

FINAL REPORT

# CHRISTCHURCH WASTEWATER TREATMENT PLANT PRELIMINARY ASSESSMENT OF ENVIRONMENTAL EFFECTS



*Prepared for*

Christchurch City Council  
P.O. Box 237  
Christchurch

18 September 2000

## URS

URS New Zealand Ltd  
Level 5, Landsborough House  
287 Durham Street  
PO Box 4479 Christchurch, New Zealand  
[www.urscorp.co.nz](http://www.urscorp.co.nz)  
Tel: +64 3 374 8500  
Fax: +64 3 377 0655

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## Final Report

# Christchurch Wastewater Treatment Plant Preliminary Assessment of Environmental Effects

*Prepared for*  
Christchurch City Council  
Tuam Street  
Christchurch

*Prepared by*  
Cliff Tipler \ Jeanine Keller

*Authorised by*  
Cliff Tipler

18 September 2000

**URS**

Woodward Clyde  
Dames & Moore

URS New Zealand Ltd  
Level 5, Landsborough House  
287 Durham Street  
Christchurch, New Zealand  
PO Box 4479 Christchurch  
Tel: +64 3 374 8500  
Fax: +64 3 377 0655

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## 1.1 The Purpose Of This Document

The purpose of the Preliminary Assessment of Environmental Effects is three fold;

- To provide information to enable the community to make informed decisions on their preferences for Christchurch City's wastewater treatment and disposal.
- To enable Council to make a choice between wastewater disposal to the Avon-Heathcote Estuary and the Ocean.
- To ensure that all environmental issues required to be included in the Assessment of Environmental Effects for the disposal of the city's wastewater are addressed.

## 1.2 Background

The Christchurch City Council operates a wastewater treatment and disposal system for the majority of the Christchurch City. In order that the system achieves the standards required to meet new resource consent requirements and the aspirations of the community the system of both treatment and disposal of the wastewater requires upgrading.

The Christchurch Wastewater Treatment Plant (CWTP) at Bromley, presently discharges to the Avon-Heathcote Estuary under a discharge consent authorised by the Resource Management Act (1991)(RMA). The consent will expire in October 2001, and before this the Christchurch City Council (CCC) will be required to apply for a new consent. Unlike the present consent, the new application will have to be made under the provisions of the RMA.

Developing the future treatment and disposal of the city's wastewater has been ongoing for a number of years. In 1996 planning begun for the upgrading of the treatment facilities, in order to increase the capacity of the plant to meet 30 years of city growth, including industrial growth. This upgrade is presently underway and is expected to be completed by 2006.

Planning and consultation in relation to a new discharge consent application was initiated in 1996, with;

- the establishment of a Working Party to advise and recommend on issues, options and possible solutions to the City's wastewater treatment and disposal solutions,
- general consultation with the public,
- the production of an issues and options document which addressed all the issues and potential treatment and disposal options available and provided a short list of the most likely solutions
- the undertaking of a wide range of investigations to address gaps in knowledge and aspects of the assessment of environmental effects.

### 1.3 Broad Description Of The Existing CWTP And Activities

The Christchurch City Wastewater Treatment Plant (CWTP) treats 99% of the sewage produced in Christchurch. Smaller treatment plants at Templeton and Belfast treat the remainder.

For over 100 years sewage treatment has been carried out at the Bromley site, initially treatment involved solids removal in large septic tanks, and effluent application to land. The present treatment involves full primary and secondary treatment, plus oxidation ponds and discharge on the outgoing tide to the Avon-Heathcote Estuary. The plant was commissioned in 1962, but has since undergone a number of major upgrades. In 1969 the number of primary sedimentation tanks were increased from three to seven. In 1975 a fourth secondary tank was added, the trickling filters upgraded and a third digester built. In 1985/86 covers were constructed over the trickling filters to deal with odour issues, and an odour treatment system installed. In 1996 a major upgrade was initiated that will increase the plant capacity, by installing a Trickling Filter Solids Contact (TFSC) process. This is further described in section 2.

### 1.4 Existing Consents

Until the enactment of the Water and Soil Conservation Act (1967) the disposal of effluent into the Estuary was lawful under the Christchurch Drainage Act (1951). When the Water and Soil Conservation Act came into effect, the Christchurch City Council (then the Christchurch Drainage Board) was required to seek authorisation to continue the discharge. The North Canterbury Catchment Board (now the Canterbury Regional Council) granted this authorisation on 24 July 1973.

This authorised the Christchurch Drainage Board to legally discharge until:

- (a) a final classification is established for the waters of the Estuary; or
- (b) the Water and Soil Conservation Act 1967 was either modified or repealed and replaced by new legislation, that necessitates the Council to apply for a new “water right”; or
- (c) The volume discharged exceeds the limit set by the authorisations.

No quality standards were prescribed – the only restriction was a flow limit of 231,200m<sup>3</sup>/day from the oxidation ponds and 982m<sup>3</sup>/day from the toe drains as follows:

Southern and northern effluent structures (Pond 5) – 30,700m<sup>3</sup>/day/outfall each

Southern and northern effluent structures (Pond 6) – 84,900m<sup>3</sup>/day/outfall each

Toe drains draining directly to Estuary

- Southern - 655m<sup>3</sup>/day
- Northern - 327m<sup>3</sup>/day

The approval allowed for unrestricted discharge (i.e. 24h/day) irrespective of total conditions.

The average volume of effluent currently discharged from the ponds is substantially less than that authorised (average 155,000m<sup>3</sup>/day total, in 1995/96). However, the total flow limit/day is being exceeded at times with up to 450,000m<sup>3</sup>/day being released.

## 1.5 Required Consents

A new 15 year discharge consent is sought for the discharge of wastewater from the CWTP into the Avon-Heathcote Estuary, from the Environment Canterbury. In addition, there will be a number of further consents required from both Environment Canterbury and the Christchurch City Council, related to the implementation of changes in wastewater treatment and disposal. These include the following:

### *Consents required from Environment Canterbury*

- Discharge consent to the Avon–Heathcote Estuary
- Land use consent for the outfall structure
- Air consent from the treatment of wastewater.
- Stormwater consent for the drains which flow into the Avon–Heathcote Estuary.

### *Consent required from Christchurch City Council*

- Land use consents for alteration of the oxidation ponds
- Land use consent for the UV disinfection structure.

## 1.6 Land Ownership

The land on which the CWTP is located is owned by the Christchurch City Council. The site is not designated, but zoned by Conservation Zone (C1B) under the Proposed Christchurch City Plan (1999). This zoning specifically allows for the wastewater treatment processes, while also recognising the extremely high conservation values of the ponds, surrounding land, and the Avon-Heathcote Estuary.

## 1.7 Present Plant Upgrade

At present the CTWP is undergoing an upgrade. This relates to the treatment plant processes and specifically deals with increasing the capacity of the plant rather than permitting of a new discharge consent.

## 1.8 Issues and Options Study

The need for an Issues and Options study was recognised by both the Christchurch City Council and the Working Party. The aim of such a study was to address the issues identified by the Working Party, and assess the range of options available for treating and disposing of the wastewater. This information then provided a basis for the Working Party to decide which method/s of waste treatment and disposal should be recommended to the City Council for further investigation and implementation.

The Working Party was required to identify the issues of concern. These issues were collated and were used to form the basis of this Issues and Option Report. The issues raised included generic issues, to do with the broader waste management concepts, and more specific issues relating to the environmental effects of the present treatment and disposal methods, the potential effects of other waste treatment and disposal methods, and the state of the estuary environment. Issues of concern covered a wide range of ecological, social, cultural and economic issues.

It was at this point that URS New Zealand Ltd (formerly Woodward-Clyde), together with its associates for this study, were engaged to undertake the Issues and Options Study.

The Working Party identified a wide range of issues relating either directly or indirectly to the treatment, disposal and effects of wastewater from Christchurch City. These issues were discussed and revised in a workshop on the 29 September 1997.

The aim of the Issues and Options study was to develop an understanding of the issues, and provide a summary, which can provide the basis to the discussion of the various treatment and disposal options.

The process undertaken by the consultants was to initially collate all available information and knowledge, and identify where the gaps in the understanding of the identified issues occurred. “Experts” in each of the various issue areas undertook this assessment.

Many of the issues identified by the Working Party relate to the effects of the present treatment and disposal of the wastes. The “experts” were asked how these effects were or could best be managed, and the requirements for this management.

Other issues were generic and where they were within the scope of this study, they were addressed. Some generic issues related to changes in institutional frameworks and behaviour changes. These issues were outside the scope of this study and as such were only identified.

A number of issues related to how future management might affect the environment, for example, how different waste management options might affect bird life on the estuary, and where possible, these issues were addressed. However, it was only later in the study, in the discussions relating to feasible options, that issues could be more thoroughly addressed.

The understanding gained from the analysis of the issues forms the basis to the identification of feasible options. (Sections 5, 6, and 7).

## 1.9 Working Party

A Working Party of approximately 15 members reflecting a wide range of interests was established, and a facilitator was provided to help co-ordinate the process. The Working Party also included councillor and community board representation.

The objectives of the Working Party included:

- to collate, link the needs, issues and ideas, with the support of the Council's staff and the facilitator,
- to identify the issues to be addressed within an Issues and Options Report, and
- to assess the Issues and Options Report and if possible recommend one or a number of the described potential discharge solutions to the Christchurch City Council.

## 1.10 Structure Of The Preliminary Assessment of Environment Effects

This report includes eight sections.

**Section 1.0** Includes an introduction which covers the existing and required consents, the present plant upgrade, and description of the working party (and expert panels contributions) and a brief summary of the early Issues and Options document.

**Section 2.0** This provides a full description of the activities; including the characterisation of discharges, liquid, air and solids; methods of discharges, how, where and when; a description of the treatment processes; land use activities; operational activities. An implementation section is also included which describes the waste management strategy and staging.

**Section 3.0** describes the alternatives options in relation to receiving environments, treatment and disposal options, and is concluded with a discussion of the selection process.

**Section 4.0** summarises the consultation process undertaken. This includes the working party, special interest groups, Tangata Whenua, Canterbury Regional Council, The General Public and the role of Peer Review.

**Section 5.0** provides a description of the environment including both natural and physical resources, ecosystems, amenity and social values.

**Section 6.0** provides the assessment of the environmental effects, looking at the RMA and its definition of effects, various scoping techniques, methods of analysis, a discussion of assessment criteria, effects and evaluation of effects.

**Section 7.0** describes the mitigation measures, and includes discussion on risk assessment, contingency measures, monitoring and consent conditions.

**Section 8.0** covers the planning aspects in terms of the RMA, as well as including issues related to the National Coastal Policy Statement, and regional and district plans.

## 2.1 Introduction

This section provides a description of the discharges involved in the Christchurch Wastewater Treatment Plant (CWTP), as well as describing the treatment processes and facilities required for the upgraded discharge. There are many discharges resulting from the treatment of wastewater, including the treated liquid, discharges to air of odour, aerosols and particulate matter, discharges of the by-products of treatment including the gross solids and biosolids. The application for resource consents relates to the discharges to air from the CWTP and the discharge of treated wastewater. The disposal of gross solids and biosolids are provided for by other resource consents held by the City Council.

## 2.2 Characterisation of the Discharges

### 2.2.1 Wastewater

The wastewater from the CWTP is a combination of domestic sewage and industrial and commercial discharges. In addition to the wastewater from the immediate city environs, sewage is currently collected from Springston, Lincoln, Prebbleton and Tai Tapu and capacity has been provided to include the sewage discharge from Belfast and Lyttelton as well as the industrial discharges from Belfast.

At present approximately 10% of the average flow comes from industries and about 20% and 16% of the average BOD and SS loads respectively.

In a capacity study undertaken for the City Council, (Beca Steven 1996), a design horizon of 2026 was established for the upgrades to the treatment plant. In 1996, the population of Christchurch was 313,000. The design population at 2026 including the Belfast residents and allowing for growth is 423,000. At 2016 and assuming a high growth rate, the population of Christchurch may rise to 383,000. It also took into account industrial growth within this time.

#### **Quantity**

The average daily flow is currently between 130,000 m<sup>3</sup>/day and 160,000 m<sup>3</sup>/day. The upgraded treatment plant is being designed for an average 200,000 m<sup>3</sup>/day.

Current peak flows are about 5 m<sup>3</sup>/s, which occurred during wet weather in July 1996 and reflects the capacity of the pumping stations supplying wastewater to the CWTP. Allowing for growth and the additional wastewater from neighbouring communities, a future peak flow rate of 6 m<sup>3</sup>/sec has been provided for in the plant design.

#### **Quality**

The quality of the wastewater from the existing treatment plant is summarised in Tables 2-1, 2-2 and 2-3 following.

In general the treatment plant will be design to treat 56 t BOD/day, 40 t SS/day, 4.4 t NH<sub>3</sub>-N/day and 8.2 t TKN/day.

**Table 2-1 Existing CWTP Wastewater Characteristics**

Parameter	Units	1998 Median Discharge Data	1998 Maximum discharge Data	1986-99 Median Discharge Data	1986-99 Maximum discharge Data	1986-99 90 percentile discharge Data
BOD <sub>5</sub>	g/m <sup>3</sup>	27.5	95	27.5	103	52
BOD <sub>5</sub> (filtered)	g/m <sup>3</sup>	6	22.5	8	49.5	17.5
SS	g/m <sup>3</sup>	42.5	140	40.5	178	75
Total Nitrogen	g/m <sup>3</sup>	36.6	44.4	32	56.8	41.4
Ammoniacal N	g/m <sup>3</sup>	26	33.2	22.6	43.7	28.7
Nitrite N	g/m <sup>3</sup>	0.24	2.3	0.1	4.65	0.85
Nitrate N	g/m <sup>3</sup>	0.28	0.74	0.2	5.8	2.16
Reactive Phos	g/m <sup>3</sup>	7.0	8.0	5.2	8.2	6.9
Total Phos	g/m <sup>3</sup>	7.8	10.2	6.1	10.6	7.83
pH		7.9	7.45 - 9.0	7.8	6.9 - 9.65	8.45
Temp	°C	14.3	6.1 – 23.3	13.5	3.75 – 26.0	19.75

**Table 2-2 Existing CWTP Wastewater Characteristics – Faecal Coliforms**

Year	Units	Maximum Value of 5 sample Rolling Median	Maximum Value of 5 sample Rolling 80 <sup>th</sup> Percentile
92/93	Cfu/100ml	100,500	122,400
93/94	Cfu/100ml	43,000	66,400
94/95	Cfu/100ml	93,000	122,400
95/96	Cfu/100ml	230,000	430,000
96/97	Cfu/100ml	23,000	43,000
97/98	Cfu/100ml	23,000	55,400
98/99	Cfu/100ml	43,000	53,000
92/99	Cfu/100ml	8,250 <sup>1</sup>	33,000 <sup>1</sup>
Range	Cfu/100ml	23,000-230,000	43,000 – 430,000

Notes:

1. Median and 80<sup>th</sup> percentile of total data.**Table 2-3 Existing CWTP Wastewater Characteristics – Heavy Metals**

Parameter	Units	1998 Median Discharge Data	1998 Maximum discharge Data	1986-99 Median Discharge Data	1986-99 Maximum discharge Data
Arsenic	mg/m <sup>3</sup>	3.0	3.0	3.0	7.0
Cadmium	mg/m <sup>3</sup>	0.1	0.2	0.18	1.10
Chromium	mg/m <sup>3</sup>	52.5	56.0	37.5	161
Copper	mg/m <sup>3</sup>	15.5	25.0	15.5	53.0
Lead	mg/m <sup>3</sup>	4.0	9.0	5.5	30.0
Nickel	mg/m <sup>3</sup>	27.0	41.0	25.5	60.0
Zinc	mg/m <sup>3</sup>	25.0	60.0	33.8	167

The treatment plant is currently being upgraded to a Trickling Filter Solids Contact (TFSC) process which will increase the treatment capacity of the plant as well as improving the quality of the wastewater discharged into the pond systems. The design expectations for the upgraded TFSC process are contained in Table 2-4. This table includes the performance based on an Average Daily Flow of 160,000 m<sup>3</sup>/day and 200,000 m<sup>3</sup>/day.

**Table 2-4 Proposed TFSC Wastewater Characteristics (prior to ponds)**

Parameter	Units	Design Data 160,000 m <sup>3</sup> /day	Design Data 200,000 m <sup>3</sup> /day
BOD <sub>5</sub>	g/m <sup>3</sup>	15	15
BOD <sub>5</sub> (filtered)	g/m <sup>3</sup>	15	15
SS	g/m <sup>3</sup>	15	15
Total Nitrogen	g/m <sup>3</sup>	40	40
Ammoniacal N	g/m <sup>3</sup>	26	26
Reactive Phos	g/m <sup>3</sup>	7.0	7.0
Faecal Coliforms	No/100ml	1,000,000	1,000,000

Note: TFSC performance based on no nitrification.

In addition to the upgrade to the TFSC process, the approximately 226 ha of ponds will be upgraded to improve their treatment performance. Initially the upgrade will include rerouting the flow through all ponds in series (at present the six ponds operate as two parallel trains of three ponds each). This will minimise the potential for short circuiting of wastewater and will improve the natural disinfection processes within the ponds.

The upgraded treatment plant and reconfigured ponds will also reduce the nitrogen in the wastewater in the short term. The long term sustainability of the nitrogen removal process once the load on the treatment plant increases will be determined through ongoing research during the term of the consent applied for.

The upgrading of the ponds will be followed by the installation of UV disinfection, such that the treated wastewater will meet the microbiological standards for Contact Recreation in the Regional Coastal Environment Plan. Table 2-5 contains the expected median values for the wastewater characteristics as discharged from the ponds.

**Table 2-5 Fully Upgraded CWTP and Ponds Wastewater Characteristics**

Parameter	Units	Design Data	Design Data
		160,000 m <sup>3</sup> /day	200,000 m <sup>3</sup> /day
BOD <sub>5</sub>	g/m <sup>3</sup>	30	30
BOD <sub>5</sub> (filtered)	g/m <sup>3</sup>	10	10
SS	g/m <sup>3</sup>	30	30
Total Nitrogen	g/m <sup>3</sup>	25	30
Ammoniacal N	g/m <sup>3</sup>	15	20
Reactive Phos	g/m <sup>3</sup>	7.0	8.0
Faecal Coliforms <sup>1</sup>	No/100ml	200	200

Notes:

1. Median value of 5 consecutive samples

Heavy metals will be reduced as a consequence of the upgrade, as the TFSC process will produce more biosolids which in turn will absorb more heavy metals, removing them from the wastewater discharge. The figures presented in Table 2-3 are therefore conservative.

### 2.2.2 Other Discharges

#### **Odours**

There will be odours from the CWTP. The current upgrade has included extensive works to capture and control the release of odour from the treatment plant (Beca Steven 1996). As a consequence of these upgrades, there will be no objectionable or offensive odours beyond the boundary of the site.

#### **Aerosols**

Aerosols are small particles of water or solid matter which are smaller than the eye can see. These are produced in a number of processes in wastewater treatment, and therefore may contain pathogenic organisms which if inhaled in sufficient numbers would result in illness. The workers at the CWTP would therefore be the most at risk from these. However the control measures in place for odour control will also minimise the risk from aerosols such that there will not be significant adverse effect from aerosols.

**Gross Solids**

The gross solids are those removed from the treatment plant at the inlet to the treatment plant. These are the large items which can cause problems with mechanical equipment in the plant. In addition to this, grit is removed from the wastewater so that treatment tanks do not become filled by this material.

These gross solids are disposed of off site, and are not part of the present consent application. These gross solids are disposed of in a sanitary manner at the Christchurch Landfill.

**Biosolids**

Biosolids are those organic and inorganic solids removed through settling of the wastewater. In the CWTP, these solids undergo anaerobic digestion treatment which recovers valuable energy in the form of biogas which is used to generate electricity at the CWTP. The digested biosolids are then dewatered and removed from site to be applied to forests close to Christchurch. The application of biosolids to forest land is provided for in separate resource consents held by the City Council and are not part of this application.

**2.3 Methods of Discharge**

The method of discharge is dependent upon the receiving environment, either the estuary or directly to the ocean. It should be remembered that a discharge to the estuary also will result in a discharge to the ocean, with the difference being the complex flushing which occurs with the estuary tidal flows. Each discharge is described separately.

**2.3.1 Estuary Discharge**

The estuary discharge at present is from three concrete pipes which are connected to tidally timed operated gates. These gates open at high tide and typically close 3 hours after high tide. Because of the turbulence created at each of the discharge points, the discharge is clearly visible from residential areas on the Port Hill suburbs.

The new discharge would be via a shoreline outfall that would be constructed using a porous rock wall such that the discharge is spread out over a length of approximately 300 m. This will reduce the potential for foaming and will result in a much less obvious discharge.

The discharge rate would be set such that approximately 55% of the daily flow would be discharged on each tide. For the average design flow of 200,000 m<sup>3</sup>/day, this would amount to 110,000 m<sup>3</sup>, which over three hours would give a discharge rate of 10 m<sup>3</sup>/s. Peak wet weather discharge rates would increase to approximately 13.5 m<sup>3</sup>/s.

### 2.3.2 Ocean Discharge

A number of locations for an ocean outfall were considered. The favoured option would be a 2 km buried pipeline off Bridge Street in South Brighton. This would discharge wastewater into water approximately 12 – 15 m in depth. Figure 2-1 shows the location of the 2km outfall.

One of the advantages of discharging wastewater into deep water is the initial dilution that is achieved as the buoyant plume rises to the surface. Initial dilutions of between 100 times to 1000 times can be expected from a diffuser at the end of the 2km outfall. An assessment of the diffuser performance is depicted in Figure 2-2. This figure shows the depth to the top and bottom of the plume, which at times will not reach the surface i.e. will stay submerged. An ocean discharge would occur continuously over the 24 hour period. At the design flow of 200,000 m<sup>3</sup>/day, the average discharge rate would be 2.3 m<sup>3</sup>/s. With the flow balancing that would occur in the wastewater treatment ponds, the peak wet weather flow rate for the discharge would be approximately 3.1 m<sup>3</sup>/s, which is reduced from a peak wet weather flow entering the plant of 6 m<sup>3</sup>/s.



Figure 2-1: Two Kilometre Outfall off Bridge Street

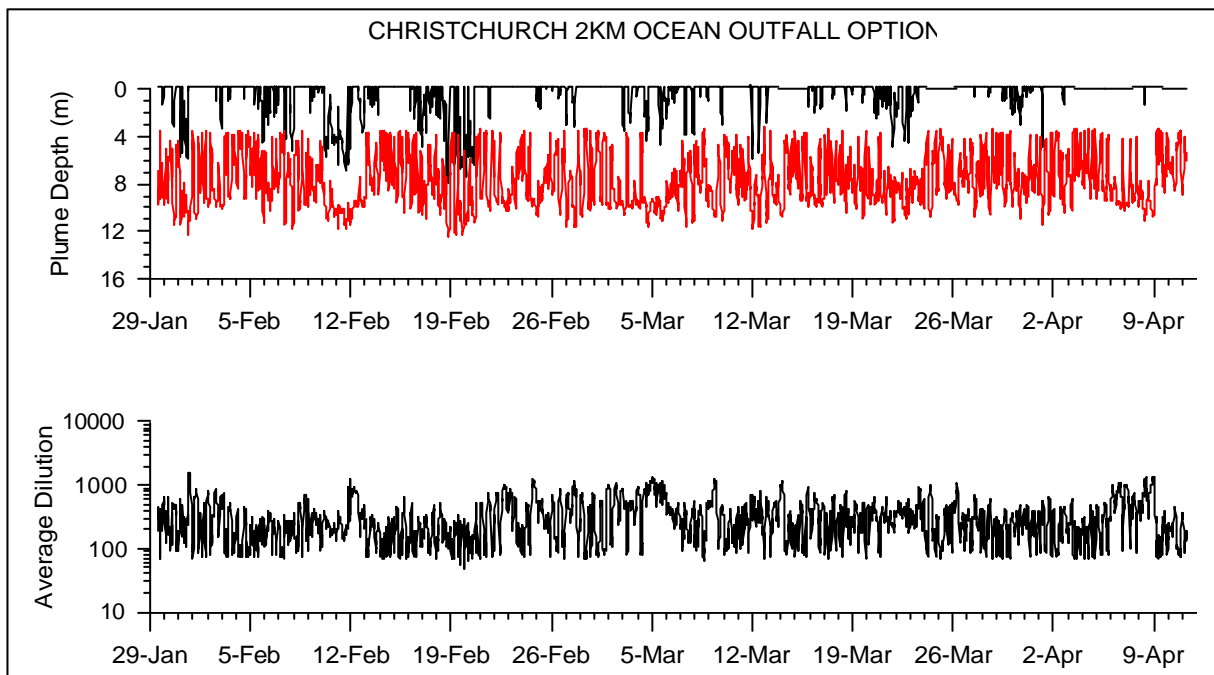


Figure 2-2: Initial Dilution Assessment for 2km Outfall

## 2.4 CWTP Treatment Processes

### 2.4.1 Existing Treatment Plant

The existing treatment plant processes are shown in Figure 2-3 following. Each process is briefly described below.

The fine screens remove the rag, plastic and other gross solid material which can cause blockages in mechanical equipment and reduced treatment performance. Grit disposal is to a sanitary landfill.

The pre-aeration and grit removal performance the dual process of freshening the incoming sewage by vigorous addition of air, and removal of grit which can lead to excessive wear on pumps and other mechanical equipment and is also difficult to remove from treatment tanks such as the digesters.

The primary sedimentation tanks allow the incoming screen sewage to settle, such that some organic matter is removed before the biological treatment stage. The settled material (primary sludge) is transferred to the digesters.

The trickling filters contains a solid core of plastic honey comb type media which allows biomass to grow on it. This biomass is fed on the organic matter remaining in the primary settled sewage and a portion of the recycled settled secondary effluent. Air is also blown through the media to supply the oxygen necessary for the biomass.

