikino Stream is continuous.
- The frequency of exposure to recreational users is moderate due to the limited access and limited number of people using this section of the stream for recreational purposes.

7. Urban Fringe Risk Assessment

7.1 Risk Assessment Methodology

The risk assessment methodology applied to small decentralised wastewater treatment systems has been modified to take account of the relative uncertainty of potential health impacts for small schemes compared to the health impacts of large schemes, such as Christchurch, which are clearly measurable. The assessment is a preliminary risk assessment and was carried out on a qualitative basis. A full description of the risk assessment methodology is provided in Appendix A. The methodology followed is based on the guidance provided in AS/NZS 4360:1999 Risk Management Standard and its associated guideline documents. Evaluation criteria (descriptors) used to assign probabilities (likelihood / frequency) of an event occurring and the consequence of that event were developed using a combination of data from AS/NZS 4360²³ and HB203²⁴.

The risk matrix used to assign four levels of risk to an event is based on the matrix published in AS/NZS 4360. The evaluation criteria (look-up tables) for frequency and consequence and the risk matrix are presented in Table 15, Table 16 and Table 17.

■ **Table 15: Frequency Descriptors and Scales**

Level	Descriptor	Alternative Descriptor	Description	Value	Frequency
A	Almost Certain	Frequent	Expected to occur at least once per year	1	1/year
B	Likely	Probable	Expected to occur several times during life of asset	0.1	1/10 years
C	Possible	Occasional	Might occur at some time during life of asset	0.01	1/100 years
D	Unlikely	Remote	Could occur at some time; very unlikely in life of asset	0.001	1/1,000 years
E	Rare	Very Unlikely	Improbable; event has happened but not anticipated; could occur in exceptional circumstances	0.0001	1/10,000 years

■ **Table 16: Consequence Descriptors and Scales**

Level	Descriptor	Effects		
		Social (health & safety)	Environment	Fiscal
1	Insignificant	No injuries or minor health effects	Incidental on-site effect. No ecological consequences	Low financial loss. <\$10,000
2	Minor	First aid treatment. Incidental injury or health effects to persons exposed (vomiting etc but self medicated). Minor nuisance	Minor release immediately contained. Reduction in abundance / biomass of flora / fauna in affected area. No changes to biodiversity	Medium financial loss. \$10 -100 k.
3	Moderate	Injuries or health effects to persons, requiring medical treatment. Significant sustained nuisance.	Off-site release contained with outside assistance. Reduction in biomass in local area without significant loss of pre-impact ecological functioning.	High financial loss. \$100 – 1,000k

Level	Descriptor	Effects		
		Social (health & safety)	Environment	Fiscal
4	Major	Extensive injuries or health effects to persons. Illness requiring hospitalisation of one or two persons.	Off-site release with significant impact to biodiversity and ecological functioning with eventual recovery (maybe not to pre-impact conditions).	Major financial loss. \$1-10 million
5	Catastrophic	Single public fatality or severe permanent disabilities to more than one person. Multiple persons (>2) being hospitalised	Toxic release with off-site detrimental effect. Irreversible changes to abundance of biomass in affected environment. Loss of ecological functioning with little prospect of full recovery.	Huge financial loss. >\$10 million

The level of risk was determined for each hazard, and the fault / failures and events pertaining to that hazard, based on the scales assigned by the qualitative frequency and consequence descriptors using a risk matrix, as described by NZS 4360:1999.

■ **Table 17: Risk Matrix**

Consequence Likelihood vs	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
A (Almost Certain)	H	H	E	E	E
B (Likely)	M	H	H	E	E
C (Possible)	L	M	H	E	E
D (Unlikely)	L	L	M	H	E
E (Rare)	L	L	M	H	H

Based on AS/NZS 4360:1999

7.2 Wastewater Treatment Scheme Risk Factors

The potential public health risks associated with operation of a small decentralised wastewater treatment scheme relate to the design and construction of the treatment scheme, the operational management and maintenance, and the site-specific environmental factors.