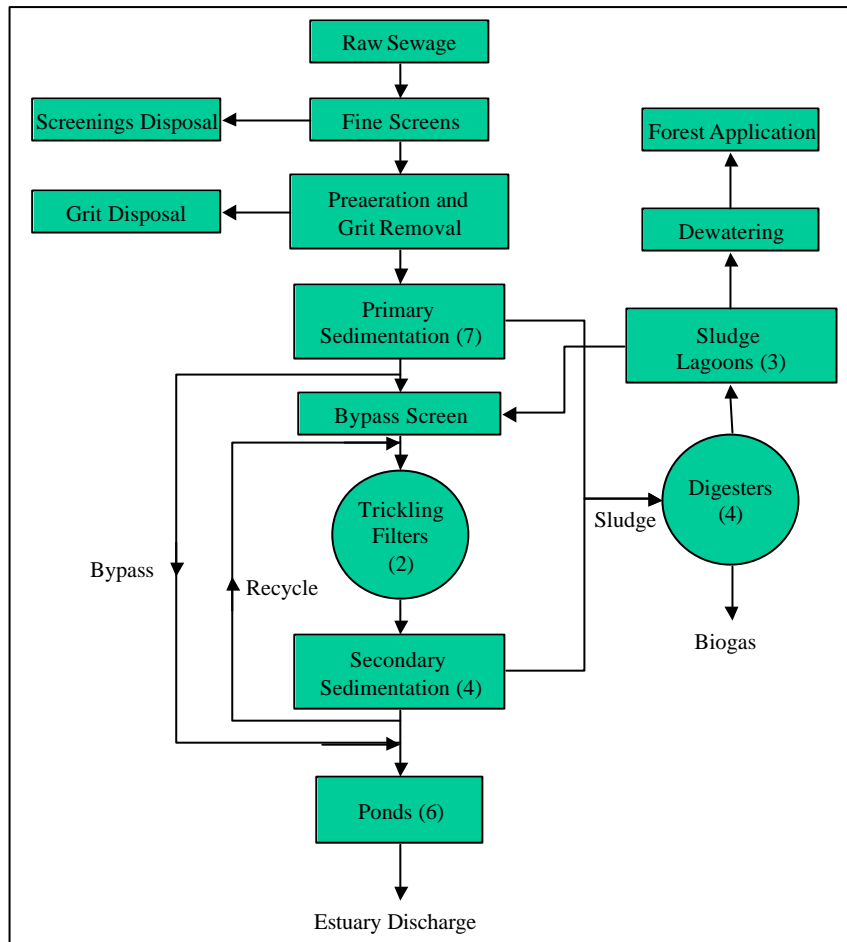
The secondary sedimentation tanks allow excess biomass which falls off the trickling filter media to be separated from the wastewater. This material (secondary sludge) is transferred also to the digesters.

The digesters are heated tanks which receive sludge from the primary and secondary settling tanks. These tanks are anaerobic (operate without oxygen) and produce biogas which is recovered and used as an energy source to generate electricity and drive engines for the main pumps in the CWTP.

The treated sludge from the digesters is stored in sludge lagoons prior to being dewatered by being squeezed between porous belts. The liquid squeezed from the sludge is returned to the treatment plant ahead of the trickling filters. The dewatered sludge is then applied to land as a source of nutrients and organic matter under separate resource consents held by the City Council.

The secondary treated effluent is passed on to the ponds. There are six ponds which operate as two parallel trains of three ponds each. These ponds are approximately 226 ha and further stabilise the organic matter in the treated wastewater as well as exposing the wastewater to UV sunlight which aids in killing the pathogenic organisms in the wastewater.

The last two ponds in the series, discharge into the estuary commencing at high tide and ceasing after approximately 3 hours.



**Figure 2-3: Existing Process Schematic for the CWTP**

Note: Number of treatment units in brackets.

### 2.4.2 Upgraded Treatment Plant

The treatment is being upgraded to increase the treatment capacity of the plant, improve the quality of the wastewater entering the ponds and to reduce the potential for pond failure through over loading. The upgrade also improves the screening facilities, increases the hydraulic capacity and minimises odour release from the plant.

The treatment process of the upgraded plant is known as the trickling filter solids contact process (TFSC). This takes the wastewater from the trickling filters and passes it through an aerated basin. The biomass removed in the secondary clarifiers (settling tanks) is recycled back into the aeration basin, with excess fed to the digesters. The aeration and settling processes are much the same as activated sludge processes, except that they receive trickling filter effluent instead of raw sewage. Figure 2-4 depicts the TFSC process for the CWTP.

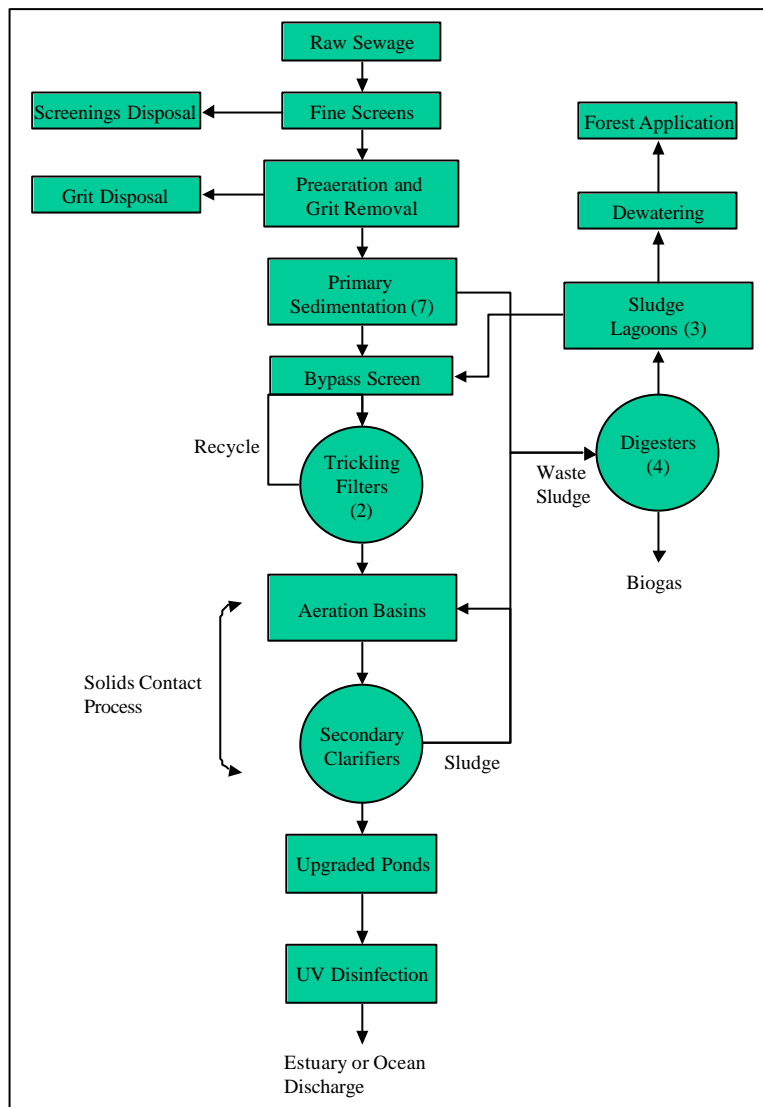
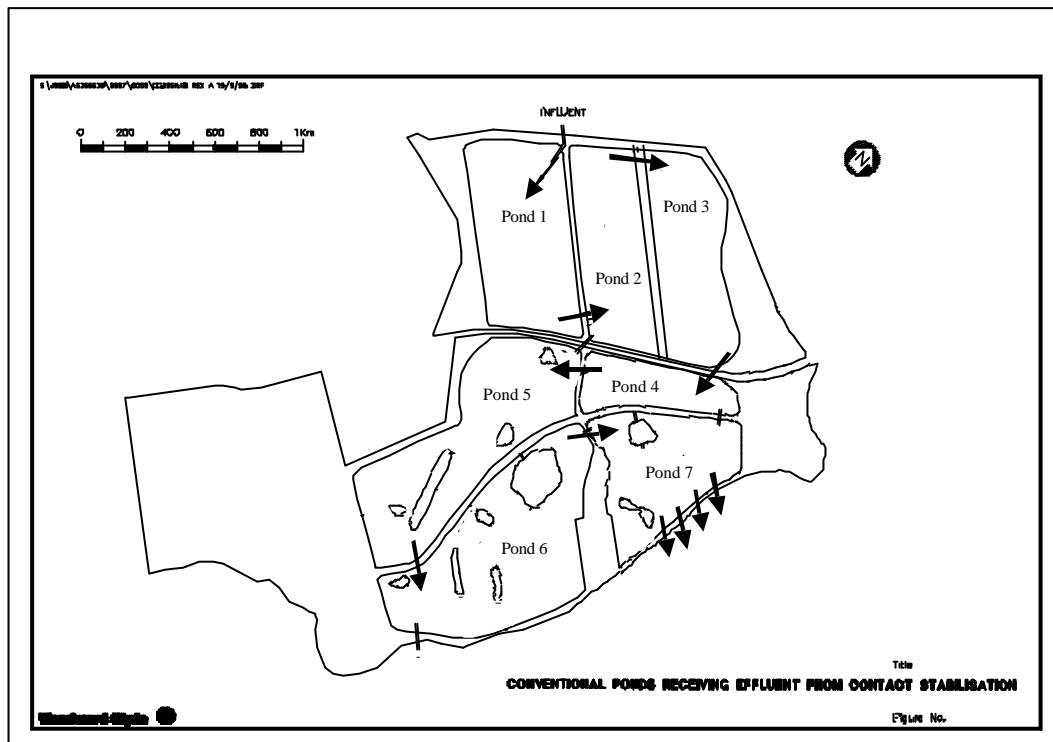


Figure 2-4: Upgraded Treatment Plant Process Schematic

The wastewater treatment ponds will be upgraded in a series of stages. The first stage will be to convert the ponds to a series of seven ponds, which will enhance the pathogen reduction. This will involve dividing the existing pond two into two, and utilising the existing pond six as the final tidal storage basin prior to discharge through the shoreline diffuser. Figure 2-5 depicts the reconfigured ponds. Once the ponds have been reconfigured and are functioning in a biologically stable manner, UV disinfection will be added between ponds six and seven. Pond 7 will then hold the disinfected wastewater prior to discharge.



**Figure 2-5 Proposed Upgraded Ponds to Maximise Pathogen Reduction**

### 2.4.3 Future Upgrades

In addition to the upgrades describe above, during the term of the consent applied for, trials will be undertaken to determine the potential for nutrient reduction in the main treatment plant and the ponds as well as the need for additional pathogen reduction and other measures depending upon environmental monitoring results.

#### ***Nutrient Removal***

There are a number of nitrogen removal processes that will be fully assessed as part of the ongoing investigations. These include the in-tank methods as well as considering the potential of the ponds/wetlands development. The options to be considered are:

**In-Tank Processes**

- Nitrogen Removal from Biosolids Dewatering Streams.
- Series Operation of Trickling Filters
- Extra Aeration in Solids Contact Tanks

**Ponds/Wetlands Processes**

- Rock Filters/Gravel Bed Wetlands in the Oxidation Ponds
- Full Wetlands Development

***Ponds/Wetlands***

Figure 2-6 shows a preliminary concept plan for development of the Estuary Green Edge. This preliminary concept plan for the Estuary Green Edge will include from south to north:

- Restoration and/or relocation of the protected Cobb Cottage.
- New Ferrymead Bridge.
- Naturally restoring saltmarsh at the mouth of the Heathcote River, and around Humphrey's Drive.
- Linwood Paddocks are shown as being developed as a passive recreational area, with excavation of the paddocks to allow the re-vegetation by saltmarsh habitat, and an area of grassland maintained to provide the required wintering sites for pied stilts and other waders as well as the pukeko.
- At the edge of the Linwood paddocks, wetland, shrubland and coastal forest could be established.
- Sandy Point would provide a key area for visitor access and interpretative centres, as well as providing nesting and resting areas for estuary birds.
- As part of the requirement for improved treatment of the City's wastewater, the existing oxidation ponds will have to be modified, to ensure a longer retention period.
- Soft edging of the oxidation ponds to restore a type of sandland topography.
- Finally Bexley landfill could be enhanced by the establishment of coastal forest, where soil depths allow, and the other parts of the landfill used as for farmland, walking, ecotourism or active recreation, for example, biking, and horse riding.

By working with the natural systems and the needs of the wildlife of the area, a solution can be found which meets the wildlife, aesthetic and treatment requirements. The pond system is a major aspect of this solution.

The development requirements of ponds 1 and 2 (to the west of Dyer’s Road) are largely functional and aesthetic. Wildlife values of these two ponds are not significant. The design of these ponds should incorporate a large area of open water from a functional viewpoint, and provide an aesthetically pleasing design, which breaks the hard edges of the existing structures and also is connected to the design for the other ponds in the series.

The broken spiral form of the lower ponds 3,4,5 and 6 (to the east of Dyer’s Road) will meet both wildlife and broader ecological requirements and well as the wastewater treatment requirements. The spiral islands incorporate the existing islands, and the open water spaces between them are calculated on the area presently used by birds for resting and feeding. The design allows new habitats to be created, while maintaining the existing integrity of the ecosystem flourishing on the ponds at present.



Figure 2-6 Preliminary Concept Plan for Estuary Green Edge

**Disinfection**

The proposed upgrade includes disinfection to meet the Canterbury Regional Council’s Contact Recreation standard as set in their Regional Coastal Environment Plan. This standard is expressed as limits on Faecal Coliforms, which are an indicator of public health risk. Another commonly used indicator for marine environments is entroccoci. While it is planned that these criteria will be surpassed, it is possible that public health risk in the future may focus on other organisms for which different

disinfection technology may be more appropriate. During the term of this consent, public health risks will be investigated to ensure that the most appropriate disinfection and disposal options are selected.

## **2.5 Land Use activities**

### **2.5.1 Facilities and Structures**

#### ***Main Treatment Plant***

The main CWTP (excluding the ponds) is currently undergoing a capacity upgrade. This includes the construction of new pipes, clarifiers, mechanical equipment and odour control facilities. Resource consents are not required for these works as it all fits within the designated activities for the site.

#### ***Ponds***

Construction work within the pond area will require Land Use Consent from the Christchurch City Council as the ponds are designated as a wildlife refuge. The initial upgrades to the ponds to improve the pathogen reduction will include a separation wall in the centre of pond 2 and ultimately the installation of UV disinfection prior to the final pond. The full Estuary Green Edge development would require significant reconstruction of all the ponds as shown in Figure 6. These works would be staged so that the pond treatment system can still operate and disturbance to wildlife is minimised.

#### ***Disinfection Unit***

UV disinfection of wastewater is normally performed within concrete channels into which the UV lamps are inserted. A UV disinfection plant of the size required for the CWTP will be a large consumer of electricity. This will require a building to house the switch gear disinfection equipment.

#### ***Outfall***

The estuary outfall will be a rock embankment approximately 300m long constructed along the shore of the estuary. As this work will be undertaken within the Coastal Marine Area, resource consents will be required specifically for this.

The ocean outfall would be a major structure which for the majority of its length would be buried. A pumping station would be required adjacent to the ponds. This structure would be combined with the UV disinfection building for the ocean outfall option as tidal storage after disinfection is not required.

A pipeline from the pump station, crossing the mouth of the Avon River and travelling down the centre of Bridge Street would be required. The installation of the river crossing would require consents for its construction as it is within the Coastal Marine Area, as well as land use consents from Christchurch City Council.

The ocean section of the outfall would be constructed of either concrete encased steel pipe or polyethylene pipe. The nominal diameter of the pipe would be 1800 mm, which would increase to approximately 2250mm once the concrete weight coat was applied. Concrete coated steel pipe is the normal construction material. The pipeline would be fully buried along its entire length, at a depth such that it would not be exposed during changing sea bed levels associated with storm events. At the ocean end of the pipeline a diffuser structure would be built. This would include approximately 13 riser pipes, each with a rosette arrangement of eight discharge ports. These diffusers would require protection against damage from trawlers. This could include shields to allow trawlers nets to ride safely over the top of the diffuser.

### **2.5.2 Activities**

In addition to having resource consents for the physical structures, the activities involved in their construction and use will require consents also.

#### ***Main Treatment Plant***

The main treatment plant requires consent only for the discharges to air. The construction and use activities on the site are permitted by way of the designation of the site.

#### ***Ponds***

The wastewater treatment ponds will require consents for their construction and use. The discharge from the ponds to either the estuary or the ocean will form the major part of these consent applications. In addition to this direct discharge, consent will be needed for discharges to air of odour and discharges to ground for any seepage that may occur. The overall purpose of the ponds for wastewater treatment will be recognised in these consents.

#### ***Outfalls***

The estuary shoreline diffuser will be an integral part of the estuary discharge option. Access for construction would be from the City Council land adjacent to the estuary and impacts will be minimal. As there will be some disturbance of the foreshore during construction, consent will be required. Impacts from the construction will be minor and of short duration.

The impacts from the construction of the ocean pipeline could be large for a short period of time. The ocean outfall pipeline would be constructed on land and towed into the ocean by large pulling barges. A construction area would be required close to the bridge on Dyers Road on which the individual pipes would be joined into long strings (200m long). These strings would be loaded onto bogies and rail tracks that would run along Bridge Street to the coast. Each string would be joined and then slowly towed into the ocean. The South Brighton Surf Life Saving Club building would either have to be removed for the construction, or tunnelled underneath. Access along Bridge Street and each of the roads running along the

estuary spit would be restricted for up to one week while the launch was taking place. Alternative access across the pipeline route would be required for this phase.

Alternatives including construction of each string on staging on the beach frontage, or laying the pipeline from a moveable trestle platform would be considered as part of the design phase. Each option would have implications on cost.

Consents for the construction of the ocean outfall would include disturbances to the ocean floor and shoreline, as well as for construction activities such as traffic, hours of work and noise effects and site effects such as stormwater and land use.

### 2.5.3 Implementation

#### ***Wastewater Management Plan***

The Christchurch City Council is committed to prepare a wastewater management plan. This plan will be an ongoing document and will not specifically form part of the application for new resource consents. There are numerous aspects which can be incorporated within and assist in the achievement of the wastewater management plan including:

- Asset management (pipe network, pumping stations, treatment plants).
- Minimising waste.
- Cleaner production.
- Reuse and/or recycling of waste.
- Onsite treatment.
- Industrial pre-treatment.
- Use of satellite disposal systems.
- Stormwater treatment.
- Education.
- Planning mechanisms.
- Trade Waste Bylaw.
- Plant capacity upgrade.
- Improvement of the quality of treatment and disposal environments (including integration with other Council objectives relating to the estuary's edge).

- Treatment and disposal of wastewater.

This plan will be presented to the City Council in 2001.

**Staging**

Table 2-6 lists the key items for development during the period 2000 to 2015. These actions are required regardless of the long-term strategy adopted. If an ocean outfall is to be constructed, the term of the consent sought will be 35 years, and the construction would possibly be scheduled to commence at year 15.

**Table 2-6: Recommended Plan of Action for 2000 to 2015**

Year	Action
2002	Reconfigure oxidation ponds in series to maximise reduction of pathogens
2003	Rebuild outlet from oxidation ponds with submerged diffuser at western edge of estuary to reduce foaming and visual impact
2004-2006	Install UV plant at end of ponds as required to achieve stated environmental outcomes
2000-2008	Actively monitor and trial a variety of technologies for possible inclusion later; these should include: <ul style="list-style-type: none"> <li>• Alternative disinfection technologies to maximise reduction in pathogens and increase efficiency of energy use</li> <li>• Potential of oxidation ponds, rock filters and engineered wetlands to reduce pathogens and remove nitrogen</li> <li>• impacts on public health, sea lettuce, benthos, fish and birds</li> <li>• ocean current movements over a 12-month period.</li> </ul>
2005-2007	Instigate Green Edge development along western edge of estuary from Bexley Landfill to Linwood Paddocks, with a co-ordinated plan that will: <ul style="list-style-type: none"> <li>• return the area towards its natural ecological state</li> <li>• maximise opportunities for natural removal of nutrients from the wastewater</li> <li>• create opportunities for recreation and tourism</li> <li>• re-establish traditional mahinga kai values, including growth of flax and potential rearing of eels</li> <li>• consider advisability of re-routing roads to enhance the above developments.</li> </ul> <p>These should be done in parallel with the wastewater developments as the visual design of the ponds needs to be co-ordinated with their purification functions and the Linwood Paddocks will be used for wastewater treatment trials</p>
2008-2015	Possibly further enhancements depending on quality achieved for discharge, and results of technology trials and environmental monitoring.

### 3.1 Alternative Receiving Environments

Potentially there are four alternative receiving environments possible; open ocean (Pegasus Bay), estuary (Avon Heathcote Estuary), river and land.

An ocean or an estuary receiving environment are considered part of the Coastal Marine Area under the Resource Management Act and the New Zealand Coastal Policy Statement. Normally, any resource consents required for discharges into either of these environments, will be determined by the Minister of Conservation (if the activity is a restricted coastal activity) through a recommendation from Environment Canterbury. At the present time, there are no restricted coastal activities, as these must be defined under an operative plan. As there is only a proposed coastal plan at present, there are no restricted coastal activities and applications for resource consents will be determined by the Regional Council.

Both these options (estuary and open ocean) were investigated in depth.

In addition Policy 5.1.2 of the New Zealand Coastal Policy Statement (see section 7 ), places an obligation on the Christchurch City Council to have investigated alternative options which involve the treatment and disposal of the wastewater through, soil or wetland. In relation to this requirement therefore, a number of land receiving environments have also been considered as alternatives, including forestry, agricultural and direct injection options.

A freshwater discharge alternative, involving disposal to the Waimakariri River was also briefly considered.

#### 3.1.1 Ocean

The coastline between the Waimakariri River in the north, and New Brighton Spit in the south, was considered as a potential receiving environment. Disposal into this environment would require the construction of an outfall, which in order to meet acceptable environmental standards would be of several kilometres length. Significant additional wastewater treatment before disposal would also be required to meet environmentally acceptable standards.

#### 3.1.2 Estuary

The existing receiving environment is the Avon-Heathcote Estuary. Presently wastewater enters this environment after treatment, during the outgoing tide. Discharges into the estuary enters Pegasus Bay and therefore these two receiving environments share many similar issues, relating to environmental effects. In addition, the estuary is a very dynamic and ecological rich natural (albeit significantly modified) environment, located in the midst of a city which uses the area as a significant recreational resource, and into which two urban waterways discharge their waters. These factors combined with the slow dispersal of estuarine water to the open ocean highlight additional environmental issues

### 3.1.3 Land

The general philosophy of using land as an alternative receiving environment is to minimise the adverse environmental effects on the environment, as well as meeting cultural and spiritual concerns of the mixing of “clean” water and “unclean” waters.

The use of land as a receiving environment for Christchurch’s wastewater is restricted to the drylands of the plains. As a very large area of land would be required for the disposal of the quantities of wastewater generated from Christchurch, this would likely involve the use of land beyond Christchurch City District’s legal boundaries. This land would have to be acquired or leased. In addition this option would involve the most significant infrastructure costs of development of any of the receiving environments.

An important consideration for any wastewater land disposal on the Canterbury Plains is the significant potential adverse impact on the region’s groundwater resources. These groundwater resources are currently used for drinking water supplies, and/or feed into Te Waihora

### 3.1.4 River

The final potential receiving environment is freshwater. For Christchurch’s wastewater the only possible freshwater environment would be the Waimakariri River. Discharges into this receiving environment would rapidly move to the coastal marine environment, specifically Brooklands Lagoon, and into Pegasus Bay. The advantage over the Avon-Heathcote Estuary would be that the dilution of any discharge before entry into the coastal environment would certainly be greater. However the proximity to a high population, the environmental, cultural and recreational impacts are constraints shared by both these receiving environments. In addition, infrastructure costs for this solution would be very high.

## 3.2 Alternative methods of Discharge

### 3.2.1 Ocean

For an ocean discharge option, the most accessible pipeline route would follow Bridge Street down to South Brighton Beach, and out into Pegasus Bay. An alternative discharge point could be north, near Burwood Forest, south of Spencer Park. Of the two sites, however, the first is the more likely as there would again be significant infrastructure cost to go to the northern site, with no general advantage.

The outfall lengths considered, at either site, are 2 or 3 kilometres. The actual length would be determined by the physical environment and desired environmental standards. The seabed slopes downward to 13 m depth at 2 km offshore, thereafter flattening out to be only 15 m deep at 3 km offshore.

#### ***Bridge Street Outfall 2kms***

This option would involve discharging treated wastewater continuously to the ocean via a 2 kilometre long ocean outfall. This distance from the foreshore would facilitate increased dilution of any potential

discharge before reaching the beach. By combining good diffuser design and appropriate wastewater treatment, a 2km outfall can easily meet the environmental goals sought.

### ***Bridge Street Outfall 3kms***

This option would involve discharging treated wastewater continuously to the ocean via a 3 kilometre long ocean outfall. The additional distance would facilitate increased dilution of any potential discharge before reaching the shoreline.

### ***Burwood, South Spencer Park Short or Long Outfall***

Alternative northern ocean discharge locations were considered. These discharge options were closely related to the treatment options of spreading the treatment of wastewater to various satellite plants around the city, including one in the northern zone at Belfast. This would then discharge through a separate outfall to the north of the city.

In conclusion, throughout this assessment of environmental effects, any discussion related to an ocean outfall discharge, refers to one located off Bridge Street, approximately 2 kilometres offshore, unless otherwise stated.

## **3.2.2 Estuary**

There are three options for disposal into the estuary. The first is the “change nothing” option of maintaining the existing pipe discharge points on the shoreline. The second option is a modification to the first, which would be to alter the discharge outlets so that the discharge is distributed along the northwest shoreline of the estuary edge, in a diffuse manner, through a rock filter. The third option is to transport the treated wastewater into one of the main estuary channels closer to the mouth of the estuary with the objective of increasing the flushing effect.

The discharge period for all estuary options would be on the out-going tide. The nature of the estuarine environment involves varying but only little initial dilution therefore it is advantageous to facilitate as rapid a discharge out of the estuary as possible, to minimise the quantity of wastewater that will be returned to the estuary on the next incoming tide. The additional dilution from a shoreline diffuser compared to the existing pipe discharges is very low. The real advantage of the second option being and aesthetic improvement.

With the outfall at the estuary edge previous dye studies have shown that at least 45% of the released wastewater returns into the estuary on the next in-coming tide. It is not possible to determine the percentage of wastewater likely to return into the estuary from a centre channel outfall, without further modelling or dye studies.