Considering each element of a small decentralised wastewater treatment system, potential risks and their assessments are set out below:

■ **Table 18: Small Wastewater Treatment Scheme Risk Factors**

Risk factor	Description and consequence
Treatment plant or disposal field poorly designed	If the treatment plant is poorly designed or offers a low level of treatment (primary only), this increases the biological loading on the disposal field. A more highly loaded disposal field is at a greater risk of failure over a long period of time due to slime build-up or biological clogging within the disposal field.
Treatment plant or disposal field poorly maintained	If the disposal field is poorly designed maldistribution can result, leading to premature failure of part of the bed due to excessive loading while other parts of the bed may receive little or no effluent at all.
Poor quality or	Poor maintenance of the treatment scheme, including the disposal field,

hydraulically limited soils	enhances the risk of potential operating problems and associated public health risks.
Shallow groundwater	Shallow groundwater in proximity to the disposal field is a recognised risk factor. If the separation between the disposal field wastewater distribution pipes and groundwater is less than 1 m, or the soil profile within the disposal bed is less than 0.6 m deep, there is significantly increased risk of groundwater contamination with faecal coliforms, ammonia and nitrate.
Shallow groundwater bores in close proximity	Shallow groundwater bores in close proximity to the disposal field introduce the risk of water supply contamination especially when combined with high groundwater
Surface water resources in close proximity	Surface water sources in close proximity to the disposal field increases the likelihood of surface water contamination with faecal coliforms, ammonia and nitrate due to human wastewater disposal.
Failure of electricity, pumps or pipework	Plant failure, including failure of electricity or failure of mechanical equipment (eg. pumps), may cause problems with scheme operation. The worst case scenario is likely to be overland flow of raw sewage, depending on the layout of the specific treatment plant.

7.3 Northeast Fringe Risk Assessment

Risk Assessment for Northeast fringe is summarised in Table 19 below.

■ **Table 19: Northeast Fringe Risk Assessment**

Risk factor	Domestic septic tanks			Marshlands School			Ouruhia School		
	Likeli.	Conseq.	Risk	Likeli.	Conseq.	Risk	Likeli.	Conseq.	Risk
Treatment plant or disposal field poorly designed	B	2	H	E	2	L	E	2	L
Treatment plant or disposal field poorly maintained	B	2	H	E	2	L	E	2	L
Poor quality or hydraulically limited soils	C	2	M	C	1	L	C	1	L
Shallow groundwater	B	2	H	B	2	H	B	2	H
Shallow groundwater bores in close proximity	E	3	M	E	3	M	E	3	M
Surface water resources in close proximity	B	2	H	D	2	L	D	2	L
Failure of electricity, pumps or pipework	D	1	L	D	1	L	D	1	L

7.4 Northwest Fringe Risk Assessment

Risk Assessment for Northwest fringe is summarised in Table 20 below.

■ **Table 20: Northwest Fringe Risk Assessment**

Risk factor	Domestic Septic Tanks			Yaldhurst School			McKenzie School			Paparua Youth Justice Facility			Isaac Construction Company		
	Likelihood	Conseq.	Risk	Likelihood	Conseq.	Risk	Likelihood	Conseq.	Risk	Likelihood	Conseq.	Risk	Likelihood	Conseq.	Risk
Treatment plant or disposal field poorly designed	B	1	M	E	2	L	E	2	L	E	2	L	E	2	L
Treatment plant or disposal field poorly maintained	B	1	M	E	2	L	E	2	L	E	2	L	E	2	L
Poor quality or hydraulically limited soils	D	1	L	D	1	L	D	1	L	D	1	L	D	1	L
Shallow groundwater	E	2	L	E	2	L	E	2	L	E	2	L	E	2	L
Shallow groundwater bores in close proximity	E	2	L	E	2	L	E	2	L	E	2	L	C	2	M
Surface water resources in close proximity	D	2	L	D	2	L	D	2	L	D	2	L	C	2	M
Failure of electricity, pumps or pipework	D	1	L	D	1	L	D	1	L	D	1	L	D	1	L