From the occurrence of sea lettuce on the beaches at Sumner and South Brighton, which would have originated from the estuary, it is evident that the water that discharges from the estuary will at times

impact upon surrounding beaches. It can therefore be inferred that the discharged wastewater also reaches these environments.

For all estuary discharge options, wastewater treatment becomes the critical factor, as there is limited scope for substantial dilution with the receiving waters or for separation from users of the estuary.

### ***Estuary Margin Outfall***

This option is to continue with the present estuary edge outfall or to add a diffuser, thereby dispersing the wastewater over a wider zone. The major advantage of the diffuser would be to spread the flow, and is therefore a largely aesthetic reason.

Compared to the existing oxidation ponds and outfall the visual effects of the structures and modifications to the present system are not likely to be significant. The visual aspects of the discharge itself will be improved by a shoreline diffuser.

### ***Central Channel Outfall***

Sites for a mid-channel discharge or a pond outlet discharge in the Avon-Heathcote Estuary were evaluated as part of a desk-top exercise to compare the water quality benefits with the existing discharge location and an ocean outfall. The 3 options for mid-channel sites and associated depths below mean tide level (MTL) are:

- Avon Channel (East of existing pond outlets) – Depth  $\approx$  1.4 m
- Opposite Beachville Rd in main channel – Depth  $\approx$  2.5 m
- Entrance channel – Depth  $\approx$  2.5 m

All the mid-channel options pose some complex engineering issues including: the sizes of pipes and manifolds required relative to channel size, to allow for the release of the required quantity of wastewater over the possible 3.5 hours after high water. Navigation hazard, the aesthetic and landscape issues associated with the structure, scouring around the manifold structure and the long-term stability of the channels and storage capacity.

### **3.2.3 Land**

There are five disposal to land scenarios considered. These include agricultural use - where the application of water and nutrients is designed to optimise production from the land, and the closely related forestry use, aquifer recharge – where the wastewater is applied at a high rate to minimise land area requirements, deep aquifer injection, and lastly landscape reuse – where the wastewater is treated for reuse within the city boundaries.

Land area requirements are vastly different for the various options, as are the infrastructural requirements. Sites of a few hundred to a few thousand hectares may be suitable for Rapid Infiltration, depending on the

site, whereas many thousands of hectares would be required for both the forestry and agricultural irrigation options. For landscape reuse a much larger area than the currently available public open space would be required to dispose of even the current levels of disposal rates.

In relation to the aquifer recharge, agricultural and forestry land disposal options, three potential sites were investigated for comparison. These are referred to as the Halkett Site, Aylesbury Site and the Eyrewell Site respectively.

The Halkett Site is within a flood plain of the Waimakariri River. The soils are very shallow and free draining. Depths to groundwater vary between 2 - 20 m across the site and this is in the locality of a known recharge zone for the Christchurch City aquifer systems.

The Aylesbury Site is predominantly developed for dry-land farming with limited cropping. The depth to groundwater is between 20 - 80 m depending on specific location, and the soils are predominantly free draining. The application of wastewater and irrigation water would substantially increase the dry matter production of this land.

The Eyrewell Site is the Eyrewell Forest, which is under the control of Carter Holt Harvey. The majority of other forestry plantations within this area of Canterbury are not as extensive as the Eyrewell Forest and would therefore have much higher infrastructural costs associated with their use.

An additional location for land disposal closer to Christchurch was considered. This was referred to as the Templars Site, however this was immediately eliminated due to the shallow depth to groundwater, the frequent occurrence of springs and surface waterways, existing and proposed land uses and severe limitations in terms of mounding of groundwater effects.

## **Forestry**

The forestry option will require the greatest area of land, due to the lower ability of tree systems to uptake nutrients compared to cropping systems, and the need to prevent water logging of the soils which may be adverse to the health and security of the trees. Basic requirements are:

- Approx. 11,000 ha.
- Located on free draining soils
- Pipeline of 8.5 km through urban areas and 24 km through rural areas
- Spray irrigation into plantations
- High wastewater quality required including:
- Nutrient removal
- Disinfection

***Agriculture***

The agricultural option will require also a large area of land. Basic requirements are summarised as:

- Approx. 6000 ha required to maximise crop production and nutrient harvesting.
- Located on drier portions of the Canterbury Plains with greater depths to groundwater
- Pipeline of 8.5 km through urban areas and 38 km through rural areas required
- Irrigation systems to be spray irrigation (centre pivot).
- High wastewater quality required including:
- Nutrient removal (Nitrogen < 10 g/m<sup>3</sup>)
- Disinfection

***Aquifer Recharge***

As a recharge option, the aim would be to apply as much wastewater to the smallest area of land that was sustainable. This could be achieved through high rate flood irrigation or through rapid infiltration basins. Basic requirements are summarised as:

- Area of land required depend on location, 100s to 1000s of hectares.
- Soils are required to be free draining, and a known recharge zone for the aquifer systems.
- Pipelines and other infrastructure from treatment site to disposal sites required through City.
- Very high level of wastewater treatment required
- Disinfection required

As the wastewater would be draining directly into the aquifers that supply Christchurch City with drinking water, a higher quality of wastewater would be required compared to the agricultural options. The risk involved in applying treated sewage into a major city’s water supply becomes a major factor in considering this option.

***Landscape Reuse***

Landscape reuse could encompass two scenarios. The first is that a portion of the wastewater is treated to sufficiently high standards so that it may be reused on CCC owned land within the city boundaries. The second option is that it is made available to all residents within Christchurch for non-potable reuse.

Normally the conditions which justify the extra expense and difficulty of water reuse option are:

- high population density
- low or intermittent rainfall
- lack of available sources of raw water not already committed
- extremely stringent discharge requirements or a zero discharge requirement.

### ***Aquifer Injection***

Groundwater injection systems are used in a number of countries around the world to augment groundwater resources and to provide other benefits, such as a barrier to saltwater intrusion into a fresh water aquifer for Christchurch. The concept of injecting wastewater into the gravel aquifer system beneath the city has been suggested as an alternative to ocean, estuary and land treatment discharges.

A number of significant issues with respect to the effects on the groundwater system and the viability of such a scheme require addressing before this type of disposal method could be contemplated, including the role that the confined aquifer system provides in supplying drinking water to Christchurch City, and the impact of pressurising a confined aquifer system beneath the eastern part of the city.

## **3.2.4 River**

### ***Waimakariri River***

The Waimakariri River currently receives wastewater from the Belfast industries, Belfast township via the south branch and Kaiapoi. The river water quality in the lower reaches has been improved over the last 10-15 years with reductions in the quantity of wastewater and an improvement in the quality of the wastewater discharged. It has been recognised that the river is an important water resource in Canterbury and for this reason capacity to transfer the Belfast wastewater into the CWTP has been made. Industry contributes 10% of the City's flow. It would be unrealistic to consider a river discharge as a consentable option.

## **3.3 Alternative Treatments**

### **3.3.1 Nutrient Removal**

Nutrient removal involves the treatment of wastewater to remove nitrogen and phosphorus. Currently, the most reliable and affordable treatment for nutrient removal is biological nutrient removal (BNR), which can remove both nitrogen (N) and phosphorus (P).

Three BNR process configurations need to be considered, each depending on the eventual disposal option chosen.

The costs for biological nutrient removal are approximately \$100M, with approximately \$2M annual operating costs.

### ***Reduction of N and P by using BNR only***

Reduction of N and P to low levels using BNR only is technically possible although generally expensive. This may be considered for some of the estuary disposal options where a major aim is to reduce the impacts from nutrients entering the estuary.

An 85% removal of N could be expected when treating Christchurch wastewater in a BNR process provided there is no inhibition by wastewater constituents. A similar level of removal of P could be achieved under ideal conditions but P removal is often less reliable.

### ***Reduction of N and P using BNR and chemical precipitation***

This involves the reduction of N and P to very low levels using BNR and chemical precipitation. This may be required for estuary disposal as above, but with a greater reliability for P removal. Enhancing the BNR process with chemical addition to precipitate more P can increase this reliability.

### ***Reduction in N only***

Reduction of N only may be required for land disposal options where nitrate contamination of groundwater is a concern.

Removal of N could be expected when treating Christchurch wastewater in a BNR process provided there is no inhibition by wastewater constituents.

## **3.3.2 Disinfection**

Disinfection of treated wastewater is necessary to ensure that the potential risks to public health are reduced to acceptable levels. The level of public health risk is assessed in relation to indicator organisms such as Faecal coliforms (FC) and Enterococci (EC). Therefore if the concentration of these organisms are reduced to acceptable limits, then it is assumed that other pathogens are similarly reduced to a level where the risk becomes acceptable, depending upon the use of the receiving water. The technologies available for disinfection include ponds and wetlands, chlorination, ozone, and ultra-violet light disinfection.

Ponds and wetland systems can be very effective in disinfecting provided there is a sufficient number of ponds in the series, retention times are sufficient and short circuiting is minimised. Due to the natural processes in pond and wetland systems there is greater variability in the bacteriological quality of this type of disinfection. Ponds and wetlands treatment is described later in this section.

The levels of disinfection required are dependent on the environmental outcome that is to be achieved, and the ultimate disposal method.

If water standards are to be met at the surface of the sea, or the shore, the level of disinfection required to meet the same standard in the receiving water, for the ocean disposal option is less than for the estuary disposal option. This is due to the higher dilution factors in the ocean and the greater distance from the shore to the actual outfall diffuser. Higher levels of disinfection are required if the same environmental outcomes are to be met in the Avon - Heathcote Estuary, as the outfall will be very accessible to the public and the dilution levels are very low. Disinfection requirements for wastewater disposed onto land will be higher, as the risk of contamination of the potable groundwater resource, and the difficulty of mitigating any such effect, are in themselves so high.

### ***Chlorination***

Chlorination has been used worldwide but is no longer favoured in many countries due to the toxic by-products that can be formed.

### ***Ozone Disinfection***

Ozone disinfection has been used to a lesser extent, mainly in Europe. It is an expensive option, but effective in killing *Giardia* and *Cryptosporidium*, which UV disinfection treatment is not.

### ***Ultra-Violet Light Disinfection***

UV disinfection would normally require a high quality secondary wastewater for effective disinfection and optimum power consumption. Several modular units would be installed to handle the full range of flows with only one or two modules in operation under average flow conditions. The facility would be fully automated so as to allow adjustment of the number of UV units in operation and the light intensity according to the solids content and clarity of the wastewater. UV disinfection is currently the most common treatment used both due to its performance and cost effectiveness.

The wastewater from the treatment ponds could also be treated by UV disinfection. The clarity of the wastewater will be reduced as a consequence of algae in the pond water, however, as the ponds themselves are effective in reducing pathogens, there would be a lower demand on the UV disinfection unit. Trials on the effectiveness of UV disinfection of pond wastewater are currently underway.

### **3.3.3 Aquaculture**

The use of treated wastewater in aquaculture worldwide is a very small percentage of total volumes, although increased attention to this option is likely. Health concerns from pathogens and eutrophication due to nitrogen and phosphorus are potential constraints.

There are also likely to be concerns relating to the possible contamination of wildlife habitats. Fish species, which are likely to be used in such an option, are introduced species and the potential impacts on native species will be an important concern.

A significantly greater amount of research in the New Zealand context is required before this can be considered a practicable option.

### **3.3.4 Wetlands**

There are many different types of wetlands that are used for wastewater treatment. These fall into two broad categories, the surface flow wetland and the sub-surface flow wetlands. As the names suggest, the surface flow wetlands involve the wastewater flowing in and around the wetland plants, with a free water surface exposed. The sub-surface flow wetland has the wastewater flowing through a porous bed in which the wetland plants grow, so that the wastewater comes into contact with the plant roots. Both systems have their advantages. The surface flow wetlands are more able to cope with variations in flow, while the sub-surface wetlands are capable of achieving a higher standard of treatment.

In the Christchurch context, the existence of the 226 ha of ponds is a major consideration in evaluating both pond and wetland systems. Given that the proposed upgrade of the treatment plant (trickling filter solids contact process) will result in wastewater with low BOD and suspended solids, the ponds and wetlands will be primarily required to provide storage, disinfection, some nutrient removal and buffering prior to discharge.

### **3.3.5 Drinking Water**

Considerable research on treatment of wastewater for direct potable reuse has been undertaken in the USA. Typically, the treatment process following secondary wastewater treatment includes the following processes:

- High pH lime clarification
- Recarbonation
- Multimedia filtration
- Ultraviolet disinfection (as an option)
- Activated carbon adsorption
- Reverse osmosis or ultrafiltration (as alternative options)
- Air stripping
- Ozonation, and
- Chlorination

In Christchurch there is a relatively abundant supply of high quality artesian water, which does not require any treatment, and it is comparatively inexpensive to supply. It is therefore considered that the community would not accept the use of reclaimed sewage for potable water.

### **3.3.6 Pond Systems**

The existing treatment plant incorporates a system of six ponds totalling 226 hectares. These ponds operate as two parallel lines of three ponds each.

Options have been discussed of reorienting the ponds, primarily to improve the ability of the ponds to reduce pathogens. This is achieved through reducing the potential for short-circuiting through the ponds by increasing the number of cells through which the wastewater passes.

The performance of the existing ponds in terms of faecal coliform (FC) removal is variable and monitoring indicates the need for a significant reduction in the FC concentration of the discharge, or very large dilutions to be able to meet contact recreational standards in the estuary or the ocean.

It should also be acknowledged that the existing ponds adjacent to the Avon-Heathcote Estuary form a significant feature in the ecology and habitat of the area. The preservation of the ponds is therefore seen as an important feature in consideration of the options.

In considering the feasible options for pond and wetland upgrades, a technical workshop involving CCC staff, the CCC external Peer Reviewers, and the Woodward-Clyde project team was held. Two options were considered as feasible. These were slightly modified ponds and significantly modified ponds with wetlands.

#### ***Slightly Modified Ponds***

The total flow from the treatment plant would be directed into Pond 1 and then progressively through a subdivided Pond 2, and still further subdivided Ponds 3, 4, 6 and 5. This development would increase the number of cells in series from 3 at present to 11.

#### ***Significantly Modified Ponds***

The second option involves considerable modifications to the ponds and new wetlands and pond extending into the Linwood paddocks.

As the Linwood paddocks are lower than the land on which the existing ponds are situated, there is the need for considerable earthworks to raise the embankments for the new wetlands and final storage pond. This has resulted in a significant increase in the cost of development of this option. One of the effects on this option, is that a valuable winter feeding habitat for wildlife including pukeko, oystercatchers and other birds would be lost. During the winter when food becomes less abundant in the estuary, the birds revert to feeding in the paddocks. The original idea behind new wetlands was in part that these would

enhance the habitat through the provision of more wetlands. The result may in fact be that the ecological balance is tipped towards the negative.

**Green Edge Modified Ponds**

This option looks at enhancing the functioning of the ponds, while also enhancing the values for wildlife and amenity values. The design loosely incorporates a spiral pattern, which allows the water to remain in the ponds for longer, and preserves the existing islands and open areas of water for the bird species which require them.

**Table 3-1: Cost Comparison Between Costs Of Discharge Options**

	<b>Initial 15 year programme (Stage 1)</b>	<b>Long term estuary outfall (Stage 2)</b>	<b>Long term ocean outfall (Stage 2)</b>	<b>Land High Rate Disposal Option</b>	<b>Land Agricultural Option</b>
<b>Capital cost</b>	\$32.1M	\$11.75M	\$41.7M	\$258M	\$350M
<b>Annual running cost (excluding debt servicing and depreciation)</b>	\$1.3M	\$0.8M	\$0.38M	\$6.22M	\$47.48M

Table 3-1 gives a breakdown of the capital and annual operating costs of the three disposal options; Estuary Stage1 and 2, Ocean Stage 2, and two Land options.

**3.4 Alternative Treatment Locations**

These options looked at the feasibility of treating the city’s wastewater at a number of satellite plants around the city, rather than treating all the wastewater at a centralised point (i.e. the Christchurch Wastewater Treatment Plant). The effect of this would be to decrease the load to the existing treatment plant and thereby remove the need to increase its treatment capacity. Although this option does not address the issue of the discharge from the treatment plant, the reduced load to the treatment plant will result in reduced contaminants discharged, and a potentially improved treated wastewater quality.

**Northern Zone**

The northern zone treatment options could be situated at the present Belfast Wastewater Treatment Plant (located west of Belfast), or at a new site such as at Chaney’s which was the proposed site for the Christchurch North Treatment Plant during the 1970’s and 80’s. The area being served by the plant would

include the northern parts of the city such as Bishopdale, Redwood, Belfast, Brooklands and north to the Waimakariri River.

The northern options looked at separate domestic, combined domestic and industrial, and industrial only treatment plant options. The separate domestic treatment option is very similar to the present treatment plant at Belfast, which discharges into the Otukaikino Creek (formerly the South Branch of the Waimakariri River, downstream of the Groynes), and therefore this option has not been considered further. For the other two options considered in this report, discharge to the Otukaikino would not be acceptable, so discharges to land and the ocean only have been considered. The direct discharge to the Waimakariri River, of wastewater that includes domestic sewage, has not been considered due to expected environmental and cultural concerns over such options.

### ***South-Western Zone***

The south-western zone would include the areas of Upper Riccarton, Hornby, Sockburn, Wigram and Halswell, and all other areas to the south and west. The south-western zone would serve a domestic base only, as there is no significant wet industry in this zone, unless new industry is established, or Heinz-Watties join the city sewerage system.

It has been assumed that the surface waters in the south-west, such as the Halswell and Heathcote, would not be acceptable receiving waters, and that all these options would include discharge onto land or discharge of partially treated wastewater to the headwaters of the city sewerage network. Upgrade of the reticulation network to accommodate this would cost in the vicinity of \$20m in addition to the treatment costs.

The satellite treatment plant options address the following identified issues. They reduce the need to increase the capacity of the existing CWTP. The combination of the Northern and South-west options would remove approximately 30% of the total loading to the CWTP. They would also reduce the effects of heavy metals and hazardous wastes in the existing treatment plant and Avon-Heathcote Estuary, although the benefits from this have not been quantified.

These options would not eliminate the need for changes in the CWTP, to improve the quality of wastewater from the remaining city areas. While they may reduce the extent of the impacts from the existing CWTP, each of the options considered would have significant resource management issues themselves. There will be many more resource consents required for the satellite treatment plant options than for the CWTP based options.

Separate disposal options would have to be developed for any of these options. Costs for the disposal of the waste to the ocean and on to land have been estimated. Each of these options has high costs due to the loss of economy of scale, compared to combining with the existing infrastructure of the Christchurch sewerage system. The total capital cost for all of the combined treatment and disposal options (Northern and South-western zones) is approximately \$164.4m.

There will also be a high cost to redevelop the sewerage reticulation infrastructure into these zones, and to convey the sewage to the satellite treatment plant sites. These have not been included in the above costs.

While the satellite options would improve the quality of the water in the Avon-Heathcote Estuary, they would not in themselves lead to an improvement in the estuary water quality to allow contact recreation within the estuary. There would still be a requirement to further upgrade the CTWP to achieve this.

There is also concern that the satellite options may lead to contamination from a greater number of smaller treatment sites, scattered through different environments, rather than having the treatment and potential contamination confined to one site, where it could be managed more efficiently and effectively.

Any of the satellite options would not obviate the need for the CCC to obtain resource consents for the present CWTP.

### 3.5 Selection Process

There is a wide range of options available for the treatment and disposal of wastewaters, and this collection was examined to a preliminary level during this first stage of the issues and options study. This examination included an identification of the infrastructure requirements, the environmental effects that would result from the particular option, and any specific issues, which would have to be addressed.

A matrix was developed to initially, test that all the Working Party issues and potential effects in any one of the issue areas had been noted. This matrix was completed with input from the Working Party. It helped the Working Party to identify which of the available options should be examined further (as feasible options), and which options the Working Party required more information about before either including it with the other feasible options or rejecting it as an option.

From this initial matrix and the workshop a group of feasible options were identified for further analysis. These options were as follows

- Nutrient Removal
- Disinfection
- Modifications to the Ponds and Wetlands
- Ocean Outfall
- Estuary Outfall
- Land Treatment and Disposal.

Further analysis was undertaken of these options of treatment and disposal, and a series of potential solution developed, by using the treatment and disposal components as building blocks. The potential solution were based on the completion of the current upgrade.

Potential solutions could be divided in Ocean, Estuary or Land solutions; there were:

- Disinfection      Ponds      Ocean
- Ponds and Wetlands      Ocean
- Disinfection      Ocean
- Biological Nutrient Removal      Disinfection      Ponds      Estuary
- Biological Nutrient Removal      Ponds and Wetlands      Estuary
- Disinfection      Ponds and Wetlands      Estuary
- Ponds and Wetlands      Estuary
- Biological Nutrient Removal      Disinfection      Ponds and Wetlands      Land

From this list the feasible solutions were short-listed. The Land solutions were rejected (see Section 3). The two feasible solutions were identified as: 1. disinfection, modification of ponds and wetlands, disposal to estuary and, 2. Modified ponds and wetlands to ocean.

The Working Party made their recommendation (see section 4) with the acknowledgement that more investigation and analysis was required of both of these solutions before a final recommendation could be made.

Further analysis in a wide range of area was then undertaken including an extensive ocean modelling project. The Working Party then gave their majority recommendation for an ocean disposal solution. The Council subcommittee recommended a short-term (15 year) Estuary disposal option, and the Council supports this recommendation subject to the outcome of public consultation.

## 4.1 Introduction

In June 1996 the Waste Management Unit, of the Christchurch City Council initiated the process to renew its discharge consent with the Canterbury Regional Council. Consultation with interested parties, the community and tangata whenua begun at this time.

Initially, interested parties were consulted, and this led to the establishment of a Working Party, which represented the interests of various groups, and the broader community.

Later, specialist groups linked to this Working Party were established and were consulted in relation to particular topics. The specialist groups roles were also to provide the Working Party with information and feedback. These specialist groups covered; recreation, Ecology, Commercial/Industrial and Neighbourhood interests. Later in the process, an Ocean Outfall specialist group (including representation from commercial interest groups) was also initiated.

## 4.2 Working Party

A Working Party of approximately 15 members reflecting a wide range of interests was established, and a facilitator was provided to help co-ordinate the process. The Working Party also included councillor and community board representation.

### 4.2.1 Terms of Reference

The objectives of the Working Party included to:

- collate, link the needs, issues and ideas, with the support of the Council's staff and the facilitator, in relation to the treatment and disposal of Christchurch's wastewater.
- identify the issues to be addressed within an Issues and Options Report, and assess report and recommend one or a number of described potential solutions to the Christchurch City Council.

### ***The Issues and Options Report***

The need for an Issues and Options Study was recognised by both the Christchurch City Council and the Working Party. The aim of such a study would be to address the issues identified by the Working Party, and assess the range of options available for treating and disposing of the wastewater. This information would then provide a basis for the Working Party to decide which method/s of waste treatment and disposal should be recommended to the City Council for further investigation and implementation.

The Working Party identified a wide range of issues relating either directly or indirectly to the treatment, disposal and effects of wastewater from Christchurch City. These issues were discussed and revised in a workshop on the 29 September 1997.

The study undertaken by consultants was to initially collate all available information and knowledge, and identify where the gaps in the understanding of the identified issues occurred. “Experts” in each of the various issue areas undertook this assessment.

Many of the issues identified by the Working Party relate to the effects of the present treatment and disposal of the wastes. The “experts” were asked how these effects were or could best be managed, and the requirements for this management.

Other issues were generic and where they were within the scope of this report, they were addressed. Some generic issues related to changes in institutional frameworks and behaviour changes. These issues were outside the scope of this report and as such were only identified.

A number of issues related to how future management might affect the environment, for example, how different waste management options might affect bird life on the estuary, and where possible, these issues were addressed.

#### **4.2.2 Areas of Interest**

The Working Party comprised a broad range of individuals with different interests and skills, and either representing a particular group or groups, or individual concerns. Communities groups such as Friends of the Estuary and residents and recreational groups were represented. Business interests, and well as resident interests were represented, along with Community Board representatives. Some members of the Working Party were included as individuals due to their personal interest in, and knowledge of the area or issues.

The Working Party’s interests therefore covered ecological, social and economic aspects of the environment.

#### **4.2.3 Results and Outcomes**

There have been two major milestones in terms of outcomes from the Working Party. The first recommendation to the Council was made after completion of the CCC Issues and Options Report.

24/7/98 – Preparation of a recommendation from the Working Party to the Council.

The recommendation was as follows: (taken from City Services Committee, Environmental Committee Supplementary Agenda. Friday 31 July 1998). The Working Party produced the following recommendation at a meeting in June 1998:

1. *The Working Party prefers an ocean outfall, provided shellfish standards can be achieved at the beach.*
2. *Both ocean and estuary outfalls need more investigation to increase confidence about:*
  - *Standards that will be achieved from the present upgrade and further proposals.*

- *Details of the impacts of currents in Pegasus Bay and the Estuary.*
3. *The Working Party strongly recommended the Christchurch City Council does not make a final decision until it receives the information above.*
  4. *The Christchurch City Council could work towards the ocean outfall in stages as long as:*
    - *A timeline is included in the consent for reviewing the outcome of staged improvements*
    - *Proposed conditions on the consent are checked with the Working Party prior to the application being lodged.*
    - *The end target of an ocean outfall is clearly stated so there is certainty about the end of the process*

*The final step of this recommendation – the ocean outfall- is seen as the minimum cost option that will ensure shellfish standards are maintained on the ocean beaches:*

- *Give the maximum feasible reduction in sea lettuce in the estuary.*
- *Lead to confidence that the contact recreation standards will be maintained consistently throughout the estuary.*

At the final official Working Party meeting on 8<sup>th</sup> May 2000 a set of conclusions were presented to the Council. This was as follows:

1. *Long term planning is needed to achieve the long-term goals. Achieve a long-term sustainable system.*
2. *High standards are needed from wastewater; a number support at least meeting the contact recreation standard for faecal coliforms in the discharge (some UV needed to achieve this).*
3. *We must not use the environment to clean up wastewater – high quality effluent is emphasised.*
4. *Environmental outcomes must be achieved (the Working Party has a list of outcomes).*
5. *Aim for reuse wastewater products wherever possible.*
6. *Research, particularly new field data is essential.*
7. *We must monitor the receiving environment to ensure environmental outcomes are being achieved as well as monitor the quality of the wastewater. For example, monitor fish populations and patterns.*
8. *The community must have access to new information and monitoring results.*

### **4.3 Special Interest Groups**

In January 1999, two special interest groups were established: a Coastal Reference Group and an Estuary Group. Meetings were held with these two groups between January and May 1999.

#### **4.3.1 Terms of Reference**

These two teams were established to review the progress with field data collection and issue resolution directly related to either the ocean or estuary outfall options.

### **4.4 Tangata Whenua**

There was an initial meeting with the Ngai Tahu Resource Committee in late 1996. The CCC has continued with consultation with this group and the Ngai Tuahuriri Resource Committee throughout the consultation process. The tangata whenua chose to be involved in a separate process from the Working Party.

Meetings were held to discuss the Working Party's identified issues, and also to discuss the various options for treatment and disposal of the waste. Views expressed are included throughout this document and the issues of concern were considered during the development of the report. On-going consultation is vital and will continue, to address concerns of Maori in this important area of resource management.

#### **4.4.1 Composition**

Meetings were held with both Te Runanga o Ngai Tahu as well as representatives from the various interested and affected Runanga.

#### **4.4.2 Cultural Importance**

The tangata whenua have a number of concerns related to both the treatment and disposal of wastewater generally and this consent application specifically.

The main values of importance for Ngai Tahu in relation to the Avon – Heathcote Estuary (Ihutai) have been in relation to eating and catching food.

Concerns in relation to this proposed activity were discussed in a report written by Ecological Services Limited (1999), of discussions with the tangata whenua participating Papatipu Runanga. This report recognised the following values that may be effected by this activity:

- Tangata whenua relationships with the environment. This will occur no matter whatever the discharge point.
- Mahinga Kai, past and present uses.

- Kaitiaki Roles and responsibilities.
- Sites of significance, Waahi Tapu, Waahi Taonga.
- Pollution
- Water and Coastal Water
- Coastal Processes
- Marine Environment
- Social and Commercial Use of Fish

#### **4.4.3 Results and Outcomes**

From meetings with Te Runanga o Ngai Tahu, there is support for the upgrading of treatment and also upgrading of the ponds. They were supportive of a ten-year consent and opposed to any solution that asks for a 35-year consent. Ngai Tahu is not prepared to commit the next generation in relation to this matter.

Support was also given to the proposal to upgrade the discharge into the ponds and through the ponds to include UV disinfection for ultimate discharge of the sewage.

It is identified that Ngai Tahu values and ability to undertake its traditional and cultural association with the estuary has been destroyed by urbanisation including the discharge of sewage. Nga Runanga considered that there are measures the Council can take in mitigation that acknowledge this degradation and will assist Ngai Tahu continue its traditions and cultural uses.

Interest was expressed in the concept of the restoration of the ponds and surrounding area into a more ecologically sustainable area, both in terms of improving the sewage discharge, and for the reintroduction of native species, both plants and animals.

### **4.5 General Public**

Further public meetings with various stakeholders within the community were undertaken. Interested public were thereby kept informed about the progress of the Working Party, and were encouraged to provide comments and information to the Working Party, relating to their specific needs and issues of concern. Interested groups or individuals could also receive the Working Party's newsletters, if desired, to keep them up to date with progress.

#### **4.5.1 Programme**

Meetings with various groups within the community begun in 1996 with a general Public Meeting. Public meetings were also held 9/1998, 12/1998

Special interest area meetings on recreation were undertaken, 2/1997, 12/1997

Special interest area meetings on ecology, 2/1997, 12/1997

Special meetings for manufactures and commercial interests, 2/1997, 12/1997

Meeting for neighbours of the Spit 3/1997, and neighbours of Bromley, 12/1997

A joint meeting for all the above groups was undertaken in 5/1998.

Pegasus Bay Outfall Option special meeting, 2/1998.

South Brighton Residents Association, 7/1998, 10/1998

New Brighton Residents Association, 2/1999

Bexley Residents Association, 4/1999

Redcliffs Residents Association, 5/1999

Southshore Ratepayers Association, 5/1999

Mount Pleasant Ratepayers Association, 3/2000

Sumner Residents Association, 6/1999

Bromley Residents Association, 7/1999

Waimakariri District Planning Committee, 4/1999

Friends of the Estuary, 2/1999, 2/2000

Estuary Association, 4/1999, 4/2000

Coast Care (Brighton Area), 8/1999, 12/1999

Pier and Foreshore Society, 5/1999

Youth Council, 5/1999

Workers Education Association, 5/2000

Burwood-Pegasus Community Board, 3/1999, 5/1999

Hagley-Ferrymead Community Board, 3/1999, 5/1999

#### **4.5.2 Results and Outcomes**

The objectives of these meetings were to both inform and incorporate issues and comments into the decision-making process.

## **4.6 Environment Canterbury**

Consultation begun with Environment Canterbury in 1996, and various council officers have been involved in the Working Party meetings. Independent consultation has taken place throughout the preparation of the AEE document to ensure that it addresses the Council's concerns in relation to the activity and discharges.

## **4.7 Peer Review**

Three peer reviewers were appointed and chosen for their technical skills. They were:

Dr Alex Sutherland  
Department of Civil Engineering  
University of Canterbury

Humphrey Archer  
Specialist in Treatment Process  
Beca Steven  
Christchurch

Dr Paul Gillespie  
Estuarine Ecologist  
Cawthron Institute  
Nelson

### **4.7.1 Terms of Reference**

The task of the peer review team was to overview investigations and report to the City Council. The Council required to be advised on whether the investigations address the issues the team sees as important for seeking a consent, whether they are being undertaken in a competent manner, and finally whether the consultants results are credible. The team was required to be involved throughout the process, and to provide a short written report on the draft Assessment of Environmental Effects, and an independent report to the City Council.

A definition of the environment as defined in the Resource Management Act 1991 is as follows:

The “environment” includes;

- ecosystems and the constituent parts, including people and communities; and
- all natural and physical resources
- amenity values, and
- the social, economic, aesthetic and cultural conditions which affect the matters above.

This section describes the environment of the Avon-Heathcote Estuary and its surrounds. The objective of the section is to provide a description of the estuarine system, which will provide the framework for the assessment of the environment effects.

The information presented here has been derived from numerous studies of the area, including studies commissioned for the purposes of this assessment of environmental effects (see section 6. X), as well as, previous studies of the area.

Peer Reviewers will report independently to Christchurch City Council.

## **5.1 Natural and Physical Resources**

Natural and physical resources include air, land, soils, and water, all forms of plants and animals, and structures.

### **5.1.1 Air**

#### ***Ambient Air***

Christchurch’s air quality issues relate in particular to pollution for fuel combustion, and the high levels of particulate matter (PM<sub>10</sub>) which occur in the air during winter. This issue is exacerbated by the city’s geographic location and calm winter weather.

Ambient air quality in Christchurch is continuously measured for concentrations of suspended particulate, sulphur dioxide, nitrogen dioxide and carbon monoxide.

#### ***Climate***

Long term wind speed and direction data is available at Christchurch Airport, about 15km from the coast on the north-western fringe of Christchurch.

Winds in Christchurch are characterised by strong onshore north-easterlies during summer and slightly weaker south-westerlies in winter that blow off shore (Allen *et al* 1999).

Low pressure systems can be expected to pass through Pegasus Bay on an average every 6-7 days. Southerly waves are often associated with them. These events generally last longer in winter compared to summer.

### 5.1.2 Land

#### *Land Form*

The city of Christchurch has developed on the flat plains, north of Banks Peninsula, and the Port Hills which form the outside rim of eastern Banks Peninsula. The CWTP including the oxidation ponds developed on the sand dunes that originally formed the western edge of the Avon Heathcote estuary. These dunes have been completely destroyed, flattened and developed as the ponds, the Bromley farm paddocks, landfill sites, for example Sandy Point and Bexley landfill to the south and north of the ponds respectively. The edge to the estuary now has a hard edge around much of its length, with the major exception the western edge of the Brighton Spit. The Spit itself is highly dynamic landform which has changed its location and physical characterises often, even since European settlement of the area. Although the Spit has been developed for housing, it is recognised as a changing landscape and still retains much of its natural coastal character.

The estuary itself is roughly triangular in shape, with rivers entering from two corners, see Figure 5-1. To the north the Avon and the south the Heathcote River. Water exits the estuary through a narrow neck and into Pegasus Bay, from the third, southern corner.

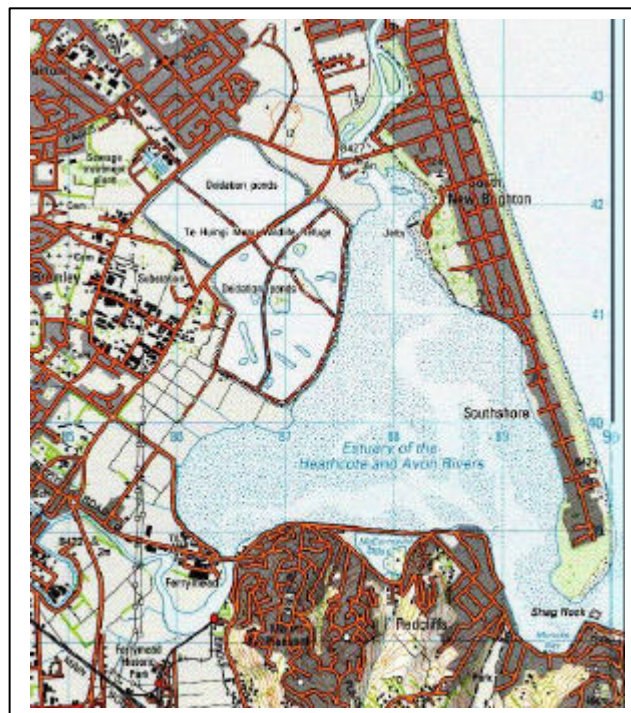


Figure 5-1 Avon-Heathcote Estuary

### **Geomorphology**

Sea floor sediments in Pegasus Bay comprise sands and silty sands of the Pegasus Bay Formation to the edge of the continental shelf, approximately 30km offshore. These sediments attain a thickness in excess of 28 metres, and are believed to correlate with the onshore Christchurch Formation, which underlies much of eastern Christchurch. Underlying these sediments are Canterbury Bight Formation gravels, which are the offshore correlative of Riccarton Gravels the first confined aquifer beneath Christchurch.

The seabed profile is very flat between the shore and the edge of the continental shelf, where gradients increase dramatically. At a distance of 35km offshore from New Brighton, the water depth is only 20 metres (Woodward-Clyde Report, August 1999).

Major sources of sediments include the Waimakariri and Ashley Rivers, and to a lesser extent the seabed. Fine particles are also sourced from river suspended load and erosion of loess off Banks peninsula transported by tidal currents.(Allen *et al.*, 1999)

According to Kirk (1979), much of Pegasus Bay is now characterised by mud sedimentation.

The nearshore is characterised by modern fine sands which extend out to a depth of some 15-12 m. Mean grain sizes decrease in size with distance from the shore. Beyond the depths of 15 –20 m, the sea bed becomes increasingly dominated by muds (Allen *et al.*, 1999).

### **Coastal Environment**

The Pegasus Bay environment has been extensively modified by humans over the past 140 years. In particular the foredune system has been significantly affected by the planting of different species of dune vegetation, contouring, and the construction of hard surfaces such as sea walls (Allen *et al.*, 1999).

The bay shore is broadly crescent shaped and is composed predominantly of fine sandy beaches.

Much of the bay can be characterised as shallow while the sea-bed slopes gently toward the outer edge of the continental shelf. In the nearshore, the bed slopes moderately steeply out to the 4 m depth contour (some 80m from the shore). Beyond this the gradient decreases significantly to out to the 10 m contour, reducing beyond this. Offshore from about 2.5km the slope of the bed reduces to about 0.020 to 0.080 (Allen *et al.*, 1999)

The long term pattern of beach change on the Canterbury coast has been one of rapid progradation over the past 4-5000 years with average rates of +2m.yr. However, trends over the past 150 years indicate that these rates have declined significantly.

The decrease in accretion and progradation of southern Pegasus bay is thought to reflect both a decline in offshore sand as a sediment source and a progressive decrease in the quantity of sand supplied by the various rivers.

The contemporary Pegasus Bay coastal system is presently regarded as existing in a state of long-term dynamic equilibrium (neither advancing nor receding).

Patterns of beach change over the past 100 years has been characterised by accretion of sands and more gradual seaward progradation of the shore. Since 1990, it has been estimated that the beaches accumulated some 1.2 million m<sup>3</sup> of sand, at an annual rate of 151,290m<sup>3</sup> per year. The findings of the CR99 report show that southern Pegasus Bay continues to accumulate sands, albeit at fairly slow rates.

### **The Avon-Heathcote Spit**

The report (Allen *et al* 1999), summarises the changes which have occurred showing that South Brighton Spit has undergone periodic and at times substantial movements in its position. The Avon Heathcote Estuary altered from a predominantly tidal bypassing system to a mixed tidal and bar bypassing system. South Brighton Spit eroded between 1840 and 1949, and because of the low volumes of stored sand, it can be expected to continue to undergo periodic and often dramatic changes in the position of its shore.

### **Waves**

Waves on the Canterbury coast are a mixture of swell waves derived from distant storm centres in the Southern Ocean and locally generated wind waves.

Prevailing wave directions occur from the north-east, east, and south-east. Further, these directions of waves exhibit a seasonal component so that waves from the north-east predominate in summer, while south-easterly waves occur more frequently in winter.

Waves heights and periods tend to increase toward winter. Although large waves (>20m) can occur at any time of the year and do not demonstrate any seasonal component.

### **Currents**

A reversed eddy associated with the Southland Current flows anticlockwise in Pegasus Bay and the flow direction is to the south. Longshore currents have been identified as occurring in both northerly and southerly directions along the coast and occur in response to the prevailing directions of wave approach at the shore.

### **Sediments**

Incoming tides drop their heavier, coarser particles near the estuary's mouth. Near the river mouths, fine particles carried down the river form clumps and fall to the bottom and the fine sediments get trapped near the river mouths.

Fine particles lead to siltier mudflats at the river mouths and along the western shore of the estuary. The mudflats around the mouth of the Heathcote are siltier than those off the Avon mouth. This is possibly due to a third of the Heathcote's catchment runoff being from the loess erosion prone soils of the Port Hills.

At low to mid tide, finer silts are scoured from the deeper channels of the estuary, leaving the heavier sands behind. As the tide rises and the water spreads out over the flats, the particles in the water settle out. In the estuary there tend to be finer silts lower down on the shore, and coarser sediments further up. In the shallows of the higher mudflats the wind stirs the water and the finer silts do not settle out.

**Natural Hazards****Sea Level Rise**

Consideration has to be given to the potential hazard associated with a rise in sea level predicted to take place over the next 50 –100 years. The IPCC (1995) have estimated that global mean sea level will rise from between 18 cm to + 46 cm, which correlates well with findings of Hannah (1988), who noted a rise of +16 cm and +19.3 cm from 1900 to 1988. While there may be uncertainty with the future predictions of sea level rise, it should be expected that sea level will continue at least at historic rates.

**Tsunami**

The Christchurch coast has been influenced by tsunami in the past. Since 1840, the Christchurch coast has been subjected to at least 13 events. Within this time there have been two large events, and although the incidence of a major tsunami is very low, consideration must be given to the potential scouring effects associated with such an event.

Areas affected by tsunami hazards are Brooklands, Spencerville, North Brighton, New Brighton, Brighton Spit, Ferrymead and east of Ferrymead Bridge.

**Local Flooding**

Local flooding due to rainfall events in Christchurch have in the past placed stress on the system at CWTP, however the upgrade presently being undertaken which deals specifically with increasing the capacity of the system will help mitigate this issue.

**Seismic Hazard**

All civil services are under some level of risk from earthquake hazard. Specifically the CWTP buildings were identified in the 1997 Lifelines Report as likely to be of low risk, as were the pumping systems and electrical services. The pipe and connections were highly vulnerable at interfaces. Various mitigation measures were identified in the report.

**Snow**

In the August 1992 snow storm, power failure lead to the Sumner pump station and two pumps to the east of Ferrymead Bridge failing. At the treatment works themselves, a build up of snow on the trickling filters caused concern and the ponds themselves were close to overtopping.

**Wind**

At the treatment works, some scour of the oxidation pond banks is possible but serious damage is considered unlikely.

**5.1.3 Water**

Contaminants enter the Avon Heathcote Estuary from a number of sources, with the principal contributors being the CWTP and the Avon and Heathcote Rivers.

To illustrate this, water quality data routinely obtained by Christchurch City Council for the years 1997/8 and 1998/9, was analysed by Woodward-Clydes in order to obtain base flow quality data, and separate sampling of the rivers during two storm events were used to assess the storm flow quality data.

Sediment transport into the estuary was found to be completely dominated by storm events and approximately 99% of the total annual load of sediment being attributed to these events.

The nutrients nitrogen and phosphorus, are of interest in that they contribute to algal growth within the estuary. The dominant form of nitrogen was nitrate, of which 62-83% of the total load was in the base flow from the two rivers. Concentration of nitrate decreased in the storm flows.

The Avon River reactive phosphorus concentration went up 2-3 times during storm events. The Heathcote River, although having a smaller flow than the Avon, contributes approximately twice as much phosphorus to the estuary than the Avon. In storm events reactive phosphorus levels were 2-3 times higher than base flow data. The source of phosphorus in the Heathcote is most likely from the Ravensdown Fertiliser Company in Hornby, from which runoff is routed through the Wigram Retention Basin and into the Heathcote River.

**Hydrology**

During the last 10,000 years changes in sea level have resulted in movement of the coastal shoreline inland. 6,500 years B.P ( before present) . the shoreline was located at the western edge of Riccarton Bush. Progradation of marine sands and estuarine deposits post 6,500 years B.P. has shifted the shoreline back to its current position. These deposits are known as the Christchurch Formation and are approximately 30-35 metres thick in the Bromley/Avon-Heathcote estuary area. The Christchurch Formation in the Bromley region predominantly comprises of fine marine sand. Further south, i.e. around the Avon-Heathcote estuary and the lower tributaries of the Avon and Heathcote rivers, the Christchurch Formation deposits have higher silt contents with the presence of some peat layers.

The water table in the Christchurch Formation is shallow and unconfined and is in direct connection with the lower reaches of the Avon River, the Heathcote River and the Avon-Heathcote estuary. Shallow groundwater levels in South Brighton Spit are also in direct connection with surface water bodies.

The Riccarton Gravel is the shallowest confined water-bearing body in the Bromley/Avon-Heathcote region and is extensively utilised by industry and domestic suppliers. It is approximately 10-15 metres

thick in the Bromley/Avon-Heathcote estuary area and lies directly below the Christchurch Formation deposits. The direction of groundwater flow in the Riccarton Gravel is generally eastward to the coast and upward toward the surface. However in southern areas, i.e. the Avon-Heathcote estuary and Heathcote Valley, excessive groundwater abstraction by industrial and domestic groundwater users has resulted in a westward and downward groundwater flow direction. This has enabled saltwater to leak down from surface water bodies into the Riccarton Gravel, which is contaminating groundwater supplies in the Heathcote Valley and Woolston areas.

### ***Freshwater***

The two major sources of freshwater flow entering the Avon-Heathcote Estuary are the Avon and Heathcote Rivers. Both rivers are spring-fed, but flow through urban (largely residential and commercial areas for the Avon River and rural, residential and industrial, in the case of the Heathcote River) areas. Both these rivers have numerous tributaries, with Heathcote River catchment including many of the hill tributaries of the Port Hills.

The Avon River is 26 kilometres long with a catchment of 84.3 km<sup>2</sup>. At Bridge Street near its mouth the estimated low-flow is 2.7m<sup>3</sup>/s.

The Heathcote River has a catchment of 104 km<sup>2</sup>, which includes a substantial area of rural and hill land. At Ferrymead, near its mouth the low-flow is approximately 0.9m<sup>3</sup>/s.

Other sources of freshwater into the estuary include; to the south of the oxidation ponds, Charlesworth Street Waterway, Outfall Basin Linwood Avenue, Lovatt's Stream, and to the north of the oxidation ponds, Breezes Road Stream and Estuary Stream.

### ***Estuarine Water***

The wind, tides and interaction between the denser ocean waters and the lighter freshwater produce a complex pattern of salinity throughout the estuary. Freshwater dilutes the tides so the areas near the river mouths have much lower salinity. The denser salt water tends to flow beneath the freshwater. However due to the shallow depths in the estuary, on average only 1.4 metres, there is little difference between the surface and the underlying water on windy day, although on calm days the difference is significant.

The water gradients within the estuary affect where certain species of plants and animal live, depending on their tolerance of salt and fresh waters.

The data presented in the NIWA report indicate that the effluent from the Bromley Oxidation Ponds entering the Avon Heathcote Estuary immediately after high tide mixes rapidly with seawater. However, despite this mixing, under the weather conditions prevailing at the time of sampling, effluent plumes remained discernible as a layer of water slightly lower in salinity than estuary water, and with a green coloration. Plumes clearly contained a high concentration of suspended phytoplankton relative to outside. These suspended cells were evident in chlorophyll-a fluorescence measurements, as well as the colouration of the plume water.

### **Seawater**

Data was collected by NIWA (1999) at the site where an ocean outfall would most likely be located off the New Brighton shoreline. The data showed that this area of seawater is affected by freshwater with high anthropogenic nutrient loading, and there is some circumstantial evidence that most of this loading comes from the CWTP discharge, via the Avon –Heathcote Estuary.

## **5.2 Ecosystems**

An ecosystem is a community of different species interacting with one another and with the chemical and physical factors that make up the non-living environment. An ecosystem is the minimum system that includes and sustains life on earth.

### **5.2.1 Estuaries**

Estuaries have been recognised as the most productive ecosystems in New Zealand.

At the base of this productivity is the microscopic world of bacteria, single cell plants and microscopic animals (plankton). The autotrophs (plants) in the ecosystem obtain their energy through photosynthesis, and form the basis to the food web within the estuarine environment. The detritus formed from the breakdown of organic matter in the estuary together with nutrients entering the estuary either from the rivers and drains, the oxidation ponds, the ocean and/or the land; provide nutrients for plants such as, eelgrass, sea lettuce and the marginal sedges and rushes. Filter feeders such as, cockles, pipis, worms and crabs feed on both the detritus in the sediments and the plankton in the water column. Grazing invertebrates such as snails also feed on the larger plants. Surface feeders such as the wedge shell and mudflat snail also feed on the detritus. Further up the food web carnivorous invertebrates are joined by fish to feed upon the lower animals. These in turn are preyed upon by other fish, and a wide range of birds.

Both wetlands and coastal systems are dynamic, and the Avon-Heathcote Estuary is no exception. It is also an open system, being influenced dramatically by other ecosystems such as the marine ecosystem of Pegasus Bay, the Avon and Heathcote River freshwater ecosystem, as well as the less “natural” ecosystems of the urban city. The ecosystems which exist in the oxidation ponds and on Linwood paddocks although artificially created, display processes present within natural ecosystems.

Many of the animals found in the estuary are only temporary visitors. For example many fish species spend only a part of their life in the estuary, spending the remainder either in freshwater and/or the open ocean. These species often use the estuary for a particular stage or function in their life-cycle, such as a nursery, for feeding, or a transition zone between either heading out to sea or heading up the rivers. A similar situation exists for birds, many of the birds which use the Avon-Heathcote Estuary are migratory species and therefore may use the estuary for feeding or resting, however some species use the estuary all the time, but use different parts at different times of the year.

## 5.2.2 Plants

### ***Terrestrial and Estuarine***

Plants which survive in the tidal areas and along the margins of an estuary must be able to tolerate regular and large changes in their environments. The length of time a plant is submerged under water and its tolerance to salt water are two important factors in the natural distribution of plants in and around the estuary. The impact of urban development is another important factor in the distribution of plants on the margins.

### ***Algae***

Algae are flowerless water plants, especially seaweeds and phytoplankton. Phytoplankton are the small microscopic plants which together with zooplankton and bacteria make up the base of the food web in an estuary.

Estuarine sand and mud habitats contain a diverse assemblage of phytoplankton such as, blue green algae and flagellates.

Three species of macroalgae are found in the Avon-Heathcote Estuary intertidal flats – the green algae *Ulva lactuca* (broad fronds), and *Enteromorpha ramulosa* (slender, rounded, spiny fronds) and the red alga *Gracilaria secundata*.

When nutrients are plentiful these plants “bloom” colouring the surface of the mud. In winter the plants tend to stop growing, but as the temperature warms the plants begin to grow again. One of the major issues of concern in the Avon-Heathcote Estuary is the problem of sea lettuce blooms. This species can grow very rapidly when the temperature and nutrient supplies are correct.

When sea lettuce blooms it tends to drift. As the sea lettuce begins to rot and the bacteria multiply rapidly releasing hydrogen sulphide gas which causes a smell like rotting eggs. It is this odour which is a cause of concern to many nearby residents.

### ***Wetland and Terrestrial Plants***

Eelgrass (*Zostera novaezelandica*) is the only New Zealand flowering plant able to survive below mid tide. Patches of this plant grow around the Avon channel. To live in this environment eelgrass has become like seaweed, absorbing nutrients through its leaves. They are highly productive systems contributing large quantities of detritus to the estuarine ecosystem and providing a rich feeding area for flounder and yellow-eyed mullet.

Eelgrass also alter the local environment by modifying sedimentation processes in a variety of ways, in particular increasing the sedimentation rates, to concentrate preferentially the finer particle sizes and to stabilise deposited sediments.

Additionally a diverse benthic invertebrate community with a high biomass is associated with *Zostera* beds. *Zostera* was fairly abundant in the estuary until at least 1920, but by 1952 it had almost disappeared. The exact reasons for this are not known.