■ **Table 21: Northwest Fringe Risk Assessment Continued...**

Risk factor	Christchurch International Airport			The Leisure Club			Canterbury Kennel Association		
	Likelihood	Conseq.	Risk	Likelihood	Conseq.	Risk	Likelihood	Conseq.	Risk
Treatment plant or disposal field poorly designed	E	2	L	E	2	L	C	2	M
Treatment plant or disposal field poorly maintained	E	2	L	E	2	L	C	2	M
Poor quality or hydraulically limited soils	D	1	L	D	1	L	D	1	L
Shallow groundwater	E	2	L	E	2	L	C	2	M
Shallow groundwater bores in close proximity	E	2	L	E	2	L	C	2	M
Surface water resources in close proximity	D	2	L	D	2	L	D	2	L
Failure of electricity, pumps or pipework	D	1	L	D	1	L	D	1	L

7.5 Southeast Fringe Risk Assessment

Risk Assessment for Northwest fringe is summarised in Table 22 below.

■ **Table 22: Southeast Fringe Risk Assessment**

Risk factor	Domestic septic tanks		
	Likelihood	Consequence	Risk
Treatment plant or disposal field poorly designed	B	2	H
Treatment plant or disposal field poorly maintained	B	2	H
Poor quality or hydraulically limited soils	C	2	M
Shallow groundwater	B	2	H
Shallow groundwater bores in close proximity	E	3	M
Surface water resources in close proximity	C	2	M
Failure of electricity, pumps or pipework	D	1	L

7.6 Southwest Fringe Risk Assessment

Risk Assessment for Northwest fringe is summarised in Table 23 below.

■ **Table 23: Southwest Fringe Risk Assessment**

Risk factor	Domestic septic tanks		
	Likelihood	Consequence	Risk
Treatment plant or disposal field poorly designed	B	2	H
Treatment plant or disposal field poorly maintained	B	2	H
Poor quality or hydraulically limited soils	C	2	M
Shallow groundwater	B	2	H
Shallow groundwater bores in close proximity	E	3	M
Surface water resources in close proximity	C	2	M
Failure of electricity, pumps or pipework	D	1	L

8. Options to Meet Demand

8.1 Existing Plans

The Council is committed to and actively pursuing policies and programmes to protect the people in its territorial area from risks associated with sewage disposal. To this end, the Council has prepared a management plan for the wastewater system.

The Council's key strategic objectives relevant to wastewater published in the *Wastewater Management Plan 2003, Part 1 Strategic Issues*, include:

- Promoting and protecting health standards.
- Recognising the unique role of tangata whenua.
- Protecting artesian water resources.
- Maintaining the quality of streams and rivers.
- Promoting the efficient use of physical resources, an increase in recycling and resource recovery and a reduction of waste.
- Minimising the risks from earthquake, flood, fire and other natural hazards.
- Ensuring high quality utilities meet the reasonable service demands of residents and are cost-effective.
- Designing projects to enhance environmental and social sustainability and otherwise avoiding or mitigating, where possible, adverse affects of both natural and technological hazards on people, property or the environment.

The Council's vision statement that encapsulates these strategic objectives is as follows:

"An affordable, reliable, culturally acceptable and ecologically sustainable wastewater system that meets the needs of present and future communities."

The goals the Council has set to meet this vision statement are²:

- Appropriate plans are in place to show that wastewater will be managed to meet the agreed levels of service.
- System risks are understood and managed to appropriate and agreed levels
- The system addresses the public health needs of the community in a way that is socially and culturally acceptable.
- Environmental impacts are recognised and minimised.
- The effects of growth and other change projections are recognised and planned for.
- The linkages between wastewater management and the management of natural and man-made systems are recognised and accounted for.
- Projections for the cost per connection of providing wastewater services in Christchurch are maintained below the average for similar communities.