Above the mid-tide is a plant community known as saltmarsh. Within this community there are distinctive zones caused by changes in salinity. Species such as glasswort (*sarcocornia quinqueflora*), sea blite (*Suaeda novae-zelandiae*), cord grass (*Spartina anglica*) and sea rush (*Juncus maritimus*) grow immediately above mid tide. Further up the shore where salinity is lower more species are present. In the upper marsh, jointed wire rush/oioi (*Leptocarpus similis*), coastal ribbonwood (*Plagianthus divaricatus*) and tall fescue (*Festuca arundinacea*) also appear.

### 5.2.3 Animals

#### ***Invertebrates***

NIWA was commissioned to carry out a study of historical data relating to benthic (bottom dwelling) invertebrates in both the Avon –Heathcote Estuary and Off South Brighton, their studies shows that:

#### **Avon-Heathcote Estuary**

- The benthic invertebrate community in the Avon-Heathcote Estuary is dominated by bivalves (shellfish), gastropods (snails, slugs and limpets), polychaetes (bristleworms) and crustacea (including shrimps, crabs). More species have been identified than in any other estuary in New Zealand, although this may be due to the high level of study of this estuary. The fauna is typical of east coast estuaries and is of at least regional significance.
- Most of the species are salt tolerant and are characteristic of mudflats where there is no reduction in the salinity of the sea water (Knox 1992).
- Species confined to essentially freshwater or brackish water comprise a small proportion of the total fauna.
- Polychaete worms comprise the greatest number and probably biomass of the invertebrate fauna of the Avon-Heathcote Estuary (Knox 1992, Marsden 1998), and so are an important component of the community.

A number of earlier studies of the benthic invertebrates of the Avon-Heathcote Estuary have been undertaken; including: Knox and Kilmer (1973) and Knox (1979/80). In addition studies have been undertaken of indicators species, including the cockle *Austrovenus stutchburyi* and the mudsnail *Amphibola crenata* by (Griffin and Thomson 1992, Wong and Thomson 1992), and the benthos in general (McAllum 1993, Walls 1996). Not all these sets of data are comparable.

Marsden (1998) presented the most complete analysis of the benthic communities, densities and population structures of the dominant species. She also examined patterns of physical and chemical

characteristics within the Estuary and compared densities of the dominant bivalves, gastropods and crustaceans sampled in 1997 with those collected by Knox (1997) during 1979/80.

Considerable changes have occurred in the distribution and densities of benthic invertebrates in the Avon-Heathcote Estuary since the 1920s.

### **South Brighton**

- Four zones were identified; 0-3metre: dominated by crustaceans and very high densities of young surf clams, 3-6metres more turbulent and diverse zone with crustaceans, surf clams, as well as some polychaetes and gastropods (snails), 10-14metres transition zone was the most diverse including species from the shallower and deeper zones, 18+ metres were dominated by tube building polychaetes and tube dwelling crustacea dominated this more stable zone.
- These zonal patterns are similar to those found off sand beaches elsewhere in New Zealand.
- Numbers of species were lowest, but total faunal densities highest, closest to shore due to the very high densities of surf clams.
- The regional and national significance of the South Brighton subtidal macrobenthos resource cannot be determined due to the very limited knowledge of this fauna off New Zealand's sand beaches.

A further study was commissioned from NIWA looking at the Pegasus surf clam resource. This preliminary assessment identified the following.

- Several species of surf clam occur from low water levels to 10+ depth of Pegasus Bay beaches. Four occur in appreciable quantities and one is harvested by Maori and recreational fishers, but not commercially.
- Clam densities identified make this shoreline the most abundant surf clam resource reported for any New Zealand beach. Pegasus Bay is, therefore, a nationally significant habitat for surf clams.

### **Fish**

The major role of the Avon Heathcote Estuary in regard to fish fauna is as a nursery area, particularly for flatfishes, and as an essential migratory route for anadromous (species which swim up rivers from the sea, such as inanga) and catadromous (species which migrate from rivers to the sea, such as, eels) species.

Knox (1992) and NIWA (1999) identified five groups of fish species can be identified within the estuary based on their distribution patterns.

1. Seasonal species that move into the estuary predominantly to breed, for example, inanga.
2. Permanent species that breed along the rocky shorelines of the estuary, for example, the triplefins, and probably common bullies, spotty and rockfish.

3. Species that migrate freely between the estuary and the sea but spend their juvenile life in the estuary e.g., sand flounder, yellowbelly flounder and yelloweyed mullet.
4. Transitory species whose main habitat is the sea, but will occasional enter the estuary, for example, kahawai, red cod, barracouta and red gurnard, and lastly;
5. Species that use the estuary as a migratory route to other areas, for example, short and longfinned eels, brown trout and lamprey.

From 1966 to the present, 34 species of fish have been identified in the Avon Heathcote Estuary.

The two major surveys 1966-67 by Webb, and Nairn in 1998-99, identified changes, which may at least partly be due to very different sampling methods. Webb's study concluded that nine species; sand flounder, yellowbelly flounder, common sole, yelloweyed mullet, kahawai, spotty, triplefins, common bully and the globefish, comprised 90% of the total number of fish caught in his survey. Nairns survey in 1996-97 identified only 11 species in comparison to Webb survey identifying 28 species. Webb in the 1966-67 survey identified very high numbers of sand flounder, the numbers recorded in the later survey were much lower. While flatfish populations are know to fluctuate considerably from year to year, the 1999 report of NIWA considers the almost total absence of adult sand flounder from the estuary in Nairn's 1996-67 survey, surprising.

Other species that were identified as common in Nairns 1996-97 survey included, common bully sand flounder and yellowbelly flounder.

Other surveys have also been carried out but it is difficult to make comparisons between any, as different methods were used.

Many of the species that use the estuary are fished commercially around Kaikoura and elsewhere, and this may also have an impact on their numbers and distribution, however for some fish species, such as pufferfish, which are not commercial fished this should not be an issue.

There has been little documented relating to the marine fish fauna within a few kilometres of the shore in Southern Pegasus Bay. It is likely to be fairly typical of Canterbury inshore sandy-bottomed habitats.

Some information was obtained in 1978 by Knox *et al.* This study was undertaken to provide baseline data in the area of a possible ocean outfall at Spencerville. As fish habitats along this area are reasonably uniform, the data is still relevant. Ten species were caught, although pelagic (species inhabiting the upper layers of the sea) species were undersampled due to the sampling method. It is also likely that many other species of fish occur in the area and with more intensive sampling would be identified.

Sole (*Peltorhamphus* sp) was the most abundance species taken in the Spencerville survey. Spiny dogfish was the commonest species of shark. Other species included stargazer species, schoolshark, red cod and elephant fish. Other species not caught but likely to be present include sand flounder (Mundy (1968), determined that there was a major spawning ground for sand flounder off the Waimakariri River mouth), kahawai, kingfish and barracouta.

The south-western Pegasus Bay is likely to be more sheltered from the southerly quarter winds and may be a preferred area for spawning or rearing by some species such as elephant fish.

There are no published data on commercial or recreational fish catch or fishing effort figures which apply specifically to the area. However due to its proximity to the city, recreational fishing is likely to be higher than elsewhere along this coast.

### **Birds**

In the Canterbury Region, the estuary and ponds comprise one of a number of important lowland/coastal wetland sites.

The Avon-Heathcote Estuary and Bromley Oxidation Ponds comprise an important site for a wide variety of bird species (104 species have been recorded since 1980, including 75 wetland/coastal species) that use the area for one or more of the following reasons; breeding, migration staging, moulting, post-breeding flocking and wintering. The majority of birds occurring in the estuary and oxidation ponds breed elsewhere but rely on the area for crucial parts of their life cycle. For example, most caspian terns spending winter on the estuary come from a breeding colony near Invercargill; many of the South Island Pied Oystercatchers come from inland breeding areas in central South Island, and the bartailed Godwits migrate to the estuary from as far away as Siberia and Alaska. The estuary and the oxidation ponds are recognised by the Department of Conservation as outstanding wildlife habitats.

Between 15,000 and 22,000 wetland birds use the estuary and oxidation ponds or their margins, with a peak of up to 32,000 in late summer-autumn. At different times of the year this population may include peak numbers of up to 8000 waders, 15,000 ducks, geese and swans, 10,000 gulls, 1800 terns, 600 shags and cormorants, 400 pukeko, 350 swallows, 200 herons and spoonbills and over 100 kingfishers (Parks Unit, 1992).

New Zealand Shoveller, Grey Teal, NZ Scaup, Royal Spoonbill, three species of cormorants, SI Pied Oystercatcher, Eastern Bar-tailed Godwit, and Pukeko are considered priority species because the estuary and oxidation ponds provide habitat which supports numbers of regional or national importance (Crossland and Sagar1999).

Over the past 150 years, the pressure placed on the estuary by the rapidly growing population of Christchurch has been large. The composition of the estuary's birdlife has also changed dramatically. Before European settlement extensive wetlands bordering the estuary contained healthy populations of wetland species such as, bitterns, rails, fernbirds, black stilts. With the drainage of these wetlands the bird species changed to include new species such as spur-winged plovers, welcome swallows, white-faced heron and numerous introduced songbirds. The creation of the oxidation ponds has done a lot to compensate for the loss of wetland habitat, particularly by providing permanent open water for wintering habitat, however the species using these areas are not the same species as prior to drainage.

## 5.3 Amenity and Social Values

### 5.3.1 People and Communities

For the Taylor Baines report the communities around the coast and Estuary have been grouped into four major areas comprising the suburbs from North Shore to Sumner and those on the margins of the Estuary. Statistics and area units used were those of the 1996 census. The four major areas are:

- North Beach (North Beach and Rawhiti area units);
- Brighton (New Brighton and South Brighton area units);
- Estuary suburbs (Bexley, Bromley and Ferrymead area units); and
- Hill suburbs (Mount Pleasant, Moncks Bay and Sumner area units).

The usual resident populations North Beach, Brighton and the Estuary grew more slowly than the population of Christchurch over the 1990-1996 period. There are differences in the age structures of the 4 areas, with the hill suburbs having fewer children and more senior citizens, and a more homogenous European population.

Four fifths of the workforces of North Beach, Brighton and the Estuary were paid employees, compared to two thirds of the Hill suburbs. The Hill suburbs had high levels of self-employed. The North Beach, Brighton and Estuary suburbs may be characterised as low-income areas. In contrast the hill suburbs are a high-income area.

### 5.3.2 Heritage Values

#### ***Maori Heritage***

The Avon-Heathcote Estuary was traditionally considered a *taonga* and was a regulated *mahinga kai* for a number of Ngai Tahu whanau (Tau, H.R 1992). Of particular significance to Ngai Tahu were the wetlands along the Avon River and at its mouth, which was a rich source of fish and shellfish and birds. The Heathcote River area was along a significant seasonal food gathering area.

Another important site to Ngai Tahu was Te Ihutai. This name often refers to the entire estuary, but traditionally refers to the fishing easement and Maori Reserve around the area now occupied by the CWTP. In 1956 the Reserve was taken under the Public Works Act. The reserve was considered so valuable, the owners would not accept the money offered as compensation to them. The only acceptable form of compensation was land having similar characteristics to that taken from them (EPPU, 2000). Other important heritage sites include Te Ana-O-Hineraki at Redcliffs, and Jellicoe Park or South New Brighton Domain, was the site of a village called Te Kai O Te Karoro, (Tau, T.M 1990). Prehistoric middens also exist around the edge of the estuary, and on New Brighton Spit (Te Karoro Karoro).

### ***European Heritage***

When European settlement began the rivers were of significance as they provided transport. Ferrymead was important because it was the main crossing point of the Heathcote River for settlers coming from the Port via the Bridle Path. Metalled all-weather roads and the Lyttelton rail tunnel (opened in 1867) destroyed the basis to the river trade. Then in the 1880s and 90s the rivers began to be choked with silt and became shallow. Between 1900 and the 1940s there were various schemes for developing the estuary as a port by dredging and connecting it to the city via a canal.

Sumner was one of the earliest of Christchurch dormitory towns. It also became a holiday resort. The New Brighton settlement began about 1850 and 1870. From the 1880's onwards New Brighton was the rival of Sumner as the foremost beach resort.

Within 50 years of European settlement the landscape of the estuary had dramatically changed. Vegetation was removed, the Peninsula narrowed, stopbanked, and prominent sand dunes along the coast were flattened. In 1883 the Drainage Board established a sewage farm on 18.4 hectares at Bromley. Industrial wastes also entered the estuary from industry located along the rivers. Silt resulting from the drainage of wetlands and building sites also entered the rivers and flowed into the estuary. The quality of the estuary was reduced.

### **5.3.3 Land Uses**

Under the Proposed Christchurch City Plan, the existing Christchurch Wastewater Treatment Plant including the ponds, and Linwood Paddocks has been zoned Conservation 1B (Bromley) Zone. The incorporation of the sewage treatment facilities in a conservation zone reflects the fact that a great majority of the land area comprises oxidation ponds and farmland having significant wildlife values.

Surrounding the mouth of the Avon River the zoning varies from Open Space (recreational zoning) to C1 and C1A zoning (conservation zoning). Around the mouth of the Heathcote River the land is zoned C1A and B4 (business zone) and Living Hills zone, the southern edge of the estuary has a variety of Living and Open Space zonings.

The Proposed City Plan also recognises a number of ecological heritage sites around the estuary. It is identified as ecological heritage site 19.01.

In the wider surrounds of the Estuary the land use tends to be largely residential with some significant areas of industrial use. This reflects the history of the area; a largely industrial part of the city, with a number of old landfill sites and noxious industries, and associated residential accommodation. The Brighton Spit, has developed as a largely residential area, although there are restrictions on building due to the dynamic coastal environment.

### 5.3.4 Recreation

The close proximity of the Avon Heathcote Estuary and Pegasus Bay, to a large urban population makes them significant social resources for the City. These areas provide sites for numerous recreational activities. Many of these uses, particularly in the Avon Heathcote Estuary are not compatible with each other or the existing water quality or alternatively compromise the ecological values of the area.

The 1998 Taylor Baines Report undertook a survey of recreational activities. Of their sampled group, 188 people were interviewed and it was found that at the time of the interview and over the early year, swimming and walking were the most common activities along the estuary and ocean beaches from Brighton to Sumner. The report also indicated that many people were involved in multi activities in the study area.

The most common activities undertaken were shown to be swimming and walking, and there was a wide range of outdoor recreation undertaken. Some activities particularly surfing, windsurfing and fishing were male dominated, whereas woman were more likely to be involved in walking, swimming and sunbathing.

Over half the people (53%) of the people survey dwelling in the study area, the rest, elsewhere in the city.

It is likely the recreational pressures on the estuary will increase as the city grows and people continue to become more involved in individual activities rather than team sports, and passive recreation increases.

### 5.3.5 Educational and Research Users

A wide range of schools use this area for study including pre-school groups and kindergartens, primary schools visit both the beaches and estuary as well as the CWTP. Tertiary institution which use the area for research include University of Canterbury, Christchurch College of Education, Christchurch Polytechnic and Lincoln University.

### 5.3.6 Landscape Values

Christchurch has a distinctive natural character and landform including estuary and coastline and rivers. The landscape values result from a combination of natural, cultural activities, historical associations, and built elements.

The Avon Heathcote Estuary is a very significant feature of the City's landscape. For those living nearby, either around the edges or on the hills, the landscape values include the interaction between the water and the tides, the estuary edges and the contrast between land and water. The natural character of the coastal area set against open space and the built environment provides variety and these aspects provide an identifying feature to this area.

### 5.3.7 Amenity Values

Amenity values can be defined as “those natural and physical qualities and characteristics of an area that contribute to people’s appreciation of its pleasantness, aesthetic coherence and cultural and recreational attributes”.

In term of the estuary environment this relates to the quality of the open space, the accessibility, its pleasantness and attractiveness, its recreational qualities, and its cultural and historical identity. The estuary itself as a natural environment and recreational asset, has a high amenity value for all of Christchurch. However, some of the past land practices and adverse environment effects of those practices have lowered the amenity values of the area as a whole.

### 5.3.8 Economic Issues

Business activities are concentrated in several areas around the coastal beaches, and margins of the estuary.

- The community at New Brighton has tried to attract more visitors to the area. The new Pier has been built. The brightest prospect for the recovery of this area’s former prosperity, however seems to be as a seaside destination.
- Bromley-Ferrymead. This area contains a large light industrial area along Dyers Road, and the metro refuse station that borders the oxidation ponds. Ferrymead has changed considerable in recent years with commercial and retail development along Ferry Road and Humphrey’s Drive. Many of these outlets relate directly to recreational activities.
- Redcliffs and Sumner are focused on retail, cafes and bars.

#### Fisheries

The Pegasus Bay fishery extends from Port Robinson (latitude 42 de52’) to Steep Head (43 deg 44’) and out to a longitude of 174 deg 50’ in the Pacific Ocean. Between 1 October 1997 and 30 September 1998, the main species landed, by volume, from the fishery were; barracouta, red cod, silver warehou, spiny dogfish, tarakihi and sea perch (Ministry of Fisheries Data, Taylor and Baines 1999).

Along the coastline from the Waimakariri River there is a large recreational fisheries for shellfish, particularly pipi.

## **6.1 Environmental Effects**

### **6.1.1 Definition of Effect (R.M.A. 1991)**

*In this Act, unless the context otherwise requires, the term “effect”, includes-*

- (a) Any positive or adverse effect; and*
- (b) Any temporary or permanent effect; and*
- (c) Any past, present, or future effect; and*
- (d) Any cumulative effect which arises over time or in combination with other effects- regardless of scale, intensity, duration, or frequency of the effect, and also includes*
- (e) Any potential effect of high probability; and*
- (f) Any potential effect of low probability which has a high potential impact.*

## **6.2 Scoping Techniques**

### **6.2.1 Issues Identification**

The Issues and Options Document (1998), identified a wide range of issues related to the treatment and disposal of Christchurch wastewater. This report provided the framework for the discussion of the various options for treatment and disposal, as well as providing a basis to the consideration of the potential effects of any treatment or disposal option.

The investigations which preceded the writing of this Assessment of Environmental Effects are in part a reflection of the issues identified in this report as well as other issues identified since the completion of this report.

In summary, however, some of the major issues identified are as follows:

### **6.2.2 Expert Review Panel**

An expert review panel was established at the start of the AEE process. The role of this panel was to provide peer review and feedback on the decisionmaking process, scientific analysis and documentation.

### 6.3 Methods of Analysis

#### 6.3.1 Field Investigations

In response to the need to assess the issues, options and ultimately the solutions to the alternative treatments and disposal methods; a wide range of studies have been undertaken. Initially an Issues and Option Document was commissioned and completed, looking at the issues and all the potential treatment and disposal alternatives. As a result of this report, a series of studies were undertaken with the aim of addressing gaps in knowledge about the various issues and options and potential wastewater solutions. These studies included:

Report Title	Contents Description
Assessment of Avon and Heathcote River Contaminant Mass Loads	Examines Contaminant Mass Loads, from storm events and past information, to provide some estimation of rivers contribution to estuary contaminant levels.
Christchurch City - Wastewater Discharge Issues and Options-Easy Read Report.	Easy read version of the issues and options report.
Contribution to the assessment of the effects of the Bromley oxidation ponds effluent on the Avon-Heathcote Estuary: Modelling the growth of sea lettuce in the estuary.	Results of model showed that removal of the effluent discharge from the estuary would reduce sea lettuce growth in some areas that are currently prone to high biomass, but have little effect on estuary as a whole.
Christchurch City Wastewater Discharge: Issues and Options	Report discusses many issues related to wastewater treatment and disposal, and looks at the wide range of treatment and disposal options available.
Estuary Green Edge –Te Ihutai	Preliminary concept plan for the Western edge of the Avon-Heathcote Estuary, including Linwood Paddocks, Oxidation Ponds and Bexley Landfill.
Organic Contaminants and Heavy Metals in the Avon-Heathcote Estuary	Examined how contaminant is the estuary in relation to heavy metals and organic contaminants. What are the changes over time and what effect does the discharge have.
Changes in the Benthic macroinvertebrate communities if the Avon- Heathcote Estuary	Assessment of existing data, looking at significance of the resource, long-term changes, what extend it is affected by the discharge and how proposed changes may affect them.

Pegasus Bay surf clam resources: a preliminary assessment	Assessment of surf clams distribution in relation to their significance for tangata whenua.
Coastal Processes in Southern Pegasus Bay: A Review	Examination of the coastal and beach processes in southern Pegasus Bay.
Preliminary Hydrological Assessment of Land Treatment and Disposal Options	Assessment of Hydrology and groundwater effects of land disposal of City's wastewater.
Effluent concentrations to meet water quality criteria for preliminary Christchurch outfall options	Looked at water quality criteria for both ocean and estuary outfall effluent.
Fish resources of the Avon-Heathcote Estuary and inshore Pegasus Bay: current knowledge and assessment of effects of treated discharges	Review of existing information. Survey data from 30 years ago. Qualitative data show marked changes in abundance over last three decades.
Christchurch City Outfall Preliminary Geotechnical Investigation	Investigations to characterise seabed materials of Pegasus Bay for an ocean outfall.
Preliminary Hydrological Assessment of Aquifer Injection Options for Disposal of Wastewater.	Undertaken for Issues and Options Report. Looks at the hydrological and engineering issues associated with aquifer injection disposal on land.
The Benthos off South Brighton, Pegasus Bay: a preliminary assessment.	Addressed two issues:  What is the nature of the benthos in the vicinity of the proposed outfall?  How significant is the benthos resource?
Tangata whenua Participating Papatipu Runanga	Discussion of the issues of concern to the tangata whenua in relation of he disposal of wastewater.
Effects of the Bromley Oxidation Ponds effluent on colour, clarity and oxygen concentrations in the water of the Avon-Heathcote Estuary.	Examine the issue relative to the discharge plume and surrounding water. Does the plume cause localised reductions in dissolved oxygen concentrations.
Microbial Risk Assessment	Reviews previous studies of virus contamination carried out by CRC. A study of virus occurrence, and assessment of the comparative risk.

Review of Water Quality Guidelines	Summarises the relevant regional, national and international standards and identifies the likely dilution factors required to meet these guidelines.
Assessment of effects of Bromley sewage effluent on Phytoplankton growth at the proposed Pegasus Bay ocean outfall site.	Assesses the potential for algal blooms with an ocean outfall. General result was that bloom conditions are unlikely to be met or cause a “eutrophic” condition.

### 6.3.2 Predictive Tools Used

#### *Ocean Modelling*

Unisearch Ltd at the Water Research Laboratory of the University of New South Wales was commissioned to undertake oceanographic and water quality modelling of a number of short listed options. In conjunction with the numerical modelling, a program of oceanographic data collection was undertaken to provide information about oceanographic and estuarine processes and provide model input and calibration data.

The numerical modelling work consisted of:

- establishment of hydrodynamic and water quality models of the Avon-Heathcote estuary and Pegasus Bay offshore of Christchurch;
- calibration of the model using the data from the field data collection program and other available information; and
- use of the model to evaluate the water quality impacts of the different outfall options under consideration.

Dynamic three dimensional modelling of the effluent plume from each outfall option was undertaken for the two month period of the field data collection program, and for typical and worst case scenarios.

Long term and scenario modelling of the currents in the estuary and Pegasus Bay was undertaken using the three dimensional finite element model RMA-10.

RMA-10 is a three dimensional finite element hydrodynamic model for stratified flow (King, 1993). One, two and three dimensional elements may be combined in the same mesh to enable the amount of detail to be varied according to the dominant processes and importance of different areas in the model. Areas of wetting and drying in the model are included by means of a ‘marsh element’ formulation whereby an element gradually drops out of the model as the water level falls. The hydrodynamics are

coupled to an advective diffusive model allowing temperature, salinity and sediment concentrations to be simulated if required.

Near field modelling of the 2 km and 3 km ocean outfall options was undertaken using JETLAG, the generalised Lagrangian model of Lee and Cheung (1990). JETLAG is a near field model designed for the prediction of three dimensional trajectories of buoyant jets in a stratified ambient current. The model treats the unknown jet trajectory as a series of 'plume elements' which rise due to buoyancy while gaining mass through entrainment of the ambient fluid. The performance of JETLAG has been verified for multiport outfalls in similar depths to the Christchurch outfall (Horton et al, 1996).

Input to JETLAG consists of parameters describing the outfall characteristics (depth, number of ports, port diameter, spacing and discharge angle), the effluent characteristics (total discharge rate, temperature and salinity) and the receiving waters (current, temperature and salinity throughout the water column). Model output is in terms of the average effluent dilution, plume trap depth and plume radius (half thickness). Average dilutions obtained using JETLAG may be converted to the minimum dilution in the centre of the plume by assuming a Gaussian profile. Values for the ratio of average dilution to minimum dilution quoted in Lee and Cheung (1990) are 1.7 for a horizontal jet in a co-flowing current and 2-2.5 for a vertical jet in cross flow.

The far field behaviour of the effluent plumes from both estuary and ocean outfall options was modelled using the particle tracking model 3DRWALK (Wang and Miller, 1995) and the hydrodynamic model results as input. 3DRWALK is a three dimensional random walk, particle tracking water quality model. Pollutants in the model are represented by a large number of particles, each of which is advected by an input velocity field, with diffusion included as a random walk step during each time step. Each particle may be characterised by a mass, age, floating or settling rate and source. Decay rates for each particle may be specified as a function of time of day, particle depth, and particle age.

Details of the modelling are included in the Unisearch Report (WRL Technical Report 99/39).

### ***Sea Lettuce Model***

A study has been undertaken using a model describing growth of sea lettuce. This model uses input from a hydrodynamic model of the estuary provided by Unisearch to estimate distribution and concentrations of nutrients, and locally measured irradiance and water temperature. McCormack's Bay is not part of the Unisearch model and could therefore not be included. The model was run for the period for which hydrodynamic input data were available, that is from 5 February 1999 to 11 April 1999.

Constructing a precise growth model of sea lettuce is difficult. Assumptions are associated with each of the three stages; a) estimating environmental variables, b) producing environmental-growth relationships and c) translating growth rate to biomass yield.

### ***Algal Bloom***

NIWA undertook an assessment of the potential for nutrient-rich effluent discharged from an ocean outfall in Pegasus Bay to stimulate algal blooms (NIWA, May 1999). They also considered issues of oxygen, clarity and colour in the water of Avon Heathcote Estuary (NIWA, April 1999).