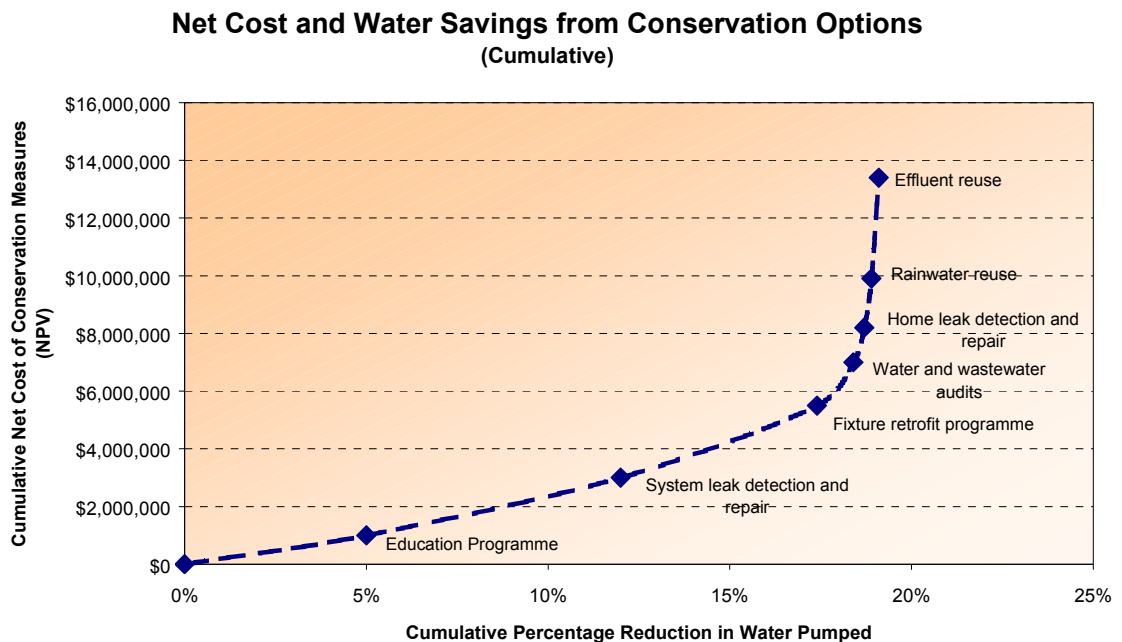
The ECan proposed NRRP sets out policies and objectives for the protection of the environment. These policies and objectives are implemented by rules and conditions for discharges to the environment and for taking of resources from the environment. Through this process safeguards will be put in place to protect the community and environment from potential contamination from sewage discharges.

8.2 Options to Meet the Demands

Options to meet demand resulting from population growth

- Construction of additional pumping stations and pipelines to increase capacity to help meet peak demands
- Inflow and infiltration reduction programmes
- Increase capacity of treatment plant
- Wastewater system modelling to identify operational changes to increase system efficiencies, monitor effectiveness of capital works and rehabilitation programmes, assist with pipe sizing and capacities required
- Investigate alternative systems such as storage or decentralised treatment systems to help cater for peak flows.
- Rainwater, grey water and effluent re-use for non-potable needs

The cumulative effect of various demand management approaches, from a Water Conservation Cost Benefit Analysis study carried out for Christchurch Water Supply in 1996, is shown in the graph below.



The cumulative net cost takes into account the cost of implementing the conservation measure minus the benefits of reduction in capital and operating costs. The most cost-effective measures

are those where the curve is flatter, such as education and system leak detection, a greater reduction in water use is achieved for the amount of money spent. Less cost-effective measures lie at the top of the curve, such as rainwater and effluent re-use.

Because of the low unit cost of water supply in Christchurch and high cost of water conservation measures there are no economic incentives to reduce demand. If grey water and stormwater re-use technologies were to advance sufficiently then these options may become economic. There is a pilot project, currently in the planning phase, programmed for the CWTP where final effluent will be used for process and cleaning functions after suitable additional treatment.