In relation to the water in the estuary, a Chelsea Instruments Aquapak was used to determine conductivity, temperature and fluorescence. Dissolved oxygen concentration was determined using a YSI meter equipped with a submersible probe. Water clarity was determined by measuring the attenuation of light with depth. This was done by lowering a LiCor submersible light into the water column, and recording the light at 0.2m intervals. A LiCor Li800 spectroradiometer was used to measure the spectral characteristics of light.

## **6.4 Assessment Criteria**

Any discharge from the Christchurch Wastewater Treatment Plant (CWTP) will be assessed against specific water quality standards to ensure that public health and the environment are suitably protected from the discharge. The standards used for this type of discharge around New Zealand vary and are predominately based on water quality standards used nationally or internationally. These standards have been developed using a risk-based approach based on human and environmental toxicological tests.

### **6.4.1 Water Quality Standards**

#### ***Regional Coastal Environment Plan – Water Classifications***

The Canterbury Regional Council (Environment Canterbury – ECAN) provides the most specific standards relating to water quality of the Coastal Marine Area (CMA) for New Brighton Beach and the Avon Heathcote Estuary.

Under the Variations to the Proposed Regional Coastal Environment Plan (October 1998), rules have been proposed relating to the discharge of water and contaminants into the CMA. The proposed rule affecting any possible discharge to the CMA from the CWTP is Rule 7.3 Restricted Coastal Activities which are Discretionary Activities. Specifically this identifies the discharge of human sewage into water in the CMA. This requires compliance with the standards and terms of Schedule 4 of the Proposed Plan. Schedule 4, Classes of Coastal Waters and Minimum Standards of Water Quality, identifies specific areas of the CMA waters requiring management to one of three sets of standards: AE (maintenance of aquatic ecosystems), CR (contact recreation and maintenance of aquatic ecosystems), and SG (shellfish gathering, contact recreation and maintenance of aquatic ecosystems).

These standards should be considered as minimum thresholds, as other higher performance standards may be more appropriate to protect the environment or meet community expectations.

Discharges into the Avon Heathcote Estuary from the CWTP or from any discharge near to the mouth of the estuary would require compliance with the Class CR standards. A discharge out from South Brighton would be outside any classified zones. However, to the north, at the mouth of the Waimakariri, and to the South, inside the mouth of the Avon Heathcote Estuary, the waters are classified as Class CR.

The minimum standards applicable to Class CR are presented in Table 6.1.

**Table 6.1 Class CR Water, Minimum Standards of Water Quality**

Parameter		Concentration	Notes
Faecal coliforms	cfu/100ml	200	Median concentration of not less than 5 samples taken within any consecutive 30 days
Faecal coliforms	cfu/100ml	800	Not more than 20% of samples within any 30 days to exceed
Dissolved oxygen	Reduction in % saturation	80	Reduction by not more than this in receiving waters
Bacterial/Fungal slime growth	Visibility		Not be visible to the naked eye as plumose growths or mats
Change in Temperature	°C	3	And not to exceed 25°C
BOD <sub>5</sub>	g/m <sup>3</sup>	2	Filtered through GF/C
Arsenic	mg/m <sup>3</sup>	50	acid-washed 0.45 micron filter
Cadmium	mg/m <sup>3</sup>	2	acid-washed 0.45 micron filter
Chromium	mg/m <sup>3</sup>	50	acid-washed 0.45 micron filter
Copper	mg/m <sup>3</sup>	5	acid-washed 0.45 micron filter
Lead	mg/m <sup>3</sup>	5	acid-washed 0.45 micron filter
Nickel	mg/m <sup>3</sup>	15	acid-washed 0.45 micron filter
Zinc	mg/m <sup>3</sup>	50	acid-washed 0.45 micron filter

There are a number of proposed policies that would affect applications for resource consents to discharge to either the ocean or the Estuary.

- Policy 7.2: where no water quality classification has been set (i.e. off New Brighton), the discharge shall not unreasonably restrict existing lawful uses of the coastal water, and after reasonable mixing the discharge shall not have more than minor adverse effect on the existing water quality.
- Policy 7.5: the discharges of human sewage to coastal marine waters that do not pass through land or wetlands should only be granted where the discharge better meets the purpose of the Act, and there has been consultation with tangata whenua, and with the community.
- Policy 7.6: a reasonable mixing zone should be determined when setting conditions for any resource consent to discharge to the CMA.
- Policy 7.7: that discharges to the CMA avoid significant adverse effects on cultural or spiritual values associated with sites of special significance to the tangata whenua.
- Policy 7.8: that after reasonable mixing a discharge to the CMA should not give rise to significant adverse effects on habitats or feeding grounds of indigenous fauna or any aquatic ecosystem, or have acute or chronic toxic effects on fish.

**Ministry for the Environment – Bacteriological Water Quality Guidelines for Marine and Fresh Water**

The Guidelines for the Management of Recreational and Marine Shellfish-Gathering Waters (December 1998) are presented in Table 6.2.

**Table 6.2 MfE Guidelines for the Management of Recreational and Marine Shellfish-Gathering Waters**

Parameter	Concentration	Action	
<b>Marine Bathing Waters</b>			
Enterococci	#/100ml, running median	<35	
			SURVEILLANCE Continue routine monitoring (e.g. weekly)
	#/100ml, running median	>35	ALERT Increase sampling to at least 2x weekly, prepare a report on potential health risks and causes
	#/100, single sample	136-277	ALERT Increase to daily sampling, undertake a sanitary survey to identify source
#/100, single sample	>277	ACTION Increase to daily sampling, undertake a sanitary survey to identify source, erect warning signs, inform public through media	
<b>Shellfish Gathering</b>			
Faecal coliforms	Median over a gathering season, MPN/100 ml	14	
	All samples over a gathering season, MPN/100 ml	43	Not more than 10% of samples to exceed this.

**ANZECC Water Quality Guidelines (1992)**

The Australian Water Quality Guidelines for Fresh and Marine Waters, prepared by the Australian and New Zealand Environment Conservation Council in November 1992, identifies marine water quality guidelines for the protection of aquatic ecosystems (see Table 6.3).

**Table 6.3 ANZECC Marine Water Quality Guidelines for the Protection of Aquatic Ecosystems**

Parameter		Marine Concentration	
Colour and Clarity		<10% change in euphotic depth	
Dissolved oxygen	mg/l	>6 (>80-90% saturation)	
Nutrients/nuisance growth	µg/l	Coastal water	Estuaries
Indicative levels:			
PO <sub>4</sub> -P		1-10	5-15
NO <sub>3</sub> -N		10-60	10-100
NH <sub>4</sub> -N		<5	<5
Chlorophyll-a		<1	1-10
PH	pH units	<0.2 change	
Suspended particulate matter/turbidity		<10% change seasonal mean concentration	
Temperature	°C	<2 increase	
Arsenic	µg/l	50.0	
Cadmium	µg/l	2.0	
Chromium	µg/l	50.0	
Copper	µg/l	5.0	
Cyanide	µg/l	5.0	
Lead	µg/l	5.0	
Mercury	µg/l	0.1	
Nickel	µg/l	15.0	
Zinc	µg/l	50.0	

#### 6.4.2 Existing and Proposed Wastewater Characteristics

The characteristics of the wastewater to be discharged from the CWTP can be described in terms of the current discharge parameters for those parameters which are not significantly affected by the upgrade, along with design expectations for those that will change. Tables 6.4 to 6.7 following contain data which is used to characterise the discharge.

Heavy metals will not be significantly altered by the proposed upgrade. As the TFSC process will involve the generation of more biosolids, this will result in more of the heavy metals in the wastewater being adsorbed onto the biosolids and therefore there will be a reduction in the metals discharged. It is difficult to quantify this effect, as it is difficult to quantify the benefits of at source reduction through tradewaste and voluntary mechanisms. Therefore the conservative approach is to utilise existing discharge parameters for metals. These are contained in Table 6.4.

**Table 6.4 Existing CWTP Wastewater Characteristics – Heavy Metals**

Parameter	Units	1986-99 Median Discharge Data	1986-99 Maximum discharge Data
Arsenic	mg/m <sup>3</sup>	3.0	7.0
Cadmium	mg/m <sup>3</sup>	0.18	1.10
Chromium	mg/m <sup>3</sup>	37.5	161
Copper	mg/m <sup>3</sup>	15.5	53.0
Lead	mg/m <sup>3</sup>	5.5	30.0
Nickel	mg/m <sup>3</sup>	25.5	60.0
Zinc	mg/m <sup>3</sup>	33.8	167

The indicator organisms which are typically used for water quality standards are faecal coliforms and enterococci. Data from the existing CWTP are provided in Tables 6.5 and 6.6. It is not appropriate to use this data to assess the effects of the discharge, as it is proposed to modify the ponds to increase the pathogen reduction, and to install UV disinfection. The existing data is provided to indicate the degree of reduction required through these new processes to achieve the performance standards mentioned earlier.

**Table 6.5 Existing CWTP Wastewater Characteristics – Faecal Coliforms**

Year	Units	Maximum Value of 5 sample Rolling Median	Maximum Value of 5 sample Rolling 80 <sup>th</sup> Percentile
92/93	Cfu/100ml	100,500	122,400
93/94	Cfu/100ml	43,000	66,400
94/95	Cfu/100ml	93,000	122,400
95/96	Cfu/100ml	230,000	430,000
96/97	Cfu/100ml	23,000	43,000
97/98	Cfu/100ml	23,000	55,400
98/99	Cfu/100ml	43,000	53,000
92/99	Cfu/100ml	8,250 <sup>1</sup>	33,000 <sup>1</sup>
Range	Cfu/100ml	23,000-230,000	43,000 – 430,000

Notes:

1. Median and 80<sup>th</sup> percentile of total data.

**Table 6.6 Existing CWTP Wastewater Characteristics - Entrococci**

Year	Units	Maximum	Median
1999 <sup>1</sup>	Cfu/100ml	2900	270

Notes:

- 24 samples from ponds 5 and 6.

The upgrade to the TFSC process and modified ponds with disinfection will result in an effluent quality as contained in table 6.7. All values in this table are median values.

**Table 6.7 Fully Upgraded CWTP and Ponds Wastewater Characteristics**

Parameter	Units	Design Data 160,000 m <sup>3</sup> /day	Design Data 200,000 m <sup>3</sup> /day
BOD <sub>5</sub>	g/m <sup>3</sup>	30	30
BOD <sub>5</sub> (filtered)	g/m <sup>3</sup>	10	10
SS	g/m <sup>3</sup>	30	30
Total Nitrogen	g/m <sup>3</sup>	25	30
Ammoniacal N	g/m <sup>3</sup>	15	20
Reactive Phos	g/m <sup>3</sup>	7.0	8.0
Faecal Coliforms <sup>1</sup>	No/100ml	200	200
Entrococci <sup>1</sup>	No/100ml	35	35

Notes:

- Median value of 5 consecutive samples

### 6.4.3 Assessment Against Water Quality Standards

The appropriate water quality criteria and the expected wastewater discharge parameters have been used to estimate the degree of dilution required in the receiving environment to meet the standards. The required dilutions are then compared to the dilutions predicted from the Unisearch draft assessment of water quality parameters from their oceanographic modelling exercise. This determines whether or not the discharges into the estuary or the ocean will meet the standards.

The hydrodynamic modelling has indicated dilutions from an estuary discharge and the ocean outfall options. Dilution values used in this assessment are included in tables 6.8 and 6.9. These tables have

assumed the contaminants are conservative, (ie they do not decay with time), therefore are appropriate to use for contaminants such as heavy metals.

**Table 6.8 Statistics of Modelled Conservative Pollutant Dilutions – Estuary Option**

	Median <sup>1</sup>	90th%ile <sup>1</sup>	Min <sup>2</sup>
<b>Coastal Sites</b>			
North Brighton Beach			123
Brighton Pier			142
South Brighton Beach		1351	90
South Brighton (500 m north of estuary entrance)		901	53
Scarborough Beach (south end)	1351	108	17
Taylors Mistake		270	20
<b>Estuary Sites</b>			
Pleasant Point Jetty (PPJ)	901	22	9
Opposite Oxidation Pond Outfalls (TPO)	41	10	6
Opposite Heron Street (HST)	68	18	7
Opposite Bone Tip (BON)	16	9	5
Humphreys Drive (HDR)	22	8	4
Beachville Road Jetty (BRD)	50	13	5
Moncks Bay (MBY)	100	17	5
Shag Rock	135	16	8

Notes:

1. No value indicates an absence of contact with the discharge plume for 50% or 10% of the time for median or 90 percentile values respectively.
2. The minimum dilution will result in the maximum concentration.
3. Beach sites refer to outside the surf zone. Mixing in the surf zone will increase dilutions further than that indicated in this table.

**Table 6.9 Statistics of Modelled Conservative Pollutant Dilutions – 2 km Ocean Outfall Option**

	Median <sup>1</sup>	90th%ile <sup>1</sup>	Min <sup>2</sup>
<b>Coastal Sites</b>			
North Brighton Beach	5882		485
Brighton Pier	3571		321
South Brighton Beach	5882		254
South Brighton (500 m north of estuary entrance)			353
Scarborough Beach (south end)	5882		257
Taylor's Mistake	3030		383
<b>Estuary Sites</b>			
Pleasant Point Jetty (PPJ)			2000
Opposite Oxidation Pond Outfalls (TPO)			752
Opposite Heron Street (HST)			400
Opposite Bone Tip (BON)			429
Humphreys Drive (HDR)			752
Beachville Road Jetty (BRD)			310
Moncks Bay (MBY)	5882		261
Shag Rock	9091		340

Notes:

1. No value indicates an absence of contact with the discharge plume for 50% or 10% of the time for median or 90 percentile values respectively.
2. The minimum dilution will result in the maximum concentration.

**Regional Coastal Environment Plan – Water Classifications**

Effluent discharging from Ponds 5 and 6 of the CWTP is routinely analysed by CCC for a variety of parameters. Data from 1 January 1986 to 27 July 1999 has been reviewed. Based on this and using median and maximum discharge concentrations a range of dilution factors has been identified which would be required to ensure that any discharge complies with the Class CR water classification water quality standards.

**Table 6.10 Class CR Water, Minimum Standards of Water Quality**

<b>Parameter</b>		<b>Limit</b>	<b>Discharge Value</b>	<b>Dilutions required</b>
Faecal coliforms	cfu/100ml	200 <sup>1</sup>	<200	ND
Faecal coliforms	cfu/100ml	800 <sup>2</sup>	<800	ND
Dissolved oxygen	Reduction in % saturation	80		Note 3.
Bacterial/Fungal slime growth	Visibility	Not visible	N/A	Will be met
Change in Temperature	°C	3		Note 4.
BOD <sub>5</sub>	g/m <sup>3</sup>	2	5	2.5
Arsenic	mg/m <sup>3</sup>	50	7.0 <sup>5</sup>	ND
Cadmium	mg/m <sup>3</sup>	2	1.10 <sup>5</sup>	ND
Chromium	mg/m <sup>3</sup>	50	161 <sup>5</sup>	3.2
Copper	mg/m <sup>3</sup>	5	53.0 <sup>5</sup>	10.6
Lead	mg/m <sup>3</sup>	5	30.0 <sup>5</sup>	6
Nickel	mg/m <sup>3</sup>	15	60.0 <sup>5</sup>	4
Zinc	mg/m <sup>3</sup>	50	167 <sup>5</sup>	3.3

## Notes:

1. Median concentration of 5 consecutive samples.
2. 80<sup>th</sup> percentile of samples taken within a 30 day period.
3. Studies show that the discharge into the estuary does not result in oxygen depletion at all.
4. Temperature changes within in the discharge plume in the estuary have been measured to be less than 0.5 degrees.
5. Maximum value from all data used. Total metal concentration.
6. ND = No dilution required.

Based on the dilution levels provided in the table above (physical parameters) it can be seen that the median concentrations in effluent for all parameters for the complete data set (1986-99) could meet the Class CR Waters Standards with a maximum of 11 times dilution (based on the dilution required to meet ECAN standard for Copper). It should be noted in the above table, that the metal standards relate to only the dissolved fraction, while the analytical data represents total metals. Therefore comparison on this basis is very conservative. It can be seen from Table 6.10 that the minimum dilution for the ocean outfall is approximately 250. The minimum dilution for the sites within the estuary ranges from 4 – 9 times. This indicates that the limits for copper and lead may under worst case conditions be hard to meet, however this should be considered in light of the fact that the limits are applied to dissolved metals while the calculations have been based on total metals.

The standard for faecal coliforms and enterococci can be met without dilution as a consequence of the provision of UV disinfection. Table 6.11 following indicates the degree of dilution required to meet the ECAN standards without disinfection.

**Table 6.11 Dilutions Required to Meet ECAN Class CR Water Standards without Disinfection (Biological parameters)**

Parameter	Units	Class CR Waters	Dilution Required to Reach Class CR Water Standard	
			1986 to 99 Maximum Rolling 5 (monthly) Sample Median	1986-99 5 Sample (monthly) Rolling 80 <sup>th</sup> percentile
Faecal coliforms	Cfu/100ml	200 <sup>1</sup>	1,250	
Faecal coliforms	Cfu/100ml	800 <sup>2</sup>		700

Notes:

<sup>1</sup> Median concentration of not less than 5 samples taken within any consecutive 30 days. <sup>2</sup> Not more than 20% of samples within any 30 days to exceed. Neither of these is directly applicable to the discharge maximum.

Faecal coliforms is the parameter that would require the highest dilution. To enable comparison of these discharge concentrations to the Class CR Waters Standards (see note above), the median concentration of rolling 5 samples was taken (in general 5 samples are taken per month), and also the rolling 80<sup>th</sup> percentile concentration was taken. More significant dilution is required to meet these standards than for the physical parameters (between 700 and 1,250 times dilution without disinfection). These dilutions are not practical to achieve in the estuary with an estuary discharge. This indicates the necessity of UV disinfection for an estuary discharge.

Initial dilutions with an ocean discharge range from 100 – 1000 times. The preliminary diffuser design undertaken by Unisearch indicates a mean dilution above the outfall under peak wet weather flow conditions of 5.8 m<sup>3</sup>/sec would be 64 times. The proposed modifications to the ponds would result in faecal coliform concentrations in the range 500 – 1000 cfu/100ml. With a minimum dilution of 64 times, the resulting concentration at the surface would be less than 16 cfu/100 ml, which is significantly less than the CR standard.

**Ministry for the Environment – Bacteriological Water Quality Guidelines for Marine and Fresh Waters**

The Ministry for the Environment’s Bacteriological Water Quality Guidelines are for recreational and shellfish gathering water. These identify a median faecal coliform concentration of 14 MPN/100 ml for the whole shellfish gathering season and that no more than 10% of samples are to exceed 43 MPN/100 ml. For the most likely gathered shellfish around Christchurch there is no season. Comparison has thus been made with the medians for each year and with the top 10% value.

Shellfish gathering standards should be met along the coastal beaches. The estuary has been significantly affected by the stormwater runoff from the city and it will not be safe to consume shellfish from within the estuary, even if the discharge from the CWTP was completely removed. Therefore the shellfish gathering standard is only applied at the coastal beaches.

Medians of all data for ponds 5 and 6 respectively were, 7,500 and 9,000 No./100ml, and the 90<sup>th</sup> percentile values for ponds were 43,000 and 93,000 No./100ml. For these data, dilutions of 535-640 and 1,000 - 2,163 would be required to meet the shellfish gathering standards without disinfection.

The modification to the ponds will reduce the median faecal coliforms to less than 1000, therefore a dilution of 71 times would be required to meet the limit of 14 MPN/100m for 50% of the time. The preliminary diffuser design indicates a dilution of 99 times under average dry weather flows of 2.3 m<sup>3</sup>/sec (200,000 m<sup>3</sup>/day). Therefore the median faecal coliform concentration at the surface above the outfall diffuser will meet the shellfish gathering standard of 14 MPN/100ml.

The MfE guideline for marine bathing waters is based on Entrococci. Existing entrococci data from ponds 5 and 6 indicate a median concentration of 270 cfu/100ml and a maximum concentration of 2900 cfu/100ml. A dilution of 7 times (based on the median) would be needed to meet the guideline, and a dilution of 83 times would be needed for the maximum value. Each of these dilutions assumes there is no modification to the ponds, nor UV disinfection.

For the estuary discharge, it is likely that the modifications to the ponds will reduce these concentrations by a factor of ten. UV disinfection would further reduce these concentrations. The UV disinfection would be designed such that no dilution was required for an estuary discharge to meet the MfE entrococci guideline value.

Disinfection would not be required for an ocean discharge but the ponds would require modification.

### ***ANZECC Water Quality Guidelines (1992)***

The 1992 ANZECC Guideline values for heavy metals are identical to the ECAN Class CR Waters Standards specified in Table 6.10. Therefore the maximum dilution required to meet the ANZECC 1992 Guideline values is 11 times (based on the maximum dilution required to meet the guideline value for copper).

The nutrient indicative levels provided in the ANZECC guidelines are those levels at which it is known that sometimes algal blooms may occur. However it is very difficult to apply universal standards to all situations. For this reason, NIWA have undertaken a site specific and wastewater specific assessment of the potential for phytoplankton growth in the estuary and Pegasus Bay. (NIWA Report CHC99/30).

This study showed that marine water at the site of the proposed outfall was already affected by fresh water with a high nutrient loading. Further the assessment considered a scenario which provided a repeated exposure of the same phytoplankton patch to the discharge nutrients over a 3 day period. It was found that while there was scope for considerable growth under this scenario, it would not be of a magnitude normally associated with blooms or eutrophic conditions. This study obviated the need to specifically assess the indicative levels for nutrients in the guidelines.

#### **6.4.4 Qualitative Criteria**

By their nature qualitative criteria are more difficult to use in the assessment of environmental effects. However the RMA places great emphasis on those part of the environment which cannot easily be assessed by other means. For example, sustainable management under the RMA requires balancing management with people and communities to provide for their social and economic and cultural wellbeing. This requires that amenity, recreational, landscape values also need to be considered and many of these aspects can only be measured in a non-specific qualitative manner.

### **6.5 Assessment of Effects**

The assessment of effects is considered in terms of the discharge, structures and construction.

#### **6.5.1 Natural and Physical**

##### ***Air***

There is unlikely to be any adverse environmental impact on air quality for either an ocean or estuary discharge or the structures related to them. There are however likely to be temporary adverse effects to the air quality during the construction phase.

##### ***Land***

###### **Coastal Margin**

- Estuary Discharge

There will be minor effects to the coastal margin within the Estuary itself. In relation to the discharge structure the interface with the estuary and the oxidation ponds will be softened with the outfall structure being buried and the discharge dispersed over a broader area. Therefore in terms of the quality of the coastal environment the effects will result in a positive environment impact.

- Ocean Discharge

There will be significant adverse environmental effects during construction of the ocean discharge structure. This will occur where the pipeline and other structure have to be located through the coastal dune system and across the beach. After construction the structure will not be visible above ground level.

###### **Sediments**

- Estuary Discharge

There will be no significant change in the sediments entering the estuary from a proposed estuary discharge. There may be activities undertaken during both construction of the pond reconfiguration, the discharge structures and changes to the margin of the estuary that may have temporary effects.

- Ocean Discharge

There will be an increase in sediments directly entering the ocean from an ocean discharge. Due to the depth of water at the discharge point, and the dynamic nature of the coastal environment it is likely that most of this will be dissipated, but no doubt some will sink to the ocean floor. It is however, concerned that due to the dilution rates the impacts on ocean sediment will be less than presently exists.

### **Soil**

- Estuary Discharge

There will be not significant changes to the soils due to this proposed discharge or associated treatment processes.

- Ocean Discharge

There will be not effects on soils due to an ocean discharge. However there are likely to be environmental effects on the soil during construction of the pipeline. In order to pass from the CWTP the pipeline will have to cross the Avon River and may had significant effects on natural habitats along side the River.

### **Water**

#### **Freshwater**

There will be not significant changes to the freshwater environment due to either of the proposed discharge options or their associated treatment processes. There are some potential effects during the construction of the ocean discharge pipeline, when the pipeline will have to cross the Avon River.

#### **Estuarine Waters**

- Estuary Discharge

The major impacts to the estuarine water quality will be a positive reduction in bacteria and viruses. However, is unlikely that the visual appearance of the plume will be altered significantly from that which presently occurs. Timing of the discharge will not be altered.

- Ocean Discharge

There will be a significant reduction in the quality of sediments and nutrients entering the Avon-Heathcote Estuary if the discharge environment is moved to the ocean. Nutrients and sediments will still be entering from the drains and river, however the quality of the water will be significantly improved.

### **Ocean Waters**

- Estuary Discharge

There will be no significant environmental effects on the ocean water quality from the estuary discharge.

- Ocean Discharge

Due to the high dilution of the discharge there will be no significant adverse environmental effects to the ocean waters from the ocean discharge. This is based on the water quality standards discussed earlier in Section 6 of this report.

### **6.5.2 Ecosystems**

- Estuary Discharge

There are unlikely to be any major changes to the broad ecosystem values of the estuary from the discharge itself. They may be some improvements in the health of components of the ecosystem, such as a reduction in ammonia likely to lead to an increase in fish health. A minor effect will be caused to the edge of the estuary due to the construction and subsequent alteration of the margin, however the outcome is likely to be a positive environmental effect, due to the removal of the present outfall structure and softening of the estuary edge.

There are however likely to be significant effect from the redevelopment of the oxidation ponds. These ponds will have to be carefully constructed so as not to have significant adverse environmental effects on the existing wildlife. However, if care is taken during construction the environmental effects are likely to be positive and significant.

Creation of the improved pond habitat is likely to encourage increased number of birds to roost, feed and nest in the area, thereby improving the quality of the wider estuarine environment. Many of the species of birds which may use the improved pond system will spend part of their time on the estuary itself for feeding, for example Caspian terns, or move to other part of the city, such as NZ Scaup, Shoveler and Grey Teal. If further enhancement of the estuary edge is undertaken, further species of birds will be encouraged including wetland species, and forest birds. The consequence of this will be a significant improvement in the estuarine environment and the City's biodiversity.

- Ocean Discharge

Due to the high level of dilution of the discharge waste from the ocean discharge there is unlikely to be any direct significant adverse environmental effects to the Pegasus Bay ecosystem. There is some concern relating to the impacts on sediment dwelling animals and the impacts of the breeding site of the elephants fish. The concern relates to the sediment accumulations interfering with survival of the eggs.