Options to meet demand related to environmental issues

- Inflow and Infiltration reduction programmes
- Capital works to reduce wet weather overflows
- Diversion of Belfast's wastewater flow from the Otukaikino Creek
- Construction of ocean outfall to replace estuary discharge

Options to meet demand related to night soil collection

- Investigate options to get properties off night cart collection
- Investigate reticulated septic tank options (STEP/STEG systems)
- Extend city reticulation to service the properties

8.3 Proposed Action Plan

The Wastewater Management Plan 2003, Part 1 sets out the strategy of the Council to meet the goals defined in the Plan. This strategy is summarised as follows²:

- Produce an integrated water plan (in conjunction with the Council's proposed Urban Development Strategy)
- Maintain and improve the present centralised collection, treatment and outfall system which is the most cost effective, socially and environmentally sustainable option available to Christchurch
- Remove the need for future significant capacity upgrades of the centralised system by managing wastewater quantity and quality and introducing reticulated septic tank systems where appropriate
- Pipe the wastewater of Belfast and the surrounding growth areas to the Christchurch WTP system by 2006.
- Improve the value of biosolids through a detailed investigations of alternative uses, including composting with organic waste

- Develop and maintain “Best appropriate practice” asset management plans and practices to minimise the costs and risks associated with Christchurch’s wastewater system
- Actively cooperate with other agencies and Units of the Council to facilitate improved integration of water, waste, and urban development planning
- Prepare design and installation standards for the use of reticulated septic systems in appropriate circumstances.
- Encourage alternatives to conventional sewerage by waiving or reducing treatment and reticulation capacity upgrading contributions for such alternatives
- Retain existing Council owned land in the vicinity of the Wastewater Treatment Plant and seek opportunities to acquire non-residential sites adjacent to the site boundary where they:
 - link directly with other Council owned land
 - would have meaningful benefit for community use
 - would maintain existing buffers that provide protection from adverse effects of the Plant.
 - maintain the opportunity for future initiatives involving wastewater by-products (such as the composting of wastewater solids)
- Continue investigations and trials for nutrient recovery as part of the Council’s “Green Edge” project for enhancement around the estuary.
- Consider applications for cross-border flows of wastewater only where the applicant can demonstrate that:
 - discharge into the Christchurch centralised system is deemed to be the best practicable option for their wastewater
 - the flows will not unduly impact on trunk main and treatment plant capacity
 - they are willing to cover all costs associated with the wastewater.
 - the acceptance does not encourage development adjacent to the City that the City Council considers inappropriate.
 - satisfactory strategies to deal with:
 - daily and storm peak-flows
 - emergency management
 - public health risks and potential for increased odour in the Christchurch system
 - trade waste (where applicable)
- Develop an Area Cultural Plan for water in conjunction with Tangata Whenua and others with a key interest in water planning
- Develop a Customer Charter backed by an education programme to articulate Council service commitments and to ensure customers recognise their own responsibilities to manage inputs into the liquid waste stream
- Develop a Council policy regarding greenhouse gases in conjunction with other agencies and Council Units.

The Council will also continue to:

- Investigate and implement options to reduce the number of properties that rely on “night cart” sewage collection.
- Provide input into city plan variations and regional plans and build the asset for development and growth projections.
- Monitor feedback from the Special Consultative Procedure and other consultations and incorporate inputs into Asset Management Plans and future assessments.
- Seek clarification on the responsibility of the Council to assess the operation and management of non-Council sewerage services.

Appendix A Risk Assessment Methodology

Introduction

The risks pertaining to public health and environmental effects for those communities within the Christchurch City Council area that are not connected to the municipal water and sewage reticulation systems have been assessed. The assessment is a high level preliminary risk assessment and was carried on a qualitative basis. The methodology, assessment and evaluation criteria used are described in the following sections.

The risks from the reticulated water supply and sewerage system operated by Christchurch City Council have previously been assessed by other projects run by CCC and only the results of these risk assessments are discussed in this report. The level of risk identified in these risk assessments is contained in the following reports published by Christchurch City Council:

- Wastewater Management Plan, 2004, Part 2 Asset Management Overview.
- Water Quality Public Health Risk Management Plan, Draft 2003.

No comment is provided in this report as to the appropriateness of the methodology used to determine the level of risk for each of the hazards and failure events assessed in these reports.

Methodology

The methodology followed in conducting this qualitative risk assessment is based on the guidance provided in AS/NZS 4360:1999 Risk Management Standard and its associated guideline documents. The assessment has focussed on only two areas of risk pertaining to the operation and use of non-reticulated water and sewage systems. These are the risk to public health and to the environment. This includes both normal operations and failure modes associated with these activities.

Key definitions used throughout the assessment are set out below.

Hazard as a source of potential harm or a structure with a potential to cause loss.

Event is an occurrence that can have an adverse impact on the environment or on public health. An event releases the intrinsic potential of a hazard

Consequence is the outcome of an event expressed in the assessment qualitatively, being illness, injury, loss of biological community, or environmental damage.

Risk is the combination of the likelihood and the consequence of a specified hazard being realised.

Environmental risk recognises that activities of an organisation can cause some form of environmental change as the result of an event.

The following steps in the risk assessment process were followed:

- Establish context of the risk assessment.
- Identify hazards associated with non reticulated water supply and sewage disposal.

- Determine for each hazard the fault/failure modes that could result in an event which could impact on public health or the environment.
- Describe the event as a result of the fault/failure.
- Describe the potential effect as a consequence of the event.
- Analyse the level of risk using the evaluation criteria (likelihood and consequence sections) as set out in the report.
- Evaluate whether the level of risk is acceptable or not using risk matrix.

The initial identification of hazards, fault/failure modes and the establishment of credible events was undertaken by a team of SKM consultants with expertise in water supply, wastewater treatment and reticulation, public health and environmental effects.

A spreadsheet (Risk Register) which sets out the list of hazards, fault/failures, events, level of effect, frequency based on evaluation scales, consequence level and level of risk separately for reticulated and non-reticulated sewage dispersal is presented in Appendix B.

Evaluation Criteria

Evaluation criteria (descriptors) used to assign probabilities (likelihood/frequency) of an event occurring and the consequence of that event were developed using a combination of data from AS/NZS 4360¹ and HB203², plus some expansion and enhancements based on knowledge derived from previous qualitative risk assessments, experience and common sense.

The risk matrix used to assign three of four levels of risk to an event is based on the matrix published in AS/NZS 4360.

The evaluation criteria (look-up tables) for frequency and consequence and the risk matrix are presented in Tables 1 to 3 in the following sections.

¹ Standards Australia/Standards New Zealand, AS/NZS 4360: 1999 Risk Management

² Standards Australia/Standards New Zealand, HB203:2000, Environmental risk management – Principles and process

■ **Table A.1: Frequency Descriptors and Scales**

Level	Descriptor	Alternative Descriptor	Description	Value	Frequency
A	Almost Certain	Frequent	Expected to occur at least once per year	1	1/Year
B	Likely	Probable	Expected to occur several times during life of asset	0.1	1/10 Yrs
C	Possible	Occasional	Might occur at some time during life of asset	0.01	1/100 Yrs
D	Unlikely	Remote	Could occur at some time; very unlikely in life of asset	0.001	1/1,000 Yrs
E	Rare	Very Unlikely	Improbable; event has happened but not anticipated; could occur in exceptional circumstances	0.0001	1/10,000 Yrs

■ **Table A.2: Consequence Descriptors and Scales**

Level	Descriptor	Effects		
		Societal (Health and Safety)	Environmental	Fiscal
1	Insignificant	No injuries or minor health effects	Incidental on-site effect. No ecological consequences.	Low financial loss <\$10,000.
2	Minor	First aid treatment. Incidental injury or health effects to persons exposed (vomiting etc but self medicated). Minor nuisance.	Minor release immediately contained. Reduction in abundance / biomass of flora fauna in affected area. No changes to biodiversity	Medium financial loss. \$10 -100 k.
3	Moderate	Injuries or health effects to persons requiring medical treatment. Significant sustained nuisance.	Off-site release contained with outside assistance. Reduction in biomass in local area without significant loss of pre-impact ecological functioning.	High financial loss. \$100 -1000k
4	Major	Extensive injuries or health effects to persons. Illness requiring hospitalisation of one or two persons.	Off-site release with significant impact to biodiversity and ecological functioning with eventual recovery (maybe not to pre impact conditions).	Major financial loss. \$1-10 million
5	Catastrophic	Single public fatality or severe permanent disabilities to more than one person. Multiple persons (>2)being hospitalised	Toxic release with off-site detrimental effect. Irreversible changes to abundance of biomass in affected environment. Loss of ecological functioning with little prospect of full recovery.	Huge financial loss. >\$10 million