In the short term the environmental effects on the Estuary will not be noticeable. Although the discharge will not be entering the estuary, there exists a large reservoir of nutrients which can feed the ecosystem. However, over time this reservoir will reduce and there are likely to be changes in the ecosystem's structure

and composition. This change can be seen as movement towards a more sustainable and “natural” system.

### ***Natural Habitats***

There is unlikely to be any permanent significant effects on the natural habitats of the estuary and the shoreline. During construction there may be impacts on the wildlife from construction activity, including traffic, noise, dust, and general disturbance from the construction of the discharge structure.

In addition there are potential significant adverse effect possible if construction of associated treatment processes are not undertaken with careful staging to avoid critical disturbance of wildlife habitat on the ponds. In a similar manner construction of the pipeline where it crosses natural habitats around the mouth of the Avon River should also be carefully staged.

### ***Estuarine Plants***

- Estuary Discharge

Direct effects relating to the discharge of wastewater from the oxidation ponds are not likely to alter the composition or abundance of estuarine plants in the estuary itself. As the nutrient status of the discharge is unlikely to change significantly there is unlikely to be any major impacts on the estuarine plant populations.

- Ocean Discharge

Effects on the estuarine plants of the estuary due to removal of the discharge are likely to be minor and slow. As nutrients reduce there may be an increase in other native estuarine plants, if this is accompanied by active restoration and management takes place the environmental effects are likely to be positive.

### ***Algae***

Direct effects relating to the discharge of wastewater from the oxidation ponds are not likely to alter the composition or abundance of algae in the estuary itself. In terms of an ocean discharge the algae discharge will be freshwater algae which cannot survive in sea water, therefore they will die are discharge.

### ***Algal Blooms***

Studies undertaken by, on the assessment of effects of CWTP sewage effluent on phytoplankton growth at the proposed Pegasus Bay ocean outfall site, NIWA (1999), and effects of the CWTP Oxidation Ponds effluent on colour, clarity and oxygen concentrations in the water of the Avon-Heathcote Estuary show that there is little likelihood of algal blooms in either the ocean or the estuary.

The occurrence of algal blooms relies on the duration of high nutrient water remaining in the estuary long enough for very high levels of phytoplankton growth to occur. Data analysed indicated that the effluent

from the Oxidation Ponds entered the Avon Heathcote Estuary immediately after high tide mixes rapidly with seawater. Effluent plumes may remain discernible under certain weather conditions, and have a green colouration. These plumes clearly contain a high concentration of suspended phytoplankton relative to beyond the plume. Dilution of effluent water within the plume was rapid. However, water does not remain long enough in the estuary to allow an algal bloom to establish and effluent re-entering the estuary on the incoming tide is highly diluted and carries increased sediment therefore further reducing the likelihood of blooms.

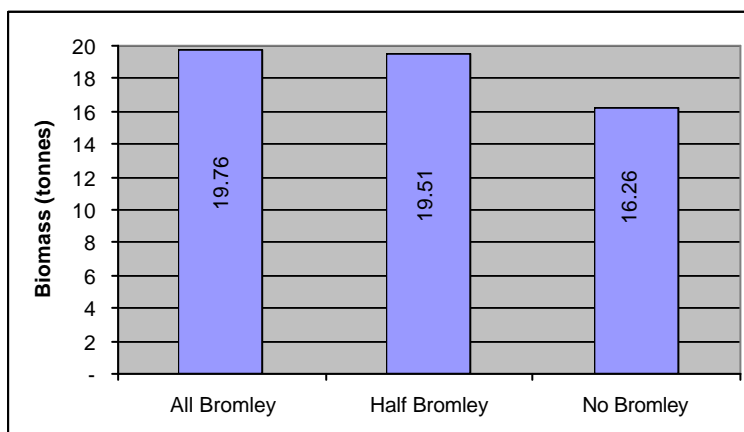
Under the proposed estuary discharge option the plume will remain similar in colour to that existing.

**Sea Lettuce**

A major issue of concern to the residents surrounding and users of the estuary is the growth of sea lettuce. There has been a perception that the high levels of nutrient entering the estuary from the CWTP, is at least partly responsible for the some times high biomass of the aquatic plant. The Ocean Modelling work undertaken for this study, (Unisearch, 2000) analysed tidal, wind and outfall locations (both estuarian and open ocean), to determine the likely nutrient status of the waters. This data was then used in combination with the Sea Lettuce modelling by NIWA to determine the potential impacts of the changes in nutrient levels to the biomass of sea lettuce in the estuary.

Diagrams showing the biomass (g/m<sup>2</sup>) of sea lettuce under various nutrient level reductions from the CWTP are contained. Figure 6-1 shows that sea lettuce biomass can not be significantly reduced by reducing nutrient entering the estuary from the CTWP. A reduction of half of the nutrients from the CWTP shows almost no reduction in the biomass, total removal of the outfall from the estuary reduces the biomass by only 20%.

The modelling does not take into account potential reductions in biomass of sea lettuce should there also be a reduction in the nutrients entering the estuary from the Avon and Heathcote Rivers.



**Figure 6-1:** Reduced Biomass of Sea Lettuce

Under the proposed estuary discharge option the nutrient levels entering the estuary will be reduced by approximately 50%, and therefore there is unlikely to be a significant reduction in the sea lettuce biomass.

**Marine Algae**

The results of the studies undertaken by NIWA, indicate that phytoplankton would have to remain in contact with fairly high concentrations of effluent (about 0.5%) for about four days to show an increase of  $3\mu\text{g chl-}a/\text{L}^{-1}$ . This could occur if water is repeatedly reinfused with effluent during calm winds and tidal conditions, which bring the same parcel of water near the outfall repeatedly. However, this increase would still not be considered an increase of 'bloom' proportions, nor likely to cause a 'eutrophic' condition.

A more quantitative assessment of the potential for phytoplankton growth could be made by using the results of this study in combination with a model of nutrient, phytoplankton growth, and hydrodynamics. Run under different scenarios of winds and tides, the model would allow prediction of the likely increase in chl-*a* associated with an outfall.

**Animals****Invertebrates**

- Estuary Discharge

The proposed discharge and associated treatment option are unlikely to result in any directly discernible effects on benthic invertebrates. Although improved treatment will result in a removal of 50% of the nitrogen it will not result in removal of other nutrients from the estuary, and therefore the food source of invertebrates is unlikely to change significantly.

- Ocean Discharge

With the removal of the discharge from the estuary there will a reduction in the nutrients feeding the invertebrates of the estuary. As there are large quantities of existing nutrients in the estuary it is likely that any changes to invertebrate population are unlikely to happen rapidly. Changes may lead to a more "natural" invertebrate composition for such an ecosystem.

**Fish**

Data and anecdotal evidence indicate that fish numbers and their diversity have decreased over the years as pollution has increased. Other effects likely to have helped contribute to reduced fish numbers include loss of riparian habitat, loss of wetlands both in the surrounding area and beyond, and over-fishing beyond the estuary itself.

**Low salinity**

While low salinities occur naturally within estuaries, these could be exacerbated by increased releases of low salinity water. Certain fish species susceptible to changes in salinity and elevated levels of dissolved compounds, for example sand flounder in the Avon Heathcote Estuary, were found by Kilner (1973) suffered mortalities at low salinity.

**Dissolved Compounds**

Elevated levels of estrogenic chemicals contained in effluent from sewage treatment plants in Britain have included feminised responses in male fish, thus interfering with breeding. (NIWA 1999). The possible effects of any discharges of similar compounds into the Avon Heathcote Estuary are unknown.

Fish can also incorporate into their tissues pollutants, such as heavy metals and organochlorides. There appear to have been no surveys of the levels of pollutants in fish species in the Avon-Heathcote Estuary.

Ammonia is a substance known to be toxic to fish. It is likely that the proposed discharge will reduce the amount of ammonia in the water thereby improving the quality of habitat for fish.

**Loss of Wetland and Riparian Habitat**

Many of the fish species which use the estuary will also use rivers and wetlands for parts of their life cycle. Therefore loss of, or reduction of the quality of these habitats would have had significant effects on parts of the fish population. A part of the proposed treatment option, enhancement of the ponds and further restoration of saltmarsh and other wetlands around the margin of the estuary, in conjunction with the continued improve of the inland waterways of the city, are likely to have a significant positive environmental impacts of the fish population.

Continuing a discharge to the estuary will possibly lead to an increase in the quality of fish populations from the present due to reduction of the level of ammonia in the water. However other wise there is unlikely to be any significant change.

An ocean discharge is likely in the long term to lead to a more "natural" estuarine environment, thereby improving the habitat for fish within the estuary. There are no known adverse environmental effects for fish from the discharge into the ocean,. The one area of concern it for the elephant fish breeding site in Pegasus Bay and whether increased sedimentation may affect this.

**Birds**

Because most birds spend times at places other than the Estuary and Ponds, their numbers are influenced by factors particular to these areas. For example, the numbers of South Island Pied Oystercatchers have increased markedly throughout New Zealand since the 1940s and this is attributed to a prohibition of shooting and the use made of farmland for breeding. (Sagar *et al.* 1999).

Productivity and type of food available are the primary factors affecting the numbers of birds in the Estuary and Ponds, In turn productivity of food species is influenced by the availability of favourable habitat and nutrients. For the estuary this involves small aquatic animals such as zooplankton, crustaceans, molluscs and insects; small fish, shrimp cockles and mussels and polychaetes.

The increasing bird numbers on the estuary increased rapidly during the 1940s and 50s are indicative of changes in the abundance and distribution of food species (Crossland 1993). Number in creased during

the 1960s and 1970s but at a reduced rate, except a large increase in gulls ( opening of Bexley Tip) and waterfowl numbers from 1962 when the ponds were commissioned.

A further increase in the numbers of wetland birds occurred during the 1980s (Crossland 1993). This has been attributed to improvements in the wastewater quality and regime, and to changes in the substrate composition of the estuary.

Changes in distribution of the dominant species of invertebrates have been influenced primarily by changes in sedimentation patterns, primary production, input of organic matter ,and increases in effluent discharge from the ponds (Knox 1992). Changes in the abundance of invertebrates in the vicinity of the Pond outfall lead to the conclusion that the discharge of effluent from the ponds has a beneficial effect on the invertebrate community (Knox 1992). Nutrients from the effluent enabled the primary productivity of the estuary, especially that of the micro-algae, to increase, and so support a greater number of invertebrates. In turn the primary production and numbers of invertebrates are assumed to have supported increased numbers of birds (Knox 1992)The proposed change in the discharge to the estuary are likely to have no significant effects on the birdlife values of the estuary and ponds. Bird numbers are most likely to be effected by changes that affect the abundance and distribution of their main food species and the main actors affecting these are sediment composition and nutrient concentration.

### 6.5.3 Health Effects

#### ***Existing Shellfish Contamination***

Cockles are filter feeding bivalves and as such may be expected to accumulate and passively concentrate viruses from the water during feeding. Filter feeding shellfish are used as biomonitors of contamination because they concentrate and retain pollutants that occur sporadically or in very low concentration in water. These attributes also mean that shellfish present a specific health risk to people who harvest and eat them.

Zenith Technologies Corporation of Dunedin undertook a survey of pathogens in cockles in the estuary at 13 sites on 5 occasions in 1991 and 1992 for the Canterbury Regional Council.

Salmonella and Shigella were not detected in any sample. Total and faecal coliform data for cockles suggest that those sites closest to the CWTP discharge and from near the mouth of the Heathcote river are the most adversely affected.

The results show that enterovirus was detected in 3 sites and always occurred in the presence of coliphage. Enterovirus was only detected where indicator bacteria (total and faecal coliforms) occurred in very high numbers (> 6000 mpn/100g). This indicates that pathogen contamination present in the CWTP wastewater may lead to contamination of estuary shellfish.

**Human Virus and Indicator Analysis**

Limited sampling of the CWTP wastewater for human and indicator viruses occurred in late summer (February 7 and 29) 2000. The results are shown in Table 6.12.

**Table 6.12 Virus occurrence in Oxidation ponds at CWTP: Christchurch, February 2000**

Date	Sample	Culturable enterovirus (PFU <sup>1</sup> /L)	F-Specific Bacteriophage (PFU/L)
7.2.00	Pond influent	72	280000
7.2.00	Pond 5 & 6	<3	550
	Reduction	> 96%	99%
29.2.00	Pond influent	186	630000
29.2.00	Pond 5 & 6	<3	2600
	Reduction	>98%	99%

<sup>1</sup> PFU plaque forming units

This very limited data set suggests that 99% reduction might be expected for human viruses in the pond system at the CWTP. A range of viruses, other than human enteroviruses, is likely to occur in sewage wastes but cannot be easily detected or quantified. The potential occurrence of these viruses is discussed below.

**Human Pathogenic Protozoans**

*Giardia* and *Cryptosporidium* occurrence was relatively low (Table 6.13)

**Table 6.13 Protozoal pathogen occurrence in Oxidation ponds at CWTP: February 2000**

Date	Sample	Giardia (Viable cysts)	Cryptosporidium (Viable oocysts)
7.2.00	Pond influent	2.5/2L	1/2L
7.2.00	Pond 5 & 6	Not detected/2L	Not detected/2L
29.2.00	Pond influent	64/100L	212/100L
29.2.00	Pond 5 & 6	0/100L	33/100L

***Estimated Human Virus Level in CWTP Wastewater***

The occurrence of viruses in the community is somewhat variable and a predicted range of virus occurrence derived from reports in the international literature is shown in Table 6.14. Analysis of CWTP effluent suggests that virus occurrence is generally towards the low end of the described range. The mean range of human viruses in CWTP effluent is very unlikely to exceed 1410 units/L when all virus types are considered.

Further reduction of virus content of the effluent by addition of effluent disinfection step, such as UV irradiation would further reduce virus occurrence. A conservative level of 90% reduction has been used as a base for prediction of virus occurrence given this added disinfection process. The calculated virus level with UV treatment is also included in Table 6.14.

In this table the designations “low” and “high” represent the upper and lower ranges of estimated virus occurrence derived from the literature.

**Table 6.14 Potential occurrence of human viruses in raw sewage wastes (units/L).**

Virus type	Estimated Mean Occurrence (international)		Likely mean range for CWTP <sup>6</sup>			
	Primary Effluent		Primary effluent		Final effluent (90%)	
	Range (units/L)		Range (units/L)			
	Low	High	low	High	low	high
Enterovirus <sup>1,4</sup>	100	100,000	100	10000	10	1000
Adenovirus <sup>2</sup>	10	10,000	10	1000	1	100
Reovirus <sup>2,4</sup>	10	10,000	10	1000	1	100
Calicivirus <sup>3</sup>	10	10,000	10	1000	1	100
Astrovirus <sup>3</sup>	10	10,000	10	1000	1	100
Hepatitis A <sup>1</sup>	10	1,000	10	100	1	10
<b>Total Virus</b>	<b>150</b>	<b>141,000</b>	<b>150</b>	<b>14,100</b>	<b>15</b>	<b>1410</b>
HCGI associated virus <sup>5</sup>	30	30,000			3	300
<b>Total after UV treatment</b>					<b>1</b>	<b>140</b>

Notes:

- 1 Field Virology 3<sup>rd</sup> edition: 1996 Raven Press
- 2 Irving *et al* 1981 App Environ Micro 41: 51- 59
- 3 Estimate based on non-quantitative detection in effluents
- 4 Not usually associated with gastroenteritis. Rotavirus is not considered to be an important waterborne pathogen although it may occur in effluents.
- 5 HCGI =highly credible gastroenteritis. Adenovirus, calicivirus and astrovirus appear to be those most frequently associated with gastroenteritis.
- 6 Human enterovirus were in the range of 72 – 186 pfu/L in pond inflow and could not be detected in 1 L samples in CWTP pond effluent in the 2 summer samples tested.

**Hydrological Modelling of the Effluent Discharge**

Hydrological modelling of the discharge for each proposed option has been carried out and described the dilution rate for effluent at various locations on the coast and the likelihood that such dilution will

occur. Median, 90<sup>th</sup>ile and maximum pathogen levels based on a notional 10,000 No./100ml are provided in tables 6.15 and 6.16. These dilution models may be used to predict the virus occurrence at the coastal locations.

**Table 6.15 Statistics of Modelled Conservative Pollutant Concentrations – Estuary Option (Discharge concentration 10,000)**

	Median	90 <sup>th</sup> ile	Max
<b>Coastal Sites</b>			
North Brighton Beach	0	0	81.3
Brighton Pier	0	0	70.4
South Brighton Beach	0	7.4	111
South Brighton (500 m north of estuary entrance)	0	11.1	189
Scarborough Beach (south end)	7.4	92.6	585
Taylors Mistake	0	37.0	488
<b>Estuary Sites</b>			
Pleasant Point Jetty (PPJ)	11.1	455	1126
Opposite Oxidation Pond Outfalls (TPO)	245	1000	1779
Opposite Heron Street (HST)	148	556	1447
Opposite Bone Tip (BON)	610	1156	1905
Humphreys Drive (HDR)	463	1319	2415
Beachville Road Jetty (BRD)	200	794	2058
Moncks Bay (MBY)	100	599	1845
Shag Rock	74.1	641	1244

**Table 6.16 Statistics of Modelled Conservative Pollutant Concentrations – 2 km Ocean Outfall Option (Discharge concentration 10,000)**

	Median	90 <sup>th</sup> %ile	Max
<b>Coastal Sites</b>			
North Brighton Beach	0	1.7	20.6
Brighton Pier	0	2.8	31.2
South Brighton Beach	0	1.7	39.4
South Brighton (500 m north of estuary entrance)	0	0	28.3
Scarborough Beach (south end)	0	1.7	38.9
Taylor's Mistake	0	3.3	26.1
<b>Estuary Sites</b>			
Pleasant Point Jetty (PPJ)	0	0	5.0
Opposite Oxidation Pond Outfalls (TPO)	0	0	13.3
Opposite Heron Street (HST)	0	0	25.0
Opposite Bone Tip (BON)	0	0	23.3
Humphreys Drive (HDR)	0	0	13.3
Beachville Road Jetty (BRD)	0	0	32.3
Moncks Bay (MBY)	0	1.7	38.3
Shag Rock	0	1.1	29.4

Human contact with diluted effluent from the CWTP may occur during recreational activity or shellfish gathering. Humans may be exposed to microbial contamination derived from the CWTP outfall by ingestion and inhalation of water during recreational activities, and through consumption of shellfish grown in impacted waters. Contact between humans and diluted wastewater will present some level of health risk.

***Recreational Water Use***

The 1999 New Zealand recreational water quality guidelines for marine waters are designed to allow no more than 19 cases of swimming related illness<sup>1</sup> per 1000 swimmers. This risk level was initially devised in American recreational water studies and identified “highly credible gastroenteritis” as the key illness. The risk level has been adopted in New Zealand as a basis for risk evaluation since 1992 but key illness types have been changed to include “any water related illness” (e.g. also encompasses respiratory, skin, ear and eye any other infections). Saline recreational water epidemiological water studies carried out in New Zealand in 1994/95<sup>2</sup> (which included Spencerville Beach in Canterbury) found relationships between indicator bacteria levels and illness risk to coincide relatively well with these risk levels. The waters surrounding the proposed outfall locations are used for a variety of recreational activities, with each of these activities posing a different level of risk to the health of the human user. Table 6.17 summaries the water-based activities that take place in the area.

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<sup>1</sup> Highly credible gastroenteritis is defined as one of the following - vomiting, loose bowel with fever, loose bowel with disability (1 or more days away because of illness or days unable to do normal activities, or sought medical advice, or hospitalised), Nausea with fever, or indigestion with fever.

<sup>2</sup> McBride et al 1998. International J Environmental Health Research. 8, 173-189

**Table 6.17 Recreational activities undertaken within and around the Avon-Heathcote Estuary and beach at varying tidal stages**

Activity	Location and tidal stage		
	New Brighton Beach to Estuary mouth	Avon-Heathcote Estuary	Moncks Bay/Sumner
Little or no water contact:			
Walking/Running	All tidal stages	All tidal stages	All tidal stages
Picnicing	-	Mid-tide	Mid-tide
Fishing	High and mid tides	Mid and low tides	Low and high tides
Sunbathing	-	Mid-tide	Mid and low tides
Volleyball	-	-	High tide
Observation	All tidal stages	All tidal stages	High and low tides
Some water contact:			
Rowing	-	Low tide	-
Power boating	High tide	-	High tide
Yachting	Low tide	High tide	-
Kayaking	Low tide	-	High tide
School groups	Mid-tide	Low tide	-
Full water contact:			
Swimming/surfing	All tidal stages	High tide	All tidal stages
Life saving	High and mid tides	-	-
Shellfish gathering	-	Low and mid tides	Low tide
Windsurfing	Low tide	High tide	-

**Source: Draft Social Impact Report Taylor Baines 1999**

**Quantification of Exposure to Water during Recreational Activities**

It is difficult to estimate the amount of seawater that may be swallowed or inhaled during water activity, however the following best estimate, derived through discussion with recreational water experts at the USEPA, surf life saving organisations and swimming coaches, is:

- Active swimming and surfing: 10.5 ml per 30 minutes
- Paddling (no head immersion): 0.5 ml per session
- Sailing: 10.5 ml per session
- Windsurfing: 20.5 ml per session
- Snorkelling: 20.5 ml per session
- Kayaking: 0.5 ml per session

Note: Inhalation of water droplets will occur in all these activities and 0.5 ml is included in the estimate to account for this factor.

Those who swim for extended periods within the zone of impact (which will vary depending on the outfall location option selected) may increase the likelihood of water ingestion and as such increase their potential exposure to potential infectious agents. New Zealand<sup>3</sup> studies suggest that increasing water contact time does result in an increase in swimming associated illness.

**Community Baseline Illness Level**

The New Zealand saline recreational water epidemiological study also quantified the level of illness in those people who went to the beach but were not exposed to the water. The illness data for beach goers not exposed to water is shown in Table 6.18. This data may be used as a base for comparison of illness risk although to remain conservative, this rate has been halved for the assessment. To recognise a demonstrable illness risk associated with exposure to diluted wastewater in water then that risk must exceed that normally found in the community.

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<sup>3</sup> McBride et al 1998. International J Environmental Health Research. 8, 173-189

**Table 6.18 Baseline illness rates among beach-goers who were not exposed to water (New Zealand National Saline Waters Epidemiological Study: McBride et al 1998<sup>4</sup>)**

Illness type	Attack rate per 1000 people
Any Gastro-enteritis	35
Respiratory	23
Total	58

**Estimation of Health Risk Associated with Virus Contamination**

The potential for exposure to viruses derived from the CWTP wastewater at each proposed discharge location, the modelled coastal locations and for each activity, which may occur there, was calculated as described below. Potential virus exposure calculations were used to estimate the risk of infection at selected locations and for each identified activity. The infection risk was then compared with the baseline community infection level (0.029) and those locations and occasions on which risk of infection would exceed the community baseline level were identified. The risk level was then simplified based on the likelihood of occurrence as derived from the contaminant dispersion modelling and is expressed in terms of likely risk of illness exceeding the community base line level 50% or more of the time, 10% of the time, or at maximum contamination levels.

The final excess risk predictions associated with water use are shown in Tables 6.19 and 6.20.

Table 6.19 shows the Best, Likely and Worst case scenarios for virus occurrence in the CWTP effluent based on current effluent quality. The addition of UV treatment of the effluent might be expected to further reduce virus levels by 10 fold. This situation is shown in Table 6.12.

These Tables show that with current effluent quality:

**The estuary discharge** is most likely to increase illness risk to estuary water users. The Humphries Drive area is likely to present occasional excess risk illness (e.g. 10% of the time for windsurfing) even under the “best case” scenario. This discharge will also affect Brighton and South Beach activities – particularly swimming and windsurfing - in the “worst case”, and on some occasions South Beach in the “likely” case.

**The 2 km outfall** options will occasionally impact the consumption of shellfish in all areas but will not affect recreational activities in the estuary and only impact Brighton and Southern beaches in the “worst case”.

With further treatment of the effluent by UV the excess health risk is somewhat reduced.

<sup>4</sup> McBride et al 1998. International J Environmental Health Research. 8, 173-189

**The Estuary outfall** will still occasionally impact shellfish at all locations for the likely and worst case scenarios but effects will be greatest for consumption of shellfish from the estuary. Even the lowest virus discharge rate modelled may give rise to occasional risk to shellfish consumers. Some minor impact on windsurfers may also occur with maximum effluent dispersion and virus content in the effluent at Humphries Drive and Moncks Bay.

**2 km outfall** carrying UV disinfected wastewater still shows potential for some impact on shellfish for consumption but will not cause excess illness risk in other water users. It should be noted that while there may be some impact on shellfish for consumption, the shellfish water quality standards will be met.

**Table 6.19 Predictions of the extent of risk exceedance over community baseline levels associated with exposure to water in the vicinity of the proposed Christchurch City Wastewater Treatment plant outfalls. Current Effluent Quality.**

Potential that risk of infection associated with discharge from the Christchurch City Wastewater Treatment Plant outfall will exceed that of background community level

**Current Effluent Quality**

<b>Key</b>	4 = Risk of water related viral illness will exceed background level in the community 50% or more of the time
	2 = Risk of water related viral illness will exceed background level in the community 10% of the time
	1 = Risk of water related viral illness will exceed background level in the community only at time of maximum contamination.
	0 = Risk of water related viral illness will not exceed background level in the community.

Note: Background illness rates for illness of the type that may be contracted from water are derived from McBride et al (1998) and conservatively estimated at 2.9 per 100 people per period equivalent to water exposure.