The descriptors/criteria adopted for the consequence have been developed to reflect society's tolerance and acceptance of risk pertaining to illness and fatalities associated with water and sewage. Society tends to set its level of tolerance based on the level of voluntary or non-voluntary exposure to a risk. For non-voluntary type risk exposures, the levels of tolerance by society are generally lower. For activities over which the public has limited voluntary control (such as water

supply, or a chemical factory located nearby), the level of risk that could result in a fatality to the member of public is usually valued at a higher consequence level than an activity where there is some degree of voluntary acceptance of the level of risk (eg driving a car). Society is more tolerant over road accidents or industrial worker fatalities, than a person dying from meningitis.

A fatality from a water-borne illness in New Zealand or a contagious disease such as meningitis is generally regarded as being unacceptable, and for this reason a fatality of a member of the public has been set as the highest level of consequence.

The scale of the descriptors set in terms of public fatality (single) is conservative. This approach will for some events potentially over-estimate the level of risk. However, given that this risk assessment is a preliminary assessment and is based on limited data, those risks identified as being extreme or high can be subject to further scrutiny once more detailed data has been collected which allows the level of risk to be better qualified.

The level of risk was determined for each hazard and the fault/failures and events pertaining to that hazard based on the scales assigned by the qualitative frequency and consequence descriptors using a risk matrix, as described by NZS 4360:1999.

■ **Table A.3: Risk Matrix**

Consequence vs Likelihood	1 (Insignificant)	2 (Minor)	3 (Moderate)	4 (Major)	5 (Catastrophic)
A (Almost Certain)	H	H	E	E	E
B (Likely)	M	H	H	E	E
C (Possible)	L	M	H	E	E
D (Unlikely)	L	L	M	H	E
E (Rare)	L	L	M	H	H

Based on AS/NZS 4360:1999

Risk is assigned one of four levels, being:

L	LOW	Low risk; managed by routine procedures
M	MODERATE	Moderate risk; required above normal attention
H	HIGH	High risk; ALARP must be applied
E	EXTREME	Extreme risk; not acceptable and must be reduced

The principle of ALARP (As Low As Reasonably Practicable) means that while the risk is in the tolerable band, measures (mitigation) must still be applied to reduce it further. Risk levels of High (H) and Moderate (M) both fall into the tolerable region and must be addressed.

However, the level of attention applied to a High (H) risk (compared to a Moderate Risk) is much greater and it is possible the actual cost of those risk reduction measures may outweigh the financial (equivalent) benefits gained. When the risk level is Moderate, risk reduction measures can always be applied but are mandatory if they result in a positive cost/benefit outcome.

Appendix B Risk Assessment Spreadsheet

References

- 1 Assessment of Environmental Effects for Christchurch Wastewater Discharge, URS, 2001
- 2 Wastewater Management Plan, 2003, Part 1 - Strategic Issues, Christchurch City Council
- 3 Wastewater Management Plan, 2004, Part 2 – Asset Management Overview, Christchurch City Council
- 4 Council website address www.ccc.govt.nz/consultation/wastewater
- 5 <http://www.ccc.govt.nz/consultation/Wastewater/wastewaterconsultation> document 16
- 6 Christchurch City Library website <http://library.christchurch.org.nz>
- 7 Dept of Statistics Website <http://www.stats.govt.nz>
- 8 Roger Grenfell Drainage Services South Island, pers comm. 9/9/04
- 9 Auckland Regional Council TP58 Onsite Wastewater Disposal from Households and Institutions
- 10 Environment Canterbury website <http://www.Environment Canterbury.govt.nz>
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