**Worst Case**

High virus level in effluent 1410 per Litre of effluent

Activity	Outfall	Brighton Beach				South beaches			Estuary			
		NBB	BP	SBB	SBE	SR	SB	TM	HD	BS	PP	MB
Rowing	E estuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Power Boating	E estuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Yachting	E estuary	1	1	1	1	4	2	2	4	1	2	4
	2Km	1	1	1	1	1	1	1	0	0	0	1
	3km	0	0	0	0	0	1	1	0	0	0	0
Kayaking	E estuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
School Groups	E estuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Swimming and surfing	E estuary	1	1	1	1	4	2	2	4	1	2	4
	2Km	1	1	1	1	1	1	1	0	0	0	1
	3km	0	0	0	0	0	1	1	0	0	0	0
Life Saving	E estuary	1	1	1	1	4	2	2	4	1	2	4
	2Km	1	1	1	1	1	1	1	0	0	0	1
	3km	0	0	0	0	0	1	1	0	0	0	0
Windsurfing	E estuary	1	1	1	2	4	2	2	4	2	4	4
	2Km	1	1	1	1	1	1	1	1	0	0	1
	3km	1	1	1	1	0	1	1	0	0	0	0
Shellfish gathering	E estuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Shellfish consumption	E estuary	1	1	2	2	4	4	2	4	2	4	4
	2Km	2	2	2	1	2	2	2	1	0	1	2
	3km	1	1	1	1	1	1	2	1	0	1	1

**Likely Case**

Likely level virus 100 per Litre of effluent

Estuary outfall:

No excess risk at any site for Rowing, powerboating, Kayaking, school Groups, shellfish gathering

Yachting :	0	0	0	0	2	1	1	4	0	2	2
Swimming/surfing	0	0	0	0	2	1	1	4	0	2	2
Lifesaving	0	0	0	0	2	1	1	4	0	2	2
wind surfing	0	0	0	1	2	1	1	4	0	2	2
Shellfish consumption	1	1	2	2	4	4	2	4	2	4	4

2 km Outfall: No excess risk except to shellfish consumption

Shellfish consumption	2	2	2	1	2	2	2	1	0	1	2
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3 km Outfall: No excess risk except to shellfish consumption

Shellfish consumption	1	1	1	1	1	1	2	1	0	1	1
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**Best Case**

Low virus level 15 virus per Litre of effluent

Estuary outfall

No excess risk except

Yachting	0	0	0	0	0	0	0	1	0	0	1
Swimming/surfing	0	0	0	0	0	0	0	1	0	0	1
Lifesaving	0	0	0	0	0	0	0	1	0	0	1
Windsurfing	0	0	0	0	1	0	0	2	0	1	1
Shellfish consumption	1	1	2	2	4	4	2	4	2	4	4

**Key to locations**

NBB	New Brighton	SR	Shag Rock	HD	Humphries Drive
BP	Brighton Peir	SB	Scarborough Beach	BS	Bridge Street
SBB	South Brighton	TM	Taylor's Mistake	PP	Pleasant point
SBE	Estuary end SB			MB	Moncks Bay

**Table 6.20 Predictions of the extent of risk exceedance over community baseline levels associated with exposure to water in the vicinity of the proposed Christchurch Wastewater Treatment Plant outfalls. UV treated effluent**

Potential that risk of infection associated with discharge from the Christchurch City Wastewater Treatment Plant outfall will exceed that of background community level

**UV treated Effluent**

**Key**

4 = Risk of water related viral illness will exceed background level in the community 50% or more of the time
2 = Risk of water related viral illness will exceed background level in the community 10% of the time
1 = Risk of water related viral illness will exceed background level in the community only at time of maximum contamination.
0 = Risk of water related viral illness will not exceed background level in the community.

Note: Background illness rates for illness of the type that may be contracted from water are derived from McBride et al (1998) and conservatively estimated at 2.9 per 100 people per period equivalent to water exposure.

**Worst Case**

High virus level in effluent 140 per Litre of effluent

Activity	Outfall	Brighton Beach			South beaches			Estuary				
		NBB	BP	SBB	SBE	SR	SB	TM	HD	BS	PP	MB
Rowing	E stuary	0	0	0	0	0	0	0	0	0	0	0
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Power Boating	E stuary	0	0	0	0	0	0	0	0	0	0	0
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Yachting	E stuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Kayaking	E stuary	0	0	0	0	0	0	0	0	0	0	0
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
School Groups	E stuary	0	0	0	0	0	0	0	0	0	0	0
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Swimming and surfing	E stuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Life Saving	E stuary	0	0	0	0	2	1	1	4	0	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Windsurfing	E stuary	0	0	1	1	2	1	1	4	1	2	2
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Shellfish gathering	E stuary	0	0	0	0	0	0	0	0	0	0	0
	2Km	0	0	0	0	0	0	0	0	0	0	0
	3km	0	0	0	0	0	0	0	0	0	0	0
Shellfish consumption	E stuary	1	1	2	2	4	4	2	4	2	4	4
	2Km	2	2	2	1	2	2	2	1	0	1	2
	3km	1	1	1	1	1	1	2	1	0	1	1

**Likely Case**

Likely level virus 10 per Litre of effluent

**Estuary outfall:**

No excess risk at any site for

Rowing, Powerboating, Yachting, Swimming/Surfing, Lifesaving, Kayaking, School Groups, shellfish gathering

wind surfing	0	0	0	0	0	0	0	1	0	0	1
Shellfish consumption	1	1	2	2	4	4	2	4	2	4	4

**2 km Outfall:** No excess risk except to shellfish consumption

Shellfish consumption	1	1	1	1	1	1	1	1	0	1	1
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**3 km Outfall:** No excess risk except to shellfish consumption

Shellfish consumption	1	1	1	1	1	1	1	1	0	0	1
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**Best Case**

Low virus level 1 virus per Litre of effluent

<b>Estuary outfall</b>	No excess risk except Shellfish consumption										
Shellfish consumption	1	1	1	1	4	2	1	4	1	2	4

**2 km Outfall:** No excess risk at any site

**3Km outfall** No excess risk for any activity at any site

**Key to locations**

NBB	New Brighton	SR	Shag Rock	HD	Humphries Drive
BP	Brighton Peir	SB	Scarborough Beach	BS	Bridge Street
SBB	South Brighton	TM	Taylor's Mistake	PP	Pleasant point
SBE	Estuary end SB			MB	Moncks Bay

***Contribution of Stormwater to Health Risk***

Recent studies in various urban locations shows that sewer overflows and stormwater are significant contributors of contaminating micro-organisms to coastal water bodies and estuaries. Urban stormwater has been shown to contain bacterial indicators at levels 10 to 100 times higher than treated sewage effluents. Pathogenic bacteria and viruses have also been detected in stormwater on occasions<sup>5</sup>. These observations show that sources of bacteria and pathogens from other water sources may have significant localised effects on water quality unrelated to the CWTP discharge

***Contribution of Bird Faecal Contamination to Health Risk***

The Christchurch oxidation ponds and the Avon Heathcote estuary sustain a large and diverse population of birds. Of these Black Swan, Canada Goose, Mallard, Grey Duck, Paradise Shelduck, Grey Teal and internationally important populations of New Zealand Shoveler and New Zealand Scaup, frequent and nest around the oxidation ponds. The population of ducks, geese and swans on the estuary and oxidation ponds was estimated in a 1993 report to number approximately 15,000<sup>6</sup>.

***Implications of Bird Occurrence for Water Quality Management***

Bird populations present in the oxidation ponds and Avon-Heathcote Estuary are likely to contribute to bacterial loading in these two water environments. While the true significance of this input for human health risk is unknown we can use the research data presented above to estimate the potential contribution of faecal coliform bacteria by ducks geese and swans to the Average Dry Weather Flow of effluent from the plant. Assuming that half of the birds in the area frequent the ponds and that half of their faecal material reaches the water then this would contribute between 1 and 90 faecal coliforms per 100ml of the current effluent discharge depending on the bird species mix.

Bacterial and protozoal pathogens that may affect both birds and humans will only be present in part of the bird population and will be introduced to the ponds and estuary with bird wastes. The contribution of these bird derived pathogens to human illness will fluctuate in relation to the bird population, species mix present at any time, the proportion carrying pathogens and the favoured roosting and feeding locations.

Animal wastes (including birds) are known to be associated with human illness when transmitted through water. The New Zealand saline recreational waters study<sup>7</sup> showed clearly that beaches impacted by rural and agricultural wastes resulted in elevated illness in water users. This illness rate (though not necessarily illness type) was equivalent to that observed at beaches affected by human waste discharges.

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<sup>5</sup> McEwing J NSCC pers comm.

<sup>6</sup> Crossland A: Birdlife of the Avon Heathcote estuary and rivers and their Margins. Report to CRC DoC Canterbury Conservancy Technical Report Series No 6 1993.

<sup>7</sup> McBride et al 1998. International J Environmental Health Research. 8, 173-189

The findings of the McBride study taken into consideration with the presence of birds and the likely pathogens they carry suggests strongly that some increased risk of waterborne infection could be expected as a result of the presence of birds in the estuary.

The true magnitude of the risk of illness to water users posed by birds carrying organisms that may infect humans is, for the reasons described above – and in the absence of local data unable to be quantified. In terms of the oxidation pond bird waste is part of the current discharge and included in the consideration of risk of that waste.

It is difficult to control bird numbers in these environments, particularly the estuary. Removal or discouragement of these birds is undesirable due to the diverse and internationally important populations of many species inhabiting the Avon-Heathcote Estuary and oxidation ponds. The pathogens carried by birds all appear to be amenable to treatment within the pond effluent by a form of non-residual disinfection such as UV irradiation. Such treatment would allow quantifiable control of bacterial and protozoal pathogens derived from bird wastes and collected in that part of the treatment system.

#### **6.5.4 Amenity and Social**

##### ***People and Communities***

###### **Cultural**

The improved quality of the water will to a limited extent improve the cultural values of the area. However, significant cultural values related to the actual disposal of sewage effluent into water will not be addressed by the proposed activity. During consultation with tangata whenua, the discharge to land was fully discussed and it was accepted by tangata whenua that a discharge to land would potentially put at risk the water quality of the drinking water sources and ultimately Te Waihora. Tangata whenua have therefore supported the continuing discharge to surface water as a pragmatic acceptance of a difficult situation.

###### **Heritage**

There are no additional adverse effects on the heritage values of the discharge or associated treatment processes. Enhancement and restoration of the natural values surround the margin of the estuary are likely to promote the heritage values of both Ngai Tahu and European.

###### **Land Use**

The present zoning of the estuary surrounds specifically allows for the type of activities presently undertaken at the CWTP, the proposed activities are not significantly different in their function and effects to require rezoning or to significantly alter the land use.

***Built Environment***

There are likely to be no significant adverse environmental effects on the built environment in relation to proposed discharge and associated treatment facilities. The upgrades to the treatment plant and ponds will have a positive effect on the built environment.

***Recreation***

At present many of the recreational activities undertaken within the estuary are incompatible with the quality of water entering the estuary from the CWTP. One of the major purposes of the new discharge is to improve the water quality for recreation in the estuary. In relation to recreation, the meeting of a contact recreation water quality in the estuary will be a significant positive effect.

***Landscape***

The landscape values of the estuary will be significantly enhanced, particularly by the changes to the edge of the estuary margin and redevelopment of the oxidation ponds.

***Amenity***

A number of factors related to the proposed discharge option impact on the amenity of the estuary and the surrounding environs. These involve either the nature of the discharge, or the infrastructure relating to the discharge.

With the present discharge, a visible plume does occur under particular weather conditions. This plume is slightly green in coloration due to the phytoplankton concentration. This wastewater colour will not be significantly reduced under the proposed discharge option, however with the shoreline diffuser proposed there will be an improvement in the impact of the discharge in the immediate area of the outfall.

One of the main visual features of the discharge into the estuary from the present structures is the foaming that can occur as a result of the turbulence as the wastewater discharges from the pipes. This will be significantly reduced with the shore line diffuser.

The physical structures related to the discharge and associated treatment process will largely significantly improve the amenity values of the area. Proposed alteration to the ponds will reduce the hard edges, birdlife will increase and extensive planting will be undertaken. These factors will all significantly improve the amenity values of the area. In addition plans to create walkways around the enhanced ponds will allow more people to experience the values of the estuary and it's surrounding natural environment. The actual discharge structure will be constructed in such a way as to blend into the surrounding environment, thereby enhancing the coherency and aesthetics of the area. There will be a requirement to build some structure such as for the UV treatment facility. This however will also be constructed in such a way as to blend in with the surrounding environment.

***Odour***

Odour levels associated with the existing discharge are minimal. With a reduced turbulence associated with a shoreline diffuser, the potential to release odour at this point will be reduced.

***Noise***

Noise levels are unlikely to be altered due to the proposed disposal. There may however, be temporary changes to the noise levels during the construction phase of structure and facilities. The noise generated from the UV disinfection unit will not be significant.

***Economics***

The upgrade to the CWTP will potentially have a positive economic effect. With the improved water quality of the estuary, in particular in relation to contact recreation standards, an increase in activity on the estuary could arise. This may have benefit to those clubs and businesses that derive financial returns from members or clients who use the estuary.

In the broader context, Christchurch City will be seen to be taking a positive step in terms of improving the environment. This will aid in the Clean Green image of New Zealand.

The estuary is a wildlife area of national significance. Opportunities will exist to promote ecotourism tours within the upgraded pond system. In the full Estuary Green Edge concept, increased public access will be provided for this purpose.

***People***

People will benefit from the improvement in water quality and the enhancement of the ecology of the estuary edge. The area and the discharge will be more aesthetically pleasing. Public health will be improved through the provision of UV disinfection.

An outcome that this application will not achieve is to make the shellfish within the estuary safe to eat. This cannot be achieved even if all of the wastewater discharge was removed from the estuary.

Public health will be protected by the improvement in water quality, in particular due to the use of UV disinfection.

**6.6 Requirement to Avoid/Remedy/Mitigate**

Part II of the Resource Management Act places an onus on all people to avoid, remedy or mitigate any adverse effect of their activities on the environment.

Avoidance is the prime aspect of these applications, as the upgrades to the CWTP will remove some of the pollutant load from the treatment plant discharge, thereby avoiding adverse effects. Nevertheless it

must be acknowledged that there are contaminants discharged into the environment and these effects will require mitigation.

Mitigation will depend upon the scale of the effects and the risks associated with each aspect. Mitigation measures will be included in the City's Wastewater Management Plan that will form part of this overall project. This will include ongoing research into treatment systems that will improve water quality in the future as well as monitoring of the environment to ascertain the impacts from these activities.

In this preliminary AEE, a risk based assessment of the effects, from which mitigation measures will be derived, has not been undertaken. This will form part of the final application for resource consents following feedback from the general public and stakeholders.

Remedial actions will be required if a significant adverse environmental effect occurs. Contingency items to remedy adverse events will also form part of the Wastewater Management Plan.

This section provides an introductory summary of the statutory documents considered being of relevance to consenting of the Christchurch City Council Wastewater Treatment and Disposal Project. The following documents provide the statutory framework:

Resource Management Act 1991;  
New Zealand Coastal Policy Statement;  
Canterbury Regional Council Policy Statement;  
Proposed Canterbury Regional Coastal Environment Plan;  
Transitional Christchurch City Plan;  
Proposed Christchurch City Plan.

## 7.1 Resource Management Act

### Part II Matters

The purpose of the resource management Act 1991 (RMA) is defined in section 5 of the Act as the promotion of the sustainable management of natural and physical resources.

Specifically “sustainable management” is defined as:

*“managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while-*

- (a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonable foreseeable needs of future generations; and*
- (b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
- (c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

The RMA identifies particular matters that must be addressed in relation to the effects of the proposed treatment and disposal of Christchurch’s wastewater. In particular, consideration will need to be given to the following matters:

As matters of national importance under section 6 of the RMA:

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

- (b) *The protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:*
- (c) *The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
- (d) *The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers:*
- (e) *The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga.*

Other matters to which particular regard shall be given (Section 7)

- (a) *Kaitiakitanga:*
  - (aa) *The ethic of stewardship:*
  - (b) *The efficient use and development of natural resources:*
  - (c) *The maintenance and enhancement of amenity values:*
  - (d) *Intrinsic values of ecosystems:*
  - (e) *Recognition and protection of the heritage values of sites, buildings, places or areas:*
  - (f) *Maintenance and enhancement of the quality of the environment:*
  - (g) *Any finite characteristics of natural and physical resources.*

Under Section 8, the principles of the Treaty of Waitangi (Te Tiriti o Waitangi), shall be taken into account.

### **7.1.1 Other matters**

Part III of the Act (Duties and Restrictions Under This Act) in section 9 identifies the restrictions on the use of land, excluding land within the coastal marine area. Section 9 requires that all persons must use land in a manner that does not contravene any rules in district and regional plans, unless expressly permitted by a resource consent.

The following sections in Part III identify restrictions on

- Section 12 On the use of coastal marine area.
- Section 13 Restrictions on certain uses of beds of lakes or rivers
- Section 14 Restrictions related to water
- Section 15 Restrictions of contaminants into environment

Sections 104 and 105 of the RMA identify those matters to be considered by the consent authority. In relation to this project they include:

Section 104 (1) Matters to be considered

- (1) Subject to Part II, when considering an application for a resource consent and any submissions received, the consent authority shall have regard to-*
- (a) Any actual and potential effects on the environment of allowing the activity; and*
  - (b) Any relevant regulations; and*
  - (c) Any relevant policy statement, New Zealand coastal policy statement, regional policy statement, and proposed regional policy statement; and*
  - (d) Any relevant objectives, policies rules, or other provisions of a plan or proposed plan; and*
  - (e) Any relevant district plan or proposed district plan, where the application is made in accordance with a regional plan; and*
  - (f) Any relevant regional plan or proposed regional plan, where the application is made in accordance with a district plan; and*
  - (h) Any relevant designations or heritage orders or relevant requirements for designations or heritage orders; and*
  - (i) Any other matters the consent authority considers relevant and reasonably necessary to determine the application.*

Section 104 (3)

- (3) Where an application is for a discharge permit or coastal permit to do something that would contravene section 15(or15a)(relating to discharges of contaminants), the consent authority shall, in having regard to the actual and potential effects on the environment of allowing the activity, have regard to –*
- (a) The nature of the discharge and the sensitivity of the proposed receiving environment to adverse effects and the applicants reasons for making the proposed choice; and*
  - (b) Any possible alternative methods of discharge, including discharge into any other receiving environment.*

Section 104 (4)

- (4) Without limiting subsections (1) and (3), when considering an application for a coastal permit, a consent authority shall have regard to-*

- (a) *Any relevant policy stated in a New Zealand coastal policy statement in respect of the Crown's interests in land of the Crown in the coastal marine area; and*
- (b) *Any relevant provisions included in the appropriate regional coastal plan to implement that policy.*

## **7.2 New Zealand Coastal Policy Statement (1994)**

The purpose of a New Zealand policy statement is “*to state policies in order to achieve the purposes of the Act in relation to the coastal environment of New Zealand*” (Section 56)

It provides a framework for the sustainable management of the New Zealand coastal environment. The following chapters are of the most relevance to this project.

Chapter 1 – National priorities for the preservation of the natural character of the coastal environment including protection from inappropriate subdivision, use and development. In particular Policies 1.1.2 and 1.1.4

Chapter 2 – The protection of the characteristics of the coastal environment of special value to the tangata whenua including waahi tapu, tauranga waka, mahinga, maataitai, and taonga raranga.

Chapter 3 – Activities involving the subdivision, use or development of areas of the coastal environment

Chapter 5 – The matters to be included in any or all regional coastal plans in regard to the preservation of the natural character of the coastal environment, including the specific circumstances in which the minister of conservation will decide resource consents. In particular 5.1 Maintenance and Enhancement of Water Quality;

- Policy 5.1.2 Those rules should provide that a discharge of human sewage direct into water, without passing through land, may occur where:
  - (a) it better meets the purpose of the Act than disposal onto land;
  - (b) there has been consultation with the tangata whenua in accordance with tikanga Maori and due weight has been given to Sections 6,7 and 8 of the Act; and
  - (c) there has been consultation with the community generally.
- Policy 5.1.3 Those rules should also provide that, after reasonable mixing, no discharge (either by itself or in combination with other discharges) may give rise to any significant adverse effects on habitats, feeding grounds or ecosystems.

## **7.3 Proposed Canterbury Regional Coastal Environment Plan**

The Canterbury Regional Council (Environment Canterbury – ECAN) provides the most specific standards relating to water quality of the Coastal Marine Area (CMA) for New Brighton Beach and the Avon Heathcote Estuary.

Under the Variations to the Proposed Regional Coastal Environment Plan (October 1998), rules have been proposed relating to the discharge of water and contaminants into the CMA. The proposed rule affecting any possible discharge to the CMA from the CWTP is Rule 7.3 Restricted Coastal Activities which are Discretionary Activities. Specifically this identifies the discharge of human sewage into water in the CMA. This requires compliance with the standards and terms of Schedule 4 of the Proposed Plan. Schedule 4, Classes of Coastal Waters and Minimum Standards of Water Quality, identifies specific areas of the CMA waters requiring management to one of three sets of standards: AE (maintenance of aquatic ecosystems), CR (contact recreation and maintenance of aquatic ecosystems), and SG (shellfish gathering, contact recreation and maintenance of aquatic ecosystems).

These standards should be considered as minimum thresholds, as other higher performance standards may be more appropriate to protect the environment or meet community expectations.

Discharges into the Avon Heathcote Estuary from the CWTP or from any discharge near to the mouth of the estuary would require compliance with the Class CR standards. A discharge out from South Brighton would be outside any classified zones. However, to the north, at the mouth of the Waimakariri, and to the South, inside the mouth of the Avon Heathcote Estuary, the waters are classified as Class CR.

There are a number of proposed policies that would affect applications for resource consents to discharge to either the ocean or the Estuary.

- Policy 7.2: where no water quality classification has been set (i.e. off New Brighton), the discharge shall not unreasonably restrict existing lawful uses of the coastal water, and after reasonable mixing the discharge shall not have more than minor adverse effect on the existing water quality.
- Policy 7.5: the discharges of human sewage to coastal marine waters that do not pass through land or wetlands should only be granted where the discharge better meets the purpose of the Act, and there has been consultation with tangata whenua, and with the community.
- Policy 7.6: a reasonable mixing zone should be determined when setting conditions for any resource consent to discharge to the CMA.
- Policy 7.7: that discharges to the CMA avoid significant adverse effects on cultural or spiritual values associated with sites of special significance to the tangata whenua.

Policy 7.8: that after reasonable mixing a discharge to the CMA should not give rise to significant adverse effects on habitats or feeding grounds of indigenous fauna or any aquatic ecosystem, or have acute or chronic toxic effects on fish.

## **7.4 Canterbury Regional Council Regional Policy Statement, June 1998**

The Canterbury Regional Council Regional Policy Statement includes a number of chapters that are relevant to the consent process for this project. These includes

- Chapter 8 Landscape, ecology and heritage.

The issues this chapter seeks to address are include; adverse effects on the integrity, distinctive characteristics and contribution to a regional sense of identity of: wetlands, the coast, lakes and rivers, natural features and landscapes, indigenous flora and fauna, heritage values, and the relationship of Tangata whenua with these things. Objectives and Policies of special relevance to this project include

- Chapter 9 Water
- Chapter 11 The coastal environment

Issues addressed in this chapter of particular relevance to this project include:

the adverse effects; on the life support capacity of coastal environments; natural features and landscapes; natural character; amenity values; heritage values and Tangata whenua values.

adverse effects of discharges on ecosystems, amenity, recreation and cultural values.

- Chapter 13 Air

Issues addressed in the air chapter of relevance to this project include; adverse effects from localised discharges of contaminants to air.

- Chapter 17 Hazardous substances

Adverse effects on the environment from the storage, use, disposal, or transportation of hazardous substances, is an issue of relevance to this project.

- Chapter 18 Solid and hazardous waste management treatment.

## Regional Rules

At present there are no proposed plans containing rules for the management of the environment other than the coastal plan. Therefore the Transitional Regional Plan still takes effect. This Plan covers land use, discharges and permits required by the Regional Council.

## Conclusions

Regional consents will be required for both discharges, and also for any changes to the treatment activities. Coastal permits will be required for the disturbance to the coastal marine area for any modification of the edge/shore and the discharge structures. Land use consents will be required from the region in relation to the construction of the pipeline across the Avon River. It is also likely that a range of discharge consents will be required during the construction phase to mitigate adverse effects on the environment.

## 7.5 Christchurch District Plans

Although the Proposed Christchurch City Plan was renotified in May 1999, after planning hearing decisions, it is not operative. Therefore both the Proposed and the Transitional District Plan will have to be considered in relation to any activities which take place.

The Proposed Christchurch City Plan does have the greatest status.

### Proposed Christchurch City Plan (May 1998)

The proposed Christchurch City Plan contains objectives and policies related to the management of the effects of activities on the environment. The plan is an effects based plan developed under the RMA, and the therefore rules are developed in order to remedy, avoid or mitigate adverse effects. The zoning of the CWTP and the ponds recognises both the important conservation values of the site and the functional requirement of a waste treatment plan. Therefore, changes to the treatment plant and ponds, and the discharge to the Estuary is consistent with this plan.

#### **Rules**

The areas of rules of most importance to this project are as follows:

- Part 5 Conservation Zones
- Part 9 General City Zones
- Part 11 Health and Safety

#### **Part 5 Conservation Zones**

The existing Christchurch Wastewater Treatment Plant including the ponds, and Linwood Paddocks has been zoned Conservation 1B (Bromley) Zone. The incorporation of the sewage treatment facilities in a conservation zone reflects the fact that a great majority of the land area comprises oxidation ponds. And farmland having significant wildlife values.

#### **Part 9 General City Rules**

Rules relating to this project include:

- 4.4.3 Other utility structures
- 5.1 Rules: Filling, excavation and building adjacent to waterways, the coastline and ponding areas.
- 5.2 Rules: Filling and excavation on other land.
- 5.3 Rule: Content of fill and excavation material

**Part 11 Health and Safety**

Rules relating to this project include:

- 1.3 Specific rules – Noise control
- 3.3 Specific rules – Manufacturing, use, storage and disposal of hazardous substances

**7.5.1 Transitional District Plan**

Under the Transitional District Plan the area of the oxidation ponds, Linwood paddock and the CWTP are zoned Ru2 (Rural 2). The area is also covered under a designation and is identified as a wildlife reserve.

**7.5.2 Conclusions**

Under the relevant District Plans the proposed changes tot treatment and discharge to the Estuary is not inconsistent with the rules. However, there will still be a requirement for various land use consents relating to changes to the ponds and surrounding land. There will also be requirements for land use consents related to the construction and path of the pipeline for an ocean discharge.